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A 144-MHz Amplifier Using the 3CX1200Z7

This 2-meter, 1-kW amplifier uses the Eimac 3CX1200Z7 triode. The original article by Russ Miller, N7ART, appeared in December 1994 *QST*. The tube requires a warm up of about 10 seconds after applying filament voltage—no more waiting for three agonizingly long minutes until an amplifier can go on-line!

The 3CX1200Z7 is different from the earlier 3CX1200A7 by virtue of its external grid ring, redesigned anode assembly and a 6.3-V ac filament. One advantage to the 3CX1200Z7 is the wide range of plate voltages that can be used, from 2000 to 5500 V. This amplifier looks much like the easily duplicated W6PO design. The RF deck is a compact unit, designed for table-top use (See **Fig 18.39** and schematic in **Fig 18.40**.).

Table 18.8 gives some data on the 3CX1200Z7 and **Table 18.9** lists CW operating performance for this amplifier.

Fig 18.39—This table-top 2-meter power amplifier uses a quick-warm-up tube, a real plus when the band suddenly opens for DX and you want to join in.

Input Circuit

The author didn't use a tube socket. Instead, he bolted the tube directly to the top plate of the subchassis, using the four holes (drilled to clear a #6 screw) in the grid flange. Connections to the heater pins are via drilled and slotted brass rods. The input circuit is contained within a $3^1/_2 \times 6 \times 7^1/_4$-inch (HWD) subchassis (Fig 18.40).

Control Circuit

The control circuit (**Fig 18.42**) is a necessity. It provides grid overcurrent protection, keying control and filament surge control. To protect the tube filament from stressful surge current, a timer circuit places a resistor in series with the primary of the filament transformer. After four seconds, the timer shorts the resistor, allowing full filament voltage to be applied. C2 and R4 establish the time delay.

Another timer inhibits keying for a total of 10 seconds, to give the internal tube temperatures a chance to stabilize. C1 and R3 determine the time constant of this timer. After 10 seconds, the amplifier can be keyed by grounding the keying line. When the amplifier is not keyed, it draws no plate current. When keyed, idle current is approximately 150 mA, and the amplifier only requires RF drive to produce output. A safety factor is built in: The keying circuit requires +12 V from the high-voltage supply. This feature ensures that high voltage is present before the amplifier is driven.

The grid overcurrent circuit should be set to trip if grid current reaches 200 mA. When it trips, the relay latches and the NORMAL LED extinguishes. Restoration requires the operator to press the RESET switch.

Plate Circuit

Fig 18.43 shows an interior view of the plate compartment. A $4 \times 2^1/_4$-inch tuning capacitor plate and a 2×2-inch output coupling plate are centered on the anode collet. See **Fig 18.44**. Sufficient clearance in the collet hole for the 3CX1200Z7 anode must be left for the fingerstock. The hole diameter will be approximately $3^5/_8$ inches. **Fig 18.45** is a drawing of the plate line, **Fig 18.46** is a drawing of the plate tuning capacitor assembly, and **Fig 18.47** shows the output coupling assembly.

Cooling

The amplifier requires an air exhaust through the top cover, as the plate compartment is pressurized. Fashion a chimney from a $3^1/_2$-inch waste-water coupling (black PVC) and a piece of $^1/_{32}$-inch-thick Teflon sheet. The PVC should extend down from the underside of the amplifier cover plate by $1^1/_8$ inches, with the Teflon sheet extending down $^3/_4$ inch from the bottom of the PVC.

The base of the 3CX1200Z7 is cooled using bleed air from the plate compartment. This is directed at the tube base, through a $^7/_8$-inch tube set into the subchassis wall at a 45° angle. The recommended blower will supply more than enough air for any temperature zone. A smaller blower is not recommended, as it is doubtful that the base area will be cooled adequately. The 3CX1200Z7 filament draws 25 A at 6.3 V! It alone generates a great deal of heat around the tube base seals and pins, so good air flow is critical.

Construction

The amplifier is built into a $12 \times 12 \times 10$-inch enclosure. A 12×10-inch partition is installed $7^1/_4$ inches from the rear panel. The area between the partition and the front panel contains the filament transformer, control board, meters, switches, Zener diode and miscellaneous small parts. Wiring between the front-panel area and the rear panel is through a $^1/_2$-inch brass tube, located near the shorted end of the right-hand plate line.

