MODULE :- 3

TEMPERATURE MEASURMENT.

⇒ Electrical Method :-

why we use electrical method ; easy to track electrical signal.
Here temperature converted to electrical signal
we can process it in amplification, Modulation, Control

⇒₁ Materials whose resistance change with temp. is used in measurment
- +ve temperature Co-eff : ↑ Temp. ↑ Resist.
- -ve " " : ↓ Temp. ↓ Resistance

⇒₂ Temp. effect induce a thermoelectric . emf on combination of some materials.

1) RESISTANCE THERMOMETER

- Resistance temperature detector (RTD)

* Here $\Delta T \longrightarrow \Delta R$ occurs. Now relation of R & T

$$R = R_0\left[1 + \alpha_1 T_1 + \alpha_2 T^2 + \alpha_3 T^3 + \cdots + \alpha_n T^n + \cdots\right]$$

R_0 = Resistance when $T = 0$

$\alpha_1, \alpha_2, \alpha_3, \cdots$ are Constants.

* we can approxim. above equation to $R = R_0\left[1 + \alpha_1 T + \alpha_2 T^2\right]$

* For a narrow range of materials :

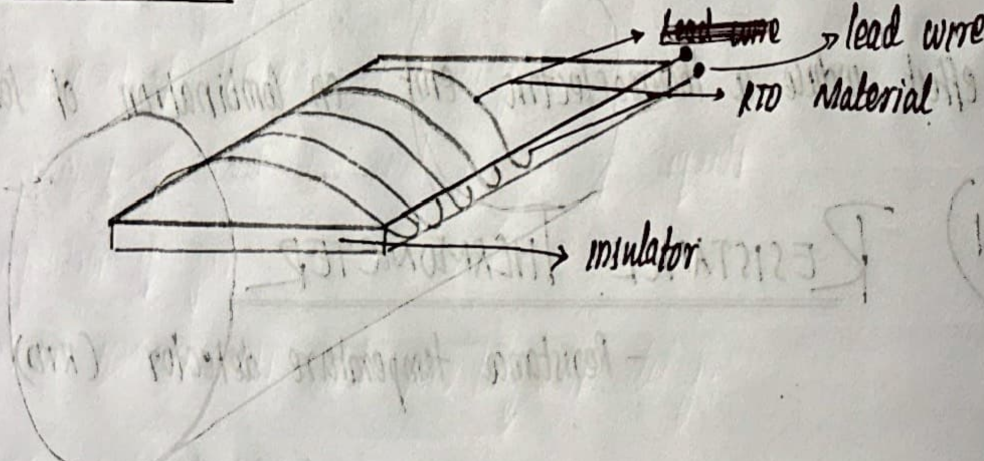
$$R = R_0[1 + \alpha T]$$ where α = Resistance temp. coeff.

* Materials used as RTD can be Platinum, silver
Change in temperature can be in the region -250°c to 1000°c.

* **A GOOD RTD Material Has following properties :**

⇒ If the material has suitable resistivity
⇒ It should have high temp. Coeff. of resistivity and should be stable
⇒ Corrosion resistance and chemically stable
⇒ It should not undergo any phase changes during operating
⇒ Material should be available in a pure and uniform form.

CONSTRUCTION OF RTD :-



⇒ insulator can be mica, Ceramic

* It is used for fast response and high sensitivity application
* It is interchangable (same type of RTD
* It has rugged construction reliable for industrial application
* Self heating nature may be there (error in temp. may accure due to the current passing)
* Lead wire resistance may introduce error in measurment

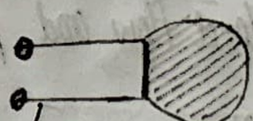
THERMISTERS :-

* Thermal resistors $\rightsquigarrow$ +ve or -ve temp. Coefficiant
* Most of semi conductors are in this thermistors (Combination of metal oxide).
* used for measuring sensitive temp and presicion.

