BUILDING THE RECEIVER

THE construction of the receiver should be started as soon as one begins to learn the code. Building the receiver gives one a familiarity with radio parts and construction, and the finished product will enable the operator to boost his code speed by listening to short-wave amateur and commercial stations. The experience gained in tuning different stations will stand the operator in good stead when he obtains his license and starts actual two-way communication with other amateur stations.

While almost every amateur builds his own transmitter, many of them buy factory-built receivers because the complex multi-stage receivers can be had from dealers for little more than the cost of the components. You may prefer to buy your receiver, new or second-hand, or to assemble a simpler one from one of the kits on the market. However, we are going to describe one that you may build yourself because it is easy and cheap to do, and thereby you will learn a great deal about how radio works — information that will always be useful to you.

The receiving sets we describe are of simple design and are quite inexpensive. They are easy and straightforward to assemble and operate and, with a suitable antenna and ground, are capable of bringing in amateur and other short-wave signals from distant places. The two receivers are practically identical from an electrical and operating standpoint, but the mechanical features have been made different to illustrate methods of construction. The receivers can be used either with standard metal tubes or, for portable and other operation where batteries must be used with the octal-base battery tubes. Thus the receiver can serve as the station unit and also as a battery-operated portable when the occasion arises, although the performance with the metal tubes is better, because of the improved characteristics of the tubes.

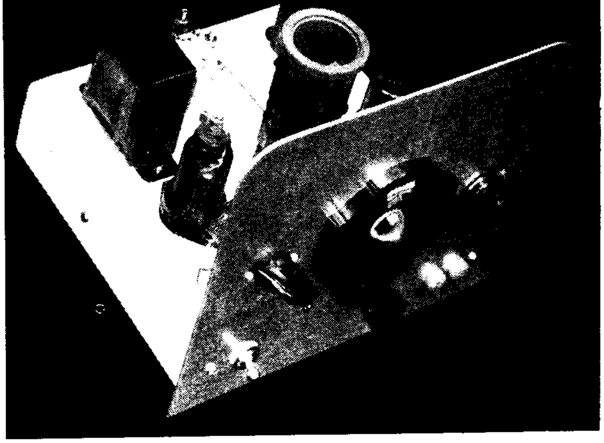

Fig. 6 — A view of the completed wood/metal version, with a coil in place in the socket.

In describing these units, as well as the others which follow, the use of picture diagrams has been avoided. One reason for this is that such diagrams are not acceptable in license examinations, the use of standard symbols being compulsory. A second reason is that the schematic diagrams, once understood, are far less confusing

In the construction of any piece of amateur gear the skilled constructor can often take great liberties in choice of equipment. This ingenuity often results in increased efficiency, particularly as the individual becomes more adept in workmanship and more proficient in the art. While this is a healthy condition and one to be encouraged, it can hardly be recommended for the neophyte just breaking into the game. The beginner will do well to abide by the layout and choice of parts recommended by the editors. The apparatus has been selected carefully and assembled into foolproof circuits to cause the least amount of perplexity to one who may be constructing his first piece of radio apparatus.

To one just being initiated into the mysteries of any science, it seems that no descriptions, regardless of how elementary or comprehensive, can be sufficient to answer all the questions that come up. After giving this much consideration, we think that a happy medium has been struck, with just the essentials to accomplish the purpose, striving not to be overlengthy and thus possibly disconcerting. One who is sufficiently intrigued and who wishes to delve further into the fascinating hobby of amateur radio will find a wealth of information in a companion book, *The Radio Amateur's Handbook*.

The apparatus described in these pages is neither the simplest that may be constructed to serve the purpose nor the most elaborate that might have been followed; it is the most logical and foolproof. The degree of success to be attained will depend upon the care in construction, the final tuning of the equipment and operation, and the actual location of the station and antenna system. The gear was constructed in the A.R.R.L. laboratory especially for this book, after a thorough investigation of the problem. The finished products were used in actual communication and performed up to expectations from a location and with an antenna system that were anything but ideal. Our fondest hopes will be realized if this book helps in successfully introducing new followers to this hobby of ours — one which is not only a source of personal gratification and enjoyment but also of inestimable public value in time of community emergency.

than picture diagrams. A list of the more generally used symbols is given on page 41.

The receivers shown here will enable you to tune in on practically all the useful high frequencies (short waves) so that you can hear stations at almost any hour of the day or night. Many of them will be sending slowly, giving plenty of opportunity for code practice. To cover the wide frequency range, a number of interchangeable or "plug-in" coils are used in the receiver, but these are not difficult to make or adjust.

General views of the receivers are given in Figs. 6, 7, 8, 10, 11, 12, 13 and 15, and the circuit diagram is shown in Fig. 9. A complete list of the parts needed is given, and the symbols (C_1, etc.) identify the parts as shown in Fig. 9 and the various photographs. There is no difference between the two receivers other than that one is mounted on a wooden base and the other on a metal one. The metal one can be used in conjunction with a metal cabinet, or, if desired, a wooden cabinet might be built for the wood-metal version.

Before actually deciding which receiver to build, it might be a good idea to explain just how they work. When a radio wave strikes the antenna, a very small current flows in the circuit formed by the antenna, the coil L_2 and the ground connection. This current causes a radio-frequency voltage to be induced across L_1. The tuning condensers, C_1 and C_2, are adjusted so that the circuit is *resonant* with (or tuned to) the same frequency as the signal, so that other waves of different frequency which may strike the antenna will be discriminated against, or "tuned out." The radio-frequency voltage so developed is applied between the grid and cathode of the detector tube through the grid condenser, C_4, across which is connected the grid leak, R_1; and is "detected" or made audible by the action of the grid condenser and leak and the grid circuit of the detector tube. The radio-frequency voltage at the grid of the tube also causes a radio-frequency current to flow in the screen-grid circuit through L_3 and C_5 to ground (the wire to which the −B connections are made, and which in turn is grounded as indicated by the "Gnd." post on the diagram) and thence to the cathode. The radio-frequency current flowing through L_3 ("feedback") causes a further voltage to be induced in L_1 which reinforces the original signal. The amount of feedback or regenerative amplification is controlled by the setting of R_4, which controls the screen-grid voltage and hence the amplification. When the feedback reaches a certain critical value the detector tube will generate oscillations of its own and further amplification ceases. The most satisfactory way to operate the tube is to set R_4 just below the point at which the detector tube starts to oscillate, if modulated signals such as those from a radiotelephone are being received, and just beyond the oscillating point if continuous-wave telegraph signals are to be picked up. In the latter case the oscillations generated by the detector tube "beat" with the incoming signal and an audible note or whistle results; we listen to this whistle when we say we are "copying c.w. signals."

