



## UNIT III – ELECTRICAL WIRING AND SAFETY

**WIRING:** General Rules, Materials and Accessories, Types of Wiring- Conduit Wiring-Wiring Layout of Residential Building

**,GROUNDING:** Importance of Grounding, Types of Grounding-

**SAFETY :** Causes of Accidents, Accident Prevention

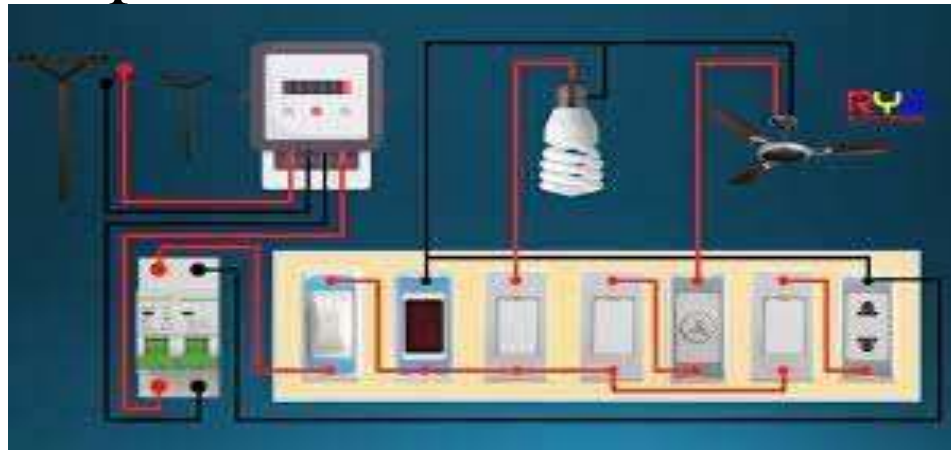
**CIRCUIT BRAKERS** (MCB & ELCB), Electronic Fuses.



# ELECTRICAL WIRING

Electrical wiring is process of connecting cables and wires to the related devices such as Fuse, sockets, fans, lights ect.. to the main distribution boards is a specific structure for continues supply.

House wiring deals with the distribution within the domestic premises. House wiring is generally done for consumption of electrical energy at 230V- single phase or at 400V - Three phase.





# RULES OF ELECTRICAL WIRING



The total lighting load in a sub circuit should not be more than 100W.

- Every fitting or appliance must be controlled by switch.
- Every socket outlet must be controlled by switch.
- The switch should be on the line conductor.
- The incandescent lamp should be hanged at least 2.5 m above the floor level.
- All the metal coverings, frames etc. should be earthed.
- Every sub circuit must have a separated distribution fuse.



# WIRING ACCESSORIES AND MATERIALS

All the wiring systems and electrical installations needs the following accessories:

- Cables
- Flexible wires
- Switches
- Fuses
- Ceiling rose
- Lamp holders
- Plugs
- Socket outlets
- Junction boxes





# CABLES

A cable is made of some conducting material such as copper or aluminium. It is surrounded by insulation and a sheath for mechanical protection.

The cables are generally classified according to the insulation used. Different types of cables are as follows:

- Weather- proof cables
- Polyvinyl chloride insulated cables (PVC)
- Lead sheathed cables
- Cab tyre sheathed cables (CTS)



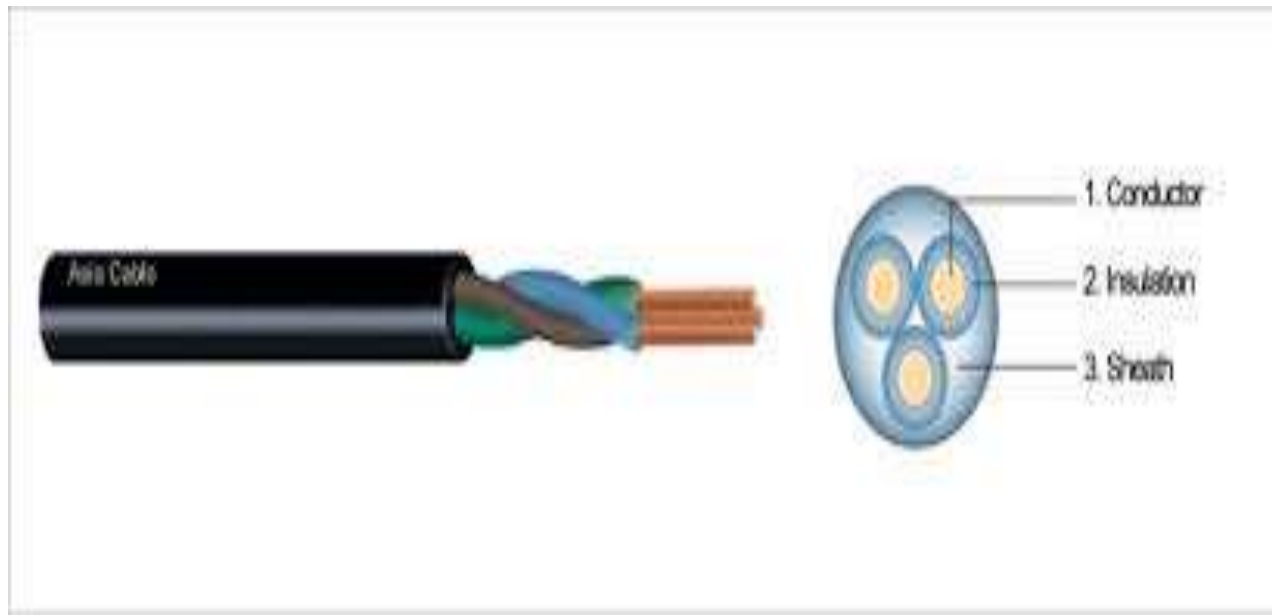


# FLEXIBLE CORD

In the flexible cord, a large number of fine wires are used to form the conductor. These are insulated by plastic insulation.

