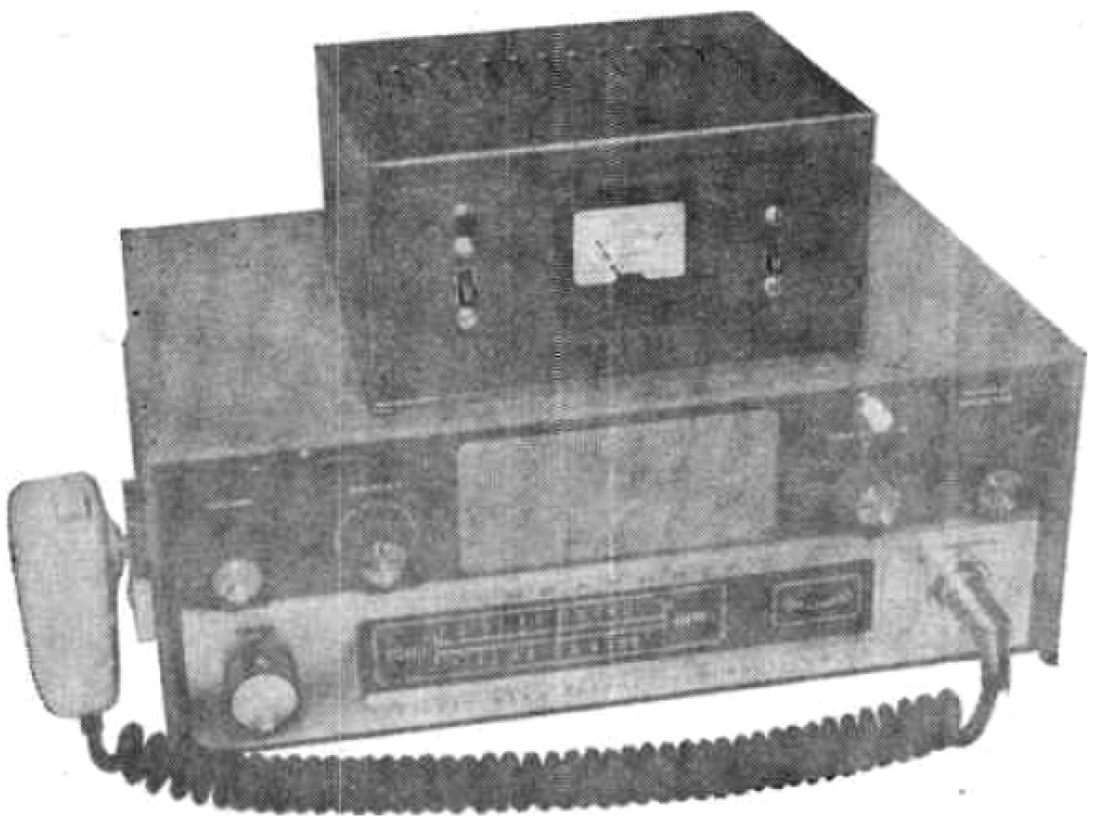


BUILD The "Mule Box"

OUTBOARD CONVERTER OFFERS "LEGAL" INCREASE OF CB TALK POWER

By **DANIEL MEYER,** KMT 2967

IN RESPONSE to hundreds of inquiries as to how the serious CB user can make his communications network more effective—and remain "legal"—the author developed the "Mule Box," an outboard converter that changes the CB signal before it goes on the air from amplitude modulation (regular AM) to double-sideband with reduced carrier (DSBRC). For all means and purposes, any receiver intercepting a DSBRC signal reacts as though the signal were regular AM—with two notable exceptions. The S-meter reading will be much lower, and the apparent "talk power" will be vastly increased.

Due to the circuit design of the Mule Box, it is practically impossible to operate this converter illegally. The power supply will put out only so much voltage, the single tube will take only a moderate "beating," and if you try to overdrive the Mule Box, your signal will be distorted. But if the instructions published in this article are followed, the converter will operate within the FCC interpretation of "average" power input of 5 watts and "average" power output of 4 watts.

EDITOR'S NOTE: The construction, installation, servicing, and maintenance of the project described in this article MUST be made by or under the immediate supervision of a person holding a first- or second-class commercial radio operator FCC license—a CB license is not enough to build or install this amplifier.

How It Works. The circuit (Fig. 1) combines two separate functions: it is an r.f. amplifier that generates the reduced carrier signal; and a switching circuit that operates the T-R change-over relay. When the transceiver is in the receive position, relay *K1* simply connects the antenna directly to the receiver, bypassing the amplifier circuit. When the transmitter is keyed, however, the r.f. voltage present at *J1* is sufficient to force diodes *D1* and *D2* into conduction, applying a positive voltage to the SCR gate. This, in turn, switches on SCR1 to operate the relay.

The output of the transmitter is then switched to the grid circuit of *V1* while the antenna is switched to the plate circuit (point *E*). Because the amount of

power required to drive *V1* is considerably less than the 4 watts at the transmitter output, a limiting resistor (*Rx*) is put in series with the grid circuit to cut down the power level and also to present, as nearly as possible, a 52-ohm resistive load to the transmitter output. This is important because some transmitters will not operate properly if the load is highly reactive.

The input voltage of *V1* is stepped up by matching coil *L1* to a level sufficient to drive *V1*. Tube *V1* is biased to almost complete cutoff by battery *B1*. The idea is to drive *V1* so it produces an output of 1 to 2 watts carrier power. This is done by adjusting the matching coil (*L1*) and the drive trimmer (*C1*). When the transmitter is modulated, the additional grid voltage caused by forward modulation drives *V1* to a higher output. However, amplification is nonlinear, and