The detected signal is then passed on to the audio coupling apparatus, $L_4C_8R_2$, through a radio-frequency choke coil, *RFC*, which prevents radio-frequency currents in the plate circuit of the detector tube from getting into the audio amplifier. The radio-frequency by-pass condensers, C_6 and C_7, provide a low-impedance return path for any stray r.f. that may try to get into the audio system but have little effect on the audio signal. The audio-frequency current flowing in L_4 causes a voltage to appear across R_2, through C_8. This audio voltage is applied between the grid and cathode of the audio amplifier tube, which increases or "amplifies" the signal. The

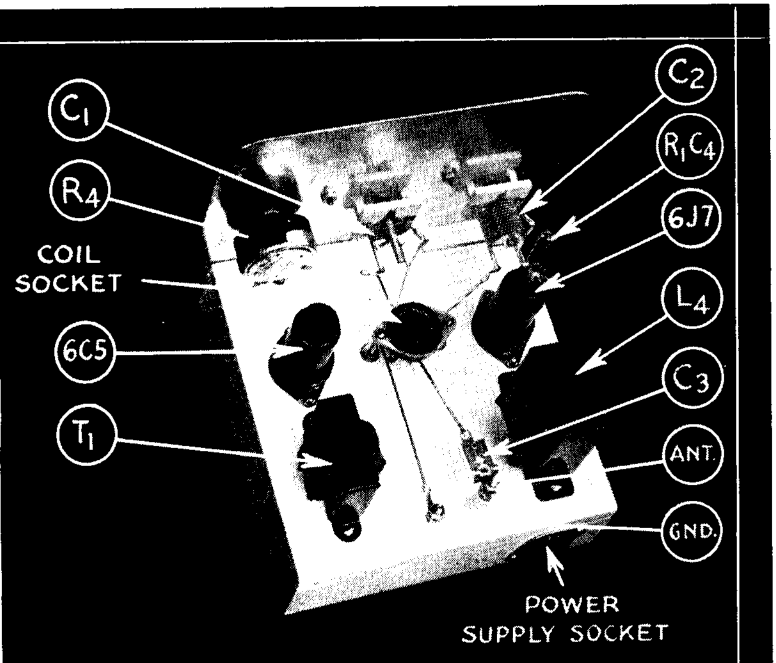

Fig. 7 — A plan view of the wood/metal version of the receiver. The parts are labeled for easy identification.

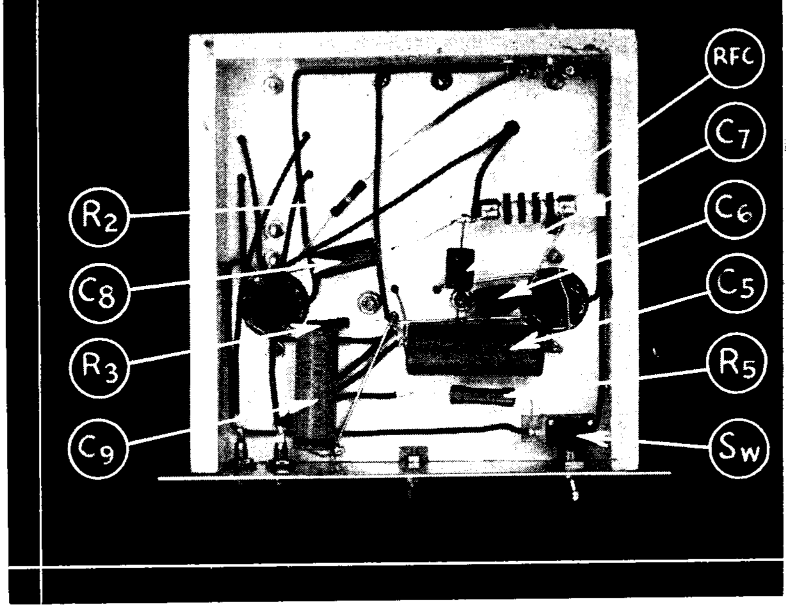

Fig. 8 — A view underneath the chassis shows more of the wiring and the placement of the rest of the parts. Note the ground lead from the panel, shown at the lower end of C_9. Part of the base must be cut away to accommodate a dial-mounting screw.

resistor R_3 is used to develop grid bias for the tube so it will operate properly; condenser C_9 by-passes the audio-frequency currents around R_3. When filament-type tubes are used for low battery-drain portable operation, the bias for the amplifier tube is furnished by a 4½-volt battery, since the cathode resistor type of grid bias is not readily obtained with filament-type tubes.

There is one more point about the circuit to be explained before getting down to the constructional work. The detector tuned circuit consists of the coil L_1 and the two variable condensers C_1 and C_2, C_2 being connected across the whole of the coil and C_1 across only part. The purpose of this arrangement is to give "band-spreading"; that is, a small slice of the high-frequency spectrum is made to cover a large part of the tuning dial. As shown in Fig. 1, the amateur bands are rather widely-separated groups of frequencies; if the receiver has continuous range the number of kilocycles covered on each plug-in coil will be very large and an amateur band will represent only a small portion of the range. Tuning would also be difficult; the dial would have to be set with extreme care because the space occupied by each station would be little more than a knife edge. But with band-spreading we pick out one section of the spectrum — for example, an amateur band — and make that number of kilocycles occupy the whole dial. This effect is obtained by connecting the small tuning condenser, C_1, across only part of the coil. The particular part of the spectrum to be spread out is selected by adjusting C_2, the "band-setting" condenser. The taps on the coils, as given later in the table of specifications, will spread each amateur band so that it occupies very nearly the whole of the tuning range on C_1 when C_2 is properly set. C_2 also can be used as the tuning condenser when general coverage, not band-spread, is wanted.

