6-meter amplifier

A companion unit to the 2-meter and 1 ¼-meter amplifiers

This six-meter amplifier is a companion unit to the 2-meter and 1-1/4-meter amplifiers previously described in *ham radio* articles.[1] All three amplifiers are built using the same chassis configuration originally described by K2RIW for a stripline kilowatt for 432 MHz.[2] The 50-MHz version uses a conventional pi-network output with inductive tuning, and a coil simulated half-wave line for its input section. Both the tetrode (**fig. 1**) and the triode (**fig. 2**) versions will be discussed. Like its predecessors, the 50-MHz amplifier uses parallel combinations of any of the 4CX250 type tetrodes, the 8930 tetrodes, or the 8874 triodes. Metering and power supply connections are identical to the 2-meter and 1-1/4-meter amplifiers. Using a standard design for VHF/UHF amplifiers, a single power supply can be switched from one amplifier to another. Remote operation with a separate metering unit at the operating position or built into the power supply is another adaptation, useful particularly at 432 MHz.

These four 12 × 6 × 8 inch (30.5 × 15.2 × 20.3 cm) power amplifiers for the four popular VHF/UHF

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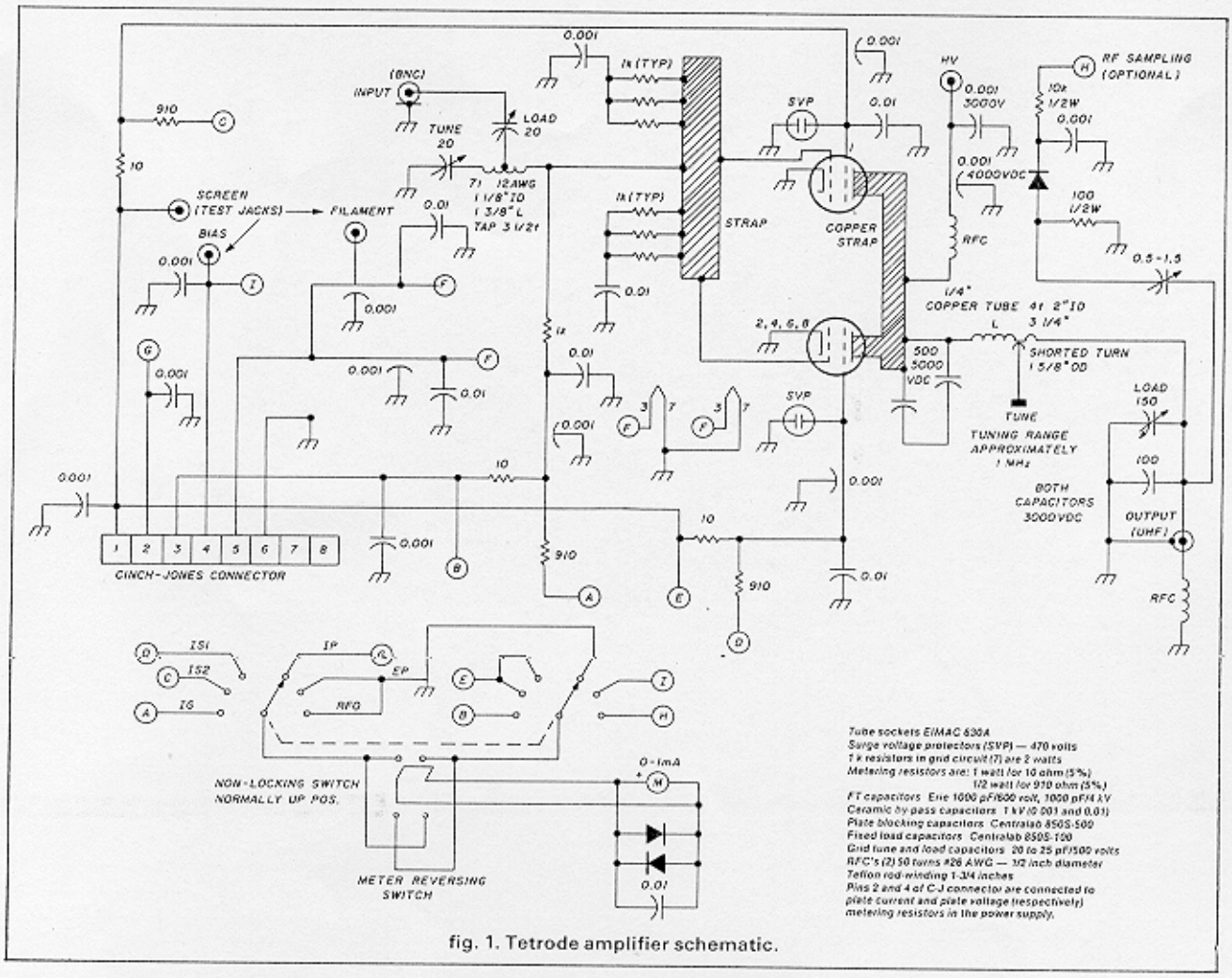


fig. 1. Tetrode amplifier schematic.

Amateur bands have been successfully duplicated hundreds of times. They are rugged and offer a proven performance developed by thousands of hours of testing and use over the past eight years. They provide flexible and reliable high-power operation.

