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Meter Made

Here's how to recycle those VU meters in old stereos.

Meters from discarded stereos can be used in many ham radio projects. This article shows how to measure their characteristics and put them to use as ammeters and voltmeters.

A typical stereo set, such as the Realistic 13-1198 originally sold by Radio Shack, will have two VU meters on the front panel as shown in **Photo A**. This meter is 1.5 inches square and it has a white pointer with a black background.

Another stereo rescued from the trash man, a Superscope Imperial Model C-5060, is shown in **Photo B**. This one had a bonanza of five meters. They are 1.9 inches square. Two had a level scale (VU) shown in **Photo C** and two had a watts scale. The fifth meter has a tuning scale. All five have a black pointer with a silver background.

Radio amateurs should have no difficulty in locating an endless supply of similar meters from discarded stereo sets. Check out neighborhoods where renters are frequently moving in and out, especially college students. The meters are easily removed from the sets. There may also be other parts of use to the radio amateur such as a power transformer, heat sink, variable capacitor, switches, potentiometer, etc.

Measuring the meter's characteristics

A meter can be characterized by the current level required to drive it to a full-scale reading and by its internal resistance. One way to measure these characteristics is to set up a circuit shown in **Fig. 1**. A 1.5-volt "D" cell and 10k ohm potentiometer are connected in series with the meter. Adjust the potentiometer for a full-scale reading on the meter as shown in **Photo D**.