Although the uninitiated might gather from the photographs that two different receivers are being described, we wish to point out that both receivers use exactly the same circuit and constants. It was felt desirable to describe two different types of construction so that the potential amateur can select the one best suited to his talents and available tools and material. The performance of the two receivers is practically identical. Either one can use either metal tubes or the 1.4-volt battery tubes, the only changes necessary being the substitution of the tubes, coil changes and a modification of the power connections. The metal tubes will give slightly better performance because of their higher gain and lower susceptibility to mechanical vibration, but the low-voltage filament tubes are usually more desirable for portable operation or in districts where a.c. power is not available.

CONSTRUCTION OF THE WOOD/METAL RECEIVER

THE construction of the receivers is almost self-evident from an inspection of the photographs. The one pictured in Figs. 6, 7, 8 and 10 uses a wooden baseboard and a metal panel. The wooden baseboard is made by cutting a piece of ½-inch stock 7 inches square and nailing side pieces on three sides to form a base which measures 7 inches by 7 inches on the top and 2 inches high all around. Finishing nails are used to fasten the wood together and, after all of the holes have been drilled in the wood, the wood is sanded and given several coats of white paint or, if desired, clear lacquer can be used, so that dirt and dust can be readily wiped off.

The top view of the set shows clearly how the

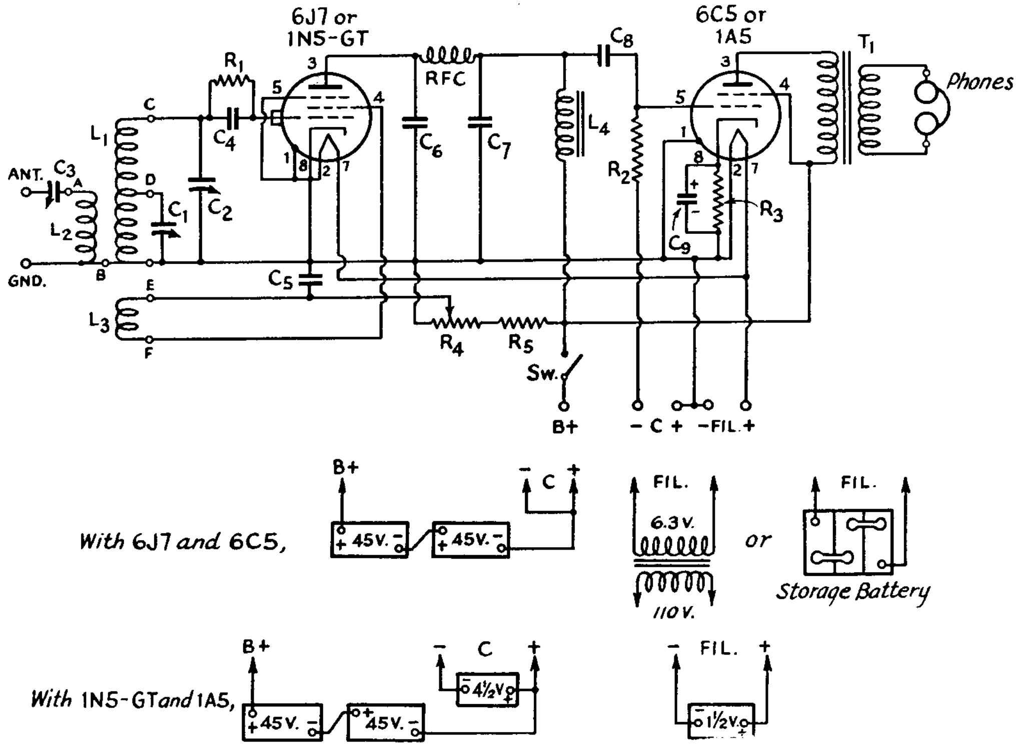

Fig. 9 — **Wiring diagram and list of parts for the receiver.**

C_1 — 35-μμfd. midget variable (Millen 20035 or Hammarlund HF-35).
C_2 — 100-μμfd. midget variable (Millen 20100 or Hammarlund HF-100).
C_3 — 3-30-μμfd. mica trimmer condenser (Millen 26030, Hammarlund MEX or National M30).
C_4 — 100-μμfd. midget mica (Mallory).
C_5 — 0.5-μfd., 400-volt paper (Mallory).
C_6, C_7 — 0.0005-μfd. midget mica (Mallory).
C_8 — 0.01-μfd., 600-volt paper (Mallory).
C_9 — 10-μfd., 25-volt electrolytic (Mallory).
R_1 — 2-megohm, 1-watt carbon (Centralab).
R_2 — 0.5-megohm, ½-watt carbon (Centralab).
R_3 — 1000-ohm, ½-watt carbon (Centralab).
R_4 — 25,000-ohm wire-wound potentiometer (Clarostat).
R_5 — 15,000-ohm, 1-watt carbon (Centralab.)
L_1, L_2, L_3 — See Fig. 13.
L_4 — 500-henry audio choke (Thordarson T67C46).
T_1 — Audio transformer (Thordarson T13A34).
Sw — Single-pole single-throw toggle switch.
RFC — 2.5-mh. radio-frequency choke (National R-100U or Millen 34100).
Baseboard or metal chassis (Par-Metal 7 x 7 x 2).
Panel, aluminum or one furnished with cabinet (Par-Metal CA-200).
Tuning dial (Eby, or National Type B).
Two pointer knobs.
Five 6-prong coil forms (Hammarlund SWF-6).
Two octal sockets (Amphenol MIP).
One 6-prong socket (Amphenol MIP).
One 5-prong socket (Amphenol MIP).
One 5-prong cable plug (Amphenol) or old 5-prong tube base.
One small stand-off insulator (National GS-10).
Four- or five-wire cable.
Two pin jacks (Amphenol or American Hardware).
One small grid cap.
Wire, screws, etc.
One type 6J7 or 1N5-GT.
One type 6C5 or 1A5.

At current net prices, the total cost of the metal/wood receiver will be approximately $11.00, with the price of the all-metal receiver running higher by the amount of the chassis, dial and cabinet (if used). The following accessories will also be needed, at an approximate cost of $5.00 or more, depending on the quality of the headphones.

