House alarm is simple to construct, features high reliability

Collyn Rivers

This project is adequate for the average household or small business and will provide years of reliable operation.

WHEN YOU HEAR a burglar alarm the chances are less than three in a hundred that the alarm has been set off by an intruder. The other 97 times it's been falsely triggered. And if it's raining at the time — especially if there's a thunderstorm — the chances of the alarm being genuine are very much smaller still.

This is a thoroughly unsatisfactory situation and one that has caused police and security organisations many headaches over the years.

False alarms are generally caused by poor installation techniques and/or the wrong choice of alarm control unit for the specific application. In the case of non-professional designs and installations the cause is usually lack of appreciation of the problems inherent in what at first seems to be a simple problem in electronic circuit design.

The alarm unit and installation techniques described in this article have been devised to combine total reliability with immunity to false triggering. Both were progressively developed over a number of years and the unit itself was produced commercially (by the author) in large quantities for the security industry some years ago. It is still one of the simplest and most reliable units around.

The system is adequate for the average household or small business. If built and installed as described it will provide years of reliable operation.

Defining the risk

Really determined and skilled burglars will find ways to break into almost anywhere — no matter how well it is protected. But experts like these will be far too occupied sizing up the local bank to bother about most houses or small businesses. Who you're mainly up against are 15-25 year olds with generally limited intelligence.

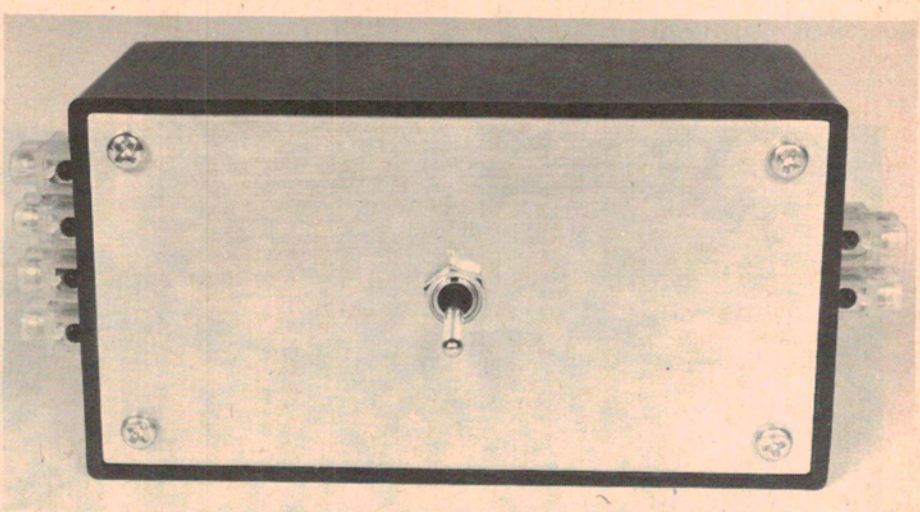


Figure 1 shows how and where most forced entries will be attempted. A surprising 29.2% of illegal entries are made through unlocked doors or windows. Most other entries are made by forcing with a jemmy. Only rarely is entry made by breaking glass.

So your first step should be to 'harden up' the house. Fit really strong concealed catches, especially to those windows which are not overlooked from the street or by neighbours' houses. You'll have to search around for decent fittings — the sliding bolt catches sold by most hardware stores are jokes. One good kick will tear them in half — if the toy screws supplied don't pull out first! So consider carefully how the various devices will withstand a jemmy used in earnest — and whether the woodwork to which they are attached will need strengthening.

Once this is done it's time to think about alarm protection.

The basic system

The simplest adequate alarm system detects the opening of doors or windows and when an 'opening' signal is received causes the alarm to sound continuously even after the door is subsequently closed.

The alarm should also sound and continue to sound if any associated wiring is detected and cut. The alarm should be battery operated so that it will continue to operate if mains power fails or is disconnected.

This all seems simple enough to do but there are a number of unsuspected traps along the way.

Detecting entry

Doors and windows may be protected by switches which are closed when the openings to be protected are closed. All such switches are connected in a series loop so that if one or more are opened, or interconnecting wiring is cut, the alarm is actuated.

