
# SECURITY VARI-LIGHT


BY A.R.WINSTANLEY

WE ARE constantly reminded that burglaries on private homes seem to be continuously on the increase. Everyone can take obvious precautions like locking doors and windows, but the device to be described here offers a more subtle means of combating casual prowlers and burglars.

It does this by tricking the would-be prowler into believing that the house is occupied at night, even though the occupants are out.

The Security Vari-Light is a unit designed for use with floor-standing standard lights or table-top lamps, therefore installation is very simple. The Security Vari-Light operates the lamp on a random cycle which has been carefully designed to give a realistic effect.

A timer circuit is incorporated so that the system will switch on after a predetermined delay of between two to seven hours. Having lights flashing on and off at four o'clock in the morning could be deemed counterproductive, as this may draw attention to the house. The timer will help to overcome this and can be switched out if it is not required.

## REPEATER

The system has been further developed and although this unit is designed to control just one lamp, by adopting a system of optical links, "repeater" units can be employed to operate lights throughout the house. The object in this respect, is to avoid having to alter any of the house's existing lighting and wiring, in order to make installation an easy matter.

Furthermore, by employing optically-coupled repeater units to drive other lights, mains wiring is avoided. Instead, a light sensitive cell connected to the repeater unit detects when the "main" security light is illuminated, and causes a second lamp to light up. Indeed, by making several photo-resistors "look at" the main Security Vari-Light, almost any number of secondary lamps could be controlled in this manner.

## CIRCUIT DESCRIPTION

Fig. 1 is the circuit diagram for the Security Vari-Light and it can be divided into two distinct sections, the Timer/Power Supply section and the Logic Control section, the latter to be described first.

IC3 comprises two four-bit shift registers, a CMOS 4015 is used, and by connecting the Q4 output of the first shift register to the D input of the second, a single eight-bit shift register is formed. The CLOCK and RESET pins for both registers are connected in parallel for this application.

IC1 is a simple 555 astable multivibrator which provides a low-frequency clock signal, approximately one clock pulse every ten minutes is passed to the shift registers. An EXCLUSIVE-OR gate, a CMOS 4070 is the only other logic element and this device contains four separate gates, all of them utilised in the circuit.

## LOGIC CONTROL

The circuit operation is as follows. Upon initial application of power, a reset pulse is delivered by IC2d to the shift registers, the outputs of which are then cleared to zero.

