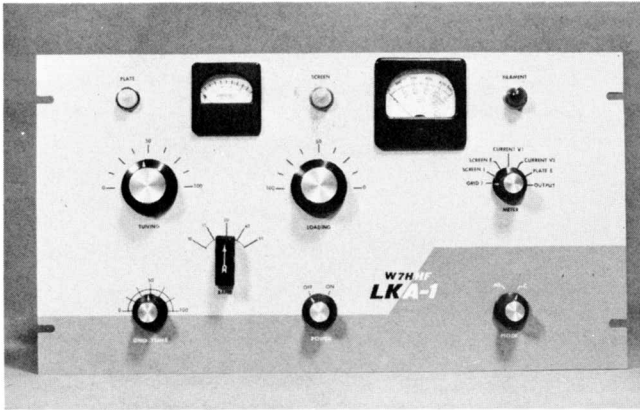


The LKA-1



Linear Amplifier

BY CECIL C. COPE,* W7HHF

DURING RECENT YEARS, a number of transistorized transceivers and transmitters of various types have made their debut. These units are designed to operate QRP, and usually deliver from five to ten watts output. If one intends only to operate at low power, he need read no further. However, there are times when band conditions dictate the use of higher power.

The amplifier to be described, which covers 80 through 10 meters, should fill the bill nicely for those who wish to run higher power and use the low-power transmitter for an exciter. This amplifier uses 4CX250B tubes (which are more commonly used at vhf). It is capable of a full kilowatt input on ssb, cw and RTTY, provided the power supply has the capability for operation under the higher duty cycle encountered on RTTY. Drive requirements are very modest for this amplifier. In fact, drive conditions approach those of the venerable 6146. The author has been able to obtain very satisfactory results using a transceiver delivering only five watts.

Included in the design is provision for Class-C operation of the amplifier, thereby achieving maximum efficiency on cw and RTTY. Drive requirements for this mode are in the neighborhood of ten watts. Output efficiency is very high. According to the *RCA tube manual* rf-output ranges from 650 watts in Class AB1 to over 800 watts when operated Class C. While these figures may be a bit

optimistic, experiments conducted by the author indicate that if tank circuit conditions are approximately correct, efficiency is very good. The prospective builder may note several unique features in this amplifier as shown in Fig. 1. The first is the screen supply. The second feature is the method of metering the various functions, and the third is the thermal time-delay relay circuit. Screen voltage for the amplifier is obtained from an electronically regulated supply. This was done primarily for two reasons. First, during normal operation the screens draw 60 mA which is more than the usual VR-tube string is capable of handling. Secondly, by using this type of supply, it is much easier to alter the screen voltage when changing from Class AB1 to Class C. An added advantage is that the screen voltage can be set to the exact voltage desired. The electronically regulated supply provides excellent voltage stability over its dynamic range.

Metering is rather unconventional in that the instrument is used as a voltmeter which measures the drop across the series resistors located in the various circuits. This was done to eliminate the need for winding meter shunts, a rather time consuming task. Accuracy is good using this method and no problems have developed. The series resistances are of sufficiently low value to cause no effect in operating conditions. In this amplifier, M1 is connected in the B- return (see Fig. 1) from the high-voltage supply and con-

