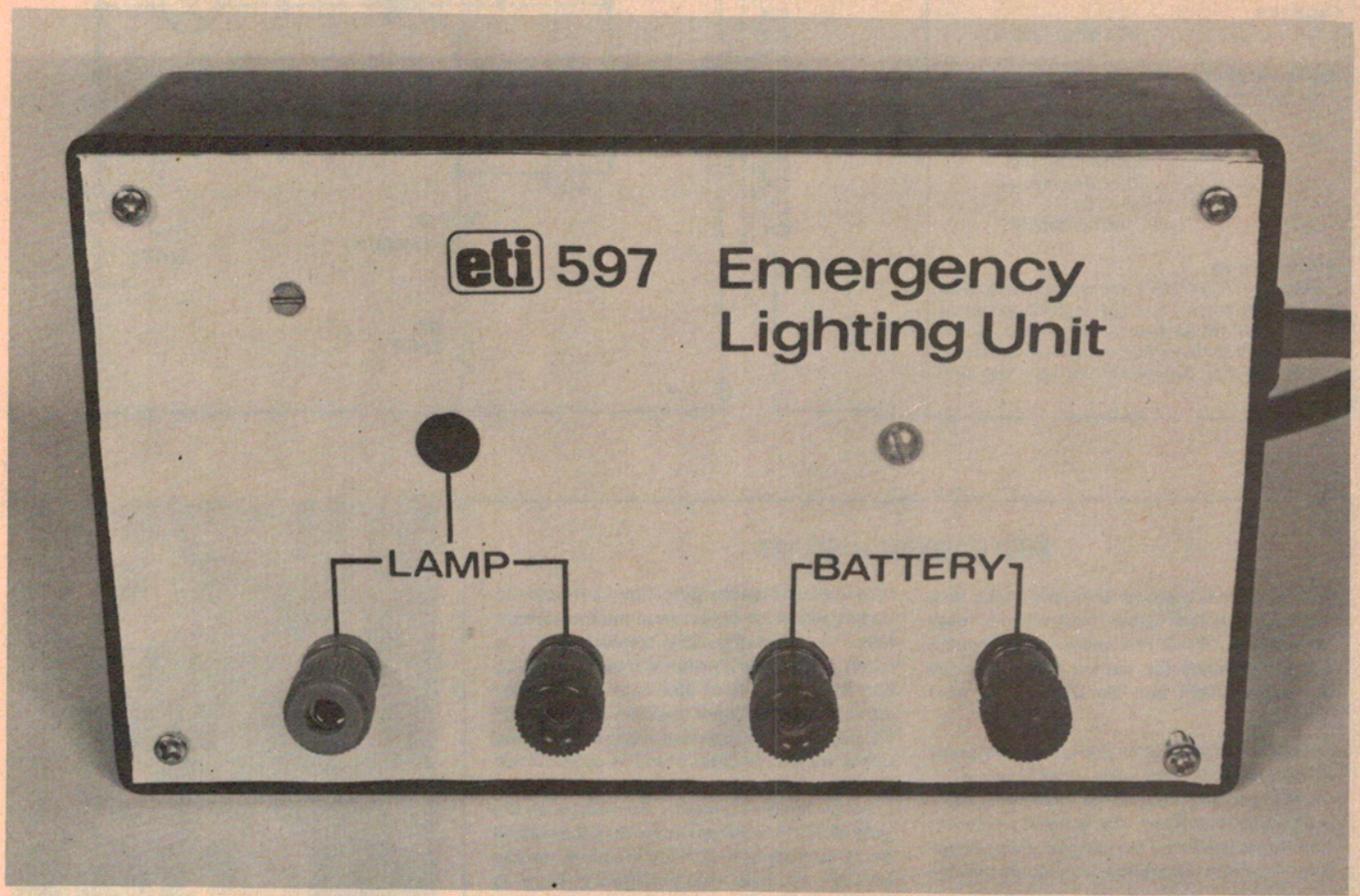
Emergency lighting unit

If the mains power fails, you needn't be left completely in the dark. This unit automatically switches on a battery operated lamp as soon as the power goes off and keeps the battery always fully charged and ready for action.



IF YOU LIVE in an isolated country area where the mains supply is erratic, or if your local electricity authority is not too good at labour relations and its workers are always going on strike, then you'll know what it's like to be suddenly and completely without any electric power.

Being deprived of the TV and hi-fi for a while could well be good for the imagination and improve your conversational skills no end, but trying to find the toothpaste in a pitch black bathroom is simply infuriating!

