Moving Coil Galvanometer

It is an instrument used for the detection and measurement of current. Its action is based on the torque acting on a current carrying coil placed in a magnetic field.

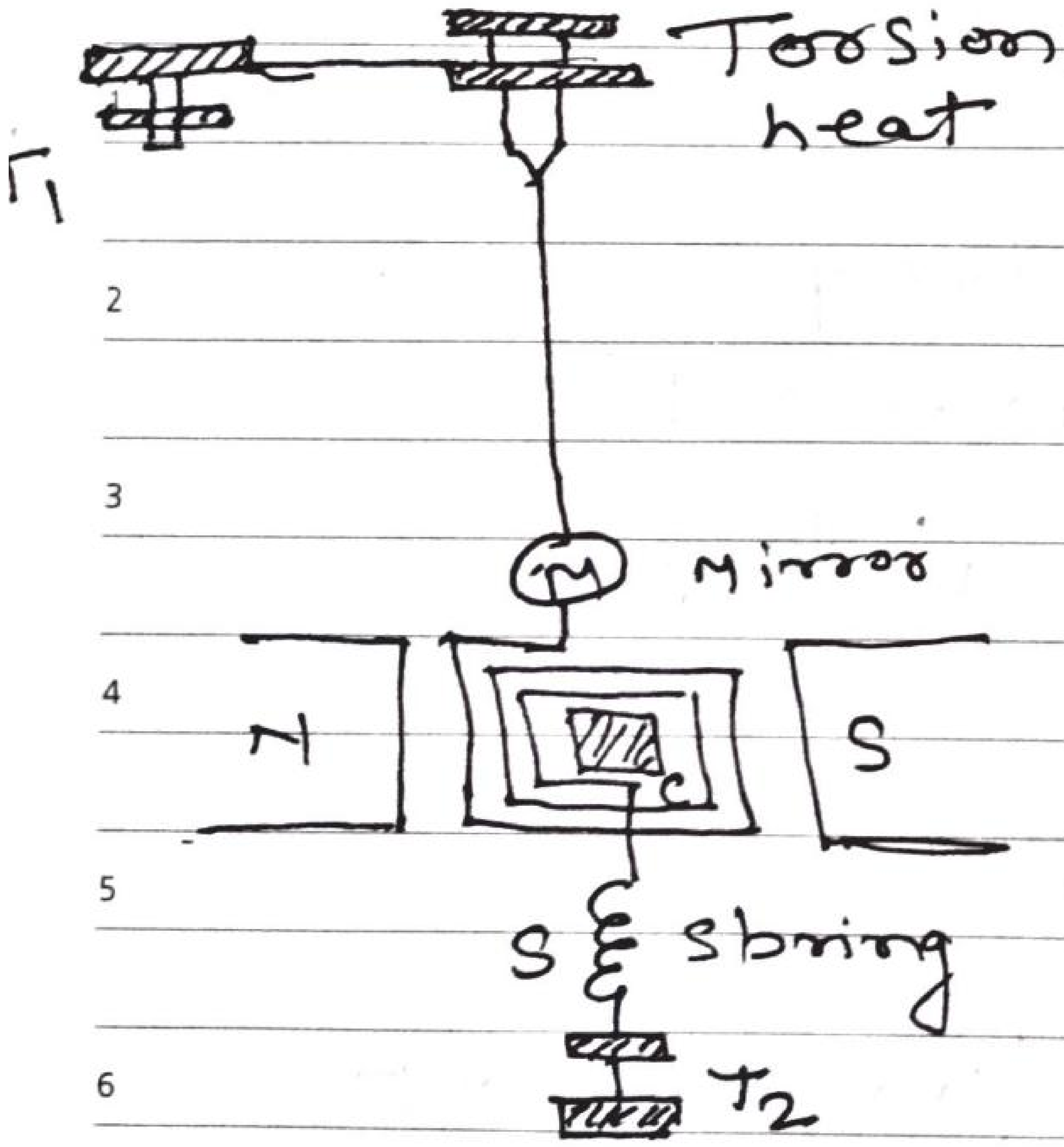


fig M Galvanometer

Construction → It consists of a rectangular coil made by a large number of turns of insulated copper wire wound on a rectangular frame. The coil is suspended between the cylindrical pole pieces of a permanent horse-shoe magnet NS by means of a thin phosphor-bronze strip. The upper end of which is attached to a torsion head and lower end is loosely wound spring of very fine phosphor-bronze wire. A soft iron cylindical core C is placed symmetrically within the coil without touching it, It ~~constro~~ ~~concentrat~~ contentrate the line of force and thus makes the magnetic field between the pole-pieces strong. A small mirror is attached to the power portion of the suspension strip. The whole arrangement is enclosed in a magnetic case with a glass window on the front side and levelling screw at the base.

The current to be measured enters at one terminal T_1 and passes through the suspension, coil and spring and finally leaves at the second terminal T_2.

