Electrical Measurement and Measuring Instruments(EMMI) EE13102

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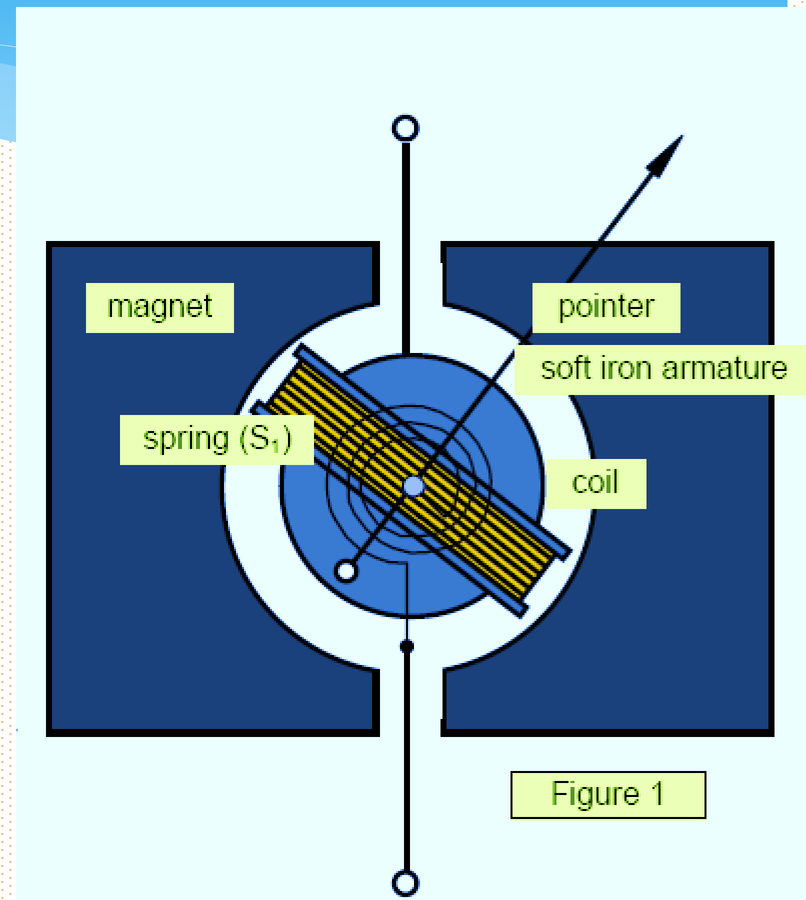
Permanent Magnet Moving Coil (PMMC) Instruments

- To measure DC current or DC voltage

- Can be used for measuring AC currents and voltages by introducing additional circuit and proper calibration