By initially drilling and punching a set of chassis boxes for all four models (432, 220, 144, and 50 MHz), an amplifier can be converted from one band to another. This might be achieved by using a quick-change mechanical procedure for the four separate frequency-sensitive circuit elements.

construction details

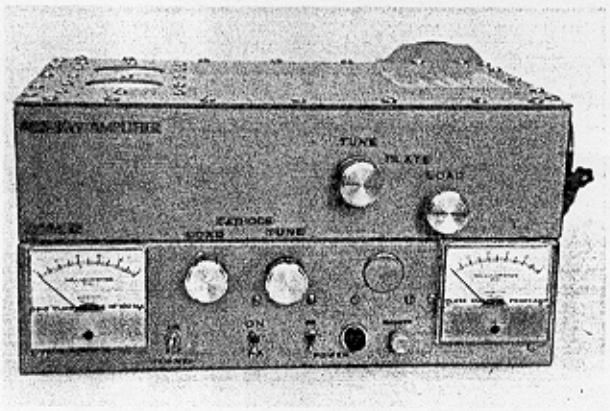
The essential dimensions for chassis drilling and punching are contained in the articles listed in reference 1. This article covers only construction details peculiar to the 50-MHz amplifier.

Referring to the schematic of the 50-MHz tetrode amplifier (**fig. 1**), notice that the two grids are connected by a copper strap between the sockets. The two anodes are paralleled by a brass or copper plate assembly which uses fingerstock for connection to the anodes, providing a mounting for the plate blocking capacitors and a connection point for the high-voltage RFC. The dc circuitry is similar to that found in the previously described amplifiers.

In the triode amplifier (**fig. 2**), the rf section is exactly the same as that shown in **fig. 1** except that rf chokes are used in the filament leads and in the cathode bias lead. The cathode bias and metering circuitry is conventional for a grounded grid amplifier. Two meters are used with the grid current meter on a non-locking switch to read plate voltage.

control and safeguard options

The optional circuitry shown in **fig. 2** provides examples of control and safeguard features which can be added to these amplifiers. The blower option provides 120 Vac on pins 2 and 4 of the cable connector. This permits powering the blower from a receptacle on the amplifier chassis, rather than running a lead



Tetrode amplifier — front view.

back to the power supply. An air switch is mounted in the blower air stream and connected via the blower connector to two power switches (one locking and one non-locking) and to pin 7 of the amplifier connector. Pin 7 is the power relay operate lead in the power supply.[1]

To turn the amplifier on, the locking-type power switch is switched to the on position and the non-locking (push-button type-momentary) switch is pressed to operate the power relay. The power relay energizes the power supply and provides 120 Vac on pins 2 and 4 to start the blower. With the blower up to speed, the air switch keeps the power relay actuated. Once the push button is released, the power supply relay is under the control of the air switch.

