4-250-A's in a 1-Kw. Final

The amplifier shown in the accompanying photographs uses two 4-250As in parallel and covers 3.5 to 28 Mc. with complete band-switching. The output circuit is a pi network designed for working into reasonably well-matched 52- to 75-ohm coaxial lines. The amplifier can handle a kilowatt input in Class C operation on either phone or c.w. without pushing the tubes to their limits. It can also be operated as a linear amplifier for single side band.

The various components are mounted on a 17 × 13 × 4-inch aluminum chassis attached to a standard 19-inch relay rack panel 15¾-inches high. The above-chassis section is enclosed in a 11½-inch high shield made from 1/16-inch sheet aluminum. An aluminum bottom plate completes the below-chassis shielding. Enclosing the amplifier in this way, plus the use of shielded wire and filters in the supply leads, takes care of the harmonic TVI question.

The 4-250As are cooled by forcing air into the chassis and thence up past the tubes by means of a 21 cu. ft. per minute blower. The air is exhausted through two 3-inch diameter circular openings over the tubes in the top cover. To maintain the shielding intact, these are covered with perforated aluminum.

A Barker and Williamson Model 850 band-switching pi-tank inductor is used in the output circuit. It is tuned by a vacuum variable capacitor operated through the counter dial (Groth TC-3) shown in the panel view.

Circuit Details

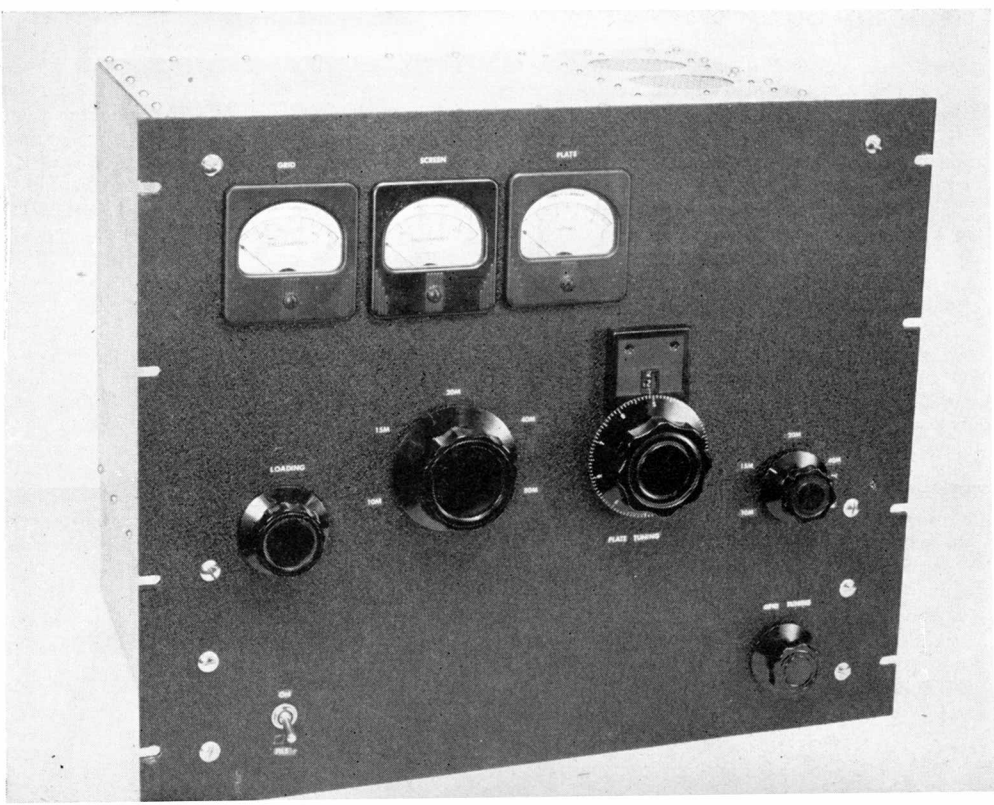
The circuit, Fig. 6-83, is electrically the more-or-less standard arrangement of a parallel-tuned grid circuit and a pi-network output circuit. The amplifier is neutralized by the capacitive bridge method. A filament transformer is included, but all other voltages come from external supplies.

