MEASURING INSTRUMENTS

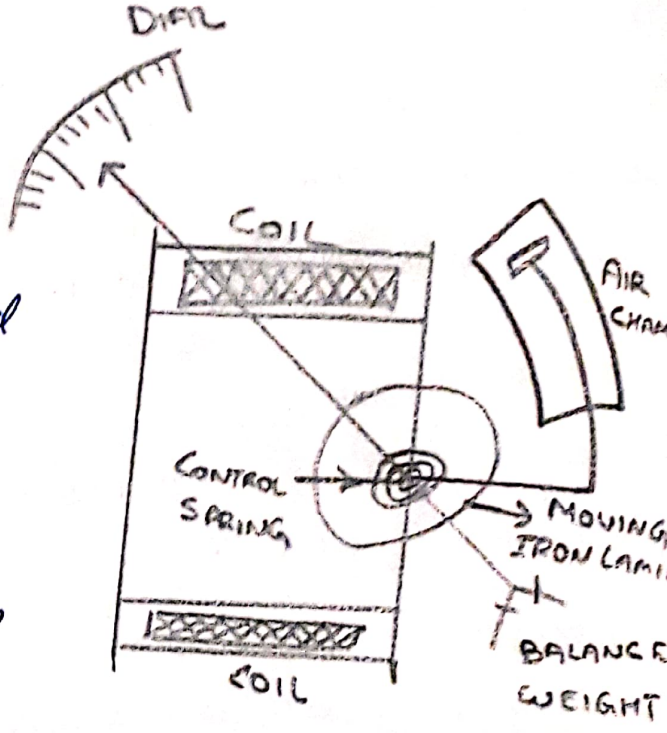
→ DIFFERENT TORQUES

- DEFLECTING TORQUE (τ_d)
  - → Operating torque
  - → Essential to initiate movement of pointer.
  - → Causes pointer to move from zero posⁿ to required value.
- CONTROLLING TORQUE (τ_c)
  - → Essential to control movement of pointer.
  - → Opposes the deflecting torque
  - → To make pointer come back to rest when $\tau_c = \tau_d$.
  - → To bring pointer back to zero when $\tau_d = 0$.
  - → METHODS OF GENERATION : 1) SPRING CONTROL
    2) GRAVITY CONTROL
- DAMPING TORQUE
  - → Process of controlling movement by producing motions such that it opposes the natural oscillation of system.
  - → METHODS OF GENERATION :
    1) AIR FRICTION
    2) EDDY CURRENT

→ Moving Iron Instrument

- Reasonably Accurate, cheap & simple construction
- Used as ammeters or voltmeters.

Attractive Type



Principle

Based on the principle that when an unmagnetised soft iron piece is placed in a magnetic field of a coil, the piece is attracted to the coil.

The operating current creates a magnetic field, which attracts the iron piece causing a deflecting torque in the pointer.

Construction

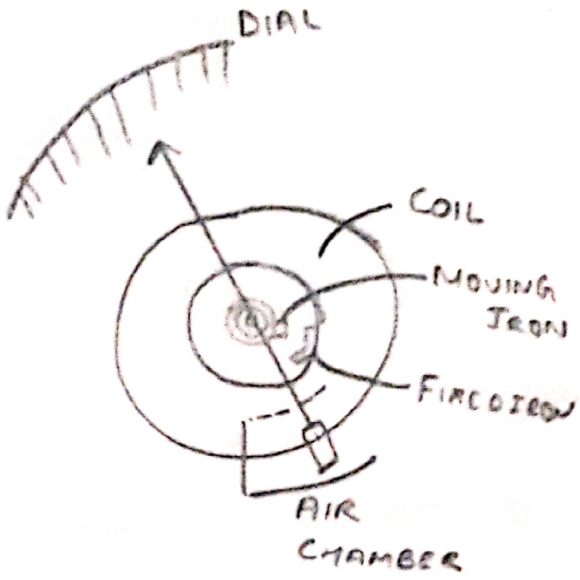
- Consists of a hollow cylindrical coil that is fixed.
- Oval soft iron piece is attached such that it can move in/out of the coil.
- Pointer is attached to spindle such that it moves with the iron.
- Controlling torque is provided by Spring control.

Working:

- When instrument is connected in circuit, the operating current flowing through the coil sets up a magnetic field. The coil then behaves like a magnet and attracts the metal piece.
- If the dir^n of current is reversed, dir^n of mag. field is also reversed and so is the magnetism in iron piece. Hence these instruments can be used in AC or DC circuits.

$$\theta \propto I^2$$

REPULSION TYPE



PRINCIPLE

Repulsion blw two iron pieces magnetised with same polarity

CONSTRUCTION

- Fixed cylindrical hollow coil
- Two soft iron pieces of vanes, one of which is fixed
- Fixed vane is attached to coil
- Under action of deflection torque, pointer moves over the scale.

