

INDUCTION TYPE WATTMETER

Induction type wattmeter is used for only A.C. power measurement. Here the principle of mutual inductance is used for the measurement of A.C. power. It is used for such applications where frequency and supply voltage is constant.

Construction of Induction Type Wattmeter

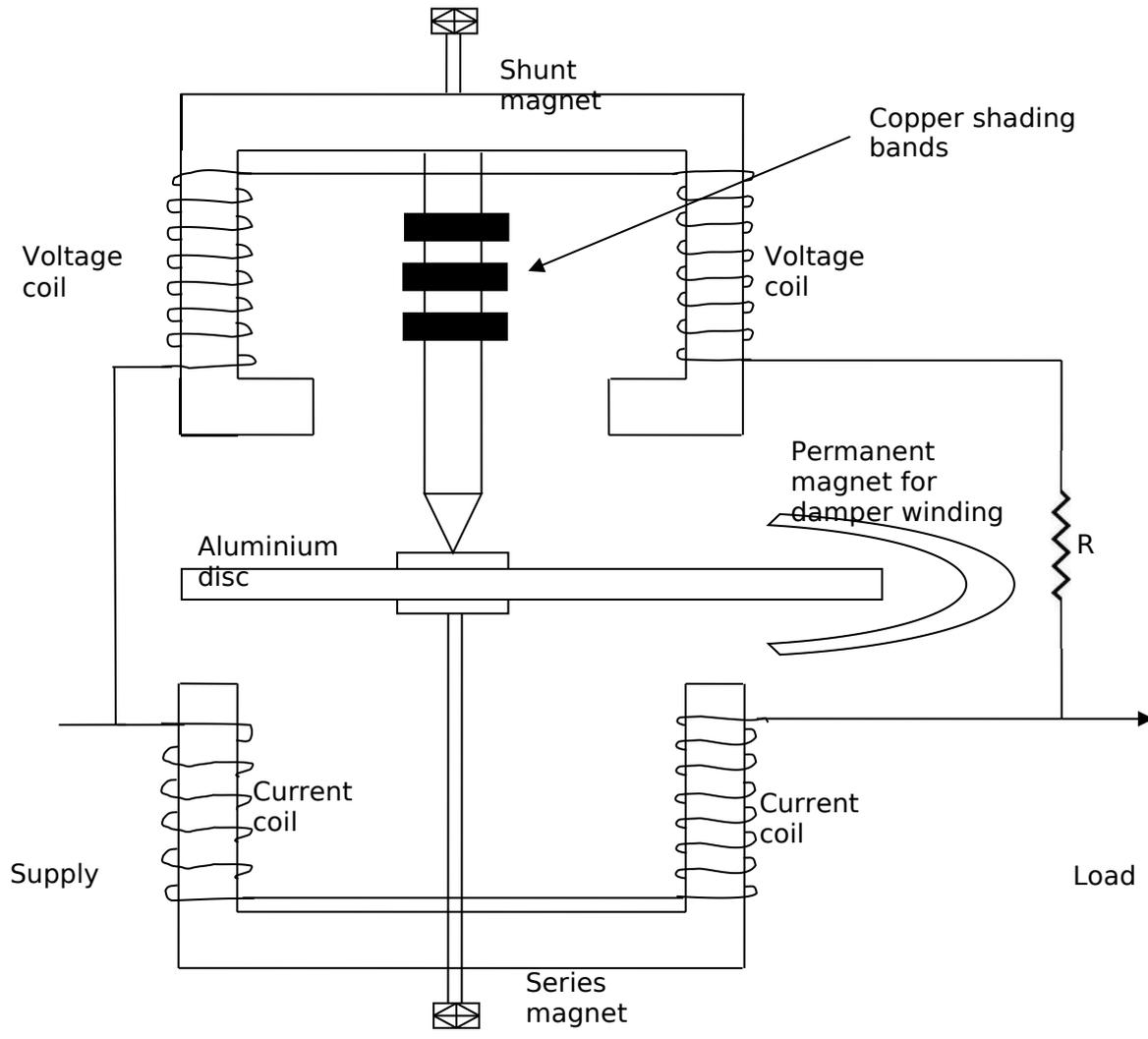


Fig. Induction type wattmeter

Induction type wattmeter has two laminated iron core electromagnets, namely the series magnet and the shunt magnet. The series electromagnet is excited by the load current and the shunt electromagnet is excited by the current proportional to the voltage of the circuit in which power is to be measured.

A aluminium disc is mounted between these two electromagnets in such a way so that it cuts both fluxes produced by these two electromagnets. These fluxes will produce eddy current in the aluminium disc. Due to the interaction between the flux and the eddy current of the disc a deflecting torque will be produced.

The two voltage coils, connected in series are wound on the limbs of the shunt electromagnet in such a way so that both of them send flux through the central limb.

The two current coils wound on the series electromagnet are connected in such a way so that both magnetize the core in the same direction.

