A 75-Watt Transmitter for 3 Bands

Simplified Shielding and Filtering for TVI

BY DONALD H. MIX, W1TS

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The transmitter shown in the photographs is a 3-stage 75-watt CW rig designed to cover the 80-, 40- and 20-meter bands. It is complete with built-in power supply. Plug-in coils are used only in the final amplifier. The problem of shielding has been studied with the aim of reducing labor and material to a minimum.

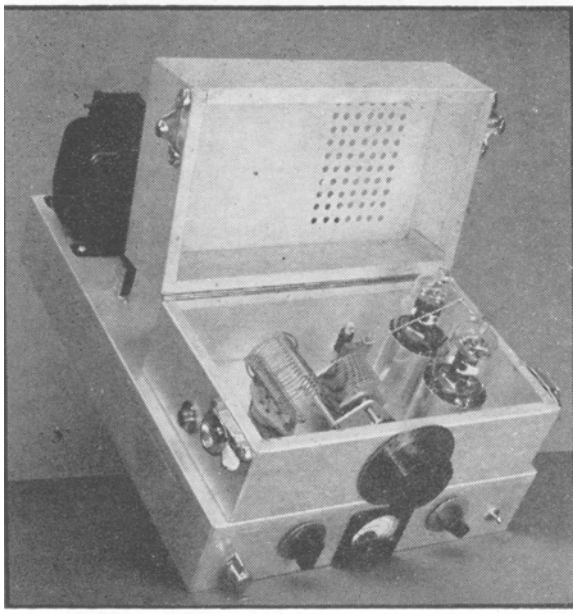


Fig. 6-61 — Front view of the 75-watt 3-band transmitter, showing the interior of the amplifier enclosure.

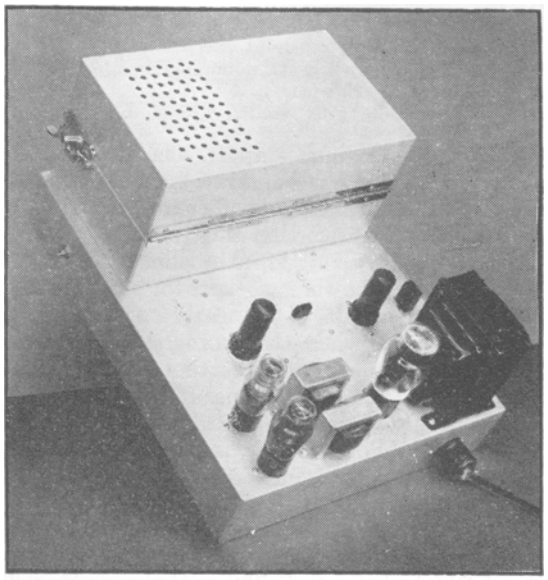
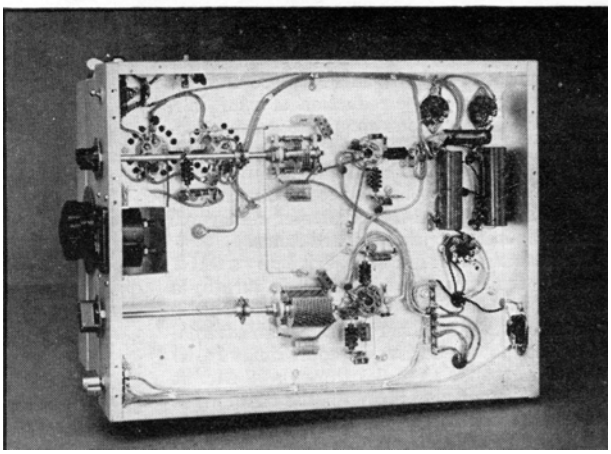


Fig. 6-62 — Rear view, showing the placement of the exciter tubes and the shorting-plug sockets.



Typical Meter Readings

Oscillator plate current	5 to 10 ma.
Oscillator screen current	4 to 5 ma.
Oscillator screen voltage	110 to 130.
Doubler plate current, idle	2 ma.
Doubler plate current, operating	14 ma.
Doubler grid current	2.3 ma.
Doubler cathode bias	90 v.
Doubler grid-leak bias	35 v.
Total doubler bias	125 v.
Amplifier grid current, loaded	10 ma.
Amplifier grid bias	50 v.
Amplifier screen current, loaded	22 ma.
Amplifier plate current, for 75 w.	165 ma.
Amplifier cathode current, for 75 w.	200 ma.
Off-resonance plate current	220 ma.
Power-supply voltage, key open	530
Power-supply voltage, key closed, amplifier loaded to 165 ma.	460

