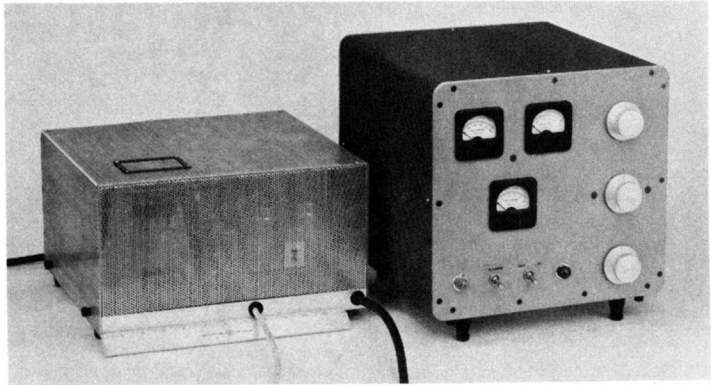


A HIGH-POWER GROUNDED-GRID AMPLIFIER AND POWER SUPPLY

Fig. 6-70—The 3-1000Z grounded-grid linear and its solid-state power supply are shown here with a 12-inch rule to show the relative sizes of the units. The chart frame on the top of the power-supply housing holds the clear plastic through which the voltmeter can be read.

The amplifier is mounted on short legs to allow air to be drawn in at the bottom and blown up past the tube. The meters indicate grid (left)

and plate current and relative output (below). Knobs at right (B & W 901) control plate (top), band switching and loading. (Built by Robert Smith, WILLF.)



The grounded-grid linear amplifier and power supply shown in Fig. 6-70 are designed for the amateur power limit in single-sideband operation. The amplifier uses a 3-1000Z triode to handle a p.e.p. input of 2 kw. on peaks. The amplifier and supply each occupy just over 1 cubic foot and are made from readily available components. The 3-1000Z requires a driver capable of supplying at least 65 watts p.e.p.

Referring to the amplifier circuit diagram in Fig. 6-84, the grid of the triode is grounded for both r.f. and d.c. The cathode is maintained above r.f. ground by feeding it through a homemade filament choke wound on a ferrite rod. Although the input impedance of the grounded-grid 3-1000Z is close to 50 ohms and would provide a good match for a driver with fixed-impedance output, a pi network input circuit, $C_1C_2L_1$ is used to supply some Q to the circuit, for better linearity. The Q is low, however, and once adjusted an input circuit requires no further attention for operation anywhere within its band. For simplicity in the circuit diagram, only one set of capacitors and inductor is shown in Fig. 6-84.

The plate tank circuit uses a commercial coil assembly (Air Dux .195-2) that has been rearranged to conserve space and fit better into the compact package. The bandswitch is made from the products of two different companies, ganged together to provide an input-circuit 2-pole switch and a plate-circuit single-pole switch. The plate-circuit switch is modified slightly, as described later, to permit the switching in of a plate loading capacitor on 75 meters.

During "receive" periods a 50,000-ohm resistor in the filament-transformer center tap practically cuts off the plate current; leads from it are brought to two phone jacks so that the resistor can be shorted out during "transmit" by a set of contacts on the antenna transfer relay (or by the VOX control if an electronic t.r. switch is used).

Three meters are used in the amplifier. The grid and plate currents are read separately by a 0-500 milliammeter and a 0-1 ammeter. The third meter is a relative-output indicator metering the r.f. voltage at the output. D.c. for the meter is derived from a germanium-diode rectifier connected to a resistive r.f. voltage divider.

Panel switches and associated neon indicators are provided for control of the filament (and blower) and high-voltage power.

Construction

Two identical pieces of $\frac{1}{8}$ -inch thick aluminum, $11\frac{1}{4}$ inches high and $12\frac{1}{4}$ inches wide, are used for the front panel and the rear plate. These may be cut from $12\frac{1}{4}$ -inch rack-panel material (Bud SFA-1837) if no other source is available. The major chassis that supports the tube socket and the filament transformer is a standard one measuring $7 \times 12 \times 3$ inches (Premier ACH-433). It is held to the front panel by the two toggle switches and the two indicator lamp housings (Dialco 951308X) and to the rear panel by the 25,000-ohm variable resistor in the output-metering circuit and various screws that hold J_1 , J_3 and J_6 in place (see Fig. 6-73). The plate choke, RFC_3 , is mounted on this chassis, with a 1000-pf. 5-kv. ceramic capacitor (Centralab 858-S) near its base; the high-voltage lead is brought from the base of the r.f. choke (and from the capacitor) through the chassis in a ceramic feedthrough insulator. The output-indicator circuitry, consisting of the 22,000- and 470-ohm resistors, the 1N34A rectifier and the 0.001- μ f. capacitor, is also mounted on the chassis (see Fig. 6-75). These are mounted on a multiple tie-point strip fastened to the top edge of the chassis near C_4 . The assembly is shielded by a $2\frac{3}{4} \times 2\frac{1}{2} \times 1\frac{1}{2}$ -inch "Minibox" (Bud CU-3000-A).

