Piezo-electric Transducers:-

- Based on Piezo-electric crystal

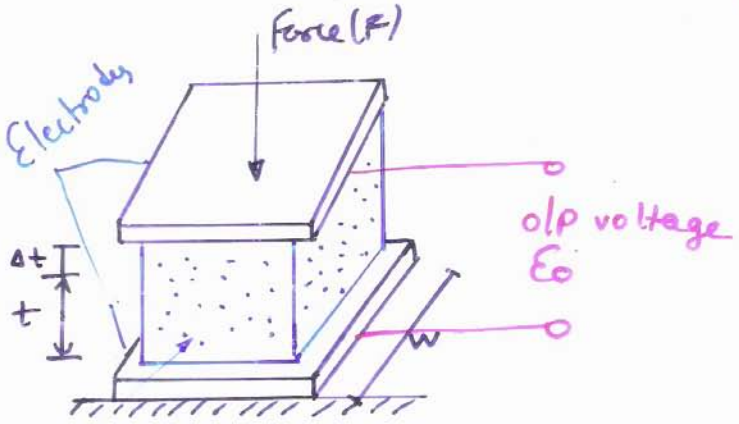
Principle:- Application of mechanical force across the surface of crystal ⇒ produces electrical potential (voltage) across it.

'Piezo-Electric effect.'

This effect is Reversible.

Mechanical Motion ⇄ Electrical o/p.

- Materials used:- Rochelle Salts, Quartz
  Lithium sulphate.



Piezo-electric crystal

- Piezo-electric transducers are used for measurement of displacement. They can also be used for measurement of Force, Pressure or acceleration.
- They are used for 'Dynamic Measurements'.
  → Used in measurement of Quantities such as Surface roughness, in accelerometers & vibration pickups.

Measurement of Vibrations:-

→ Specifications requirement for Equipments to withstand definite levels of vibrations.

- Vibration measurements are frequently carried out on rotating & reciprocating machinery for Analysis, design and Trouble-shooting purposes.

- Nature of Vibrations:-

  - Most vibrations are sinusoidal displacement of vibrating member about its mean position.

For sinusoidal vibrations,

Displacement : $x = A\sin\omega t$

Velocity, $v = \dot{x} = A\omega\cos\omega t$; $\boxed{V_0 = A\omega}$ max

Acceleration, $a = \ddot{x} = -A\omega^2 \sin\omega t$; $\boxed{a_0 = -A\omega^2}$ max.

- Quantities Involved in Vibration measurements:-

1) Displacement 2) Velocity 3) Acceleration

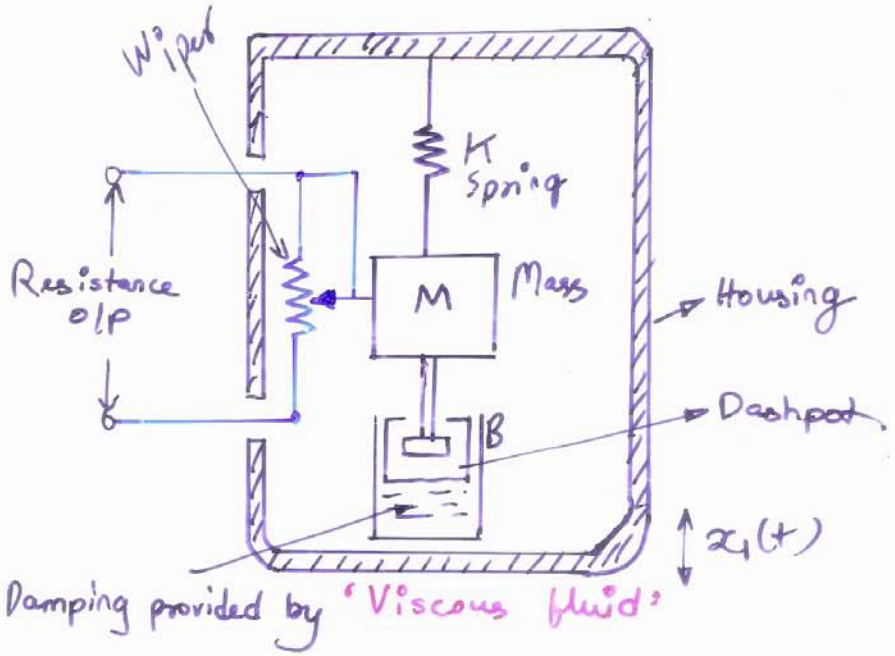
→ If one of 3 variables (x, v, a) is measured, it is possible to determine the other two by integration or differentiation using Electronic devices.