Now measure the voltage of the "D" cell with a digital voltmeter. I

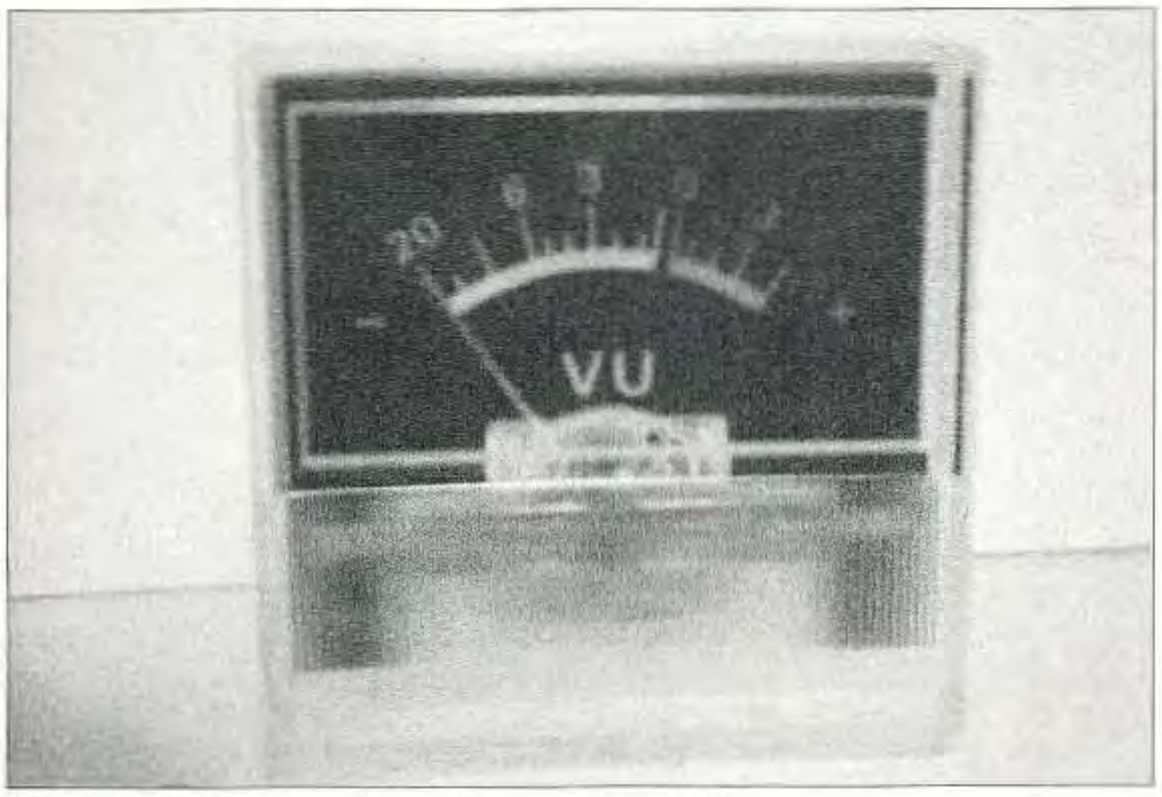

Photo A. *VU meter from Realistic 13-1198.*

