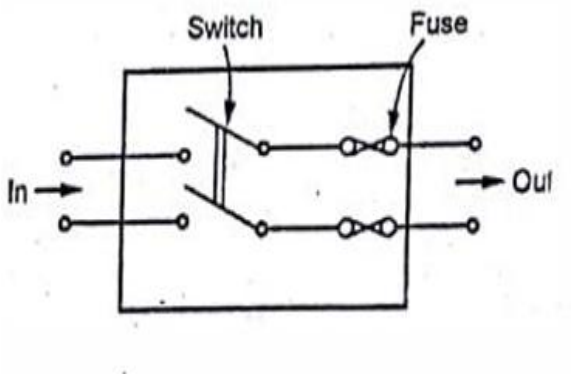
UNIT-5
Electrical Installation

COMPONENTS OF LT SWITCHGEAR

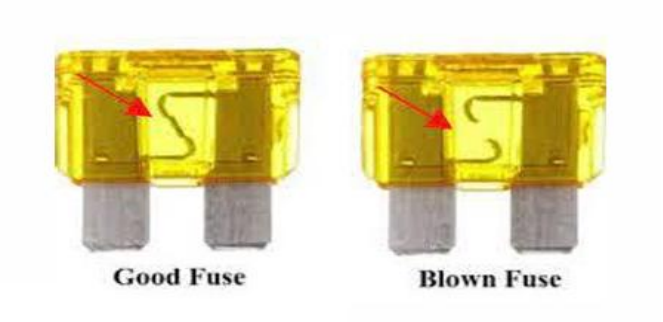
- Switch fuse unit (SFU)
- Miniature circuit breaker (MCB)
- Moulded case circuit breaker (MCCB)
- Earth Leakage circuit breaker (ELCB)

SWITCH FUSE UNIT (SFU) : Combination of switch and fuse together is called SFU. A switch isolate the circuit from supply for repair and maintenance. It is manually operated. Fuse is a protective device which acts quickly during abnormal condition to disconnect the circuit from the supply.



Advantages of SFU:

- ➢ The number of joints in the circuit get reduced.
- ➢ Less space is required due to compact construction.
- ➢ Easy to handle/operate.



Switch fuse unit

Fuse

MINIATURE CIRCUIT BREAKER (MCB):

An electromechanical device which makes and breaks the circuit in the normal operation. During fault/abnormal condition when current exceeds the preset value, MCB disconnects the circuit.

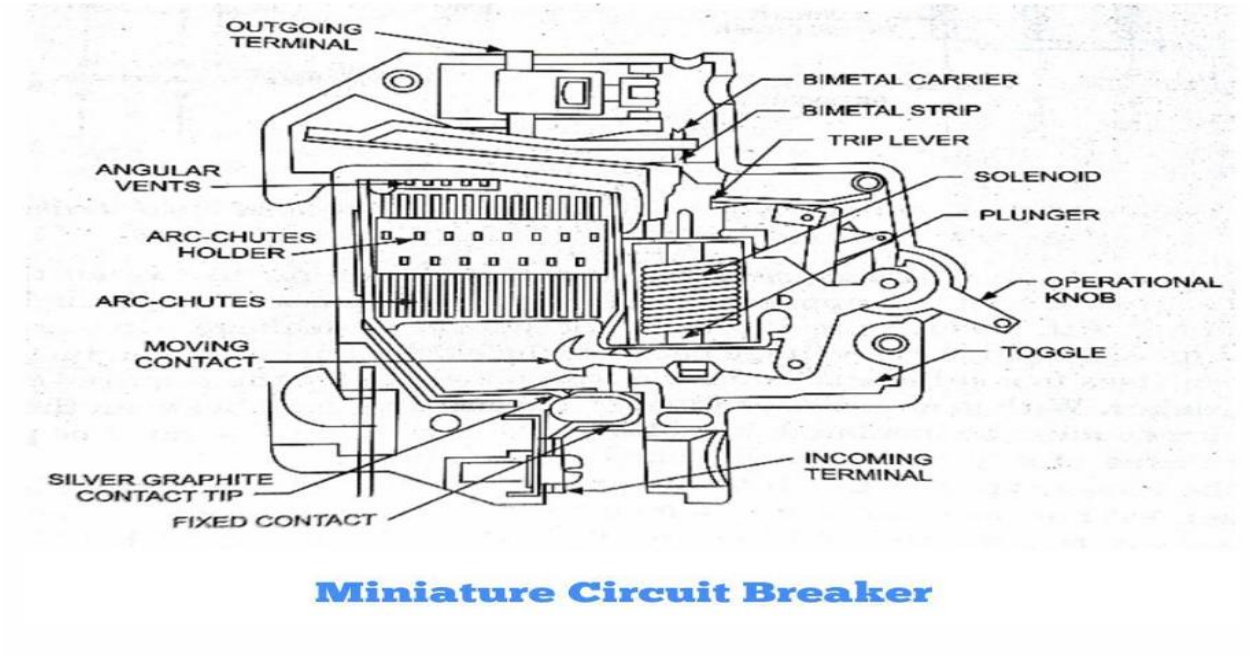
- MCB is high fault capacity current limiting, trip free, automatic switching with thermal and magnetic operation.
- MCB provides protection against overload and short circuit.
- MCBs are rated for 240V single phase, 415V three phase, and 220 V dc.
- The current rating is 0.5A to 63A

