Car Headlights Reminder

Alarm automatically sounds an audible alert and provides visual indication to tell you to turn on your vehicle's headlights at dusk

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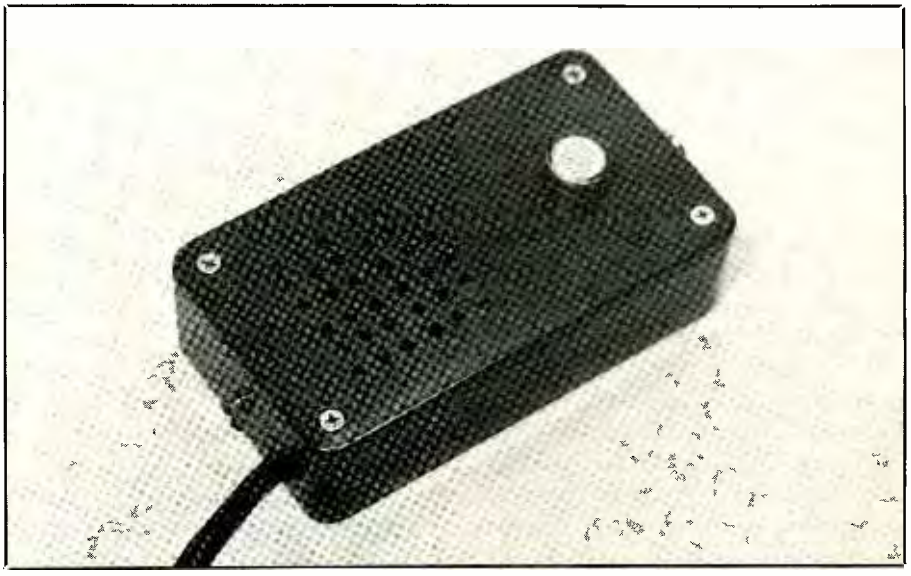

Here is a handy little device that will remind drivers to turn on the headlights of their automobiles as night descends. Called the "Headlights Reminder," it sounds an audible alert and illuminates a light-emitting diode as lighting conditions become too low to provide enough visibility for other drivers and pedestrians to see your car. Once the alarm triggers, it continues to sound for 5 to 10 seconds, long enough to alert you even under conditions of high traffic noise. It then silences.

Our Headlights Reminder can be designed to be plugged into the cigarette-lighter receptacle on the dashboard of your car, or it can be wired directly into the car's electrical system. Installation is simple and straightforward. All you need do is mount the project in a location inside the passenger compartment where it will easily be heard and is out of the way and connect it to chassis ground and any point that is at +12 volts with the ignition on and is at 0 volt with the ignition off.

About the Circuit

Shown in Fig. 1 is the complete schematic diagram of the Headlights Reminder circuit. As you can see, the circuit is divided into three separate function blocks—a power timer, a light-level decision circuit and a pulsed tone oscillator.

The purpose of the power timer function is to provide control of power to the rest of the circuit when the ignition switch of the vehicle in which the project is installed is on and to shut off the project 5 to 10 seconds after an alert is triggered. The light-level decision circuit monitors ambient light conditions and turns on the pulsed tone generator and LED if the detected light level is less than a certain preset threshold. The pulsed tone generator merely provides a pleasant "beeping" sound that serves as the audible alert.

Operation of the circuitry begins with turning on of the vehicle's ignition. When power is first applied to the circuit, resistor *R1* and capacitor *C2* provide a trigger pulse to input pin 2 that sets 555 timer *IC1* into operation. The 555 is configured here as a retriggerable one-shot multivibrator. It has an output pulse at pin 3 whose width is determined by the values of resistor *R2* and capacitor *C4*. This positive pulse turns on transistor *Q1* to provide +12 volts to the rest of the circuit.