The input circuitry and S_{1A} and S_{1B} are housed in a $4 \times 4 \times 2$ -inch aluminum case (Premier

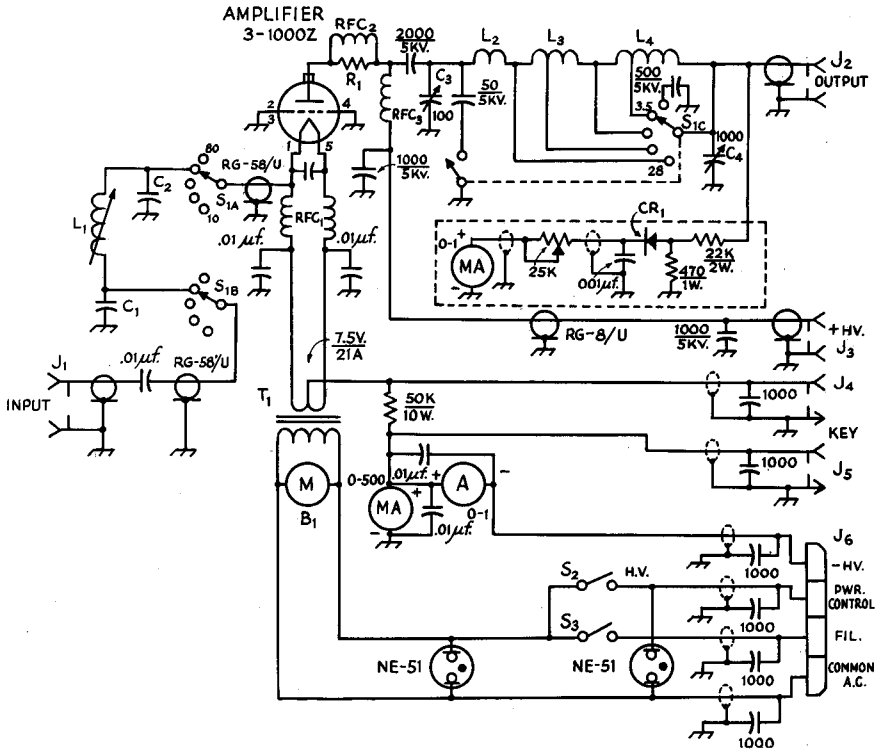


Fig. 6-71—Circuit diagram of the 3-1000Z amplifier. Unless specified otherwise, capacitances are in picotads (pf. or $\mu\mu\text{f.}$).

B₁—65 c.f.m. fan (Rotron "Whisper").

C₁, C₂—See L₁ Coil Table

C₃—100-pf. variable, 0.125-inch spacing (Johnson 154-14).

C₄—1000-pf. variable, (Johnson 154-30, buy direct).

CR₁—1N34A or equivalent.

J₁—Coaxial receptacle, SO-239.

J₂—Coaxial receptacle (Dow-Key DK-60P).

J₃—Coaxial receptacle, UG-560/U (Amphenol 82-805).

J₄, J₅—Phono jack

J₆—Octal male connector (Amphenol 86-CP8 in Amphenol 61-61 shell).

L₁—See L₁ coil table.

L₂—4 t. 5/16-inch strap, 1½-inch diam., 2 t.p.i.

L₃—4 turns ¼-inch tubing, 3-inch diam., 2 t.p.i. Tapped 1¾ turns from L₂ end.

L₄—16 turns No. 8, 3¼-inch diam., 4 t.p.i. Tapped 7 turns from L₃ end.

L₁, L₂ and L₃ are parts of commercial kilowatt coil assembly (Air-Dux 195-2).

R₁—Two 35-ohm "Thermistors" in series (GC 25-918).