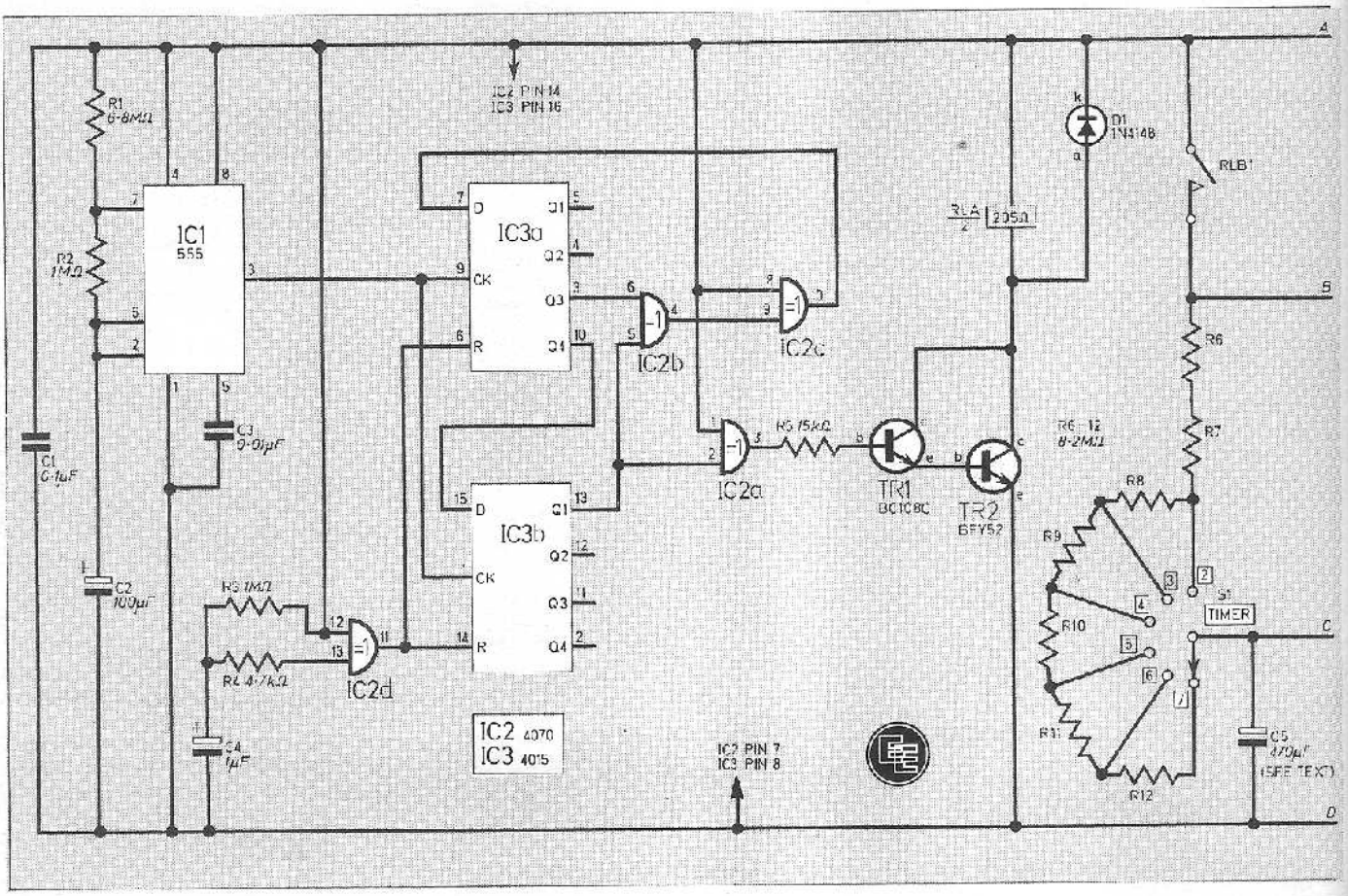



Fig. 1. Circuit diagram of the Security Vari-Light.

Simultaneously, the first positive clock transition is despatched by IC1 but the effect of this upon the logic circuit is cancelled by the switch-on reset pulse.

Since the inputs of IC2b are at logic zero, the output of IC2b is also zero, remembering that IC2 is an EXCLUSIVE-OR function. However, IC2c is connected as an inverter since one input is permanently wired to logic 1. The logic 0 generated by IC2b, then, is inverted by IC2c to generate a logic 1 which is injected into the DATA input of IC3a.

In effect, IC2b and IC2c have combined to form an EXCLUSIVE-NOR gate which serves to "start up" the shift registers and prevent them from remaining at logic zero, as detailed earlier. The pseudo-random sequence will then follow on with each successive positive clock pulse.

## SHIFT REGISTER

The output from the shift register is taken from the Q1 bit of IC3b (pin 13) and it is here that the pseudo-random pattern will be observed. This is inverted by IC2a and drives a high-gain transistor switch comprising of TR1 and TR2, which themselves complete the circuit to the mains relay RLA.

Thus when the output of IC3b (Q1) is low, which it is for the first five steps of operation, then this is inverted by IC2a to form a logic one. This high signal activates the relay RLA through the transistor switch, so that the contacts RLA1 close and power is applied via the mains socket SK1 to the mains lamp, so the lamp illuminates.

Since the logic 0 output of the shift register (Q1 of IC3b) is inverted by IC2a to form a logic 1, this means that the lamp will illuminate immediately upon power switch on. It will extinguish when a logic 1 eventually reaches pin 2 input of IC2a.

After ten minutes or so, the clock generator will deliver another positive-going pulse which will advance the shift registers by one step. The logic circuit will now generate the pseudo-random sequence, the lamp switching on and off accordingly.

