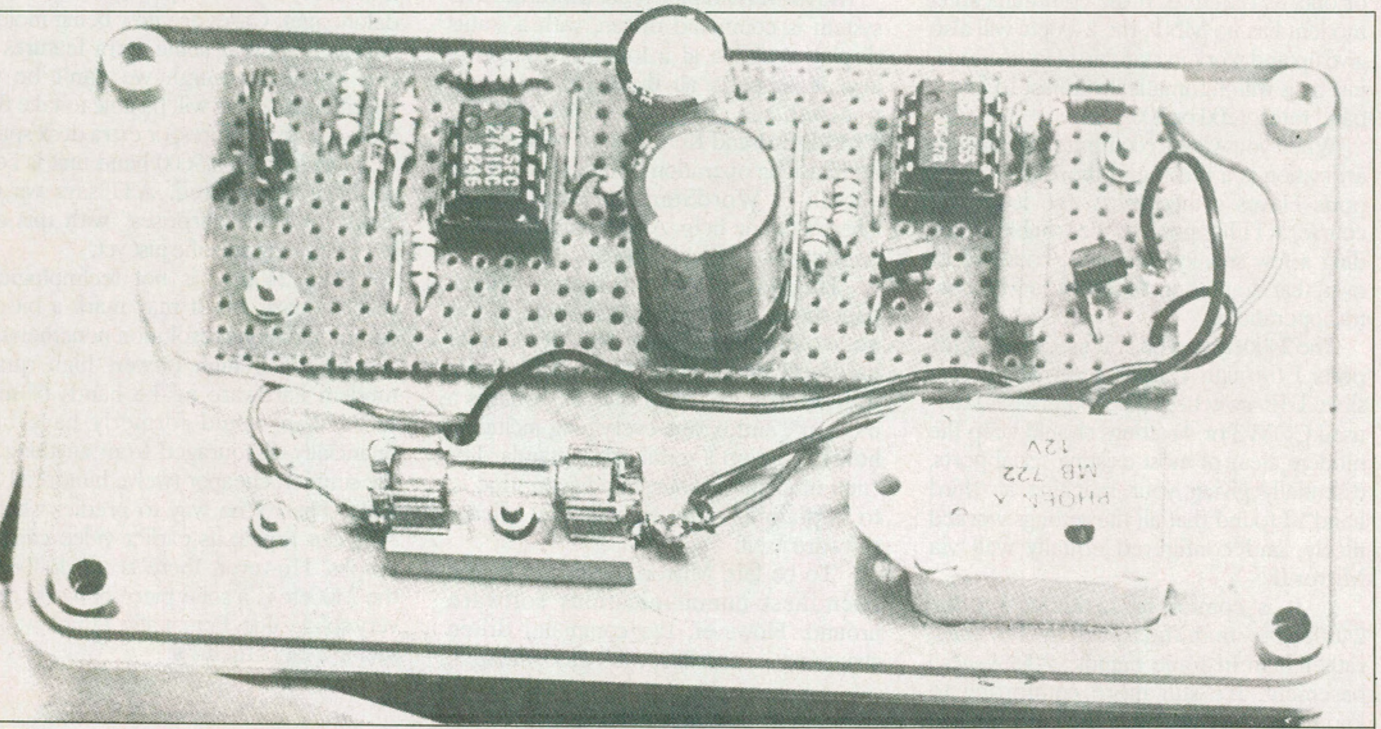
Thermal Alarm

An audible warning of high temperature such as car overheating.

T.R. de VAUX-BALBIRNIE



This circuit is designed to detect high temperatures, and has many uses; It could also be useful to readers who experience overheating problems with any car. It is suitable for both positive and negative ground systems.

Audible warning

Although the car may be fitted with a water temperature gauge, the reading on this is easily missed and an *audible* warning is more effective in attracting attention. Some designs produce a continuous signal in the event of overheating. This is unnecessary and causes undue annoyance, especially since it may take several minutes for the engine to cool to normal operating temperature again. In the present system, a short bleep (of nominally one second duration) is given each half-minute. This gives excellent warning without being obtrusive.

