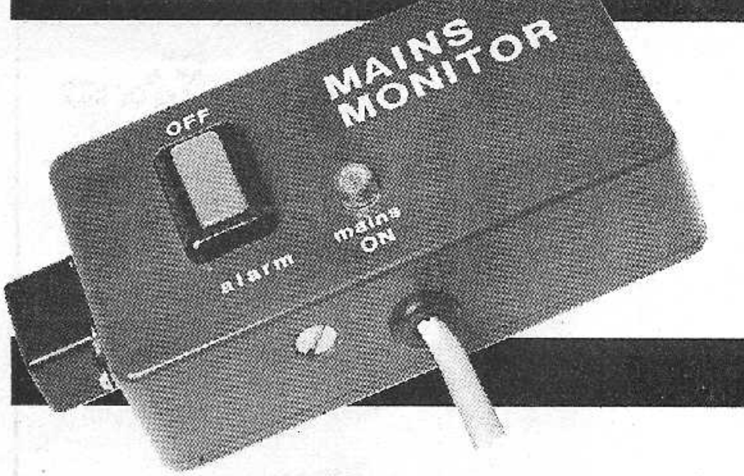

MAINS MONITOR

A.R.WINSTANLEY

OWNERS of deep freezers or tropical aquaria will appreciate the need to know immediately when the mains supply has failed; although under these circumstances there is little that can be done to rectify the situation. Unless you are lucky enough to own a standby generator, you can at least take steps to reduce the risk of consequential damage caused by disconnection of the mains.

The unit takes the form of a battery-operated pulsed alarm, the operation of which is disabled when the mains is connected. Failure of the electricity supply will cause the alarm to bleep until the supply is restored. In the meantime, the alarm can be switched off if you wish.

The circuit diagram of the Mains Monitor is shown in Fig. 1. IC1 is a CMOS 7555 timer i.c. connected as an astable multivibrator. The CMOS version of the popular 555 chip is used to reduce the quiescent or standby current drawn by the i.c. and this helps to increase battery life.

CIRCUIT DESCRIPTION

When S1 is closed d.c. power is applied to the astable and IC1 is triggered because the trigger terminal (pin 2) is initially at 0V. Then capacitor C1 starts to charge up through R4 and R5 as the output (pin 3) goes high to roughly the supply rail voltage. C1 continues charging until the voltage at the "threshold" terminal (pin 6) exceeds precisely two-thirds of the supply rail.

At this point an internal comparator switches over (also causing pin 3 to go low to about 0V) and starts to discharge C1 through R5 and into pin 7, the discharge terminal. Eventually the potential across C1 will drop back to one-third the supply voltage and this is detected by the trigger pin and once more the chip switches over, permitting C1 to charge up again to two-thirds the supply rail with the output going high.

Basically what happens then is that C1 charges and discharges between one-third and two-thirds the supply potential and the output switches high and low accordingly.

The three components R4, R5 and C1 control the frequency of operation and with the values indicated, the output high time (or mark) will be roughly one second. The low period (or space) is about 0·7 of a second and this equates to a frequency of 0·6Hz.

CURRENT AMPLIFIERS

The integrated circuit, IC1, drives a current amplifier TR1 which completes a circuit to WD1. This is an audible warning device consuming 15mA or so and the warning device will sound when the output of IC1 goes high. Note that ordinary electromechanical buzzers must not be used in place of WD1 on account of the much greater current that they consume.

Operation of the astable may be inhibited by taking the reset terminal pin 4 to 0V. R2 and the light-dependent resistor PCC1 form a potential divider network, the output of which is wired to the astable reset pin.

The resistance of the l.d.r. according to its data, may vary from less than 100 ohms when brightly illuminated, to several megohms in darkness. Consequently the reset signal to IC1 is light-dependent and relies upon the amount of light falling upon PCC1.

FAILURE DETECTION

Now we turn to the method by which the Mains Monitor detects when the mains electricity has failed. *Live* and *neutral* feeds (no earth is required) are connected to a neon bulb, LP1, and its associated voltage-dropping resistor R1. Thus LP1 is illuminated when the mains is switched on.

The bulb is placed directly over PCC1 so that its illumination determines the resistance of the photo-resistor. This assembly forms a home-made "opto-isolator."

Thus when the mains is connected, LP1 lights up and causes the l.d.r. resistance to be quite low, approximately 200 ohms, or so. By potential divider action this means that the voltage at IC1 pin 4 will be at a fraction of a volt and so the oscillator is inhibited.

