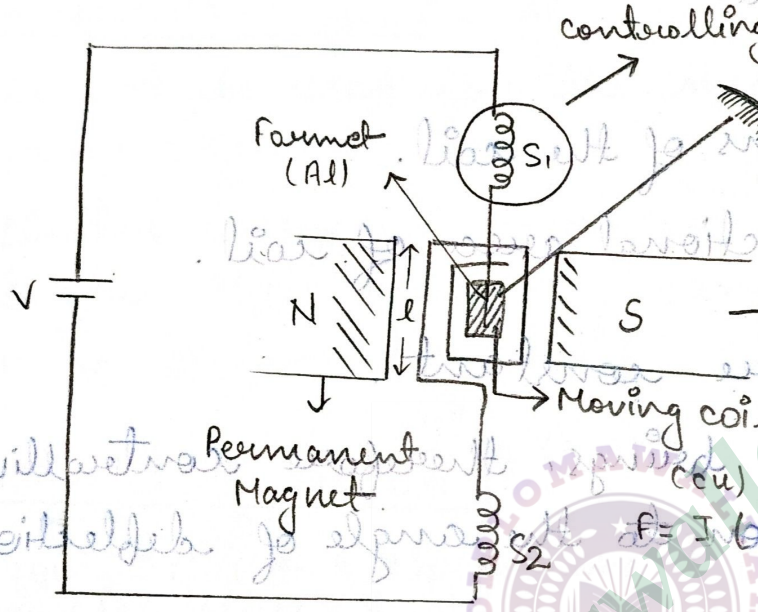
≫ PMMC (Permanent Magnet Moving Coil) :-

A PMMC works on the principle that when a current carrying conductor is placed in a magnetic field, it is acted upon by a forced which tends to move it to one side and out of the field".



Construction :-

* A permanent magnet on two pole sectional shape, soft iron piece are drilled.
* The utility of soft iron piece is to focus field of permanent magnet in the air gap.
* The moving system of this instrument consist of a spendil into which a soft iron core, aluminium former which carries the moving coil, a pointer and a set of control springs are mounted.

Working :-

* Whenever the current to be measured and passed through the moving system then the coil bound on the Al former.

* This causes the pointer to deflect away the zero position against the controlling torque of a spring control mechanism system.

Deflecting Torque $Td \propto I$

$$Td = BINA$$

B = Magnetic Field.

I = Current.

N = No. of turns of the coil.

A = A cross sectional area of coil.

Here, N, B and A are constant.

The control is by springs, therefore controlling torque is proportion to the angle of deflection.

i.e $Tc \propto \theta$

$$Tc = K\theta \qquad [K\theta = BINA]$$

θ = radian

At steady state condition.

$$Tc = Td$$

$$\theta \propto I$$

These instrument have uniform scale because the deflection θ is directly proportional to the operating.

Advantages :-

1) Low power consumption (20 - 200 mW) generally.

2) Due to high torque to weight ratio because

large operating field the accuracy and se are high.

3.) Does not require magnetic shielding due to strong magnetic field.

4.) As $Q \propto I$, the scale is uniform.

Disadvantages :-

1.) Cannot be used for the measurements of Ac parameters.

2.) Limited current carrying capacity (150mA) due to the thin and light wire that is used to wind the moving coil.

Sources of error :-

1.) Ageing effect of permanent magnet.

2.) Ageing effect of Spring.

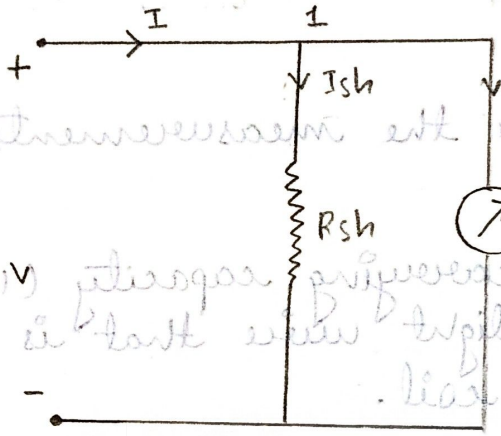
3.) Temperature effect of the coil and the control spring.

Application of PMMC :-

* Ammeter
* Multi-range ammeter
* Voltmeter
* Multirange voltmeter.

DC Ammeter :-

Current is the rate of flow of electric charge. This electric charge flows only in one direction, then the resultant current is called direct current (DC). This instrument is used to measure the direct current called DC ammeter.



Working :-

* If we place a resistor in parallel with the permanent magnet moving coil (PMMC) galvanometer, then the entire combination acts as DC ammeter.

