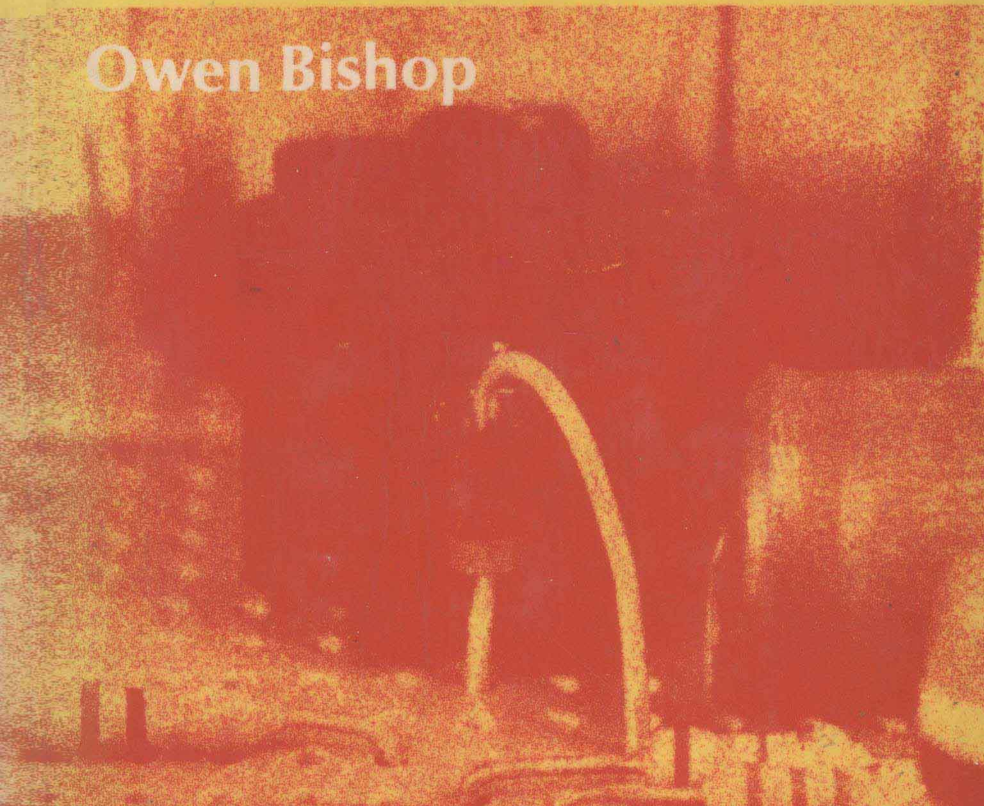
Electronic Projects for Home Security

Owen Bishop



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Owen Bishop
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1

Perimeter Detectors

Most of the circuits described in his book are designed to detect the entry or presence of intruders. The first stage of detection is at entry, when the intruder attempts to cross the perimeter of the house or, possibly, of the surrounding land.

The simplest form of system consists of a wire running around the perimeter of the property, with switches placed at all points at which an intruder is likely to attempt an entry (Fig. 1.1). The types of switches that can be used are described later.

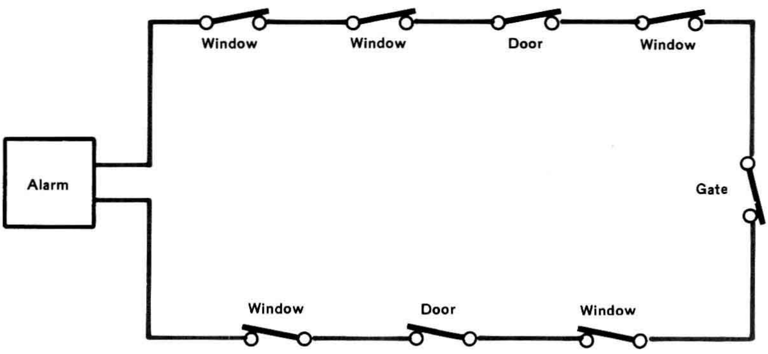

Figure 1.1

Perimeter circuit for normally closed switches

The essential feature of all switches is that they are *normally closed*. A current flows from the alarm circuit and is able to pass around the loop. If any one of the switches is opened, for example by the opening of a door or window, or if the wire is cut, the flow of current is interrupted and the alarm is triggered.