The flexible cords are used as connecting wires to connect the portable domestic appliances and light fittings etc.

These cords are easy to guide and handle.





# SWITCHES

A switch is supposed to carry out the make (connect) and break (disconnect) of electrical connection to the load.

Switches should be connected to the live (L) wire in the circuit.

The switches can be classified into two types as follows:

1. Tumbler switch
2. Flush switch





# SURFACE OR TUMBLER SWITCH

Mounted on the mounting block directly connected to the surface of the wall. It is projected out of the surface of the wall.

- Single-way switch
- Two-way switch







# PULL SWITCHES OR CEILING SWITCHES

- The Pull switches are fixed on the ceiling and all live parts are out of reach of the operator
- The switch has strong mechanical action. It is operated with a single pull.





# ROTARY SNAP SWITCH





# PUSH BUTTON SWITCH

- This type of switch consists of one blade only.
- The blade is given a rocking action by press button and movement is controlled by a cam and spring.





# FUSES

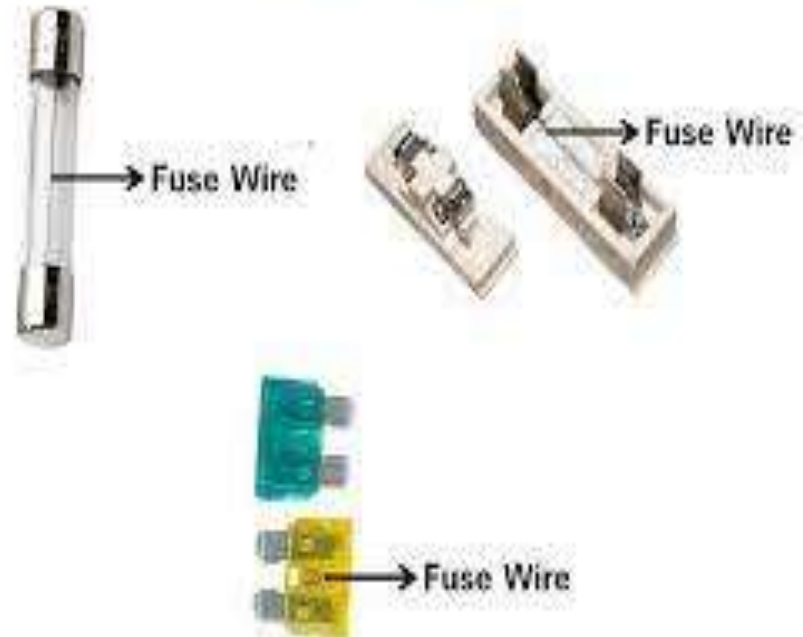
In any electrical installation, fuse is used for protecting the appliances against over current.

Fuse is used in different stages of the wiring.

A fuse can be made of the following conducting materials:

1. Copper
2. Lead
3. Aluminium
4. Alloys of lead and
5. Zinc
6. Tin

## Fuse Wire





# SHOCKET OUTLETS

The socket outlets are provided for temporary electrical connections such as table lamps, table fans, radio, TV, mobile chargers etc.

The socket outlet can be of the following two types:

- Two pin type (Live, Neutral)
- Three pin type (Live, Neutral, Earth)





# PLUGS

The plugs along with flexible cords are used for providing the electrical supply to the portable appliances like table fan, table lamps, radio etc.

The plugs are available in two types, similar to the sockets:

1. Two pin plugs
2. Three pin plugs





# LAMP HOLDER

A lamp holder supports the lamp and connects it to the supply system as well

The lamp holders are classified into following different types:

1. Batten holders
2. Angle holder
3. Pendant holder
4. Water tight bracket holders
5. Bracket holders





# CEILING ROSE

The ceiling rose is used for connecting the ceiling fans, pendant lamps etc to the supply system.

Ceiling rose is made of the following two parts:

1. Base
2. Cover




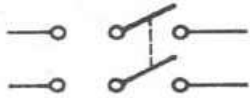






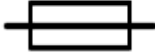


# SYMBOLS USED IN ELECTRICAL WIRING

Following are the conventional symbols to be used for wiring accessories in wiring plans and drawing of electrical installations

Sr. No.	Description	Symbol
1.	Earthing	
2.	Single pole one way switch	
3.	Single pole double throw switch (S.P.D.T.)	
4.	Double pole double throw switch (D.P.D.T.)	



# SYMBOLS USED IN ELECTRICAL WIRING

Sr. No.	Description	symbol
5.	Fuse	
6.	Circuit breaker	
7.	Two way switch	



# TYPES OF WIRING



The type of wiring to be selected for a particular place of use is based on several factors such as **durability** , **mechanical protection** , **appearance** , **environmental condition etc.** The various type of wiring in practice are as follows:

- Cleat wiring
- Wooden casing and capping wiring.
- Batten wiring
- Conduit wiring.
- Lead sheathed wiring.



