Earthing In Electrical Systems

Department: Electrical Engineering (EEE)
Course: Basic Electrical Engineering
Semester: 3rd / 4th (Diploma or B.Tech)
Prepared for: BVM Engineering College, Anand & also for other colleges
Academic Use: Class Notes | Viva Prep | Exam Revision

Flow of presentation

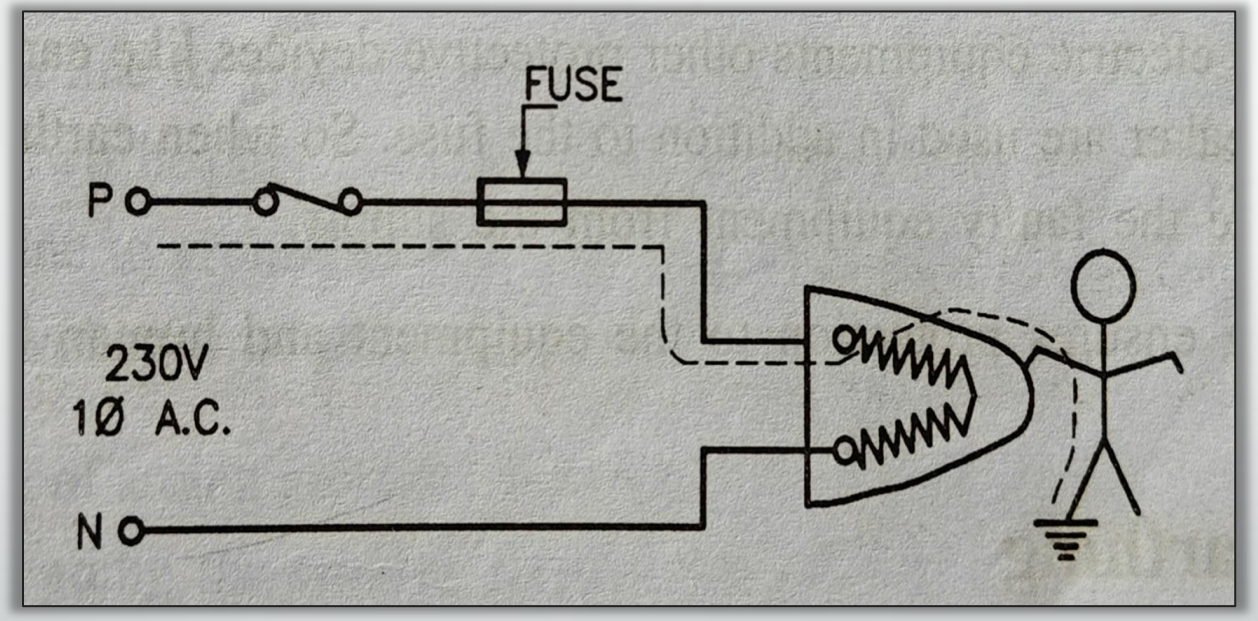
- Introduction
- Necessity of earthing
- Objective of earthing
- Types of Earth electrodes
- Methods of earthing
- Earthing resistance

Introduction

- **Earthing** is the process of connecting the metallic parts of electrical equipment to the ground to ensure **safety and protection**.
- It safeguards both equipment and humans from electrical faults, preventing electric shocks and damage.

