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A recording telethermometer for use at airports

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ABSTRACT. A recording telethermometer for use at airports, developed at the Instruments Division, Meteorological Office, Poona is described. The instrument designed for reliable and almost unattended performance over long periods, gives a continuous record of temperature at a remote location, with an accuracy of $\pm$ 0·2°C. A rapid response time and high sensitivity render the instrument also useful for micrometeorological measurements and temperature profile studies.

1. Introduction

The measurement of runway temperatures is an important requirement in modern aeronautical meteorological practice. Remote temperature indicators have been designed by some Indian workers (Das and Kapoor 1962, Subramanian 1964, Sreedharan 1965). The present note describes a recording telethermometer developed in the Instruments Division of the Meteorological Office at Poona for runway temperature measurements at airports. It can be used with a dewcel for remote recording of dew point temperature with some modifications in the bridge constants and is sensitive enough for use in micrometeorological measurements and temperature and humidity profile studies.

2. Description

The recording telethermometer consists of a bead thermistor probe, a bridge and D.C. amplifier unit with power supply and recording milliammeter. The sensor chosen for reliability, rapid response and sensitivity is a F-1512/300 bead-in-glass thermistor of the Standard Telephones and Cables. Its continuous power dissipation tolerance is 10 milliwatts. The temperature resistance characteristic of the thermistor, determined in a precision calibration thermostat, is shown in Fig. 1. For routine measurements, the probe is enclosed in a radiation shield and exposed at the required height.

2.1. *Bridge* — The details of the resistance measuring circuit are shown in Fig. 2. The thermistor is shunted by a 101 KΩ resistor to obtain a nearly linear scale for temperature. The bridge output for changes in temperature from 20° to 50°C is shown in Fig. 3. Except for temperatures below 20°, the output is linear. A reference resistor provides a check on the circuit performance and bridge stability and can be switched into the circuit in place of thermistor whenever required, by a double-pole double-throw switch S_1. All the bridge resistance are of high stability type with one per cent tolerence. The out-of-balance voltage from the bridge is fed to a high quality, constant-gain D. C. amplifier.

2.2. *D. C. Amplifier* — The circuit diagram of the D. C. amplifier designed after Valley and Wallmann (1948), is shown in Fig. 4. The current feed-back employed ensures a constant amplifier gain. The pentode in the second stage with its cathode returned to the cathode follower, allows a differential input without the disadvantage of using a dropping resistor in the grid circuit. The local positive feed-back in the second stage coupled with the over-all negative feed-back increases the amplifier linearity. The output current is limited in either direction by the plate current cut-off or grid current. A very useful feature is the constancy of gain which is not affected even after the valves are changed. The only adjustment required is balancing the first tube by varying the cathode potentiometer. This point was verified by changing twelve tubes, four in each stage at random. The scale factor potentiometer enables the adjustment of the current through a meter. The output from the amplifier is connected to a 0—1 mA range milliammeter recorder having 1·5 KΩ internal impedance. The power for the amplifier is derived in present case from two BEL electronically regulated power supply units in series. Any suitable power supply, regulated, capable of delivering +250 and — 105 volts can, however, be used.

3. Performance

The long-term amplifier drift was found to be less than 200 μV per hour. The recorder zero and the reference reading showed no appreciable drift during 24 hours. The amplifier characteristic is shown in Fig. 5 and is quite linear. The gain of the amplifier and the bridge values were so chosen that changes in the recorder reading correspond approximately to 0·02 mA per degree in the temperature range 20° to 50°C. Thus with a chart with 50 divisions, temperature can be directly read from the chart. For lower temperatures, slight