In order to make the resultant flux in the shunt magnet lag the applied voltage exactly by 90° , one or more copper rings, called shading bands are provided in the central limb of the shunt magnet. To obtain the correct phase difference between the series and shunt magnetic fluxes, the position of the copper bands are adjusted.

These type of wattmeter's also has spiral springs for controlling torque and a permanent magnet for damping torque. The scale of induction type wattmeter is almost uniform and extends over an angle of about 300° . Also this type of wattmeter can handle current upto 100A.

Operating Principle

The phasor diagram of induction type wattmeter is shown in Fig.

Where,

V is the supply voltage

I is the current through the current coil of the wattmeter.

ϕ_{sh} is the flux of the shunt electromagnet.

ϕ_{se} is the flux of the series electromagnet.

E_{sh} is the voltage induced due to flux ϕ_{sh} .

E_{se} is the voltage induced due to flux ϕ_{se} .

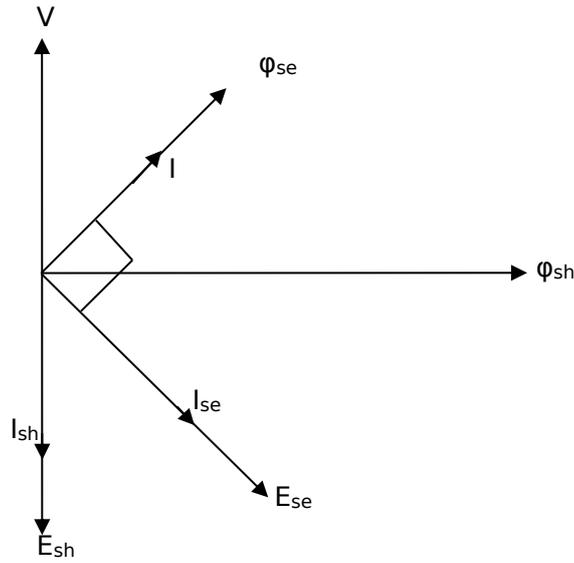


Fig. Phasor diagram of induction type wattmeter

The phase angle between voltage V and ϕ_{sh} is 90° and also the angle between E_{sh} and ϕ_{sh} is 90° . The angle between E_{se} and ϕ_{se} is 90° . If the aluminium disc is assumed to be fully resistive then the currents I_{se} and I_{sh} will be in phase with E_{se} and E_{sh} respectively. To make the phase angle between V and ϕ_{sh} 90° , the pressure coil circuit is made as inductive as possible.

Let,

$$V = V_m \sin \omega t$$

$$I = I_m \sin (\omega t - \theta)$$

Again, $\phi_{se} \propto I$

or $\phi_{se} \propto I_m \sin (\omega t - \theta)$

also $\phi_{sh} \propto - \int V dt$

or $\phi_{sh} \propto - \int V_m \sin \omega t dt$

or $\phi_{sh} \propto - \frac{V_m}{\omega} \cos \omega t$

Again, $e_{sh} \propto \frac{d}{dt} \phi_{sh}$

or $e_{sh} \propto \frac{d}{dt} \left(-\frac{V_m}{\omega} \cos \omega t \right)$

or $e_{sh} \propto V_m \sin \omega t$

Similarly,

$$e_{se} \propto \frac{d}{dt} \phi_{se}$$

or $e_{se} \propto \frac{d}{dt} (I_m \sin (\omega t - \theta))$

or $e_{se} \propto I_m \omega \cos (\omega t - \theta)$

and $i_{se} \propto I_m \omega \cos (\omega t - \theta)$

and $i_{sh} \propto V_m \sin \omega t$

Now deflecting torque (T_D) is,

$$T_D \propto \phi_{se} i_{sh} - \phi_{sh} i_{se}$$

$$T_D \propto (I_m \sin (\omega t - \theta)) \times (V_m \sin \omega t) + \left(\frac{V_m}{\omega} \cos \omega t \right) \times (I_m \omega \cos (\omega t - \theta))$$

$$\propto V_m I_m [\sin (\omega t - \theta) \sin \omega t + \cos \omega t \cos (\omega t - \theta)]$$

$$\propto V_m I_m \cos (\omega t - \theta - \omega t)$$

$$T_D \propto V_m I_m \cos \theta \quad ()$$

From the equation we can say the deflecting torque is proportional to the power in the circuit.

Advantages of Induction Type Wattmeter

1. It has greater working torque and large length of scale
2. It has a uniform scale.

Disadvantages of Induction Type Wattmeter

1. It has less accuracy
2. It has high power consumption

3. It has greater weight of moving part

Comparison between Dynamometer Type Wattmeter and Induction Type Wattmeter

The comparison between dynamometer type wattmeter and induction type wattmeter is tabulated in Table.1.1

Dynamometer type wattmeter	Induction type wattmeter
The current coil is divided into two parts.	Both the current coil and the potential coil is divided into two parts.
Potential coil is the moving part.	Aluminium disc is the moving part.
Can be used for both DC and AC applications.	Can be used in AC applications.
It has non linear scale	It has linear scale
Can be used in circuits with variable frequency	Cannot be used in the circuits with variable frequency.