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Cheap and Simple

—your basic 13.8-V, 25-A power supply

The 13.8-volt ham radio transceiver has really come of age. Many of these units are great for mobile operation, but when it comes to fixed-station use, the transceivers can really come up short—primarily because of the comparatively high current values they draw on peaks.

The two-meter FM and police-scanner industries have given us a variety of 13.8-volt, low-current power supplies which in many cases can be bought more cheaply than built. However, the seemingly rarified 13.8-volt, fifteen-Amp (or higher) power supply is not that easy to come by, which really limits the possibilities with transceivers drawing anywhere from sixteen to twenty Amperes.

Scanning the catalogs became a depressing experience for me, particularly when supporting one wife, three cats, and twelve hobbies on a pilot's salary. There are a number of excellent commercial power supplies available, but you can expect to pay an absolute minimum of $100 for low-current versions and as much as $300 for a power supply beefy enough to keep my Vibroplex Presentation dancing its way through the kilos and megas. Besides all that, my idea of a power supply is something that sits in a darkened corner, is not seen, and is purely an accessory to my equipment. $100? $200? $300? For a lousy power supply?

Occasionally, a magazine article has slipped through on the subject of 13.8-volt, high-current power supplies. Unfortunately, in many cases the authors have escaped the world of simplicity and featured components and techniques that are available easily only through NASA. Hence, I drew up a priorities list so that I could readily view my criteria for such a power supply: 1) cheap, 2) simple, 3) cheap, and above all, 4) cheap. I am one of those chicken-wire and chewing-gum types whose home-brewed projects are best characterized as "functional" and are best unseen. (At least with power supplies, anyway.)

My particular need was to supply power to an Atlas 210X. While my home station is basically a salvage yard for old boat anchors, six years or so ago I pressed the Atlas into mobile service. In fact, mobile operation is all my Atlas has ever seen. Until recently it has