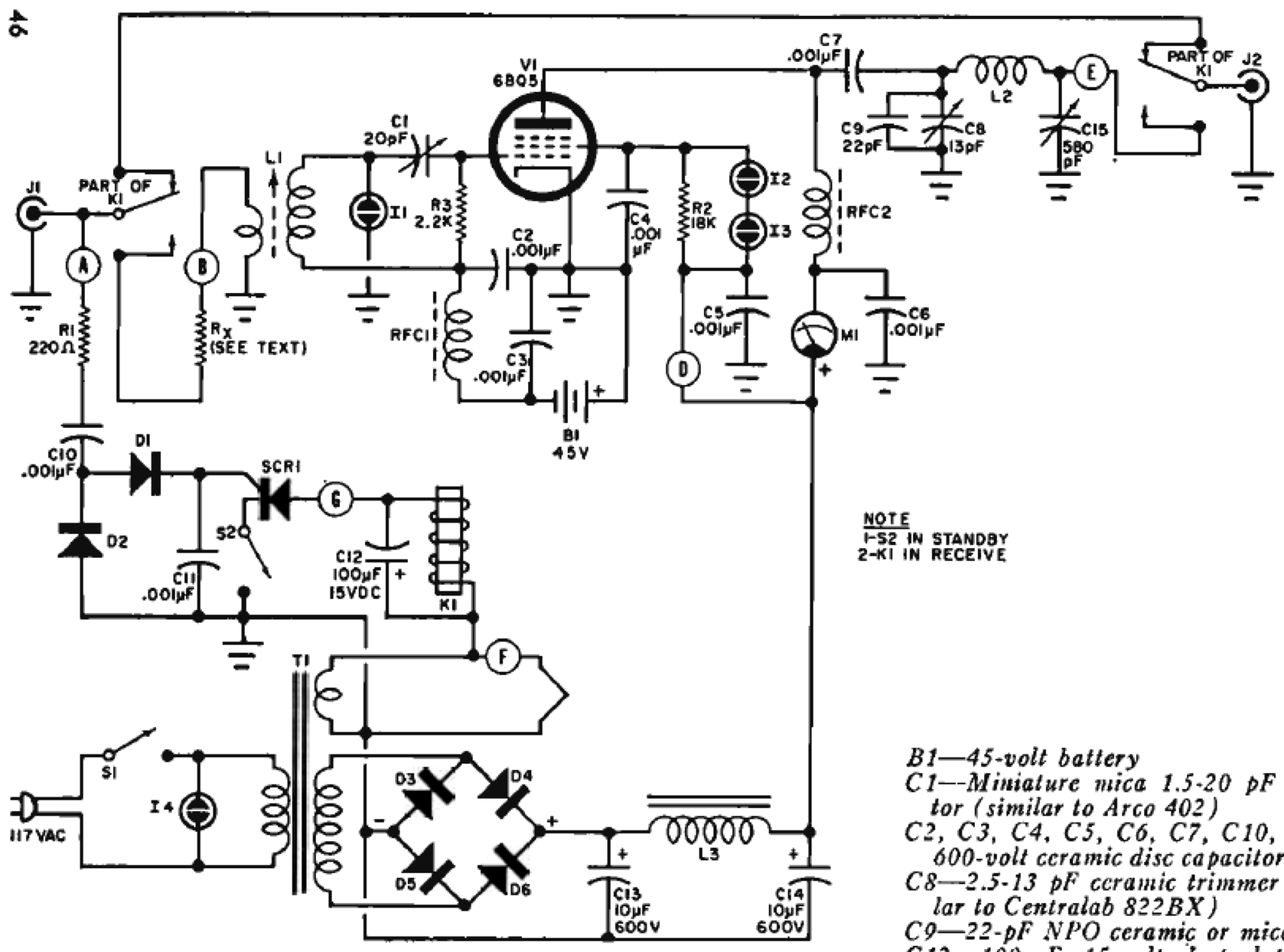


Fig. 1. Schematic diagram of the complete "Mule Box" showing T-R change-over relay K1 in receive position, and OPERATE-STANDBY switch S2 in STANDBY. With S2 set to OPERATE, the transmitter's output appearing at J1 is switched to the grid of V1 while the plate is switched to the CB antenna.

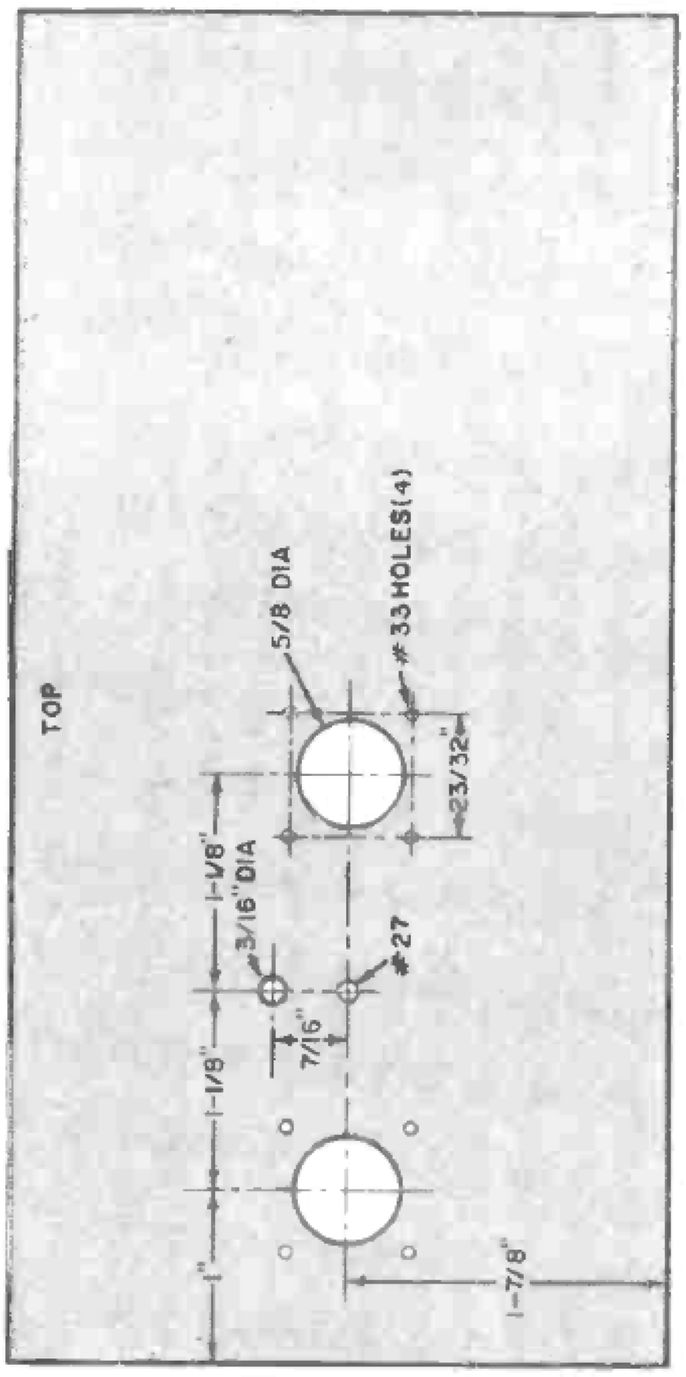
Fig. 2. If you buy the LMB CB-2 aluminum box specified at right, you can build the "Mule Box" using the dimensions below for the front panel.

