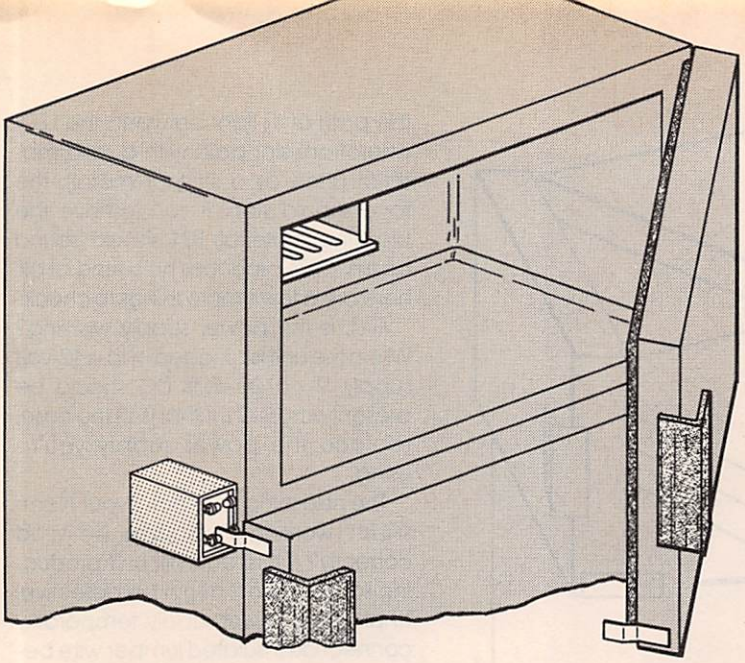


Save money on electric bills and keep food from spoiling with this simple device.

BUILD A Refrigerator-Door Alarm

BY EDWARD ANDREWS

Refrigerators do, on occasion, get left open, whether it's because the kids run off with their snacks and neglect to close the door, or you aren't awake enough during your midnight snack to realize your error. However, there is a way to make sure your milk won't get spoiled—build the *Refrigerator-Door Alarm* described here. This simple project, which can be built in an afternoon, sounds an "obnoxious" tone when either the refrigerator or freezer door is open or ajar.

Circuit Description. The schematic for the Alarm is shown in Fig. 1. Power for the circuit is supplied by a 12-volt DC source, and is filtered by capacitor C1.

The core components of the Alarm are two IR, LED-and-phototransistor pairs: LED1 and Q1, and LED2 and Q2. If IR light shines from LED1 onto Q1 or from LED2 onto Q2, piezoelectric-buzzer BZ1 emits a tone in the 2000- to 3000-Hz range (the part specified for BZ1 is self-contained, combination oscillator and sounding element). Resistors R1 and R2 limit the current flow to the phototransistors and the buzzer.

The sound quality produced by BZ1 is influenced by filter-capacitor C1. If C1 is reduced in value (or omitted entirely), the DC supply will have a noticeable 60-Hz AC component; the circuit will still operate, but the alarm will sound very "raspy." If it's of the value specified in the schematic, C1 will produce an "alarm-clock"-like sound having some of the 60-Hz component. For a clean, sinewave-like sound, increase the value of C1 to 100 μF or more.

The Mechanics of the Alarm. The circuit just described will only sound the buzzer when IR light reaches either or both of the phototransistors. Therefore, for our application, the flow of IR light to those detectors should be blocked when both the refrigerator and freezer doors are closed.

The diagram in Fig. 2 shows how that can be accomplished. A metal strip is attached to each of the refrigerator doors so that when the doors are closed all the way, the beam of IR light flowing between the detector pairs is blocked. If one of the doors is opened, the alarm will sound.

Construction. Considering the low parts count of the Alarm, it is easiest to build it on a small piece of perforated board using point-to-point wiring. Begin assembly by mounting the capacitor, resistors, and buzzer on one side of the board. Double-check the polarity of the capacitor and buzzer.

On the other side of the board, you should mount the two LED/phototransistor pairs (be sure to use the ones specified in the Parts List). Note that the LEDs and phototransistors have spherical lenses. Position LED1 and Q1 so that the rounded ends of their lenses are facing each other. They should be separated by a distance of about ⅛ to ¼ inch. Do the same for LED2 and Q2 (see the photo of the unit shown elsewhere in this article).

Because the LEDs look a lot like the phototransistors, you have to take care not to interchange them; the circuit will not work with the devices swapped! The LEDs are the units in the clear or translucent epoxy cases, while the phototransistors are the ones in the dark or opaque epoxy cases. When you're certain of the identity of the devices, electrically connect them to the circuit, making sure to orient them properly.