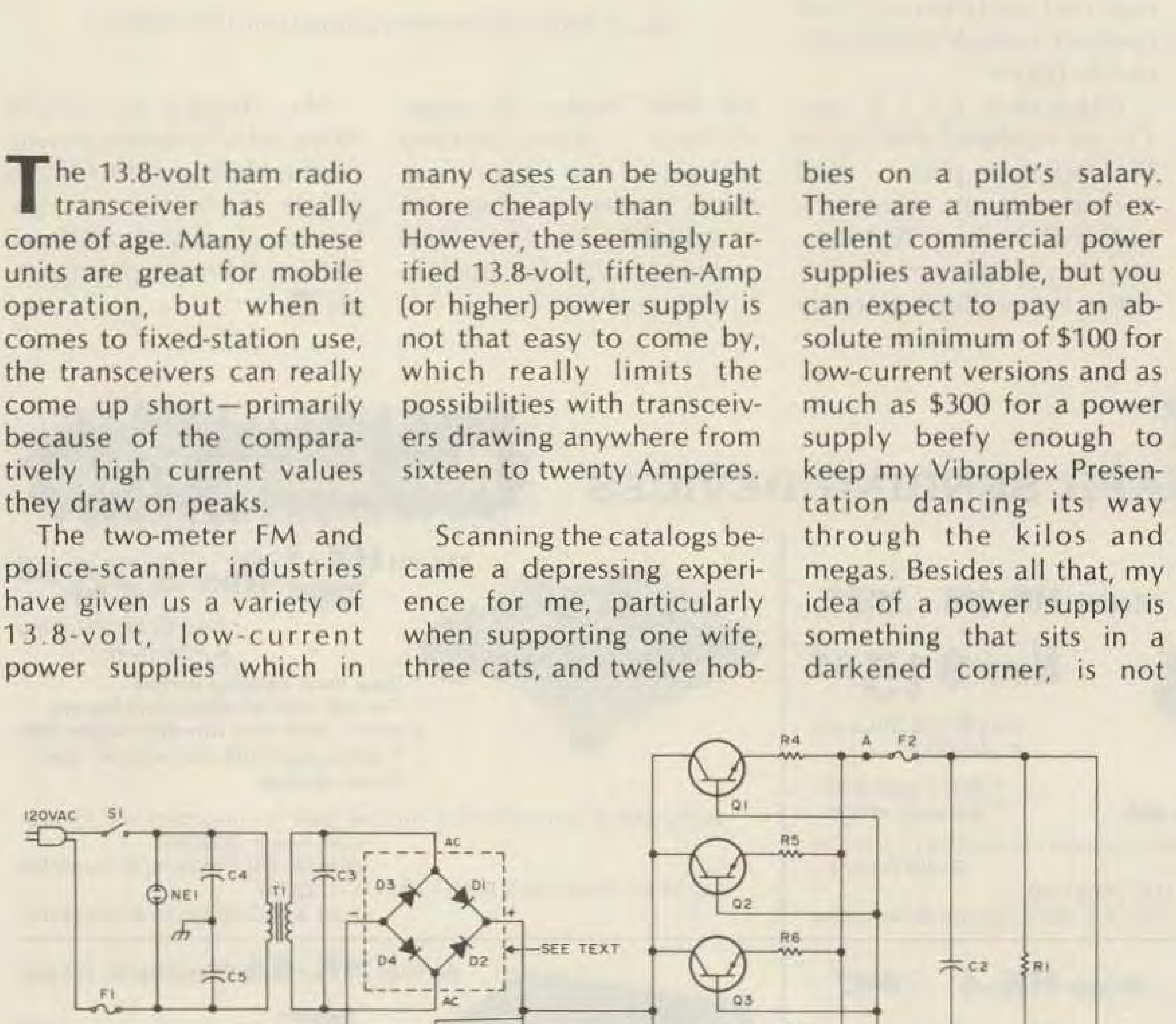

Fig. 1. Power supply schematic diagram.

never known the joy of taking a spike from the ac mains. Besides, with a dc supply, I could haul the 210X into the motel room, run coax out to the bumper mount, and dit-dah my eyeballs out.

Why not carry around a car battery and trickle charger, you ask? Too messy and cumbersome. Another option was to buy the factory-built console/power supply, but I heard rumors (only rumors) that the console/power supply left a little to be desired in the regulation department.

The Circuit

The power-supply circuit uses 2N3055 transistors. You can tailor your current capability by the number of pass transistors you use. I wanted a 25-Amp supply, so I used five 2N3055s. You can figure roughly one transistor for every 5 Amps you'll be drawing. In a 10-Amp supply, only two transistors would be used, and so on.

The 2N3055 is an NPN power device built into a TO-3 case. The 3055 is one of the more easily come by transistors and is very cheap (meeting criteria 1, 3, and 4). Because of the power these little devils are going to be dissipating, heat sinks should be employed. I used a heat sink with approximately 27 square inches of surface area with four half-inch fins, which cools nicely. Extreme heat can quickly mess up the transistor junction (not to mention a nice paint job). Before securing the transistors to the heat sink, apply some silicone thermal compound between the 3055s and the surface of the heat sink to provide a good positive heat transfer.

I have always used the rule of thumb that if you can't touch it, you can blow it. If you don't care to go heat-sink shopping, use a cooling fan. If you use a fan in addition to the heat sink, be sure the air circulates in line with the fins. Blowing air perpendicularly to the fins sets up standing waves—the aerodynamic kind—and turbulence and the cooling effect is minimal.

Transistor-mounting hardware is nice, but I didn't feel that it was necessary. I attached the transistors directly to the heat sink and then mounted the whole heat-sink assembly on a sheet of Plexiglas™ attached to four standoffs. Since the transistor case is common to the collector, I tapped a screw into one of the heat-sink fins and this became my common collector tiepoint. It is important to keep all lead lengths constant. After drilling matching holes for the base and emitter pins in the heat sink, heavy-gauge wire was soldered (carefully) to each emitter pin through a 0.25-Ohm resistor, and then a second piece of wire was attached to each base pin. I then had only to connect the rest of the circuit to either the heat sink or one of the two bus wires.

