

# CQ REVIEWS:

## The Commander HF-2500 HF Amplifier

BY LEW McCOY\*, W1ICP

**T**here is one thing I really appreciate whenever it comes to reviewing a product, and it is best described by a single word—rugged. If ever I reviewed a piece of equipment that fits this word, it is the new Commander HF-2500 linear amplifier manufactured by Command Technologies. You'll see why I say this as we go through the review.

Basically, the HF-2500 is a full-legal-power (1500 watts), grounded-grid linear amplifier covering 160, 80, 40, 20, and 15 meters, and a slight modification will put it on 10 or 12 meters. However, you must send a copy of your license before Command Technologies will provide the information.

Why do I use the term *rugged*? Simple. The amplifier uses a pair (that's right, a pair) of 3CX800A7 tubes. This provides a total plate dissipation of 1600 watts. You can run 1500 watts output, key down, as long as you desire.

The amplifier is completely self-contained, weighing in at 75 pounds (it gets in just under the UPS and Federal Express shipping requirements). It measures 17" x 16" x 7 3/4". A single switched meter is used to measure plate voltage, plate current, or grid current. The normal drive power required is 50 to 80 watts for a full 1500 watts output, in any mode desired. Fig. 1 is the circuit diagram of the amplifier. However, while not shown, there are RF bypass capacitors on the timer circuit and in other spots where needed.

In fig. 1 note the input circuit with capacitors C28 through C32, which is a tuned network on each band. These tuned input circuits are L-C-L or "T" impedance matching networks with a design "Q" of 5. These circuits reduce intermodulation components plus permit "tailoring" the output of any exciter to the cathode input of two 3CX800s; more about this later. The capacitors are adjustable from the rear panel of the amplifier. The front-panel bandswitch selects the proper tuned circuit. Also, a negative going adjustable ALC circuit is built in which can be used to limit the output of the amplifier.



This is the front-panel view of the HF-2500. At the upper left is the band switch. To the right are the TUNE and LOAD controls. There are two lights, one indicating AC power is on (green) and another showing you are in the transmit mode (red). The OPERATE-STANDBY switch is also an exciter-only switch. In the standby position the exciter is connected straight through to the antenna.



This the final amplifier deck showing the tank circuit. The toroid mounted on the rear is the 4 to 1 balun used to bring the 200 ohm tank output down to 50 ohms.

