BY WILLIAM VANCURA

Simple circuit triggers electronic system to close garage door after selected time period.

AN AUTOMATIC GARAGE-DOOR CLOSER

THE STANDARD electrically powered radio-controlled garage-door opener has a drawback. It can be falsely triggered by a CB or amateur radio transmitter or other actuating signal, or the user can forget to send a signal command to close the door. In either case, an open garage door could invite thieves to remove valuable equipment—bicycles, lawn mowers, etc. The "Auto Closer" described here overcomes this problem. It automatically commands the system to close the door after a preselected time interval, providing improved security and convenience. The automatic function can be disabled by the user, too, in the event that it is desirable to keep the garage door open.

About the Circuit. The Auto Closer is shown schematically in Fig. 1. Switch *S1* is the door-position sense switch; it remains open as long as the garage door is closed. The open switch prevents the Auto Closer circuit from drawing current from the power supply and keeps it isolated from the rest of the door opener circuit. When the sense switch closes as the door opens, 24 volts ac from the main opener power supply is applied to the Auto Closer. Diode *D5* rectifies the ac into pulsating dc which is filtered by *C1* and *R3*. Zener diode *D1* provides +15 volts regulated for *IC1*, a CMOS 4020 14-stage binary counter.

When power is first applied to the Auto Closer, *R1* and *C2* momentarily keep pin 11 of *IC1* high, ensuring that the counter is reset as the timing cycle begins. A 60-Hz signal from the opener power supply is coupled by *R2* to the counter's CLOCK input. This clocking signal is peak limited by diodes *D2* and *D3*, thereby protecting the counter IC from excessive input levels. The outputs of the twelfth, thirteenth and fourteenth counter stages are available at pins 1, 2, and 3, respectively. When the counter is clocked by a 60-Hz signal, the periods of the square waves at these three outputs are 68 seconds (pin 1), 136 seconds (pin 2) and 272 seconds (pin 3). Each output is high for one-half of its square-wave period.

The time interval that the Auto Closer will hold the door open before automatically closing it is selected by connecting *R4* to one of the output pins of *IC1*. If, for example, *R4* is connected to pin 1, no base current will flow into *Q1* for 34 seconds and the garage door will remain open. At the end of that time, pin 1 will go high and source base current for *Q1* through *R4*. When *Q1* begins to conduct, the coil of reed relay *K1* becomes energized.

This causes the contacts of *K1* to place diode *D4* across the 24-volt ac line. The negative half-cycle of the ac control input is shorted out by the diode. This not only triggers the control circuit to close the door, but also allows the Auto Closer circuit to remain active until the door closes far enough to reopen sense switch *S1*. Capacitor *C3* is connected across the coil of *K1* to keep the relay from chattering and to protect *Q1* from inductive transients. When *S1* reopens, *R5* discharges the Auto Closer capacitors and effectively resets the circuit after a few seconds to ready it for another cycle. Cutout switch *S2* allows you to keep the garage door open for extended periods of time by effectively deactivating the Auto Closer.

Two other time periods are available. If *R4* is connected to pin 2, the garage door will be closed after 68 seconds