You may or may not have difficulty locating a suitable transformer capable of taking 120 V ac and squeezing it down to 17 to 24 V ac. I was lucky enough to locate an old, beat-up, ex-battery-charger transformer at a hamfest which gave me 120/17 V ac. I think you will find old battery chargers to be a good source for the transformer you will need. Remember, the transformer must be capable of carrying the current you are going to draw from your power supply. I paid $3.00 for my transformer and felt robbed; I have seen them for a dollar. Yes, you do take a risk, but remember, even if the transformer is no good, it is an excellent source of #14 AWG antenna wire (or larger)!

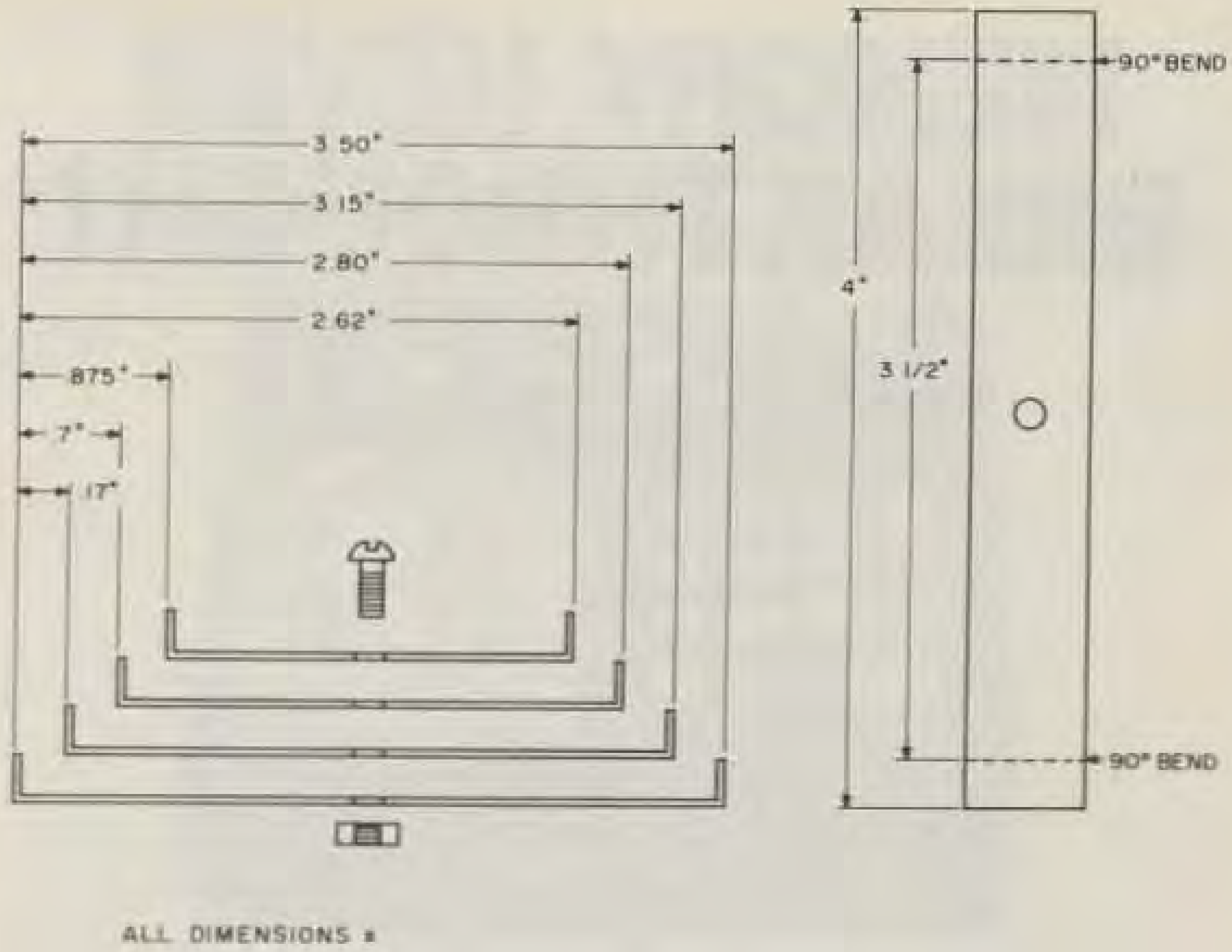

Fig. 2. Heat sink construction details.

In the rectifier circuit there are two avenues to follow. You can buy four diodes and make your bridge or you can do as I did and use one of the nifty one-inch-square epoxy bridge rectifiers. The little one-inch jobs are convenient because you don't have to mess around figuring which end is the anode and which is the cathode. Ordinarily, the epoxied bridges are simply marked AC, AC, +, and −. Can you beat that?

As always, no matter what you do for rectification, be sure your rectifier is rated for the current you will be needing. Most of the little square bridges are rated between 20 and 35 Amps. I am using a Semtech-Alpac 7905 only because I happened to have one on hand. Motorola, International Rectifier, VARO, and EDI make excellent equivalents.

Voltage regulation depends on adequate filtering and an IC known as a 7812. After much experimentation, I found that my voltage regulation (as well as hum attenuation) improved as I increased the value of filter capacitor C2. Starting out with 2000 uF, I worked my way upward to 13,000 uF. Though I now have a 37,000-uF filter capacitor in the circuit, 13,000 uF seemed to be enough. The amount of filtering achieved by going from

