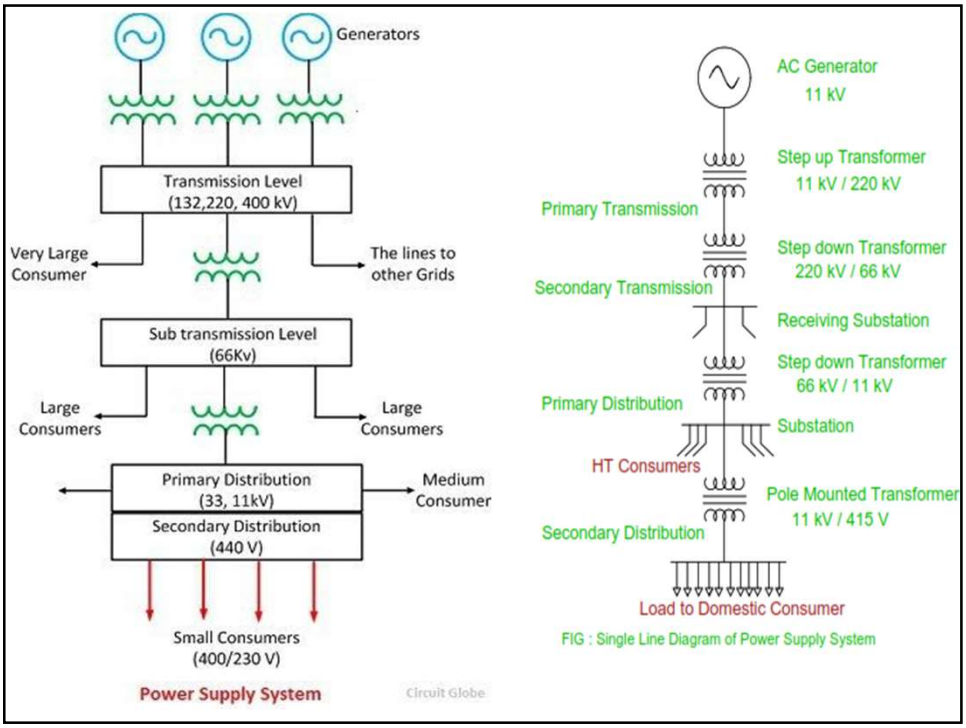
Module – 6

- Electrical power generation
- Transmission and distribution systems
- Electrical safety earthing protective devices



SAFTEY

A - *AWARE*

B - *BREAK* **(THE SUPPLY)**

C - *CONFIRM* & COMMUNICATE

D - *DISCHARGE*

E - *EARTH*

AWARE

BEFORE STARTING ANY WORK

YOU SHOULD BE AWARE OF:

- SOURCE OF SUPPLY
- WHETHER NORMAL OR UNDER BACK FEEDING
- WHERE TO ISOLATE
- WHERE TO WORK
- HOW TO WORK
- WHAT IS THE NATURE OF WORK
- MATERIALS REQUIRED FOR THE WORK
- TIME REQUIRED TO COMPLETE THE WORK
- HOW MANY PERSONS REQUIRED FOR THE WORK

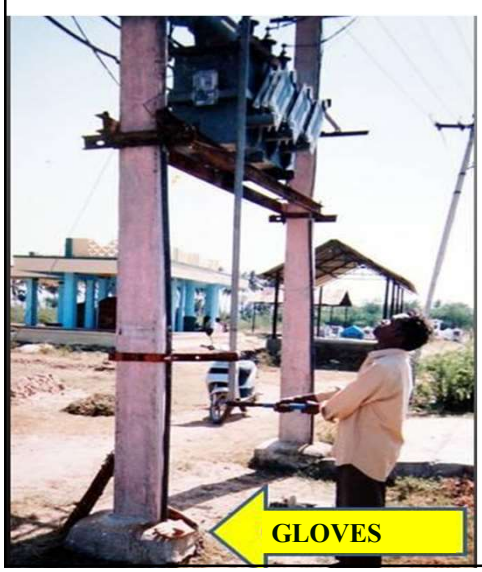
BREAK (THE SUPPLY)

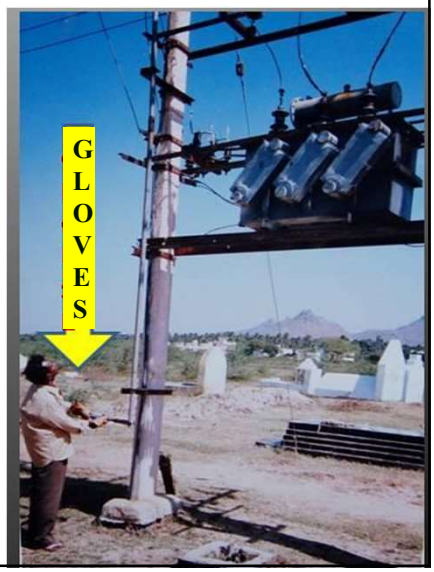
BREAKING OF SUPPLY IS ESSENTIAL FOR CARRYING OUT ANY WORKS:

SWITCH ***OFF*** THE CORRECT CIRCUIT ON WHICH YOU ARE GOING TO WORK.

ALWAYS GLOVES SHOULD DE USED WHEN OPERATING ***AB*** SWITCHES .

USE GLOVES WHILE OPENING AB SWITCH





The handle of AB switches should be effectively earthed by means of a good wire so that in case of insulation failure , there is an alternate path to earth and the person operating is protected.