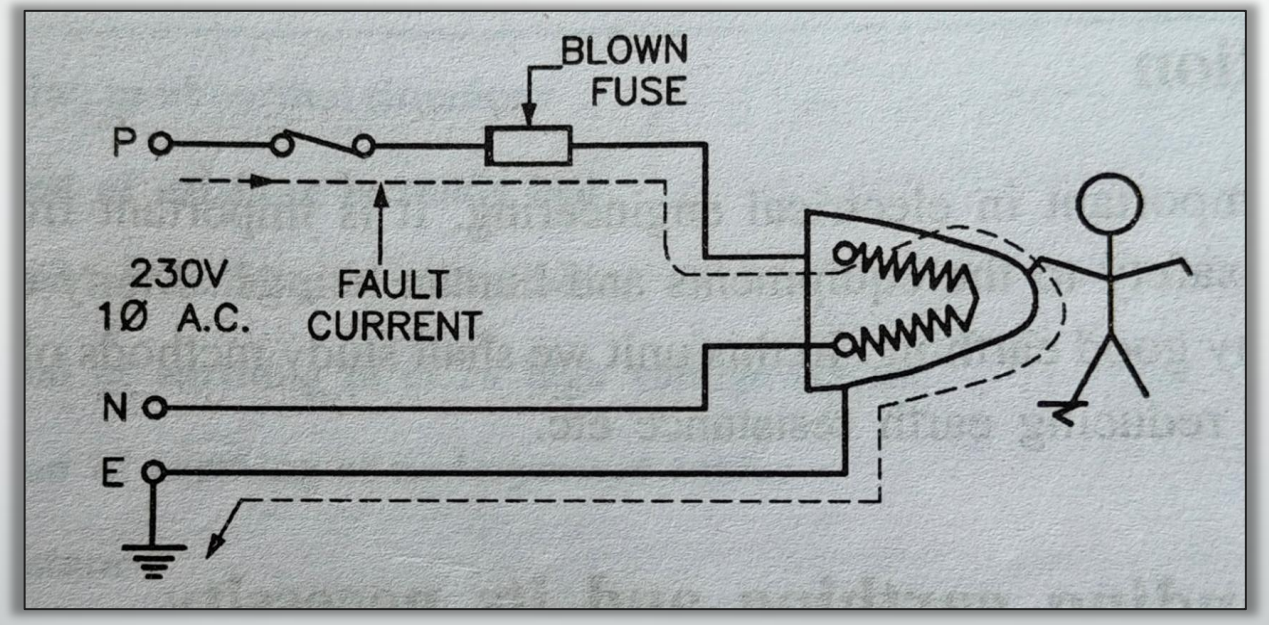
Necessity of Earthing

- **Unearthed equipment** can become dangerous during insulation failure.



Metal body not earthed

- **Earthed equipment** ensures that any leakage current is safely directed into the ground.
- Protects users from electric shocks and fires caused by stray currents.



Metal body earthed

Objective of Earthing

- To keep all the metal parts of the equipment except the live parts at the earth potential and keep the operator and attendant also at the earth potential.
- To arrange the system such that sufficient fault current can flow for a sufficient duration so that the protective system operates, so there is no possibility of fire and explosion
- To isolate the faulty equipment from the supply, so that the performance of the system is not affected.

Earth Electrodes

- Types of earth electrodes:
  - Rod electrode
  - Pipe electrode
  - Plate electrode
  - Strip electrode
  - Coil electrode
  - Concrete-encased rod or wire
- Each type is selected based on **site condition, soil resistivity**, and application.