When the pulse from the output of *IC1* goes low once again, *Q1* is biased into cutoff. At this time, power to the rest of the circuit is cut off. The maximum on time (output pulse from *IC1* positive) is approximately 10, seconds and is set by trimmer control *R4*. Diodes *D1* and *D2* and capacitor *C1* clean up the +12-volt supply line to assure reliable operation.

Switching *Q1* into conduction

causes the light-level decision circuit to become active. Cadmium-sulfide photocell *PC1* has a low resistance when fairly bright light is striking its sensitive surface and a high resistance when the device is in darkness. The photocell is not a simple on/off device but, rather, a variable-resistance device whose actual resistance at any given moment depends on the amount of light striking its sensitive surface.

Note here that photocell *PC1* is one element in a series voltage divider made up of this device and resistors *R4* and *R5*. Consequently, the actual potential delivered to the noninverting (+) input at pin 3 of comparator *IC2* depends on the level of light striking the sensitive surface of the photocell at any given moment.

Inverting (−) input pin 2 of *IC2* is connected to the middle of a second voltage divider, this one made up of *R6* and *R7*. The values of these two resistors are the same. Hence, the potential delivered to pin 2 of *IC2* is one-half the supply voltage, or +6 volts. This potential does not vary and, thus, serves as the reference against which the input at pin 3 of the IC is compared.

When trimmer potentiometer *R4* is set to the desired range, voltage comparator *IC2* switches on when the input at pin 3 exceeds +6 volts. At this point, transistor *Q2* is biased into conduction and couples +12 volts to the pulsed tone generator circuit and turns on light-emitting diode *LED1*.

The pulsed tone generator is a two-stage regenerative-feedback oscillator, with each stage made up of two of the four AND gates inside *IC3*. Each stage generates a tone at a different frequency, with the tone generated by the stage made up of *IC3C* and *IC3D* coupled from output pin 11 to input pin 1 of the stage made up of *IC3A* and *IC3B*. Thus the first tone "modulates" the second one. The resulting combined tone, available at output pin 4 of *IC3B*, is coupled through *C7* to speaker *SPKR*.

Frequency of oscillation is governed by the values selected for the resistor and capacitor elements in