WORKING

- Current sets up a magnetic field in coil, both the iron vanes are magnetised in the same direction. Since one vane is fixed, the other iron vane moves, as a result the pointer also moves.
- If dir^n of current is reversed, deflection remains unchanged.

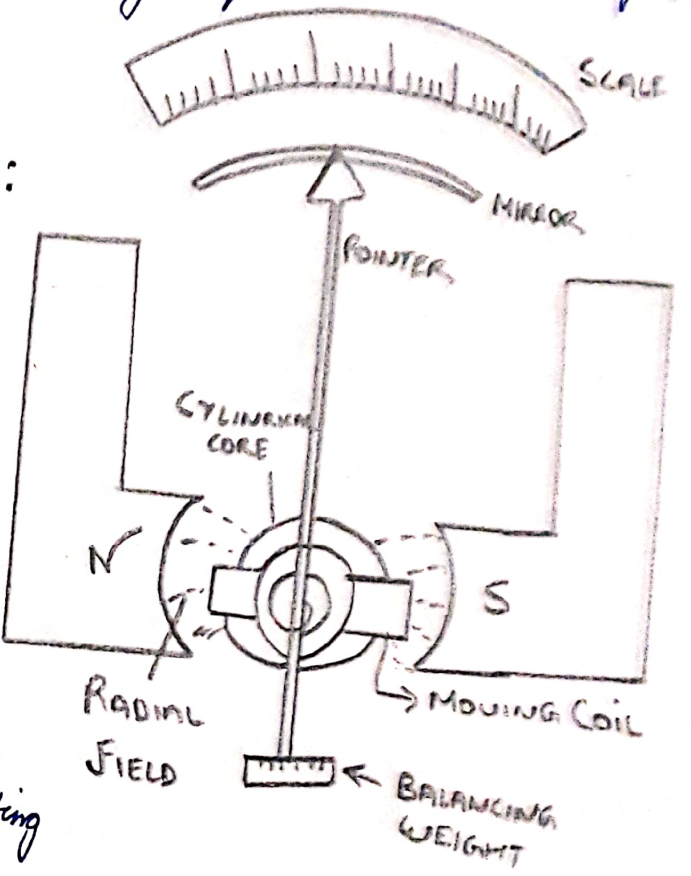
DISADVANTAGES

- NON-UNIFORM SCALE
- LESS SENSITIVE TO CHANGES OF OPERATING VARIABLES
- ERRORS IN AC (DUE TO CHANGE IN FREQUENCY)
- HIGH POWER CONSUMPTION

MOVING COIL INSTRUMENT

- Current carrying conductor placed in magnetic field experiences torque.

→ PERMANENT MAGNET MOVING COIL (PMMC):



CONSTRUCTION

- Powerful permanent magnet
- Cylindrical iron core, mounted b/w poles to make uniform magnetic field.
- Light rectangular coil

WORKING

- When current to be measured or current proportional to voltage is passed, a deflecting torque is produced
- Dir^ is determined by Flemings Left Hand Rule.
- Deflecting Force, $F = BiLN$
- DEFLECTING TORQUE, $\tau_d = BILN \cdot a \Rightarrow \tau_d \propto i$
- SPRING CONTROL, $\tau_c \propto \theta$

  $\Rightarrow \tau_c = \tau_d$ (FOR STEADY DEFLECTION)

  $\therefore \theta \propto i$

- EDDY CURRENT DAMPING

ADVANTAGE

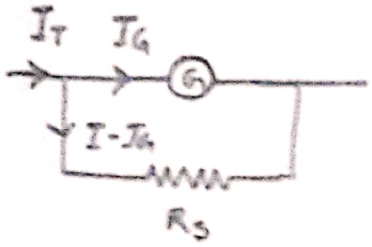
- SCALE IS UNIFORM
- LOW POWER CONSUMPTION
- NO HYSTERESIS LOSS

DISADVANTAGE

- Cannot be used for A.C
- Costlier
- Ageing of magnet
- ERRORS DUE TO FRICTION & TEMP

MOVING COIL INSTRUMENT AS AMMETER

Connect a low shunt resistance in parallel.



$$\Rightarrow \boxed{(I_T - I_G) \cdot R_S = I_G \cdot R_G}$$

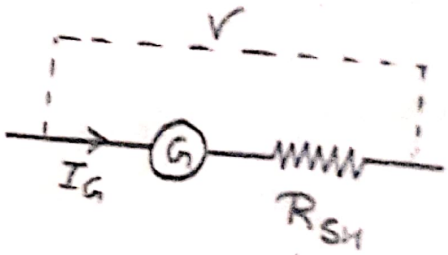
where $I_T \rightarrow$ CURRENT TO BE MEASURED

$I_G \rightarrow$ FULL SCALE DEF. CURRENT

$R_S \rightarrow$ SHUNT RESISTANCE

MOVING COIL INSTRUMENT AS VOLTMETER

A high series ~~sun~~ SHUNT MUST BE CONNECTED.