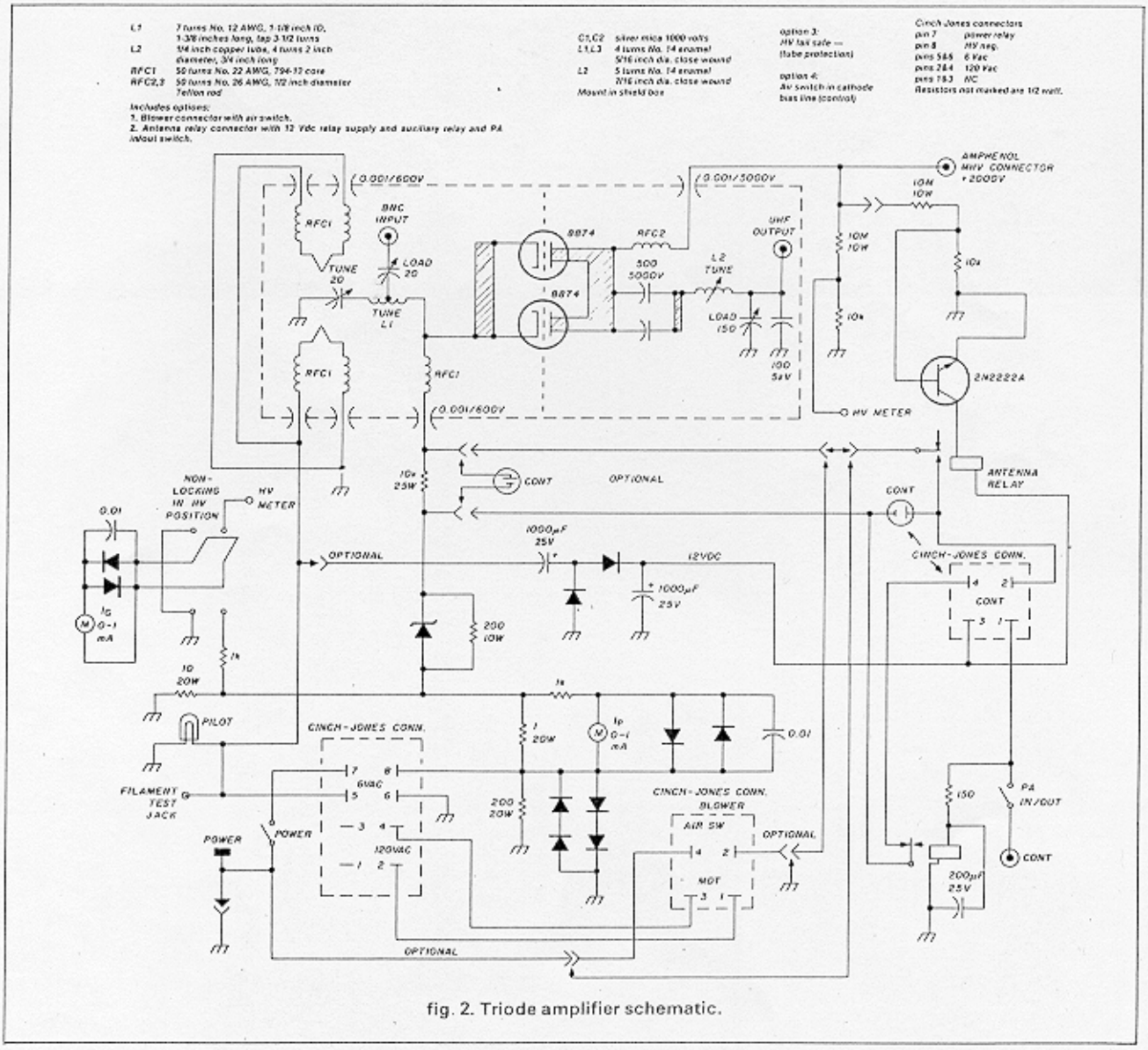
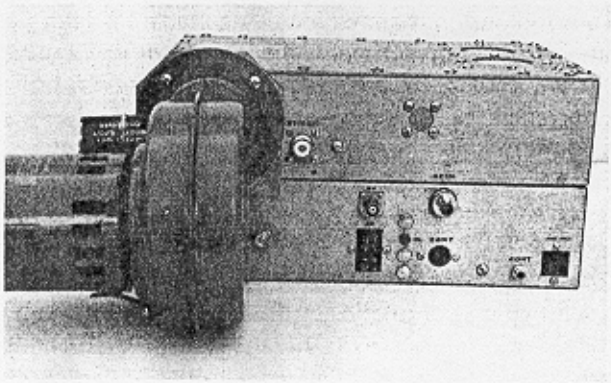
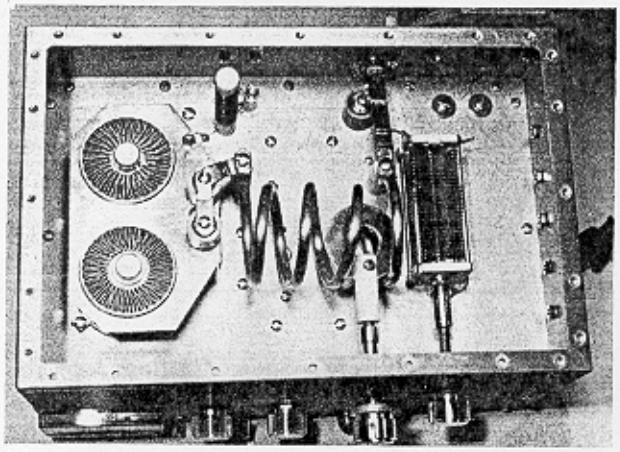


fig. 2. Triode amplifier schematic.



Tetrode amplifier — rear view.



Tetrode amplifier — upper chassis.

Should the blower fail or not come up to speed, the power supply will automatically shut down, an important safeguard considering the two hundred dollar price tag on 8874s.

If excitation is applied with no plate voltage on the tubes, damage to the grid structure may result. The high-voltage fail-safe option provides a safeguard by using a transistor and a relay to open the bias control circuit if high voltage is not present. A 12-volt power supply for this feature is provided by a voltage doubling circuit from the filament line.

The remaining option, shown in **fig. 2**, is used to operate a DPDT coaxial relay which can be mounted (with a coaxial adapter) on the output connector of the amplifier. The coil of the relay and a set of auxiliary make-contacts are connected to the amplifier chassis via a four-contact connector. The 12-volt supply, auxiliary control relay circuitry, a power amplifier (PA) in/out switch, and a control jack complete this feature. Note that a ground on transmit to the amplifier control jack will apply operating bias to the amplifier only if the antenna relay is operated and the auxiliary relay (in this optional circuit) is released. In receive, 12 volts is applied through the winding of the antenna relay to the auxiliary relay winding. The auxiliary relay operates, but the antenna relay, which requires more current than the auxiliary relay, does not operate with the PA switched to the in position. A ground on transmit from the exciter causes the antenna relay to operate immediately and the auxiliary relay to release after a slight delay. This prevents the amplifier from being "hot switched" and provides additional protection for the rf amplifier in the receiver. A layer or two of cellophane tape on the pole piece of the antenna relay is usually required to guarantee release. More sophisticated antenna relay-control circuitry is desirable, however, for EME amplifier applications.

Construction and mounting arrangements for the various options are covered in the construction infor-

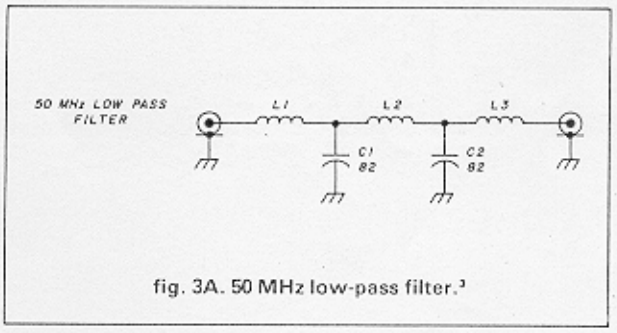


fig. 3A. 50 MHz low-pass filter.[3]

