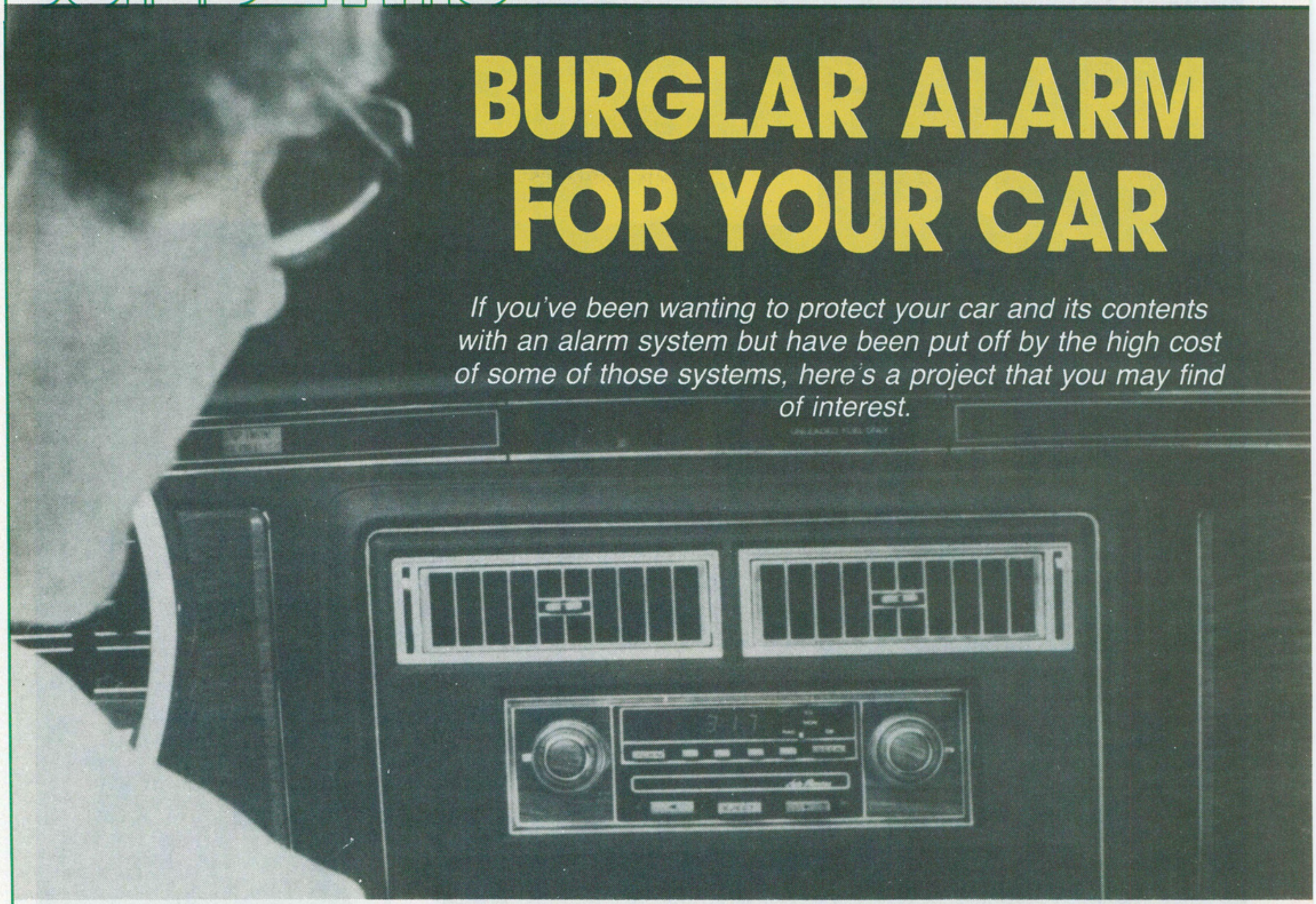


BURGLAR ALARM FOR YOUR CAR

If you've been wanting to protect your car and its contents with an alarm system but have been put off by the high cost of some of those systems, here's a project that you may find of interest.