One pair headphones.
One 6.3-volt filament transformer or 6-volt storage battery (1½-volt dry cell if battery tubes are used).
Two 45-volt medium-size "B" batteries.
(One 4½-volt "C" battery, if battery tubes are used.)

parts are arranged on the base and panel. The sockets for the two tubes and the power-supply plug (at the rear) project partly through the base, the mounting rings being flush with the top. A wood brace with an expansion bit will cut the socket holes cleanly. Each hole should be just large enough to pass the socket — about 1⅛ inches in diameter — and the centers should be 2⅝ inches back from the panel and 1¼ inches in from the edges of the baseboard. The sockets are held down by small wood screws or by bolts running through the base and fastened with nuts on the underside.

The coil socket is midway between the two tube sockets and is also 2⅝ inches behind the panel. This socket is supported by two 1½-inch

6-32 bolts. The socket ring is held firmly on the head end of the bolts by tightening nuts on the under side of the ring, and the bolts are then run through holes in the base and held firmly by nuts and washers on both sides. If small brass pillars are available to slip over the bolts, they can be added for some slight additional strength.

The coil socket is mounted with the two large holes facing towards the right-hand side of the set (looking at the receiver from the front) and the tube sockets are mounted with the notches on the centering holes towards the panel. The orientation of supply-plug socket is immaterial — it is mounted on the side at the right-hand rear of the base.

The antenna terminal is made from a small porcelain stand-off pillar, secured to the base by a bolt from the underside, and a bolt is screwed in at the top of the pillar (after the head of the bolt has been sawed off) and locked in place by a nut. The antenna condenser, C_3, is then slipped over the bolt and held in place by another nut. Two washers are then slipped on the bolt and a final nut completes the assembly, which serves as a support for the condenser and also as the antenna binding post. The ground post is made from a bolt through the baseboard which has a convenient soldering lug held in place by a washer and the bottom nut.

The choke L_4 and the transformer T_1 are held in place by wood screws or bolts, and holes are drilled in the base for the wires from these components. Holes should also be drilled in the base under pins B, E and F so that wires may be run under the base from these terminals.

The arrangement of parts on the panel will become clear after inspection of the front and top views. The condensers C_1 and C_2 are supported on the panel by bolts fastening to the mounts provided on the condensers. Large holes are drilled to clear the shafts. In this manner, the condensers are not fastened directly to the panel as is done in some cases, and it eliminates the possibility of poor connections. The dial is fastened by the three bolts provided for the purpose, and it should be centered carefully so that there is no tendency towards binding, which might keep the dial from working smoothly. Some dials of this type are made with only two mounting bolts, but this type should be avoided because it is practically impossible to make it lie flat on the face of the panel. If the dial slips at all, loosen up on the mounting bolts a bit. The National-type dial used on the all-metal receiver is smoother working but more expensive.

The panel is made from a piece of 1/16-inch aluminum cut 7 inches by 8 inches. After all of the holes have been drilled, it can be immersed for 20 or 30 minutes in a water bath in which some lye has been dissolved. A half-can of lye to a gallon of water is about the right proportion, but the ratio is not at all critical. This will take the bright shine off the aluminum and render it less sensitive to finger marks. The tuning condenser, C_1, is mounted exactly in the center of the panel. The band-set condenser, C_2, and the regeneration control, R_4, are mounted 2½ inches away on either side, at the same height. The switch, *Sw*, and the phone-tip jacks are mounted at a height of 1 inch from the bottom of the chassis and directly under C_2 and R_4, respectively. Although other materials than aluminum could be used, the panel should be of metal, to act as a shield. This simple shielding prevents "body capacity" effects which cause a shift in the receiver tuning when the hand is brought near the radio-frequency circuit. The panel is held to the baseboard by four wood screws.

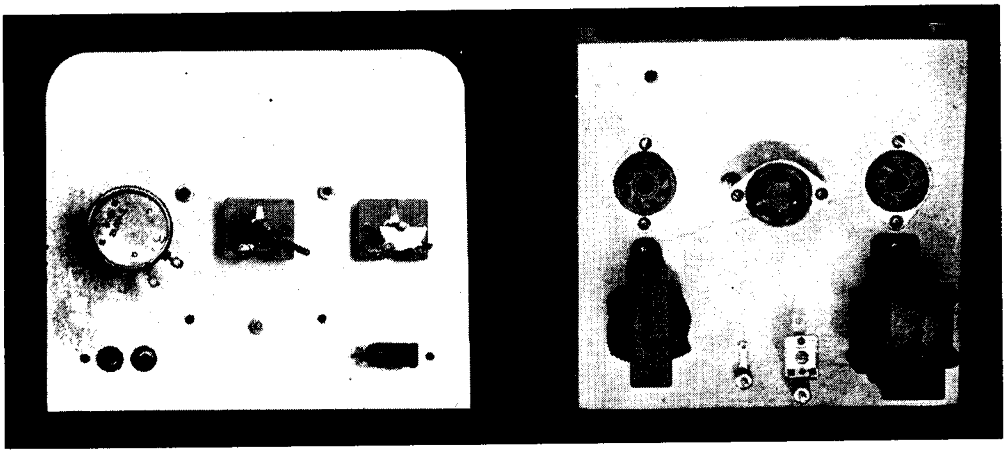

Fig. 10 — The components mounted on the wood base and metal panel before the wiring is done and before the panel is attached. The hole in the upper left-hand corner of the base takes the wires from the regeneration control. The four blank holes on the panel are for the screws that fasten the panel to the base. The three nuts hold the dial to the panel.