# TYPES OF WIRING



There are additional types of **conduit wiring according to Pipes installation** (Where steel and PVC pipes are used for wiring connection and installation).

- **Surface or open Conduit type**
- **Recessed or concealed or underground type Conduit**



# SURFACE OR OPEN CONDUIT TYPE

If conduits installed on roof or wall, It is known as **surface conduit wiring**. in this wiring method, they make holes on the surface of wall on equal distances and conduit is installed then with the help of rowel plugs





# CONCEALED CONDUIT TYPE

If the conduits is hidden inside the wall slots with the help of plastering, it is called concealed conduit wiring. In other words, the electrical wiring system inside wall, roof or floor with the help of plastic or metallic piping is called concealed conduit wiring. Obviously, It is the most popular, beautiful, stronger and common electrical wiring system nowadays



Concealed Conduit wiring



# CONCEALED CONDUIT TYPE

Following conduits are used in the conduit wiring systems

- Metallic Conduit
- Non-metallic conduit





# METALIC CONDUIT WIRING

Metallic conduits are made of steel which are very strong but costly as well.

There are two types of metallic conduits.

➤ **Class A Conduit:** Low gauge conduit (Thin layer steel sheet conduit)

➤ **Class B Conduit:** High gauge conduit (Thick sheet of steel conduit)







# METALIC CONDUIT WIRING

Metallic conduits are made of steel which are very strong but costly as well.

There are two types of metallic conduits.

➤ **Class A Conduit:** Low gauge conduit (Thin layer steel sheet conduit)

➤ **Class B Conduit:** High gauge conduit (Thick sheet of steel conduit)





# NON - METALIC CONDUIT WIRING



A solid PVC conduit is used as non-metallic conduit now a days, which is flexible and easy to bend.





# ADVANTAGES



- It is the **safest wiring system** (Concealed conduit wiring)
- **Appearance is very beautiful** (in case of concealed conduit wiring)
- **No risk of mechanical wear & tear and fire** in case of metallic pipes.
- **Customization** can be easily done according to the future needs.
- Repairing and **maintenance is easy**.
- There is **no risk of damage** the cables insulation
- It is **safe from corrosion** (in case of PVC conduit) and risk of fire.
- It can be used even in **humidity , chemical effect and smoky areas**.
- **No risk of electric shock** (In case of proper earthing and grounding of metallic pipes).
- It is **reliable and popular** wiring system.
- Sustainable and long-lasting wiring system.



# DISADVANTAGES



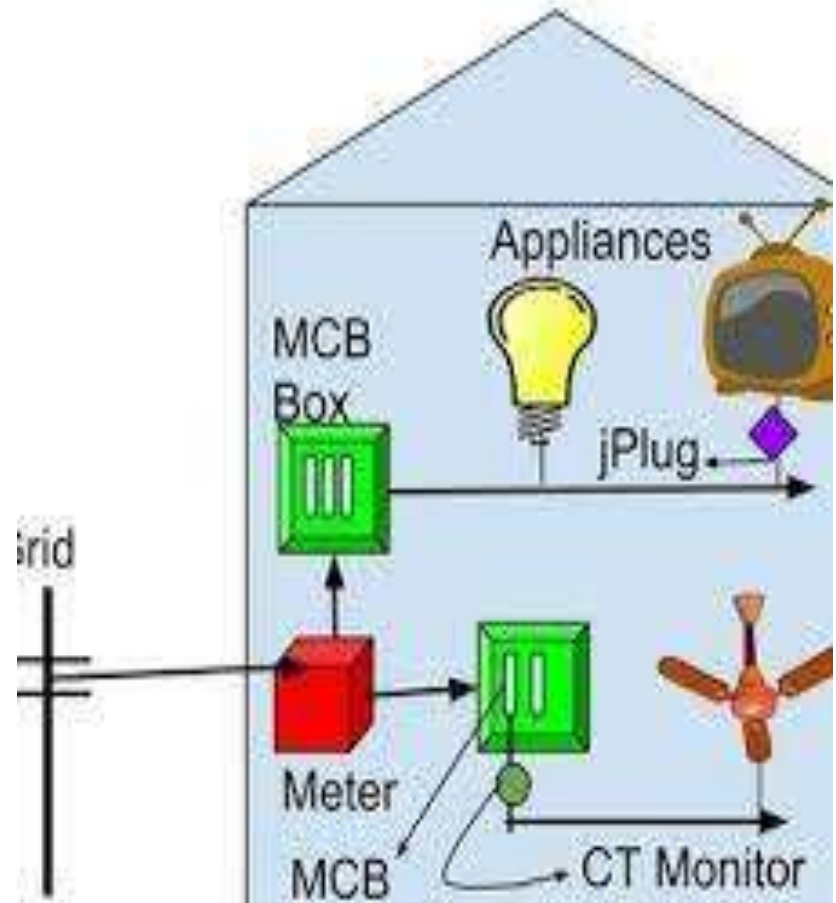
- **It is expensive wiring system** (Due to PVC and Metallic pipes, Additional earthing for metallic pipes Tee(s) and elbows etc.
- **Very hard to find the defects** in the wiring.
- **Installation is not easy** and simple.
- **Risk of Electric shock** (In case of metallic pipes without proper earthing system)
- **Very complicated to manage additional connection** in the future.



# RESIDENTIAL WIRING

Residential electrical wiring systems **start with the utility's power lines and equipment that provide power to the home**, known collectively as the service entrance.

