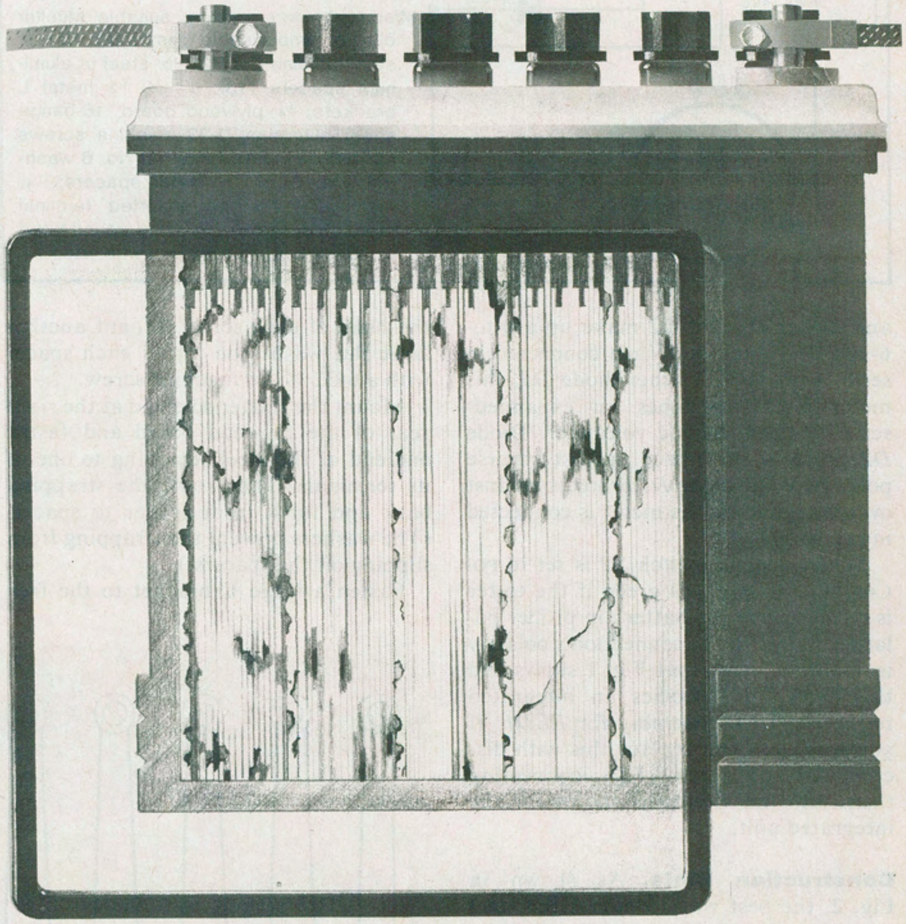
INEXPENSIVE

AUTO BATTERY TESTER

BY HANK OLSON

Simulates 200-ampere starter-motor load



AN AUTOMOTIVE battery works very hard, especially when cranking the engine, and if you have a plethora of electrically operated accessories that often draw more power than the unaided alternator can deliver, it may not have a full charge to work with. Even a battery that loafs most of the time may age to the point where it can no longer start the engine on a cold day, so it's a good idea to check your battery's health now and then.

Numerous tests can be made on a battery, and all of them give some indication of its condition. But none is as conclusive as checking its performance under load. To do that you need a professional battery tester, an inexpensive version of which you can build, as described in this article.

The Circuit. The battery tester, shown schematically in Fig. 1, assumes the test current to be 200 amperes at 12 volts. (To determine appropriate load current, refer to the box.) Using Ohm's Law and assuming a 12-volt battery, you can readily see that load resistor *R2*'s value would have to be a very low 0.06 ohm ($R = E/I = 12$ volts/200 amperes $= 0.06$ ohm). Furthermore, its power rating would have to be a whopping 2400 watts ($P = IE = 200$ amperes $\times$ 12 volts $= 2400$ watts). Clearly, you're not going to find a resistor with these ratings in your local electronics parts store. Fortunately, however, you can fabricate your own power resistor from available inexpensive materials.

Continuing with our example of 12 volts and 200 amperes, you'll need about 12 feet of 1/2-inch wide, 0.025-inch thick steel banding strap (used to cinch wooden packing cases) to fabricate *R2*. Connect the strap in series with an ammeter that can handle at least 2.5 amperes across a variable power supply capable of delivering up to 1 volt at more than 2 amperes. Adjust the power supply for a 2-A output and measure the voltage across the load. If it is over 0.12 volt, trim the strap until it equals 0.12 V.

Turn off the power supply and disconnect the test setup. You've now determined the length of steel strap to use for a 0.06-ohm load resistor. (You can use the same test setup to determine the length needed for any other battery voltage/power ratings simply by changing the voltage or/and current to the appropriate values in the formulas that are provided in the box.)