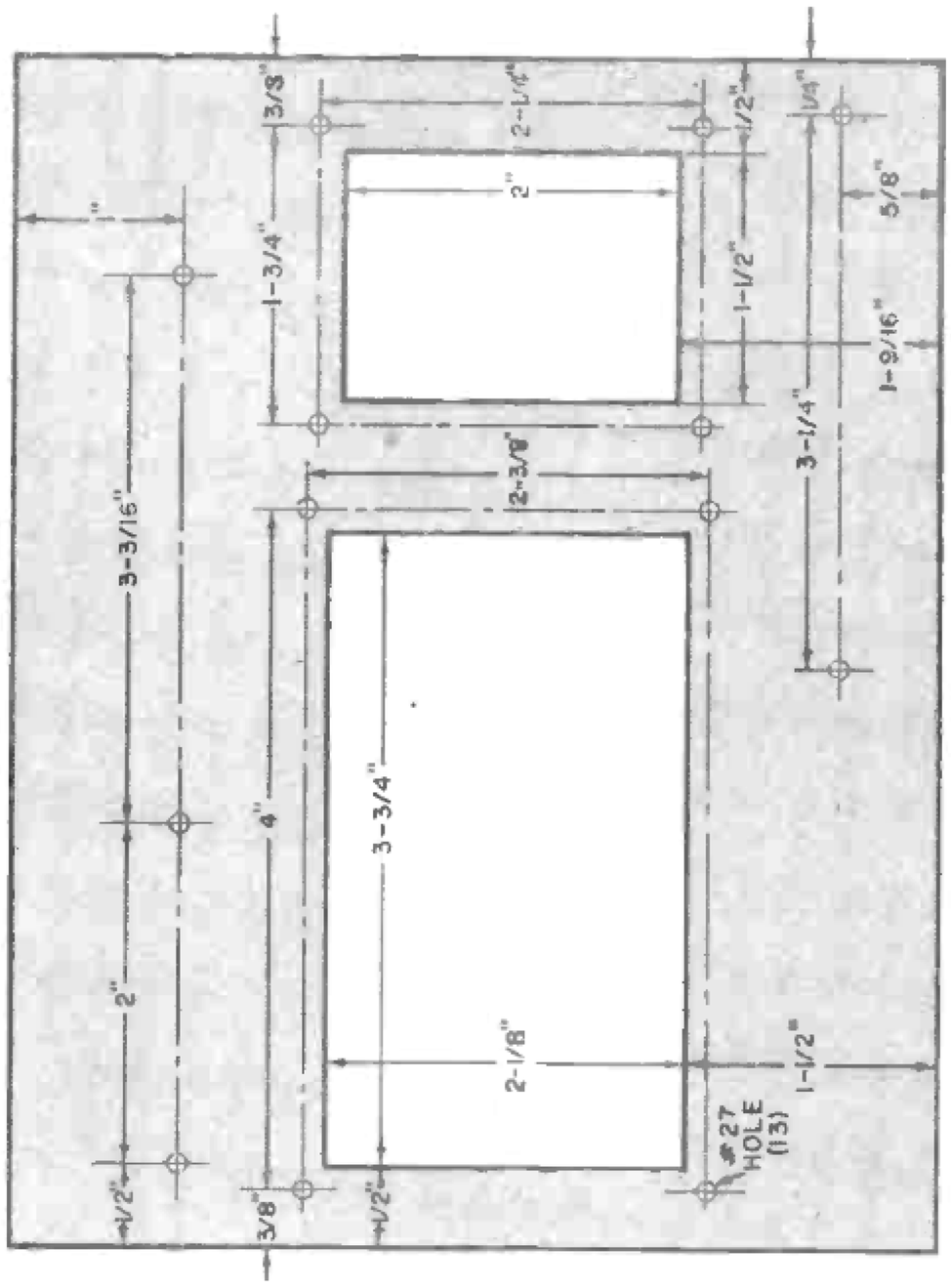
Fig. 3. The back panel, which mounts the input and output connectors as well as the T-R change-over relay, is drilled following dimensions below, right.

PARTS LIST

B1—45-volt battery
C1—Miniature mica 1.5-20 pF trimmer capacitor (similar to Arco 402)
C2, C3, C4, C5, C6, C7, C10, C11—0.001-µF, 600-volt ceramic disc capacitor
C8—2.5-13 pF ceramic trimmer capacitor (similar to Centralab 822BX)
C9—22-pF NPO ceramic or mica capacitor
C12—100-µF, 15-volt electrolytic capacitor
C13, C14—10-µF, 600-volt electrolytic capacitor
C15—110-580 pF mica trimmer capacitor (similar to Arco 467)
D1, D2—1N34, or 1N294, or other similar germanium diode
D3, D4, D5, D6—0.75-ampere, 600-volt PIV silicon rectifier
I1, I2, I3—NE-2 neon lamp
I4—Neon pilot lamp, with current limiting resistor (similar to Lafayette 34 R 5208)
J1, J2—Coaxial connector (similar to Amphenol 83-1R)
K1—D.p.d.t. relay, 6-volt d.c. coil (similar to Potter and Brumfield KT11D)
*L1—Input coil: primary, 3 turns of #24 enameled wire; secondary, 18 turns of #24 enameled wire on ¼"-dia. coil form with ferrite slug**
L2—Output coil: 9 turns of #16 enameled wire on ¾"-dia. coil form
L3—8-H, 40-mA filter choke (similar to Thordarson 20C52)
M1—0-30 mA, 2¼" d.c. meter (similar to Emico RF-2C)
R1—220-ohm, ½-watt, 10% resistor
R2—18,000-ohm, 1-watt, 10% resistor
R3—2200-ohm, ½-watt, 10% resistor
RFC1, RFC2—22-µH r.f. choke (similar to Wilco W220)
Rx—33-ohm, 1-watt, 10% resistor (see text—value may be reduced for low-power transmitters)
S1, S2—S.p.s.t. slide switch
SCR1—25-volt PIV silicon-controlled rectifier (similar to Motorola MCR 2304L)
T1—Power transformer: primary, 115 volts; secondaries, 360 volts @ 42 mA and 6.3 volts @ 2.8 A (similar to Thordarson 22R38)
V1—6BQ5 vacuum tube
1—6" x 8" x 4½" cabinet (similar to LMB CB-2, gray finish)
*1—Circuit board (DEMCO 135)**
1—9-pin printed circuit miniature tube socket

*Circuit board and coil L1 are available from DEMCO, Box 16297, San Antonio, Texas 78216, for $3 postpaid in U.S.A.; complete kit of parts with punched chassis, $35 postpaid in U.S.A.