Occasionally it may be necessary to use *normally open* switches for part of a system (Fig. 1.2). In this case, the closing of any *one* switch triggers the alarm. The diagram shows a complete loop of wiring around the perimeter. The advantage of this is that the system is not rendered inoperative if the wires are cut at any one point. Cutting the leads between the alarm

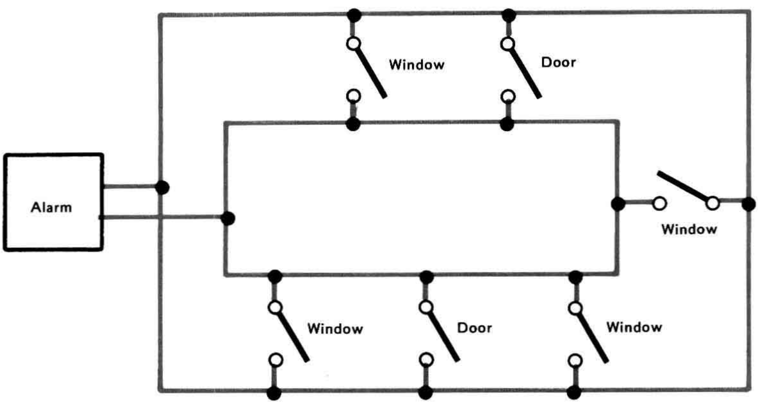

Figure 1.2

Perimeter circuit for normally open switches

and the loop would inactivate the system, but this part of the wiring can be placed well inside the perimeter so as not to be accessible from the outside. The chief disadvantage of the normally open system is that it requires approximately twice as much wire as the normally closed system. Although it is possible to inactivate the normally closed system by connecting a wire to bypass or short circuit a switch, this operation is generally more difficult to perform than simply snipping a wire. For these reasons the normally closed system is preferred.

Switches

Several types are available and the choice of type depends on circumstances:

1 Proximity switches These are usually operated by magnetism. The switch consists of two parts, a magnet which is mounted in or on the door or window, and a reed switch which is mounted in or on the frame of the door or window. The reed switch contains two pieces of springy metal (the reeds) which overlap but are not in contact. When a magnet is placed near to the reeds, they become magnetised temporarily, are attracted toward each other, and make contact. As shown in Fig 1.3 we

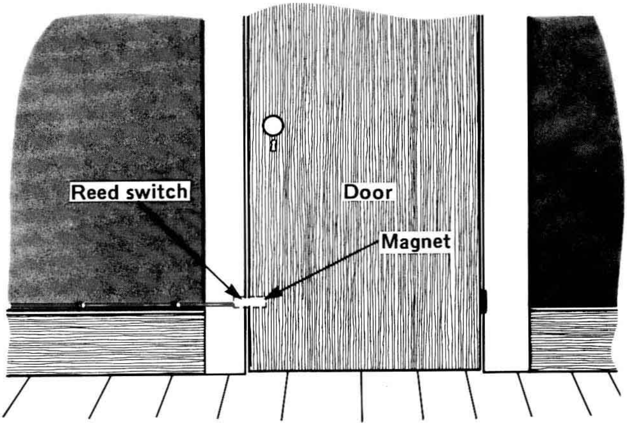

Figure 1.3

Fitting a magnetically operated reed switch in a door

arrange that a magnetic field is present when the door (or window) is closed. The reeds are then in contact, so the switch operates as a normally closed switch. When the door is opened, the magnetic field is removed and the reeds spring apart. The perimeter loop is broken and the alarm sounds. With switches of good design it is only necessary for the door to be opened by abour 1 cm to cause the switch to open, making it impossible for a person to pass through the doorway (or window) without triggering the alarm.