The grid input circuit of the amplifier uses a slightly modified B&W turret assembly. The grid coils are tuned by a 75-$\mu\mu$f. variable. The 20-, 15-, and 10-meter coils each must have a few turns removed for proper grid tuning on these bands.

The circuit includes a 2000-ohm grid leak and has provisions for external bias, which should be used in combination with the leak. The by-pass capacitors on the screen leads all carry a rating of 1600 volts. This rating is necessary to avoid capacitor breakdowns when operating the amplifier screens at their rated voltages for AB_1 operation, and also with plate-modulated Class C operation where the 600-volt rating of the smaller ceramic capacitors would be exceeded on modulation peaks. All of the 0.001- and 0.003-μf. capacitors are the disk type, and aside from the screen by-passes are used mainly for filtering TV harmonics from the supply leads.

The by-pass capacitors in the high-voltage lead

Fig. 6-83—A 1-kw. final using a pair of 4-250-A's in parallel.



1-Kw. Amplifier

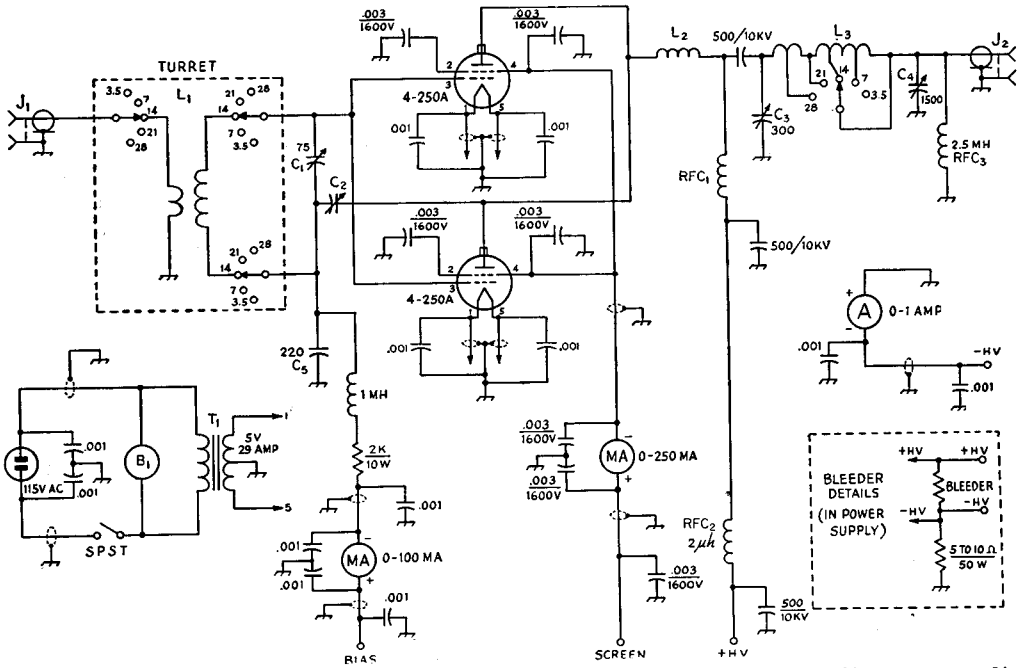


Fig. 6-84—Circuit diagram of the 4-250A amplifier.

B_1—Blower-motor assembly, 21 c.f.m. (Ripley model 8433).

C_1—75-$\mu\mu$f. variable, receiving spacing (Millen 19075).

C_2—7-$\mu\mu$f. neutralizing capacitor (Cardwell type ADN).

C_3—300-$\mu\mu$f. vacuum variable (Jennings type UCS).

C_4—1500-$\mu\mu$f. variable (Cardwell type 8013).

C_5—220-$\mu\mu$f. mica or NPO ceramic.

J_1, J_2—Coax receptacle, chassis mounting.

L_1—Turret assembly (B&W BTEL with 14-, 21-, and 28-Mc. coils modified by removing turns).
3.5 Mc.: 39 turns No. 22, 1¼ inches diam., ⅜ inches long, link 3 turns No. 18.
7 Mc.: 20 turns No. 20, 1¼ inches diam., 1W inches long, link 3 turns No. 18.
14 Mc.: 8 turns No. 18, 1¼ inches diam., ¾ inch long, link 2 turns No. 18.
21 Mc.: 4 turns No. 16, 1¼ inches diam., ½ inch long, link 1 turn No. 18.
28 Mc.: 2½ turns No. 16, 1¼ inches diam., ½ inch long, link 1 turn No. 18.

