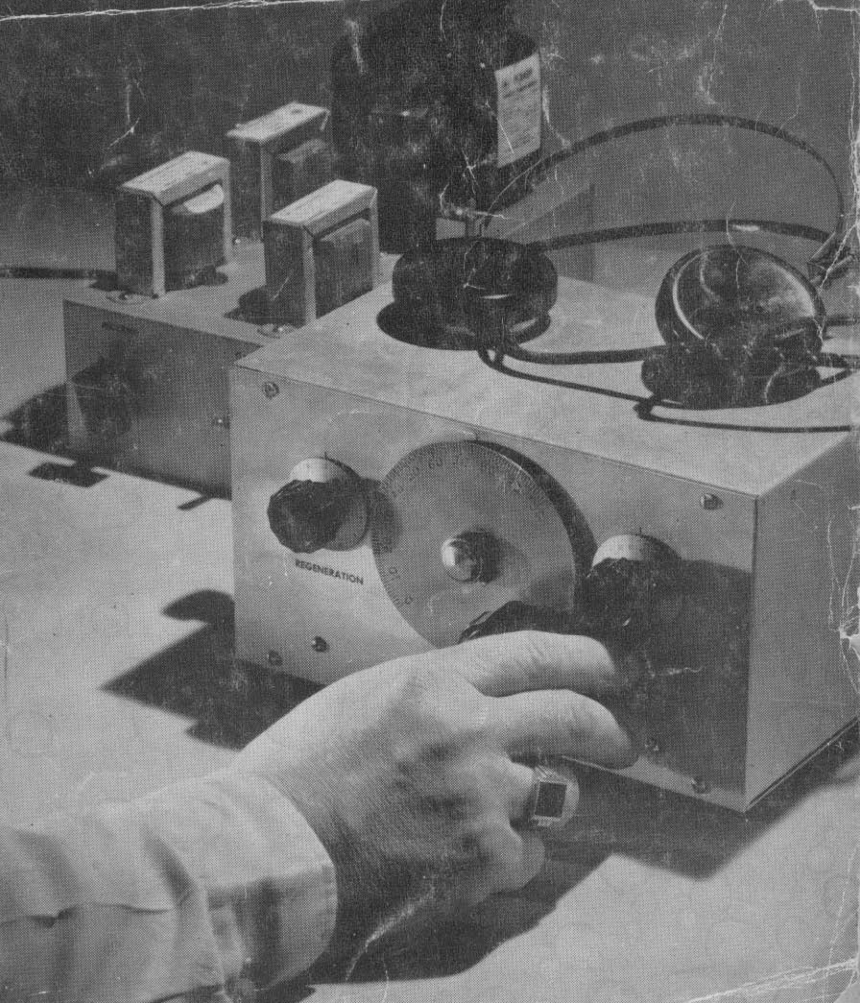
Novice Special Receiver



A Two-Tube Receiver for the Beginner

Now that we've reviewed some of the fundamentals, let's think about building some equipment. There is no better way for you to take an active part in the game, before you have the qualifications to pass your license examination, than to try your hand at building a simple receiver. The cost will be nominal, and most of the components can be used in other equipment. In the process of assembling the receiver, you will learn the fundamentals of the arts of reading circuit diagrams, working metal, and handling the soldering iron.

The receiver shown in the photographs is called a **regenerative** receiver. It is a type of receiver that was used by almost all amateurs many years ago. The communications receivers you see today on dealers' shelves are all of the

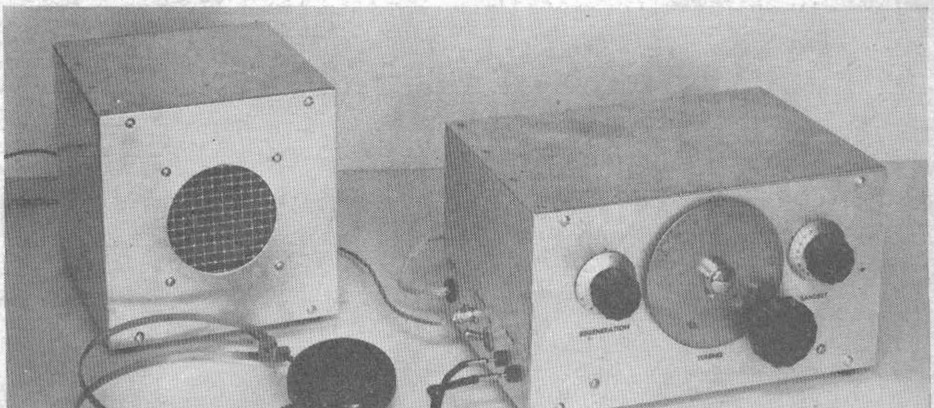


Fig. 1 **— The two-tube beginner's receiver is built into a standard 5 × 6 × 9-inch aluminum box. Panel controls, from left to right, are for regeneration, bandspread tuning, and band-set adjustment. From front to back along the side are phone-tip jacks, loudspeaker switch, speaker jack and power cable. The 3-inch speaker is mounted in a 6 × 6 × 6-inch box.**

superheterodyne type. You will not find the regenerative receiver there except occasionally in kit form, and then not usually designed for amateur work. Nevertheless the regenerative receiver represents a very worthwhile project for the beginning amateur because good sensitivity is obtained with simple circuit and construction. The performance of the receiver described here, on 80 and 40 meters, will compare very favorably with that of the less expensive superheterodynes on the market. You will not have to strain your ears to hear plenty of signals — both in the amateur bands and on frequencies in between the bands. At the right time of day or night, you should find many amateur signals as well as commercial code and shortwave broadcast signals strong enough to work a small loudspeaker with good volume.

Receiver Construction

Cutting the Holes

The receiver is assembled on a 5 × 7 × 2-inch aluminum chassis. The enclosure is a standard 5 × 6 × 9-inch aluminum box. One of the removable covers of the box is used as the panel. The material is quite soft so that holes made with a ¼-inch hand drill can be filed out to the proper size without much difficulty. First locate the center of the hole and mark it with a center punch. Using the punch mark as a center, scribe a circle of the required size with a pencil compass or dividers. Then drill a ¼-inch hole at the center, and file out to the scribed line. In drilling holes larger than ⅛ inch, it is always easier and more accurate to start out with a drill ⅛ inch or smaller and then enlarge the hole gradually with larger drills. A large drill has a tendency to creep away from the center-punch mark. Burrs left around the hole after drilling can be removed with a sharp knife.

The panel should be marked first. If exact duplicate variable capacitors and dial are used, Fig. 3 may be used as a template, fastening it over the panel with Scotch tape. Handle the template carefully so that the chassis template on the reverse side will not be damaged.

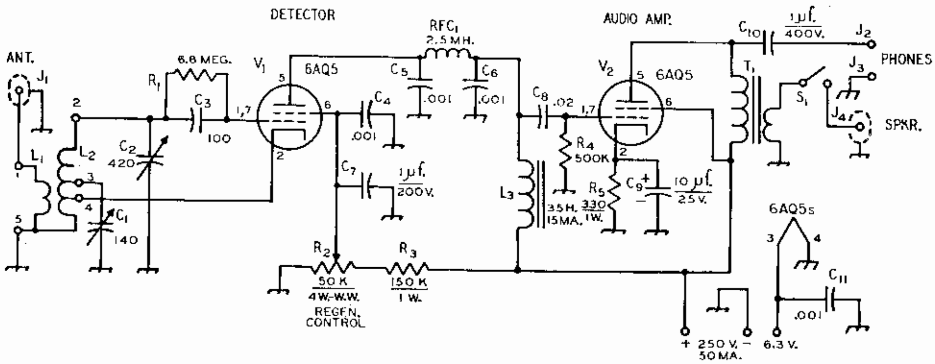


Fig. 2 **— Circuit of the two-tube receiver. All capacitances less than 0.001 µf. are in µµf. All fixed resistors are ½ watt unless otherwise specified.**

