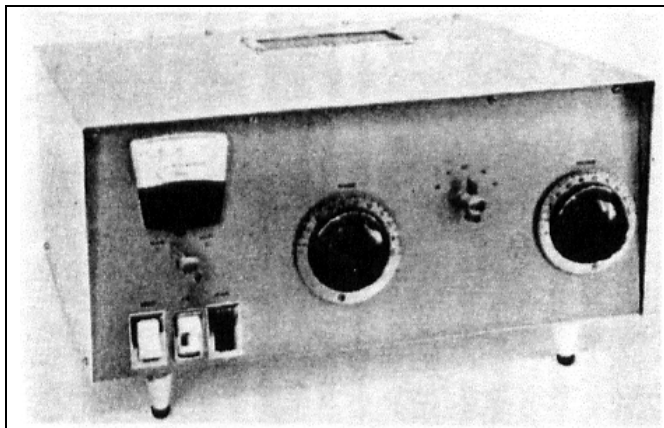


Beginner



At the lower left are the switches, for relay, ac, and plate, in that order. The meter switch is directly above. The band switch is at the upper right, between the tuning and loading controls. A section of the top of the cabinet is removed and perforated aluminum stock installed to allow air flow.

The "Junker" Amplifier

500 Watts — 80 through 10 Meters

BY LEW MCCOY,* WIICP

A FEW YEARS BACK we described a low-cost amplifier¹ that used a pair of 572Bs operated in grounded-grid fashion. It was evident from the mail received that this was a popular article. Some of the questions concerned substitution of lower-priced tubes, such as 811As, or 813s. In fact, we still receive queries asking for an amplifier design using such surplus tubes because they remain relatively low in cost. The amplifier described in this article is in answer to these requests.

Three types and combinations of tubes were tried. These included a pair of 811As in parallel, a single 813, and a single 803. The 803 tube is a pentode and is rated for operation up to 20 MHz. We found that the 803 worked well on the 21-MHz band but was quite inefficient on 10 meters. However, the 803 is cheap (surplus), and if the builder isn't too concerned about 10-meter operation the tube is a good buy which helps keep the cost of the amplifier down.

Another reason for designing this amplifier was to see how low the cost could be for a 500- to 600-watt unit. Depending on how good a scrounger you are, and how extensive your junk-box stock is (and not overlooking your own ingenuity), the amplifier should be less than \$50. As one can see from the photographs, it is strictly a junk-box special. However, the neophyte builder should keep one thing in mind: the watts that come out of this amplifier are just as useful as the watts out of the most expensive amplifier you can buy. A good example of ways to save money is seen in the pi-network tank coil. Our version cost only a few dollars to make, but a suitable commercial assembly would run close to \$30.

No newcomer should be afraid to tackle a construction project such as this. There is nothing particularly critical in building the unit. There *are* certain precautions which should be followed, and we'll point those out, but even a beginner in ham radio can easily duplicate this amplifier, and should be able to save money in the process.

Circuit Details

Fig. 1 shows the circuit of the 813 amplifier. Fig. 2 shows the variations for using a pair of 811As or a single 803. Drive from the exciter is coupled to the filaments of the amplifier by means of a .01- μ F capacitor. The filaments are isolated from rf chassis ground by RFC1, a bifilar-wound choke. Whenever the term "bifilar" is used, mail comes in asking what the term