- While switching OFF Supply, it should be watched whether all the 3 blades are coming out uniformly.
- While opening the AB switch, please ensure that the ARC should not persist for a long time and the ARC should not be jumped to other circuits.

LOCK OUT AND TAG OUT

- ONCE THE CIRCUIT HAS BEEN SHUT-OFF AND DE-ENERGISED, LOCK OUT THE SWITCH GEAR TO THE CIRCUIT,SO THAT POWER CANNOT BE TURNED BACK ON IN ADVERTANTLY.
- THEN TAG OUT THE CIRCUIT WITH AN EASY TO SEE SIGN OR LABEL THAT LETS EVERY ONE KNOW THAT YOU ARE WORKING.

C-CONFIRM

- **THOUGH YOU HAVE SWITCHED “OFF” THE SUPPLY, IT IS NOT ENOUGH AND SHOULD BE CONFIRMED THAT THERE IS NO POSSIBILITY OF SUPPLY IN THE SPOT OR AREA OR EQUIPMENT WHERE YOU HAVE TO WORK.**
- **CONFIRMATION PROVIDES ADDITIONAL SAFETY FOR PERSONNEL.**

CONFIRMATION CAN BE MADE BY THE FOLLOWING WAYS.

- 1) PHYSICAL INSPECTION TO SEE ALL THE 3 BLADES WERE OPENED AND THERE IS NO PARTIAL CLOSING.
- 2) WATCH THE TRANSFORMER HUM,OR STOPPAGE OF WORKING APPLIANCES.
- 3) IT SHALL BE ENSURED THAT THE SUPPLY “CUT-OFF” IS ONLY DUE TO OUR SWITCHING OPERATION ONLY.

High voltage neon lamp contact indicator

Contact Indicator and Phasing Rods

DISCHARGING

- **After disconnection from supply has been made the line / equipment on which work is to be taken up shall be discharged and effectively earthed.**

- **Even after they are disconnected from supply source, some equipment (and also by transmission lines) retain an Electrical charge which makes it dangerous to touch. They shall be discharged by a suitable discharging rod.**

- **Usually sparks are noticed while discharging. It is also likely that the line which is being discharged may actually be live**
- **In such cases it is necessary to use gloves or both hands for handling the discharge rods.**

- **The wires carrying the discharge current shall be kept at least 0.75m away from the body of the person who is handling it.**

- **As far as practicable, the person discharging the lines or equipments shall maintain his position well below the level of conductors to be earthed in order to keep his / her body away from any arc that may occur during discharge.**

- The discharging rod shall be brought near to the circuit slowly and if any arcing or flash over is noticed then it shall be with drawn immediately.
- A report on such arcing / flash over shall be made to the person who issued the LCP.

- Each & every one of the conductor including neutral shall be discharged as above.
- All the conductors after discharging shall be short circuited together and earthed effectively as per the procedure narrated in the next chapter.

- The leads used for discharging shall be tested for continuity before use and is of stranded flexible conductor instead of solid wire, preferably of copper.
- The discharging rod shall be of a standard design to ensure good contact with the conductor and the earth. It shall be tested for insulation at least once in a quarterly and checked before use.

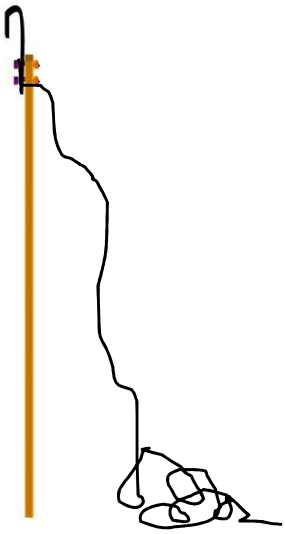
Procedure for Earthing:

- Earthing shall be done on all the sides (incoming & out going) at the place of work.
- Short circuiting shall not be treated as a substitute for earthing and standard Earthing rods shall be used.

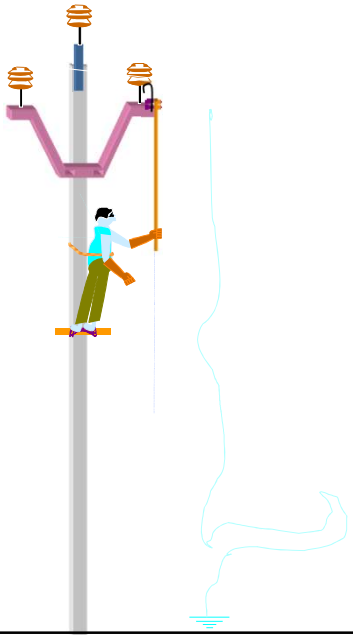
- The earthing and discharging shall be done by an authorized person only.
- The earthing kit consists of 3 No wooden rods with clamps on top of each, designed for securing and holding tightly with the line or droppers. This can be done by turning the bottom end of the rod.

- From each of the above top clamps leads are brought down and bunched together. These are connected directly to an earth or to a pole clamp which is again earthed.
- If there is no earth near by, a temporary earth shall be provided by driving a crow bar or pipe in to the earth.