High voltage is routed from an MHV jack on the rear panel, through a piece of solid-dielectric RG-59 (not foam dielectric!), just under the shorted end of the left-hand plate line. The cable then passes through the partition to a high-voltage standoff insulator made from nylon. This insulator is fastened to the partition near the high-voltage feedthrough capacitor. A 10-Ω, 25-W resistor is connected between the insulator and the feedthrough capacitor.

The plate lines are connected to the dc-blocking capacitors on the plate collet with $1^3/_4 \times 2$-inch phosphor-bronze strips. The bottom of the plate lines are attached to the sides of the subchassis, with the edge of the L-shaped mounting bracket flush with the bottom of the subchassis.

When preparing the subchassis top plate for the 3CX1200Z7, cut a $2^{11}/_{16}$-inch hole in the center of the plate. This hole size allows clearance between the tube envelope and the top plate, without putting stress on the envelope in the vicinity of the grid flange seal.

Exercise care in placing the movable tuning plate and the movable output coupling disc, to ensure they cannot touch their fixed counterparts on the plate collet.

Operation

When the amplifier is first turned on, it cannot be keyed until:

- 10 seconds has elapsed.
- High voltage is available, as confirmed by presence of +12 V to the keying circuit.

Connect the amplifier to a dummy load through an accurate power meter capable of indicating 1500 W full scale. Key the amplifier and check the idling plate current. With 3200-V plate voltage, it should be in the vicinity of 150 mA. Now, apply