L_2—V.h.f. parasitic suppressor, 4 turns No. 12, ¼ inch dia., turns spaced wire diameter.

L_3—Pi-tank inductor (B&W Model 850). Inductances as follows: 3.5 Mc., 13.5 μh.; 7 Mc., 6.5 μh.; 14 Mc. 1.75 μ.; 21 Mc., 1 μh.; 28 Mc., 0.8 μh.

RFC_1—National type R175A r.f. choke.

RFC_2—2-μph. 500-ma. r.f. choke (National type R-60).

RFC_3—2.5-mh. r.f. choke.

T_1—Filament transformer, 5 volts, 29 amp. (Thordarson T-21FO7-A).

are the TV high-voltage ceramic type, as is also the blocking capacitor in the tank circuit. The loading capacitor, C_4, in the output circuit of the amplifier is a variable having enough range (1500 $\mu\mu$f. total capacitance) to give adequate loading on 80 through 10 meters when working into a 52- or 75-ohm resistive load.

Plate current is metered by a 0–1 ammeter shunted across a resistor in the negative high-voltage lead. As shown in Fig. 6-84, this resistor is incorporated in the power supply, not in the amplifier unit. A 50-watt rating represents an ample safety factor, since the power dissipated would not exceed a few watts should the ammeter open up.

Separate milliammeters are provided for the grid and screen circuits. The screen meter is quite essential since the screen current, and hence screen dissipation, is very sensitive to grid driving voltage and plate tuning.

Layout Details

Fig. 6-85 is a view looking into the amplifier with the top cover removed. The variable capacitor at the right is the output loading control, C_4. To the left of C_4 is the Model 850 inductor unit. Immediately to the rear (below, in the photograph) of the inductor is the output lead, connected to a coaxial receptacle mounted on the rear cover. The vacuum variable, C_3, is mounted between the inductor and the 4-250As. It is supported by an aluminum bracket 6 inches high and 4 inches wide. The neutralizing capacitor C_2 is between the 4-250As and the front panel.

The grid turret and tuning capacitor are mounted underneath the chassis to take advantage of the shielding afforded thereby. To fit under the chassis the turret is mounted with the switch shaft vertical, necessitating a right-angle drive to the panel control. The shaft approaches the panel at an angle, so a flexible coupling of the ball type (Millen 39001) is used between the shaft and panel bearing.

The meters are in a separate enclosure measuring 11 × 3 × 3-inches. It is mounted to the front of the box by countersunk flat-head screws. The top lips of the meter box are drilled to take sheet-metal screws when the lid is in place.

