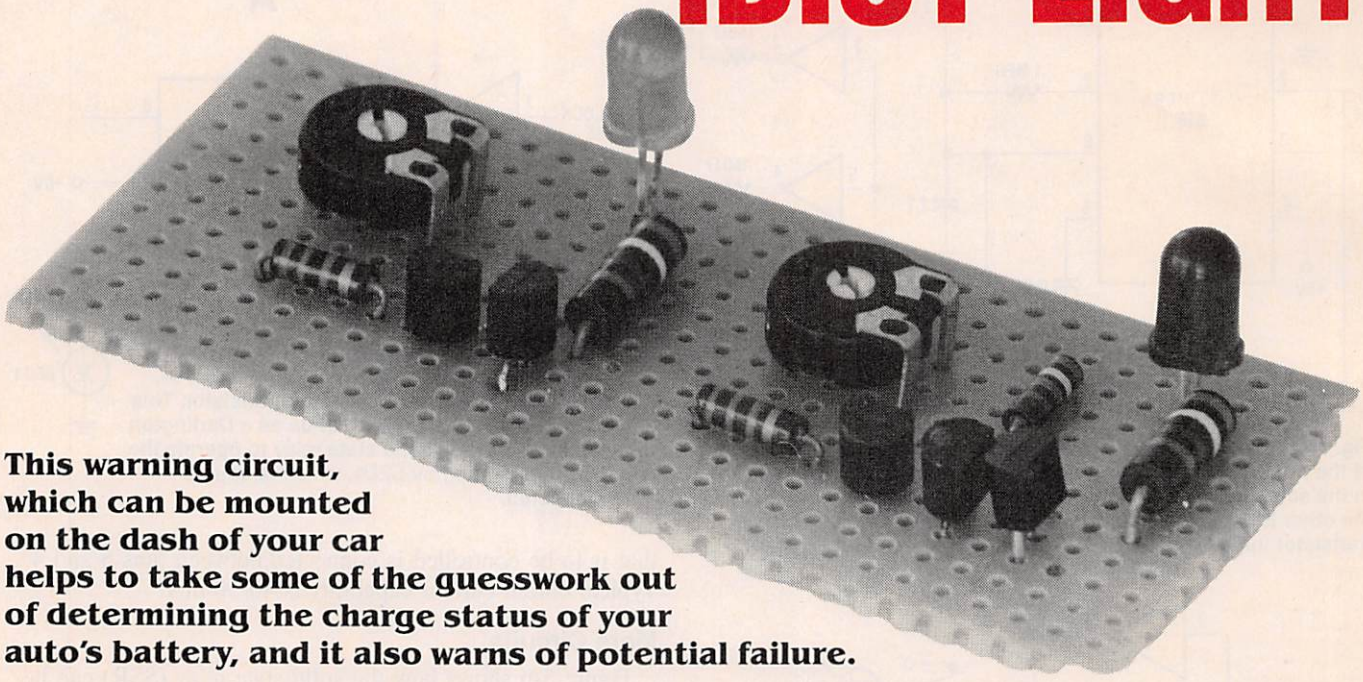
INTELLIGENT IDIOT LIGHT



This warning circuit, which can be mounted on the dash of your car helps to take some of the guesswork out of determining the charge status of your auto's battery, and it also warns of potential failure.

By Evert Fruitman

IF YOU'VE EVER BEEN STRANDED ON A LONG STRETCH OF road out in the middle of nowhere because of a battery failure, then you surely know what a blessing it would be to have your car outfitted with an "early warning system" to alert you to impending danger. I, myself, recently experienced just such an event: While driving down the road, my engine gave off a loud thumping and hissing sound just before the temperature gauge lit, glaring at me from the car's dashboard. A quick check showed that a fan belt had let go without the courtesy of some advance warning. The alternator light didn't glow because it had be left unconnected during a recent repair, in which the regulator had been replaced.

After fixing the problem, I decided that it was time to think about a warning system or perhaps a status indicator that would show whether things where working correctly, as well as giving indications that something had failed. At one time, auto manufacturers equipped their cars with meters. A glance at the instrument panel showed the oil pressure in pound per square inch, water temperature in degrees Fahrenheit, and the battery-charge rate in amperes.

But then someone in Detroit became aware of the fact that the average motorist didn't have a clear understanding of what the gauges meant, and that a bright red light would get attention faster than a wiggling needle. The fact that two bulbs cost less and take up less panel space than meters didn't escape their attention either. And so, the auto makers replaced the gauges with the glowing red lamps that we've all become accustomed to.

