BUILD THE DOOR MINDER

BY BRIAN PLILER

This entry-way monitoring circuit can effectively guard the various accesses to your home or business.

Do you have a frequently used door in your home or business that needs to be closed when not in use? If so, then maybe you need the *Door Minder* described in this article. The Door Minder is a device that uses a magnetic reed switch to determine if the monitored door is open or closed. The unit has a built-in delay period that keeps it silent for up to about 24 seconds after the door has been opened to allow normal use of the monitored door. But if the door is not closed within the 24-second period, the alert tone sounds until the door is closed. The alert signal emitted by the Door Minder sounds like an electronic chime, and is struck once per second. That sound was chosen because it is too annoying to ignore, but not harsh enough to startle anyone. The prototype was assembled on a small section of perfboard using point to point wiring and was installed in a small speaker enclosure that was originally used with a personal stereo. The speaker in the enclosure was used as the project's speaker.

How It Works. A schematic diagram of the Door Minder is shown in Fig. 1. While the circuit may look complicated at first glance, a closer inspection reveals that it is actually comprised of several smaller circuits. Integrated circuit U1-a along with R1 and C1 form a simple delay timer. When C1 is discharged through the closing of door switch S1, the output at pin 1 goes high. That turns on transistor Q1 and prevents transistor Q2 from receiving any base drive. But, as soon as S1 is opened, C1 begins to charge through R1. When the voltage on C1 exceeds the reference voltage at pin 3 of U1-a (approximately 4 volts as established by R4 and R5), the output at pin 1 goes low, turning off Q1, which now allows Q2 to be activated by the striker signal. Since the reference voltage is roughly half of the supply voltage, the formula for determining the delay time is:

$$(R1 \times C1)/2 = \text{time}$$

where R1 is resistance in ohms and C1 is capacitance in farads. For example: 470,000 × .000100 = 47/2 = 23.5 seconds.

The "striker" oscillator, which is built around U1-b and configured as an astable multivibrator, outputs a narrow positive-going pulse once a second. Resistor R3 provides just enough gain for the op-amp to oscillate. The reference voltage at pin 5 of U1-b is also set to approximately 4 volts through R4 and R5. Capacitor C2 is tied directly to the inverting input of U1-b and to that IC's output through R2 and D1. When the voltage on C2 is below the reference voltage at pin 5, pin 7 is forced high and immediately charges C2 through D1. Since the voltage at C2 is now higher than the reference voltage, pin 7 switches low and begins discharging C2 through resistor R2. As soon as the voltage on C2 dips below the reference voltage, the cycle repeats.

Op-amp U1-c is configured as a voltage follower. It simply prevents C3 and other associated components from affecting the operation of the striker oscillator. Capacitor C3 changes the narrow positive-going pulse generated by the striker oscillator into somewhat of a spike pulse to imitate the abrupt striking of a real chime.

When transistor Q2 is turned on, its collector is pulled low, thereby pulling the base of Q3 low through resistor R7. That activates Q3 and causes it to output almost 8 volts on its collector lead. Resistor R6 is included in the circuit to ensure that Q3 turns off when Q2 does. The voltage output from the collector of Q3 is fed to C4 and R8. Their values determine the decay rate of the chime, which as configured is 0.47 second. Resistor R9 is used to buffer the voltage and limits the current to Q4.

Op-amp U1-d is configured as a phase-shift oscillator, which produces a sinewave-output signal of approximately 1200 hertz, but only when Q4 is on. To make the audio tone as stable as possible, a second voltage divider—comprised of R13, R14, and filtered by C8—was added to help isolate the audio-tone oscillator from possible voltage fluctuations created by the striker oscillator. The audio-tone output at pin 14 of U1-d is capacitively coupled to an LM386 audio amplifier (U2), which is configured for a voltage gain of 20.

With the exception of U2—which is powered directly from an unregulated 12-volt source—the entire circuit is powered from a well regulated 8-volt supply built around an LM78L08 (100 mA) or LM7808 (1-amp) 8-volt regulator. Pinouts for those two devices are shown in Fig. 2.