You're not likely to find a switch that can handle 200 amperes in an electronic parts store, but a conventional 12-volt automotive starter solenoid (*K1* in Fig. 1) will fill your need. Operating current for the solenoid is controlled by normally open pushbutton switch *S1*.

Meter *M1*, resistors *R3* through *R6*,

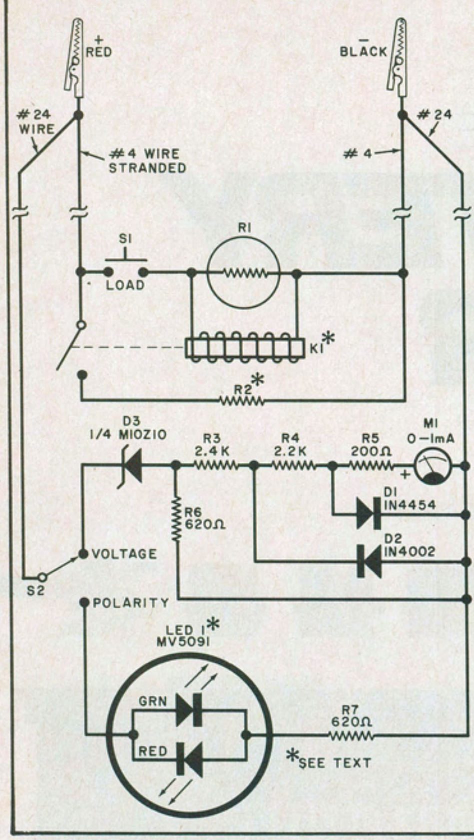


Fig. 1. In the circuit, a standard starter solenoid and contact are used instead of a switch.

PARTS LIST

D1—1N4454 diode
D2—1N4002 diode
D3—10-volt zener (Motorola ¼ M10Z10 or similar)
K1—12-volt automotive starter solenoid
LED1—Two-color LED (Monsanto MV5091 or similar; see text)
M1—0-1-mA meter movement
R1—Thyrite varistor for solenoid
R2—See text
R3—2.4-kΩ, ½-W, 5% resistor
R4—2.2-kΩ, ½-W, 5% resistor
R5—200-Ω, ½-W, 5% resistor
R6, R7—620-Ω, ½-W, 10% resistor
S1—Normally open pushbutton switch
S2—Spdt switch
Misc.—#4 wire cables; suitable Mueller clips or jumper-cable clamps (2); 12 feet steel banding (for R2); ½" steel or aluminum spacers (13); 1" × ½" metal L brackets; ¾" plywood board; 16-gauge sheet aluminum; 6-32 machine screws (1" and ¼" long); large flat No. 6 washers; No. 6 × ½" metal spacers; ¼" machine hardware; assorted terminal strips (see text); ¾"-long round-head wood screws; #24 hookup wire; etc.

and diodes *D1* and *D2* make up a 0-to-6-volt dc voltmeter. When connected in series with 10-volt zener diode *D3*, this meter circuit becomes an expanded-scale 10-to-16-volt dc voltmeter. Diode *D2* protects the meter against reverse polarity, while diode *D1* protects against overvoltage when the meter is connected in proper polarity.

When selector switch *S2* is set to POLARITY, *LED1* glows green if the tester is connected to the battery in proper polarity, red when the connection's polarity is incorrect. Note that Fig. 1 shows and the Parts List specifies an integrated red/green LED assembly for *LED1*. If you wish, you can replace this with discrete red and green LEDs, connecting them into the circuit as shown for the integrated unit.

Construction Hints. As shown in Fig. 2, the best way to mount the steel strapping that makes up the load resistor, *R2*, is on a ¾-inch plywood board, using No. 6 metal—*not* plastic—spacers and machine hardware. Start by drilling a ¼-inch hole spaced ¼-inch in from each end of the strapping.

Next, drill two rows of ⅛-inch holes through the board, spacing the rows about 8 inches apart and the holes within each row about 1 inch apart. Then mount a metal spacer at each hole location with a 6-32 × 1" machine screw, placing a large flat No. 6 washer under the head of each screw. Mount another large flat washer on top of each spacer with a 6-32 × ¼" machine screw.

Mount the starter solenoid at the right rear of the plywood board and fasten one end of the steel strapping to one of its terminals. Then route the strapping back and forth from spacer to spacer. (The washers prevent the strapping from slipping off the spacers.)

Fasten a large L bracket to the free end of the strapping with ¼-inch hardware. Then secure the L bracket and one- and two-lug terminal strips to the wood base with ¾-inch round-head wood screws.

For the front panel, you will need a sheet of 16-gauge aluminum. Trim it to the width of the plywood base. Then, if possible, bend a 90° lip, about 1 inch wide, along the panel's bottom edge (alternatively, use three large L brackets) and drill three or four ⅛-inch holes along the length of the lip to permit mounting the panel to the plywood base.

Machine the panel and mount on it the meter movement, integrated LED assembly (or discrete LEDs), switches, and two three-lug terminal strips. This done, mount the panel to the top front of the plywood base with ¾-inch-long roundhead wood screws.