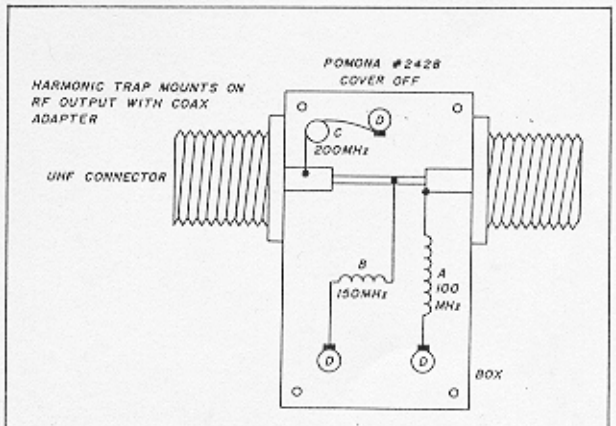
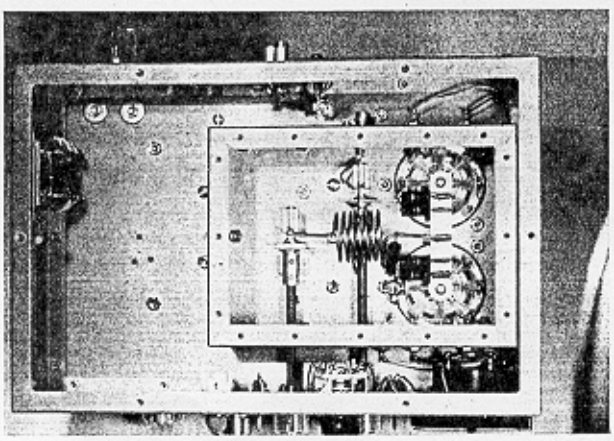


fig. 3B. Trap filter.



Tetrode amplifier — lower chassis.

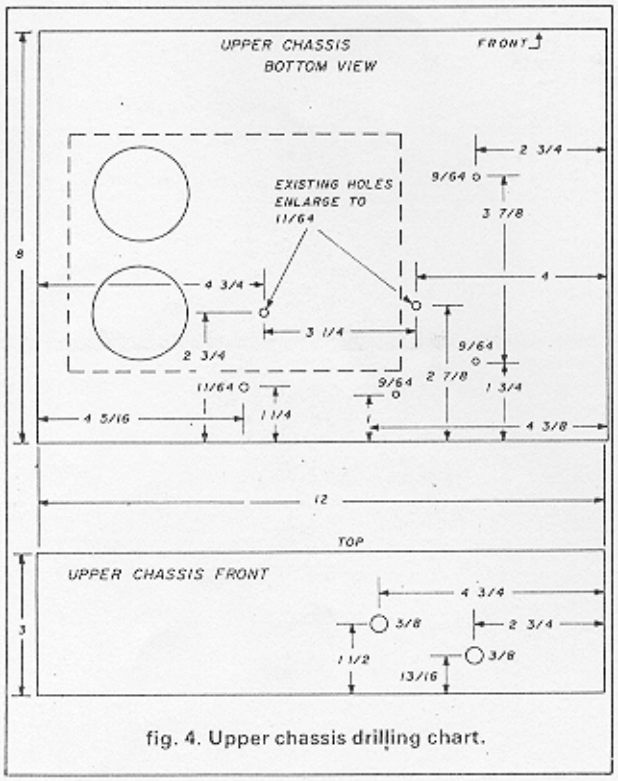


fig. 4. Upper chassis drilling chart.

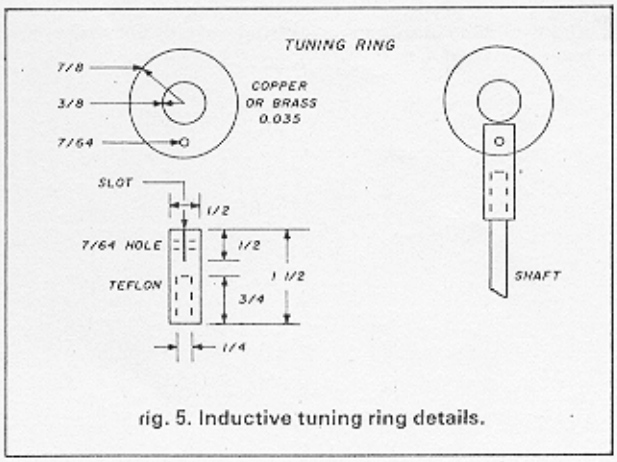
mation for the triode amplifier. Which options are chosen, and whether they are mounted inside or outside the amplifier, is determined by the intended application and the builder's inclination. These options are also applicable to the 50-MHz *tetrode* amplifier version as well as to the other models of these amplifiers, already described.

A lowpass filter or harmonic trap circuit is needed in the rf output to attenuate harmonics in the amplifier output. These amplifiers, even when operated in the linear mode, may have harmonic components no more than 40 dB down from the fundamental, a level of harmonic attenuation which no longer meets modern RFI design requirements. A suitable LP filter design for this 50-MHz amplifier is shown in the 1981 *ARRL Handbook*, pages 7-11 (**fig. 3A**). Harmonic trap circuit construction is shown in **fig. 3B**.

