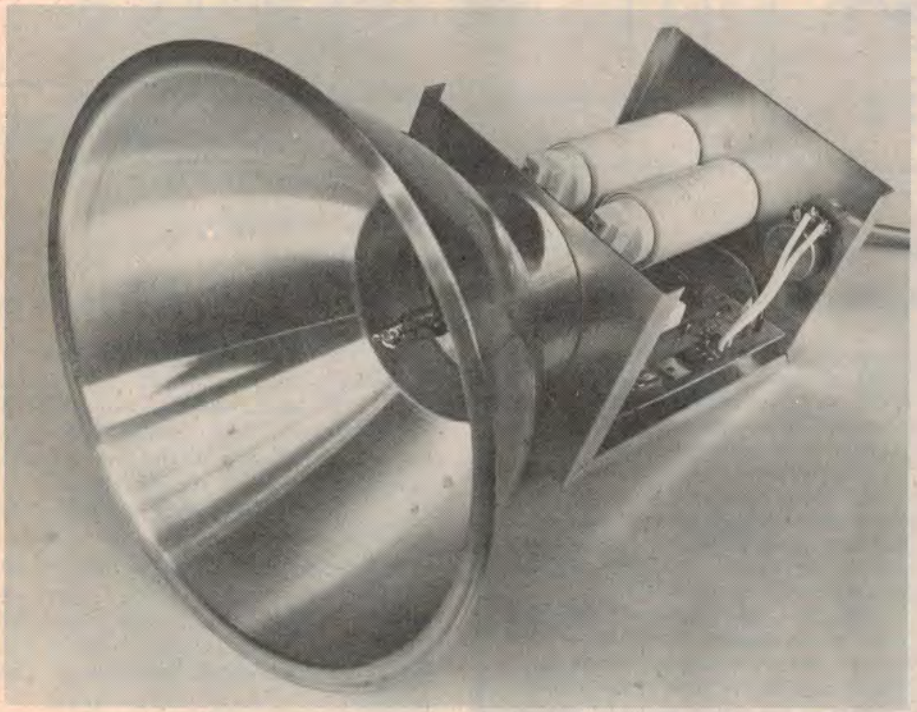
# Disco strobe light

We published our first strobe unit way back in August 1971. It has been one of our all-time popular projects. This unit is an up-dated version featuring a number of improvements.

**Phil Wait**



STROBE LIGHTS are very popular as lighting effects devices at parties and discos. Emitting a series of bright flashes of light several times per second, the movement of dancers takes on a jerky 'stop-motion' effect. Used in conjunction with coloured 'light show' effects units that vary the colour and intensity of a bank of lights, the overall effect achieved can be quite stunning.

We first published a strobe unit for this application back in August 1971. That was the ETI 505 High Power Strobe. It has been by far the most popular project we have ever described. The ETI 505 was still available as a kit — and a steady seller by all accounts — quite recently.

When the demand for a new strobe became apparent earlier this year, we sat down and took a long hard look at the original design. But despite all the revolutionary technology that has appeared since then, there was no way we could see of significantly altering the device to any advantage. That original design was just about the simplest, least expensive and most effective for a strobe that could be devised. However, experience over the years showed up a number of minor shortcomings and we have modified the circuit to eliminate these — and this Disco Strobe is the result.

## The effect

How does a strobe produce the 'stop-motion' effect? Quite simply, really. At each flash of light, in a darkened room, you will see everybody in the position they are in at the instant of the flash. During the short interval before the next flash, they will have moved and you will see them in a slightly different position, and so on. Thus, it seems they 'jump' from position to position and anything or anybody that moves does so in the characteristic jerky fashion. If the flash rate of the strobe is fairly close to the rhythmic movements of the dancers, the effect is quite dramatic.

## Improvements

There were a couple of points on which we though the old strobe could be improved. Firstly, some constructors reported intermittent false triggering of the strobe tube, resulting in a disturbing 'flutter' in the flash rate. In the original circuit, the gate of the SCR pulsing the strobe tube was connected directly to the two neon trigger tubes with no resistor from the SCR gate to ground. Without being 'clamped' to ground by a resistor, the sensitive SCR gate is prone to being triggered by mains-borne noise 'spikes' capacitively coupled to it via the neon tube or adjacent circuitry. This has been corrected in the current project.