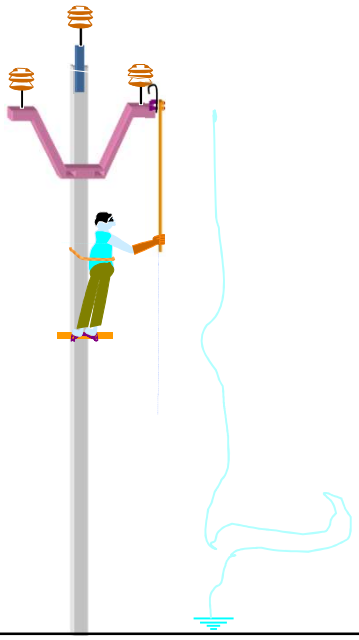
DISCHARGE ROD



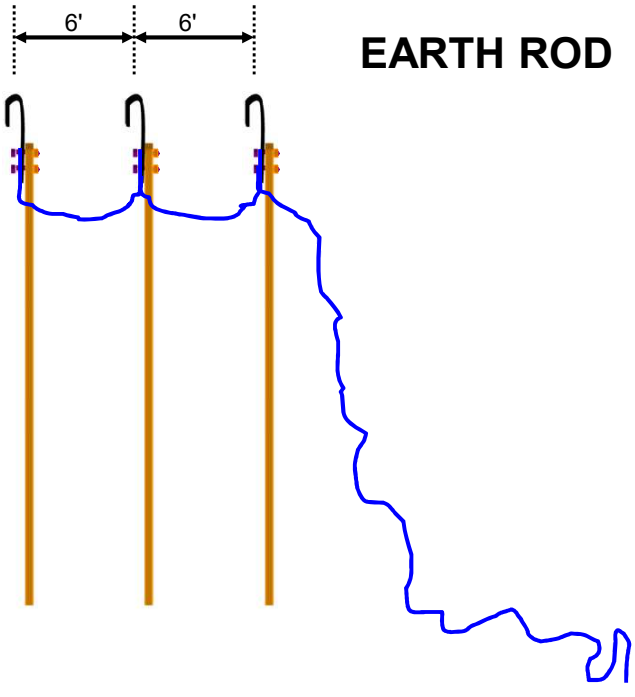
DISCHARGING



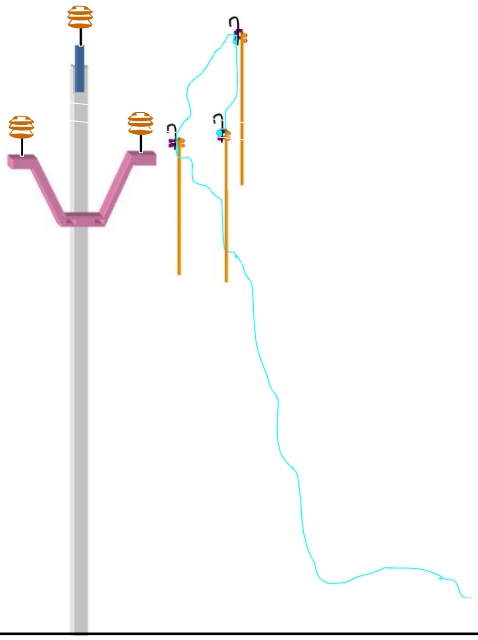
DISCHARGING



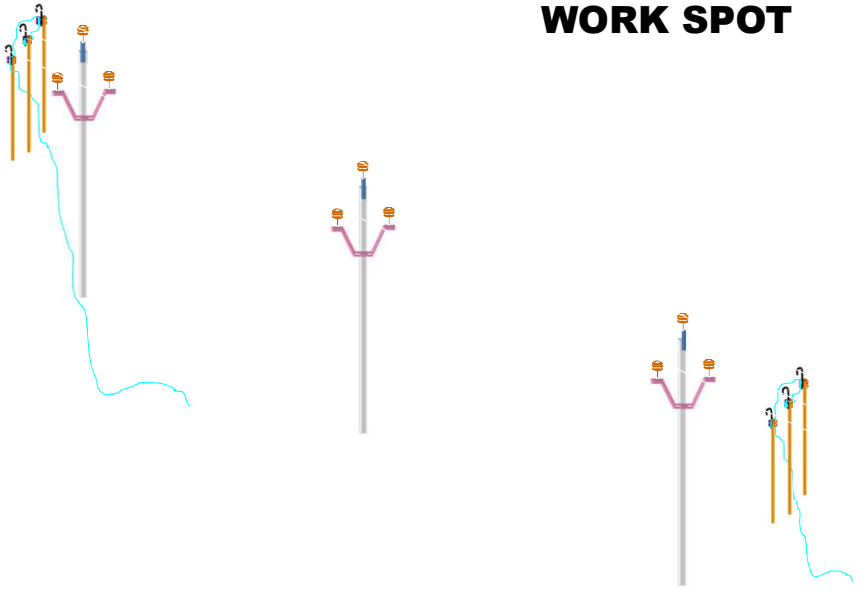
EARTH ROD



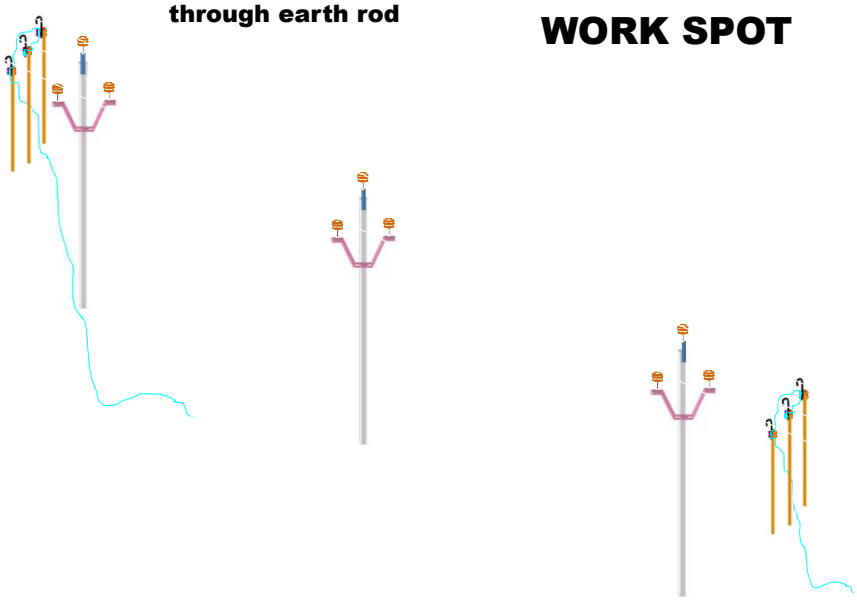
EARTH ROD



WORK SPOT

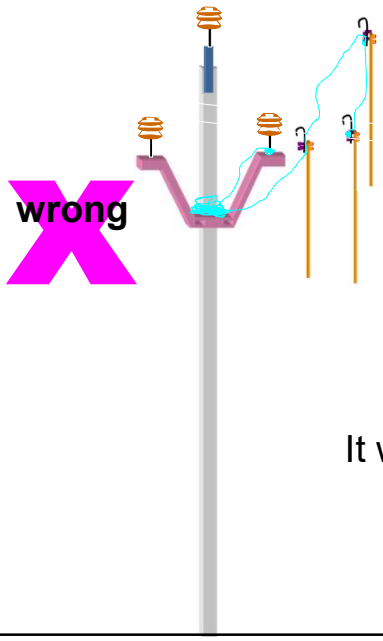


If any Back feeding supply comes to the work spot It will be Discharged to the earth through earth rod



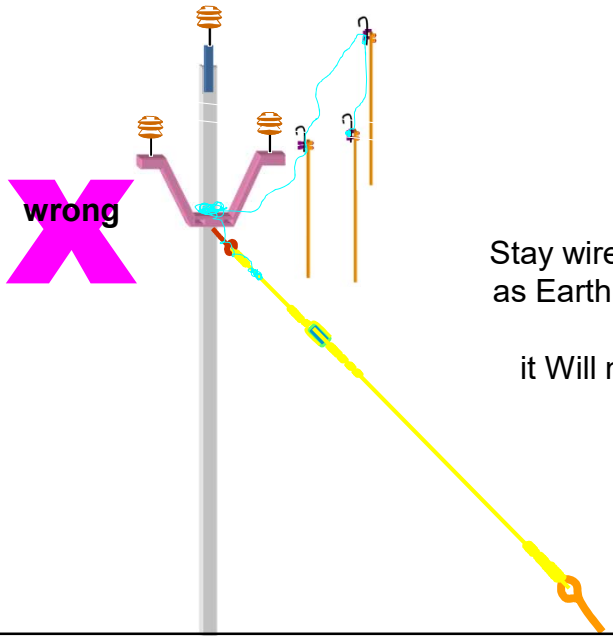
WORK SPOT

EARTH ROD



if earthing is done so,
it will be ineffective and
Will not give protection.
It will cause in convenience
for working

EARTH ROD



Stay wires shall not be used as Earth wires. if earthing is done so,
it Will not give protection

- At first, the bunched end of the earth leads should be connected to the earth firmly, and then only to the line.
- Simultaneous connection one to the earth and another to the line shall not be resorted to at any case.

- After discharging only, the earth rods shall be secured by screwing and than the rest of the line similarly earthed.

- **While removing the earthing, the earth rod shall first be removed from the spot and after all the earth rods are so removed, the connection to the earth pipe shall be removed finally.**

- **The earths shall be placed in such a manner that they will not be detached in advertently due to movements of men and other causes.**
- **In the case of lines meeting or crossing at any poles on which work is to be taken up, all the lines crossing or ending at this pole shall be earthed.**

- **Stay wires shall not to be used for the purpose of earthing.**
- **All conductors shall be treated as alive until they have been grounded properly.**
- **Earthing shall never be fixed or removed by bare hands.**

EARTHING

What is Earthing ?

Earthing means an electrical connection to the general mass of earth to provide safe passage to fault current to enable to operate protective devices and provide safety to personnel and Equipments.

Objectives of Earthing :-

- Avoid potential rise of parts of equipments other than the live parts.
- Safe passage to earth for the fault current.
- Suppress dangerous potential gradients on the earth surface.
- To retain system voltages within permissible limits under fault conditions.
- To facilitate using of Graded insulation in power transformers

Types of Earthing

- ***Neutral Earthing*** : deals with the earthing of system neutral to ensure system security and protection.
- ***Equipment Earthing*** : deals with earthing of non-current carrying parts of equipment to ensure safety to personnel and protection against lightning.

