A Simple One-Tube Transmitter

Now that you have a receiver, it's time to think about a transmitter. The photographs and sketches of Figs. 14 through 31 show various details of a one-tube 25-watt crystal-controlled transmitter for the 80-meter band. With a reasonably good antenna it should be possible to work (communicate with) other amateurs within a radius of several hundred miles under favorable conditions. It represents one of the simplest satisfactory forms of transmitter that can be built. But remember, you must have an amateur license before you use it.

Transmitter Construction

The transmitter is built on a 5½ × 9½ × 1½-inch aluminum chassis. A standard 7 × 12 × 6-inch aluminum box is used as the shielding enclosure. One of the removable covers is used as the panel. Figs. 16 and 18 show the locations of the various holes in the panel and chassis. Reference should be made to the earlier section on cutting holes, page 44.

The holes in the panel and chassis will be most accurately matched if Holes A and B (Fig. 16) are first made with a No. 24 drill. Then scribe a line across the back of the panel 4$^{15}/_{16}$ inches down from the top edge. Center the chassis on the panel with its top surface flush with the scribed line. Through Hole A in the panel, mark a corresponding hole in the chassis. When this hole

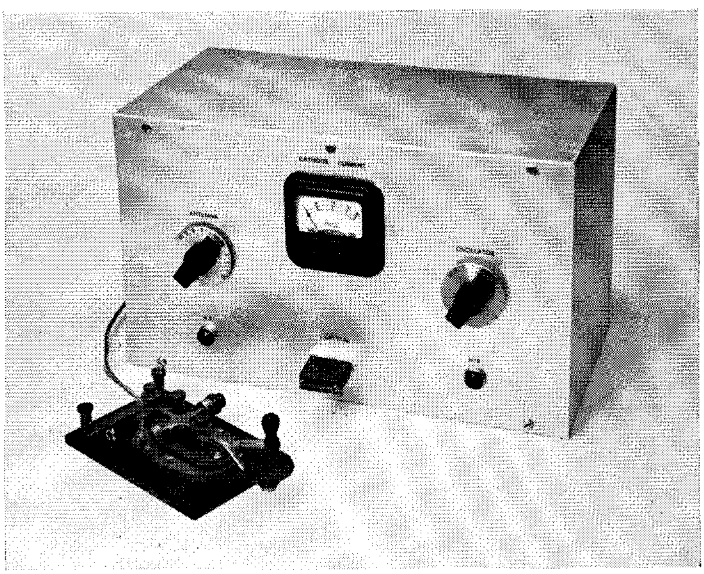

Fig. 14 **— A 25-watt 80-meter transmitter. A standard 6 × 7 × 12-inch aluminum box is used as the enclosure. The plate tank tuning control is to the right and the antenna tuning control to the left. The pilot lamp to the left is an r.f. output indicator.**

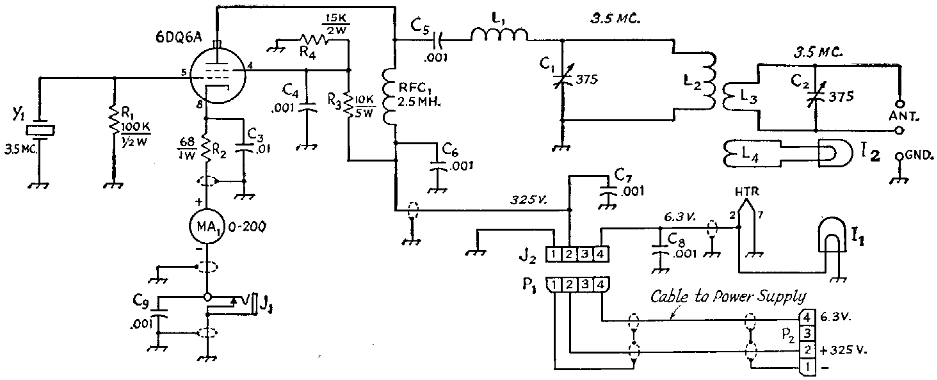

Fig. 15 — **Circuit of the 25-watt 80-meter beginner's transmitter. All capacitances less than 0.001 μf. are in μμf. All by-pass capacitors are disk ceramic.**

C_1 — Plate tank capacitor (Allied Radio Cat. No. 61H009).
C_2 — Antenna tuning capacitor (same as C_1).
C_3 — Cathode r.f. by-pass capacitor.
C_4 — Screen r.f. by-pass capacitor.
C_5 — D.c. blocking capacitor (disk ceramic).
C_6 — Plate r.f. by-pass capacitor.
C_7, C_8, C_9 — V.h.f. by-pass capacitor.
I_1 — Pilot lamp (6-volt 150-ma. dial lamp).
I_2 — Antenna output indicator (2-volt 60-ma. dial lamp).
J_1 — Closed-circuit key jack (Switchcraft 12A).
J_2 — Power connector (4-prong male connector — Amphenol 86-RCP-4).
L_1 — V.h.f. parasitic suppressor — 5 turns No. 16 wire, ¼ inch diam., ½ inch long.
L_2 — Plate tank coil (see text).
L_3 — Antenna coupling coil (see text).
L_4 — Output-indicator coupling coil (see text).
MA_1 — Cathode milliammeter (Shurite Model 950).
P_1 — Female power plug (Amphenol 78-PF4).
P_2 — Male power plug (Amphenol 86-PM4).
R_1 — Grid leak.
R_2 — Cathode biasing resistor.
R_3 and R_4 — Screen voltage divider.
Y_1 — Quartz crystal (controls frequency — see text).

Additional Parts for the Transmitter Not Shown Under Fig. 15

1 6 × 7 × 12-inch aluminum box (Premier AC1276)
1 5½ × 9½ × 1½-inch aluminum chassis (Premier ACH-400)
1 6DQ6A tube
1 ceramic octal tube socket (Millen 33008)
1 ceramic terminal strip, 3 terminals (Millen 37303)
1 crystal socket (Millen 33102)
2 small dials (National R)
2 pilot-light assemblies (Johnson 147-306)
4 ⅝-inch cone insulators (Johnson 135-500)
1 panel-bearing unit (Johnson 115-256)
1 flexible shaft coupling (National TX-8)
3 feed-through points (National TPB)
2 insulated tie points

(Continued on next page)

1 ¼-inch insulated tube plate cap (TV replacement type)
2 rubber grommets to fit ⅜-inch hole
1 rubber grommet to fit ¼-inch hole
1 strip coil (Barker & Williamson 3015 Miniductor)
1 5-inch length of 1-inch wood dowel
18 ¼-inch 6-32 machine screws
4 ½-inch 6-32 machine screws
2 ½-inch 4-40 machine screws and nuts
9 6-32 nuts
1 ft. ⅛-inch insulating sleeving (spaghetti)
Approx. 2 ft. No. 16 bare wire
Approx. 1 ft. insulated hook-up wire
Approx. 3 ft. shielded hook-up wire (Belden 8885)
6 ½ inches 1/16 × ¾-inch aluminum strip

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has been drilled in the chassis, fasten the panel to the chassis with a machine screw at A. Square the chassis up along the scribed line and mark the chassis through Hole B. Drill the hole corresponding to Hole B in the chassis and again fasten the panel to the chassis with machine screws at both Holes A and B.

Now mark the centers of the four holes near the bottom center of the panel and drill through both the panel and the chassis at the same time. The space between the two 5/16-inch holes should be filed out to form a slot. The panel can then be removed and the remaining holes made in both the chassis and the panel, enlarging holes A and B to proper size at the same time.

