This lamp 'flasher' is simple, has many applications

This circuit, simple though it is, illustrates a number of common circuit 'building blocks'.

CIRCUITS which flash a light, or turn something on and off at a fairly slow rate, are widely used in electronics. Many car alarms, for example, have a light installed on the dash of the car that flashes about once per second to indicate that the alarm is 'armed'. A flashing light is used as a warning indicator in many situations. This circuit illustrates the electronic principles involved, as well as having practical uses – but we'll leave those to your inventive imaginations!

How it works

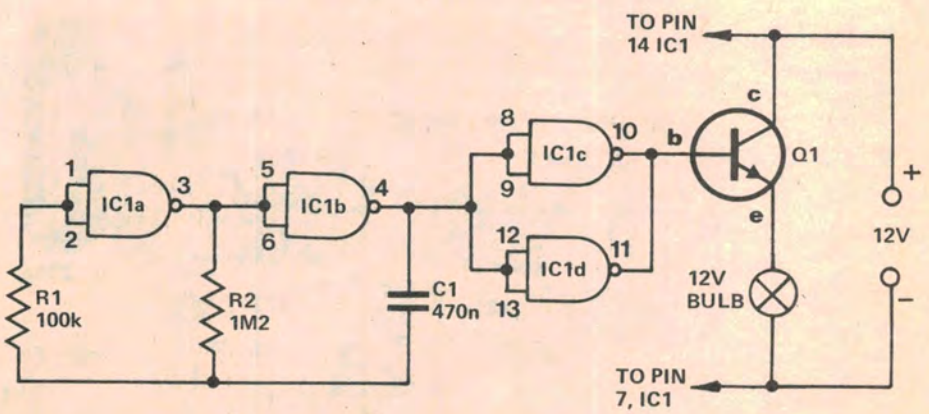
The heart of this circuit is a CMOS digital IC containing four NAND gates. Two are used to form a low-frequency oscillator, ICIa and ICIb. A NAND gate is a functional circuit block which has two 'inputs' and an 'output'. When both inputs are 'high', the output will be 'low'. For any other combination of input conditions, the output will be high. The 'high' and 'low' terms here refer to the voltage on the gate's terminals. Above a certain limit, the terminal (input or output) will be 'high', below that limit, it is said to be 'low'. A 'high' level will be close to the supply voltage; a 'low' level, close to zero volts.

If we connect the two inputs of a NAND gate together then it will act as an 'inverter'. Thus, if the input to this inverter is high, the output will be low; if the input is low, the output will be high.

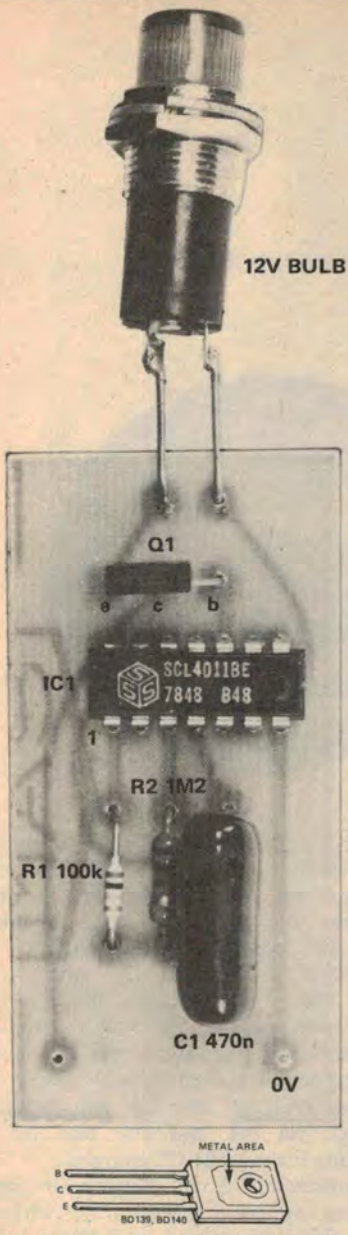
The oscillator in this circuit consists of two NAND gates from the package connected as inverters with the output of one (ICIa) connected to the input of the other (ICIb).