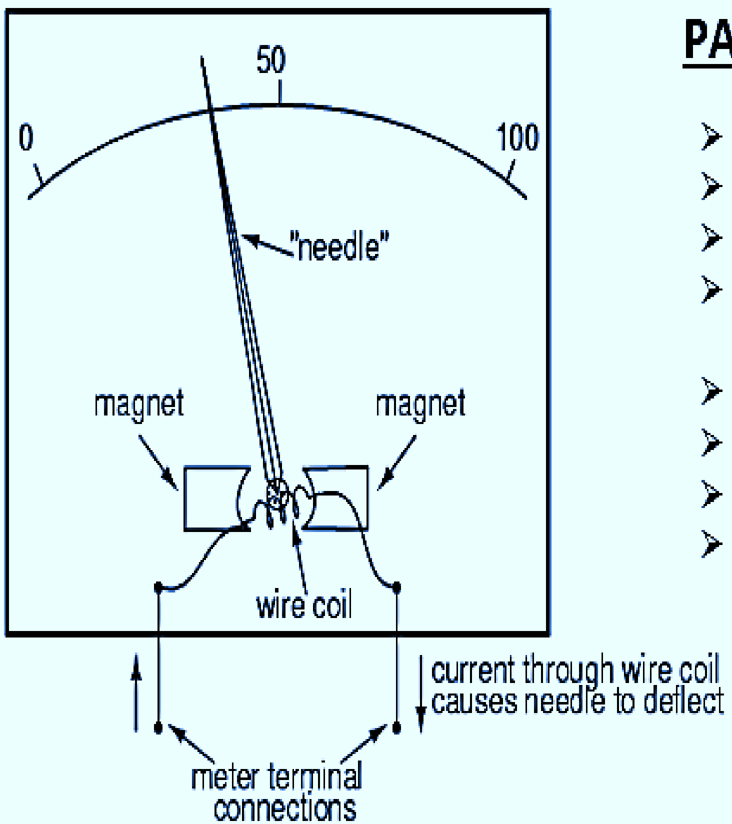
Constructional Features of PMMC



Enameled or silk covered copper wire is used for coil

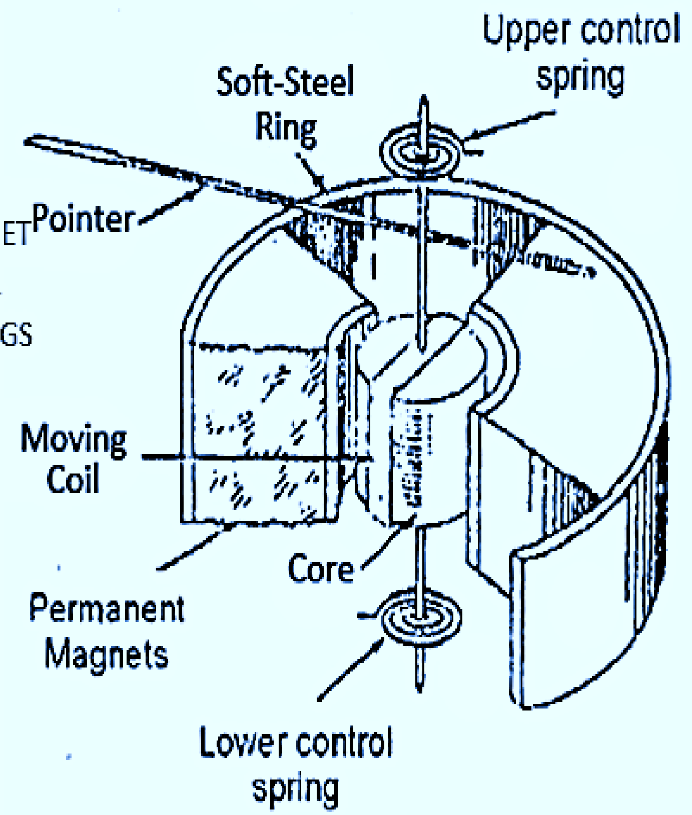
Constructional Features of PMMC

Permanent magnet, moving coil (PMMC) meter movement

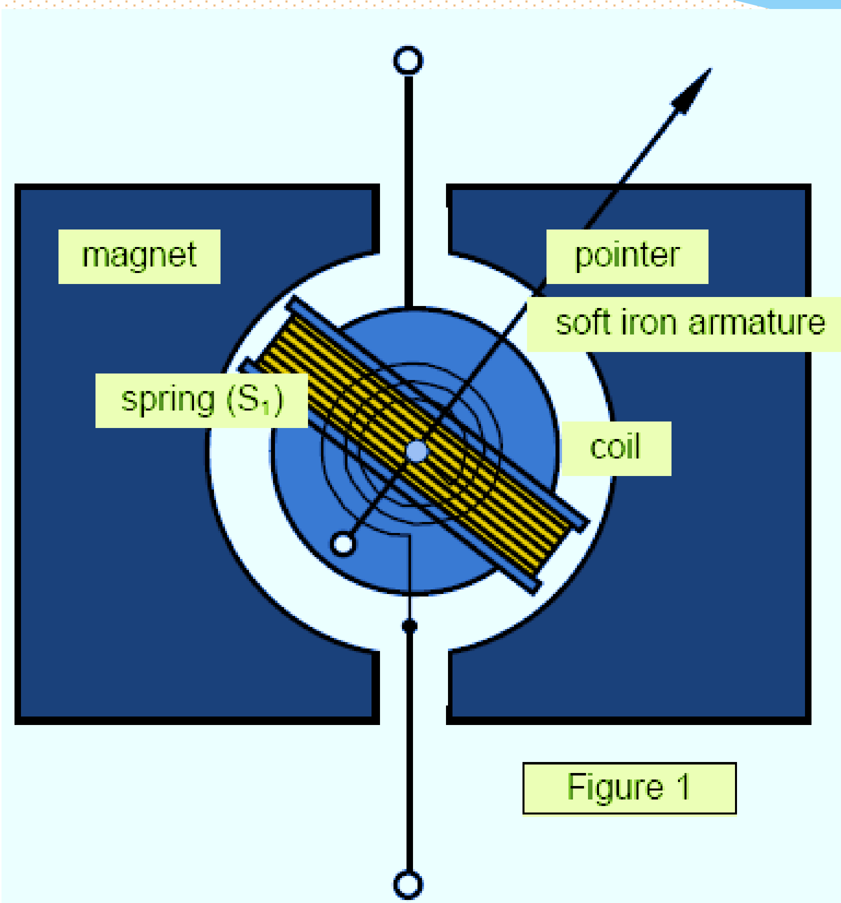


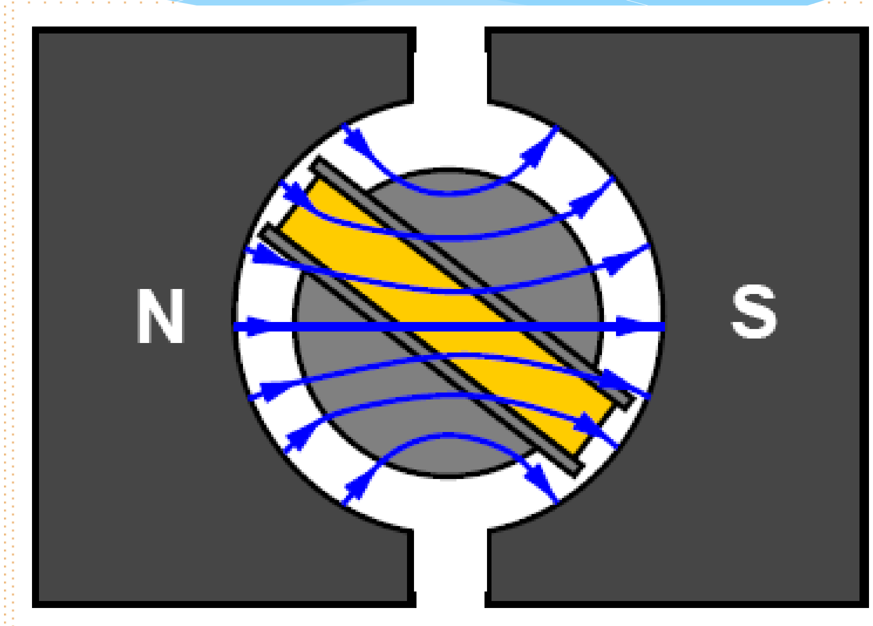
PARTS:

- PERMANENT MAGNET
- RECTANGULAR COIL
- CONTROLLED SPRINGS
- ALLUMINIUM
  CYLINDRICAL CORE
- POINTER
- PIVOTS
- SCALE
- DUST PROOF CASE