Switches of this type are available for flush mounting in wooden-framed doors or windows, as shown in the figure. To protect metal-framed windows a surface-mounting switch must be used instead. The action of the switch may be affected by steel-framed windows, and some preliminary trials are necessary before using proximity switches in these circumstances.

2 Microswitches A microswitch is generally of small size and is operated by small pressures. Most microswitches are of the single-pole double-throw pattern. When used as part of a security system they are better wired so as to be normally closed. The precise way in which a microswitch is used depends very much on the nature of the door or other entry point that is to be protected. A microswitch can be operated either by button or by a built-in lever (which transmits pressure to the button). Some types have a roller on the end of the lever, but this type is not likely to be required for security purposes. By mounting the microswitch on the frame or sill below a window, it is easy to arrange that the window depresses the button (or lever) when closed and that pressure is released if the window is opened by only a small amount. Naturally, such a device must be out of sight from outside the house, for it might be a simple matter to break the glass and hold the switch closed whilst opening the window. In general, microswitches are less effective than reed switches but they can be useful under certain conditions.

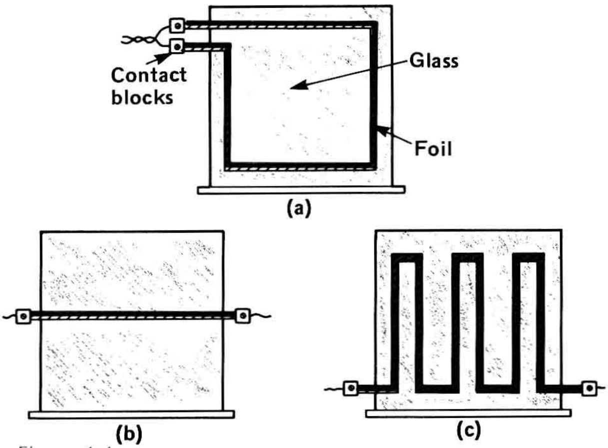

Figure 1.4

Using window foil

3 Home-made switches The inventive person can protect doors and windows with a variety of normally closed switches made from scrap such as drawing-pins and strips of springy metal. The design must be suited to the structure of the door or window, so details cannot be given here, but, with careful construction, home-made switches provide a good way of cutting the costs of installing a security system. However, reliability is an essential part of the system and, if the switches fail to make contact properly when doors and windows are closed, there will be a false alarm and the tedious necessity to check *all* switches to discover the faulty one.

4 Window foil An experienced intruder can remove the glass from a window without making much sound. Entry can then be made without opening the *frame* of the window, so that proximity switches are unaffected. Window foil is a protection against this. It is a strip of self-adhesive metallised foil that is attached to the inner surface of the glass. Some suggested patterns are shown in Fig. 1.4. The ends of the foil are taken to contact blocks mounted beside the window, or on the frame of the window at the hinged side if the window is one that opens. The arrangement of Fig. 1.4a provides very good protection whilst leaving the view relatively unobstructed. A single strip (Fig. 1.4b) is economical, quick to instal and easy to wire, especially if a row of windows in one room is to be protected. If security is the prime consideration, the pattern of Fig. 1.4c is recommended.

Doors too may be protected by using window foil. It is not unknown for an intruder to saw a large aperture in a door and enter through this, without actually opening the door itself. As an alternative to foil, fine wires can be fixed to the inside surface of the door. Glass panels in or beside doors should be protected by foil, to prevent intruders breaking the glass and then putting a hand through to undo the locks and bolts.

Where to place switches

In most systems a switch is fixed to every door and every opening window on the ground floor. If there is risk of an intruder being able to remove window glass without being observed, window foil should be fixed to all such windows on the ground floor. With careful planning, a single loop can be run from the alarm control box around the whole of the perimeter, including every door and window on the way.

There are also other points of entry that should not be overlooked:

1 *Second-floor windows* If these can be reached by climbing drain-pipes, porches, adjacent walls or outhouses, or if it would be easy for an intruder to make use of a ladder unobserved, these should be protected as part of the perimeter loop.

2 *Skylights* If accessible these need protection just as much as windows.