Circuit

NOTE: The schematic shows no plate parasitic suppressors, but 1 mH RF chokes (*R6* and *R7*) on the 807 control grids. There are also 47 ohm non-inductive resistors on the screens (*R9* and *R10)*. Those are old ways of killing parasitic oscillations, and are not considered good practice any more.
The 'proper' method is plate parasitic suppressors (couple of turns of #18 or so wire on a low-value 1 watt carbon resistor) and direct bypassing of the screens to ground. Some folks use small (less than 100 ohm) resistors in the grid leads.
The RFCs in the grid and plate make nice tuned circuits at about 100 KHz and can create significant parasitic oscillations.
If you see any 807 grid current with no drive from the 6AG7, you have a parasitic oscillation.

- The oscillator output condenser, *C7*, has a sufficient range of capacitance to cover both 80 and 40 meters, making coil changing in this stage unnecessary.
- The output of the oscillator can be fed either directly to the grid circuit of the final amplifier, or to the grid of an intermediate frequency doubler for 20-meter operation.
- The two triode sections of the 6N7 doubler tube are connected in parallel. The doubler is cut in and out of the circuit by a system of crystal sockets and shorting plugs instead of a switch, for simplicity. This permits the doubler coil also to be permanently mounted under the chassis for shielding purposes. The shorting plugs are Millen type 37412 with the pins wired together.
- When a shorting plug is inserted in *J1*, the output of the oscillator is fed to the grid circuit of the amplifier. When this plug is shifted to *J2*, the oscillator is connected to the doubler grid. Then a second plug inserted in *J3* connects the output of the doubler to the input circuit of the amplifier.
- The 6N7 cathode biasing resistor is chosen to give the same grid current as obtained on the lower-frequency bands. When not in use, this tube draws only a milliampere or two of plate current.

The desired power level in the final amplifier is most economically obtained through an inexpensive 450 volt power supply. Two 807s are required operating in parallel, to attain the necessary plate current for an input of 75 watts.

RFC6, *RFC7*, *R9* and *R10* are necessary to prevent VHF parasitic oscillation. **See NOTE above.**

The amplifier is keyed in the cathode circuit. This permits good clean keying and avoids the problem of protecting the tubes with fixed bias, a necessity that arises when the oscillator is keyed.

A single milliammeter, *MA1*, may be switched to read amplifier grid current, when connected across *R7*, or cathode current when switched across *R8*. The value of *R8* is adjusted to give a meter-scale multiplication of 10. The ARRL Handbook gives information on making meter shunts from copper wire.

Power Supply

The basic power-supply circuit is a conventional choke-input filter to hold the voltage within the rating of the filter condensers.

Reduced voltage for the oscillator and doubler and also for the amplifier screens is supplied across a pair of voltage-regulator tubes.

Since the high-voltage and filament windings are on a common transformer, it is necessary to remove high voltage from the oscillator during receiving periods by breaking the transformer center-tap connection to ground.

- This is done by means of the power-control switch, *S1*, which also controls the AC primary voltage to the transformer.
- With the switch turned to the left in Fig. 1, the filaments are lighted, but high voltage is off (*S1A* on, *S1B* power transformer center tap not connected).
- In the central position, both circuits are open.
- With the switch turned to the right, both circuits are closed for transmitting (*S1A* on, *S1B* completes the grounding of the center tap).
- The central position is chosen as the all-power-off position so that the switch can be turned against the stops in switching quickly from transmitting to receiving.

Construction

A 13 X 17 X 3-inch aluminum chassis is used as the base. The generous size not only makes provision for the power supply, but it also facilitates wiring with shielded wire which is not easily handled in restricted space, without experience. All parts of the oscillator and doubler circuits are shielded by mounting them underneath the base chassis. Since the amplifier must be accessible for changing coils, the components are mounted on top and shielded by an enclosure made up of two 7 X 12 X 3-inch aluminum chassis, one of which forms a cover hinged to the lower one. Good contact along the seam between the two chassis is assured by the use of a pair of ordinary window latches which easily provide considerable pull-down force. Any gap caused by inaccurately-formed chassis can be taken care of by bending the chassis lips outward with pliers wherever necessary to make a tight fit.