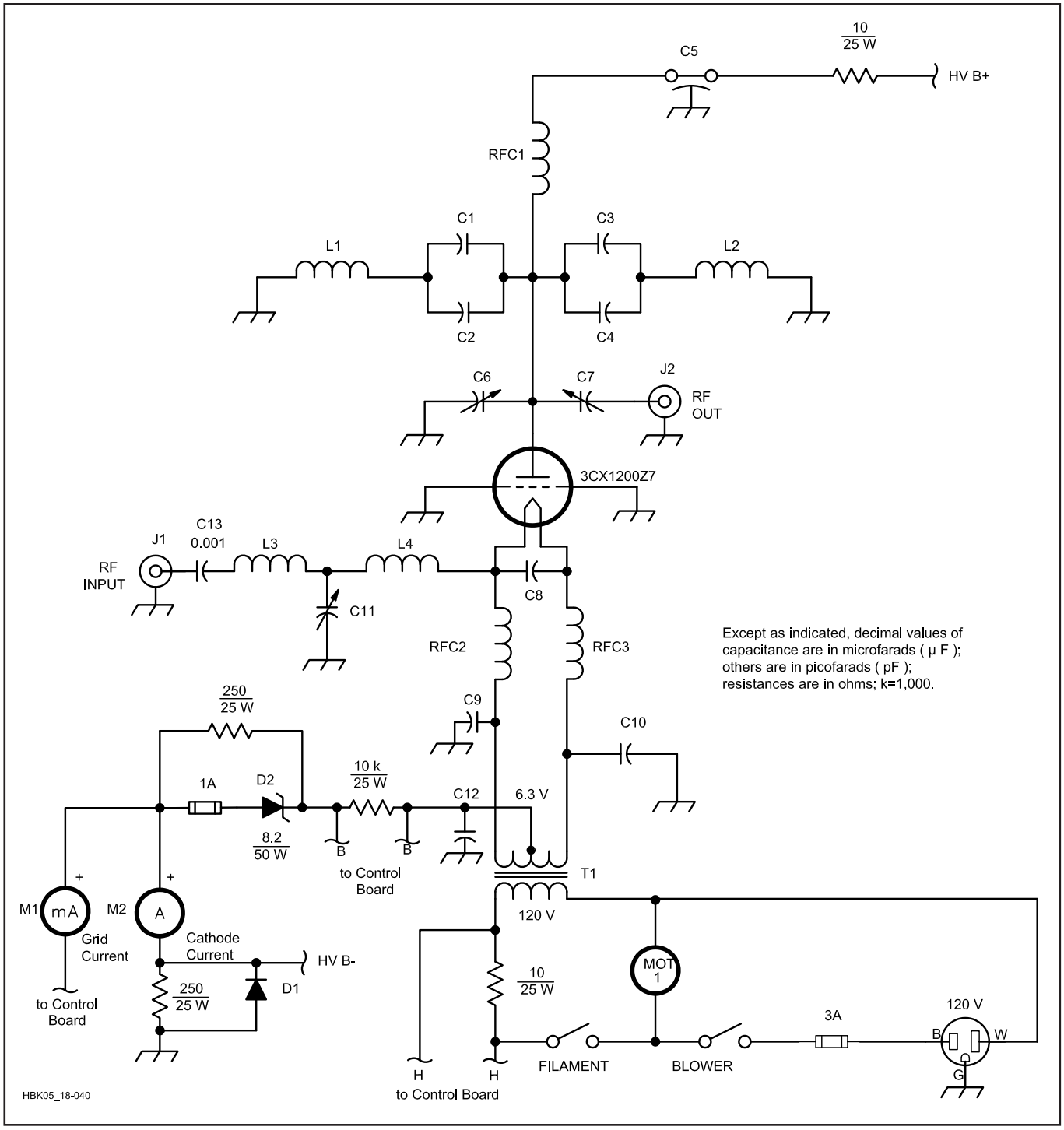


Fig 18.40—Schematic diagram of the 2-meter amplifier RF deck. For supplier addresses, use *TISFind* (www.arrl.org/tis) or other search engines.

C1-C4—100 pF, 5 kV, Centralab 850.
C5—1000 pF, 5 kV.
C6—Anode-tuning capacitor; see text and Fig 18.46 for details.
C7—Output-loading capacitor; see text and Fig 18.47 for details.
C8-C10, C13—1000-pF silver mica, 500 V.
C11—30-pF air variable.
C12—0.01 µF, 1 kV.
D1—1000 PIV, 3-A diode, 1N5408 or equiv.
D2—8.2-V, 50-W Zener diode, ECG 5249A.
J1—Chassis-mount BNC connector.
J2—Type-N connector fitted to output coupling assembly (see Fig 18.47).
L1, L2—Plate lines; see text and Fig 18.45 for details.
L3—5 t #14 enameled wire, 1/2-inch diameter, close wound.
L4—3 t #14, 5/8-inch diameter, 1/4-inch spacing.
RFC1—7 t #14, 5/8-inch diameter, 1 3/8 inch long.
RFC2, RFC3—10 t #12, 5/8-inch diameter, 2 inches long.
T1—Filament transformer. Primary: 120 V; secondary: 6.3 V, 25 A, center tapped. Available from Heritage Transformer Co.; part number AV-539.
M1—Grid milliammeter, 200 mA dc full scale.
M2—Cathode ammeter, 2 A dc full scale.
MOT1—140 free-air cfm, 120-V ac blower, Dayton 4C442 or equivalent.
Sources for some of the hard to get parts include Fair Radio Sales and Surplus Sales of Nebraska.

Table 18.8

3CX1200Z7 Specifications

Maximum Ratings

Plate voltage: 5500 V
Plate current: 800 mA
Plate dissipation: 1200 W
Grid dissipation: 50 W

Table 18.9

CW Operating Data

Plate voltage: 3200 V
Plate current (operating): 750 mA
Plate current (idling): 150 mA
Grid current: 165 mA
DC Power input: 2400 W
RF Power output: 1200 W
Plate dissipation: 1200 W
Efficiency: 50%
Drive power: 85 W
Input reflected power: 1 W