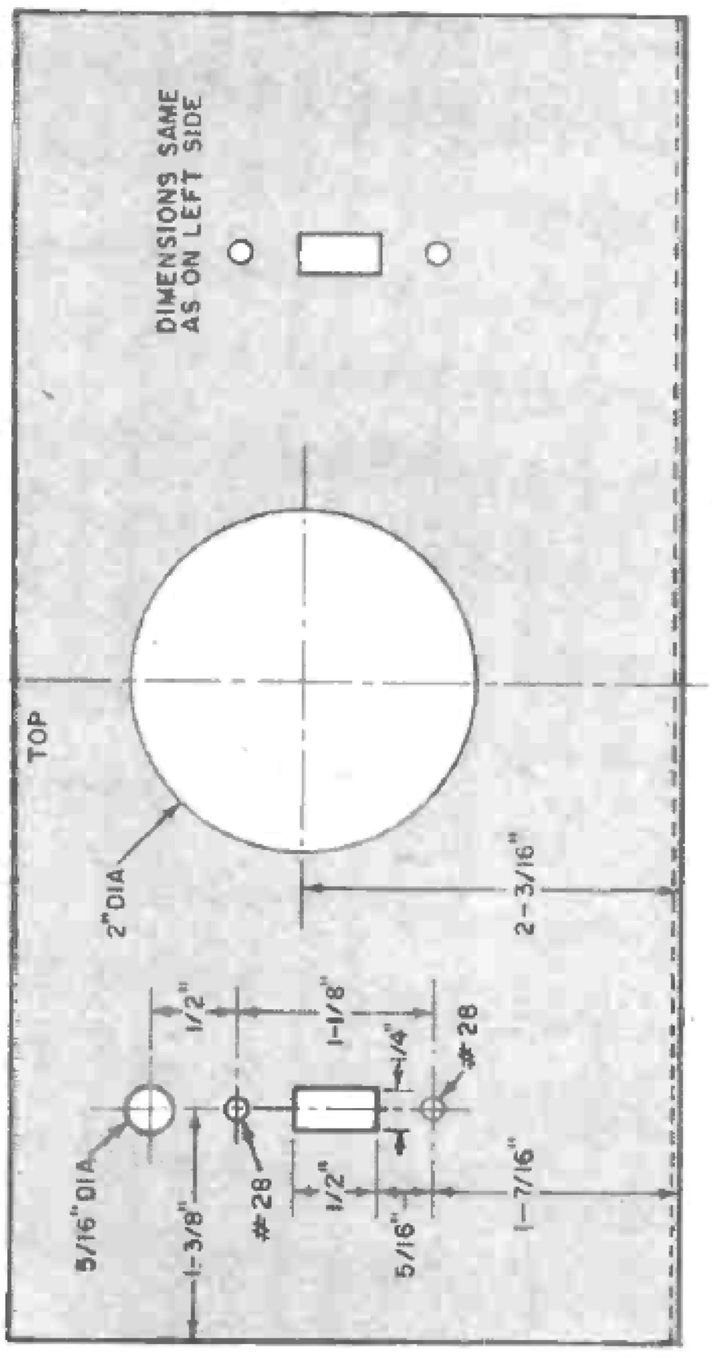
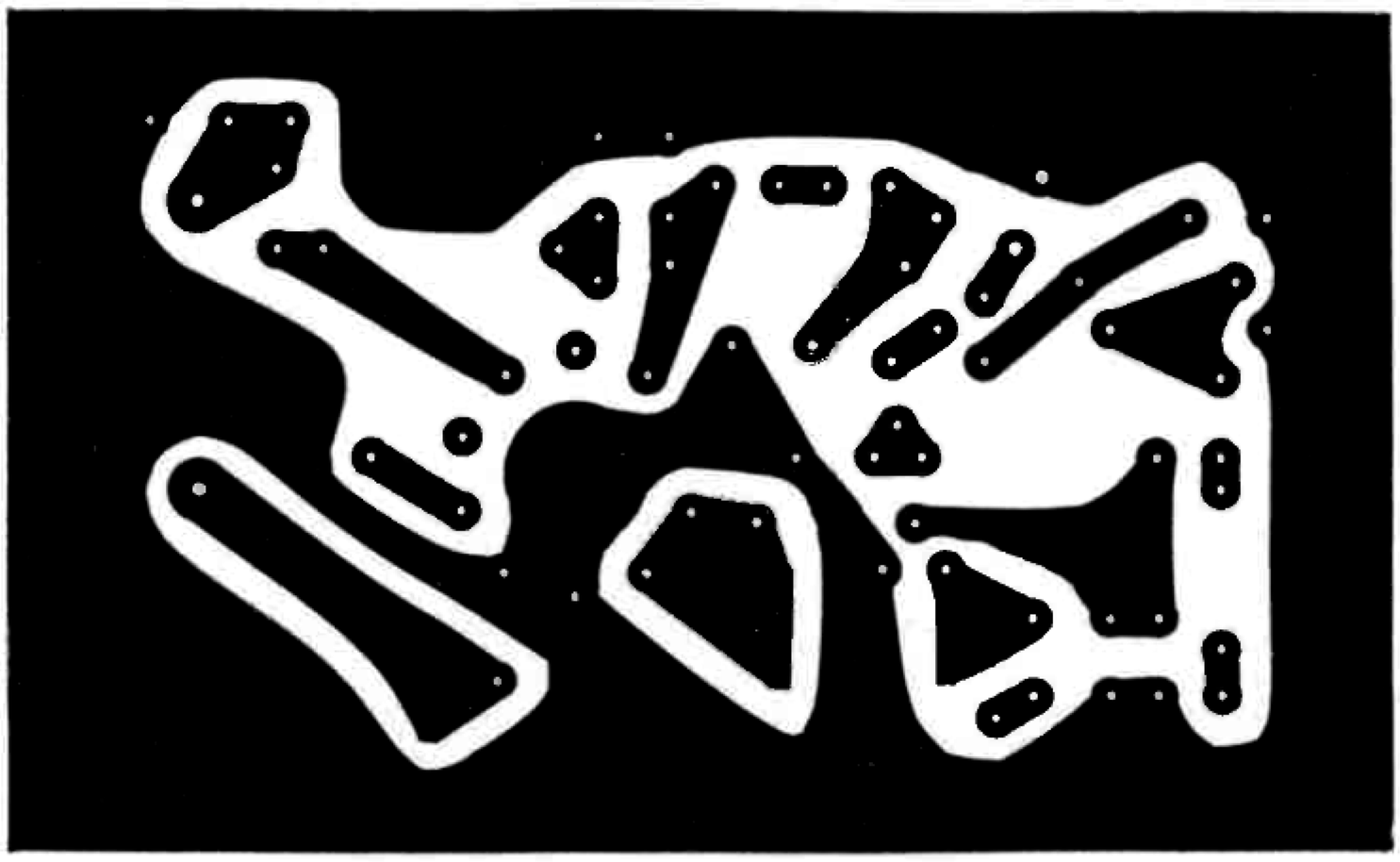