↳ MULTIPLIER

$$\boxed{V = I_G (R_G + R_{SH})}$$

where $V \rightarrow$ VOLTAGE TO BE MEASURED

$R_G \rightarrow$ RESISTANCE OF INSTRUMENT

$R_{SH} \rightarrow$ RESISTANCE OF SHUNT

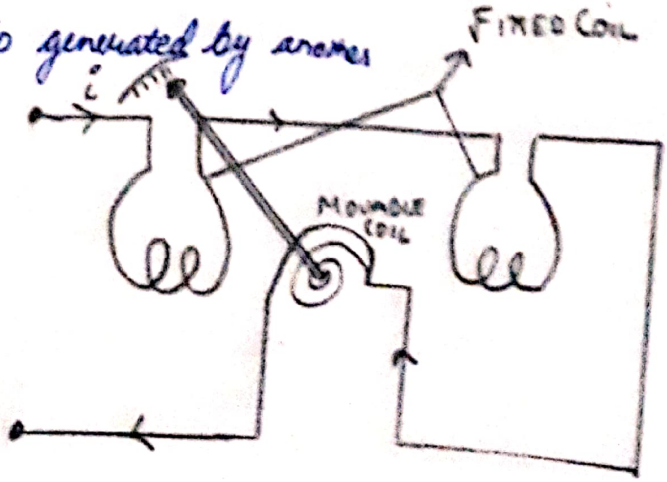
$I_G \rightarrow$ FULL SCALE CURRENT

DYNAMOMETER TYPE WATT METER

A indicating instrument used to measure power in circuit

PRINCIPLE

Same as PMMC, but mag. field is generated by another circuit

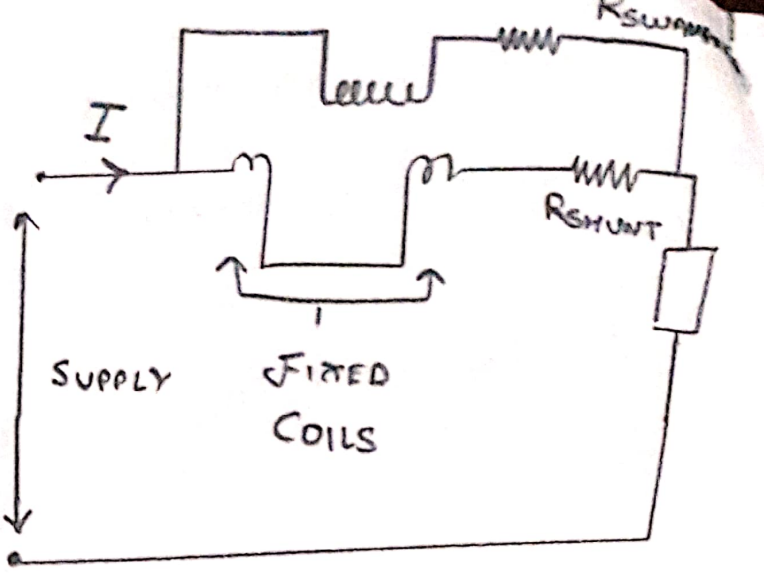


CONSTRUCTION

- 2 FIXED COILS (HEAVY WIRE)
- 1 MOVABLE COIL
- FIXED & MOVABLE IN PARALLEL

Electrodynamometer Ammeter

$\theta \propto I^2$ where $I \rightarrow$ Rms

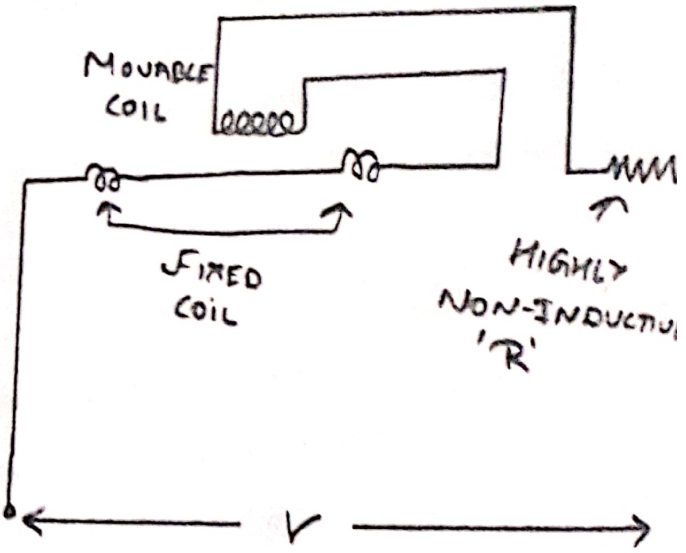


$R_{SWAMPING}$ normalised temp. variation

R_{SHUNT} Extends Range

Electrodynamometer Voltmeter

$\theta \propto V^2$



Resistor 'R' Extends Range

Imp. Points:

→ Used for both AC & DC

→ Non-Linear Scale

→ Expensive

→ High Power Consumption

→ Air-Friction Damping