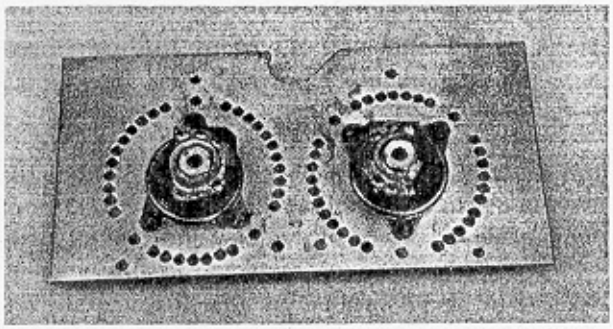
Information on the triode and tetrode amplifier power supplies has already been provided in the 220-MHz amplifier article.[1]

construction — tetrode amplifier

If you do *not* intend to use the chassis for the 50-MHz amplifier on any of the other VHF/UHF bands, *omit* the following in its construction: five holes (11/64 inch or 4.4 mm) in the right side of the upper chassis used for mounting the 2-meter plate line, four holes (7/64 inch or 3 mm) and one hole (5/8 inch or 15.9 mm), on the rear of the upper chassis for mounting the rf output connector; two holes (7/64 inch or 3 mm), one hole (3/8-inch or 9.5 mm) for the plate load control in the top plate, and the hole in the front of the lower chassis for the plate tune control. The remaining holes not used for 50 MHz can be drilled and disregarded or filled with 6-32 (M3.5) hardware.



rig. 5. Inductive tuning ring details.



Triode amplifier socket plate assembly — bottom view.

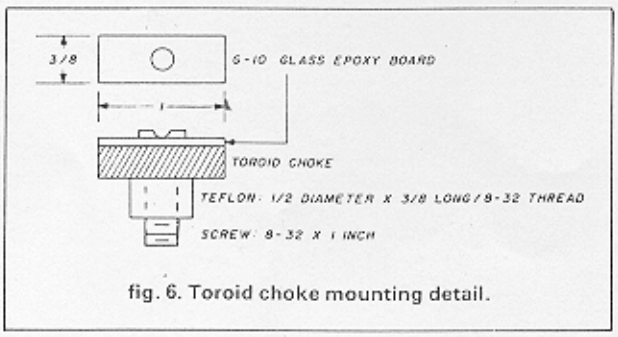
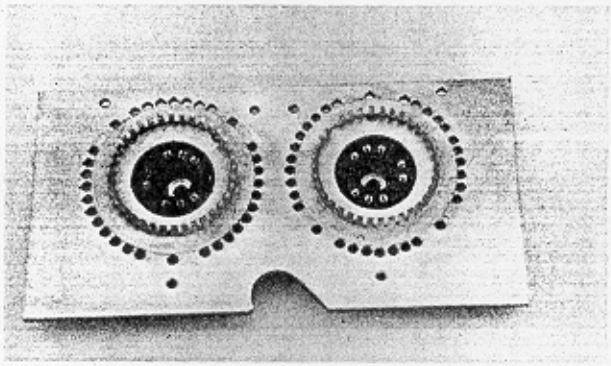


fig. 6. Toroid choke mounting detail.



Triode amplifier socket plate assembly — top view.

Fig. 4 shows the upper chassis drilling required for mounting the plate coil, variable load capacitor, rf choke, fixed load capacitor, and tune and load controls. Fig. 7 shows the drilling and punching for the rf output connector. This completes the chassis preparation.

Details of the inductive tuning ring are shown in fig. 5. Fig. 8 gives the dimensions for the plate line. Fig. 9 provides information on the plate rf choke.

The plate coil is wound with 1/4-inch (6.3-mm) copper tubing, four turns, 2 inches (50 mm) ID, 3-1/4 inches (8.3 cm) long. The ends of this coil are flattened, bent and drilled 11/64 inch (4.4 mm), to mount the coil on 1-1/2-inch (3.8-cm) Teflon pillars midway between the top and bottom of the upper chassis. When construction is completed, the spacing between the turns of the plate coil is adjusted to provide the required tuning range. The tuning range with the inductive ring is in excess of 1 MHz. An accurate grid dip meter is useful for preliminary adjustment of turns spacing for the desired frequency range. The final adjustment of coil size to the desired range is made during the final rf testing.

The assembly and wiring may be done in the same sequence used for the 144- and 220-MHz amplifier, by first assembling and wiring the lower chassis and then assembling the upper chassis and grid box. Mount the sockets and install the plate line parts. Finally, join the upper and lower chassis, make filament and grid bias connections, and install the grid box parts to complete the assembly.