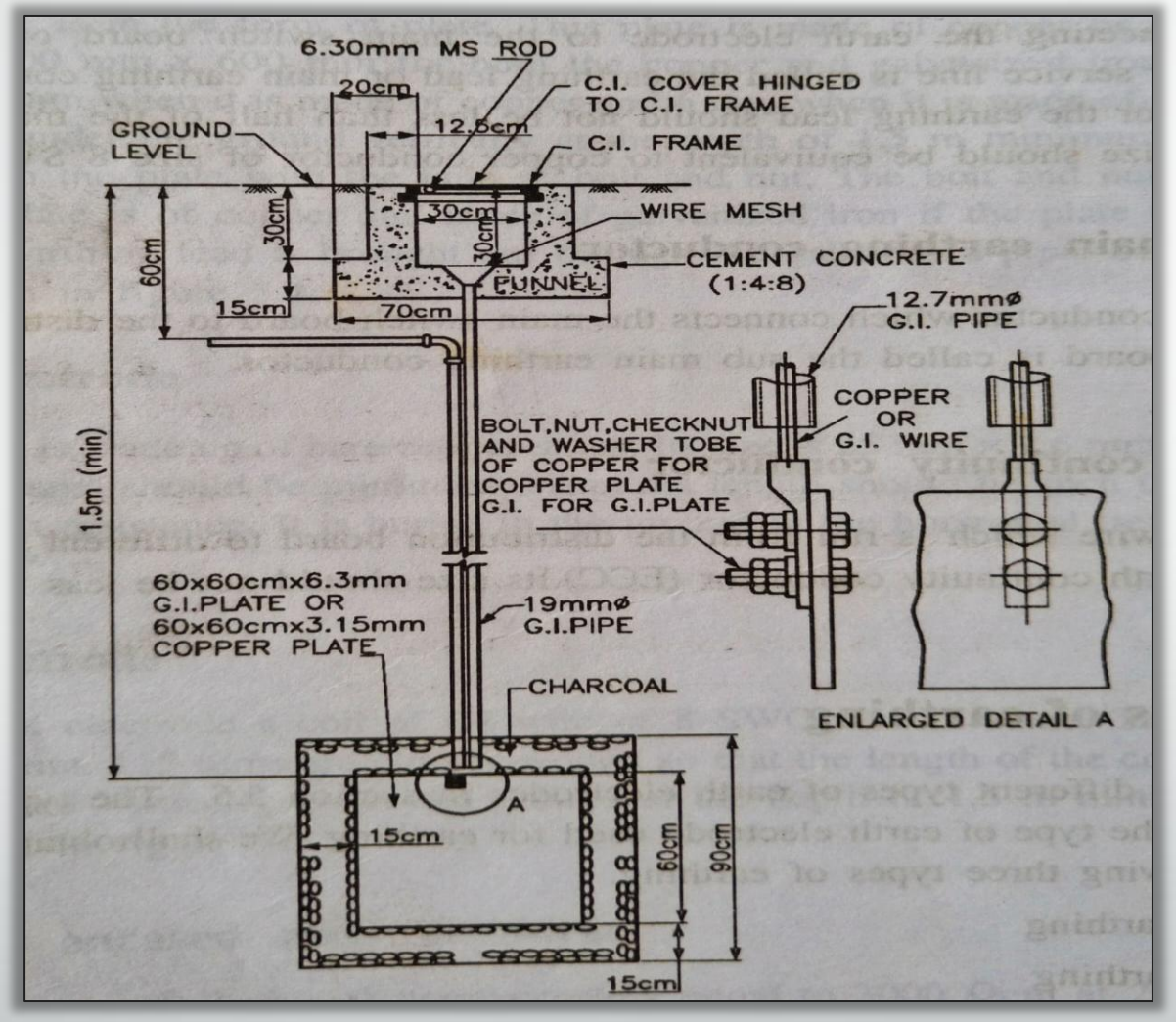
Methods of Earthing

- The following three types of earthing:

1. Plate earthing
2. Pipe earthing
3. Coil earthing

- Include diagrams here for each method with installation depth, materials used, etc.