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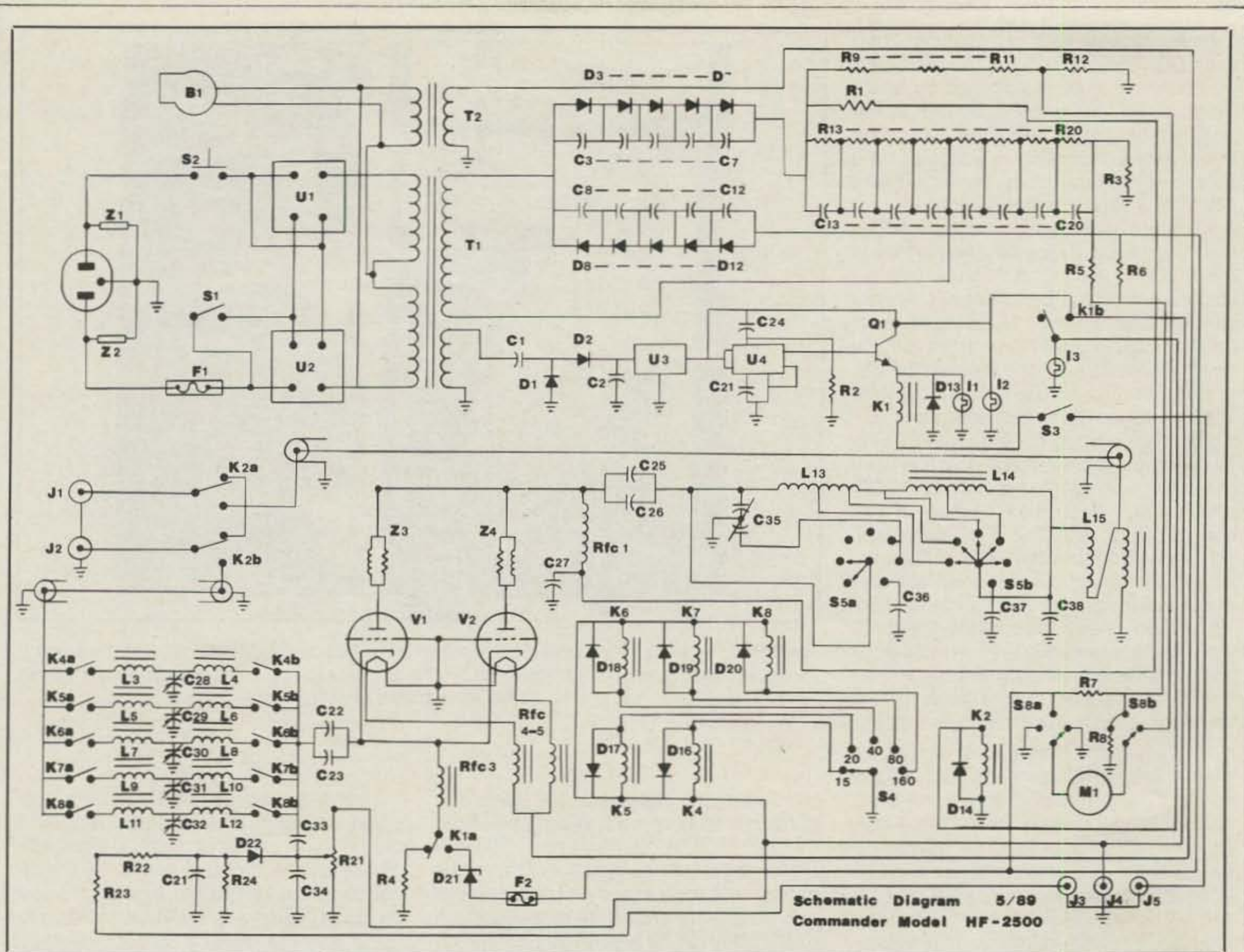


Fig. 1 - Circuit diagram of the HF-2500.

In addition, the ALC is adjustable from the rear panel.

On the plate side of the amplifier, the tank circuit consists of a pi variable network that converts the plate load of 1400 ohms down to 200 ohms. Two air variables and a switched inductor are used to accomplish the transformation. I might add here that the air variables are products of the Oren Elliott Corporation, a firm in Ohio which specializes in building high-quality variables and roller inductors.

The pi network is designed for a "Q" of 14, which provides excellent harmonic attenuation. Fifteen and 20 meters (and 10) are covered by L13, the large-diameter silver-plated inductor shown in the photos. A toroidal wound inductor, L14, covers 160, 80, and 40. In addition, a reactance tuned ferrite core provides a 4 to 1 impedance transformation for the pi from 200 ohms down to 50 ohms. This also provides additional harmonic attenuation. Harmonics are down to a minimum of 50 to 60 dB, well above FCC requirements.

The bandswitch, S5A and B, is an extremely well-constructed unit easily capable of handling high RF voltages (it is rated at 7000 volts). Everything about the final amplifier construction and quality is really first class, as evidenced by the photos.

Of course, one of the important points about any amplifier is its power supply. Don't forget—in fact, *don't ever forget*—that this is no 12 or 24 volt supply. **The voltages and currents in any amplifier using high-voltage triodes or tetrodes can be lethal.** We have acquired countless new amateurs in the last few years who were introduced to amateur radio via the 12 volt, solid-state route, and believe me, it is easy to become careless when all you have dealt with are such low voltages.

