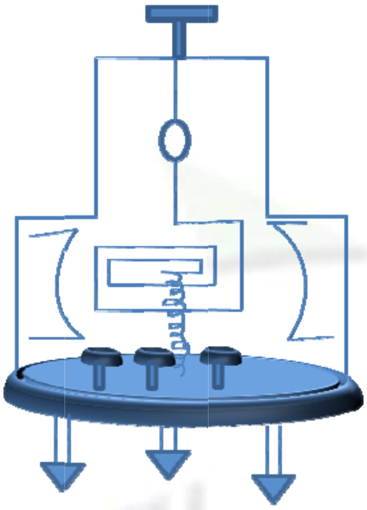
Moving coil Galvanometer:

Principle :(Based on the principle of the force of interaction between the current carrying conductor and a magnetic field) A coil is suspended in a magnetic field. The current to be measured is passed through the coil. The current through the coil produces a magnetic field which interacts with the given magnetic field in which the coil is suspended. Due to the interaction the coil gets deflected and measuring the angle of rotation current can be calculated.



A circular or rectangular coil of about 10 to 15 turns of a fine insulated copper or aluminium wire is suspended from a torsion head T, by means of quartz fibre in between the concave pole pieces of a strong magnet. The lower end of the coil is attached to a light springs which brings the coil back to its original position when the current is stopped. The suspension wire and the spring are connected with two terminal screws at the base which acts as the leads of current. The whole thing is enclosed in a metal box provided with glass face and is supported on leveling screws. The angle of rotation of the coil is measured by lamp & scale arrangement, reflection takes place from the tiny mirror M attached with the suspension wire.

Theory : Given n = the number of turns in the coil

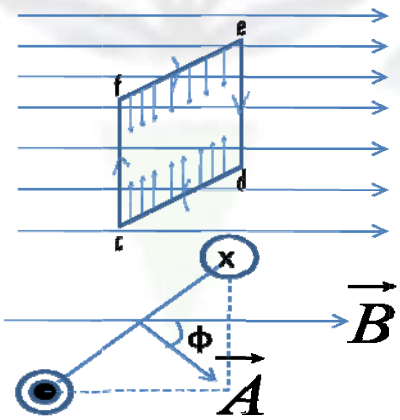
l & b = the length of each vertical & horizontal side of the coil respectively (assuming) the coil to be rectangular

i = the current flowing through the coil.

B = the induction vector of the magnetic field in which the coil is suspended.

We know that the force experienced by the current carrying conductor placed in a magnetic field is

$\vec{F} = i\left(\vec{l} \times \vec{B}\right) \rightarrow (1)$



Force on each wire 'de' and 'fc'

$\left|\vec{F}\right| = ibB\sin(90-\phi) = ibB\sin\phi$

where ϕ = angle between the normal to the plane of the coil and the direction of the magnetic field.

The direction of the force on the wires 'de' & 'fc' are in the plane of the coil along the downward and upward direction respectively and hence cancel out.

The force on the two vertical wires 'cd' and 'ef' by using equation (1) are found to have magnitude

$F = ilB\sin 90^0 = ilb$

Applying the right hand curl rule for vector product the directions of the force are as shown in the figure. These two forces being equal in magnitude, opposite in direction parallel and non co-planer constitute a couple.

Moment of the couple $\Gamma = ilB \times OC$

$\Gamma = ilBb\sin\phi = i(lb)B\sin\phi = iAB\sin\phi$

Since there are n turns in the coil the total torque experienced by the current carrying coil in the magnetic field

$\Gamma = niAB\sin\phi$

Due to this torque the coil rotates a restoring couple due to the torsion rigidity sets in and when the restoring couple equals to the deflecting couple the coil comes to equilibrium

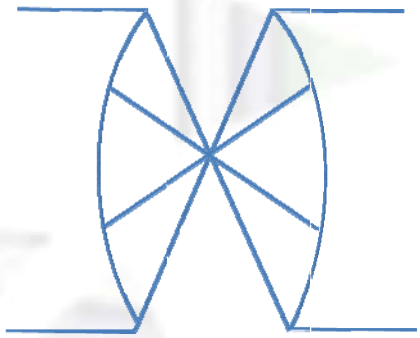
Let c = torsional couple per unit twist of the suspension wire

θ = the angle through which the coil rotate in the position of equilibrium

Restoring couple $= c\theta \rightarrow (1)$

From equation (2) and (3): $nAiB\sin\phi = c\theta$

$i = \frac{c}{nAB}\frac{\theta}{\sin\phi} \rightarrow (4)$



By using concave pole pieces the magnetic field is made radial so that for any position of coil ϕ is always 90^0,

$\sin\phi = \sin 90^0 = 1$

$\therefore i = \frac{c}{nAB}\theta \rightarrow (5)$

Since c, n, A & B are all constant

$i \propto \theta$