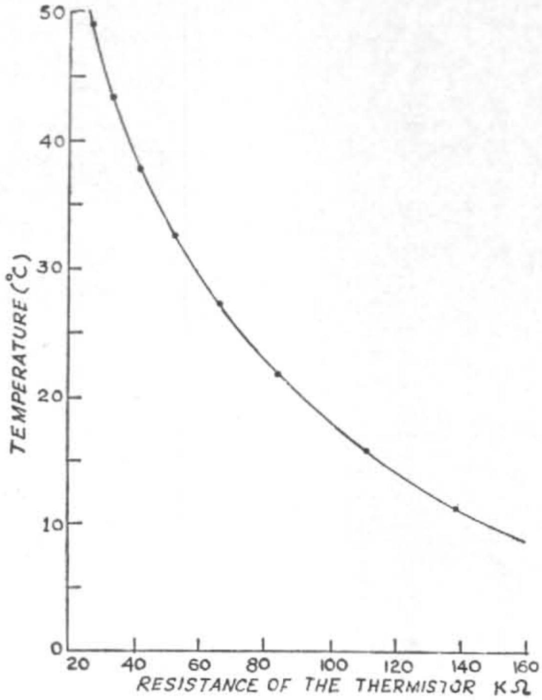

Fig. 1

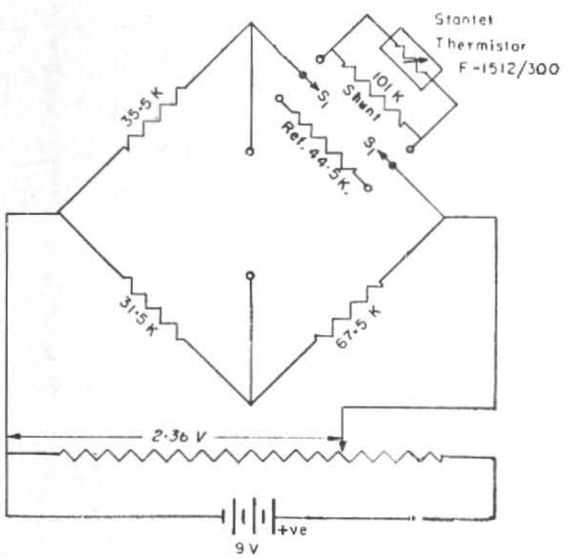

Fig. 2. Bridge for the thermistor temperature recorder

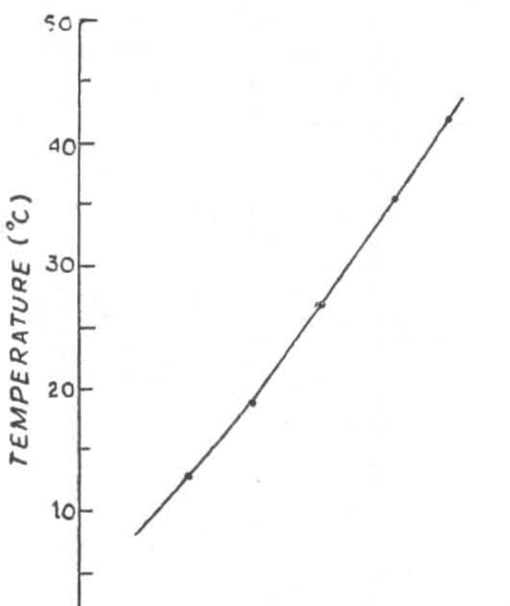

Fig. 3

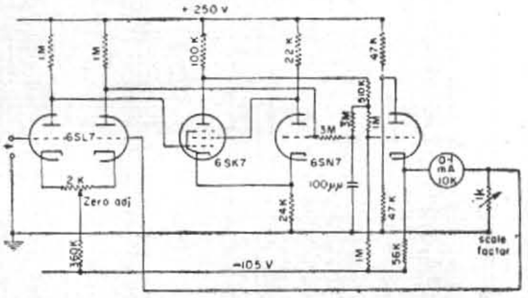

Fig. 4. Constant gain DC amplifier circuit diagram

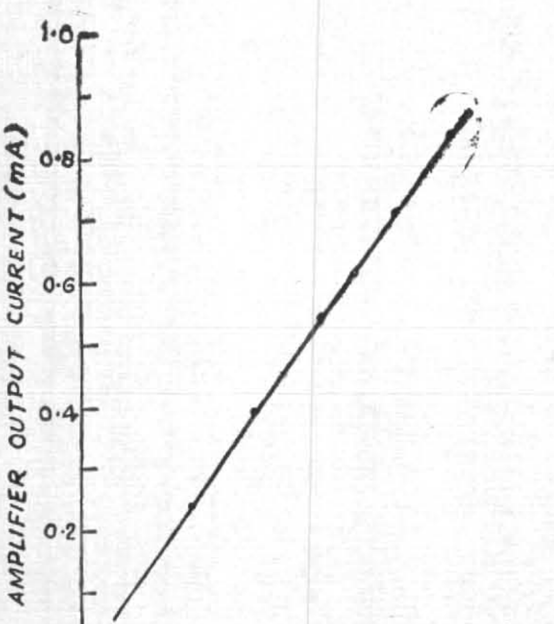

Fig. 5

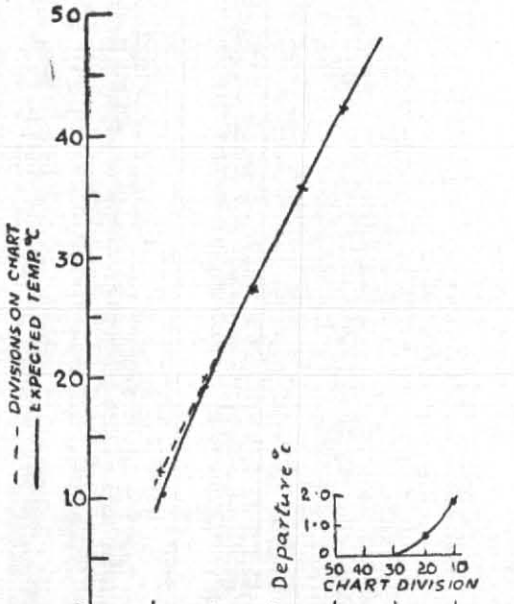

Fig. 6

departure from linearity of the output current has to be taken into account. The instrument calibration curve for different temperatures is given in Fig. 6.

The power dissipation in the thermistor is only one fiftieth of the maximum rated value. The large value of the thermistor and bridge resistances makes it possible to use long cables up to 2 to 3 miles in length (resistance 10–15 ohms) without any serious error in the temperature measurement. The cable to the thermistor must, however, be shielded to avoid any pick-up. The response of the instrument is very fast due to the combined rapid response of the thermistor to temperature variations and the almost instantaneous response of the amplifier and recording milliammeter. Since the power dissipation in the bridge is very small, an Eveready 286, 9 V battery suffices for the bridge over a period of several months. The very small drift of the amplifier makes the instrument very stable and the zero need not be set more than once in 24 hours.

The recorder readings were compared with those of a thermometer exposed in a Stevenson Screen nearby for over a month and the two were found not to differ by more than $\pm$ 0·2°C.

4. Acknowledgement

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