Objectives of grounding:

- Provides an electrical supply system with a reference to the ground (system grounding)
- Protective grounding of electrical equipment enclosures
  - Makes them safe to persons who may come into contact with them
  - Enables the flow of fault current in the event of a failure
- Provides a low impedance path for accumulated static charges and surges (lightning protection grounding)
- Helps in mitigating the generation and propagation of noise (grounding of shields and signal reference planes)

System grounding

- Provides reference for the entire power system to groundmass
- Establishes a path for current to ground during insulation failure
- Provides protection against equipment damage due to faults
- Provides protection against high voltage transients
- Enables detection by circuit protective devices for isolation
- Reduces maintenance time and expenditure

Electricity likes to travel the path of least resistance. When there's too much of it, it needs somewhere to go. That's where grounding comes in. You see, without it, that path of least resistance is your appliances and electronics

Earthing System

Shall satisfy Safety, Functional requirements of electrical installation

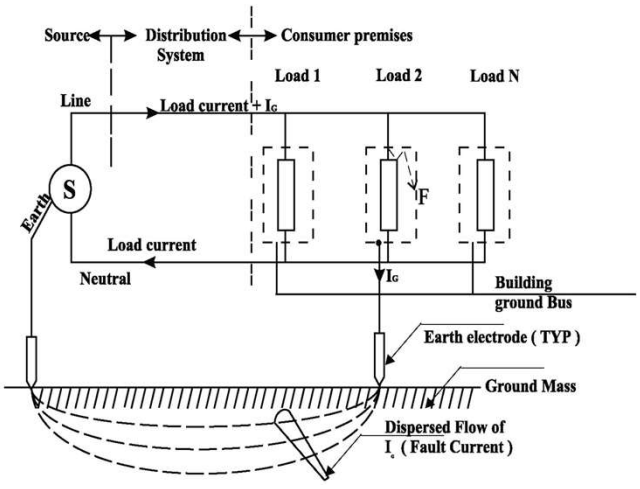
Shall ensure

- Protection against indirect contact
- Proper functioning of electrical protective devices
- Protective and functional requirements are met under expected conditions
- Earth fault, earth leakage currents can be carried safely
- Adequate strength appropriate to external influences
- Adequate value of earthing resistance

Benefits Of Earthing

- Low Fault Currents reduce possibility of igniting gases
  Minimizes explosion hazard
- Lower Magnetic or thermal stresses imposed on plant during fault
- Transient overvoltages limited
  Prevents stressing of insulation, breaker restrikes

Ground fault current flow:



Importance of Earthing

! Ensure earthing before working on electrical equipment

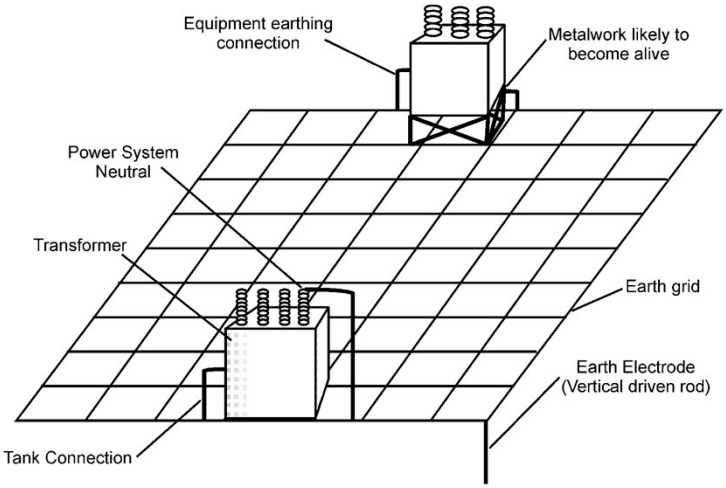
Earthing

- Connect apparatus electrically to general mass of earth in such a manner as will ensure at all times an immediate safe discharge of electrical energy
- Connect to earthed metal earth bar or spike with good metallic conductor

Earthing by

- Closing of earthing links
- Attaching of fixed earthing devices
- Affixing of portable earthing straps

Typical Earthing System



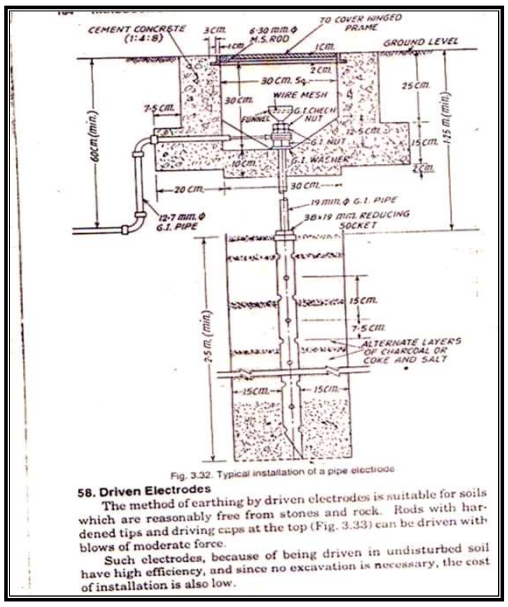


Fig. 3.32. Typical installation of a pipe electrode

58. Driven Electrodes

The method of earthing by driven electrodes is suitable for soils which are reasonably free from stones and rock. Rods with hardened tips and driving caps at the top (Fig. 3.33) can be driven with blows of moderate force.

Such electrodes, because of being driven in undisturbed soil have high efficiency, and since no excavation is necessary, the cost of installation is also low.