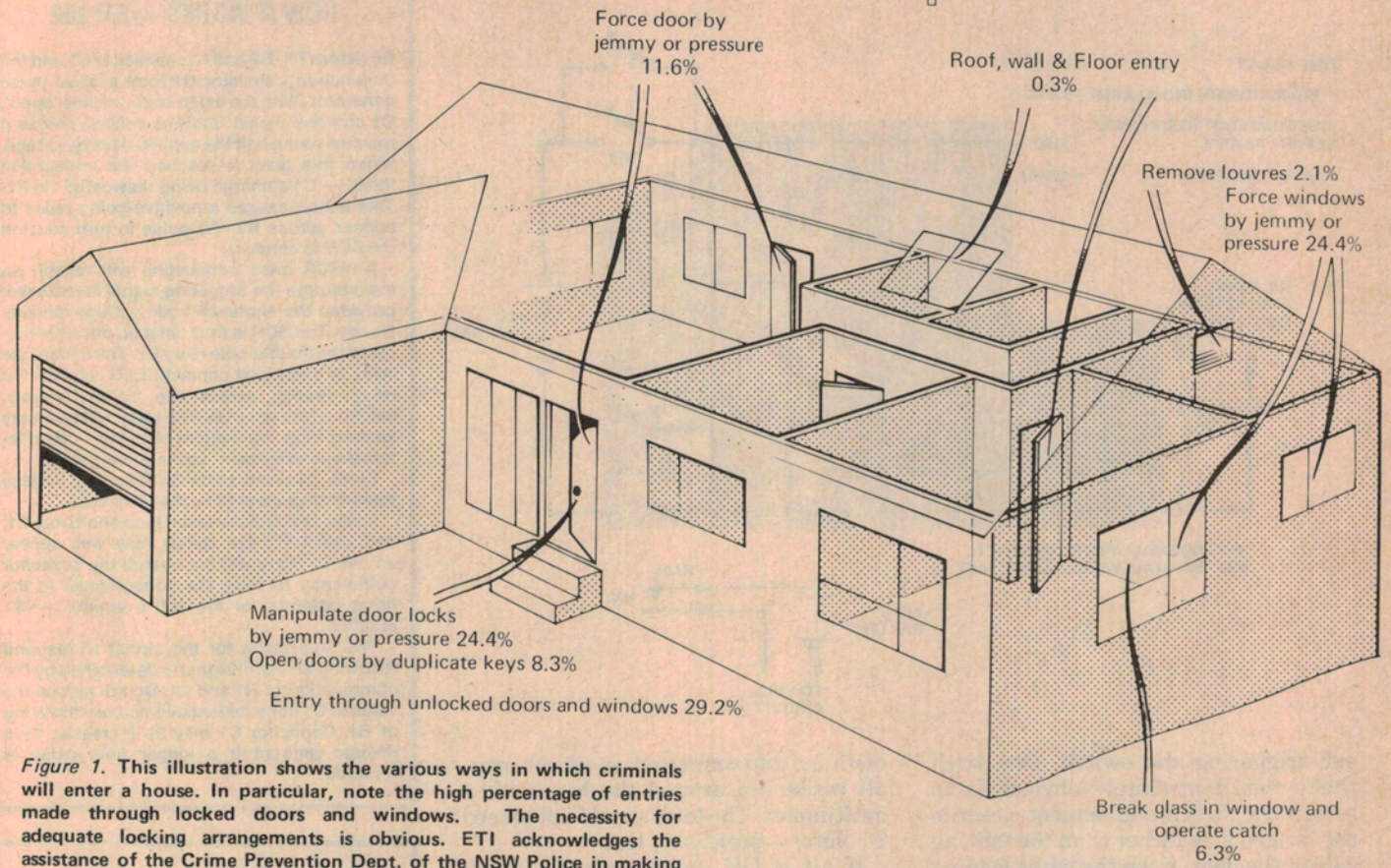


Figure 1. **This illustration shows the various ways in which criminals will enter a house. In particular, note the high percentage of entries made through locked doors and windows. The necessity for adequate locking arrangements is obvious. ETI acknowledges the assistance of the Crime Prevention Dept. of the NSW Police in making these statistics available.**

Many of the windows to be protected may remain closed for months — sometimes years — so the switches chosen must be absolutely reliable and resistant to corrosion. Most switches are designed so that the contacts are automatically cleaned every time the switch is operated — but this doesn't help much if the switch is actuated only once in ten years!

Another essential requirement is that the door or window must be able to open at least 20 mm before the switch is actuated. This will allow for movement caused by swelling in wet weather and rattling during storms.