EDWARD W. LOXTERKAMP

ABOVE ALL ELSE, A GOOD ALARM SYSTEM should offer adequate protection at an affordable cost. The project we'll be presenting here meets both those criteria. First of all, it monitors all possible entry points (doors, hood, etc.); a motion detector can even be added if desired. A relatively simple, compact timing system provides for an approximate 13-second delay upon opening the door, allowing you plenty of time to enter the car and disarm the system before the alarm sounds; the alarm sounds instantly when the hood is opened.

As far as cost goes, even if you use brand-new parts, you should be able to build the unit for about $25.00, excluding the siren. A good siren—one that's sure to be heard and noticed—should run you about another $20.00. If you compare that to some similar systems on the market the cost is quite reasonable, and you can reduce it a bit more if you have a reasonably well-stocked junkbox.

About the circuit

The schematic diagram for the circuit is shown in Fig. 1. Except for the siren, it requires 5 volts DC for operation. Since 12 volts is available from the car battery, getting that voltage is no problem if a voltage regulator is used. That's taken care of by IC6, a 7805 5-volt regulator. If that IC is properly heat sinked—and because of the power that the device must dissipate, it has to be—it can handle one amp.

You can use a standard TO-220 heat sink, but a better solution is to take a piece of aluminum measuring ¾ × 1 × ¼ inches and bend it 90°. The result is a less expensive heat sink, but more important, one that takes up less space. And since we're trying to make the circuit as compact as possible, every little bit helps.

Returning to IC6, its output will be 5-volts DC as long as the input is maintained above 7 volts. Capacitors C1 and C2 are used to filter the IC's output, and for stability. Those capacitors are tantalum types and must not be substituted for. The regulator's output is used to power all the circuit except the siren.

As for the siren, one side is connected directly to +12 volts (the car battery). The other side is connected through Q2, a TIP120 Darlington transistor, to ground. When 0.6 volt is applied to the base of Q2, it conducts, turning on the siren. Now let's turn to the interesting part of the circuit—how we get the siren to turn on only when we want it to...and when the thief does not.

Hood alarm

You'll want the alarm to turn on as soon as the hood is lifted in case someone tries to tinker with your engine or battery. That's why the hood sensor should trigger the alarm without any delay.

The sensor in the hood, S1, is a normally-closed switch that is open when the hood is closed. When that switch is open, the base of Q1 is pulled up causing pin 8 of IC1-a to be pulled high. That IC is half of a 556, a dual negative-edge-triggered monostable timer. Opening the hood will release the switch, thus closing it. That, in turn, will cause Q1 to conduct, and pull pin 8 low. That high-to-low transition triggers the timer and pin 9, its output pin, goes high. When that happens, Q2 conducts and the siren sounds. Once triggered, just closing the hood