The entire circuit, apart from the engine mounted temperature sensor, is housed in a plastic box with an audible warning device mounted on top. A terminal block connects the sensor and car electrical supply. The sensor is attached with adhesive so, although firmly mounted on the engine, it may be removed should the need arise.

Circuit description

The circuit of the Overheating Alarm is shown in Fig. 1; IC1 is an operational amplifier used in comparator mode. It switches on when the temperature of the sensor, R1, rises above some preset value — nominally 95 degrees C. The potential divider R3/R4, applies a fixed reference voltage to IC1 non-inverting input (pin three). A second potential divider is formed between R2 and VR1 in the upper section and R1 in the lower one. Since R1 is a negative temperature coefficient device, its resistance falls as its temperature rises. Thus, the voltage applied to the inverting input falls with rising temperature.

With correct adjustment of VR1, the inverting input voltage will fall below the non-inverting one at the required temperature. IC1 output (pin six) then goes high (positive supply voltage). This allows no current to flow through R6 and D2 since D2 is reverse- biased. There is therefore no effect on IC2 which functions as a free running multivibrator producing a train of positive-going pulses from its output (pin three). With the values of C1, R7 and R8 used in the prototype, each pulse will be high for 30 seconds and low for one second approximately.

Transistors TR1 and TR2 invert the pulses to give short high and low states (see Fig. 2). This happens in the following way. With IC2 pin three high, current flows through R9 to the base of TR1, turning it on. TR1 collector is then low so TR2 is off. With IC2 pin three low, TR1 is off with its collector high. TR2 is then switched on and the audible warning device, WD1, in its collector circuit operates. The inverting effect causes WD1 to bleep for one second each 30 seconds approximately. With R1 below the operating temperature, IC1 pins two and six low also, resulting in IC2 output being high continuously. After inversion WD1 remains off.

The purpose of R5 and Zener diode, D1, is to stabilize the supply to the op-amp inputs for precise operation. D3 and C3 smooth the fluctuations produced by the car generator, FS1 is a fuse which protects the system from accidental short-circuits.

Construction

Construction is based on a circuit panel made from a piece of 0.1 inch matrix stripboard size 11 strips by 34 holes. Refer to Fig. 3. Drill the two mounting holes and make all breaks and inter- strip links. Use a small drill to make the breaks and check that these are complete. Follow with the soldered on-board components. Note that C1, C3 and the diodes must be connected the correct way around. Solder lengths of light-duty stranded connecting wire to strip E on the left-hand side and strips A and J on the right- hand side of the circuit panel.

Refer to Fig. 4 and mount WD1 (using a little glue around the rim), FS1 and TB1 on the lid of the case (see photograph), WD1 could be direct surface-mounted if desired. Drill a 3 mm diameter hole near TB1 for the wires passing through from inside. Complete all wiring and mount the circuit panel on the lid of the box using the holes drilled for the purpose. Drill a hole in the side of the case so that VR1 may be adjusted using a small screwdriver when the lid is in position. Leave VR1 adjusted to approximately mid-track position, insert the fuse and fit the lid checking for trapped wires.

Sensor

The bead thermistor used for the sensor is delicate and needs good protection. Fig. 5 shows how this was achieved in prototype. The sensor should be attached to a *sheltered* part of the engine where it will not be subject to the effect of cool moving air — make a small shield if necessary. Choose a part of the engine which becomes hot in operation and is clear of moving parts. Clean this part carefully and roughen the surface with fine sandpaper. Treat the attachment surface of the sensor in a similar fashion. Bond the sensor in position using a thin film of quick-setting expoxy resin adhesive.