Fig. 4. These are the chassis dimensions. The cutout at the left mounts the circuit board while the one at right provides seating for the power transformer.

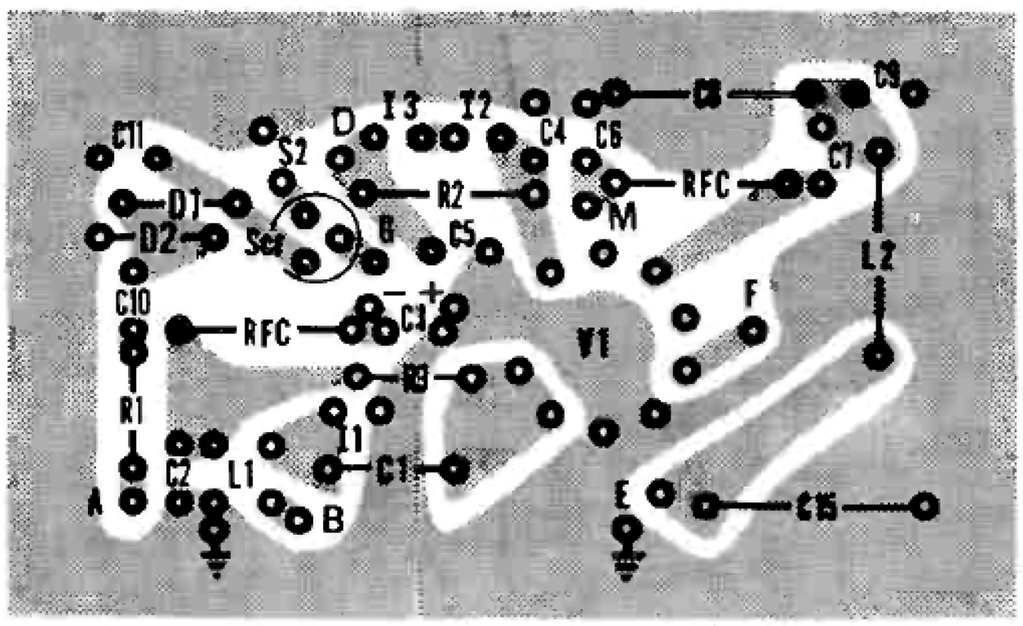
only the forward modulation sideband energy is amplified. The negative half cycle of the modulation envelope is attenuated, resulting in a distortion of the audio waveform—although not enough to cause any great loss of intelligence.

The amplifier output feeds into a *pi* matching network of the type found in most transmitter finals. It matches the Mule Box into an antenna load of approximately 40 to 70 ohms. The power supply, which uses a full-wave bridge rectifier and a capacitor-choke filter, provides good voltage regulation for the amplifier.

Construction. As with all high-frequency r.f. circuits, parts layout and lead dress are critical. Too much coupling between output and input circuits can easily turn the amplifier into an oscillator. Therefore, closely follow the layout given unless you are pretty much a pro and have sufficient experience in building similar equipment. The chassis recommended comes in three separate parts,



Actual-size photo shows foil side of printed circuit board (top); component side of board is at right. Observe polarity markings when installing diodes and electrolytic capacitors.



