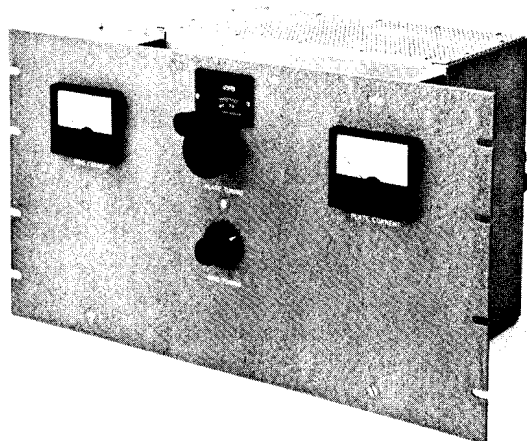




high performance 144-MHz power amplifier

This efficient
easy-to-tune
grounded-grid
8877 amplifier
can be run
at 2000 watts
PEP ssb
or 1000 watts cw

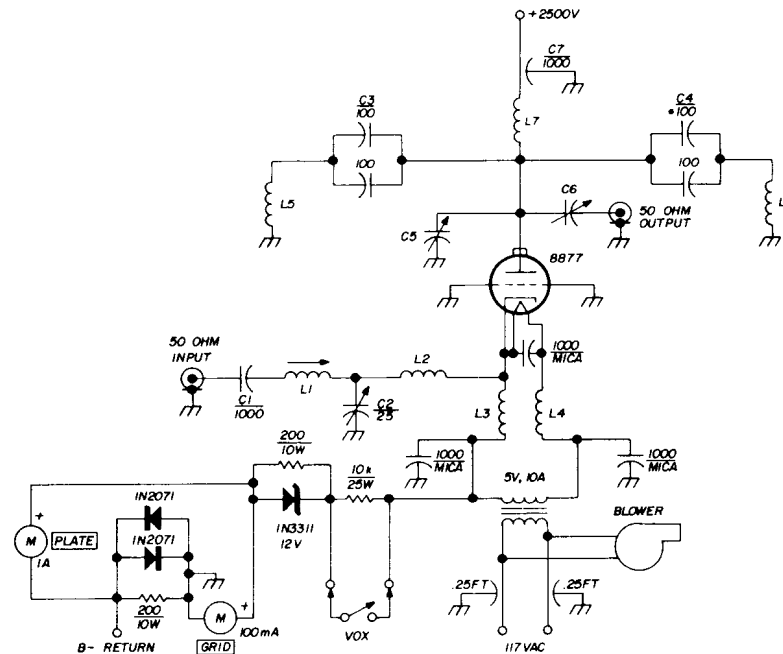
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The new Eimac 8877 is a ceramic/metal high-mu triode rated for use up to 250 MHz. Operation of this tube at 50 MHz proved to be so satisfactory¹ that other 8877 amplifiers have been designed and built for frequencies up to 350 MHz. Two of these amplifiers are of interest to the serious vhf operator. One amplifier is designed for the amateur 2-meter band and is described here. The other amplifier covers the range from 150 to 230 MHz, and is well suited for use on the amateur 220-MHz band; it will be described later.

The 8877 triode has good division between plate and grid current and low intermodulation distortion. It has a plate dissipation rating of 1500 watts and mu of approximately 200. The cathode is indirectly heated; filament requirements are 5.0 volts at 10 amperes. The tube base mates with a standard septar socket.

This 144-MHz 8877 linear amplifier is designed for the serious DXer who demands reliable service combined with

reserve. For operation at 2000 watts PEP the plate voltage should be between 2500 and 3000 volts; under these conditions the amplifier will deliver 1240 watts



- | | | | |
|-------|--|-------|---|
| C1 | 1000 pF (Centralab 858S-1000) | L1 | 5 turns no. 14, 3/4" long on 1/2" diameter form with white tuning slug (CTC 1538-4-3) |
| C2 | 25 pF variable (Hammarlund HFA-25B) | L2 | 4 turns no. 14, air wound, 3/4" long |
| C3,C4 | each consists of two parallel-connected 100-pF, 5000-V capacitors (Centralab 850S-100) | L3,L4 | 10 turns no. 12 enameled, bifilar wound, 5/8" diameter |
| C5 | plate-tuning capacitor (see fig. 3) | L5,L6 | plate resonators (see fig. 4) |
| C6 | output loading capacitor (see fig. 2) | L7 | 7 turns no. 14 wire, 5/8" diameter, 1-3/8" long |
| C7 | 1000 pF, 4 kV feedthrough (Erie 2498) | | |

requires no neutralization, is completely stable and free of parasitics, and is very easy to operate.