## TIMER CIRCUIT

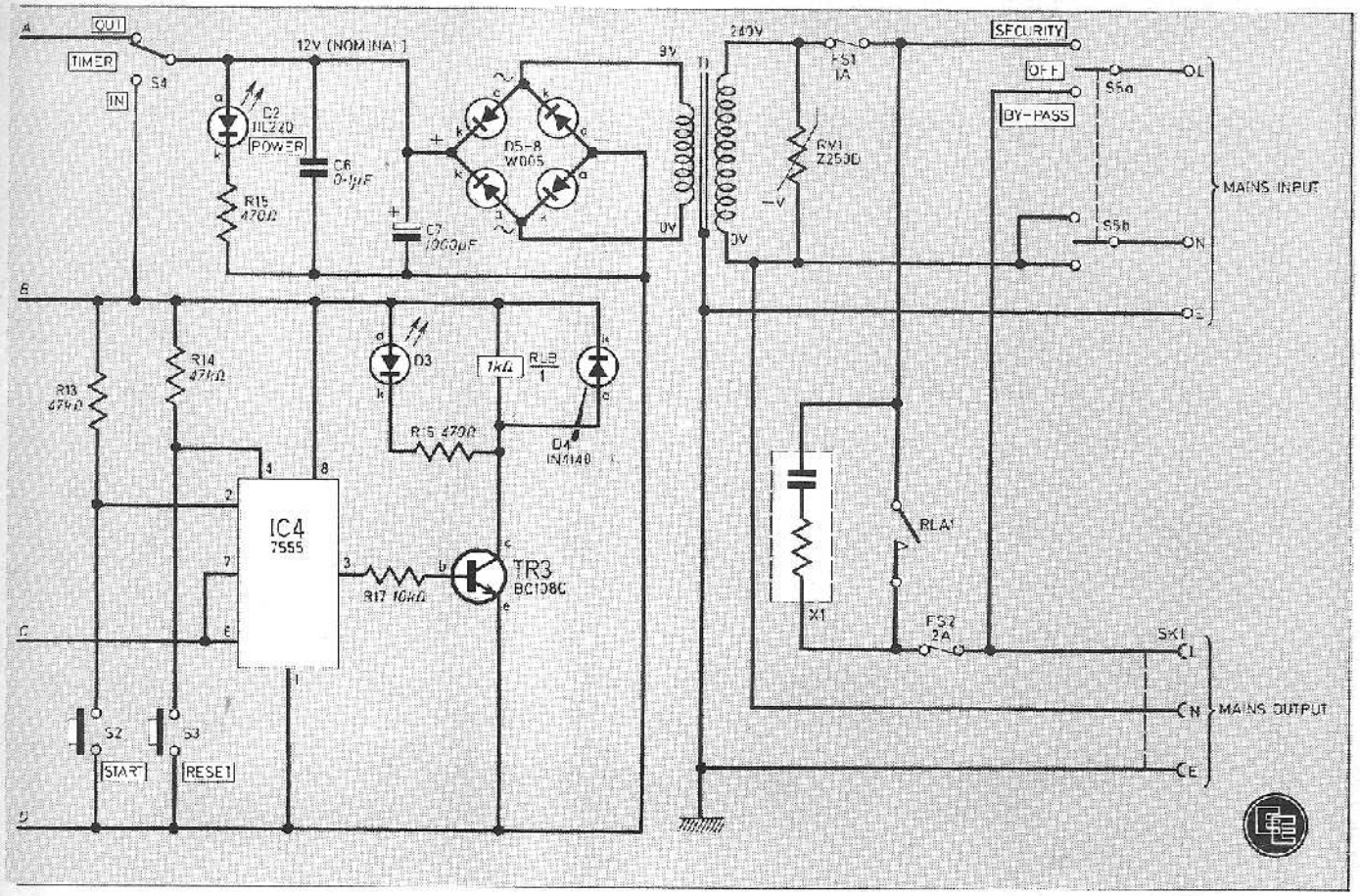
A timer has been incorporated which will operate the logic section for a predetermined period, between approximately two to seven hours, and will then disconnect the lamp. Thus the user can set the Security Vari-Light to operate randomly for a suitable period while he is away, the device will then turn off automatically.

The timer is formed by IC4, a CMOS 7555 connected as a monostable. Timing is initiated by closing S2 temporarily and the timer can be reset by closing S3, if required.

## TIMING PERIOD

The timer period is controlled by resistors R6-12, and C5. By rotating S1 one may adjust the value of the timing resistor network and thus the timer period can be altered as required. One problem with a simple circuit of this type is the leakage current through the timing capacitor C5. The long time constants which are required imply that a large-value capacitor is needed, specifically, an electrolytic type. These have high leakage currents which greatly affect the accuracy of the timer. With C5 at 470μF, each 8·2 megohm timing resistor corresponds to a delay of one hour.

When the timer is initiated, pin 3 of IC4 goes high, and this is buffered by TR1 to drive the reed




relay RLB and the TIMING l.e.d. indicator, D3. The reed contacts RLB1 then close and supply power to the logic section.

This in turn activates the switch-on reset circuit (IC2d) and then the logic sequence starts up in the manner described, causing the mains lamp to operate in a pseudo-random fashion.

If the timer is not needed, it can be bypassed by setting S4 to OUT which disconnects the timer circuitry and provides power straight through to the logic.

## POWER SUPPLY

The power supply is a standard type in which 240V a.c. is stepped down by T1 to about 9V a.c., and subsequently full-wave rectified by D5-8 and smoothed by C7 to give about 12V d.c. at no load. D2 is the POWER l.e.d. and illuminates when the Security Vari-Light is switched in.