C_1 — Bandspread tuning capacitor (Johnson 140R12).
C_2 — Band-set capacitor (Philmore 1945T).
C_3 — Grid coupling capacitor (postage-stamp mica).
C_4, C_5, C_6, C_{11} — R.f. by-pass capacitor (disk ceramic).
C_7 — Minimizes noise from moving contact on R_2 (Aerovox P92ZN).
C_8 — Audio coupling capacitor (Aerovox P92ZN).
C_9 — Audio by-pass capacitor (electrolytic).
C_{10} — Headphone coupling capacitor (Aerovox P92ZN).
J_1 — Antenna connector (phono jack).
J_2, J_3 — Headphone connector (Johnson 105-603-1).
J_4 — Speaker connector (phono jack).
L_1 — Antenna coupling coil (see text).
L_2 — Detector tuned-circuit coil (see text).
L_3 — Audio coupling choke (Thordarson 20C51).
R_1 — Detector grid leak.
R_2 — Regeneration control (Mallory M50MPK).
R_3 — Screen voltage-dropping resistor.
R_4 — Amplifier grid resistor.
R_5 — Amplifier cathode biasing resistor.
RFC_1 — R.f. filter choke (National R-50).
S_1 — Speaker switch (toggle, ¼-inch stem).
T_1 — Output transformer (Thordarson 24S51).

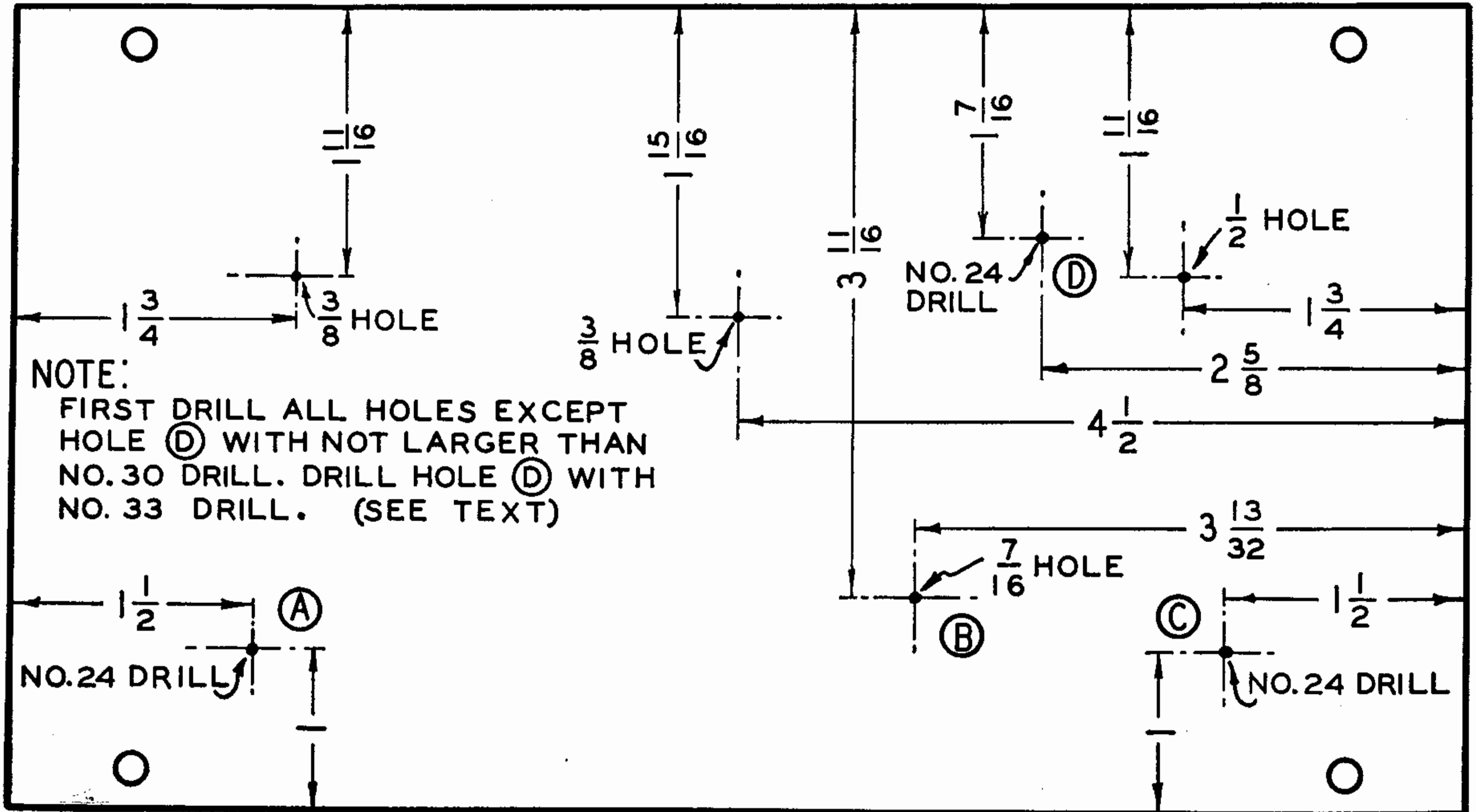


Fig. 3 — **Panel template. Be sure to observe note on predrilling, printed on template.**