The second point was more of a construction problem. The capacitor charging circuit and the flash timing circuit on the original strobe were each powered by separate half-wave rectifiers. Now that appears like a full-wave bridge rectifier with the bridge not completed. Many constructors saw this and immediately took it to be a mistake — so they 'put it right' by connecting the cathodes of D3 and D4 in that circuit. The result was always disastrous! Our sympathies to those who were caught.

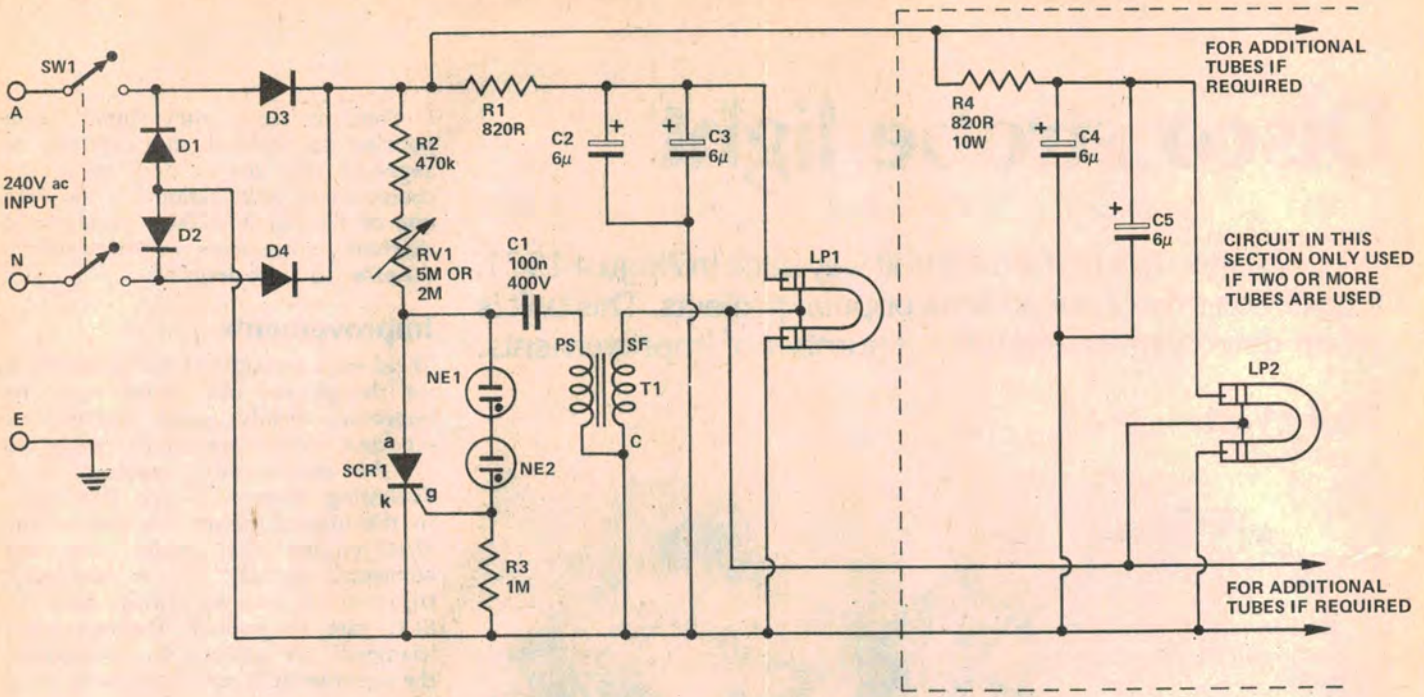
To avoid this occurring again we decided to use a conventional bridge rectifier to power the complete circuitry.

## Construction

Carefully examine the photographs and the construction diagrams. Assembly is quite straightforward and little difficulty should be experienced. Care must be taken with the wiring though, as the unit operates directly from the mains.

The electronics is all mounted in a 145 x 115 x 90 mm aluminium box. A 180 mm diameter spun aluminium reflector is mounted on one end, the strobe tube(s) being mounted inside this by a plug and socket arrangement. An octal valve socket is used, its mounting screws being used to secure the reflector to the box.

At the opposite end of the box, the discharge capacitors are mounted, two or four being used depending on whether one or two strobe tubes are ▶




## HOW IT WORKS – ETI 574

The principle of operation of the strobe tube is discussed in the general text, so here we'll concentrate on the overall circuit.