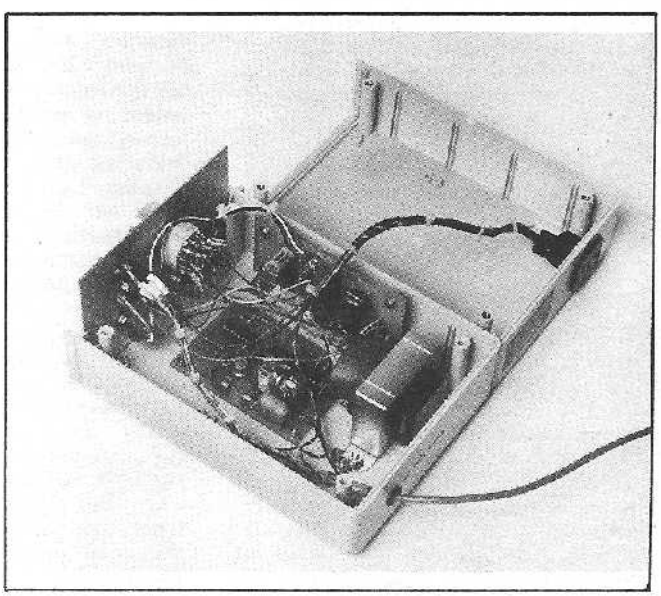
In the SECURITY mode, S5 (the mode switch) passes mains current through to T1 primary winding and then the random logic sequence will operate the mains lamp, and this can then be timer-controlled if desired. However, S5 can be moved to the BYPASS mode and this will supply power to the lamp continually, bypassing the electronics.

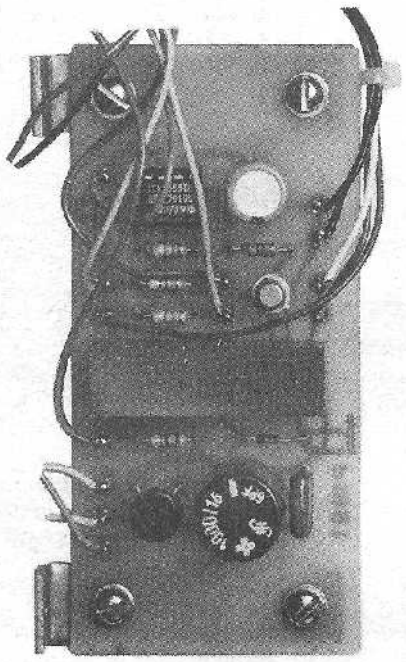
S5 is actually a centre-off type so when in middle position, both the electronics and the lamp will be completely disconnected from the mains supply.