In these circumstances, even a low intensity light is infinitely better than none at all. With this in mind we've designed this project, which switches on a 12 volt lamp of up to 24 watts as soon as the mains power fails. It could also be used of course to power any other 12 volt appliance with the same power rating.

The emergency lamp runs on current supplied by a 12 volt battery, which is kept fully charged when not in use by a trickle of current from the mains. We used a NiCad battery for our prototype, but there is no reason why you shouldn't use a lead/acid accumulator instead, because the charging current is kept so low there is no risk of overcharging and damaging the cells. The charging current is determined by a current limiting resistor, which must be chosen to suit the capacity and charge characteristics of the battery you are using. On page 58 is a table which lists the necessary values of this resistor for different batteries.

We've also included a red LED on the front panel of the unit, to show when it is operating (i.e. when the battery is discharging). This may seem superfluous, because after all you can see for yourself whether a lamp is lit or not, but if you are using the unit to run a fish tank heater or suchlike, then an indication that the unit is operating will be reassuring. ▶

PARTS LIST — ETI 597

Resistors

R1	1k, ½W, 5%
R2	100R, ½W, 5%
R3	Current limiting resistor, see table
R4	1k, ½W, 5%

Capacitor

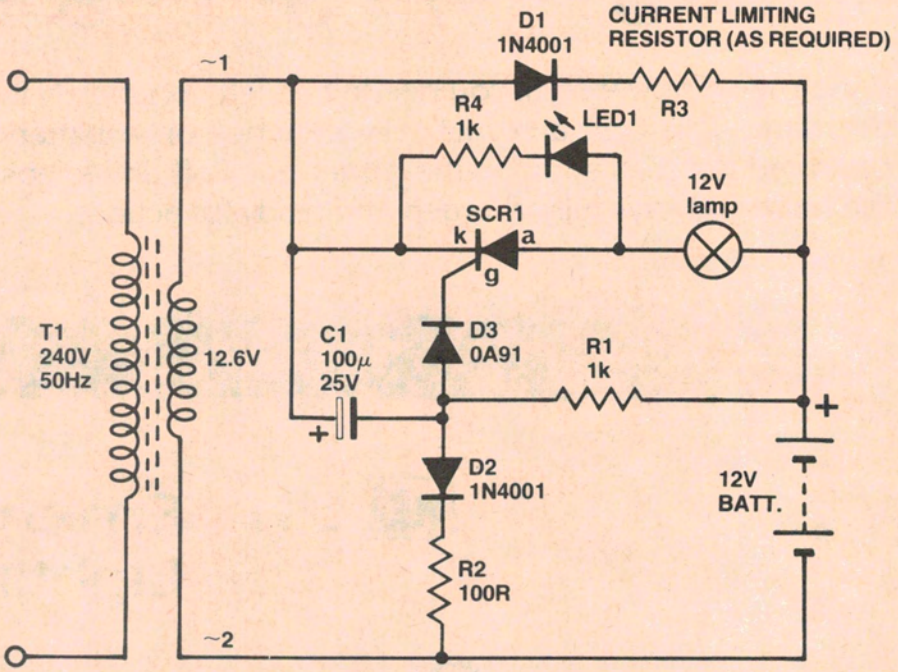
C1	100μ electrolytic, 25V

Semiconductors

D1, D2	EM401, 1N4001, A14A or similar silicon diode
D3	0A91, 0A95 or similar germanium diode
LED1	TIL220R or similar red LED
SCR1	C106Y or similar

Miscellaneous

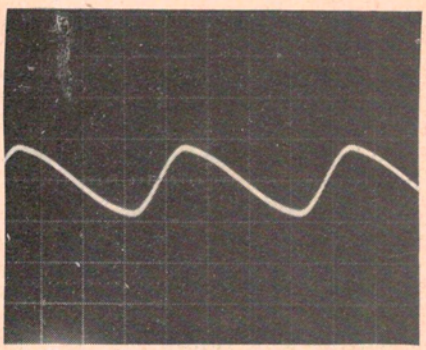
Ferguson PL24/20VA or similar transformer with 240V primary and 12V secondary rated at 1.5A; 12V NiCad battery; plastic box to suit (155mm x 95mm x 50mm); four screw terminals, two red, two black; 12V light bulb and socket.



HOW IT WORKS — ETI 597

When the mains power is on, the circuit float charges a NiCad battery from a transformer and rectifier. When the mains fails, a control circuit switches the battery through to the emergency light and the LED on the front panel.

