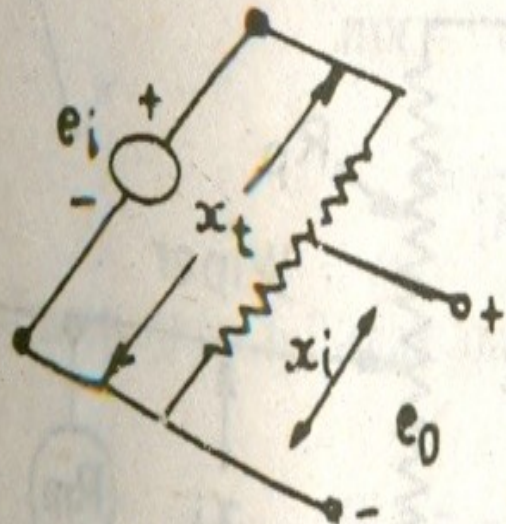


Resistive Transducers

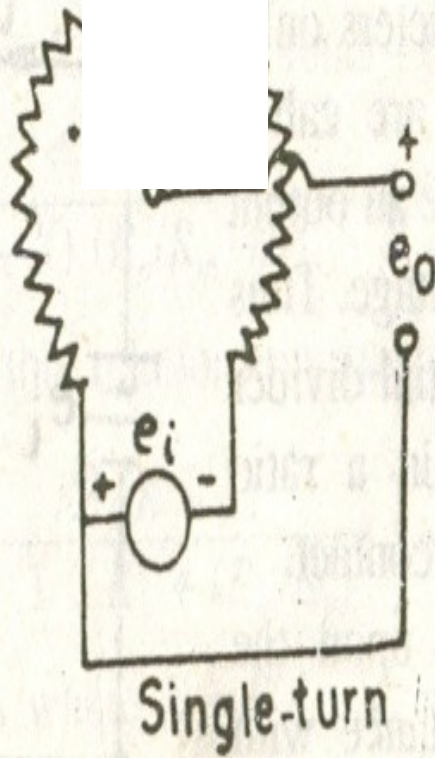
- ▶ It is used for ac as well as dc current and voltages measurements.
- ▶ $R = \rho L / A$

Potentiometers

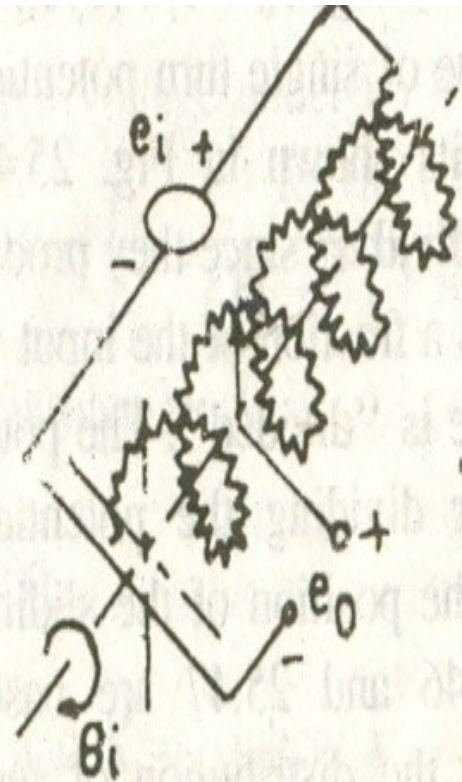
- POT is a *PASSIVE TRANSDUCER*.
- The *translation and rotational potentiometers* which work on the basis of change in the value of resistance with change in the length of the conductor can be used for measurement of translational or rotary displacements.
- Some POTS use the combination of the 2 motions, i.e. translational as well as rotational. These POTS have their resistive element in the form of a helix and therefore they are called *helipots*