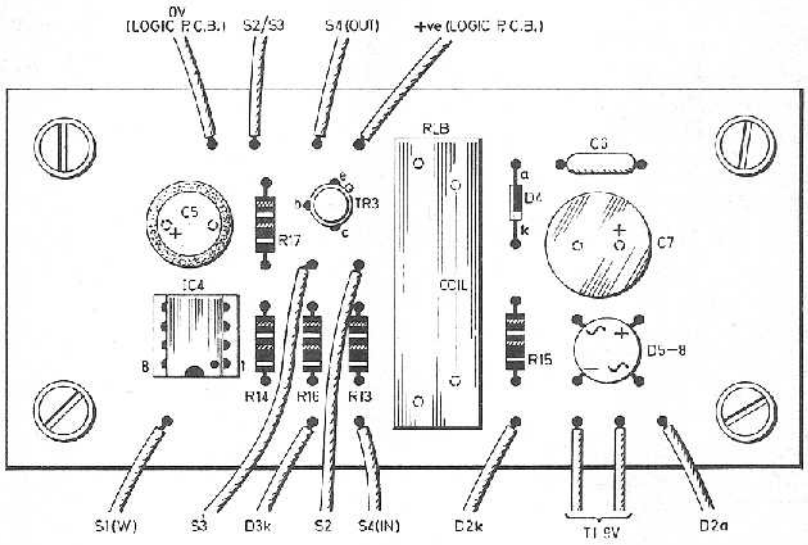
## MAINS SUPPRESSOR

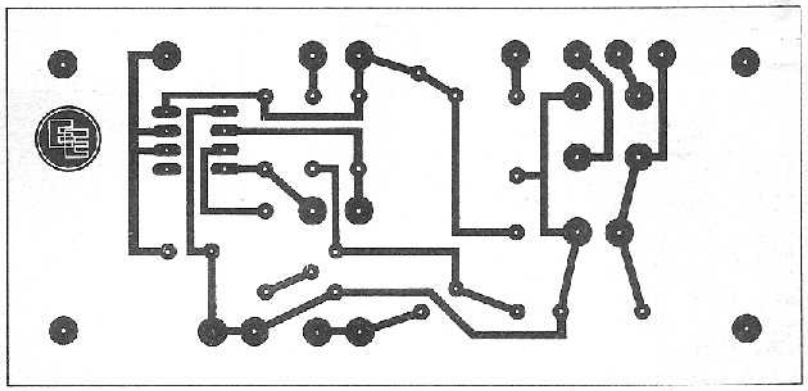
Finally, the mains contacts of RLA1 are protected by a suppressor network, X1. This reduces contact wear and prevents mains transients from working through the power supply causing the logic section to malfunction. Protection of this nature is increased by the mains transient suppressor, RV1.

However, the presence of X1 provides a route for mains power when S5 is in the BYPASS mode, so even though the electronics are disconnected, enough power may be transmitted through X1 to operate the CMOS. As a result of this the light-emitting diodes glow very dimly.





# CONSTRUCTION starts here

## PRINTED CIRCUIT BOARDS

Construction is relatively straightforward, because nearly all components, including the mains relay, are mounted on two specially-designed printed circuit boards.

The first p.c.b., which carries the power supply and timer section, is shown in Fig. 2. This is mounted vertically using metal brackets or plastic vertical p.c.b. guides. Assembly of components is as indicated in the diagram, noting that Veropins should be used where flying leads are taken off the board. Also an eight-pin d.i.l. holder is used for IC4 to prevent damage occurring to the i.c. when soldering. The reed relay used is a Maplin type FX51F, other makes may not be compatible with the holes in the p.c.b.

The arrangement of components on the second board is illustrated in Fig. 3. The relay for this layout is a Maplin 5A mains relay type YX98G, this will solder directly to the circuit board. FS2 is a 20mm p.c.b. mounting type, rated at 2A.

The integrated circuits IC2 and IC3 are CMOS devices and are particularly sensitive to static electricity. Do not remove the devices from their conductive packing until they can be inserted into their respective holders on the board.

## CASE

The case used on the prototype was a plastic Verobox type 202-21311 which has dimensions 138 x 190 x 91mm. As mentioned earlier, it is recommended to fix the timer p.c.b. vertically to obtain the most compact arrangement, layout is otherwise not too critical. Keep the lengths of mains wire to a minimum and away from the mains interwiring, this will ensure that no problems are caused by mains interference.

The timing resistors RG-12 are soldered directly to the tags of S1, in accordance to Fig. 4. This diagram details all necessary interwiring and must be followed closely.

The earth input is connected to the mounting frame of the transformer, and this is accomplished by

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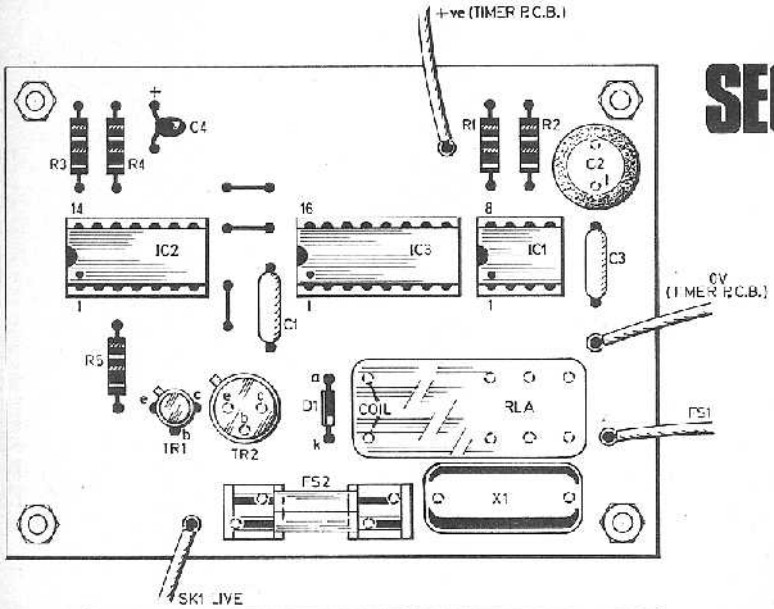
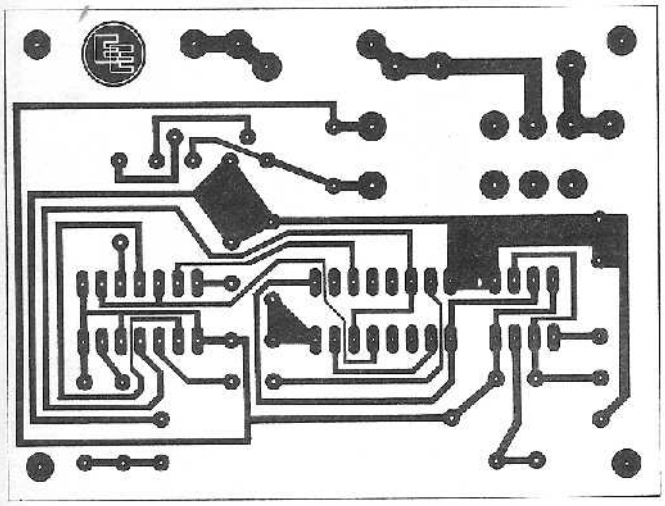
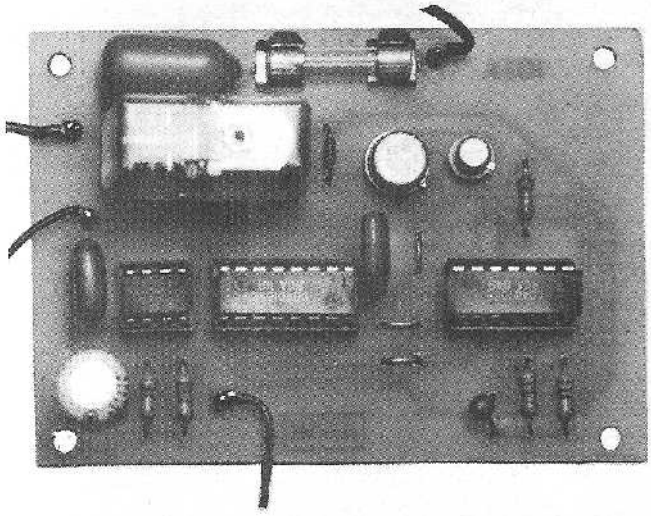