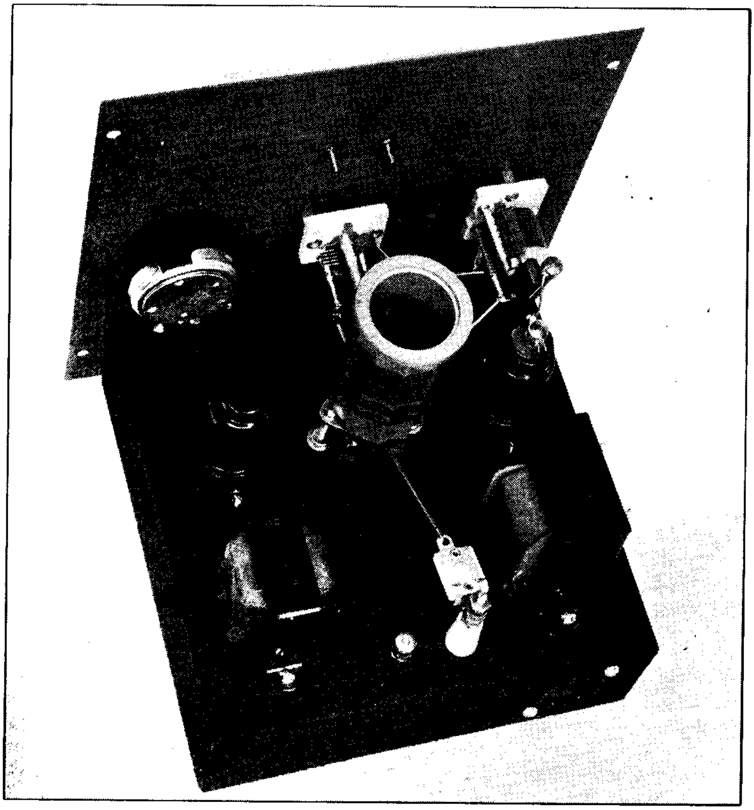

Fig. 11 — A plan view shows the arrangement of parts to be identical with that of the wood-metal version with the exception of the plane of the band-set condenser, C_2.

The remaining receiver parts are mounted underneath the baseboard. They can be identified readily in Fig. 8. Although the exact placement of parts is not critical, the general arrangement shown should be followed, since it results in short radio-frequency leads and also lends itself to convenient wiring.

The wiring is fairly straightforward and need not be a cause for concern if the diagram, Fig. 9, is followed carefully. Connections in the tuning circuit (between the variable condensers and the coil socket) are made with bus wire as shown in Fig. 7. A wire from the rotor of C_2 goes to the rotor of C_1 and thence to B on the coil socket. Another wire from B goes through the base and over to the No. 2 pin of the detector socket. A wire from a soldering lug slipped under a mounting screw on the panel, runs over to the point where the ground wire comes through the base and thus grounds the panel. Finally, a wire from B is run to the ground binding post at the rear of the set.

The grid condenser, C_4, and the grid leak, R_1, are mounted on the stator terminal of C_2, being soldered directly to the lug. Thus only a short connection is needed to run to the grid cap of the tube and there is little tendency to pick up hum from nearby power wires. The grid lead is not soldered to the grid of the tube but is fastened with a small "grid cap" which permits easy removal of the tube.

Pieces of bus wire are used to connect the stators of the tuning condensers to the proper coil socket terminals, and another piece of the wire is used from F on the coil socket to the screen-grid pin (No. 4) of the detector socket. The rest of the connections are made with smaller "push-back" wire, which is very convenient for wiring since the insulation can be slid back to expose enough of the wire for soldering. Neither the bare bus wire nor the push-back requires scraping or flux.

Of the three wires from the variable resistor, R_4, the one from the right-hand side (looking at it from the back) goes to the ground bus, the center one runs over to one side of C_5, and the third terminal connects to switch *Sw* through R_5. Connected in this manner, turning the knob clockwise will increase the screen voltage and consequently the feedback.

In connecting C_9, be sure the "plus" terminal goes to the No. 8 pin on the amplifier tube socket. The "minus" terminal should connect to the common ground wire. If this connection is not made properly, the condenser will not function correctly and may be damaged.

The rest of the wires are placed in convenient positions, and a study of Fig. 8 will furnish a clear picture of how to run the leads. The sequence of the connections on the power-plug socket is of no importance, and it can be made anything that is convenient. The switch, *Sw*, in the positive B lead, is necessary so that the battery plate supply will not be wasted during transmission periods. The heater or filament power, which is left on during any operating period, is most conveniently disconnected at the source, whether it be battery or transformer.

CONSTRUCTION OF THE ALL-METAL VERSION

THE construction of the all-metal receiver differs from the wood-metal version in only a few points. The components on top of the 7- by 7- by 2-inch chassis are mounted the same as on the wood version with the exception of the ground binding post. A hole is drilled for the post and the paint is scraped away on the under side so that the bolt used for the binding post makes good contact with the metal chassis. Holes in the chassis for leads from E and F on the coil socket are made large enough to accommodate small rubber grommets which insulate the wires running through the holes from the metal. A soldering lug is fastened under the supporting bolt adjacent to the hole under B, and the wire from B solders to this lug to form a ground connection. The paint is, of course, scraped away at the bolt so that the lug makes contact with the chassis.

The holes for the sockets can be made with a metal-worker's circle cutter or with any of the several punches sold for the purpose. The diameter of the holes should be 1⅛ or 1³⁄₁₆ inch. The socket mounting rings are held to the chassis with small 6-32 bolts and nuts.

The panel measures 8 inches by 8¼ inches and is the one furnished with the cabinet. If a cabinet is not used, the panel can be made of aluminum, as described for the receiver with the wood base. However, if the National dial (pictured in the metal receiver photographs) is used, it will be necessary to place the band-set condenser, C_2, and the regeneration control, R_4, 2¾ inches away from the main tuning condenser, C_1, so that the knobs will clear the edge of the dial. C_1 is placed in the center of the panel, as before, and the switch, *Sw*, and the phone tip jacks are centered under C_2 and R_4 respectively, at a height of 1 inch from the bottom of the panel.

The panel is held to the chassis by four bolts, but washers or nuts are used between the panel and chassis to space them apart slightly. This is necessary if a cabinet of the type shown is used because of the small lip at the bottom of the cabinet front. If no metal cabinet is used, the panel need not be separated from the chassis. Spacing the panel from the chassis requires that the switch, *Sw*, be mounted on the chassis, with enough of the hub projecting to show through the hole in the panel, while the insulated phone tip jacks are mounted on the panel and project through clearance holes in the chassis, since the jacks must not ground to the chassis.

