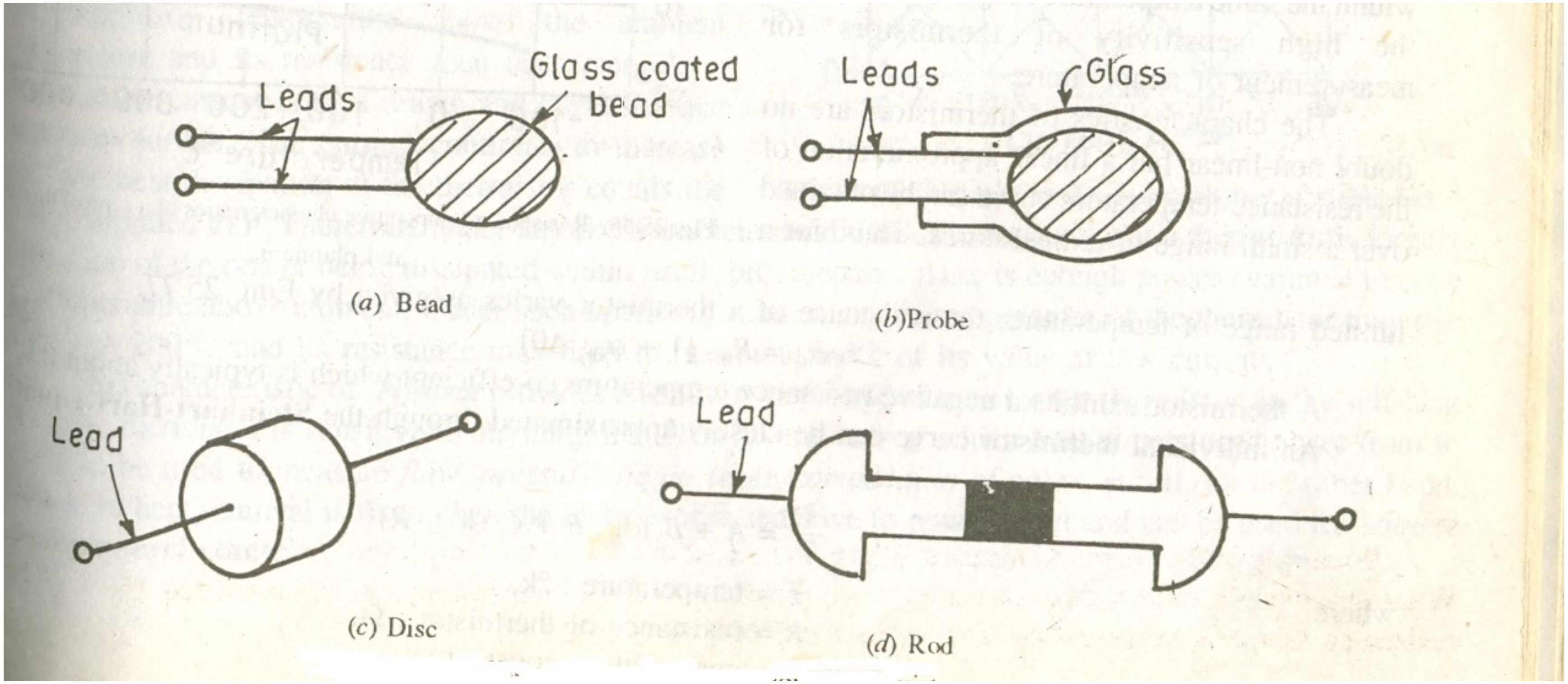
Thermistors



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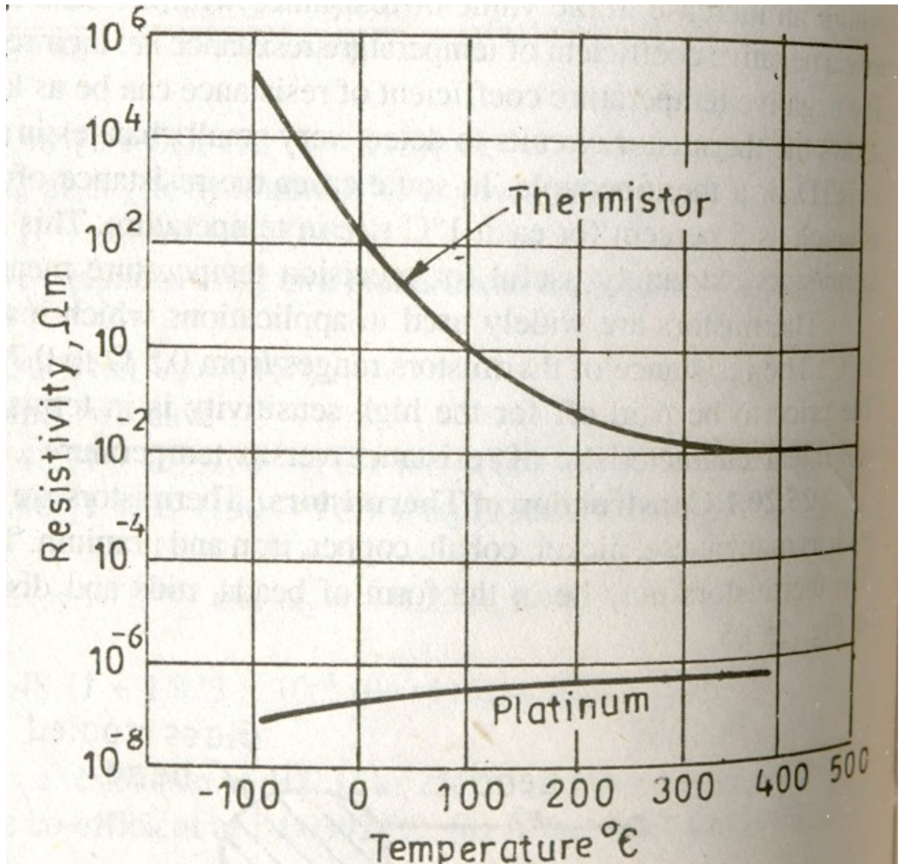