3-pole MCB

2-pole MCB

MCBs are used because of following features:

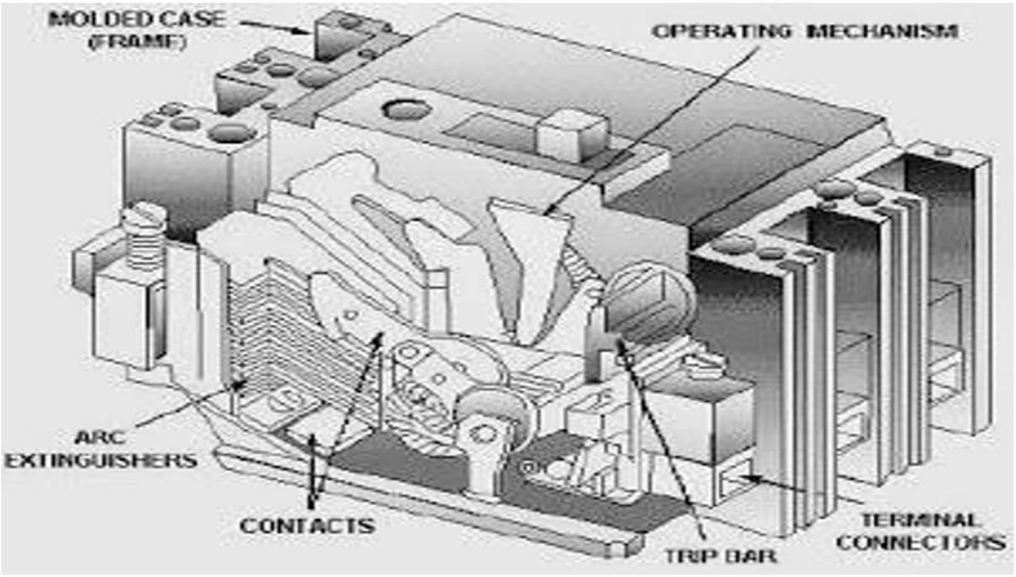
- Its operation is very fast.
- No tripping circuit is required for automatic operation.
- Protection against overload and short circuit without noise, flames or smoke.
- Reset quickly after fault correction.
- No rewiring is required.
- Cannot be reclosed if fault exists.



MOLDED CASE CIRCUIT BREAKER (MCCB):

MCCB is similar to MCB but used for circuit having current range from 63A to 3000A. Working is based on thermal mechanism. The bimetallic contact expands and contract when there are temperature changes.

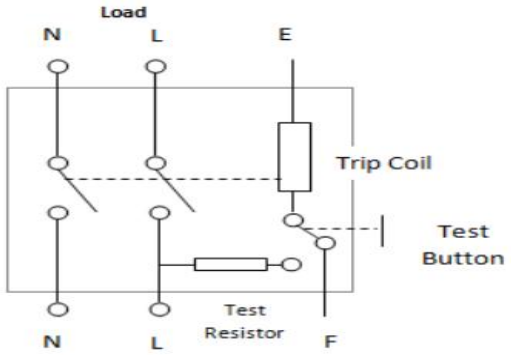
- Under normal conditions, the contacts are closed allowing current to pass.
- Under overload or short circuit conditions, current exceeds its safe value. Due to this, heat is generated, and the contacts are opened to interrupt the circuit.
- Due to the interruption of high current, there is arc formation. Hence in MCCB there are arc extinguishers which suppress the arc.
- There is a disconnection switch, with the help of which, the MCCB can be operated manually.
- It has adjustable trip settings which can be used for high current applications.
- It can be easily reset after the fault rectification. Thus it provides operational safely and convenience.
- All the operating parts of MCCB are covered within a plastic moulded housing made in two halves.
- The two halves are joined together to form the whole structure.
- The basic difference between MCB and MCCB is the current rating.
- Hence MCCBs are used for industrial and commercial applications such as main feeder protection, generator and motor protection, capacitor bank protection, welding applications and applications which require adjustable trip setting.