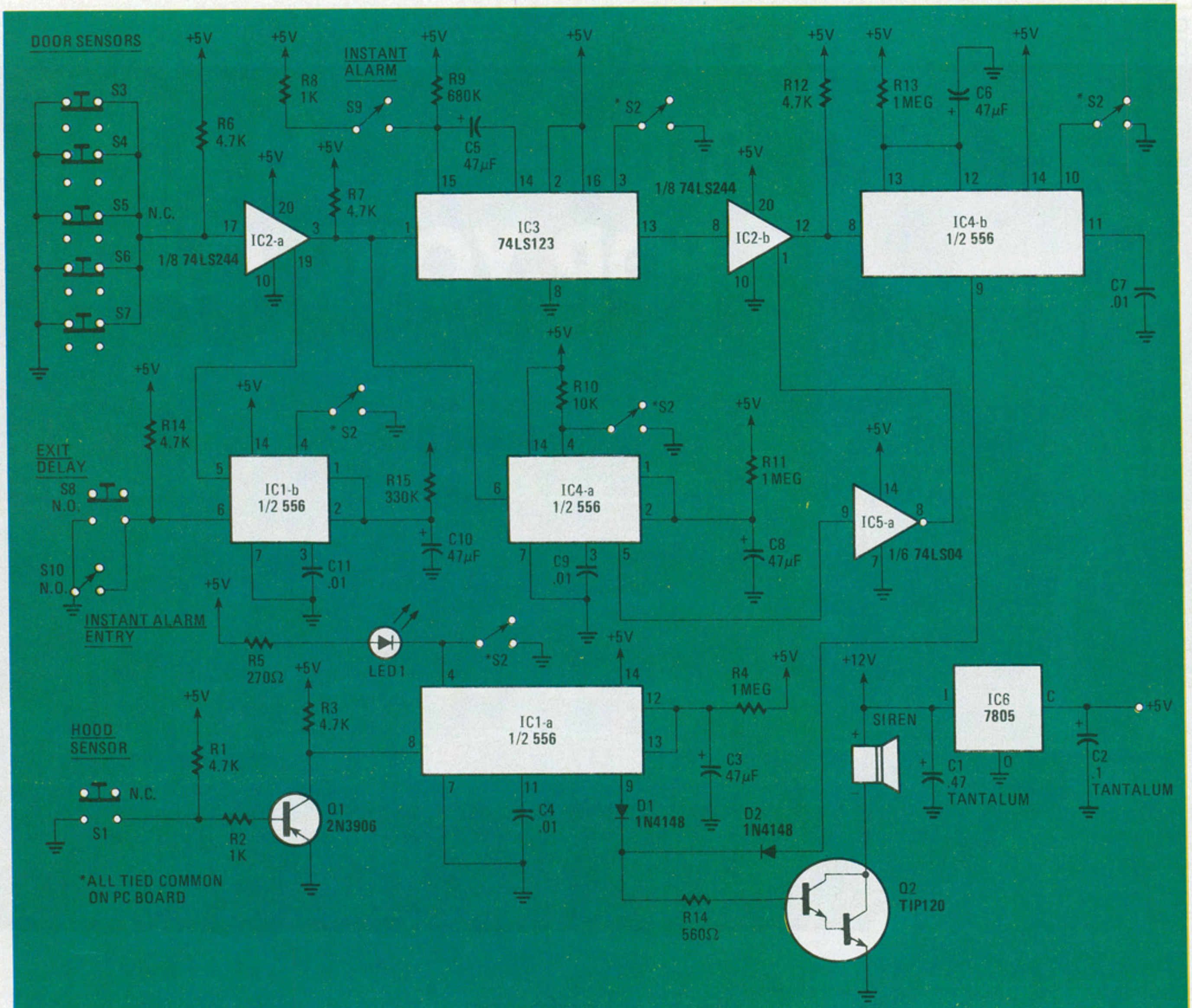


FIG. 1—SCHEMATIC DIAGRAM of the car alarm. This circuit offers reasonable protection at an affordable cost.

again will not turn the siren off. Switch S2, the master arm/disarm switch must also be thrown. If it is not, the siren will sound for a period set by the values of R4 and C3—about 52 seconds with the values shown in the schematic—before it turns off and the system is rearmed. (Note, however, that component-to-component variances can cause the alarm on-time to vary greatly from your calculated value. That on-time for this IC can be found from the formula: t = 1.1RC.) Diodes D1 and D2 are there simply to isolate the two timer-circuits from each other—D1 keeps IC4-b from outputting into IC1-a while D2 keeps IC1-a from outputting into IC4-b. We'll discuss the other timer circuit in a moment.

An LED, LED1, is connected to the reset pin (pin 4) of the timer and is off when the circuit is armed. When S2 is closed, the LED is forward biased and lights. Since closing the switch disarms the system, if the LED is lit the system is *dis*armed.