Use light-duty auto type wire for all connections — where it passes through any hole in metal use a rubber grommet. For a

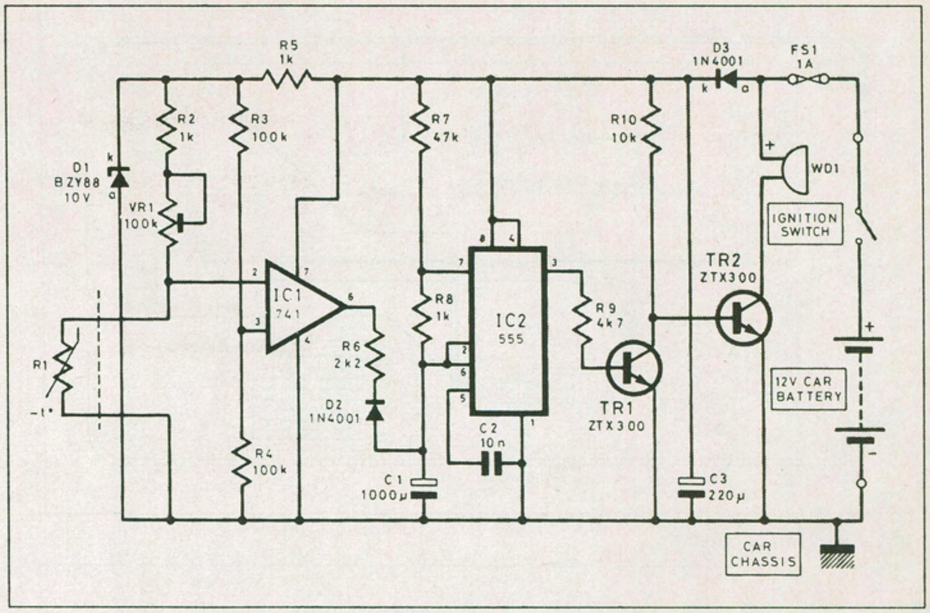


Fig. 1 Circuit diagram of the Thermal Alarm.

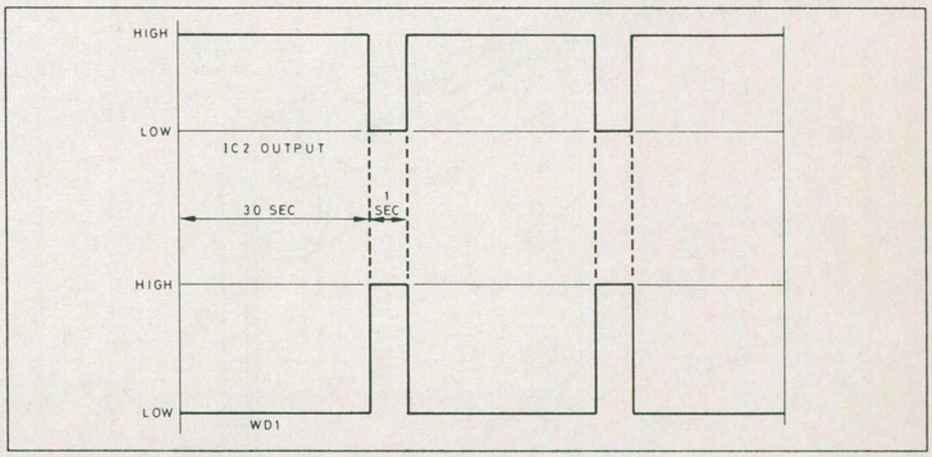


Fig. 2 IC2 output and WD1 drive waveforms.