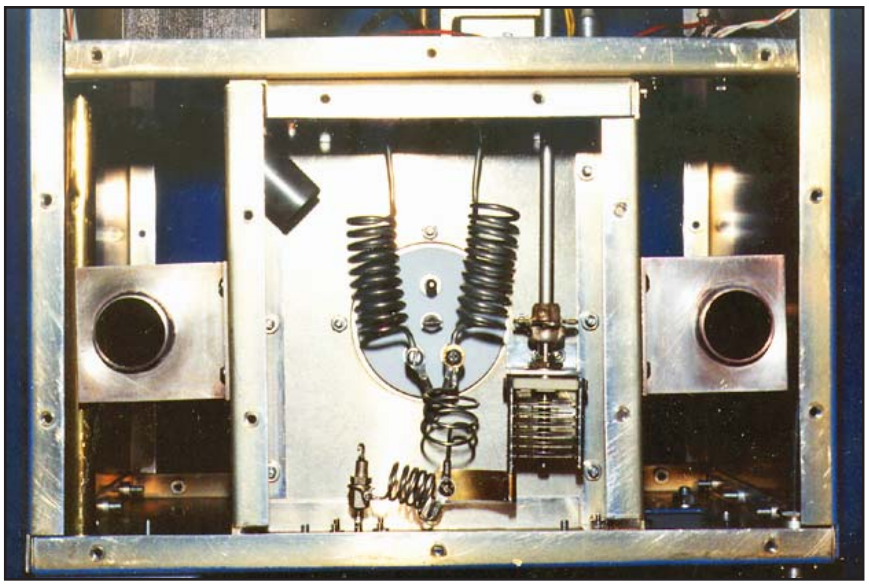
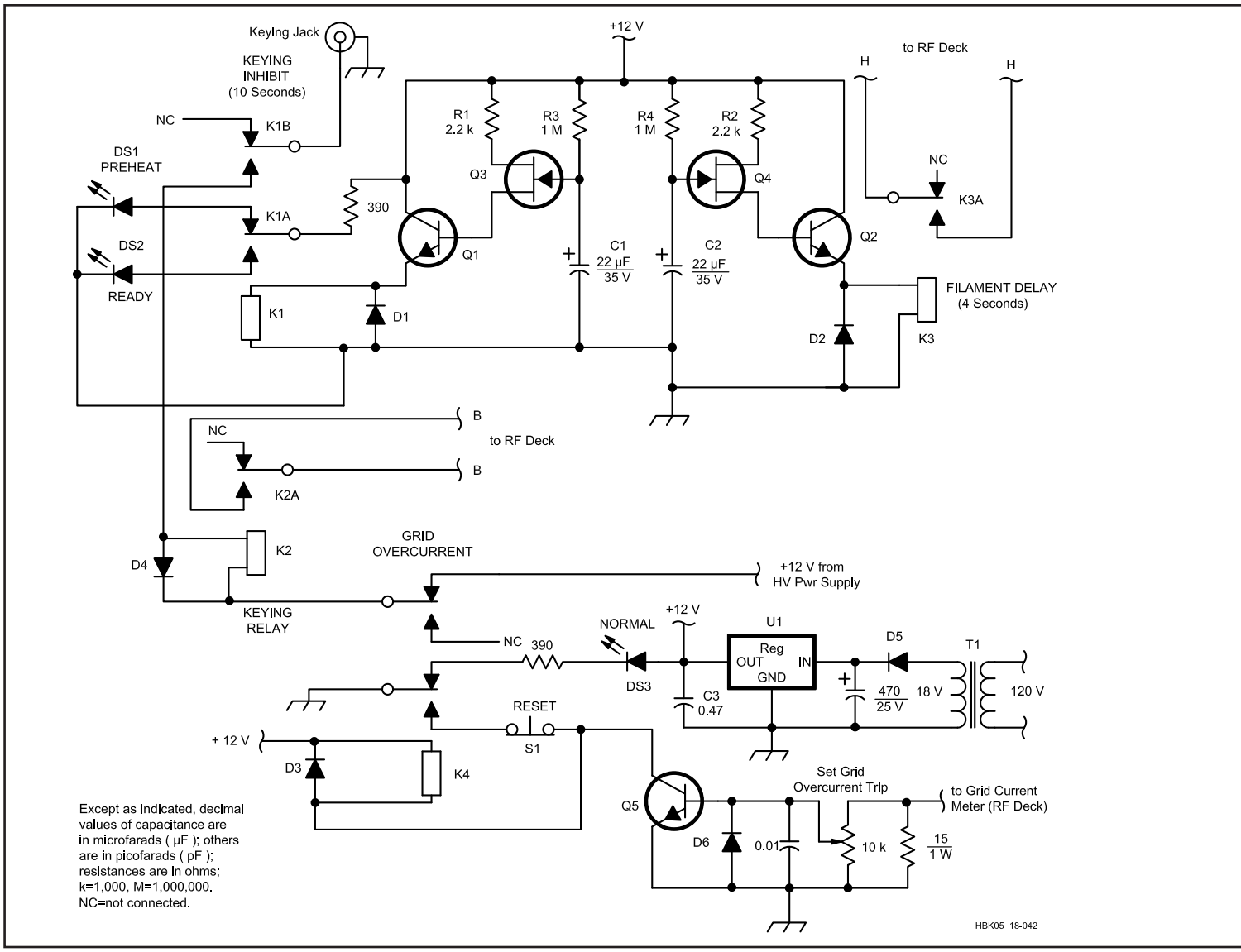


Fig 18.41—This view of the cathode-circuit compartment shows the input tuned circuit and filament chokes.



a small amount of drive and adjust the input tuning for maximum grid current. Adjust the output tuning until you see an indication of RF output. Increase drive and adjust the output coupling and tuning for the desired output. Do not overcouple the output; once desired output is reached, do not increase loading. Insert the hold-down screw to secure the output coupling capacitor from moving. One setting is adequate for tuning across the 2-meter band if the SWR on the trans-mission line is reasonably low.