If an 8-volt regulator is unavailable, a 5-volt unit, such as the LM78L05 or LM7805 5-volt regulators may be

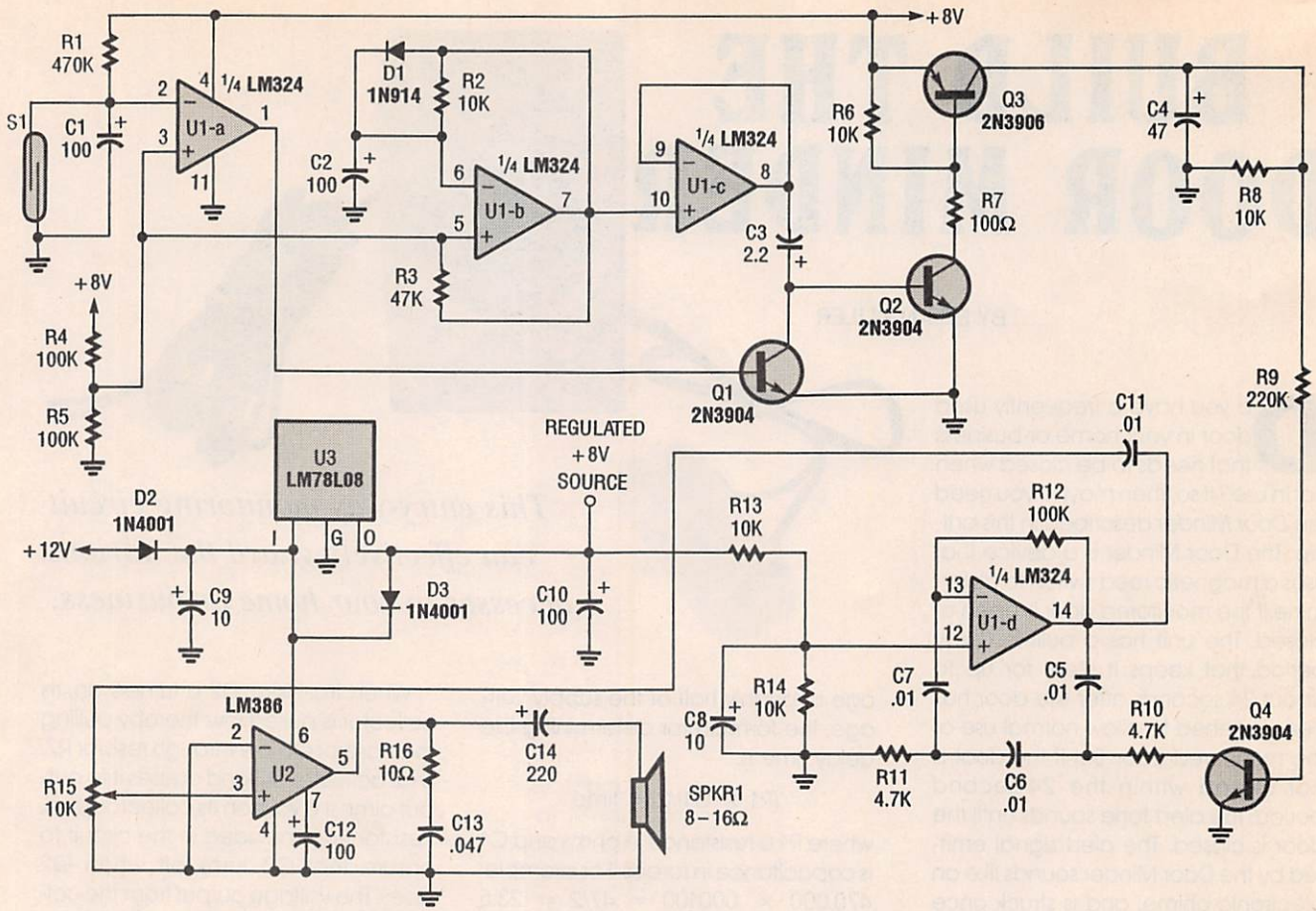

Fig. 1. The Door Minder is built around three integrated circuits: U1, an LM324 quad op-amp; U2, an LM386 low-voltage audio amplifier; and U3, a 78L08 8-volt, low-power, voltage regulator.

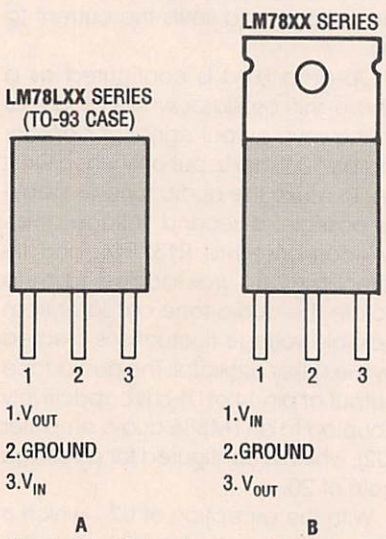

Fig. 2. To aid you in assembling the power-supply section of the circuit, we present the pinout diagrams for both the 78LXX and 78XX series of regulators.

used. Figure 3 shows how to configure the 5-volt regulators to produce an 8-volt output.