Parts List

C1—13,000-uF, 25-V electrolytic capacitor
C2—10-uF, 25-V electrolytic capacitor
C3—0.22-uF, 100-V tubular capacitor
C4, C5—0.01-uF, 500 V ceramic capacitor
D1-D4—25-A diodes or epoxy bridge rectifier (see text)
D1-D5—1N4004 diodes
F1—Fuse, 5 Amp
F2—Fuse, 30 Amp
Q1, Q2, Q3, Q4, Q5—2N3055 transistors
R1—120-Ohm 4-W resistor
R2—3000-Ohm, ½-W resistor
R3—500-Ohm, 1-W potentiometer
R4, R5, R6, R7, R8—0.25-Ohm, 1-W resistor
IC1—7812 voltage regulator
S1—SPST switch
S2—6-position wafer switch
T1—120/17-24-V ac power transformer (see text)
Miscellaneous: NE1 neon bulb, binding posts, line cord, 0-25-V dc voltmeter, 0-30-A ammeter, heat sinks, chassis, blower, fuseholders, and bulb socket.

13,000 to 37,000 uF is very, very slight and detectable only with a scope. Obviously one can't ignore the thought that if 13,000 uF is good, a higher value would be better, but let me caution you enthusiastic high-capacity freaks against installing 150,000-uF capacitors without limiting inrush current. I haven't experimented beyond 37,000 uF.

The 7812 voltage regulator is an IC device capable of maintaining excellent regulation as long as the input voltage falls between 14.6 and 19 volts nominally. A number of companies are producing the 7812 and it generally has some sort of prefix or suffix, but the digits remain the same.

In this circuit, the 7812 is above ground through a 200- to 500-Ohm resistor. I don't put an exact value on this because it is not that critical. Going from receive to full-output transmit on my Atlas (300 mA to peaks of 16 Amperes), the voltage drop on the power supply is 0.4 V, which ain't bad. Since I normally don't run my equipment at full bore, the drop from receive to transmit is quite small.