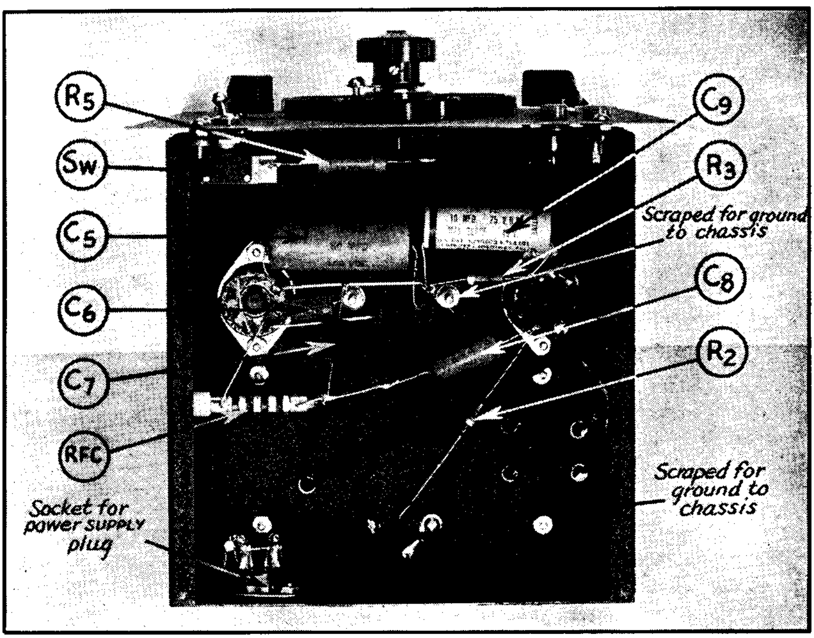

Fig. 12 — The underside of the chassis, showing how the panel is spaced away from the chassis (necessary only when a cabinet is used).

It will be noted that the band-set condenser, C_2, is mounted in a slightly different plane than in the wood-metal version. This was done to illustrate how, by only a slight re-arrangement of parts, leads can often be shortened. In this case, the lead from the rotor becomes shorter. This is of no practical importance on the frequencies for which this receiver is designed, but it is a point to bear in mind when the amateur starts to design his own equipment later in his career. It is important to keep leads short that are carrying radio-frequency currents — the length of leads carrying direct or low-frequency alternating current is not important.

As with the wood-metal receiver, the tuning condensers C_1 and C_2 are not grounded to the panel at their mounting, and the holes that take the shafts must be large enough so that the shafts do not touch the panel at any point.

The wiring of the metal version is similar to the wood/metal receiver, with minor exceptions of the ground leads as described above, and need not be repeated here.

WINDING THE COILS

Coil data are given in the table in Fig. 14, and should be followed closely as a start. When starting to wind a coil, first solder one end of the wire in the proper pin, after threading the wire through a small hole in the coil form. Then secure the distant end of the wire (after unwinding from the spool as much wire as is judged necessary for the coil) to a doorknob or other convenient point, and wind the coil by stretching the wire taut and walking towards the far end of the wire as the coil form is revolved in the hand. This will wind the wire tightly on the form and result in a much better-looking coil than if the form is held and the wire wrapped around. When the proper number of turns has been wound on the form, the wire is cut a foot from the form and this end threaded through the proper hole and pin in the form. The insulation is then scraped from the end of the wire brought through the pin, and the wire is soldered to the pin. The important thing is to wind on the wire evenly and as tightly as possible. In the case of spaced turns, the wire is wound on first by spacing the turns by eye and, after the ends have been soldered, the turns can be moved slightly to give more even spacing, or string can be wound between the turns and then unwound.

Taps are made on L_1 by drilling a small hole in the form at the proper point (after the coil has been wound and properly spaced), scraping the insulation on the wire for a very small distance either side of the hole, and soldering the end of a short length of wire to the scraped portion. It isn't difficult to make a neat job if a little care is taken.

Since it is practically impossible to exactly duplicate coils, it is to be expected that some slight modifications may be necessary. However, probably the only changes necessary will be in L_3, the coil that determines the oscillation point of the detector. The proper value of this coil will vary with the particular antenna used, and the proper adjustment is now to be described.

OPERATION OF THE RECEIVER

After the set is completed and the wiring checked to make sure that it is exactly as shown, insert the No. 3 coil (selected because signals can usually be heard in this range at any time of the day or night) in the coil socket and connect the headphones, antenna and ground, and the heater supply. The heater supply, as

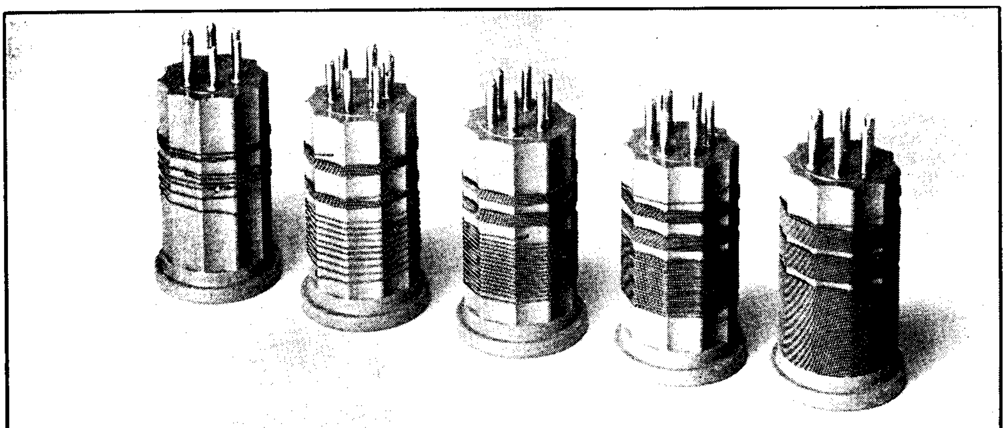

Fig. 13 — Five coils are used to cover the range from 1.55 to 33 Mc.

well as the plate power, is conveniently connected by means of a 5-wire cable and a 5-prong plug which fits into the socket at the rear of the set. A cable from three to five feet long will be required, depending on where the power supply is located at the operating position. After the heater supply has been connected for a few minutes, the metal tubes should feel warm to the touch; in the case of the dry-battery tubes, they heat up instantly but there is no detectable sign that they are on. If the tubes do not warm up, the wiring should be checked. The "B" battery (and "C," if needed) can now be connected and the switch, *Sw*, closed. The switch is closed when the toggle is pointing towards the side of the switch from which the terminals are brought out.