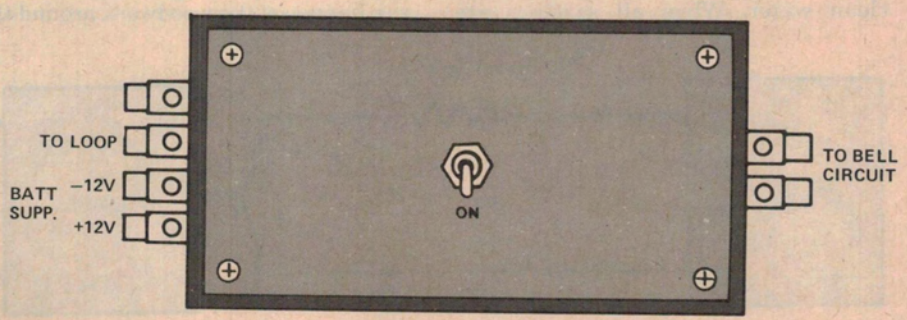
The ideal device for this purpose is the magnetic reed switch. This consists of a pair of ferro-magnetic reeds and contacts, hermetically sealed in a small glass tube, and held closed by a magnet a few millimetres away. The contacts open when the magnet is moved away from them.

Commercial installers use these switches extensively but they generally keep them packaged in rectangular plastic mouldings. A neater, but more time-consuming method, is to recess them into the architrave surrounding the opening. Whichever type is used the magnet should always be attached to the moving part of the door or window.

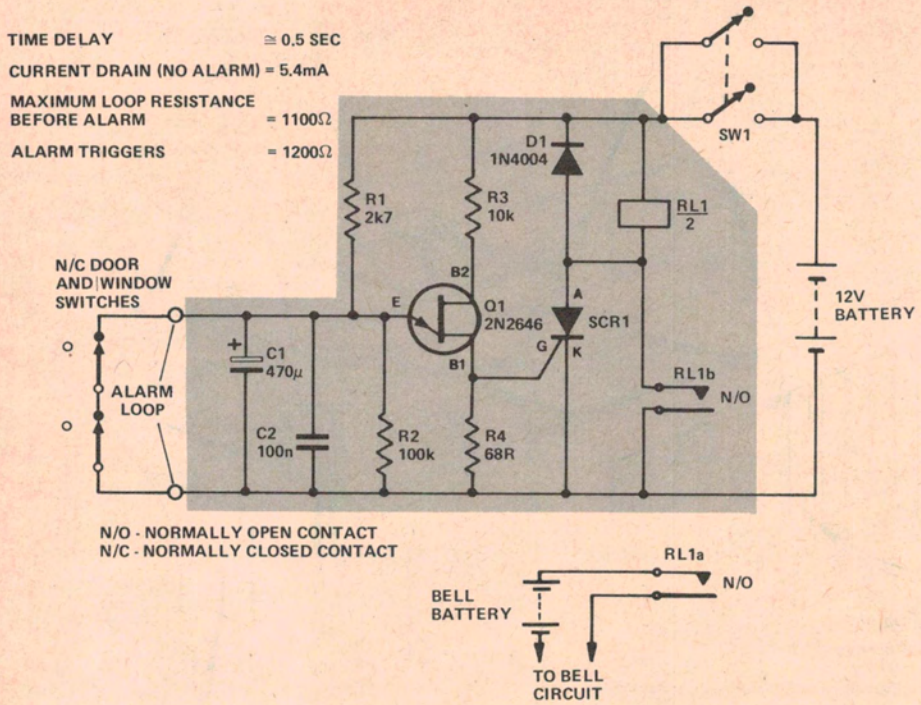
The reed switches *must* be designed specifically for security and similar applications — standard reed switches may not necessarily be suitable as some tend to remain closed when the magnet is removed if they've been held closed for any length of time. To be on the safe side, buy your switches from a security equipment supplier — you'll find addresses in the Yellow Pages.

The best magnets are ferritic-ceramic bar types — they're made by many companies and should not be hard to locate. They're usually round or square and sections 25 mm or so long will be fine. These will pull in the switch at a distance of 10-12 mm and will hold it closed at 15-20 mm.

Choose suitable locations and install switches and magnets as shown in the accompanying picture. Before making the final choice of position make sure that the door can open 20-30 mm with- ▶



External connections to the unit are made via the two plastic screw-terminal blocks.



out triggering the switch. One trick that's not immediately obvious is to mount the switch and magnet closer to the hinged side rather than the moving side of the door. Keep the wires leading to and from the switches as far apart as possible. Leave a small amount of slack in the wiring so that building movements will not stress the wiring or connections.