- Seismic transducer :-
  - two modes of operation:
    - Displacement mode (large Mass M, soft spring)
    - Acceleration mode. (small mass, stiff spring)

- Most important transducer for vibration, shock & general purpose motion measurement is 'Accelerometer'.

- Types of Accelerometers : (Measurement of Accelerations)

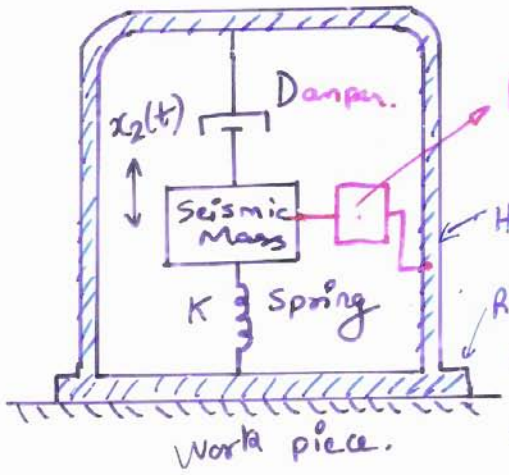
1. Potentiometric type.



- Suitable for low frequency Applications.

- Vibration measurements may be therefore, be made with a transducer sensitive to amplitude (displacement), velocity or acceleration.

- Seismic Transducer / Seismic Accelerometer



Relative Displacement
$x_0 = (x_2 - x_1)$

→ Housing frame connected to source of vibrations whose characteristics are to be measured.

- There is a (Vibratⁿ motion) → as a relative displacement betn Mass and housing frame.
- This displacement is sensed & indicated by an appropriate transducer.

Natural freqⁿ $\boxed{\omega_n = \sqrt{\frac{K}{M}}}$

- Thus dp of instrument is an indication of acceleration, hence called as 'Accelerometer'.