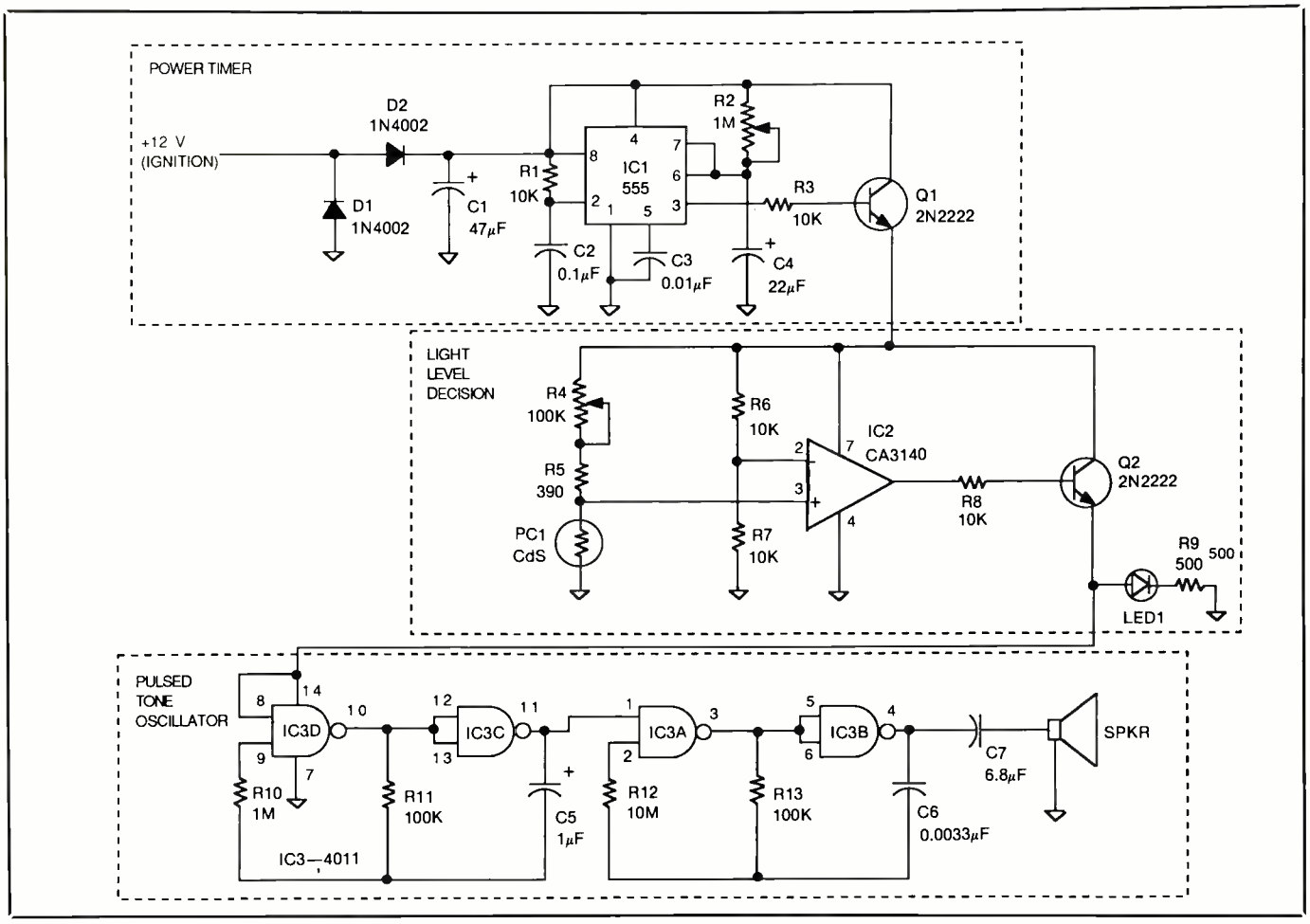

Fig. 1. Complete schematic diagram of the Headlights Reminder circuit.

PARTS LIST

Semiconductors
D1,D2—1N4002 or similar silicon rectifier diode
IC1—555 timer
IC2—CA3140 voltage comparator
IC3—4011 quad 2-input NAND gate
LED1—Green 50-mA light-emitting diode
Q1,Q2—2N2222 or similar general-purpose npn silicon transistor

Capacitors
C1—47-μF, 25-volt electrolytic
C2—0.1-μF Mylar or polyester
C3—0.01-μF Mylar or polyester
C4—22-μF, 25-volt electrolytic
C5—1-μF, 25-volt electrolytic
C6—0.0033-μF Mylar or polyester (see text)
C7—6.8-μF, 25-volt nonpolarized

Resistors (¼-watt, 5% tolerance)
R1,R3,R6,R7,R8—10,000 ohms
R5—390 ohms
R9—500 ohms
R10—1 megohm
R11,R13—100,000 ohms
R12—10 megohms
R2—1-megohm pc-mount trimmer potentiometer
R4—100,000-ohm pc-mount trimmer potentiometer

Miscellaneous
PC1—Cadmium-sulfide photocell (Radio Shack Cat. No. 276-116A or similar)
SPKR—Miniature 8-ohm speaker (Radio Shack Cat. No. 40-245 or similar)
Suitable circuit board (Radio Shack Cat. No. 276-150 experimenter board—see text); suitable enclosure (Radio Shack Cat. No. 270-221 project box—see text); standoffs; Velcro fastener (see text); power cable terminated in automotive cigarette-lighter plug (optional—see text); machine hardware; stranded hookup wire; solder; etc.

each oscillator stage. The low-frequency output signal from the first stage modulates the higher-frequency signal developed by the second stage. The frequency of the audible tone is best changed by changing the value of capacitor *C6*. A value of 0.01 microfarad sounds like a "busy" signal on a telephone, while a value of 0.0033 microfarad generates a tone that is higher in pitch.