The mains voltage is rectified by a diode bridge circuit formed by D1, D2, D3 and D4. Since there is no capacitor directly across the dc output of the bridge rectifier, the output consists of a series of half-wave pulses at a frequency of 100 Hz (i.e.: twice the mains frequency). The storage capacitors, C2 and C3 (plus C4, C5 etc if extra tubes are added) are charged from the bridge rectifier output via R1 (R3 etc for extra tubes). They will charge to the peak value of the rectifier output, about 340-350 volts. (That is, 1.414 times the mains voltage: 240 x 1.414 = 339 volts).

The resistor in series with the storage capacitors (R1, R3) limits the peak charging current to prevent damage to the rectifier diodes and also serves to isolate the strobe tube from the mains.

The two neon 'trigger' lamps, NE1 and NE2, each have a 'striking potential' of around 120 volts. That is, the neon gas inside will ionise, ('break down') and the lamp 'fires', conducting current very suddenly when this striking voltage is reached or exceeded.

Now, C1 is charged from the bridge rectifier output via R2 and RV1. As the voltage across C1 rises it will eventually reach the striking voltage of the two neons. As these are in series, the voltage across C1 must reach about 240 volts before they strike. When this occurs, a pulse of current will flow into the gate of SCR1, causing it to conduct. This effectively places C1 across the primary of T1 as the anode of SCR1 is then connected to earth for all intents and purposes. C1 will then rapidly discharge, the resulting pulse in the primary of T1 being transformed to about 4 kV at the secondary.

As the secondary of T1 is connected to the trigger electrode of the strobe tube, this will 'break down' and emit a bright flash of light when the trigger electrode receives the 4 kV pulse from T1.

After C1 has discharged, NE1 and NE2 will extinguish, SCR1 will turn off and C1 will commence to charge again. The whole cycle will then be repeated.

Varying the rate at which C1 charges, and thus the amount of time it takes to charge C1 to about 240 volts, will vary the time between flashes. Thus RV1, a 2 M or 5 M potentiometer, serves as a 'flash speed' control. Increasing the resistance of RV1, increases the time it takes C1 to charge to 240 volts, increasing the time between flashes – which decreases the flash rate.

The storage capacitors, C2 and C3 (with one tube), discharge when the strobe tube fires, recharging between successive flashes.

When two (or more) tubes are used, each must have a separate storage capacitor (made up of two capacitors here, for convenience) and limiting resistor, otherwise – as explained in the text – the first tube to fire in a parallel-connected arrangement would prohibit the other tube(s) from firing.