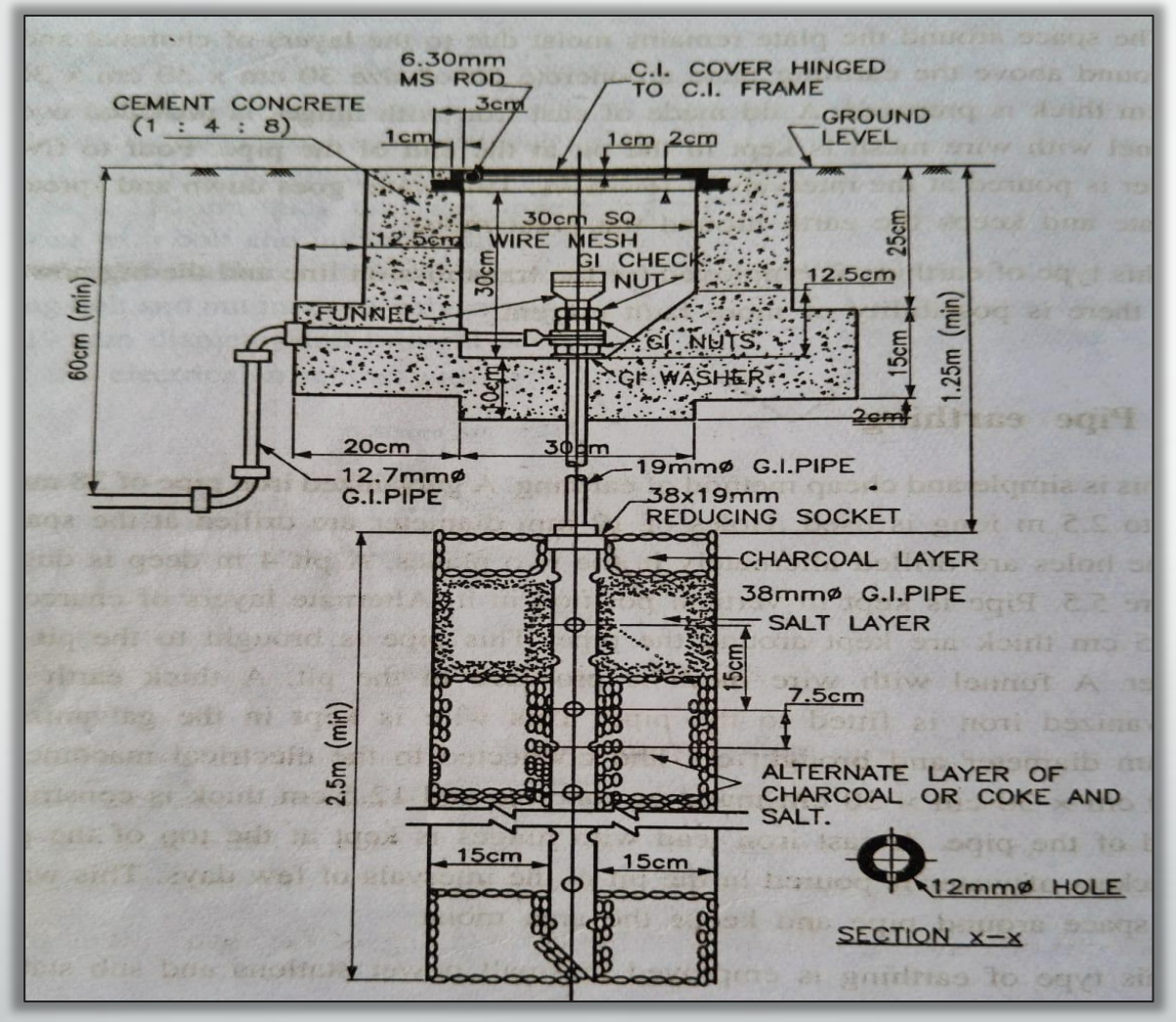
Plate Earthing



- A copper or galvanized iron plate of size **600 mm × 600 mm** is used.
  - Copper plate: 3 mm thick
  - GI plate: 6 mm thick
- The plate is buried **vertically at a depth of less than 3 meters**.
- **Alternate layers of charcoal and salt**, each 150 mm thick, are placed around the plate to improve conductivity and moisture retention.
- A **thick copper or galvanized iron wire** is bolted to the plate and brought above ground using a **19 mm GI pipe**.

- A **concrete pit (30 cm × 30 cm × 30 cm)** is constructed above the ground to access the wire connection.
- A **cast iron lid with wire mesh** is used to cover the pit. Water is added periodically to keep the Earth moist.
- **Used in:** Transmission lines and large power stations due to high fault current capacity.

