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Moving Iron Instruments – Voltmeter and Ammeter



Analog ammeter and voltmeter designed to measure a.c. current and a.c. voltage

Moving-iron instruments

Construction and basic principle operation

Moving-iron **instruments** are generally used to measure alternating voltages and currents. In moving-iron instruments the movable system consists of one or more pieces of specially-shaped soft iron, which are so pivoted as to be acted upon by the **magnetic field** produced by the current in coil.

There are two general types of moving-iron instruments namely:

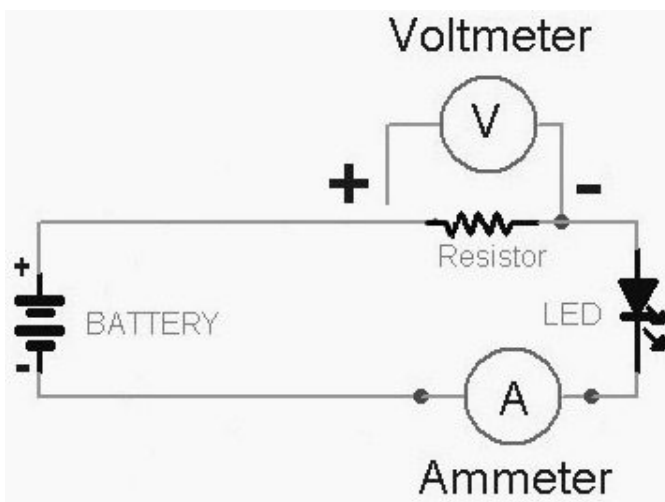
1. **Repulsion** (or double iron) type (figure 1)
2. **Attraction** (or single-iron) type (figure 2)

The brief description of different components of a moving-iron instrument is given below:

- **Moving element:** a small piece of soft iron in the form of a vane or rod.
- **Coil:** to produce the magnetic field due to current flowing through it and also to magnetize the iron pieces.
- **In repulsion type,** a **fixed** vane or rod is also used and magnetized with the same polarity.
- **Control torque** is provided by spring or weight (gravity).
- **Damping torque** is normally pneumatic, the damping device consisting of an air chamber and a moving vane attached to the instrument spindle.
- **Deflecting torque** produces a movement on an aluminum pointer over a graduated scale.

How it works?

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.



Typical scheme of measuring el. current and voltage

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 somewhat crowded in the lower range of calibration.

Figure 1 – Repulsion moving iron-instrument

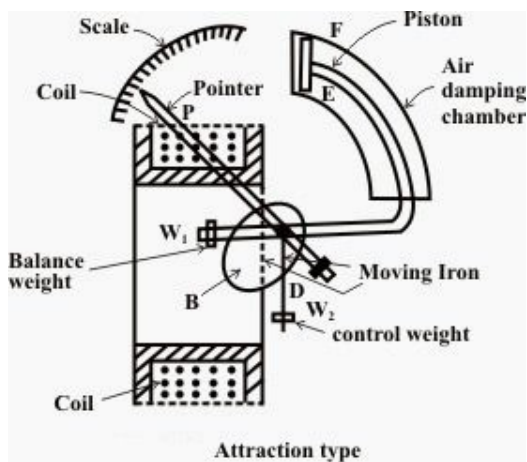
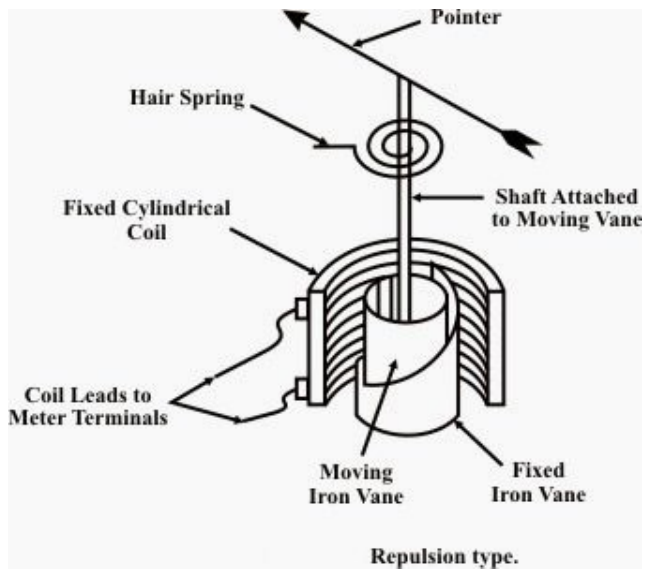


Figure 2 – Attraction moving iron instrument

Measurement of Electric Voltage and Current

- Moving iron instruments are used as Voltmeter and Ammeter only.
- Both can work on AC as well as on DC.

Ammeter

- Instrument used to measure current in the circuit.
- Always connected in series with the circuit and carries the current to be measured.
- This current flowing through the coil produces the desired deflecting torque.
- It should have low resistance as it is to be connected in series.

Voltmeter

- Instrument used to measure voltage between two points in a circuit.
- Always connected in parallel.
- Current flowing through the operating coil of the meter produces deflecting torque.

- It should have high resistance. Thus a high resistance of order of kilo ohms is connected in series with the coil of the instrument.

Ranges of Ammeter and Voltmeter

- For a given moving-iron instrument the ampere-turns necessary to produce full-scale deflection are constant.
- One can alter the range of ammeters by providing a shunt coil with the moving coil.
- Voltmeter range may be altered connecting a resistance in series with the coil. Hence the same coil winding specification may be employed for a number of ranges.

Advantages

- The instruments are suitable for use in AC and DC circuits.
- The instruments are robust, owing to the simple construction of the moving parts.
- The stationary parts of the instruments are also simple.
- Instrument is low cost compared to moving coil instrument.
- Torque/weight ratio is high, thus less frictional error.

Errors

- Error due to variation in temperature.
- Error due to friction is quite small as torque-weight ratio is high in moving coil instruments.
- Stray fields cause relatively low values of magnetizing force produced by the coil. Efficient magnetic screening is essential to reduce this effect.
- Error due to variation of frequency causes change of reactance of the coil and also changes the eddy currents induced in neighbouring metal.
- Deflecting torque is not exactly proportional to the square of the current due to non-linear characteristics of iron material.

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Bipul Raman - Bipul Raman (@BipulRaman), a graduate in Electrical Engineering had presented two research papers in National Conferences. He has overtaken and successfully completed a project to design an Automated CB Test-Rig for Light Combat Aircraft at Aircraft Research and Design Center (HAL). Apart from this, he has done several projects at NTPC and Grid Substation. Not only limited to Electrical Engineering, He is also very much passionate in Software Development. He has contributed few of his code to 'Codeplex' (a Microsoft OpenSource software hosting website). Visit his complete profile

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