- First lay out the power-supply components along the rear edge of the base chassis and make the mounting holes including holes for the terminal wires from the transformer and chokes. The AC power-input plug is mounted in the rear edge of the chassis, close to the power transformer. Underneath, the two filter condensers are mounted on small lug strips which also provide terminals for making connections to the condensers.
- Now spot the holes for the crystal socket, the tube sockets for the oscillator and doubler on a line 6 inches from the rear edge of the chassis. These tubes are central and their centers are spaced 6 inches apart. The two exciter tuning condensers, *C7* and *C14*, are similarly spaced 6 inches apart and sufficiently to the rear of the base chassis so that their forward mounting screws come about 0.25 inch behind the amplifier enclosure.
- The amplifier enclosure is set with its front edge flush to the front edge of the base chassis.

- The three sockets for the shorting plugs are placed as nearly as possible in the positions shown in the photographs.
- The meter is mounted in the center of the front edge of the base chassis. It is very important from the consideration of TVI that the meter be tightly shielded at the rear. The enclosure shown in the photograph of the bottom was bent up from sheet aluminum.
- Extension shafts with panel bearings are run from the two variable condensers underneath to the base chassis front edge. The power switch and the meter switch are at the ends.
- In the lower of the two smaller amplifier chassis, the sockets for the two 807s are spaced with their centers 3 inches from the edge of the chassis and about 2.25 inches apart. The sockets are ringed with 0.25-inch holes, which show in the bottom-view photograph, to provide ventilation for the tubes. The lower portions of the tubes are enclosed in Millen type 80007 shields and the ventilating holes must come within the diameter of the shields.
- The bottom plate, which must be provided to cover the bottom of the base chassis with a tight fit, should likewise be perforated in the area below the sockets.
- The base chassis should be provided with feet of some sort at the four corners to allow air to circulate up through the ventilating holes.
- The coil socket alongside the tank condenser is mounted on tubular pillars that raise the socket to clear its prongs underneath. *C21* is attached to one of the rear stator nuts.
- The plate choke, *RFC8* is mounted vertically immediately to the rear on a small ceramic feed-through insulator.
- A short length of coaxial cable connects the link terminals of the coil socket to the output coaxial fitting set in the end of the chassis.

As soon as all holes have been drilled in the small chassis, it should be placed on the base chassis and all holes in the bottom of the smaller chassis should be traced on the top of the base chassis so that the two sets of holes will match exactly.
The cover chassis is attached to the lower one by means of a section of piano hinge — a hinge running the entire length of the chassis. The area over the tubes is perforated with 0.25-inch holes. The two window latches should be fitted carefully so that they will exert a good pull on the top of the chassis when they are closed. If desired, the front of the unit can be provided with a panel to make it uniform in appearance with other equipment.

- Underneath, a long lug strip is used as a terminal board for the transformer leads that require extension. Connections will be easiest if the ground end (-) of the filter condenser to the rear is toward the transformer and the ground end of the condenser in front is towards the VR tubes.
- The VR voltage-dropping resistor, *R11*, then is mounted by soldering it between the positive terminal of *C27* (the condenser toward the front) and an insulated terminal of the lug strip holding the other condenser. A wire then connects the lower end of this resistor to Pin 5 of the VR tube toward the rear. Pin 2 of this tube connects to Pin 5 of the other VR tube and Pin 2 of the latter to ground.
- RF chokes are supported by attaching to the associated tube-socket terminal at one end and to a short lug strip at the other. The lug strip also serves as a mounting for any resistor that may be connected to the choke.
- All power wiring is done with shielded wire and all by-pass condensers are applied to the shielded wire. The braid of the wire connecting to the terminal is pushed back about 0.5-inch and solder is flowed around it to anchor it to the insulation. The exposed insulation is removed for about 0.25 inch, and the condenser is soldered between the end of the

braid and the exposed end of the wire. The braid is then grounded to the chassis at the nearest possible point. Lead length on the 0.001 mF capacitor is kept negligible.

- It is often simpler to run individual power wires from each socket or each choke, rather than to go from one point to the other and thence to the power-supply or other terminals with a single piece of wire. From the standpoint of TVI reduction, it is probably preferable.
- Each filament, screen and cathode of the two 807s should have its individual by-pass capacitor. Where the shielded wires run parallel, they should be spot-soldered together every few inches, and hold-down lugs should be placed wherever needed to anchor the wires firmly.
- The two exciter coils, *L1* and *L2*, are soldered directly across the terminals of the tuning condensers. A short sleeve of spaghetti over each coil lead will help to add strength to the wire.
- The 807 sockets are turned so that their grid terminals (Pins 3) are closest. Then *RFC6* and *RFC7,* end to end, should just about bridge the gap between the two terminals.
- The connections between the shorting-plug sockets and the junction of the two 807 grid chokes are made with No. 14 wire well spaced from the chassis. This wire also is used in connecting each of the amplifier tank-condenser mounting screws to one of the two tube cathode terminals (Pins 4).