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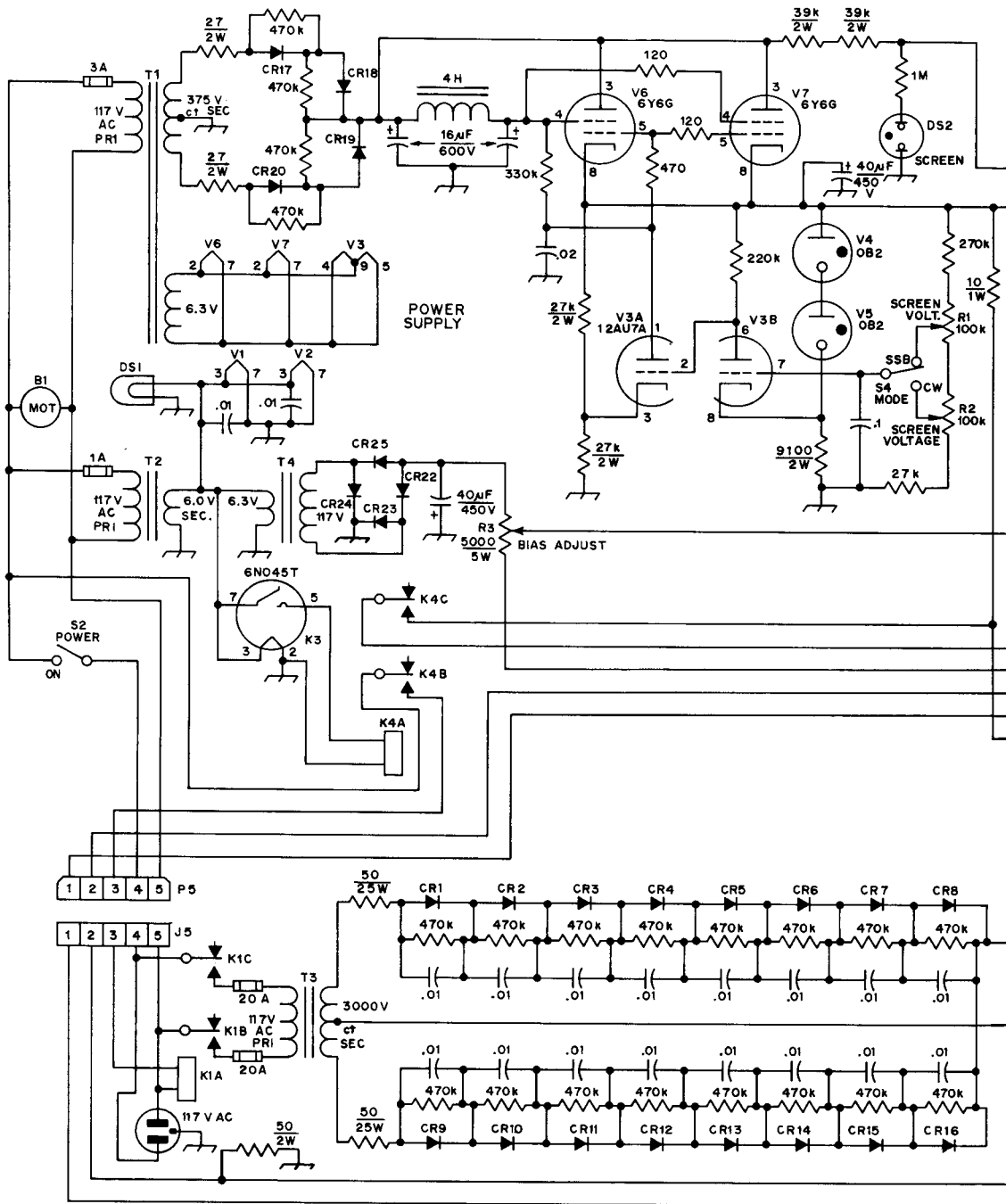
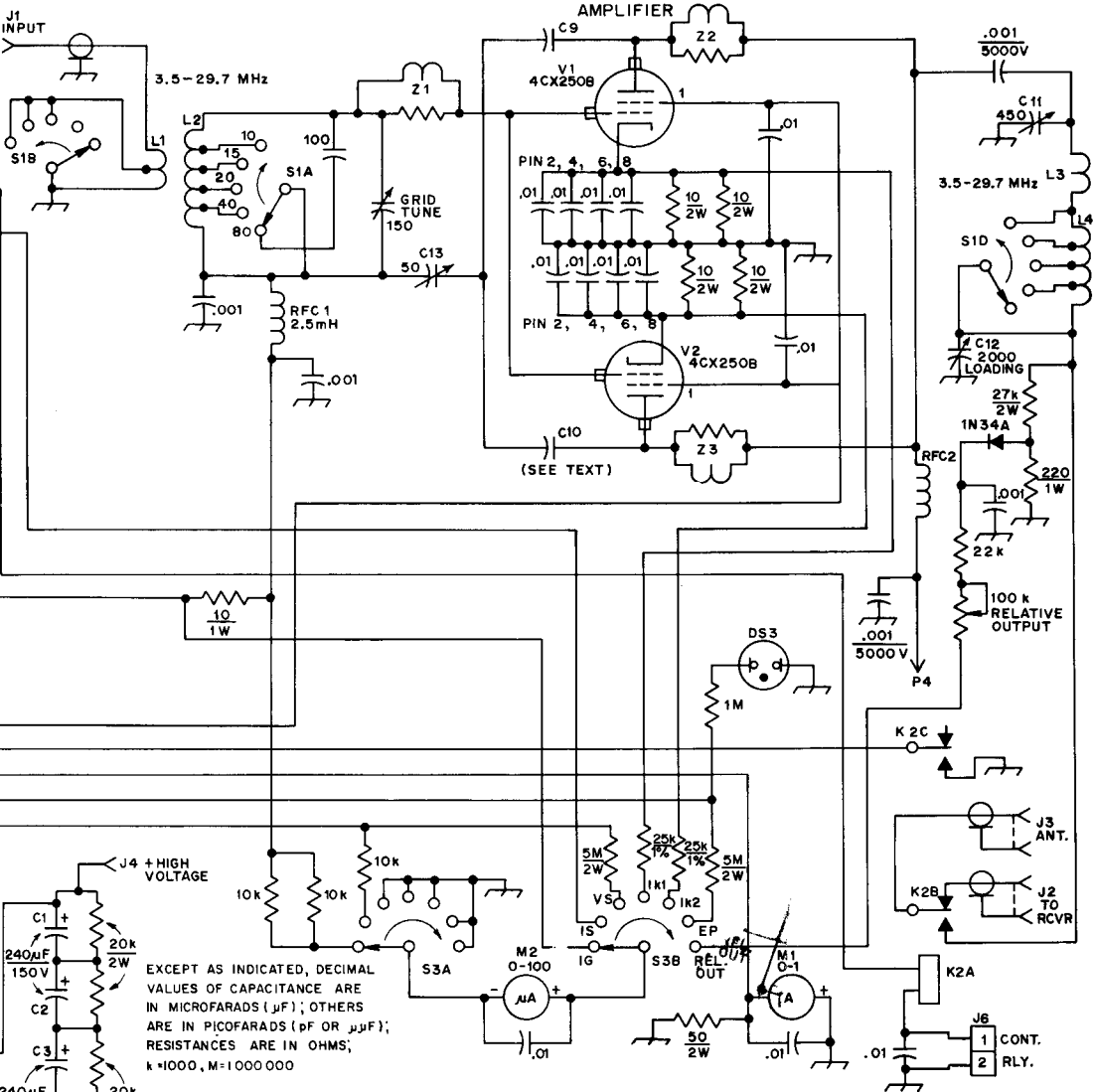