EARTH LEAKAGE CIRCUIT BREAKER (ELCB):

The ELCB is used to protect the circuit from electrical leakage. When someone gets an electric shock, then this circuit breaker cuts off the power for protecting the personal safety and the circuit against short circuit and overload. ELCB is a security device used in electrical system with high Earth impedance to avoid shock.

- It notices the difference in current between line and neutral wire, and interrupts the circuit if an unsafe current is detected.
- ELCB consists of a small current transformer (C.T.) surrounding live/line/phase and neutral wire.
- The secondary winding of the C.T. is connected to relay circuit which can trip the circuit breaker (CB) which is connected in the circuit.
- Under normal conditions, the current in the line and the neutral is same. There will not be any production of flux in the core and no induced e.m.f.
- If there is a fault due to leakage, then the net current through the core will no longer remain as zero but equal to difference between line current and neutral current, which will set up flux and emf in C.T.
- As per the preset value, the unbalance in the current is detected by C.T. and relay coil is energized which will give tripping signal for the circuit breaker.
- Thus ELCB provides protection against electric shock when a person comes in contact with live parts resulting in flow of current from body to earth.
- A properly connected ELCB detects such small currents in mA flowing to earth through human body or earth wire and breaks the circuit to reduce the risk of electrocution to humans.



WIRES:

Metal drawn out into the form of thin flexible thread or rod is called a wire. For example, copper wire, aluminium wire, steel wire etc..

The various types of wires which are used for various wiring schemes are:-

1. Vulcanised India Rubber wires (V.I.R.)

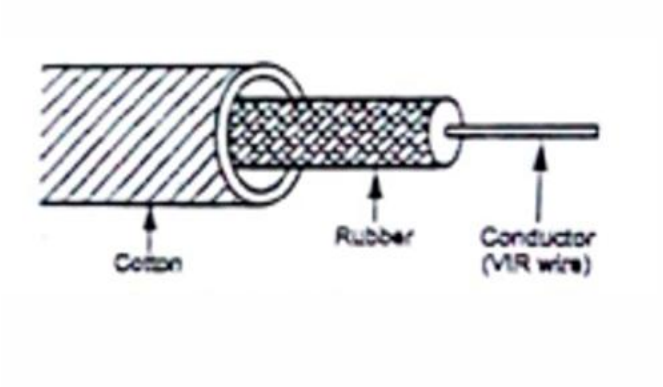
2. Cab Tyre Sheathed wires (C.T.S.)

3. Poly Vinyl Chloride wires (P.V.C.)

4. Flexible wires

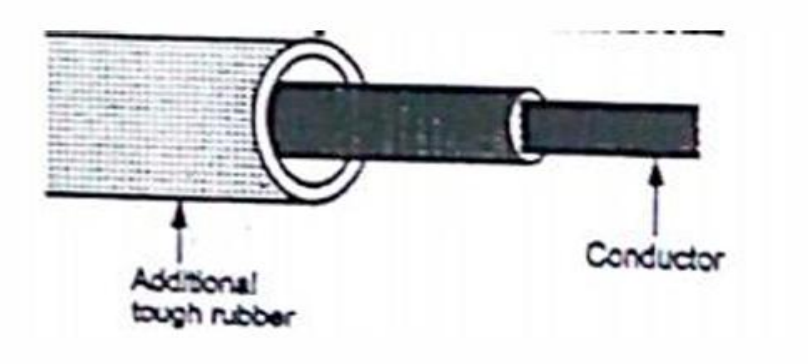
VULCANISED INDIA RUBBER WIRES (V.I.R.)

This type of wire consists of tinned conductors coated with rubber insulation. This is further covered with protective cotton and bitumen compound and finally finished with wax. This makes it moisture and heat resistant. These are always single core wires. Though are covered with a cotton layer it has tendency to absorb moisture and hence rarely used, now a days.



CAB TYRE SHEATHED WIRES (C.T.S.)

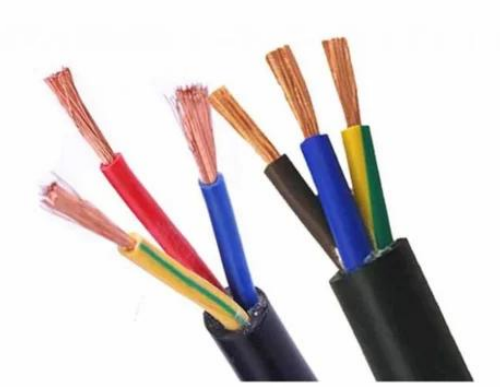
In this type, ordinary rubber insulated conductors are provided with an additional tough rubber sheath. The wire is also known as tough Rubber Sheathed (T.R.S.) wire. It provides additional insulation and along with that a protection against moisture, chemical fumes and wear and tear. These are also available in single core, double core and three core varieties.