CONSTRUCTION :-

* Manganese, iron, uraneum

Type ① : Bead type thermisters :

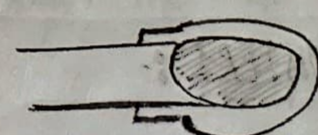


smallest

diamet : ·015 mm → 1·25 mm

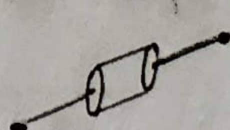
lead wire

Type ② : Prob type thermisters :



dia : 2·5 mm

Type ③ : Disc type :



2·5 mm to 25 mm.

Compressing material to form disc type thermisters.

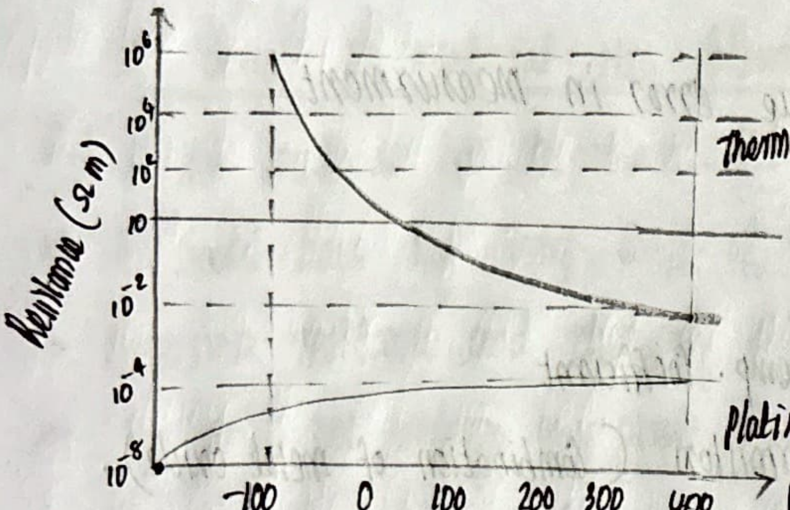
→ Relation of R & T in thermistors:

$$R_{T_1} = R_{T_2}\, e^{\left[\beta\left(\frac{1}{T_1} - \frac{1}{T_2}\right)\right]}$$

R_{T_1} = resist. @ T_1

R_{T_2} = resist. @ T_2

Resistance temperature charact:-



OTHER APPLICATIONS OF RTD :-

* Use to measure power @ high freq.
* Measurement of thermal Conductivity
* Measurement of level flow and pressure of liquids
* Composition of gas
* Vaccum measurments and providing time delay.

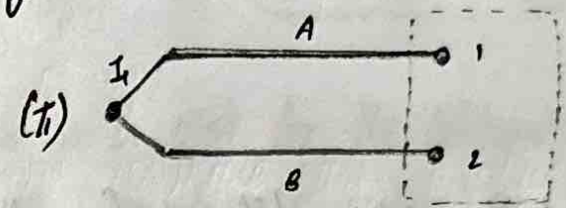
FEATURES OF THERMISTERS :-

* They have good stability & response time of thermister Can vary from fraction of seconds to minutes.
* Compact and inexpensive.
* upper operating temp. is dep. on physical change of temp.
* lower limit depends on measurment method.

* Measuring current may cause self heat.

THERMOCOUPLE

⇒ Joining 2 dissimilar materials;



electric ckt.

- Seebeck effect : Pd → voltage : A fxⁿ of time

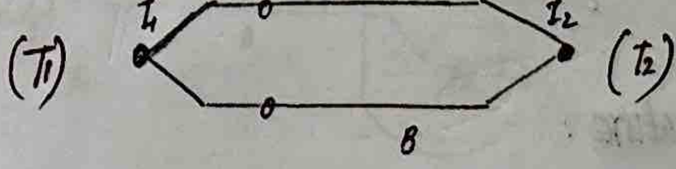
– Connecting to a electric ckt.
– Draw a current
} Alteration in emf : Peltier effect.

- Either or both : temp gradient — Alteration in emf → Thompson effect.

THERMOELECTRIC LAW :

1st : Application of heat to a single homogenous metal in itself not capable of producing an electric current or sustaining electric current.

