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THERMISTORS AND THEIR USE IN METEOROLOGY

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/A Digest/

The uses of thermistors are many and varied, and their field of application continues to expand. Thermistors are used for automatic temperature regulation of volume in negative-feedback amplifiers and for measurement of power at superhigh frequencies; as time relays in telephone circuits, instruments for temperature regulation, remote control cutout switches, generators, modulators, amplifiers, starting current limiters, manometers, anemometers, compensators of the temperature variation of conductors, and finally as thermometers. The compensating potentialities of thermistors have been thoroughly studied.

Such advantages as small size, comparative simplicity of production, cheapness, stability over a wide range of temperatures, and possible use as remote-control thermometers make the introduction of thermistors into meteorological practice compulsory. The last potentiality was illustrated in a work by Kolomiyets and Sheftel' (1), in which a bridge circuit was used for remote measurement of the temperature of a granary 100-150 meters from their laboratory. Temperatures from 0 to 50° C were measured with an error of 0.1° C, and it was emphasized that this sensitivity was not to be regarded as a maximum. The entire metering circuit in their unit was mounted in a wooden box 33 x 22 x 12 cm. A galvanometer with sensitivity of 10^{-6} amp/division was used at the output. One dry cell was used for the supply source. This work also convincingly demonstrated that uranium dioxide thermistor thermometer has considerably less inertia than a mercury thermometer.

The temperature of moving bodies or bodies whose temperature is too high to be measured directly by the contact method can be measured with the help of thermistors placed in the focus of an elliptical mirror which gathers radiation from the object whose temperature is to be measured. It is important that the sensitivity of thermistors be considerably higher than that of thermopiles and bolometers.

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The most important property of thermistors for meteorology as well as for other fields is the strong dependency of their resistance upon temperature. Kolomiyets and Sheftel' (1) designed uranium dioxide thermistors with a temperature coefficient of resistance of 3.15% per degree in the temperature interval 15-25° C. Kolomiyets (2) also constructed a table /appended/ for electrical conductivity and temperature coefficient of resistance of a number of other substances.

Another important property of thermistors is aging, i.e., change of thermistor resistance with time for the same temperature. In some thermistors, the aging process occurs in the first 2-3 dyas of production, in which time the resistance changes by 20-25% (1) Lack of stability due to aging could hinder the use of thermistors in practice, but this can easily be avoided. The uranium dioxide thermistors designed by Kolomiyets and Sheftel' had high stability. Stable thermistors can be obtained by observing the following specifications: (1) the thermistors must be made from semiconductors having purely electron conductivity because ionic conductivity causes irreversible processes; (2) possibility of chemical reactions between the thermistor substance and air must be eliminated for all temperatures at which the thermistor will operate; (3) the admixtures contained in the thermistor material must be in equilibrium and the point of equilibrium must shift very slowly for a changing temperature; (4) good contact of the electrodes with the thermistor must be provided by the selection of accurate coefficients of expansion for the electrode and thermistor materials; and (5) the thermistors should undergo for a long period (days or weeks, depending upon the type) at a temperature slightly higher than the operating temperature.

BIBLIOGRAPHY

1. Kolomiyets, B. T., and Sheftel', I. T. Zhurnal Teknicheskoy Fiziki, Vol XII, No 10, 1947, p 1105. [redacted]

2. Kolomiyets, B. T., Elektrichestvo, No 3, 1947, p 20 [redacted]

Table 1

Substance	Specific Conductivity σ (ohms$^{-1}\cdot$cm^{-1})	Temp Coefficient of Resistance α (% per °C)
Ag_2S	2×10^{-3}	-3.8 to -5
CuO Mn_3O_4	10^{-1} - 10^{-2}	-3 to -3.2
UO_2	1.3×10^{-3}	-3.2
CuO	10^{2} - 10^{-6}	-2.6
Co_3O_4	1.5×10^{-3}	-2.7
TiO_2MgO	1.6×10^{-2}	-1.3
$CuOCr_2O_3$	1.0×10^{-3}	-2.8
Mn_3O_4 NiO	1.0×10^{-6}	-3.2
PbSe	2.4×10^{-1}	-0.8

Alpha α is given for the temperature interval 16 to 20° C

Sigma σ is measured at 20° C

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