WHEN POWER IS ON the NiCad battery is trickle charged through a rectifier diode D1, which supplies half wave rectified current pulses to the battery. Capacitor C1 smooths out these pulses by charging to the peak voltage from the transformer secondary through D2 and R2 and discharging through R1 and the battery when the output from the transformer falls. The discharge time constant of C1 is much longer than its charge time constant, so that it does not have time to discharge fully during the transformer negative half cycle. So C1 stays at a high positive voltage, with some ripple, as can be seen from the oscilloscope photograph.



Waveform at the positive lead of C1, showing the 50 Hz ripple.

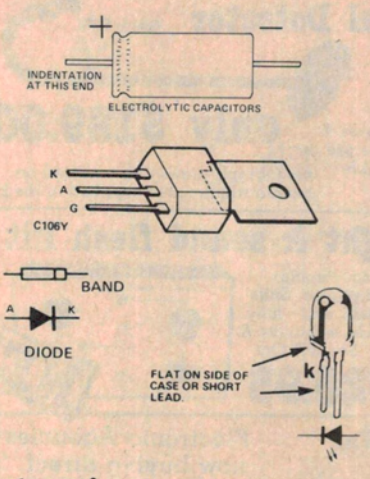
As C1 remains charged, the voltage on the gate of SCR1 is always lower than the voltage on its cathode and SCR1 is therefore reverse biased, so that the emergency lamp is switched off. LED1 is also reverse biased and not illuminated.

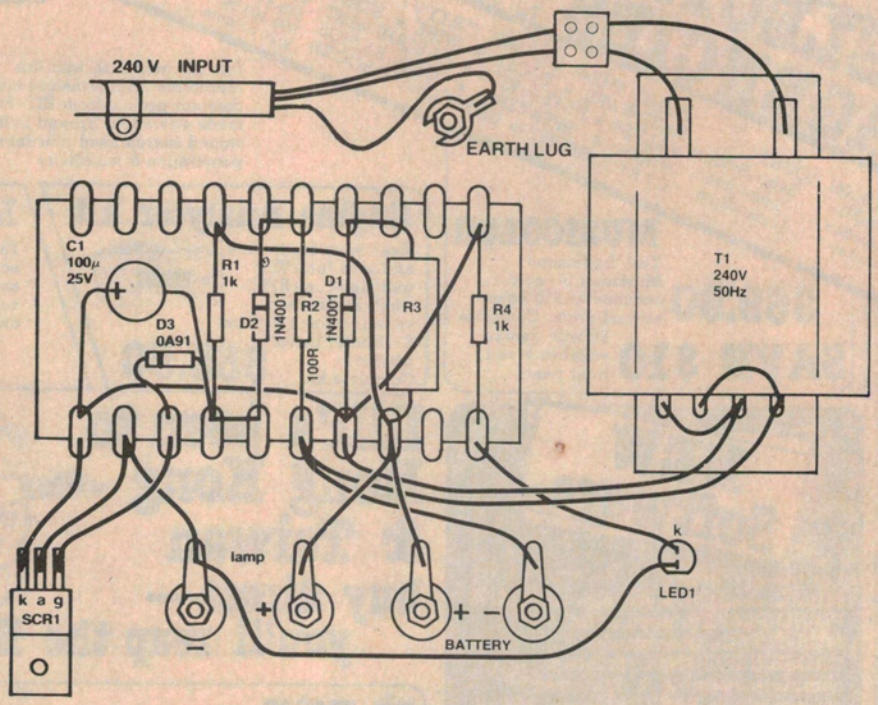
WHEN THE POWER FAILS the output from the transformer falls to zero and C1 starts to discharge through R1 and the battery. Once C1 is fully discharged it begins to charge in the reverse direction from the battery until the voltage on the gate of SCR1 is about 0.6 volts higher than the voltage on its cathode. SCR1 then switches on, lighting the emergency lamp. LED1 is now forward biased and illuminated. The voltage on C1 does not rise any further and the capacitor is not damaged by the reverse polarity because the voltage across it is less than the forming voltage of the electrolyte.

When the power returns, C1 charges again through D2 and R2, turning off SCR1 and resetting the circuit.

NiCad batteries may be used with this project and they can be obtained in ratings from 500 mAh up to 2 Ah capacity. Sealed lead-acid batteries can be obtained in higher capacities (see page 61).