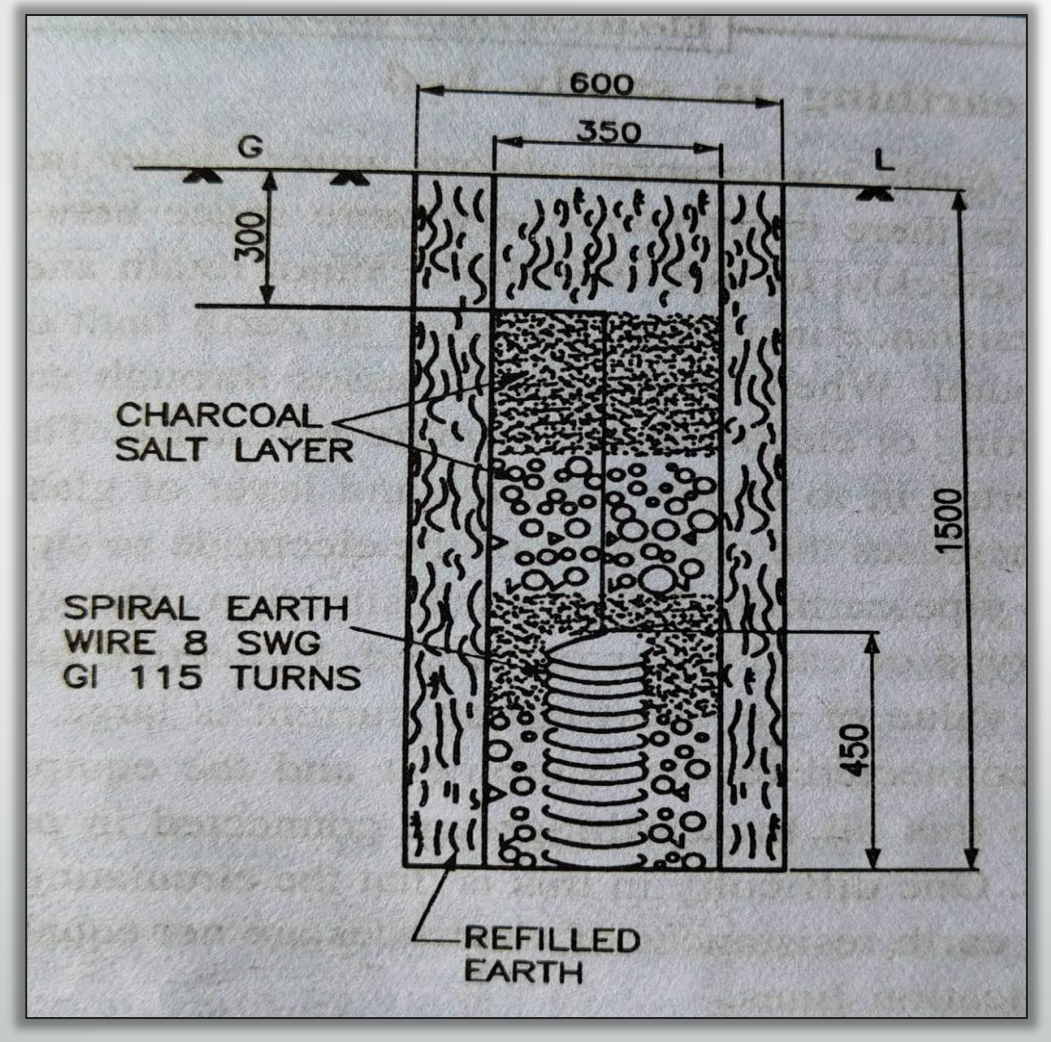
Pipe Earthing



- Uses a **galvanized iron pipe**, 38 mm in diameter and **2 to 2.5 meters long.**
- Holes of **12 mm diameter** are drilled along the pipe at 15 cm intervals.
- The pipe is placed **vertically in a 4-meter-deep pit**.
- **Charcoal and salt layers**, 150 mm thick, are added around the pipe.
- A **GI wire (12.7 mm dia)** connects the pipe to electrical equipment.

- A **concrete inspection pit (30 cm cube, 12.5 cm thick)** is built around the pipe’s top.
- A **cast iron lid with a funnel and mesh** is used to pour water and maintain moisture.
- **Used in:** Small power stations and substations where fault currents are moderate.

Coil Earthing



- A **50 mm diameter coil** is wound with **8 SWG galvanized wire**. Approx. **115 turns** and **450 mm** in length.
- The coil is placed **vertically inside a 600 mm diameter, 1.5 m deep pit**, located 1.2 meters from the pole.
- **Charcoal and salt layers**, 300 mm thick, are added around the coil.
- The remaining space is filled with earth, and the **earth leads to exit 300 mm below ground**.
- **Used in:** Earthing of **distribution poles** in electrical networks.

Earthing Resistance

- The frame of electrical equipment is connected to the earth electrode with the help of an earth conductor, which is called earthing.
- When a fault occurs, the fault current goes to ground through this earth electrode. The resistance of the path through which this fault current reaches ground is called the earthing resistance.
- A lower value ensures efficient fault current discharge.

Factors affecting earth resistance

- The following factors increase the Earth's resistance:

- Loose connection
- High soil resistivity or dry soil
- Shallow installation depth
- Rust at joints

Methods of reducing earth resistance

- The following steps can be taken to reduce the earth resistance:
- The earthing rod should be buried at least 2 m below the ground surface.
- Regularly clean joints and refill earthing pit
- Fresh layers of charcoal and salt are to be kept around the earth electrode after cleaning of the electrode.
- Earthing resistance can be decreased by connecting more than one electrode in parallel.

