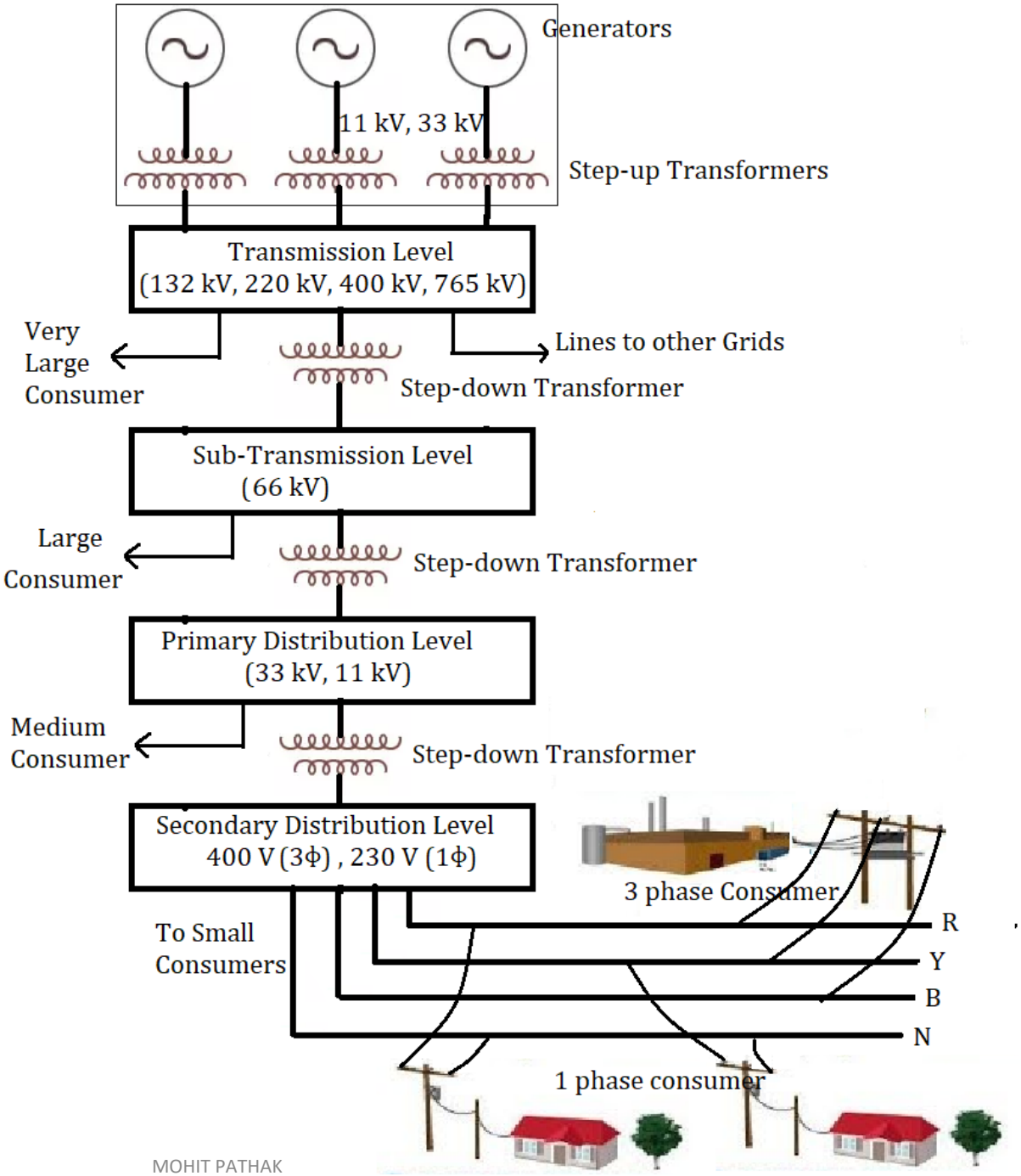
Introduction to Power System

- The power system is a network which consists generation, distribution and transmission system.
- It uses the form of energy (like coal and diesel) and converts it into electrical energy. The power plant, transformer, transmission line, substations, distribution line, and distribution transformer are the six main components of the power system.

