Wiring , Electrical installations and components of LT Switchgear

Basic electrical engineering

Contents

Earthing

- Definition:

  An earthing means connecting the **neutral point** of the supply system and the **non-current carrying** conductive parts of electrical appliances and equipments to the

  general mass of the earth.
- Electrical potential of earth is assumed to be **zero**.
- Higher voltage falls to zero or lower voltage rises to zero.

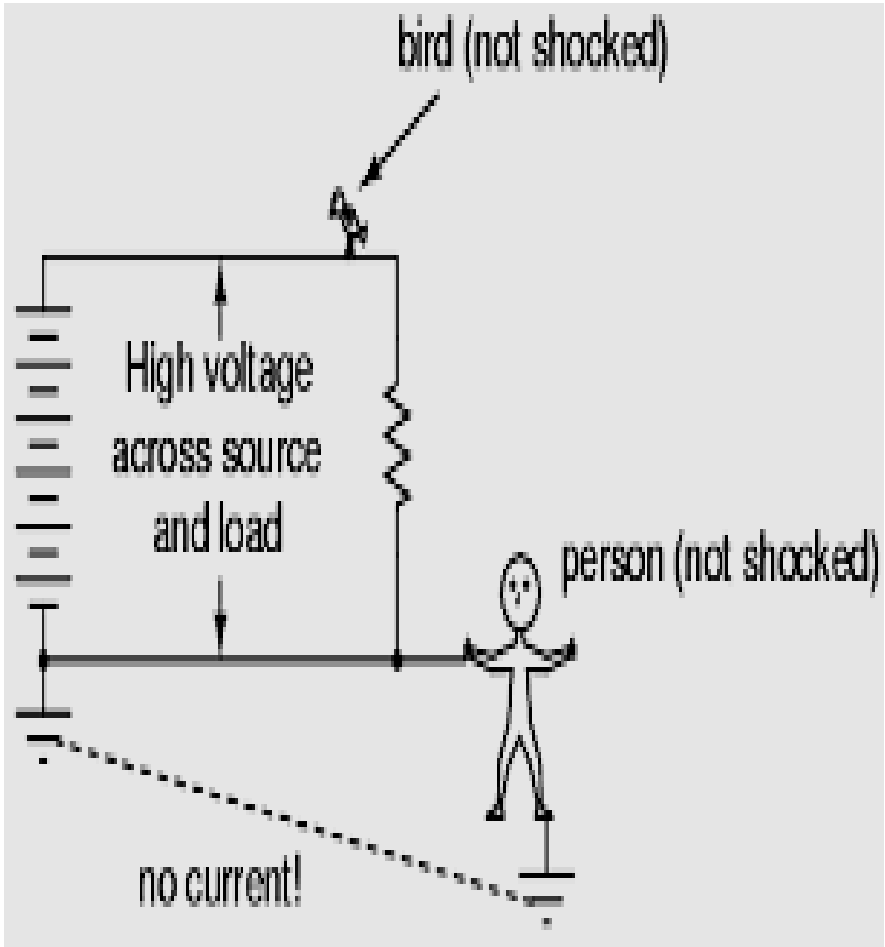
Necessity of Earthing

- Protection of **metallic bodies and casing** from leakage current and heavy short circuit when insulation failure.
- Eliminates the possibility of **injury** or death of human beings due to electrical shock.
- Eliminates the risk of **fire** due to heavy fault or short

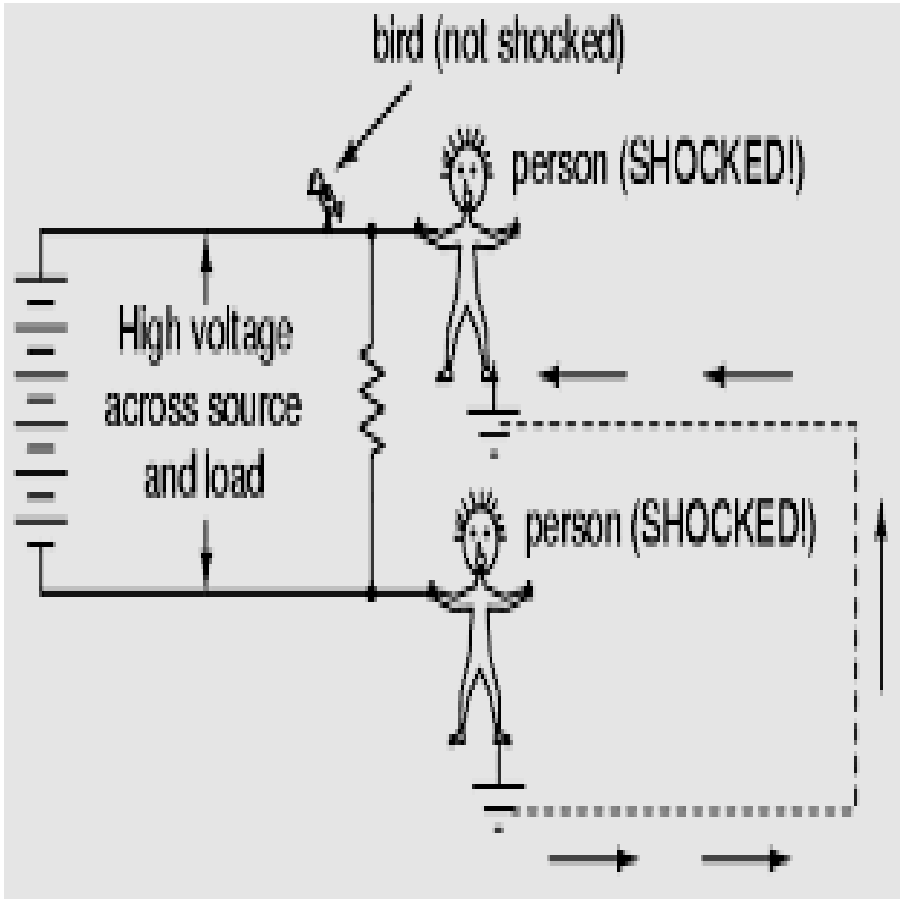
  circuit currents as a results of insulation break-down.
- Protection from **lightning strokes** to electrical machinery, fed from overhead supply lines
- Protection of buildings against lightning strokes

Electric Shock and Earthing

No Shock



Shock



Earthing Methods

- The electric installation is earthed at the supply end by earth conductor **of large diameter and very low resistance.**
- The resistance of earth material should be very low in order to achieve **minimum opposition** to flow of current through earth connection towards earth.