3 *Coal chutes* A burglar will not mind getting dirty if the rewards are great enough. If the chute has a door, a proximity switch may be used. If it has a metal cover, a microswitch may be fixed so that it is closed when the cover is in position.

4 *Loft trap-door* Determined thieves have been known to remove tiles from a roof and gain entry to the house through

the loft. The loft trap-door can be protected by a proximity switch. If your house contains many valuables, an intruder might even attempt to break in through the ceiling itself, for ceiling-board is considerably easier to penetrate than brick-work. Thin wires beneath the roof insulation could detect entry by this route.

5 Thin panels and partitions Check your house for weak points. Thin plywood or hardboard panels may be found beside the front door, or where a building has been divided into separate apartments. These may be protected by window foil or thin wire.

Pressure mats

Although these are not strictly part of the perimeter defences they are essentially a simple switch and are best considered in this chapter. Pressure mats are placed beneath the carpet or other floor-covering. They have two electrical contacts inside and normally they are open-circuit. When pressure is exerted on any part of the mat, contact is made. Thus the pressure mat acts as a normally open switch and must be wired separately from the normally closed perimeter circuit. Mats are available in several shapes and sizes, some kinds being shaped for putting under the carpet on stairs. The mats may be located in various strategic places. For example, place them in living-rooms (especially near shelves holding valuables, or in front of the TV set), in halls, corridors and on stairways along which an intruder is likely to pass. Pressure mats can be switched by relatively slight pressures, so they are not recommended if a large dog is free to wander in the house at night or when the house is unoccupied. However, the presence of a large dog makes it possible to dispense with the use of pressure mats altogether!

2

Alarms

An alarm has two main functions. One function is to alert those in the house, and also occupants of nearby houses, that intruders are present. The other function is to let the intruder know that the break-in has been detected. Even if there is no-one else in the house, the intruder cannot be *sure* that the alarm has gone unheard. Already a neighbour may have telephoned for the police, who may be on their way to the scene of the crime. In these circumstances, most thieves make off as quickly as possible. Although an alarm system can never *prevent* an intruder from entering the home, it can certainly make sure that the intruder is not left in peace for long enough to complete the robbery.

The essential features of an alarm are that it should be loud enough to be heard over a sufficiently wide radius and above ambient levels of noise, that it should have a distinctive sound, and that after have been triggered it should sound continuously until it is reset. The alarms described below all have these characteristics. All operate on a 12 V d.c. supply. This may be provided by batteries, or by a mains-powered unit (see Chapter 12).

Buzzer alarm

This is the simplest of the three circuits described in this chapter. It is loud enough to alert the occupants of a small house in a quiet area, though it would probably not be heard by neighbours. It could also be used as a personal bedside alarm at night, where other members of the household are not to be disturbed.

How it works

The circuit is based on a bistable latch, constructed from two NOR gates (Fig. 2.1). The two gates are cross-connected in such a way that the output of one of them is high (+12V) and the output of the other is low (zero volts). When the 'reset' button (S1) is pressed, one of the inputs of gate 1 is made high for an instant, causing its output to go low. The output of gate 2 goes high. A low output from gate 1 means that very little current flows through the buzzer.

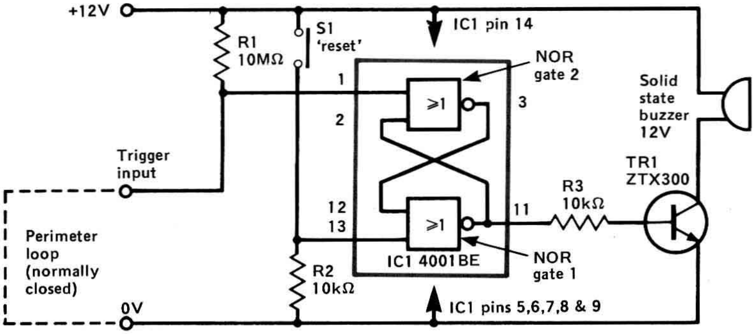

Figure 2.1

Simple triggered alarm circuit using a solid-state buzzer

Table 2.1. Components required for the buzzer alarm and bell alarm

Resistors	
R1	10 MΩ
R2, R3	10 kΩ (2 off)
(all carbon, ¼ W or ⅓ W)	
Semiconductors	
TR1	ZTX300 (buzzer alarm); VN 66AF (bell alarm)
D1	1N4148 (bell alarm only)
Integrated circuit	
IC1	CD4001BE quadruple 2–input NOR