Introduction to Power System

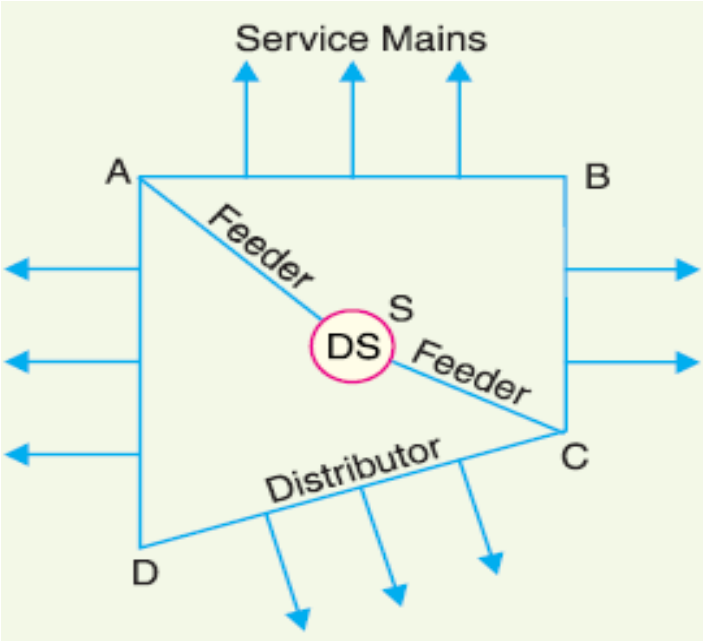
- **Layout of Power System**
- The power system is the complex enterprise that may be subdivided into the following sub-systems.

1. Generating System
2. Transmission System
3. Distribution System



Components of Distribution System:

- The secondary distribution system consists of *feeders, distributors and service mains*.
- Feeders (*SC* or *SA*) radiating from the distribution sub-station (*DS*) supply power to the distributors (*AB*, *BC*, *CD* and *AD*).
- No consumer is given direct connection from the feeders.
- Instead, the consumers are connected to the distributors through their service mains.

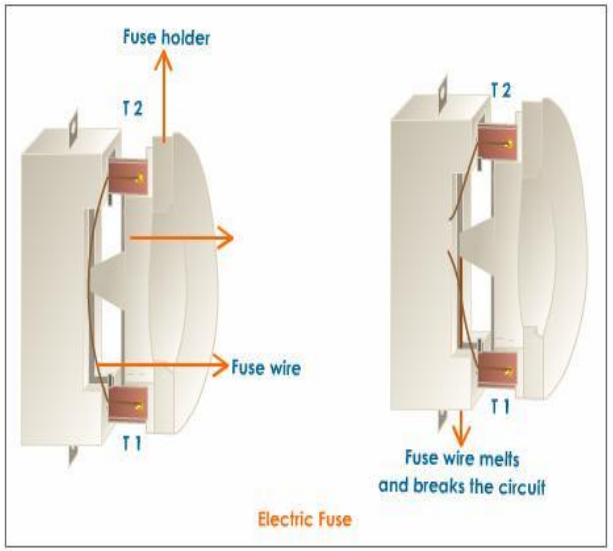


Components of LT Switchgear

- The apparatus used for switching, controlling and protecting the electrical circuits and equipment is known as switchgear.

- The term ‘switchgear’ is a generic term encompassing a wide range of products like Switch fuse unit (SFUs), Miniature circuit breaker (MCBs), Earth leakage circuit breakers (ELCBs), Molded case circuit breaker (MCCBs) etc...

1. Switch Fuse Unit (SFUs)



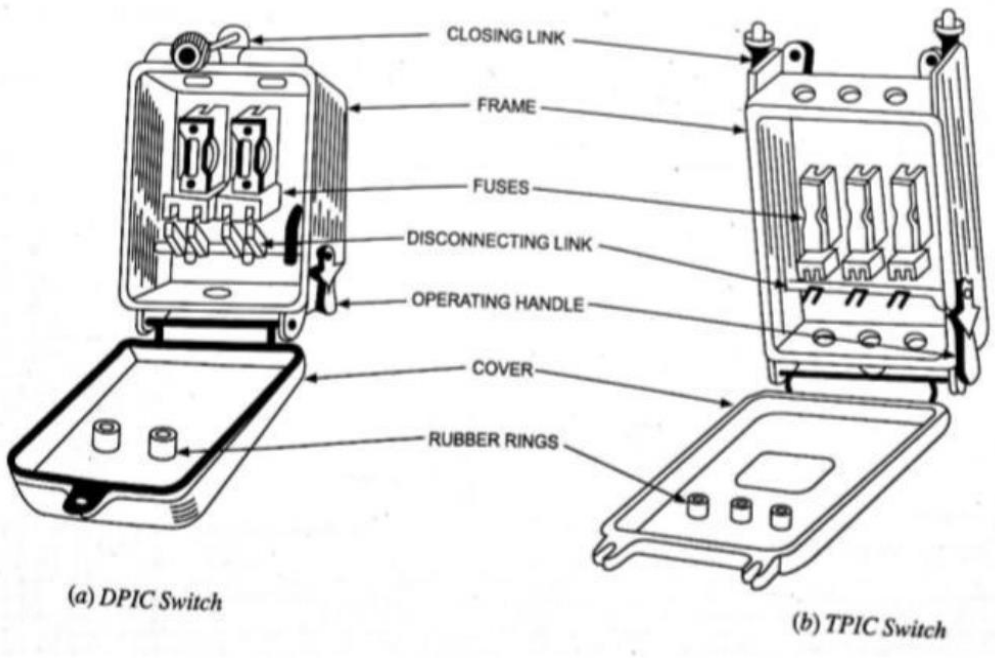
1. Switch Fuse Unit (SFUs)