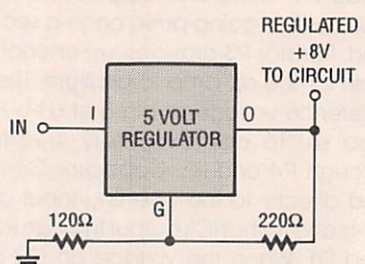

Fig. 3. If you have trouble locating an 8-volt regulator, although they are commonly available, a 5-volt unit can take its place by connecting the regulator as shown here.

Construction. The author's prototype of the Door Minder circuit was assembled in a small section of perfboard, measuring about 2 inches square. When Assembling the circuit it is recommended that sockets be provided for U1 and U2. Aside from serving as a convenient marker around which to wire the other components, the sockets also prevent possible damage due to excessive heat during soldering.

In any event, once the sockets are in place, install the support components, connecting them to the pins of the IC sockets, as you would connect them to the IC's themselves. Check the orientation of the polarized components and semiconductors—especially the transistors—as they are installed. Once all of the components have been installed, double check your work for misoriented or misconnected components. Pay particular attention to the two transistor types (2N3906 and 2N3904) used in the circuit, as on the surface they appear to be identical. Also check for solder bridges and cold solder joints

After double-checking your work for possible construction errors, it is time to apply power to the circuit and make sure that the project works correctly before installing it in an enclosure.

Checkout and Troubleshooting. Apply power to the circuit, and wait awhile. If, after a delay period, nothing is heard, there are several tests that can be done to determine which section isn't working.

First take a small jumper and place it from the collector of Q4 to ground.

(Continued on page 91)

DOOR MINDER

(Continued from page 54)

PARTS LIST FOR THE DOOR MINDER

SEMICONDUCTORS

U1—LM324 quad op-amp, integrated circuit
U2—LM386 low-volt audio-amplifier, integrated circuit
U3—LM78L08 8-volt, 100-mA voltage regulator (see text)
Q1, Q2, Q4—2N3904 NPN general-purpose silicon switching transistor
Q3—2N3906 PNP general-purpose silicon switching transistor
D1—1N914 small-signal silicon diode
D2, D3—1N4001 1-amp, 50-PIV, silicon rectifier diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—470,000-ohm
R2, R6, R8, R13, R14—10,000-ohm
R3—47,000-ohm
R4, R5, R12—100,000-ohm
R7—100-ohm
R9—220,000-ohm
R10, R11—4700-ohm
R15—10,000-ohm PC-mount trimmer potentiometer
R16—10-ohm

CAPACITORS

C1, C2, C10, C12—100-μF, 16-WVDC, electrolytic
C3—2.2-μF, 16-WVDC, electrolytic
C4—47-μF, 16-WVDC, electrolytic
C5–C7, C11—0.01-μF, 50-WVDC, Mylar
C8, C9—10-μF, 16-WVDC, electrolytic
C13—0.047-μF, 50-WVDC, Mylar
C14—220-μF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

SPKR1—8- to 16-ohm, ½-watt speaker
S1—Magnetic reed switch (closed when near a magnet)
Perfboard materials, enclosure, IC sockets, 12-volt power source, wire, solder, hardware, etc.

The 1200-Hz tone should now be heard continuously. Remove the jumper and place one end on the collector of Q2, while tapping the opposite end to ground. The "chime" should "ring" each time the jumper is grounded. If the unit doesn't work correctly, disconnect the collector of Q1 from the base of Q2. The unit should now be "ringing" on its own. If not, place a jumper wire from the positive (+) side of C2 to ground. The unit should "ring" once each time the jumper is grounded.

Once you have isolated the faulty section, it is easier to locate and correct your error. After everything is working correctly, mount the unit in a suitable enclosure and set the volume to a level that can't be ignored, but not loud enough to startle anyone. A bit louder than normal speech works best.

Use. It would be a good idea to install a hidden bypass switch so that the unit could be silenced when necessary. I have found that the circuit tends to get better response than simply having a sign posted nearby with the words *Please keep door closed.* Perhaps that's due to its pulsing alert tone. When choosing a suitable mounting position for the project, be sure the speaker is mounted up high so that it cannot be obstructed. ■

PIPE ANTENNA

(Continued from page 48)

Finally, be sure to obey all local electrical and mechanical codes for antenna construction. The codes are a pain in the neck, or so it seems, but they also represent good engineering practice. While rugged individualists may disdain having some "bureaucrat" tell them how to install the antenna, the codes actually represent someone's experience—bad experience—so the codes should be followed closely.

There is one real good reason to follow the electrical codes, even if you are unconvinced of their inherent wisdom. In the event of an accident, your homeowner's insurance might not pay off if the antenna was installed *ad hoc* without the advice and consent (which means a permit and inspection) of the local building and mechanical authorities.

Antennas made from pipe and tubing are low cost, are easy to design, and are not overly complex or difficult to install. Try one! ■