It is worthwhile protecting one or two internal doors — particularly if you have one leading from a garage or carport into the house — but don't overdo the number of protected entry points. Every additional switch increases the probability of false alarms.

The switches should be connected in series using multi-strand wire (14/0076 is about right). Don't use single strand wire — it's more prone to failure if moved. Solder the wires to the switches using *non-corrosive* solder and clean off any residual flux with detergent and clean water. When all switches are installed and connected, check the overall resistance around the loop with a multimeter. The total should not exceed 20 ohms — preferably less.

If all is OK, paint over the solder points and any bare wire with bituminous paint — or smear well with Vaseline. This may seem technical overkill but it's surprising what pollution can do to wire left bare for several years.

The unit itself

The alarm unit should ideally be battery powered and draw little current. It should be capable of accommodating *some* resistance in the external signal loop but must *not* accept more than two hundred ohms before triggering. And that's where so many amateur and magazine-designed alarms go wrong, for in the quest for low current consumption designers plump for a high impedance input. Figure 2 shows what can happen if the woodwork around the

HOW IT WORKS — ETI 262

Resistors R1, R2 and R3, capacitor C1 and the unijunction transistor Q1 form a basic pulse generator. With the external alarm loop 'open', C1 charges via R1 until the voltage across it reaches about half the applied battery voltage. When this level is reached the unijunction 'fires' — C1's charge being dissipated via R2. This action causes a positive-going pulse to appear across R2, the pulse in turn causing the SCR to conduct.

An SCR once conducting will remain so even though the triggering signal is removed, provided the anode-cathode voltage remains steady. The SCR is thus 'latched on' and energises the double-pole relay RL. The instant the relay is energised contacts RLb connect the relay directly across the battery supply, 'latching' the relay on. The relay will now stay latched even if the entire circuitry — both internal and external — subsequently fails.

Diode D1 protects the SCR against voltage transients generated by the relay coil.

In use, the external alarm loop shorts out C1, and whilst voltage spikes may well appear across C1, they will not charge the capacitor sufficiently to raise the voltage level to the firing potential of the UJT's emitter — B1 junction.

The time taken for the circuit to respond following an alarm signal is determined by the combination of R1 and C1. Do not *reduce* the value of C1 nor substantially *increase* the value of R1. Capacitor C1 may be increased by a desired amount if a longer time delay is required.

PARTS LIST — ETI-262

Resistors all ¼W, 5%
- R1 ..... 2k7
- R2 ..... 100k
- R3 ..... 10k
- R4 ..... 68R

Capacitors
- C1 ..... 470u16 V electro
- C2 ..... 100n greencap

Semiconductors
- Q1 ..... 2N2646 UJT
- SCR1 ..... C106D SCR
- D1 ..... 1N4004 or similar

Miscellaneous
RL1 — cradle relay, 12 V coil with two changeover contacts (Pye, type 265/12/G2V); SW1 — DPST toggle switch; 12 V battery; pc board ETI-262; small box to suit; barrier strip terminals (six-way), plated type; suitable reed switches; magnets etc as per the article.