Adjustment

The VR tubes should glow soon after the power is turned on. If they do not, and a check of the wiring shows no mistake, the resistance of *R11* should be reduced until the VR tubes light with the key closed. Variations in line voltage may require this.

- The transmitter should first be set up for 80-meter operation, with *C7* set at maximum capacitance and *S2* turned to read grid current.
- After the key is closed, turn *C7* slowly until a reading of grid current is obtained. This is the 80-meter resonance point.
- Now slowly reduce the capacitance of *C7* still further until another reading in grid current is obtained. This is the resonance point at 40 meters.
- Now, insert the shorting plugs for 20-meter operation, leaving *C7* set for 40 meters.
- Close the key and adjust *C14* for maximum grid-current reading. This initial reading may be slight, but it should be possible to bring it up to normal by a slight readjustment of *C7*.

With the exciter operating satisfactorily, you can now turn your attention to the amplifier.

- Set up again for 80-meter operation and plug the 80-meter coil in the amplifier. Adjust *C7* for maximum grid current at 80 meters.
- Then throw the meter switch over so that it reads cathode current.
- Holding the key closed, turn *C23* to maximum capacitance and then turn it slowly backward, watching for a dip in cathode current. The first dip you encounter should be resonance at 3.5MHz. This setting should be marked down and always used thereafter when tuning up on 80 meters. Amplifier tuning for the other bands is accomplished by always first setting *C23* at maximum and tuning for the first dip in cathode current.
- A coaxial cable should be connected at the output connector, thence to a low-pass filter and from there through another piece of cable to an antenna tuner. Reference should be made to the ARRL Handbook for antenna coupling and tuning and the use and construction of a low-pass filter. It may be advisable also to use a shielded keying lead.

Parts List: See NOTE on Page 1 regarding *RFC 6* , *RFC7*, *R9* and *R10*

C_1 — 15-μμfd. mica.
C_2 — 47-μμfd. mica.
C_3, C_4, C_5, C_6, C_9, C_{10}, C_{11}, C_{13}, C_{15}, C_{17}, C_{18}, C_{19}, C_{20}, C_{22}, C_{24}, C_{25}, C_{28}, C_{29}, C_{30}, C_{31}, C_{32}, C_{33} — 0.001-μfd. disk ceramic.
C_7 — 335-μμfd. variable (National STH-335).
C_8 — 100-μμfd. mica.
C_{12} — 47-μμfd. mica.
C_{14} — 35-μμfd. variable (National ST-35).
C_{16} — 0.01-μfd. disk ceramic.
C_{21} — 0.001-μfd. mica or 0.01-μfd. disk ceramic.
C_{23} — 300-μμfd. variable (National TMS-300).
C_{26}, C_{27} — 8-μfd. 700-volt-wkg. electrolytic (C-D BRHV-708).
R_1 — 68,000 ohms, ½ watt.
R_2 — 470 ohms, 1 watt.
R_3 — 47,000 ohms, 1 watt.
R_4 — 15,000 ohms, 1 watt.
R_5, R_6 — 4700 ohms, 1 watt.
R_7 — 100 ohms, ½ watt.
R_8 — Meter multiplying shunt (see text).
R_9, R_{10} — 47 ohms, ½ watt, noninductive.
R_{11} — 2500 ohms, 25 watts.
L_1 — 7.5 μh. — 32 turns No. 22, ⅝-inch diam., 1 inch long (B & W 3008 Miniductor).
L_2 — 1.3 μh. — 12 turns No. 18, ¾-inch diam., ⅝ inch long (B & W 3011 Miniductor).
L_3 — 3.5 Mc. — 6.3 μh. — 15 turns 1½ inches diam., 1¼ inches long (B & W JEL-40 with 7 turns removed).
— 7 Mc. — 2 μh. — 9 turns 1½ in. diam., 1½ in. long (B & W JEL-20, 3 turns removed).
— 14 Mc. — 0.8 μh. — 6 turns 1½ inches diam., 2 inches long (B & W JEL-40).
L_4, L_5 — 2.3-hy. 150-ma. filter choke (Stancor C-2304).
J_1, J_2, J_3 — Ceramic crystal socket (Millen 33102).
J_4 — Open-circuit 'phone jack.
J_5 — Coaxial connector (Jones S-101).
MA_1 — D.c. milliammeter, 25-ma. scale.
RFC_1, RFC_2, RFC_3, RFC_4, RFC_5 — 2.5-mh. r.f. choke (National R-50).
RFC_6, RFC_7 — 1-μh. r.f. choke (National R-33).
RFC_8 — 2.5-mh. r.f. choke (National R 100-S).
S_1 — Double-pole three-position rotary (Mallory 3223J).
S_2 — D.p.d.t. toggle.
T_1 — Power transformer: 600–0–600 volts r.m.s., 200 ma.; 6.3 volts, 3 amp.; 5 volts, 3 amp. (Stancor P-6170 or PC8414).
VR — VR-150 voltage-regulator tube.