Mounting the Components

In mounting the components, only the mounting of C_2 requires special attention. This capacitor is supported by two ⅝-inch cone insulators (Johnson 135–500). Turn the capacitor upside down with the shaft facing you. You will

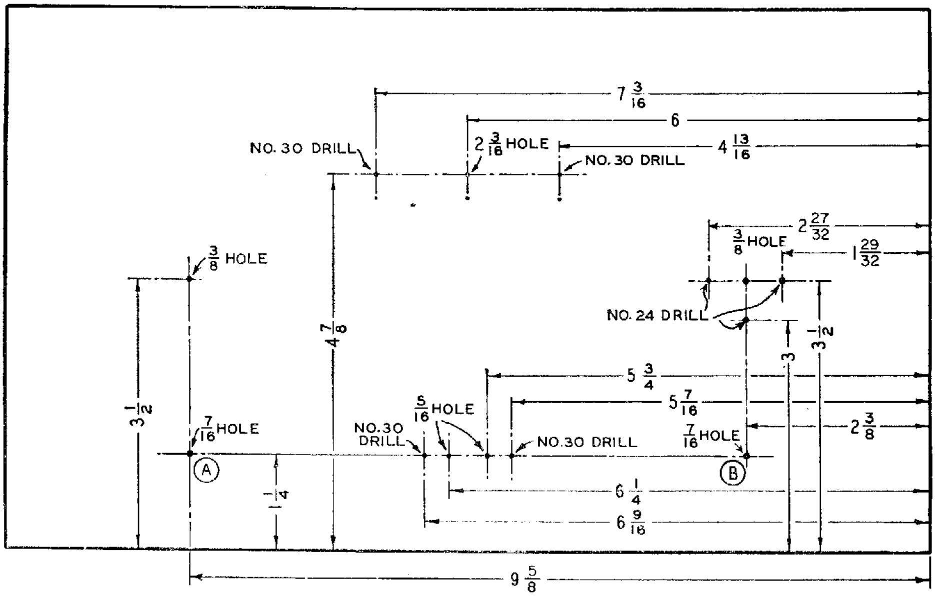

Fig. 16 **— Sketch showing the panel drilling plan. All holes should be started with a small drill and then enlarged to proper size. Holes A and B should be drilled first as discussed in the text.**

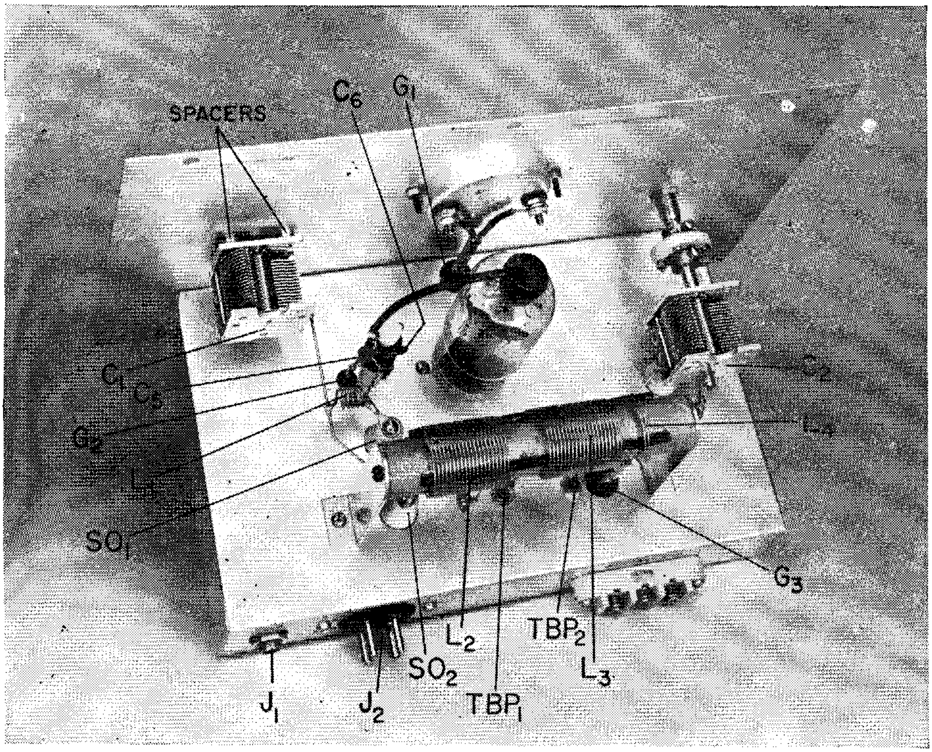

Fig. 17 — **This view shows the assembly of small components to the left of the tube. Spacers are used between the panel and the frame of the tank capacitor C_1 to the left.**

see four small holes in the bottom of the frame. The front hole on the right-hand side and the rear hole on the left-hand side are used for mounting. These two holes should be enlarged with a No. 33 drill and threaded with a 6-32 tap. The drilling and tapping must be done very carefully so as not to damage the stator plates of the capacitor.

Now insert ½-inch (or longer) 6-32 machine screws in the tops of the insulators. Make them as tight as possible with a screwdriver. Cut the heads of the screws off with a hacksaw, leaving studs about ⅛-inch long protruding from the cones and file the ends smooth. Thread the studs into the frame of the capacitor.

A panel-bearing unit (Johnson 115–256) is used to drive C_2. The rear section of the shaft should be cut off to a length of ⅜ inch. Mount the bearing on the panel, and the capacitor on the chassis. If the two shafts do not line up accurately, use washers on top of the cone insulators to raise the capacitor. Carefully file out the mounting holes or the bearing hole in the panel as necessary to make the shafts line up. The bearing shaft and the shaft of the capacitor are joined with a flexible shaft coupler (National TX-8).

C_1 is mounted on the panel by means of ¼-inch 6-32 screws and ⅛-inch spacers, using the three threaded holes in the front of the capacitor frame.

In mounting some of the other components, the mounting screws are used also for fastening grounding lugs or insulated tie points. Place a grounding lug (see Fig. 7) on top of the chassis, under the base of RFC_1, and a left-hand (see Fig. 7) tie point (TP_2) under the chassis, fastening it with the mounting screw of RFC_1. Place a grounding lug under the mounting screw of the cone