(a) Translational



(b) Rotational



(c) Helipot

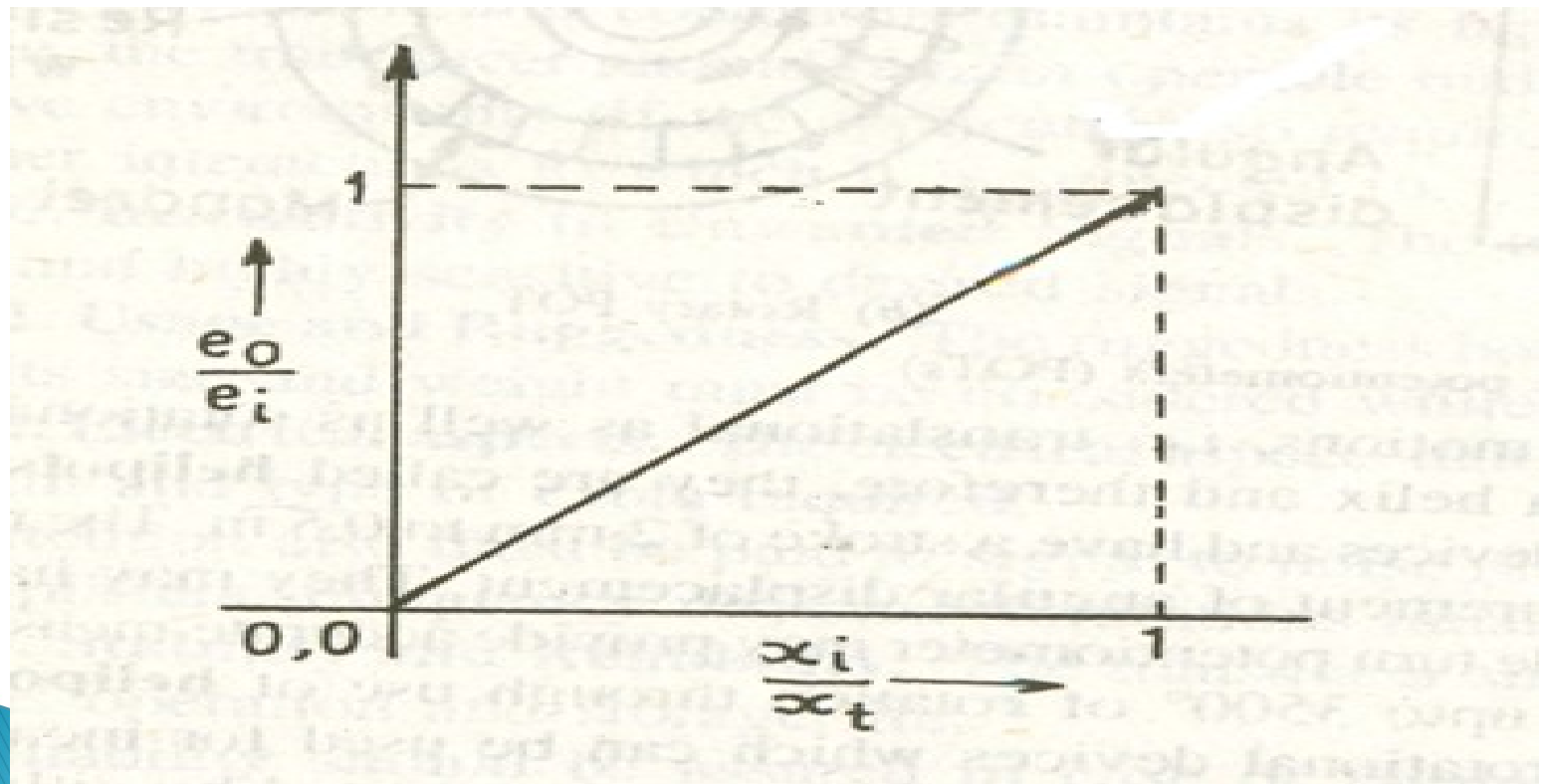
1)Potentiometers

Contd.....

- ▶ ***The Translation elements*** are straight devices & have a stroke of 2mm to 0.5m.
- ▶ ***The rotational elements*** are circular in shape and are used for measurement of angular displacement small as 10° (full scale angular displacement)
- ▶ ***The Helipots*** may *measure upto 3500° of rotation.*

Resistive Transducers

- ▶ Characteristics of potentiometer–



Resistive Transducers

▶ $e_o = \frac{\text{resistance at the output terminals}}{\text{resistance at the input terminals}} * \text{input voltage}$