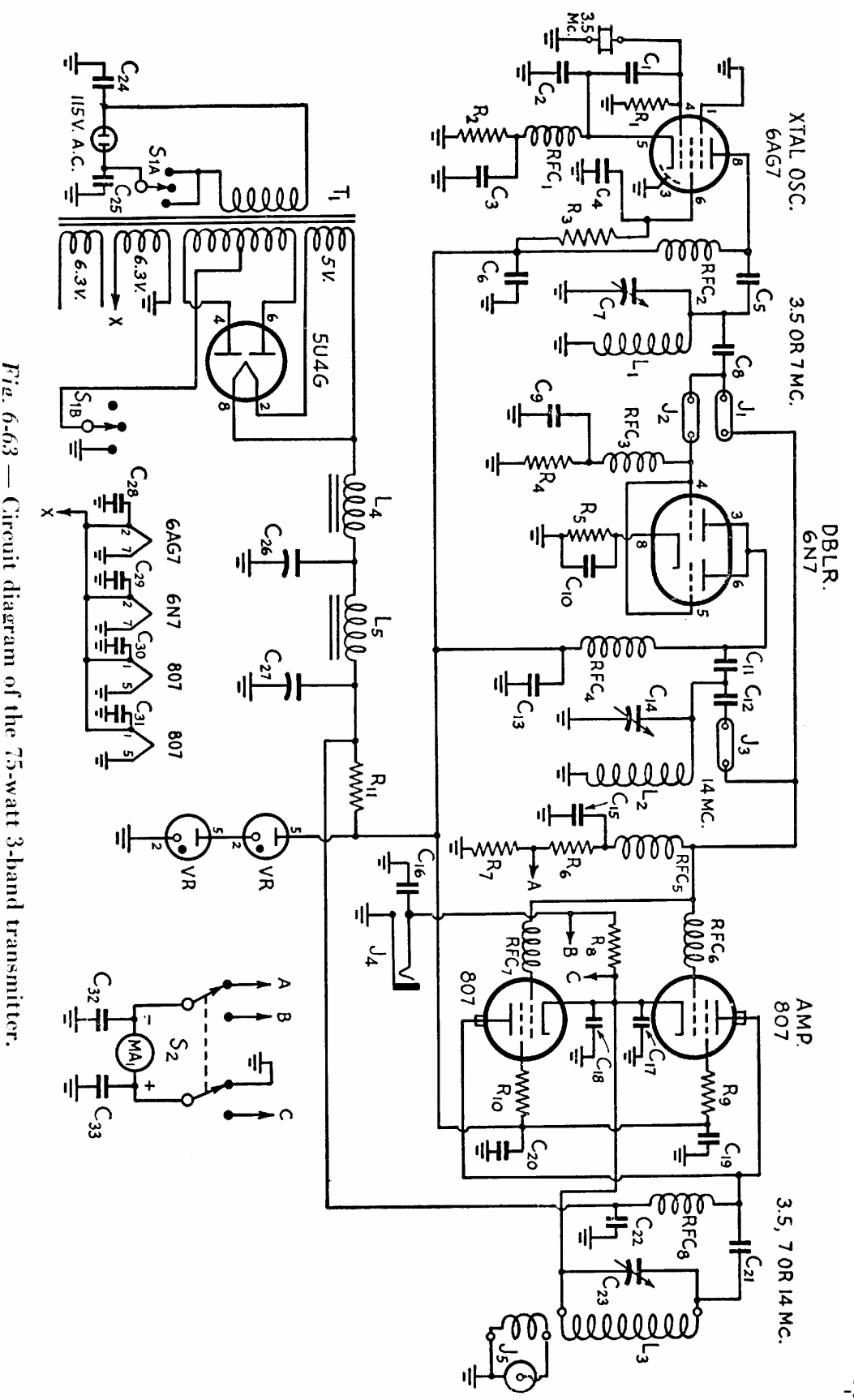


Fig. 6-63 — Circuit diagram of the 75-watt 3-band transmitter.