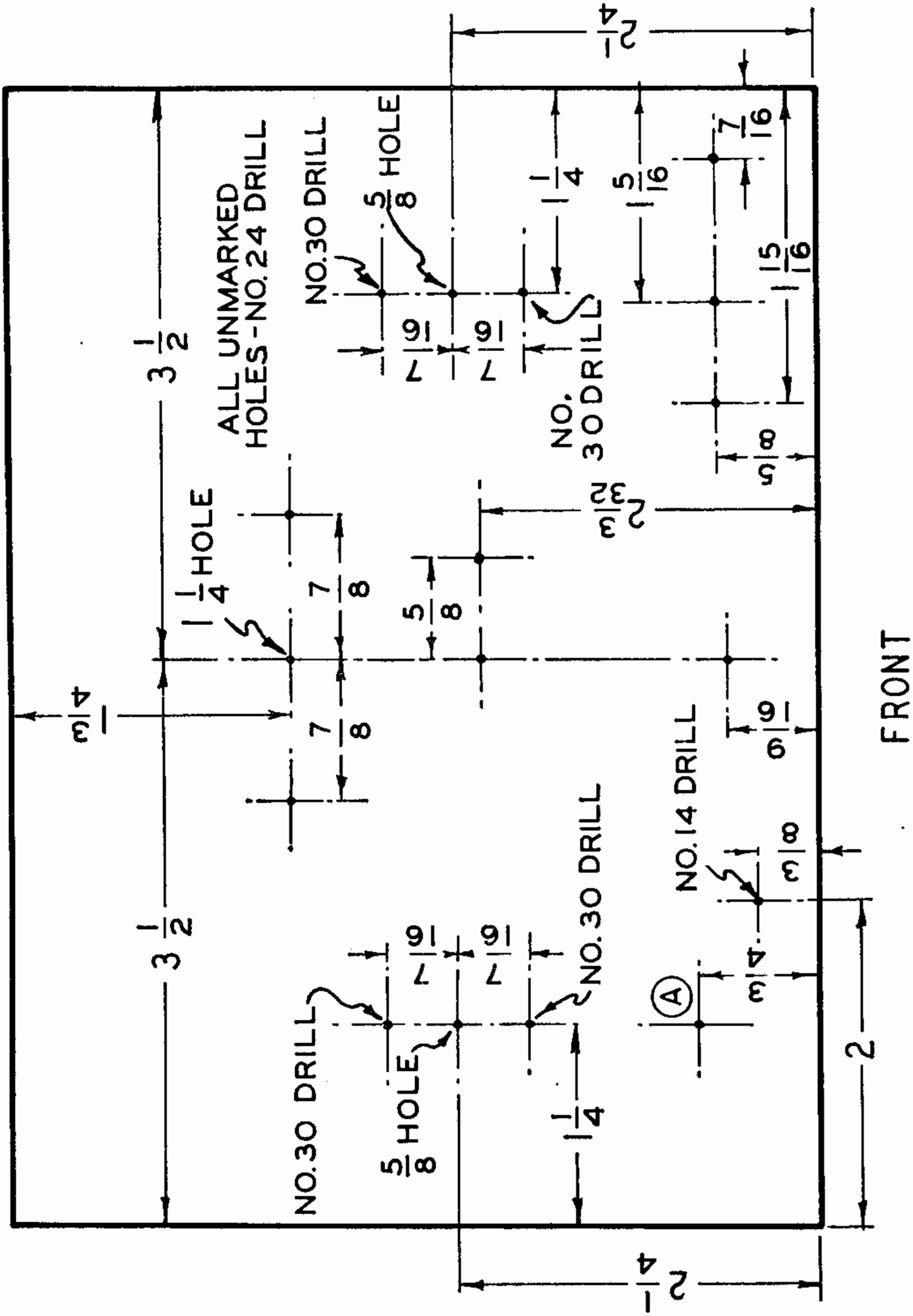


Fig. 4 — Chassis template. See text before drilling chassis.

List of Components Additional to Those Listed Under Fig. 2

2 miniature 7-pin sockets (Eby 9064)
1 ceramic 5-pin tube socket (Millen 33005)
1 5-pin male power plug (Amphenol 86-PM5)
1 3½-inch vernier dial (National type K)
1 1⅝-inch vernier knob (Johnson 116–260)
1 small dial for C_2 (Johnson 116–222–1)
1 small dial for R_2 (Johnson 116–222–2)
1 5 × 6 × 9-inch aluminum box (Premier AC 596)
1 5 × 7 × 2-inch aluminum chassis
About 25 ft. of insulated hook-up wire
6 No. 4–36 machine screws and nuts, ¼ inch long
14 No. 6–32 machine screws, ¼ inch long
10 6–32 nuts
9 soldering lugs (see text)
2 6AQ5 tubes
4 rubber feet
1 rubber grommet for ⅜-inch hole
14 No. 6 sheet-metal screws, ⅜ inch long
Washers (see text)
Few inches of bare wire for ground connections
3 tie points (see text)

Coils As Desired (All Barker & Williamson)

1 MEL-20 (for 80 meters)
1 MEL-10 (for 40 meters)
1 MEL-10 or MEL-20 and 1 3006 (for 20 meters)
1 MEL-10 or MEL-20 and 1 3002 (for 15/10 meters)

After center-punching the hole centers through the template, remove the template, scribe the large holes if they are to be filed out, and drill the hole centers with a drill not larger than ⅛ inch (See note on template, Fig. 3, regarding Hole D.) Place the panel against the front wall of the chassis, with the bottom edge of the panel extending 1/16 inch below the bottom edge of the chassis, and the chassis centered *exactly* lengthwise on the panel. While holding the two securely in this position, mark the chassis through Hole *A*, Fig. 3. Center-punch and drill the chassis. Enlarge the hole in the panel and the one in the chassis with a No. 24 drill.

Fasten the panel to the chassis with a No. 6 screw and nut. Square the panel up with the chassis, and mark the chassis through Holes *B* and *C*, Fig. 3. Remove the panel and center-punch the chassis holes. Drill the hole in the chassis corresponding to *C*, and enlarge this hole and Hole *C* in the panel with the No. 24 drill. Replace the panel, fastening it to the chassis with two No. 6 screws. Drill the chassis through Hole *B*. With the panel still fastened to the chassis, enlarge Hole *B* to proper size by reaming out with succeedingly larger drills or by filing. Remove the panel, and enlarge all of the remaining holes, *except* Hole *D*, to proper size.

Now the chassis can be marked and drilled. While the three socket holes can be made more easily if you can buy or borrow standard socket-hole punches, drilled holes can be enlarged by filing after scribing as mentioned earlier. Although the chassis template of Fig. 4 shows the locations of all holes in the

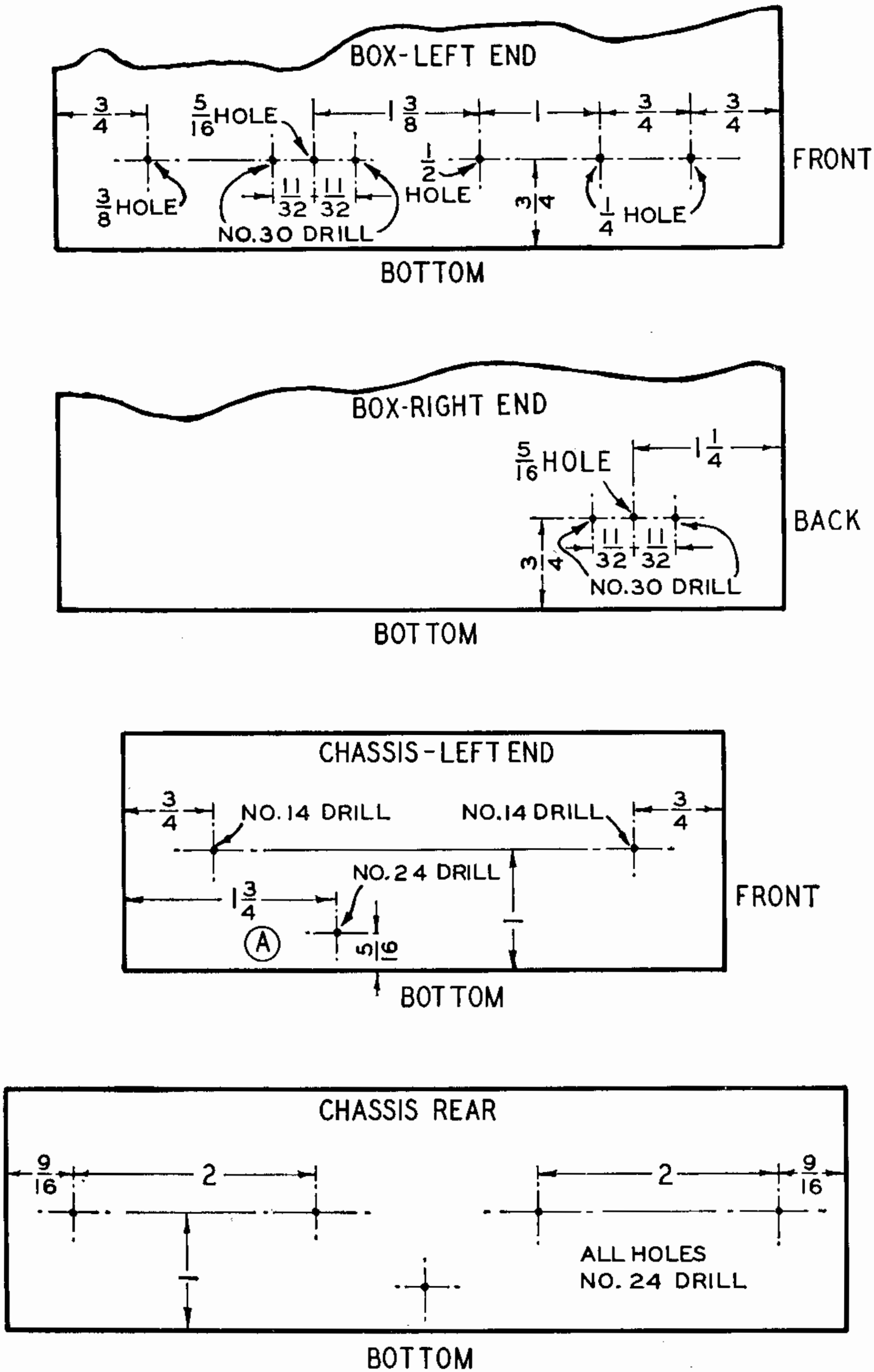


Fig. 5 — Sketches showing drilling dimensions in the edges of the chassis and the box.

top of the chassis, it is safer to use each component itself as a template when possible. The large center holes for the sockets should be made first. Then the sockets can be inserted in the holes and one of the mounting holes marked and drilled. With the socket again in the hole, and fastened with the first mounting screw, the second mounting hole can be spotted accurately through the second mounting hole in the socket. The mounting holes for the coil socket can be similarly spotted on the top of the chassis by inserting the socket upside down in the center hole. The coil socket and the socket of V_1 should be mounted with Pin 1 toward the rear of the chassis. Pin 1 of V_2 should be toward the front. See Fig. 9.