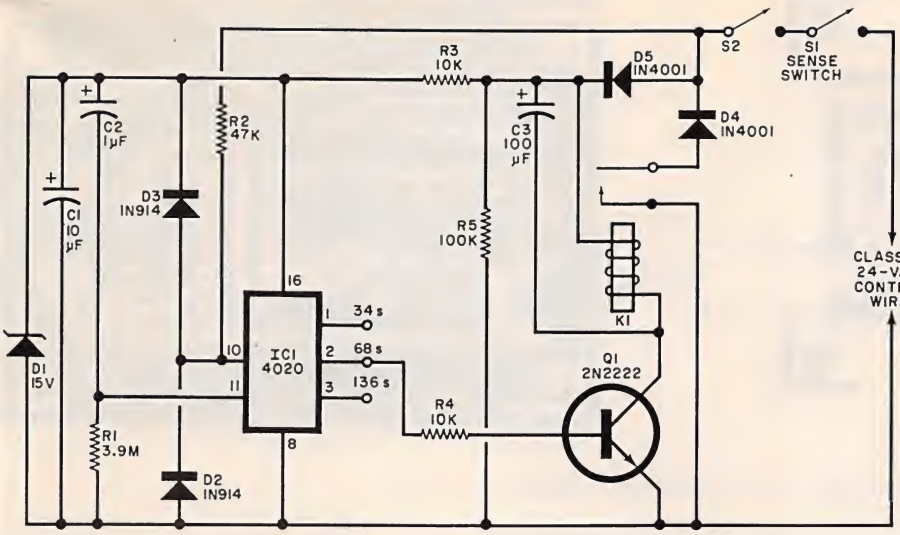

Fig. 1. Schematic of circuit. CMOS counter IC1 develops the delay interval from the 60-Hz line frequency.

PARTS LIST

C1—10-μF, 25-volt electrolytic
C2—1-μF, 25-volt electrolytic
C3—15,100-μF, 25-volt electrolytic
D1—15-volt, 400-mW zener diode
D2, D3—1N914 switching diode
D4, D5—1N4001 rectifier
IC1—CD4020 or MC14020 14-stage CMOS ripple counter
K1—12-volt reed relay (Arrow-M DA-1A or equivalent)
Q1—2N2222 npn silicon switching transistor
The following are ¼-watt, 10% tolerance carbon-composition fixed resistors:
R1—3.9 megohms
R2—47,000 ohms
R3, R4—10,000 ohms
R5—100,000 ohms
S1—SPST spring-loaded, normally open lever switch or other suitable door sense switch (see text)
S2—SPST toggle switch
Misc.—Printed circuit or perforated board, IC socket or Molex Soldercons, suitable enclosure, hookup wire, solder, machine hardware, etc.
Note—The following are available from William Vancura, 4115 35th Avenue, Moline, Illinois 61265: kit of parts, less enclosure and switches $15 plus $1 postage and handling; 12-V reed relay, $5 plus $1 P&H; etched and drilled pc board, $4 with SASE.

have elapsed. Connecting the resistor to pin 3 results in a 136-second delay. The latter interval is enough time for one person to move two cars out of the garage and into the driveway. A delay of 68 seconds is enough time to open the trunk, place a package in it, close the trunk, enter the car, buckle up, start the car once or twice and coax the car into the driveway. A 34-second delay is ideal for an efficient individual who moves quickly but is a cautious driver. Any time delay less than 34 seconds increases the possibility of hitting the door.

The Door Opener. A typical garage door opener employs a "Class 2" wiring system. Basically, this means that the control system comprises a low-voltage supply (usually 24 volts ac derived from a step-down transformer), a control relay which applies power to the motor, and one or more activating switches. The low-voltage power supply cannot cause any serious accidental shocks and permits the use of relatively inexpensive bell wire in connections to the activating switches and relay. A typical system schematic is shown in Fig. 2.

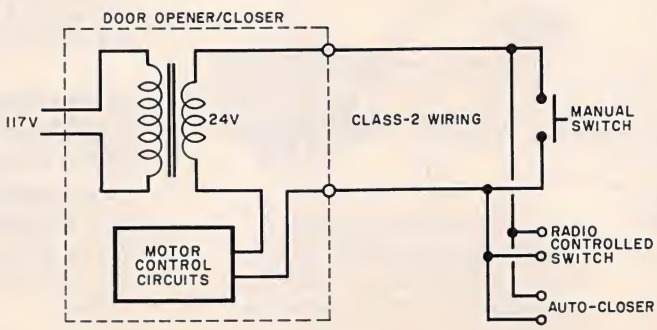

Fig. 2. Class 2 wiring of a typical garage door opener.

Several activating switches can be and usually are wired in parallel across the opener's control input terminals. The system schematic shows a manual pushbutton switch, a radio-controlled switch, and the Auto Closer so connected. Normally, the control circuit is designed to be able to supply power to several low-power switching devices via the Class 2 control wiring itself. This is how both the Auto Closer and radio-controlled switch's receiver are powered.

Construction. Wire-Wrap, point-to-point or printed-circuit techniques can be employed in the construction of the Auto Closer. Parts placement and lead dress are not critical. Although the printed circuit board (see Fig. 3) has been designed to accommodate a reed relay, a perf-board version of the project could use a standard low-power relay such as the Radio Shack No. 275-003.