RFC₁—28 double turns No. 10 Formvar or Nylclad, closewound on ½-inch diam., 7½-inch long ferrite rod (Lafayette Radio, N.Y.C., 32 R 6103).

RFC₂—2 turns No. 10, 1¼-inch diam., 2 t.p.i., on R₁.

RFC₃—90- $\mu\text{h.}$ 500-ma. r.f. choke (B & W 800).

S₁—2-pole 6-position (5 used) ceramic rotary switch (Centralab PA-2003) ganged to 1-pole 6-position (5 used) heavy-duty ceramic switch (Communications Products 86-B, Marlboro, N. J.). See text.

S₂, S₃—S.p.s.t. toggle.

T₁—7½-volt 21-ampere filament transformer (Stancor P-6457). Meters are Simpson Model 127; 1000-pf. 5-kv. capacitors are Centralab 858-S; 50-pf. 5-kv. capacitor is Centralab 850S.

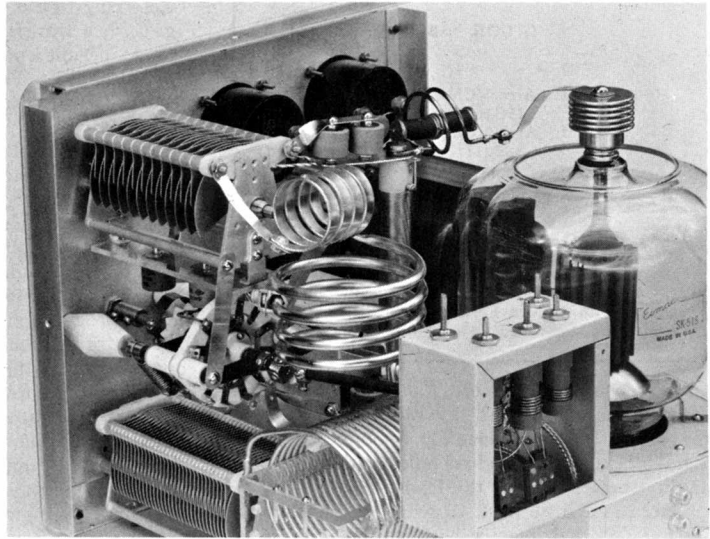
AC-442) held to the main chassis by two ¼-inch panel bearings; the RG-58/U leads to the switches are run through the holes in the bearings. The switch section is mounted on one removable plate of the case; the other plate is not used.

To conserve space and to provide a shaft extension for ganging, switch S₁₀ must be modified slightly. This is done by removing the rear shaft bearing and replacing the two ceramic insulators with shorter (⅝-inch long) ones. If suitable insulators cannot be found in surplus (8-32

tapped holes are required), they can be machined from suitable insulating material. When the rear bearing is replaced, it should first be reversed. The combination of reversing the rear bearing and using a shorter pair of insulators leaves enough shaft extending to take a flexible shaft coupling (Millen 39005). This coupling is connected to a similar coupling on S_{1A-B} through a length of ¼-inch diameter insulating rod.

To provide an extra grounding contact, switch S₁₀ must be further modified. A brass collar that

Fig. 6-72—Rear view of the 3-1000Z amplifier with the back wall removed. Note the two ceramic capacitors mounted on the plastic strip below the plate tuning capacitor (top left). The left-hand capacitor is cut into the circuit on 3.5 Mc. by the spring arm on the switch shaft (see text).



will fit the shaft is required. It is drilled and tapped to fasten to the shaft and also to hold a strap made of spring material (silver solder ribbon, $0.020 \times \frac{3}{4}$ inch was used, trimmed to the width of the collar). The strap is located on the shaft so that in the 3.5-Mc. position it will contact the 100-pf. 5-kv. ceramic capacitor supported by a strip of plexiglas hung from C_1 (see Fig. 6-72). The switch is supported on the panel by four 1-inch high ceramic cone insulators (Johnson 135-501) mounted base-to-base. On the panel, shaft bearings are used for the switch shaft and the two capacitor shafts.

The tank coil assembly is modified by first removing the strap coil and the copper tubing coil from the polystyrene strip that supports them. Then saw a 3-inch long strip from one end and mount it at right angles to the original strip with cement or brass screws (see Fig. 6-72). Coil L_4 , the wire coil, is supported by the polystyrene strip, which rests on the bottom plate at the outside and on the basic chassis on the inside. The in-

side end of L_4 is bent up and a loop formed in the end. Coil L_3 is bolted to this loop with a brass 8-32 machine screw, and the tap running to the 20-meter pin on the switch is taken off at the same junction. All coil taps were made of $\frac{5}{16}$ -inch wide straps cut from copper flashing. The coil L_2 is supported at one end by an end of L_3 and at the other by a copper strap fastened to the stator of C_3 (see Fig. 6-75).