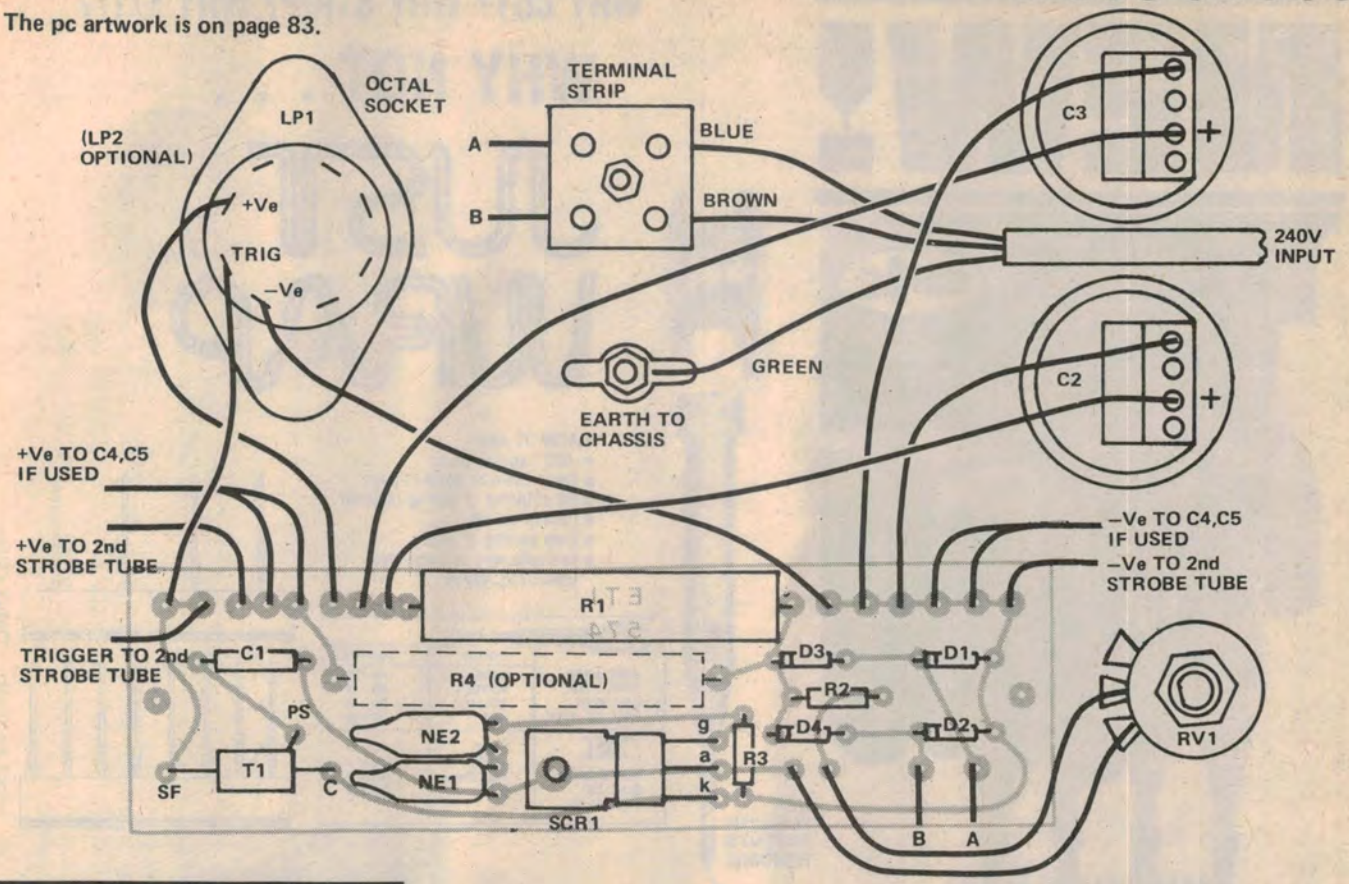
The resistor between the gate of SCR1 and ground, R4, prevents spurious triggering of SCR1.

used. The capacitors specified have a threaded mounting bolt protruding from the base, making mounting a simple matter. Also mounted on this end of the box are the flash speed potentiometer and the power switch. The power cord passes through the panel also, being secured by a clamp-type grommet. A two-pole mains switch must be used and can be either a separate switch or integral with the flash speed potentiometer. Note that a switch-pot. has been specified in the parts list.

If one strobe tube is used, only two capacitors will be required. These should be mounted, so that two more may be mounted at a later stage if another strobe tube is added. The potentiometer may have a value of either 5M or 2M, depending on which is the more readily available. The 5M pot. will give a speed from about one flash per second to about 20 flashes per second. The slowest speed is somewhat too slow for most applications, but this matters little as the desired flash rate will be within the general speed range in any case. The 2M pot. gives a range of about two or three flashes per second up to about 20 flashes, as before.

Whatever you do, do not omit the plastic cover over the front of the reflector. This is to prevent accidental contact with the flash tube and the lethal voltages present.

The pc artwork is on page 83.




## PARTS LIST – ETI 574

**Resistors**

R1 . . . . . .820R 10W
R2 . . . . . .470k ½W
R3 . . . . . .1 meg
R4* . . . . . .820R 10W
RV1 . . . . . .2M or 5M linear potentiometer with double pole switch (see text)

**Capacitors**

C1. . . . . .100n 400Volt polycarbonite
C2,C3,C4*, C5* . . . . . 6μF 240Vac capacitor (RIFA type PHN)

**Semiconductors**

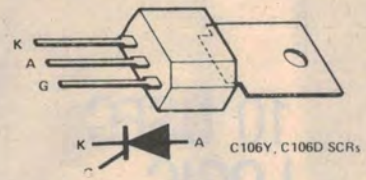
D1-D4 . . . . .EM4004,EM404, A14A or sim.
SCR1. . . . . .C106D,BT100A 500R, or sim.