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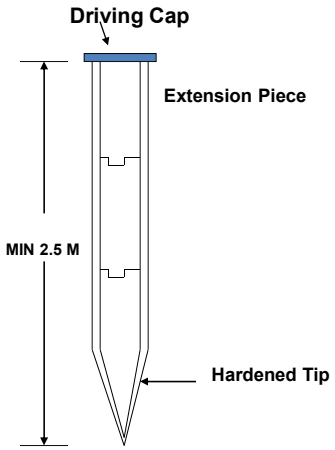


ROD DRIVEN ELECTRODE FOR M.V.INSTALATIONS

Touch Voltage

Permissible Touch Voltage

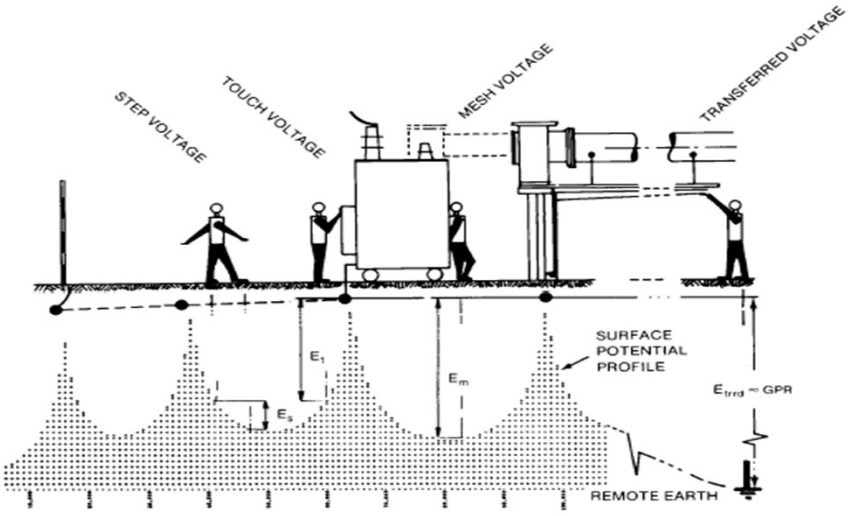
Voltage at any point of contact with uninsulated metal work

- Within 2.5 mtrs from ground surface and
- Any point on ground surface within horizontal distance of 1.25 mtrs from vertical projection of point of contact with uninsulated metal work

Step Voltage

- Difference in surface potential experienced by a person bridging a distance of 1 mtr with his feet apart, without contacting any other earthed object
- Shall not exceed twice the value of Touch voltage

Voltages in grounding system:



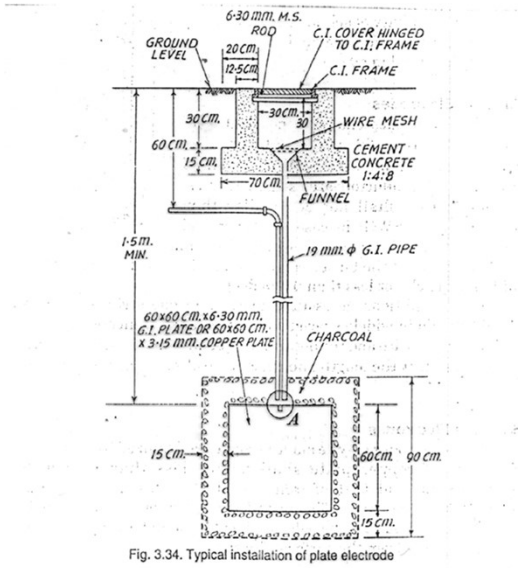
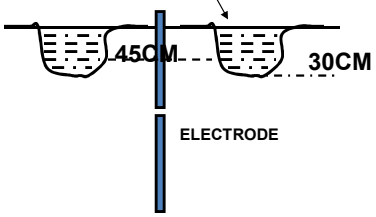


Fig. 3.34. Typical installation of plate electrode

The use of plate electrodes is recommended in generating stations and sub-stations where current-carrying capacity is the prime consideration.