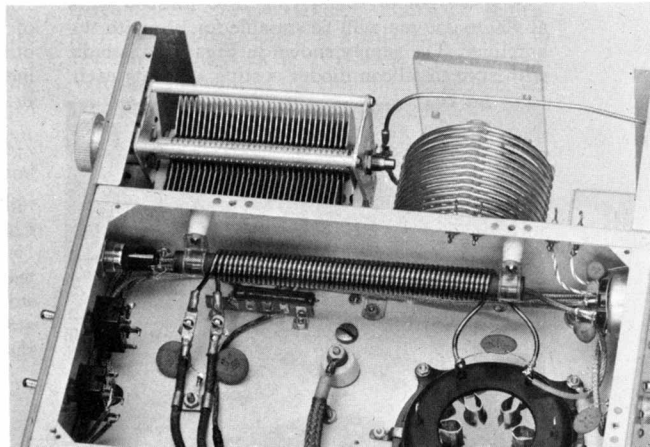
Two 1000-pf. 5-kv. capacitors and the parasitic suppressor, RFC_2R_1 , are supported by the top of RFC_3 , and a flexible strap runs from the other end of the parasitic suppressor to the plate cap. To avoid contact between the cap and the amplifier cover, two layers must be cut off the top of the plate connector (Eimac HR-8).

The chimney (Eimac SK-516) is held in place around the 3-1000Z by four metal clips, and the socket (Eimac SK-510) is modified slightly as mentioned in the caption for Fig. 6-86. The blower is mounted on the $12 \times 11\frac{1}{4} \times \frac{1}{8}$ -inch bottom plate so that it is not directly under the tube socket but near the front panel. Rubber (they could be turned wooden) feet attached to the bottom plate support the amplifier above the operating table and allow the free flow of air into the blower.

Fig. 6-73—A view under the sub chassis of the amplifier. The filament choke can be seen supported off the side wall by ceramic stand-off insulators and plastic cable clamps. A lip on the tube socket (right foreground) has been removed to provide more space and better air flow; the three grid pins of the socket are grounded to the chassis by short straps. Don't try to bend the terminals out of the way before sawing off the lip; remove them entirely.

The resistor mounted on a tie-point strip and visible under the left end of the filament choke is the 50,000-ohm cathode resistor used for stand-by bias; leads from it run in shielded wire to J_4 and J_5 . Wires and plug dangling over the side run to the blower (see Fig. 6-87).

The jack on the rear wall closest to the near side (foreground) is J_8 , the high-voltage cable jack. A 1000-pf. 5-kv. capacitor is mounted on the chassis just inside this point.



L₁ COIL TABLE

Band	C ₁ , C ₂	L ₁
80	1600 pf. (Arco VCM-35B162K)	16 t., closewound
40	910 pf. (Arco VCM-20B911K)	8 t., closewound
20	430 pf. (Arco VCM-20B431K)	6 t., closewound
15	300 pf. (Arco VCM-20B301K)	4 t., closewound
10	220 pf. (Arco VCM-20B221K)	4 t., spaced to fill form.

Capacitors are 1000-v. silver mica. Inductors wound with No. 16 Formvar or Nyclad on ½-inch diam. slug-tuned form (National XR-50).

To conserve space, the filament transformer T_1 must be modified so that the leads come out the bottom. This is done by removing the end bells, blocking the original holes with paper and drilling new holes for the leads.

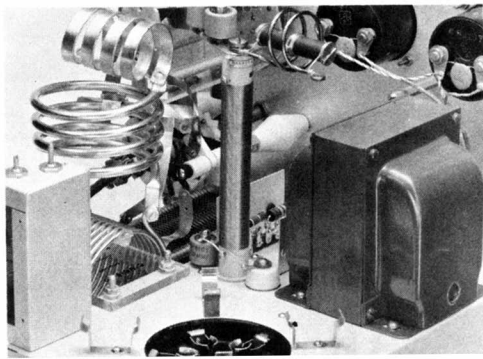
There is a little trick to winding the filament choke, RFC_1 , primarily because the wire is so heavy that it cannot be wound directly on the ferrite rod without springing out. To overcome this, the dual winding of the choke is wound first on a length of 7/16-inch wooden dowel. When it is released it will spring out slightly, enough to permit it to be slipped off the dowel and on to the ferrite core. One-half inch nylon cable clamps mounted on 5/8-inch standoff insulators hold the core in place on the inside wall of the chassis (see Fig. 6-73). Formvar or Nyclad wire is recommended for the choke because with it there is very little chance that the insulation will be chipped off as the core is inserted in the coils.