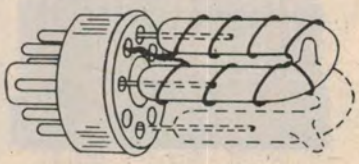
**Miscellaneous**

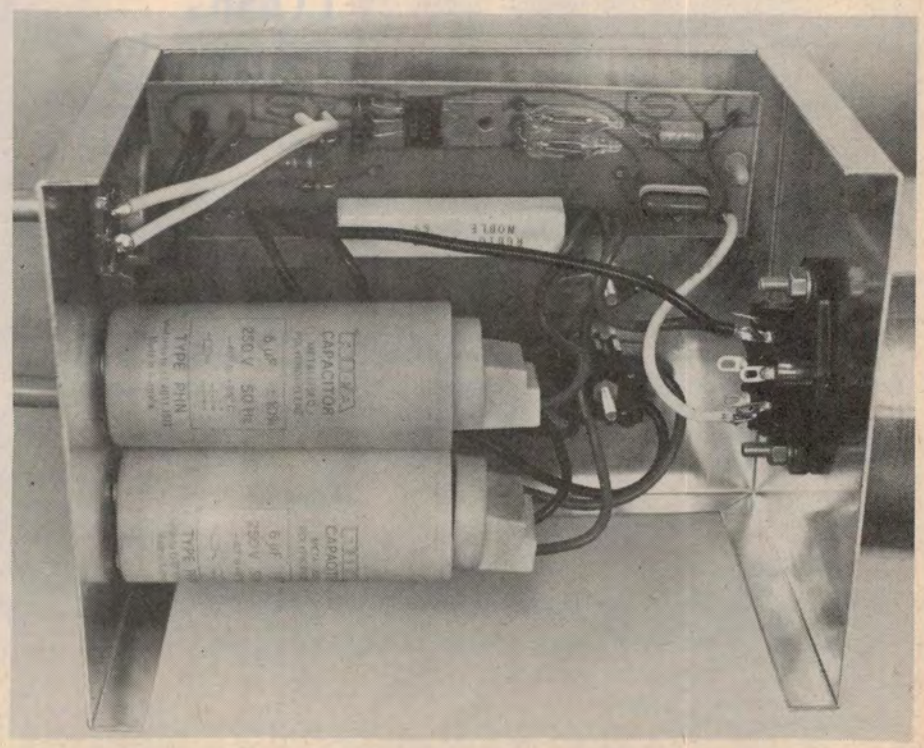
NE1,NE2. . . .neon indicator tube GE - NE2
LP1,LP2* . . .Strobe tube, Circuit Components type MFT 1210 or Dick Smith type.
T1. . . . . .pulse transformer to suit tube type TR4KN or sim.
Octal Plug . . .McMurdo L8USR1

Octal Socket McMurdo type RT8, reflector, metal box 145 mm x 115 mm x 90 mm, perspex cover, hinge, magnetic catch, power cable, ETI 574 pc board.

*Components marked with an asterisk are only used for two tubes.





## Caution!

The entire circuit is at mains potential (including the tube) and, if you don't want to fry yourself – or be responsible for somebody else accidentally doing likewise – it is essential that the case be securely earthed. The power cord must be arranged and secured strictly as shown in the diagrams. Use proper 240 Vac rated wiring (23-0076 PVC insulated) for all connections. For safety's sake, a perspex cover is bolted over the open end of the reflector.

Assemble the printed circuit board according to the overlay, noting the polarity of the diodes. If two strobe tubes are to be used, include the additional 820 ohm, 10 watt resistor as shown.

Plastic standoffs must be used to mount the pc board. These standoffs decrease the chance of a short to the metal case. They are necessary secondly because the trigger transformer develops 4 kV pulses which could possibly develop arcs across the pc board should metal standoffs be used.