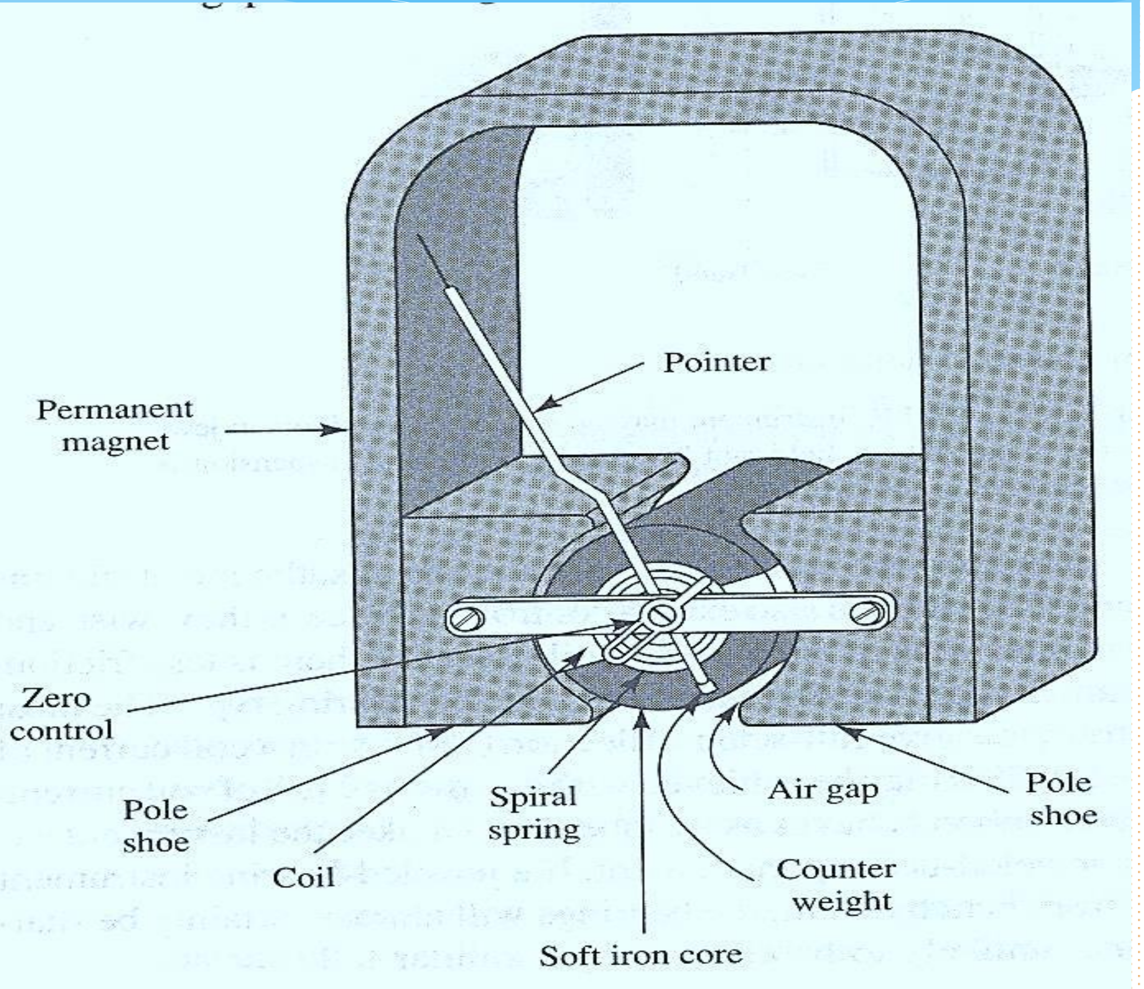
Construction: TOP View





Constructional Features of PMMC

* Magnetic system:
  Permanent magnet
  U Shaped Magnet
  Alnico
* Moving System
* Control System
* Damping system



