

7.8 CAPACITIVE TRANSDUCERS

The principle of operation of capacitive transducers is based upon the familiar equation for capacitance of a parallel plate capacitor :

$$\text{Capacitance, } C = \frac{\epsilon A}{d} = \frac{\epsilon_r \epsilon_0 A}{d} \quad \dots(7.1)$$

- where,
- $\epsilon = \epsilon_r \epsilon_0$ = Permittivity of medium, F/m,
 - ϵ_r = Relative permittivity, (for air $\epsilon_r = 1$),
 - ϵ_0 = Permittivity of free space = 8.85×10^{-12} F/m,
 - A = Overlapping area of plates, and
 - d = Distance between the two plates.

Any physical quantity which can cause a change in ϵ , A or d can be measured by the capacitance gauge.

- The displacement is measured by measuring the change in capacitance brought about by
- (i) Change in area, or
 - (ii) Change in distance between the plates.
- The change in capacitance on account of change in dielectric is used to measure change in liquid and gas levels.

7.8.1. Capacitive Transducers—Using Change in Area of Plates

Figure 7.16(a), (b) shows the elementary diagrams of the arrangements of a capacitive transducer where capacitance change occurs because of change in the area of plates. Since capacitance is directly proportional to the effective area of the plates, response of such a system is linear.

Fig. 7.16(c) shows variation of the capacitance.

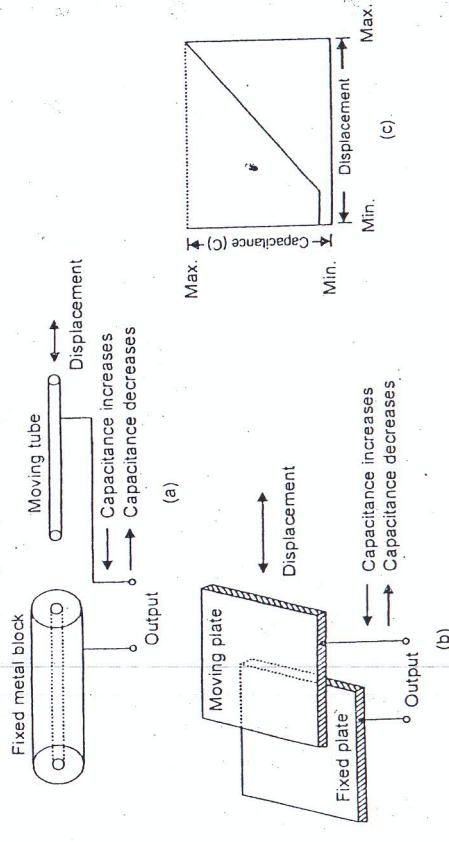


Fig. 7.16. Capacitive transducers working on the principle of change of capacitance with change of area.

7.8.2. Capacitive Transducer—Using Change in Distance Between the Plates

Fig. 7.17 shows the basic form of a capacitive transducer utilizing the effect of change of capacitance with change in distance between the plates.

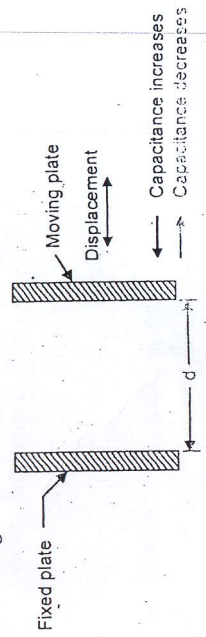


Fig. 7.17. Capacitive transducer.

One is a fixed plate and the displacement to be measured is applied to the other plate which is movable. Since, the capacitance, C varies inversely as the distance between the plates the response of this transducer is not linear.

Differential capacitor system:

In a differential capacitor system, let the normal position of the central plate be represented by a solid line as shown in Fig. 7.18. The capacitances C_1 and C_2 are then identical.

$$\text{i.e.,} \quad C_1 = C_2 = C = \frac{\epsilon A}{d} \quad \dots(7.2)$$

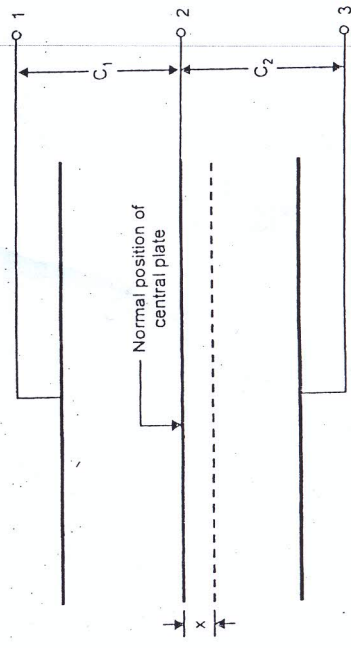


Fig. 7.18. Differential capacitor system.

When the central plate is displaced parallel to itself through a distance x , the capacitances are

$$C_1 = \frac{\epsilon A}{d+x}, C_2 = \frac{\epsilon A}{d-x} \quad \dots(7.3)$$

For an alternating voltage E applied between the terminals 1 and 2, the voltages across C_1 and C_2 are given by

$$E_1 = \frac{EC_2}{C_1 + C_2} = E \frac{d+x}{2d}$$

and,

$$E_2 = \frac{EC_1}{C_1 + C_2} = E \frac{d-x}{2d} \quad \dots(7.4)$$