- It has one switch unit and one fuse unit. When we operate the breaker, the contacts will get close through switch and then the supply passes through the fuse unit to the output.

- Switch fuse is a combined unit and is known as an iron clad switch, being made of iron. SFUs are of three types:

- DPIC
- TPIC
- TPNIC

1. Switch Fuse Unit (SFUs)



a) DPIC (double pole iron clad) type: It is used for controlling single phase two-wire circuits and available for 240V, 16A.

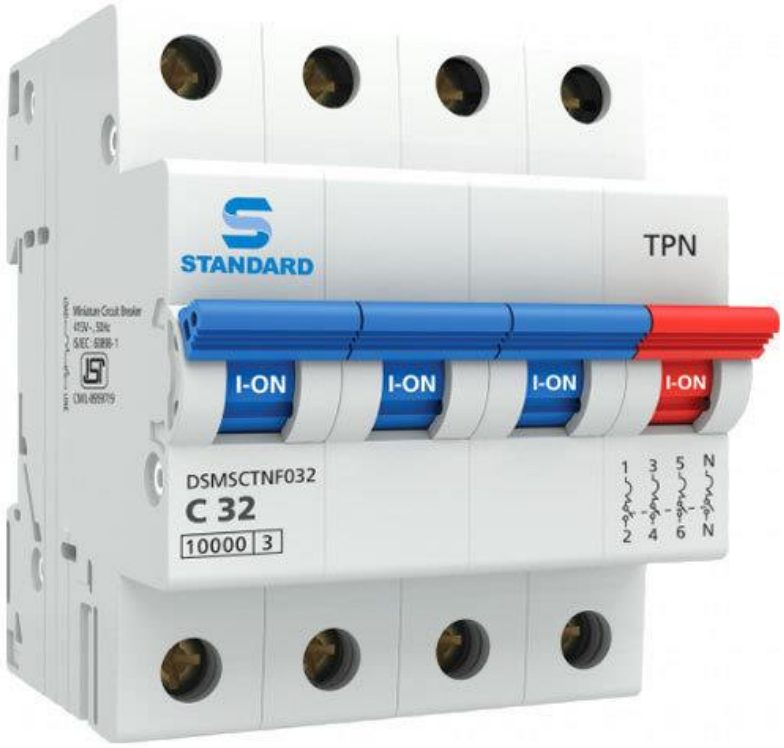
b) TPIC (triple pole iron clad) type: It is used for controlling three-phase, 3-wire circuits and available for 500V, 32A (63/100/150 or higher amperes).

c) TPNIC (triple pole with neutral link iron clad) type: It is used for controlling 3-phase, 4-wire circuits and available for 415V, 32A (63/100/150 or higher amperes).