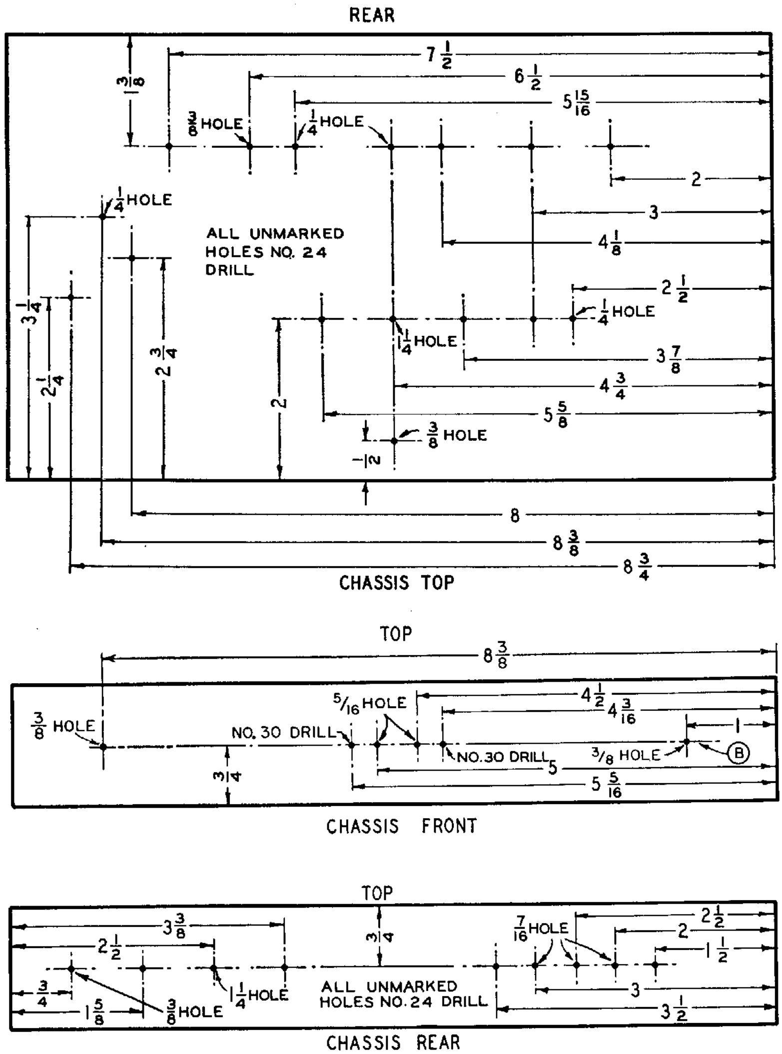

Fig. 18 **— Drawings showing the location of holes in the top, and in the front and rear edges of the chassis. All holes should be started with a small drill and then enlarged to proper size.**

insulator SO_1. Place a grounding lug on top of the chassis at the hole to the right of SO_2 (see Fig. 20), and another at the same hole underneath the chassis. Fasten with a ¼-inch 6-32 screw and nut.

Place two grounding lugs under the lower (see Fig. 22) tube-socket mounting screw, and a grounding lug and a right-hand tie point (TP_1) at the upper mounting screw. A grounding lug should also be placed under the nut of the right-hand (see Fig. 20) mounting-bracket screw of the coil assembly. A grounding lug should be placed at each of the mounting screws of J_2 and the crystal socket.

On top of the chassis, a lug should be fastened at the lower threaded hole in the rear of the frame of C_2. Two lugs should be fastened to the top of the cone insulator SO_2, and one at SO_1. Rubber grommets (G_1 and G_3) should be placed in the two ⅜-inch holes in the top of the chassis, and one (G_2) in the ¼-inch hole near RFC_1.

The Coils

L_2, L_3 and L_4 are made of sections of Barker & Williamson 3015 Miniductor, 1 inch in diameter, 16 turns per inch. L_2 and L_3 have 20 turns each. L_4 has two turns. L_2 and L_3 should first be cut with a few more turns than is required. The end turns can then be unwound to form leads long enough to reach the terminals below. The ends of L_4 should be made about ½ inch long.

The coils are mounted on a 1-inch wood dowel obtainable at hardware stores. (The actual diameter is something less than an inch.) The dowel is supported at each end with a bracket cut from 1/16-inch sheet or strip aluminum. Those shown in the photographs are 2¾ inches high, the same width as the dowel diameter, and have a ⅜-inch lip bent out at the bottom end. Holes are made with a No. 24 drill in the lips and near the top ends of the brackets. The brackets are mounted with ¼-inch 6-32 machine screws and nuts. The dowel should be cut to fit between the two brackets, and fastened with No. 6 wood screws.

In mounting the coils on the dowel, two 4-inch lengths of ⅛-inch insulating tubing (spaghetti) are slid in between the coils and the dowel, and cemented to the dowel with Duco cement. This provides enough friction to hold the coils securely in place, yet it allows the spacing between them to be adjusted for proper coupling.

Wiring

Most of the r.f.-circuit wiring is done with bare No. 16 wire. The power wiring is done with the shielded wire (Belden No. 8885). The shielded wire is one of the means used to suppress interference to television receivers from the transmitter (TVI).

The shielded wiring should be done first. In each case, the wire should be cut to fit between the two points mentioned. The braid should then be pushed back on the wire for a distance of about ¾ inch. The shielding can be anchored in this position by flowing a little solder into the braid. The shielding at the other end of the wire should be pulled out smooth, and then the braid should be frayed out (see Fig. 23A) to expose about ¾ inch of the insulation. The frayed braid should then be twisted into a lead. This lead is used to ground the braid to the chassis. As a last operation, the insulation should be stripped off the last half inch at each end, leaving about ¼ inch of insulation protruding from the braid.

Where a by-pass capacitor is used at the end of the lead, it should be attached as indicated in Fig. 23B. One of the terminal wires of the capacitor should be wound around the braid as close to the end as possible, leaving a minimum of lead between the capacitor and the braid. The other terminal lead of the capacitor should be made as short as possible and soldered to the inner conductor, close to the insulation.

Run a shielded wire from the insulated terminal of TP_2 to Pin 2 of J_2 (see Fig. 19). Connect a 0.001-μf. by-pass capacitor (C_7) at the J_2 end of the

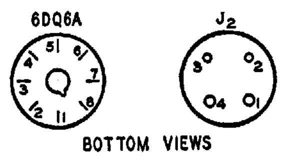

***Fig. 19* — Sketch showing the pin numbering of the tube socket and power connector of the transmitter.**

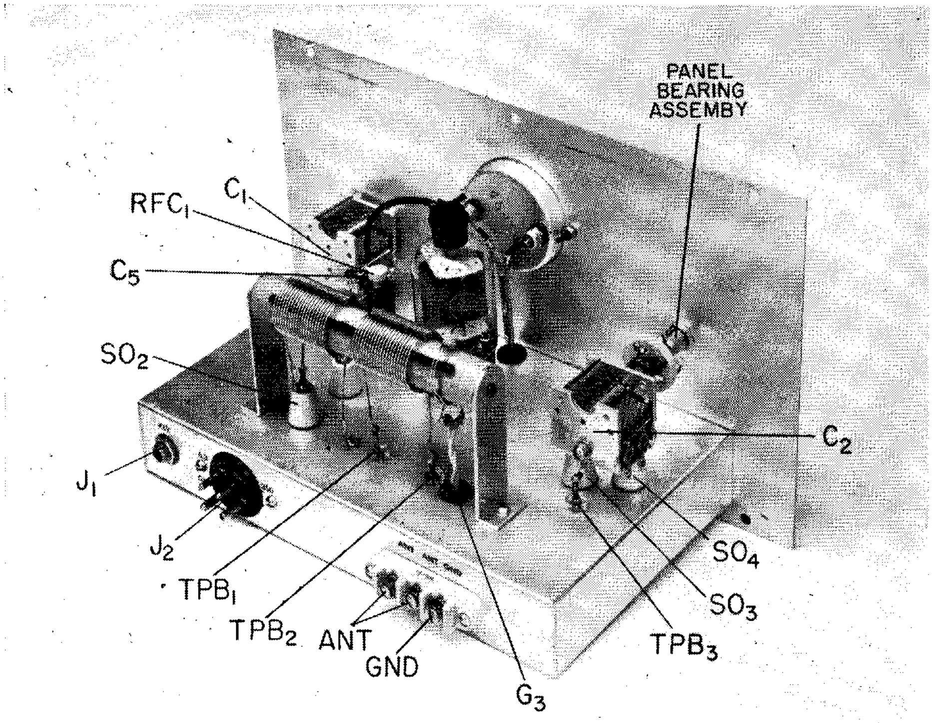

Fig. 20 — **The three coils are mounted on a section of wood dowel supported on aluminum brackets. The antenna tuning capacitor is mounted on small cone insulators.**

wire, grounding the braid at the nearest grounding lug. Near the opposite end of the wire, solder the braid to the grounding lug under SO_1. Solder the wire at J_2.