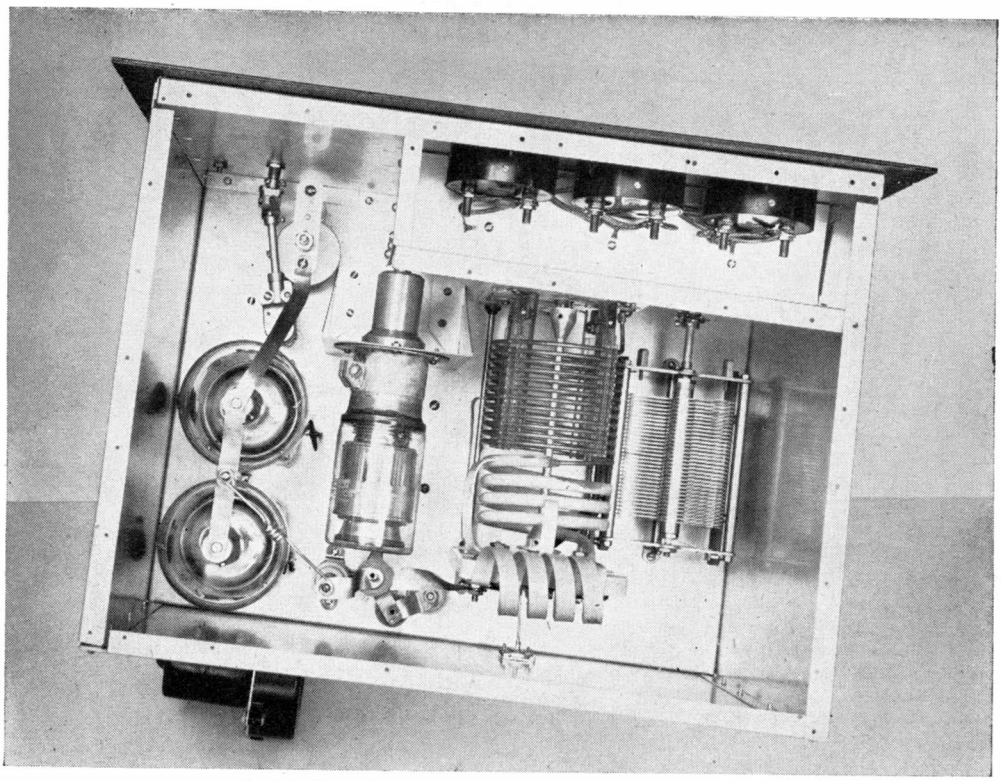


Fig 6-85 (above)

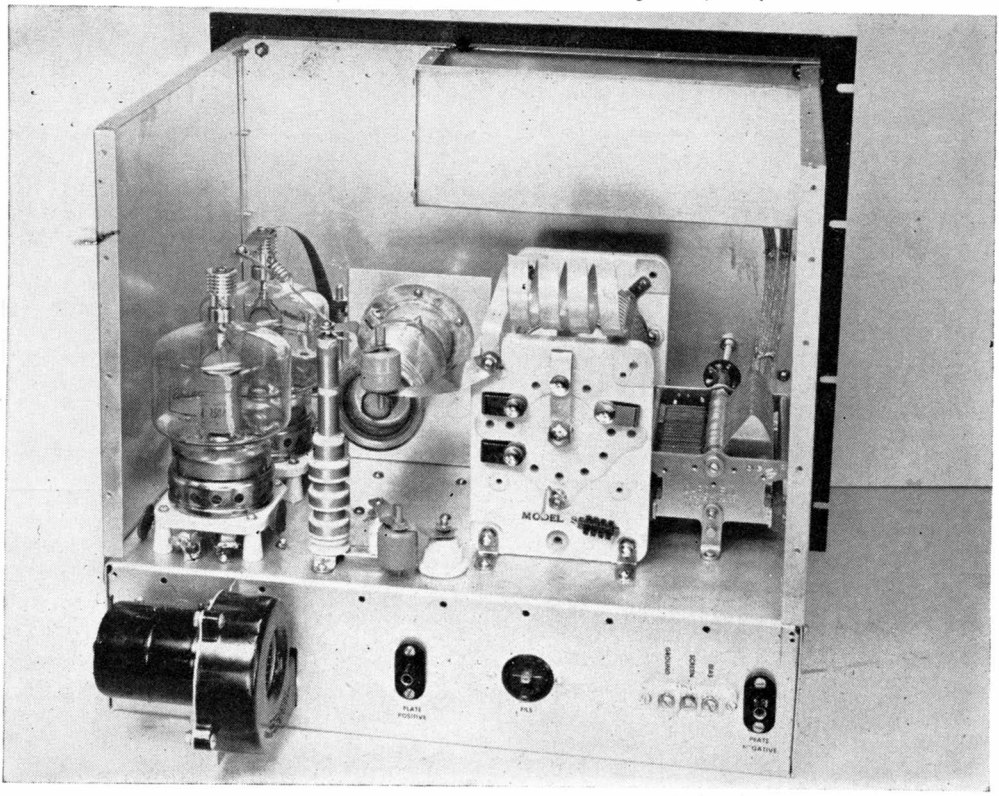


Fig. 6-86 (below)