Fig. . Resistance-temperature characteristics of a typical thermistor and platinum

Resistance temperature characteristics of Thermistors

- $R_{T1} = R_{T2} \exp[\beta\{(1/T_1) - (1/T_2)\}]$

- Where R_{T1}=reistance of the thermistor at absolute temperature T_1;^0K
- R_{T2}=reistance of the thermistor at absolute temperature T_2;^0K
- β =a constant depending upon the material of thermistor,typically 3500 to 4500 ^0K.

Thermistors

- An individual thermistor curve can be closely approximated through the Steinhart-Hart equation:
- $1/T = A + B \log_e R + C(\log_e R)^3$

Where T=temperature :^{0}K,

R=resistance of thermistor;Ω

A,B,C=curve fitting constants.

T=(B/logeR-A)- C

Applications of Thermistors

- Measurement of temperature.
- Control of temperature.
- Temperature compensation.
- Measurement of power at high frequencies.
- Measurement of thermal conductivity.
- Measurement of level,flow and pressure of liquids.
- Measurement of composition of gases.
- Vacuum measurements and
- Providing time delays.

Thermocouples

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What Is A Thermocouple Sensor??

Thermocouples are among the easiest temperature sensors to use and obtain and are widely used in science and industry.

Thermocouples are the most common temperature sensing device. They can be made in very tough designs, they are very simple in operation and measure temperature at a point. Over different types they cover from -250C to +2500C.

Accurate temperature measurements can be made with thermocouples sensors at low cost with shop-built probes and ordinary low-level voltmeters.

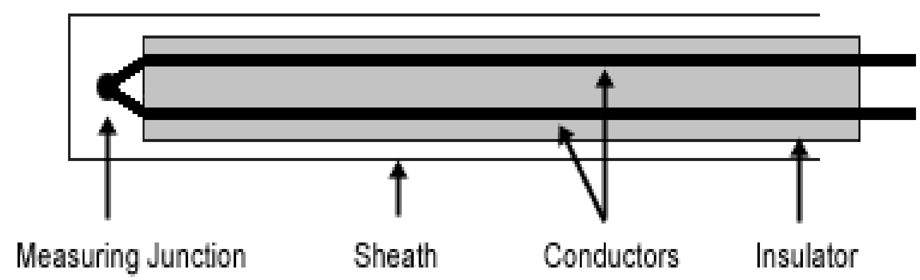
Basic Working Principle

The principle of operation is on the Seebeck effect. A temperature gradient along a conductor creates an EMF. If two conductors of different materials are joined at one point, an EMF is created between the open ends which is dependent upon the temperature of the junction. As T1 increases, so does V. The EMF also depends on the temperature of the open ends T2.

The junction is placed in the process, the other end is in iced water at 0C. This is called the reference junction.

Practical Thermocouple Construction

A thermocouple construction consist of two conductors, welded together at the measuring point and insulated from each other long the length. It will usually have an outer protection sheath.



Thermocouple Materials

The three most common thermocouple materials for moderate temperatures are Iron-Constantan (Type J), Copper-Constantan (Type T), and Chromel-Alumel (Type K).

1-) The first named element of the pair is the positive element.

2-) The negative wire is color coded red.

All three types (J, K, and T) are available as insulated duplexed pairs from 0.001-inch diameter on up. For accuracy, and minimum system disturbance, the smaller the wire the better, but wire smaller than 0.003-inch diameter is very fragile.