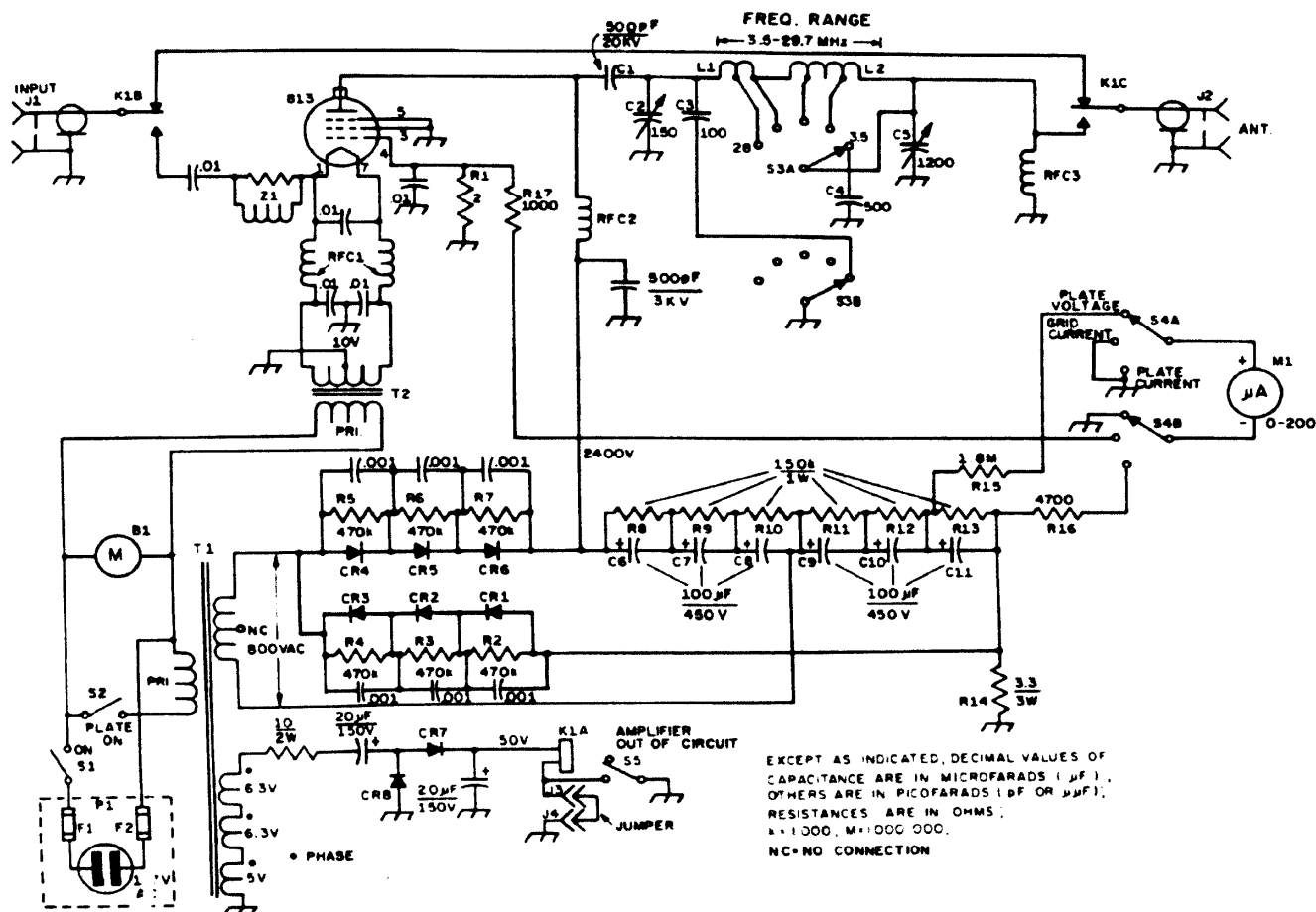


Fig. 1 — Circuit diagram of the 500-watt amplifier. Unless specified, all resistors are one watt composition. All decimal value capacitors are disk ceramic. Labeled components not listed below are for text reference purposes.

- | | |
|---|---|
| <p>B1 — Cooling fan, 117-volt ac motor.
 C1 — 500-pF, 20-kV TV-type high-voltage.
 C2 — 150-pF variable (E. F. Johnson 154-8, Millen 12515 or equiv.).
 C3 — 100-pF mica, transmitting type (see text).
 C4 — 500-pF mica, transmitting type, see text.
 C5 — 1200-pF variable, trf type, 3-gang, 400-pF per section, stators connected in parallel.
 C6-C11, incl. — 100-pF, 450-volt electrolytic.
 CR1-CR6, incl. — 1000-volt piv, 1-ampere diode, see text.
 F1, F2 — 10-A fuse.
 J1, J2 — Coax chassis fitting, type SO-239.
 J3, J4 — Binding post terminals, (jumper can be removed and relay controlled from exciter circuits.)
 K1 — Dpdt relay (see text.)
 L1 — 10 turns, 2-inch diameter, 1/4-inch copper tubing. Space turns 1/8 inch.</p> | <p>L2 — 15 1/2 turns No. 12 solid wire, 3-inch diameter (see text.) Tap information: Tap points counted from the C5 end of the coil, 40-meter tap 9 3/4 turns; 20-meter tap, 15 turns; 15 meter tap 5 1/4 turns from junction of L1L2; 10-meter tap. 7 1/4 turns from junction of L1L2.
 P1 — Fuse-in-plug assembly.
 R1 — 2 ohms, 2 watts.
 R14 — 3.3 ohms. Three 10 ohm, 1-watt resistors in parallel. jRFC1 — 28 bifilar turns No. 14 Formvar or Nylcad, close-wound on 1/2-inch dia., 7 1/2-inch long ferrite rod (see text.)
 RFC2 — 90 μH, 500-mA rf choke (B & W 800 or equiv.).
 RFC3 — 2.5 mH rf choke.
 S1, S2, S5 — Spst toggle switch.
 S3, S4 — Two-pole, 6-position, 2-section rotary (Centralab 2511 or similar).
 T1, T2 — See text.
 Z1 — 7 turns No. 16 space-wound on 100-ohm, 2-watt resistor.</p> |
|---|---|