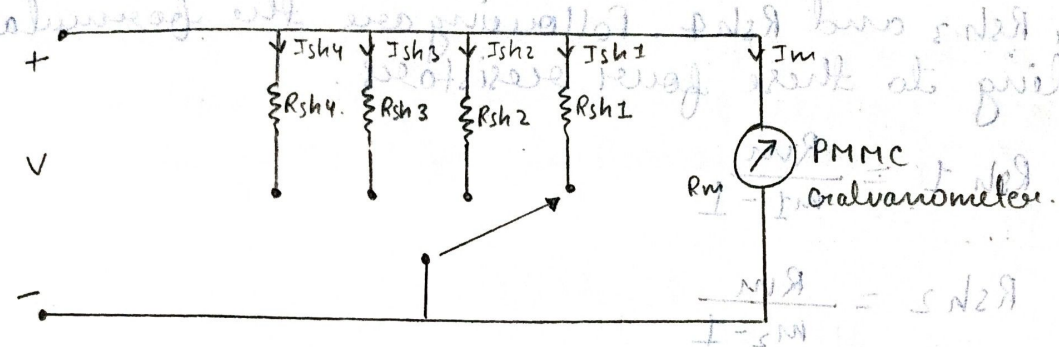
* The parallel resistance, which is used in DC ammeter is also called shunt resistance or simply shunt. The value of this resistance should be considered small in order to measure the DC current of large value.

* We have to place this DC ammeter in series with the branch of an electric circuit, where the DC current is to be measured.

* The voltage across the elements which are connected in parallel is same. So, the voltage across shunt resistor, Rsh and the voltage across galvanometer resistance, Rm is same, since those two elements

are connected in parallel to above resistor.

Multirange DC Ammeter...



If we want to use the DC ammeter for measuring the direct currents of multiple ranges, than we have to use multiple parallel resistors instead of single resistor and this entire combination of resistors is in parallel to the PMMC galvanometer.

Working :-

* Place this multi range DC ammeter in series with the branch of an electric circuit, where the direct current of required range is to be measured.
* The desired range of currents is chosen by connecting the switch, s to the respective shunt resistor.
* Let m_1, m_2, m_3 and m_4 are the multiplying factors of DC ammeter when we consider the total direct currents to be measured as I_1, I_2, I_3 and I_4 respectively.

Following are the formulae corresponding to each multiplying factor.

$$m_1 = \frac{I_1}{Im}$$

$$m_2 = \frac{I_2}{Im}$$

$$m_3 = \frac{I_3}{Im}$$

$$m_4 = \frac{I_4}{I_m}$$

In above circuit there are four shunt resistors, R_{sh1}, R_{sh2}, R_{sh3} and R_{sh4}. Following are the formulae corresponding to these four resistors.

$$R_{sh1} = \frac{R_m}{m_1 - 1}$$

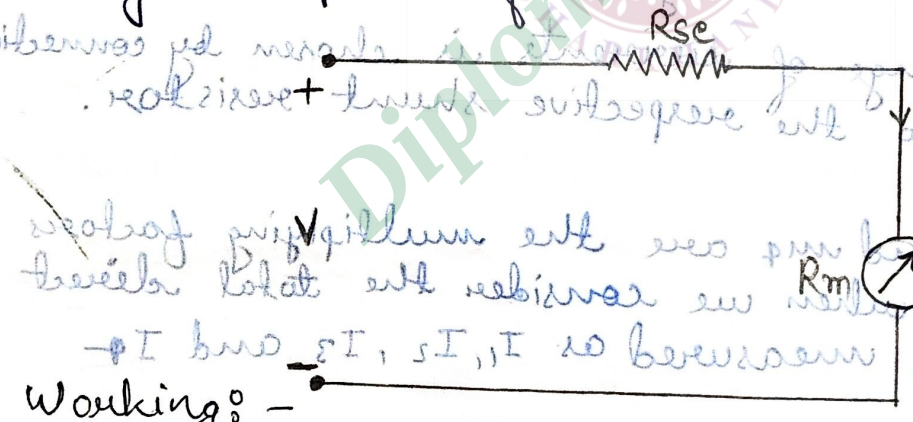
$$R_{sh2} = \frac{R_m}{m_2 - 1}$$

$$R_{sh3} = \frac{R_m}{m_3 - 1}$$

$$R_{sh4} = \frac{R_m}{m_4 - 1}$$

DC Voltmeter using PMMC :-

DC voltmeter is a measuring instrument, which is used to measure the DC voltage across any two points of electric circuit.