2. Miniature circuit breaker (MCBs)

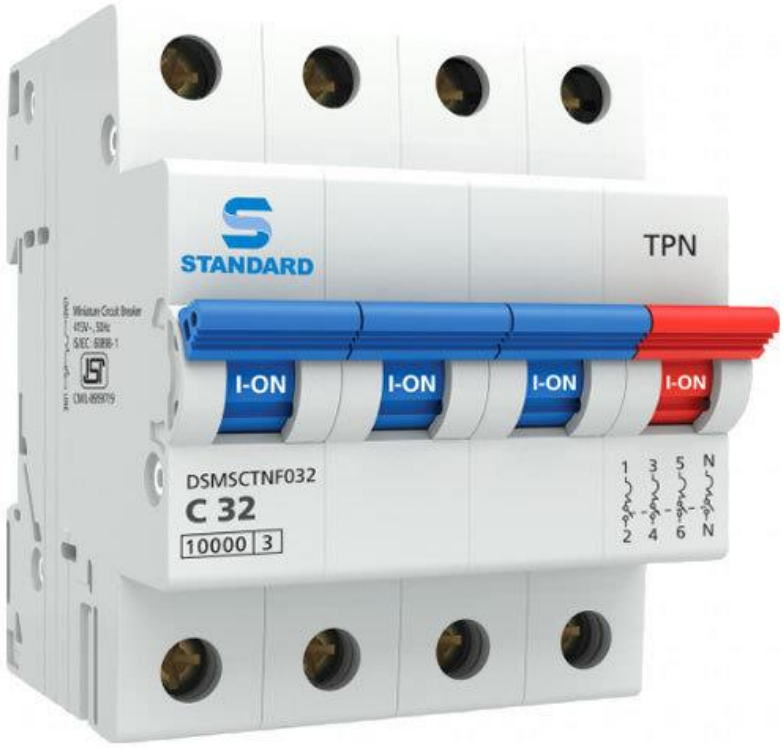
MCB is an electromechanical device which guards an electrical circuit which automatically switches off electrical circuit during abnormal condition of the network means in over load condition as well as faulty condition.

It provides definite protection to the wiring installations and equipment against over-currents and short-circuit faults.



2. Miniature circuit breaker (MCBs)

MCBs are available with different current ratings of 0.5, 1.2, 2.5, 3, 4, 5, 6, 7.5, 10, 16, 20, 25, 32, 35, 40, 63, 100, 125, 160 A and voltage rating of 240/415 V AC and up to 220 V DC. Operating time is very short (less than 5ms).



3. Earth leakage circuit breaker (ELCBs)

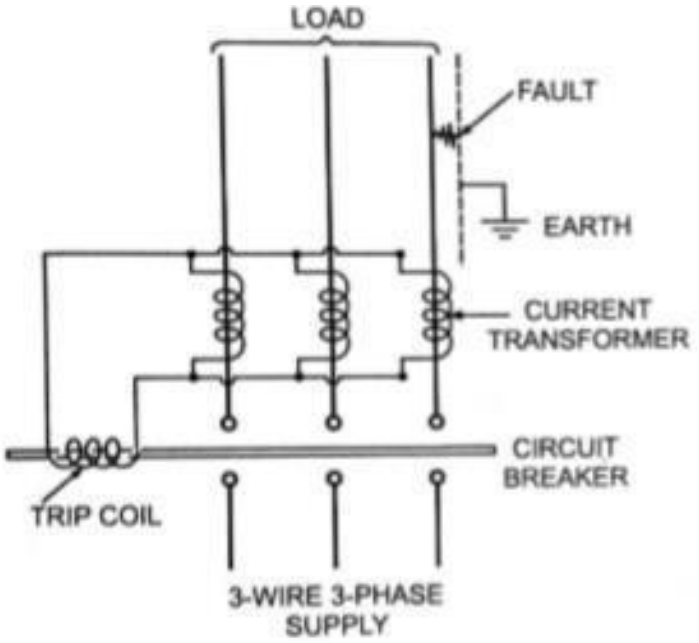
- None of the protection devices like MCB can protect the human life against electric shocks or avoid fire due to leakage current.
- ELCB is a device that provides protection against earth leakage.
- These are of two types.

1. **Current operated earth leakage circuit breaker.**
2. **Voltage operated earth leakage circuit breaker.**

3. Earth leakage circuit breaker (ELCBs)

1. **Current operated earth leakage circuit breaker:**

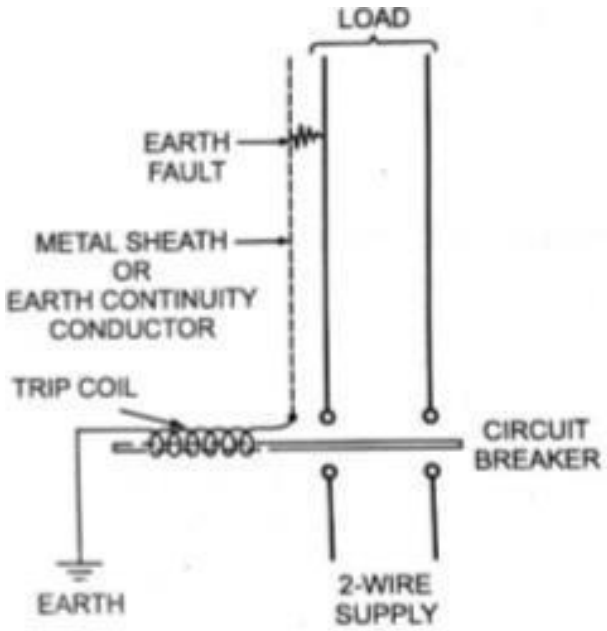
- A current-operated earth leakage circuit breaker is applied to a 3-phase, 3-wire circuit.
- In normal condition when there is no earth leakage, the algebraic sum of the currents in the three coils of the current transformers is zero, and no current flows through the trip coil.
- In case of any earth leakage, the currents are unbalanced and the trip coil is energized and thus the circuit breaker is tripped.