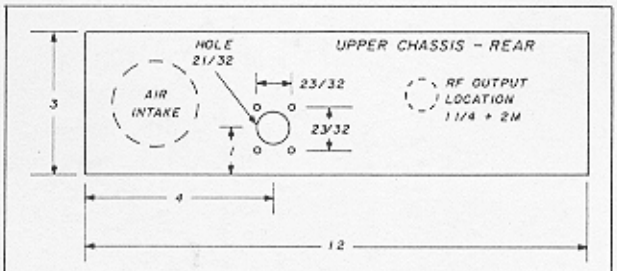
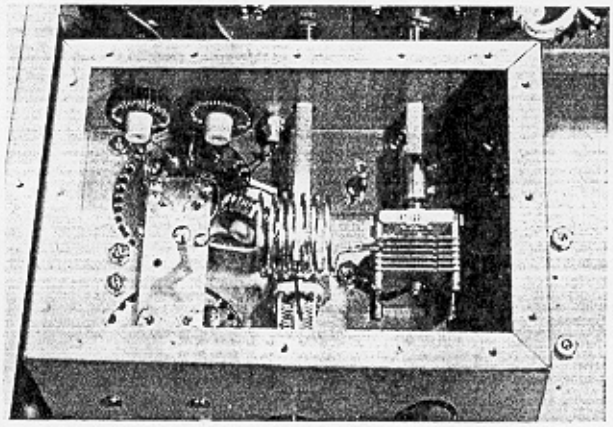
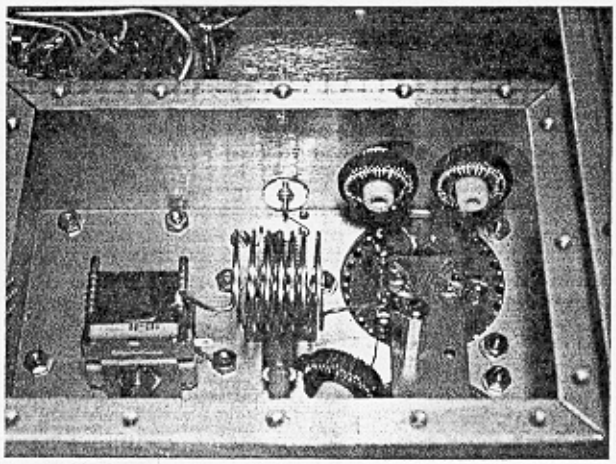


fig. 7. Upper chassis drilling for rf output connector.



Cathode box of triode amplifier viewed from rear of amplifier (toward front of amplifier). Note that toroid choke mountings are not exactly the same as *fig. 6*.



Bottom view of cathode box of triode amplifier.

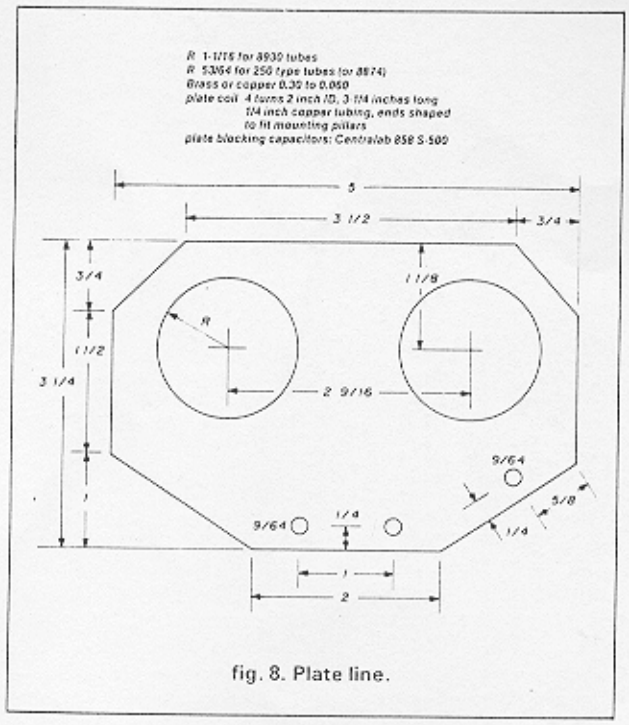


fig. 8. Plate line.

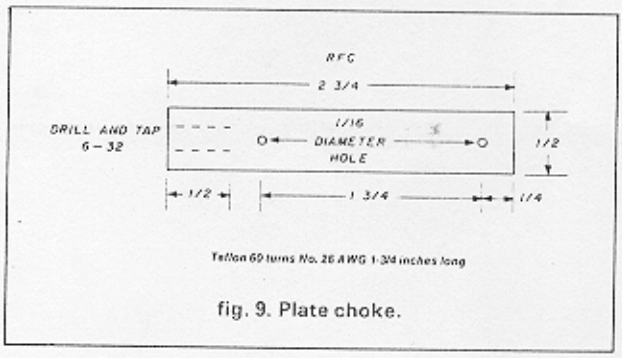


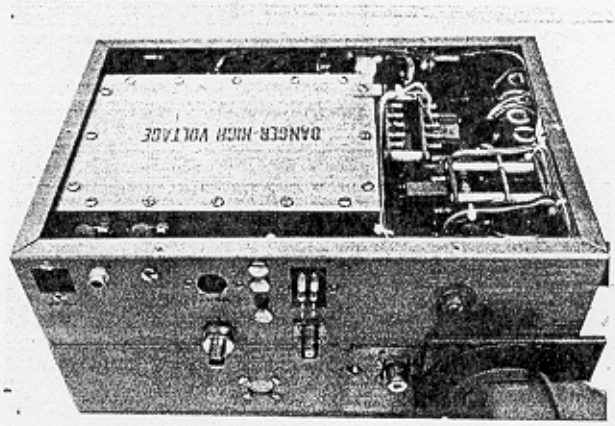
fig. 9. Plate choke.

construction — triode amplifier

Follow the directions for the tetrode amplifier construction for chassis drilling and punching, for the plate line and plate coil. The cathode tuned circuit for the triode amplifier is the same as that described for the grid circuit of the tetrode version. The holes in the grid box for the filament feed-through capacitors are relocated toward the bottom of the box to accommodate the toroid chokes (**fig. 6**). An additional meter hole is punched in the lower chassis front on the right side.

