SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF COMPUTER SCIENCE AND DESIGN

COURSE NAME : 19EE01 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

I YEAR /II SEMESTER - COMPUTER SCIENCE AND DESIGN

Unit 1 – Electrical Circuits and Measurements

Topic 7 : Moving iron instruments(Ammeters and Voltmeters),

What is a Moving Iron Type Instrument?

Moving iron type voltmeter and ammeter Instruments are devices used to measure electrical quantities such as voltage and current. They operate based on the principle of electromagnetic attraction or repulsion, where a piece of iron moves in response to the magnetic field produced by the current.

Moving iron type instruments are analog meters that use the deflection of a soft iron element to measure alternating current (AC) and alternating potential difference or voltage. When placed in a varying magnetic field created by the current flowing through the coil, the soft iron element experiences a torque due to magnetization.

This torque causes the iron element to rotate and deflect the pointer attached to it, thus providing a visual indication of current or voltage level on a calibrated scale.

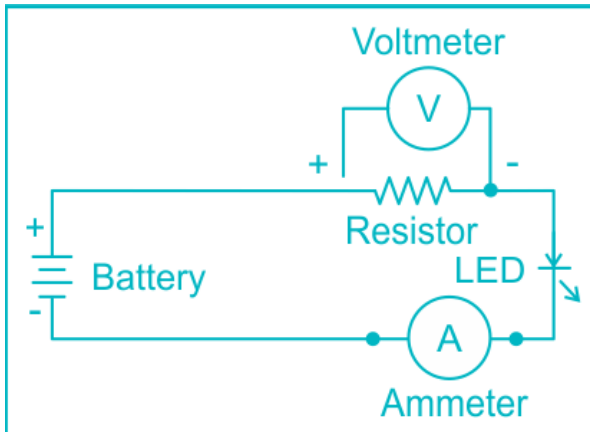
Working of Moving Iron Type Instrument

The working principle of moving iron type instruments involves the movement of an iron piece within the magnetic field generated by the current flowing through a coil. The movement is translated into a reading on a calibrated scale, indicating the magnitude of the measured quantity.

•The essential components of a moving iron type instrument include a soft iron element, coil, control spring, damping mechanism, and pointer-scale arrangement.

•When an AC current passes through the coil, it sets up a varying magnetic field. The soft iron element situated in this field becomes alternately magnetized in opposite directions with each half-cycle of the current. This magnetization produces a torque on the iron element, causing it to oscillate.

•Damping is applied using air friction or eddy currents to stabilize the oscillations. The iron element then rotates at twice the supply frequency and in proportion to the current or voltage being measured. The control spring opposes this rotational torque to bring the pointer to rest at a point on the scaled dial corresponding to the measured quantity.



Detailed Process:

- **Current Flow:** When an electrical current flows through the coil, it generates a magnetic field.
- **Iron Movement:** The magnetic field causes the iron piece to move, either attracting or repelling it.
- **Measurement Display:** This movement is linked to a pointer that moves over a calibrated scale to provide a reading.

Types of Moving-iron Instruments

The repulsion and the attraction are the types of moving iron instruments. They are explained in detail below.

1. Repulsion Type

In repulsion-type instruments, the movement is based on the repulsion between two iron pieces placed within the magnetic field. These instruments are typically used for measuring higher ranges of current and voltage. The repulsion-type instrument has two vanes or iron plates. One is fixed, and the other one is movable. The vanes become magnetized when the current passes through the stationary coil and the force of repulsion occurs between them. Because of a repulsive force, the moving coil starts moving away from the fixed vane.

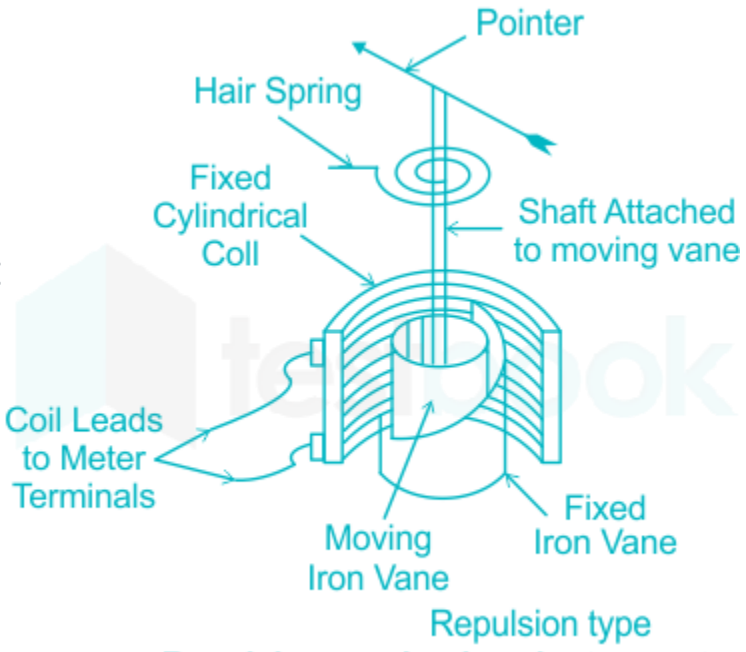
Construction of Repulsion Type Instrument

In the repulsion type, two soft iron elements called vanes are placed in a fixed coil carrying the current to be measured. One vane remains stationary while the other is free to rotate. Both vanes experience the same magnetic polarity from the coil current and repel each other, causing deflection.