Disconnection of the mains will extinguish LP1 and as a consequence the resistance of PCC1 will rise dramatically. This pushes pin 4 towards the positive d.c. supply rail and enables the astable, permitting the audible warning device to operate in a pulsed manner. This will continue until the mains is restored.

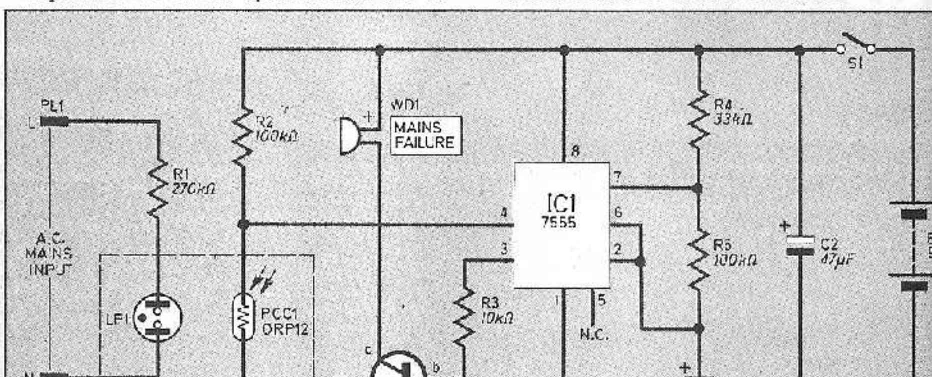

Fig. 1. Circuit diagram of the mains monitor.

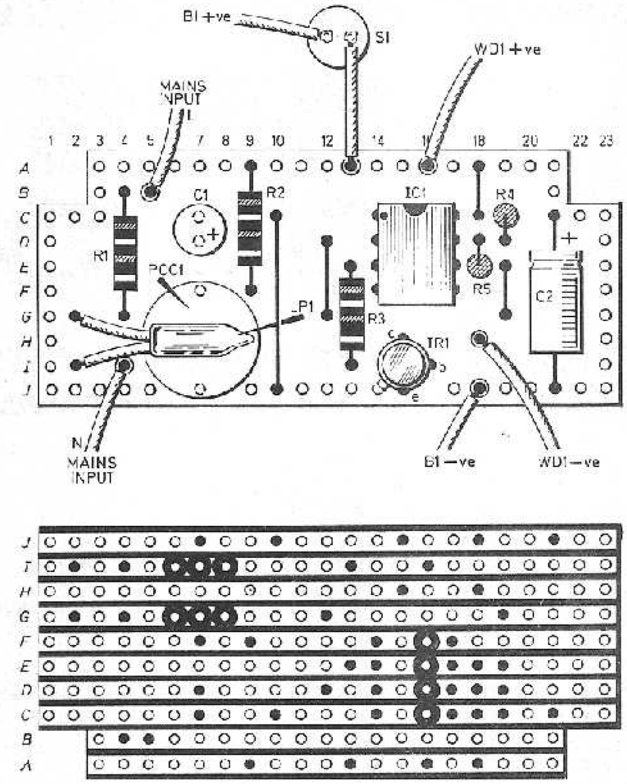

Fig. 2. Drilling details and component layout for the mains monitor.

COMPONENTS

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Resistors
- R1 270k
- R2,5 100k (2 off)
- R3 10k
- R4 33k
- All ¼W carbon ±5%

Capacitors
- C1 10µ 25V radial elect.
- C2 47µ 25V radial elect.

Semiconductors
- TR1 BC108C silicon *npn*
- IC1 ICM7555 CMOS timer i.c.
- PCC1 ORP12 light-dependent resistor

Miscellaneous
- LP1 wire ended neon
- WD1 6V, 15mA audible warning device
- S1 s.p.s.t. rocker switch

Case, 113 × 63 × 31mm (BIM2003); 0·1in matrix stripboard, 10 strips by 23 holes; 8-pin d.i.l. i.c. socket; battery clip; transparent l.e.d. cover; connecting wire; rubber grommet; "P" clip.

COMPONENTS approximate cost £5·50

Finally the function of capacitor C2 is to decouple the d.c. power supply and it compensates for low-frequency ripple which will eventually appear on the rails due to increased internal resistance of the battery as it begins to age.

CONSTRUCTION starts here

CASE

The prototype was constructed in an all-plastic box type BIM2003 measuring 113 × 63 × 31mm. Of course, a light-proof box must be used so that the resistance of PCC1 is not affected by external light sources. Also the lack of any metal panel on the box obviates the requirement that the box be earthed.