Miscellaneous

0.1in matrix stripboard, 63 mm × 25 mm (*Vero* 14354); aluminium box 155 mm × 205 mm × 80 mm (or similar); SPST toggle switch; push-to-make pushbutton (S1); terminal sockets (2 off); battery holders (6V, 2 off); press-on connectors for battery holders (2 off); solid-state buzzer, 12V; small grommet; 6 BA bolts, 1in (4 off); 6 BA nuts (8 off) 6 BA shakeproof washers (4 off); terminal pins for 0.1in matrix board (8 off); connecting wire; solder; heatsink for VN66AF

The circuit remains in this state for as long as the perimeter loop is unbroken. This loop can consist of any number of normally closed switches, including window foil. The loop is connected to the zero volt line; for as long as it is intact the potential of the input to gate 2 is held low. When the perimeter loop is broken, even for a fraction of a second, the pull-up resistor R1 causes the potential at the input of gate 2 to go high. This triggers the bistable to change state. The output of gate 2 goes low; the output of gate 1 goes high. The bistable will remain in this state even though the perimeter loop is made complete again. Current flows from gate 1, through R3 to the base of TR1. The transistor is turned fully on, the potential at its collector drops almost to zero and a current flows through the buzzer, causing it to sound. The buzzer continues to sound until the 'reset' button is pressed or the circuit is switched off.

This circuit takes only 1μA when in the inactive or quiescent condition, so it is very suitable for operation by battery. When the buzzer is sounding it requires 20mA.

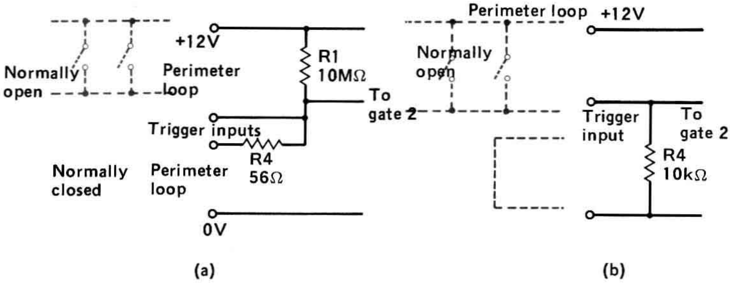

Figure 2.2

Adapting the simple alarm circuit for use with (a) normally open switches, and (b) both types of switch

If you wish to operate this alarm from normally open switches, or from both kinds of switch, the circuit may be modified as shown in Fig. 2.2. In the modification of Fig. 2.2a, R1 is omitted and the input to gate 2 is held low by resistor R4. When one of the switches is closed the input to gate 2 is made high and the bistable changes state. In Fig. 2.2b the normally closed loop holds the input to gate 2 low (as in the original circuit). A high input to gate 2 is required to trigger the circuit. This can be obtained *either* by breaking the loop *or* by closing one of the switches of the normally open loop. Resistor R4 is inserted to limit the flow of current to a reasonable amount when one of the normally open switches is closed.

Construction

The circuit is built on a small piece of stripboard (Figs. 2.3 and 2.4). Although a socket may be used for the i.c., it is hardly necessary here and the extra cost is more than that of the i.c. itself. Remember to observe the usual precautions needed with CMOS devices: avoid static charges by not wearing clothing made from artificial fibre; work on an earthed metal sheet (lid of biscuit 'tin', sheet of kitchen foil); use an earthed soldering iron.