POLY VINYL CHLORIDE WIRES (P.V.C.)

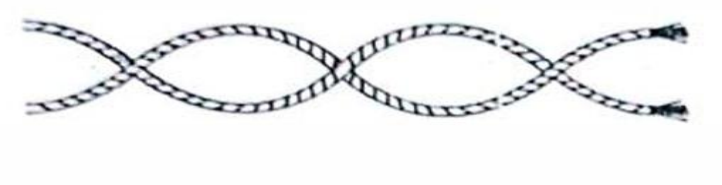
These are the most commonly used wires. These have conductors with P.V.C. insulation.

- It has following characteristics:
- It is moisture proof.
- It is tough and hence durable.
- It is chemically inert, therefore resistant to corrosion.
- As it is tough so additional covering is not required.
- The only disadvantage is, it softens at high temperature and hence it avoided where extreme temperatures may occur e.g. in heating appliances.



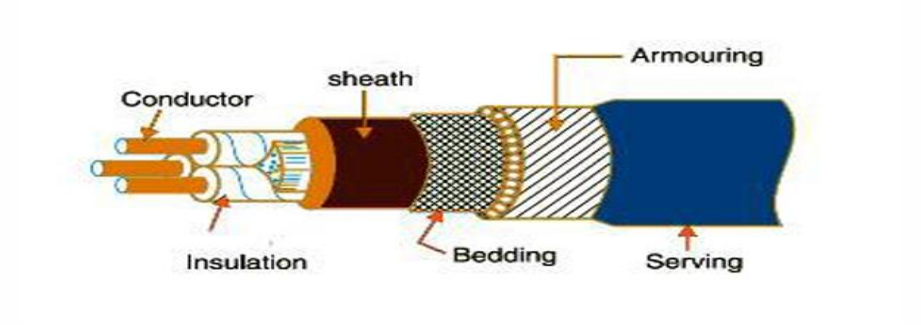
FLEXIBLE WIRES:

These are used very commonly in domestic wiring or for wiring of temporary nature. It consists of two separately insulated stranded conductors. The insulation is mostly rubber and more commonly available in parallel or twisted twins. Due to its flexible nature, the handling of these wires becomes very easy.



CABLES:

- A cable is defined as the group of individually insulated one or more conductors which is put together and finally provided with number of layers of insulation to give proper mechanical support.
- **Conductor of Core**: This section consists of single conductor or more than one conductor. The conductors are also called cores. Cables with three conductors used are aluminium or annealed copper. The conductors are stranded conductors in order to provide flexibility to the cable.



- **Insulation**: Each conductor or core is covered by insulation of proper thickness. The commonly used insulating materials are varnished cambric, vulcanized bitumen and impregnated paper.
- **Metallic Sheath**: The insulated conductors are covered by lead sheath or aluminium sheath. This provides mechanical protection but mainly restricts moisture and other gases from reaching the insulation.
- **Bedding**: The metallic sheath is covered by another layer called bedding. The bedding consists of paper type compounded with a fibrous material like jute strands or hessian tape. The purpose of bedding is to protect the metallic sheath from corrosion and from mechanical injury resulting due to armouring.

- **Armouring:** This layer consists of the layers of galvanized steel wires which provide protection to the cable from the mechanical injury.

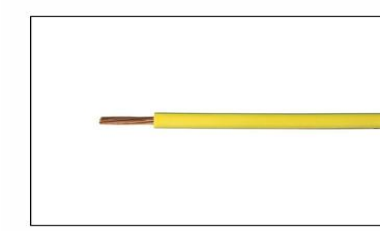
Based on voltage level the various types of cables are:

- Low tension cables: Used for the voltage levels upto 6.6kV.
- Medium tension cables: Used for 11kV level and are called belted cable.
- High tension cables: Used for 22kV and 33kV levels. These are screened type cables.
- Extra high tension cables: Used for voltage levels more than 33kV. These are pressure cables which are further classified as:
    a. Oil filled Cables.
    b. Gas pressure cables.

Based on the cores, the various types of cables are:

1. **Single core cable:**

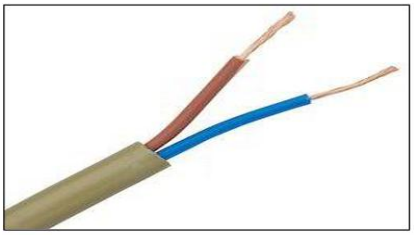
    Single core cables are made up of a single conductor covered by a PVC insulation. They are mainly used in power and lighting circuits, both domestic and commercial applications. They are also used in the internal wiring of appliances suitable for installation in conduits and trunks.