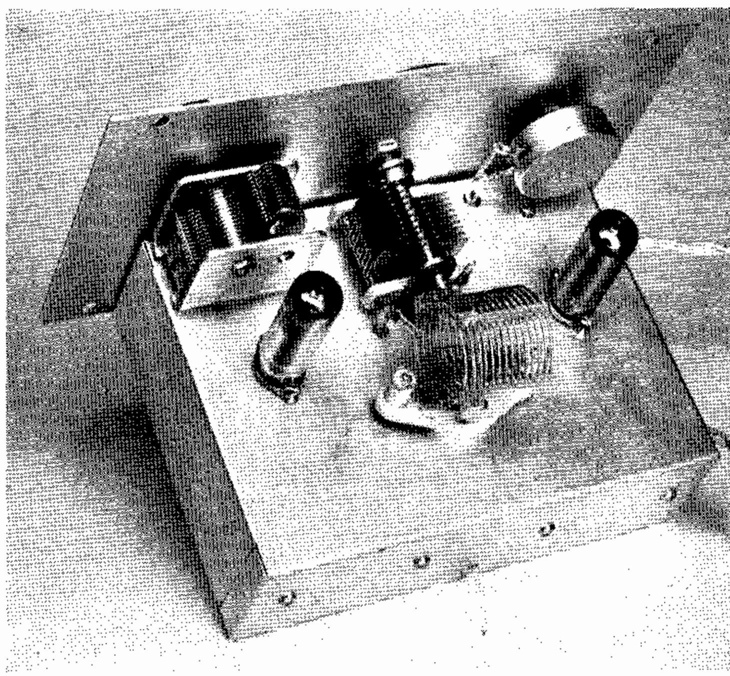


***Fig. 6* — Rear view of the Novice Special with the 80-meter coil in place. The detector tube V_1 is to the left and the audio tube V_2 to the right.**

When drilling the mounting holes for L_3 and T_1, drill one hole first, fasten the unit on the *outside* of the chassis, and mark the second hole.

The sockets for the tubes, and the phono jacks, require No. 4 screws and nuts; all other machine screws are 6-32 (six-thirty-two; No. 6 screw, 32 threads per inch).

After the holes have been drilled in the top of the chassis, the holes in the sides of the chassis and the enclosure box should be made according to the sketches of Fig. 5. Also drill a No. 33 hole in each of the four corners of the bottom of the box, about 5⁄8 inch in from each edge, and a No. 24 hole 1¼ inches from the rear edge, and centered lengthwise on the bottom of the box. In the center of the rear side of the chassis drill a No. 24 hole, 3⁄8 inch up from the bottom. When the drilling is complete, the aluminum can be given a satin finish by immersing it in a solution of grocery-store lye and water, as described in the construction-practices chapter of the ARRL *Handbook*. Panel controls and box terminals can be suitably labeled with decals if desired.

Mounting Components

The variable capacitors and sockets should be mounted first. Some of the mounting screws of these components are used to fasten insulated tie points and grounding lugs. The type of tie point sketched in Fig. 7 is the most convenient. The insulating strip can be cut along one of the dotted lines with

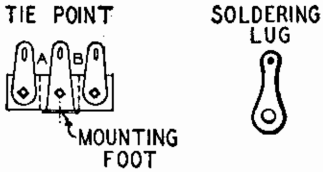


Fig. 7 **— Sketches showing the types of tie points and soldering lugs used in constructing the receiver. Cut the tie points either at A for right-hand tie point, or at B for a left-hand tie point.**

diagonal cutting pliers to form either right-hand (cut at line A) or left-hand (cut at line B) as most desirable.

In mounting the variable capacitors and sockets, view the bottom of the chassis as in Fig. 8. Make sure that the mounting screws for the capacitors are not so long that they protrude through to make contact with the stator plates. These screws should be not longer than ¼ inch. Place a tie point (left-hand) and a soldering lug under the left-hand mounting screw of C_2. Place a tie point (l.h.) under the front mounting screw of C_1, and a soldering lug under the rear mounting screw. Place soldering lugs under each mounting screw of V_1. Place a soldering lug under the front mounting screw of V_2. Place a tie point (r.h.) under the left-hand mounting screw of the coil socket. Place a tie point (l.h.) and a soldering lug under the right-hand mounting screw of the coil socket. Fasten a tie point (r.h.) with a screw and nut at Hole *A*, Fig. 5, and another (r.h.) in Hole *A*, Fig. 4.

Wiring

All references to "ground" indicate connections to the chassis. All other wires must be insulated from the chassis and from each other unless a connection is specifically mentioned. Wire known as "insulated hook-up wire" should be used except for short connections to grounding lugs where small bare wire may be used. View the chassis as in Fig. 8.

Run a wire from Pin 4 on V_1 to Pin 3 on V_2 (see Fig. 9). Lay it flat against the chassis. Connect a 0.001-μf. (C_{11}) capacitor from Pin 1 on V_1 to the nearest ground soldering lug. Connect Pin 3 on V_1 to this lug. Solder the connections on V_1 and the lug.

Solder a wire two or three feet long (long enough to reach the power supply) to Pin 3 of V_2, and run it out through the rear hole in the left-hand side of the chassis. Connect Pin 4 on V_2 to the nearest ground lug. Connect a long power-supply wire to the lug. Solder at the lug and on V_2. Run the long wire out through the rear hole in the left-hand side of the chassis.

Run a wire from Pin 2 on V_1 to Pin 4 on the coil socket (see Fig. 9). Solder both ends. Connect the 100-$\mu\mu$f. mica capacitor (C_3) from Pin 1 of V_1 to the nearest tie point on the coil socket. (Be sure to connect to the insulated terminals of the tie points, and not to the grounded mounting terminals unless so directed.) Connect the 6.8-megohm resistor R_1 (blue-gray-green) also from Pin 1 of V_1 to the tie point. Connect the same tie point to Pin 2 on the coil socket. Solder at V_1 and at the tie point.

Run a wire from Pin 2 on the coil socket through the hole in the chassis near C_2 to the terminal on the side of the capacitor. Solder at both ends. Run a wire from Pin 3 on the coil socket up through the hole at the rear of C_1, to the stator terminal immediately above. Solder at both ends. Solder a 6½-inch length of wire to Pin 1 of the coil socket. Run it directly out through the hole in the rear of the chassis. This is the antenna lead to be connected later to the antenna input jack, J_1. Connect Pin 5 of the coil to the nearest ground lug. Solder at both ends.

Run a wire from Pin 5 on V_1 to the insulated tie point under the mounting screw of C_2. Solder at V_1. Connect a 0.001-μf. (remember "μf" on page 25?) capacitor (C_5) from the insulated terminal of the same tie point to the grounded terminal of the tie point. Connect the r.f. choke (RFC_1) from the insulated terminal of this same tie point to the tie point under the front mounting screw of C_1. Solder connections at the first tie point.

Connect a 0.001-μf. capacitor (C_4) between Pin 6 of V_1 and the nearest ground lug. Solder at the lug. Connect a 7-inch length of wire to Pin 6 on V_1. Run it along the right-hand side of the chassis and thence along the front edge and up through the hole near the front edge. Connect the 1-μf. 200-volt capacitor (C_7) from Pin 6 on V_1 to the ground lug under the mounting screw of C_2. Solder connections at both ends.