3. Earth leakage circuit breaker (ELCBs)

❑ 2. **Voltage operated earth leakage circuit breaker:**

- A current-operated earth leakage circuit breaker is applied to a 1-phase, 2-wire circuit.
- When the voltage between the earth continuity conductor (ECC) and earth electrode rises to sufficient value, the trip coil will carry the required current to trip the circuit breaker.



4. Molded case circuit breaker (MCCBs)

- Molded case circuit breakers are a type of electrical protection device that is commonly used when load currents exceed the capabilities of miniature circuit breakers.
- They are also used in applications of any current rating that require adjustable trip settings, which are not available in plug-in circuit breakers and MCBs.
- MCCBs are much larger than MCBs.

4. Molded case circuit breaker (MCCBs)

- An MCCB has three main functions:

- **Protection against overload.**
- **Protection against electrical faults.**
- **Switching a circuit ON and OFF.**

- MCCB can have current ratings of up to 2,500 amperes, and its trip settings are normally adjustable.

Electrical Earthing

- The process of transferring the immediate discharge of the electrical energy directly to the earth by the help of the low resistance wire is known as the electrical earthing.
- The qualities of good earthing are:

➢Must be of low electrical resistance

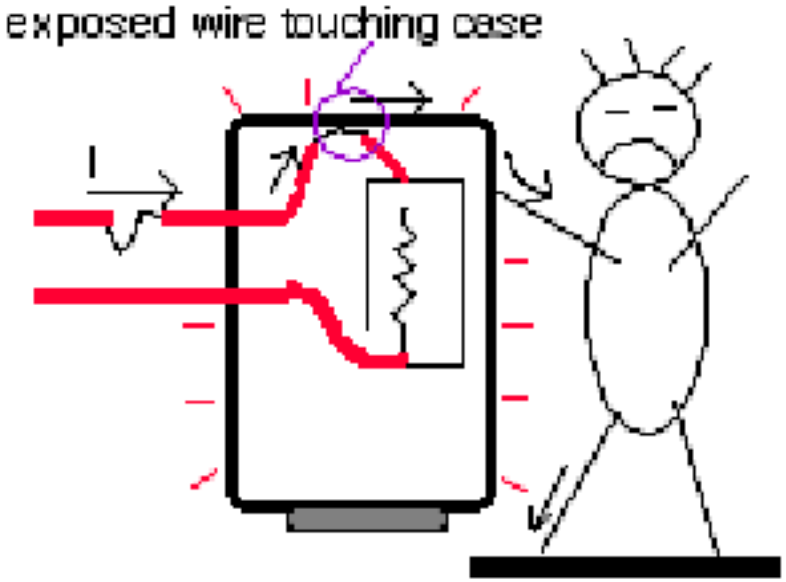
➢Must be of good corrosion resistance

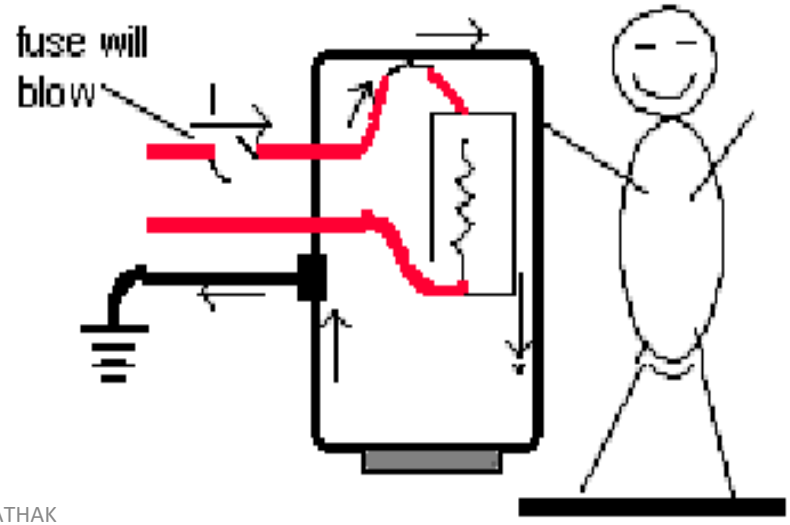
➢Must be able to dissipate high fault current repeatedly

Need of Earthing

- It keeps people safe by preventing electric shocks.
- It prevents damage to electrical appliances and devices by preventing excessive current from running through the circuit.
- It prevents the risk of fire that could otherwise be caused by current leakage.