output. With the higher plate-voltage supply, up to 13.8-dB gain can be obtained with an amplifier efficiency of 62%.

the circuit

august 1971 23

grid ring at the base of the tube provides a low-inductance path between the grid element and the chassis. Plate and grid currents are measured in the cathode-return lead; a 12-volt, 50-watt zener diode in series with the negative return

ly burn open.

input circuit

The cathode input matching circuit is a T-network which matches a 50 ohm termination to the input impedance of

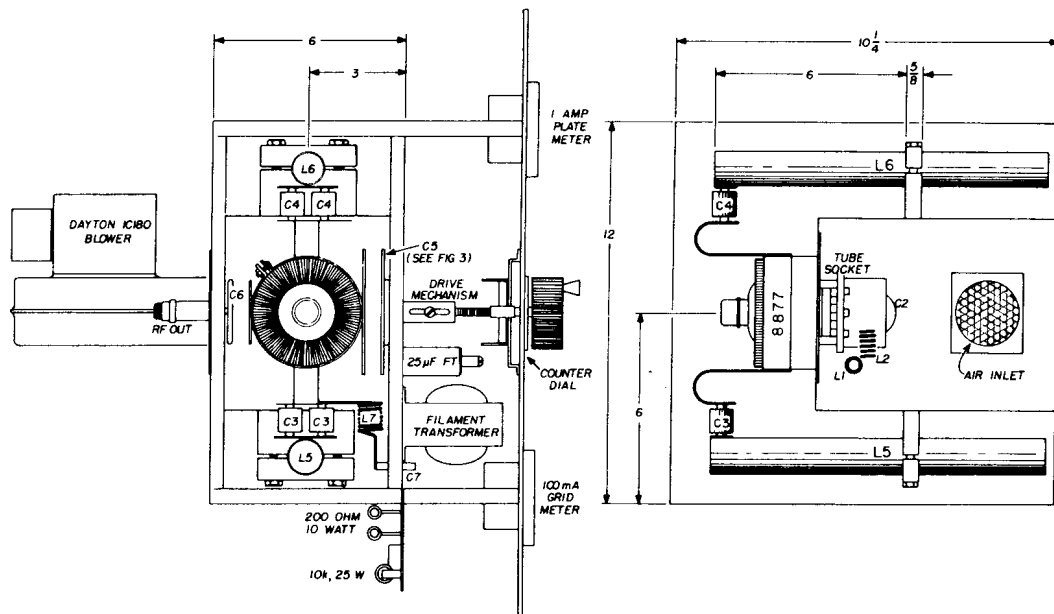


fig. 2. Structural details of the amplifier show the relative size and position of the various components. Assembly is made of aluminum panels.

sets the desired value of idling current. Two additional diodes are shunted across the meter circuit to protect the instruments.

Standby plate current of the 8877 is reduced to a very low value by the 10,000-ohm cathode resistor; this resistor is shorted out when the vox circuit is energized, permitting the tube to operate in normal fashion.

A 200-ohm safety resistor insures that the negative power circuit of the amplifier does not rise above ground potential if the positive side of the plate-voltage supply is accidentally grounded. A second safety resistor across the 1N3311 zener diode prevents the cathode potential from rising if the zener should accidental-

ly burn open. The tube (about 54 ohms in parallel with 26 pF). The network consists of two series-connected inductors and a shunt capacitor. One inductor and the capacitor are variable so the network is able to cover a wide range of impedance transformations.

The variable inductor (L1) is mounted on the rear wall of the chassis and may be adjusted from the rear of the amplifier. The input tuning capacitor (C2) is adjustable from the front panel. When the network has been properly tuned no adjustment is required over the 4-MHz range of the 2-meter band.

