Low-Cost A.C. Ammeter

Measures up to 5 amperes with $3 outlay

BY NEIL JOHNSON, W2OLU

YOU SEE all sorts of meters and indicating instruments in ham shacks and electronics experimenters' workshops, but you very seldom see an a.c. ammeter. Obviously, lots of people could put one to good use—the trouble is, they are too expensive.

A reasonably good a.c. ammeter sells for about $12 and, in most cases, at least two of them are required in order to make a broad range of measurements. This is because the commonly used a.c. instrument works on the moving vane principle and the low end of the scale is severely compressed. On most 0-5-ampere a.c. ammeters, indications below 1 ampere are next to useless. So, in addition to a 5-ampere meter, you have to have a 1-ampere instrument to cover the full range adequately.

You can build yourself a good, wide-range ammeter very inexpensively, if you take advantage of some government surplus items that are widely available. Part of every "command set" used in airplanes at one time was an "Antenna Current Indicator" (military nomenclature: BC-442). The current meter used in this device has a nonlinear scale and is more sensitive at the low end of the scale than at the high end. This prevents crowding at the low end of the scale—a feature not found in conventional a.c. indicating instruments.

The BC-442 comes with a built-in thermocouple about the size of a small domino. When the thermocouple is heated (in any way), it generates a small d.c. current at its output. An input to the thermocouple of half a volt generates enough current to deflect the companion d.c. meter to full scale—about 5 milliamperes. When operating together, the thermocouple and d.c. meter are reasonably accurate over a wide range of frequencies and essentially linear over a large part of the meter scale.

To extend the meter range to 4.5 amperes, a meter shunt of 0.1375 ohm is required. This resistance can be fabri-

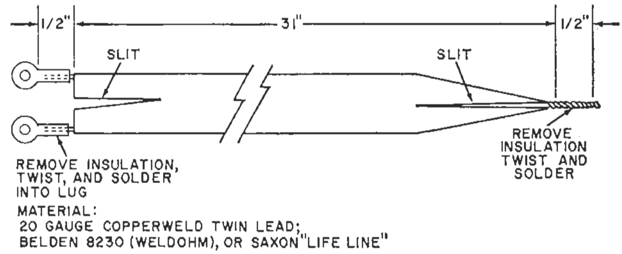
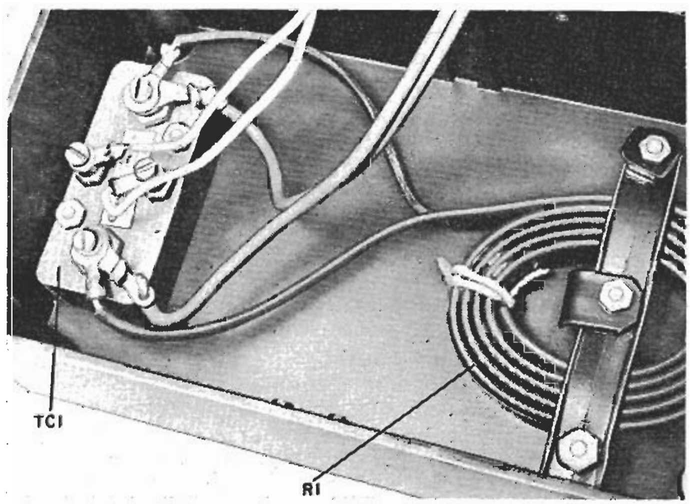
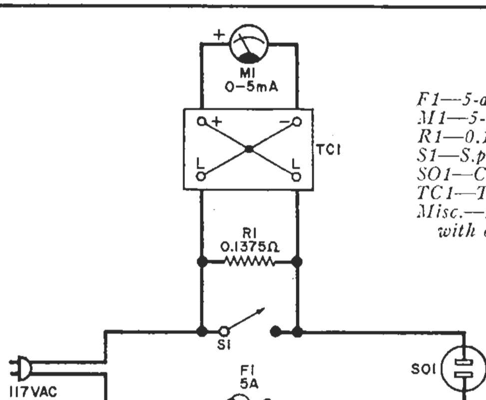


Fig. 1. Though primarily used as TV lead in, twin lead can be used to make a high-quality, low-value resistor (0.1375 ohm).

The shunt can be rolled up and mounted at one end of the case. This makes for a non-inductive resistor that can be used at frequencies far above 60 Hz.