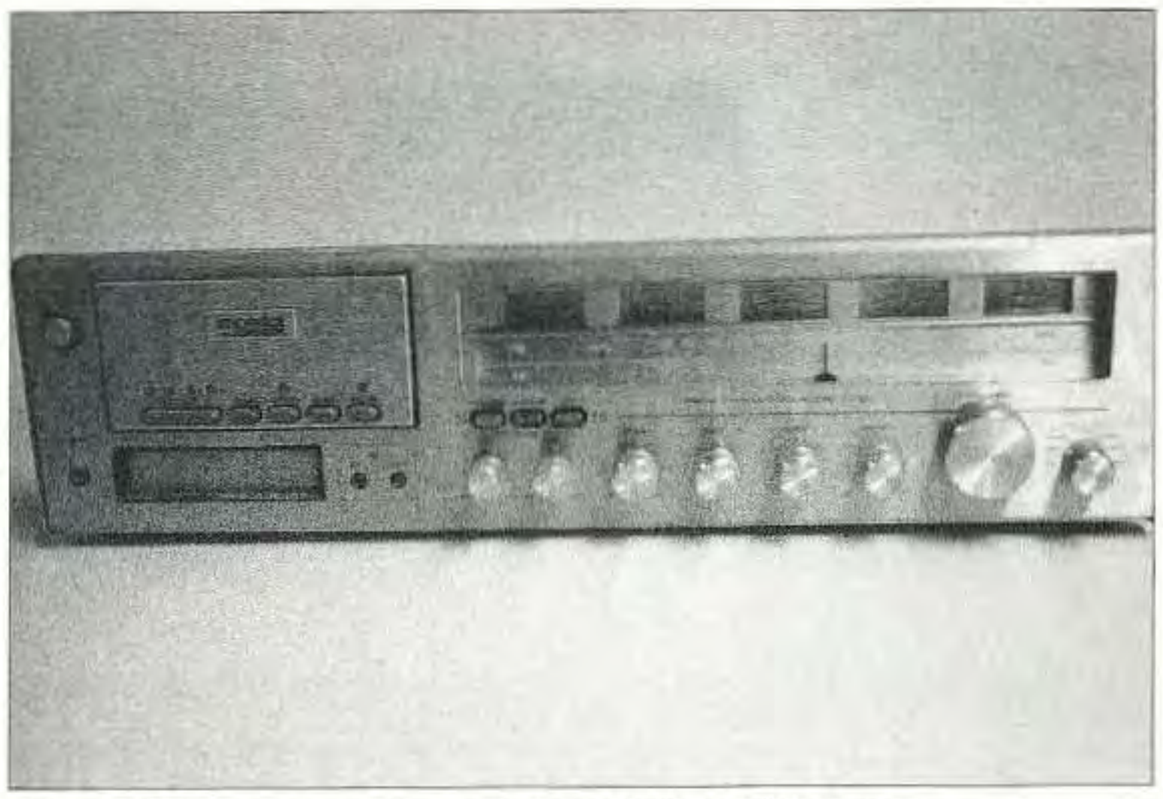

Photo B. *Superscope Imperial C-5060 AM/FM stereo.*

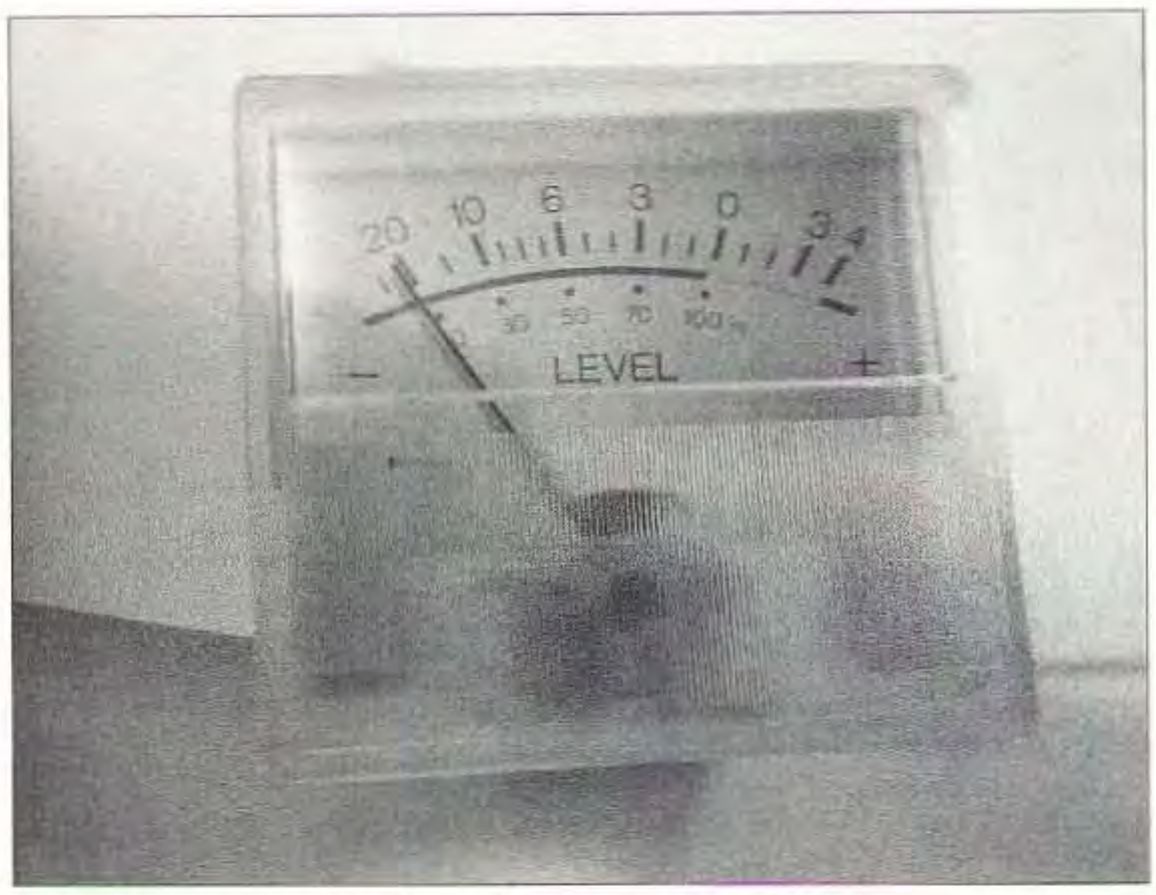

Photo C. Level meter from Superscope set.

