WATTMETER

Electrodynamometer Wattmeter

- These instruments are similar in design and c o nst r u c t i on to electrodynamometer type ammeters and voltmeters.
- The two coils are connected in different circuits for measurement of power.
- The fixed coils or “field coils” arc connected in series with the load and so carry the current in the circuit.
- The fixed coils, therefore, form the current coil or simply C.C. of the wattmeter.
- The moving coil is connected across the voltage and, therefore, carries a current proportional to the voltage.
- A high non-inductive resistance is connected in series with the moving coil to limit the current to a small value.
- Since the moving coil carries a current proportional to the voltage, it is called the”” pressure coil“” or “voltage coil” or simply called P.C. of the wattmeter.

Construction of Electrodynamometer Wattmeter Fixed Coils

- The fixed coils carry the current of the circuit. They are divided into two halves.
- The reason for using fixed coils as current coils is that they can be made more massive and can be easily constructed to carry considerable current since they present no problem of leading the current in or out.
- The fixed coils are wound with heavy wire. This wire is stranded or laminated especially when carrying heavy currents in order to avoid eddy current losses in conductors. The fixed coils of earlier wattmeter’s were designed to carry a current of 100 A but modem designs usually limit the maximum current ranges of wattmeter’s to about 20 A. For power measurements involving large load currents, it is usually better to use a 5 A wattmeter in conjunction with a current transformer of suitable range.

Fig 2.28 Dynamometer wattmeter

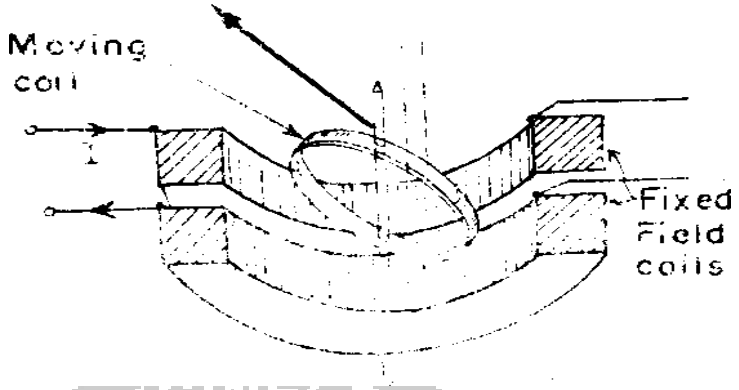


Fig 2.28 Dynamometer wattmeter

Damping:

- Air friction damping is used.
- The moving system carries a light aluminium vane which moves in a sector shaped box.

Electromagnetic or eddy current damping is not used as introduction of a permanent magnet (for damping purposes) will greatly distort the weak operating magnetic field.

Scales and Pointers:

They are equipped with mirror type scales and knife edge pointers to remove reading errors due to parallax.

Theory of Electrodynamometer Watt-meters

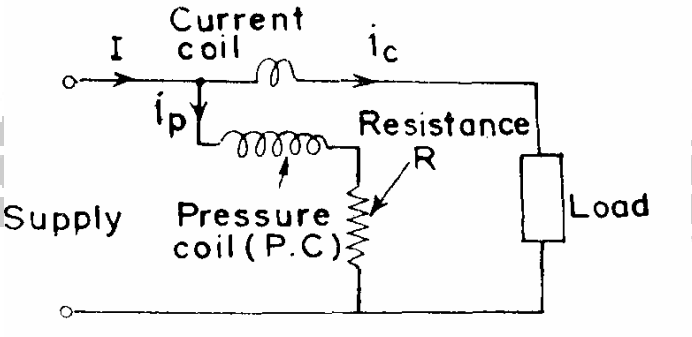


Fig 2.29 circuit of electrodynamometer

It is clear from above that there is a component of power which varies as twice the frequency

of current and voltage (mark the term containing 2Ȧt).

Average deflecting torque

$$T_d = \frac{1}{T}\int_0^T T_i \, d(\omega t) = \frac{1}{T}\int_0^T I_p I [\cos\phi - \cos(2\omega t - \phi)] \frac{dM}{d\theta} \, d(\omega t)$$
$$= I_p I \cos\phi \cdot dM/d\theta$$
$$= (VI/R_p) \cos\phi \cdot dM/d\theta$$

Controlling torque exerted by springs Tc= Kș

Where, K = spring constant; ș= final steady deflection.

Errors in electrodynamometer

i) Errors due to inductance effects

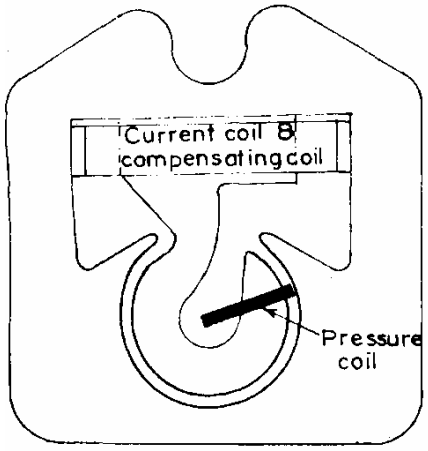
ii) Stray magnetic field errors

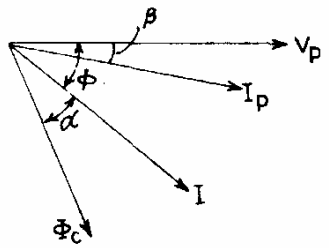
iii) Eddy current errors

iv) Temperature error

Ferro dynamic Wattmeter's

- The operating torque can be considerably increased by using iron cores for the coils Ferro dynamic wattmeter's employ cores of low loss iron so that there is a large increase in the flux density and consequently an increase in operating torque with little loss in accuracy.
- The fixed coil is wound on a laminated core having pole pieces designed to give a uniform radial field throughout the air gap.
- The moving coil is asymmetrically pivoted and is placed over a hook shaped pole piece.
- This type of construction permits the use of a long scale up to about 270° and gives a deflecting torque which is almost proportional to the average power.
- With this construction there is a tendency on the part of the pressure coil to creep (move further on the hook) when only the pressure coil is energized.
- This is due to the fact that a coil tries to take up a position where it links with maximum flux. The creep causes errors and a compensating coil is put to compensate for this voltage creep.





- The use of ferromagnetic core makes it possible to employ a robust construction for the moving element.
- Also the Instrument is less sensitive to external magnetic fields. On the other hand, this construction introduces non-linearity of magnetization curve and introduction of large eddy current & hysteresis losses in the core.

Three Phase Wattmeter's

- A dynamometer type three-phase wattmeter consists of two separate wattmeter movements mounted together in one case with the two moving coils mounted on the same spindle.
- The arrangement is shown in Fig.
- There are two current coils and two pressure coils.
- A current coil together with its pressure coil is known as an element.
- Therefore, a three phase wattmeter has two elements. The connections of two elements of a 3 phase wattmeter are the same as that for two wattmeter method using two single phase wattmeter.
- The torque on each element is proportional to the power being measured by it. The total torque deflecting the moving system is the sum of the deflecting torque of the two elements. Hence the total deflecting torque on the moving system is proportional to the total Power. In order that a 3 phase wattmeter read correctly, there should not be any mutual interference between the two elements.

- A laminated iron shield may be placed between the two elements to eliminate the mutual effects.