When you shut down the amplifier, leave the blower running for at least three minutes after you turn off the filament voltage. The 3CX1200Z7 is an excellent tube. The author tried it with excessive drive, plate-current saturation, excessive plate dissipation—all the abuse it's likely to encounter in amateur applications. There were no

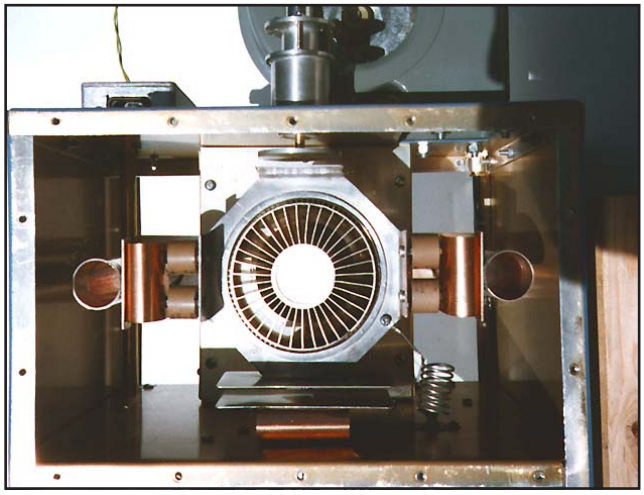


Fig 18.43—This top view of the plate compartment shows the plate-line arrangement, C1-C4 and the output coupling assembly.

Fig 18.42—(Schematic diagram of the amplifier-control circuits.
C3—0.47-µF, 25-V tantalum capacitor.
D1-D5—1N4001 or equiv.
D6—1N4007 or equiv.
DS1—Yellow LED.
DS2—Green LED.
DS3—Red LED.
K1—Keying-inhibit relay, DPDT, 12-V dc coil, 1-A contact rating (RadioShack 275-249 or equiv).
K2—Amplifier keying relay, SPDT, 12-V dc coil, 2-A contact rating (RadioShack 275-248 or equiv).
K3—Filament delay relay, SPST, 12-V dc coil, 2-A contact rating (RadioShack 275-248 or equiv).
K4—Grid-overcurrent relay, DPDT, 12-V dc coil, 1-A contact rating (RadioShack 275-249 or equiv).
Q1, Q2, Q5—2N2222A or equiv.
Q3—MPF102 or equiv.
Q4—2N3819 or equiv.
S1—Normally closed, momentary pushbutton switch (RadioShack 275-1549 or equiv).
T1—Power transformer, 120-V primary, 18-V, 1-A secondary.
U1— +12 V regulator, 7812 or equiv.