Fig. 1 — Schematic diagram of the amplifier. Unless otherwise specified, resistors are 1/2-watt composition and capacitors are disk ceramic. C1-C6, incl. — Electrolytic (Mallory CG241T450DI). C7, C8 — Four .01 disk ceramic capacitors connected to each of the cathode terminals (4) of each tube. C9, C10 — See text.

- C11 — Variable capacitor, 450 pF, 3 kV.
- C12 — See text.
- C13 — Small air variable, 50-pF.
- CR1-CR23, incl. — Silicon diode, 1 A, 800 PRV.
- K1 — Power relay, 20-A contacts, 117-V ac coil.
- K2 — Antenna relay, 10-kΩ coil, dpdt, 5-A contacts (Potter and Brumfield GB11D).
- K4 — Dpdt relay, 6.3-V ac coil, 5-A contacts (Potter and Brumfield KT11A).



EXCEPT AS INDICATED, DECIMAL VALUES OF CAPACITANCE ARE IN MICROFARADS (μF); OTHERS ARE IN PICOFARADS (pF OR μpF); RESISTANCES ARE IN OHMS; k=1000, M=1000000

- L1 - Insulated hook-up wire, 4 turns around the low-frequency end of L2, 3 turns around the high-frequency end (total, 7 turns), tap at 4 turns from ground end.
- L2 - Grid coil, 22 turns of No. 20, 1-1/4 inch diameter, 1-1/2 inches long. Taps at 10, 15, 17, and 19 turns from cold end.
- L3 - Copper tubing, 1/4 inch dia., 1-1/2 inch OD, 2-1/2 inches long mounted at right angles to L4.
- L4 - (See text) 10 turns of No. 8 copper wire and 4 turns 1/4-inch copper tubing, 3-3/8 inch dia., total length 5 inches. Taps at 7-1/2 9-1/2, and 10-1/2 turns from loading capacitor end. Ten-meter tap is made at the junction of L3 and L4.
- RFC2 - Plate choke, 60 turns of No. 24 enam. wire close-wound on 3/4 inch

- plastic dowel stock. Dowel stock is drilled and tapped at one end for attachment to chassis.
- T1 - Plate transformer, 375 V ct at 120 mA, 6.3 V at 4 A (Thordarson 25R08 or equiv.).
- T2 - Filament transformer, 6.0 V at 6 A (Thordarson 21F73 or equiv.).
- T4 - Filament transformer, 6.3 V at 1.2 A (Thordarson 21F09 or equiv.). T4 is connected in reverse. That is the 117-V winding supplies voltage for the bias supply.
- Z1 - Five turns of No. 20 enam. wire over length of 220-ohm 1-W composition resistor.
- Z2, Z3 - Four turns of No. 14 solid copper wire, 3/4 inch diameter, 3/4 inches long, wound over 2 paralleled 220-ohm, 2-W composition resistors.



screened openings are provided also in the tank-circuit compartment.

A circuit board located near the grid compartment supports the various resistors associated with the metering circuits. Another circuit board is used to mount the diodes, resistors, and other components used in the screen and grid-bias supplies. The transformers used in these supplies are mounted directly on the main chassis.

