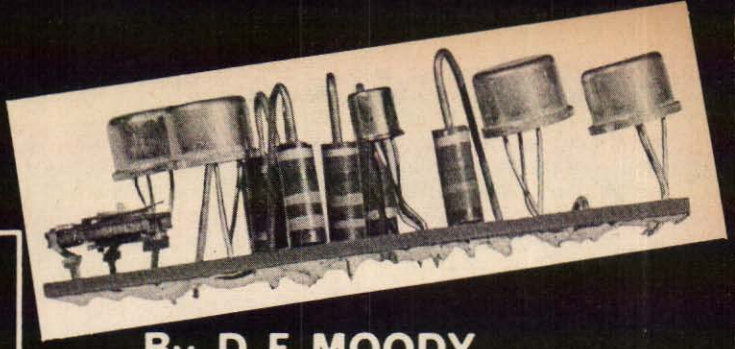
FROST ALARM



By. D. F. MOODY

THIS unit, although primarily designed for the motorist as a road ice indicator, can also be used as an early warning device for the protection of domestic water pipes and greenhouse or outdoor plants when frost is imminent.

In preparing this design the requirements were for long term stability, ease of initial calibration, immunity from small supply variations and operation of the indicator from off to full on over a narrow temperature range.

The circuit employed is essentially a solid state bridge arrangement with a thermistor, or temperature sensing element, included in one of the bridge arms. Indication of bridge unbalance, caused when frost is imminent, can be either visual or audible.

Since ice formation on dimly lit roads at night is much less apparent than in the day, a lamp on the car dashboard which is illuminated with a cautionary red glow, when external temperature is at 0 degree Centigrade will prove an excellent indicator of prevailing road conditions.

For the householder, who is usually asleep when frost is abroad, the strident tones of an electric bell will provide the spur for some protective action.

In describing the unit, both systems will be presented.

HOW IT WORKS

In Fig. 1 it will be seen that TR1 and TR2 are complementary *pnp* and *npn* transistors forming two arms of a bridge circuit with the base bias resistors R1–R4, which span the supply, making up the other arms.

When balance is achieved by adjustment of VR1, the potential at the junction of the bias chain resistors R2 and R3 will be equal to the potential at the collector junction of TR1 and TR2 which is half the supply voltage. TR3 and TR4, which form part of the detector circuit, are non-conducting as the base/emitter potential drops of both transistors are negligible ensuring that both are cut off.

If the emitter resistance of TR2 increases the bridge circuit will become unbalanced. The resistance of thermistor X1, which exhibits a negative coefficient of resistance, will increase with a reduction of temperature with a subsequent increase of potential drop across the collector load of TR1 comprising TR2, VR1 and the thermistor.

Since this collector voltage rise is positive, both TR3 and TR4 will conduct so switching on TR5 which bottoms to illuminate the lamp LP1 or energise a relay, whichever load is employed.

CONSTRUCTION

Construction of the unit is fairly simple. Cut the copper strips according to Fig. 2. Then assemble the components, starting at one end of the board and working through to the other end.

When complete check the wiring and make sure the cases of the ASY26 and ASY28 transistors are not

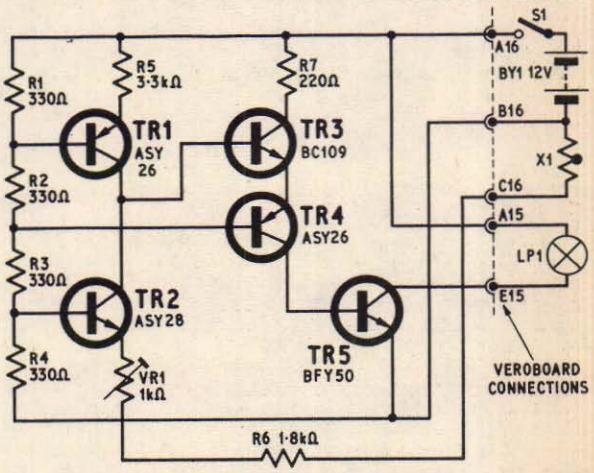


Fig. 1. Circuit diagram of frost alarm. Connections at A15/E15 can be either lamp or relay depending on application

touching each other or any part of the circuit as the cases are connected to the base. If the lead lengths of the transistors are kept short this will prevent any subsequent movement and possible damage.

CALIBRATION

The most convenient way to calibrate the unit is to connect the 12-volt supply, lamp, thermistor, and switch to the Veroboard as shown in Fig. 2, using long lengths of miniature p.v.c. 7/40 wire for the thermistor connection.

The module and supply should then be arranged on top of a refrigerator.

If a Centigrade thermometer is placed at a spot close to the ice-box, it is possible by adjustment of the thermostat controller to set the temperature at freezing point or 0 degree Centigrade. If the indicating unit is intended for domestic use, the refrigerator temperature adjustment should be for a couple of degrees above zero.