Now turn the regeneration control knob in a clockwise direction until the set goes into oscillation. This phenomenon is easily recognizable by a distinct click, thud or hissing sound. The point where oscillation just begins is the most sensitive operating point at that particular dial setting.

The tuning dial may now be slowly turned, the regeneration control knob being varied simultaneously (if necessary) to keep the set just oscillating. A number of stations will probably be heard. A little practice will make tuning easy.

If the set refuses to oscillate, the sensitivity will be poor and no code signals will be heard on the frequencies at which such signals should be expected. It should oscillate easily, however, if the coils are made exactly as shown and the tubes and batteries are good. It sometimes happens that the antenna takes so much energy from the set that it cannot oscillate, this usually resulting in "holes" in the range where no signals can be

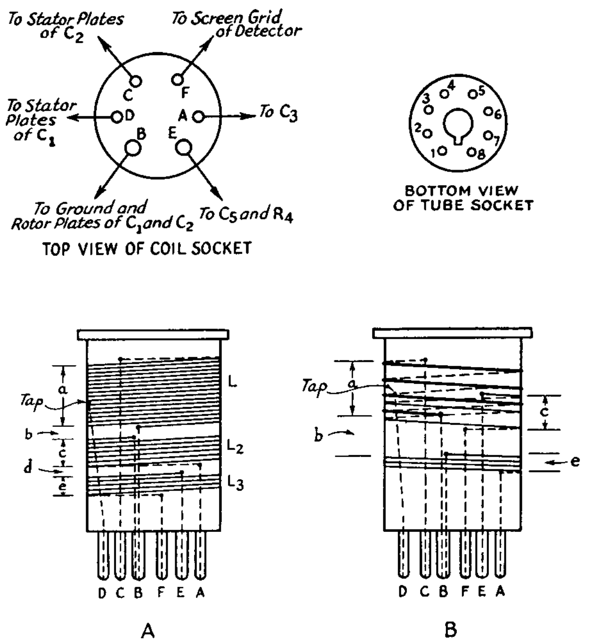

Fig. 14 — Tube and socket connections for the receiver. All of the coils except No. 5 for metal tubes and No. 4 for battery tubes are wound as at A; B shows how coil No. 5 for metal tubes and No. 4 for battery tubes are wound. All coils for any one range must be wound in the same direction. In the table below, the values given in parentheses apply only to the battery-tube coils, otherwise the values are the same for both types of tubes.

No.	Range, Mc.	Amateur Band, Mc.	Turns L_1	Turns L_2	Turns L_3	Dimensions, Inches a	b	c	d	e	Band Spread Tap
1	1.55- 3.0	1.75	48¾	13½	13 (28)	1⅛	⅛	⅜	⅛	⅜ (¾)	—
2	2.8 - 6.5	3.5	22¾	10½	8½ (20½)	⅞	⅛	¼	⅛	¼ (½)	—
3	5.0 -10.5	7.0	15¾	7½	5½ (12½)	⅞	¼	¼	⅛	⅛ (⅜)	7
4	7.5 -16.5	14.0	9¾ (8¾)	4½	5½ (5½)	⅞	¼	⅛	¼ (—)	⅛ (¼)	2½
5	16.0 -33.0	28.0	3	3¼	2¼	½ (not recommended)	¼	¼	—	⅛	1

All coils are wound with No. 24 d.s.c. wire. The taps are counted off from the lower end of L_1 (connection B); coils No. 1 and 2 are not tapped and terminal D goes directly to C inside the coil form. All L_1's are space-wound except on coil No. 1; all L_2's and L_3 are close-wound except on coil No. 5, where L_3 is space-wound within L_1.

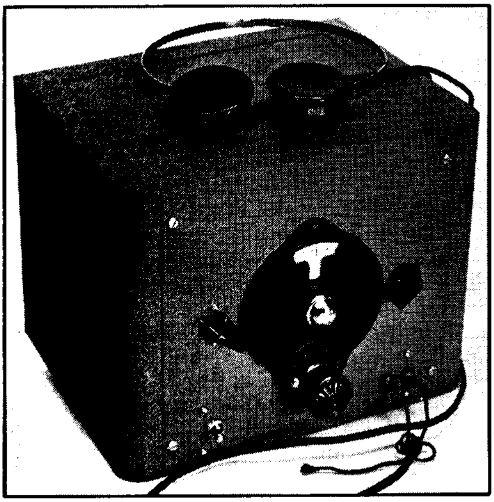

Fig. 15 — The receiver mounted in its cabinet and ready for use.

picked up (and where the hissing sound cannot be obtained). This can be cured by reducing the capacity of C_3 (unscrewing the adjusting screw) until the detector again oscillates. If it still refuses to oscillate, the coil L_3 must be moved nearer to L_2 or, in extreme cases, a turn or two must be added to L_3. This is best done by rewinding with more turns rather than by trying to add a turn or two to the already-wound coil. For any given band of frequencies, adjust C_3 (and possibly L_3) so that the detector oscillates over the whole range, using as much capacity at C_3 as is possible. This will give the best compromise between dead spots and signal strength. It will be found that it requires less advancing of the regeneration control, R_4, at the high-frequency end of a coil range (C_2 at or near minimum capacity) than at the low-frequency range. Since it is desirable to have the detector go into oscillation with the regeneration control advanced well towards its maximum, the best adjustment of the antenna condenser, C_3, and the feedback coil, L_3, is that which requires almost a maximum setting of the regeneration control at the low-frequency end (maximum capacity of C_2) of any coil range. Once the set has been used for a while, the above will be much clearer and sound not at all complicated. Any experimenting with the coils will be amply repaid in optimum results. Coils L_1 and L_2 will require no modification if the specifications have been followed closely.

Coil No. 1 just misses the high-frequency end of the broadcast band, but it is possible to hear police stations and the 160-meter amateur band with it, as well as other services. The amateur band is most easily located by listening at night (when there is the most activity), setting C_1 at maximum and slowly tuning with C_2 until some of the police stations are heard. These stations operate on 1712 kc., so that once found they become "markers" for the low-frequency end of the band. Further tuning then should be done with the main tuning dial, and many amateur stations should be heard. The band-set condenser setting will work out to be about 70% to 80% fully meshed, for the 160-meter amateur band.