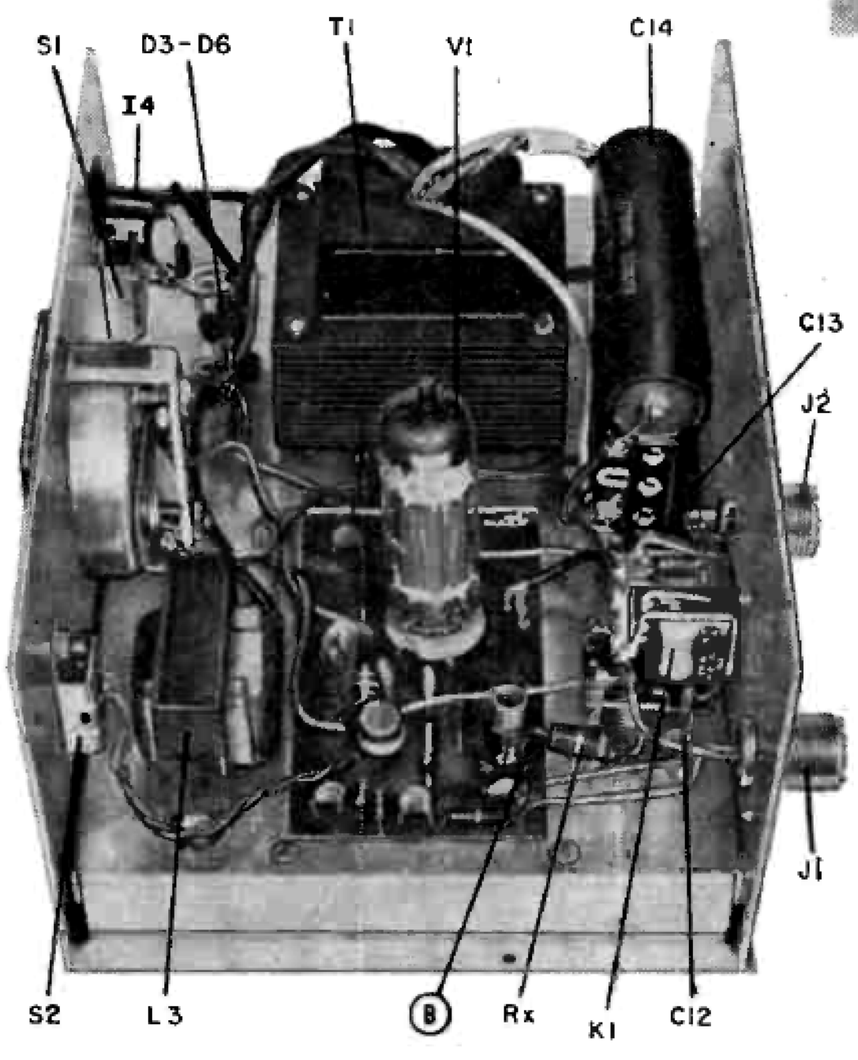


Fig. 5. With cabinet wrap-around cover removed from unit, the completely assembled "Mule Box" should look like this. Note positions of major components.

making the unit relatively easy to assemble.

Begin construction by drilling and punching the necessary holes in the chassis (see Figs. 2, 3 and 4). The meter, pilot light, and switches are mounted on the front panel (Fig. 2) while the connectors (*J1* and *J2*) and relay are mounted on the back panel (see Fig. 3). Mount *C12* under the relay (Fig. 5) and wire the leads directly to the coil lugs of the relay, observing orientation of the capacitor polarity.

Mount the transformer on the main chassis by first removing the four mounting screws holding the transformer together, and reinserting them from the opposite ends of the holes. Then secure the transformer upside-down in its place with wires visible from the top. The four rectifiers go on a terminal strip situated between the transformer and front panel. Follow the schematic (Fig. 1) for proper

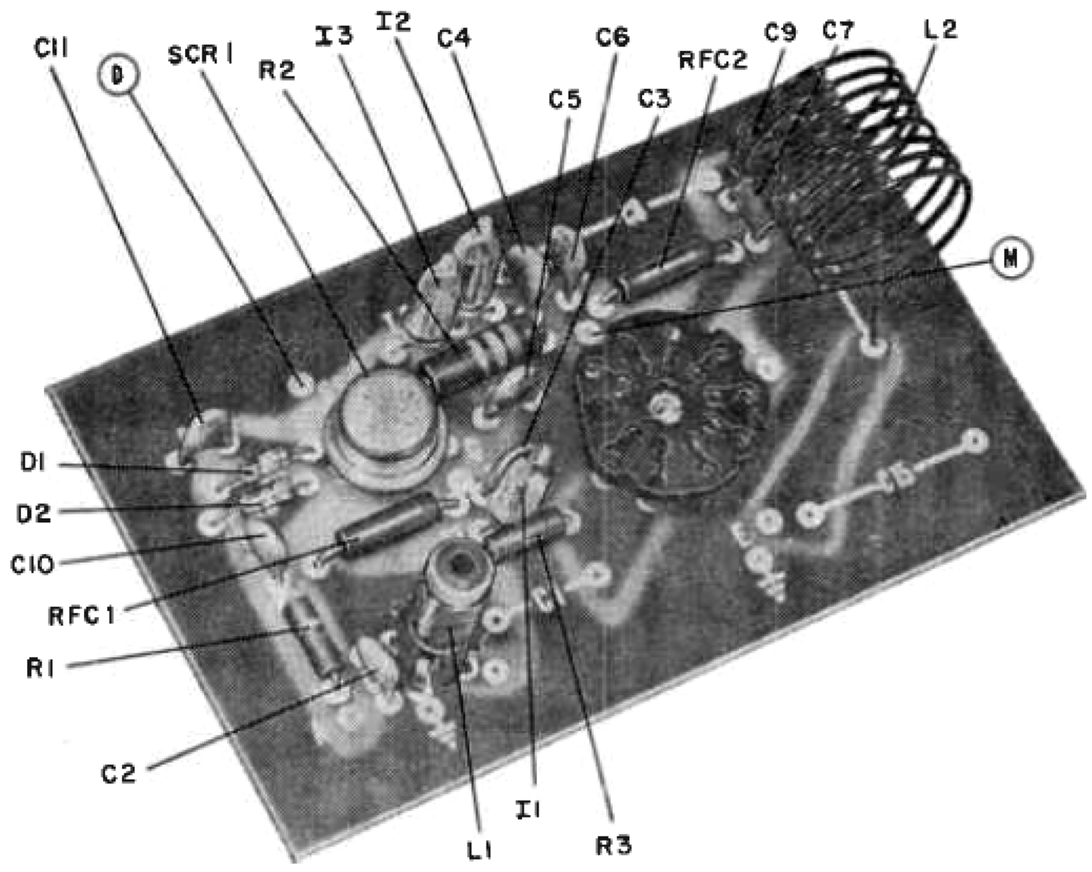


Fig. 6. Except for the necessary inter-unit wiring, the printed circuit board must be fully assembled as shown here before it is installed on the chassis.

polarity orientation of the rectifiers. Filter capacitors *C13* and *C14* are mounted on two terminal strips positioned vertically on the chassis between the transformer and back panel. The filter choke (*L3*) is bolted on the chassis behind *S2*, as shown in Fig. 5.

The circuit board can now be assembled with the parts in the positions indicated by the markings on the printed circuit board (Fig. 6). Trimmers *C1*, *C8*, and *C15* are mounted on the foil side of the board (Fig. 7) so that they will be accessible for adjustments from the bottom of the unit.

Trim off the connecting lugs on *C1* and *C15* where they protrude on the reverse surface of the circuit board to prevent their touching other components. Also, don't let an adjusting screw touch the board, as this would short out the bias battery. Mount *C8* flat against the circuit board as shown, and be sure that the lug on *C8* and *C15* which goes to the adjusting screw is soldered to the circuit board ground.

Screw the main chassis to the back panel and begin final wiring of the circuit. The transformer filament leads go first to the relay coil, and then to point *F* on the board. Mount resistor *Rx* between the relay and point *B* on the board. The connection from *J1* to the relay should be made with bare heavy stranded wire (Fig. 8); the connection from *J1* to point *A* on the board and ground is made with solid bare wire. The connections from the output circuit (point *E*) to the relay and *J2* are made with short pieces of shielded coax cable. Solder the ends of the cable shields at a common point and ground them to the front panel and to the ground near terminal *E* on the circuit board.