When the circuit is first turned on, the input of ICIa will be low and its output (pin 3) high. The output of ICIb will therefore be low. The capacitor, C1, will start to charge via R2 as one end of R2 is connected to pin 3 of IC1a which is high (in this case, at 12 V). The voltage on C1 is fed back to the input of IC1a via R1. Eventually, the voltage on C1 will reach a point where the input of IC1a will be high and the output (pin 3) will go low. This will produce a high on the output of IC1b and C1 will then discharge via R1 as the input of IC1a and the output of IC1b are both high. C1 will not charge via R2 as the value of R1 is very much less and the discharge current will be much greater than the possible charge current. The current through R1 will hold the output of IC1a high until the capacitor is discharged. At this point there is nothing to hold the input of IC1a high and it will go low, the output (pin 3) will go high and the output of IC1b (pin 4) will go low, and – you guessed it, we're back where we started!

The whole process will repeat itself, the frequency of oscillation depending on the values of R2 and C1. In this case, the frequency is about one cycle per second, or 1 Hz. This oscillator is one form of "multivibrator". Another is illustrated in our Fog Horn project.



The pc board pattern is on page 145.



To turn a lamp on and off requires a little more circuitry. We couldn't connect the lamp at the output of IC1b as it would rapidly discharge C1 at the wrong time! To switch the 150-200 mA required by the lamp, we use a transistor to amplify a small current supplied to its base, the lamp being connected between the emitter and the negative side of the supply. This sort of circuit is called an "emitter follower". This is a *current* amplifier.

The output of IC1b is still unable to drive the base of Q1 directly as, again, when the output of IC1b (pin 4) would be supplying current to the base of Q1, the capacitor, C1, would discharge rapidly, upsetting the frequency of oscillation. Thus, we have used the other two NAND gates to form a "buffer". IC1a and IC1d are connected as inverters with their inputs and outputs connected in parallel. As the inputs require a miniscule current to operate the gates they can be connected directly to the output of IC1b. The outputs of IC1c and IC1d will supply enough current to the base of Q1 to turn it on, the emitter current lighting the lamp.

Each time the output of IC1 goes low, the outputs of IC1c and IC1d (pins 10 and 11) go high, Q1 turns on and the lamp lights. When the output of IC1b goes high, pins 10 and 11 of IC1 go low, Q1 turns off and the lamp goes out.

Construction

There is nothing critical about the construction. You can use the printed circuit board we have designed for this project or build it up on matrix board – tag strips are a bit impractical for mounting IC1!

Take care with the connections to IC1 and Q1 – see that you have them correctly oriented. Q1 has a metal plate set into one side of it. This is to enable heat to flow from the transistor chip inside the package to a heatsink to which the device may be bolted. In this application a heatsink is unnecessary. Note that the collector is connected to the metal plate on the package, as well as having its own connection pin.

The power supply must be connected correctly – reverse connection will almost certainly damage IC1 and Q1.

This circuit may be modified to operate a relay which controls something else – to pulse a horn or a siren, for example. The lamp may be replaced by a 12 V relay; common types have a coil resistance of between 180 and 300 ohms or so and may be substituted directly. The relay contacts should be rated to switch the voltage used on the device being controlled as well as handle the current drawn by it. Your supplier should be able to assist.●