Once triggered, the pulsed tone from the oscillator will be heard from the speaker (and the light-emitting diode will remain on) until the power timer circuit times out. When the timed period is done, *Q1* will be cut off and the rest of the circuit will be deprived of power. At this time, the LED will extinguish and the tone will be silenced.

Construction

Owing to its basic simplicity and the fact that nothing is critical about component layout and lead routing, you can assemble the Headlights Reminder circuit using just about any traditional wiring approach. For example, you can design and fabricate your own printed-circuit board, use a readily available "project board" with pre-drilled holes and solder pads or use perforated board with holes on 0.1-inch centers and suitable soldering or Wire Wrap hardware. The prototype of this project, shown in Fig. 2, was assembled on a Radio Shack project board.

Trim the circuit board material you have chosen to a size to fit inside the selected enclosure. If you are using an all-plastic enclosure, such as the one mentioned in the Parts List, cut whatever notches are necessary in the board for it to clear any internal hardware posts or other obstructions.

Whichever method of assembly you choose, it is a good idea to use sockets for the ICs. Use only premium sockets that assure positive gripping action so that the ICs will not work loose from them under the severe mechanical vibrations that normally occur in the automotive environment. However, if you cannot find sockets that will bear up to mechanical stresses, it is better to do without altogether and wire the ICs directly into the circuit. If you go this route, save installation of the ICs themselves until after you have performed preliminary voltage checks. Try to keep the circuit as compact as possible to permit mounting it inside a small enclosure that can be conveniently tucked away inside the passenger compartment where it will not get in the way.

Begin construction by mounting the IC sockets in their respective locations on the board. You can install the ICs in the sockets after you finish wiring the circuit-board assembly. When you do so, make sure each is in the correct socket and is properly oriented. Also, make sure that no pins overhang the sockets or fold under between ICs and sockets.

As you install each component on the board and wire it into the circuit, make sure it has the correct value or is the correct type before soldering any connections. Also, make certain you place polarity-sensitive components like diodes, electrolytic capacitors and ICs in the proper orientation on the board.

Mount the two trimmer controls—*R2* and *R4*— on the bottom, or wiring, side of the circuit board. This allows you to conveniently access their adjustment slots from holes drilled through the floor of the enclosure without having to open the enclosure. If the controls were mounted on the top of the board with the other components, they would not be accessible because of how the speaker is mounted to the top panel.

Note that the speaker mounts off the board and that you have the option of mounting the photocell directly on the board or on the top panel of the enclosure in which the circuit-board assembly will be housed (see Fig. 3). If you choose the former,

