A 1500-W-Output Amplifier for 160 Meters

Until a few years ago, most commercially available power amplifiers included no provision for top-band operation. With low sunspot numbers, 160 meters has become a great DX band. Sometimes a barefoot transceiver just isn't enough, and an amplifier is needed to make the QSO. The project described here and shown in Figs. 51 through 57 can enhance DX possibilities for those amateurs with an older five-band HF amplifier. It uses an EIMAC 3CX1500A7/8877 in grounded-grid configuration and will develop 1500 watts PEP output with 2500 volts on the plate. The amplifier is easy to drive, 50 to 60 W for full output, so any of the 100-W transceivers will do the job. Dick Stevens, W1QWJ, designed and built this project.

Fig. 51 — The 160-meter amplifier is built behind a 19- × 7-inch rack panel. Meters with bezels add to the clean appearance of the unit.

Circuit Details

The schematic diagram is shown in Fig. 52. The RF deck includes everything except the high-voltage power supply. Several suitable supplies are described elsewhere in this book. See Chapters 27 and 31, and the six-band 8877 HF amplifier described later in this chapter for ideas on building a high-voltage supply.

The input circuit (C7, L1, C8) is a low-Q pi network. No filament choke is needed with the 8877, which further simplifies the circuit.

The plate circuit is a pi network designed for a Q of 12. The tuning capacitor consists of a 300-pF fixed value (C17) in parallel with a 241-pF variable (C18). L2 is a section of standard Barker and Williamson coil stock. The loading capacitor consists of a 1600-pF fixed value (C20) in parallel with a 1000-pF variable (C19).

C13 bypasses the B+ line. Although an 8-kV unit was used here, any value above 4 kV should work fine. RFC2 is a Millen 1-mH, 1-A transmitter plate choke. RFC3 is included for safety to ground the high voltage that would appear at the antenna connector if dc blocking capacitor C16 fails.

Filament inrush current protection is provided by R1 and K1 in the T1 primary. After the initial current surge, K1A shorts out R1, applying full filament voltage. Power is applied to DS2, indicating that the filaments are on. T1 is a 5.0-V, 10.5-A transformer made by Avatar Magnetics. The primary is tapped to allow for precise adjustment of the filament voltage at the tube pins.

A grid overcurrent trip circuit is included to protect the 8877 from damage. The cost of an 8877 makes protection circuitry a must! Grid current is sensed across R5. If the grid current exceeds a preset value, Q1 conducts and actuates K2. Contact K2A, in the K3 coil supply line, opens and removes power from K3, placing the amplifier in STANDBY. To restore normal circuit operation, turn S3 to the off position; this will reset K2. S3 is "on" for normal operation. This switch provides an additional function: It controls the VOX circuit and antenna bypass relay circuit, so the amplifier can be switched in and out of the line between antenna and transceiver.

Zener diode D5 provides operating bias for the 8877. During receive periods, R6 is in the circuit, and the tube is cut off. For transmit, K3A shorts out R6.

All metering is done in the negative return lead for safety. C5, C6, D3 and D4 protect the meters. The antenna bypass relay (K4) is located externally but is powered from the amplifier.

Construction

The amplifier uses parts that are not too hard to find and are often available at flea markets at a very reasonable price. All components are, however, available commercially if the builder chooses that route. Most of the parts used in this project were purchased from Radio Shack, Electronic Emporium and RadioKit. See Chapter 35 for addresses.

Although an EIMAC SK-2200 series socket could be used, the socket used for this amplifier was homemade. It is built around a Johnson type 247 and an aluminum plate. Complete details of this plate, along with a full-size template, are shown in Fig. 53. This socket assembly can be made with hand tools — there is no fancy or complex metal work required.

Figs. 54 and 55 show the top and bottom of the chassis of the completed amplifier. Construction of a single-band amplifier is significantly easier than that of a multiband unit. Layout is not critical, and there is plenty of room to spare.

The amplifier is built on a 2 × 17 × 13-inch (HWD) aluminum chassis (Bud AC-419). This chassis is bolted to a standard 19 × 7-inch rack panel (Hammond PBPA 19 007). The top and side panels are formed from a single piece of perforated sheet metal often found at hardware stores.

