

V.H.F. Transmitters

THE very-high frequency region is generally considered to have its lower frequency limit in the vicinity of the 28-Mc. band, and it is also in about this region that it becomes desirable to adopt more compact methods of construction and to select tubes with particular care. As the frequency becomes higher the length of connecting leads becomes more important, because a length of a few inches may represent a considerable fraction of the operating wavelength. Tube interelectrode capacities, as well as the stray capacities normally existing, also must be given particular attention, because an unduly high shunt capacity in the circuit not only may reduce the efficiency but also will ultimately set the upper limit of frequency at which the transmitter can be made to work. For best results at very-high frequencies, tubes designed to operate well in that region must be used. All of these considerations indicate the advisability of building separate r.f. equipment for transmission at very-high frequencies, rather than attempting to adapt for v.h.f. use a transmitter primarily designed for operation at ordinary communications frequencies.

Transmitter stability requirements for operation in the 56-Mc. band are the same as for the lower-frequency bands. Above 112 Mc. there are no restrictions as to frequency stability except that the whole of the emission must be confined within the band limits. Modulated-oscillator type transmitters therefore can be used above 112 Mc. and are, in fact, used practically exclusively above 224 Mc., since few available tubes will operate satisfactorily as amplifiers at this high frequency. However, up to 60 Mc. methods similar to those em-

ployed in the transmitters described in Chapter Twelve can be used.

Most of the 56-Mc. transmitters shown in this chapter are crystal controlled, for use with amplitude modulation. However, they can be adapted for f.m. by replacing the crystal with excitation from an f.m. oscillator similar to that described in Figs. 1519, 1520 and 1521. Higher-powered transmitters can be built by adding amplifiers to the units shown, basing the design of the amplifier on the medium-power unit shown in Fig. 1516.

A 10-Watt 56-Mc. Transmitter

The transmitter shown in Figs. 1501, 1502, 1503 and 1504 is an inexpensive affair using 6A6-type tubes throughout. As can be seen from Fig. 1503, one section of the first tube is used as a triode crystal oscillator on 7 Mc. while the second half doubles to 14 Mc. The two sections of the second tube are used as 28- and 56-Mc. doublers, and the third tube is a push-pull final amplifier. Capacitive interstage coupling is employed throughout except between the 56-Mc. doubler and the grid circuit of the final, where inductive coupling is used.

In the oscillator, parallel plate feed permits grounding the rotor plates of the tuning condenser; since the following grid circuit is series-fed, there is no essential difference in r.f. performance between this and the more common circuit with series plate and parallel grid feed. Cathode bias allows the tube to operate at low plate current; it is not necessary to work the oscillator very hard, since the excitation requirements of the first doubler are rather low.

The 14- and 28-Mc. doubler circuits are identical except for the cathode resistor, R_2 , in the first doubler stage. The second doubler uses no cathode bias, because as much output as possible is desirable to drive the 56-Mc. doubler. Parallel plate feed is used in both stages.

The 56-Mc. doubler has series plate feed through an untuned plate coil. Since the coupling to the final grid circuit is fairly loose, the coil is made nearly self-resonant so that maximum energy transfer will occur. The push-pull amplifier circuit is the standard arrangement for neutralized triodes.

Fixed or cathode bias is not required in the last three stages, either for operating or pro-

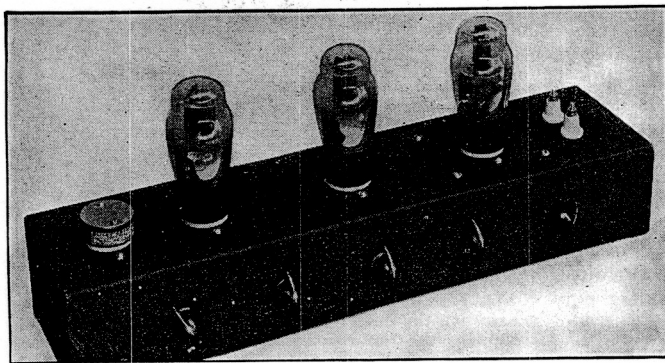


Fig. 1501 — In this front view of the 10-watt 56-Mc. transmitter the oscillator, doubler and amplifier tubes are from left to right. The crystal socket is at the left end of the chassis and the output terminals are at the right. The tuning controls are arranged in line along the front wall of the chassis.

protective purposes. The plate currents of the 6A6s will not be excessive in the event that excitation fails or is purposely shut off. This is a convenience where the oscillator is to be keyed for c.w. work.

Meter switching with shunt resistors (R_7 to R_{12} , inclusive) provides for measuring the plate current in each stage, although the meter is not incorporated in the transmitter itself.

The transmitter is built on a chassis measuring $3 \times 4 \times 17$ inches. One tube is located at the exact center of the top and the other two are $4\frac{1}{8}$ inches to the right and left, respectively. It is advisable to mount the oscillator and doubler tube sockets with the filament prongs toward the front of the chassis and the amplifier tube socket with its filament prongs facing the right end. This arrangement serves to keep the r.f. wiring simple and straightforward. The crystal socket and output terminals each are centered $1\frac{3}{4}$ inches from the ends of the chassis. The second-doubler tuning condenser, C_3 , is mounted in the center of the front wall of the chassis. The other

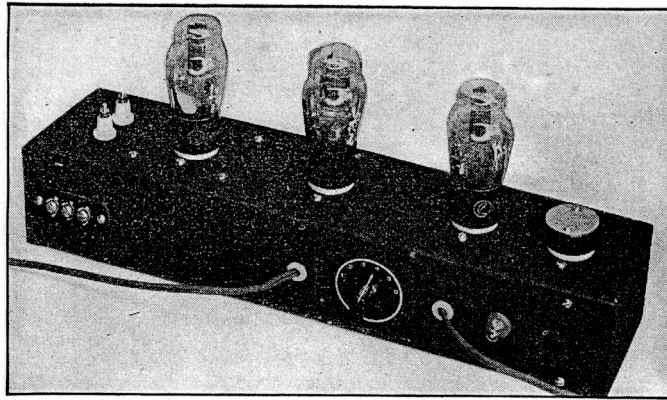


Fig. 1502 — The plate-voltage terminals are at the left in this rear-view photograph of the 10-watt 56-Mc. transmitter. The meter switch near the center is flanked by the meter cord on the left and the 115-volt line cord on the right. The crystal-current bulb is mounted in a rubber grommet.

variable condensers are located to the left and right, with ± 2 -inch spacing between shaft centers. C_1 , C_2 and C_3 are supported by the chassis wall, but C_4 and C_5 are mounted on small metal pillars from the upper side of the chassis. This mounting arrangement brings the shafts of C_4 and C_5 in line with the other three.

Fig. 1502 shows the placement of parts on the rear wall of the chassis. Wiring to the meter switch is simplified if the switch is located $6\frac{1}{2}$

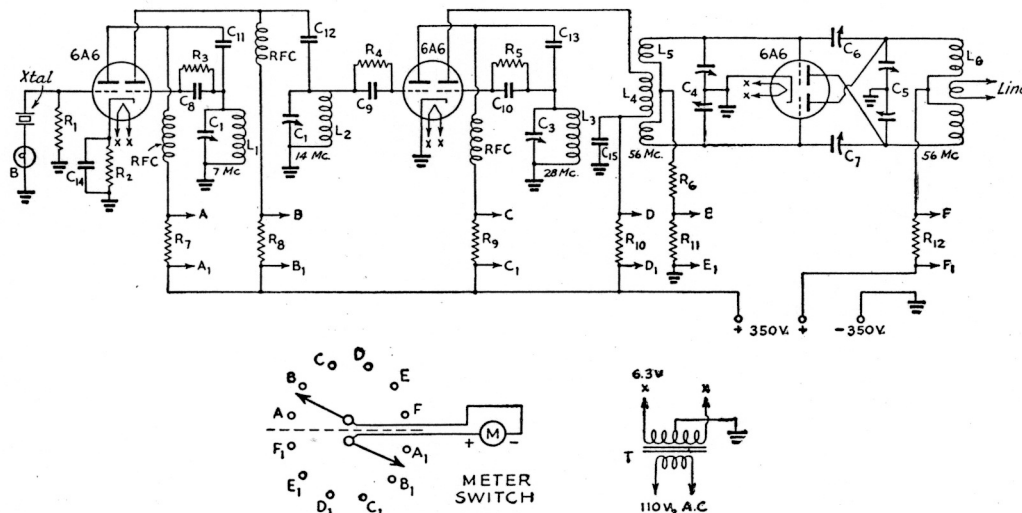


Fig. 1503 — Wiring diagram of the 10-watt 6A6 dual triode crystal-controlled 56-Mc. transmitter-exciter unit:

C_1 — 50- μ fd. variable (Hammarlund HF-50).

C_2 — 35- μ fd. variable (Hammarlund HF-35).

C_3 — 15- μ fd. variable (Hammarlund HF-15).

C_4 — 50- μ fd. per section dual variable (Hammarlund HFD-50).

C_5 — 15- μ fd. per section dual variable (Hammarlund HFD-15-X).

C_6 , C_7 — 3-30- μ fd. mica trimmer (National M-30).

C_8 , C_9 , C_{10} — 100- μ fd. midget mica.

C_{11} , C_{12} , C_{13} , C_{14} , C_{15} — 500- μ fd. midget mica.

R_1 — 15,000 ohms, $\frac{1}{2}$ -watt.

R_2 — 500 ohms, 1-watt.

R_3 , R_4 , R_5 — 30,000 ohms, $\frac{1}{2}$ -watt.

R_6 — 1000 ohms, 1-watt.

R_7 , R_8 , R_9 , R_{10} , R_{11} , R_{12} — 25 ohms, $\frac{1}{2}$ -watt.

RFC — 2.5-mh. r.f. choke (National R-100).

B — 60-ma. pilot bulb.

Sw — Two-circuit 6-position selector switch (Mallory 3226-J).

T — 6.3-volt filament transformer (Thordarson T-19F81).

L_1 — 21 turns No. 22 d.s.c., close wound, 1-inch diameter.

L_2 — 11 turns No. 22 d.s.c., 1 inch long, 1-inch diameter.

L_3 — 6 turns No. 14, $\frac{3}{4}$ inch long, 1-inch diameter.

L_4 — 9 turns No. 14, $\frac{3}{8}$ inch long, $\frac{3}{4}$ -inch diameter.

L_5 — 2 turns No. 12 each side of L_4 , 1-inch diameter, center opening $\frac{3}{4}$ inch. Turns spaced diameter of wire.

L_6 — 3 turns No. 12 each side of coupling link, $\frac{7}{8}$ -inch diameter, center opening $\frac{3}{4}$ inch. Turns spaced diameter of wire.

Link — 5 turns No. 12, $\frac{1}{8}$ -inch diameter, $\frac{1}{2}$ inch long.

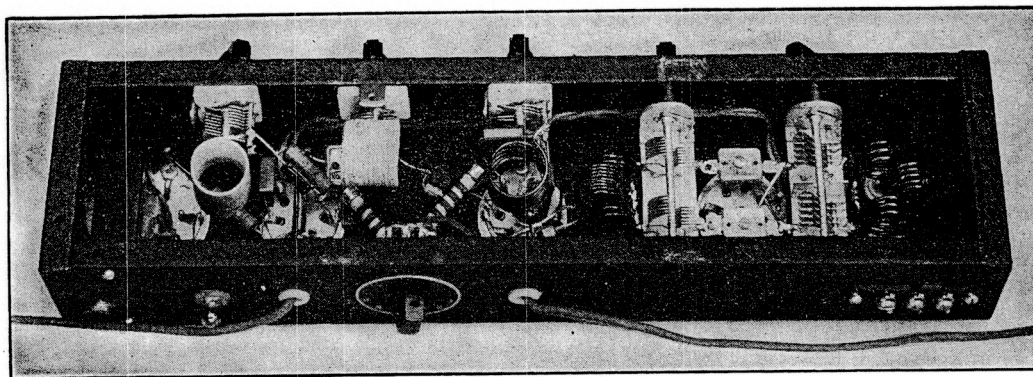


Fig. 1504 — This bottom view shows how the tuning condensers are mounted with respect to the tube sockets. The self-supporting coils mount directly on the tuning condensers. Filament transformer is in lower left-hand corner.

inches in from the right-hand end, looking at the rear, where there is a comparatively open spot in the r.f. layout. This point is also convenient to the supply ends of the plate chokes for the first three stages, so that these chokes can be mounted directly on the switch points. The shunt resistors should be soldered to the switch contacts before the switch is installed.

The filament transformer and crystal lamp are at the left end of the chassis, in the bottom view. The transformer should be kept as far as possible to the left so that it will not be near the r.f. circuits. The lamp is held firmly in the grommet by stiff leads soldered to its base. The plate-supply terminals are out of the way at the extreme left end of the base. Two positive terminals are provided, so that a modulator transformer secondary may be connected in the plate lead of the final amplifier.

The rest of the parts are mounted so that r.f. leads will be short and direct; short leads are particularly important in the last two or three stages. The grid connections in the amplifier should be made directly between the grid prongs of the socket and the stator plate terminals of the grid tank condenser, which should be directly above the grid prongs if the unit is laid out as recommended. The plate prongs and the stator sections of C_5 should be cross-connected so that the neutralizing condensers, C_6 and C_7 , may be supported by the condenser lugs, as shown in Fig. 1504. This gives leads of negligible length and perfect symmetry, both

of which contribute to good neutralizing. The trimmer-type condensers used for neutralizing are a departure from usual practice. However, since the neutralizing capacity required is small the actual dielectric is mostly air, the effect of the mica is inconsequential, and the small physical size of the condensers make them ideally suited for the purpose. The output coupling coil has its ends soldered to lugs which are held in place by the feed-through terminals. The lugs will bend as the position of the coil is varied to change the coupling.

A power supply delivering 350 volts at 150 ma. is needed. Circuit performance is similar to that to be expected at the lower frequencies; each tank circuit will be in resonance when adjusted for minimum plate current to the tube with which it is associated. The current values should be 10, 18, 18 and 40 ma., in the order listed, for the first four stages. It is quite possible that the values will vary slightly in different layouts, but they should be approximately as given. Tuning of the various tanks should be adjusted to obtain maximum output from the 56-Mc. doubler, as indicated by maximum grid current in the final-amplifier grid leak, R_6 . If no grid current is obtained, it is probably an indication that the coupling between L_4 and L_5 is either too tight or too loose; this coupling is quite critical, and therefore deserves careful adjustment. The amplifier grid current should be 25 ma. or more when the coupling is optimum. Each time the coupling is changed, the grid condenser, C_4 , as well as the preceding tuning condensers should be readjusted.

After a grid-current indication is obtained, the amplifier should be neutralized. Plate voltage must be removed from the final amplifier but the rest of the circuits should be in normal operating condition. Start with the plates of the neutralizing condensers screwed up tight and then back off a full three turns on each condenser. This places the neutralizing capacities at approximately the correct values. Condenser C_5 is then rotated through

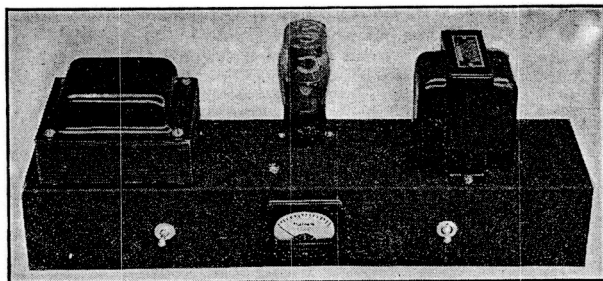


Fig. 1505 — The power-supply chassis also houses the milliammeter for all plate-current measurements in the 56-Mc. transmitter.