It will be noted that the three grid leads are connected directly to the chassis. There are slots in the SK-510 socket especially provided to allow low-inductance ground terminations to be made to each of the grid terminals. The grounding straps are slipped through the slots and soldered to the socket pins.

The 7 × 7 × 2-inch chassis that shields the three meters is held to the panel by a single screw that threads into a metal stud. To clear the shielded wires running up to the meters from the hole in the main chassis, a suitable slot is cut on one side of the shield chassis.

Power Supply

A power supply delivering 2500 to 3000 volts at 400 to 350 ma. will be suitable for use with the amplifier. The supply shown in Figs. 6-76 is built with sixteen silicon diodes costing 85 cents each.



Referring to the circuit diagram of the supply, Fig. 6-77, a transformer with a dual primary is used, to permit operation from either a 115- or a 230-volt line. The higher voltage is recommended. No fuses are shown; it is expected that the supply will be protected by the fuses (or circuit breakers) in the wall outlet box.

The filter capacitors are called "computer grade" capacitors; the 25K resistors across them serve both as the bleeder resistor and the equalizing resistors. In operation, the idling current of the amplifier (180 ma.) further bleeds the supply. The 0-5000 voltmeter is included to comply with the FCC regulations. It is a good idea to get into the habit of watching the voltage decay when the power supply is turned off; in this way you are less likely to get mixed up with a residual charge in the capacitors. An interlock switch in series with the relay makes it necessary to replace the cover before turning on the supply.

The 10-ohm resistor between the negative terminal and chassis allows plate-current metering in the negative lead with no difference in poten-

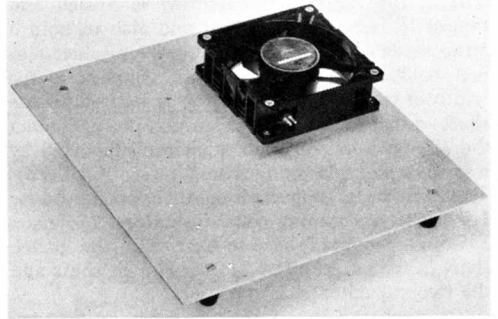


Fig. 6-74—Blower is mounted on bottom plate of amplifier near the front panel (not directly under the tube). A.c. power connector for blower is stock item (Rotron 16415).

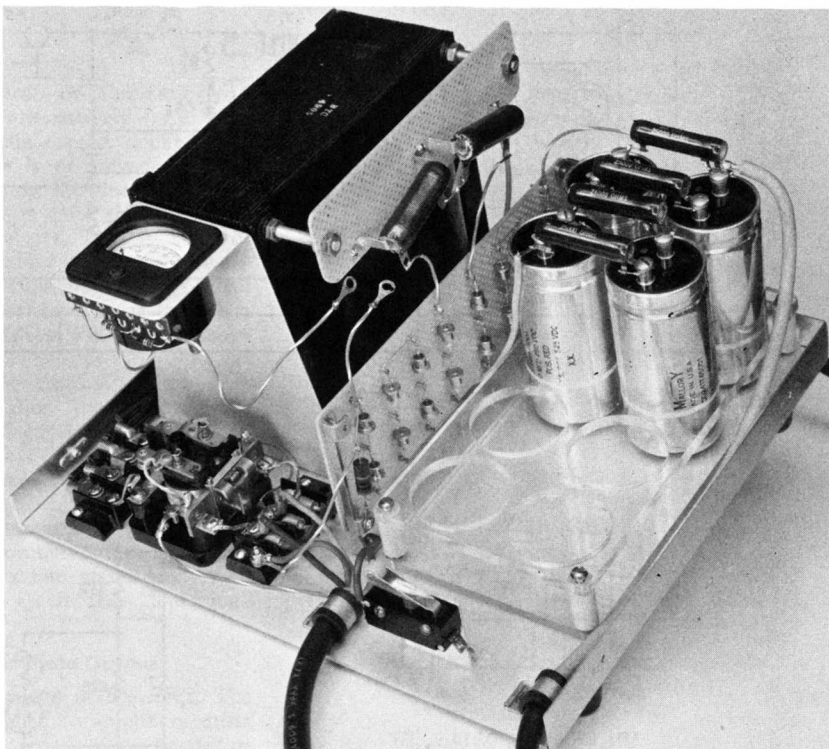
tial between power-supply and amplifier chassis.