The circuitry for the other sensors differs in that it does not turn the alarm on instantly. Let's look at it next.

Door and hatchback sensors

The basic difference between the hood-sensor circuitry and the door- and hatchback-sensor circuitry is that the latter features a time delay. That delay allows you time to enter the car and disarm the system before the alarm sounds. It also allows you time to leave the car after you've armed the system.

When a door (or the rear hatch) is opened, one of S3–S7 closes, pulling pin 17 of IC2-a low, which in turn causes pin 1 of IC3 to go low. Integrated circuit IC2-a is a quad Tri-State buffer/driver (74LS244). Normally, it passes an input signal to its output unchanged, but when the input to pin 19 is high the output becomes high impedance. Looking into pin 3, it appears as if the device were not there at all. We'll see how that IC is used in this circuit a little later.

Let's now look at IC3, a 74LS123 dual one-shot that it is negative-edge triggered. When its pin 1 goes low, the device is triggered. Once that happens, there are only two ways to turn the alarm off—wait for the system to shut off automatically, or reset the entire system.

The length of the pulse output by IC3 is determined by the values of R9 and C5. When IC3 goes low, the signal passes through IC2-b (assuming that pin 1 is low) and triggers IC4-b. When that happens, pin 9 goes high and the alarm sounds. Pin 9 will remain high, and the siren will continue to sound, for a period of time determined by the values of R13 and C6.

Pin 1 of IC2-b goes high, putting that device into its high-impedance state, shortly after IC3 triggers the alarm. What happens is that, in addition to being fed to pin 1 of IC3, the signal from IC2-a is picked off and fed to another 556, IC4-a. The values of C8 and R11 are chosen so that the duration of that IC's output pulse

PARTS LIST

All resistors ¼-watt, 5%, unless otherwise specified
R1, R3, R6, R7, R12, R14—4700 ohms
R2, R8—1000 ohms
R4, R11, R13—1 megohm
R5—270 ohms
R9—680 ohms
R10—10,000 ohms
R15—330,000 ohms
R16—560 ohms

Capacitors
C1—0.47 μF, 25 volts, tantalum (do not substitute)
C2—0.1 μF, 25 volts, tantalum (do not substitute)
C3, C5, C6, C8, C10—47 μF, 25 volts, electrolytic, radial leads
C4, C7, C9, C11—.01μF, 25 volts, ceramic disc

Semiconductors
IC1, IC4—556 dual timer
IC2—74LS244 octal Tri-State noninverting driver
IC3—74LS123 retriggerable monostable multivibrator
IC5—74LS04 hex inverter
IC6—7804 5-volt regulator
Q1—2N3906 PNP transistor
Q2—TIP 120 NPN Darlington pair
D1, D2—1N4148 switching diode
LED1—red LED
S1, S3-S7—SPST momentary pushbutton, normally closed
S2, S9—SPST switch
S8—SPST momentary pushbutton, normally open
S10—SPST keyswitch, normally open

Miscellaneous: PC board, heat sink (see text), IC sockets, Molex connectors, wire, solder, etc.