Fig. 54 shows the top of the chassis. The 8877 is located along the back edge, near the center. C18 is mounted along the left-hand edge of the chassis, and the fixed capacitors that make up C17 mount directly behind C18. Details of the mounting plate for C17 are given in Fig. 56. C19 is mounted to the right of C18, and the capacitors that make up C20 mount to the chassis behind C19. L2 is mounted on an acrylic strip that is supported above the chassis by two ceramic standoff insulators. J3 and J5 mount to an aluminum bracket that bolts to the rear of the chassis.

The blower and filament transformer may be seen along the right-hand edge of the chassis. M1 and M2 mount to the front panel near the filament transformer. K1 and K3 mount in sockets between the filament transformer and the front panel.

Fig. 55 shows the underside of the chassis.

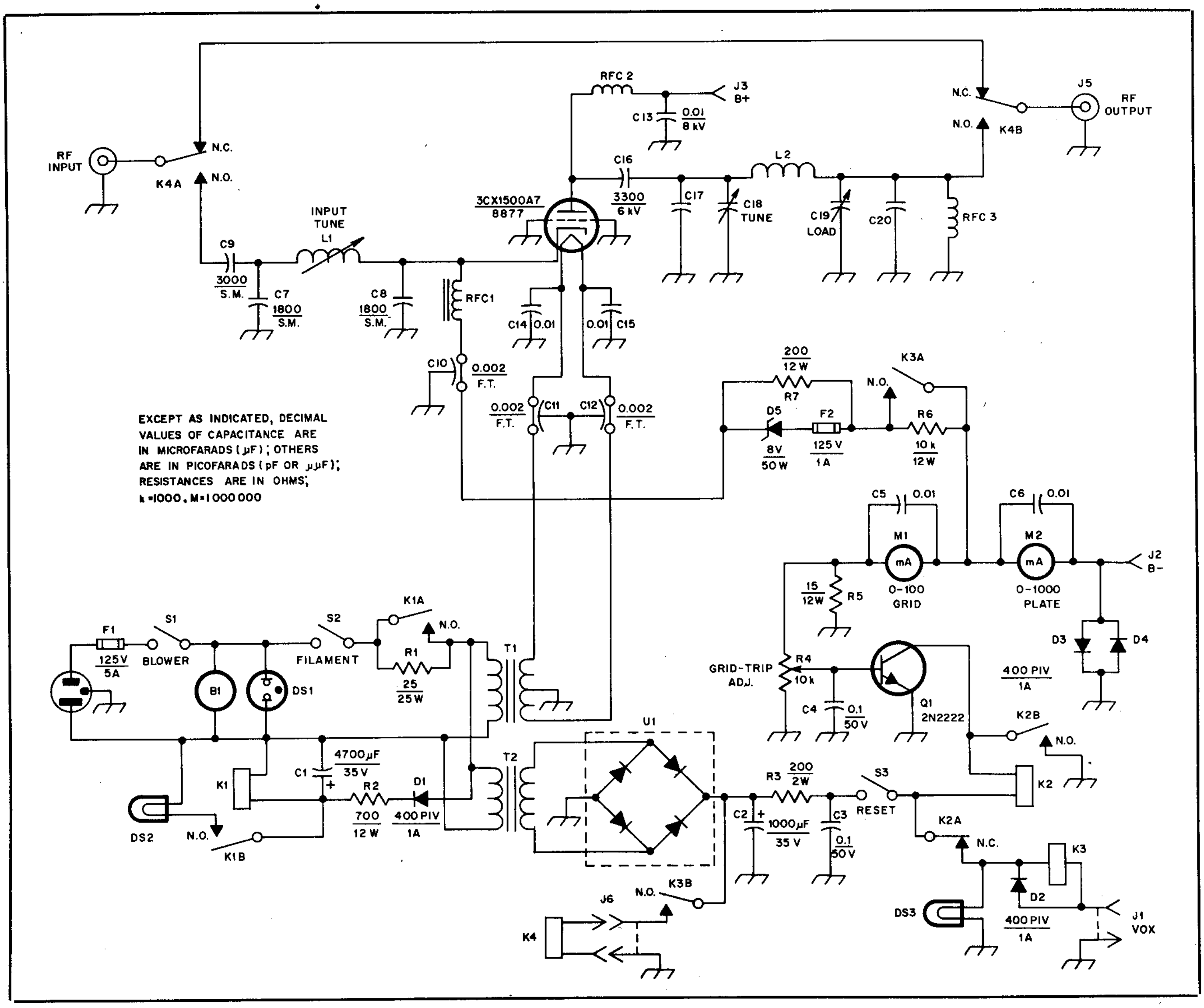

Fig. 52 — Schematic diagram of the 160-meter amplifier. Capacitors are disc ceramic unless otherwise noted. S.M. means silver-mica. Capacitors marked with polarity are electrolytic.

B1 — Dayton 4C012A 54-CFM blower.
C7, C8 — 1800-pF silver-mica capacitor; made from a 1500-pF unit in parallel with a 300-pF unit.
C9 — 3000-pF, 400-V silver-mica capacitor.
C10, C11, C12 — 0.002-µF, 8-kV feedthrough capacitor (Erie 1202-005 or equiv.).
C13 — 0.01-µF, 8-kV ceramic capacitor.
C16 — 3300-pF, 6-kV ceramic doorknob capacitor.
C17 — Three 100-pF, 5-kV ceramic doorknob capacitors in parallel.
C18 — 241-pF, 4.5-kV air variable capacitor (Cardwell 154-16 or equiv.).