Wire the circuit as shown in Fig. 1. Note that separate #24 wires are used as voltage sensors and are run in parallel with the large #4 cables that carry the actual current. The #24 wires are used to measure the voltage at the battery before any voltage drops in the cable resulting from the high-current flow through *R3*. When installing the #24 wires, route them along the #4 cables and use either lacing cord or tape to bind wire and cable together. Finish the assembly by attaching large Mueller clips or jumper-cable clamps to the free ends of the #4 cables.

Use. To use the tester, connect the two Mueller clips (or clamps) to the battery/charger system (at the battery's terminals) in the vehicle you wish to test and set *S2* to POLARITY. If the LED glows green, the tester is properly connected, but if the LED glows red, reverse the connections to the battery.

Continued on page 126

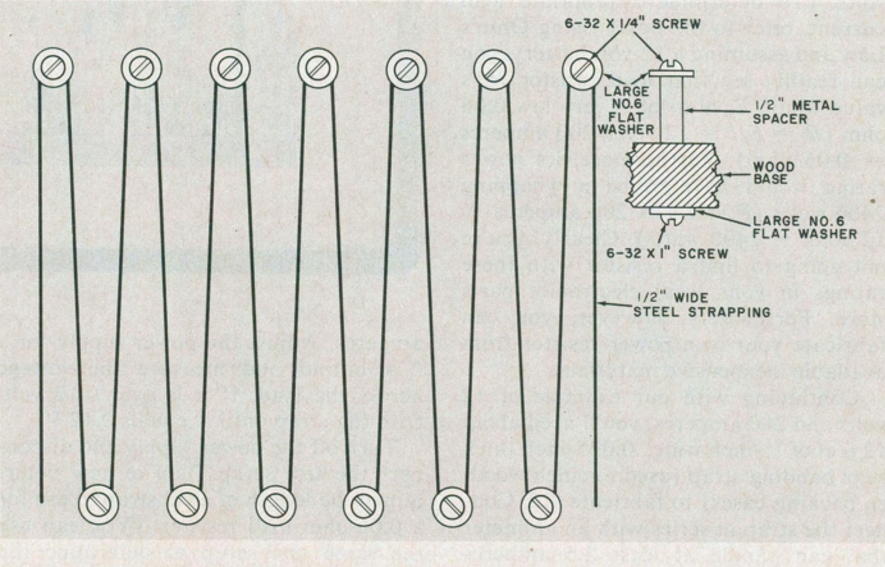


Fig. 2. Using this diagram as a guide and following instructions in the text, you can make up your own load resistor from ½-inch steel banding strap.

battery tester

(Continued from page 122)

Now set *S2* to VOLTAGE; the meter should indicate between 10 and 13 volts. Press and hold LOAD switch *S1* for no longer than 5 seconds (the limit because as *R2* heats up, from the current flowing through it, its resistance increases) and note the meter indication. A fully charged battery should indicate 10 volts or more.

Release *S1* but leave *S2* set to VOLTAGE. Start the vehicle's engine. The meter's pointer should now swing up-scale to a point between 13 and 15 volts as the vehicle's charging system comes into play. If you obtain abnormally low readings at any time, try fully recharging the vehicle's battery and repeat the tests. If the condition still persists, the battery is most likely bad.

You should periodically "load test" your vehicle's battery, say, once a month. Regular testing will help you keep track of the battery's condition and can also indicate preventive maintenance steps to keep it delivering maximum current for as long as possible. Periodically clean the battery terminals and connectors and, unless yours is a sealed, "no-maintenance" type, check the liquid level in each cell often and add distilled water where necessary. ◇

SELECTING A LOAD

Battery testers used by professionals have built-in load resistors specifically selected for testing a range of typical automotive battery power-delivery capabilities. As a general rule, load-resistance values are calculated from a simple formula that states that the load resistor should draw half of the battery's maximum current during a voltage measurement. Since automotive batteries are usually rated in watts, rather than current-delivery capability, it is necessary to first convert to current before you can calculate the load resistance.

Using the standard power formula $P = IE$ (P is rated battery power, I is unknown battery current, and E is battery voltage), we obtain $I = E/P$. Now, let's assume the battery is rated at 12 volts and 4800 watts. First, we divide the power rating by 2, obtaining 2400 watts. Plugging these values into the formula, we get $I = P/E =$ 2400 watts/12 volts = 200 amperes.

Now, use Ohm's Law to calculate the resistance of the load: $R = E/I$, where R is load resistance, E is battery voltage, and I is test current (calculated above). Continuing our example, we obtain $R =$ 12 volts/200 amperes, or 0.06 ohm. Therefore, for a typical 12-volt, 4800-watt automotive battery, the load resistance should be 0.06 ohm at 2400 watts.

Using the procedure described above, you can calculate the required load resistor's parameters for any battery voltage/power ratings.