LVDT Accelerometer:-

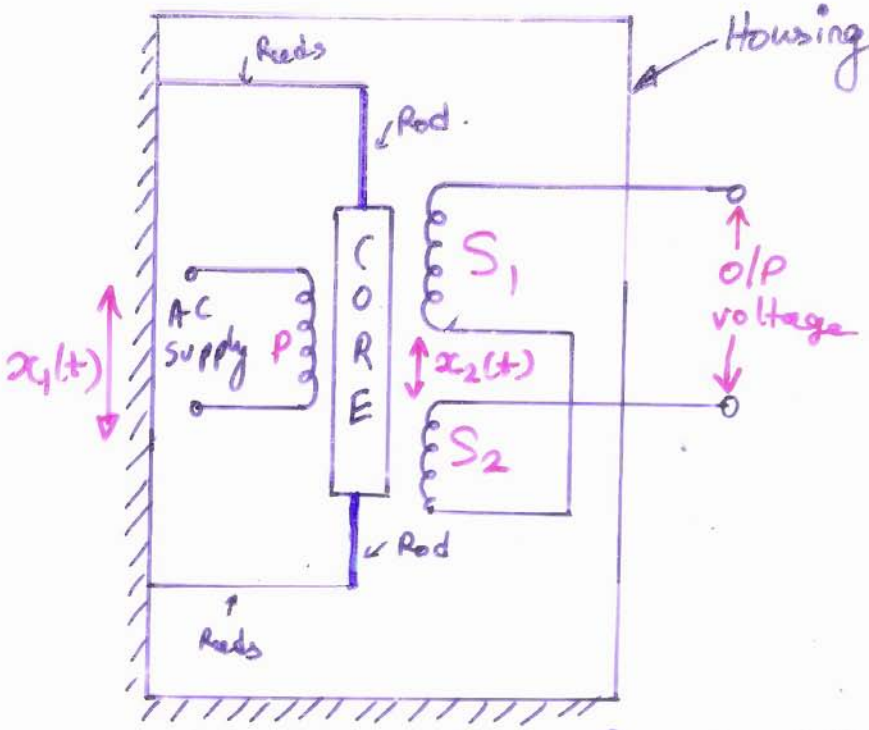


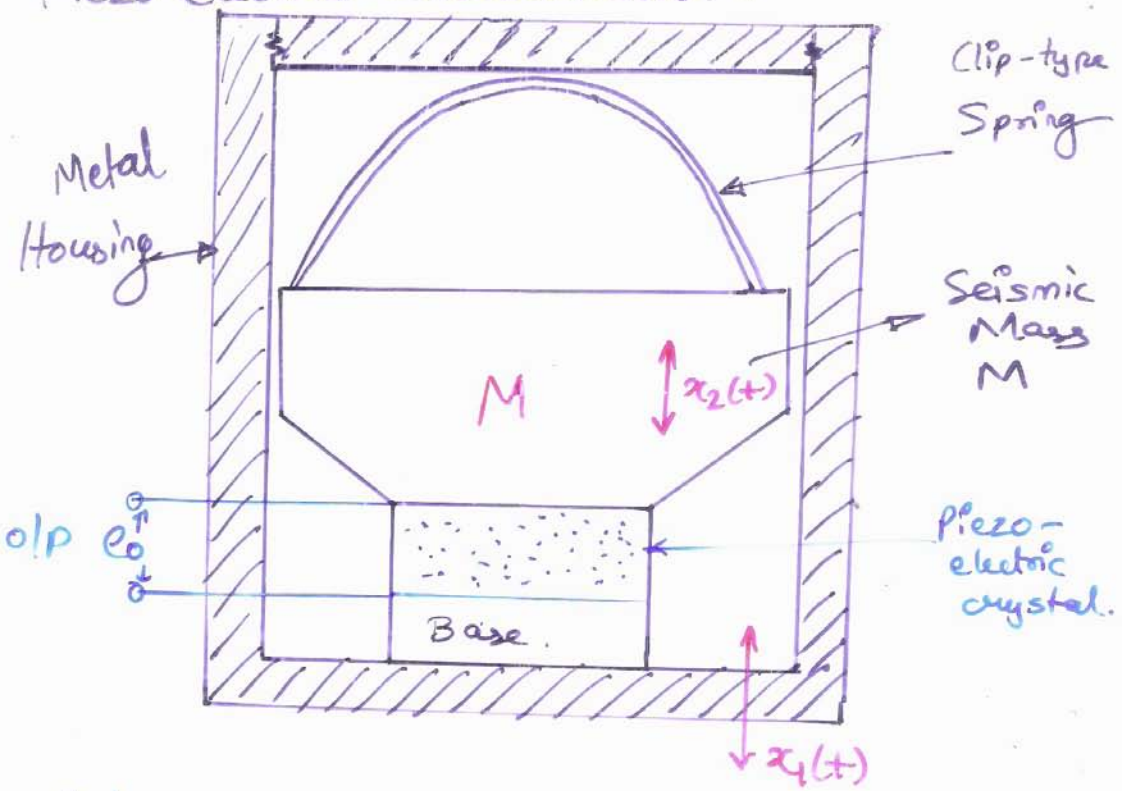
fig:- Seismic Accelerator using LVDT

- Core of LVDT acts as Mass.
- Two flexible reeds attached to rods of core, provide necessary spring action.
- Reeds are Attached to a housing which are subjected to vibrations.

→ As sensor moves up & down on account of vibrations, LVDT 2° gives an AC o/p vtg. whose magnitude depends upon amplitude of vibration.

- Used for low freq^n Vibration Measurement.

Piezo-electric Accelerometer: -



→ When subjected to acceleration, M stresses the crystal to a force $F = ma$, resulting in a voltage/charge generated across the crystal. $(Q = dF) \Rightarrow Q = dma$.
This force generates o/p vtg which is proportional to accelerations. d → Piezo-electric constant.

. If crystal has a capacitance C, no load o/p vtg is $e_o = \frac{Q}{C} = \frac{dF}{C} = \frac{dma}{C}$

∴ $\boxed{e_o \propto a}$ → o/p vtg is a measure of acceleratn.

. Used for any vibration & shock applications