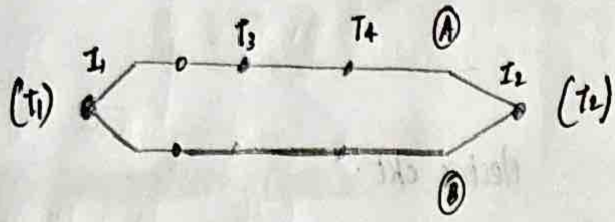
2nd : A thermoelectric emf which produce in jxⁿ's of 2 dissimilar homogenious materials are kept on different temperatures. This emf is not affected by temp. gradient along condⁿ's.



3rd : Law of intermediate metals:

In a ckt consisting of 2 dissimilar homogenous metals, having jxⁿ's @ different temperatures, the emf developed will not be affected

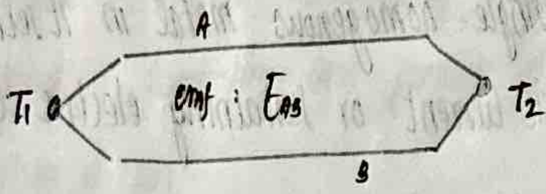
When a third homog. metal is made a part of ckt, provided the temp. of it's 2 jx's are the same.

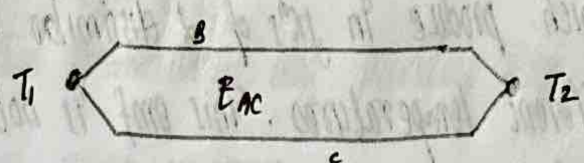


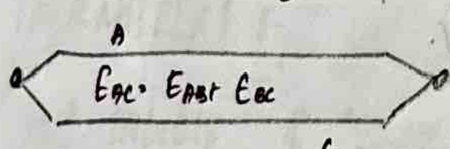
Application of this law:

* This law make it possible to use extension wire different from the metal used for thermo couple.
* This law enable a measuring instrument to introduce in a ckt, without affecing the emf generated.
* We can solder / brazed the wire forming the jx's.

4^{th} : The thermal emf of any 2 homogenous metals w.r.t another is the algebraic sum of their individual emf's w.r.t a third homogenous metal.

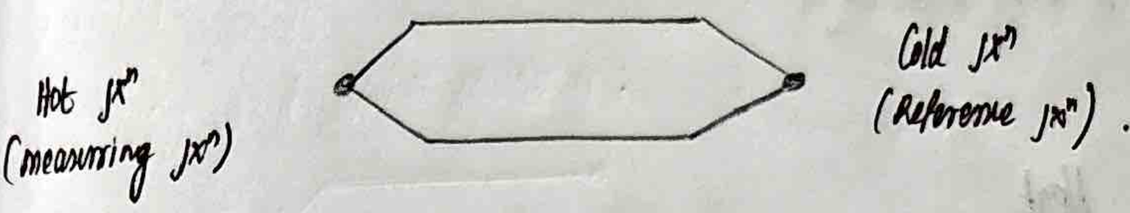






5^{th} : law of intermediate temperature:

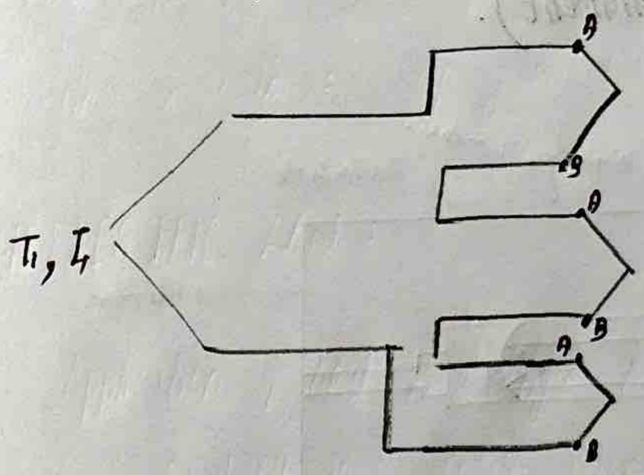
The thermal emf produced in the ckt of 2 homog. metals exist b/w a first temperature and a second and thermal emf produced when the same ckt exist b/w the 2^{nd} temp. & a third are algebraically equal to the thermal emf produced when the ckt exist b/w first and third temperature.