The power is run through an electric meter, which records how much energy is used in the home and is the basis for the monthly electric bill.

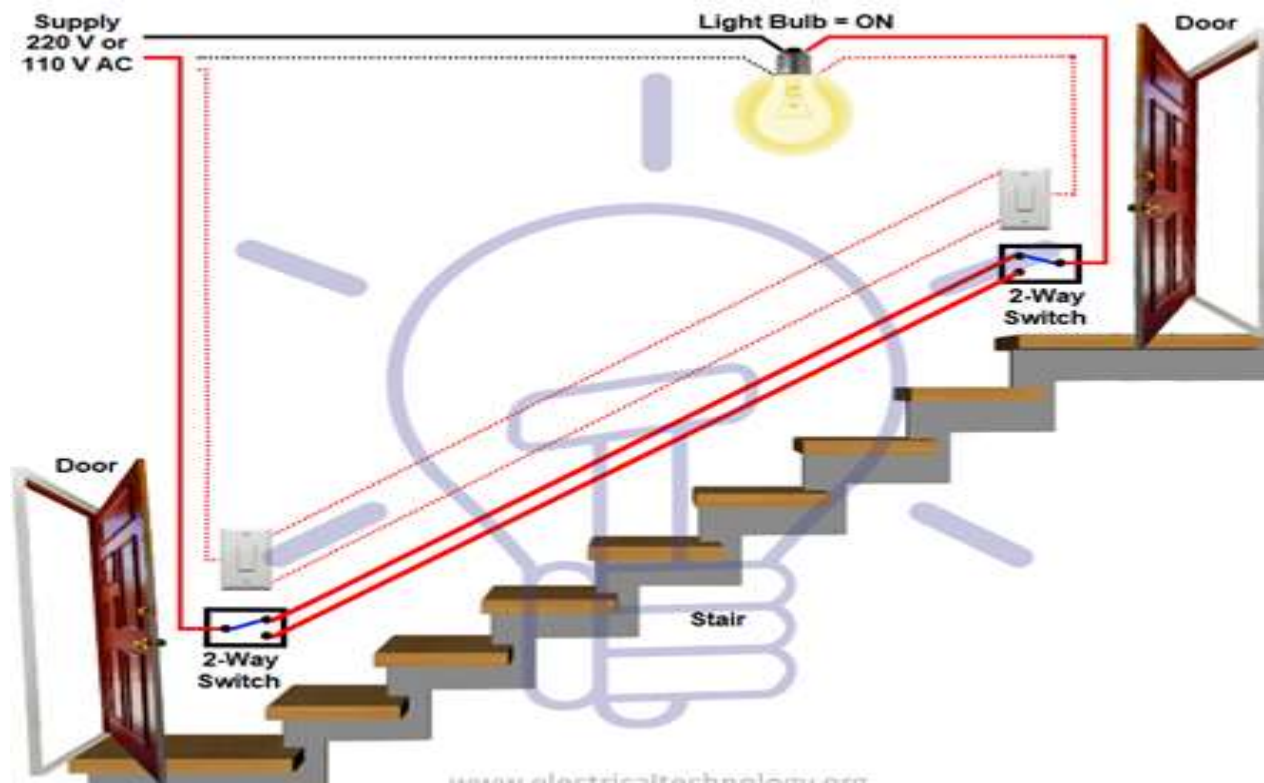




# LAYOUT OF HOUSEHOLD WIRING

## Staircase Wiring Circuit Diagram Connection

Here we can control a bulb from two different places by using two 2-way switches.

