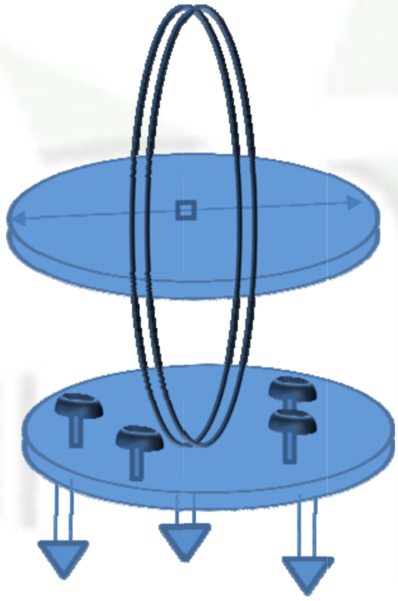
Moving Magnet Galvanometer (Pivoted Type)

Tangent galvanometer:

Principle: Based on the principle of tangents law in magnetism we need two uniform magnetic fields at right angle to each other in which a magnetic needle is kept free to rotate. One of the two fields is earth's horizontal component of magnetic field along N-S direction and the other magnetic field along E-W direction is produced by passing the current to be measured through a circular coil. A compass box is kept at the centre of the coil. From the deflection of the needle the current can be calculated.



A compass box mounted on the spindle is kept exactly at the centre of the circular coil kept with its plane vertical. A non conducting circular coils having different no of turns 50,100,200 & 500 all kept mounted from one another. One end of all the coils are connected to a common terminal C at the base while the other end of all are connected to four separate terminals. The vertical frame carrying the coils can be rotated about a vertical axis passing through the centre. The instrument is supported on levelling screws.

Theory: Since the direction of the magnetic field due to the current through the coil should be along E-W and magnetic field due to the circular coil carrying current is along its axis hence the plane of the coil should be placed along N-S direction.

Let n = no. of turns in the coil
A = the area of the plane of the coil
a = the mean radius of the circular coil
i = current flowing through the coil
B_H = the horizontal component along earths magnetic field
θ = the deflection of the compass needle
By applying tangent law :
$F = B_H \tan\theta \rightarrow (1)$

The magnetic field at the centre due to the circular coil carrying current is

$$F = \frac{\mu_0}{2}\frac{ni}{a} \rightarrow (2)$$

From equation (1) and equation (2)

$$\frac{\mu_0}{2}\frac{ni}{a} = B_H \tan\theta$$

$$i = \frac{2B_H a}{\mu_0 n}\tan\theta$$

Putting $K = \frac{\mu_0 n}{2aB_H}$

$$i = K \tan\theta \rightarrow (3)$$

Thus by measuring the angle of deflection of the compass needle the current flowing through the coil can be calculated.

Sensitivity : $i = K\tan\theta \rightarrow (4)$

The proportional error is defined as $\frac{di}{i}$

Differentiating equation (4) we get

$$di = K\sec^2\theta d\theta \rightarrow (5)$$

$$\therefore \frac{di}{i} = \frac{K\sec^2\theta d\theta}{K\tan\theta}$$

$$\frac{di}{i} = \frac{d\theta}{\cos^2\theta \times \frac{\sin\theta}{\cos\theta}}$$

$$\frac{di}{i} = \frac{2d\theta}{2\sin\theta\cos\theta}$$

$$\frac{di}{i} = \frac{2d\theta}{\sin 2\theta}$$

Thus we see that the proportional error is minimum when $\sin 2\theta$ is maximum

i.e. $\sin 2\theta = 1 = \sin\frac{\pi}{2}$

$$2\theta = \frac{\pi}{2}$$

$$\theta = \frac{\pi}{4}$$

Thus the reading of a tangent galvanometer is most accurate when the reading is 45^0