1. Plate Earthing
2. Pipe Earthing
3. Rod Earthing

Plate Earthing

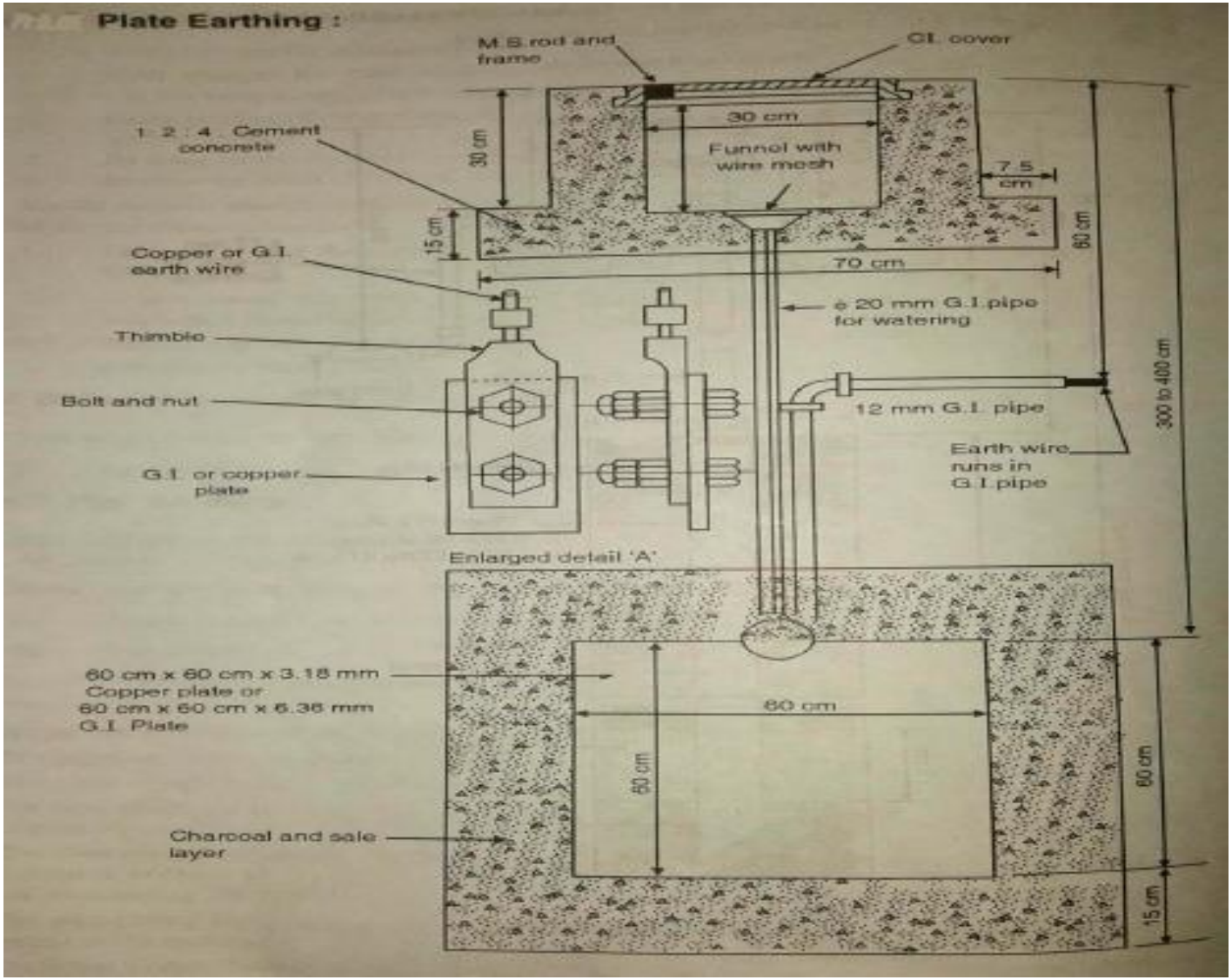
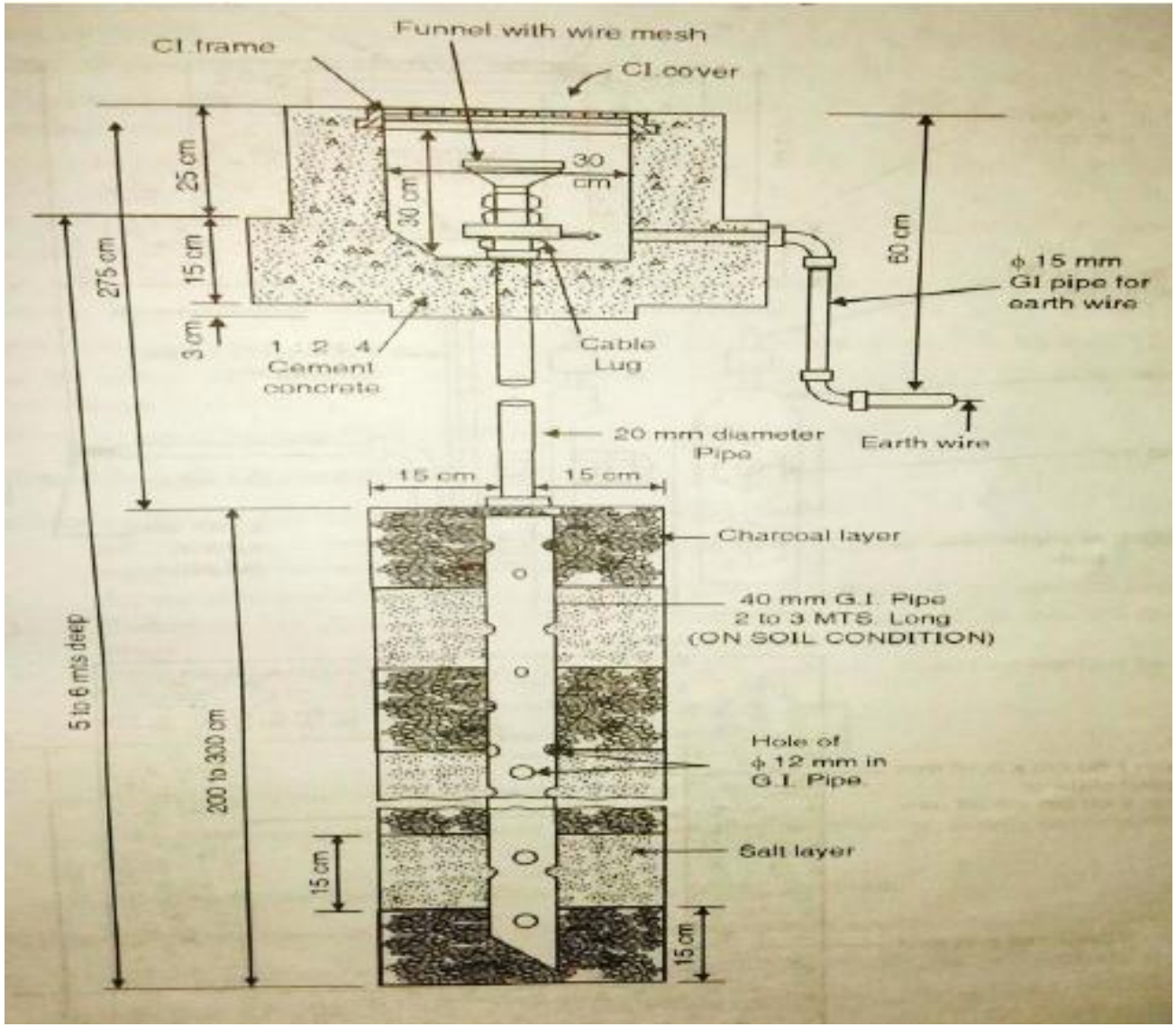


Plate Earthing

- **Copper plate** of size 60cm X 60cm X 3.18mm as effective earth electrode.
- **GI plates** of size 60cm X 60cm X 6.3mm for normal installation.
- Buried 3m into ground vertically.
- Embedded in alternate layers of **coal and salt** for minimum thickness of 15cm.
- **Earth wire** is perfectly bolted to earth plate and taken out through GI pipe of 19mm diameter.
- The cross section of earth lead should be sufficient to carry the large fault current safely.
- **GI pipe** of diameter 12.7mm is joined between the funnel at the top and earth plate deep into the ground.
- Pouring of salt water to ensure effective earthing.

Pipe Earthing



Pipe Earthing

- **GI pipe** of 38mm diameter and 2m length is used as earth electrode. (Depth = 4.75m approx)
- Alternate layer of **salt and charcoal**.
- Another GI pipe of 19mm diameter is joined to funnel.
- Pouring of salt water for making ground soil wet.
- **Earth wire** from this GI pipe to carry fault current quickly.
- Earth wires are connected to GI pipe above ground level. The contact surface of GI pipe earth **electrode** with soil is much higher the that of plate earthing due to circular shape (Handles high current).
- 2 to 5 Ohm.
- Higher soil resistance, length and depth should be increased.

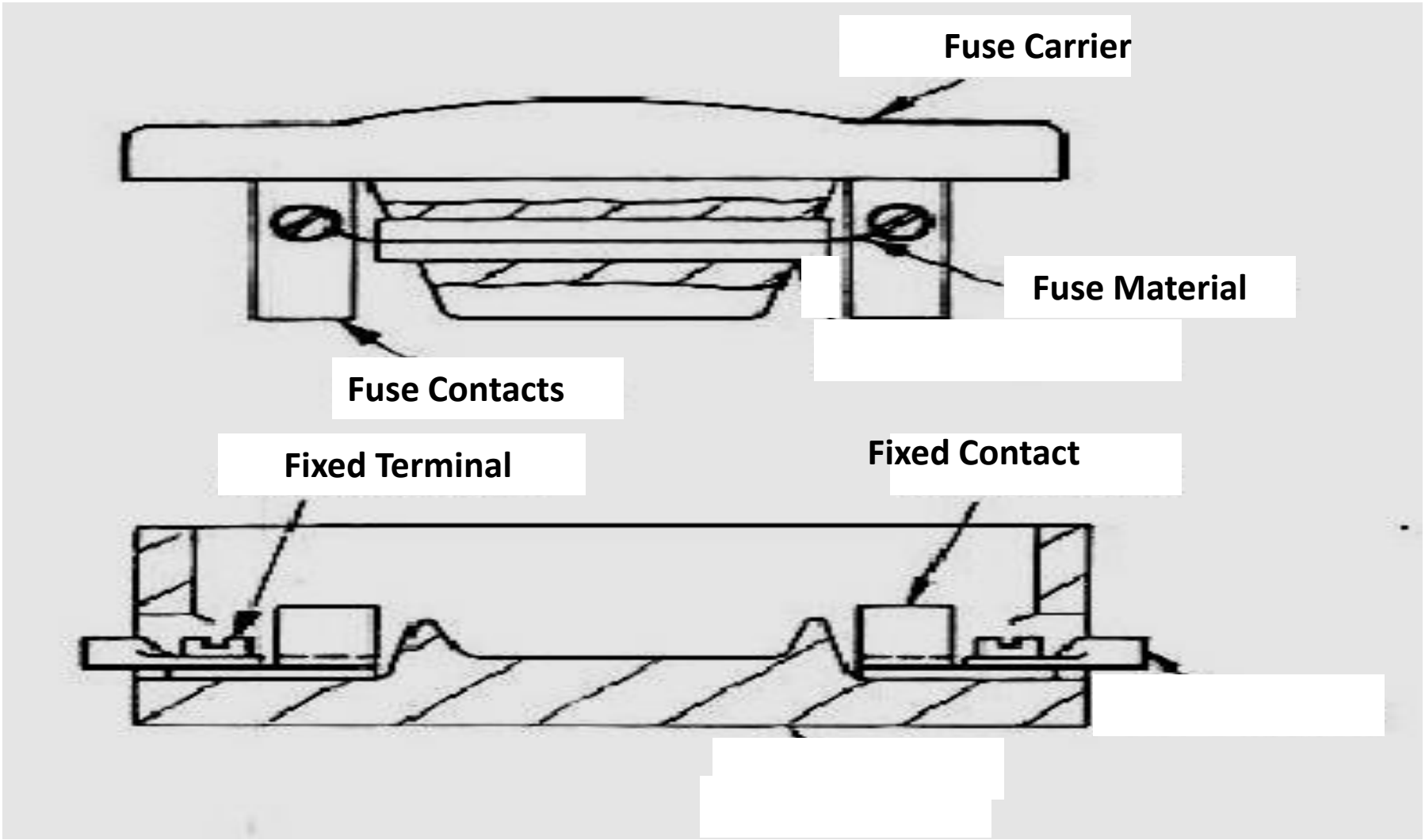
Fuse

- Small piece of metal wire which **melts** when predetermined value of current passes through it.
- Connected in **series**.
- Carries normal circuit current safely and Protective device for high current.
- Fuse wire from copper, aluminum, iron etc.