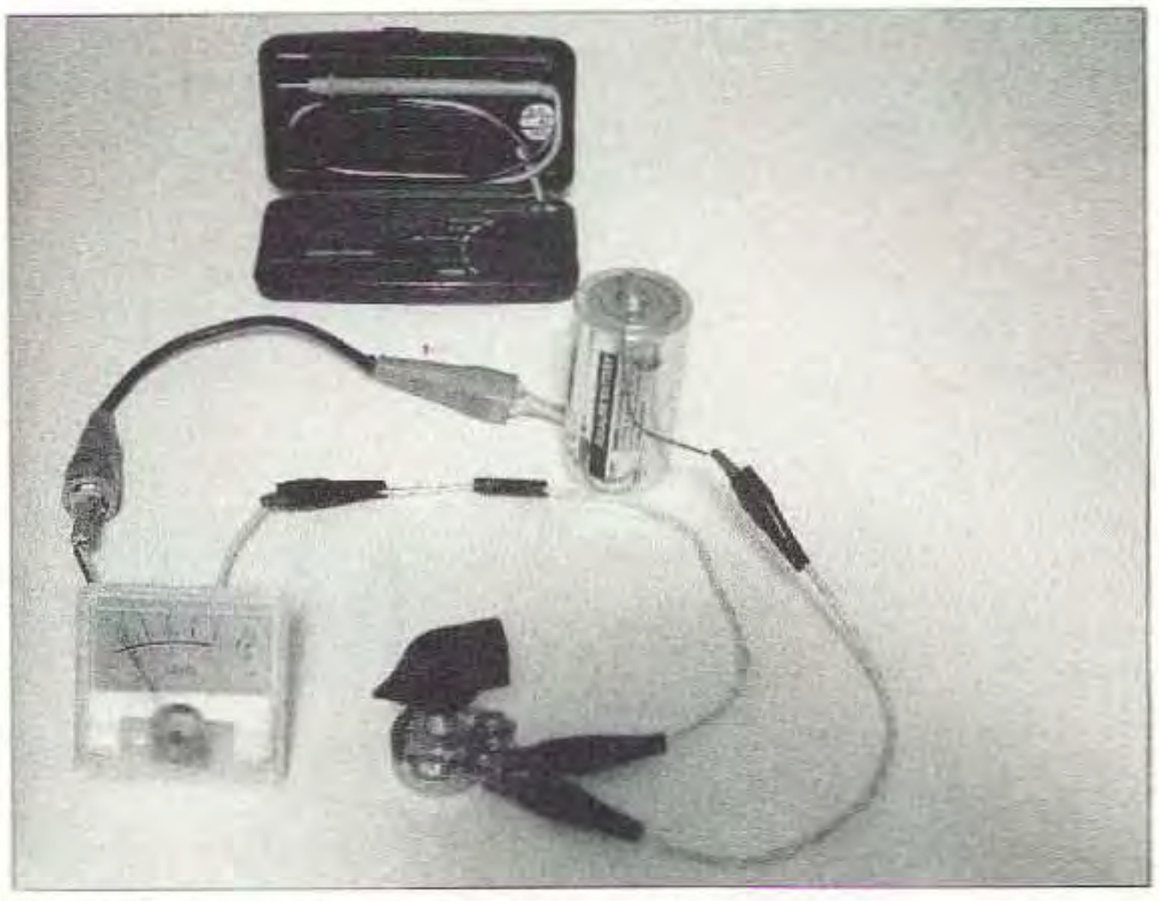

Photo D. Measuring meter characteristics.

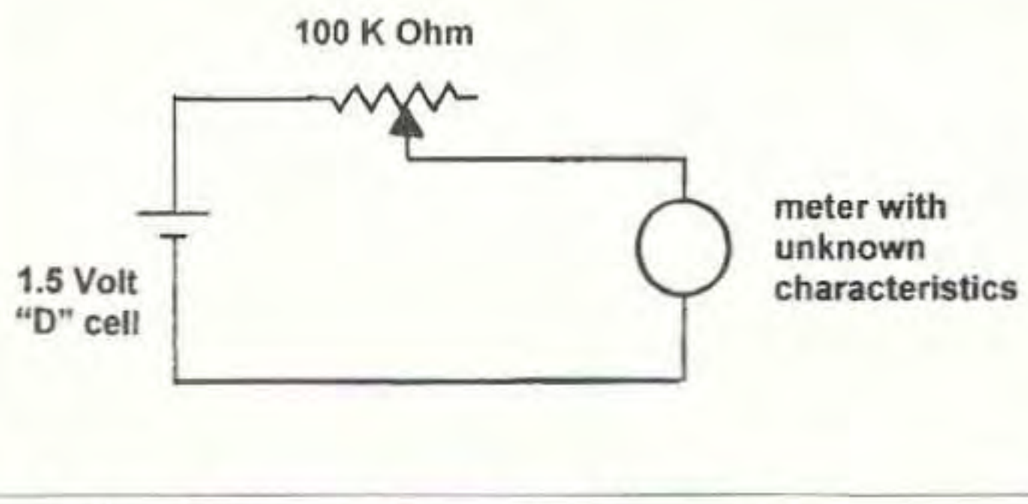

Fig. 1. Circuit for measuring meter characteristics.