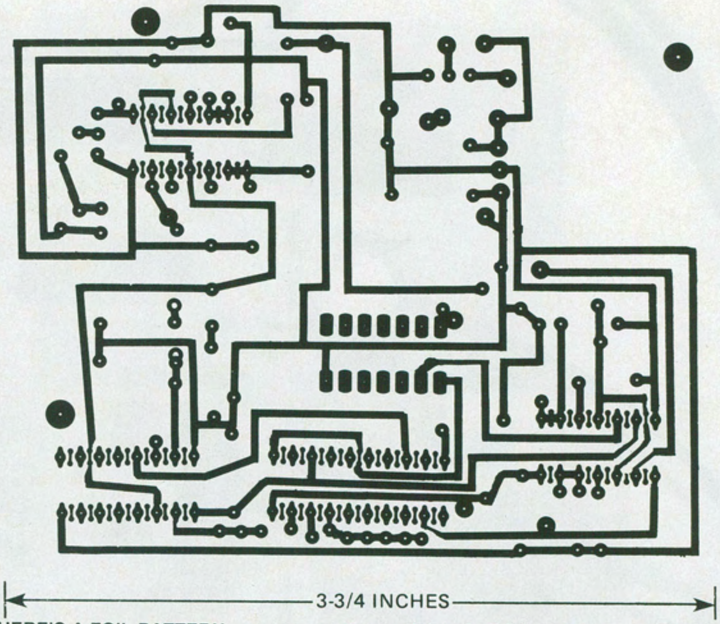


FIG. 2—HERE'S A FOIL PATTERN you can use if you wish to build the project on a PC board. Note, however, that almost any construction technique can be used.

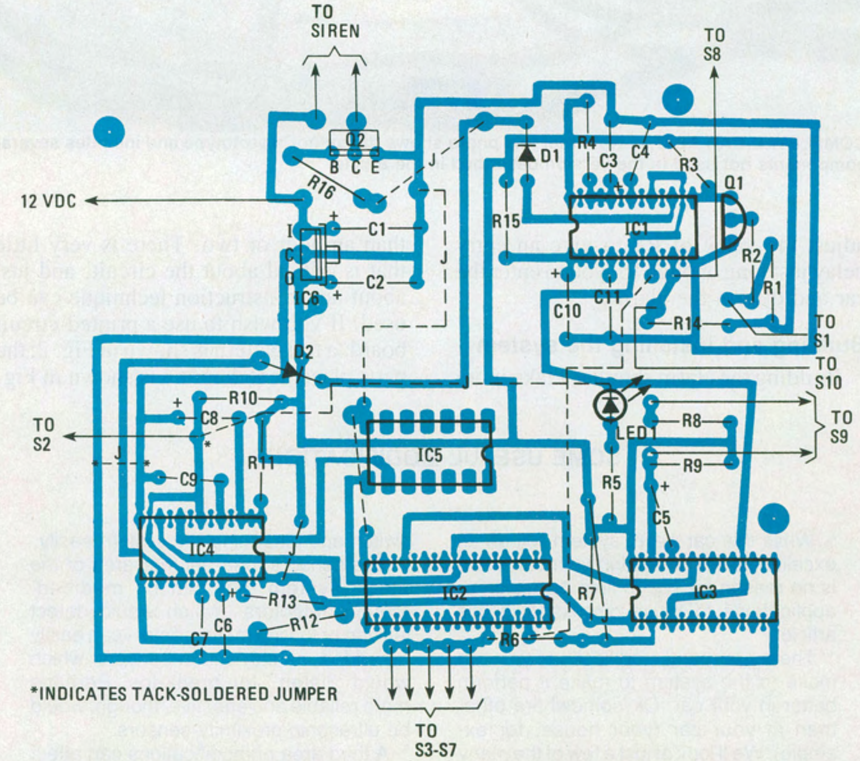


FIG. 3—PARTS-PLACEMENT DIAGRAM. Note that the foil-side jumpers are shown by dashed lines.