On V_2 connect the 500K (we defined "K" on page 22) resistor R_4 (green-black-yellow) from Pin 1 to the nearest ground lug. Solder at the lug. Connect the 150K resistor R_3 (brown-green-yellow) from Pin 6 to the nearest tie point. Connect a long power-supply wire to Pin 6. Run it out through the rear hole in the left-hand side of the chassis.

Placing it as close to the V_2 socket as possible, connect the 1-μf. 400-volt capacitor (C_{10}) between Pin 5 of V_2 and the unused tie point on the coil socket.

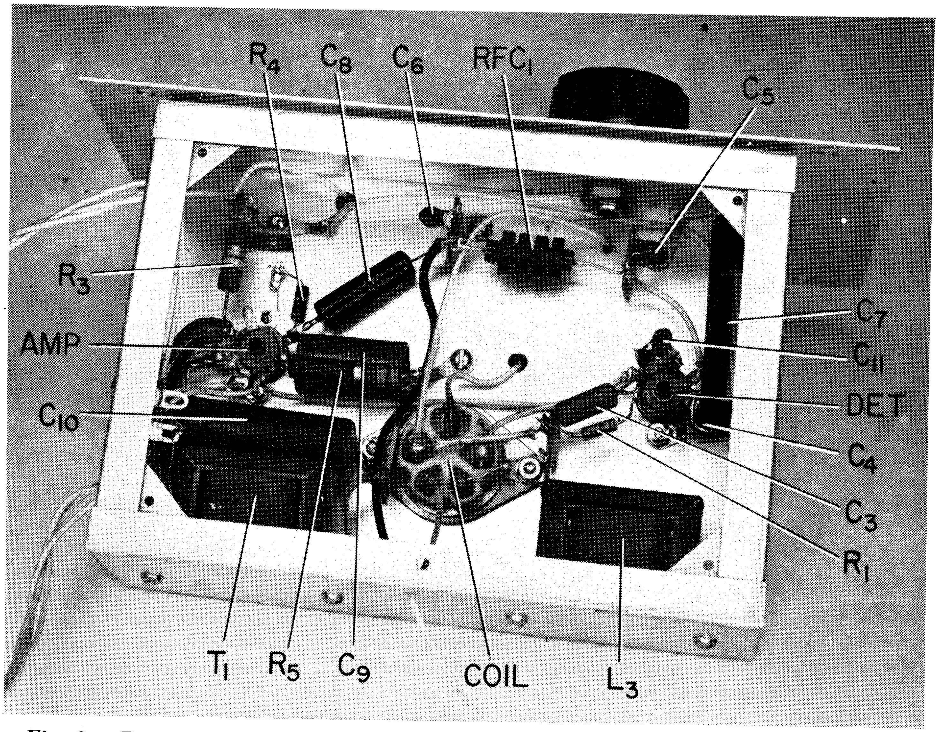


***Fig. 8* — Bottom view of the beginner's receiver. Most of the tie points mentioned in the text can be seen in this view. L_3 is to the right and T_1 to the left.**

Connect a 12-inch length of wire to this tie point. Solder, and run the wire along the rear of the chassis and up the left-hand side of the chassis and out through the front hole in the left-hand side of the chassis.

Now mount the audio choke, L_3. Run its left-hand terminal wire along the rear of the chassis, then up the left-hand side to Pin 6 of V_2. Run the other terminal wire up along the left-hand side of the coil socket to the tie point at the left-hand end of the r.f. choke. Connect a 0.001-μf. capacitor (C_6) from

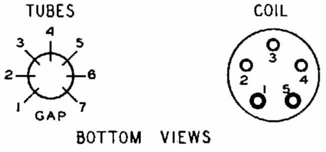


***Fig. 9* — Sketch showing pin numbering for tube and coil sockets in the receiver.**

this insulated tie point to the grounded terminal of the tie point. Solder at the grounded terminal.

Now mount the output transformer, T_1, with the primary terminal wires (red and blue) downward toward the chassis, and its secondary leads (bare) facing you. Place a soldering lug under the right-hand mounting-screw nut. Run the blue terminal wire along the left-hand end of the chassis to Pin 5 on V_2 and solder. Run the red wire to Pin 6 and solder. Connect the right-hand bare secondary wire to the ground lug at the mounting screw, and solder. Connect the other bare wire to the tie point on the left-hand end of the chassis. Solder an 8-inch length of wire also to this tie point. Run the wire along the left-hand wall of the chassis to the hole near the front. Solder a 7-inch length of wire to the ground lug near this hole, and carry the wire out through the hole.

Solder a 1½-inch length of wire to the second ground lug at the point just mentioned above. Run it up through the adjacent hole to the right in the top of the chassis. Solder a 3-inch length of wire to the tie point near these two grounding lugs (the tie point that is already connected to the 150K resistor). Run the wire up through the hole to the right in the top of the chassis.

Connect the 10-μf. 25-volt electrolytic capacitor (C_9) with its positive terminal to Pin 2 of V_2 and its other terminal to the ground lug in front of the coil socket. Also connect the 330-ohm resistor R_5 (orange-orange-brown) between these points and solder at both ends. Connect the 0.02-μf. capacitor (C_8) between Pin 1 of V_2 and the tie point at the left-hand end of the r.f. choke. Solder at both ends.

Mounting the Panel

The size may vary fractionally from chassis to chassis. Therefore, a check should be made before fastening the panel in place to make sure that the panel hole fits the shaft of C_1. If necessary, file the hole out a bit to fit, but no larger than necessary.

The panel must be spaced 1⁄16 inch from the chassis to allow the lower lip of the enclosing box to slide up in between the two. Washers 1⁄16 inch thick should be placed between the panel and chassis over the two mounting screws and the dial-drive bearing. A large hardware-store iron washer will do for the latter. A strip of 1⁄16-inch aluminum, 1⅜ inches wide, running the length of the chassis, top edge flush with the top of the chassis, and having holes corresponding to those in the panel may also be used as a spacer.

Before mounting the panel permanently, connect the three wires protruding from the hole in the top of the chassis to the regeneration-control potentiometer, R_2. As you look at the potentiometer from the rear, with the terminals to the left (see Fig. 6), the bottom terminal should be connected to the wire going to the ground lug underneath the chassis. The center terminal should connect to the wire going to Pin 6 of V_1, and the top terminal to the tie point underneath.

If the shaft bearing of C_1 comes furnished with two mounting nuts, one should be threaded on before the panel is mounted. After the panel has been mounted, the nut should be brought up against the back of the panel. Then

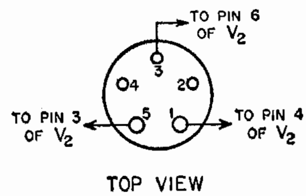


***Fig. 10* — Sketch showing how to connect the power-supply wires to the power plug.**

the second nut should be threaded on so that the panel is clamped firmly between the two nuts. If the capacitor is furnished with only one nut, washers should be placed on the shaft bearing to fill the space between the panel and the frame of the capacitor. The panel should similarly be clamped between two nuts on the bearing of the potentiometer. Adjust the rear nut to space the potentiometer far enough behind the panel to bring the control knob close to the panel.

Turn the plates of C_2 to either maximum or minimum capacitance and, through Hole D drill a hole in the frame of C_2 with a No. 33 drill. Enlarge Hole D (in the panel but not in the capacitor frame) with a No. 24 drill. Place small washers to fit snugly between the panel and the capacitor frame, and thread a 3/8-inch No. 6 sheet-metal screw into the frame of the capacitor. This will brace the capacitor against the panel for additional stability.

The vernier drive for the tuning dial should be pressed onto the rim of the dial before mounting. Then, as the shaft of the vernier drive is inserted in its bearing, the dial should be simultaneously slid onto the shaft of C_1. The dial should be set so that it reads 100 when C_1 is at minimum capacitance. The dial on C_2 should be carefully set also to read 100 when the capacitor is at minimum. In Fig. 1, a Johnson type 116–260 knob has been substituted for the one originally supplied, not only because its larger diameter makes tuning easier, but also because it matches the two smaller dials.