Need of Earthing





Methods of Earthing

There are different types of earthing methods are used:

1. Strip or Wire Earthing.
2. Rod Earthing.
3. Pipe Earthing.
4. Plate Earthing.

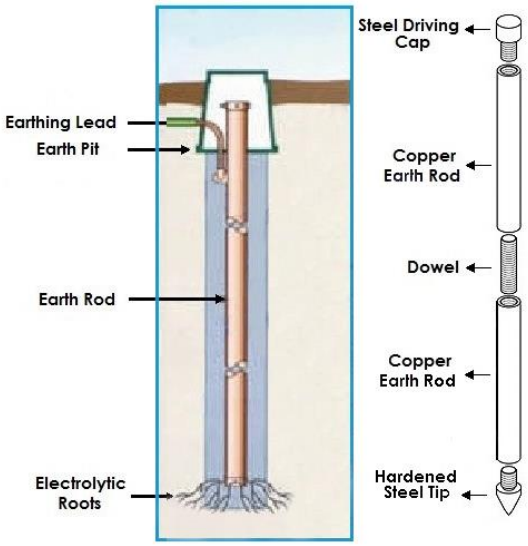
Methods of Earthing

1. Strip or Wire Earthing:

- strip electrodes of copper or galvanized iron or steel are buried in horizontal trenches of minimum depth 0.5 metre.
- The length of buried conductor shall be sufficient to give the required earth resistance.
- Used at places which have rocky soil earth bed because at such places excavation work of plate earthing is difficult

Methods of Earthing

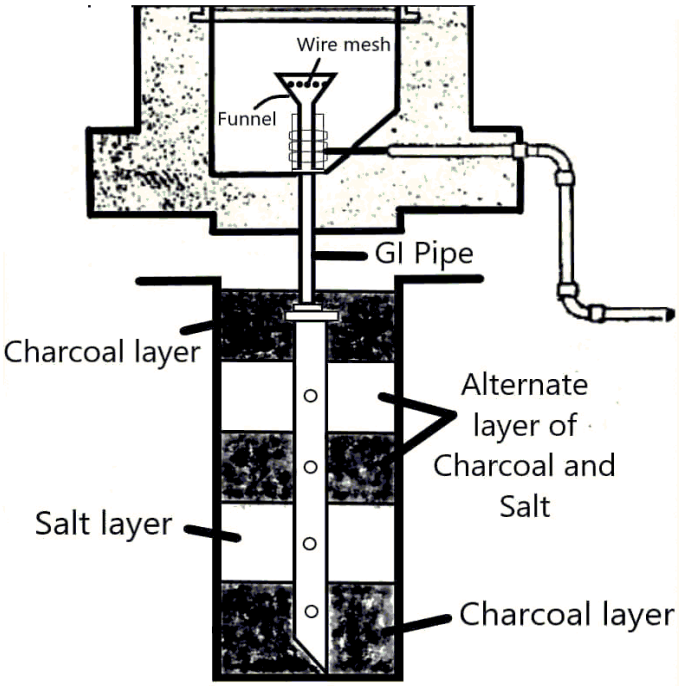
2. Rod Earthing:



- In this type of earthing, 12.5 mm solid rods of copper or 16 mm diameter solid rods of galvanized iron or steel is driven vertically into the earth either manually or by pneumatic hammer.
- In order to increase the embedded length of electrodes under the ground, which is sometimes necessary to reduce the earth resistance to desired value, more than one rod sections are hammered one above the other.
- Suitable for areas which are sandy in character. This system of earthing is very cheap as no excavation work is involved.