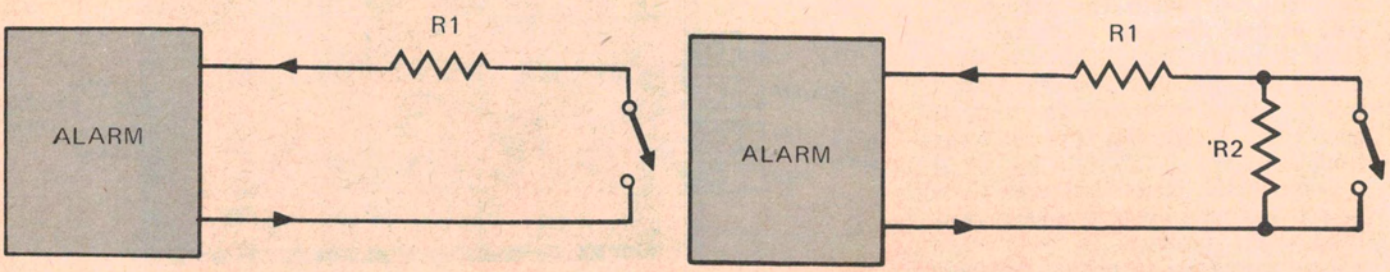
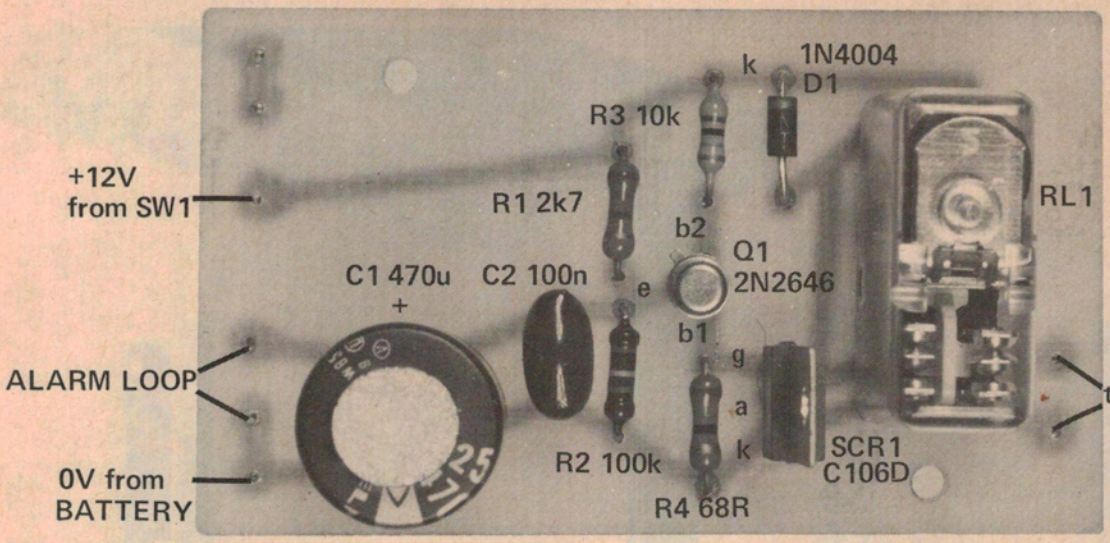
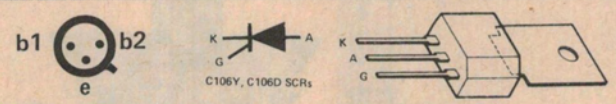


Figure 2. **Resistance R1 represents series resistance of the loop (see text). Resistance R2 represents leakage paths across alarm contacts.**





2N2646 BOTTOM VIEW

switches gets moist — a leakage path may develop in parallel with the switch (that's why you keep those leads apart) and if this happens when the control unit can tolerate more than a few hundred ohms, that switch can be opened *without triggering the alarm* !

The alarm unit must be insensitive to voltage spikes picked up by the external loop — remember that's quite an antenna you'll have there. Such voltages can be surprisingly high and are caused by lightning strikes, arc welders, faulty fluorescent lighting starters, capacitor start motors (often found in 'fridges and freezers), contactors, etc. Existing alarms can be protected to some extent by connecting two capacitors (in parallel) across the input terminals. One should be about 10 uF, the other about 10n. Figure 3 shows how — and why you need the two.

A good test for voltage spike immunity is to wind fifty to a hundred metres of wire around a power drill. Connect the two ends to the input of the alarm unit and switch the drill on and off about fifty times. If the alarm isn't triggered by this it's a fair bet it will be satisfactory when installed. Very few alarm control units will withstand this test and those that don't will sooner or later cause problems.

Don't for a moment consider any alarm unit in which the external loop is connected directly to the gate of an SCR. It is *impossible* to protect such a circuit if the external loop is more than a few centimetres long. Yet, incredibly, such circuits are shown time and again in electronics magazines — presumably because at first sight an SCR is (almost) a single component control unit.

Likewise, don't connect a bell or siren directly to the anode of an SCR. Voltage spikes induced in the wiring to and from the bell can and will trigger the SCR into conduction. If you have such a device at present, modify it by interposing a relay between the SCR and the bell circuit — and connect a diode across the relay coil to protect the SCR against the relay's collapsing magnetic field.