Working :-

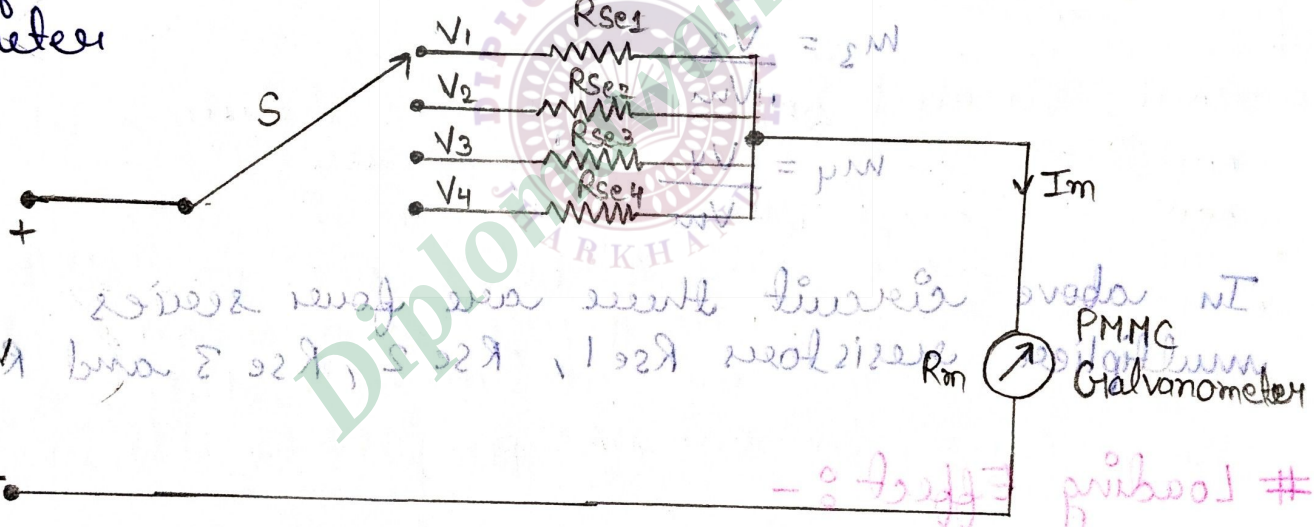
- If we replace a resistor in series with the permanent magnet moving coil (PMMC) galvano, meter then the entire combination together acts as DC ammeter.
- The series resistance while is used in DC voltmeter is also called series multiplier resistance or simply, multiplier. It basically limits the amount

of current that flow through galvanometer in order to prevent the meter current from exceeding the full scale deflection value.

- We have to phase this DC voltmeter across the two points of an electric circuit, where the DC voltage is to be measured.

Multirange DC Voltmeter :-

If we want to use the DC voltmeter for measuring the DC voltage the DC voltages of multiple ranges, then uses we have to use multiple parallel resistances instead of single multiplier resistor and this entire combination of resistors is in series with the PMMC galvanometer



* Working :-

- We have to place this multirange DC voltmeter across the two points of an electric circuit where the DC voltage of required range is to be measured.
- We can choose the desired range of voltages

by connecting the switch S to the very multiplier resistor.

- Let m_1, m_2, m_3 and m_4 are the multiplying factor of DC voltmeter when we consider the full range DC voltage to be measured as V_1, V_2, V_3 and V_4 respectively.

  * Following are the formula corresponding to each multiply factor:

$$m_1 = \frac{V_1}{V_m}$$

$$m_2 = \frac{V_2}{V_m}$$

$$m_3 = \frac{V_3}{V_m}$$

$$m_4 = \frac{V_4}{V_m}$$

In above circuit there are four series multiplier resistors Rse1, Rse2, Rse3 and Rse4.

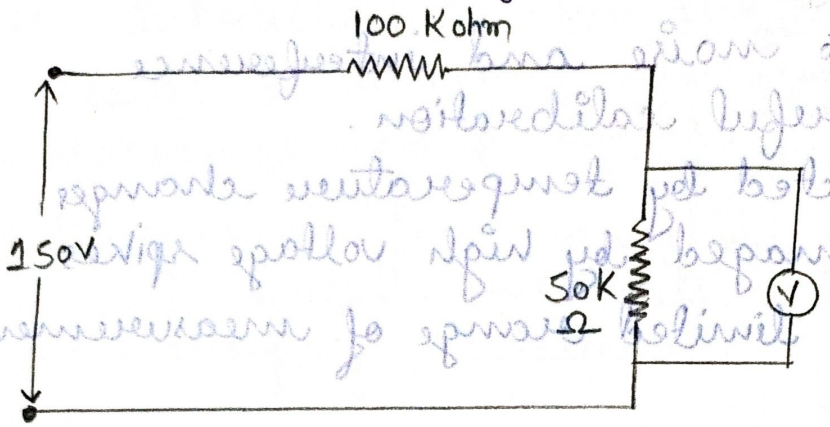
Loading Effect :-

The loading effect is the degree to which a measurement instrument impacts electrical properties like the voltage current and resistance of a circuit.