Theory →

when a current is passed through the coil, it experiences a magnetic torque due to the magnetic field

$$\tau = NIBA \sin\theta$$

where

B = The magnetic field induction due to the permanent magnet

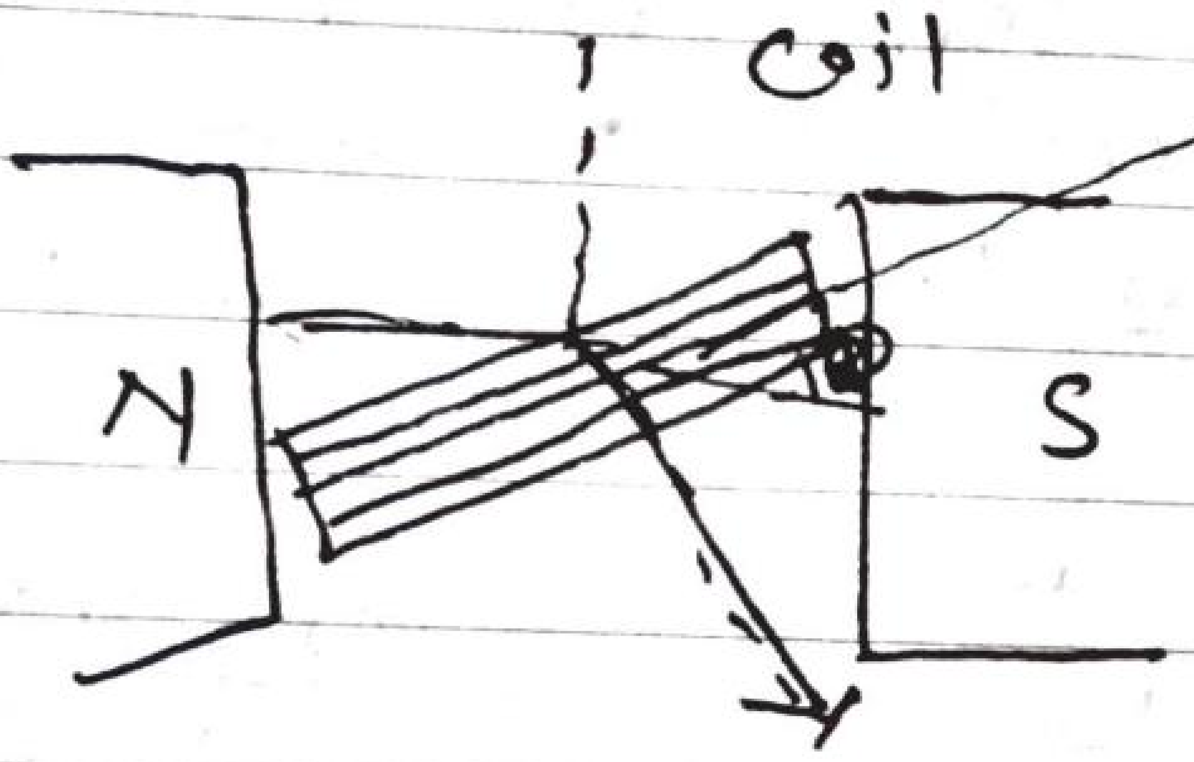
A = Area of the Coil

N = The number of turns
I = coil carrying a current
θ = The angle which the normal to the plane of the coil makes with the direction of $\vec{B}$

The cylindrical poles of the magnet produces a radial field. If $\theta = 90^\circ$

The torque acting on the coil is

$$\tau = NIBA \sin 90^\circ = NIBA$$



Due to action of this torque the coil is set in rotation about the axis of suspension producing into play in the opposite direction which increases with the increase in the angle of twist and eventually when this torque equals the magnetic torque the coil comes to rest.

If C is the torsion torque per unit twist, then torsional torque for twist θ = $C\theta$

In the equilibrium position

$$NIAB = C\theta$$

$$I = \frac{C}{nAB}\theta = K\theta$$

$$K = \frac{C}{nAB}$$ (Current reduction factor)

when the coil rotates through θ, the reflected ray rotates through 2θ so

$\tan 2\theta = d/2D$. If θ small

where $2\theta = d/2D$

d = deflection of the spot of light on the scale

D = The distance of the scale from the mirror

$$\boxed{I = K\, d/2D}$$

Current sensitivity → These galvanometers are extremely sensitive because the reduction factor K of such ~~galvano~~ galvanometers is extremely small. The current sensitivity defined as the current required to produce a displacement of 1 mm of a scale 1 m away from the mirror. This is also called the "figure of merit" of the galvanometer.

sensitivity is inversely proportional to the reduction factor K

$$K = \frac{C}{nAB}$$

(ii) sensitivity is proportional to the number of turns, area of cross section and intensity of the magnetic field.

(iii) sensitivity is inversely proportional to torsional torque per unit twist called 'torsional rigidity' of the wire.

Advantages → (1) They are extremely sensitive.

(2) The moving-coil galvanometer may be placed in any position and not be set in the magnetic meridian.

(3) The galvanometer coil is placed in a strong magnetic field, so that it is not affected by earth's field or any other external magnetic field. Hence it can be graduated permanently.

(4) The deflection of the coil is proportional to the current. Hence divided scale can be used to measure current.

(5) when the coil is deflected, eddy currents are set up in the metallic frame on which the coil is wound. The direction of currents in such

as to oppose the motion of the coil so that the coil of the galvanometer quickly comes to rest after deflection. The galvanometer under these conditions is called " dead beat". It can be made 'ballic' by winding the coil on a non-metallic frame.

Disadvantages → (1) They are not portable.

(2) They are not suitable for measuring strong currents.

(3) These instruments are so bulky and its suspension wire is so delicate that they cannot be carried from table to table at ease. They are kept in fixed positions on wall brackets in physical laboratories.