Controls which are mounted on the rear apron are as follows: the output voltmeter adjust and the grid-bias control. The neutralizing capacitor, C13, is accessible through a capped hole at the rear of the chassis. Connectors on the rear of the chassis include control connectors to the high-voltage supply, input/antenna/receiver coaxial-cable fittings, and the high-voltage connector. Front panel controls are as follows: plate tuning, plate loading, ac power, multimeter switch, mode switch and band switch. The screen-voltage adjust controls are located near the front panel, just below the multimeter on the main chassis. These are "set-and-forget" type controls, so ready access is not needed.

It should be pointed out that the grid-tuning capacitor must be isolated from ground, as bias voltage is present on the rotor. An insulated shaft with universal joints is used to connect this capacitor to its control knob on the front panel. All leads entering the grid and plate compartments, with the exception of rf carrying leads, are bypassed at the point of entry. This is accomplished best by the use of ceramic feedthrough capacitors.

Neutralization of the amplifier is achieved by the voltage-dividing network composed of C13, C9 and C10. C9 and C10 are aluminum plates, 1 x 4 inches long, fitted with a small bracket which is attached to a ceramic feedthrough bushing terminating in the grid compartment. C13 is connected in series with C9 and C10 which provides a means of adjusting the feedback to the proper amount. C9 and C10 are located 3/8 inch from the radiators of the 4CX250B-tubes.

The plate-circuit rf choke (RFC2) is home-made. Plastic dowel stock is used for the coil form and is drilled and tapped for attachment to the chassis. A cutout is made in the chassis which is used to conduct the output of the blower to the chassis compartment. Brackets for the blower are formed from aluminum stock, and exact dimensions will depend on the blower model used.

The blower on this amplifier is a 110 cubic-foot-per-minute "squirrel-cage" type. Blowers of smaller capacity may be used, but it must be kept in mind that this type of device normally loses efficiency because of back pressure. The tubes present considerable resistance to air flow and using a blower with a rather high output ensures that adequate cooling is accomplished under all conditions.

Operation

After construction is complete and a check performed for wiring errors, disable the high-

voltage and screen supplies by removing the appropriate fuses. Be sure that no high-voltage is present before proceeding. One word of caution: *under no circumstances should the amplifier be operated with the bottom plate removed.* The 4CX250Bs require a flow of cooling air at all times to maintain tube seal temperatures within specified limits. Be sure that the blower is operating and that the tubes are receiving adequate air flow before high voltage is applied.

Apply filament voltage. Using the bias-adjust control, set the grid bias to -50 volts. The amplifier may now be neutralized. Procedures for accomplishing this are covered thoroughly in *The Radio Amateur's Handbook* and other sources, so further details will be omitted here. After neutralization is complete, screen and plate voltages may be connected to the amplifier. Using the multimeter in the screen-voltage position and with the mode switch set for AB1, adjust R1 for a reading of 350 volts. Switch to the Class-C mode and adjust R2 for 250 volts. The amplifier is now ready for operation.

When used as a Class AB1 amplifier, the proper amount of drive occurs at the point which almost produces a flow of grid current. Current flow indicates that the amplifier is being overdriven - a condition which is to be avoided. Quickly load the amplifier until screen current is at an indicated 60 mA. When this has been done, operation is close to optimum. Avoid running the amplifier under maximum drive and minimum loading conditions for more than a short time, as screen dissipation is excessive during these periods.

Class-C operation is accomplished in the following manner: switch the MODE switch to the Class-C position. Apply drive to the amplifier until an indicated 25 mA of current flows in the grid circuit. Load the amplifier for 60 mA screen current. As with the Class AB1 mode, conditions approach optimum at this point. No adjustment is made to the grid-bias control for Class-C operation. The bias voltage is raised to the proper level by the flow of grid current through the bias-control potentiometers.

Conclusion

The amplifier seems to function well over a wide range of plate voltages. In fact, it was operated for a period of time with only 500 volts on the plates. It has provided many hours of operation with a supply delivering 1100 volts. Of course, maximum output and efficiency will be achieved when the power supply produces a full 2000 volts at approximately 500 mA.

This amplifier has proven to be a very stable and efficient one. No problems of any sort have been encountered with parasitic oscillations, and TVI has been almost nonexistent. The only known case of TVI has occurred due to overloading of the front end of the author's TV set - a condition caused mainly by the close proximity of the TV antenna to the "antenna farm."

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Linear Amplifier *(continued from page 43)*

Nothing really new or revolutionary is claimed for this amplifier. It is presented mainly in the hope that it will provide an answer to a gap which exists today in amplifier design. With this amplifier, the owner of a low-power exciter need not go to an intermediate amplifier to obtain the power needed to drive the more common grounded-grid amplifiers so much in vogue today. However, the amplifier is of sufficient complexity so as to make it impractical as a project for the beginner. But for the experienced constructor with a few pieces of equipment under his belt, it should prove to be an enjoyable and worthwhile undertaking. 