Connect one choke (*L3*) lead to a terminal on the rectifier terminal strip, together with a wire run from the positive side of *C13* to this point. Then cut and strip the ends from two 3½″ pieces and one 5″ piece of hookup wire. Connect one 3½″ wire from point *D* (Fig. 6) to the positive (+) meter terminal, and the 5″ length of wire from this terminal to the positive side of *C14*. Connect the other 3½″ hookup wire from point *M* to the negative side of the meter.

Now mount the front panel on the main chassis. Connect the line cord to one side of the power switch, *S1*, and to the unused lug on the rectifier terminal strip. Connect the transformer primary leads to the rectifier terminal strip and to the unused lug on *S1*. Connect the two leads to *S2* (see Fig. 5). And, finally, connect the battery clip to the points marked + (plus) and — (minus) adjacent to *C3* on the circuit board. (See Fig. 6.)

WARNING: All tests and adjustments must be made by an appropriately licensed technician—your CB license is *not* a commercial operator's license.

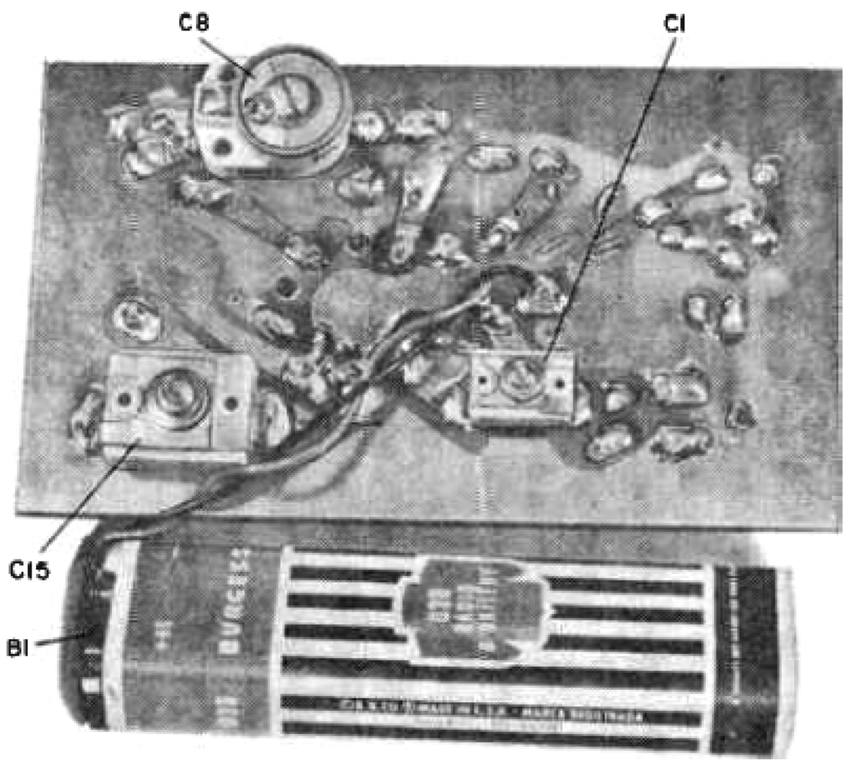


Fig. 7. The trimmer capacitors are mounted on the foil side of the printed circuit board, and are accessible for adjustments from bottom of unit only.

