Extension of range of PMMC instrument

Case-I: Shunt

A low shunt resistance connected in parallel with the ammeter to extent the range of current. Largecurrent can be measured using low current rated ammeter by using a shunt

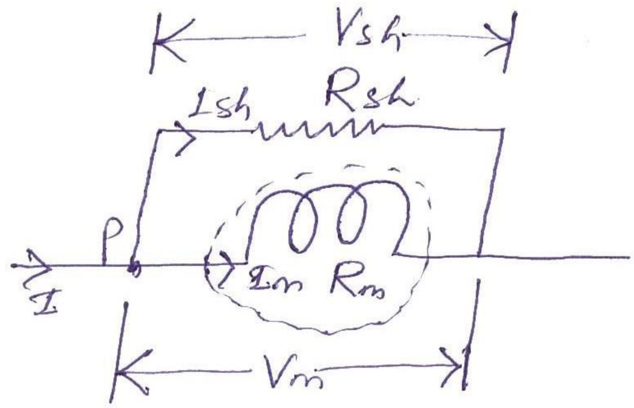
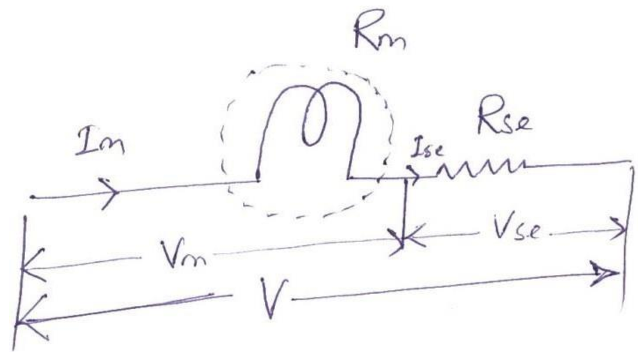


Fig. 2.8 Extension of range of PMMC instrument - Shunt

Shunt resistance is made of manganic. This has least thermoelectric emf. The change is resistance, due to change in temperature is negligible.

Case (II): Multiplier

A large resistance is connected in series with voltmeter is called multiplier (Fig. 2.9). A large voltage can be measured using a voltmeter of small rating with a multiplier.



Moving Iron (MI) instruments

One of the most accurate instrument used for both AC and DC measurement is moving iron instrument. There are two types of moving iron instrument.

- Attraction type
- Repulsion type

Attraction type M.I. instrument

Construction: The moving iron fixed to the spindle is kept near the hollow fixed coil (Fig. 2.10). The pointer and balance weight are attached to the spindle, which is supported with jeweled bearing. Here air friction damping is used.

Principle of operation

The current to be measured is passed through the fixed coil. As the current is flow through the fixed coil, a magnetic field is produced. By magnetic induction the moving iron gets magnetized. The north pole of moving coil is attracted by the south pole of fixed coil. Thus the deflecting force is produced due to force of attraction. Since the moving iron is attached with the spindle, the spindle rotates and the pointer moves over the calibrated scale. But the force of attraction depends on the current flowing through the coil.

Torque developed by M.I

Let „θ“ be the deflection corresponding to a current of „i‟ amp

Let the current increases by di, the corresponding deflection is „$\theta + d\theta$“