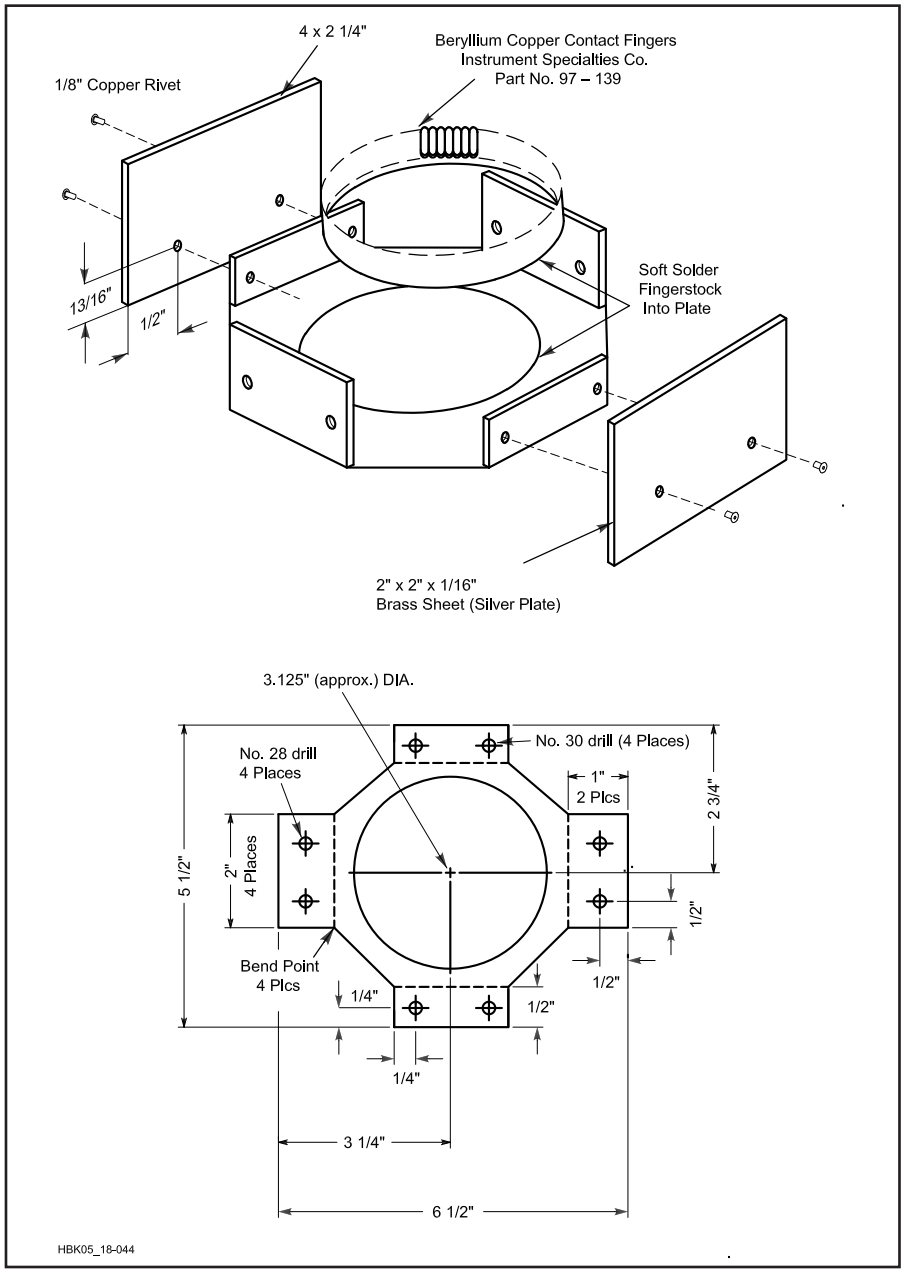


Fig 18.44—Anode collet details.

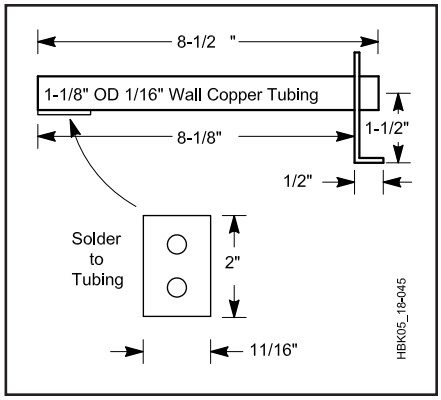


Table 18.10

Power Supply Specifications

High voltage: 3200 V
Continuous current: 1.2 A
Intermittent current: 2 A
Step/Start delay: 2 secs

Fig 18.45—Plate line details.