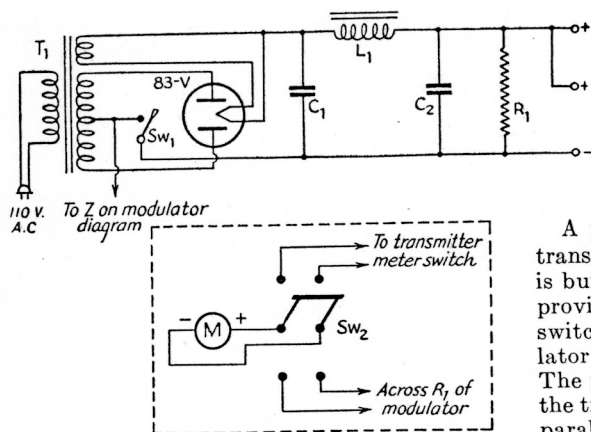


Fig. 1506 — Wiring diagram of the power-supply unit.

C_1, C_2 — 8- μ fd. 450-volt electrolytic.
 R_1 — 25,000 ohms, 25-watt wire-wound.
 Sw_1 — S.p.s.t. toggle switch (see text).
 Sw_2 — D.p.d.t. toggle switch.
 M — 0-150 ma. d.c. milliammeter.
 T_1 — Power transformer, 375-0-375 volts, 180 ma.; 5 volts 3 amperes (Thor-darson T-13R09).
 L_1 — Filter choke, 5 henrys, 200 ma., 80 ohms (Thor-darson T-67C49).

resonance, which will be indicated by a kick in the grid current. Adjust the neutralizing condensers in small steps, turning both screws in the same direction and the same amount each time, until the grid current remains stationary when C_5 is rotated. This indicates complete neutralization. Retune the grid circuit after neutralization, so that maximum excitation will be secured. It is also a good idea to recheck the coupling between L_4 and L_5 , as described above, since neutralization will change the load on the driver somewhat.

Plate voltage may now be applied to the amplifier. When the plate tank is tuned to resonance, the plate current should fall to 20 or 25 ma. A load, such as an antenna or feeder system or a 10-watt lamp used as a dummy antenna, should be connected and the coupling adjusted until the plate current reaches the full-load value of 60 ma. The grid current will fall off to 10 ma. or so when the amplifier is loaded.

The transmitter output may be fed into any type of antenna, if an appropriate matching or tuning system is used. A system employing a two-wire non-resonant line may be coupled directly to the output coil without tuning.

At the recommended input of 21 watts (60 ma. at 350 volts), the output as measured in a dummy antenna is something over 10 watts. To modulate the transmitter 100 per cent, an audio power output from the modulator of about 11 watts is required. The modulator output transformer must match an impedance of 5833 ohms (modulated-amplifier plate voltage divided by modulated-amplifier plate

current expressed in amperes). A 6000-ohm output winding will be close enough to provide a satisfactory match. A modulator using a Class-B 6A6 makes an excellent companion unit for the transmitter, because it maintains the uniformity of tube types. Such a unit is described in Chapter Thirteen.

A power supply capable of supplying this transmitter is shown in Figs. 1505 and 1506. It is built on a 3 $\times$ 4 $\times$ 17-inch chassis and has provision for mounting a meter which can be switched to either the transmitter or the modulator for checking the respective plate currents. The plate switch, Sw_1 , is used to turn on both the transmitter and the modulator, since it is in parallel with the switch on the modulator power supply. (Bib. 1.)

Ⓐ A 12-Watt 56-Mc. Transmitter

The transmitter shown in Figs. 1507, 1508, 1509 and 1510 is designed to work from a power supply delivering 125 ma. at 325 volts. Since there are vibrator-type packs available which deliver this output, it is quite suitable for installation in a car for mobile work. To achieve maximum economy in the exciter and audio stages, high-gain doubler tubes and Class-B audio modulation are used.

From the diagram in Fig. 1508 it may be seen that a 6AG7 Tri-tet oscillator using a 7-Mc. crystal quadruples frequency to drive a 6AG7 doubler to 56 Mc., and this latter tube drives a 6V6 amplifier on 56 Mc. A 6L6 could be substituted for the 6V6, but with no improvement in performance at 12 watts input. Provision for neutralizing the 6V6 is included in

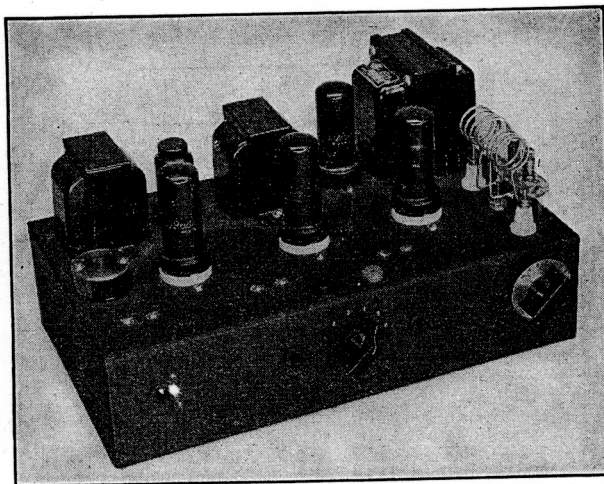


Fig. 1507 — A complete 12-watt 56-Mc. 'phone transmitter, ready for installation in either car or home. The tubes along the front, from left to right, are the 6AG7 Tri-tet oscillator, 6AG7 doubler and 6V6 final amplifier. The 6N7 Class-B modulator is at the rear between the transformers. The knob on the right controls the final tank condenser, C^4 . The other tuning condensers are adjusted by screwdriver through the rubber grommets. The meter switch, Sw_1 , is mounted at the front center, just under the meter pin jacks. The antenna coil is mounted on the binding-post strip. Coupling is adjusted by swinging the antenna coil.

the design of the unit, but it was found unnecessary with this particular parts arrangement. It is not to be assumed, however, that the 6V6 will work well without neutralization in every arrangement — the necessary neutralizing capacity is small, and is doubtless present in this layout as a stray capacity. The grid of the 6V6 is tapped down on the driver plate coil to lighten the loading and give a better match.

The modulation equipment consists of a 6C5 driver stage and a 6N7 Class-B modulator. Any arrangement except one using a single-button microphone would require more audio gain and hence increase the possibility of "hash" pick-up in mobile operation.

The transmitter is built on a $7 \times 12 \times 3$ -inch chassis, thus providing plenty of room for the parts. Reference to Figs. 1507 and 1509 will show the placement of parts, but some of the minor constructional points should be pointed out. The tuning condensers, C_1 , C_2 and C_3 , are mounted on the underside of the chassis on the small brackets with which they are furnished. They are set far enough back from the front so that the ends of the shafts do not quite touch the metal, and are screwdriver

adjusted. Rubber grommets in the chassis holes prevent shorting the condenser shafts to chassis through the metal shaft of the screwdriver. The final tank condenser, C_4 , is supported on the panel.

All of the inductances are mounted on or near their respective tuning condensers, except for the final tank coil, L_4 , which is mounted above the chassis on feed-through insulators. This arrangement makes it more convenient to adjust the antenna coupling coil, L_5 , after installing the transmitter in the car.

The plate circuits and the final grid circuit can be metered by plugging the meter leads into the two pin jacks on the front center of the chassis and setting the meter switch to the proper position. This is a convenience when tuning up with a different crystal or antenna. The power leads are terminated at a four-prong plug mounted on the back of the chassis.

One problem in connection with mobile units is the voltage drop in the line from the battery to the vibrator or motor-generator unit, and these leads must be kept as short as possible. This transmitter is intended to be installed in the trunk rack of the car, with the control box mounted on the dashboard of the car and the

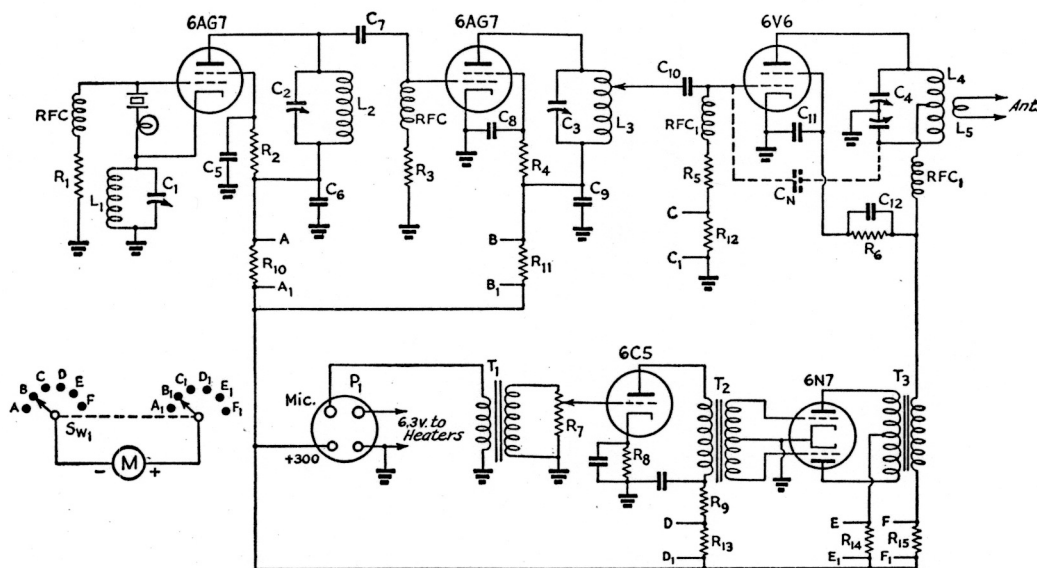


Fig. 1508 — Wiring diagram of the 12-watt 56-Mc. 'phone transmitter for mobile or fixed station operation.

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|---|---|---|
| C_1 — 50- μ fd. variable (National UM-50). | C_{13} — 25- μ fd. 25-volt electrolytic. | RFC — 2.5-mh. r.f. choke (National R-100U). |
| C_2 , C_3 — 25- μ fd. variable (National UMA-25). | C_N — See text. | RFC ₁ — V.h.f. choke (Ohmite Z-1). |
| C_4 — 30- μ fd. per section variable (Hammarlund HFD-30-X). | R_1 , R_3 — 0.2 megohm, 1-watt. | SW ₁ — 2-circuit, 5-position rotary switch, non-shorting (Mal-lory 3226J). |
| C_5 , C_8 — 0.01- μ fd. 400-volt paper. | R_2 , R_4 — 40,000 ohms, 1-watt. | T_1 — Microphone transformer (Stancor A-4726). |
| C_6 , C_9 , C_{11} — 0.002- μ fd. mica. | R_5 — 3000 ohms, 1-watt. | T_2 — Driver transformer (Stancor A-4721). |
| C_7 , C_{10} — 250- μ fd. mica. | R_6 — 5000 ohms, 2-watt. | |
| C_{12} , C_{14} — 8- μ fd. 450-volt electrolytic. | R_7 — 0.1-megohm volume control. | |
| T_3 — Modulation transformer (Stancor A-3845). | R_8 — 1000 ohms, $\frac{1}{2}$ -watt. | |
| L_1 — 19 turns No. 18 enam., spaced slightly to occupy $\frac{3}{8}$ -inch winding length, on $\frac{3}{8}$ -inch diameter form (National PRF-2). | R_9 — 6000 ohms, 1-watt. | |
| L_2 — 8 turns No. 14, spaced to occupy $1\frac{1}{8}$ inches, $\frac{7}{8}$ -inch diameter, self-supporting. | R_{10} – R_{15} — 25 ohms, $\frac{1}{2}$ -watt. | |
| L_3 — $3\frac{1}{2}$ turns No. 14, spaced to occupy $\frac{7}{8}$ inch, | | |
- $\frac{7}{8}$ -inch diameter, self-supporting. The 6V6 grid tap is 1 turn from the plate end.
 L_4 — 3 turns No. 14, each side of center, spaced to occupy $\frac{3}{4}$ inch, $\frac{7}{8}$ -inch diameter.
 L_5 — 2 turns, No. 14, $\frac{7}{8}$ -inch diameter.
 P_1 — 4-prong base-mounting plug (Amphenol RCP-4). The lamp in series with the crystal is a 60-ma. dial light.

vibrator pack mounted under the hood on the fire wall. This applies when the battery is under the hood of the car; for cars with the battery elsewhere, the vibrator pack and control box might have to be mounted differently. The drop in the leads running to the heaters of the tubes from the battery will be small if heavy wire is used, and the drop in the 325-volt line from the vibrator pack is negligible.

The wiring diagram of the control box is shown in Fig. 1510. As may be seen, the microphone battery is mounted in this box and a jack is provided for the microphone. Switch Sw_1 turns on the vibrator pack and the heaters of the tubes. Switch Sw_2 is used as an "on-off" switch for the transmitter, controlling the microphone battery and the plate-supply lead. The control box is only $4 \times 4 \times 2$ inches. (Parmetal MC-442), and takes up little room.

An alternative system is to mount the vibrator pack and an additional storage battery in the trunk rack, and to control both the "on-off" of the heaters and vibrator pack and of the plate power through suitable relays controlled from the dash. However, the storage battery then must be removed from the car for recharging, and thus the installation may not always be available when needed.

Adjustment of the transmitter is conventional in every way. With 325 volts from the power supply, the total plate and screen currents of the 6AG7 Tri-tet and the 6AG7 doubler will be 12 and 16 ma. respectively, and the final grid current should be about 2 ma. If, when the voltage is removed from the screen and plate of the 6V6 final, there is no flicker in the grid current as the final tank is tuned through resonance, there is no need to worry about neutralizing the final amplifier. However, if a flicker (0.1 ma. or so) does show up, a neutralizing capacity, C_n , can be introduced by running a stiff wire from the free end of the final tank to a point near the grid terminal on

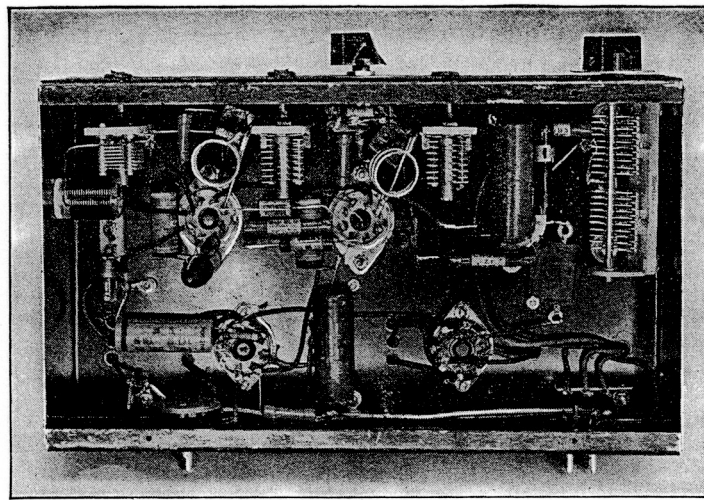


Fig. 1509 — A view under the chassis of the 56-Mc. transmitter shows the straight-forward arrangement of parts. The coils, L_2 and L_3 , are self-supporting and are mounted on their respective condensers. The audio volume control and the power-supply plug are mounted at the rear of the chassis. The lead from the plug to the microphone transformer is run through grounded shield braid.

the 6V6 socket (shown by dotted lines in Fig. 1508). The stage is then neutralized in the usual manner, varying the neutralizing capacity by moving the free end of the wire.

With voltage applied to the screen and plate of the 6V6 and the output tank circuit tuned to resonance, the total plate and screen current should be under 35 ma. unloaded and about 39 or 40 ma. loaded. In the audio section, the 6C5 plate current will be about 8 ma. and the no-signal 6N7 plate current around 35 ma., kicking up to about 50 ma. on peaks.