The tube sockets are mounted on a brass plate, as described for the 220-MHz triode amplifier. This assembly (**fig. 10**) lets you solder the grid collet (EIMAC part #882931) in position. Vent holes are provided around the base of the tube; it's a good idea to have this assembly silver plated. The assembly is bolted in place in the same position as the two 630A sockets used for the tetrode amplifier. A brass strip (**fig. 11**) may be used to connect the cathode pins of the two sockets together. This strap is soldered in place after the socket plate has been mounted. Its position is such that the cathode socket pins protrude through the holes about 1/8 inch (3 mm).

Alternatively, a small brass plate mounting a brass bushing (tapped 10-32) may be soldered to the cathode pins of each socket. This method of construction is more involved, but avoids soldering the grid strap in place after the socket plate is mounted. The grid strap is fastened by the 10-32 screws on each mounting plate.



Triode amplifier bottom view to illustrate mounting of optional circuit features on terminal boards in lower chassis.

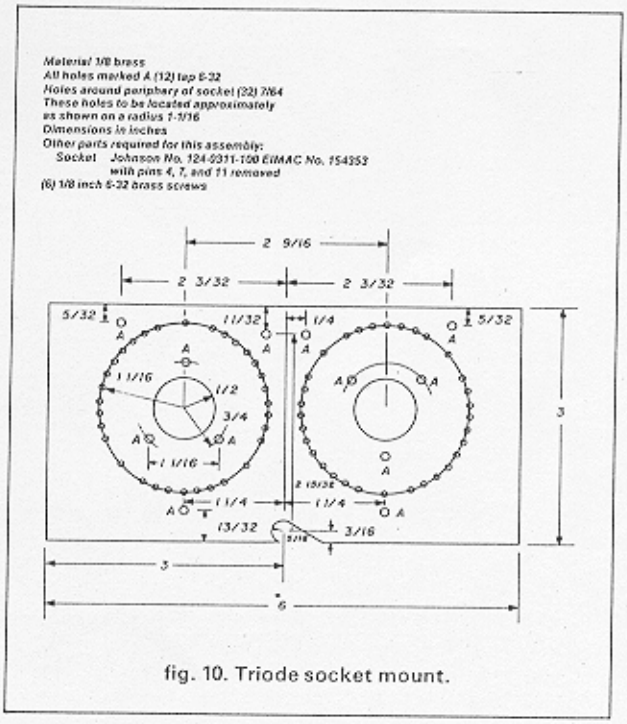


fig. 10. Triode socket mount.

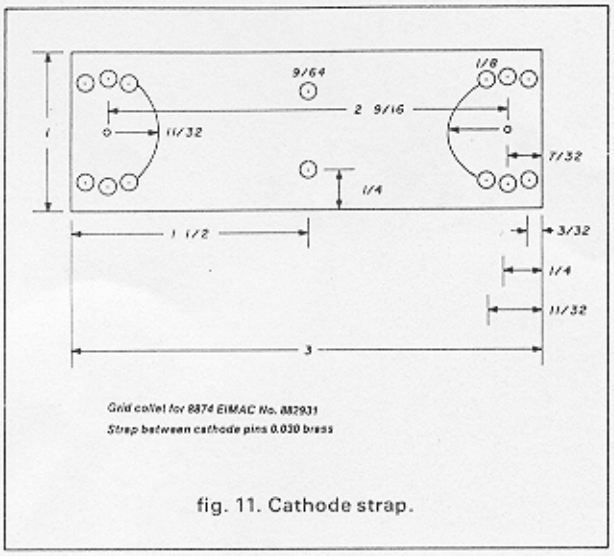
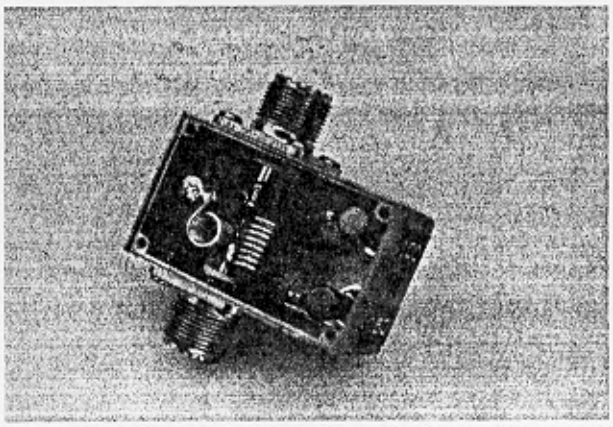


fig. 11. Cathode strap.



Output harmonic trap assembly. Three series traps — 100 MHz, 150 MHz, and 200 MHz. Piston capacitor adjustment screws (3) protrude out the bottom of the box.

Metering and other circuitry is mounted in the lower chassis, as shown in the photos. The vitreous-type resistors are mounted to the chassis wall. Other resistors and parts are mounted on terminal boards secured to the chassis with mounting spacers.

The options shown on the triode amplifier schematic (fig. 2) are mounted as follows:

The antenna relay connector is located on the right side of the lower chassis (rear). The small relay associated with this option is located in any convenient spot in the lower chassis. The various resistors, capacitors, and other parts for the antenna relay control circuit, the 12-Vdc supply, and the high voltage fail-safe circuitry are on terminal strips which are located in the lower chassis.

The blower connector is located on the left (side) rear of the lower chassis.

The PA in/out switch, the power switch, and the non-locking switch to start the blower are located on the front of the lower chassis.