Locating the amateur bands on the other coils is done in much the same manner, by searching carefully with C_2. The 3.5–4.0-Mc. amateur band will be found on coil No. 2 at about 65% setting of C_2; it will be easiest to locate this band by setting C_1 at minimum capacity (plates unmeshed) and adjusting C_2 until amateur 'phone stations are heard. Again this is best done at night, when the activity is heaviest on this band. On coil No. 3, the 7-Mc. amateur band will be found with C_2 meshed about 45%; the 14- and 28-Mc. bands are found with C_2 meshed about 20% and 15% respectively. Of course signals can be picked up on any of the coils at random settings of C_2; in time you will become familiar with the tuning range of the receiver, and the process of finding a particular band — which may sound somewhat complicated from this explanation — actually will be easy.

Sometimes local broadcasting stations cause interference, especially when the lower-frequency coils are being used. A simple but effective cure for such interference is the wave trap. The trap is simply a coil and condenser, tuning to the frequency of the broadcast station causing the trouble, inserted in the antenna lead. It acts as a rejector circuit and prevents the unwanted signal from getting to the receiver, although having no effect on signals of other frequencies. The values shown in Fig. 16 will be effective over the entire broadcast band.

A suitable antenna for the receiver would be 50 to 75 feet long, and as high and clear of surrounding objects as possible. The same precautions as to insulators that you would apply to your broadcast receiving antenna should also be applied to this short-wave antenna. The transmitting antenna may be used for receiving, by means of a suitable switch, but it is normally more convenient to use a separate receiving antenna. Unless the building is a metal one or the room too near the ground level, a small wire run around the room and lying out of sight in the picture molding will often serve as a fair receiving antenna. The ground lead should preferably be short — do the best you can with your particular conditions. A ground to a heating radiator or any of the water piping is good. Do not use gas pipes for grounds, since the joints in these lines often are insulated, particularly at the meter.

A good pair of headphones is an excellent investment, as these will always be useful regardless of the advancement to more complicated gear as the station becomes more elaborate, and the best type that can be afforded should be bought. Light-weight headphones are quite popular, but many operators prefer the heavier ones because they clamp tighter on the ears and keep out outside noises. The price of the headphones is a good indication of the quality.

USING THE RECEIVER

Unless you are a very abnormal type of person it is probable that you will have your receiver hooked up to the antenna and "on the air" within a very few minutes after you have soldered the last connection and tested the set for satisfactory operation. And it is probable, too, that all other activity will be suspended for a number of days thereafter, while you learn to tune the set to best advantage, find out where the amateur bands are, and generally have a good time exploring the new world that opens up to those who venture forth into high-frequency reception.

At first it is probable that you will listen-in on all sorts of transmissions in addition to amateur signals. By careful tuning you should be able to pick up police calls when using Coil No. 1. Aeronautical signals can be heard when using Coil No. 2 and careful tuning with various of the other coils will frequently produce satisfactory reception of foreign broadcast stations. It is not unlikely that you will occasionally find yourself listening to one side of a ship-to-shore telephone conversation, and if you happen to pick up one side of a telephone speech that is so garbled that you can't quite make out what the people are saying, you are listening to one of the transoceanic radiotelephone links with a "scrambler" to assure privacy. As you become used to the receiver and your proficiency in its operation increases, you will find yourself picking up more and more material which you seemed unable to hear at first, and you will also begin to acquire a good idea of what frequencies each coil covers, and where to find a certain frequency on your tuning dial when you want to look for some particular station.

Listening-in on the high frequencies is a revelation to people who up to that time have thought that most radio transmission and reception is confined to broadcasting. A horde of radio signals from dozens of different types of services tell their story hourly to whomever will listen. Some stations send slowly and leisurely, and even the beginner can read them. Others race along furiously so that whole sentences become meaningless buzzes. There are both telegraph and telephone signals: press messages, weather reports, time signals, transocean commercial radiotelephone and telegraph messages, international broadcasting of voice and music, transmissions from government and experimental stations, airplane dispatching, police broadcasts, signals from private yachts and expeditions exploring the uttermost parts of the earth — signals jam the high-frequency spectrum from one end to the other. And sandwiched in among all these services are the amateurs, hundreds of whose stations may be heard every night.

You will soon become familiar not only with the location of the various amateur bands but with the fact that there is quite a bit of difference in the type of work carried on in each band.

The 1750-kc. band is especially popular for medium-range amateur radiotelephony. Code practice transmissions are made in this band for beginning amateurs and many beginners may be heard in this region making their first two-way telegraph contacts with each other.

The 3500-kc. band is where most of the amateur message handling and organized amateur radio work (the ARRL trunklines, the Army-Amateur Radio System net, special emergency nets, etc.) takes place and at night, particularly in the winter, stations will be heard over distances of several thousand miles. At one end of this band, as seen in Fig. 1, there is a 'phone subband, and this is always jammed with signals from more advanced amateur telephone stations.

It is in the 7000-kc. band that much of the international transmission and reception takes place, for reasons we have previously outlined in commenting on the properties of various high frequencies. But it will probably take you some time to learn to pick out foreign stations, because of the intense interference resulting from stations all over the world operating in this popular but narrow slice of territory. However, we might caution you against assuming that foreign signals will be the weakest ones — it is one of the characteristics of high-frequency work that some of the longest-distance signals are frequently as loud or louder than signals from stations closer at hand.

Listening-in on the 14,000-kc. band in the daytime, or early evening, will bring you signals from all over the country and from foreign points as well. This is an excellent place to listen for foreign amateur telephone stations, by the way.

A word of caution: United States radio laws prescribe heavy penalties for divulging the contents of any radiogram or message to other than the addressee. You may copy anything you hear, but must preserve its secrecy — unless it is something broadcast for the general public.

INTERPRETING WHAT YOU HEAR

Listening to police broadcasts, etc., is all very well for a short time, but you did not build your receiver just for that and within a few days it is probable that you will want to