C19 — 1000-pF, 1.5-kV air variable capacitor (Cardwell 154-30 or equiv.).
C20 — Two 800-pF, 5-kV ceramic doorknob capacitors in parallel.
DS1 — 117-V ac pilot light.
DS2, DS3 — 12-V dc pilot light.
J1 — Female chassis-mount phono jack.
J2, J3 — Millen 37001 high-voltage connector.
J4, J5 — Chassis-mount SO-239 connector.
J6 — Two-pin chassis-mount Cinch-Jones connector.
K1 - DPDT relay, 12-V dc coil, 10-A contacts, socket-mount.
K2 — Subminiature DPDT relay, 12-V dc coil.
K3 — DPDT relay, 12-V dc coil, 3-A contacts.
L1 — 4.4 µH; 25t no. 24 enam. on a ½-inch-OD, slug-tuned ceramic coil form.
L2 — 20 µH; 17t no. 12 tinned, 3-inch ID, 6 turns per inch (B&W 3033 miniductor stock or equiv.).
M1 — 0-100 mA meter.
M2 — 0-1000 mA meter.
RFC1 — 100-µH RF choke.
RFC2 — 1-mH, 1000-mA transmitting type RF choke (Miller 4534 or equiv.).
RFC — 2.5 mH, 200-mA RF choke (Miller 4537 or equiv.).
T1 — Filament transfformer. 117-V ac primary; 5-V, 10.5-A center-tapped secondary (Avatar AV-434 or equiv.). Available from Avatar Magnetics, 1147 N. Emerson St., Indianapolis, IN 46219.
T2 — Power transformer. 117-V ac primary; 12.6-V, 1.2-A secondary.
U1 — 50-PIV, 4-A bridge rectifier.

An enclosure is fashioned around the input circuit for shielding and to direct the air flow up through the socket. The blower draws air from behind the amplifier and blows it into the input compartment. A homemade chimney, fashioned from Teflon sheet, directs air through the tube cooler. A suitable chimney, part number SK-2216, is available from EIMAC.