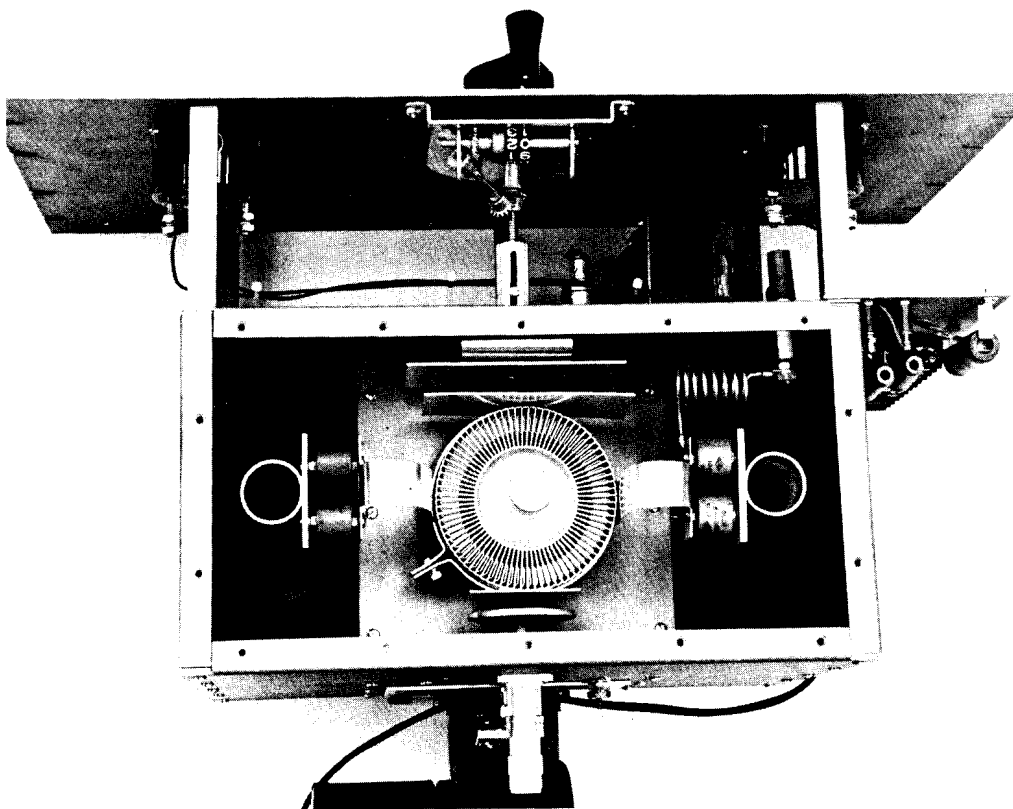
Underchassis layout of components is shown in the photograph. The cathode input circuit is in center compartment.

The slug-tuned coil in the input matching circuit is mounted on the rear wall. Air-wound filament chokes are placed in front of the socket. The cathode-heater rf choke is near the top edge of the enclosure. All of the cathode leads of the

mechanism are placed in the area between inclosure and panel.

plate circuit

The plate circuit of the amplifier is a transmission-line type resonator. The line



Top view of amplifier showing plate compartment. 8877 tube is at center with plate lines on each side.

socket, plus one heater pin (pin 5) are connected in parallel and driven by the input matching network.

The ceramic socket for the 8877 is mounted one-half inch below chassis level by spacers. Four pieces of brass shim stock (or beryllium copper) are formed into grounding clips to make contact to the control grid ring. The clips are mounted between the spacers and the chassis. The aluminum clamps holding ends of plate lines are visible in the side compartments. The filament transformer and dial

(L5 plus L6) is one half-wavelength long with the tube placed at the center (**fig. 2**). This type of tuned circuit has several advantages. A quarter-wave circuit would normally be preferred because of its greater bandwidth, but I wanted to use easily obtainable standard copper water pipe as the center conductor of the transmissionline tank circuit. The resulting high-impedance transmission line would make a quarter-wave plate tank circuit physically short and difficult to handle.

In addition, the heavy rf current that flows on the tube seals and control grid would, in the process of charging up the output capacitance to the plate voltage

this type of cavity is complex and difficult to build.

A practical compromise is to use two quarter-wave lines connecting to opposite

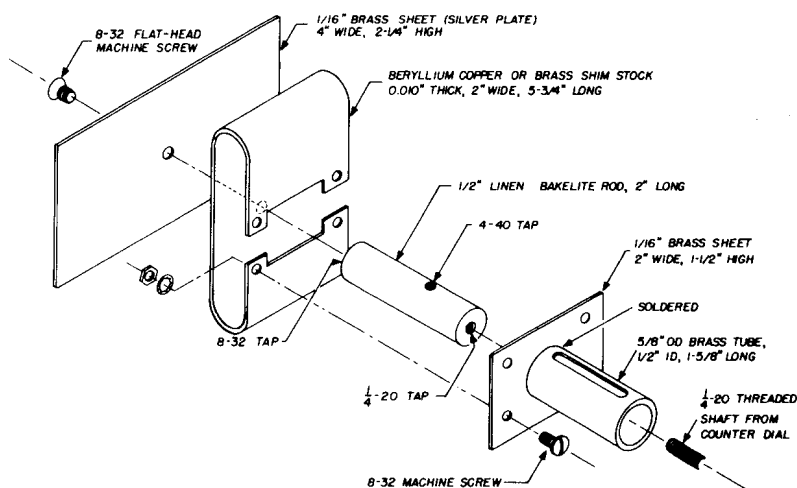


fig. 3. Variable plate portion of plate-tuning capacitor C3. This arrangement permits the capacitor to be adjusted under full power without "jumpy" tuning as there are no moving or sliding contacts which carry heavy rf current.