BATTERY CAPACITY	VALUE OF R3 (5W, 5%)
500 mAh	82R
1.2 Ah	33R
2 Ah	22R
4 Ah	10R
6 Ah	6R8





Construction

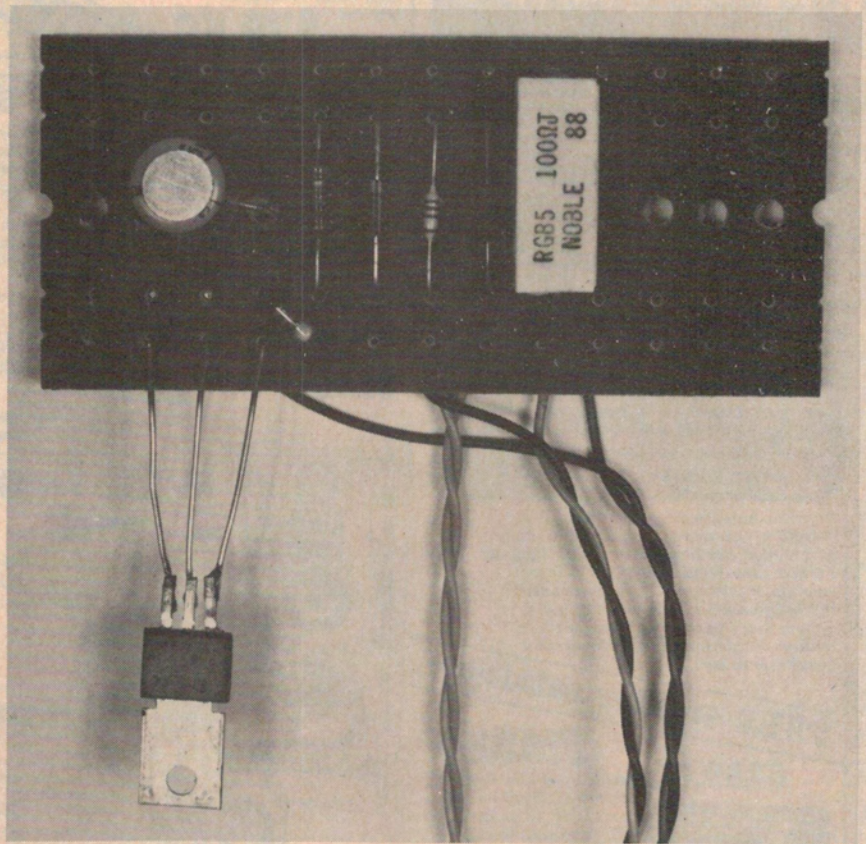
All the components are housed in a plastic case with an aluminium front panel that has terminals for the battery and lamp connections. The LED which indicates power failure is set in the panel above the lamp terminals.

As the circuit is very simple, we decided to mount the electronics on a length of twin tag strip. Mount the components as shown in the diagram on this page, being careful with the orientation of the diodes and the electrolytic capacitor.

The current limiting resistor R3 sets the charging current to the batteries and must be selected to suit the voltage and capacity of the battery. Consult the table on page 58 for the correct value. This resistor may run quite warm, so it should be mounted so that it is spaced about 5mm above the tag board for adequate ventilation.

If the emergency lamp draws 1 A or less, the SCR does not need a heatsink; if the lamp draws between 1 A and 2 A, the SCR can be mounted on the aluminium front panel with an insulating mica strip between it and the metal. For load currents over 2 A a heavier SCR with its own heatsink would have to be used, but we do not recommend drawing this much current because this is an emergency lamp and you won't want to discharge the battery too quickly.

Next wire the connections from the tag board to the LED, the terminals and the transformer. Be extra careful with all of these connections and use insulated hookup wire for all wiring, including connections across the tags on the tag board. The transformer is mounted in the top right corner of the box, leaving enough room for the terminals and the tag board. ▶



Showing the components mounted on the tagstrip.

emergency lighting unit

Secure the mains power lead by passing it into the box through a clamping type grommet. Connect the earth wire of the mains lead to the solder lugs on the transformer case and to the front panel. Make sure that these connections are well made and that there is slack left on the mains earth wire, so that if the cable is pulled out of the grommet the earth wire will be the last to break off. ●

Lead-acid storage batteries, such as these sealed, gel electrolyte types are ideal for use with this project and can be obtained in ratings up to 6 Ah. The two batteries on the left are 6 V types rated at 4 Ah, while the 12 V type on the right is rated at 6 Ah.