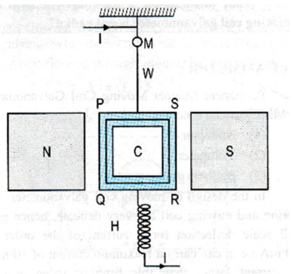
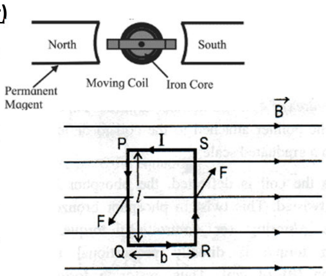
MEEC PART 3

MCG(Moving Coil Galvanometer)





It consists of a coil of many turns mounted (suspension or pivoted) in such a way that it can rotate freely about a fixed axis, in a radial uniform field created by concave poles. Central soft iron core makes field strong and radial. The coil rotates due to a torque acting on it when the current flows through it.

There is no force acting on PS and QR, because they are parallel to $\vec{B}$

Moment of a couple or torque = Magnitude of one force x perpendicular dist between the forces

τ = (nBil)(b) = BinA , where A = l x b

The above torque deflects the coil, hence is called deflecting torque

Since the magnetic field is radial, the deflecting torque in all positions of the coil is the same and is equal to BinA. Thus, the deflecting torque is proportional to the number of turns, magnetic induction of the magnetic field, current flowing in the coil and area of the coil.

As the coil is deflected, the phosphor bronze spring gets twisted creating a restoring torque which is directly proportional to the deflection θ.

$\tau_c \alpha \theta$, $\tau_c = c\theta$, where c= twist constant or restoring torque per unit twist

For equilibrium, $\tau_d = \tau_c$ i.e. BinA = cθ

$i = \theta\left(\frac{c}{nAB}\right)$. Hence, i = Kθ i α θ

Thus current flowing through MCG is directly proportional to the angle of deflection of the coil.

Advantages: not affected by strong magnetic field, High torque/weight ratio, Very accurate and reliable, Uniform scale

Disadvantage: Change in temperature affects restoring torque, Restoring torque cannot be easily changed, Possible damage to the phosphor bronze suspension due to usage stress, Cannot be used for a.c. measurement

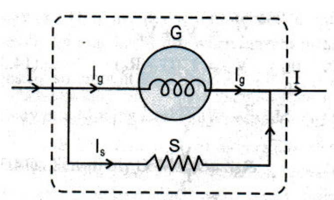
AMMETER

A Permanent Magnet Moving Coil (PMMC) galvanometer cannot directly be used as an Ammeter due to the following:

>>Its Resistance is not small enough

>>Its current range for full scale deflection is small

Thus, we shunt the galvanometer (using a low value resistance in parallel) and the new device is calibrated to read the current directly.



Shunting allows most current to pass through the shunt and a very negligible current pass through the galvanometer. Shunt is made up of manganin, since it has a very negligible temperature coefficient of resistance.

Ideal ammeter should have ZERO resistance. Practical Ammeter have finite low resistance.

I is the maximum current to be measured and Ig is the current flowing through the galvanometer for full scale deflection. 'Is' is the shunt current

Is = I – Ig

G: Galvanometer resistance

S: Shunt resistance.

Voltage across G = Voltage across S

Ig G = Is . S

Thus, Ig G = (I – Ig)S Thus, $S = \left(\frac{Ig}{I-Ig}\right) G$

This is the resistance we need to connect in parallel to convert the galvanometer into an Ammeter capable of measuring current upto I.

Functions of Shunt resistor (S):

- Reduces the effective resistance of the galvanometer
- Increases the range of the instrument
- Provides an alternative path for the current to pass thus protecting the galvanometer

NOTE: If I = n.Ig , then $S = \frac{G}{n-1}$

VOLTMETER

A Permanent Magnet Moving Coil (PMMC) cannot directly be used as an Voltmeter due to the following:

>>Its Resistance is not high hence connecting it across high potential will cause high currents, thus burning the coil of the MCG.

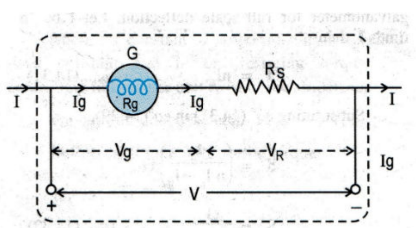
>>Its voltage range for full scale deflection is small

A PMMC instrument in series with high resistance can be used as voltmeter.

Here too, manganin (alloy of copper, manganese and nickel) is used since it has a negligible temperature coefficient of resistance.

Voltmeter is always connected in parallel across the device whose potential difference is to be measured.

Ideal voltmeter has infinite resistance, hence when attached to the device is parallel will not affect the current flowing in that device.



Let, Ig= Current in galvanometer for full scale deflection

G: Galvanometer Resistance Rs: High value series resistance

V: Potential Difference to be measured.

$V = Vg + V_R = Ig.G + Ig.Rs = Ig(G+Rs)$

Functions of high series resistor (Rs):

- Increases the effective resistance of the galvanometer
- Increases the range of the instrument
- Protecting the galvanometer from damage due to large current

AMMETER	VOLTMETER
1. It measures current.	1. It measures potential difference
2. It is connected in series.	2. It is connected in parallel.
3. It is an MCG with low resistance. (Ideally zero)	3. It is an MCG with high resistance. (Ideally infinite)
4. Smaller the shunt, greater will be the current measured.	4. Larger its resistance, greater will be the potential difference measured.
5. Resistance of ammeter is $R_A = \frac{S \cdot G}{S+G} = \frac{G}{n}$	5. Resistance of voltmeter is $R_V = G + X = G \cdot n_V$