swing, tend to concentrate on one side of the tube if a single-ended quarter-wave circuit were used. This current concentra-

sides of the tube. It is interesting to note that each of the two quarter-wave lines is physically longer than if only one quar-

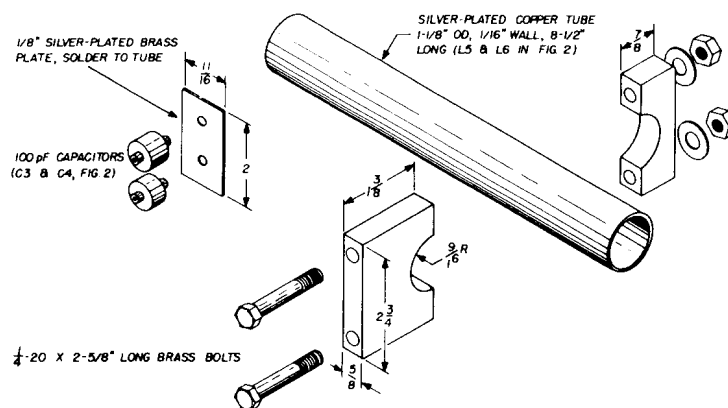


fig. 4. Details of plate lines L5 and L6. Copper tubes are standard copper water pipe.

tion would cause localized heating of the tube. The best tuned circuit configuration to minimize this effect is a symmetrical cylindrical coaxial cavity. Unfortunately,

ter-wave line were used. This is because only one-half of the tube output capacitance loads each of the two lines.

Resonance is established by a moving

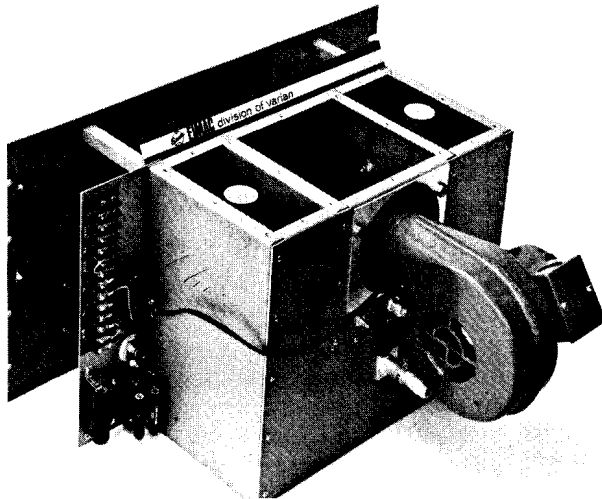
plate capacitor (C5); antenna loading is accomplished by a second capacitor (C6) placed at the anode of the 8877. Output power is coupled from the plate circuit through the series capacitor into a 50-ohm output. In the top-view photo tuning capacitor C5 is at the front of the compartment; variable loading capacitor C6 is at the rear. The plate choke is visible in the front corner.

construction

The two-meter amplifier is built in an enclosure measuring $10\frac{1}{4} \times 12 \times 6\frac{1}{4}$ inches. The 8877 socket is centered on a 6 x 6 subchassis plate. A centrifugal blower forces cooling air into the under-chassis area; the air escapes through the 2-5/8-inch diameter socket hole.

The plate tuning mechanism is shown in fig. 3. This simple apparatus will operate with any variable plate capacitor, providing a back and forth movement of about one inch. It is driven by a counter

Rear of amplifier showing blower and coaxial output connector. Amplifier is upside down in this photograph.



dial and provides a quick inexpensive and easy means of driving a vhf capacitor. The ground return path for the grounded capacitor plate is through a wide low-

inductance beryllium-copper or brass shim stock which provides spring tension for the drive mechanism.

The variable output coupling capacitor

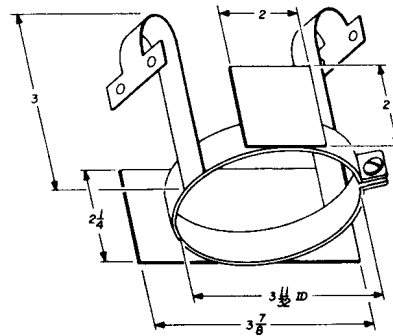


fig. 5. Anode clamp assembly for the two-meter linear amplifier.

is located at the side of the 8877 anode. The type-N coaxial fitting is connected to the moveable plate of the coupling capacitor. The fitting is centered in a special tubular assembly which allows the whole connector to slide in and out of the chassis, allowing the variable plate of the coupling capacitor to move with respect to the fixed plate mounted on the tube anode clamp. When the final loading adjustment has been set the sliding fitting is clamped by an arrangement similar to the slider on a variable wire-wound resistor.