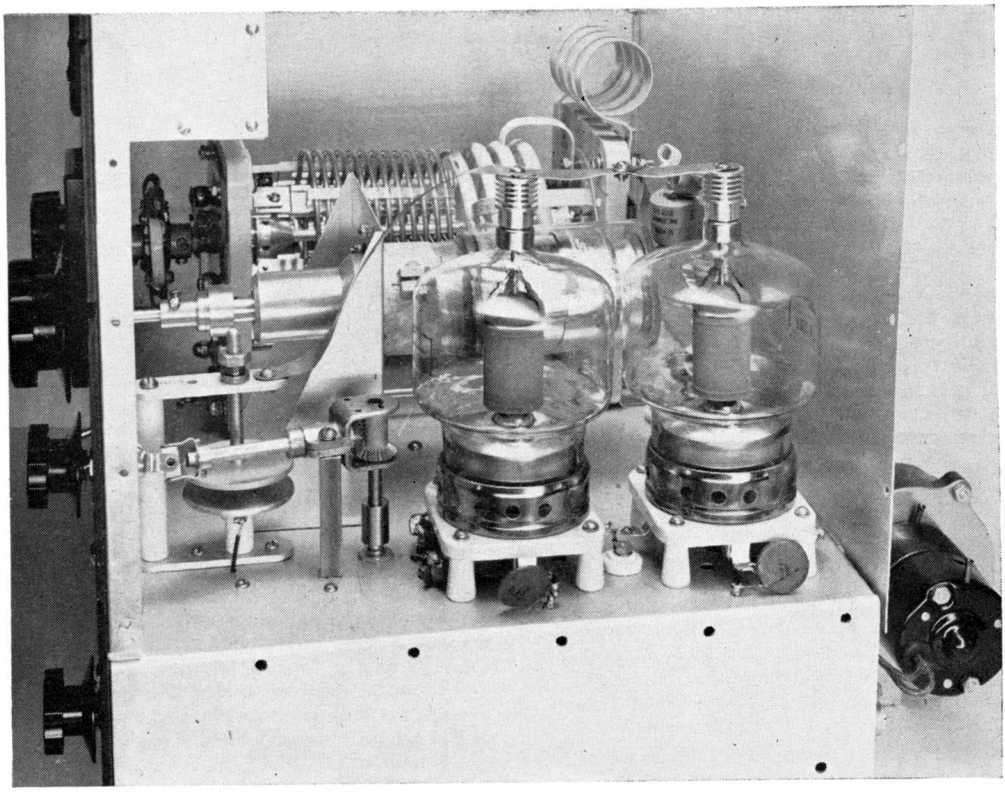


Fig. 6-87

Connections to the tube plates and neutralizing capacitor are made from flexible brass strip ½ inch wide. A piece of ¾-inch wide brass strip is used for the connection between the stator terminal of the vacuum variable and the tank inductor. The blocking capacitor is mounted on this strip.

Fig. 6-86 shows the amplifier with the top and back panels removed. The blower assembly is mounted on the rear chassis wall. To the right of the motor is the high-voltage terminal, the 115-volt connector, the grid and screen terminals, and the high-voltage negative connector. Leads from these last three terminals run below chassis in shielded wire and then up to the meter box. These leads are visible in front of the loading capacitor. Belden 8885 shielded wire is used for the leads. The inner conductor is bypassed to the shield braid at each end. The 2.5-mh. "safety" choke, RFC_3, shunting the output end of the pi network is mounted on the back of the tank coil between the output lead and chassis ground.

The isolantite feed-through insulator to the left of the inductor is used to bring the high voltage through the chassis. Adjacent to it is the bypass at the bottom of the plate choke, RFC_1.

Mounting details of the right-angle drive assembly for switching the grid circuit are clearly visible in Fig. 6-87. A ½-inch square rod 2¾ inches long is drilled and tapped at both ends to support the drive.

The sockets for the 4-250As are mounted on one-inch isolantite pillars. The screen and filament terminals are bypassed directly at the socket terminals. The grid terminals on the sockets face each other, and a small feedthrough is used to bring the grid lead up through the chassis.

Fig. 6-88 is a bottom view of the amplifier and Fig. 6-89 is a close-up view of the grid circuit. A short length of RF-58/U is used to connect J_1 on the rear chassis wall to the link terminals on the turret assembly. The high-voltage lead is filtered by the 500-$\mu\mu$f. ceramic bypass and RFC_2. These two components are visible on the inside of the rear wall above the blower assembly. Two-terminal tie-points are used for the a.c. connections to the filament transformer and blower motor. Shielded leads are used between the tie-points and the 115-volt connector.