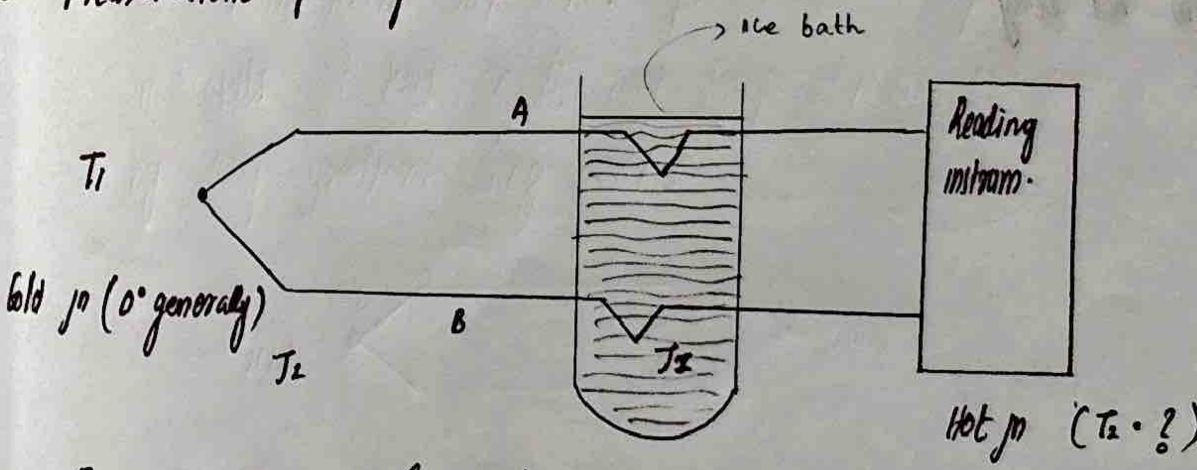
→ This law can be used for the caliberation of reference temp.

→ Algebraic sum of emf's produced in a ckt containing 2 or more thermocouple all @ the same temp is zero.

→ Net emf containing 2 thermocouple is uneffect by the addition of more thermocouple at the same temp.



• Measurement of temp. T_2 :-



$$E = E_2 - E_1$$

$$E = E_1 - E_2 = (E_1 - E_a) - [E_2 - E_0]$$

- Cold junction Compensation
- Ice bath
- Bridge
- Double oven

To bring 0° @ Cold jxn

Measurment of Heat

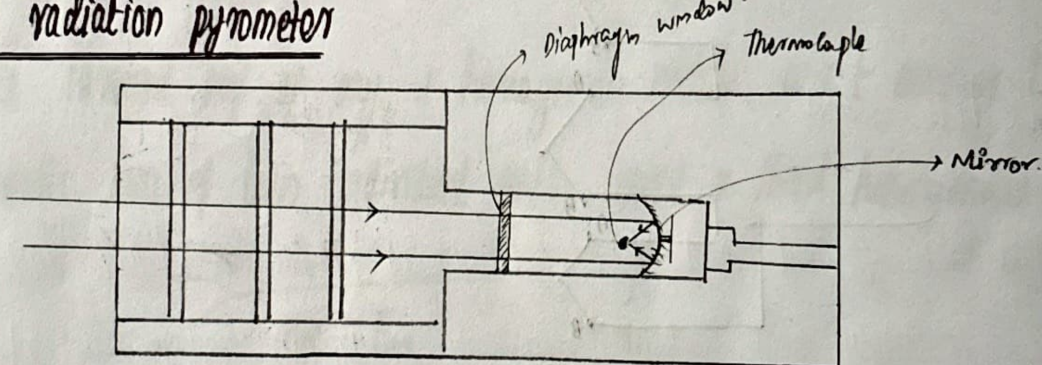
⇒ **Radiation method** - pyrometer.

i) Total radiation pyrometer

ii) IR radiation pyrometer [Selective radn pyrometer]

iii) optical pyrometer (Disappearing filament).

1) Total radiation pyrometer



* All radn from hot body