The length of the plate-line inductors (L5 and L6) is adjusted by means of dural blocks placed at the shorted end of the line (fig. 4). The position of the blocks is determined by setting capacitor C5 at its lowest value and adjusting line lengths so that that plate circuit resonates at 148 MHz with the 8877 in the socket.

The plate rf choke is mounted between the junction of one plate strap and a pair of the dual blocking capacitors; the high-voltage feed-through capacitor is mounted to the front wall of the plate compartment. The blocking capacitors are rated for rf service, and inexpensive tv-type capacitors are not recommended for this amplifier. A short chimney to

direct cooling air from the socket through the anode of the 8877 is made from Teflon and clamped between the chassis deck and the anode strap.*

operation

Amplifier operation is completely stable with no parasitics. The unit tunes up exactly as if it were on the "dc bands." As with all grounded-grid amplifiers excitation should never be applied when plate voltage is removed from the amplifier.

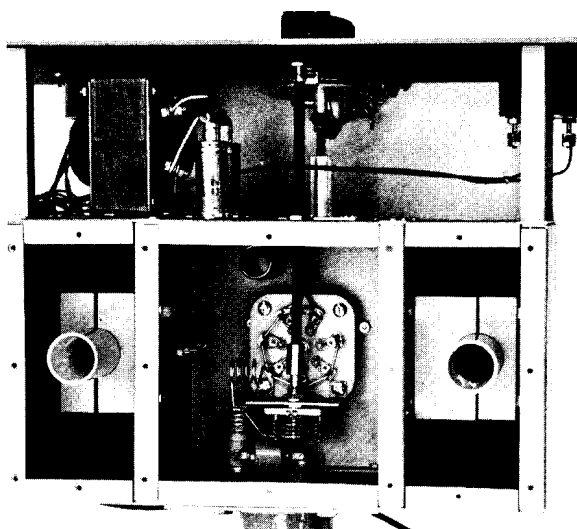
The first step is to grid-dip the input and output circuits to near-resonance with the 8877 in the socket. A swr meter should be placed in series with the input line so the input network may be adjusted for lowest swr.

Tuning and loading follows the same sequence as any standard grounded-grid

amplifier. Connect a swr indicator at the output and apply a small amount of rf drive. Quickly tune the plate circuit to resonance. The cathode circuit should now be resonated. The swr between the exciter and the amplifier will not neces-

table 1. Performance data for the 144-MHz power amplifier under the conditions most suitable for amateur ssb (2000 watts PEP) and cw (1000 watts).

Plate voltage	3000 V	2500 V	2500 V
Plate current (single tone)	667 mA	800 mA	400 mA
Plate current (idling)	54 mA	44 mA	44 mA
Grid voltage	-12 V	-12 V	-12 V
Grid current (single tone)	46 mA	50 mA	28 mA
Power input	2000 W	2000 W	1000 W
Power output	1240 W	1230 W	680 W
Efficiency (apparent)	62 %	62 %	68 %
Drive power	47 W	67 W	19 W
Power gain	13.8 dB	12.6 dB	15.5 dB



Underchassis view of the two-meter amplifier. The cathode input circuit is in the center compartment. Plate lines are visible in the side compartments.

sarily be optimum. Final adjustment of the cathode circuit for minimum swr should be done at full power because the input impedance of a cathode-driven amplifier is a function of the plate current of the tube.

Increase the rf drive in small increments along with output coupling until the desired power level is reached. By adjusting the drive and loading together it will be possible to attain the operating conditions given in the performance chart in **table 1**. Always tune for maximum plate efficiency: maximum output power for minimum input power. It is quite easy to load heavily and underdrive to get the desired power input but power output will be down if this is done.

I would like to thank K6DC for his help in adjusting and determining the operating conditions for this two-meter amplifier.

references

1. R. Sutherland, W6UOV, "Two Kilowatt Linear Amplifier for Six Meters," *ham radio*, February, 1971, page 16.
2. R. Barber, R. Rinaudo, W. Orr, R. Sutherland, "Modern Circuit Design for VHF Transmitters," *CQ*, November, December, 1965.

ham radio

*Detailed drawings of the anode clamp, plate resonator and blocking capacitor assembly, and variable plate tuning capacitor (C5) are available from R. Sutherland, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070. Ask for drawing numbers 168658, 168648 and 168647.