The antenna for mobile work may be from 0.25 to 0.6 wavelength long. Since the transmitter can be mounted close to the end of the antenna, there is no particular problem in feeding it aside from finding a suitable insulator to run through the side of the car. If an antenna near a quarter wavelength long is used, one side of the antenna coil, L_5 , should be grounded to the car and a variable condenser connected in series with the antenna and the other side of L_5 . When the antenna is nearer a half wavelength long, parallel tuning of L_5 should be used. Regardless of the length of antenna, the antenna coupling is varied by movement of L_5 with respect to L_4 after tuning both amplifier and tank circuit to resonance. (Bib. 2.)

Fig. 1510 — Circuit diagram of a control box for the 56-Mc. transmitter. J — Small microphone jack (Mallory 702B).

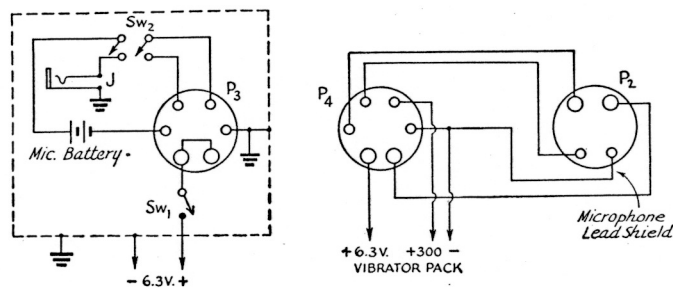
Sw_1 — D.p.s.t. high-current toggle switch, sections in parallel.

Sw_2 — D.p.s.t. toggle switch.

P_2 — 4-prong cable socket (Amphenol PF-4).

P_3 — 6-prong cable plug (Amphenol RCP-6).

P_4 — 6-prong socket (Amphenol PF-6). Microphone battery is a Burgess 3A2. Microphone lead in cable is shielded throughout.



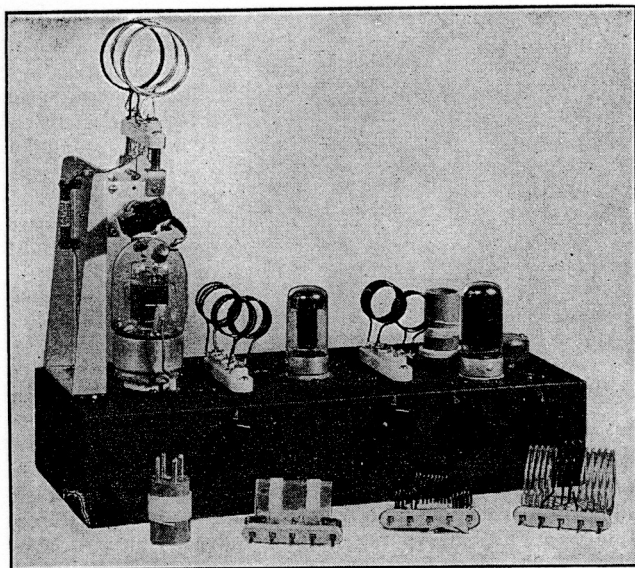


Fig. 1512 — The 815 transmitter with 56-Mc. coils in place. The 815 amplifier is at left, 7C5 driver in center, and 7N7 oscillator-doubler at right. Panel controls are, left to right, final grid, second doubler grid, first doubler plate and oscillator plate. Coils in front are used on 28 Mc.

to the tube plates until the stage is neutralized, as indicated by no reaction on the grid current when the plate circuit is tuned through resonance (with plate and screen voltage off).

Jacks are provided for metering grid and plate current in the driver and final stages.

The transmitter is built on a $6 \times 14 \times 3$ -inch chassis. Reference to Figs. 1512, 1513 and 1514 will show how the various components are arranged. The tuning condensers on the chassis are mounted on the small brackets available for the Cardwell Trim-Air condensers. Low-loss bakelite loktal sockets are used for the exciter portion, and a ceramic octal socket is used for the 815. The oscillator coil, L_1 , plugs into a four-prong ceramic socket, and Millen 41205 sockets, mounted above the chassis, are provided for coils L_2L_3 and L_4L_5 .

The final tank condenser, C_5 , is mounted on a bracket of aluminum so formed as to support the condenser just over the top of the 815. Two copper straps, wrapped around the center of the rotor and fastened to the end-plate spacer bars, provide a central rotor contact to keep the final tank circuit perfectly symmetrical. A Millen 40205 plug fastened to the bottom of the aluminum bracket holds the assembly in place and provides a connection for the d.c. plate voltage as well as a ground connection for the bracket. The 112-Mc. parallel-line tank similarly is mounted on a 40205 plug.

The heater current and low-voltage plate current are introduced at the rear of the set through a four-prong plug, while the high voltage plus modulation is introduced through a separate safety terminal. The two grid-current jacks are mounted directly on the rear of the chassis and the two plate-current jacks are mounted on a strip of bakelite supported well

away from the chassis by brass pillars for safety and for better insulation than would be provided by fibre washers.

The adjustment of the coils is similar to that in any other transmitter, with a few minor modifications. If the oscillator plate coil, L_1 , is wound as specified, the crystals should oscillate with condenser C_1 about half meshed. Coils L_2 and L_3 are next wound and plugged in, and a 0-10 milliammeter is connected in the grid circuit of the 7C5. With the crystal oscillating (as indicated by a neon bulb touched to the "hot" end of L_1 , or by monitoring the signal in a receiver), C_2 and C_3 should be tuned for maximum grid current to the 7C5. There will be some interlocking of the tuning of these two condensers if the coupling between L_2 and L_3 is too tight, and the two coils should be moved in relation to each other until practically "one-spot" tuning is obtained.

The grid current to the 7C5 should be 1.5 to 2 ma. with 275 volts applied to the plate of the 7N7. Next, L_4 should be wound,

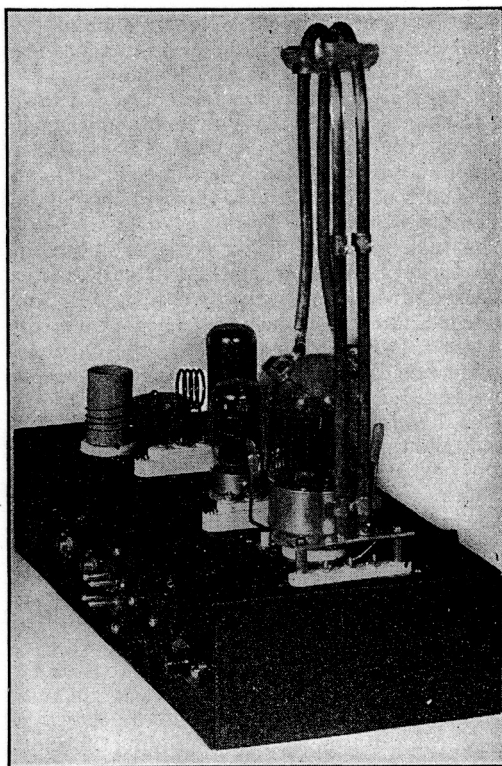


Fig. 1513 — Another view of the 815 transmitter with 112-Mc. coils and final tank in place. Note the small tabs alongside the 815 used for neutralizing. Meter jacks and power-supply terminals are at the rear of the chassis.

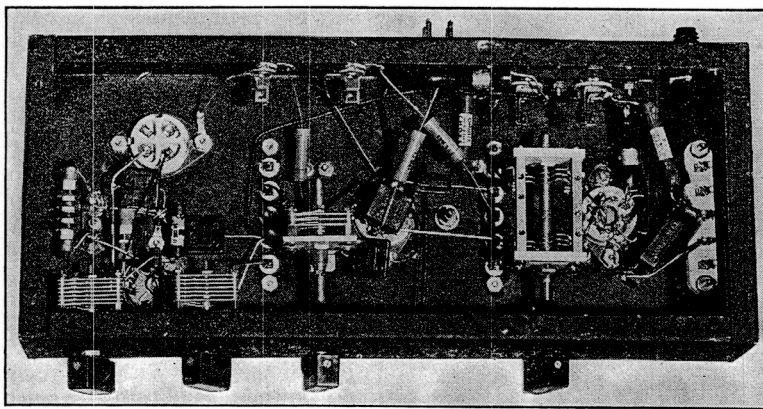


Fig. 1514 — A view underneath the chassis of the 815-tube transmitter. By-pass condenser leads are made as short as possible, and r.f. leads are made with heavy wire.

leaving off L_5 for the time being since L_4 is to be made self-resonant. If it is in resonance, as indicated by a neon bulb touched to the plate end, L_5 may be wound on; but if not, the turns should be pushed together or pulled apart until signs of r.f. can be seen. When L_5 is added the coupling should be made rather loose at first, since it will be found that there is more than enough drive available as indicated by the grid current to the 815. The coupling can be increased until the grid current is 6 or 7 ma. It will not normally be possible to obtain more than 4 to 5 ma. grid current to the 815 on 112 Mc., even with the coils tightly coupled, but this value is sufficient. The plate current of the 7C5 will be between 35 and 40 ma.

When grid current has been obtained in the 815 stage (with no plate or screen voltage applied), the tank circuit should be tuned to resonance as indicated by a sharp flicker of the grid current. The plates of the neutralizing condensers should then be moved with respect to the tube until no flicker remains, indicating that the tube is neutralized. Neutralization should always be checked when shifting from one band to another, since an accidental jarring of the tube or some unbalance in the stage may affect the adjustment. If the stage is correctly neutralized, it will be possible to apply several hundred volts (more might injure the tube) to the screen and plate and, with no bias, the excitation off and the plate tank unloaded, be able to detect no signs of r.f. anywhere in the circuit with any setting of the tank condenser. Unless the stage is neutralized, it will be impossible to modulate the amplifier fully without distortion.

When the amplifier has been neutralized, plate voltage may be applied with the excitation on and the amplifier loaded up to its rating of 150 ma. at 400 volts. About 30 watts of audio power will be required to modulate the stage.

The linear tank is tuned by sliding the shorting bar (two National metal-tube grid clips soldered together) up and down the bar until resonance is indicated. The bar has plate voltage on it, and all tuning should be carefully

done with an insulated screwdriver. The antenna coupling is by means of two similar grid caps which can be moved up and down the lines until proper loading is obtained.

If f.m. is to be used on the 56- or 112-Mc. bands the frequency-modulated oscillator can be coupled in through several turns around L_1 , with crystal removed from its socket. An f.m. oscillator is described in Figs. 1519, 1520 and 1521.

More than enough excitation is available on the 28- and 56-Mc. bands, but there is no advantage in running the grid current above 4 or 5 ma. since the output will not increase and the linearity of the amplifier is good with only 3 to 4 ma. grid current. The r.f. output of the transmitter could not be measured accurately above 28 Mc. (where it was close to 40 watts) but, with the lamp loads used, it appeared to be about 35 watts on 56 Mc. and 30 watts on 112 Mc., at the rated input of 60 watts.

A 275-volt and a 400-volt power supply are required for this transmitter. Figs. 1237 and 1215 show suitable power supplies, although the voltage from the supply of Fig. 1215 as shown will be too high, and a lower-voltage transformer should be substituted. A pair of 6L6s in Class AB₁ will furnish enough audio power to modulate fully the 815; such a modulator unit is shown in Fig. 1311. (*Bib.* 3.)

⚡ A 300-Watt 56-Mc. Amplifier

The 56-Mc. amplifier shown in Figs. 1515, 1516, 1517 and 1518 uses a pair of 35Ts or 35TGs running at 200 ma. with 1500 volts on the plates. With approximately 25 to 30 watts driving power, the efficiency and performance will be excellent. The 815 transmitter in Fig. 1511 is a suitable driver, although any transmitter of comparable output will serve.

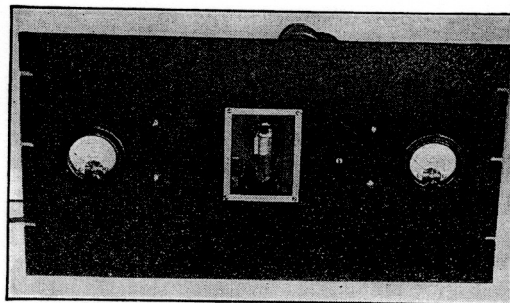


Fig. 1515 — The 300-watt 56-Mc. amplifier is built on a chassis which is supported by a Presdwood panel. The grid and plate tuning condensers are adjusted by an insulated screwdriver through holes in the panel.

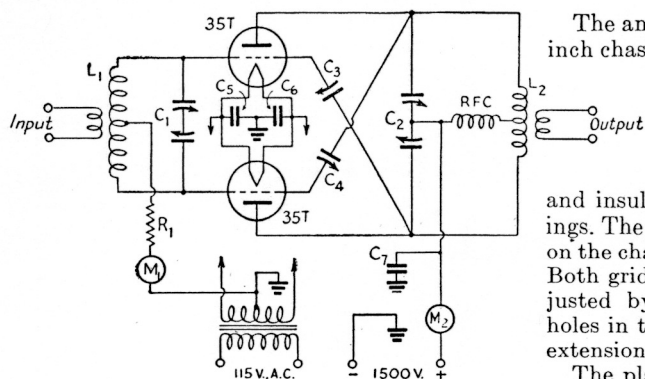


Fig. 1516 — Wiring diagram of the 300-watt amplifier.

- C_1 — 25- μ fd. per section dual (Cardwell ER-25-AD).
 C_2 — 35- μ fd. per section dual, rotor contacted at center (Millen 13035).
 C_3, C_4 — Homemade neutralizing condensers (see text).
 C_5, C_6 — 0.001- μ fd. mica.
 C_7 — 0.001- μ fd. mica, 5000-volt rating.
 R_1 — 2500 ohms, 10-watt.
 L_1 — 6 turns No. 12, $\frac{3}{4}$ -inch diameter, spaced to occupy $\frac{7}{8}$ inch. Link is 2 turns No. 14, $1\frac{1}{2}$ -inch diameter.
 L_2 — 4 turns No. 12, $1\frac{1}{2}$ -inch inside diameter, spaced diameter of wire with $\frac{3}{4}$ -inch gap in middle to accommodate 3-turn swinging link of No. 14 wire.
 M_1 — 0-100 or 0-150 milliammeter.
 M_2 — 0-300 milliammeter.
 T_1 — Filament transformer, 5 volts, 8 amperes (Thordarson T-19F84).

Fig. 1517 — A view behind the panel of the 300-watt amplifier shows the plate tuning condenser mounted on the panel bracket and gives a good idea of the construction of the neutralizing condensers. The plate coil socket is supported on the plate tuning condenser by two brass angles.

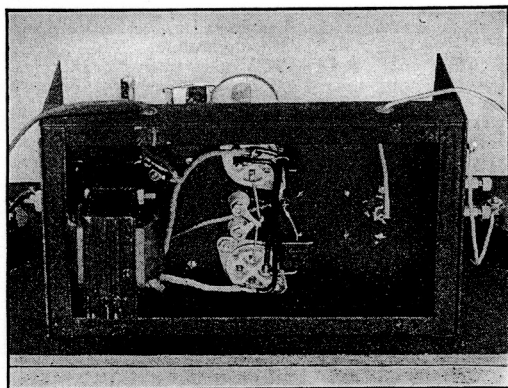
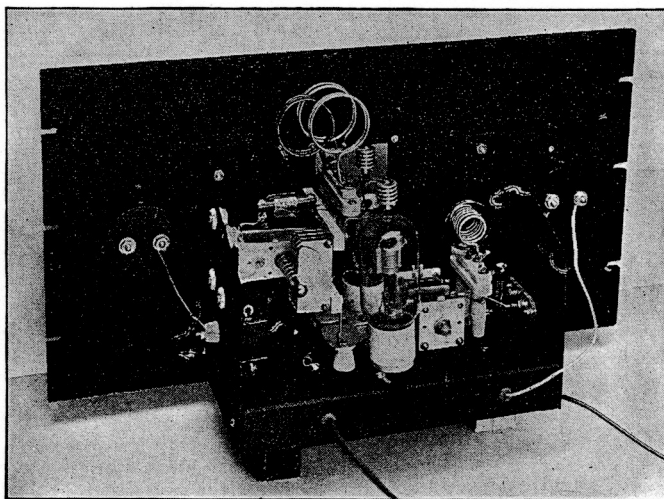


Fig. 1518 — The filament transformer is mounted underneath the chassis. Note how the leads from the neutralizing condensers to the grids of the tubes are crossed.