•Coil: Wound around a non-magnetic frame.

•Iron Pieces: Two iron pieces are positioned within the coil.

•Pointer and Scale: Connected to one of the iron pieces to display the measurement.



Repulsion moving iron-instrument

2. Attraction Type

Attraction-type instruments work on the principle of magnetic attraction, where a single piece of iron is attracted towards the coil carrying the current. In the attraction-type instrument, a single soft iron element is eccentrically mounted on a spindle in front of the fixed coil. Here, the magnetic field produced by the coil current attracts the soft iron element towards itself, producing deflection.

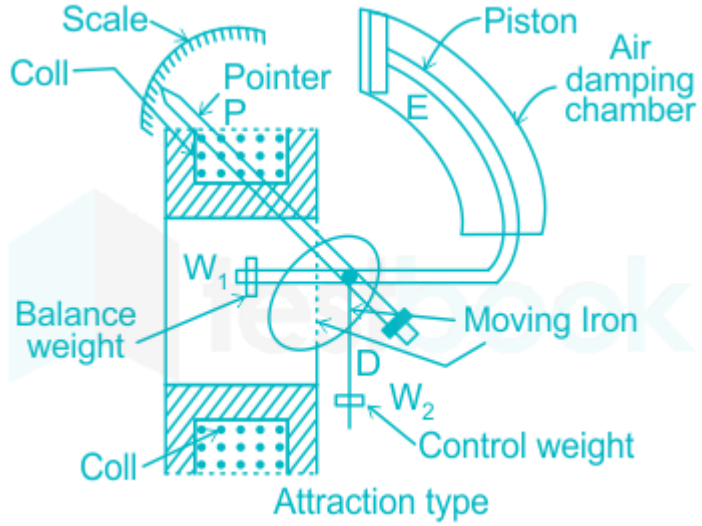
Construction of Attraction Type Instrument

The stationary coil of the attraction-type instrument is flat and has a narrow opening. The moving element is the flat disc of the iron core. The current flow through the stationary coil produced the magnetic field which attracts the iron coil. The iron vane deflects from the low magnetic field to the high magnetic field, and the strength of the deflection is directly proportional to the magnitude of the current flow through it. In short, we can say that the iron coil attracts towards in.

The attraction-type instruments use springs, which provide the controlling torque. The deflection of the coil is reduced by the aluminum piston which is attached to the moving coil.

The key components of an attraction-type moving iron instrument are -

- **Soft Iron Element:** A thin disc-shaped soft iron core forms the movable element.
- **Fixed coil:** Produces magnetic field proportional to current passed through its windings.
- **Spindle**: Holds the soft iron disc and transfers its rotational motion to a pointer.
- **Pointer**: Rotates over a stationary scale dial to indicate measured value.
- **Spring:** Provides restoring torque opposing deflection to bring the pointer to rest.
- **Damping System:** Controls oscillations via air friction or eddy currents.



Attraction moving iron instrument

Measurement of Electric Voltage and Current

Moving iron instruments like ammeters and voltmeters are used to measure the following quantities:

Ammeter

Used to measure electric current in amperes. It is connected in series with the circuit whose current needs to be measured. Ammeters have low resistance coils to minimize circuit loading.

Key Points:

- **Range**: Ammeters are available in various ranges to measure different magnitudes of current.
- **Calibration:** Calibration of moving iron type ammeters using a potentiometer ensures accuracy.

Voltmeter

Used to measure potential difference or voltage between two circuit points in volts. It is connected in parallel across the two points. Voltmeters have high resistance coils as low resistance would shunt significant current from the measured circuit.

Key Points:

- **Range:** Voltmeters come in different ranges suitable for various voltage levels.
- **Calibration:** Calibration of moving iron type voltmeters using a potentiometer is crucial for precise measurements.

Advantages Moving-iron Instruments

- **Robustness:** They are mechanically strong and can withstand rough handling.
- **Accuracy:** Provide reliable measurements with high accuracy.
- **Versatility:** Suitable for both AC and DC measurements.
- **Cost-Effective:** Generally less expensive compared to other types of measuring instruments.
- High torque-weight ratio improves friction accuracy

Errors in Moving Iron Type Instrument

Despite their advantages, moving iron instruments can suffer from certain errors:

- **Hysteresis Error:** Due to the magnetic properties of iron.
- **Temperature Error:** Variations in temperature can affect the accuracy.
- **Frequency Error:** The accuracy can be affected by changes in the frequency of the measured current or voltage.
- Stray magnetic field interference
- Non-linear deflection torque due to iron core properties

Difference Between Moving Iron & Moving Coil Instruments

While both are analog instruments, moving coil meters have better accuracy as the magnetic field does not interact directly with the iron core. However, moving iron types have advantages of simpler design, ruggedness and lower manufacturing cost.

Features	Moving Iron Instruments	Moving Coil Instruments
Working Principle	Electromagnetic attraction or repulsion	Permanent magnet moving coil
Measurement	AC and DC	Primarily DC (with rectifiers for AC)
Construction	Robust	Delicate
Accuracy	Moderate	High
Cost	Generally lower	Generally higher

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