Fig. 2. (opposite page) The component layout and full size track artwork for the timer/power supply printed circuit board. The four mounting holes are for securing the board to the p.c.b. brackets. These can be seen in the photograph of the prototype also shown.

Fig. 3. (left) The Security Vari-Light main control logic board component layout and full size track artwork. This board is mounted on spacers off the bottom of the case. Photograph (below) shows the finished p.c.b. assembly from the prototype model.





using a solder tag fixed under one of the transformer mounting bolts. It is essential that the front panel, which is made of aluminium, is also soundly earthed, remembering that it is anodised, so this must be removed at the earthing point.

It is of prime importance that the three-core mains cable is properly secured so that it will not pull out and for this, a cable retention clip and grommet are utilised.

SK1 is a "Euro-Facility" 6A 250V mains socket and is a clip-in type. A suitable cutout (28 x 23mm) is made in the top half of the case, at the rear. It may be necessary to secure the socket with an adhesive, since the rather thick case wall may prevent the socket from clipping into position properly.

## MAINS WIRING

All mains interwiring should be completed using 24/0·2mm 6A wire. This is thick enough to carry the required current but can be soldered to the small tags on the rear of the mains ON/OFF switch, S5. Insulate each mains joint with 2mm bore p.v.c. sleeving for additional safety.

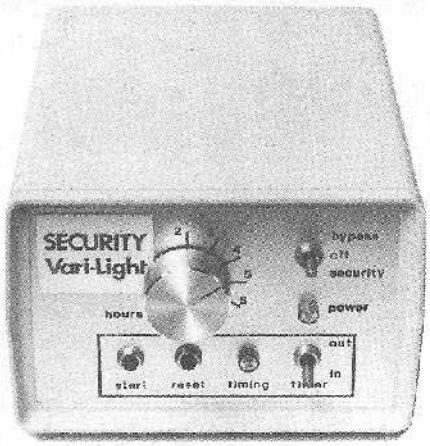
The remainder of the interwiring can be completed with standard 7/0·2mm wire. Use of several colours assists with checking, later on.

There are two light - emitting diodes to be fixed to the front panel, and this can be achieved with two transparent lens-clips or the standard black bezel clips.

To label the controls on the front panel after the panel has been drilled, use rub-down lettering (available from stationers and some component suppliers), after which carefully apply several light coats of protective clear lacquer. This will help prevent the letters from lifting off.

