Unit II : Transducers
Module Name : Inductive transducer Part 1
Module No : 10

Inductive Transducer

An inductive transducer is a device that converts **physical motion** into a **change in inductance**. Inductive transducers may be either of the self generating or the passive type. The self generating type utilises the basic electrical generator principle, i.e. a motion between a conductor and magnetic field induces a voltage in the conductor (generator action). This relative motion between the field and the conductor is supplied by changes in the measured. A self inductance or mutual inductance is varied to measure the physical quantities like displacement, force, pressure, etc. Inductive transducers are mainly used for the measurement of displacement.

Transducers of the variable inductance type work upon one of the following principles.

1. Variation of self inductance
2. Variation of mutual inductance

The displacement to be measured is arranged to cause variation in any of three variables

1. Number of turns
2. Geometric configuration
3. Permeability of the magnetic material

Principle of Change in self-inductance with Number of Turns

The output may be caused by a change in the number of turns. Fig 1.and Fig 2 are transducers used for the measurement of displacement of linear and angular movement respectively.

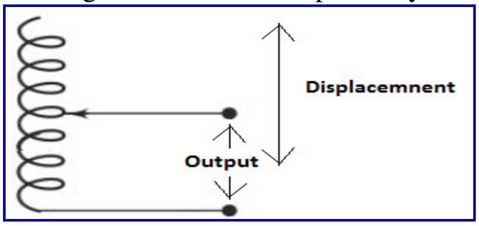

Fig 1 Linear inductive transducer (using air core)

Fig 1 is an air cored coil is used to measure linear displacement.

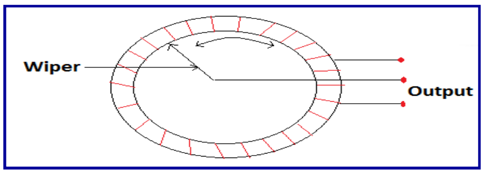

Fig 2 Angular inductive transducer (using ferrite core)

Fig 2 is an iron cored coil is used to measure angular displacement.

In both cases, as the number of turns are changed, the self inductance and the output voltage also changes.

Principle of Change in self-inductance with change in permeability

Fig 3. shows an inductive transducer which works on the principle of the variation of permeability causing a change in self inductance. The iron core is surrounded by a winding around the ferromagnetic former. If the iron core is inside the winding, its permeability is increased, thereby increasing its inductance. When the iron core is moved out of the winding, the permeability decreases, resulting in a reduction of the self inductance of the coil. This transducer can be used for measuring displacement.

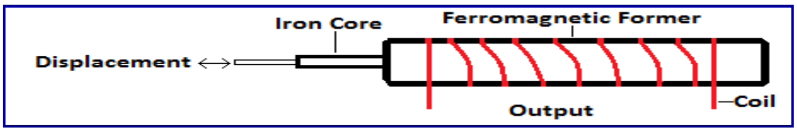

Fig. 3 Inductive transducer working on the principle of variation of permeability

Variable Reluctance Type Transducer

A transducer of the variable type consists of a coil wound on a ferromagnetic core. The displacement to be measured is applied on the target. The target does not have any physical contact with the core on which its is mounted and is separated by air gap, as shown in Fig. 4.

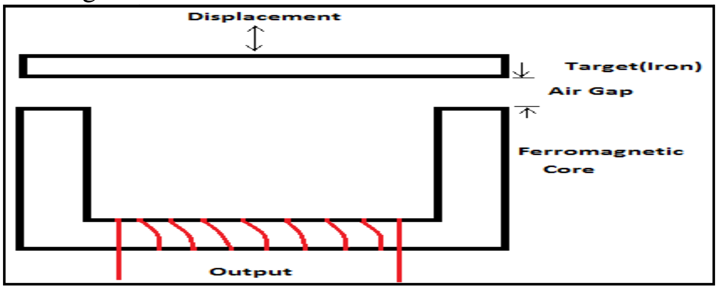

Fig 4. Variable Reluctance Type Transducer

Reluctance of the magnetic path is determined by the size of the air gap. Inductance of the coil depends upon the reluctance of the magnetic circuits. Self Inductance is inversely proportional to the length of the air gap. The self inductance of the coil is given by

$\boxed{L = \frac{N^2}{R_g}}$ where N = number of turns and Rg = reluctance of air gap

But reluctance of the air gap is given by

$\boxed{R_g = \frac{L_g}{\mu_0 * A_g}}$ where lg = length of the air gap, Ag = area of the flux path through air,

μo = permeability, Rg is proportional to lg, as mo and Ag are constants.

Hence L is proportional to 1/lg, i.e. the self inductance of the coil is inversely proportional to the length of the air gap. When the target is near the core, the length is small and therefore the self inductance large. But when the target is away from the core the reluctance is large, resulting in a smaller self inductance value. Hence the inductance of the coil is a function of the distance of the target from the core, i.e. the length of the air gap.

Variable Reluctance Bridge Circuit

The Bridge consists of two transducers coils wounded on each outside leg and a tapped secondary of the input power transformer. Iron bar is pivoted on the centre leg. The moving member is attached to one end of the iron bar as shown in fig 5. It is balanced only when the inductance of two transducer coils are equal. Whenever the iron bar at point A moves and alters the air gap, the bridge becomes unbalanced by an amount proportional to the change in inductance. Proportional to the displacement of the moving member. The increase and decrease of inductance with varying air gap size is non linear.

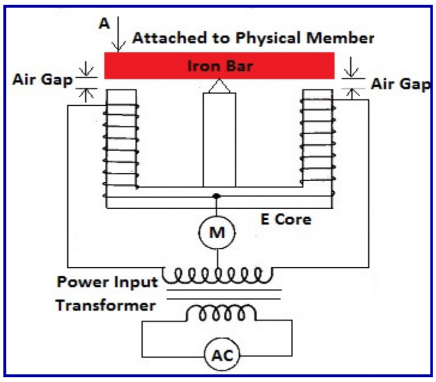

Fig 5.Variable Reluctance Bridge Circuit