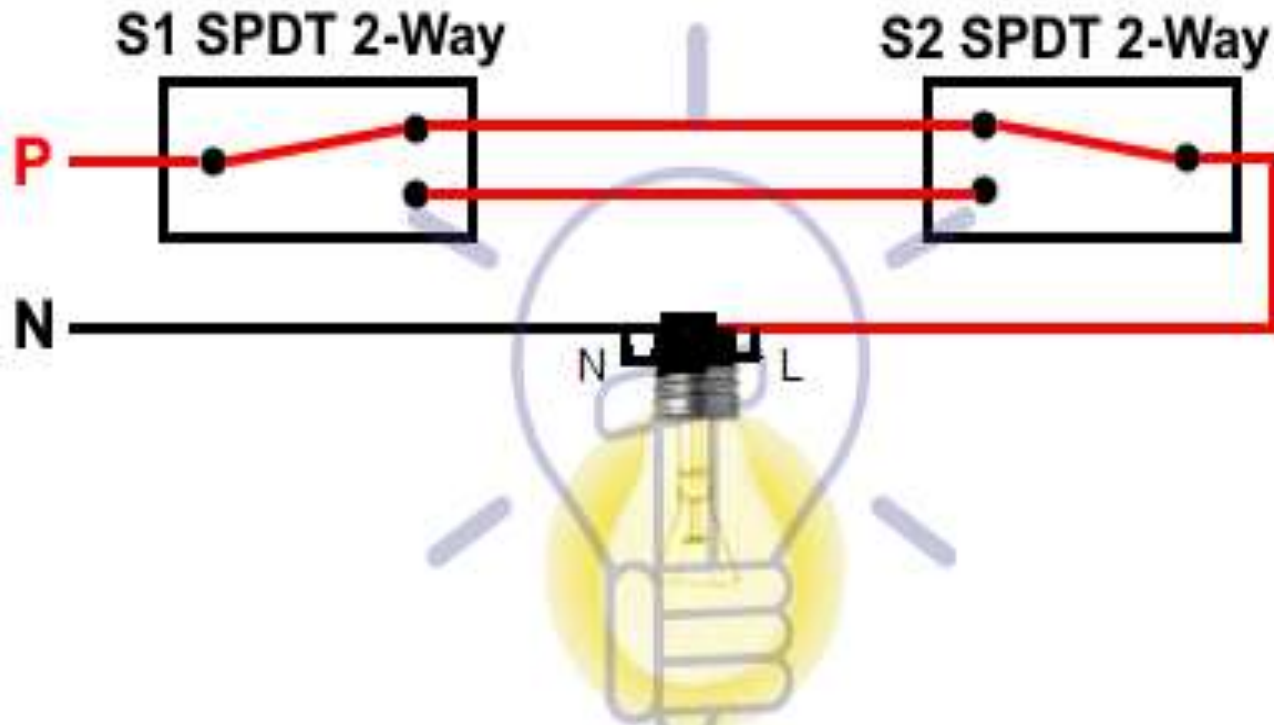




# LAYOUT OF HOUSEHOLD WIRING

## Staircase Wiring Circuit Diagram Connection

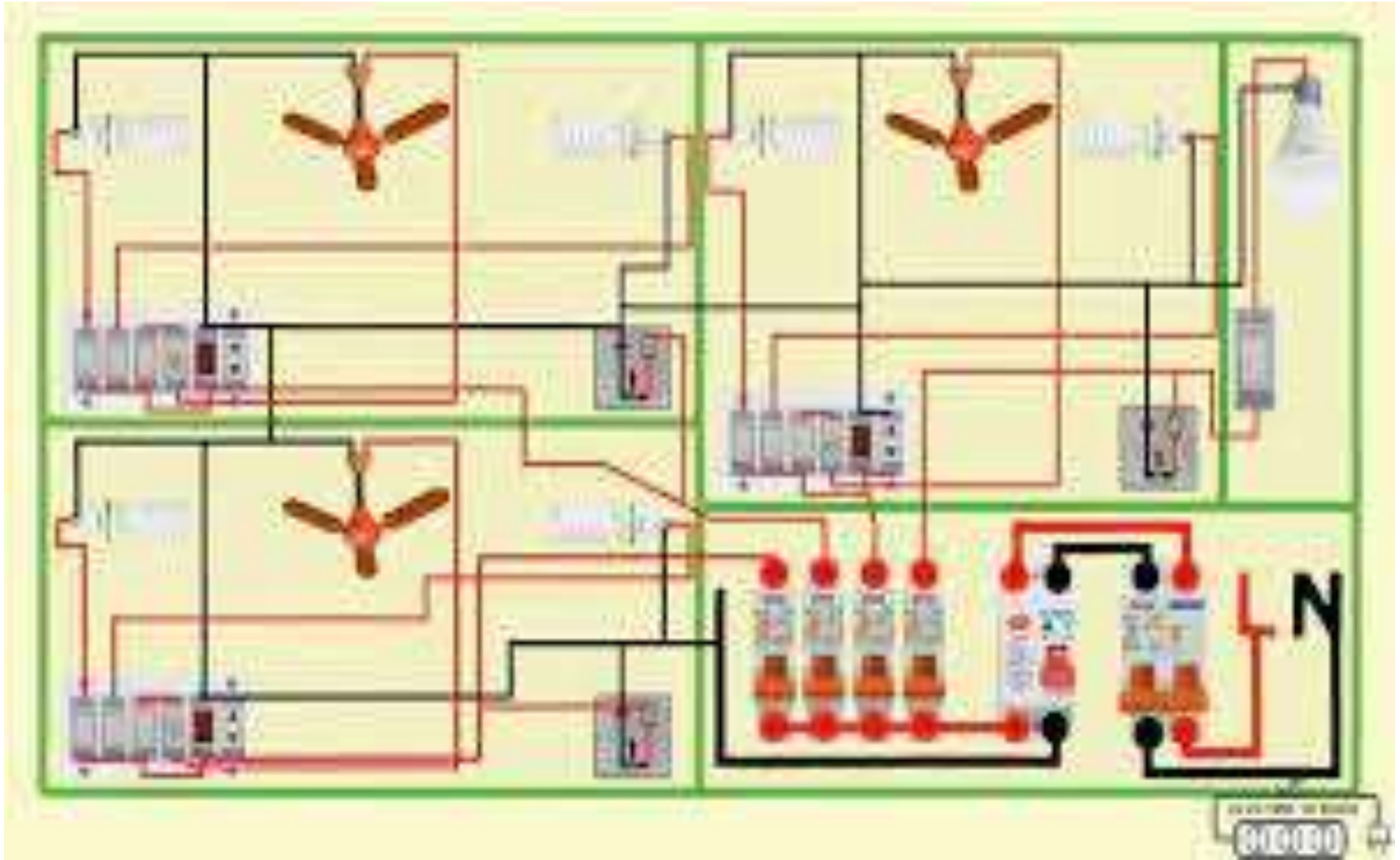
Here we can control a bulb from two different places by using two 2-way switches.