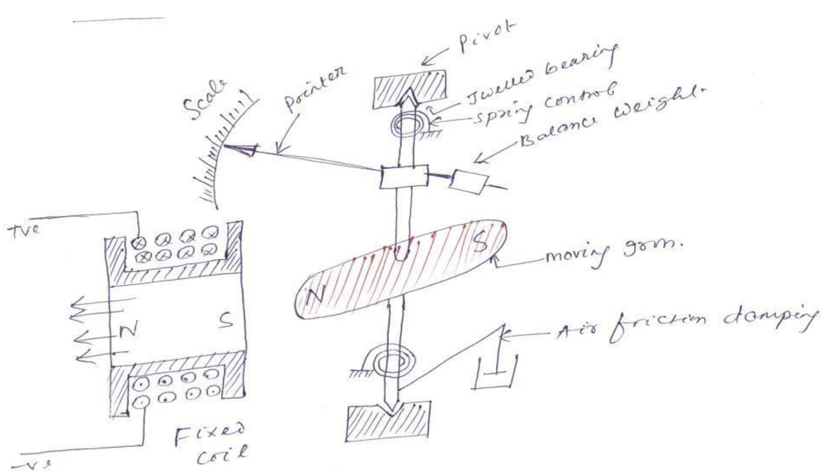


Fig. 2.10 2.8Moving Iron (MI) instruments- Attraction type

There is change in inductance since the position of moving iron change w.r.t the fixed electromagnets.

Let the new inductance value be „L+dL‟. The current change by „di‟ is dt seconds.Let the emf induced in the coil be „e‟ volt.

$$e = \frac{d}{dt}(Li) = L\frac{di}{dt} + i\frac{dL}{dt} \qquad (2.22)$$

Multiplying by „idt‟ in equation (2.22)

$$e \times idt = L\frac{di}{dt} \times idt + i\frac{dL}{dt} \times idt \qquad (2.23)$$

$$e \times idt = Lidi + i^2 dL \qquad (2.24)$$

Eq^n (2.24) gives the energy is used in to two forms. Part of energy is stored in the inductance. Remaining energy is converted in to mechanical energy which produces deflection.

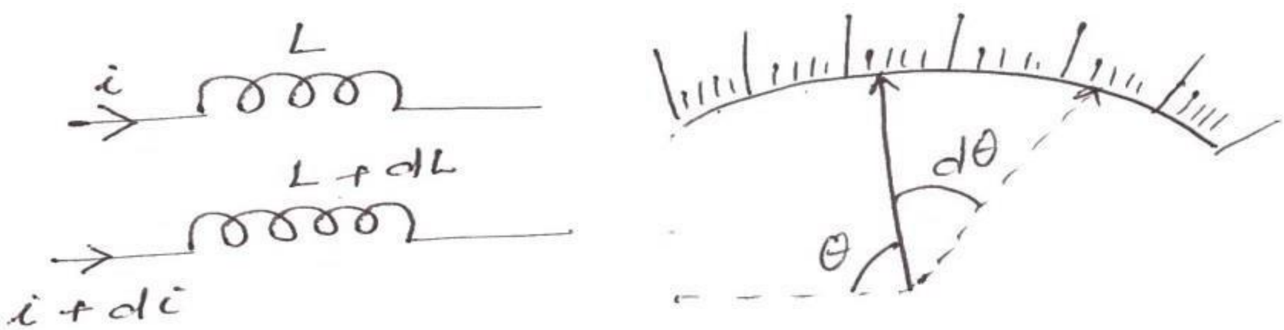


Fig. 2.11Energyused

Change in energy stored=Final energy-initial energy stored

$$= \frac{1}{2}(L + dL)(i + di)^2 - \frac{1}{2}Li^2$$

$$= \frac{1}{2}\{(L + dL)(i^2 + di^2 + 2idi) - Li^2\}$$

$$= \frac{1}{2}\{(L + dL)(i^2 + 2idi) - Li^2\}$$

$$= \frac{1}{2}\{Li^2 + 2Lidi + i^2dL + 2ididL - Li^2\}$$

$$= \frac{1}{2}\{2Lidi + i^2dL\}$$

$$= Lidi + \frac{1}{2}i^2dL \quad (2.25)$$

Mechanical work to move the pointer by $d\theta$

$$= T_d d\theta \quad (2.26)$$

By law of conservation of energy,
Electrical energy supplied=Increase in stored energy+ mechanical work done.