New Problems

Regrettably, the lights signal their warning only after something has failed. If the light is off, then the system must be working OK, right?—wrong! Indicators often fail to do their job for one reason or another. And on other occasions, by the time the light turns on, a critical system can be close to a dangerous failure. Case in point: My indicator glowed only after the cooling system was on the brink of a disaster. With those things in mind, and the smell of my steaming engine still in the air, I headed for the workshop and swing my hot soldering iron into action.

Since outboard meters can be hard to read in the dark, I decided to stick with lights, but they would have to be Intelligent Idiot Lights. I wanted a green light to signal when the battery had reached the safe-charge zone, 13.5–14.4 volts, and red to signal when the battery voltage dropped below 12.7 volts. Between those two limits, I would have a good indication that the charging system and the warning system were both working. You could look at the warning system as simple, single-range voltmeters with light-emitting diode (LED) outputs to show when the input voltage is above or below preset limits.

How It Works

Figure 1 shows that only five components make up the basic indicators. The potentiometer, R1, samples the battery voltage and delivers a percentage of that potential (deter-

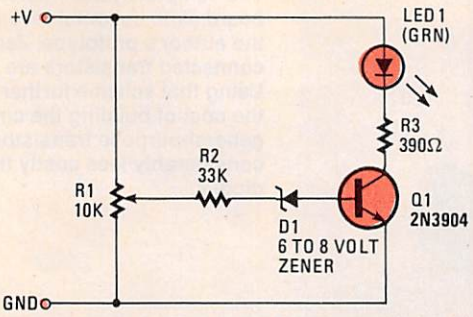


Fig. 1—The basic design of the Intelligent Idiot Light consists of only five components. The transistor (Q1), acting as a switch, turns LED1 on or off. That switching action is determined by the setting of R1 and the voltage presented to the base of Q1.

mined by the setting of R1) to current-limiting resistor R2. When that value exceeds the transistor's emitter-base junction voltage, plus the Zener voltage, the transistor turns on like an on/off switch. That causes current to flow through the LED1, and R3. Resistor R3 limits the current flowing through the LED and the collector circuit to a safe level. Although the circuit would still work without it, the Zener diode provides temperature compensation and a relatively sharp turn-off characteristic.

More gain would give millivolt resolution at the expense of additional parts; but in this application, it's not required. The second LED driver (see Fig. 2) has more gain and switches faster, but only because Q2 is included as a phase inverter, which turns LED2 on when the applied voltage dips below the desired level. Although it is possible to combine the two circuit functions and save a few parts, the final version (shown in Fig. 3) uses separate transistors and diodes for the Normal and Low indicators to simplify construction and give greater reliability.

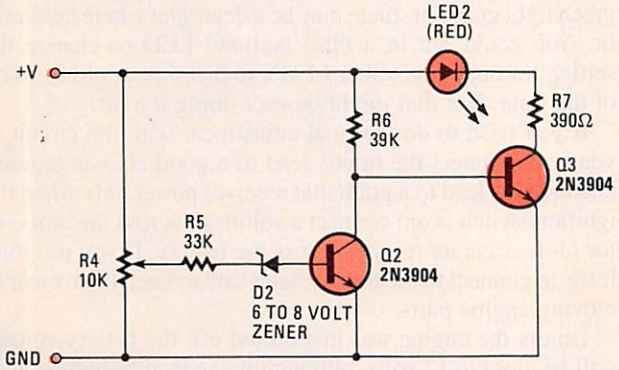


Fig. 2—Although this circuit is basically the same as that shown in Fig. 1, the light-emitting diode, LED2, turns on only when the voltage at the base of Q2 is below the reference voltage determined by potentiometer R4. Note that in addition to the the five components used in Fig. 1, a few others have been added. Transistor Q2, acting as an inverter and whose output drives Q3, provides additional gain for the operation of the circuit.

A Panoramic View

Refer to Fig. 3. With the Intelligent Idiot Light circuit connected across the the battery, as long as its voltage level remains at or above the preset level, Q1 is held on by the potential applied to its base. When Q1 conducts, current flows through the LED1, causing it to light. That shows that the charge-circuit output is at a normal level. At the same time, Q2 is held on by the voltage applied to its base. With Q2 turned on, the base of Q3 is held low; thus it is turned off—no current flows through LED2 so it remains dark.

But when the +V input falls below the preset threshold, Q1 and Q2 turn off. With Q2 off, the level of voltage at the base of Q3 is increased and causes the transistor to turn on. When that transistor turns on, current flows through LED2, which is in the collector circuit of Q3, and the light-emitting diode lights to show that the alternator voltage has dropped below the acceptable level.

Construction

The parts fit comfortably on a 1½-inch by 3-inch piece of perfboard (see photo), which also provides an easy-to-follow layout. Since I used the cheaper light-emitting diodes, which need about 20–30 mA, the resistors in series with them in the collector circuits of Q1 and Q3 had to be ½-watt units. Better grade LED's with lower ratings can cut power-supply requirements by as much as ¾, allowing you to use ¼-watt resistors throughout.