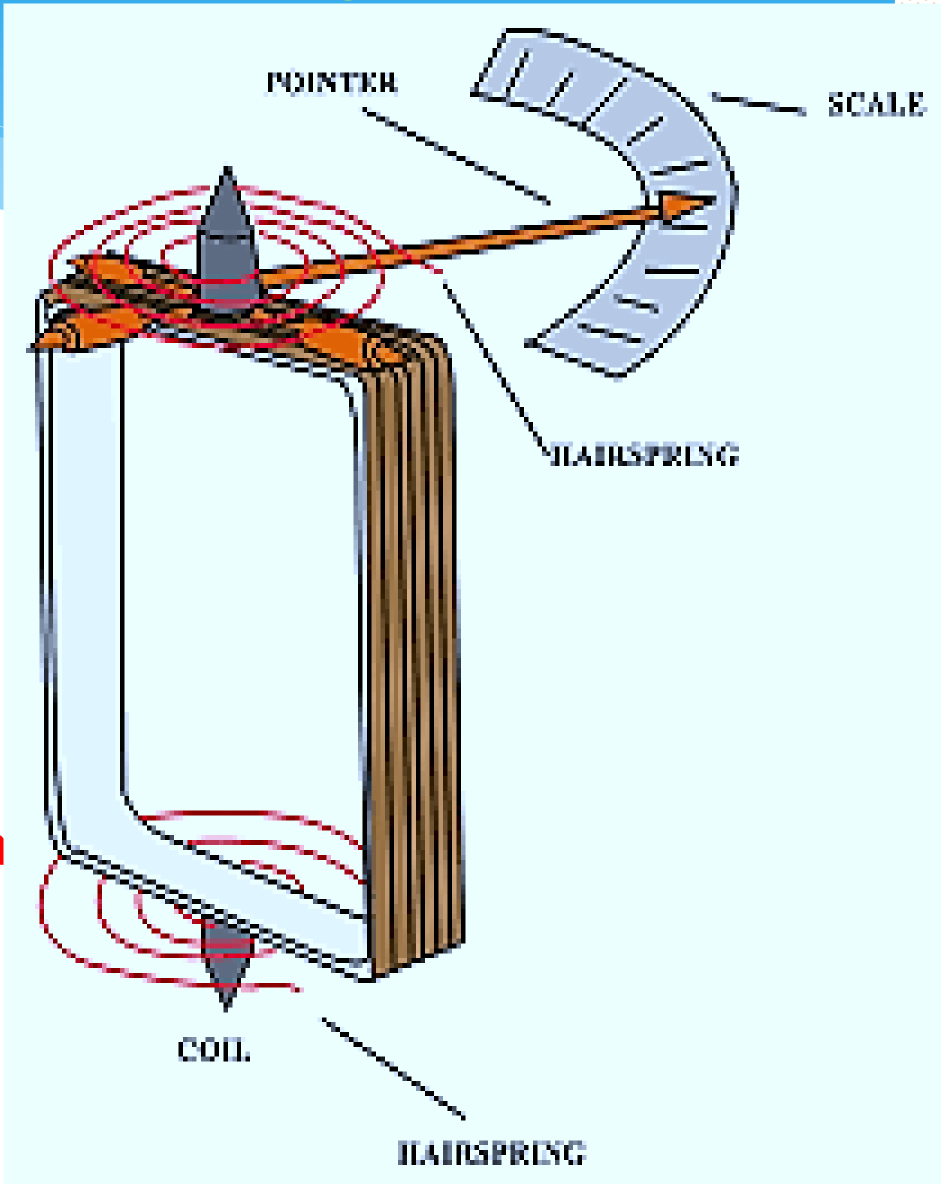
Constructional Features of PMMC

Moving System

- Rectangular coil
- Ratio L/b= 1.3 to 1.5 to have high Torque efficiency
- Aluminium is Preferred to reduce weight