The power supply in the HF-2500 is operated from 220 volts AC at 20 amperes, a little story in itself as far as I am concerned. My house has no 200 volt wiring, so I ran a 200 volt line to the shack in order to do the review on this unit. The am-

plifier I was using was running on 120 volts, but had an arrangement whereby I could change some jumpers and the amplifier would work on 220. I hooked it up, but the darned thing wouldn't come on, resulting in my troubleshooting the wiring for a full day. I finally had the sense to put a voltmeter across each side of the AC outlet to ground and found 120 volts on each side. I was stumped until I put the voltmeter across both of the hot AC leads. Instead of 240 I had 0 volts. I quickly realized I had wired both sides of the line to one side of my 220 input at the fuse box! Talk about feeling stupid!

As I said, the HF-2500 uses 220 volts. The primary of the transformer is switched on by solid-state relays U1 and U2. These relays conduct when the phase angle of the power line voltage equals zero degrees. This minimizes surge currents while the filter banks, C13 through C20, charge. A front-panel switch is used to turn the relays on and off.

The secondary of the high-voltage transformer is 900 volts AC and is fed to a

voltage doubler with a resulting 2650 volts DC. The metering of the plate and grid currents is accomplished by shunt resistors R5, R6, and R7 located in the negative return of the tube cathodes. Plate voltage metering is accomplished by use of the resistor multiplier network (R9, R10, and R11) located in the B+ line. A 50 ohm, 50 watt resistor wired in series with the tube plates limits the current in the event of an arc within the internal structure of the tubes. Relay K1A controls the bias of V1 and V2 during transmit and standby modes. During transmit a zener diode, D21, is in series with the B- supply voltage and tube cathodes, establishing bias for Class AB2 operation.

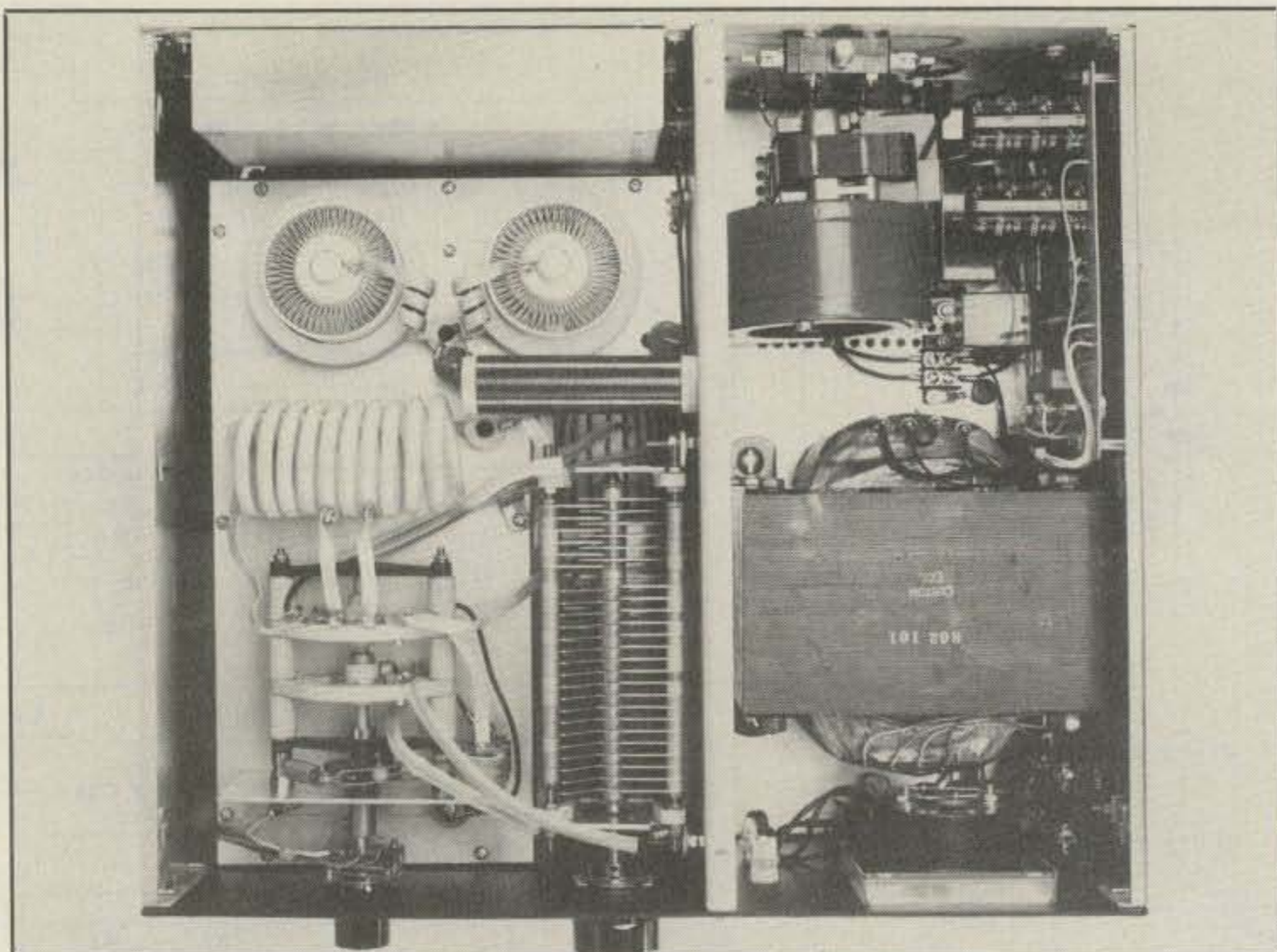
Another winding on the power transformer provides 6.3 volts, which is used in a voltage doubler to produce 17.8 VDC, which is then passed on the input of a 12 volt regulator (U3). A 555 IC timer (U4) provides a 2 minute delay before Q1 turns on. This 2 minute delay provides adequate warm-up time for the cathodes of V1 and V2. Relay K1 is activated by shorting rear-panel jack J3 (key), which places the amplifier in the transmit mode. A Dayton 50 cubic feet per minute blower (which is pressurized) is used to cool the tubes.