Single core cable

2. **Two core cable:**

    Two core cables are used to connect small appliances which are double insulated and need no earth. The cable only has two cores being live and neutral. As this is flex cable it will be of circular shape with an outer sheath and two colour coded PVC insulated cores.



Two core cable

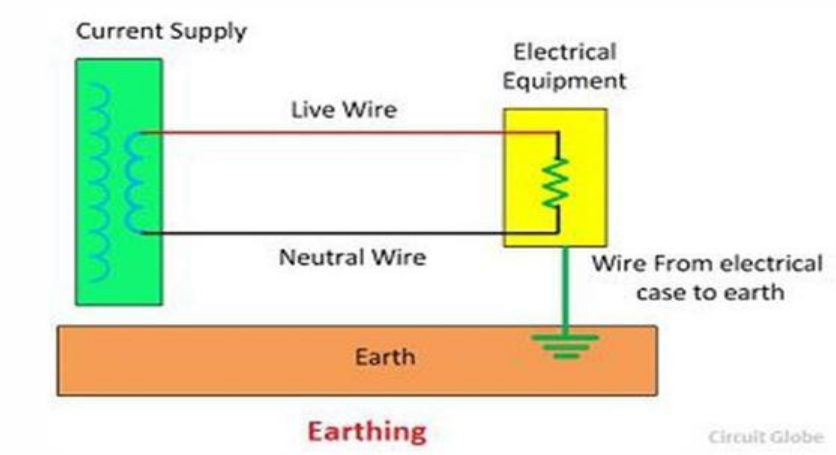
3. Three core cable:

Three core cable is made up of 3 solid cores, which are individually insulated and wrapped in an outer PVC sleeving. The colours of these cores are brown, black and grey, with a bare earth core (to be insulated with green and yellow sleeving).

Three core cable

EARTHING:

The connection of electrical machinery to the general mass of earth, with a conducting material of very low resistance is called earthing or grounding. The earthing of electrical equipment brings the equipments to zero potential and avoid the shock to the operator, under any fault conditions.



IMPORTANCE OF EARTHING:

- Consider a machine which is not earthed. It is operated at supply voltage V. If a person touches the outer part of the machine then as long as the insulation of the machine is perfect, the person will not get a shock.
- The insulation resistance of perfect insulation is infinite.
- But if there is some fault and insulation becomes weak or if one of the winding is touching the cover of the machine then insulation resistance becomes zero.

- If a person touches such a machine, current flows through the body of the person towards the earth.
- As body resistance is small, current through the body is high so that the person receives a shock.
- To avoid such a situation, the body of the machine is connected to the earth with a very low resistance.
- If the machine is earthed and the person touches a faulty machine then body resistance and earthing resistance appears to be in parallel.
- As earthing resistance is very small than the resistance of the body, hence almost the entire leakage current flows through earthing connection.
- Thus current through the body of the person is almost zero and the person does not receive any shock.
- Similarly due to earthing, the tall buildings, structures and other machines are protected from high voltage in overhead lines and the atmospheric lightning as high voltage and lightening gets discharged to earth through earthing connection.
- Due to earthing the line voltage is maintained at constant value.
- Hence earthing is necessary for all domestic appliances, machines, buildings and structures, equipments power stations etc

TYPES OF EARTHING:

1. **Plate earthing**: A copper plate or galvanized plate is buried in an earth pit below ground level. The plate electrode connects the electrical conductors to the earth.
2. **Pipe earthing**: A galvanized steel perforated pipe inside the ground connects the electrical conductors to the earth.
3. **Rod earthing**: Similar to the Pipe earthing. A copper rod replaces the pipe electrode.
4. **Chemical earthing**: Similar to the pipe earthing. A chemical compound material replaces the charcoal and salt layers.