# LAYOUT OF HOUSEHOLD WIRING

## MODEL 1

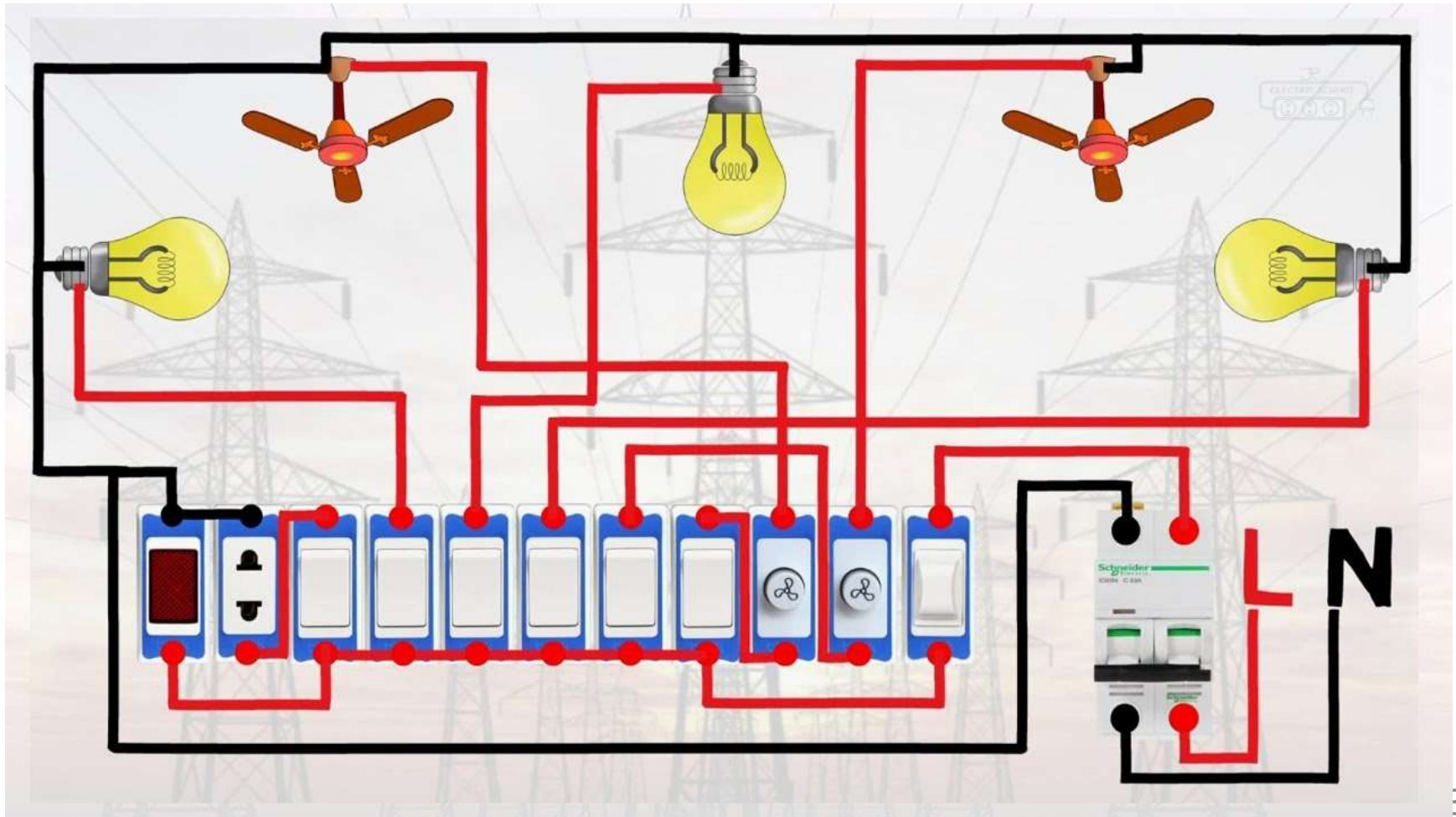






# LAYOUT OF HOUSEHOLD WIRING

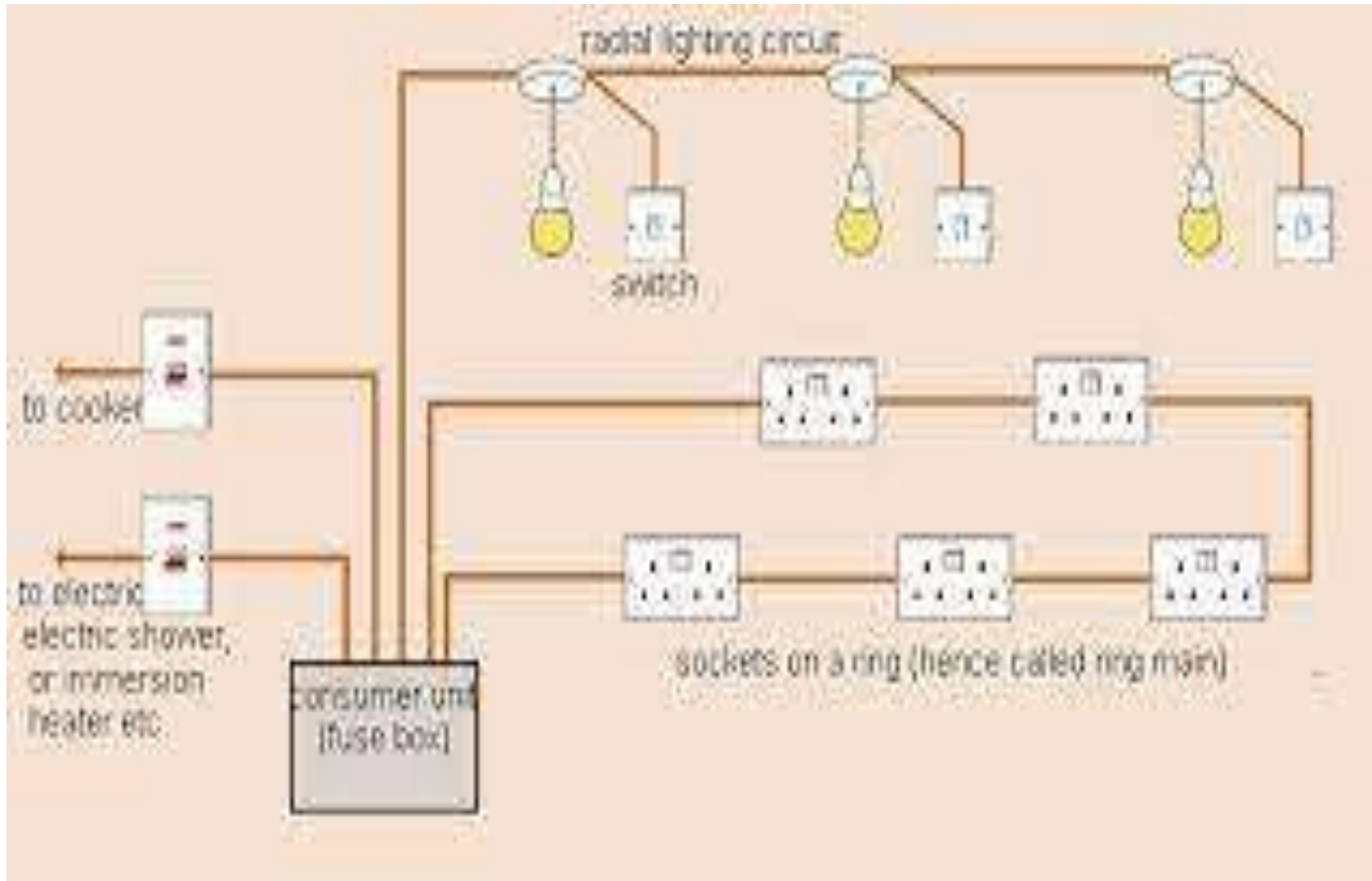
## MODEL 2





# LAYOUT OF HOUSEHOLD WIRING

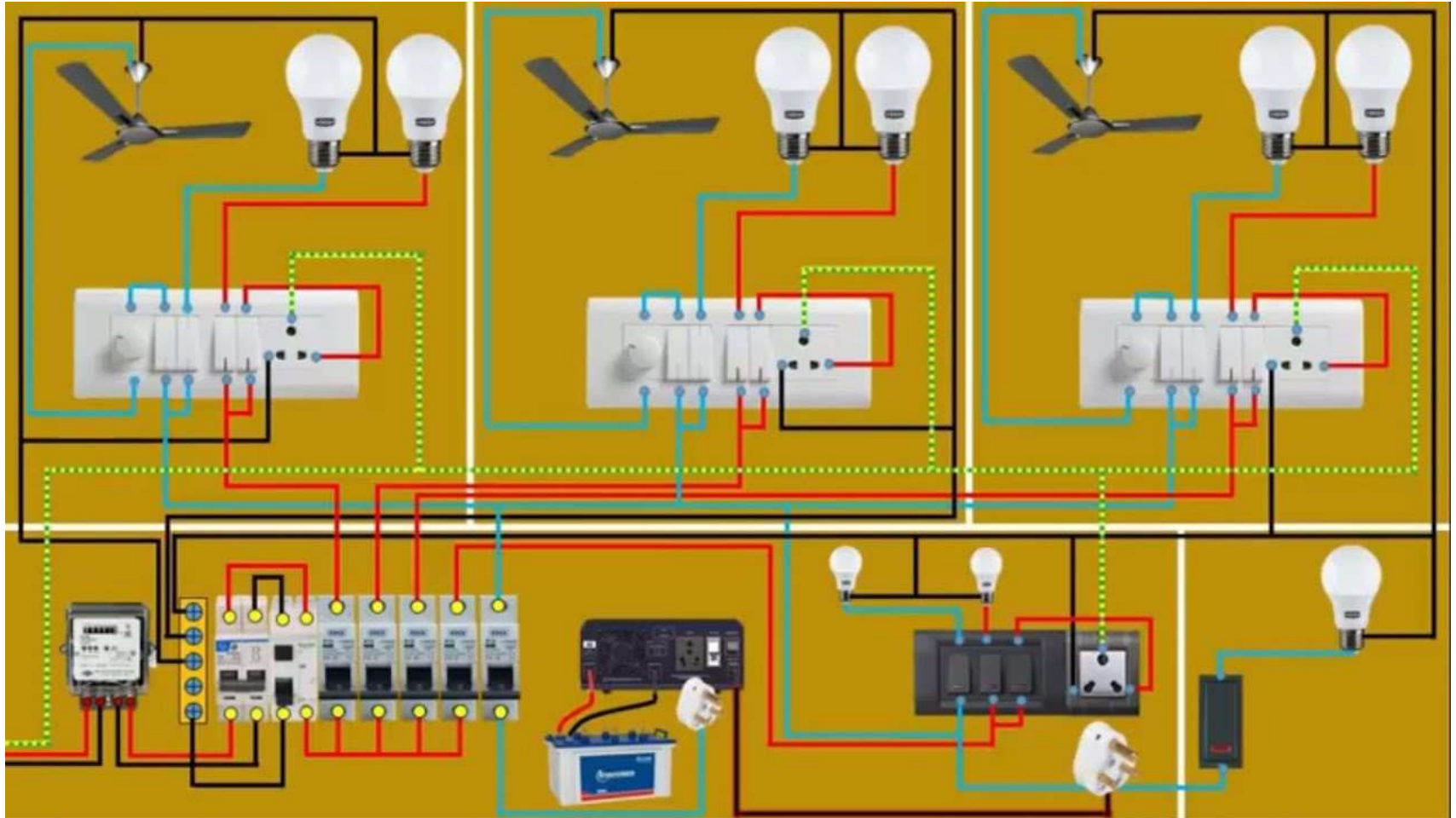
