AN INEXPENSIVE THERMISTOR TEMPERATURE MONITOR

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ADVOCATES OF ROUTINE, continuous monitoring of temperature during operations employing general anaesthesia have been deterred from providing such instruments for each operating room by their high cost. This report describes the design of an inexpensive, temperature monitor with an error of less than 0.5°C , using interchangeable thermistor probes, and costing less than \$50 for parts. The monitor, (Figure 1) is powered by two 15-volt batteries with an operational life greater

FIGURE 1. The thermistor temperature monitor.

than 100 hours under continuous use. The display is a 0–100 microammeter with a scale calibrated from 25°C to 45°C . Correction for battery voltage drift with time (less than 1°C after 8 hours of continuous use), is provided by a calibrate switch and adjusting control, which also indicates battery failure when calibration is unobtainable. The unit is not sensitive to cautery or diathermy apparatus in local use.

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FIGURE 2. Circuit diagram for the thermistor temperature monitor. Resistance values are given in ohms, ($\kappa = \times 10^3$) and the resistors are rated at $\frac{1}{4}$ watt. The integrated circuit is a Motorola operational amplifier type 1741cc. The Thermistor is a Yellow Springs Instrument Co. type 44011, 100 κ ohm at 25°C.

CIRCUIT DESIGN

The circuit (Figure 2), is based upon the use of an operational amplifier in an ultralinear bridge configuration. The resistance - temperature characteristic of the thermistor is linearized at the mid-scale point by connecting a fixed resistor in parallel with the thermistor probe, and this parallel combination forms one arm of the bridge. The other arms of the bridge are made up of fixed resistors chosen so that the output voltage of the operational amplifier is zero at 25°C. A carbon trimming potentiometer provided in the arm of the bridge opposite to the thermistor provides an initial balance adjustment. The current through the bridge arms remains constant at 38.5 microamps so that the maximum current through the thermistor is 25.6 microamps at 45°C, and therefore internal heating is avoided.

The bridge driving voltage of 3 volts is obtained from the slider of a wirewound potentiometer connected across the 15-volt positive supply battery. In order to correct the drift of this voltage as the battery voltage declines, a fixed resistor is switched in to substitute for the thermistor which should yield a scale reading of 45°C, and the bridge driving voltage is corrected. The switch and potentiometer therefore form a calibration check.

CONSTRUCTION

The thermistor probe is made by connecting a Yellow Springs Instrument Co. type 44011 (100 Kilohms at 25°C), thermistor to a pair of twisted leads enclosed in polythene tubing. The thermistor and open end of the tubing are then sealed with epoxy resin.

The electronic circuit components and batteries are fixed to a circuit board mounted on the terminals of the microammeter, and the meter is installed in an instrument case with the off-on calibrate switch and calibrate adjust potentiometer. The thermistor probe connects to the circuit with a 3 conductor jack and plug so that the probe and circuit remain isolated from the case, and the possible formation of ground connections to the subject via the probe is avoided.

SUMMARY

An inexpensive temperature monitor (Figure 1) has been constructed with interchangeable thermistors (YSI type 44011) utilizing an operational amplifier, ultralinear bridge circuit (Figure 2). The temperature error of the monitor is less than 0.5°C, between 25°C and 45°C, and the cost of materials is less than \$50.00. The monitor is operated by batteries (two 15-volt batteries), with a life expectancy greater than 100 hours.

RÉSUMÉ

Avec des thermistors interchangeables (YSI type 44011), nous avons construit à peu de frais, un moniteur de température (figure 1) en utilisant un amplificateur opérationnel, en circuit ultralinéaire (figure 2). La marge d'erreur du moniteur est inférieure à 0.5°C, entre 25°C et 45°C; le coût du matériel est inférieur à \$50.00. Le moniteur fonctionne à l'aide de deux batteries de 15 volts possédant une capacité de fonctionnement d'au-delà de 100 heures.