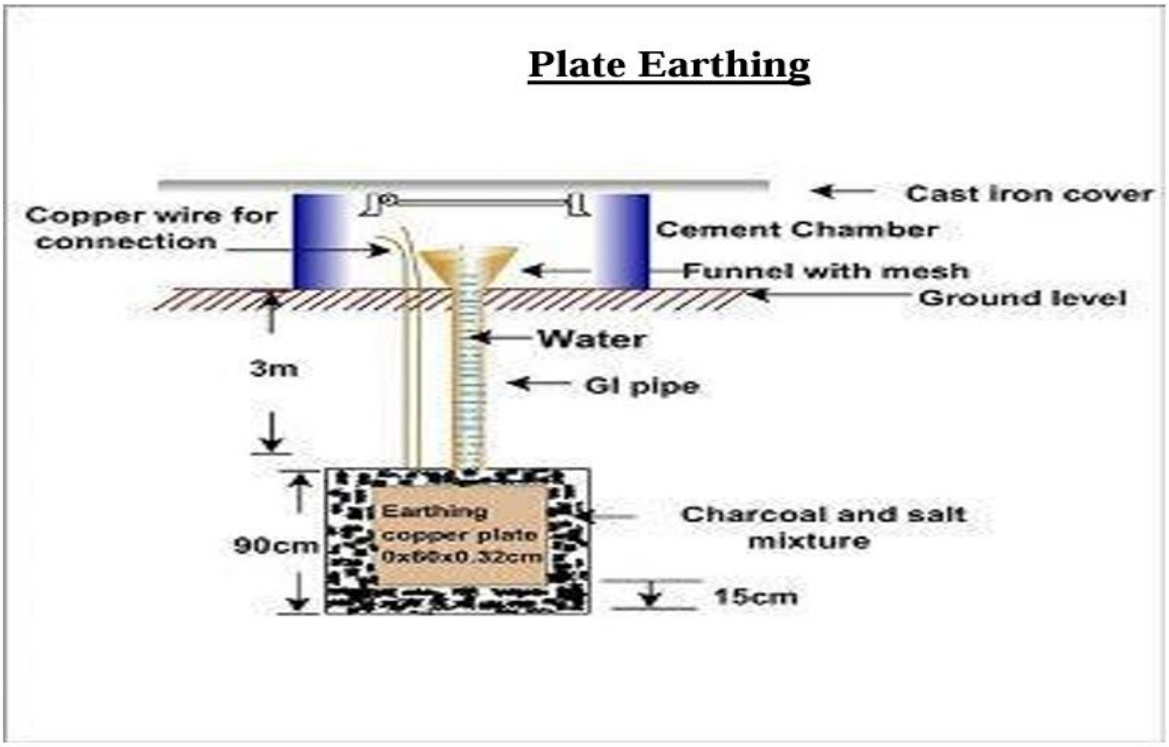
PLATE EARTHING:

The earth connection is provided with the help of copper plate or Galvanized Iron (G.I.) plate. The copper plate size is 60 cm × 60 cm × 3.18 mm, while G.I. plate size is not less than 60 cm × 60 cm × 6.3 mm. The plate is embedded 3 m (10 ft.) into the ground. The plate is kept with its face vertical. The plate is surrounded by the alternate layer of coke and salt for a minimum thickness of about 15 cm. The earth wire is drawn through G.I. pipe and is perfectly bolted to the earth plate. The nut and bolts must be copper plate and must be of galvanized iron for G.I. plate. The earth lead used must be G.I. wire or strip of sufficient cross sectional area to carry the fault current safely. The earth wire is drawn through G.I. pipe of 19 mm diameter, at about 60 cm below the ground.

- The G.I. pipe is fitted with a funnel on the top. In order to have an effective earthing, salt

water is poured periodically through the funnel.

- The earthing efficiency increases with the increases of the plate area and depth of embedding.
- If the resistivity of the soil is high, then it is necessary to embed the plate vertically at a greater depth into ground.
- The only disadvantage of this method is that the discontinuity of the earth wire from the earthing plate below the earth can not be observed physically.
- This may be misleading and may result in heavy losses under fault conditions.



PIPE EARTHING:

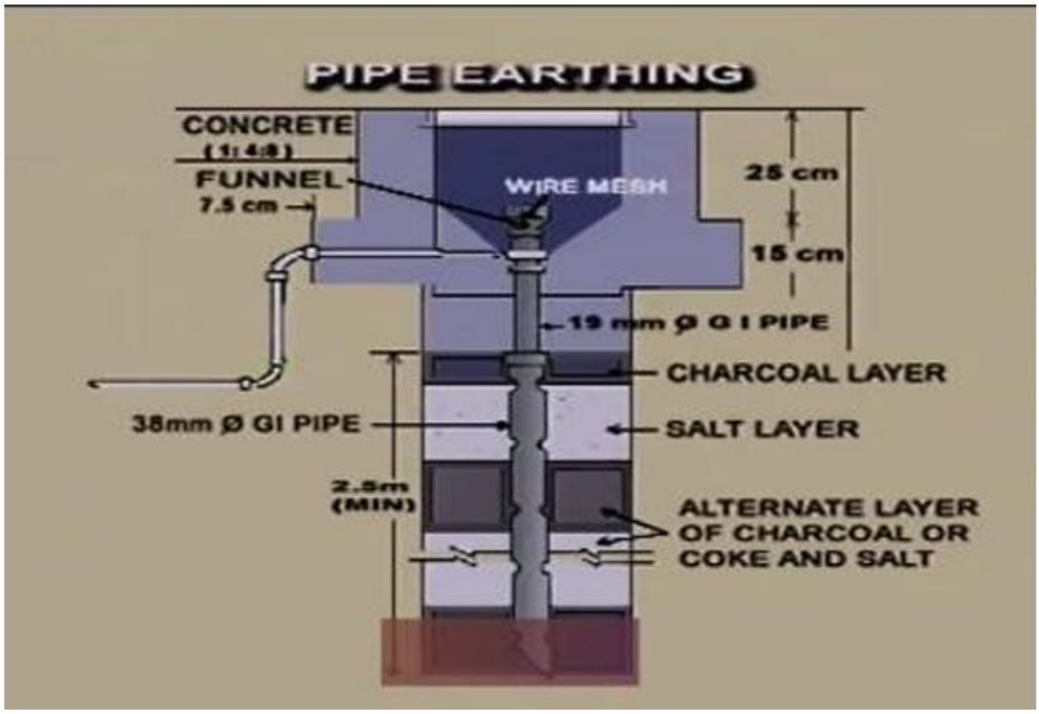
A G.I. pipe of 38 mm diameter and 2-meter (7 feet) length is embedded vertically into the ground. This pipe acts as an earth electrode. The depth depends on the condition of the soil. The earth wires are fastened to the top section of the pipe above the ground level with nut and bolts. The pit area around the pipe is filled with salt and coal mixture for improving the condition of the soil and earthing efficiency. The contact surface of G.I. pipe with the soil is more as compared to the plate due to its circular section and hence can handle heavier leakage current for the same electrode size. In the summer season, soil becomes dry. In such cases salt water is poured through the funnel connected to the main G.I. pipe through 19 mm diameter pipe. This keeps the soil wet.

- The earth wires are connected to the G.I. pipe above the ground level and can be physically

inspected from time to time. These connections can be checked for performing continuity tests.

- The earth lead used must be G.I. wire of sufficient cross sectional area to carry fault current safely.
- The only disadvantage of pipe earthing is that the embedded pipe length has to be increased sufficiently in case the soil specific resistivity is of high order. This increases excavation work and hence increased cost.

Pipe Earthing



BATTERIES:

A device that converts the stored chemical energy into electrical energy using chemical action is called battery. The chemical action that takes place in the battery is the movement of electrons from one terminal to another. Due to this chemical action, there exists a difference in charge between two terminals that creates an electrical energy between them. A cell is a device that consists of two electrodes and an electrolyte. But a battery is a single unit which comprises two or more cells which are connected together electrically.

CONSTRUCTION:

- The component of a battery that participates actively in a chemical reaction to generate electrical energy is called the active component.
- The three main active components of a battery are:
- Anode:-The electrode that oxidises and releases electrons when an electrochemical reaction occurs is called anode. It is also called negative electrode or reducing electrode. For example zinc and lithium.
- Cathode:-The electrode that acquires electrons during electrochemical reaction is called cathode. It is also called positive electrode or oxidising electrode. For example metallic oxides.
- Electrolyte:- The medium through which electrons get transferred from anode to cathode is called electrolyte. In general, electrolytes are in liquid form like water or other solvents in which the material required for ionic conduction, i.e., salt, acid, or alkalis are dissolved.

WORKING:

- When a load is connected between the cathode and anode, due to electrochemical action, the electrons get transferred from anode to cathode.
- Due to this movement of electrons, the current starts flowing from cathode to anode through the connected load.

The advantages of using batteries as energy sources are:

- Energy can be stored for a long duration of time.
- Delivers the energy effectively when compared to fossil fuels.
- Response time is less when compared to other fossil fuels.
- The efficiency of the battery is high.
- The battery can be operated at any place as it offers good tolerance to shock and vibrations.
- The operating cost of the battery is cheap.
- Low- maintenance cost is required for the battery.

CLASSIFICATION OF BATTERIES:

The two main categories of batteries are:

- **Primary Batteries:** It is also called single-use or throw-away batteries as it cannot be recharged to reuse. It is discarded after complete depletion of charge in it. Examples of primary batteries are alkaline batteries, mercury batteries. silver-oxide batteries, and zinc carbon batteries.
- **Secondary Batteries:** The batteries that can be electrically recharged again are called secondary batteries. By allowing the current in the opposite direction, these batteries can be recharged. Nickel Cadmium, Lead-Acid batteries and Lithium batteries fall into the secondary battery category.