The Enclosure

At the left-hand end of the box the two holes nearest the front are for the insulated phone-tip jacks (J_2 and J_3). (The Johnson jacks require no additional insulation in mounting. Other types may require a larger hole to take insulating washers.) The next one is for the toggle switch, S_1. The fourth hole is for a phonograph connector (J_4) used here as a jack for a loudspeaker. The last hole is fitted with a rubber grommet and the three power wires are brought out through it.

The three wires protruding from the hole near the front of the left-hand end of the chassis should be connected to terminals inside the box before the receiver is placed in the box. There should be enough slack in these leads to reach to the box terminals when the receiver is moved, left-end on, close to the box. The wire that is connected to the ground lug underneath the chassis should go to either of the phone-tip jacks. The wire connected to the tie point near the output transformer T_1 should go to the nearest terminal on the toggle switch. The remaining wire should be connected to the remaining phone-tip jack. A short wire should connect the remaining terminal of the toggle switch to the center terminal of the phono jack. Run the three power-supply leads out through the hole in the side of the box, and connect them to a male power plug (Amphenol 86-PM5), as shown in Fig. 10.

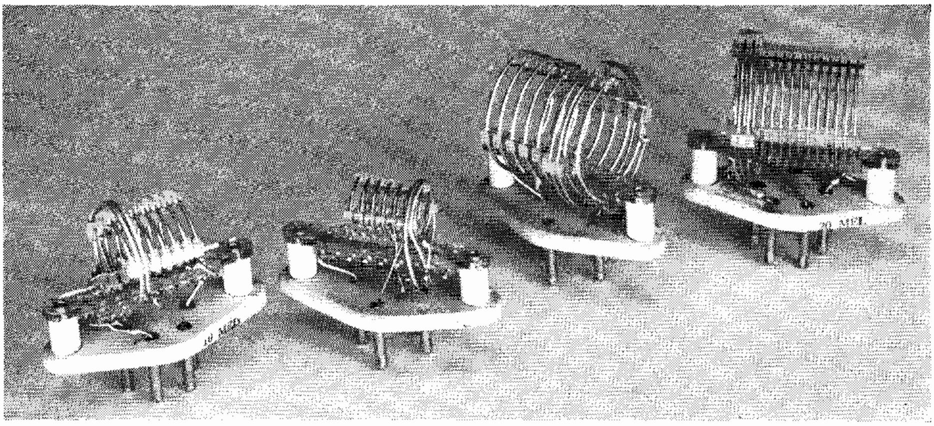


***Fig. 11* — A complete set of four plug-in coils for the two-tube regenerative receiver. From left to right, they are for the 20-, 15/10-, 40-, and 80-meter bands.**

A second phono jack is mounted in the hole at the other end of the box to serve as an antenna terminal. The single wire protruding from the rear side of the chassis should be soldered to the center terminal of this jack after the receiver has been placed in the box.

The receiver cannot be placed in the box, nor removed from it, unless the tubes and coil have been removed. Also, be sure to turn C_2 to maximum (plates completely meshed) so that the rotor plates will not be damaged by the lip of the box. Fish the power leads out through the hole in the side of the box and take up the slack inside the box as the receiver is put in. Keep the receiver high enough to clear the bottom lip of the box until the receiver is all the way in. Then push the panel downward as the lip goes up into the space between the chassis and the panel. The panel should be fastened in place with sheet-metal screws.

Now turn the box upside down and fasten rubber feet in the four corner holes with sheet-metal screws. Then, through the remaining hole, drill a No. 33 hole into the rear lip of the chassis, holding the chassis firmly against the bottom of the box. Fasten the rear of the chassis down securely with a sheet-metal screw.

Making the Coils

The B&W type 20 MEL coil (14 turns No. 18, 1⅜ inches diameter, 1⅜ inches long, 2-turn link 1⅝ inches diameter), which is used for 80 meters, has five pins, one of which originally has no connection (Pin 3). Examination of the pin connections will show that the outer end of the coupling-link coil goes to Pin 5 (see Fig. 9). The inner end of the link goes to Pin 1. The ends of the main coil go to Pins 2 and 4. The end going to Pin 4 should be cut off flush with the ceramic base with a sharp knife or a hacksaw blade. The end of the coil should then be bent around and soldered to the end of the link wire going to Pin 5.

Hold a soldering iron against the tip of Pin 4 and allow it to get reasonably hot. Then give the coil assembly a quick flip of the arm. This should eject the wire stub left in the pin, or at least bring it out far enough so that it can be pulled out with pliers on the next heating. Repeat the flipping process if necessary to clear the pin of solder so that a piece of bare wire can be fed up through the pin. Let the wire extend about an inch above the ceramic base, and solder it at the end of the pin. Cut the wire off close at the end of the pin, and file the solder to resemble the other pins. A second similar wire should be soldered to Pin 3.

Carefully bring the wire from Pin 4 under the coil, bending it so that it does not make contact with either the link coil nor the leads going to Pin 5, and solder it to the main coil a little less than one turn from the outer end of the coil. This will be on the outer turn, about ¼ inch to the right of the bottom plastic supporting strip as viewed from the link end. Cut off any excess length of tap wire after soldering to the coil.

The connection to Pin 3 will depend on how much of the 80-meter band you want to cover. If you want to cover the entire band, simply solder the wire from Pin 3 to the end of the main coil connected to Pin 2. However, if you are interested for the time being in only the Novice band, this band can be spread out over most of the dial, thereby making tuning much easier for a beginner. This can be done by connecting the wire from Pin 3 to the main coil at a point a little over four turns from the Pin-5 end of the coil. The tap should be placed on the fourth turn, about halfway between the bottom and side plastic strips. Be sure to do the job carefully so that the solder does not short from one turn to another. The 40-meter band will also be spread out over most of the dial with this tap.

Coils for Other Bands

A B&W 10-MEL coil (8 turns No. 16, 1⅜ inches diameter, 1⅜ inches long, 2-turn link 1⅝ inches diameter) is used for 40 meters. It is altered exactly as described for the 80-meter coil. The lead from Pin 4 is connected to the outer turn in the same manner, except that it is placed at about ¾ turn from the end — just below the right-hand plastic support strip. In other words, it is about ¼ inch farther up on the end turn than the 80-meter tap. The tap from Pin 3 should be placed a little over four turns from the Pin-5 end of the main coil, again about halfway between the bottom and side plastic support strips.

Attempts to use the MEL coils for 20 and 15 meters will not be very successful. The placement of the taps is too critical. The best way to make coils for these bands is to buy a couple of extra 10-MEL or 20-MEL coils and use the mounting base to support smaller coils of B&W Miniductor. If the original coil is stripped from the mounting carefully, the job can be done quite easily.

Hold the coil upright with Pin 3 facing you. You will see that the wire coming out of Pin 4 doubles back to start the first turn of the main coil. Follow this turn up on the coil and cut it just before it reaches the top supporting strip.

Now turn the coil so that Pins 1 and 5 face you. You will see that the wire from Pin 2 starts the first turn at the opposite end of the main coil. Clip this turn just under the side supporting strip. At the other end, you will see that the wire from Pin 5 starts the outer turn of the link coil. Turn the coil over so that Pin 3 faces you and cut this turn about halfway between the bottom and side supporting strips. Cut the wire from Pin 1 off close to the point where it enters the bottom supporting bar.

Bend the stubs of the cut wires out where you will not be likely to cut them off accidentally, then cut off all other turns as close to the bottom supporting strip as possible, removing both the main coil and the link coil. Be sure that you do not cut off the wire from Pin 4 at the base. Free this half turn after the others have been cut.