The amplifier is built on a $5\frac{1}{2} \times 9\frac{1}{2} \times 1\frac{1}{2}$ -inch chassis and is designed to be mounted on a panel of metal or Presdwood. Two panel brackets are used as supports, one at each end of the chassis. The plate tuning condenser, C_2 , is mounted on one of these brackets and insulated from it by small steatite bushings. The grid tuning condenser, C_1 , is mounted on the chassis and the rotor is left unconnected. Both grid and plate tuning condensers are adjusted by an insulated screwdriver through holes in the panel, although dials on insulated extension shafts could be used.

The plate tank coil is mounted on a Millen 40205 plug base, and the corresponding socket is supported on the tank condenser by two small brass angles. The grid coil is mounted on a National PB-16 plug, and its socket is raised above the chassis by small steatite stand-off insulators.

The neutralizing condensers are made from small tabs of aluminum with approximately one square inch of active area, supported about

$\frac{3}{16}$ -inch apart on individual steatite pillars or bushings. If 35Ts are used, as shown in the photographs, the lower neutralizing condenser plates are mounted on through bushings running through the chassis to the grid terminals on the sockets. If 35TGs are used, it is not necessary to carry the grid leads through the chassis. In either event, the grid leads from the neutralizing condensers are crossed to provide the proper phasing for neutralization.

The chassis is fastened to the front panel by the brackets referred to above. The two meters are mounted on the panel outside of the brackets. A rectangular hole in the center of the panel allows the tubes to be observed during operation. A National 3 $\times$ 4-inch chart frame is used to outline the rectangular hole.

Leads for the excitation input are brought to binding posts mounted on the panel bracket at the grid end of the chassis. The output leads

are run to an antenna tuning unit from the terminals on the plate coil socket. If desired, the antenna tuning unit could be mounted directly above the amplifier, or it could be mounted on the wall at the point where the antenna leads come into the station.

If sufficient excitation is available, the grid current will be 55 ma. or more when the plate circuit is loaded to 200 ma. at 1500 volts. The amplifier can be loaded to 225 ma. or higher if the grid current does not drop below this value with the increased plate loading. The plates of the tubes will run a dull red under normal operation; if the two tubes do not show the same color, it indicates unbalance in the circuit. However, with the amplifier laid out as shown no trouble of this sort should occur.

At 300 watts plate input, approximately 150 watts of audio power will be required to modu-

late fully the output of the amplifier. A pair of HY40Zs is recommended for the modulator unit. A suitable power supply, delivering the necessary 200 ma. at 1500 volts, can be built along the lines of the supply described in Fig. 1246, substituting lower-current filter chokes and power transformer.

¶ An F.M. Modulator-Oscillator Unit

Where a crystal- or e.c.o.-controlled transmitter for the 28-, 56- or 112-Mc. band is available, it is a relatively easy matter to disconnect the regular plate modulator and substitute for the crystal or e.c.o. the f.m. oscillator-modulator shown in Figs. 1519, 1520 and 1521. The r.f. output of the unit is intended to be fed through a link to a tuned circuit which substitutes for the crystal in the crystal oscillator. This tuned circuit is resonant at the same fre-

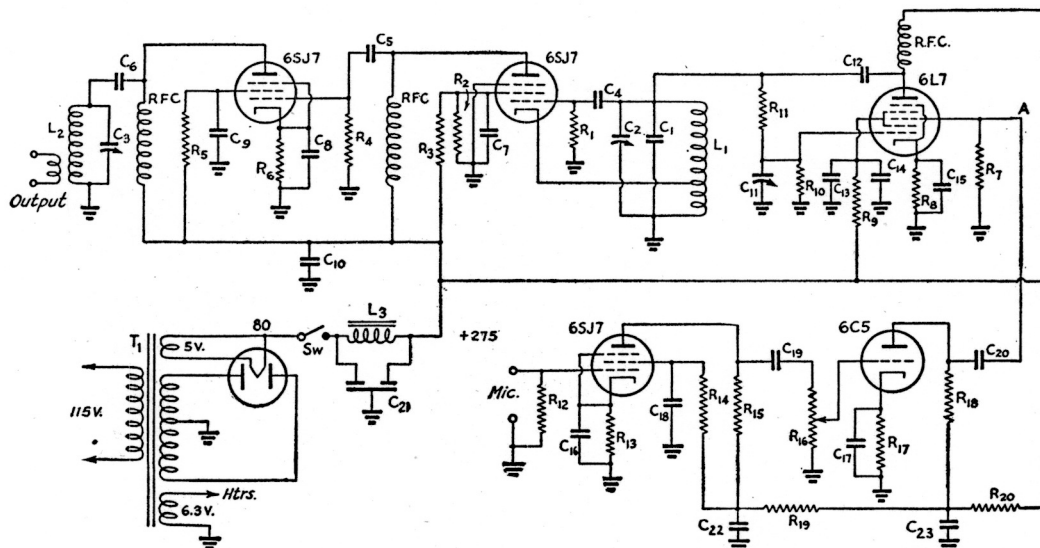


Fig. 1519 — Circuit diagram of the f.m. control unit for use with normally crystal-controlled v.h.f. transmitters.

C₁ — 150- μ fd. silvered mica for 7 Mc.; 650 μ fd. for 3.5 Mc.; 1150 μ fd. for 1.74 Mc.
C₂ — 100- μ fd. variable (National SE-100).
C₃ — 50- μ fd. variable (Hammarlund HF-50).
C₄ — 100- μ fd. mica.
C₅ — 250- μ fd. mica.
C₆ — 0-001- μ fd. mica.
C₇, C₈, C₉, C₁₀ — 0.01- μ fd. paper.
C₁₁ — 3-30- μ fd. compression trimmer (set full open).
C₁₂ — 250- μ fd. mica.
C₁₃ — 0.01- μ fd. paper.
C₁₄ — 8- μ fd. 450-volt electrolytic.
C₁₅ — 0.01- μ fd. paper.
C₁₆, C₁₇ — 10- μ fd. 25-volt electrolytic.
C₁₈ — 0.1- μ fd. 200-volt paper.
C₁₉, C₂₀ — 0.01- μ fd. 400-volt paper.
C₂₁ — Dual 450-volt 8- μ fd. electrolytic.
C₂₂, C₂₃ — 8- μ fd. 450-volt electrolytic.

R₁ — 0.1 megohm, 1-watt.
R₂ — 25,000 ohms, 1-watt.
R₃, R₄, R₅ — 50,000 ohms, 1-watt.
R₆ — 300 ohms, 1/2-watt.
R₇ — 0.5 megohm, 1/2-watt.
R₈ — 300 ohms, 1/2-watt.
R₉ — 30,000 ohms, 1-watt.
R₁₀ — 0.5 megohm, 1/2-watt.
R₁₁ — 50,000 ohms, 1-watt.
R₁₂ — 5 megohms, 1/2-watt.
R₁₃ — 900 ohms, 1/2-watt.
R₁₄ — 1 megohm, 1/2-watt.
R₁₅ — 0.25 megohm, 1/2-watt.
R₁₆ — 0.5-megohm volume control.
R₁₇ — 2000 ohms, 1/2-watt.
R₁₈ — 50,000 ohms, 1/2-watt.
R₁₉ — 0.25 megohm, 1/2-watt.
R₂₀ — 0.15 megohm, 1-watt.
RFC — 2.5-mh. r.f. choke.
L₁ — 7 Mc.: 10 turns No. 18 e., length 3/4 inch, 1-inch diameter, tapped 3rd turn from ground.

3.5 Mc.: 11 turns No. 24 e., length 3/4 inch, 1-inch diameter, tapped 4th turn from ground.
1.75 Mc.: 21 turns No. 24 e., length 1 inch, 1-inch diameter, tapped 6th turn from ground.
L₂ — 14 Mc.: 10 turns No. 18.
7 Mc.: 20 turns No. 18.
3.5 Mc.: 40 turns No. 24.
1.75 Mc.: 75 turns No. 26.
All coils wound with enameled wire on 1 1/2-inch diameter forms (Hammarlund SWF-4). 1.75-Mc. coil close-wound; others spaced to a length of 1 1/2 inches.
Link 3 to 5 turns (not critical).
L₃ — Filter choke, 10 henrys, 40 ma.
T₁ — 250-0-250 volts, 40 ma.; 6.3 volts at 2 amperes; 5 volts at 2 amperes. (Thordarson T-13R11).
Sw — S.p.s.t. toggle switch.

Note: Data for L₁ is subject to individual trimming for proper frequency coverage. Adjust inductance by changing turn spacing to bring low frequency end of band near maximum capacity on C₂. Coil specifications given apply to coil centered in round shield 2 inches in diameter and 2 1/2 inches high. The 3.5- and 7-Mc. coils give full coverage of the 56-60-Mc. band with C₂ 100 μ fd.; the 1.75-Mc. coil will cover approximately 57-60 Mc. with the same condenser.

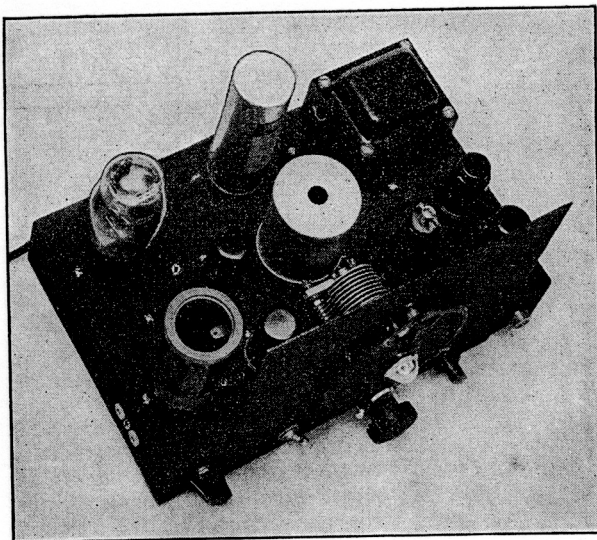


Fig. 1520 — This modulator-oscillator unit is used with normally crystal-controlled v.h.f. transmitters for frequency-modulated output. It contains a speech amplifier and power supply, so that no additional equipment is needed. The oscillator coil is in the round shield can in the center. The coil in the left foreground is the buffer output circuit. The speech amplifier and modulator are at the right, with the power supply along the rear. A 7 × 11-inch chassis is used.

quency as the output tank of the control unit, L_2C_3 in Fig. 1519, and is in fact identical with it in construction. In transmitters using triode or pentode crystal oscillators in which the tubes are not well screened, it is advisable to use the crystal oscillator tube as a doubler rather than as a straight amplifier. If the transmitter uses a 7-Mc. crystal oscillator, for example, the output of the unit may be on 3.5 Mc. and the grid circuit of the ex-crystal tube also tuned to 3.5 Mc. This will avoid difficulty with self-oscillation in the ex-crystal stage. With a pentode oscillator it is possible to work straight through, provided the grid tank substituted for the crystal is tuned well on the high-frequency side of resonance, but this procedure is not advisable since it may make the modulation non-linear. It is rather important that all circuits in the transmitter be tuned "on the nose" for best performance. Of course, if the crystal tube is a well-screened transmitting type it can be used as a straight amplifier.

With harmonic-type crystal oscillators the input frequency can be the same as that of the crystal, since the output frequency of the crystal tube is already a harmonic. In the Tri-tet oscillator, the cathode tank should be short-circuited; in the types using a cathode impedance to provide feed-back, this impedance also should be

shorted. Care should be taken to avoid short-circuiting the grid bias, whether from a cathode resistor or grid leak. In the latter case this usually will mean that a blocking condenser (500 $\mu\text{fd.}$ or larger) should be connected between the "hot" end of the grid tank and the grid of the ex-crystal tube, with the grid lead (and choke) connected on the grid side of the condenser. Such a blocking condenser may be incorporated in the plug-in tank. The grid-tank tuning condenser may be a small air padder mounted in the coil form.

Where a suitable power supply and speech amplifier are already available, the lower part of Fig. 1519 can be omitted and only the oscillator, buffer and modulator units need be built. Transformer input to the modulator may be used where the available speech amplifier happens to have a low-impedance output circuit. The transformer and gain control connect between ground and point "A" of Fig. 1519, R_7 being omitted. Any of the conventional methods may be used to couple the modulator to an available speech amplifier, with one precaution — if a high-impedance connection is used, the "hot" lead should be shielded to prevent hum pick-up. (*Bib. 4.*)

If the transmitter to be used has a self-excited oscillator, electron-coupled or otherwise, a separate oscillator need not be built. The reactance modulator can be connected directly across the tank circuit of the oscillator. If the oscillator has too high a C/L ratio, not enough deviation may be obtained without distortion. It is advisable to use an L/C ratio in the oscillator comparable to those given in Fig. 1519.

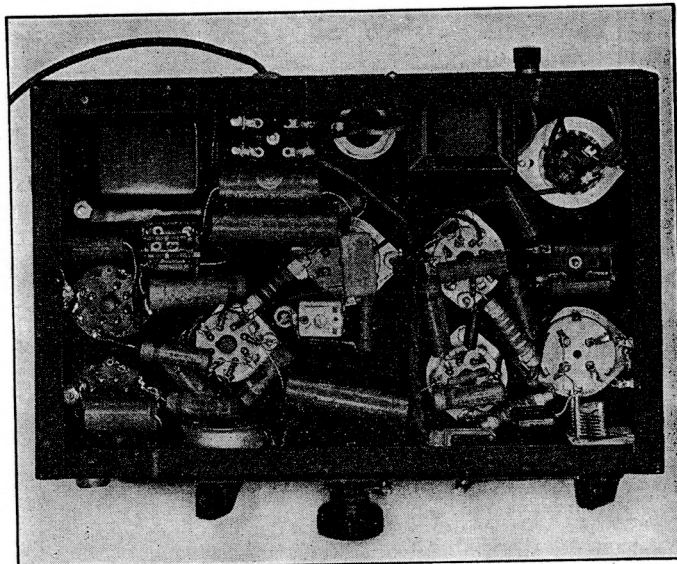


Fig. 1521 — In this bottom view, the r.f. section is at right and the audio at left. The oscillator socket is to the right of the coil socket in the center.

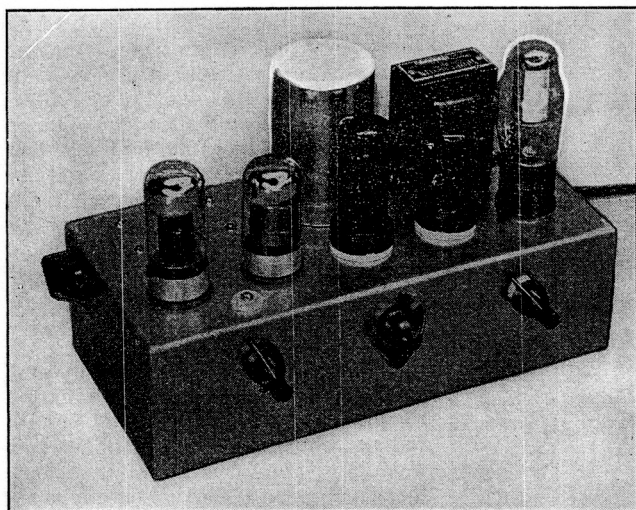


Fig. 1522—The complete 56-Mc. f.m. transmitter has all r.f. components mounted under the chassis with the exception of the oscillator grid coil, which is housed in the shield can in the rear center of the chassis. The tubes, from left to right, are 7C5 output amplifier, 7G7 doubler, 6F6 e.c.o., 6SA7 reactance modulator and VR150-30 voltage regulator.