Solder the bottom terminal of I_1 to the mounting bracket of I_1. From Pin 2 on the tube socket (see Fig. 19), run a shielded wire to the upper terminal of I_1. Solder at the tube socket. Solder the braid to the nearest grounding lug at the tube socket. From the same terminal on I_1, run a shielded wire to Pin 4 of J_2. Solder at I_1. Connect a by-pass capacitor (C_8) at the J_2 end, connect the braid to the nearest grounding lug, and solder. Solder a wire from Pin 1 on J_2 to the nearest grounding lug.

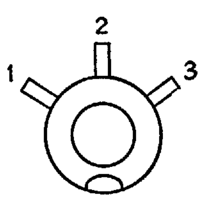

Fig. 21 — **Connections to the key jack should be made referring to this rear-view sketch for terminal numbering.**

From the insulated terminal of TP_1 run a shielded wire up through the grommeted hole (G_1) to the + terminal of the meter. Solder the shield to the nearest grounding lug at TP_1 and also at the upper (see Fig. 22) grounding lug at the crystal socket. Run a shielded wire from the − terminal of the meter down through the grommeted hole, along the right-hand end of the chassis to Terminal 3 (see Fig. 21) of J_1. Connect a by-pass capacitor (C_9) at the J_1 end of the wire, connect the shield to Terminal 2 on J_2, and join Terminals 1 and 2 with a short piece of wire. Solder all connections on J_1.

Where two shielded wires run close together, as at the right-hand end of the chassis and the wires to the meter, spot-solder the two shields together every 3 or 4 inches. This completes the shielded wiring.

Run a short length of insulated hook-up wire from the insulated terminal of TP_2 up through the adjacent hole (G_2) to the bottom terminal of RFC_1. Solder at TP_2. Solder a by-pass capacitor (C_6) between the bottom terminal of RFC_1 and the nearby grounding lug.

Connect the 0.01-μf. by-pass capacitor (C_3) between Pins 7 and 8 on the tube socket. Connect a short piece of wire from Pin 7 to the nearest grounding lug. Solder at Pin 7. Connect the 100K resistor R_1 (brown-black-yellow) between Pin 5 and the adjacent grounding lug. Solder at the lug. Solder a piece of No. 16 wire between Pin 5 and the upper (see Fig. 22) terminal of the crystal socket. Solder the other terminal of the crystal socket to the nearest grounding lug.

Solder the 68-ohm resistor R_2 (blue-grey-black) between Pin 8 on the tube socket to the insulated terminal of TP_1. Connect a by-pass capacitor (C_4) from Pin 4 on the tube socket to the nearest grounding lug. Solder at the lug. Connect the 10K 5-watt resistor R_3 from Pin 4 to the insulated terminal of TP_2 and solder

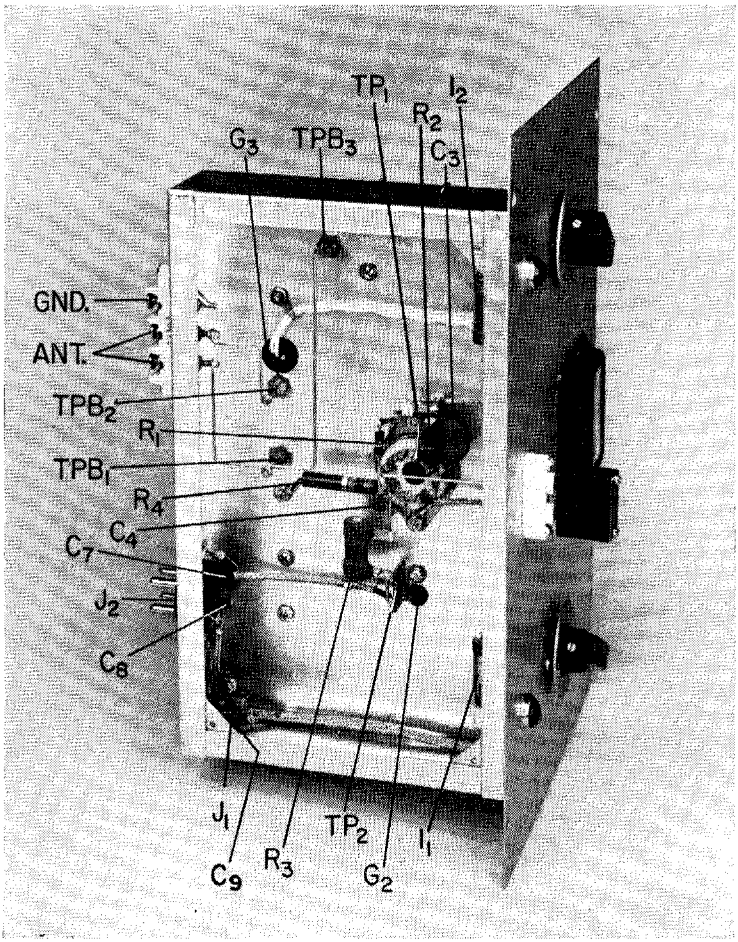

Fig. 22 — **Bottom view of the transmitter. The r.f. wiring is done with No. 16 bare wire. Power wiring is shielded to minimize TVI. The tube socket is mounted with its No. 1 and 8 pins toward the rear.**

at TP_2. Solder the 15K 2-watt resistor R_4 (brown-green-orange) between Terminal 4 of the tube socket and the grounding lug toward the rear of the chassis.

Connect a No. 16 wire from the bottom (see Fig. 22) terminal of the antenna-terminal strip to TPB_1. Solder at the terminal strip. Solder a No. 16 wire between TPB_1 and TPB_3. Solder a No. 16 wire between the middle terminal on the antenna-terminal strip and TPB_2. Solder a wire between the top terminal of the antenna-terminal strip to the nearest grounding lug.

On top of the chassis, solder the lug at the rear of C_2 to TPB_3. Solder a No. 16 wire between one of the lugs on SO_2 and a stator terminal on the right-hand (see Fig. 17) side of C_1. Cut a piece of No. 16 wire 1⅛ inches long, and solder it in a vertical position to the lug on SO_1. Connect the blocking capacitor (C_5) between the top end of this wire and the top terminal of RFC_1. Solder at the wire end. Cut the flexible lead of the bakelite tube-plate-cap connector to a

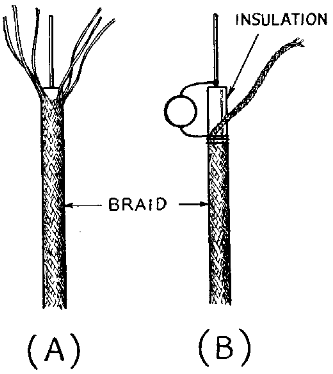

Fig. 23 **— Sketch showing how to prepare the ends of the shielded wire and how to connect the by-pass capacitors.**

length of about 3½ inches, and solder it to the top terminal of RFC_1. Solder L_1 between the lug on SO_1 and the adjacent wire between SO_2 and C_1. Connect a No. 16 wire between TPB_2 and the stator terminal on the left-hand (see Fig. 17) side of C_2.