With these reference temperatures established the thermistor should be placed at the position occupied by the thermometer. The thin, flexible, 7/40 wires will permit closure of the refrigerator doors, whilst calibration is in progress. Since the thermistor is wire ended precautions should be taken to prevent any chance of accidental short circuit, by laying it on a piece of cloth.

The supply should now be switched on and VR1 gradually advanced till the lamp just switches on. Reducing the resistance value of this potentiometer slightly will just turn off the lamp. No more adjustment of the unit is necessary as calibration is now complete and the module is ready for installation.

If a bell indicator is required a lightweight relay with suitable contact rating for a volt bell should be substituted for the lamp. The calibration procedure for this should proceed on the lines as before.

HOUSING THE UNIT

The unit, including batteries, can be housed in a suitably sized wooden box if intended for domestic use.

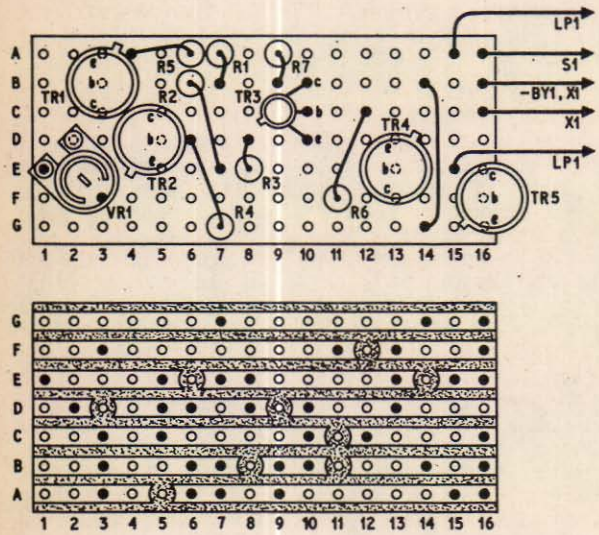


Fig. 2. Veroboard assembly showing top view arrangement of components and breaks in conductor strips

For motorists, since the supply is taken from the car battery, the box dimensions can be considerably reduced. In the author's prototype a small plastic case was used and then fitted to the dashboard. A convenient form of attachment is sticky tape.

Holes should be cut to the diameter of the lamp shank and the diameter of the calibration pre-set potentiometer VR1. This will make for easy screwdriver access even though calibration will only be rarely necessary, say once every two years.

If the unit is to be used in a car, S1 may be omitted. One of the two supply leads should be connected to some convenient anchorage point on the car chassis and the other connected to the ignition switch, so that power to the unit will be turned off when the ignition key is removed. Before embarking on these wiring instructions, it is important that the car chassis polarity should first be determined, that is whether positive or negative. When this is done, the relevant supply connections can be made without risk of damage.

COMPONENTS . . .

Resistors

R1	330Ω	5%
R2	330Ω	5%
R3	330Ω	5%
R4	330Ω	5%
R5	3·3kΩ	5%
R6	1·8kΩ	10%
R7	220Ω	10%

All ½W carbon

Potentiometer

VR1 1kΩ miniature carbon preset

Transistors

TR1	ASY26	(Henry's Radio Ltd.)
TR2	ASY28	
TR3	BC109	
TR4	ASY26	
TR5	BFY50	

Thermistor

X1 CZ9A

Switch

S1 Single pole on/off toggle

Battery

BY1 Two Ever Ready PP1, 6V batteries (see text)

Lamp

LP1 12V, 0·75W L.E.S. (Radiospares)

Relay (if required) 670Ω lightweight B and R type (Home Radio—Cat. No. Z70B)

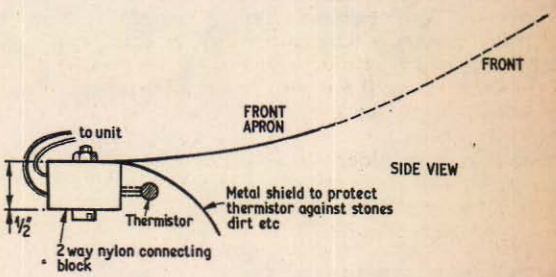


Fig. 3. Method of thermistor mounting to front apron of car

THERMISTOR MOUNTING

The thermistor was mounted on a section of nylon terminal block. In domestic applications the junction between thermistor and its unit connecting leads can be made mechanically with the terminal screws of the nylon block. For car use, these leads should be soldered and connected as before to preclude any chance of the retaining screws loosening and producing an open circuit.

Final fixing of the block should be by screw to either wall or shelf.

To detect road ice hazards, the block should be mounted at the front of the car, under the front bumper. To prevent damage to the thermistor by stones and dirt thrown up from the road, a small deflecting shield was formed by bending a length of sheet aluminium or tin to the width of the nylon block, see Fig. 3. If a ⅛in hole is drilled in the car's front apron, both shield and block can be affixed with a nut and bolt. ★