Ampere turns : 0.4 to 0.7

Radius of jewel: 0.01 mm to 0.02 mm

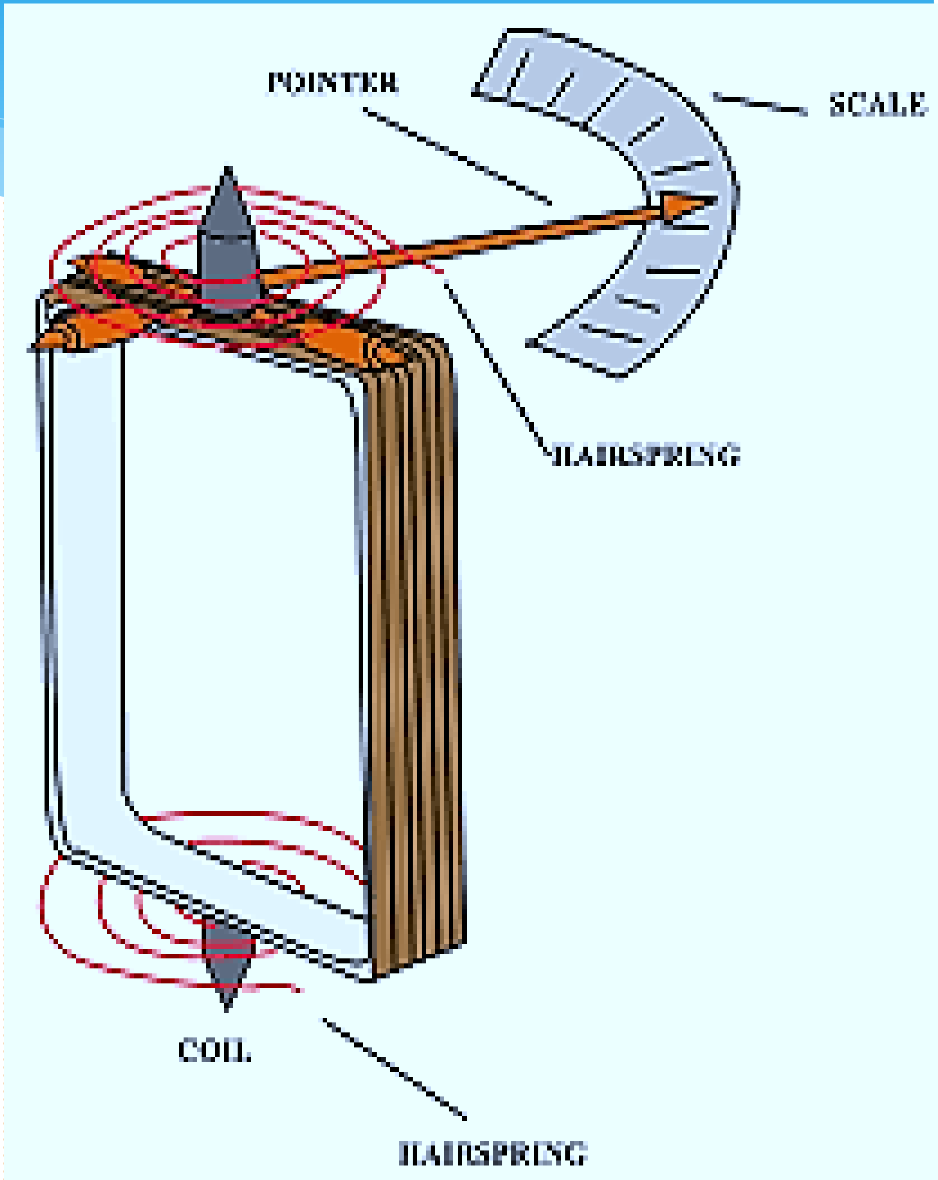


Constructional Features of PMMC

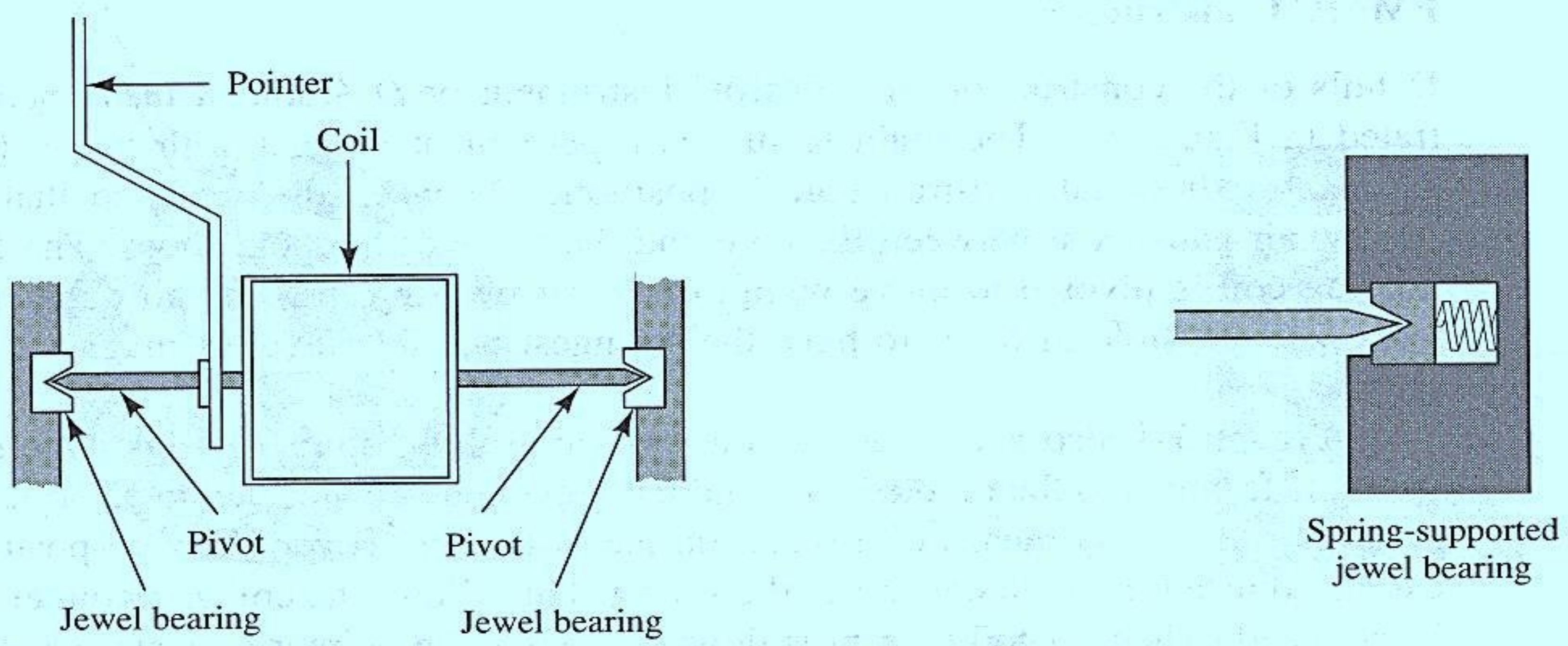
Controlling System

- Hair springs are used