Meter	Current (μA)	Resistance (Ω)
Level 1	280	649
Level 2	258	639
Tuning	250	674
Watts 1	237	675
Watts 2	264	654

Table 1. Meter characteristics, Superscope Imperial C-5060 AM/FM stereo.

Desired Full-Scale Volts	Series Resistance (Ω)
5	17.0k
20	71.2k
100	360.0k
200	1721.0k

Table 2. Series resistors.

used the inexpensive Radio Shack pocket digital multimeter shown in **Photo D**. Then measure the voltage across the meter. There should be no drop in the full-scale reading on the meter when this measurement is taken. If there is, then your digital voltmeter is drawing too much current and the measurement will not be accurate. The pocket digital multimeter has a high enough input impedance so there is absolutely no movement of the needle pointer when this reading is taken.

Desired Current	Resistance (Ω)
1 mA	388
10 mA	28.9
100 mA	2.81
1 A	0.28
5 A	0.056

Table 3. Shunt resistor values.

Remove the potentiometer from the circuit and measure its resistance with the digital multimeter. Then, using formulas 1 and 2 below, calculate the meter's characteristics.

(1) Full-scale current = $(V_{batt} - V_{meter}) / R_{pot}$

(2) Internal resistance = V_{meter} / Full-scale current

For example, the Realistic meters measured: Full-scale current = 277 μA, Internal resistance = 1013 ohms. **Table 1** gives the measurements for all five of the Superscope's meters. The average is 258 μA and 658 ohms.

Use as a voltmeter

A resistor placed in series with a meter allows it to be used as a voltmeter. The series resistor value is given by formula 3.