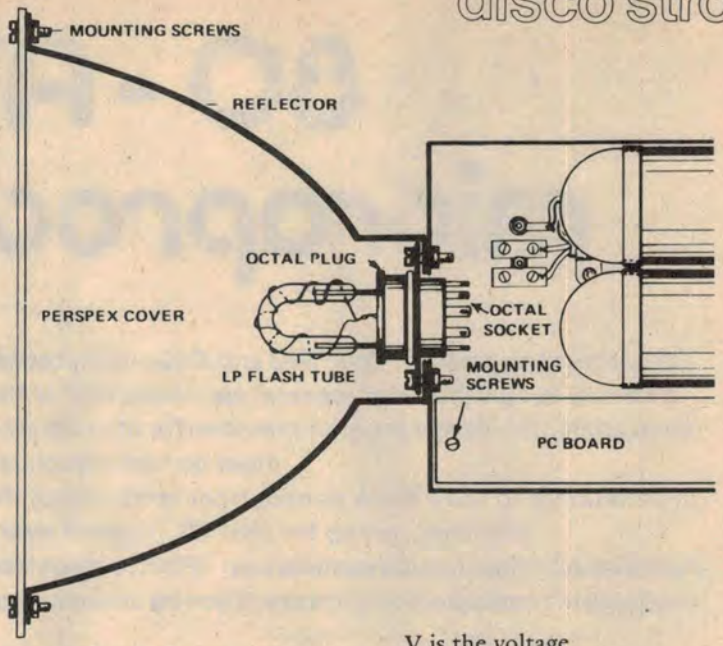
The strobe tube itself is not a critical component. Two types are commonly available. The type MFT1210 from Circuit Components of Bexley NSW is one such unit. Another is that advertised by Dick Smith, (catalogue No. S-3882).

Neither of these tubes includes a trigger electrode, so one must be attached. This is simply made by winding a length of 22 gauge (or some gauge thereabouts) tinned copper wire around the glass and taking it down to a spare pin in the octal base on which the strobe tube is mounted. The diagram shows how one or two tubes, together with their trigger electrodes, are mounted in the octal plug.

When you have the assembly complete make sure all components are securely mounted and there are no short circuits – or any possible – and **RE-CHECK THE EARTH CONNECTION.**

## The smoke test

Perhaps that's a little too strong! Nevertheless, once you have the unit assembled and carefully checked, set the speed potentiometer to minimum flash rate (fully anticlockwise), plug in and switch on. If all is well, the strobe should flash about once per second or a little faster, depending on which value pot. is installed. Advancing the control should increase the flash rate.




## How the strobe tube works

For those not familiar with a strobe tube and the way it works, the following explanation should, er . . . throw some light on the subject.

A strobe tube is a simple tube of glass, sealed at the ends and bent into a convenient shape, evacuated and then filled with a tiny amount of one of the rare gasses – in this case Xenon. Small metal electrodes are sealed in the ends of the tube, projecting into the interior. A third, 'trigger' electrode is attached in some manner around the outside of the tube, though not completely covering it. Some 300 to 500 volts dc is applied between the two end electrodes, generally from a storage capacitor, but the resistance of the gas is very high at this stage and negligible current will flow. When a very high voltage pulse, about 4 kV, is applied to the trigger electrode, the gas inside the tube ionises ('Breaks down'), its resistance falling quickly to a very low value. The storage capacitor discharges through the tube and an enormous current flows – amps of it! – the voltage across the electrodes falling in about 100 microseconds to a value below that necessary to maintain the gas ionised. When the gas ionises it emits an intense burst of light, extinguishing when the discharge ceases.

The amount of light produced during each flash is dependant on the value of the discharge capacitor and the voltage across it. For those interested, the formula for the energy of the discharge is:–

$E = \frac{1}{2}CV^2$

where E is the discharge energy, in joules

C is the capacitance in Farads

V is the voltage

Increasing either the capacitance or the voltage will increase the energy of the discharge, and hence the light output. However, as the output is increased, tube life falls off dramatically.

A better way to obtain more light output is to use two tubes. Separate storage capacitors are necessary as each tube varies with regard to discharge characteristics. If two tubes are simply connected in parallel, whichever commences to discharge first – even though it may only be microseconds earlier – will prevent the other tube from firing.

In the circuit used for this strobe unit, two 6 uF capacitors are used in parallel for the storage capacitor. For two tubes, another two capacitors are used. The same trigger transformer may be used to trigger both tubes in a twin-tube model.

For small rooms or total darkness, the light output of a single tube unit will be more than adequate. For larger rooms, halls etc, two tubes will be necessary. ●

### WARNING

Repetitive pulses of light – especially around nine flashes per second – may cause epileptics to have convulsive seizures.

Those prone to grand mal, or psychomotor attacks should avoid areas where strobe lights are operating. In fact, most people will suffer nausea or headaches after long exposure to a strobe.

In the event of an attack whilst the strobe light is operating, it must be turned off immediately.