means. In this case, the bifilar winding consists of two parallel lengths of wire wound with close-spaced turns on a single ferrite core. Two adjacent end leads connect to the tube filaments. The two remaining leads attach to the filament-voltage source — a center-tapped transformer in this instance. RFC1 is a broad-band choke, offering high impedance to rf energy from 80 through 10 meters; thus the rf drive is not shorted out by the low-impedance of the filament transformer. Z1 is a parasitic suppressor.

The tank circuit consists of plate-tuning capacitor C2, L1 and L2, and C5, the loading capacitor. This circuit covers the 80- through 10-meter bands. Fixed-value capacitors are used in combination with C3 and C4 on 80 meters. These capacitors are switched into the circuit by means of S3, the band switch. A double-pole, double-throw relay, K1, can be activated to bypass the amplifier and run only the exciter, if desired.

The power supply is a voltage-doubler type, and with the transformer specified provides a no-load voltage of approximately 2500, which chops to about 2300 volts under load. Filtering is accomplished by a series string of high-capacitance electrolytics, C6 through C11, inclusive. A meter is switched to read grid current, plate voltage or plate current.

Scrounging Parts

One of the more expensive items in any amplifier is the power transformer. One way to reduce this cost to peanuts, is to use a TV set power transformer. Many TV repair shops are loaded with old TV chassis which can be had for the asking, or for only a few dollars. Power transformers from most sets are rated at 300 to 400 watts, continuous duty. In amateur operation, such as ssb or cw, neither of which is continuous duty, it is possible to increase these ratings considerably without any damage to the transformer. The amplifier shown here has been run for long periods without the transformer getting warm to the touch.

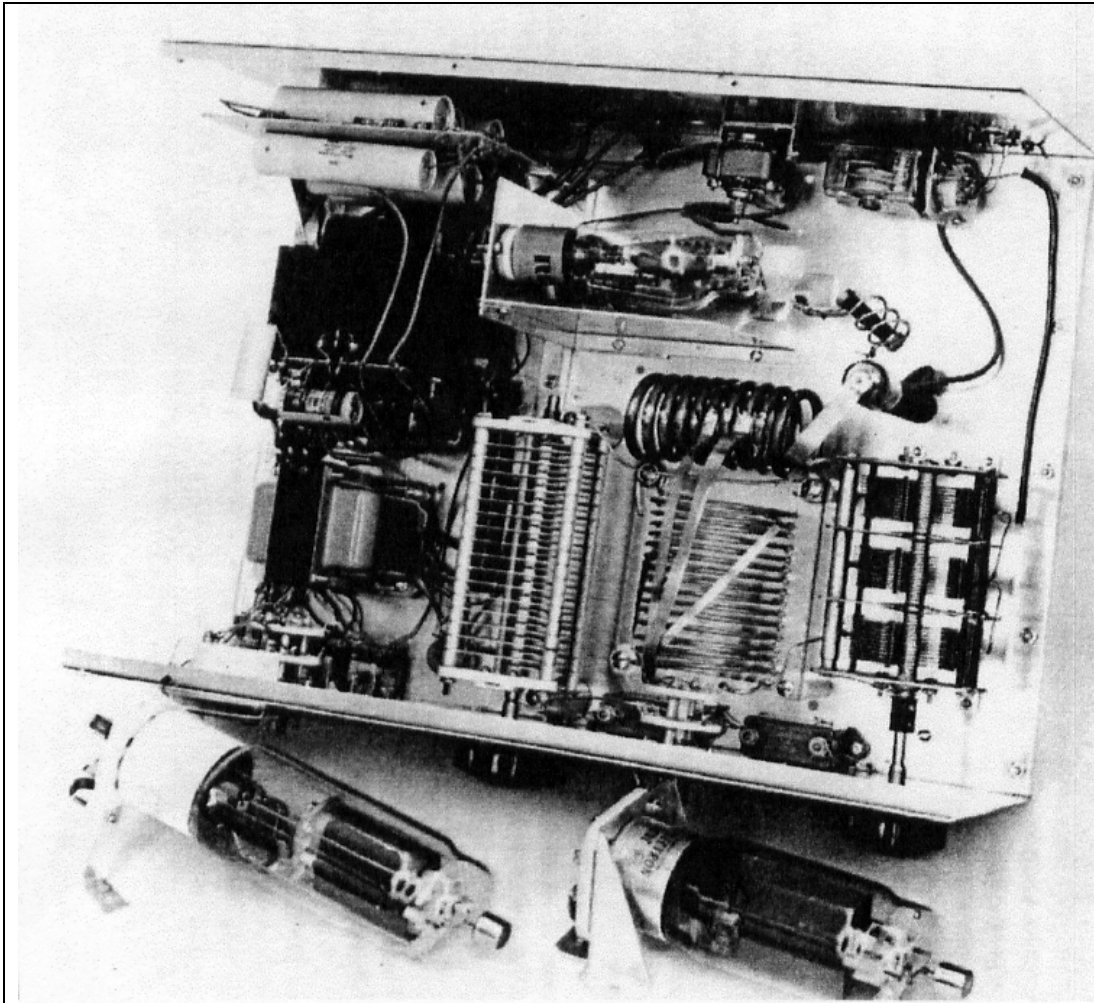
In the voltage-doubler circuit you can expect to get 2.8 times the secondary ac voltage. For example, a TV power transformer that has a total secondary ac voltage of 800 will provide about 2300 volts dc in this type of voltage doubler.