Ⓐ A Complete 56-Mc. F.M. Transmitter

The transmitter shown in Figs. 1522, 1523 and 1524 will yield a carrier of approximately 7 watts on 56 Mc., using a plate power supply delivering 300 volts. A reactance modulator is incorporated in the unit. If it is desired to use amplitude modulation, the gain control on the reactance modulator should be set at zero and

the necessary 6 watts of audio connected in series to the plate and screen lead of the 7C5 output amplifier. Used as an f.m. transmitter, the entire unit requires 300 volts at about 90 ma., making it ideal to run from a vibrator pack for portable/mobile work.

A single-button carbon microphone is transformer-coupled to the 6SA7 reactance modulator, which is connected across the tank circuit of the 6F6 e.c.o. A VR150-30 stabilizes the voltage across the oscillator and modulator and aids materially in keeping the mean frequency constant. The grid circuit of the e.c.o. tunes from 14 to 15 Mc. with a slight margin at either end of the tuning range, and the plate circuit of the e.c.o. is tuned to 28 Mc. by means of a self-resonant coil which is adjusted for maximum output by squeezing the turns together or spreading them apart. Once adjusted, it need not

be touched for any change in tuning conditions. The 28-Mc. output of the e.c.o. drives a 7G7/1232 doubler to 56 Mc., which in turn drives the output amplifier.

With a 300-volt supply, the 7C5 final-amplifier grid current should be about 0.6 ma. under load for linear amplitude modulation. If f.m. is used exclusively, the grid current can be lower with no harmful effect other than a slight de-

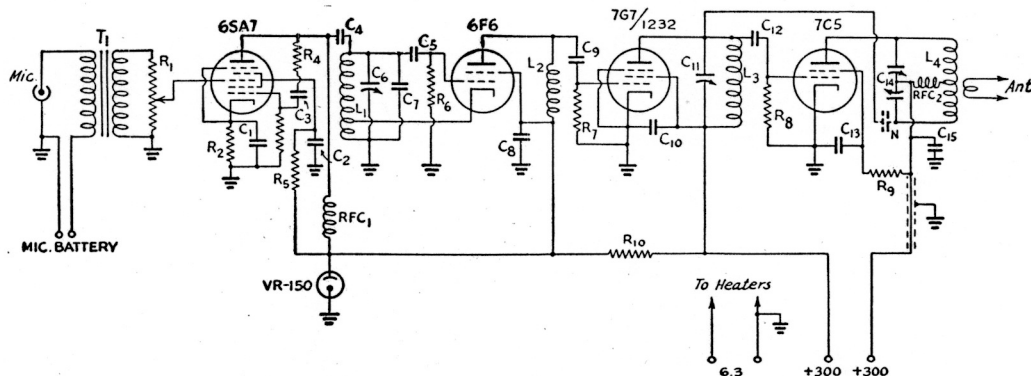


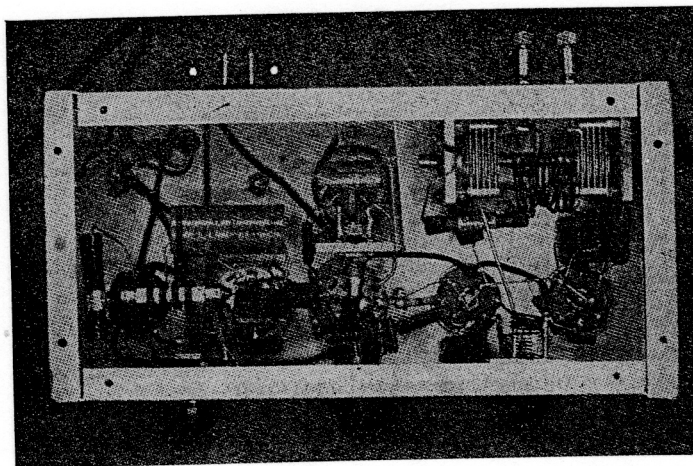
Fig. 1523—Wiring diagram of the complete 56-Mc. 7-watt frequency-modulated transmitter.

- C₁—0.01- μ fd. 400-volt paper.
- C₂—8- μ fd. 450-volt electrolytic and 0.005- μ fd. mica in parallel.
- C₃—0.001- μ fd. mica.
- C₄—500- μ fd. mica.
- C₅, C₉, C₁₂—100- μ fd. mica.
- C₆—15- μ fd. midjet variable (Hammarlund HF-15).
- C₇—25- μ fd. silvered mica.
- C₈, C₁₀, C₁₃—0.005- μ fd. mica.
- C₁₁—35- μ fd. midjet variable (Hammarlund HF-35).
- C₁₄—35- μ fd. per section dual variable (Cardwell ER-35-AD).
- C₁₅—Two 500- μ fd. mica, one at each end of rotor of C₁₄.

- N—Neutralizing condenser (see text).
- R₁—100,000-ohm volume control.
- R₂—750 ohms, $\frac{1}{2}$ -watt.
- R₃—0.25 megohm (not marked in diagram).
- R₄—50,000 ohms, $\frac{1}{2}$ -watt.
- R₅—5000 ohms, $\frac{1}{2}$ -watt.
- R₆—25,000 ohms, $\frac{1}{2}$ -watt.
- R₇—0.1 megohm, $\frac{1}{2}$ -watt.
- R₈—75,000 ohms, $\frac{1}{2}$ -watt.
- R₉—5000 ohms, 1-watt.
- R₁₀—3000 ohms, 10-watt.
- RFC₁—2.5-mh. r.f. choke.
- RFC₂—V.h.f. choke (Ohmite Z-1).
- T₁—Microphone transformer (Thordarson T-58A37).

- L₁—10 $\frac{1}{2}$ turns No. 20 e., spaced to occupy 1 inch on a 1-inch diameter form; cathode tap 2 $\frac{1}{2}$ turns up. Plugged into socket on chassis.
- L₂—14 turns No. 20 e., spaced to occupy 1 $\frac{1}{8}$ inches, 9/16-inch diameter; self-supporting (see text).
- L₃—4 turns No. 20 e., $\frac{1}{2}$ -inch diameter, $\frac{1}{4}$ -inch long.
- L₄—6 turns No. 14 e., $\frac{3}{4}$ -inch inside diameter, wound to occupy 1-inch length, with $\frac{3}{8}$ -inch gap in center for swinging link of 2 turns No. 14 e., same diameter.

Fig. 1524—A view underneath the chassis of the 56-Mc. f.m. transmitter shows the volume control at the left, the oscillator control at the center, the doubler tuning control at the right, and the final amplifier tuning control at the side. The microphone connector is on the left side of the chassis, and the four-prong plug and flexible wire connect to the power supply and microphone battery, respectively. Note the shield between the final tuning condenser and the oscillator tuning condenser, to reduce reaction between the two circuits, and the wire running from the doubler tuning condenser to near the final tank condenser which is used as a neutralizing condenser (*N* in Fig. 1523). The output connects to two binding posts on a Victron strip.



crease in output of the amplifier. The 7C5 final amplifier is plate neutralized by running a length of stiff wire from the plate side of the doubler tuning condenser over to a point near the open side of the final-amplifier split-stator tuning condenser. The capacity from this wire to the stator of the condenser is sufficient to neutralize the final amplifier. It may be adjusted by snipping off the end of the wire, a small bit at a time, until the plate-tank tuning shows no reaction on the grid current (with both plate and screen voltage off).

No difficulty should be encountered in adjusting the transmitter other than setting the e.c.o. coils to the proper frequencies. The grid coil should be adjusted to cover the proper range with the reactance modulator tube in the circuit. The range can be varied by pushing the turns together or spreading them apart, while checking the resulting frequency on a calibrated receiver. The e.c.o. plate coil can best be adjusted by reading grid current to the final amplifier (by connecting a 0-1 ma. d.c. milliammeter between R_3 and ground) and adjusting L_2 until the 7C5 grid current is a maximum with the oscillator set at 14.5 Mc.

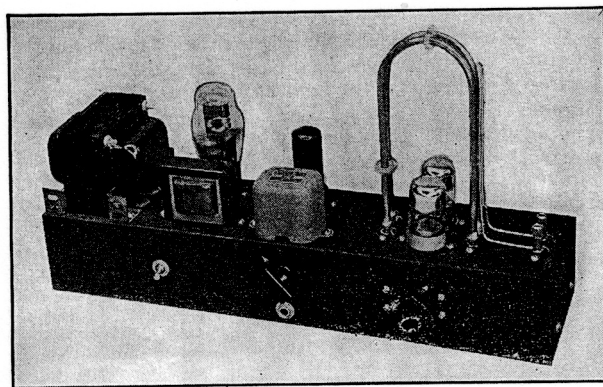


Fig. 1525—A complete low-powered 112-Mc. transmitter using linear plate and cathode tank circuits. The cathode tuning is controlled by the knob at the right and the volume control is at the center, just above the microphone jack. The rubber grommet between the two knobs insulates the screwdriver used for plate tuning.

The plate current of the final amplifier will be about 45 ma. when the stage is properly loaded. The loading is varied by changing the position of the "swinging link" fastened to the antenna output binding posts.

When using f.m. the amount of deviation is controlled by the setting of the gain control, R_1 . With the gain control wide open the deviation is over 30 kc. on 58.5 Mc., which is more than adequate for all purposes. When the receiving station does not have a regular f.m. receiver, the signal can be received on a conventional receiver by reducing the deviation at the transmitting end and tuning the signal off to one side of resonance at the receiving end.

◀ A Complete Low-Powered 112-Mc. Transmitter

The transmitter shown in Figs. 1525, 1526 and 1527 is a complete low-powered unit using linear tank circuits instead of coils and condensers. The circuit (Fig. 1526) is of the "tuned-plate tuned-cathode" variety, which gives good stability and efficiency on 112 Mc. Using 7A4-type tubes as shown, the transmitter will deliver several watts output.

The transmitter, complete with modulator and power supply, is built on a $3 \times 4 \times 17$ -inch chassis. As may be seen in Fig. 1525, the power transformer, rectifier tube and filter choke are mounted at the left-hand end of the chassis, the modulator tube and microphone transformer are in the center, and the various r.f. components are on the right-hand side. The sockets for the 7A4 tubes are oriented so that the heater prongs face the left-hand end of the chassis.

The plate lines mount in National FWB terminal strips which have been equipped with banana-plug jacks. The strips are placed $2\frac{3}{4}$ inches apart, on either side of the 7A4 sockets. The plate lines are held together firmly by a copper strip at the shorted end and by improvised polystyrene spacers at

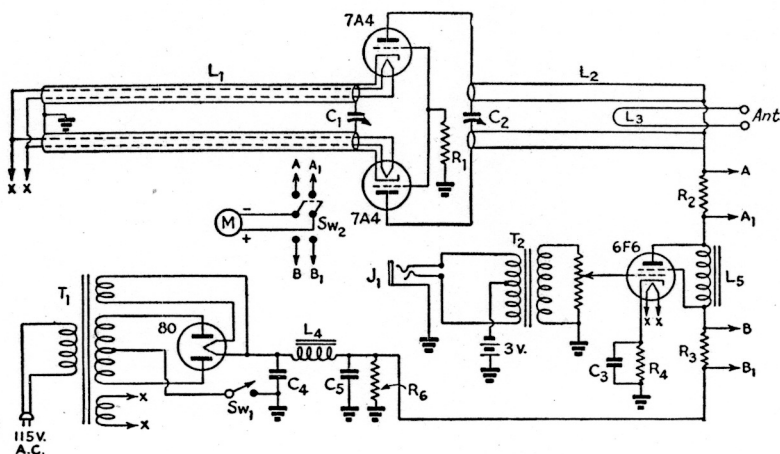


Fig. 1526 — Circuit diagram of the linear-tank low-powered 112-Mc. transmitter

C₁ — 15- μ fd. variable (National UM-15).
 C₂ — Small disk-type neutralizing condenser (Bud NC-890).
 C₃ — 25- μ fd. 25-volt electrolytic.
 C₄, C₅ — 8- μ fd. 450-volt electrolytic.
 R₁ — 10,000 ohms, 1/2-watt.
 R₂, R₃ — 25 ohms, 1/2-watt.
 R₄ — 400 ohms, 1-watt.
 R₅ — 50,000-ohm volume control.
 R₆ — 25,000 ohms, 10-watt.
 L₁ — Grid lines; 1/4-inch o.d. copper tubing, 11 1/2 inches long, spaced 1/2-inch on centers.

L₂ — Plate lines; 1/4-inch o.d. copper tubing, 15 inches long, spaced 1/2-inch on centers.
 L₃ — Antenna coupling loop, 4 inches of No. 14 wire, 1/2-inch spacing.
 L₄, L₅ — 10 henrys, 55 ma. (Thordarson T-14C64).
 J₁ — Double-button microphone jack.
 Sw₁ — S.p.s.t. toggle switch.
 Sw₂ — D.p.d.t. toggle switch.
 T₁ — 300-0-300 volt 60-ma. transformer with 6.3- and 5-volt windings (Thordarson T-13R17).
 T₂ — Double-button microphone to single grid transformer (UTC S-6).

the center and near the plate end. These spacers are made by cutting an FWB terminal strip in half and enlarging the holes so they can accept the copper tubing. The ends of the lines must be flared out sufficiently so that they equal the spacing between the holes for the banana-plug jacks. Banana plugs are soldered to the ends of the copper tubing.

The cathode lines are mounted underneath the chassis. At one end they are connected directly to the cathode pins of the 7A4 sockets, the other ends of the cathode lines being supported by a grounded metal pillar. The cathode tuning condenser is mounted on the front wall of the chassis, while the plate tuning condenser is mounted on the rear wall. The location and mounting of the other parts may be seen in the under-chassis view, Fig. 1527.

In tuning to the 112-Mc. band, first set the plate tuning condenser, C₂, so that the spacing between plates is approximately 1/4 inch. Then apply plate voltage and rotate the cathode tuning condenser, C₁, until oscillation starts,

as indicated by a drop in plate current. The oscillating plate current should be about 20 ma., rising to 50 ma. or more when the unit is not oscillating. Antenna coupling is adjusted by changing the position of the antenna coupling loop, L₃, with respect to the plate lines. The coupling should be made such that the oscillator is loaded to about 35 ma.

A 0-100 milliammeter is used for measuring plate current. When it is switched across R₂ by means of Sw₂ it reads the oscillator plate current, and when it is across both R₂ and R₃ it will read the total oscillator and modulator plate current. The 6F6 should draw about 50 ma. (combined screen and plate current).

As with all self-excited transmitters, a reliable frequency-checking system should be used to insure that the transmitter is working within the assigned band. The frequency of the oscillator is lowered by first increasing the capacity of C₂ and then retuning C₁ for maximum output. Either a single- or double-button carbon microphone may be used.

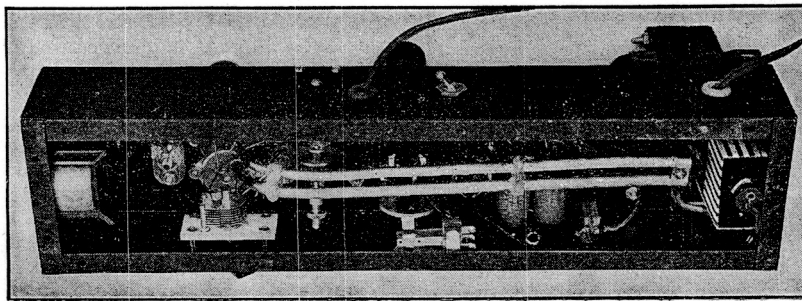


Fig. 1527 — Underneath the chassis of the linear-tank 112-Mc. transmitter, showing the cathode lines supported between the tube sockets and a metal pillar at the far end near the microphone battery. The modulation choke, L₅, is at the left-hand end of the chassis. C₁ is at the lower left, with R₅ and J₁ in the center.