- Made up of Phosphorous , bronze
- Helical or spiral
- Coiled in opposite directions
- Current flows through the spirng,

Designed to carry less current



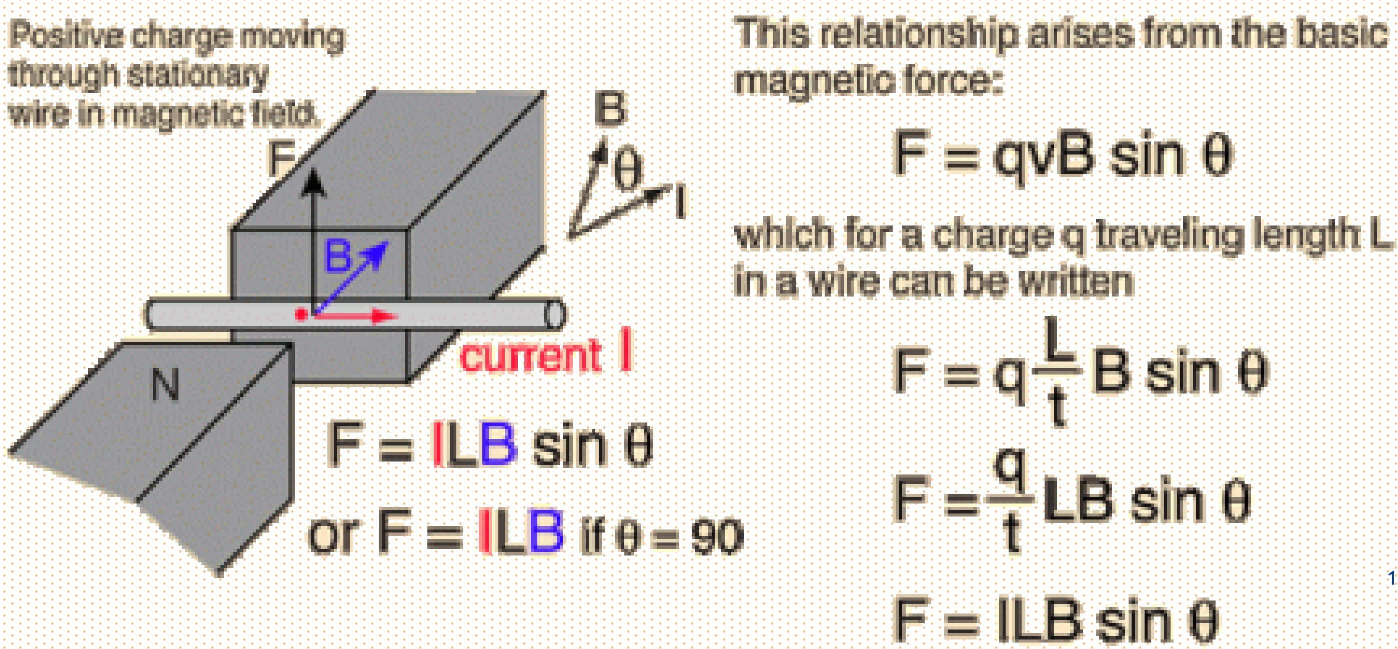
Two methods of supporting the moving system