Methods of measuring earth resistance

- The following methods are used to measure the earth resistance:

- Voltmeter-ammeter method
- Earth tester method
- Ohm meter method
- Earth loop tester method

Voltmeter-Ammeter method

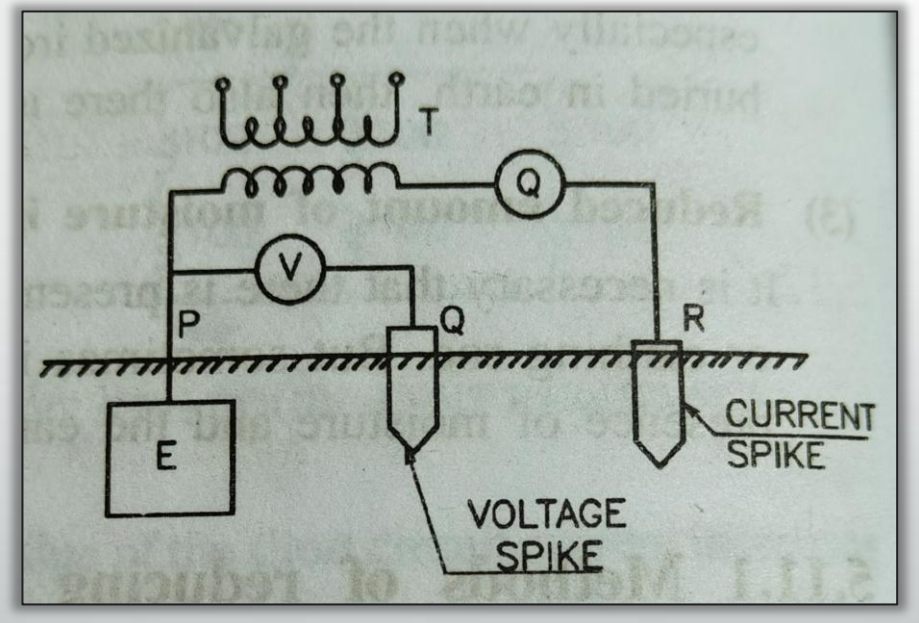
- **Concept:** Use a transformer to inject current and measure the voltage drop to calculate the resistance using Ohm's law.
- **Steps:** Place **three spikes**:

  P (earth electrode)

  Q (voltage spike, 15–20 m away)

  R (current spike, 10 m from Q)
- Connect the **voltmeter** across P–Q

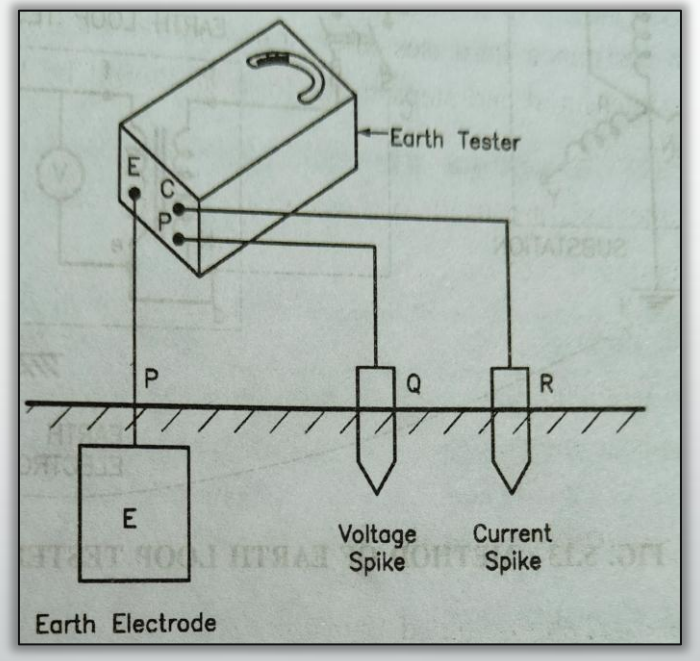
- Connect an **ammeter** across P–R
- Calculate: **Earth Resistance = V / I**
- **Use case:** Standard in **lab testing**, accurate, but needs spacing and setup.



Earth Tester Method

- **Concept:** A **special device** called an earth tester injects a small voltage and shows resistance directly on a scale.
- **Steps:** Earth tester has a **built-in DC generator (~500V)**
- Generates current through spikes (Q & R)

- A coil inside deflects; pointer shows **resistance in ohms**
- **Use case:** Used **on field sites** for fast and reliable readings.