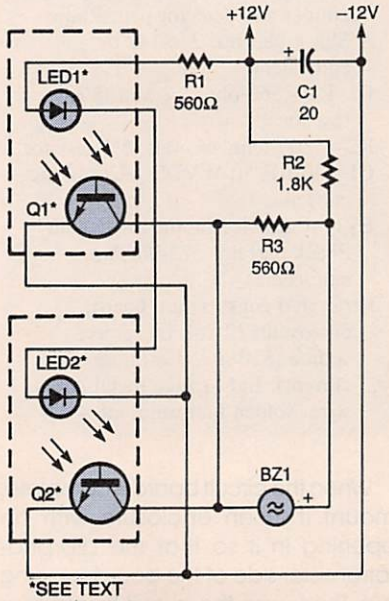


Fig. 1. Here's the schematic for the Refrigerator-Door Alarm. Buzzer BZ1 will sound when IR light from LED1 shines on Q1, or when LED2 shines IR light on Q2.

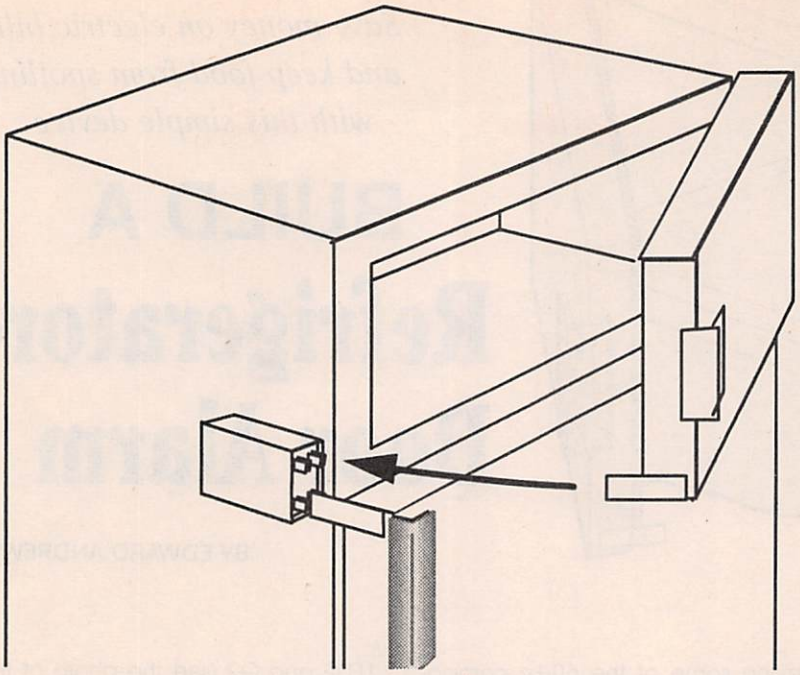


Fig. 2. As this diagram shows, two metal strips should be mounted on the refrigerator so that when a door is opened, the IR light path of an LED/phototransistor pair is unobstructed.

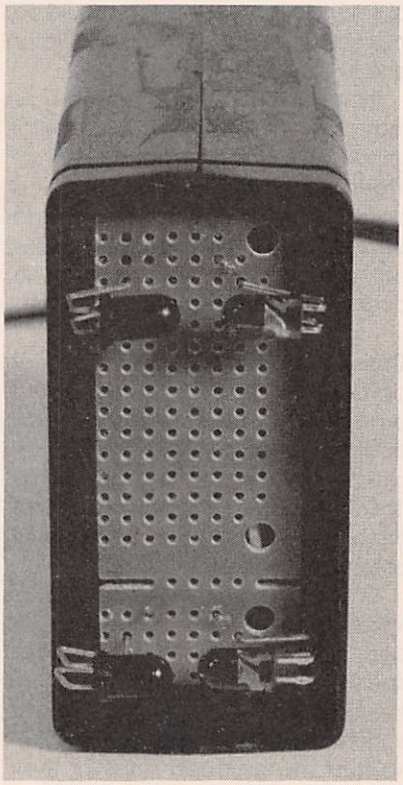
PARTS LIST FOR THE REFRIGERATOR-DOOR ALARM

Q1, Q2—Infrared phototransistor (part of matched IR emitter and detector pair, Radio Shack part no. 276-142 or equivalent)
LED1, LED2—Infrared light-emitting diode (part of matched IR emitter and detector pair, Radio Shack part no. 276-142 or equivalent)
R1, R3—560-ohm, ¼-watt, 5% resistor
R2—1800-ohm, ¼-watt, 5% resistor
C1—20-µF, 50-WVDC, electrolytic capacitor
BZ1—Piezoelectric buzzer (Radio Shack part no. 273-065A or equivalent)
Perforated construction board, enclosure, 12-volt DC power source (520-mA maximum current), light-gauge metal strips, wire, solder, hardware, etc.