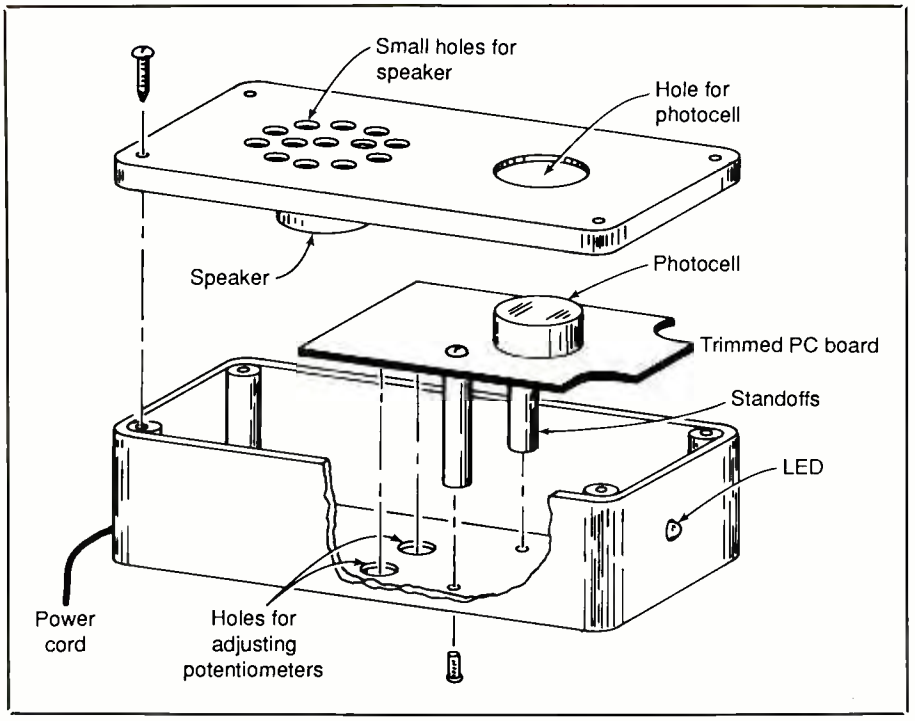

Fig. 2. Assembly details for project. Here, the photocell is shown mounted on the circuit board behind a circular cutout.

you must cut a hole in the top panel of the enclosure the same size as the top of the photocell to permit light to get at the sensitive surface of *PC1*. If you decide to mount the photocell on the top panel, make sure to drill holes for its leads or pins and interconnect it with the circuit-board assembly with stranded hookup wires.

Having wired the circuit-board assembly, proceed to preparing the enclosure. For the enclosure, you can use any type of project box that will comfortably accommodate the circuit-board assembly and speaker. You can use any of the commonly available project boxes on the market—all-plastic, plastic with a metal front panel or all-metal. The easiest to machine is all-plastic, of course, and such a one is mentioned in the Parts List.

Refer to Fig. 2 for details on preparing the enclosure. As you can see, the speaker mounts on the front panel, behind a series of holes drilled in the panel to allow the sound to escape. The light-emitting diode mounts in a hole drilled through one end wall of the enclosure. Size the hole for the LED for a press fit.

Now machine the main enclosure box as follows: First, drill two holes for mounting the circuit-board assembly inside the enclosure. Drill a third hole for routing the power leads to the circuit-board assembly. If you are using an all-metal enclosure, deburr this hole and line it with a small rubber grommet. Next, drill two ¼-⅜-inch holes exactly in line with where the adjustment slots of trimmer controls *R2* and *R4* will be when the circuit-board assembly is mounted in place.

Determine where inside the passenger compartment of your car you will mount the project. Pull apart the loop and hook portions of a 3-inch-long by about ¾-inch-wide piece of Velcro fastener strip. Cement in the selected location the strip that has the loops. Cement the other strip along one of the long side walls of the enclosure. For permanence, use fast-setting epoxy cement.

If you mounted the photocell directly on the circuit board, determine where the hole for it must be in the top panel of the enclosure. Unless you have a very large bit and a slow-speed drill, you will not be able to drill this hole directly. Fortunately, you can make quick work of the job with a nibbling tool or even a smaller drill bit and a tapered reamer.

If the photocell is to be mounted off the board, drill holes for its pins and leads in the appropriate locations of the top panel. If your photocell has solid wire pins, crimp and solder to each a 3-inch length of stranded hookup wire and feed the free ends of these through the holes. Otherwise, pass the free ends of the wire leads that come on the photocell through the holes. Mount the photocell in place with quick-setting epoxy or silicone cement. Then mount the speaker in place with a thick bead of silicone cement, centering it over the holes you drilled to permit the sound to escape. Set aside the panel assembly to allow the cement to set.

Meanwhile, prepare the power cable for the project. Use only heavy-duty stranded hookup wire for the cable. As mentioned above, you can select either of two options here. One is to terminate one end of the cable in a standard automotive cigarette-lighter plug; the other is to permanently wire the project into the vehicle's electrical system.

Whichever method you choose to go with, determine how long the two wires for the power cord must be and cut both to size. It is a good idea to use color-coded insulation here, black for vehicle ground and red for +12 volts. Strip ¼ to ⅜ inch of insulation from one end of both wires, tightly twist together the fine conductors at the stripped ends and sparingly tin with solder.