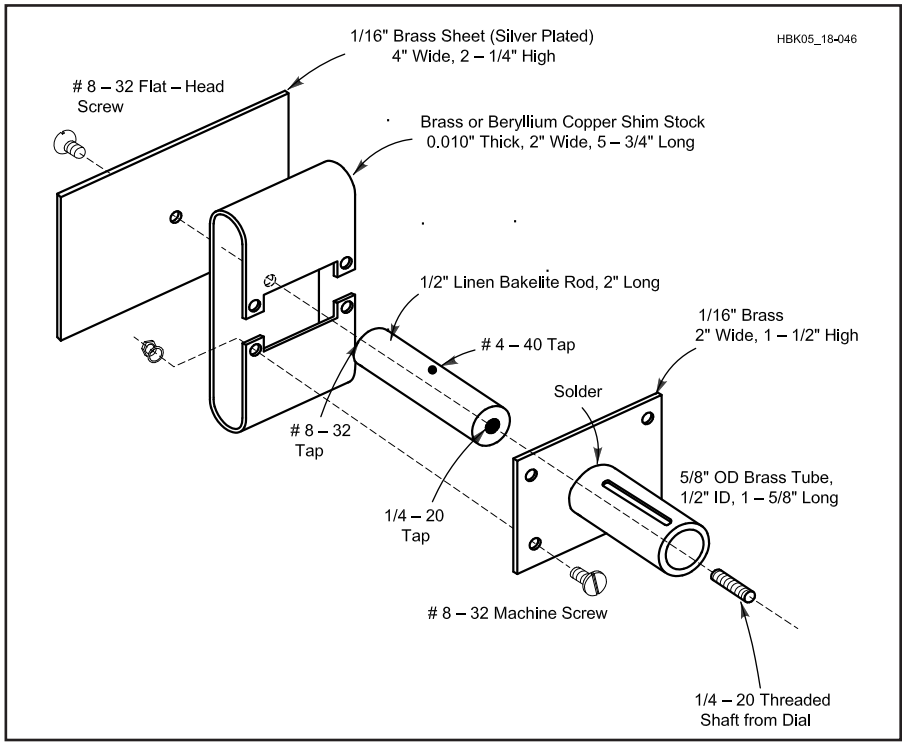


Fig 18.46—Plate tuning capacitor details.

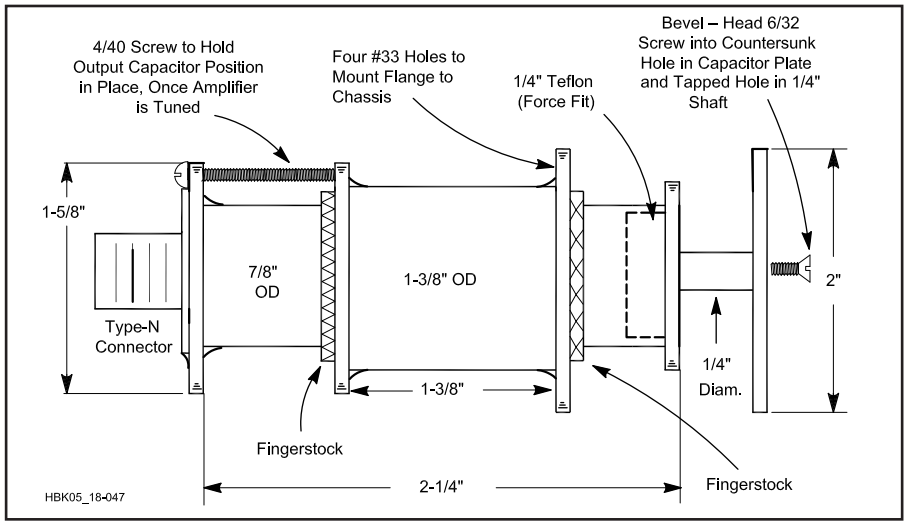


Fig 18.47—Details of the output coupling assembly.

problems, but that doesn't mean you should repeat these torture tests!

A Companion Power Supply

A well-designed and constructed high-voltage power supply is necessary to ensure linearity in SSB operation. Specifications of the power supply for this amplifier are given in **Table 18.10**. A schematic and parts list for a rugged power supply—usable with this project—are in the **Power Supplies** chapter. Although bi-level, it is otherwise similar to the author's design described in the December 1994 issue of *QST*.

Conclusion

This amplifier is a reliable and cost-effective way to generate a big 2-meter signal—almost as quickly as a solid-state amplifier. To ensure that the output of the amplifier meets current spectral purity requirements, a high-power output filter, as shown in **Fig 18.48**, should be used. The author reports that he can run full output while his wife watches TV in a nearby room.

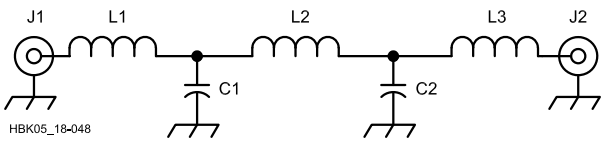


Fig 18.48—Schematic diagram of output harmonic filter.
C1, C2—27-pF Centralab 850 series ceramic transmitting capacitor.
J1, J2—Female chassis-mount N connector (UG-58 or equiv).
L1, L3—2 t #14 wire, 0.3125 inch ID, 0.375 inch long.
L2—3 t #14 wire, 0.3125 inch ID, 0.4375 inch long.