While it didn't occur to us at the time, another large savings could have been affected in obtaining the tank capacitor, C2, and some of the other components. C2 is a relatively expensive unit, but there is one piece of surplus gear that has a suitable capacitor for C2 plus many other useful parts. This is the TU-5B tuning unit that was used in the BC-375 transmitter². This piece of surplus has two variable capacitors capable of handling up to a kW of power input. Also, the unit has the large fixed-value mica capacitors required for C3 and C4. C5 is a 3-gang trf type variable that is available from many surplus houses. Close-spaced capacitor plates can be used at C5 without danger of capacitor arc over.

We used commonly-available tubular electrolytics in the capacitor string of the power supply. These units are obtainable from most radio parts dealers. However, some surplus dealers have high capacitance electrolytics in stock. In order to obtain adequate filtering, one should figure on no less than 15 μF of capacitance. When capacitors are connected in series, and all capacitors have an equal value, the total capacitance is equal to the value of a single capacitor divided by the number of capacitors used in the string. In other words, four 100 μF capacitors connected in series will provide a total of 25 μF of capacitance. The voltage rating of the string is equal to the sum of the working voltages of all the capacitors. For example, four series-connected capacitors having a working voltage of 450 volts each will handle 1800 volts. In figuring your string of capacitors it is a good idea to allow at least 20-percent safety margin on the total working-voltage rating.

As to the tube or tubes you decide to use, 811As, 813s, and 803s can all be purchased as surplus, and you'll save about 40 percent of the cost of new tubes. If you belong to a radio club it is a good idea to ask around among the other hams and see what they might have tucked away. We've found that some hams are like pack rats; they save everything.

The 811A requires 6.3 volts at 4 amperes for the filament. Two tubes will require 8 amperes. The average TV transformer has a 6.3-volt filament winding rated at about 8 amps. It may seem ridiculous, but there is no reason you cannot use two TV transformers — one for the filaments and the other for plus B. If you find a really rugged transformer, a single unit could be used, for both plate and filament but we recommend a separate filament transformer to ease the power load on the plate transformer. An 813 or 803 filament requires 10 volts at 5 amperes, and again, the surplus market is a good bet for such a transformer. Also, don't overlook club auctions!