The circuit of the ETI-262 alarm con-▶

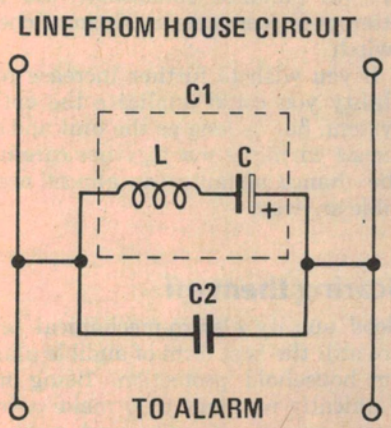
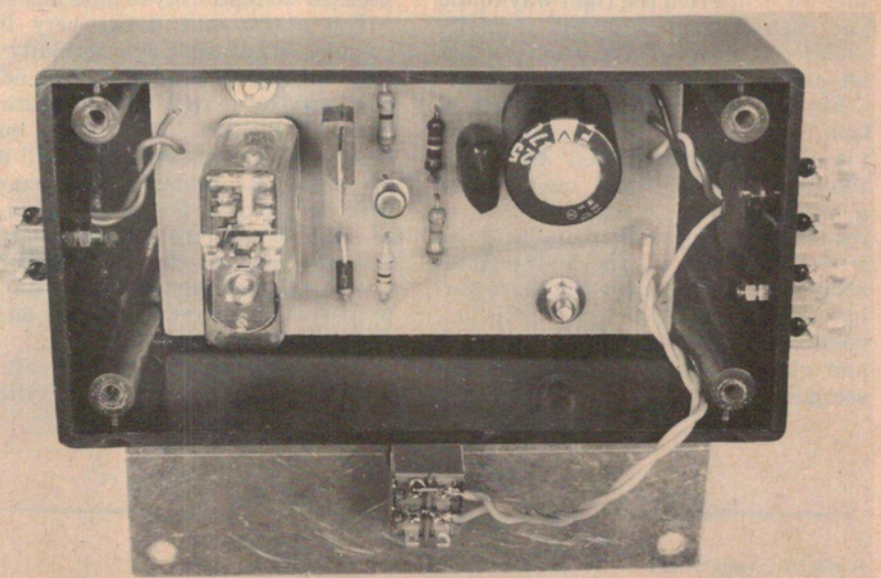
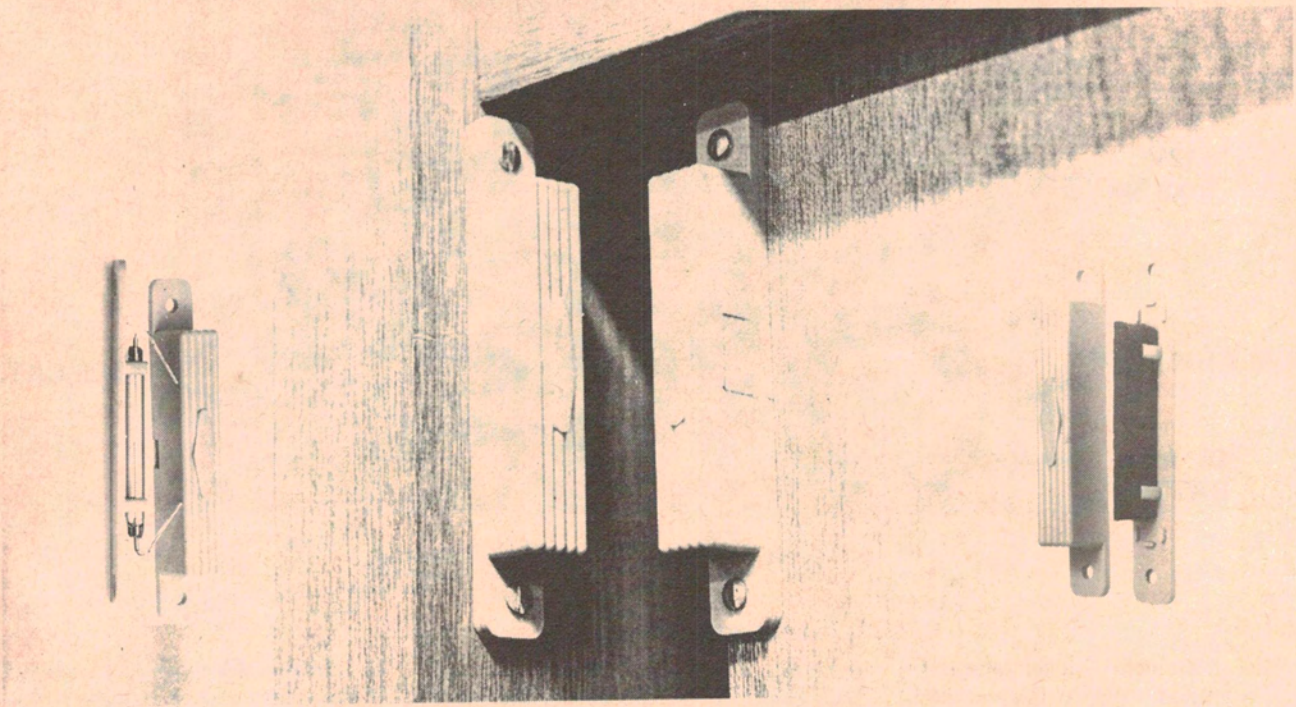