L1 mounts to the rear chassis wall so the input match can be adjusted with the covers on. Filament and bias voltage enter the input compartment through feedthrough capacitors. D5 mounts to a chunk of scrap aluminum bar for heat sinking. The grid overcurrent components (Q1, K2) are arranged on a small piece of perforated board. R4 is mounted to the chassis near

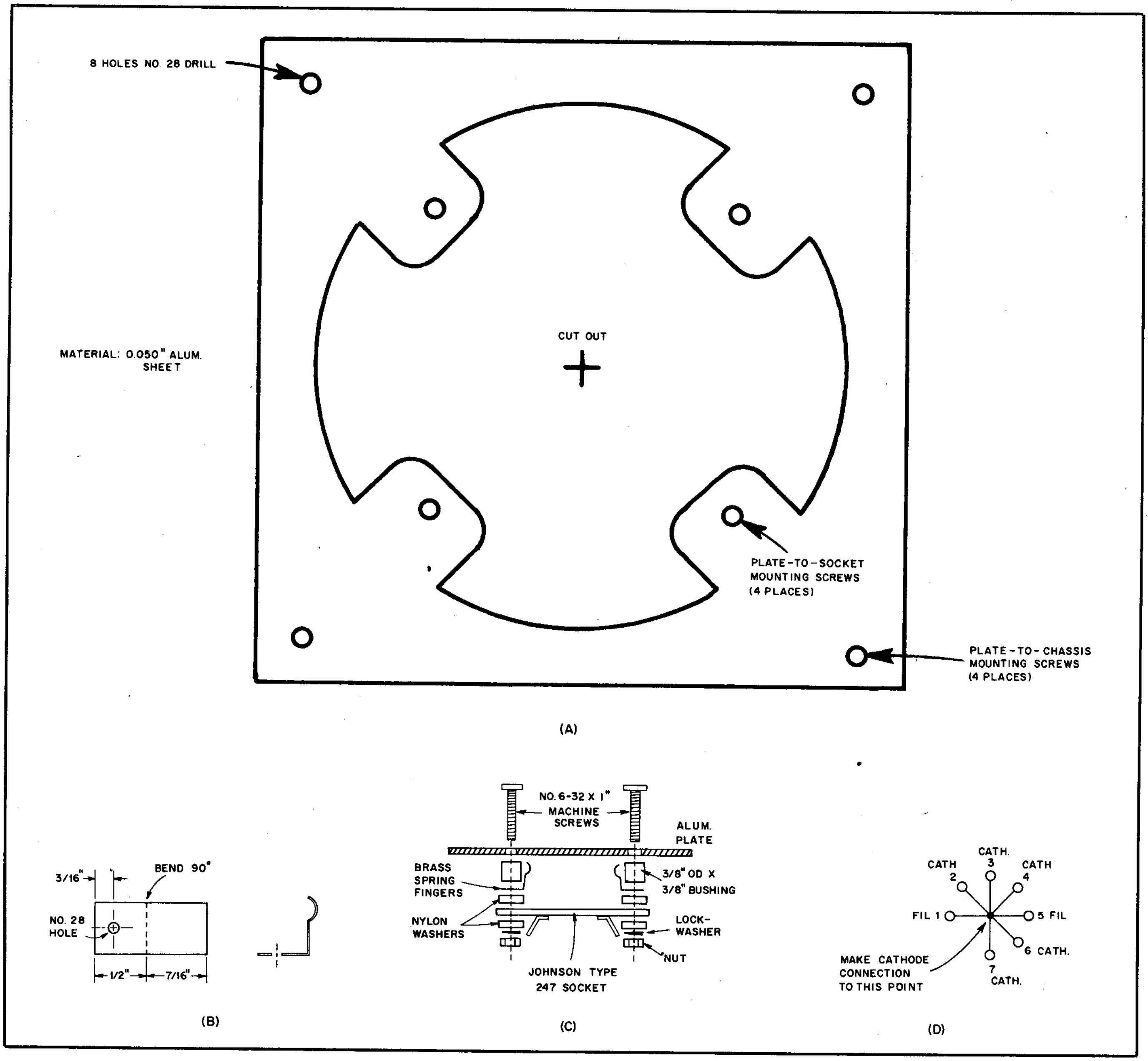

Fig. 53 — Details of the homemade socket for the 8877 tube. All hardware is no. 6-32. A full-size template for the aluminum plate is shown at A. Connection to the grid is made through four spring fingers made from spring brass or copper. Details of these clips are shown at B. Assembly of the socket is shown at C. Assemble as follows. Insert four 1-inch no. 6-32 machine screws through the plate. Slip a 3/8-inch by 3/8-inch-OD aluminum bushing over each screw. Place a spring finger on each screw, followed by a nylon washer. Slide the Johnson 247 socket onto the screws, and secure each screw with a nylon washer, metal lock washer and nut. Align the spring fingers for good contact with the grid ring and tighten. Connections to the bottom of the socket are shown at D.

the meters and is adjustable from the top. Liberal use of terminal strips simplifies wiring. There is plenty of room, and wiring is not critical at all, except that the input network should be mounted near the tube socket.