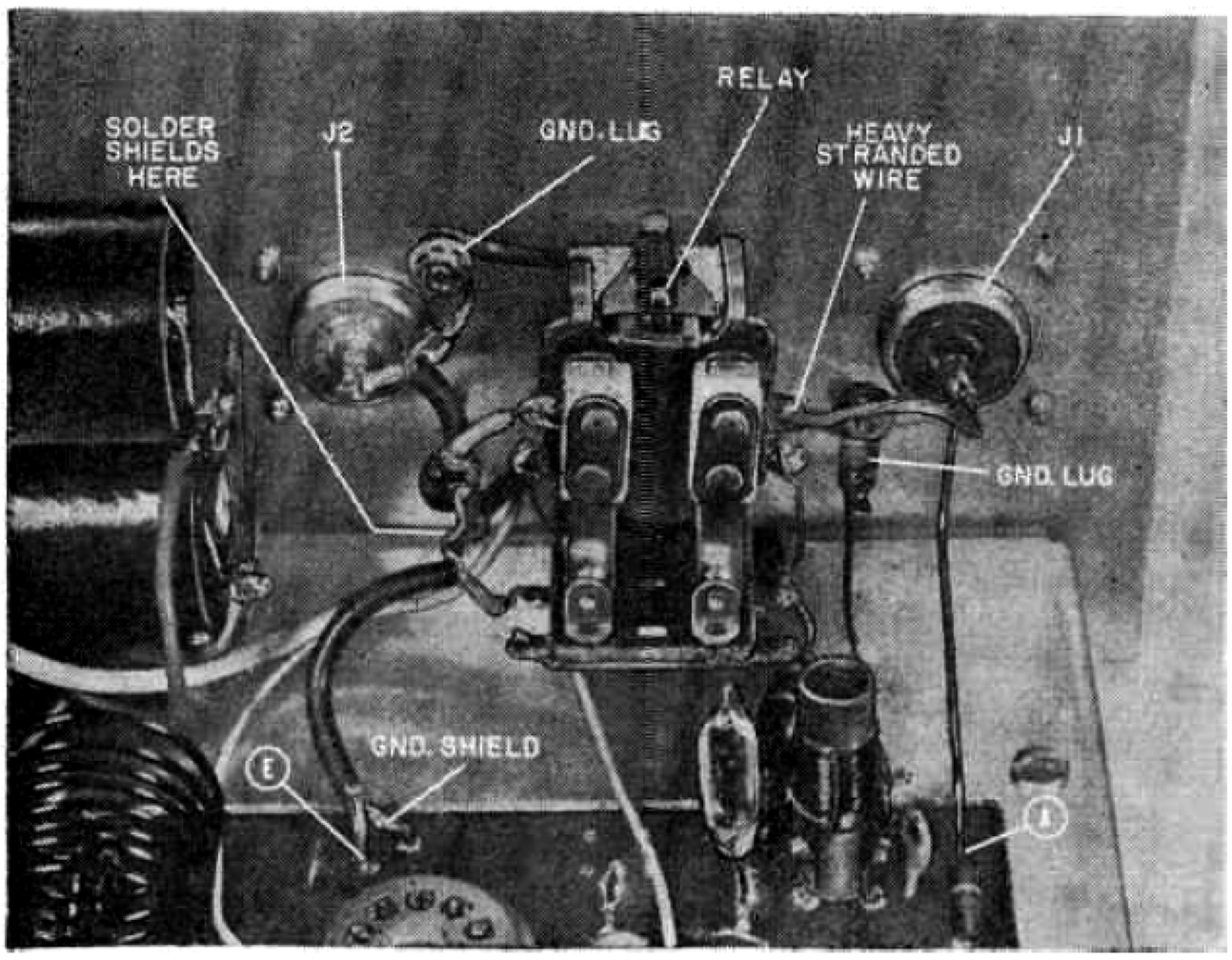


Fig. 8. Be sure to use heavy stranded wire from J1 to indicated relay terminal, and solder the cable shields together to insure common ground throughout.

Adjustment. Install the bias battery in place, turn the power switch on, and check for the presence of approximately 500 volts d.c. from the (+) side of the meter lugs to ground. Watch the Mule Box panel meter as the tube filament warms up. It should read 0 mA. If it indicates a current of more than 1 or 2 milliamperes, the bias circuit is not working properly and the circuit should be checked.

If all seems normal, connect the input of the Mule Box (*J1*) to your transmitter antenna connector, and the output (*J2*) to a 52-ohm dummy load.

Back off a couple of turns on the adjustment of *C1*, and adjust the slug in *L1* until it is even with the top of the coil form. With both your Mule Box and transmitter fired up, key the transmitter as you listen for a click from the changeover relay. The meter on the panel may, or may not, give a plate current reading. If it gives a reading beyond the mid-scale point, back off a bit on the adjustment of *C1* to reduce the reading.

In the following procedure, *C8* and *C15* must be adjusted to resonate on a channel in the center of the band. Adjust *C1* for a reading of 10 mA, and then adjust *C8* and *C15* for maximum meter deflection. These trimmers will interact to some extent, so the adjustments must be gone over at least a couple of times. If you get a reading in excess of 15 mA at any time, reduce the drive (*C1*).

After completing the adjustment of *C8* and *C15*, your next step is to adjust *C1* and *L1* to their final settings. To do this, back off on drive trimmer *C1* and adjust the slug in *L1* by screwing it into the coil form. Observe the meter while making this adjustment, and be sure to keep the current from going above 15 milliamperes. As the slug is advanced into *L1*, neon lamp *I1* in the grid circuit should fire. At the point at which it fires, back off on the slug just enough to extinguish the lamp.

Now recheck your final tank settings and set *C1* for a reading of 10 to 12 mA.

Operation. To check the operation of the unit, whistle into the microphone. If your transmitter has proper forward modulation, the reading on the Mule Box meter should increase to about 20 milliamperes and lamp *I1* should light each time the transmitter is modulated. The screen grid lamps (*I2* and *I3*) should also flash on modulation peaks.

A good operational check is to connect a #47 lamp to the antenna connector. On normal operation, with the Mule Box on *standby*, the lamp should light when the transmitter is keyed and then flicker slightly with modulation. When the Mule Box is on *transmit*, the lamp should be dim with just the carrier applied, power output being between 1½ and 2 watts. When the transmitter is modulated, the lamp should flash brightly on modulation peaks.

(*Continued on page* 95)

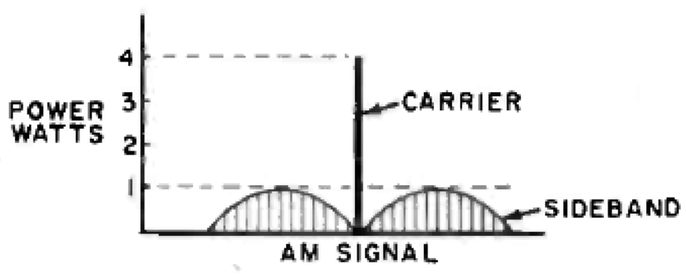
THE "MULE BOX"

(*Continued from page* 50)

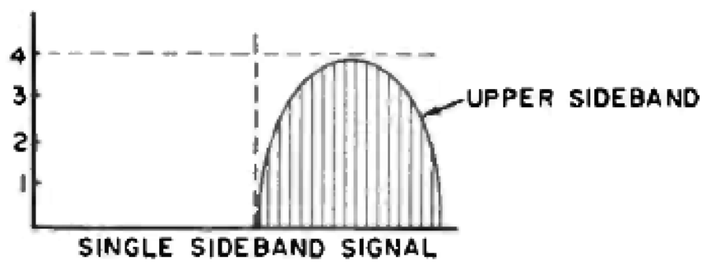
A few words of warning concerning the adjustments described above are in order at this time. First, running the carrier output at a higher level than indicated will only result in illegal operation and short tube life. Output power will not be increased, since the tube cannot produce any more power with the power supply specified. -30-

Why DSBRC?

According to FCC Regulations (Part 95.43), the ideal unmodulated CB transmitter would have an average power input of 5 watts and an average power output of 4 watts. When the carrier wave is 100% amplitude-modulated, two sidebands appear, also containing r.f. power, but particularly carrying all of the useful voice intelligence, as in (A) below. To increase the "talk power" of a CB rig, a possible method would be to eliminate the useless carrier and concentrate all of the available r.f. energy in one or both sidebands, as in (B). Although advanced forms of voice communications (SSB) do just this, the absence of a carrier introduces a new set of complex receiving problems. The "Mule Box" effects a compromise by reducing the r.f. power in the carrier and simultaneously increasing the power in the intelligence-carrying sidebands, as in (C). Thus, the DSBRC signal sounds "louder." This idea has been used commercially for several years in the Regency "Range Gain" CB transceiver.



(A)



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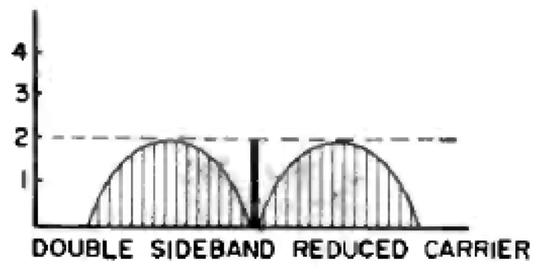

(C)