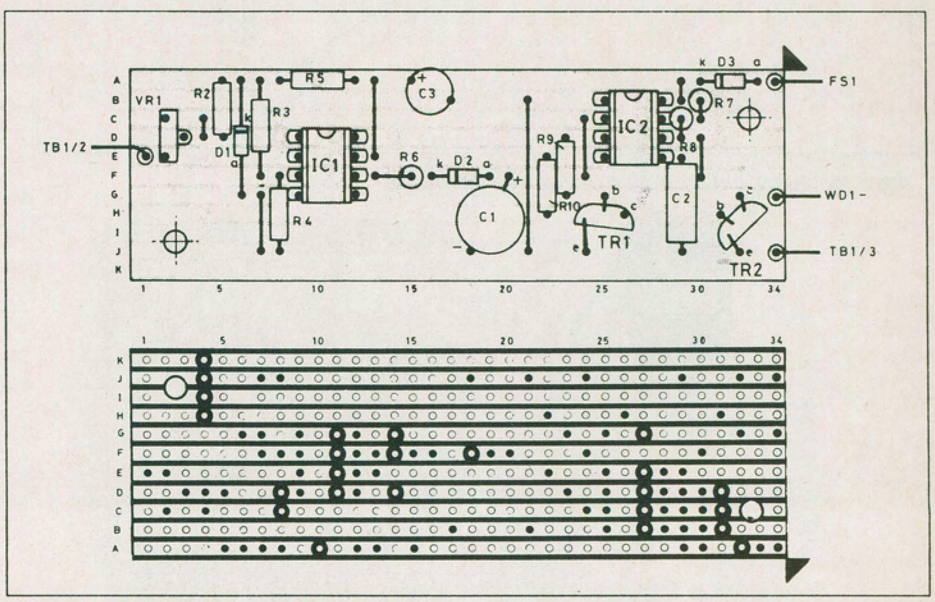


Fig. 3 Veroboard layout and wiring.

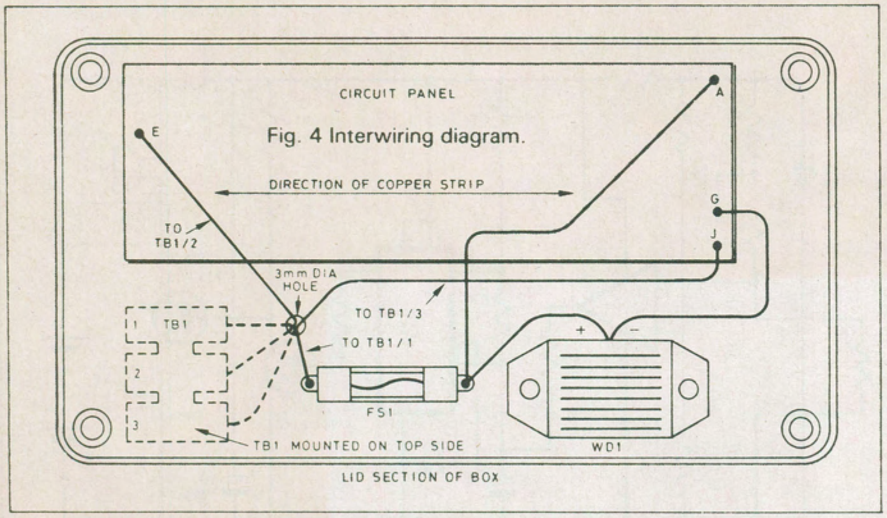


Fig. 4 Interwiring diagram.