While the tank circuit is adjustable, the manufacturer recommends operating into loads of no greater than a 2 to 1 SWR, at least at maximum powers. I also highly recommend this procedure simply because with 1500 watts and the high RF voltages developed, it isn't very smart to run with a high SWR and the corresponding high RF voltages you could develop.

The tubes used in this amplifier, the 3CX800s, are very high gain, and as I have heard, rather "touchy." One acid test for amplifier stability is to remove all drive but leave the plate voltage on and then adjust the loading and tuning controls to see if the amplifier "takes off" (self-oscillation) on its own. I did this on all the bands and found complete stability, which I consider a real credit to the designer.

Voltage regulation is also excellent, from key up to key down. Full 1500 watts output, the voltage drops approximately 200 volts. The AC input line is fused with a 15 amp, rear-cabinet-mounted unit. I blew this fuse on my initial tune-up, but never after that. I frankly don't know why. There is also a safety interlock switch on the rear wall that is activated when the top cover is removed. I feel that again I should warn any recently licensed amateur that the voltages in this or any tube-type amplifier are very lethal. As I stated, many newcomers have joined the amateur radio ranks since the advent of solid-state, and some solid-state amplifiers operate on relatively low, non-lethal voltages. Make sure that every precaution is used when using a tube-type amplifier.