For the 20-meter coil, make a coil of exactly 7 turns of No. 3006 Miniductor (5/8-inch diameter, 8 turns per inch). Place it on the plug-in base with the supporting strip at which the coil turns end against the supporting strip on the base. Cement it centrally on the base strip with Duco cement. After the cement has dried, bend the lead from Pin 2 toward the nearest end of the coil, and solder it to the end turn, close to the bottom supporting strip. Bend the wire from Pin 5 and solder it to the other end turn of the coil. Keep the wire from Pin 5 in as close to the bottom supporting strip as possible. The lead from Pin 4 should be bent into such a position that it can be soldered to a point two turns from the nearest end of the coil without shorting on the wire from Pin 5. The soldering point should be about halfway between the bottom and side supporting strips. A wire soldered to Pin 3 should be brought out and soldered to the same point on the coil.

For L_1, two turns of insulated hook-up wire should be wound over the coil, as close as possible to the Pin-5 end. These turns will pass between the bottom supporting strip and the ceramic base. Solder the outer end of this coil to the end of the main coil going to Pin 5. Solder the other end of the link coil to the wire going to Pin 1.

The 15-meter coil is made in the same way. It consists of 7 turns of No. 3002 Miniductor (1/2-inch diameter, 8 turns per inch). The tap from Pin 4 is soldered on the coil at 2 turns from the nearest end. A wire from Pin 3 should be soldered to the coil at one turn from the same end. Make sure that each lead is clear of all others. The link coil, L_1, is the same as for the 20-meter coil.

Receiver Power Supply

The receiver requires a power supply delivering approximately 250 volts at 50 ma. The diagram of Fig. 12 shows a suitable circuit. However, at only slight additional cost, a transmitter power supply can be built that will also take care of the receiver, offering a considerable saving in over-all cost and labor. Such a combination supply is described in detail on page **73.** If the

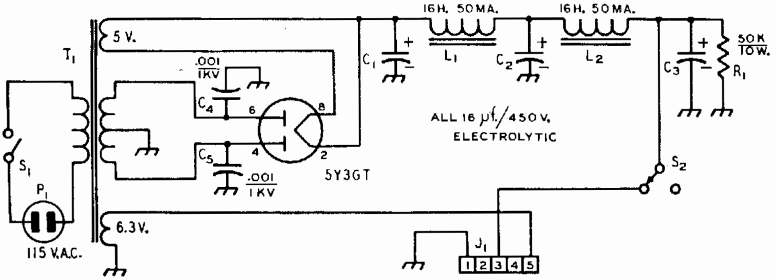


Fig. 12 **— Circuit of a simple power supply for the regenerative receiver. All capacitances are in μf.**

C_1, C_2, C_3 — Filter capacitors.
C_4, C_5 — R.f. by-pass capacitors to reduce tunable hum (disk ceramic).
J_1 — Power outlet (5-prong tube socket — Amphenol 77MIP5).
L_1, L_2 — Filter choke, 16 h., 50 ma., 580 ohms (Stancor C-1003).
S_1 — A.c. power switch (s.p.s.t. toggle).
S_2 — High-voltage switch, bakelite rotary (to mute receiver while transmitting — Centralab 1401).
T_1 — Power transformer) 480 volts, c.t., 55 ma.; 5 volts, 2 amps.; 6.3 volts, 2 amps. (Stancor PC-8402).
R_1 — Bleeder resistor (to discharge filter capacitors — a safety measure).

simple supply diagrammed in Fig. 12 is built, its construction can follow the general lines of the combination unit. The three power wires from the receiver should be connected to a 5-pin plug (Amphenol 86-PM5) as shown in Fig. 10.

Antenna

A 75-foot length of wire makes a good antenna for the receiver. Shorter lengths may be used. In fact, the shorter the antenna the more stable the receiver will be, and good signals should be obtained with a 15-foot indoor wire. In any event, the antenna should be suspended as rigidly as possible to minimize swaying. A phono plug to fit the antenna jack should be soldered to the inside end of the antenna. The antenna lead should be kept as much as possible to the rear of the receiver, away from the operator.

Tuning the Receiver

Band-Set Capacitor

The centering of the amateur bands on the dial of C_1 will depend upon a rather critical setting of C_2. However, once the correct setting has been found and recorded, it can be returned to with reasonable accuracy. Since it is anticipated that the receiver's principal use will be on 80 or 40 meters, there will be little occasion for frequent hopping from band to band. Approximate settings for C_2 will be given. Individual copies of the receiver may require slight readjustment, in one direction or the other, in order to center the band on the dial. These readjustments should be made in very small steps — perhaps not much more than the width of a pencil line on the dial at the higher frequencies. The amateur bands can be most easily recognized by the phone signals, and the bands can be centered in reference to them.

80-Meter Coil

The 80-meter coil can be used with the bandspread tap at either of two points. In either case, the total frequency range (from maximum on both C_1 and C_2 to minimum on both) will be approximately 3.2 to 11.5 Mc. When the tap is connected to the extreme end of the coil, the entire 80-meter band will be covered by C_1 when C_2 is set at approximately 14.5. (Remember that each calibration mark on the small Johnson dial is 2 points, so that 14.5 means 14 plus one quarter of the way to the next dial mark.) When C_2 is set at approximately 57.5, the 40-meter band will occupy about 10 per cent of the dial.

If the bandspread tap is set as described on page 55 for the Novice band only, C_2 should be set at about 4.5. When C_2 is set at about 57.5 with the Novice bandspread tap, the 40-meter band will occupy about 50 per cent of the dial of C_1.

40-Meter Coil

Better stability and greater bandspread will be obtained on 40 meters by using the coil designed for 40 meters, rather than the 80-meter coil as described above. The total frequency range with this coil is approximately

6 to 23 Mc. With C_2 set at about 22, the 40-meter band should occupy about 80 per cent of the dial of C_1. If C_2 is set to approximately 74, 20-meter signals may be heard, but the entire band will occupy only about 10 per cent of the dial.

20-Meter Coil

The total range with this coil is about 10 to 39 Mc. When C_2 is set at about 47.5, the 20-meter band should occupy approximately 70 per cent of the dial of C_1. By setting C_2 to about 72.5, signals in the 15-meter band can be heard, but the band will spread out over only about 20 per cent of the dial of C_1.

15-Meter Coil

The total frequency range covered with the 15-meter coil plugged in is about 11 Mc. to 40 Mc., but the regeneration control will be rather critical and not too reliable at the high-frequency end of the range. With C_2 set at 56.5, the 15-meter band will occupy about 80 per cent of the dial of C_1. With C_2 set at approximately 74.5, the 10-meter band will occupy about 70 per cent of the dial of C_1. With C_2 set at 30, the c.w. portion of the 20-meter band will occupy practically the whole dial of C_1. By resetting C_2 to a slightly higher reading, the phone portion of the band will be likewise spread out over most of the bandspread dial.

The Regeneration Control

With the power supply, antenna and headphones connected, plug in the 80-meter coil. Turn the regeneration control, R_2, all the way counterclockwise, and set C_2 as indicated previously, depending on whether or not the Novice bandspread tap is used. A minute or two after the power supply has been turned on, advance the regeneration control slowly until the detector goes into a soft hiss as it starts to oscillate. Reverse rotation of the regeneration control, and the hissing should stop. Go back and forth over this point several times so that you may familiarize yourself with the sound. See how close you can come, in advancing the control clockwise, to the point where the hissing starts without actually making the hiss start. If you listen carefully, you will hear the background noise come up (in the absence of a signal). This is the most sensitive adjustment for modulated (phone) signals. Now turn the control clockwise past the point where the hissing starts. Reverse the direction and slowly approach the point where the hissing stops. See how close you can get to this point without making the hissing stop. This is the point for greatest sensitivity on c.w. signals. Strong c.w. signals will block the detector when it is adjusted for this most sensitive condition. In this case, turn the control clockwise as far as necessary to prevent blocking. On some of the higher frequencies, advancing the control too far may result in a high-pitched squeal. If this should occur, the control should be retarded. On the higher frequencies, changing the setting of the regeneration control will have some effect on the frequency, so it may be necessary to readjust C_1 slightly to keep the signal in tune.