If you decided to permanently wire

the project into your car's electrical system, no terminating connector or plug is needed. However, if you decided to use the cigarette-lighter plug, crimp and solder the wires to the appropriate lugs on the plug. In most cases, the lug that goes to the center pin of the plug is the +12-volt contact. However, use a dc voltmeter or a multimeter set to the dc-volts function to check this before making the connections.

If you opted for the project to be permanently wired into your vehicle's electrical system, find a conductor in the system that is at 0 volt with the ignition turned off and at +12 volts with the ignition turned on.

With the ignition turned off, cut through the selected lead and strip ½ inch of insulation from both cut ends. Slide a 1½-inch length of small-diameter heat-shrinkable tubing over one end. Then twist together the fine wires at the cut ends to form an in-line splice and solder the connection. Remove an additional ¼ inch of insulation from the prepared end of the red-insulated wire and wrap this end around the in-line splice and solder this into place. Center the heat-shrinkable tubing over the connection and shrink it into place.

Terminate the stripped end of the black-insulated wire you prepared in a spade or ring lug and fasten this to the vehicle's chassis ground via an existing screw. Before doing so, however, remove the screw and rub down the area around the hole with fine emery cloth to obtain a bright metallic surface that will assure a good electrical connection.

If you terminated the wire in a ring lug, place this on the screw end, follow with an outside-tooth lockwasher and drive the screw solidly back into the hole from which it was removed. If you terminated the wire in a spade lug, place an outside-tooth lockwasher on the end of the screw and start the screw back in the hole. Slide the spade lug between screw head and lockwasher and fasten down the screw.

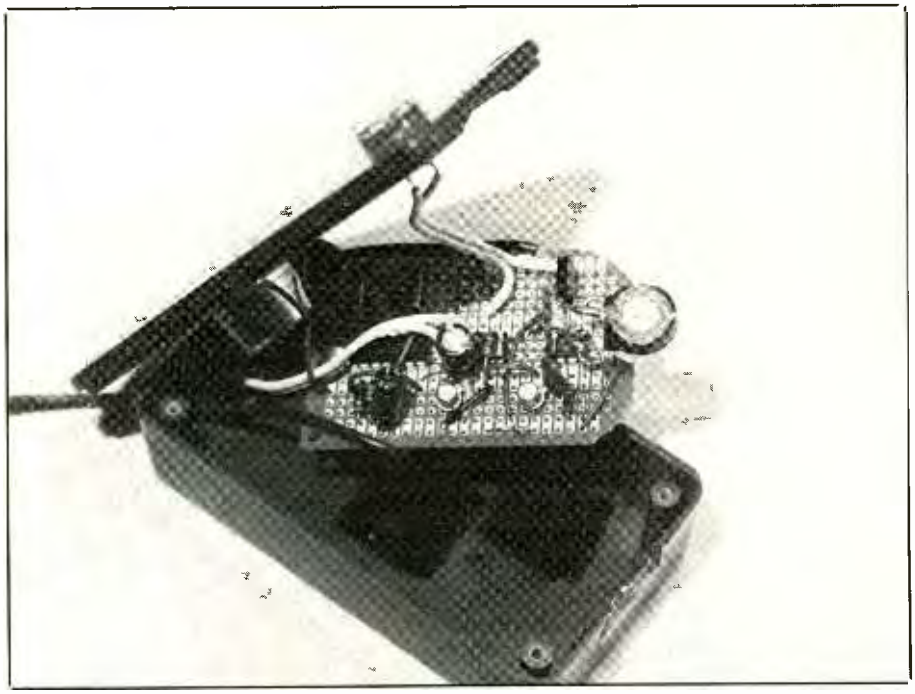

Fig. 3. An alternative way to build the project, with the photocell mounted on the front panel of the enclosure. No holes are drilled through the floor of the enclosure for access to the adjustment slots of the trimmer controls.