Methods of Earthing

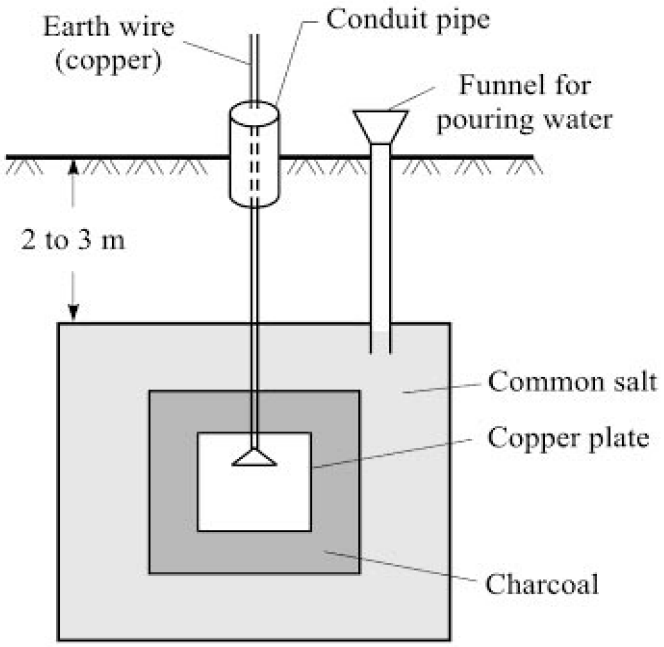
3. Pipe Earthing:



- **A** GI pipe with a few holes at its lower end is buried to a depth not less than 2 m and atleast 0.6 m away from the foundation of any building.
- Normally, the size of pipe is either 2m long and 38 mm diameter or 1.37 m long and 51 mm diameter.
- Alternate layers of common salt and charcoal have thickness of 30 mm and 80 mm, respectively.
- To maintain good conductivity of the soil, an arrangement is made for pouring water into the earth pit surrounding the earth electrode.

Methods of Earthing

4. Plate Earthing:



- In plate earthing an earthing plate either of copper of dimensions 60cm X 60cm X 3mm or of GI of dimensions 60cm X 60cm 6mm is buried into the ground with its face vertical at a depth of not less than 3 metres from ground level.
- The earth plate is embedded in alternate layers of charcoal and salt for a minimum thickness of 15cm. The earth wire is securely bolted to an earth plate.
- The copper plate and copper wire are usually not employed for grounding because of their higher cost.

Elementary calculation of energy consumption

- Electrical power is the rate which energy is delivered. It is measured in watts. Mathematically it is written as,

$$\textbf{Power} = \textbf{Voltage} \times \textbf{Current}$$

- Energy is the product of electrical power and time, and it measured in joules. It is defined as "1 joule of energy is equal to 1 watt of power is consumed for 1 second". i.e.,

$$\textbf{Energy} = \textbf{Power} \times \textbf{Time}$$

- **Watt-hour** is the standard unit used for measurement of electrical energy, describing the amount of watts used over a time.

$$\textbf{Energy in kWh} = \textbf{Power in kW} \times \textbf{Time in hours}$$

Elementary calculation of energy consumption

❖ Steps to estimate energy consumptions:

Step1: Calculate Watts Per Day: In this step, simply multiply your device's wattage by the number of hours you use it in a day. This will give you the number of watt-hours consumed each day.

Step2: Convert Watt-Hours to Kilowatts: Electricity is measured in kilowatt-hours on your bill. One kilowatt is equal to 1,000 watts.

Step3: Find Your Usage Over a Month: Now that you know the kWh used per day, multiply that by 30 to find your approximate usage for the month.

Step4: Figure Out the Cost: For the final step, refer to your last electric bill to see how much you pay per kWh, i.e. Tariff.

Elementary calculation of energy consumption

Q.1: If a home has 10 tube lights of 30W that run for 4 hours daily, 5 television of 200W running for 3 hours daily, 2 irons 1000W 1 hour weekly. Calculate total amount to be paid if the cost per unit is Rs. 7.

- Energy consumed by tube lights in one day,

$$= \frac{10 \times 30 \times 4}{1000} = 1.2\ kWh$$

- Energy consumed by tube lights in one month,

$$= 1.2 \times 30 = 36\ kWh$$

- Energy consumed by television in one day,

$$= \frac{5 \times 200 \times 3}{1000} = 3\ kWh$$

- Energy consumed by television in one month,

$$= 3 \times 30 = 90\ kWh$$

- Energy consumed by iron in one week,

$$= \frac{2 \times 1000 \times 1}{1000} = 2\ kWh$$

- Energy consumed by iron in one month,

$$= 2 \times 4 = 8\ kWh$$

Total energy consumption in one month,

$$= 36 + 90 + 8 = 134\ kW$$

Total amount to be paid = total energy consumption x price per unit

$$= 134 \times 7 = Rs.\ 938$$

Battery Backup

- A battery backup device is an electronic device that supplies secondary power in the event of main power failure.
- Battery backup devices can also protect electronic hardware from power spikes, dirty electricity and power outages.