An antenna that happens to be resonant at the listening frequency may load the detector so that it will not oscillate. These "dead" spots can usually be eliminated by inserting a 50-$\mu\mu$f. variable capacitor in series with the antenna and setting it at a point that permits oscillation. Dead spots should not occur in any of the amateur bands with the 75-foot antenna, although some will probably be found in between the bands.

You should find plenty of signals at the right time of day or night that are strong enough to work a small loudspeaker connected to the speaker jack. One of the speaker leads should be connected to the pin of the phono plug, and the other to the outside shell of the plug. The receiver has an output transformer so, of course, none should be at the speaker.

The detector should go into oscillation at screen voltages from 15 to 50. At 250 volts, the total current drain should be about 45 ma.

The frequency stability of this receiver on the amateur bands above 7 Mc. will probably not be considered good enough for regular station use on c.w. It will, however, be found entirely adequate on phone signals where high stability is of less importance.

How the Receiver Works

The Tuned Circuit

Referring to the diagram of Fig. 2, the signal from the antenna is coupled into a tuned circuit by means of the coupling coil L_1. The tuned circuit is made up of the coil L_2 and the two variable capacitors C_1 and C_2. This tuned circuit is connected to the input circuit of the detector tube. It is the part that selects the frequency on which you want to listen. The frequency that it selects will depend upon the size of the coil L_1 (inductance) and the size of the capacitor (capacitance) connected across the coil. The larger the inductance, capacitance, or both, the lower the frequency will be that is selected. If we wish to tune the circuit over a range of frequencies, we must make provision for varying the values in the tuned circuit. Although either the inductance or the capacitance could be varied with the same result, it is easier mechanically to provide a variable capacitance than to make the inductance variable. Therefore, a fixed value of inductance is used, and the frequency is changed with a variable capacitor. Inductance also is changed when a large change in frequency is necessary, such as in going from one amateur band to another. In this receiver the change is made by a series of plug-in coils.

The tuned circuit will tune to the same frequency with any size of coil and capacitor provided that the product of capacitance and inductance ($L \times C$) remains the same. The coil can be large and the capacitor small, or vice versa, or any other combination might be used where the inductance times the capacitance gives the same product. However, there may be reasons that make certain combinations of inductance and capacitance more desirable than others.

Frequency Stability

In the tuned circuit of this receiver, a comparatively large amount of capacitance is used for the purpose of **frequency stability** Frequency stability is the ability of a circuit to remain tuned to the same frequency, once the operator has tuned the circuit to that frequency. There are several things that may change the frequency of the tuned circuit without the operator touching the tuning control. Movement of the antenna as it swings in the wind, or movement of the operator's hands around the receiver have the most noticeable effects. Most of these changes not under control of the operator are in the nature of changes in capacitance in the circuit. Therefore, if a large amount of capacitance is used in the tuned circuit, the uncontrollable changes are reduced to a small percentage of the total capacitance in the circuit and their effects are minimized.

C_2 provides most of the capacitance. It is made variable so that the capacitance can be adjusted to the maximum practicable for each of the amateur bands. It can also be used to adjust the tuning range to frequencies outside the amateur bands for the reception of commercial code signals and shortwave broadcasts. C_2 is adjusted by the small dial on the right-hand side of the panel.

Bandspread

All variable capacitors of conventional type go through their complete range of capacitance with one half revolution of the control shaft. If a capacitor with a large range of capacitance, such as C_2, is used, it will cover so many frequencies that it will be very difficult for the operator to adjust the capacitor to select any one frequency he may desire. C_2 is therefore used only to adjust the circuit to the approximate vicinity of the group of frequencies (an amateur band, shortwave-broadcast band etc.) where the operator wants to listen. Then a smaller group of frequencies in this vicinity is covered more slowly by another variable capacitor, C_1, with a smaller range of capacitance. This is called the **bandspread** capacitor, and is controlled by the large dial at the center of the panel. The tuning rate can be slowed down still more by connecting the bandspread capacitor across only a portion of the coil, as shown in Fig. 2. Adjustment to the desired signal is made still easier by the friction reduction control (vernier) on the dial, which permits several revolutions of the control knob while the capacitor rotor is making its half revolution.

The Detector

V_1 is the detector tube. The detailed action of the detector is highly complex because it performs several functions simultaneously. It amplifies the signal in the form that it arrives at the antenna (one or more radio frequencies). In this detector, **regeneration** or **feedback** is introduced by connecting the cathode (Pin 2) to a tap on the coil. This provides a means of feeding the amplified r.f. signal back to the grid so that it can be reamplified in the tube, thus increasing the total r.f. amplification through the tube many times. If the incoming signal is modulated (phone) it also extracts the audio information from the amplified r.f. signal. If the incoming signal is not modulated, the regenerative detector can be adjusted (made to oscillate) so as to make the incoming signal have the characteristics of a modulated signal, and then handle it as such and deliver an audio signal in the output.

C_3 and R_1 are necessary for proper operation of the detector. R_2 controls feedback by varying the screen voltage. R_3 drops the supply voltage to a value suitable for proper control of feedback by R_2. RFC_1, C_5 and C_6 comprise an r.f. filter to keep r.f. from the grid of the following amplifier tube, V_2.

L_3 is an audio coupling choke. It has low d.c. resistance so that the plate voltage may be fed to the detector tube without loss. C_7 is an audio coupling capacitor that insulates the grid of V_2 from the detector plate voltage, yet it allows audio frequencies to reach the grid of the audio-amplifier tube.

Audio Amplifier

The audio-amplifier tube is biased by the d.c. voltage drop across R_5. Audio frequencies are bypassed around R_5 by C_9. R_4 provides a d.c. path for the biasing voltage to the grid.

The primary of the output transformer T_1 serves a purpose similar to L_3 in the output of the detector. The transformer also provides a means of coupling to the voice coil of the loudspeaker. C_{10} stops the flow of d.c. to the headphones, but permits audio frequencies to reach the headphones. S_1 turns the speaker on and off by closing or opening the circuit to the voice coil.

Interpreting What You Hear

Now that you have finished building your receiver (or have bought or borrowed one) and mastered its operation, you're in for the indescribable thrill of receiving many kinds of signals you've never heard before. Within the range of this receiver you will hear voice signals from radiotelephone stations (usually called "phone" by hams — the regular telephone becomes "landline" in ham lingo!), signals in the International Morse Code (referred to as "c.w.", an abbreviation of "continuous waves"), time signals which go "beep-beep" or which have a steady tone with a clock-like ticking mixed in, and several types of automatic sending equipment which are unreadable without special apparatus.

The phone stations won't pose too many problems to the beginner although you may be confused at first by the technical subjects often discussed or by the use of phonetic words to identify letters of the alphabet. (For instance, to avoid confusion an amateur station might say, "This is W1AW, W 1 Adam William".) A recommended "phonetic alphabet" is shown on this page. Otherwise, good operators use a minimum of abbreviations — best practice on phone is to "say it with words."

ARRL Word List for Radiotelephony

ADAM	JOHN	SUSAN
BAKER	KING	THOMAS
CHARLIE	LEWIS	UNION
DAVID	MARY	VICTOR
EDWARD	NANCY	WILLIAM
FRANK	OTTO	X-RAY
GEORGE	PETER	YOUNG
HENRY	QUEEN	ZEBRA
IDA	ROBERT	

Example: W1AW . . . W 1 ADAM WILLIAM . . . W1AW

When you get down to the serious business of learning the code, required by international law for amateurs the world over, you'll want to try copying some code stations through your own receiver.

Call signs are quite readily identifiable, since they are usually repeated several times, so it is probable that they will be the first symbols you can recognize from the jumble of dits and dahs emitting from your receiver.