Cut two pieces of insulated hook-up wire about 6 inches long. Twist them together to form a twisted pair and solder between the ends of L_4 and the terminals of I_2, running the pair down through the grommeted hole (G_3) below the coil assembly. Solder the outside end of L_2 to the remaining lug on SO_2. Solder the other end of L_2 to the grounding lug below. Solder the inside end of L_3 to TPB_1. Solder the other end of L_3 to TPB_2.

A power cable of sufficient length to reach from the transmitter to the power supply should be made up. This cable consists of two lengths of shielded wire. The inner conductor of one wire should connect Pin 4 of the female plug P_1 to Pin 4 on the male plug P_2. The inner conductor of the other wire should connect Pin 2 of the female plug to Pin 2 on the male plug. The outer braids of the two wires should be spot-soldered together every few inches, and connected to Pin 1 of the plug at each end.

A Combination Power Supply

Construction

The power supply shown in the photographs of Figs. 24 and 27 has provision for operating both this transmitter and the receiver described earlier. It is assembled on a 5 × 10 × 3-inch aluminum chassis. No drilling template is furnished since the placement of components is not critical, and it is actually easier to spot the mounting holes by using some of the parts themselves as templates.

Arrange the power transformer, filter chokes and rectifier-tube socket approximately as shown in Fig. 24. Mark the mounting holes for the transformer and chokes, and the center point of the socket. Also, mark the center of a ¾-inch hole under the transformer, directly under the point where the bunched leads come out of the bottom of the transformer, and ⅜-inch holes alongside each of the filter chokes at the point where the terminal leads emerge. Remove the components from the chassis and center-punch the hole centers.

At the front end of the chassis, the power switch, S_1, and the power-transfer switch, S_2, are centered 1¼ inches from the edges, and 1½ inches down from the top. The toggle switch requires a ½-inch hole, and the rotary switch a ⅜-inch hole. The two tube sockets, J_1 and J_2, used here as power connectors, are similarly centered in the other end of the chassis. These sockets also require a 1⅛-inch center hole. As viewed from the rear, the 5-prong socket, J_1, is to the right. A ⅜-inch hole, below the sockets and centered between them, is needed for the a.c. power cord.

All mounting holes should be made with a No. 24 drill to clear ½-inch 6-32 machine screws. See "Cutting the Holes" on page 44 for methods of making the larger holes and spotting the socket-mounting holes. The rectifier-tube socket should be turned with its key slot (see Fig. 26) toward the transformer. The power-outlet sockets should be mounted with their No. 1 pins (see Fig. 26) toward the top of the chassis.

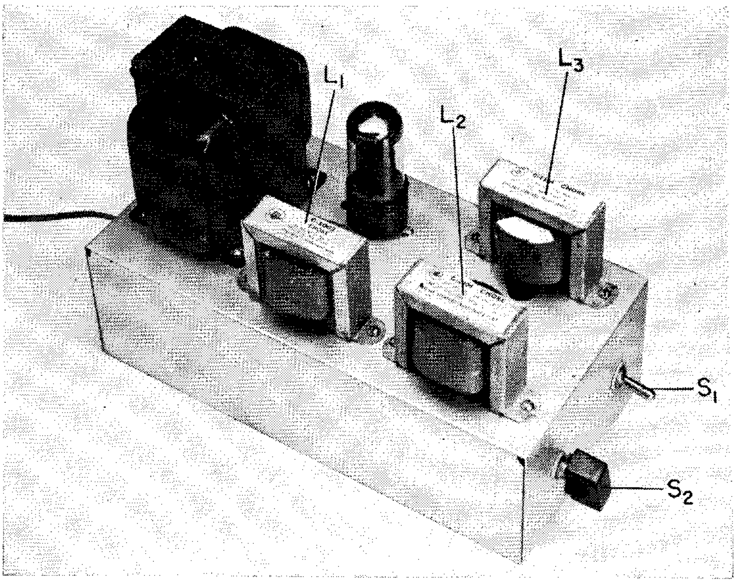

Fig. 24 **— Top view of the combination power supply for the transmitter and receiver.**

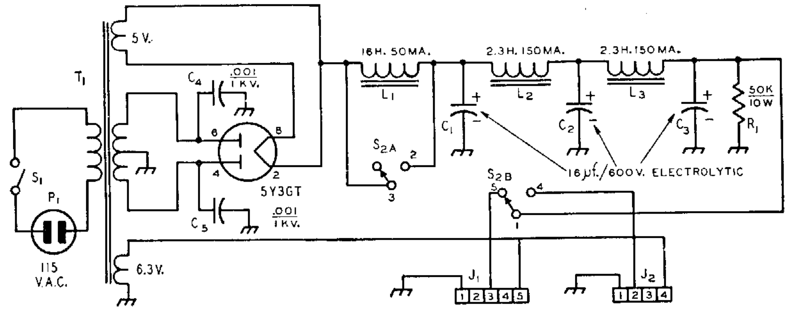

Fig. 25 — **Circuit of the combination power supply that will handle both transmitter and receiver. All capacitances are in µf.**

C_1, C_2, C_3 — Filter capacitor.
C_4, C_5 — R.f. by-pass capacitor to reduce tunable hum (disk ceramic).
J_1 — Receiver power outlet (5-prong tube socket — Amphenol 77MIP5).
J_2 — Transmitter power outlet (4-prong tube socket — Amphenol 77MIP4).
L_1 — Filter choke, 590 ohms (used for receiver only — Stancor C-1003).
L_2, L_3 — Filter choke, 60 ohms (Stancor C-2304).
P_1 — A.c. power plug.
R_1 — Bleeder resistor (to discharge filter capacitors — a safety measure).
S_1 — A.c. power switch (s.p.s.t. toggle).
S_2 — Power-transfer switch, bakelite rotary (Centralab 1405).
T_1 — Power transformer: 700 volts, c.t., 90 ma.; 5 volts, 2 amps.; 6.3 volts, 3 amps. (Stancor PC-8409).

Additional Parts for the Combination Power Supply Not Shown Under Fig. 25

1 5 × 10 × 3-inch aluminum chassis.
1 octal tube socket (Amphenol 77MIP8).
4 rubber grommets to fit ⅜-inch hole.
1 rubber grommet to fit ¾-inch hole.
1 tie point with 3 insulated terminals.
2 tie points with 1 insulated terminal.
9 soldering lugs.
16 6–32 machine screws ½ inch long with nuts.
About 5 ft. insulated hook-up wire.
About 5 ft. rubber a.c. cord.

The large hole under the transformer, the ones alongside the chokes, and the one for the a.c. power cord should be fitted with rubber grommets before mounting the components. In mounting the components on top of the chassis, several of the mounting screws are used also for fastening grounding lugs or insulated tie points. As the chassis is viewed in Fig. 27, 3 soldering lugs (see Fig. 7) are placed under the bottom right-hand mounting nut of the power transformer; a single grounding lug is at the lower left-hand corner; a tie

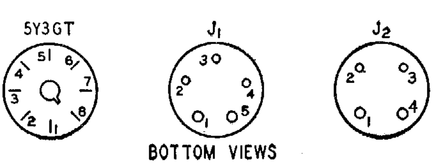

Fig. 26 — **Tube-socket and power-connector pin numbering for the power supply.**

point with 3 insulated terminals and a grounding lug are at the upper right-hand corner; a tie point with one insulated terminal is at the upper left-hand corner. A grounding lug is placed under the left-hand mounting nut of L_1, and a tie point with one insulated terminal and a grounding lug under the right-hand mounting nut of L_3. Two grounding lugs are fastened at the left-hand mounting screw of the rectifier-tube socket.