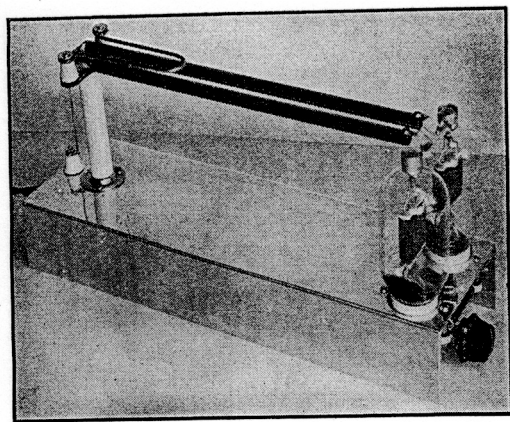


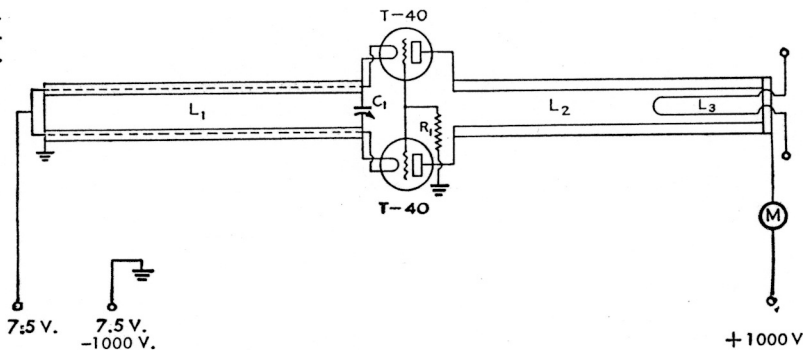
Fig. 1528 — This transmitter operates efficiently with conventional tubes at 112 Mc. A slider is used for frequency adjustment. Hairpin coupling link is at the left.

Ⓐ A Medium-Power Tuned-Plate Tuned-Filament Transmitter

Figs. 1528, 1529 and 1530 show the construction and circuit of another tuned-plate tuned-filament 112-Mc. transmitter. This set has

Fig. 1529 — Circuit diagram of the medium-power 112-Mc. oscillator. C_1 — 15- μ fd. variable. R_1 — 5000 ohms, 10-watt.

L_1, L_2 — Filament and plate lines; $\frac{3}{16}$ -inch o.d. copper tubing, length 12 inches, spaced diameter of tubing.
 L_3 — Hairpin link for antenna coupling; length approximately 3 inches.



much in common with the one described in the preceding section, but conventional tubes of the medium-power class are employed. Fundamentally, the circuit of Fig. 1529 is the same as that of the r.f. portion of Fig. 1526 except for the slight changes made necessary by the directly heated type of tube used. This arrangement, even with conventional tubes, operates with an efficiency of about 50 per cent.

A glance at Fig. 1528 will show the arrangement of the plate circuit, supported on top of the chassis. The chassis is $4\frac{1}{2}$ inches wide, 15 inches long, and $2\frac{1}{2}$ inches deep. There is no tuning condenser for the plate line; a condenser may be used, if desired, but for best efficiency the line should be made as long as possible. The line is relatively short for the frequency, the reason being that the internal tube leads make a considerable addition to the actual length of the line, plus the loading effect of the tube plate-grid capacity.

The high-voltage connection, brought through an insulator in the chassis, is

shown in Fig. 1528 just to the left of the supporting insulator. The antenna coupling link, L_3 , is made from small-diameter copper tubing; its length should be adjusted to give the desired loading with the antenna used.

Fig. 1530 is a view of the tuned filament circuit located underneath the chassis. Each pipe is soldered to, and partly supported by, a filament prong on each tube socket. The shorted end of the line is held in place by a metal pillar, which also makes the connection to the chassis ground. An insulated wire is fed through each pipe and connected to the other filament prong on the appropriate socket. These wires are connected together at the shorted end, and the filament voltage is applied between this common connection and ground.

C_1 , the filament-line tuning condenser, rests on the insulated portions of the sockets and is securely mounted by two small aluminum brackets which fit under the socket-mounting screws. Care must be taken to prevent grounding of the condenser plates. A short connection is made between the two grid prongs on the sockets; the grid resistor, R_1 , runs from the center of this connection to ground.

Tuning is similar to that already described for the low-power transmitter. The setting of C_1 which gives minimum plate current is not, however, the adjustment at which the oscillator delivers maximum output. A lamp-bulb dummy antenna coupled to the pipes will show that, as the condenser setting is slightly altered, the plate current will rise and the output will in-

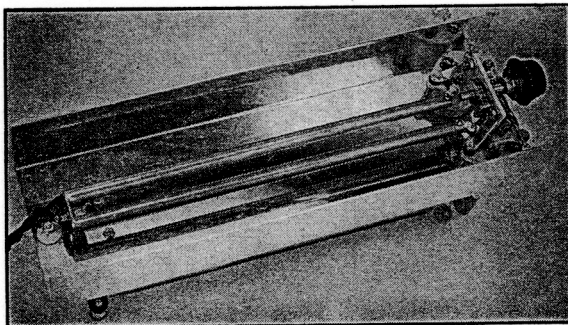


Fig. 1530 — A below-chassis view of the 112-Mc. oscillator.

crease. The current should not be allowed to exceed 200 ma. at full load.

Other tubes than the T40s shown have been used quite successfully in this circuit, including types 809, T20, RK32, RK11, RK12, 811, and TZ40. Still others of similar construction and ratings probably also would function satisfactorily. Tubes like the HK24 and 35T will work well at 224 Mc.

A modulator capable of delivering 100 watts of audio power is required when the transmitter is operated at 200 watts input. A pair of HY30Zs in Class B is recommended for the modulator unit. A suitable power supply which will furnish the necessary 200 ma. at 1000 volts is shown in Fig. 1225.

Ⓐ A Grid-Stabilized 815-Tube 112-Mc. Transmitter

The transmitter shown in Figs. 1531, 1532 and 1533 uses an 815 dual beam-power tube in a grid-stabilized oscillator circuit which can be used at an input of 60 watts with good efficiency. The circuit (Fig. 1532) is the basic tuned-grid tuned-plate circuit except that a linear tank instead of a coil and condenser is used in the grid circuit. By tapping the grids down on the line the loading is light, and consequently the line retains its high Q . The 815 does not have high enough grid-plate capacities to give all of the necessary feed-back, and some additional capacity must be added between plate and grid in both sections of the tube. This is easily done by running two short lengths of wire from the plate terminals to near the grid lines (C_F in Fig. 1532).

The transmitter is mounted on a 3 × 4 × 5-inch metal box which houses the filament transformer and the various fixed condensers, resistors, and the r.f. choke. The grid line is made of ½-inch copper tubing and is supported

one-half inch from the box by three feed-through insulators, which also serve as convenient connectors to the grids and to the grid leak. The open ends of the parallel tubes are fitted with 3-inch lengths of ⅜-inch diameter tubing which can be moved in and out to adjust the frequency of the oscillator. The extensions are held securely in place by set screws in holes tapped through the wall of the ½-inch outer tubing.

The plate tuning condenser is supported by a 3-inch steatite pillar which also acts as a guide for the sliding variable antenna coupling. Two large 866-type plate clips are slid over the pillar, and the antenna binding-post assembly (National FWB) is fastened to them with short lengths of No. 12 wire. By sliding this assembly up and down, the antenna coupling can be set to any value desired.

There is nothing unusual about the tuning of the transmitter, aside from the adjustment of the feed-back condensers. This can best be done with a dummy load, such as a 25-watt lamp bulb, connected to the antenna terminals. The lead from the grid leak, R_1 , to ground should be opened and a 0-10 milliammeter connected in the circuit. With plate voltage applied, the plate tuning condenser should be rotated for maximum output as indicated by the brilliancy of the lamp. The grid current should be between 3.5 and 5 ma. at this point. If it is higher there is too much feed-back, and the feed-back capacity should be reduced by trimming off a short length of the wire or by moving it away from the grid lines. This adjustment is not critical, but it should be made before the transmitter is put on the air. After the proper feed-back adjustment is found, the antenna can be

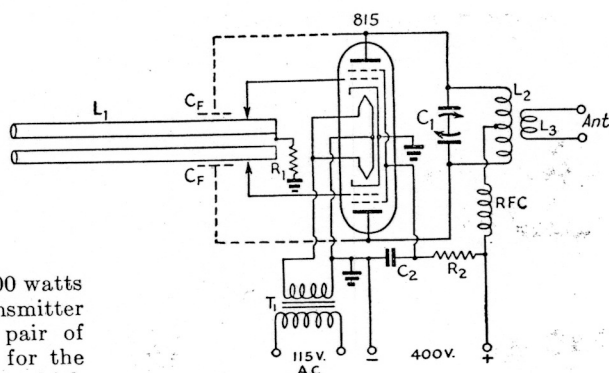
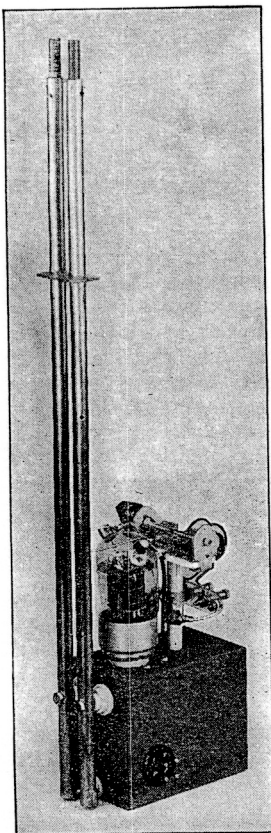


Fig. 1532 — Circuit of the grid-stabilized transmitter.

- C_1 — 15- μ fd. dual condenser (Hammarlund HF-15X).
- C_2 — 0.002- μ fd. mica.
- C_F — Feed-back condenser (see text).
- R_1 — 15,000 ohms, 1-watt.
- R_2 — 25,000 ohms, 10-watt.
- L_1 — ½-inch diameter copper tubing, 23 inches long, spaced 1 inch on centers; grids tapped 2¼ inches from shorted end.
- L_2 — 2 turns No. 12 e., 1-inch diameter, turns spaced to occupy ¼ inch.
- L_3 — 2 turns No. 12 e., ¾-inch diameter, turns spaced to occupy ¼ inch.
- RFC — V.h.f. r.f. choke (Ohmite Z-1).
- T_1 — 6.3-volt 2-ampere filament transformer (Thordarson T-19F81).



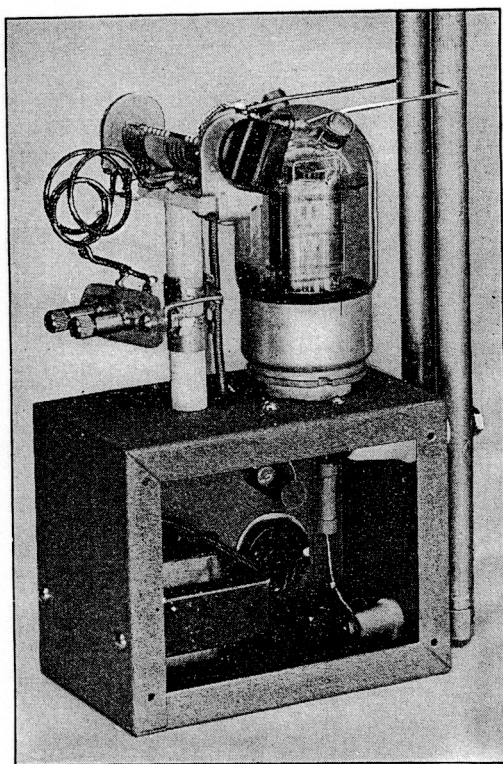


Fig. 1533 — A close-up view of the 815 transmitter, showing how the antenna coupling is changed by sliding the antenna-coil support on the insulating pillar. Note the wires for feed-back control running from the plates of the 815 close to the grid lines. The filament transformer and the various resistors and by-pass condensers are mounted in the box, shown here with one side removed.

coupled to the transmitter and modulation applied. The frequency may be checked by means of Lecher wires or a frequency meter. The antenna coupling should be tightened until the plate current is 150 ma.; the grid current should be between 3.5 and 5 ma. under these conditions.

The power supply is required to deliver slightly over 165 ma. at 400 volts, and the modulator must give at least 30 watts to modulate the oscillator fully. A pair of 6L6s in Class AB₁ will be satisfactory for the modulator, while the 400-volt supply can be the same as suggested for Fig. 1512.

Ⓐ 15-Watt 112-Mc. Transmitter for Mobile Use

The transmitter shown in Figs. 1534–1537, inclusive, is designed to be used in an automobile in conjunction with a vibrator power supply giving 100 ma. at 300 volts. The most convenient place to mount it is in the trunk compartment at the rear of the car, and a control system is shown for operating the unit from the driver's seat. The oscillator is operated at 15 watts input, and delivers enough power output to give an excellent account of itself.

As may be seen from Fig. 1535, the oscillator uses an HY75 tube in the ultraudion circuit,

using fairly high C to improve the carrier stability and reduce frequency modulation. Coupling between the oscillator tank circuit and the antenna is varied by means of a swinging link.

The audio portion of the transmitter employs a single-button carbon microphone working into a 6C5 Class-A driver stage, which is transformer-coupled to a 6Y7G Class-B modulator. With a 6-volt microphone battery, the output is more than adequate for full power output from the speech system. The Class-B modulator gives higher power efficiency and lower average plate current than a Class-A modulator, and, as a result, the proportion of the limited power-supply output current which must be reserved for the audio section is relatively low. The 6Y7G, an octal-based version of the 79, requires a plate-to-plate load resistance of about 14,000 ohms. The oscillator, operating with 300 volts at 50 ma., represents a load impedance of 6000 ohms, so that the primary-to-secondary impedance ratio required in the coupling transformer is 2.3 to 1. With the transformer specified a close approximation to this ratio is secured when the taps specified for matching 4500 ohms to 10,000 ohms are used.

The transmitter is enclosed in a $5 \times 6 \times 9$ -inch metal cabinet. Most of the parts are mounted on a chassis (ICA) measuring $4\frac{3}{4} \times 8\frac{1}{2} \times 1\frac{1}{2}$ inches. The panel and chassis are fastened together by the mounting sleeves for the d.c. input plug, gain control and jacks which may be seen in Fig. 1534; the microphone jack, J_3 , is the one at the right. The feed-through insulators which serve as antenna terminals may be seen at the top left-hand corner of the panel. A hole for screw-driver tuning of the oscillator is drilled below one of the antenna insulators. This hole preferably should be drilled after C_1 has been mounted, to insure that it lines up with the condenser shaft. The swinging-link control shaft is located to the right of this hole.