Necessity of Fuses

- To open the circuit suddenly under short circuit condition to avoid damage.
- Over current protection
- Preferred due to : i) Small size
  ii) Minimum operating time under SC
  iii) Cheap in cost
  iv) Open without noise, gas, flames
- As a backup protection for circuit breaker

Rewirable Fuse

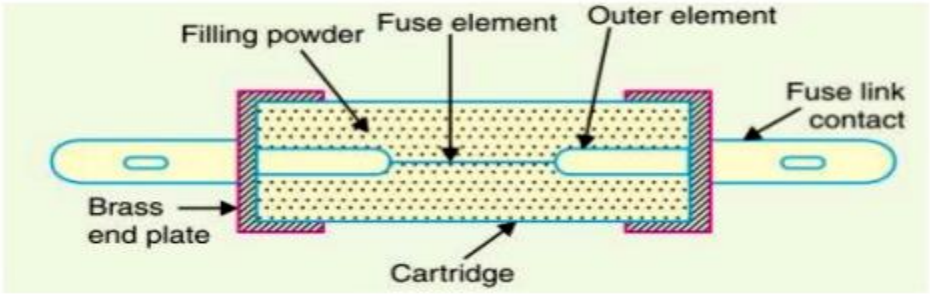


Rewirable Fuse

- In small building wiring
- **Fuse wire** of alloy of lead and tin.
- Rectangular porcelain base with fixed contacts connected to incoming and outgoing wire.
- **Porcelain carrier** or holder caries fuse wire.
- Can be replaced in case of melting of it.
- Simple, Cheap, but for small currents.

Cartridge or H.R.C. Fuse

High Rupturing Capacity (HRC) Fuse

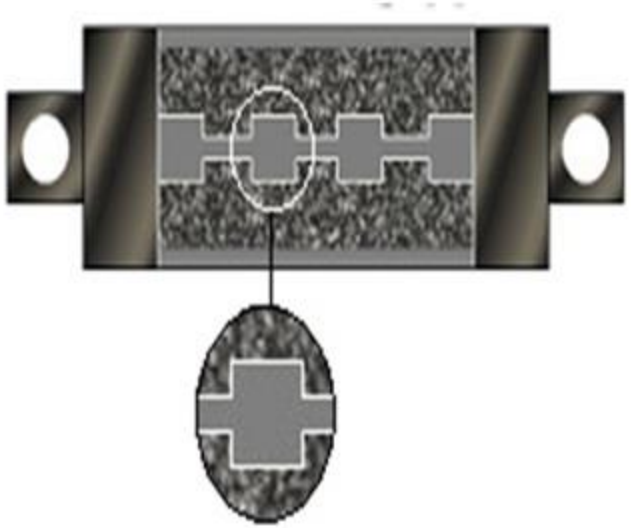


- For high rupturing capacity in modern distribution
- A ceramic body having metal end caps.
- Fusible silver or bimetallic current carrying **elements.**
- **Filling powder** inside body surrounding fuse element.
- Connected in the circuit using fuse link.
- Fuse element can carry short circuit heavy current for a known time period.

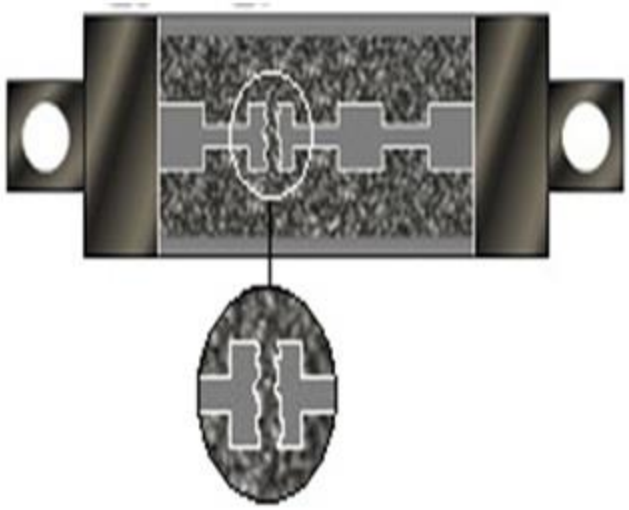
Cartridge or H.R.C. Fuse

- If the fault is removed, then it does not blow off.
- When the over rated current flows through HRC fuse, the element is melted and vapourized.
- Chemical reaction between the silver vapour and the filling powder forms a high electrical resistance substance.
- Must be replaced after operation
- For heavy currents, high speed, reliable operation.

Cartridge or H.R.C. Fuse

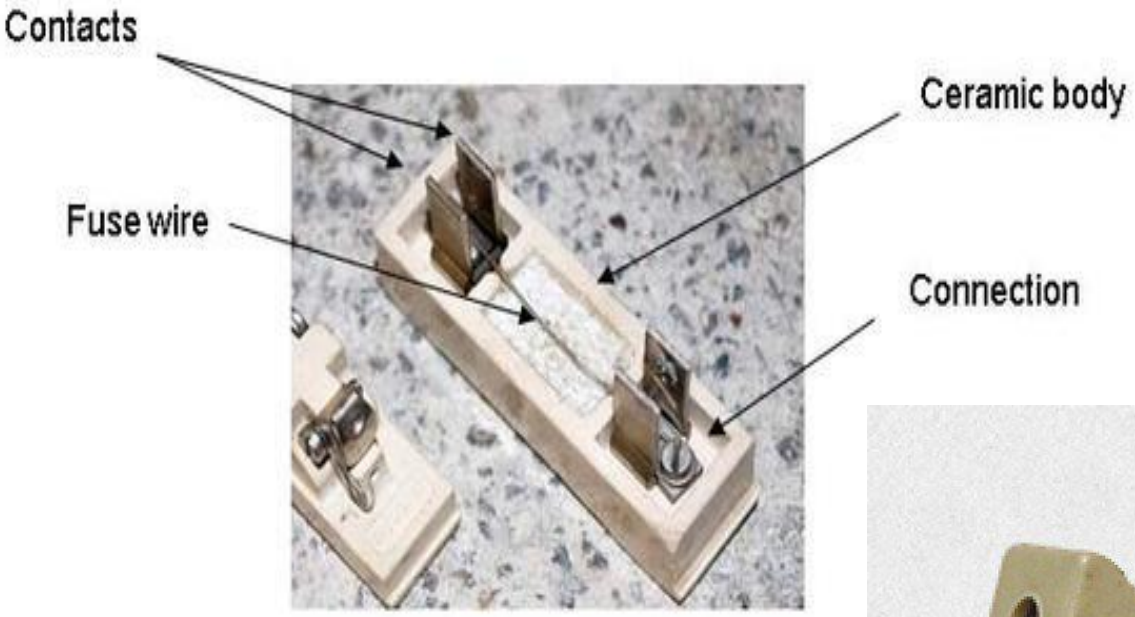


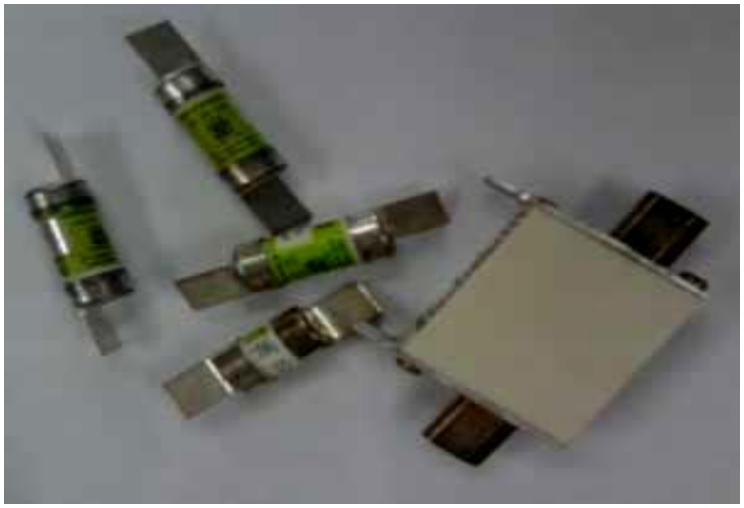
In Normal Conditions, Current Will flow through Fuse element to the circuit



In Short Circuit & Overload Conditions, The Fuse Element will Melt and open the Circuit

