UNIT V

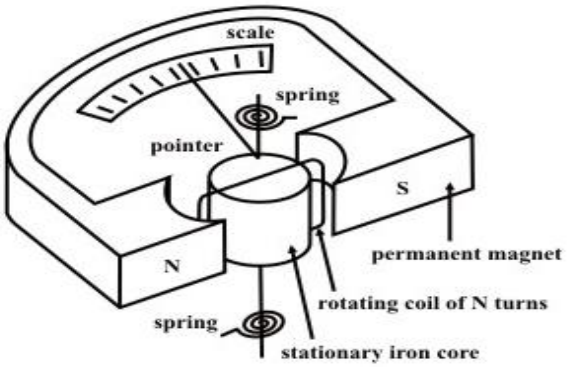
Basic Instruments

Principle of instruments:

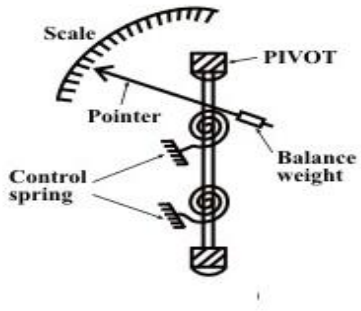
All electrical measuring instruments depend for their action on one of the many physical effects of an electric current or potential and are generally classified according to which of these effects is utilized in their operation. The effects generally utilized are:

1. Magnetic effect-for ammeters and voltmeters usually.
2. Electro dynamic effect-for ammeters and voltmeters usually.
3. Electromagnetic effect-for ammeters, voltmeters ,wattmeters and watt hour meters.
4. Thermal effect-for ammeters and voltmeters.
5. Chemical effect-for d.c.ampere-hour meters.
6. Electro static effect-for voltmeter sonly

Permanent Magnet Moving Coil (PMMC): A moving coil instrument consists basically of a permanent magnet to provide a magnetic field and a small lightweight coil is wound on a rectangular soft iron core that is free to rotate around its vertical axis. When a current is passed through the coil windings, a torque is developed on the coil by the interaction of the magnetic field and the field set up by the current in the coil. The aluminum pointer attached to rotating coil and the pointer moves around the calibrated scale indicates the deflection of the coil



Permanent Magnet Moving Coil Instrument.



Principle of operation: the interaction between the induced field and the field produced by the permanent magnet causes a deflecting torque, which results in rotation of the coil.

Deflecting Torque:

If the coil is carrying a current of , the force on a coil side = *.i amp BilN* (newton, N).

∴Torque due to both coil sides =2*rBil Nm = Gi Nm*

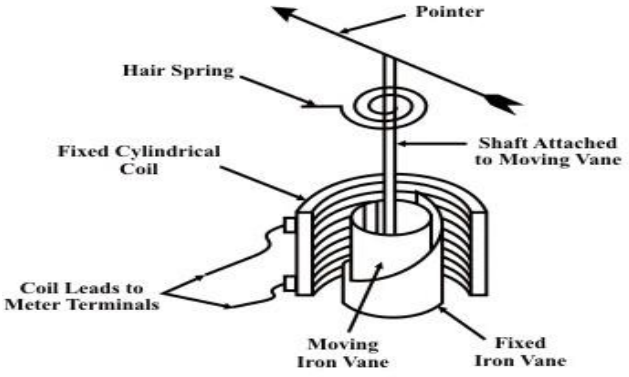
Controlling Torque: The value of control torque depends on the mechanical design of the control device. For spiral springs and strip suspensions, the controlling torque is directly proportional to the angle of deflection of the coil.,*ie* Control torque =$C\theta$

Damping Torque:

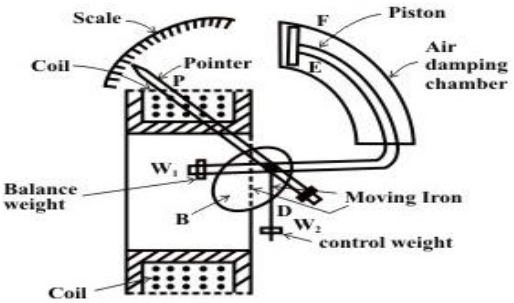
It is provided by the induced currents in a metal former or core on which the coil is wound or in the circuit of the coil itself. As the coil moves in the field of the permanent magnet, eddy currents are set up in the metal former or core. The magnetic field produced by the eddy currents opposes the motion of the coil. The pointer will therefore swing more slowly to its proper position and come to rest quickly with very little oscillation. Electromagnetic damping is caused by the induced effects in the moving coil as it rotates in magnetic field, provided the coil forms part of closed electric circuit.

Moving Iron Instruments:

The deflecting torque in any moving-iron instrument is due to forces on a small piece of magnetically 'soft' iron that is magnetized by a coil carrying the operating current. In repulsion type moving–iron instrument consists of two cylindrical soft iron vanes mounted within a fixed current-carrying coil. One iron vane is held fixed to the coil frame and other is free to rotate, carrying with it the pointer shaft. Two irons lie in the magnetic field produced by the coil that consists of only few turns if the instrument is an ammeter or of many turns if the instrument is a voltmeter. Current in the coil induces both vanes to become magnetized and repulsion between the similarly magnetized vanes produces a proportional rotation. The deflecting torque is proportional to the square of the current in the coil, making the instrument reading is a true 'RMS' quantity Rotation is opposed by a hairspring that produces the restoring torque. Only the fixed coil carries load current, and it is constructed so as to withstand high transient current. Moving iron instruments having scales that are nonlinear and some what crowded in the lower range of calibration.



Repulsion type.



Attraction type

Attraction type instrument consists of a few soft iron discs (*B*) that are fixed to the spindle (D), pivoted in jeweled bearings. The spindle (D) also carries a pointer (P), a balance weight (W_1), a controlling weight (W_2) and a damping piston which moves in a curved fixed cylinder (F). The special shape of the moving-iron discs is for obtaining a scale of suitable form.