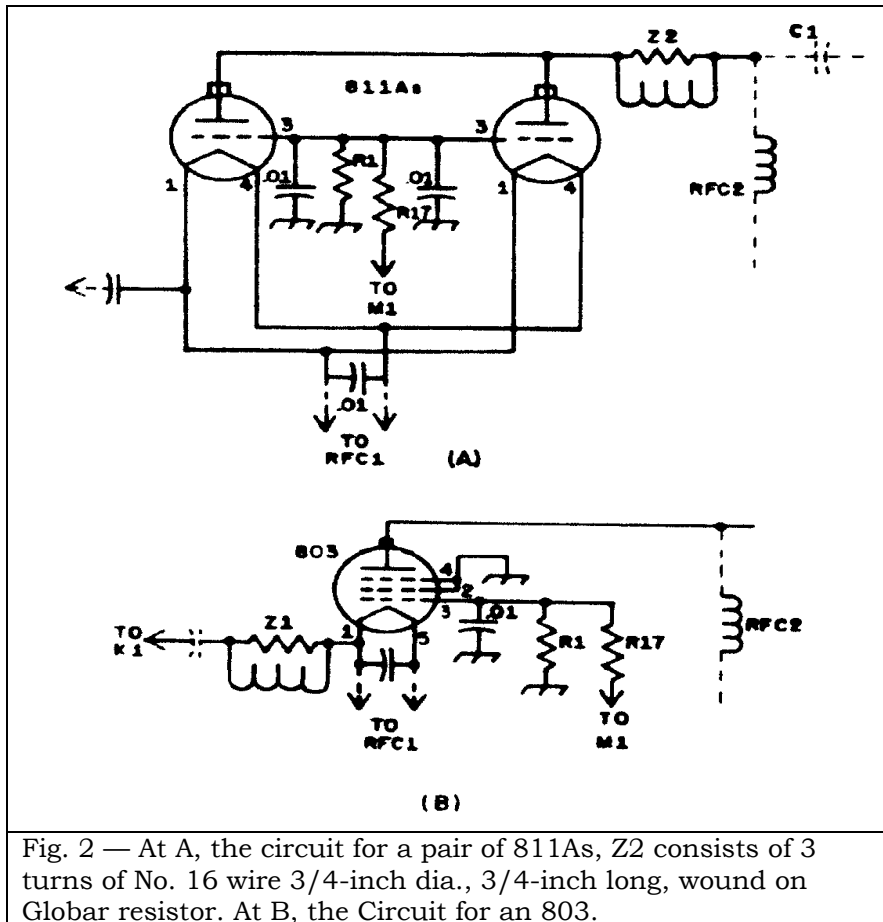
In this unit a pair of 811As is used as the amplifier tubes. Note the shield section between the tubes and the tank coil. The shield serves the dual purpose of shielding plus directing the air flow from blower fan directly behind the tubes. The power supply section is along the left side. The tank coil, at the front right, is between the tuning and loading capacitors. Visible directly below the band switch are the two mica capacitors used for 80-meter operation. In front of the unit are the two tubes that were tested in the amplifier, an 803 at the left and an 813 at the right.

The enclosure for the amplifier is a homemade unit, bent up from sheet aluminum. A small piece of perforated aluminum is used over the tube area to permit air flow for cooling of the tubes. The layout of the amplifier is not critical so any enclosure or chassis large enough to hold the parts is suitable. Local sheet-metal shops should have plenty of material for making your own cabinet. Also, the surplus market occasionally yields some good buys in cabinets and enclosures.

Which Transformer?

TV transformers provide from 500 to 750 volts across the entire secondary. The first step you must take is to decide which type of tube or tubes you will use. The 811As will work nicely with 1500 volts on the plates, so a 500- to 600-volt transformer (in a voltage doubler) will give you just about the correct voltage. The 811A unit shown in the photo has a power supply that delivers slightly over 1600 volts with no load. Without negative grid bias on the 811As (zero bias) the resting plate current of the tubes was at a safe level. If you find that the resting current is too high (the plate dissipation rating on the 811As is 65 watts) you may have to use some negative bias. (Usually only a few volts are required, and this can be obtained from batteries.) The point is that you shoot for a transformer with a 500-volt winding for powering these tubes.

The 813 has a maximum rating of 2500 volts, so a 700- to 800-volt transformer would be best. The 803 has a maximum rating of 2000 volts so the 600-volt range is called for here. In a grounded-grid amplifier it is better to run the tubes at their maximum voltage ratings rather than some lower value. Better efficiency can usually be obtained when using higher plate voltages.



Construction Information

As mentioned, any cabinet and chassis large enough to contain the amplifier will be suitable. The chassis shown was made from a single sheet of aluminum. It is 19 inches wide, 15 inches deep, and 8 inches high.

There is nothing critical in the layout of the components. But be sure that any components carrying high voltage are adequately spaced from the chassis or other ground points. With the tank circuit coil, try to keep the leads for the 15 and 10-meter taps as short as possible.