The error in the voltage reading caused by the voltmeter internal resistance.

This occurs when a voltmeter is used to

measured the voltage of a resistor



Voltmeter Sensitivity :-

Voltmeter sensitivity is the ratio of a voltmeter's resistance to its full scale reading.

Its expressed in ohms per volt (Ω/V)

Voltmeter sensitivity refers to the smallest voltage that can be detected by the voltage voltmeter, or the minimum change in voltage that it can measure.

* Uses :-

Voltmeter sensitivity is used to calculate the resistance of a multiplier in a dc voltmeter

It is also used to determine the internal resistance of a voltmeter

* Advantage :-

* Accurate measurements
- Detection of small voltage changes
- Reduced measurement errors.
- Improved System performance
- Increased efficiency in troubleshooting.

* Disadvantage :-

- Susceptible to noise and interference
- Requires careful calibration.
- May be affected by temperature changes.
- Can be damaged by high voltage spikes.
- May have a limited range of measurement.

Electrodynamometer :-

1.) Fixed Coil :- Produces a magnetic field

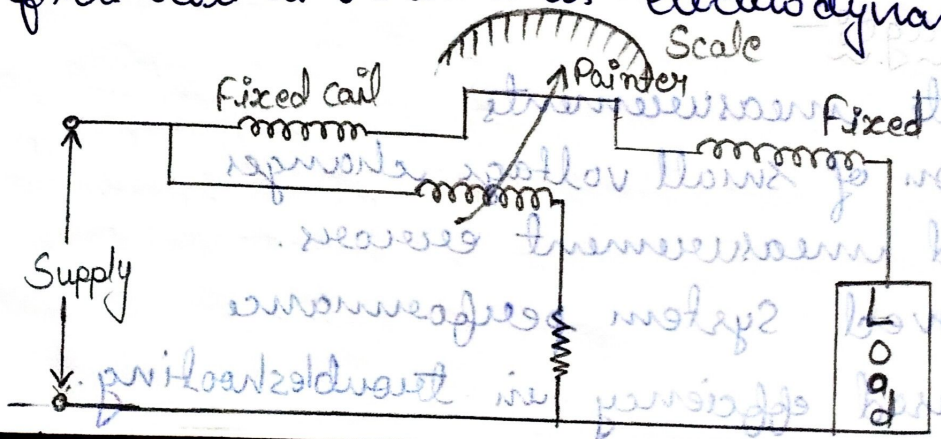
2.) Moving Coil :- Moves in response to the magnet field, causing deflection on the scale.

Key feature :-

Works on electromagnetic forces between the coil.

- Can measure both AC RDC values. use in voltmeter to measure power more accurate than moving iron instruments but sensitive to temperature changes

The instrument whose working depends on the reaction between the magnetic field of moving and fixed coil is known as electrodynamometer.



It is an electrical measuring instrument that uses the interaction between the magnetic fields of two coils to measure electrical quantities like current, voltage and power, both AC & DC

The electrodynamometer works on the principle that a mechanical force exists between two current carrying conductors.

It consist of two fixed coil (field coils) and a moving coil.

The magnetic field is created by the fixed coil and the moving coil rotates within this field.

The deflection of the moving coil is proportional to the current or power being measured.

* Application :-

- Wattmeter :- The electrodynamometer is commonly used as a wattmeter to measure power in AC and DC circuit non-inductive resistance.
- Ammeter and Voltmeter :- It can also be used as an ammeter voltmeter by connection the fixed and moving coils in series with a high non-inductive resonance.
- Power Factor meter :- It can be used as a power factor meter.

* Construction :-

Fixed Coils : This coils produce the magnetic field and are usually wound with a wire, carrying the main current in ammeter and wattmeter (accuracy AC measurement)

* Advantage :-

- Moving Coil :- The coil is wound either as a self sustaining coil or on a non-metallic former.
- Control Springs :- These spring provide the controlling torque acting as leads to the moving coil.
- Dampling :- The instrument is mechanically dampling to prevent oscillation
- Magnetic Shielding :- The instrument is often shielded from external magnetic fields to ensure accurate reading.

★ Electrodynamometer Ammeter :-

It is a type of ammeter that uses two fixed coils to create a magnetic field, rather than a permanent magnet and measure both AC and DC currents with high accuracy Making it suitable for calibration and laboratory use.

* Principle :-

The electrodynamometer ammeter operates on the principle that a mechanical for exists between carrying conductors. The magnetic field is created by two fixed coil and the movement of the moving coil is proportional the current flowing through the instrument.