Rewirable and HRC Fuse



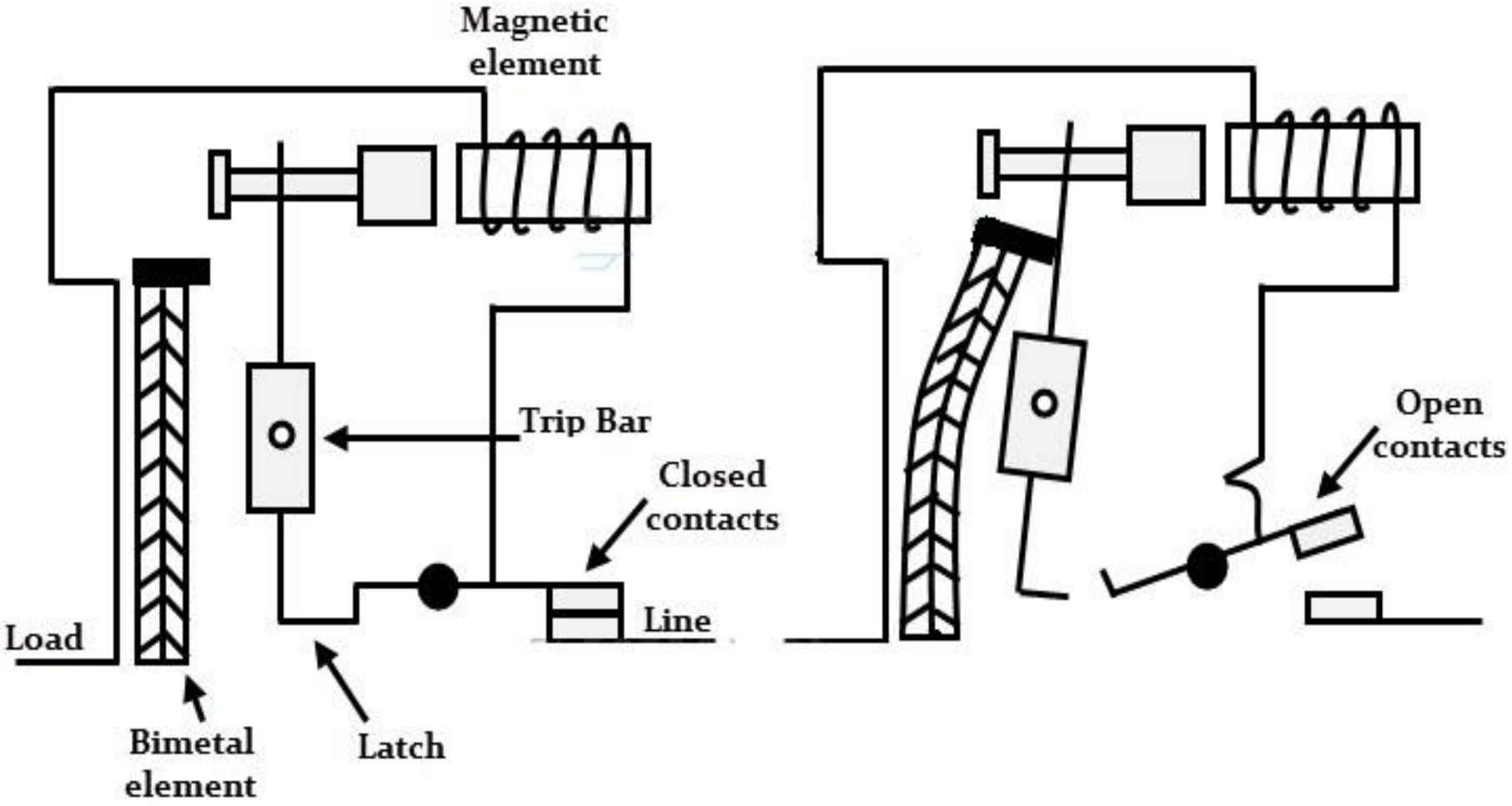


MCB

- Protective device which provides protection to wiring and sophisticated equipments against overload and short circuit.
- Normal Condition: Switch

  Faults: Trips off automatically.
- Combination of good switch and good HRC fuse.
- Tripping mechanism by magnetic and thermal sensing devices.
- Thermal device **Bimetallic strip** deflects when heated by over-currents through it.
- It releases latch to open circuit breaker contacts.
- **Solenoid** energizes due to rapidly rising current.
- It operates plunger to open MCB contacts almost instantaneously by **latch** mechanism.

MCB


Magnetic element
Trip Bar
Closed contacts
Line
Load
Bimetal element
Latch
Open contacts

MCB

- MCB has inverse time characteristics.
- **Arc chutes** have typical construction to increase the length of arc by magnetic field.
- Hot gases don’t come into contact with main parts due to it.
- Trips of automatically and resumes its operation after switching ON after removal of fault.
- Used in low voltage domestic, commercial and industrial applications.

MCCB

- The MCCB is used to control electric energy in distribution network and is having short circuit and overload protection. This circuit Breaker is an electromechanical device which guards a circuit from short circuit and over current. They offer short circuit and over current protection for circuits ranges from 63 Amps-3000 Amps. The primary functions of MCCB is to automatically open a circuit under short circuit or overload conditions. In an electrical circuit, the over current may result faulty design

MCCB

- The MCCB is an option to a fuse since it doesn’t need an alternate once an overload is noticed. Unlike a fuse, this circuit breaker can be simply reset after a mistake and offers enhanced operator safety and ease without acquiring operating cost.

Earth Leakage Circuit Breaker (ELCB)

- ELCB is device used to directly detect currents leaking to earth from an installation and cut the power
- Two types:

Voltage ELCB

Current ELCB

- It detects fault current from live to the earth wire within the installation. If sufficient voltage appears across the ELCB's sense coil , it will switch off the power and remain off until manually Reset.

- If the voltage of the Equipment body is rise which could cause the difference between earth and load body voltage, the danger of electric shock will occur.
- This voltage difference will produce an electric current from the load metallic body passes the relay loop and to earth.
- When voltage on the equipment metallic body rose to the danger level which exceed to 50Volt, the flowing current through relay loop could move the relay contact by disconnecting the supply current to avoid from any danger electric shock.

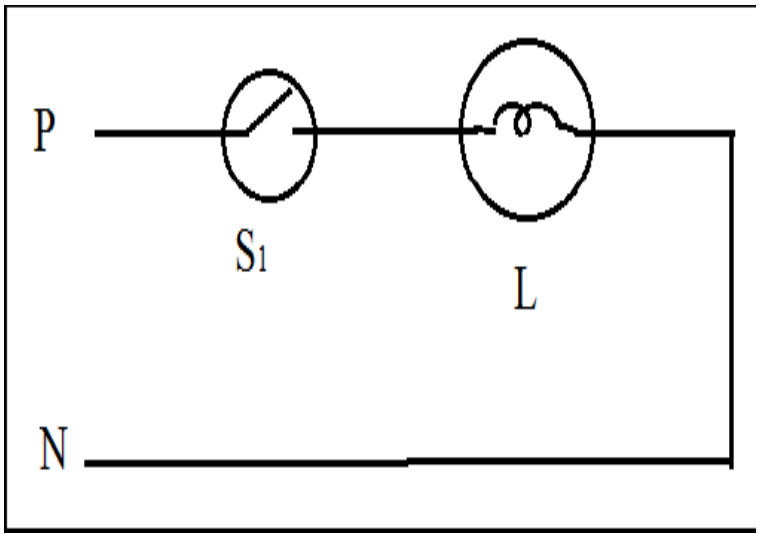
- Current-operated ELCBs are generally known as Residual-current devices (RCD).
- These also protect against earth leakage.
- In a situation when there is fault or a leakage to earth in the load circuit, or anywhere between the load circuit and the output connection of the RCB circuit, the current returning through the neutral coil has been reduced.
- Then the magnetic flux inside the transformer core is not balanced anymore. The total sum of the opposing magnetic flux is no longer zero. This net remaining flux is what we call a residual flux.
- The periodically changing residual flux inside the transformer core crosses path with the winding of the search coil. This action produces an electromotive force (e.m.f.) across the search coil. An electromotive force is actually an alternating voltage. The induced voltage across the search coil produces a current inside the wiring of the trip circuit.

- It is this current that operates the trip coil of the circuit breaker. Since the trip current is driven by the residual magnetic flux (the resulting flux, the net effect between both fluxes) between the phase and the neutral coils**, it is called the residual current device**.

- With a circuit breaker incorporated as part of the circuit, the assembled system is called residual current circuit breaker (RCCB) or residual current devise (RCD). The incoming current has to pass through the circuit breaker first before going to the phase coil. The return neutral path passes through the second circuit breaker pole. During tripping when a fault is detected, both the phase and neutral connection is isolated.

Wiring

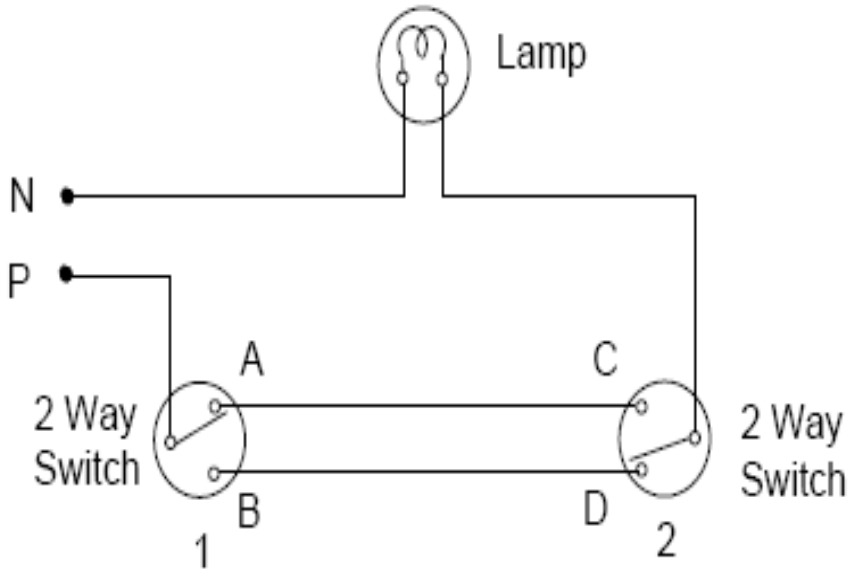
- **Simple wiring:**
- one lamp L is controlled by single pole switch introduced in its circuit.
- The live or phase wire is connected to the supply through the switch, whereas, neutral wire is directly connected to the lamp as shown in the circuit diagram.