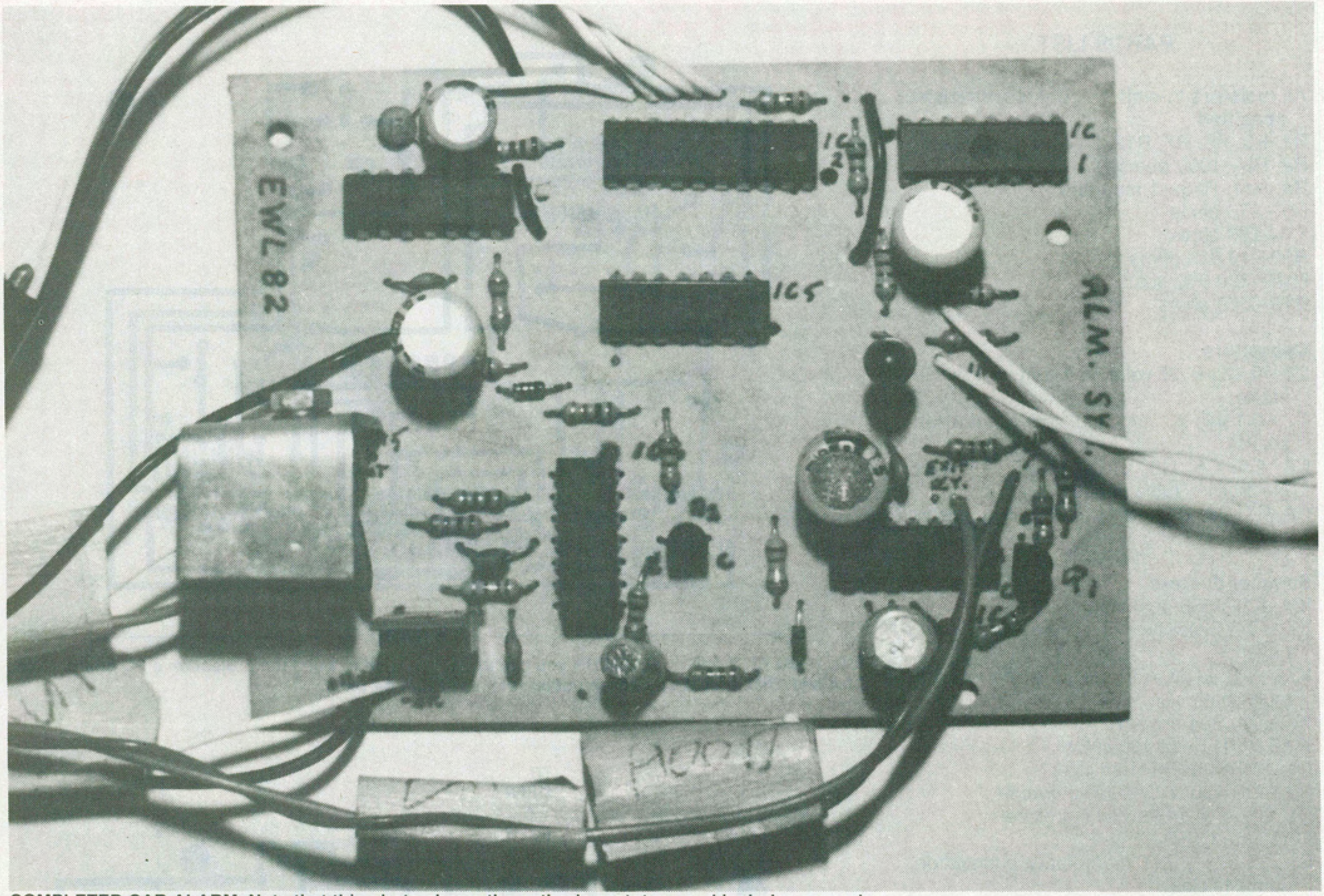
is slightly longer than the pulse output by IC3. The pin-5 output of IC4-a is then fed to IC5, one section of a 74LS04 hex inverter, and then to pin 1 of IC2-b. Thus, when the output from IC4-a cuts off, the signal at pin 1 of IC2-b goes from low to high. The purpose of all of that is to prevent any spurious or accidental triggering of the alarm.

That takes care of the operation of the entry-delay circuit, but not the exit delay. Lets go back to IC2-a again. When that device is in the high-impedance mode, it effectively disarms the sensors so they have no effect on the alarm. The trick is to disarm those sensors only long enough to allow you to get out of the car. Once that is done, the sensors should be rearmed so the circuit can fulfill its intended purpose.