## CHECKING

Check out very carefully all wiring and soldering, prior to switching on. Ensure that the mains plug is fitted with a 3A fuse and then plug a lamp (500W maximum power) into SK1. With S5 at OFF (centre) and S4 to TIMER IN, plug into the mains and switch on by moving S5 to SECURITY. This should cause the POWER l.e.d. to light up. The TIMING l.e.d. may or may not be alight, but either way, pressing S2 will activate the timer and the mains lamp should also light up. Pressing S3




# COMPONENTS

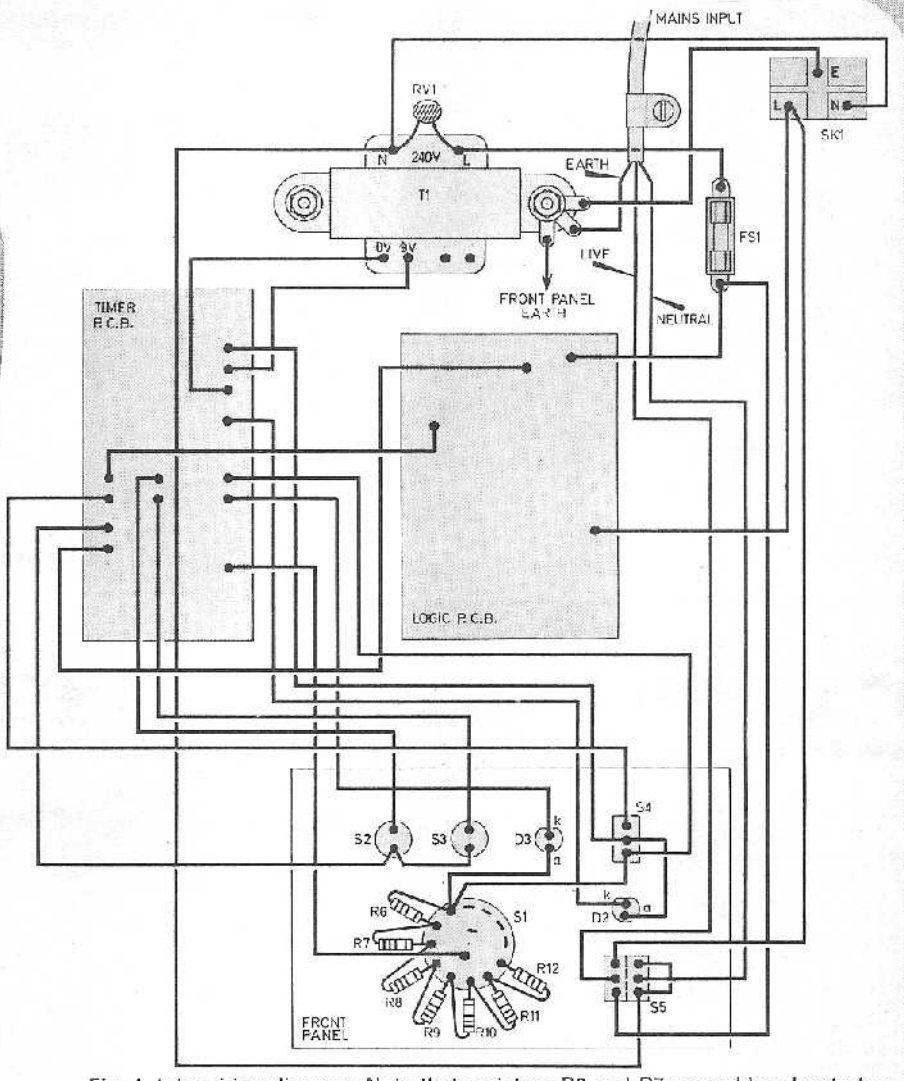



Fig. 4. Interwiring diagram. Note that resistors R6 and R7 are soldered onto two unused switch tags on the unused half of S1. The front panel earth wire was soldered to the metal case of S5.

**Resistors**

| | |
|---|---|
| R1 | 6·8MΩ |
| R2, 3 | 1MΩ (2 off) |
| R4 | 4·7kΩ |
| R5 | 15kΩ |
| R6-12 | 8·2MΩ (7 off) |
| R13,14 | 47kΩ (2 off) |
| R15, 16 | 470Ω (2 off) |
| R17 | 10kΩ |

All ¼W carbon film ±5%

**Capacitors**

| | |
|---|---|
| C1, 6 | 0·1μF polyester C280 (2 off) |
| C2 | 100μF 25V elect, radial lead |
| C3 | 0·01μF polyester C280 |
| C4 | 1μF 35V tantalum bead |
| C5 | 470μF 25V elect, radial lead |
| C7 | 1,000μF 25V elect, radial lead |