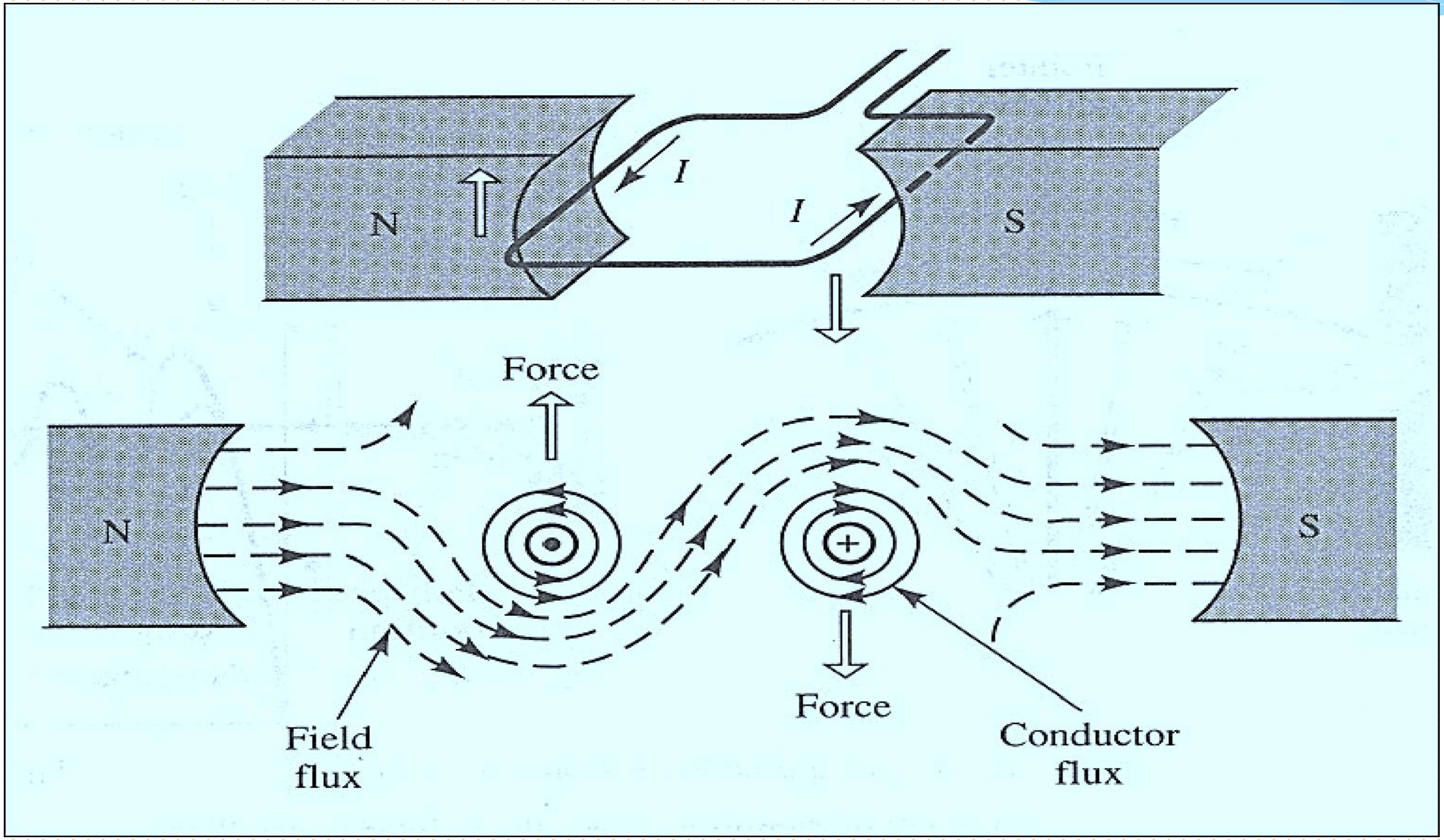
(a) Pivot and jewel-bearing suspension

Deflecting Torque

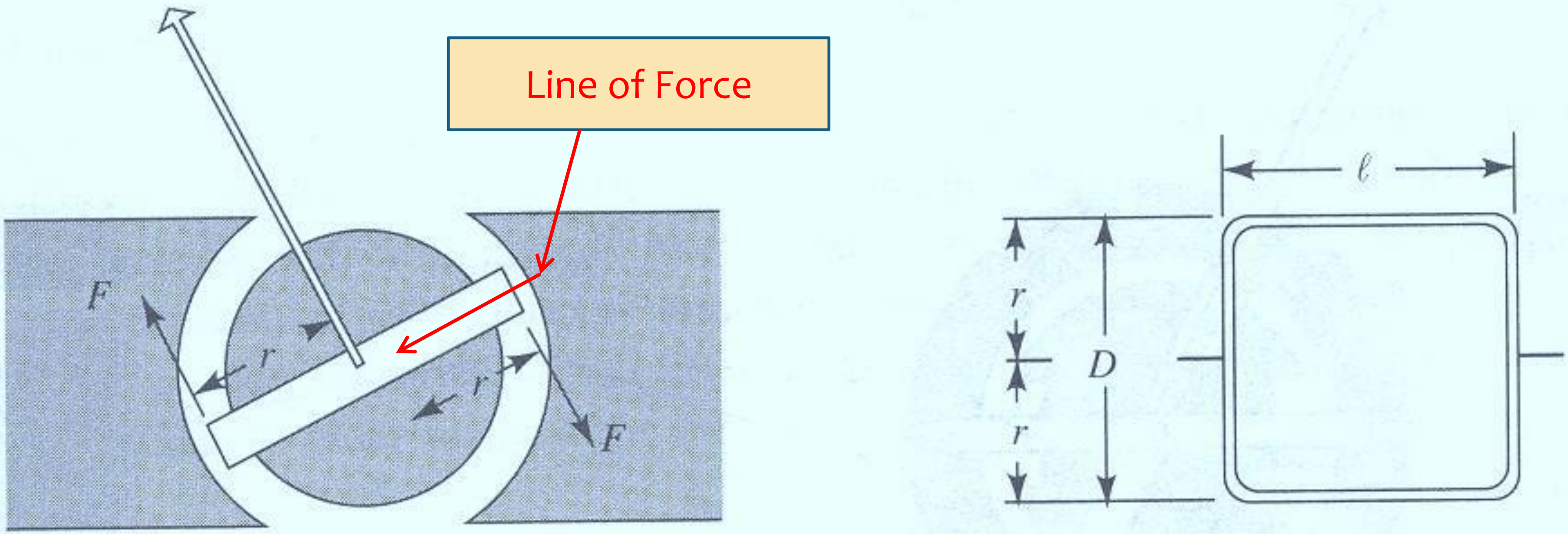
1) Deflection Torque : Force on current carrying conductor due Magnetic field



Deflection Torque



Coil ans Magnetic System



(a) Force F acts on each side of the coil

(b) Area enclosed by coil is $D \times \ell$

Deflection Torque

Torque Equation for PMMC

The equation for the developed torque of the PMMC can be obtained from the basic law of electromagnetic torque. The deflecting torque is given by,

$$T_d = NBAI$$

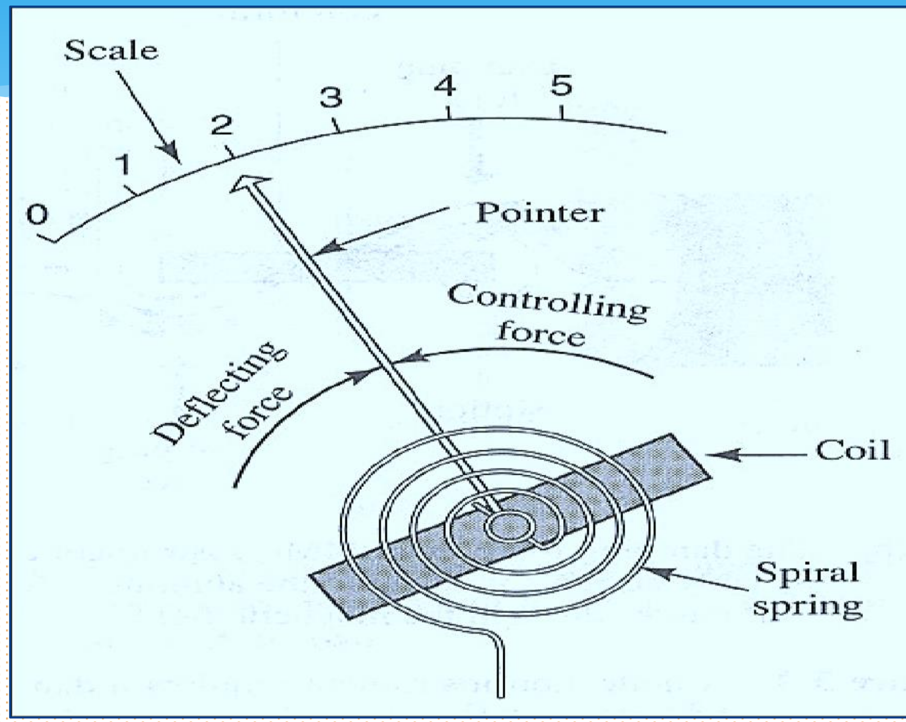
Where,

- **Td** = deflecting torque in N-m
- **B** = flux density in air gap, Wb/m2
- **N** = Number of turns of the coils
- **A** = effective area of coil m2
- **I** = current in the moving coil, amperes

Therefore, **Td = GI**

Where, G = NBA = constant

Control Torque



The spring control provides a restoring (controlling) torque $T_c = K\theta$

where K = spring constant.