In assembling and wiring the triode amplifier, follow the same pattern described for the tetrode amplifier — lower chassis parts mounting and wiring first — upper chassis and cathode box, tube socket assembly, plate circuit parts, joining upper and lower chassis, cathode parts, and the final wiring steps.

automatic load control

An ALC circuit (fig. 12) has been added as an option to the triode amplifier. The parts within the grid box are mounted close to the rf input connector. A bias winding is required on the high-voltage transformer, or a separate small transformer is required to provide the +56 volts threshold control voltage. The bias voltage parts can be mounted in the power supply chassis on a terminal board.

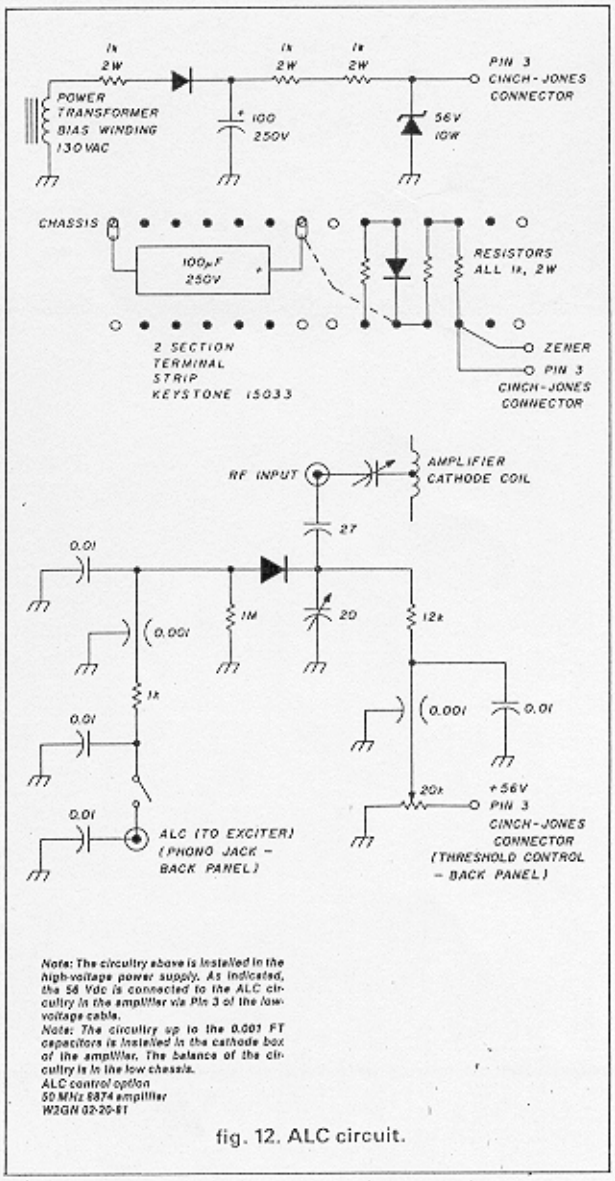
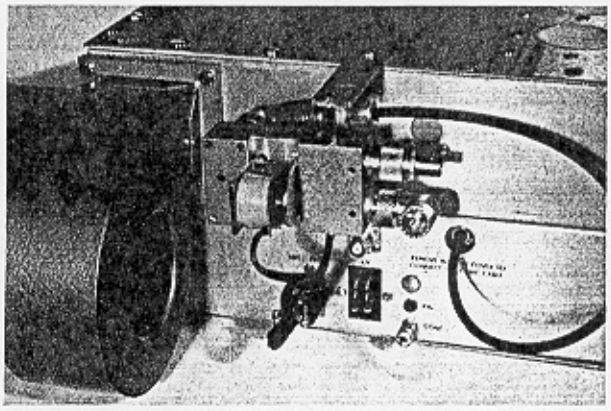


fig. 12. ALC circuit.



Mounting of double-pole coaxial relay on output connector.

table 1. Typical operation tetrode amplifier.

drive power	grid current	screen current	plate current	plate voltage	power output
0	0	0	0.100	2150	0
2.5	0	0	0.260	2010	177
5.0	0	−0.003	0.430	2000	470
10.0	0.002	0.027	0.600	2000	800

filament volts = 6.07 grid volts = 64 screen volts = 315

table 2. Typical operation triode amplifier.

drive power	grid current	plate current	plate voltage	power output
0	0	0.040	2300	0
2.5	0.002	0.210	2100	140
5.0	0.004	0.300	2050	285
10.0	0.025	0.380	2050	540

filament volts = 6.12

Note: The triode amplifier may be driven to an output level of 1 kW (SSB).

operation

The 50-MHz amplifiers tune and load in a conventional manner. Make initial adjustments with low drive power. Final adjustment of the grid (or cathode) tuning is made for lowest SWR toward the drive source. Final adjustment of the plate tuning must be done at full power output in order that the load control may be set at its optimum position.

Tables 1 and 2 show typical operation of the tetrode and triode amplifiers.

references

1. Fred Merry, W2GN, "Stripline Kilowatt For Two Meters," *ham radio*, October, 1977. Also, "Stripline Kilowatt for 220 MHz," *ham radio*, April, 1982.
2. Richard T. Knadle, Jr., K2RIW, "A Stripline Kilowatt for 432 MHz," *QST*, April, 1972, page 48; May, 1972, page 59.
3. *ARRL Handbook*, 1981, pp 7-11.