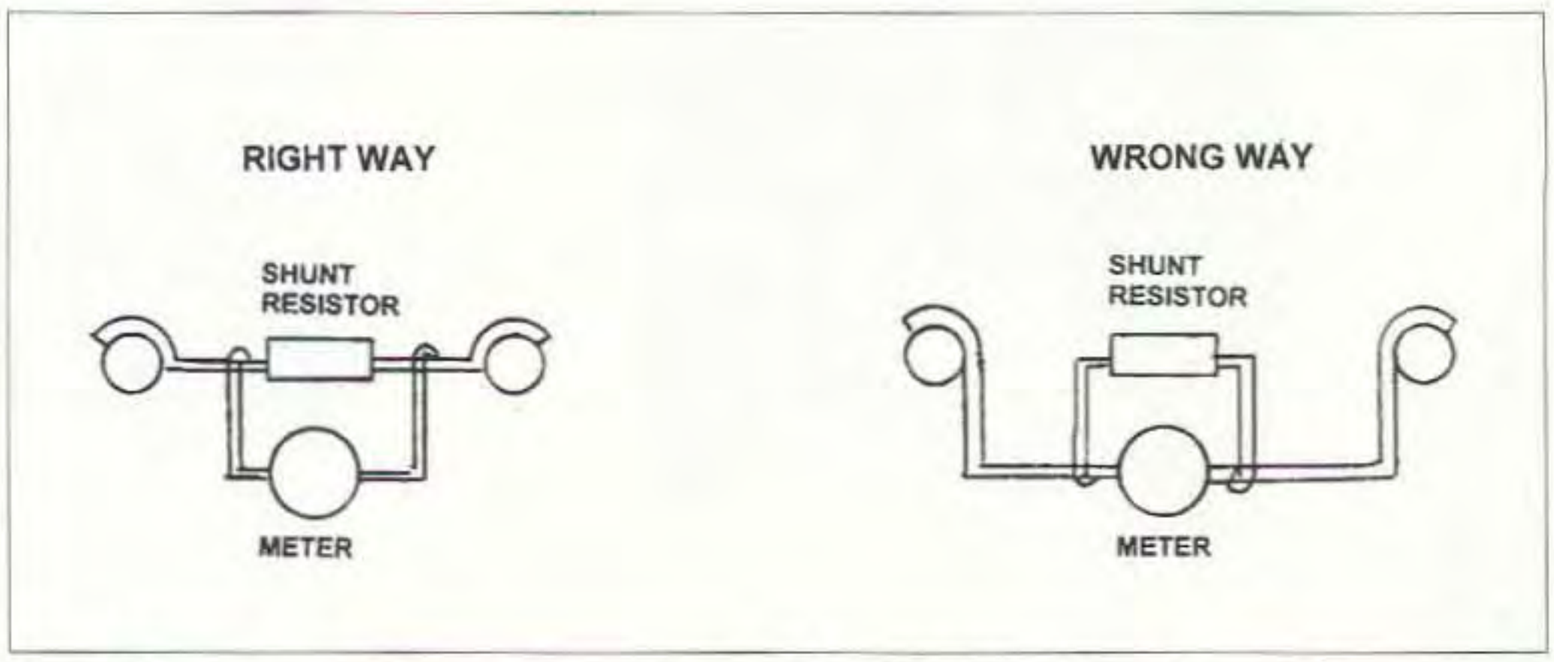

Fig. 2. Proper way to connect meter in parallel with a low-value shunt resistor.

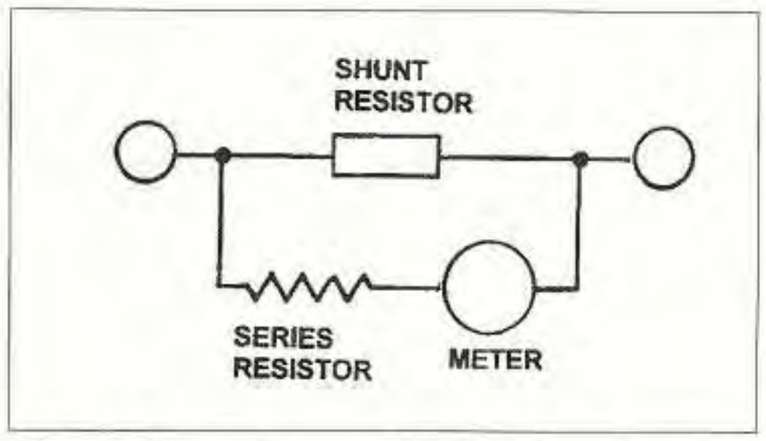

Fig. 3. Use of a standard value shunt resistor by adding a resistor in series with the meter.

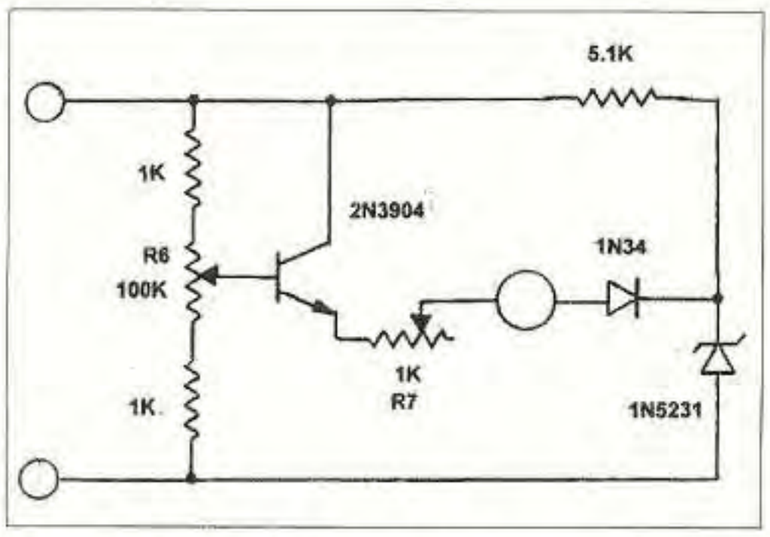

Fig. 4. Expanded scale voltmeter circuit.