In any event, use an IC socket or Molex Soldercons with the CMOS counter. Do not insert the IC into its socket at this time. Select the delay period suitable for your application and connect the lead of *R4* to the corresponding pin of the IC socket. Be sure to observe polarities and pin basing of semiconductors and electrolytic capacitors.

The Auto Closer should be housed in a metallic or plastic enclosure approximately 4" x 2¼" x 2¼" (10.2 x 5.7 x 5.7 cm). An on/off switch (*S2*) should be mounted on the enclosure if a remote power switch is not used. The mounting of the sense switch depends on how the door-open condition is to be sensed. One possibility is to install the switch in the Auto Closer enclosure and attach a lever arm to it. The arm can be extended to the door to sense the door-up position. Alternatively, you can replace the travel-limit switch of the motor control circuit with one that has an extra set of contacts. The normally open contacts can be used as sense switch *S1*.

If your garage door opener applies low voltage dc across the control lines instead of 24 volts ac, the Auto Closer circuit should be modified as follows. Replace *Q1*, *C3*, D4 and *K1* with a 1-ampere SCR. The anode of the SCR should be connected to the anode of *D5* and the pole of *S2*. The cathode should be connected to pin 8 of *IC1*, the bottom leg of *R5*, etc. The gate should be connected to *R4*, whose value and that of *R3* should be changed to 1000 ohms. Instead of connecting one end of *R2* to the *D5S2* node, apply 60-Hz CMOS-compatible square waves between it and pin

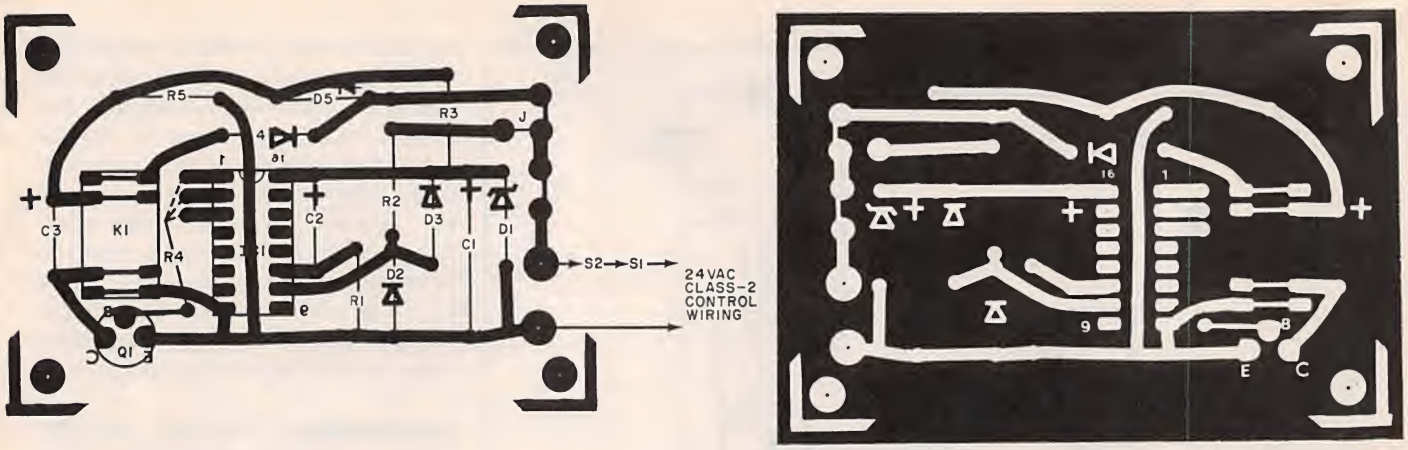

Fig. 3. Etching and drilling and parts placement guides for a suitable pc board.

8 of *IC1*. Zener diode *D1* can be eliminated if the dc control voltage is greater than (or equal to) 12 volts and less than 15 volts.