BATTERY BACKUP:

A battery backup device is an electronic device that supplies secondary power in the absence of the main power. It can also protect electronic hardware from power spikes and fluctuations. The main battery backup device which is commonly used is called uninterruptible power supply [UPS].

Need of UPS:

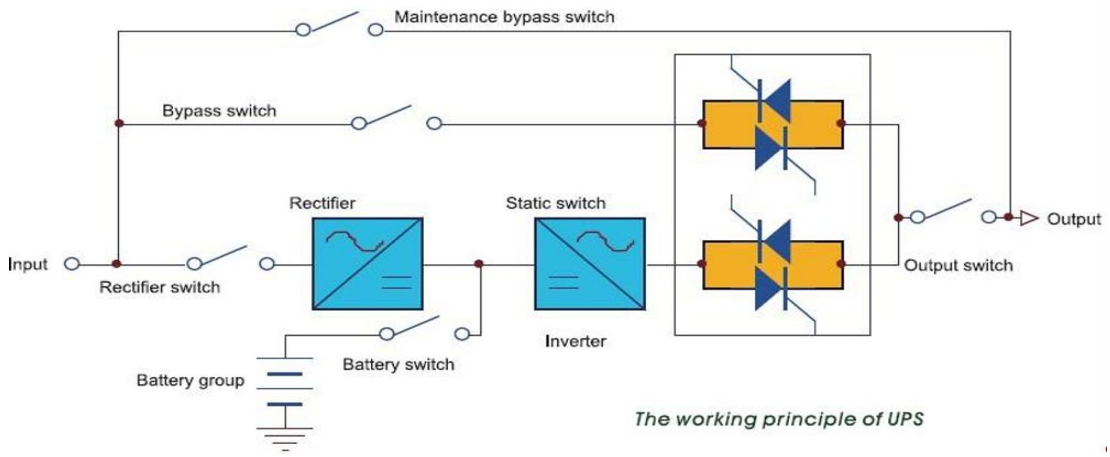
1. Most of the systems operate on A.C. supply. Thus A.C. supply failure causes periodical stoppage of the various systems.

2. Most of the modern systems are computers and microprocessors. Any interruption in the power supply may result in the loss of the work and may make the system ineffective.

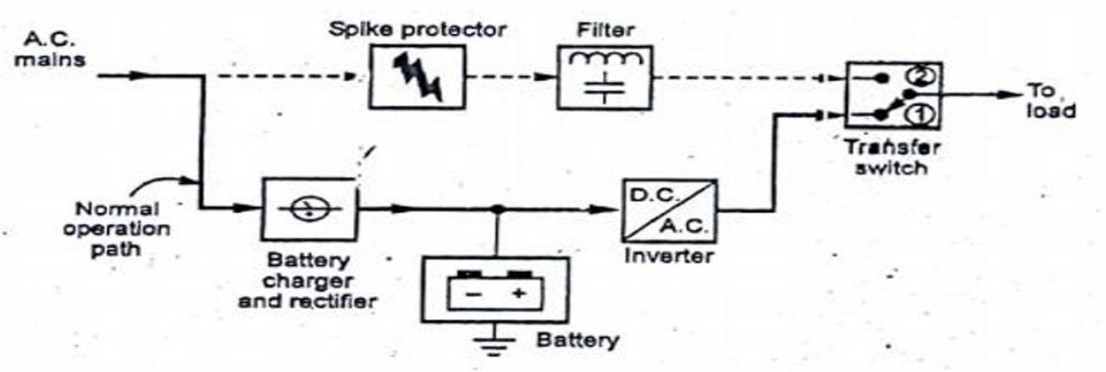
3. Many important places like hospitals, temples, playing grounds, banks etc. require continuous supply for their efficient operation.

UNINTERRUPTIBLE POWER SUPPLY (UPS):

The basic block diagram of an UPS which is using two power sources, controlled by a switch.



- The UPS is designed so that there is one source of power, used under normal conditions, known as primary power source (a.c. mains) and other source called the secondary power source that comes in to action if the primary source is disrupted.
- A switch is used as a controlling device. It changes from primary source to secondary source when it detects that the primary source has failed.
- It automatically switches back from the secondary power source to the primary when it is detected that the primary source has returned to normal.
- The power available from mains is a.c. All batteries provided d.c. Hence in UPS there is circuitry to convert a.c. to d.c. for battery charging called a converter.
- Similarly there is a device converting d.c. from battery to a.c. as required by the load. This is called an inverter. These are important components of any UPS.
- The two types of UPS are:
    - 1. On line UPS.
    - 2. Off line UPS.



Online UPS