Fig. 1536 shows the chassis arrangement of the main components for the transmitter. The 6C5, T_2 , the 6Y7G and the HY75 may be

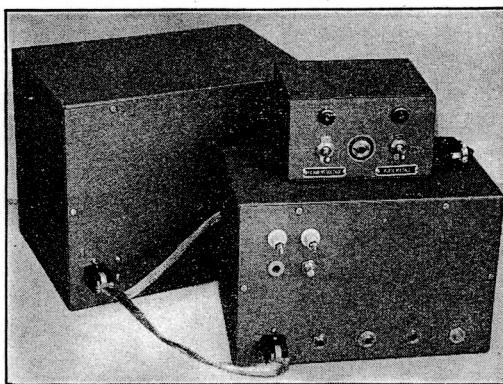


Fig. 1534 — A complete 112-Mc. mobile transmitter before installation. The vibrator supply is in the large box at the rear. The two larger units may be installed in the trunk compartment of the car, while the control box is mounted near the operator in the driver's seat.

seen from left to right along the rear edge of the chassis. T_1 is located at the front left-hand corner, with T_3 to the right. C_1 is mounted on a stand-off insulator which elevates the condenser mounting bracket $1\frac{1}{8}$ inches above the base. The nut which clamps the mounting bracket and condenser together should be loosened and the bracket rotated 180 degrees; this reduces the length of the leads associated with the tuned circuit. The condenser shaft should be slotted with a hack saw to allow screw-driver adjustment.

The r.f. circuit arrangement is kept as compact as possible. The plate r.f. choke is to the left of the tube, and the grid choke, C_2 and R_1 are at the right. L_1 is soldered directly to the terminals of C_1 . Small-sized shield braid is used for the flexible lead between the HY75 plate cap and the tuned circuit.

The swinging link is easily constructed. It is made from a panel-bearing assembly with the shaft extension cut down to a length of 1 inch. A piece of $\frac{1}{4}$ -inch polystyrene rod is fastened to the metal shaft by means of a solid metal shaft coupling. The ends of the link winding pass through holes drilled in the polystyrene rod; adequate rigidity will be obtained if the holes in the shaft are not made too large and the wires are cemented in place. The projecting end of the panel-bearing shaft is slotted, to facilitate screw-driver adjustment.

Fig. 1537 shows the arrangement of the parts mounted beneath the chassis. C_3 and R_2 are at

the upper left-hand corner. C_4 is the tubular condenser connected between the tube socket and the microphone jack. The shaft of the audio gain control, R_3 , should be slotted before the resistor is mounted. The four-prong power plug is mounted on the panel and projects through a $1\frac{3}{8}$ -inch hole in the chassis wall.

The cabinet has rolled-over edges to which the panel is fastened. The panel and chassis assembly cannot be slipped into the case unless the edges on the bottom and sides are cut out; the entire length of the side pieces need not be removed, but the bottom edge should be cut off completely.

The control-box components all are housed in a $3 \times 4 \times 5$ -inch metal utility box. The four-prong power plug is mounted at one end of the box and the rest of the parts are mounted on one of the long sides. The microphone battery also can be placed inside the case, if desired; however, this calls for filing down the turned-down edges, since the opening is a bit too small to pass an ordinary 6-volt dry battery such as the Burgess No. F4PI.

Heavy-duty toggle switches should be used for the storage-battery circuits. Most radio parts dealers carry switches of a type designed to handle 12 amperes at 125 volts. These switches are usually of the d.p.s.t. variety, and the poles may be connected in parallel to increase the safety factor.

Plate current can be measured by using a 0-100 milliammeter fitted with a plug for the

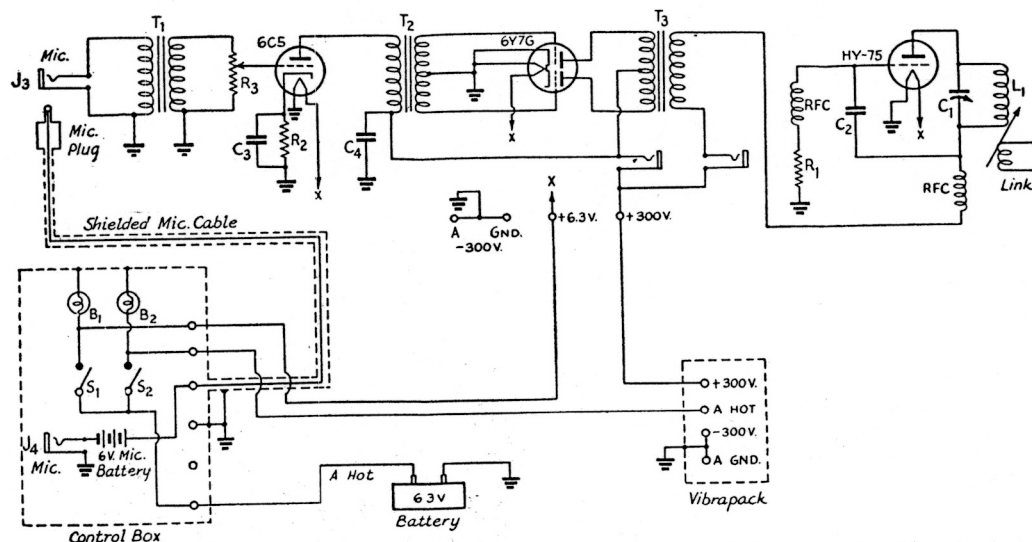


Fig. 1535 — Wiring diagram of the 15-watt 112-Mc. mobile transmitter, including control and power circuits.

C_1 — 35- μ fd. midget variable (Hammarlund HF-35).

C_2 — 100- μ fd. mica.

C_3 — 10- μ fd. 50-volt electrolytic.

C_4 — 8- μ fd. 450-volt electrolytic.

R_1 — 5000 ohms, 1-watt.

R_2 — 1000 ohms, 1-watt.

R_3 — 0.1-megohm variable.

L_1 — 2 turns of $\frac{1}{8}$ -inch diameter copper tubing, $\frac{3}{4}$ -inch diameter, turns spaced $\frac{3}{8}$ inch.

Link — 2 turns No. 12 wire, $\frac{3}{4}$ -inch diameter, turns spaced twice wire diameter.

J_1, J_2 — Midget closed-circuit jack.

J_3, J_4 — Midget open-circuit jack.

S_1, S_2 — Heavy-duty d.p.s.t. toggle switch.

B_1, B_2 — 150-ma. dial light.

RFC — V.h.f. r.f. choke (Ohmite Z-1).

T_1 — Single-button microphone to single or push-pull grids (Thordarson T-86A02).

T_2 — Interstage audio, single plate to push-pull grids (Thordarson T-19D06).

T_3 — Output transformer, 10,000-ohm primary to 4500-ohm secondary (Thordarson T-17M59).

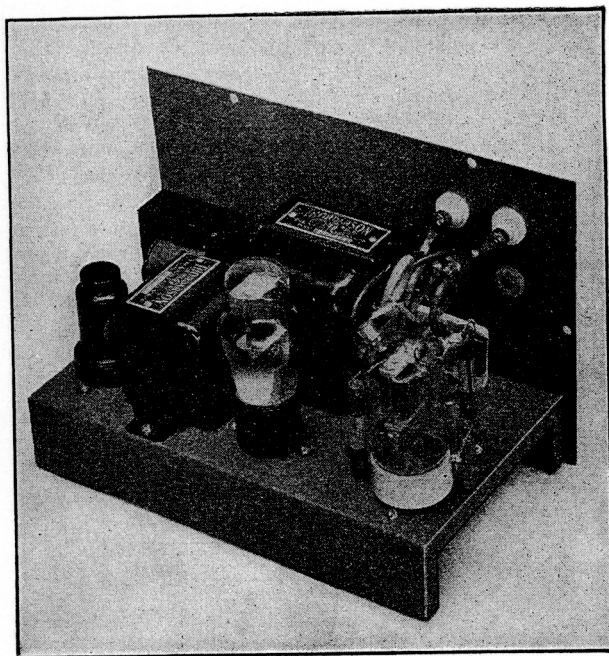


Fig. 1536 — Rear view of the 15-watt 112-Mc. mobile transmitter.

plate jacks, J_1 and J_2 . The oscillator plate-current reading should be approximately 35 ma. with no antenna load connected and with 300 volts on the plate. The antenna coupling and tuning should be adjusted to obtain a full-load current of approximately 50 ma., using the loosest antenna coupling which will give the desired plate current.

The modulator plate-current reading should be about 25 ma. without speech and should rise to about 100 ma. on modulation peaks. Under full modulation the plate current of the oscillator will kick downward slightly because of the lowered oscillator plate voltage caused by the power-supply regulation as the modulator current increases.

The preliminary testing might well be carried on with a dummy load coupled to the oscillator. As a matter of fact, this procedure is recommended unless the transmitter frequency has been set inside the 112-Mc. band before the actual installation in the automobile is started. In any event, always check the frequency carefully each time before starting regular operation because the antenna loading will affect the frequency. Also, because the oscillator has a high- C tuned circuit, a small variation in the setting of C_1 will cause a considerable jump in frequency. It is wise to check the frequency whenever an adjustment of any kind is made. Frequency checking can be done with an absorption-type frequency meter, with Lecher wires, or by listening on a calibrated receiver.

A 300-volt 100-ma. vibrator-type power supply is recommended for mobile operation. The self-rectifying type is the least expensive and places the smallest load on the car battery.

However, any supply that will deliver the necessary voltage and current will be quite satisfactory. An a.c. supply for testing purposes may also be provided; it should have the same output capabilities as the vibrator supply, and should include a filament transformer designed to deliver 6.3 volts at 3 or 3.5 amperes.

The antenna can be either a quarter-wave (24-inch), or a half-wave (50-inch) rod. It is easiest to feed the antenna with a short length of two-wire transmission line, tuning the system by connecting a small 15- μ fd. condenser across the link or in series with the line, depending on the length of the line. The antenna tuning condenser may be mounted right on the antenna terminals of the transmitter.

The control box should be mounted at some convenient point near the driver's seat, either under the dash or above it. Fig. 1535 shows how the control box is wired into the circuit, and Fig. 1427 shows how receiver control can be included in the arrangement to give a complete mobile station.

The four leads which run from the control box to the transmitter in the trunk are encased in large-sized spaghetti tubing and shielded.

The power-supply unit also is housed in a metal cabinet, for good appearance as well as for protection. Both cabinets (transmitter and power supply) should be bolted to the trunk floor before the rest of the equipment is installed. The transmitter and supply can then be slipped in place and bonded together and to the car frame.

Current and voltage readings will be low unless the power unit and the transmitter filaments receive the full battery voltage. The slight drop caused by long leads can be tolerated if the car battery voltage is up to standard, but a run-down battery may cause trouble. The voltage at the transmitter will be variable, because the voltage at the battery terminals ranges all the way from 6 to 8 volts depending on whether or not the car motor is running. Sufficient voltage should reach the equipment if motor is turning over at a speed which causes the dash ammeter "charges" to indicate. (Bib. 5.)

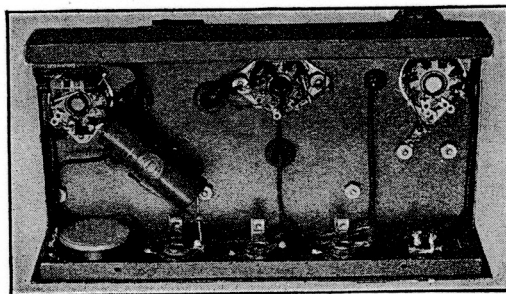


Fig. 1537 — Bottom view of the mobile transmitter.

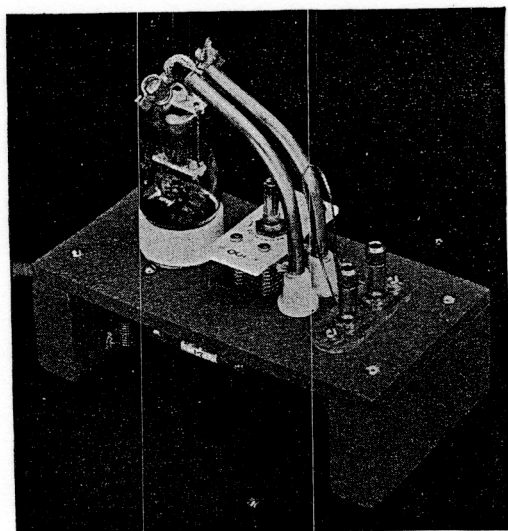


Fig. 1538 — A 224-Mc. transmitter using an HY75 tube. A rectangular hole in the top of the chassis allows the tuning condenser to be placed for shortest leads. The condenser is adjusted by an insulated screw driver.

◀ A Transmitter for 224 Mc.

At frequencies higher than 116 Mc., considerable difficulty is found in getting good performance with tubes other than those designed expressly for v.h.f. operation. However, there are several inexpensive tubes available to the amateur that will perform well on 224 Mc. The transmitter in Figs. 1538–1540 shows how one of these, the HY75, may be put to work.

The transmitter is built on a $3\frac{1}{2} \times 6\frac{1}{2}$ -inch piece of $\frac{1}{4}$ -inch Presdwood supported by two strips of 1×2 -inch wood. A rectangular hole is cut in the center of the Presdwood to accommodate the tuning condenser, which is supported by two metal pillars at one end. The tuned circuit consists of two lengths of $\frac{1}{4}$ -inch copper tubing, $3\frac{1}{2}$ inches long, which are supported at one end by two feed-through insulators. The ends of the screws in the feed-through insulators are sweated into the ends of the tubing, and the tuning condenser is connected to two lugs right at this point. Connections from the tubing to the grid and plate terminals on the tube are made by $\frac{1}{2}$ -inch lengths of flexible shield braid. The filament chokes, the plate r.f. choke, and the grid leak are mounted under the chassis.

The antenna-coupling circuit consists of a loop of wire parallel to the copper tubing and terminating in the antenna binding posts. Coupling is varied by moving the loop nearer to or farther away from the copper tubing.

The transmitter should first be tested with a dummy load. A 10-watt lamp bulb is excellent for the purpose. The load is connected to the antenna posts and the power supply turned on. If everything is connected properly the lamp will light, its brilliancy depending upon the tightness of coupling and the setting

of C_1 . It will be found that the output is greater towards the maximum-capacity end of the range of C_1 . The frequency coverage of the transmitter should be checked, using Lecher wires or a frequency meter, to make sure that it will cover the desired range. The coverage can be adjusted slightly by changing the separation of the copper tubes; if this is not enough, the tubes will have to be made shorter or longer. The tuning condenser is adjusted by means of an insulated screw driver.

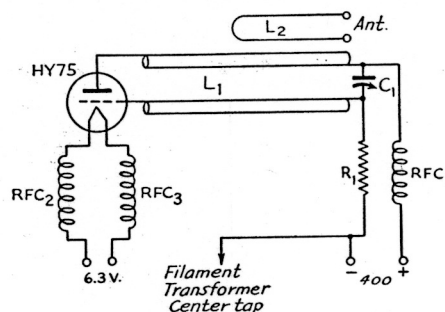


Fig. 1539 — Wiring diagram of the 224-Mc. oscillator.

C_1 — 100- μ fd. midget variable (National UM-100).

R_1 — 5000 ohms, 10-watt wire-wound.

L_1 — $\frac{1}{4}$ -inch copper tubing, $3\frac{1}{2}$ inches long, spaced $\frac{1}{2}$ -inch on centers.

L_2 — 2-inch loop of No. 16 bare wire.

RFC_1 — V.h.f. r.f. choke (Ohmite Z-1 or Z-0).

RFC_2 , RFC_3 — 10 turns No. 18 e.w. close-wound on $\frac{1}{2}$ -inch diameter, self-supporting.

The transmitter requires a plate power supply delivering 60 ma. at 400 volts, and the modulator unit should be capable of furnishing 12 watts of audio power. The 6A6 modulator described in Chapter Thirteen will be quite adequate for the purpose.

Because of its small size, a transmitter of this type can be built as a unit into a rotatable antenna for the 224-Mc. band, if desired. It is desirable not to run a feed line for any great distance at this frequency, because of the possibility of radiation from the line.