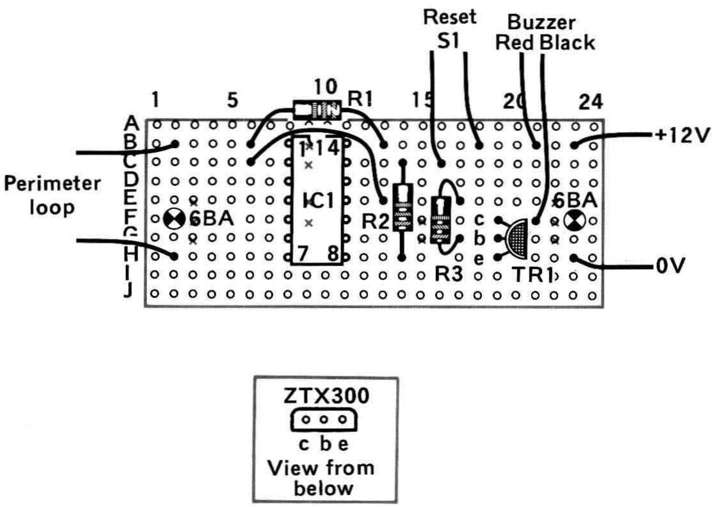

Figure 2.3

Layout of circuit board for simple alarm circuit

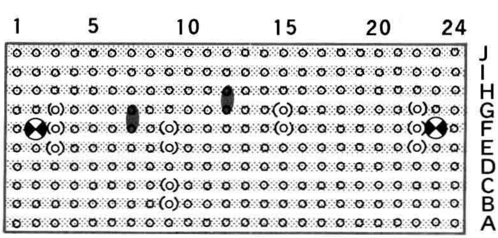

Figure 2.4

Underside of the circuit board. Strips to be cut and bridges to be made
Cuts at B9, C9, E9, F9, F15, G15, E3, F3, G3, E22, F22, G22
Bridges at F7 to G7, G12 to H12

First assemble the bistable by wiring up the i.c. and resistors R1 and R2. Note that certain connections between pins are made by way of the copper strips beneath the board. Make sure that you cut the strips beneath the board, and be sure to cut the strips only where indicated in Fig. 2.4. The input terminals of unused gates of the i.c. are connected to zero volts. This is essential to reduce power consumption to a minimum. The action of the bistable may then be tested by connecting a voltmeter between pin 11 and the zero volt rail, and joining a short length of wire between pin 1 and the zero volt rail to act as the perimeter loop. If pin 13 is briefly touched by a wire joined to the +12V supply, the voltage at pin 11 should fall to zero. If the perimeter-loop wire is briefly disconnected the output should swing sharply to almost +12V. Replacing the loop wire should not affect the output. If this test is successful, the remainder of the circuit may then be

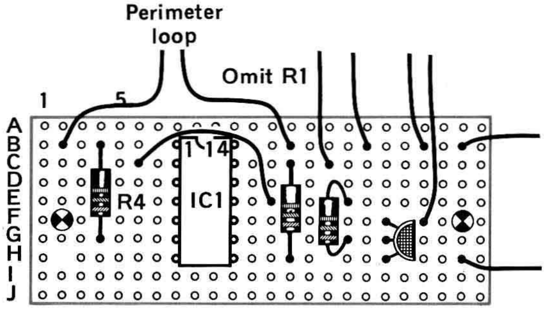

Figure 2.5

Adapted layout for use with normally open switches (Figure 2.2a)

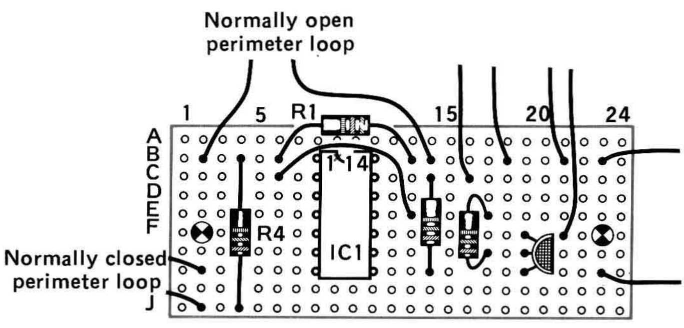

Figure 2.6

Adapted layout for use with both types of switch assembled and tested. The buzzer is a solid-state device and its polarity must be observed when connecting it. Usually the wire to be connected to the positive supply is coloured red. The layout can be adapted for operation with normally-open switches (Fig. 2.5) or with both types (Fig. 2.6).