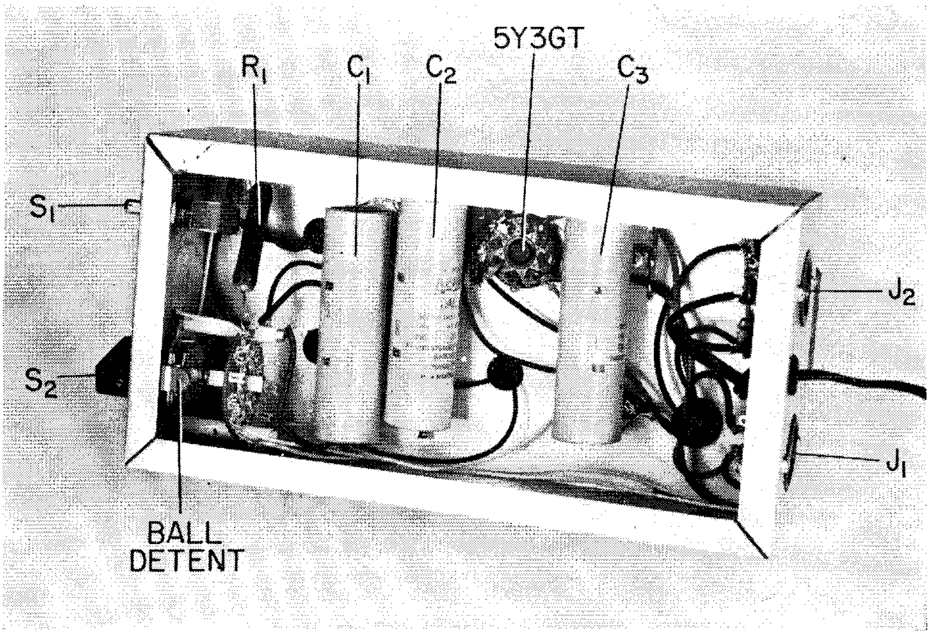

Fig. 27 — **Bottom view of the combination power supply.**

The toggle switch, S_1, should be turned with its terminals toward the top of the chassis. Fig. 28 shows a sketch of the rotary power-transfer switch as viewed from the rear. It should be mounted, as indicated, with its ball detent toward the open bottom of the chassis. The switch is equipped with an adjustable stop which can be removed after removing the mounting nut. Turn the switch as far as possible in the counterclockwise direction as viewed from the rear. With the switch viewed as in Fig. 28, replace the adjustable stop so that the tongue protrudes through the top hole on the right-hand side of the mounting head. Keep it in this position while the switch is mounted. The stop should limit the travel to two positions.

Wiring

See preliminary instructions under "Wiring" for the receiver, on page 46. All of the components may be mounted before wiring is started except the capacitors and the resistor.

Connect up the transformer first. It will make a somewhat neater job if the leads are cut off to the required length, but there is no other reason why they cannot be left at their original lengths (you may want to salvage the transformer later on). Run one of the red wires to Pin 4 on the tube socket (see Fig. 26). Run the other red wire to Pin 6. Solder one of the 0.001-μf. capacitors (C_4) between Pin 6 and the nearest grounding lug. Solder the other 0.001-μf. capacitor (C_5) between Pin 4 and the nearest grounding lug.

Solder one yellow wire to Pin 8 of the tube socket. Run the other yellow wire to Pin 2. Run one of the black wires to one of the insulated terminals on the 3-terminal tie point. From this terminal run an insulated wire to one terminal of the toggle switch and solder at both ends. Run the other black wire to another insulated terminal on the 3-terminal tie point. Connect one wire of an a.c. power cord to this terminal and solder. Connect the other wire of the a.c. cord to the remaining insulated terminal on the 3-terminal tie point. Run a wire from this terminal to the remaining terminal on the toggle switch. Solder at both ends.

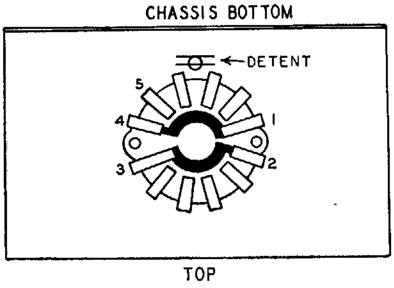

***Fig. 28* — Sketch showing terminal numbering of the rotary power-transfer switch as viewed from the rear.**

Solder one of the green wires to one of the 3 nearby grounding lugs. Run the other green wire to Pin 5 (see Fig. 26) on the 5-prong power socket. Run a wire from this pin to Pin 4 (see Fig. 26) on the 4-prong power socket. Solder at both ends.

Solder the red-yellow wire to another of the 3 nearby grounding lugs. Wind a piece of tape over the end of the green-yellow wire so it cannot make contact with anything else. This wire is not used. This completes the transformer wiring.

Solder a wire between Pin 1 on the 5-prong power socket and the remaining grounding lug immediately below. Also solder a wire between Pin 1 on the 4-prong power socket and the grounding lug below the socket. Solder a wire between Pin 3 on the 5-prong power socket and Terminal 5 (Fig. 28) of the rotary switch. Run a wire from Terminal 3 on the rotary switch to Pin 2 on the rectifier-tube socket. Solder at the socket. Connect one terminal wire of L_1 to Terminal 3 on the rotary switch and solder. Run the other terminal wire of L_1 to Terminal 2 on the rotary switch. Run one terminal wire of L_2 to Terminal 2 on the rotary switch. Run the other terminal wire of L_2 to the insulated tie point at the left of the tube socket. Run one terminal wire of L_3 to this same terminal. Run the other terminal wire of L_3 to Terminal 1 of the rotary switch. Run a wire from this terminal to the insulated terminal of the tie point to the right of the tube socket. Solder the resistor, R_1, between Terminal 1 of the rotary switch and the grounding lug in the upper left-hand corner of the chassis. Connect Terminal 4 on S_1 to terminal 2 on J_2.

Place C_1 in the chassis as shown in Fig. 27 with its + terminal toward the rotary switch. Slip a piece of insulating tubing (spaghetti) over the wire at the + end of the capacitor (or cover it with tape) and connect it to Terminal 2 of the rotary switch and solder. Solder the other end of C_1 to the adjacent grounding lug. Place C_2 in the chassis with its + terminal to the insulated tie point to the left of the tube socket and solder at the tie point. Solder the other terminal of C_2 to the adjacent grounding lug. Place C_3 in the chassis with its + terminal connected to the insulated tie point to the right of the tube socket, and solder. Solder the other terminal of C_3 to the adjacent grounding lug.

To complete the job, connect an a.c. power plug to the end of the power cord.

If you have a d.c. voltmeter, you can check the no-load output voltage to the transmitter by connecting the voltmeter with its + side to Pin 2 on J_2, and its − side to the chassis, and turning S_2 to the clockwise position. By moving the + side of the meter to Pin 3 on J_1, and turning S_2 to the counterclockwise position, the no-load voltage to the receiver can be checked. *Be sure that the toggle power switch is turned to the off position while you are connecting the meter!!!* The no-load voltage to the transmitter should be about 450 volts, and the voltage to the receiver about 300. These voltages will fall to proper values when the transmitter and receiver loads are connected.

Circuit Details

The basic theory behind the power supply is explained in an earlier section. The rectifier circuit is of the full-wave type. When the power-transfer switch, S_2, is in the receiver position (shown in Fig. 25) S_{2B} connects the high-voltage output of the supply to the receiver power connector J_1. The smoothing filter has three sections. The three sections reduce the hum level to a value low enough for satisfactory operation of the receiver. Since the first filter element after the rectifier is a choke, this filter is called a choke-input filter.