The power supply construction is not critical, and the main considerations are adequate insulation and safety precautions. The string of silicon diodes and their associated capacitors and resistors are mounted on a 3 × 9¼-inch strip of pre-punched terminal board (Vector 85G24EP), with push-in terminals (Vector T28) serving as tie points. The rectifiers are mounted on one side of the board, the resistors and capacitors on the other. The strip is mounted on the 12 × 13 × ½-inch aluminum base plate with a pair of panel brackets (Raytheon MB-128).

The pair of 50-ohm resistors is mounted on a 7½ × 1¾-inch strip of pre-punched terminal board, supported by two ¼-20 bolts, 5 inches

Fig. 6-75—Another view of the grounded-grid amplifier, showing the output voltmeter (shield cover removed) components mounted on a multiple tie point strip. The metal stud between the meters receives the screw that holds down the meter shield (7 X 7 X 2-inch chassis).

Fig. 6-76—In this view of the power supply, four filter capacitors have been removed to show how the silicon diodes are mounted on one side of the terminal board; equalizing resistors and capacitors are mounted on the other side. The meter mounting bracket is held to the base plate by two of the bolts that run through the feet of the transformer. Small switch in the foreground is the interlock; control relay is mounted on base plate to left of terminal block.



long, that replace two of the original transformer bolts. This strip also serves as a stop to prevent the cover and the resistors coming in contact.

The bank of eight 240- μ f. capacitors is insulated from the base plate by a sheet of $4\frac{3}{4} \times 9 \times \frac{1}{4}$ -inch clear plastic (Lucite or Plexiglas). A similar sheet with clearance holes is mounted higher and holds the capacitors in place. The 25K bleeder resistors mount on the capacitor terminals.

The high-voltage cable running to the amplifier is a length of RG-8/U terminated in a high-voltage coaxial plug (UG-59B/U). At the power supply end, the braid is peeled back for about a foot on the insulating material, to provide a suitably long leakage path. Disregard of this small point may result in voltage breakdown along the surface of the insulating material. The shield braid is connected to the base plate, which serves as the chassis ground. Wires to the a.c. line should be No. 14 or heavier (a cable marked "14-3 Type SJ 300 V" was used in this unit), and No. 16 wire will suffice for the control wiring.

If desired, a precision resistor can be used for R_3 , the voltmeter multiplier. However, selected standard 20-percent resistors will serve as well.

Safety Precautions

A 3000-volt power supply with a 30- μ f. filter capacitor is a lethal device. There is no such thing as a "slight electrical shock" from a power supply like this one. Make absolutely certain that the voltmeter indication has coasted down to zero before removing the protective cover or touching anything remotely connected to the high-voltage

lead. Even then it is a good idea to use a "shorting stick" across the output as a double check.

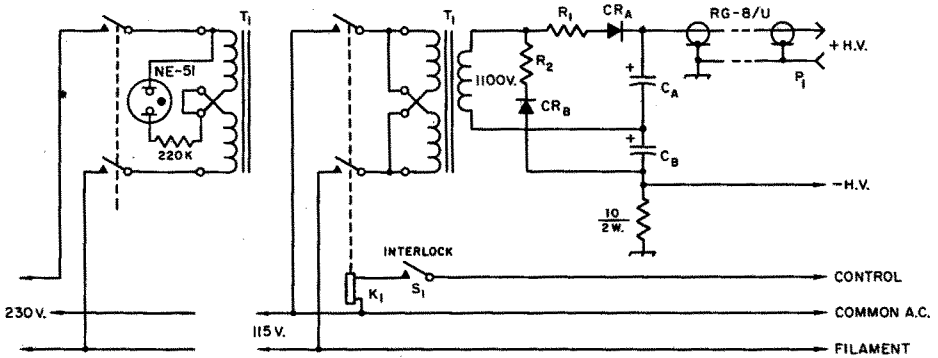
Adjustment of the Amplifier

An amplifier of this quality and power level deserves the best of treatment, and to that end it is recommended that the operator familiarize himself with its operation by using a dummy load, an oscilloscope and some method of "pulsing" the drive. This will enable the operator to work the amplifier at its maximum legal capacity with a minimum of spurious radiation.