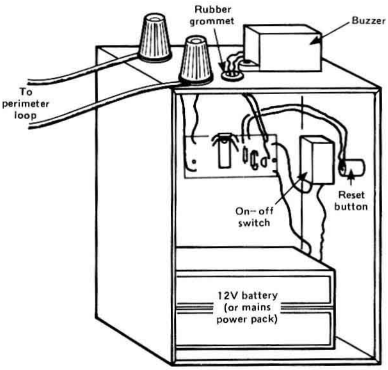

Figure 2.7
The alarm unit in its case (lid removed)

The circuit may then be mounted in its case (Fig. 2.7). This needs to be large enough to hold the battery or power supply. A suitable battery consists of two battery holders, each containing four C or D dry cells. The circuit board is mounted on the rear of the case, using two 6BA bolts. Alternatively, use a double-sided self-adhesive pad (*Sticky Fixer* etc.). The buzzer is firmly bolted to the case; it will be found that its note sounds considerably louder when it is fixed in position.

Bell alarm

An electric bell provides a sound loud enough for most purposes but requires more power than the buzzer used in the previous project. This circuit (Fig. 2.8) is very similar to that of the previous project but employs a VMOS power transistor to switch on an electric bell. This transistor can carry up to 2A, which is more than enough to operate a single electric bell. There is a wide range of other audible-warning devices available, including sirens which produce single or multiple tones. Two or more of these may be wired in parallel and placed on various parts of the premises. Their total current consumption must not exceed 2A. In the quiescent state it consumes only 2mA.

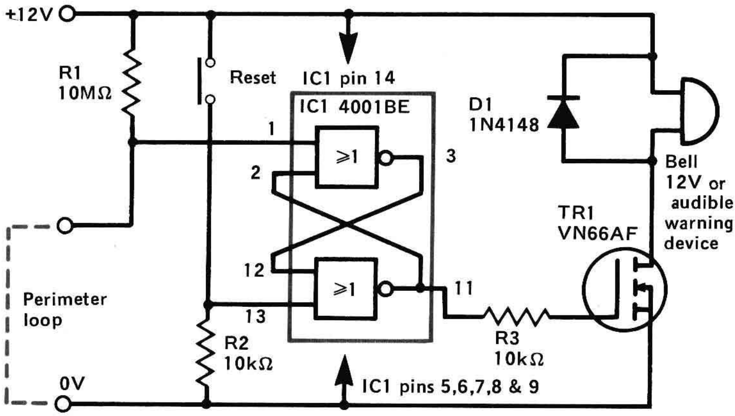

Figure 2.8

Triggered electric bell or other audible warning device

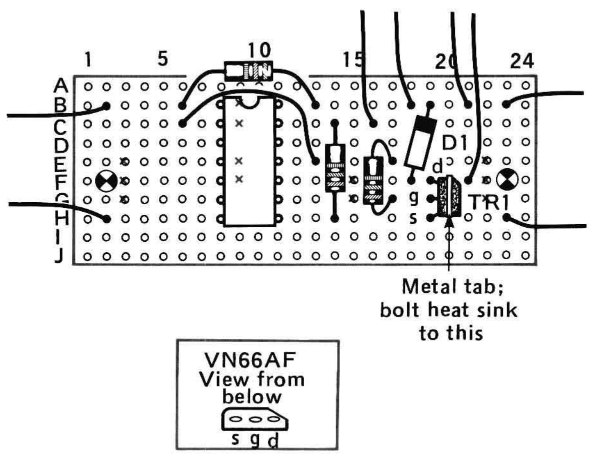

Figure 2.9

Layout of circuit board for bell alarm. this may also be adapted as in Figures 2.5 and 2.6. The underside of the board is shown in Figure 2.4