When the switch is thrown to the transmitter position, S_{2B} connects the high-voltage output of the supply to the transmitter power connector J_2. At the same time, S_{2A} shorts out the first filter choke, L_1. The first filter element after the rectifier is now a capacitor, and the filter is called a capacitive-input filter. The first filter capacitor tends to keep charged to a voltage near the peak value of the rectified wave. This is in contrast to the action of the choke-input filter where the first choke limits the charge which the first capacitor receives. As a result, the power supply delivers a considerably higher voltage for transmitting than for receiving, making the supply suitable for both. Output voltage with the switch in the transmitter position is further increased because the d.c. resistance of the first filter choke is eliminated. The filtering action of the first choke is not needed for the transmitter, since a transmitter does not require quite as much filtering in the power supply as a receiver.

The primary purpose of R_1 is to discharge the filter capacitors when the power is turned off. These capacitors hold their charges for a considerable time after the power is turned off by S_1, and there is the danger that the operator might forget this and receive a bad shock should he come in contact with the + high-voltage circuit. The resistor removes this danger.

The Transmitting Antenna

The simple random-length wire suggested for use with the receiver will not make a satisfactory transmitting antenna. There are numerous forms and dimensions that might be used with this transmitter. Some of them, however, would require an alteration in the circuit of the antenna tuner. One antenna that is quite flexible as to its length is shown in Fig. 29A. It consists of a horizontal wire elevated as high as possible, fed at the center with a 300- or 400-ohm open-wire line of the type sometimes used instead of Twin Lead with TV antennas (Fretco types BC or E, Taco 840, Knight 47TX579, etc.).

Ideally, Sections A should be 65 ft. each, and run in a straight line, while Sections B should also be 65 ft. long each, and be brought off at right angles to A. However, where the required space is not available, the ends of Sections A

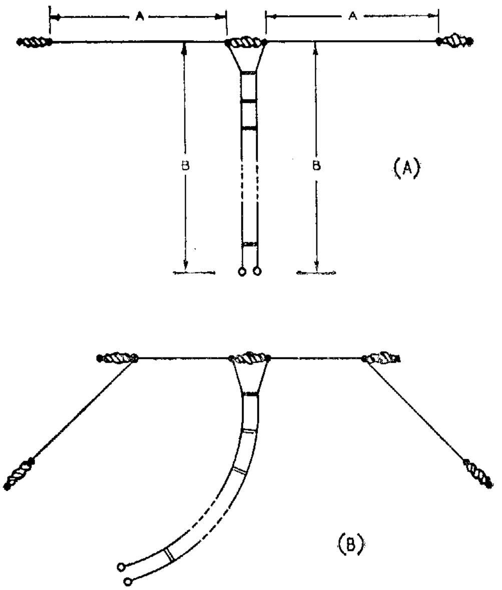

Fig. 29 — **Sketch of a recommended antenna for the transmitter. In restricted space, the ends of the antenna may be bent as shown at B. The antenna may also be shortened, so long as A + B totals 130 ft., as discussed in the text. Glass or porcelain antenna insulators should be used as shown.**

may be bent away from the line of the antenna — to one side or downward, as indicated in Fig. 29B. Also, if the station must be located at or near one end of the antenna, the feedline may be draped as indicated in B.

The system will also work quite well if Sections A are lengthened or shortened, provided that feedline Sections B are correspondingly shortened or lengthened to keep the total length (A + B) on each side at 130 ft.

Transmitter Adjustment

Before attempting to operate the transmitter into an antenna, it is a good idea to gain a little practical experience by using an ordinary 15-watt 115-volt lamp bulb as a "dummy" antenna. This will permit you to get acquainted with the operation of the transmitter without putting a signal on the air that might interfere with other amateurs. The lamp makes a good load for this sort of preliminary testing because you can find out how the various adjustments affect the power output of the transmitter by observing the relative brightness of the lamp.

The lamp should be connected across the antenna terminals of the transmitter. The ground terminal of the transmitter should be connected to a water pipe or steam radiator. This is a safety measure to reduce the danger of shock should some component break down unexpectedly.

Before turning on the power supply, plug an 80-meter crystal into the crystal socket. The crystal frequency must lie between 3700 and 3750 kc. if you are operating under a Novice Class license. Adjust the spacing between L_2 and L_3 to about ½ inch, and the spacing between L_3 and L_4 to about 1 inch. Set C_1 and C_2 to maximum capacitance (plates fully meshed).

Turn on the power (and set the power-transfer switch to the transmitter position if you are using the combination power supply described earlier). After allowing the tubes to warm up for a few minutes, close the key. The milliammeter should read about 160 ma. With the key held closed, turn C_1 slowly toward minimum capacitance, watching for a sudden dip in current. This should occur with C_1 set at approximately 70 per cent of maximum. The current should dip to a minimum of approximately 50 ma. This dip in current indicates that you have tuned the transmitter tank circuit to resonance.

Now key the transmitter for a minute or so. If the current suddenly jumps to a high value (indicating that the circuit has stopped oscillating), decrease C_1 slightly until the current drops again.

Now, slowly decrease the capacitance of C_2. This should cause the current to rise again. When the current has increased to about 70 ma., readjust C_1 for resonance. This time, the current at resonance should be greater than it was previously, and the load lamp should start to show a glow. By tuning the antenna system closer to the transmitter frequency (tuning the antenna system closer to resonance), the power input to the transmitter has been increased, and this has resulted in greater output to the antenna.

You will notice that the load lamp lights brightest at the point where the current dips as you adjust C_1. If you tune away from this point in either direction, the lamp will grow dimmer. Remember that maximum output is always obtained with C_1 adjusted for the dip in current. The *value* of current at the dip will vary with adjustment of the antenna tuning.

You should find, as you set C_2 to succeedingly lower values of capacitance and readjust C_1 each time for resonance, that the minimum current at resonance will keep increasing for a time, and the load lamp will get brighter. Then the current will begin to decrease and the output lamp will grow dimmer, indicating that you have gone past resonance in the antenna circuit. Readjust C_2 in the opposite direction and C_1 to resonance until you get back to the point where the current was greatest at resonance.

If this current is less than 100 ma. (which it probably will be), *turn off the power supply* and move L_3 a little closer to L_2 and again go through the procedure just described. (*Always turn the power supply off before touching the coils!!* With the parallel system of high-voltage plate feed used in this circuit, no high voltage should appear on the coils. However, some day you may have reason to work on a transmitter that does not have this safety feature. Get in the habit of never putting your hands into any electrical equipment until the power has been turned completely off.)

Continue the adjustment described until the current dips to 100 ma. when C_1 is adjusted for resonance and any further adjustment of C_2 causes the current to decrease. If, with any adjustment of C_2, the minimum current at resonance in the transmitter tank circuit runs above 100 ma., the coupling to the antenna should be reduced; that is, L_3 should be moved farther away from L_2.

When the transmitter is fully adjusted for maximum rated input (current 100 ma. at resonance) the load lamp should light to almost full normal brilliance. If at any point in the adjustment the circuit does not key reliably, reduce the capacitance of C_1, but only to the extent that is found necessary for reliable keying.

At this point, L_4 should be moved closer to L_2, a bit at a time, until I_1 lights up so that it can readily be seen when the key is closed. (If L_4 is moved too close to L_2, the bulb may burn out.) Now you will find that the brilliance of I_1 will vary in accordance with the load lamp when the transmitter is tuned. I_1 is useful in adjusting for maximum output when the antenna is connected.