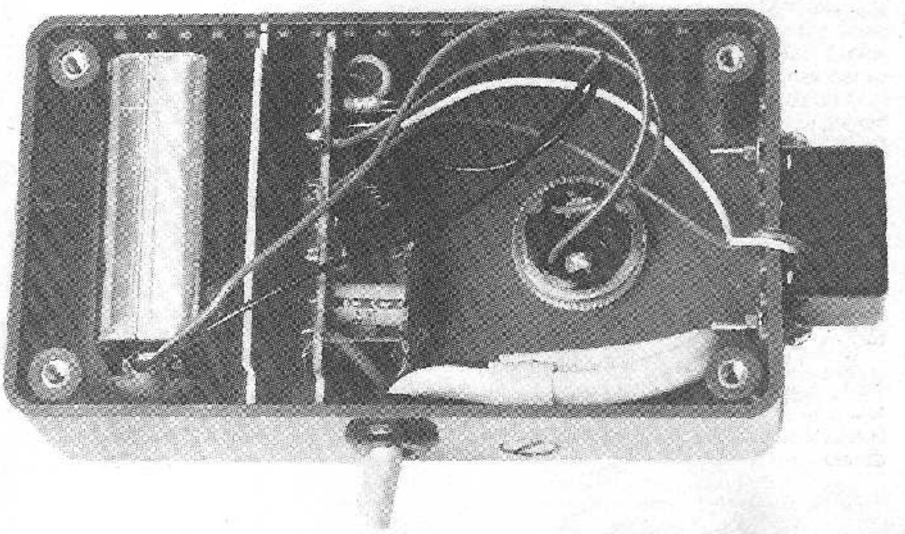
The complete circuit is assembled on 0·1in pitch stripboard, 10 strips × 23 holes (see Fig. 2). These dimensions permit the stripboard to be held by the p.c.b. guides moulded into the case interior.

Commence construction by cutting and filing the stripboard to size and then make the breaks in the copper strips in the locations shown. Notice in two locations that three track breaks are made adjacent to each other. This is a *safety precaution* designed to ensure complete isolation of mains circuitry from the rest of the components.

Continue by soldering in the i.c. socket which acts as a good reference when soldering in the rest of the components. Do not insert IC1 into its socket yet but keep it in its protective anti-static package for the moment.

Solder into place the rest of the components as shown in Fig. 2. Take care not to overheat the transistor during soldering and you would be advised to employ a heatshunt on the leads being soldered. Also it is important to observe correct polarisation of the electrolytic capacitors.

The neon bulb should be soldered into its location last of all to prevent it being damaged when assembling the stripboard; it is also necessary to insulate both leads of the bulb with about 20mm of 1mm p.v.c. sleeving prior to soldering, in order to prevent short circuiting. Then gently bend the bulb over so that it lies on top of PCC1.



Now push the i.c. quickly into its socket, making sure of course that it is correctly polarised, otherwise you may finish up with a "disintegrated" circuit!

The plastic box needs to be drilled to accept the on/off switch and audible warning device. The latter is mounted on the outside of the box and the two leads pass through an adjacent hole to the circuit panel within the case.

MAINS LEAD

The twin-core mains input lead passes through a hole in the middle of one side of the box, this hole should be fitted with a grommet. In any case it is quite essential that the cable is properly secured to ensure that it can never be pulled out of the box. In this respect, employ either a cable gland or a nylon "P" clip of appropriate size.

A further hole can be made on the front panel so that when the component panel is slotted into place the neon bulb (which is directly behind the front panel, not next to the removable lid) may be observed once illuminated. This acts as the "mains on" indicator. By drilling a $\frac{1}{4}$in hole you can then fit a transparent l.e.d. cover of the type intended for use with light-emitting diodes.

With assembly completed, check the unit most thoroughly. Since mains and low d.c. voltages are both present on the component board, it is of course essential that there are no errors in assembly. Note that it is necessary to secure the battery inside the case, so that it does not make contact with the component board.

Before connecting the mains, clip on a battery (PP3) and then close up the box. It is preferable that the mains is connected through a 1A or 3A fused plug.

TESTING

With the mains off, closing S1 should cause the alarm to sound. Switching on the mains supply should inhibit the alarm and the neon bulb should be seen to be illuminated through the front panel l.e.d. cover.

Very bright direct light (sunlight, possibly) can diffuse through the l.e.d. cover and affect correct operation of the circuit by reducing the resistance of PCC1 irrespective of whether the neon bulb is illuminated or not. Take this into consideration when placing the unit in its position.

Of course, it is wise to occasionally check the condition of the battery and this can be achieved by simply unplugging the Mains Monitor to see that the buzzer operates effectively. A battery life of several months can be expected. □