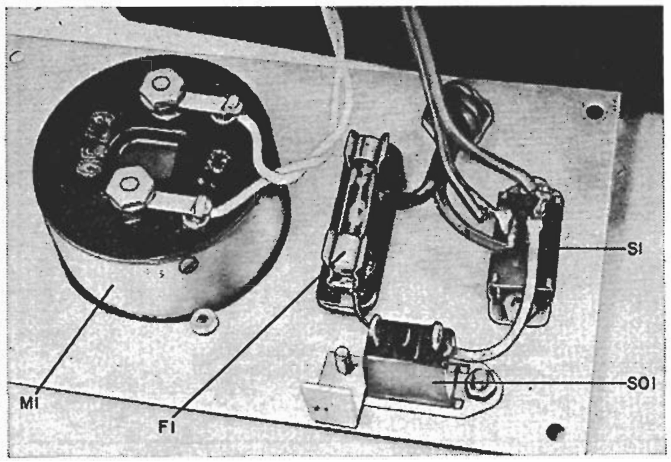




PARTS LIST

F1—5-ampere fuse (not slow-blow)
M1—5-mA meter from BC-442
R1—0.1375-ohm precision resistor (see text)
S1—S.p.s.t. switch 3-ampere rating
SO1—Conventional a.c. outlet
TC1—Thermocouple from BC-442 (0.75-A r.f.)
Misc.—Mounting cabinet, fuse holder, line cord with attached plug.

Fig. 2. Circuit operation is simple. Current passing through the thermocouple heats the dissimilar metal junction producing a small current which is indicated on the meter. The low-value shunt resistor (R1) bypasses most of the heavy current.



Other than the shunt and thermocouple, the remainder of the components are mounted on the metal front panel as shown here.

cated at a meter shop at high cost or you can use a series-parallel arrangement of 10 one-ohm precision resistors —also at a high cost. A cheaper way is to use a length of ordinary TV twin lead of Copperweld fabrication. The two conductors are well insulated and the wattage developed at maximum current is easily handled. Best of all, a "precision" resistor can be made using only a ruler. Instructions for making the shunt are given in Fig. 1. Follow the measurements carefully. It is recommended that you make up the shunt and solder it to its connector lugs at some distance from the thermocouple since the thermocouple calibration can be affected by soldering heat. When the shunt is finished, coil it into a small circular form and secure it with plastic insulating tape. The coiled-up shunt can be mounted on the rear of the meter case using a bolt and some scrap plastic to support it. Since this homebrew resistor is noninductive, the completed instrument can be used at frequencies much higher than 60 Hz.

Wire the shunt, the thermocouple and the meter as shown in Fig. 2. Note that, for safety's sake, a fuse and a shorting switch have been added to the circuit.

METER CALIBRATION TABLE

METER SCALE	AMPERES
0.5	0.6
1.0	0.75
1.5	0.90
2.0	1.00
3.0	1.25
4.0	1.50
5.0	1.80
6.0	2.20
7.0	2.50
8.0	3.00
9.0	3.70
10.0	4.50

Any 5-ampere fuse can be used as long as it is not a "slow-blow" type. The shorting switch shorts out the meter when first trying an unknown load. Once the device has been built, recalibrate the meter face to the values shown in the table.

Depending on where you buy the BC-442, the total cost of the meter will run about $3. At a nominal 117 volts, the meter will measure loads varying from 60 to 540 watts. If desired, and if you are using only the normal 117-volt power line, you can calibrate the meter in watts instead of amperes. —30—

BASIC ELECTRONIC INSTRUMENTATION

A three-week course in electronic instrumentation will be given from July 19 to August 9, 1969, at Polytechnic Institute of Brooklyn. Supported in part by the National Science Foundation, the course is open to anyone with a basic understanding of college physics. The text is "Electronics for Scientists" by Malmstadt, Enke and Toren. Lecture, laboratory, and discussion topics include: basic electrical measurements, power supplies, solid-state amplification elements, oscillators, servo-controlled devices, operational amplifiers, analog simulation, and electronic digital systems. Tuition is $500. Contact: Prof. Kenneth Jolls, Office of Special Programs, Polytechnic Institute of Brooklyn, 333 Jay St., Brooklyn, N.Y. 11201.