We made an etched circuit board to hold the electrolytic capacitors, rectifiers, and associated components in the power supply filter section. These components can be mounted on a piece of Plexiglas, or on any similar material. RFC1 can be homemade but we've run into one problem here. The ferrite core we used is a 1/2-inch diameter, 7 1/2-inch-long unit that was available from a mail order house, but they no longer stock the material. However, Amidon Assoc.³ has a choke kit available. Also, there is another commercially-made choke available⁴.

The relay, K1, is a surplus item that required about 30 volts dc to operate it. The voltage was obtained by connecting all of the filament windings on T1 in series, and using a voltage doubler circuit. If you choose this system be sure to have the windings phased correctly so that one winding doesn't buck another.

In figuring the voltage rating for the high-voltage rectifiers (CR1 through CR6) the total required in each leg must be three times that of the *total* secondary winding. In other words, for a 600-volt secondary, you would need a rating of 1800 volts for the rectifiers. It is a good idea to allow a 20-percent safety factor. (Surplus rectifiers are available in the 1,000-volt, 1-ampere range.)

A piece of Plexiglas, 4 x 5 x 1/4 inches is used to support L2. We drilled two rows of 1/8-inch diameter holes, 1/8 inch apart. The two rows are three inches apart. There are 15 holes in one row and 16 in the

other. Next, we wound 18 turns of No. 12 bare wire on a 3-inch form. You won't need 18 turns but the extra turns will provide some extra lead lengths when the coil is completed. The next step is to carefully thread the coil wire through the holes in the Plexiglas. It took us about an hour to get all the turns on, but the job wasn't a tough one at all. L2 is made of copper tubing wound up on a 2-inch form. The turns are separated 1/8 of an inch. Both end leads of this coil were then flattened in a vise and drilled so they could be mounted along with L1 on the Plexiglas. The entire assembly was then mounted on standoffs which are later mounted on the chassis. All the coil taps are made from strips of copper flashing, about 1/4-inch wide.

For either an 803 or 813, the parasitic suppressor should be installed at the filament side of the tube. If 811As are used, we found that parasitic suppression (Z2) was required in the plate lead (see Fig. 2 at A.) In constructing the unit, the three types of tubes tried were all mounted horizontally. For an 803, pins 2 and 5 should be in a horizontal plane if the tube is to be operated horizontally. For an 813, in a horizontal position, pins 2 and 6 should be in a *vertical* plane. For 811As, pins 1 and 4 should be in a vertical plane.

In testing the amplifier with the various tubes, we found that the 803 and 813 provided stable operation on its own. However, the 811As showed self-oscillation until an aluminum shield was mounted between the tubes and the tank coil.

Tune-Up Procedure

In tuning up a grounded-grid amplifier you don't look for the conventional plate-current dip that is a useful indicator in other types of circuits. What is required here is an output indicator such as most hams use in their feed lines. An SWR bridge can be used in the output position. In grounded-grid operation, the grid and plate current readings are used primarily to check the operating conditions. The ideal instrument to use in tuning up *any* linear amplifier is an oscilloscope, but you can do a good job without one. Also, additional information on adjusting linear amplifiers can be found in considerable detail in the *Handbook*.

Any exciter in the 50-watt or more class will provide adequate driving power for the amplifier. When using an 813 or 803 adjust the driving power plus the tuning and loading controls for maximum output with a grid current of approximately 50 mA and a plate current of 200 mA. With 811As (two tubes), shoot for a grid current reading of 50 to 60 mA and a plate current reading of about 350 mA. This should be done using a cw driving signal. When these conditions are met, reducing the drive slightly should cause the rf output and dc input to drop. With these conditions, the unit should be capable of linear amplification. With the voltages stated earlier, these values of plate current should give about 500-watts dc input on ssb. As general information, the 813 and 803 should show no reddening of the plate under any operating conditions. The 811As, however, can show a barely perceptible red color when operated at their maximum ratings.

We like the performance of this amplifier. It provides an inexpensive method of putting "shoes" on our low-power exciter.

* Novice and Beginner

1 *QST* February 1966.

2. These units may be available from Fair Radio
Sales, Lima, OH 45802

3 Amidon Assoc. 12033 Otsego St., North Hollywood, CA. 91607

4 William Deane W6RET, R831 Sovereign Rd., San Diego. CA. 92163.

Just so no one will think this amplifier is designed for a Prussian officer, the term "Junker" means junk. If you are a typical ham you should be able to scrounge many of the parts for this amplifier from spare parts boxes — yours and those of other hams.