Figure 3. **The large value capacitor, C1, will effectively bypass low frequency interference but its high series inductance, L, will prevent the bypassing of high frequency interference. A smaller value capacitor, C2, usually a ceramic type with a low series inductance, will bypass the high frequencies effectively.**





Reed switches and magnets for burglar alarm systems are designed for easy installation.

trol unit is shown in the accompanying diagram. It's essentially a simple circuit but one in which several components perform more than one function. The basic idea is that a unijunction pulse generator is normally prevented from operating by the closed external alarm loop. When the loop opens, the unijunction 'fires', causing an SCR to conduct and latch on, which in turn actuates the alarm relay.

The best way to construct the control unit is to use the printed circuit board shown (full size) on page 47. Make sure that C1 is inserted the right way round and that all joints are very carefully soldered. Clean off any residual flux after soldering.

Resistor R1 controls the length of time between a switch being opened and the alarm being triggered. The value shown will trigger the circuit after approximately ¾ sec. Altering values to reduce the triggering delay will increase battery drain. The delay enables doors to rattle in a gale without triggering the alarm accidentally (it is impossible to open a door, pass through and close it again in less than one second).

Don't be tempted into replacing R1 by a potentiometer — it will rarely be moved once the alarm is installed, so that corrosion will eventually build up between the wiper and the track.

Keep the leads from the alarm unit to the battery as short as possible — 300 mm at most. Preferably build the battery in with the unit as we've shown. Use a *second* battery to power the alarm bell.

Do not delete the relay and run the bell straight off the SCR. *It will work*, but with reduced reliability and increased susceptibility to false alarms.

The alarm unit draws very little current, so batteries will normally last for nine to twelve months. It is advisable however to replace them routinely every six months. It's not worth building a mains power supply. You'll need an automatic mains/battery changeover unit to cater for mains failures — so you'll have to have a battery anyway. The best power sources for this application are six volt 'lantern' batteries. Use proper soldered terminal lugs on the ends of the battery leads.

It is worth considering powering the *bell* from a small Nicad battery with an automatic charger. This is also an elegant way of ensuring that the bell cuts out after an hour or two when the Nicad has exhausted itself.

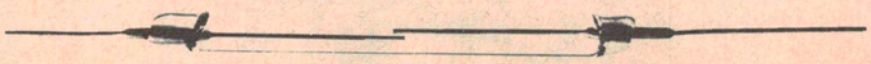
Arrange for a key operated switch to short out the alarm switch on a chosen 'silent entry' door. Suitable switches may be obtained from security equipment companies. The associated wiring should be concealed.

The main on/off switch on the unit itself should be double-pole single-throw with the contacts wired in parallel (to enhance reliability). Do not attempt to economise by fitting a cheap switch.

If you wish to further increase reliability you could duplicate the entire system, but as long as the unit and external wiring is put together carefully the chance of failure is almost negligible anyway.