When the circuit board is complete, mount it in an enclosure with an opening in it so that the LED/phototransistor side of the board is facing out. Then, wire the circuit board to a 12-volt power supply to complete the unit.

Checkout and Troubleshooting.

Before you install the Alarm, you should check it to make sure everything works as it should. As soon as the Alarm is powered, you should hear a loud tone from buzzer BZ1. By blocking the path of IR light between the LED/phototransistor pairs with a solid material (such as a strip of metal), the tone should stop. If you remove the blocking material, BZ1 should sound again. If BZ1 produces no sound at all, here are a few simple things to check:



This front view of the Alarm shows how the IR LED/phototransistor pairs should be positioned.

First, is the power supply working? When the unit is plugged in to a 12-volt supply, 9- to 20-volts DC should be present across C1. If that isn't the case, replace the power supply you're using.

The next thing to check if your Alarm still isn't working is the buzzer. Is it wired correctly? If it is, and still isn't producing sound, then it might be defective. Unplug the power supply, temporarily connect an insulated jumper wire between the negative lead of BZ1 and the negative lead of C1. Then plug in the power supply again; if no sound is heard, BZ1 is either defective or wired backwards.

Now, if the buzzer *does* work when it is shorted with a jumper, but doesn't work otherwise, you might have a problem with an LED or phototransistor. Because the LEDs operate in the infrared region, the only way to determine if current is flowing through the LEDs is to plug in the power pack and look for voltage across R1. When the LEDs are operating, there will be 3 to 15 volts present across R1, and 2 to 3.5 volts present between the anode of LED1 and the cathode of LED2.

If a voltage is measured across R1, yet zero volts is measured across a particular LED, that LED is defective or there is a wiring error. Keep in mind that wiring errors are usually to blame (that goes for the buzzer and phototransistors too), so be sure to double check all electrical connections if there is a problem.

Another problem might simply be that the distance between the LEDs and phototransistors is too great. Make sure they are directly facing each other, and separated by no more than ⅛ to ¼ inch.

If all the preceding checks still result in an inoperative Alarm, check the phototransistors next. To do that, obstruct the light path between LED2 and Q2. Then, connect a voltmeter between the collector and emitter of Q1. Next, obstruct the light path for LED1; no current should be flowing and the voltage across Q1 should be

(Continued on page 76)

DOOR ALARM

(Continued from page 58)

between 9 and 20 volts. When LED1 is unobstructed, the voltage between Q1's collector and emitter should be close to zero.

As a last test, obstruct the light path between LED1 and Q1. Place a voltmeter between the collector and emitter of Q2 and then obstruct the light from LED2; no current should be flowing, and the voltage across Q2 should be between 9 and 20 volts. When you stop blocking the light of LED2, the voltage between Q2's collector and emitter should be close to zero.

The preceding tests, in conjunction with careful wiring, should ensure that your Refrigerator-Door Alarm will work. When you're satisfied with its performance, you can go on to mount it.

Installation. Attach the completed project to the side of your refrigerator (as shown in Fig. 2), near the doors, with double-sided foam tape. If your refrigerator doesn't have its freezer door on top of the other one, and instead has its two doors opening outwards and side by side, you will need to mount the Alarm on top of the refrigerator.

Whichever way you mount the Alarm, the point is to position it so that two metal strips attached to the doors can obstruct the light path of the IR LED/phototransistor pairs when the doors are closed. Use light-gauge metal strips for that purpose; aluminum is a great material to use as it is easy to cut and bend, and will not rust.

Attach the strips to each door using screws, epoxy cement, or double-sided tape. Note that because moisture might condense on or near the door openings, a good mounting scheme is needed to make sure that the interrupters don't come loose due to moisture build up. You will know if an interrupter strip falls off as the alarm will sound!

Once the Alarm is connected, you shouldn't have any more problems with spoiled food (unless you keep it too long, of course). And by the way, if you do plan on getting a midnight snack, be prepared to fully wake up when you hear the sound of the alarm! ■