- When switch is turn ON, a full supplied voltage is applied across the lamp terminals & the lamp glows.
- Thus the lamp independently controlled by the single pole switch.

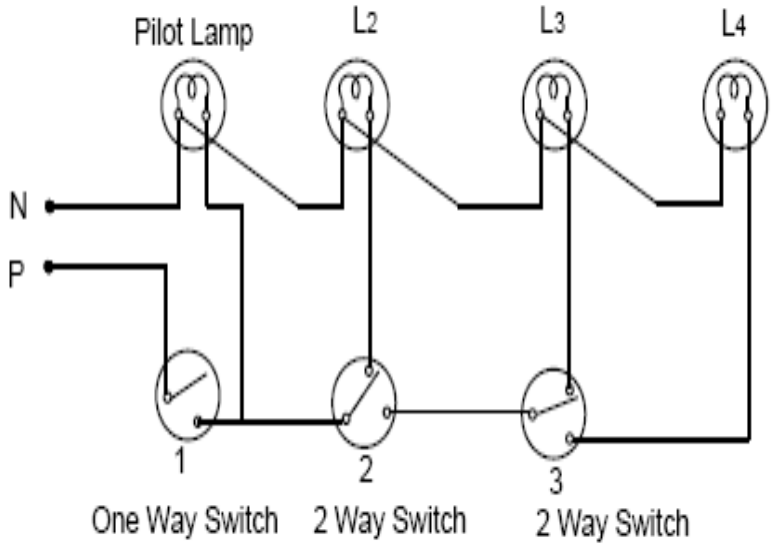
Staircase Wiring:

- This wiring system is used in staircase.
- The lamp is operated from two switches.
- **Operation:**
- For switch position shown in figure lamp is ‘off’.
- When switch 1 is changed to position ‘B’ lamp glows.



- Now if position of switch 2 is changed to ‘C’ lamp becomes off. Similarly now
- lamp can be made on by changing position of any switch and further can be made off by changing position of any switch.

Godown wiring:

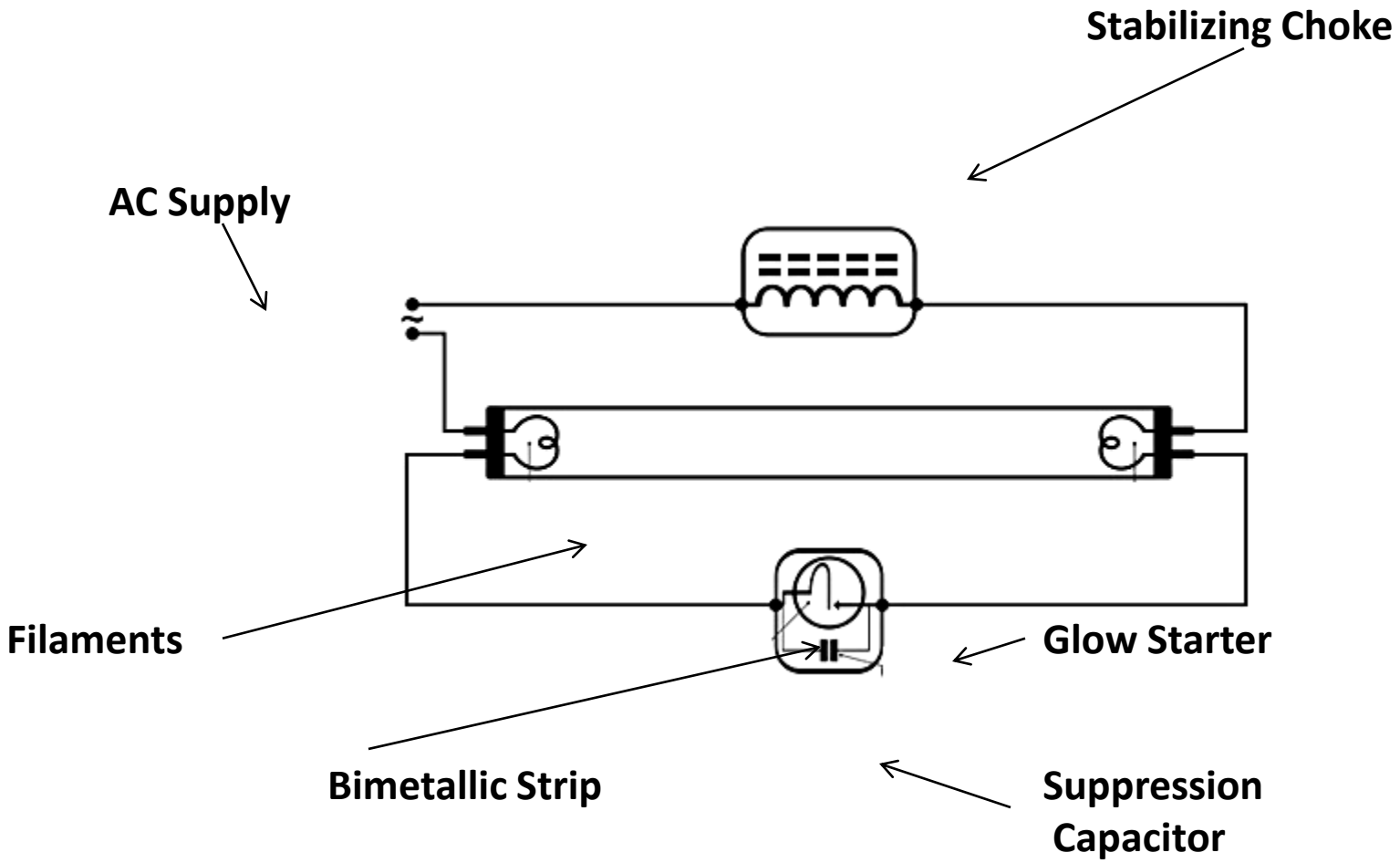


- Godown wiring is used in Godown where there are number of compartments.
- In this wiring pilot lamp is made ‘on’ and thereafter lamp in each compartment can be made ‘on’ w lamp in other compartment is automatically switched off.
- **Operation: When switch ‘1’ is made ‘on’ pilot lamps and lamp in second compartment L2** glows. Thereafter, when switch ‘2’ is made ‘on’ lamp in third compartment ‘L3’ glows and lamp L2 becomes off. When switch ‘3’ is made ‘on’ lamp L3 becomes off and lamp L4 glows.
- In reverse direction when switch ‘3’ is made off lamp L4 becomes off and L3 glows. Further when switch ‘2’ is made off lamp L3 becomes off and L2 glows and when switch ‘1’ is made off both lamps pilot and L2 goes off.

Types of Electric Lamps

- Fluorescent Lamp (Tube)
- Compact Fluorescent Lamp (CFL)
- LED Lamp

Fluorescent Lamp (Tube)



Fluorescent Lamp (Tube)

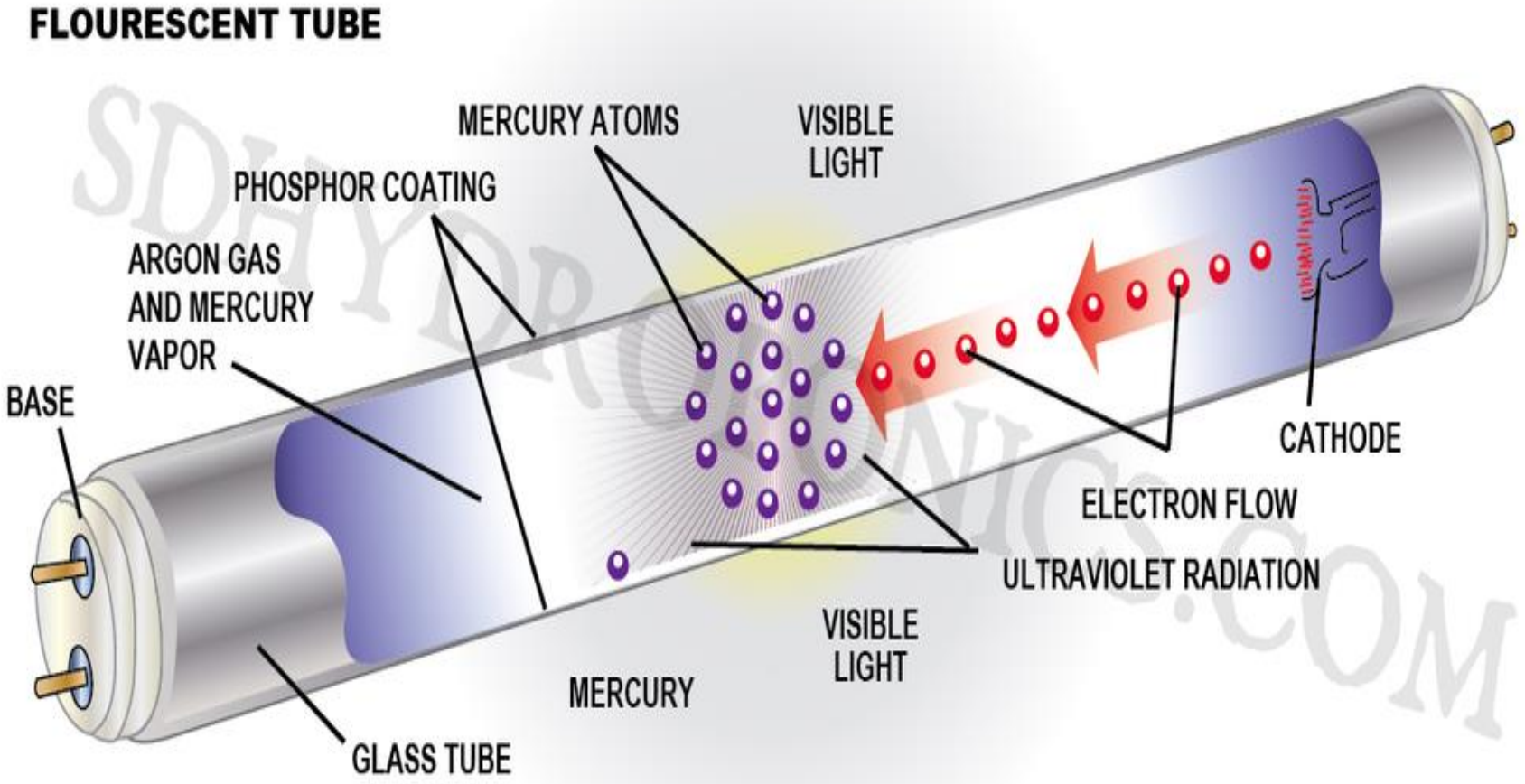
- Glass tube with **tungsten filaments** at ends.
- Coated with fluorescent powder and phosphorescent powder.
- Filled with small amount of mercury and argon glass at low pressure.
- No conduction through tube.
- Glow starter for completion of circuit.
- **Glow Starter**:

➢ Having two bimetallic strips.
➢ Arc takes place between strips and heat developed.
➢ Suppression of electromagnetic radiations by **suppression capacitor**.
➢ Protection against this radio interference due to it.
➢ Arc vanished when bimetallic contacts are closed due to heating.

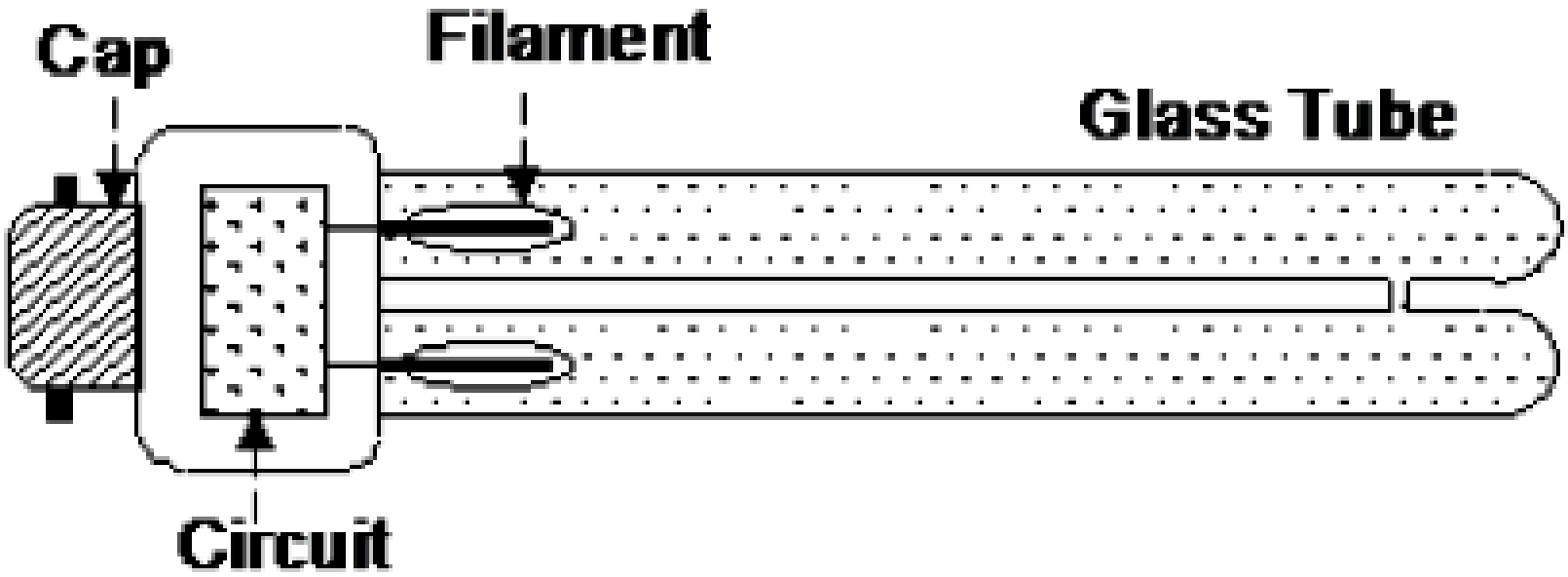
Fluorescent Lamp (Tube)

- Filaments are heated and heavy current flows.
- Cooling of bimetallic strip and open contacts.
- Heavy current is suddenly broken.
- High voltage surge between filaments.
- Discharge or conduction starts.
- Path of discharge has low resistance and so no arc in starter.
- Low resistance: High current (**Stabilizing Choke**)
- **Fluorescent Powder**: Ultra-violet radiations into glare-free diffused light.
- **Phosphorescent powder**: Continuous light even though supply is ac.
- Light Flicker
- Stroboscopic effect: When light falls on the moving parts, they may appear to be either running slow.
- 10W, 20W, 40W, 80W power ratings.

Fluorescent Lamp (Tube)



Compact Fluorescent Lamps (CFL)



1. Gas-filled tube
2. Magnetic or electromagnetic ballast:
   (High voltage pulse to start lamp)

Compact Fluorescent Lamps (CFL)

- Types: Modular and Screw-based
- Modular Design:
  - 2 or more separate parts and fits into special socket.
  - Electronic ballast (choke).
  - Energy saving

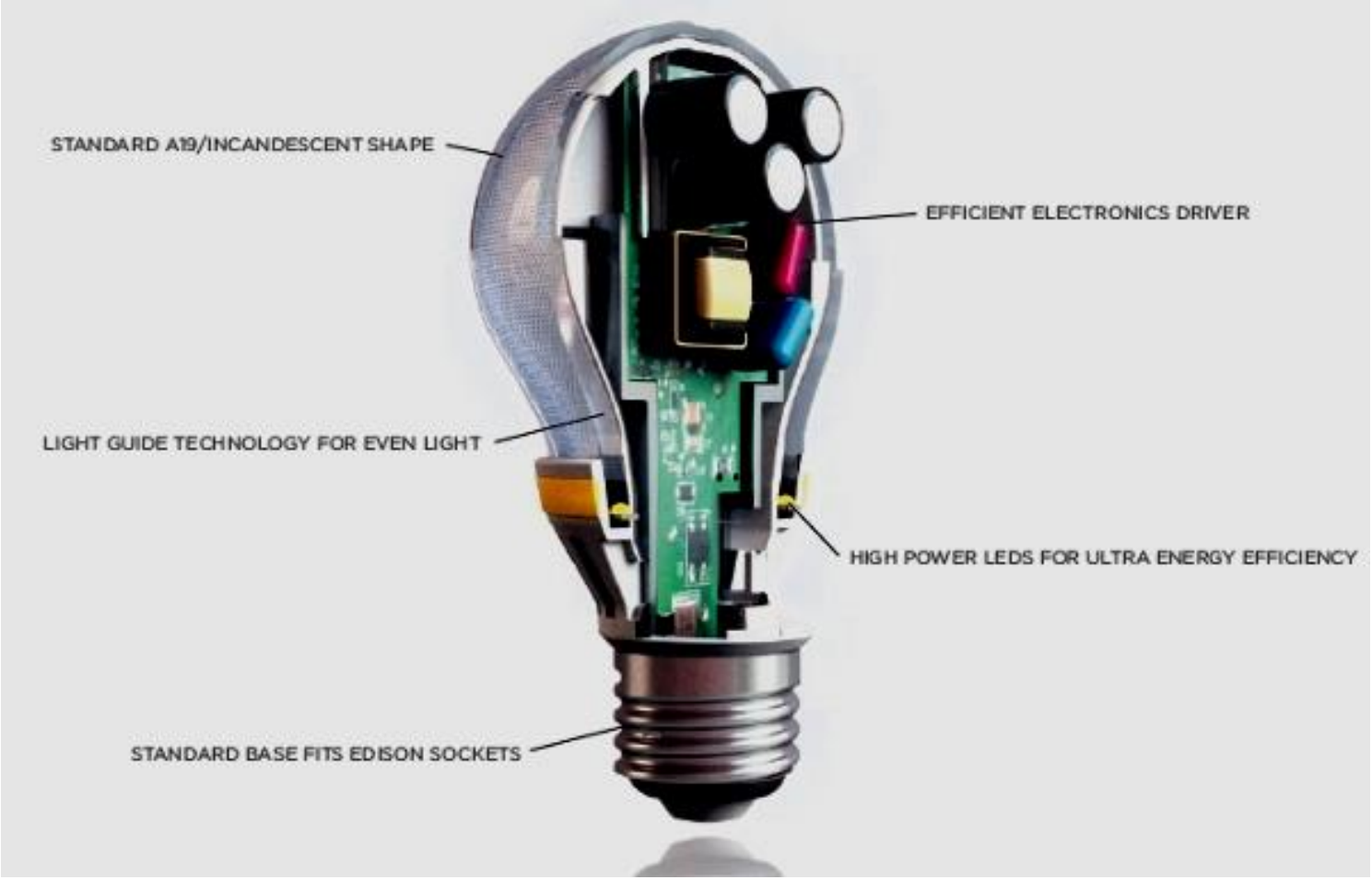
- Screw-based CFL:
  - Single piece CFL with bulb and ballast.
  - Used into socket of incandescent lamp.