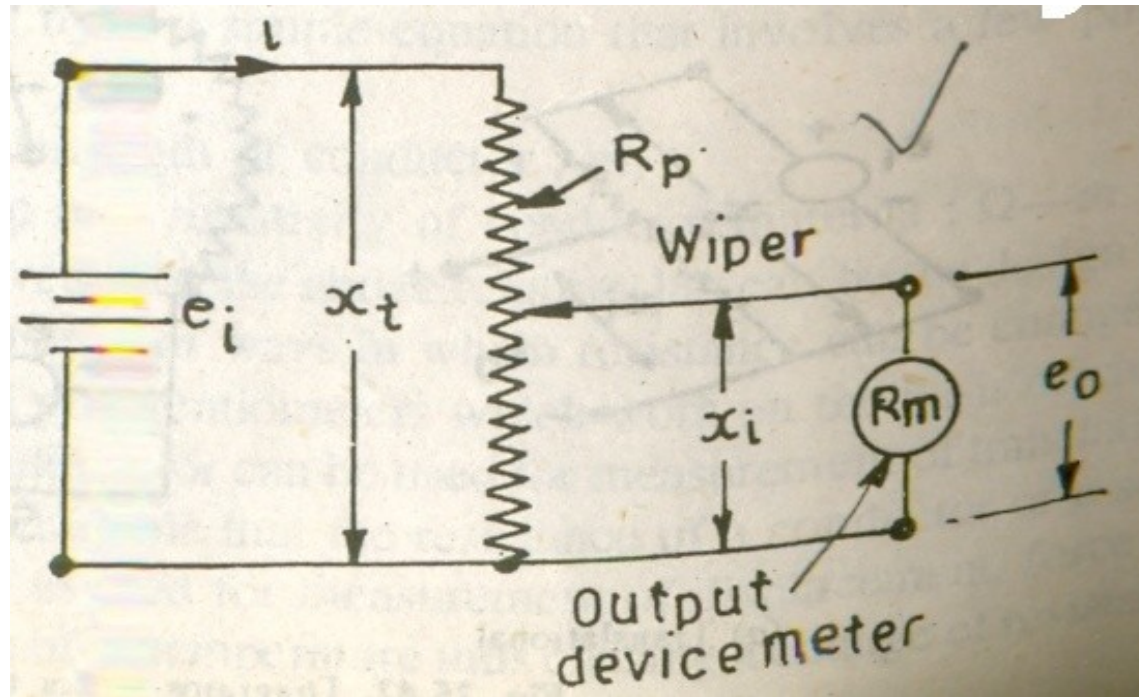
resistance at the input terminals

▶ $e_o = [R_p(x_i/x_t)/R_p] * e_i = (x_i/x_t) e_i$

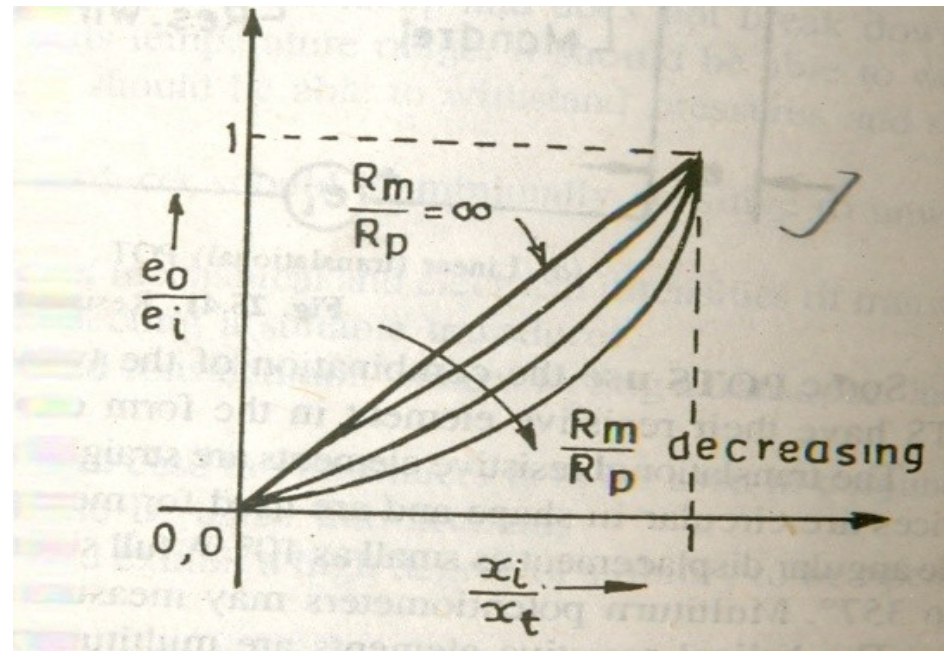
▶ Sensitivity $S = \text{output}/\text{input} = e_o/x_i = e_i/x_t$

Under ideal conditions the sensitivity is constant & the o/p is faithfully reproduced & has a linear relationship with i/p.