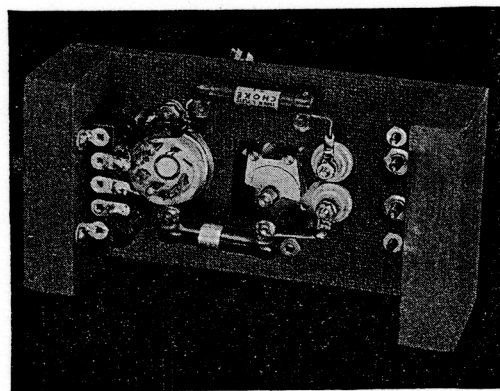


Fig. 1540 — The r.f. chokes and the grid leak are mounted under the chassis of the 224-Mc. transmitter. The power-supply cable is brought through a hole in the side piece to a tie strip mounted on the left-hand side.

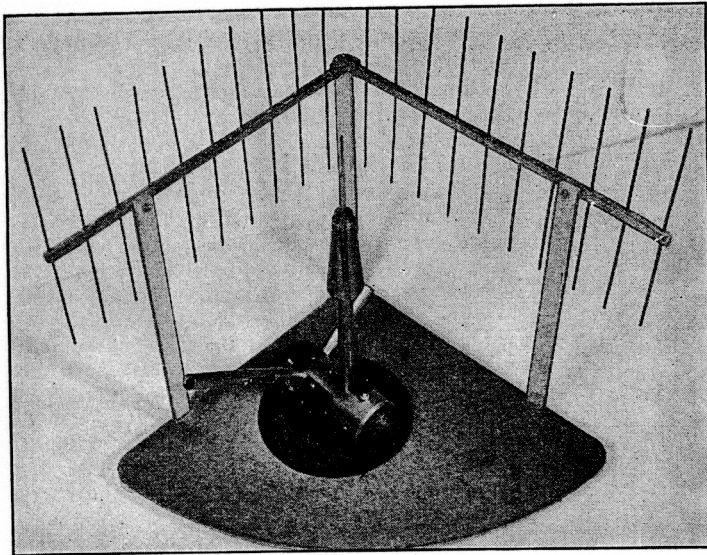


Fig. 1541 — A 750-Mc. transmitter using an acorn triode as an oscillator. The concentric antenna is an integral part of the oscillator unit. The square-corner reflector concentrates the radiation in the desired direction. (W6IOJ.)

⚡ Microwave Oscillators

In the microwave region — roughly, on wavelengths below one meter or frequencies above 300 Mc. — there is opportunity for much interesting experimental work. Figs. 1541 to 1545 show two oscillators which illustrate the type of construction necessary in this

frequency region. The oscillator in Fig. 1542 is designed to work at approximately 400 Mc., and that in Figs. 1544–1545 — also shown, complete with antenna and reflector system, in Fig. 1541 — operates at 700–750 Mc. Both oscillators use the quarter-wave parallel-line circuit shown in Fig. 1543, and both employ concentric antennas which are made a permanent part of the oscillator.

The half-wave parallel-rod type of oscillator is used because of its unfailingly consistent operation and because of its ability to transfer a relatively large percentage of its power output into the antenna, as compared to other oscillators designed for higher stability. Although the stability of the parallel-

rod oscillator is relatively poor, in many cases the lack of stability in a microwave oscillator lies not so much in the electrical design as in the mechanical construction. With this in mind, the oscillator should be required to tune smoothly, be shielded from external objects to minimize stray radiation, and have a mechanically rigid antenna system.

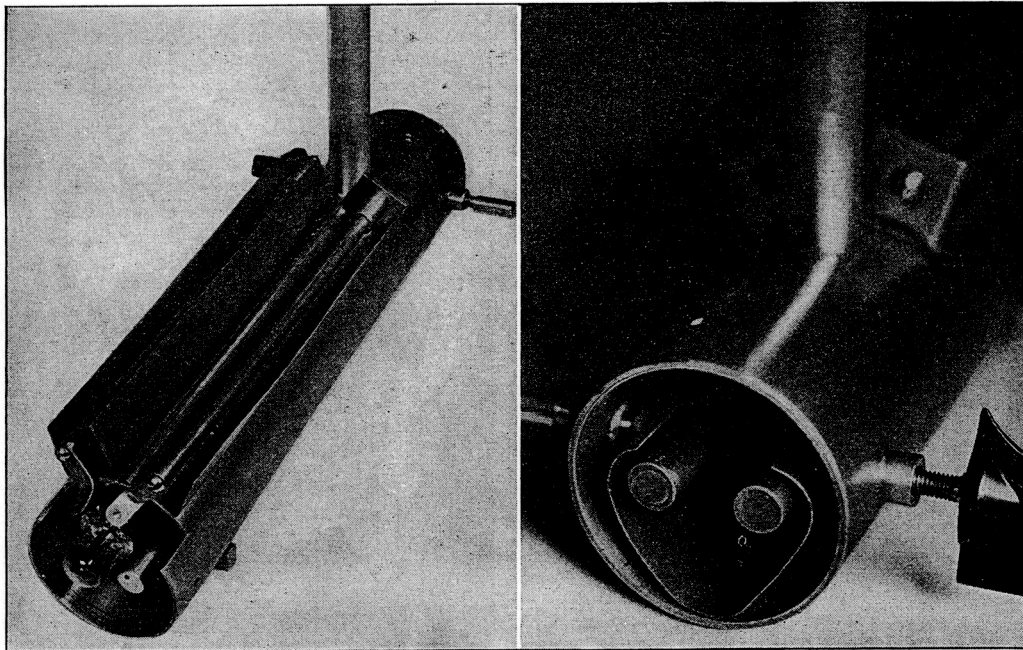


Fig. 1542 — Left — A general view of the 400-Mc. oscillator. The parallel-line tank circuit is mounted inside a 2-inch copper pipe which serves both as shield and as mounting base. The 955 acorn tube is mounted at the ends of the resonant line. Trough lines $\frac{3}{8}$ -wavelength long are used for tuning the filament circuit in this oscillator. The vertical pipe at the rear is the concentric line to the antenna. Right — The tuning mechanism of the 400-Mc. oscillator. Only one adjustment actually is used in tuning; the other balances the line for maximum output.

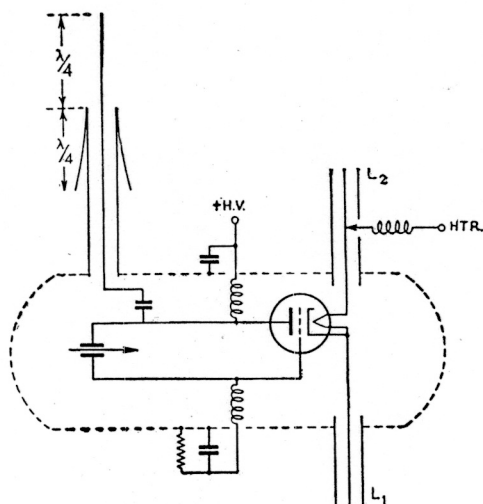


Fig. 1543 — Circuit of the shielded parallel-rod microwave oscillator. The parallel resonant lines are made of $\frac{3}{16}$ -inch copper tubing, spaced $\frac{1}{2}$ inch between centers. The lines are 4 inches long for 750–800 Mc., 10 inches long for 400 Mc. The closed filament line (L_1) for 750 Mc. is slightly longer than one quarter wave. L_2 is the length of L_1 plus a quarter wave. The 400-Mc. filament circuit is made of two trough lines, each $\frac{3}{8}$ -wave long; one line is insulated from the shell by a thin mica sheet.

A length of 2-inch copper pipe is the basic structure for each oscillator. This pipe serves the dual purpose of effectively shielding the parallel rods and of forming a solid mechanical support for everything connected with the oscillator. It also provides an excellent ground for radio-frequency by-pass condensers at any point on its surface. Shielding of the parallel rods aids stability by eliminating all hand-capacity effects, and also allows perfect bypassing for the power leads.

The mounting of the tubes as shown in the photographs indicates the precautions that must be taken to prevent losses. All connections should be direct, and no insulation should be used to support the leads if they are at voltage loops. The tuning system again illustrates the necessary low-loss construction.

The tuning system may be compared to the usual variable condenser; the surfaces of the rods act as the stator plates of the condenser and the grounded copper strip, which is varied in distance from the parallel rods, is analogous to the rotor.

Filament lines are not actually necessary for operation of the 955 tube on 400 Mc., since filament "chokes" would serve practically the same purpose. The lines are used in this case to simplify the design and to stabilize the mechanical construction, however. The use of such lines leaves no doubt as to the efficiency of the filament circuit, and, as the frequency is raised, their superiority over r.f. chokes becomes the more pronounced.

Figs. 1542 and 1545 show two types of construction for the filament lines. The trough line of Fig. 1542 facilitates adjustment, since it is

an easy matter to insert sliders between the trough and the inner conductor to adjust the electrical length for optimum performance. One trough line is fastened solidly to the shielding pipe, while the other is insulated from the pipe with thin mica sheet for the filament return connection.

Use of concentric line instead of the trough complicates the manner of adjustment. The line with the closed end, projecting to the right in Fig. 1545, is cut to approximate length and soldered in place with no means of adjustment, while the second line is made a quarter wave longer. The end of the longer line is at a voltage node and is left open, allowing the length of the inner conductor to be varied for filament-circuit adjustment. At the same time, it leaves one side of the filament insulated from the shield. The filament connection is made through an r.f. choke tapped at the current loop on the inner conductor.

The coaxial antenna consists of a quarter-wave radiator with a quarter-wave skirt attached to the outer conductor. The skirt in this case is made of sheet copper, bent so that the upper end fits tightly over the outside conductor, while the bottom flares out so that it will have a clearance of one-half to one inch from the coaxial line. Four or more quarter-wave wires or copper-tubing elements may be used

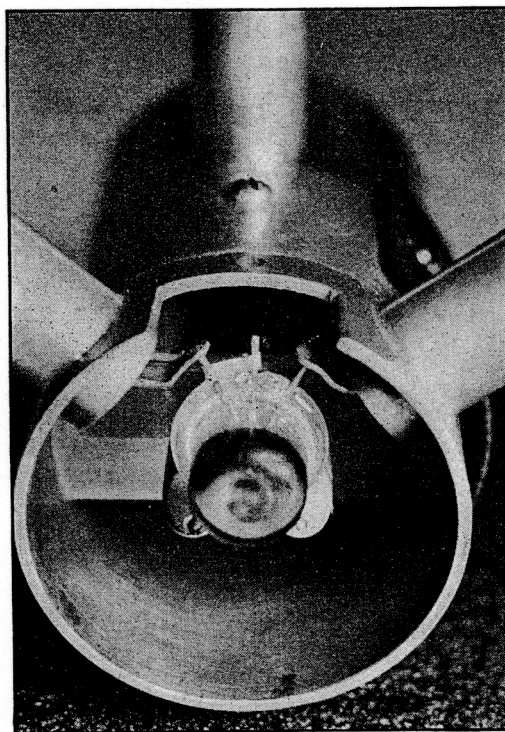


Fig. 1544 — End view of the 750-Mc. oscillator. The grid and plate pins of the 955 acorn tube are inserted in small holes in the ends of the parallel rods, with the filament connections being made through small spring connectors which also hold the tube in place. The cathode pin is strapped to one of the filament pins, as shown.

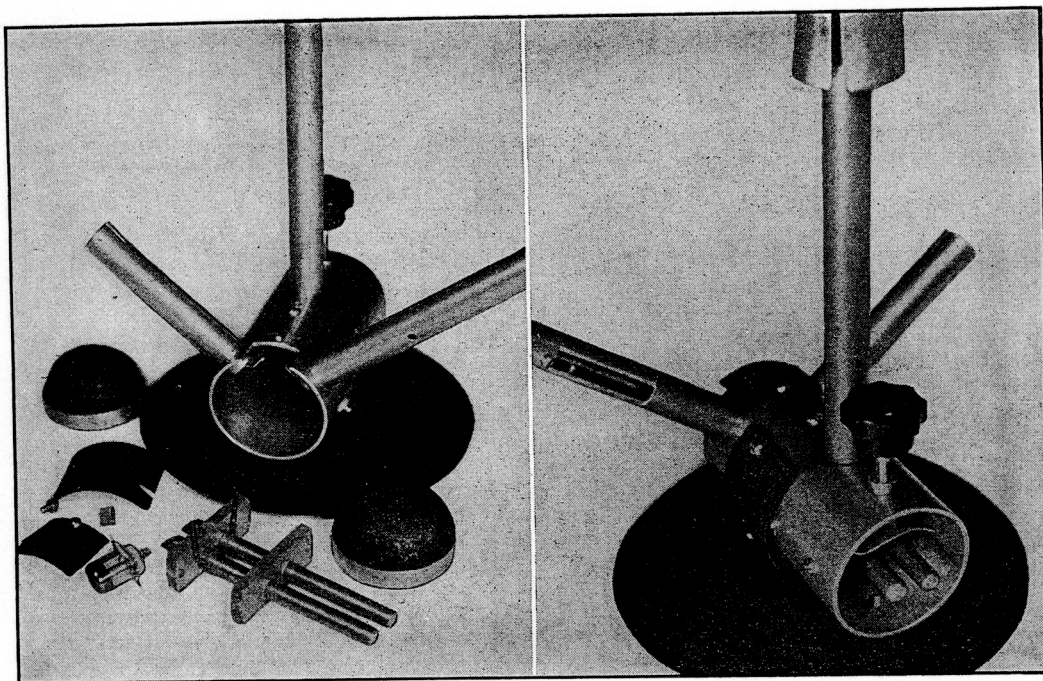


Fig. 1545 — Left — The 750-Mc. oscillator disassembled, showing the 2-inch outer shell with the filament lines and the radiator in place. The tuned-circuit parallel lines with their polystyrene insulators are in the foreground, with the feed chokes projecting upward at the terminal ends. The hemispherical end shields are of hammered copper, made to fit tightly inside the ends of the shell. Right — The tuning mechanism of the 750-Mc. oscillator. Turning the knob in its threaded bushing varies the spacing between the curved copper strip and the parallel-rod assembly. At the top may be seen the lower part of the "skirt" or lower quarter-wave section of the concentric antenna.

in place of the skirt with practically the same results. In coupling the coaxial line to the oscillator, either inductive or capacitive coupling may be used. Although the inductive coupling is the most convenient, as the frequency is raised the capacitive coupling appears to be the more satisfactory.

In the case of the 775-Mc. oscillator, there is sufficient coupling through the capacity between the rod and a copper strip, a quarter of an inch wide and three-quarters of an inch long, lying parallel to the plate rod; this strip is connected directly to the coaxial line.

The best method of adjusting the antenna coupling is through the use of a field-strength

meter. As shown in Fig. 1546, a crystal detector in the center of a half-wave pick-up antenna, coupled through r.f. chokes to a 0-1 ma. meter, will serve as a field-strength meter of ample sensitivity. With this type of indicator, good readings have been obtained at distances of four or five wavelengths from the transmitter with only a few watts input.

In use, the 400-Mc. oscillator operates normally in every way. The radiated output is as good or better than that of the average 112-Mc. transmitter using the same power input.

The 750-775-Mc. oscillator operates near the critical frequency of the 955 acorn tube as a regenerative oscillator. The highest frequency obtainable is approximately 800 Mc., with a small usable output available at frequencies between 750-775 Mc. (Bib. 6.)

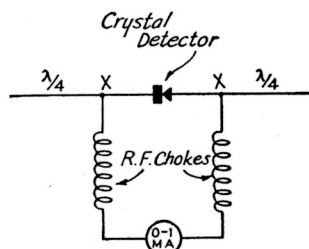


Fig. 1546 — Simple field-strength meter for checking microwave or very-high-frequency radiators. It may also be used as a sensitive indicator when making frequency measurements by connecting Lecher wires at X-X.

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