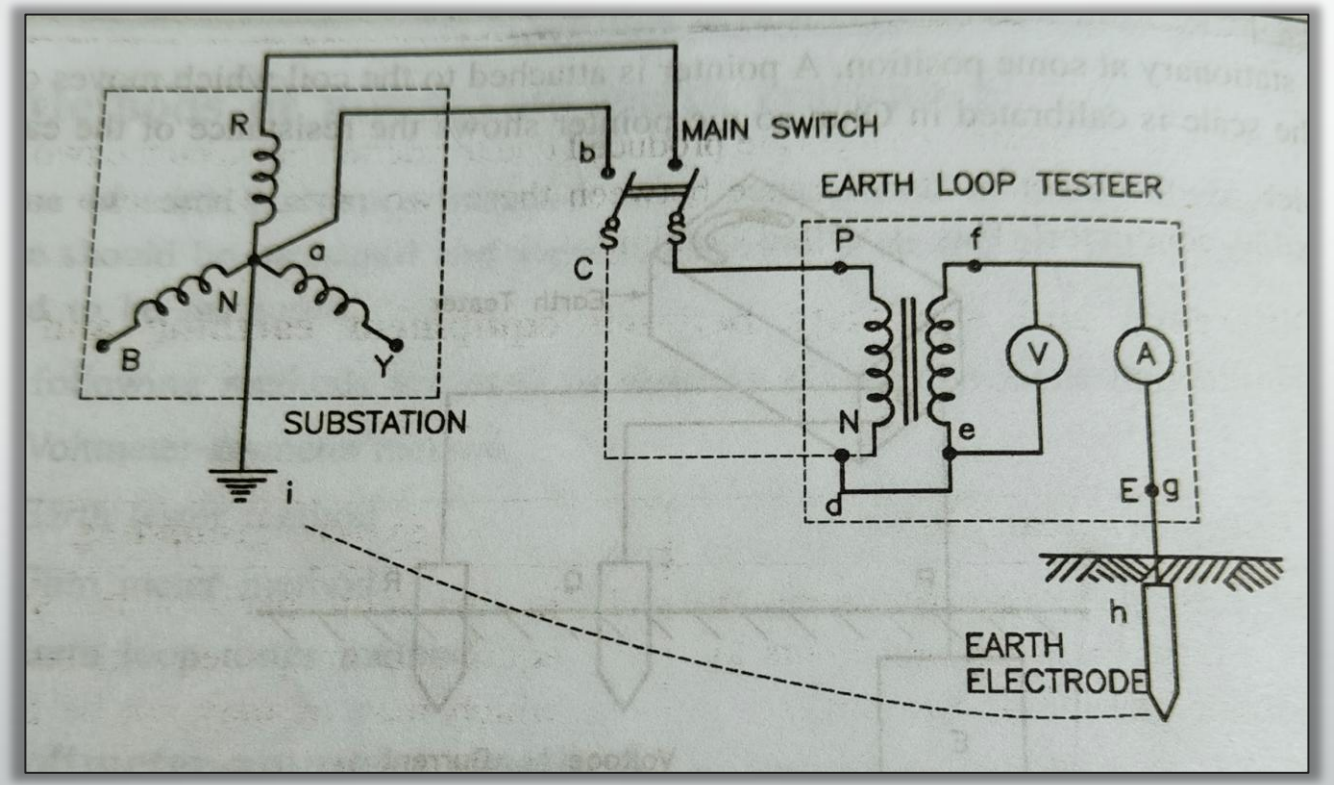
Ohm Meter Method

- **Concept:** Simplest method using a regular **Ohm meter** or multimeter.
- **Steps:**
- Set zero with probes shorted.
- Connect one probe to the **earth electrode**, other to a **nearby metal pipe or earth terminal**
- Read directly in **ohms**
- **Use case: Quick checks** in homes or when equipment is limited.

Earth Loop Tester Method

- **Concept:** Used to check the resistance of the **whole loop** from the supply to earth.
- **Steps:** Connect terminals: Phase, Neutral & Earth Electrode.
- Internal transformer injects current
- Measures total loop resistance (circuit + cable + electrode)

- **Use case:** Used in **industrial & substation settings**, often with a **500V megger**.



Conclusion

- Proper earthing is essential for both operational safety and system protection.
- A well-designed earthing system minimizes electrical hazards, ensures compliance with standards, and prolongs equipment life.

Thank You!