Whether you are using the cigarette-lighter plug or permanent electrical connection, loosely twist together the two wires and feed them through the hole you drilled for entry of the power cable or the rubber-grommet-lined hole. Tie a strain-relieving knot in the wire pair about 5 inches from the free end inside the enclosure. Then strip ¼ inch of insulation from the black-insulated wire, tightly twist together the exposed conductors and sparingly tin with solder. Connect and solder this wire to the ground bus of the circuit-board assembly. Repeat with the red-insulated wire, connecting this to the junction between *D1* and *D2* on the circuit-board assembly.

Strip ¼ inch of insulation from both ends of four (six if the photocell requires extra wire leads) 4-inch lengths of stranded hookup wire. Tightly twist together the fine conductors at both ends of all wires and sparingly tin with solder. Connect and solder one end of two of these wires to the emitter of *Q2* and free end of *C7* and another two wires to any convenient ground points in the circuit. If you mounted the photocell off the board, connect and solder another pair of wires to the junction between *R5* and pin 3 of *IC2* and another convenient ground point.

Now crimp and solder the wires coming from *C7* and ground to one lug of the speaker. Similarly, crimp and solder the wires coming from the junction of pin 3 of *IC2* and *R5* and ground to the off-the-board photocell. The two remaining wires will be terminated later, after the circuit-board assembly is mounted inside the enclosure.

Clip the cathode lead of the LED to ½ inch in length and form a small hook at the end of the stub. Slide a ½-inch length of small-diameter heat-shrinkable tubing over the free ends

of a ground wire and the wire coming from the emitter of *Q2*. Crimp and solder the free end of the ground wire to the cathode lead of the LED. Then trim the anode lead of the LED to ½ inch, form a small hook in its end and crimp and solder the free end of the wire coming from the emitter of *Q2* to the anode lead of the LED. Slide the heat-shrinkable tubing over both connections and flush against the bottom of the case of the LED and shrink into place.

Push the dome of the LED into its hole in the front panel. If the fit is loose, apply a small daub of fast-setting epoxy cement to keep the LED in place. If the photocell is mounted off the board, crimp and solder the ends of the remaining two wires coming from the circuit-board assembly to its pins, or simply connect and solder its existing wire leads to the appropriate points on the circuit board.

Mount the circuit-board assembly inside the enclosure with the aid of two standoffs and suitable-length machine hardware. Check that the adjusting slots are easily accessible with the blade of a thin screwdriver. Button up the project by fastening the front panel to the enclosure, and mount your Headlights Reminder in the selected location.

Checkout & Adjustments

When checking out and adjusting the project, you can use any dc power source capable of delivering +12 volts at at least 200 milliamperes, including the 12-volt electrical system of your vehicle. Before starting, though, set *R2* and *R4* to approximately the center of their rotation.

Turn on the dc power source (or turning on the ignition of the vehicle) while holding your thumb over the the photocell to simulate a dark condition. The project should beep and the LED should light. If the project does nothing, disconnect power from it and rectify the problem before proceeding.

Check all component installations for correct values and types and double-check all wiring against Fig. 1. Check particularly for improper orientations of the diodes, electrolytic capacitors, LED and transistors. Check also for any missed connections, connections you failed to solder and accidental short circuits.

When you are certain that your project is operating properly, adjust the setting of *R2* for the desired length of time you wish the beeping sound to continue.

Next, set the light threshold at which you want the project to trigger on by adjusting the setting of *R4*. To accomplish this, place the project in a fairly dark area in your car where the ambient level of light is similar to the lack of light level at which you want the project to trigger. Do this with no power applied to the project. Then when you apply power, if the tone sounds and the LED lights, adjust the setting of *R4* until no triggering occurs when you slightly increase the light level.

Final adjustment of threshold control *R4* should be done under actual changing of ambient-light conditions. Do this where street lighting will not influence the response of the project. **ME**