- Similar working to fluorescent tube.
- Arc is produced when high voltage is applied using ballast.
- Discharge of gas: ultra violet light by mercury.
- Emission of visible cool white light due to phosphor coating on inner surface.

Compact Fluorescent Lamps (CFL)

Advantages	Disadvantages
Compact size	High initial cost
Replacement with incandescent lamps	Slightly greater size than incandescent lamps.
Energy saving	Not a instant start lamp
Life of 10000 to 13000 working hrs.	Electronic Interference
Low heat produced	Slight humming
Minimum maintenance and low power requirement	Light flicker
High quality and cool bright white light	----------

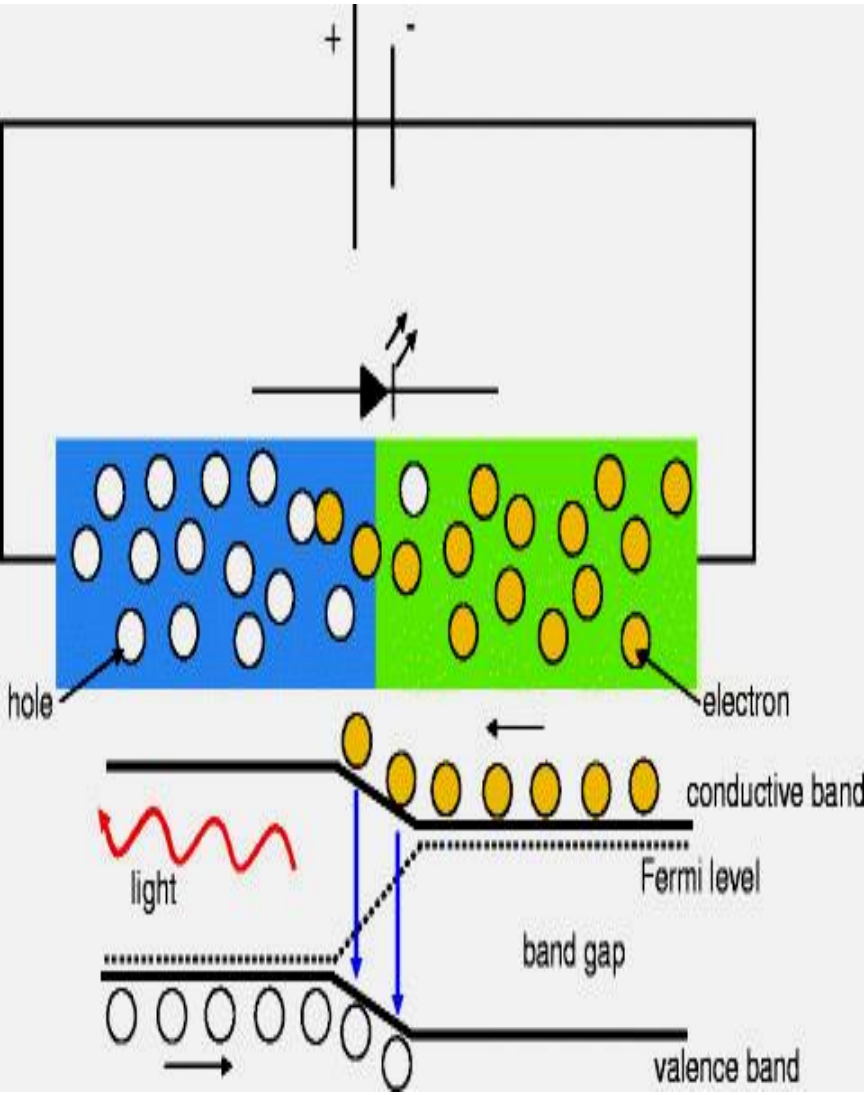
LED Lamps

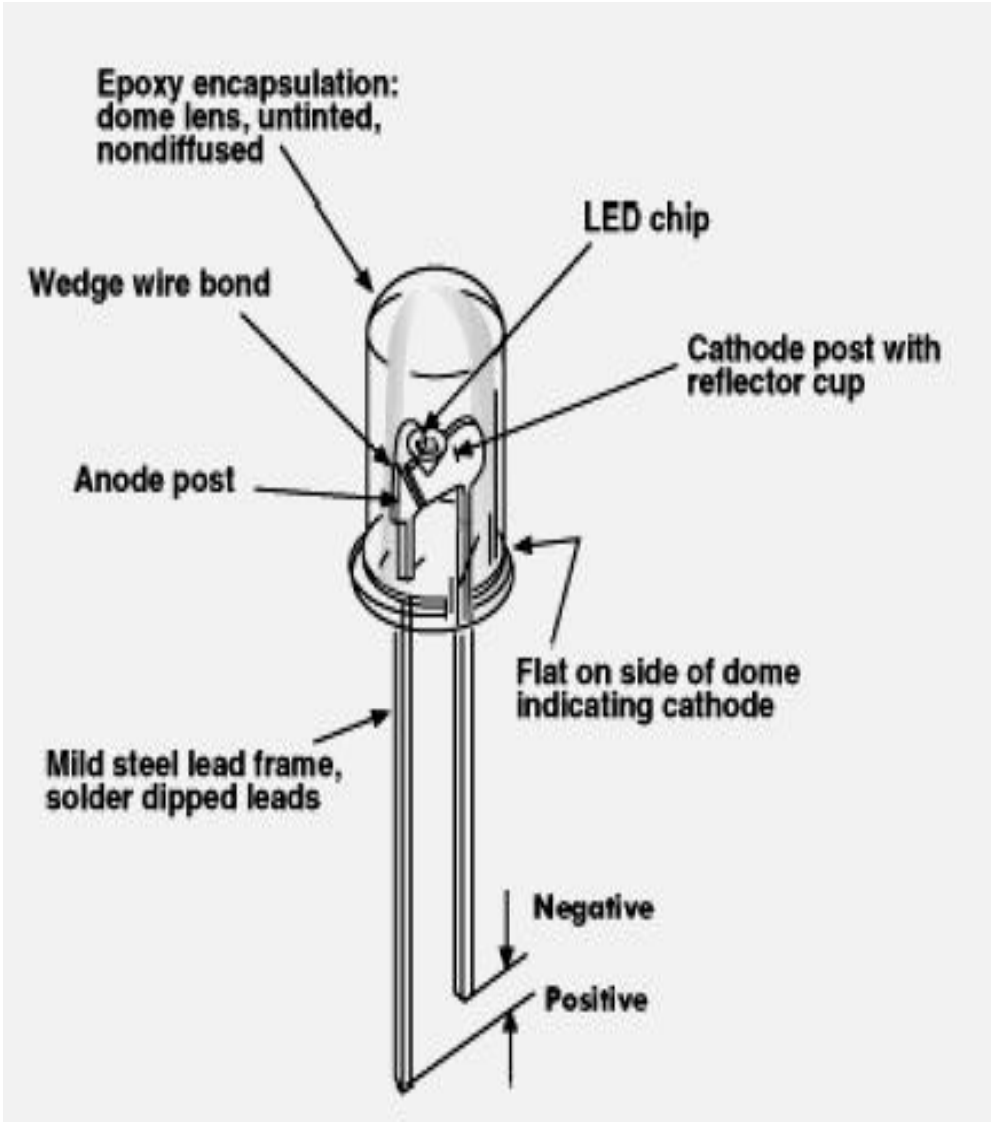

STANDARD A19/INCANDESCENT SHAPE
EFFICIENT ELECTRONICS DRIVER
LIGHT GUIDE TECHNOLOGY FOR EVEN LIGHT
HIGH POWER LEDS FOR ULTRA ENERGY EFFICIENCY
STANDARD BASE FITS EDISON SOCKETS

LEDs

- When p-n junction is forward biased, the majority carriers either electrons or holes start moving across the junction.
- When they moved from their regions they start to recombine across the depletion region.
- During the recombination of electrons and holes, some portion of energy must be dissipated or emitted in the form of heat and light.
- the majority of light is produced from the junction nearer to the p-type region. (mobile electrons)

LEDs


+
-
hole
electron
conductive band
light
Fermi level
band gap
valence band


Epoxy encapsulation: dome lens, untinted, nondiffused
LED chip
Wedge wire bond
Cathode post with reflector cup
Anode post
Flat on side of dome indicating cathode
Mild steel lead frame, solder dipped leads
Negative
Positive

LED Lamps

- Light Emitting Diodes
- Emits visible coloured light when forward biased.
- Small and solid bulb
- Energy efficient.
- Directional light.
- Instant turn ON.
- Long life (10 times CFL)
- High initial cost.

LED Lamps

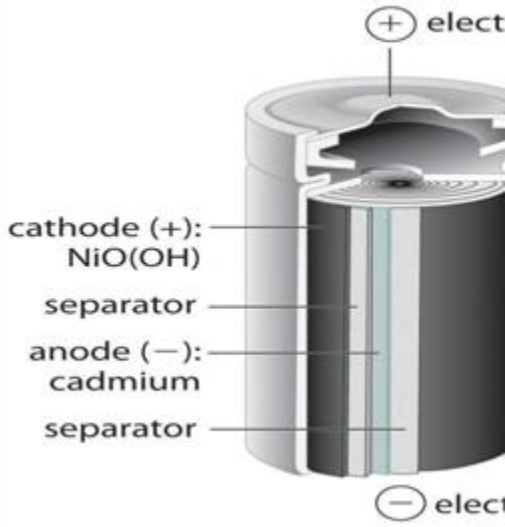
Advantages	Disadvantages
Long Lasting	Operates on DC so requires rectifier
Durable	Requires heat sinks
Cool light	Many LEDs for wide light
More efficient	Colour Rendering
Cost Effective	----------

Applications of LED Lamps

- Single bulb application
- LED tube light

Types of Batteries

There are currently three types of batteries commonly used : Nickel Cadmium, Nickel Metal Hydride, and Lithium Ion.