Standard Thermocouple Types

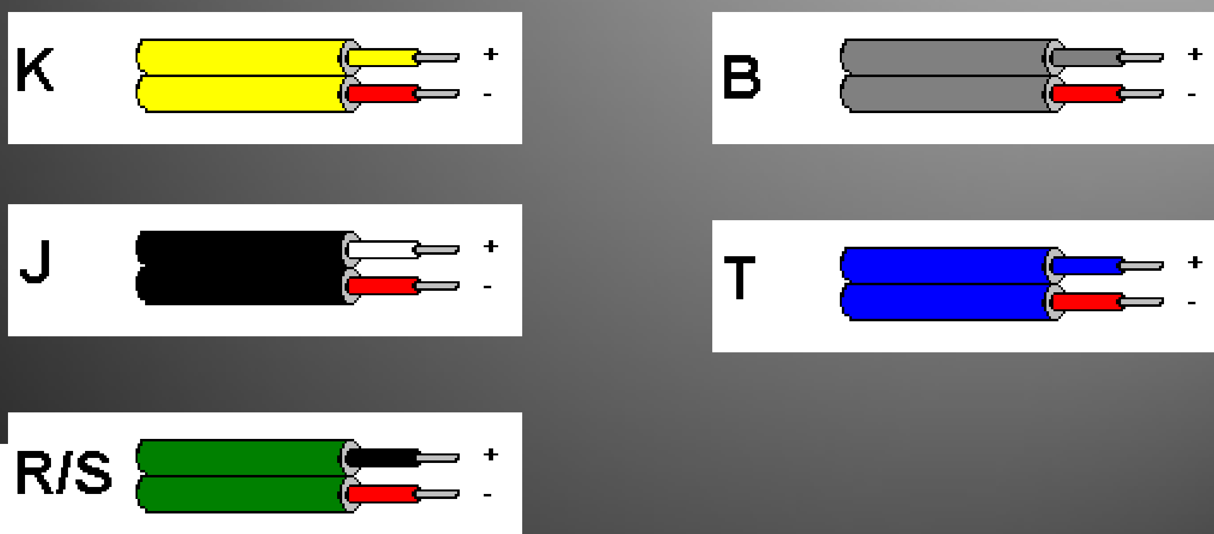
Iron-Constantan: Iron-Constantan (Type J, color coded white and red) generates about 50 μV/°C (28 μV/°F). The Iron wire is magnetic. Junctions can be made by welding or soldering, using commonly available solders and fluxes.Iron-Constantan thermocouples can generate a galvanic EMF between the two wires and should not be used in applications where they might get wet.

Chromel Alumel: Chromel-Alumel (Type K, color coded yellow and red) generates about 40 μV/°C (22 μV/°F). The Alumel wire is magnetic. Junctions can be made by welding or soldering, but high temperature silver-solders and special fluxes must be used.Chromel-Alumel thermocouples generate electrical signals, while the wires are being bent, and should not be used on vibrating systems, unless strain relief loops can be provided.

Copper-Constantan: Copper-Constantan (Type T, color coded blue and red) generates about 40 μV/°C (22 μV/°F). Neither wire is magnetic. Junctions can be made by welding or soldering with commonly available solders and fluxes.Copper-Constantan thermocouples are very susceptible to conduction error, due to the high thermal conductivity of the copper, and should not be used unless long runs of wire (100 to 200 wire diameters) can be laid along an isotherm.

Thermocouple Color Codes

Thermocouple wiring is color coded by thermocouple types. Different countries utilize different color coding. Jacket coloring is sometimes a colored stripe instead of a solid color as shown.



Characteristics

Thermocouples have non-linear characteristics given by an approximating polynomial.

For example for type J (range 1, -210 to 760°C) the characteristic is given by

$$V = c_0 + c_1 T + c_2 T^2 + c_2 T^2 + c_3 T^3 + c_4 T^4 + c_5 T^5 + c_6 T^6 + c_7 T^7$$

where V is in and T in °C

gnal from a thermocouple is up to 50mV.

Major Specifications

Type J: **Iron / Cons** o 1200F. Maximum temperature 1600F. Possible problems: Oxidizes rapidly due to the iron wire. The use of the stainless steelmetal sheathed MgO style of construction has overcome some of this problem and is much preferred over the beaded bare wire style of thermocouple.

Type K: **Chromel / Alumel** Useful range of temperature is -300F to 1800F. Maximum temperature 2300F.

Type E: **Chromel / Constantan**Useful range of temperature is -300F to 1800F. Maximum temperature 1000F.

Type T: **Copper / Constantan**Useful range of temperature is -300F to 700F. Maximum temperature 700F.

Major Specifications……

Type R and S: **Platinum / Platinum-Rhodium** Useful range of temperature is 40F to 3000F. Maximum temperature 2300F.Both the R and S thermocouples are used for very high temperatures. These couples are relatively expensive compared to other thermocouples since they are made of platinum.These thermocouples must not touch the sheath if a metal sheath is used for construction. Normally a ceramic protective tube and ceramic beads are used for construction for both high temperature reasons and to prevent contamination of the noble metal.

Capabilities and Limitations

Capabilities:

- Wide Range
- Fast Response
- Passive
- Inexpensive

Limitations:

- CJC
- Non-Linear

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