**Semiconductors**

| | |
|---|---|
| D1, 4 | 1N4148 silicon (2 off) |
| D2, 3 | TIL220 0·2in. red l.e.d. (2 off) |
| D5-8 | W005 50V, 1A bridge rectifier |
| TR1, 3 | BC108C silicon *npn* (2 off) |
| TR2 | BFY52 silicon *npn* |
| IC1 | 555 timer |
| IC2 | 4070B CMOS quad 2-input EXCLUSIVE-OR gate |
| IC3 | 4015B CMOS dual 4-bit shift register |
| IC4 | 7555 CMOS timer |

**Switches**

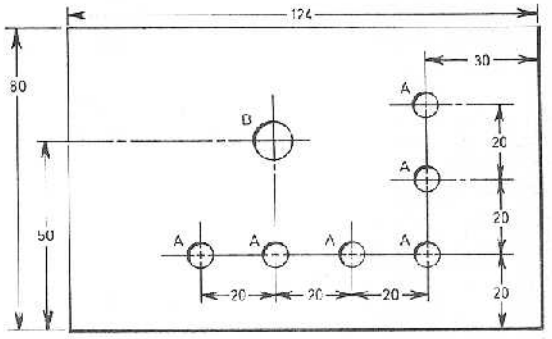
| | |
|---|---|
| S1 | 2-pole, 6-way rotary |
| S2, 3 | push-to-make momentary action (2 off) |
| S4 | s.p.d.t. miniature toggle |
| S5 | d.p.d.t. centre off miniature toggle |

See Shop Talk page 826

**Miscellaneous**

| | |
|---|---|
| RV1 | 240V mains transient suppressor Z250D |
| X1 | mains R-C contact suppressor |
| RLA | miniature mains relay, 12V, 205Ω coil, contacts rated at 240V, 5A |
| RLB | encapsulated reed relay, 9-12V, 1kΩ coil, 50V, 200mA contacts |
| FS1 | 20mm, 1A fuse with chassis mounting holder |
| FS2 | 20mm, 2A fuse with p.c.b. mounting clips |
| T1 | miniature mains transformer, 9V, 250mA secondary |
| SK1 | mains panel mounting socket |
| PL1 | shrouded pin mains plug (for SK1) |

Case, Verobox 202-21311 size 138 × 190 × 91mm; single sided p.c.b.s. size 86 × 65mm and 105 × 50mm; 16-pin d.i.l. holder; 14-pin d.i.l. holder; 8-pin d.i.l. holder (2off); 24/0·2mm wire (for mains wiring); 7/0·2mm wire; P-clip; grommet; knob; 3-core mains cable; standard 3-pin mains plug with 3A fuse; self adhesive feet (4 off); Veropins; solder tags; mounting hardware (nuts, screws, washers and p.c.b. bracket or guide).

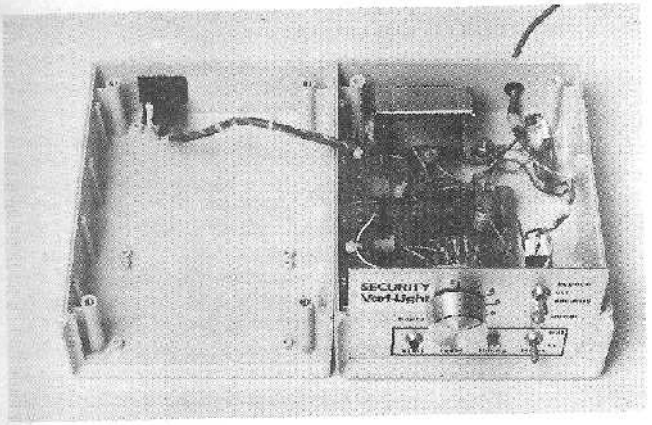



HOLE SIZES
A = 6·4mm
B = 10mm

ALL DIMENSIONS IN mm

Fig. 5. Front panel drilling details.

**COMPONENTS approximate cost £28**




View inside the finished prototype model clearly showing the mounting of the mains socket SK1, and how the mains wiring is separately held together with cable ties.

should extinguish the lamp and the TIMING indicator. This indicates that the timer functions correctly. Follow on by testing other functions.

Using a stopwatch, check the time period obtained with the timer set to the two hour delay setting. The result obtained will give a good indication of the accuracy that can be expected on other settings.

If the timer is discovered to be unacceptably inaccurate, the simplest remedy is to change the value of C5 accordingly. With the prototype, the theoretical two hour delay came out actually as more than 50 per cent over this; C5 was reduced to 220μF. The delay then was about one and three-quarter hours, which is more acceptable.

## APPLICATION

With the model suitably tested and functioning it can be pressed into service. It is possible to use the device with any mains lamp (or number of lamps) totalling not more than 500 watts.

Floor-standing spotlight units work well as a deterrent if located in the hallway or near to the entrance of a room. ⌑