Loaded potentiometer



Characteristics of potentiometer



Power rating of potentiometer

- ▶ The potentiometer are designed with a definite power rating which is directly related to heat dissipating capacity.
- ▶ A single turn potentiometer with diameter of 50mm with a wide range of ohmic values ranging from 100 Ω to 10k Ω .
- ▶ They have same heat transfer capabilities.
- ▶ Their rating is 5W at an ambient temp.of 21°C.
- ▶ Since power $P = e_i^2 / R_p$, the max.i/p excitation voltage that can be used is

$$(e_i)_{\max} = \sqrt{PR_p}, \text{ volt}$$

Linearity and sensitivity

- ▶ In order to achieve good linearity, the resistance of potentiometer R_p should be as low as possible when using a meter for reading the o/p voltage which has a fixed value of i/p resistance R_m . The R_p cannot be made low because if we do so the power dissipation goes up with the result we have to make the i/p voltage small to keep the power dissipation to acceptable level. this results in lower sensitivity.
- ▶ In order to achieve high **sensitivity** the o/p voltage e_o should be high which in turn requires a high i/p voltage e_i .
- ▶ **The Linearity and sensitivity are therefore two conflicting requirements.**

Materials used for potentiometer

1. Wire Wound Potentiometer:

- These are platinum, nickel chromium, nickel copper, or some other precious resistance elements.
- It carry relatively large currents at high temperatures.
- Their resistance temperature coefficient is usually small is of the order of $20 \times 10^{-6} / ^\circ\text{C}$ or less.
- Resolution is 0.025 – 0.05 & is limited by the number of turns that can be accommodated on the card.
- The interwinding capacitance b/w turns & b/w windings & shaft, housing etc. limits the use of wire wound potentiometer to low frequencies to about 5Hz.
- Max speed is about 300rpm.

Materials used for potentiometer

2. Non Wire Potentiometer or Continuous Potentiometer:-

- It has improved resolution & life.
- Max speed is 2000rpm.
- They are more sensitive to temperature changes, have a higher wiper contact resistance, which is variable & can carry moderate currents.

Materials used for Non Wire Potentiometer are :-

1. Cermet:-It uses precious metal particles fused into ceramic base & these fused particles acts as a resistance elements.

Advantages :

1. Large power ratings at high temperatures.
2. Low cost.
3. Moderate temperature co-efficients of the order of $100 \times 10^{-6} / ^\circ\text{C}$

Applications:-

Used for a.c. applications.

Materials used for potentiometer

2. Hot Moulded Carbon:—The resistance element is fabricated by moulding together a mixture of carbon & a thermosetting plastic binder

Applications:—

Used for a.c. applications.

3. Carbon Film:— A very thin film of carbon deposited on a non-conductive base forms the resistance element.

Advantages :

Low Cost.

Temperature Co-efficient are upto $100 \times 10^{-6} / ^\circ\text{C}$

4. Thin Metal Film:—A very thin, vapour deposited layer of metal on glass or ceramic is used as resistance element.

Advantages :

1. Its excellent resistance to changes in environments

2. Used for a.c. applications

3. Cost is also moderate

Advantages and Disadvantages of resistance potentiometer

Advantages:-

- ▶ They are inexpensive.
- ▶ They are simple to operate.
- ▶ They are very useful for measurement of large amplitudes of displacement.
- ▶ Their electrical efficiency is very high & they provide sufficient o/p to permit control operations without further amplification.
- ▶ It should be understood that while the frequency response of wire wound potentiometers is limited.
- ▶ In wire wound potentiometers the resolution is limited while in cermet & metal film the resolution is infinite.

Disadvantages:-

- ▶ Linear potentiometer requires a large force to move their sliding contacts.
- ▶ The other problem with sliding contacts are that they can be contaminated ,can wear out,become misaligned & generate noise. so life is limited.