My exciter (transceiver) is a modern



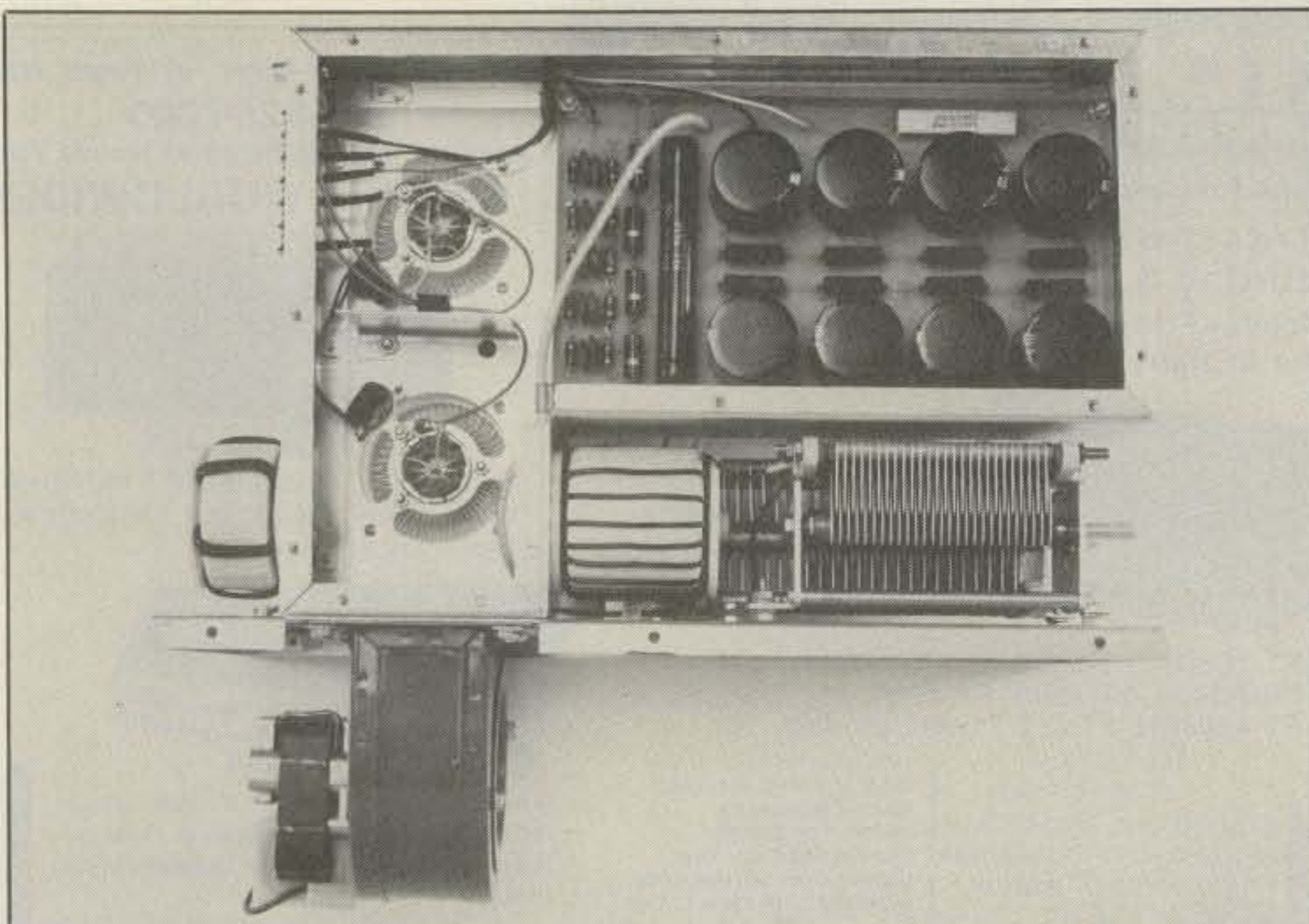
Here is the view looking down into the amplifier. The box mounted on the rear wall contains the tunable circuits for the input. At the right are the power transformer and some of the associated circuits.

solid-state unit capable of 100 watts output into a 50 ohm load. When I first tried the HF-2500, I found I had difficulty reaching the rated output figures on a few bands. I naturally assumed I had plenty of drive, but I was wrong. There was enough of a mismatch between the transceiver and the amplifier that the transceiver was tending to shut down. I realized that I needed to adjust the trimmers, C28 through C32 (fig. 1), that were on the input circuits.