Testing and Tune Up

Connect the amplifier output to a dummy load through a wattmeter capable of reading 1500 W. Connect an HF transmitter capable of supplying at least 60 W to the amplifier input through an SWR/wattmeter. Connect a high-voltage supply, preferably with a variable autotransformer on the ac line to make the B+ continuously variable, to J2 and J3. The power supply should be able to deliver approximately 2500 V at 1 A. Be careful: The high voltage in this amplifier can be lethal!

Apply 117-V ac to the RF deck and operate the blower switch. The blower should come on, and the blower indicator lamp will light. You should feel air exhausting through the tube cooler.

Operate the filament switch. After a short delay, the filament indicator will light showing that the inrush protection circuit has cycled. Operate the reset switch, and the indicator lamp will light showing the amplifier is in the "go" condition. EIMAC recommends that the 8877 filaments be on for three minutes before high voltage is applied. No delay circuit for plate voltage control has been provided here, so wait three minutes before turning on the plate supply.

Apply plate voltage gradually. Do not apply drive yet. Watch and listen for any

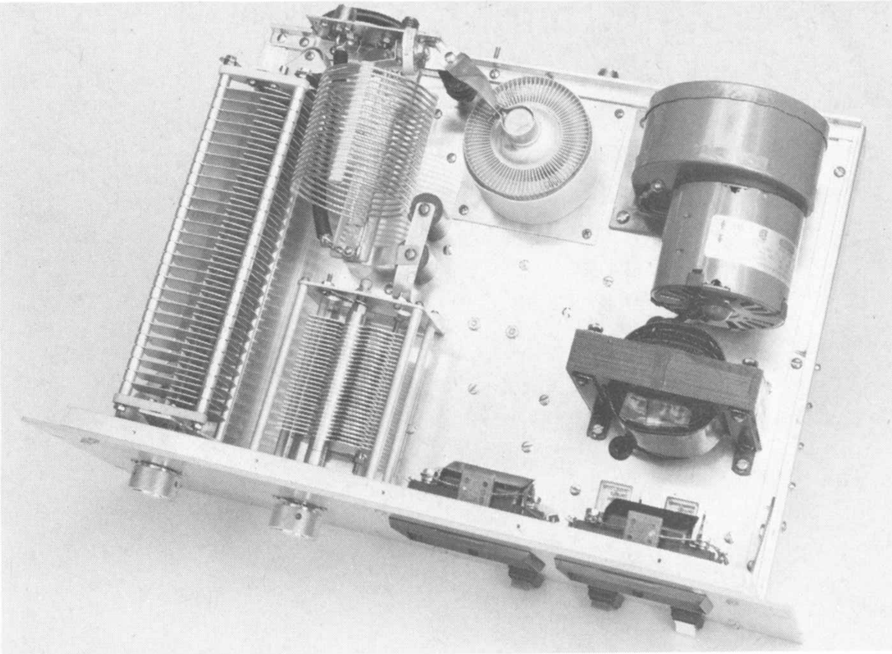

Fig. 54 — Top-side view of the 160-meter amplifier chassis.

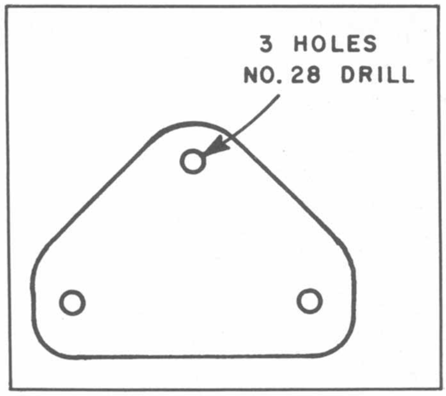

Fig. 56 — Full-size template of the plate used to connect the three doorknob capacitors that make up C17 to C18.