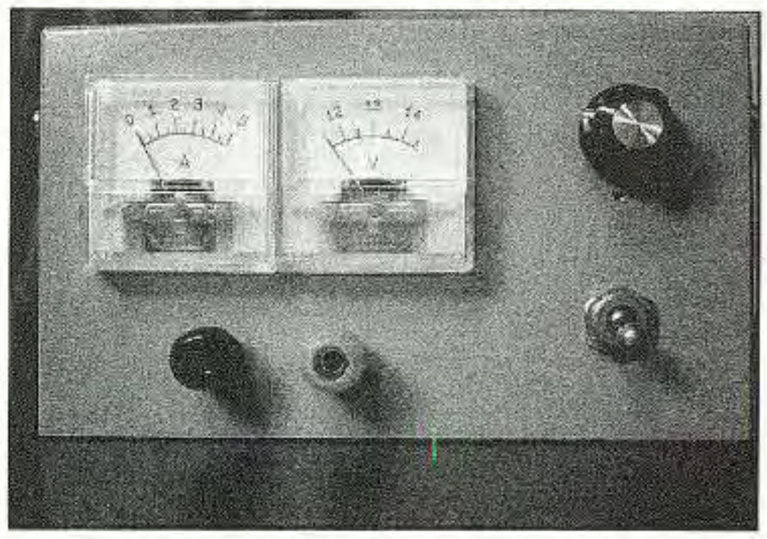

Photo E. 12-volt adjustable power supply.

(3) R_{series} = (Desired full-scale volts / Full-scale current) – Internal resistance

See **Table 2.** The closest 1% resistor can be used, or two or more 5% resistors can be combined in series or parallel to provide the necessary value.

Use as an ammeter

A resistor placed in parallel or shunt with the meter allows it to be used to measure current in milliamperes or amperes. The required shunt value is given by formula 4. The values will be in the low ohms range.

(4) R_{shunt} = Full-scale current x Internal resistance / (Desired current – Full-scale current)

Table 3 gives some typical values for the Realistic meter.

Two or more standard-value resistors can be combined in series or parallel to provide these odd values. For low values below one ohm, it is important to connect the meter across the shunt properly to minimize the effect of resistance in the connections. See **Fig. 2** for details.

The selection of low-value resistors available to the experimenter is very limited. If a particular low-value resistor is available, it may be possible to use it in the circuit shown in **Fig. 3**. A resistor is placed in series with the meter. The series resistor is calculated from formula 5.

(5) R_{series} = [(R_{shunt} x Desired current) / Full-scale current] – R_{shunt} – Internal resistance

Of course, if the calculated value of R_{series} comes out to be negative with this formula, then the circuit of **Fig. 3** cannot be used with that shunt resistor. A higher-value shunt resistor must be selected. Note that the circuit of **Fig. 3** will also have a larger (but still small) voltage drop across the terminals than the direct shunt circuit of **Fig. 2**.

Use of meter as a suppressed-zero (expanded-scale) voltmeter

In some applications, such as the 12-volt power supply described later in this article, it is desirable to have an expanded voltage scale. A circuit developed for the battery fuel gauge from *Electronics Now,* April 1997, pages 58–59, 74 can be used. See **Fig. 4**.

A percentage of the incoming voltage, set by R6, is compared to a fixed voltage set by a zener diode D1. Only when the voltage exceeds this value does the meter start to indicate. The left and right ends of the meter scale can be set by adjustment of R6 and R7 respectively.

Circuit boards for the fuel gauge, as well as full kits, are still available from Unicorn Electronics at 1-800-221-9454 or [www.unicornelex.com].