As was the case with the pass transistors, I mounted the 7812 on a heat sink affixed to a small piece of Plexiglas on standoffs (to simplify its isolation from the chassis). The heat sink (see Fig. 2) is made of four strips of one-inch-wide aluminum cut at varying lengths and bent up a half-inch at each end. I then placed each one "inside" a larger one until, voilà, La Heat Sink a la Cheap. To keep the strips aligned, a hole was drilled which also served to attach the 7812.

While it isn't necessary, you can build in a selectable voltage feature by connecting any number of 1N4004 diodes on a wafer-type switch. This switch goes between pin 3 of the 7812 and ground. (If this seems like a lot of hooey to you, you may disregard the above and connect pin 3 of the 7812 to ground through R3. You will see a voltage change of approximately 0.7 V with each position on the switch. With my supply, I have the capability of as much as 15 V or so, and the switch permits me to "switch down to" the proper voltage I desire (13.8 V dc).

The value of bleeder resistor R1 across the output is not critical either, but have something there for your protection.

By varying the resistance of R3, your output voltage will vary considerably. I believe a potentiometer instead of a fixed-value resistor is a better route so that more flexibility is available for future voltage needs which now might not be considered. As in my case, if you are receiving 16.8 V from your transformer, 250 Ohms is sufficient to yield the 13.8 V dc you want.

Should you be supplying your rectifier with 16 to 18 volts and not be getting a stable 13 volts or so, check to be sure that you are not losing (dropping) all of your voltage in your rectifier diodes or epoxy bridge. Some of the epoxy bridge rectifiers are poor in the area of voltage consistency. Try a different one, even of the same manufacturer. Another place to watch for voltage losses is in your wiring. The more current you draw, the higher your voltage drops may become in your transformer, rectifier, filter capacitor, or wiring. Wire which is too small may cause substantial voltage drops. I would suggest using #14 AWG wire at least.

H-u-m-m-m-m

My first test of the power supply was disastrous. Not only was the regulation terrible, but the audio was 80% hum, 20% ham. Two things lead to the elimination of hum: First (and already covered), I placed my voltage regulator above ground on the Plexiglas support; second, I connected all of my chassis ground connections to one point.

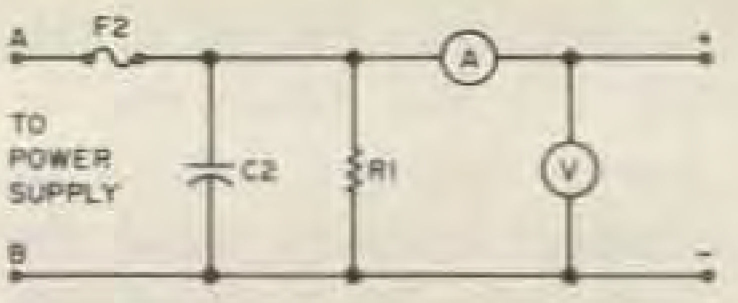

Fig. 3. Power supply metering arrangement.

As with my other home-brew endeavors, I first mounted the power supply on an open chassis. Breadboarding can save you much agony when it comes time to actually fitting the darned thing in a permanent box. Scouting around at the Dayton Hamvention, I was able to come up with a perfect cabinet (which formerly was a microvolt meter) for $1.00. When shopping for an enclosure, don't overlook old, non-working test equipment, etc.

Metering can be added easily as shown in Fig. 3. (When will the price of meters ever come down?)

The cost is going to vary depending on the state of your junk box and what kind of hamfest bargains you can locate. I spent more than I really wanted to, and that was slightly over ten dollars. You can't beat the pages of *73 Magazine* for bargains on the components used here; it was from there that I purchased all of my purchased parts.

As you build this, take your time. Do a good job. Dress all of your leads. Use red wires for + and black wires for −. Take time to consider the aesthetics of this project. Then tuck it away in a dark corner and ignore it, because it's only a stupid power supply. ■