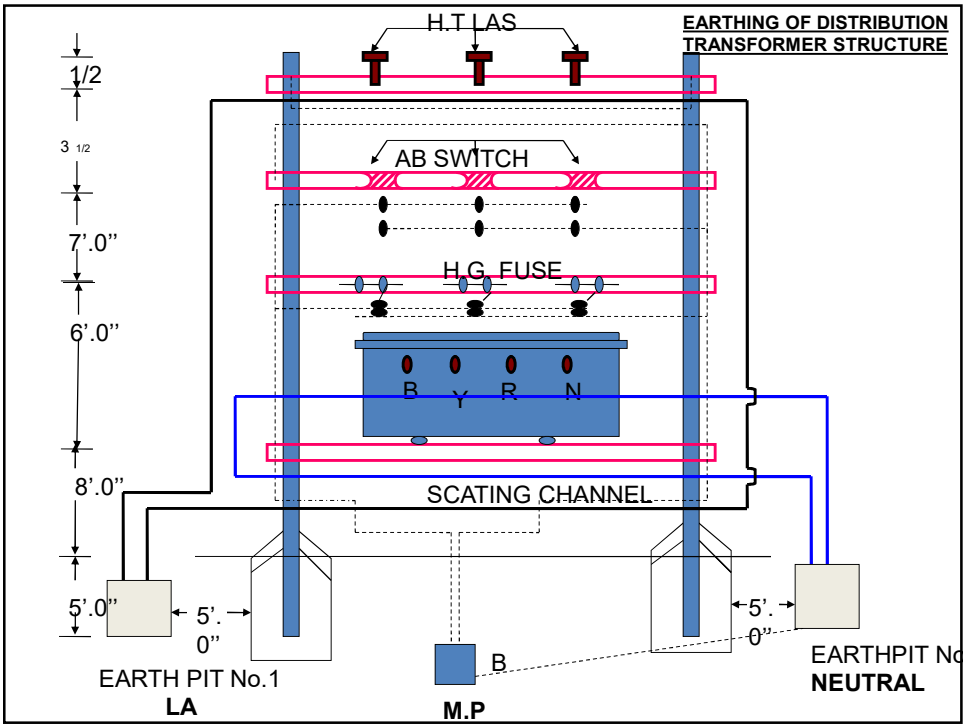
SOIL TREATING MATERIAL PLACED IN CIRCULAR TRENCH AND COVERED TO CLEAN EARTH

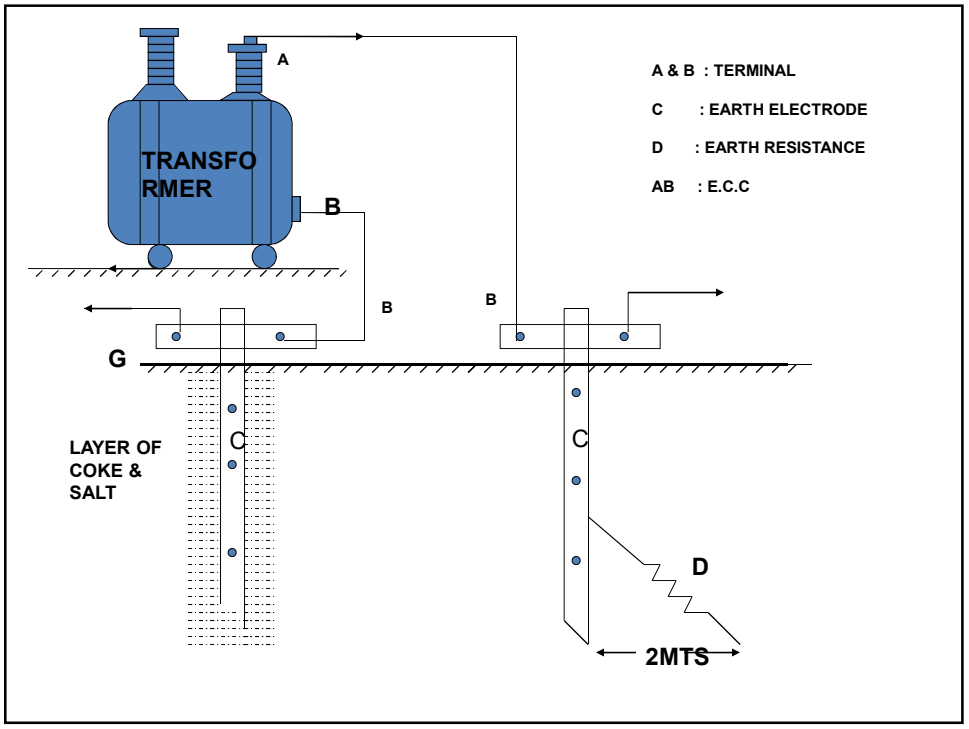


CHEMICAL TREATMENT OF SOIL

1. **BENTONITE POWDER**
2. **FLY ASH**

EARTHING OF DISTRIBUTION TRANSFORMER STRUCTURE





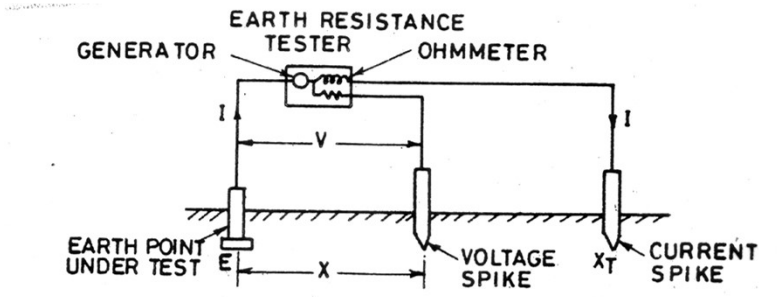
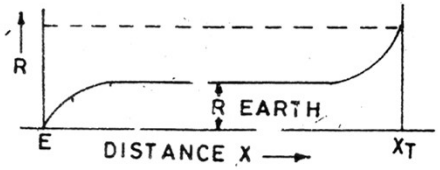


Fig. 4.4A. Earth resistance measurement (voltage spike moved between E and X_T and several readings taken).



PROTECTIVE DEVICES

Protective Devices

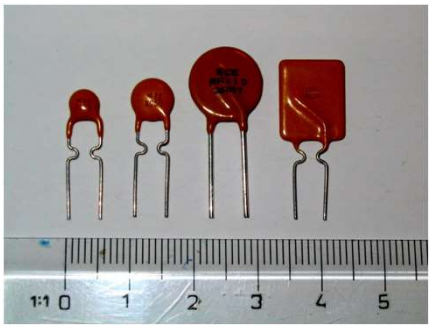
- Fuse.
- Circuit Breaker.
- PolySwitch.
- RCCB.
- Metal Oxide Varistor.
- Inrush Current Limiter.
- Gas Discharge Tube.
- Lighting Arrester.

Circuit Breaker

- A circuit breaker is one kind of electrical switch used to guard an electrical circuit against short circuit otherwise an overload which will cause by excess current supply. The basic function of a circuit breaker is to stop the flow of current once a fault has occurred. Not like a fuse, a circuit breaker can be operated either automatically or manually to restart regular operation.
- Circuit breakers are available in different sizes from small devices to large switch gears which are used to protect low current circuits as well as high voltage circuits

Poly Switch or Resettable Fuse

- A resettable fuse is a passive electronic component used for protecting electronic circuits from over-current mistakes. This device is also called as a poly switch or multi fuse or poly fuse. The working of these fuses is same as thermistors in particular situations, however, work on mechanical transforms instead of charge-carrier-effects within semiconductors.
- Resettable Fuses are used in several applications like power supplies in computers, nuclear or aerospace applications where substitution is not easy.