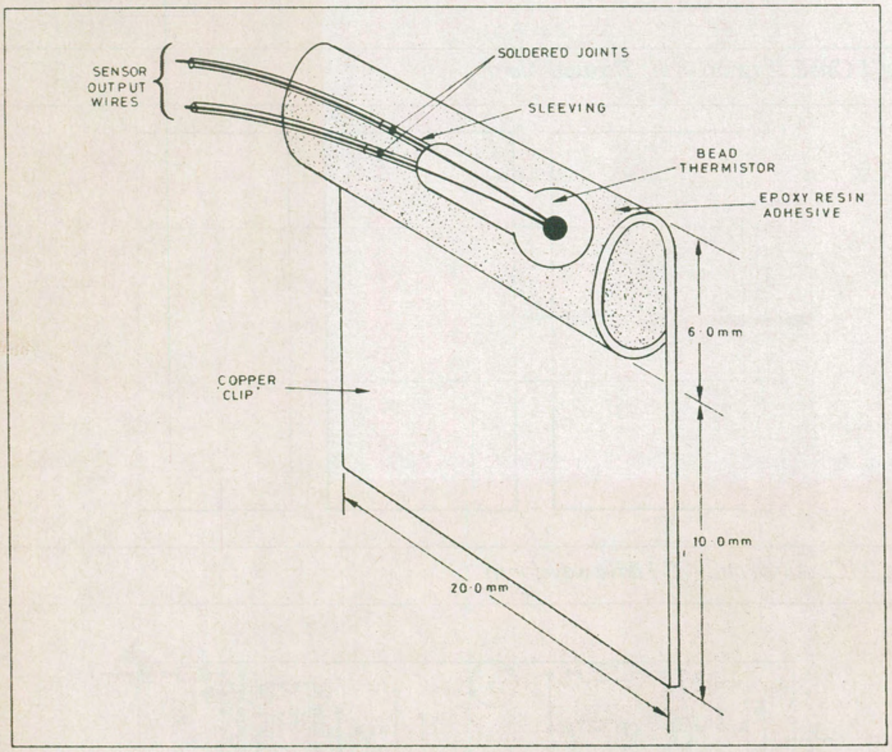
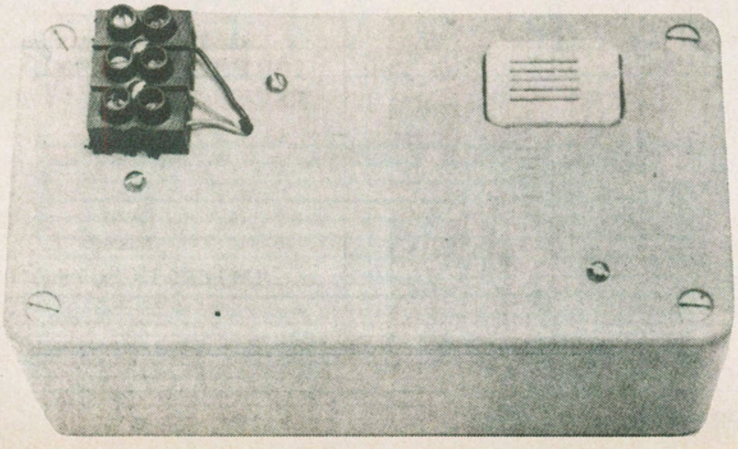


Fig. 5 Mounting and protection of the bead thermistor.



negative-ground car, connect the sensor wires to TB1/2 and TB1/3. Find a suitable fuse which is live only when the ignition is switched on and connect this to TB1/1. Make sure that the correct side has been used – when the fuse is removed the circuit should not work. Connect TB1/3 to an ground point (car chassis). For a positive-ground vehicle, make the sensor connections to TB1/2 and TB1/3. Connect the fuse to TB1/3 and TB1/1 to the ground point.

Adjust VR1 over a trial period so that the alarm *just* remains off with the engine at normal operating temperature. Clockwise rotation of the sliding contact increases the operating temperature and vice-versa. Once adjusted, the unit may be hidden behind the car dashboard. If the alarm tends to operate when the car is travelling slowly but not at higher speeds, this usually means that the sensor is badly sited and needs additional shielding from moving air. ■

PARTS LIST

Resistors

R2, R5, R8 .... 1k
R3, R4 .... 100k
R6 ....2k2
R7 .... 47k
R9 .... 4k7
R10 ....10k
All 0.25W carbon

Potentiometer

VR1 100k miniature vertical preset

Capacitors

C1 .... 1000u elect. 16V
C2 10n
C3.............. 220u elect. 16V

Semiconductors

IC1 .... 741 op amp
IC2 .... 555 timer
TR1, TR2 general purpose npn silicon, 2N3904, etc.
D1 .... 10V Zener diode
D2.D3 .... 1N4001

Miscellaneous

R1 bead thermistor, resistance at 20C 1M
WD1 12V solid-state buzzer
FS1 chassis fuseholder with 1A fuse.
TB1 terminal block – three sections.
8-pin DIP sockets (2); plastic box approx. 120 x 65 x 40mm; 0.1 inch metric stripboard size 11 strips x 34 holes; stranded wire; connectors; materials for sensor (see text).