First I loaded up on 10 meters and could only get 100 watts output. I noted I didn't have much apparent grid drive, so I adjusted the trimmer capacitor on the input circuit. It was rather amazing to see the drive go up and the output zoom up to 2 kw (into the dummy load, of course). This brought me back to the old cliché "When all else fails, read the instruction manual!" The grid meter is shunted to read 100 ma at full scale, but the two tubes are rated at 120 ma, so you have



This is the rear view of the HF-2500. Along the upper right are the adjustment access holes for the input circuits and ALC adjustment. At the lower left are the KEY, ALC input, and an auxiliary 12 VDC output.



Bottom view of the RF deck. At the upper right is the power supply capacitor deck. To the right of the lower tube is the inductor for the low bands, 40 through 160 meters.

plenty of warning with the meter reading. About 40 to 60 ma of drive will provide 1500 watts output. In fact, I found that in operation I had to reduce the RF drive control on the exciter, actually permitting it to loaf along. Normally, with RTTY and

AMTOR the exciter fan would come on to provide cooling. I found this didn't happen when I used the amplifier simply because the exciter was running at about half power to produce 1500 watts amplifier output.

I've mentioned the problems I had, and they were nearly all cockpit problems—failure to do what the manufacturer told me to do. I did have one other problem, and that was an RF arc (only one) and I attribute that to corona because of the high altitude at which I live—nearly 7000 feet above sea level.

The instruction manual is detailed and easy to read. There are plenty of cautionary notes in the manual. As I said earlier, this is no low-voltage amplifier, so all warnings should be heeded.

I tested the HF-2500 on all the bands, 160 through 10 meters. I used a Transmatch on everything below 40 meters and matched antennas on 20 and above. To repeat myself, tune-up is straightforward, and I might add, very easy to reach 1500 watts output. (I tested into a 4 kw dummy and I found I could go well over 2000 watts output!) Operating the amplifier was a real joy, and I would be less than honest if I didn't say the high power made a big difference in many of the contacts I made. Let's face it: amateur radio is a competitive hobby, and the difference in many QSOs is the ability to be heard.

Price of the HF-2500 is \$2188. The amplifier is manufactured by Command Technologies, Inc. (no connection with the former Dentron Corp. or Amp Supply), 1117 W. High St., P.O. Box 939, Bryan, Ohio 43506 (1-800-736-0443).

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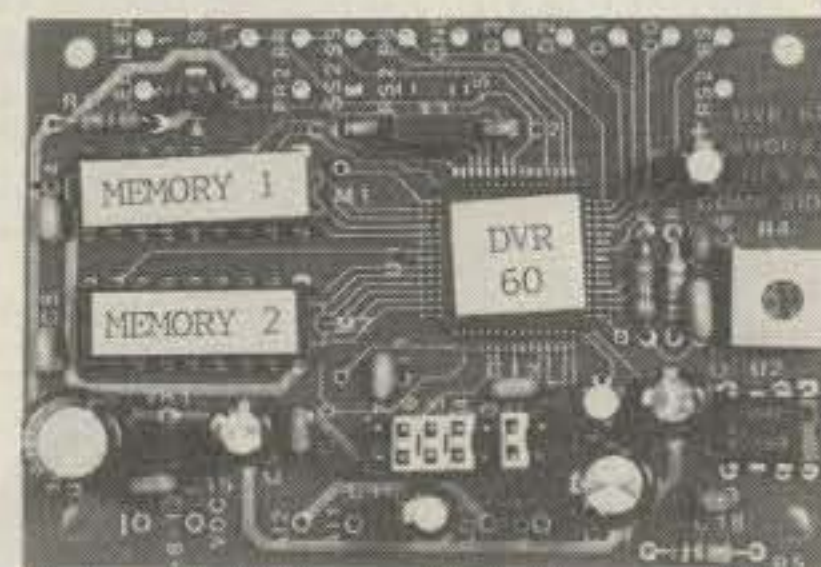
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