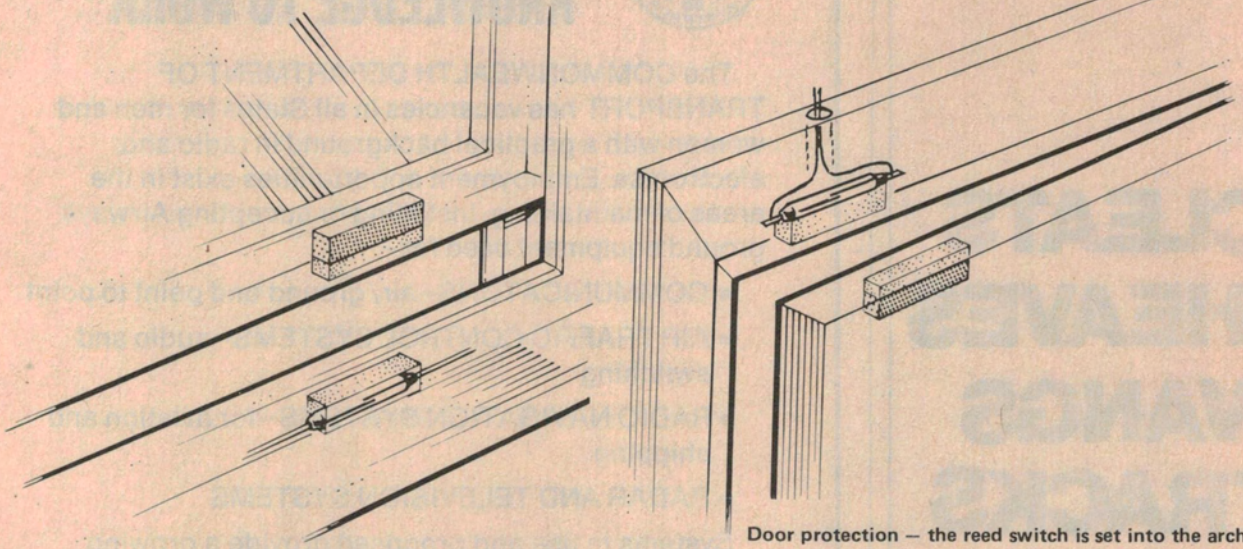
Scaring them off

Good quality electro-mechanical bells are still the best form of audible alarm for household protection. Being mechanically resonant they make a very large amount of noise and consume little power whilst doing so. The average 12 inch bell (it's an old-fashioned industry and they still think in inches) draws less than half an amp and can be heard at least a hundred metres away.



A magnetic reed switch.

For window protection, the reed switch is recessed into the frame of the casement window. The magnet is set into the moving part.



Door protection – the reed switch is set into the architrave.

A siren has a potentially larger range but is more directional. Good ones draw a lot of power — five to ten amps or more. Small cheap sirens should not be considered. The alarm bell should be mounted unobtrusively, and high up in an inaccessible position. Leads to the bell should be totally concealed. Use 40/0076 wire to reduce voltage drop.

It is worth locating one or two spotlights in strategic positions and arranging for these to be switched on as the alarm is actuated.

Finally, don't be put off by stories about people ignoring alarm bells — burglars don't!

Should you tell

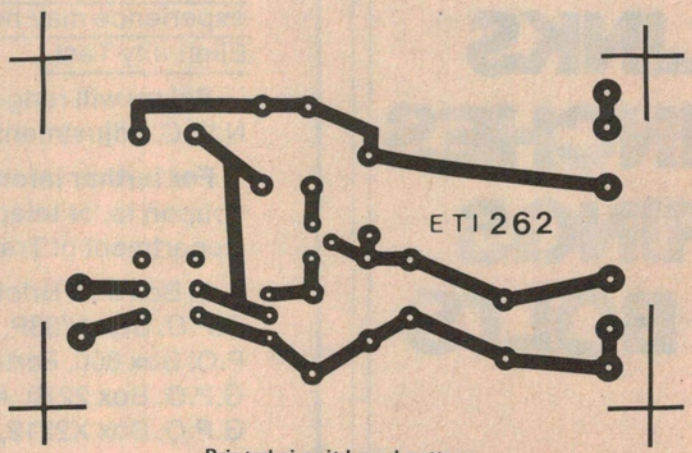
Providing you have a good installation and a concealed bell there's a lot to be said for making it clear to intending intruders that the premises *are* protected.

One way of doing so is simply to place warning notices in strategically chosen windows. This is done by most professional security companies — to such effect that there's quite a strong argument for using just notices alone!

We've included a suitable warning notice in this issue — (extra copies printed on heavier paper may be obtained directly form the magazine for 50 cents each plus a large, stamped addressed envelope).

A further very worthwhile tactic is to install a circuit which flashes red LEDs set into the frames of all visible windows and doors. The old 555 will do nicely, or those new-fangled self-flashing LEDs. Combine these with the printed notices plus the alarm circuit, just in case anyone thinks you're bluffing, and your chances of being robbed are negligible.

One final note: no matter how good the installation, it's *useless* unless you switch it on. ●



Printed circuit board pattern.

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