Advantages & Disadvantages of battery backup system:

The advantages of battery backup system over generators are:

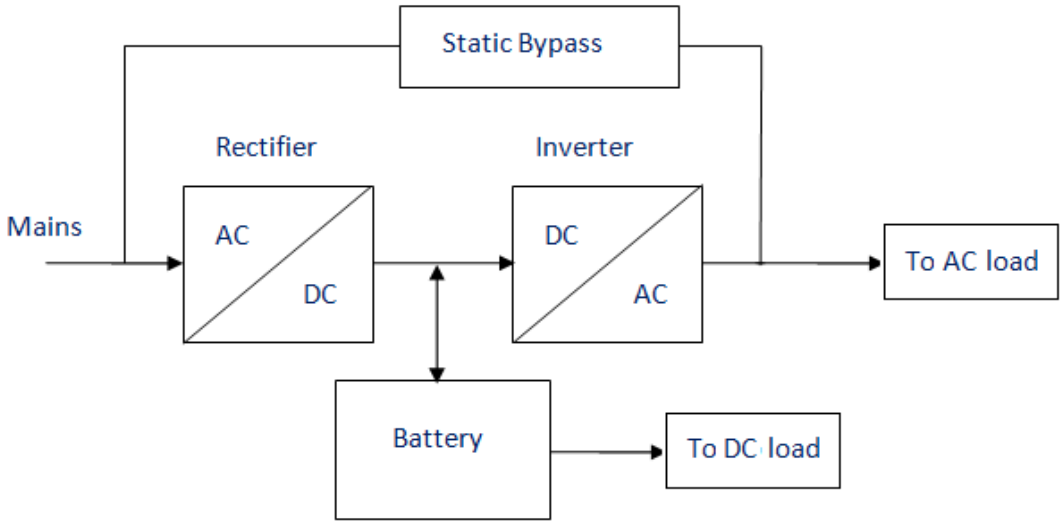
- Silent and non-polluting operations
- Instantaneous change over, when mains power fails or come back
- Low running cost (just limited to necessary power to charge the batteries.

The main disadvantage compared to generator is that the battery backup only supply power for a predetermined time and the backup decreases as the load increases.

Battery Backup

Components of battery backup system: A battery-based power back-up system has three main components.

1. Battery bank
2. Rectifier unit
3. Inverter unit



- **Rectifier unit:** the AC input is converted into DC by rectifying process with the help of the rectifier for storing it in the rechargeable battery.

- **Battery bank:** The battery bank works as the storage of the electric power. Different type of battery (Lithium-ion battery, redox-flow batteries, zinc-hybrid batteries etc) is used as per the load to be connected.

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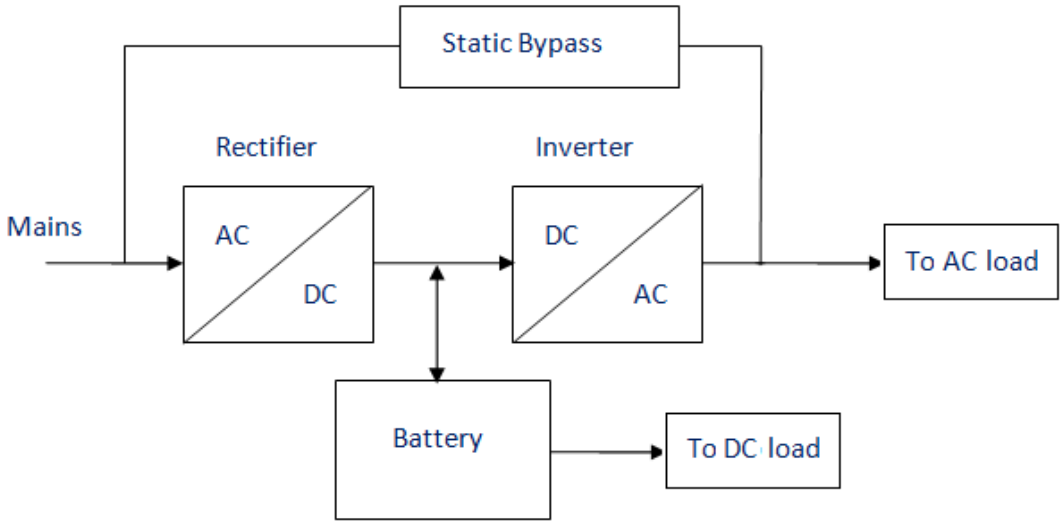

- **Inverter unit:** The DC power stored in battery is converted into AC by the process of inversion with the help of inverter and given to the load or equipment which it is connected.

- When there is any power failure, the rectifier has no role in the circuit and the steady power stored in the batteries which is connected to the inverter is given to the load by means of transfer switch.

THANK YOU