PARTS LIST FOR THE INTELLIGENT IDIOT LIGHT

(Refer to Figure 3)

SEMICONDUCTORS

D1, D2—6- to 8-volt Zener diode, or Zener-connected transistor (see text)
LED1—Jumbo green light-emitting diode
LED2—Jumbo red light-emitting diode
Q1, Q2, Q3—2N3904 or 2N2222 NPN general-purpose, silicon transistor

RESISTORS

(All resistors ¼, 20% or better unless otherwise noted.)
R1, R4—10,000-ohm, miniature potentiometer
R2, R5—33,000-ohm
R3, R7—390-ohm, ½-watt
R6—39,000-ohm (see text)

ADDITIONAL PARTS AND MATERIALS

Prefboard or printed-circuit materials, project box (optional), solder, wire, mounting hardware, etc.

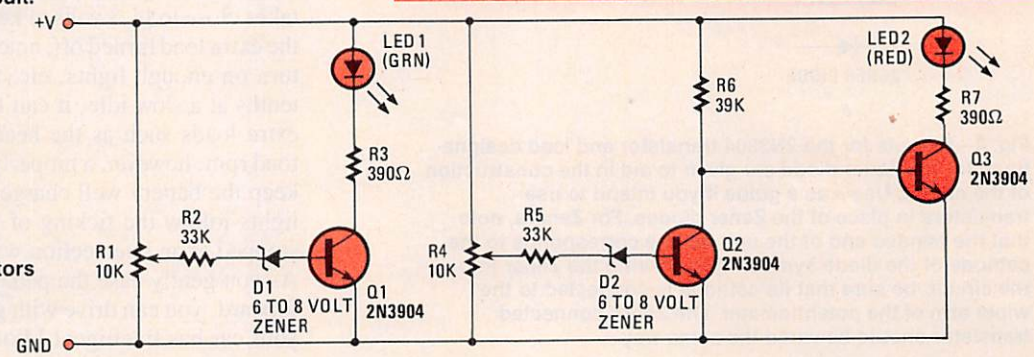
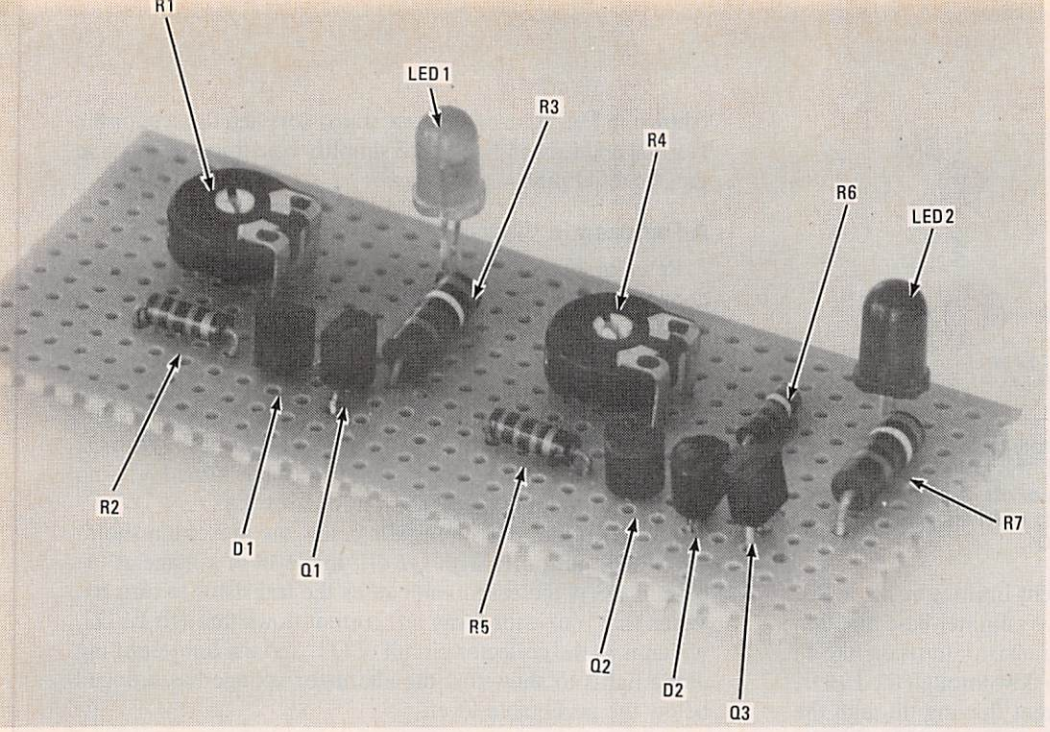


Fig. 3—The circuits of Fig. 1 and Fig. 2 are combined to produce a fully operational Intelligent Idiot Light circuit. Although the schematic diagram calls for 6 to 8-volt Zener diodes, Zener-connected general-purpose silicon transistors may be substituted (that procedure is outlined in Fig.4).