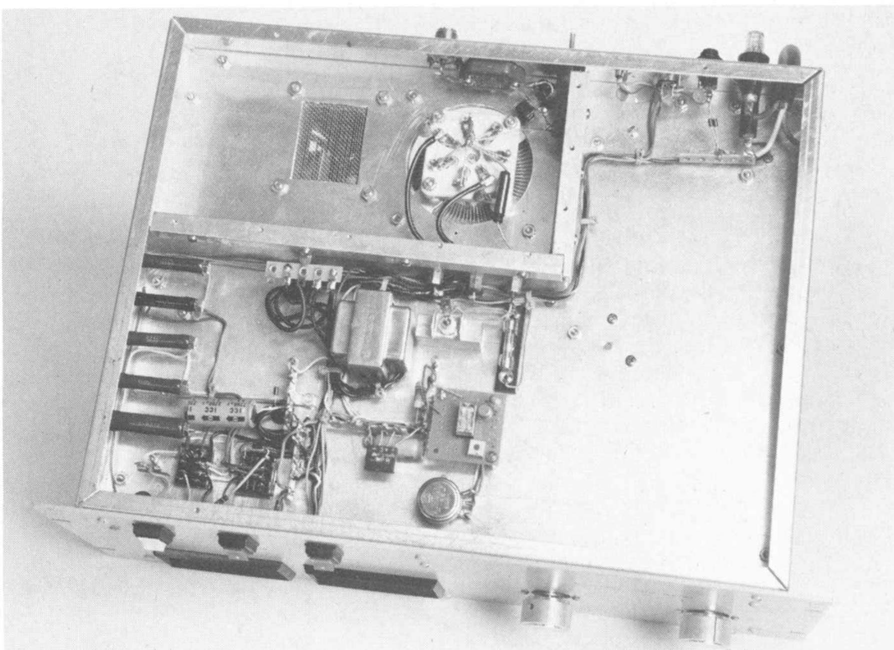

Fig. 55 — View of the underside of the 160-meter amplifier chassis.

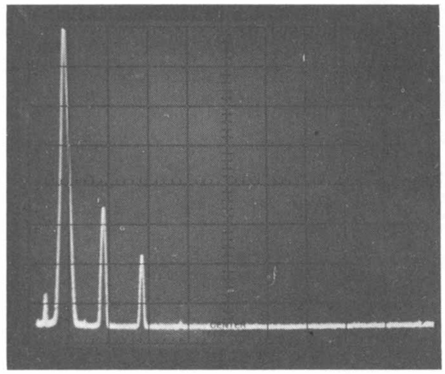

Fig. 57 — Spectral output of the 160-meter amplifier. Power output is 1500 W on 1.8 MHz. Each vertical division is 10 dB and each horizontal division is 2 MHz. All harmonics and spurious emissions are greater than 44 dB down. This amplifier complies with current FCC spectral-purity requirements.

signs of arcing as you bring the plate voltage up to full operating potential. There should be no indication on M1 or M2. If all appears to be okay, lower the plate voltage to about 1000 V and apply about 10-W drive. Adjust L1 for lowest input SWR.

Increase drive and adjust the pi network for maximum output. Most likely the grid overcurrent trip circuit will operate, placing the amplifier in STANDBY. Decrease the sensitivity by adjusting R4. This control is near high-voltage points, so take care and use an insulated screwdriver. Adjust this potentiometer so the grid protection circuit trips at 60 to 70 mA.

Apply full plate voltage and gradually increase drive. Adjust C18 and C19 for maximum output. These controls are somewhat interactive. Do not exceed 1 ampere of plate current. Recheck the input SWR when you reach full output power. Some additional adjustment of L1 may be necessary. Output power should be 1500 W with a plate voltage of approximately 2600 at 1 ampere and 60-W drive. Fig. 57 shows the amplifier spectral output.