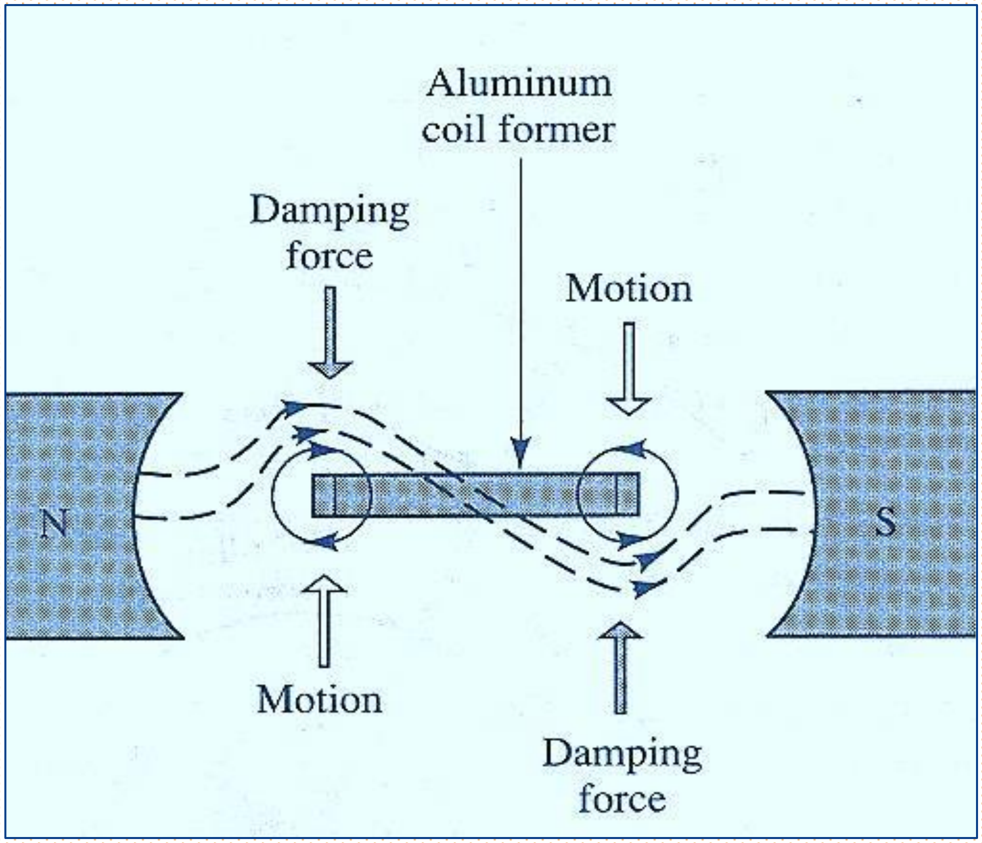
For final steady deflection $T_c = T_d$ or $GI = K\theta$

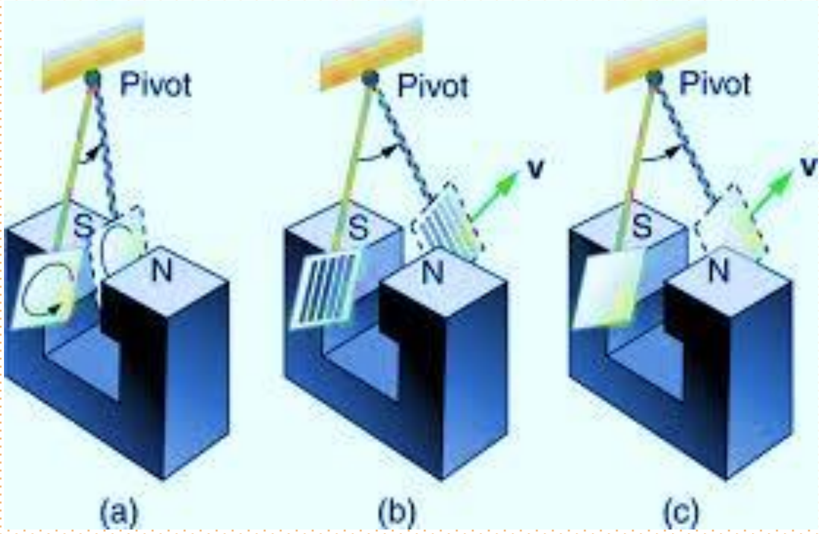
Final steady deflection $\theta = (G/K)\, I$

or current $I = (K/G)\, \theta$

Damping Torque

EDDY CURRENT DAMPING





REASON of Errors in PMMC

- FRICTION
- TEMPERATURE
- WEAKENING OF MAGNETIC FIELD
- STRAY MAGNETIC FIELD
- THERMO ELECTRIC ERROR

REASON of Errors in PMMC

FRICTION

- Very small high torque-weight ratio

Reason

- Small air gap
- difficult to prepare alight former
- minimise the winding tension

Can be avoided winding the coil carefully

REASON of Errors in PMMC

WEAKENING OF MAGNETIC FIELD

Weakening of Permanent Magnet

Reason

vibration

Change in Position

Stray Magnetic field

can be avoided by replacing the control mechanics

Effect of temperature and methods to compensate

- Hair springs, Magnetic field, Coil resistance are effected
- Series resistance with temperature coefficient nearly zero (manganin) is used
- Usually three times the coil resistance
- It is called Swamping resistance

Advantages

- Uniform scale

- Power consumption can be made very low (25 μW to 200 μW)

- Torque to weight ratio can be made high with a view to achieve high accuracy (typically 2%)

- Single instrument can be used for multi range ammeters and voltmeters

- Error due to stray magnetic field is very small
- No Hysteresis Loss

Limitations

- They are suitable for direct current only
- The instrument cost is higher than MI instruments
- Variation of magnet strength with time

Errors can be reduced by

- Proper pivoting and balancing weight may reduce the frictional error

- Considering the aging can reduce errors due to magnetic decay

- Manganin in series with coil reduces temperature effects

- Maintaining nominal temperature. The stiffness of spring, permeability of magnetic core decreases with increase in temperature

Any Questions ?