If a voltmeter is available, screen and plate voltages under load can be checked. *With the power turned off*, connect the + side of the voltmeter to the bottom terminal of RFC_1, and the − side to the chassis. With the power turned on and the key closed, the meter should read approximately 325 volts. *Turn off the power supply.* Shift the + terminal of the voltmeter to the junction between R_3 and R_4. With the power on and the key closed, the meter should read about 135 volts.

Coupling to the Antenna

After you have become thoroughly familiar with the handling of the transmitter, the antenna feedline can be connected in place of the load lamp. The procedure for adjusting the transmitter with the antenna as a load is the same as for the lamp. Start out with L_2 and L_3 separated about ¾ inch so that the dip in current will be easily noticed. Then move L_3 closer to L_2 a bit at a time until the current at resonance is 100 ma. This should occur with L_2 and L_3 separated about ½ inch.

TVI

If you have a TV receiver, switch it to the v.h.f. channels if they are in use in your vicinity. Operate the transmitter while you, or someone else, watches the screen. If you find that the transmitter causes interference, it should be possible to clear it up entirely with one of the 300-ohm low-pass filters (such as the Drake TV-300LP) connected between the transmitter output terminals and the feedline.

How the Transmitter Works

The transmitter is of the simple type in which the oscillator feeds the antenna directly. The frequency of the output signal is governed by the quartz crystal Y_1. When you buy a crystal, you must specify the frequency you want to operate on. If you want to operate on more than one frequency, you will have to provide a crystal for each frequency.

Although a screen-grid tube is used, enough capacitance remains between the plate and grid inside the tube to provide sufficient feed-back coupling. When the circuit oscillates, r.f. is rectified in the diode formed by the control grid and cathode. The rectified current flows through the grid-leak resistor R_1, causing a voltage drop across the resistor. The direction of current flow is such

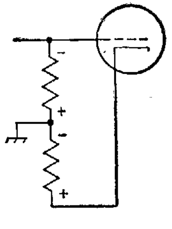

***Fig. 30* — The total bias when the transmitting tube is oscillating is the sum of the voltage drops across the grid leak R_1, and the cathode resistor R_2.**

that the grid end of the resistor is negative in respect to ground. The d.c. plate and screen currents flow through the cathode biasing resistor R_2, causing a voltage drop across this resistor. The direction of current flow is such that the cathode end of the resistor is positive in respect to ground. The total biasing voltage between cathode and grid is therefore the sum of the voltage drops across the two resistors, as illustrated in Fig. 30. If oscillation ceases, grid current stops and that portion of the biasing voltage across R_1 is lost. With zero grid bias, the tube would draw a very large plate current — enough to run the meter off scale and possibly damage it. However, since plate and screen currents continue to flow even when there is no oscillation, the voltage drop across R_2 still remains. This provides sufficient bias to limit the plate and screen currents to a total that is within the range of the meter during the time that it takes to adjust the circuit to restore oscillation. Since the meter is in the cathode circuit, it reads the sum of grid, screen and plate currents.[1]

C_3 is an r.f. by-pass capacitor around R_2, the meter and the key. The key opens and closes the d.c. connection between cathode and ground. Since the negative terminal of the high-voltage supply is connected to ground, the transmitter is turned on and off (keyed) by connecting and disconnecting the power supply as indicated in Fig. 31.[2] (*This does not mean that opening the key makes it safe to handle the transmitter while the power supply is still turned on. Never put your hands into a transmitter until the power supply has been turned completely off!!*)

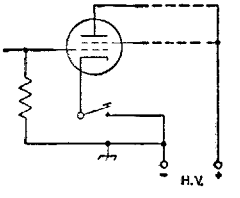

Fig. 31 **— This abbreviated circuit shows more clearly how the key disconnects the power supply from the transmitter.**

R_3 and R_4 form what is called a voltage divider. It is used to reduce the 325 volts from the power supply to a lower value that is suitable for the screen. It can be looked upon as a simple series resistor, R_3, with another resistor, R_4 in parallel with the screen of the tube. The current drawn by R_4 is added to the current drawn by the screen. Since the total current flowing through R_3 is therefore increased, any change in screen current becomes a smaller percentage of the total, and the voltage change caused by a change in screen current becomes smaller. In other words, the addition of R_4 helps toward maintaining a steadier screen voltage.

RFC_1 provides a d.c. path for feeding plate voltage to the tube. It must have a high impedance at r.f., otherwise it would short-circuit the r.f. output of the tube. C_6 bypasses r.f. around the high-voltage supply.

C_5 is a blocking capacitor that passes r.f. but blocks the flow of d.c. through the tank coil, L_2, to ground. L_1 is used to suppress v.h.f. parasitic oscillation (see an earlier section).

The plate tank circuit consisting of C_1 and L_2 serves three purposes. By proper adjustment of C_1 (so that the circuit is tuned to a frequency slightly higher than the crystal frequency) the phase of the feed-back voltage can be made proper to produce oscillation. It helps to minimize the output of energy at harmonic frequencies that are usually generated in an oscillator. It provides a means of coupling the r.f. output of the tube to the load circuit (the antenna).

L_3 and C_2 comprise a parallel-connected antenna tuner. Adjustment of C_2 will cancel any reactance that may appear at the input terminals to the an-

[1] It might be desirable to place the meter in the + high-voltage lead to the plate where it would indicate plate current only, since this determines the true plate input to the tube. However, some types of meters that might be substituted for the one specified have exposed adjusting screws on the front, setting up a hazard to the operator unless the meter is specially mounted. Placing the meter in the cathode circuit removes this danger.

[2] Actually, the keying action is not quite that simple. The key also breaks the grid-return path to cathode. An "open" grid collects a negative charge that tends to block the flow of plate current. As a result, the voltage appearing across the key contacts when the key is open is reduced to a relatively safe value. If the grid leak were returned directly to cathode so that the key did not open the grid return (negative high-voltage keying), the voltage across the key contacts would be practically the full supply voltage, with the danger of serious shock should the operator accidentally touch the bare parts of the key.

tenna system so that the system then appears as a resistive load. By adjustment of the coupling between L_2 and L_3, the load resistance represented by the antenna can be transformed to the value of plate load resistance required by the tube for proper operation. (The practical effect is to cause the tube to operate at the required plate-current input.)

C_7, C_8 and C_9 are for the primary purpose of by-passing v.h.f. harmonics to minimize TVI.

I_1 is an output resonance indicator. It is an aid in adjusting plate and antenna circuits for maximum output. I_2 is a panel lamp that indicates when the power supply is turned on.

DANGER! HIGH VOLTAGE!

In some of the equipment described in this booklet the voltage between certain points may run as high as 800 or 900 volts. Since individuals sometimes are killed by coming in contact with ordinary 115-volt home lighting circuits, the beginner must forever be aware of the potential danger attached to *careless* handling of amateur radio equipment — particularly transmitters.

Make it your *first* rule to form the habit never to touch anything behind the panel of a receiver or transmitter without first turning off *all* power. Thousands of amateurs, young and old, work daily with equipment carrying voltages as high as 8000 or 10,000 with complete safety. But the operator should never forget for a moment that harmless-appearing gear can and has been lethal in isolated instances when the operator became careless. NEVER TOUCH ANYTHING BEHIND THE PANEL UNTIL YOU ARE CERTAIN THAT ALL POWER HAS BEEN TURNED OFF!