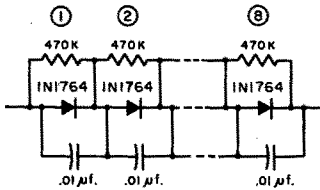
Lacking the equipment mentioned above, it is possible to approach proper operating conditions by the following rules of thumb. They are intended, however, to serve only as rough guides.

With a sideband exciter set for c.w. operation, feed its output to the amplifier at input jack J_1 , through a length of RG-58/U or RG-8/U terminated in a PL-259 coaxial plug. If an s.w.r. indicator (for 50-ohm cable) is available, insert it in the line and switch it to read reflected power. With the filament of the amplifier turned on, but with the plate voltage turned off, tune the sideband exciter at low output level, using the grid-current indication in the grounded-grid amplifier as the output indicator. Peak L_1 . It may be found that a little reflected power is indicated, but that is not important at this time. The exciter tuning and loading should approximate those obtained with any other 50-ohm load.

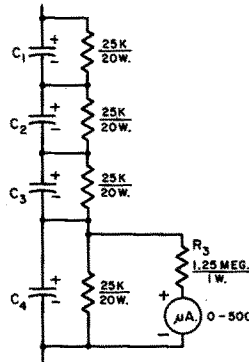
Plate voltage can now be applied, but it is recommended that early tests be carried out at half operating voltage, until it has been estab-



(A) SIMPLIFIED SCHEMATIC



(B) CR_A, CR_B DETAIL



(C) C_A, C_B DETAIL. VOLTMETER ON C_B ONLY.

Fig. 6-77—Schematic diagram of the 3000-volt power supply.

- C₁-C₄—240µf. 450-volt electrolytic (Mallory CG241T450D1).
- K₁—D.p.s.t. relay, 25-ampere contacts (Potter & Brumfield PR7AY, 115-v.a.c. coil).
- P₁—Coaxial plug, UG-59B/U (Amphenol 82-804).
- R₁, R₂—50-ohm 25-watt wirewound (Ohmite 0200D).
- R₃—Selected 0.47- and 0.68-megohm, ½ watt, in series.

- S₁—S.p.s.t. miniature switch (Acro BRD2-5L).
- T₁—1100-v. 600 v.a. transformer, dual primary (BTC-6181, Berkshire Transformer Corp., Kent, Conn.)
- 25K, 20-watt resistors are Ohmite Brown Devil 1845, 470K resistors are ½-watt, 0.01-µf. capacitors are 1000-volt disk ceramic.

lished that it is possible to tune to the various bands. Never apply plate voltage to the amplifier without a load (dummy or antenna) being connected, because there is danger of burning out CR₁ under these circumstances. Having established that the circuits can be tuned, the amplifier can be tested at full voltage. The loading and excitation (single tone, same as steady carrier or c.w.) should be adjusted to give the readings shown below, with the understanding that these are only general guides and are not strict limits. Notice that these conditions represent tuning to a steady 1 kilowatt input, the only possible legal procedure (without pulsing, which

is illegal except into a dummy load). When a set of these conditions has been met, adjust the output of the exciter to drive the amplifier just to an indicated 1 kilowatt plate input on peaks.

As a final touch, adjust the input circuits for minimum reflected power.

Although the amplifier should have no v.h.f. parasitic with the suppressor as shown (RFC₂R₁ in Fig. 6-71), the amplifier should be tested for one. Disconnect the exciter, connect a dummy load to the output, switch to 21 or 28 Mc. and apply filament and then plate power. With one hand on the plate power supply switch, swing the plate capacitor, C₃, through its range, starting at maximum capacitance. If a parasitic is possible, it will probably show up as C₃ approaches minimum capacitance; it will be indicated by a sudden increase in plate current and the appearance of grid current. If a parasitic does appear, it will be necessary to increase the inductance of RFC₂ (after turning off the plate power!) by pushing the turns together or adding another turn.

Plate Voltage	2500	3000
No-Signal Plate Current	160 ma.	180 ma.
Single-Tone Grid Current	100 ma.	75 ma.
Single-Tone Plate Current	400 ma.	330 ma.