That function is handled by IC1-b. Using S8 to bring pin 6 of that monostable timer (half of a 556) low triggers the device. Its timing cycle is determined by R15 and C10. The timer's pin-5 output is applied to pin 1 of IC2-a, causing it to go into the high-impedance state and cutting the sensors off from the rest of the circuit. When that is done the sensors will not be able to turn on the alarm until the pulse from the 556 goes low again. When that happens IC2-a returns to normal and the system is rearmed.

You can, if you wish, also set the alarm to sound instantly when any door or the rear hatch is opened. All that needs to be done is to throw S9. That switches R8, a 1000-ohm resistor, in parallel with R9, decreasing the entry delay-time to a few milliseconds. The net effect is an instantly triggered alarm.

Switch S10 is mounted outside the car so that you can disarm the system before entering when the system is in its instant alarm mode. That switch should be a key-type and/or mounted in a concealed location. If you don't want to include the circuitry associated with it—S9, S10, and R8—can be eliminated without otherwise affecting performance. Another alternative would be to eliminate only S10 and to



COMPLETED CAR ALARM. Note that this photo shows the author's prototype and includes several components not used in the version described in the article.

adjust the value of R8 to give an entry delay just long enough for you to enter the car and disarm the alarm.

Building and installing the system

Building the alarm shouldn't take more than an hour or two. There is very little that is critical about the circuit, and just about any construction technique can be used. If you wish to use a printed-circuit board, a foil pattern is shown in Fig. 2; the parts placement diagram is shown in Fig. 3. Note that several jumpers are required if you use the foil pattern shown. Some of the jumpers mount on the component side of the board, but most of them mount on the foil side; the foil-side jumpers are indicated by a dashed line in Fig. 3.

Installing the system, particularly the sensors, in the car is a little more difficult. The type of car determines how easy it is. One of the biggest problems we had was grounding the trigger inputs. When we ran the sensor lines through the doors and fire wall, insulation was pierced, causing continuous triggering. Care not to ground the sensor lines must be taken when running them. A simple check with an ohmmeter before connecting the lines to the system will save a lot of headaches.

It is very helpful to run all the lines (sensor, power, alarm, etc.) from the circuit to a female Molex connector (any type of multiple-connection connector will do). All the connections made in the car can be run to a male Molex connector. That simplifies hooking the system up, and helps prevent getting wires crossed.

There you have it—a simple, low-cost and effective, car alarm you can build and install yourself. (You can also modify it yourself—see box copy to the left.) Now there's no reason for you not to put your mind at ease by protecting your car and belongings. **R-E**

SOME USEFUL MODIFICATIONS

While this car alarm system will do an excellent job of protecting your car, there is no reason for you to limit its design or applications to those discussed in this article.

There are many modifications you can make to the system to make it perform better in your car. Or, somewhere other than in your car (your house, for example). We'll look at just a few of the many possible changes that you might care to make.

First off, for those of you who enjoy experimenting with microprocessors, why not replace S2 (the master ARM/DISARM switch) with a "combination-lock" circuit that would require the entry of a number of digits in the correct sequence before the alarm could be disarmed? For added protection—whether or not you install a combination-lock circuit—you might want to consider tying the ARM/DISARM switch to the car's ignition switch. That would eliminate the possibility of a thief finding your switch and disarming the system easily.

The sensors form another area of the alarm system that can be modified. Motion detectors—which would detect jacking or towing movements—can easily be added, as can sound sensors, which would "listen" for break-ins. Perhaps more reliable and effective, though, would be ultrasonic proximity-sensors.

A third area of modifications can affect what the alarm does once a break-in occurs.

Besides just sending out an audible alarm, why not also ground the vehicle's ignition coil so that it cannot be started? If that's not exotic enough for you, how about a radio-transmitted silent alarm?

To sum things up, you can see that the alarm system described here can serve as the basis of a larger, more complex system. There's really no limit to what features you can add. We encourage you to experiment, and we'd like to hear what you come up with.