Nickel Cadmium (Ni-Cd)

Nickel Cadmium (Ni-Cd) batteries were the standard technology for years, but today they are out of date

They are heavy and very prone to the "memory effect". When recharging a NiCd battery that has not been fully discharged, it "remembers" the old charge and continues there the next time you use it. The memory effect is caused by crystallization of the battery's substances and can permanently reduce your battery's lifetime, even make it useless. To avoid it, you should completely discharge the battery and then fully recharge it again at least once every few weeks. As this battery contains cadmium, a toxic material, it should always be recycled or disposed of properly.

NiCad batteries, and to a some degree NiMH batteries, suffer from what's called the *memory effect*. Memory Effect means that if a battery is repeatedly only partially discharged before recharging, the battery will forget that it can further discharge. The best way to prevent this situation is to fully charge and discharge your battery on a regular basis.

- **Nickel Metal Hydride (Ni-MH)**
- Nickel Metal Hydride (Ni-MH) batteries are the cadmium-free replacement for NiCad. They are less affected by the memory effect than NiCd and thus require less maintenance and conditioning. However, they have problems at very high or low room temperatures. And even though they use less hazardous materials (i.e., they do not contain heavy metals), they cannot be fully recycled yet. Another main difference between NiCad and NiMH is that NiMH battery offers higher energy density than NiCads. In other words, the capacity of a NiMH is approximately twice the capacity of its NiCad counterpart. What this means for you is increased run-time from the battery with no additional bulk or weight.

Lithium Ion (Li-ion)

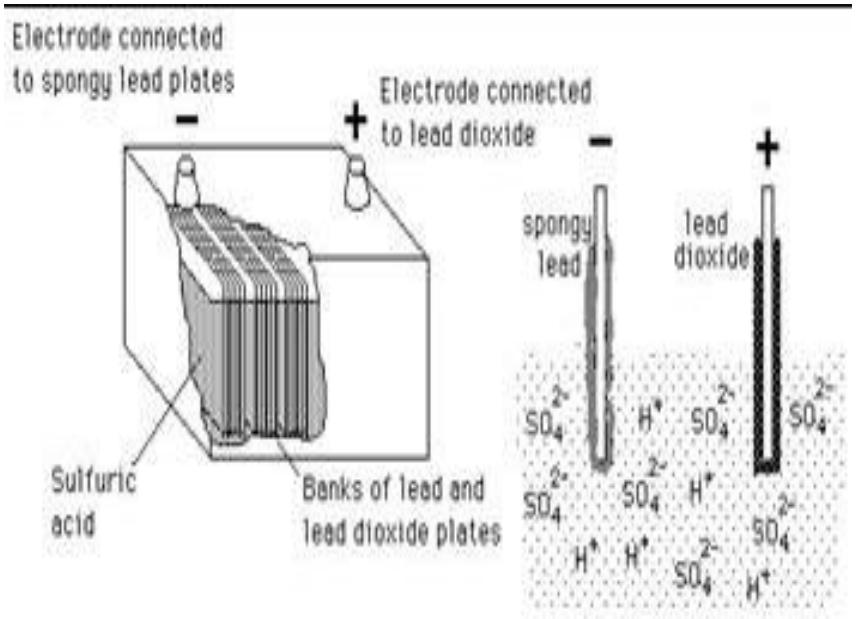
Lithium Ion (Li-ion) are the new standard for portable power. Li-ion batteries produce the same energy as NiMH but weighs approximately 20%-35% less. They do not suffer significantly from the memory effect unlike their NiMH and Ni-Cd counterparts. Their substances are non-hazardous to the 0. Because lithium ignites very easily, they require special handling.

Smart Batteries

Smart batteries are not really a different type of battery, but they do deserve special mention. Smart batteries have internal circuit boards with chips which allow them to communicate with the laptop and monitor battery performance, output voltage and temperature. Smart batteries will generally run 15% longer due to their increased efficiency and also give the computer much more accurate "fuel gauge" capabilities to determine how much battery run time is left before the next recharge is required.

- **Lead Acid Battery:**

Lead Acid batteries are widely used in automobiles, inverters, backup power systems etc. Unlike tubular and maintenance free batteries, Lead Acid batteries require proper care and maintenance to prolong its life. The Lead Acid battery consists of a series of plates kept immersed in sulphuric acid solution. The plates have grid on which the active material is attached. The plates are divided into positive and negative plates. The positive plates hold pure lead as the active material while lead oxide is attached on the negative plates.



- A completely charged battery can discharge its current when connected to a load. During the process of discharge, the sulphuric acid combines with the active materials on the positive and negative plates resulting in the formation of Lead sulphate. Water is the single most important step in maintaining a Lead Acid battery. The frequency of water depends on usage, charge method and operating temperature. During process, the hydrogen atoms from the sulphuric acid react with oxygen to form water.
- This results in the release of electrons from the positive plates which will be accepted by the negative plates. This leads to the formation of an electric potential across the battery. The electrolyte in the Lead Acid battery is a mixture of Sulphuric acid and water which has a specific gravity. Specific gravity is the weight of the acid-water mixture compared to equal volume of water. The specific gravity of pure ions free water is 1.
- The lead-acid batteries provide the best value for power and energy per kilowatt-hour; have the longest life cycle and a large environmental advantage in that they are recycled at an extraordinarily high rate. No other chemistry can touch the infrastructure that exists for collecting, transporting and recycling lead-acid batteries.

Types of wires and cables

- Wires and cables are purpose built conductors
- The size and type of wire/cable must suit the power rating required for their use. The higher the power thicker the wire or cable.
- Wires- Domestic and small industries application
- Cables- Small and big industries, Distribution lines, Transmission lines

- There are mainly 6 types of wires are there.

1. Vulcanised indian rubber wire (V.I.R)
2. Tough rubber sheathed wire (T.R.S)
3. Poly vinyl chloride wire (P.V.C.)
4. Lead alloy sheathed wire
5. Weather proof wires
6. Flexible wire

INRODUCTION TO CABLES

- A power cable is an assembly of two or more electrical conductors, usually held together with an overall sheath. The assembly is used for transmission of electrical power. Power cables may be installed as permanent wiring within buildings, buried in the ground, run overhead, or exposed.
- Flexible power cables are used for portable devices, mobile tools and machinery.

GENERAL CONSTRUCTION

1.Conductor or Core.

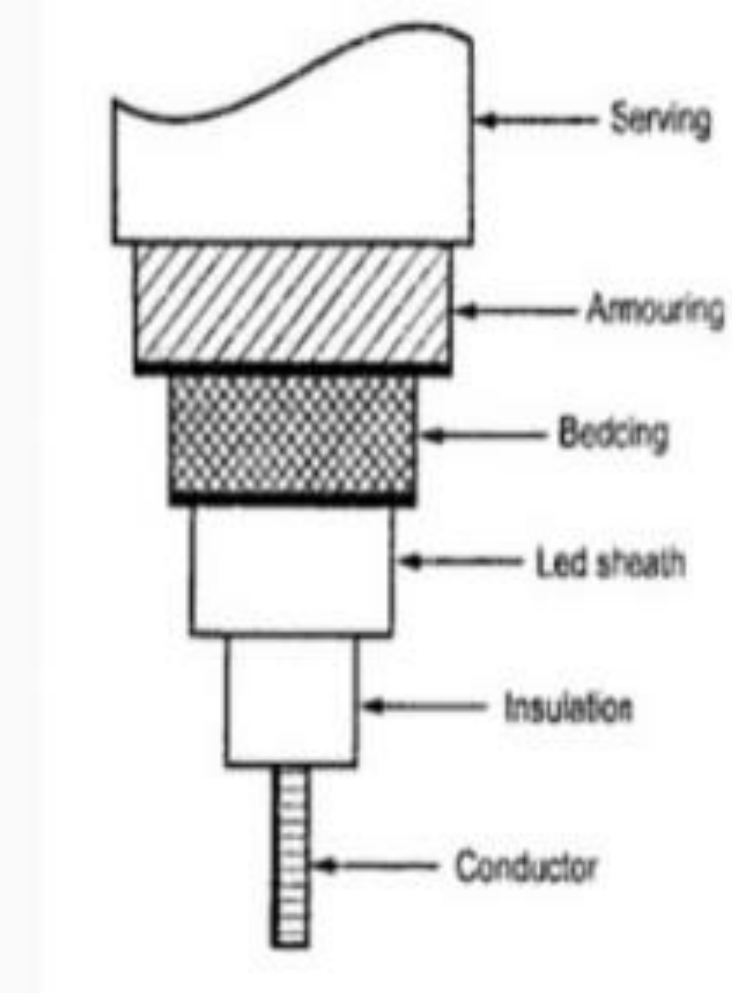
2. Insulation.

3. Metallic Sheath

4. Bedding.

5. Armouring.

6. Serving



TYPES OF CABLES

- The types of cables basically decided based on the voltage level for which it is manufactured and material used for the insulation such as paper, cotton,rubber etc.
- The classification of cables according to the voltage levels is,
- Low Tension Cables (L.T. Cables).
- Medium and High tension Cables (H.T. Cables).

THANK YOU