Variable power supply using recycled meters

You can use recycled meters to read

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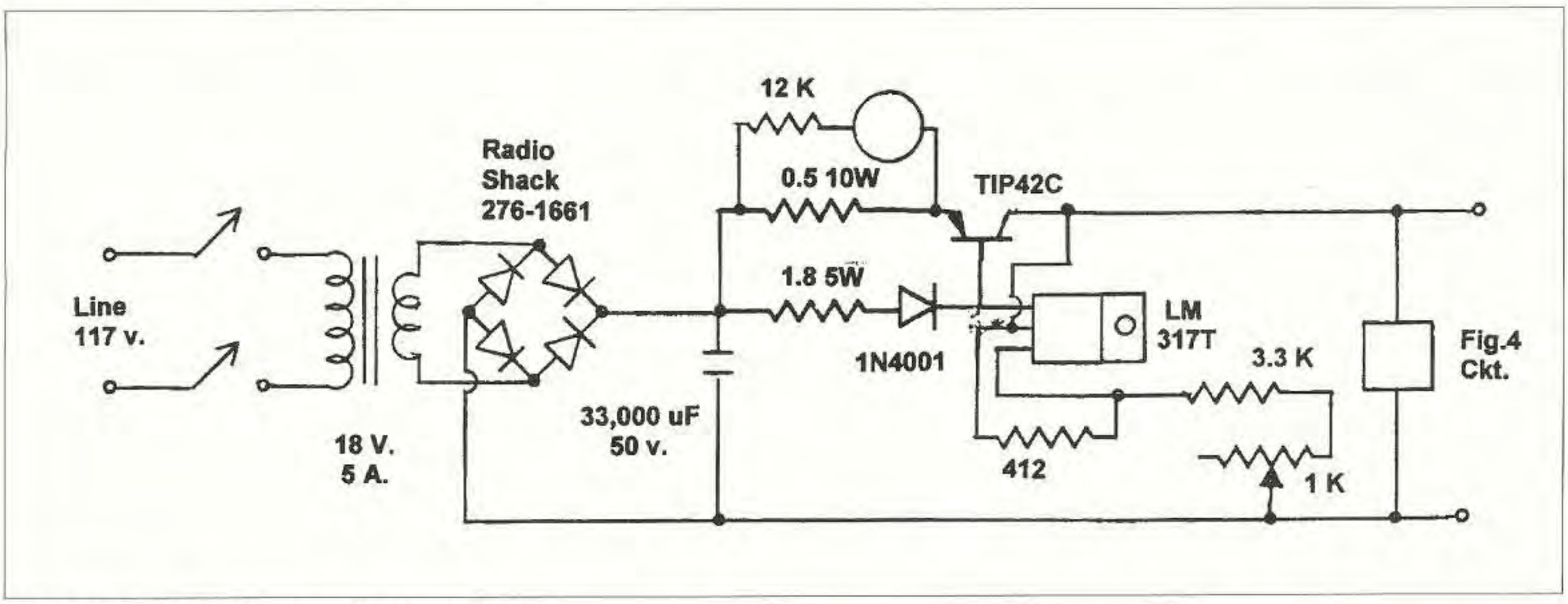

Fig. 5. Adjustable power supply circuit diagram.

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the voltage and current in an adjustable power supply. **Fig. 5** shows a 12-volt, 5-amp circuit diagram built around an LM317T adjustable regulator IC. A PNP "wraparound" power transistor increased the current capability from 1.5 amps for the LM317T to 5 amps. The voltage is adjustable from 11.5 to 14.5 volts. This is the

range of voltages normally seen in equipment powered by an automobile electrical system.

The voltmeter uses the expanded-scale circuit of **Fig. 4** with expanded-scale markings on the face. The ammeter uses the circuit of **Fig. 3** and is placed in the input of the regulator circuit. This placement eliminates the effect of any voltage drop across the meter shunt resistor from affecting the output voltage. With this placement, current drawn by the regulator circuit itself is included in the meter reading. However, the regulator circuit draws less than 5 mA, a negligible amount on a 5-amp meter scale.

Other uses

There are many other uses for recycled meters. An SWR bridge requires two meters. If purchased new, the cost would be prohibitive. With recycled meters, the cost is zero! Recycled meters can also be used in a dipper instrument, or as an S-meter in a home-built receiver. Other test instruments are described in the new book T*est Equipment* by Guido Silva I2EO, which is available from Barnes and Noble and also from Amazon on the World Wide Web [www.amazon.com].

Drawing the new meter scales

New meter scales are best drawn on bright white paper with black ink. If the original meter needle is white, you can make it black with a black felt-tip marker. Those with artistic talent can envision many other possibilities. I used a pen plotter to draw the scales for the meters on the 12-volt power supply as seen in the photos.

I hope to see many projects described in this journal using recycled meters. It's great fun to build your own instruments and gear.