Fig. 6-89 shows the grid-circuit wiring in a bit more detail, particularly the grid choke, grid resistor and C_5 clustered just above the tuning capacitor. The modifications to the 10- and 15-meter coils also are somewhat more easily seen in this photograph.

Adjustment and Operating Data

The amplifier should be neutralized with the plate and screen supply leads disconnected and the bandswitch set to 28 Mc. An indicating wave meter should be coupled to the tank circuit and drive applied to the amplifier. Resonate the grid

and plate tanks and adjust the neutralizing capacitor for minimum r.f. in the tank circuit as indicated by the wave meter. The same neutralizing adjustment should hold for all bands. Don't attempt to neutralize with the plate and screen supply leads connected — i.e., with a complete circuit for d.c. — because even with the power turned off this permits electrons to flow from the cathode to the plate and screen, and r.f. will be present that cannot be neutralized out.

The parasitic choke will, in general, resonate the plate lead in one of the low v.h.f. TV channels, and will tend to increase harmonic output in that channel. Measure the resonant frequency of the plate lead at L_2 with a grid-dip meter, and if it is in one of the channels received in your locality, either pull the turns apart, or squeeze them together to move the frequency to an unused channel. Any frequency from 70 to 100 Mc. should be satisfactory.

Power Supply

For 1 kw. input, a plate voltage of at least 2000 is required. Screen voltage is obtained preferably from a separate 400-volt supply. For Class C operation, an external bias supply regulated by a VR-150, plus a grid leak of 2000 ohms is recommended. With this combination, the grid current should be 25 ma. Screen current should be about 60 ma. with the amplifier fully loaded.

Some sort of r.f. output indicator, such as a crystal-rectifier voltmeter or r.f. ammeter in the feed line, should be used in tuning. It is preferable to do the preliminary tuning with the plate voltage applied to the tubes but with the screen voltage at zero. Zero screen voltage, provided the d.c. screen circuit is complete, will give enough output for tuning adjustments. C_2 and C_4 are adjusted to give maximum output, and the screen voltage is then increased until the amplifier is running at the desired input. C_3 is of course tuned for the plate-current dip so that the amplifier tank is kept tuned to resonance.

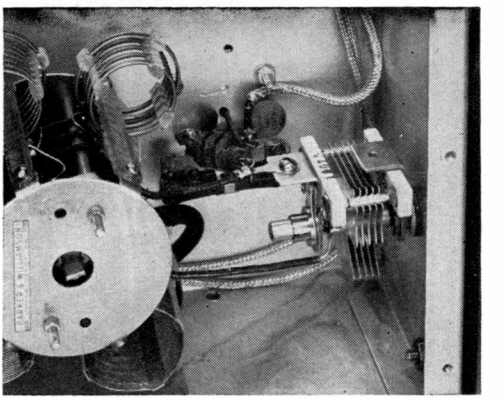


Fig. 6-89

The fixed values of inductance available in the B&W unit preclude the possibility of matching over a wide range of impedances. The circuit can handle an s.w.r. in the coax line of about 2 to 1, but with higher s.w.r. values it may not be possible to get the desired loading. Also, although the construction is such that the amplifier is "clean" insofar as direct radiation and leakage of harmonics in the TV bands are concerned, a good low-pass filter will be required in most installations. A low s.w.r. in the coax line is definitely a requirement if excessive build-up of currents or voltages in the filter is to be avoided. If the line cannot be matched at the antenna, an auxiliary antenna coupler will have to be used.

For plate modulation a choke coil may be connected in the d.c. screen lead so the screen voltage will follow the audio variations in plate voltage. The choke should have an inductance of about 10 henrys, and must be capable of carrying 125 ma. d.c. For Class AB_1 operation on single side band the circuit may be left intact, the only requirement being to supply the proper operating voltages from suitably well-regulated supplies. If the amplifier is to be operated in AB_2 on s.s.b. the grid-leak resistor should be shorted out; also, suitable loading should be applied to the grid tank to maintain good regulation of the r.f. driving voltage.

(From *QST*, June, 1956.)

Fig. 6-88