Checkout. After the Auto Closer has been assembled, but before the CMOS counter has been installed in its socket, temporarily connect one end of a convenient length (about 4 to 6 feet or 1.2 to 1.8 m) of hookup wire to pin 8 of the IC socket. Connect one end of a similar length of hookup wire to the anode of *D5*. Next, attach the two free ends to the Class 2 control wiring of the garage door opener and measure the ac voltage between the anode of *D5* and pin 8 of the IC socket. You should obtain a reading of about 24 volts. Measure the dc voltage between pins 16 and 8 of the IC socket. It should be about +15 volts. Finally, measure the voltage between pins 10 and 8. The meter should read about +15 volts in the dc mode and slightly more in the ac mode. If you have an oscilloscope, look at the signal waveform. You should see a sine wave clipped at 0 and 15 volts.

Momentarily clip a jumper between pins 16 of the IC socket and that to which R4 is connected. The relay coil should become energized and the door opener activated. Removing and replacing the jumper should cause the door opener mechanism to reverse its direction. If the relay chatters while the jumper is connected, the door will jerk back and forth and the Auto Closer will not reliably close the door. This problem can be caused by a defective *C3* or one with insufficient capacitance.

When the Auto Closer is working reliably, it is time to install *IC1* in its socket. The normal precautions should be taken when handling this CMOS device. Disconnect the Auto Closer from the Class 2 wiring and place the circuit board on a 10" x 10" (25.4 x 25.4 cm) sheet of aluminum foil. Also, place the IC (still in its protective foam carrier) and both hands on the foil, which should be grounded. Keeping the heels of both hands on the foil, remove the IC from its protective carrier and insert it into the socket, paying close attention to pin locations. Then permanently install the circuit board in the project enclosure. Reconnect the Auto Closer to the Class 2 control wiring.

If all is well, the door (after having been opened) will begin to close only after the selected delay has elapsed. When the door begins to close, momentarily disconnect the Class 2 control wires from the Auto Closer so that the relay drops out. Each time the Auto Closer is disconnected, the counter will reset itself. Complete the wiring of the sense and power switches and verify the operation of both.

Installation. The Auto Closer is now ready for permanent installation. If a remote sense switch is used, the Auto Closer can be mounted in any convenient location. Just be sure that the control and sense switch wires are positioned so that they do not interfere with the proper operation of the door opener mechanism.

Two methods of mounting an Auto Closer equipped with a built-in lever sense switch are shown in Figs. 4A and 4B. The latter installation is less sensitive to minor variations in the stopping position of a door riding on tracks beside the sense switch lever. A slight bend at the tip of the lever arm prevents the door from snagging and damaging itself. The mounting method shown in Fig. 4B allows the project enclosure to be mounted easily on the door track using a 4" (10.2-cm) hose clamp. The ceiling mount (Fig. 4A) will work equally well with either a single-piece trackless door or a multi-section tracked door.

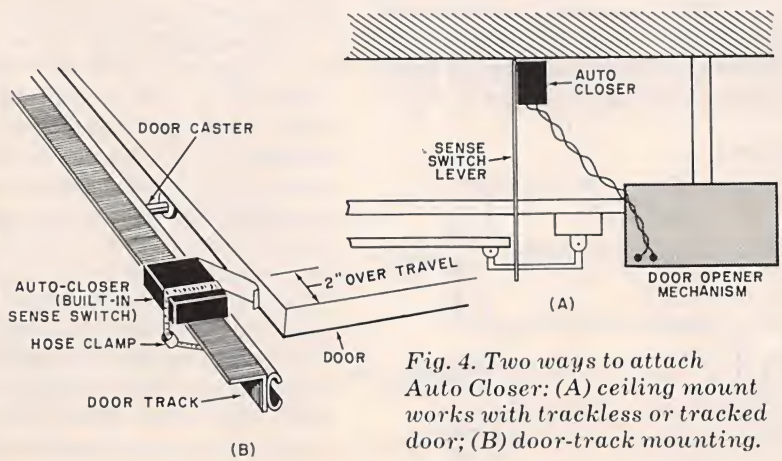

Fig. 4. Two ways to attach Auto Closer: (A) ceiling mount works with trackless or tracked door; (B) door-track mounting.

In Conclusion. You will surely find the Auto Closer to be a great convenience and an effective security device. Keep in mind, however, that you can very easily lock yourself out of the house should you forget your keys, the opener's pocket transmitter, or to disable the Auto Closer! ◇