RCCB or RCD

- The RCD-residual current device (or) RCCB- residual current circuit breaker is a safety device which notices a problem in your home power supply then turns OFF in 10-15 milliseconds to stop electric shock. A residual current device does not give safety against short circuit or overload in the circuit, so we cannot change a fuse instead of RCD.

Metal Oxide Varistor

- A varistor or VDR (voltage dependent resistor) is an electronic component and the resistance of this is changeable and depends on the applied voltage. The term varistor has been taken from the variable resistor. When the voltage of this component increases then the resistance decreases. In the same way, when an extreme voltage increases then the resistance will decrease significantly.

Surge Protection Device

- The term SPD stands for Surge Protection Device is one type of component used in an electrical fitting security system. The SPD device is allied in parallel in the power supply circuit, which can be used on all stages of the power supply system. The **surge protection device** is the most frequently used and also well-organized kind of over-voltage **protective devices**.

ELCB

- ELCB helps to break the circuit automatically whenever there is a current leak due to insulation failure or any other reason. Hence a person touching the electric circuit or a device does not get an electric shock. Nowadays RCCB, which ensures more safety than ELCB is made use of. In an ELCB one end of the relay coil is connected to the outer metallic cover and the other end is earthed.

What is a Fuse

The fuse was originally invented by Edison in the year 1880. It is being considered as the weakest link in the electrical circuit.

It is used to protect circuits from over current, overload and make sure the protection of the circuit. Many types of fuses available , but function of all same.

Fusing Element : A fuse is essentially a small piece of metal connected in between two terminals mounted on an insulated base which forms a series part of the circuit.

Duty of the fuse wire is to carry the normal working current safely without heating , but when normal current exceeds ,it should rapidly heat up to the melting point.

Different Types of Fuses

Fuses can be divided into two main categories according to the type of input supply voltage.

AC fuses

DC fuses

Different Types of Fuses

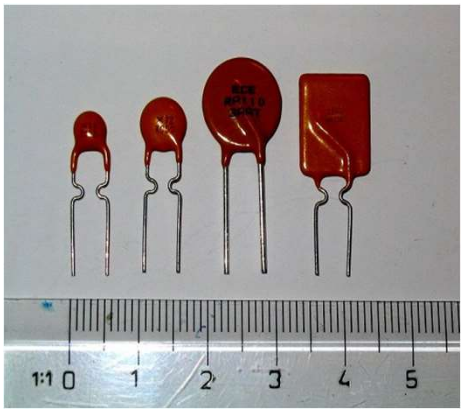
1) One time use only Fuse

2) Resettable Fuses

One time use fuses contain a metallic wire, which burns out, when an over current, over load or mismatched load connect event occur, user has to manually replace these fuses, switch fuses are cheap and widely used in almost all the electronics and electrical systems.

Resettable Fuses:

Resettable fuse is a device, which can be used as multiple times without replacing it. They open the circuit, when an over current event occurs and after some specific time they connect the circuit again. Polymeric positive temperature coefficient device (PPTC, commonly known as a resettable fuse, poly-switch or poly-fuse) is a passive electronic component used to protect against short current faults in electronic circuits. Application of such fuses is overcome where manually replacing of fuses is difficult or almost impossible, e.g. fuse in the nuclear system or in aerospace system.



Fuses can also be categorized on the following basis

- Current carrying Capacity of Fuse
- Breaking capacity
- I^2t value of Fuse
- Response Characteristic
- Rated voltage of Fuse
- Packaging Size
- Horn Gap Fuse or HG Fuse.

Fuse Current Carrying Capacity:
Current carrying capacity is the amount of current which a fuse can easily conduct without interrupting the circuit.

Breaking capacity:
The value of maximum current that can safely be interrupted by the Fuse is called Breaking Capacity and should be higher than the prospective short circuit current.

I^2t value of Fuse
The I^2t terms related to fuse normally used in short circuit condition. it is the amount of energy which carry the fuse element when the electrical fault is cleared by fuse element.

Cartridge fuses (HRC FUSE)

Cartridge fuses are used to protect electrical appliances such as motors air-conditions, refrigerator, pumps etc, where high voltage rating and currents required. They are available up to 600A and 600V AC and widely used in industries, commercial as well as home distribution panels.

There are two types of Cartridge fuses.

1. **General purpose fuse** with no time delay
2. **Heavy-duty cartridge fuses** with time delay.

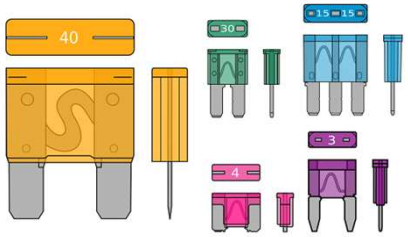
Both are available in 250V AC to 600V AC and its rating can be found on the end cap or knife blade.

HRC FUSE

The material, which has been filled inside the space, may be plaster of Paris, quartz, chalk, marble, dust and cooling mediums etc. That's why it carries normal current without overheating. The heat being produced vaporizes the silver melted element. Chemical reaction takes place between silver vapor and filling powder results in high resistance substance, which helps in quenching the arc in fuse.

Blade Type fuses:

This type of fuses (also known as spade or plug-in fuses) comes in plastic body and two metal caps to fit in the socket. Mostly, they used in automobiles for wiring and short circuit protection



HORN GAP FUSE