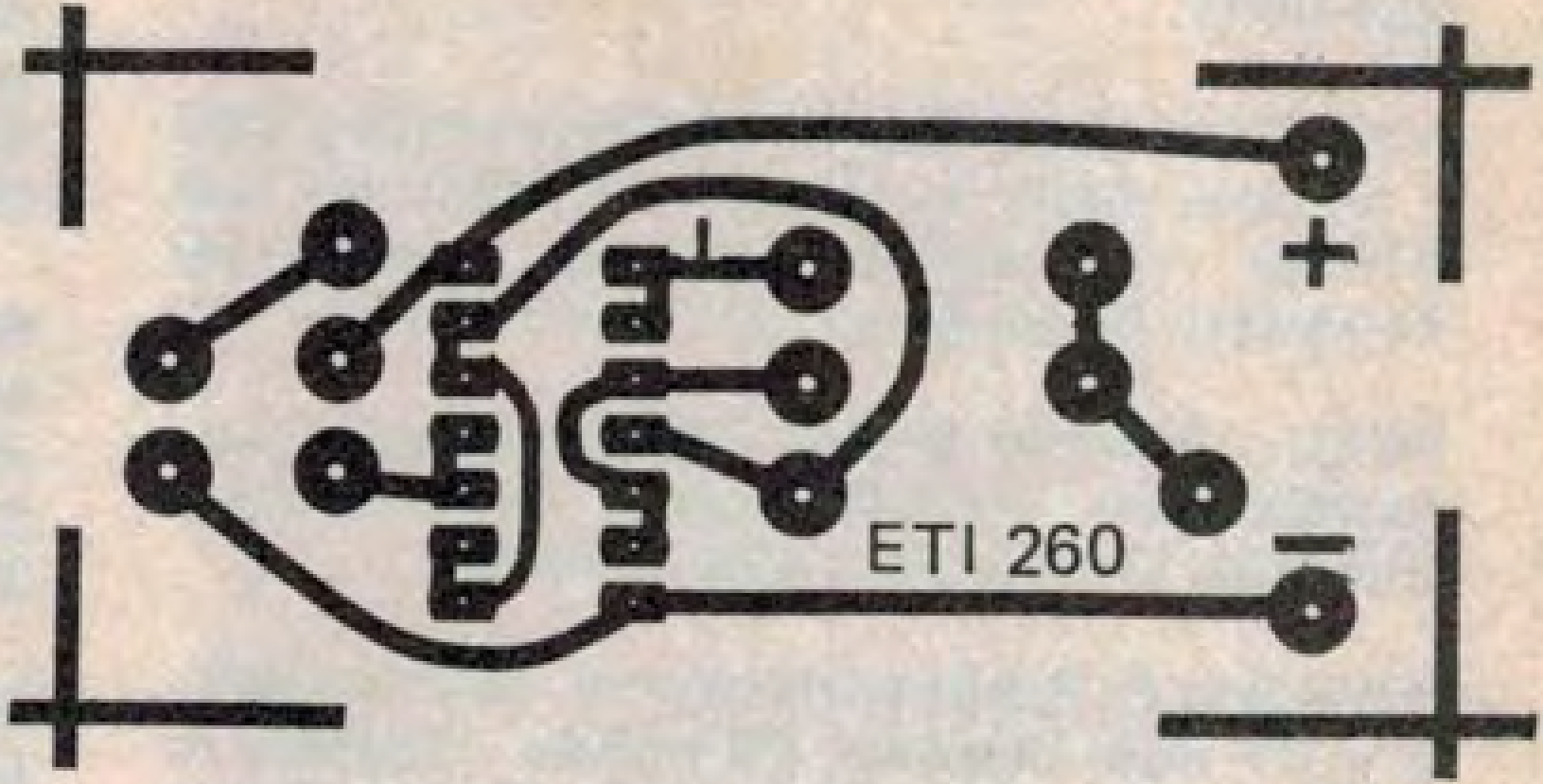
PARTS LIST - ETI 260

Resistors all ½W, 5%
R1 . . . . . 100k
R2 . . . . . 1M2

Capacitors
C1. . . . . 470n greencap

Semiconductors
IC1 4011
Q1 . . . . . BD139

Miscellaneous
Printed circuit board ETI 260; 12 V bezel lamp with holder.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