The completely assembled circuit board (with callouts) reveals that in the author's prototype, Zener-connected transistors are used. Using that scheme further reduces the cost of building the circuit, as general-purpose transistors are considerably less costly than Zener diodes.

The Zener diodes, mounted next to the 33,000-ohm resistors are really transistors: A small-signal, silicon transistor with its emitter/base junction reverse-biased makes an excellent Zener diode. Besides that, a Zener diode would cost about a dollar; whereas, transistors like the 2N3904, 2N2222, and other similar devices cost about 15 cents each, and are more likely to be found among your spare parts. Figure 4 gives the proper connections. Note that the base of the Zener-connected transistor (acting as the anode) is connected to the negative bus, while the emitter, which is effectively the cathode, goes to plus.

Whether you use perfboard or decide to make a printed-circuit board on which to mount your components, the circuit may be housed in a small project box. Or, if you want to save space, the board may be mounted directly on or under the dash in an out-of-the-way place and the two light-emitting diodes, LED1 and LED2, on a separate board. Then you can run thin (speaker) wire to the LED's and place them where they'll show without having to hunt for them.

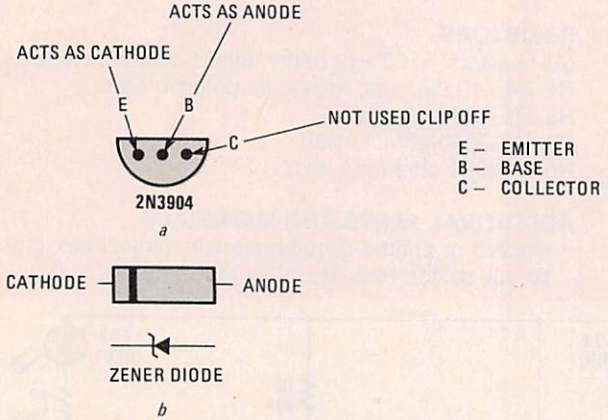


Fig. 4—Pinouts for the 2N3904 transistor and lead designations for the Zener diode are given to aid in the construction of the circuit. Use *a* as a guide if you intend to use transistors in place of the Zener diodes. For Zeners, note that the banded end of the unit outline corresponds to the cathode of the diode symbol. When wiring the Zener into the circuit, be sure that its cathode is connected to the wiper arm of the potentiometer. The Zener-connected transistor should be wired the same way.

Calibration

After completing construction, you can set the controls with the aid of an adjustable power supply and a voltmeter, or with the aid of your car (battery) and a voltmeter. If you use the power-supply method, set it for a 12.5–12.7-volt output and adjust control R4 so that the red LED turns on. Run the voltage up and down while noting the voltage at which the red LED turns on and off. It should turn on very close to the desired point and stay on as long as the voltage is below that value. At about 4–5 volts it will fade out due to a lack of available power.

To set the control for the green LED, turn the voltage up to 13.5 volts, and set control R1 so that the green LED just turns on. Then turn the voltage up to 14–16 volts. The green LED should get brighter. As you turn the voltage down and the green light goes out, there may be a dead spot where neither is lit. You could put in a third (yellow) LED or change the setting for one of the other LED's so that one would be lit all of the time. But that might be over doing it a bit.

If you wish to do the final adjustment with the circuit in your car, connect the minus lead to a good chassis ground, and the plus lead to a point that receives power only when the ignition switch is on; connect a voltmeter across the unit—or for more accurate results, across the battery. If you use long leads to connect to the battery, take care to keep them clear of moving engine parts.

Unless the engine was just turned off, the battery voltage will be close to 12 volts, although it can read as high as 12.7 volts for a few minutes after getting a good charge. Check the battery voltage with the engine off; and if the voltage is high enough, set the red LED control. If it is too low, start the engine and change the alternator load by turning on lights, blowers, etc., to get a suitable voltage around 12.7 volts.

Some cars give a full charge at 13.7 volts. My old Chevy takes close to 14.3 volts to keep the battery charged. So, with the extra load turned off, note the voltage on your battery, then turn on enough lights, etc. to drop the voltage two to four-tenths at a slow idle, it can't keep the alternator up with the extra loads such as the headlights and blowers. At normal road rpm, however, a properly operating charging system will keep the battery well charged. Don't be surprised to see the lights follow the ticking of your turn signals when you are stopped at an intersection with the headlights and heater on. As you gently ease the pedal down and the car quickly rolls forward, you can drive with greater confidence, knowing that your car has Intelligent Idiot Lights. ■