Input energy= Energy stored + Mechanical energy (2.27)

$$Lidi + i^2dL = Lidi + \frac{1}{2}i^2dL + T_d d\theta \quad (2.28)$$

$$\frac{1}{2}i^2dL = T_d d\theta$$

$$T_d = \frac{1}{2}i^2\frac{dL}{d\theta} \quad (2.29)$$

At steady state condition $T_d = T_C$

$$\frac{1}{2}i^2\frac{dL}{d\theta} = K\theta \quad (2.30)$$

$$\theta = \frac{1}{2K}i^2\frac{dL}{d\theta} \quad (2.31)$$

$\theta \propto i^2$

(2.32)

When the instruments measure AC, $\theta \propto i^2_{rms}$

Scale of the instrument is non uniform.

Advantages

- MI can be used in AC and DC
- It is cheap
- Supplyis given to a fixed coil, not in moving coil.
- Simple construction
- Lessfrictionerror.

Disadvantages

- It suffers from eddycurrent and hysteresis error
- Scale is not uniform
- It consumed more power
- Calibration is different for AC and DC operation

Repulsion type moving iron instrument

Construction: The repulsion type instrument has a hollow fixed iron attached to it (Fig. 2.12). The moving iron is connected to the spindle. The pointer is also attached to the spindle in supported with jeweled bearing.

Principle of operation: When the current flows through the coil, a magnetic field is produced by it. So both fixed iron and moving iron are magnetized with the same polarity, since they are kept in the same magnetic field. Similar poles of fixed and moving iron get repelled. Thus the deflecting torque is produced due to magnetic repulsion. Since moving iron is attached to spindle, the spindle will move. So that pointer moves over the calibrated scale.

Damping: Air friction damping is used to reduce the oscillation.

Control: Spring control is used.

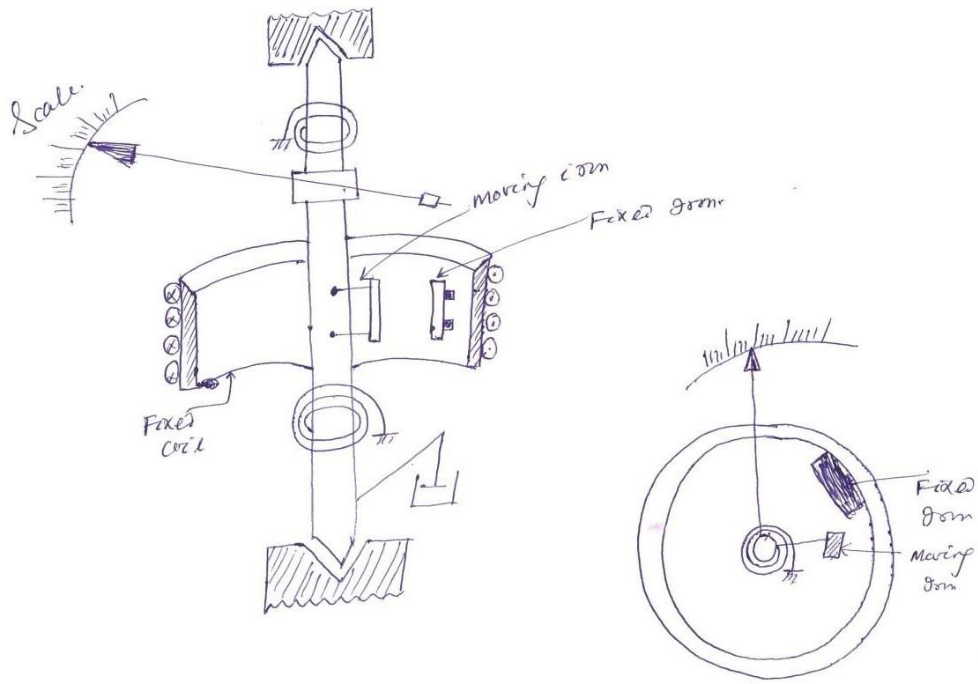


Fig. 2.12 Moving Iron (MI) instruments- Repulsion type

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