## MODEL 3





# LAYOUT OF HOUSEHOLD WIRING

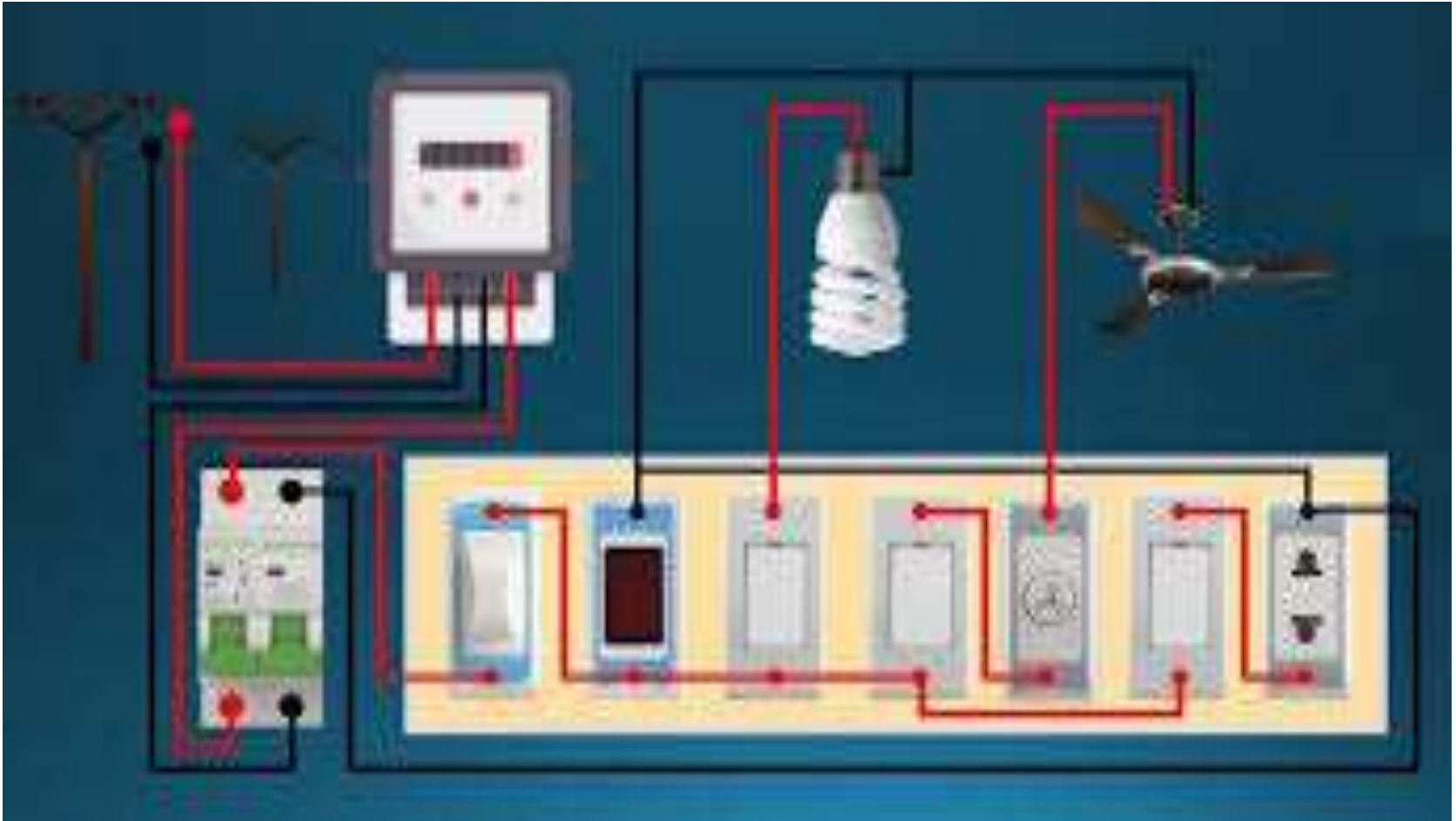
## MODEL 4





# LAYOUT OF HOUSEHOLD WIRING

## MODEL 5





# GROUNDING OR EARTHING

When there is adequate grounding, the excess current flow is removed, eliminating threats.

In the absence of grounding, the excess current can pass through the human body, which is a good conductor thereby electrocuting you. This can cause severe damage and burns.

To prevent this from happening, grounding is important.





# IMPORTANCE OF EARTHING



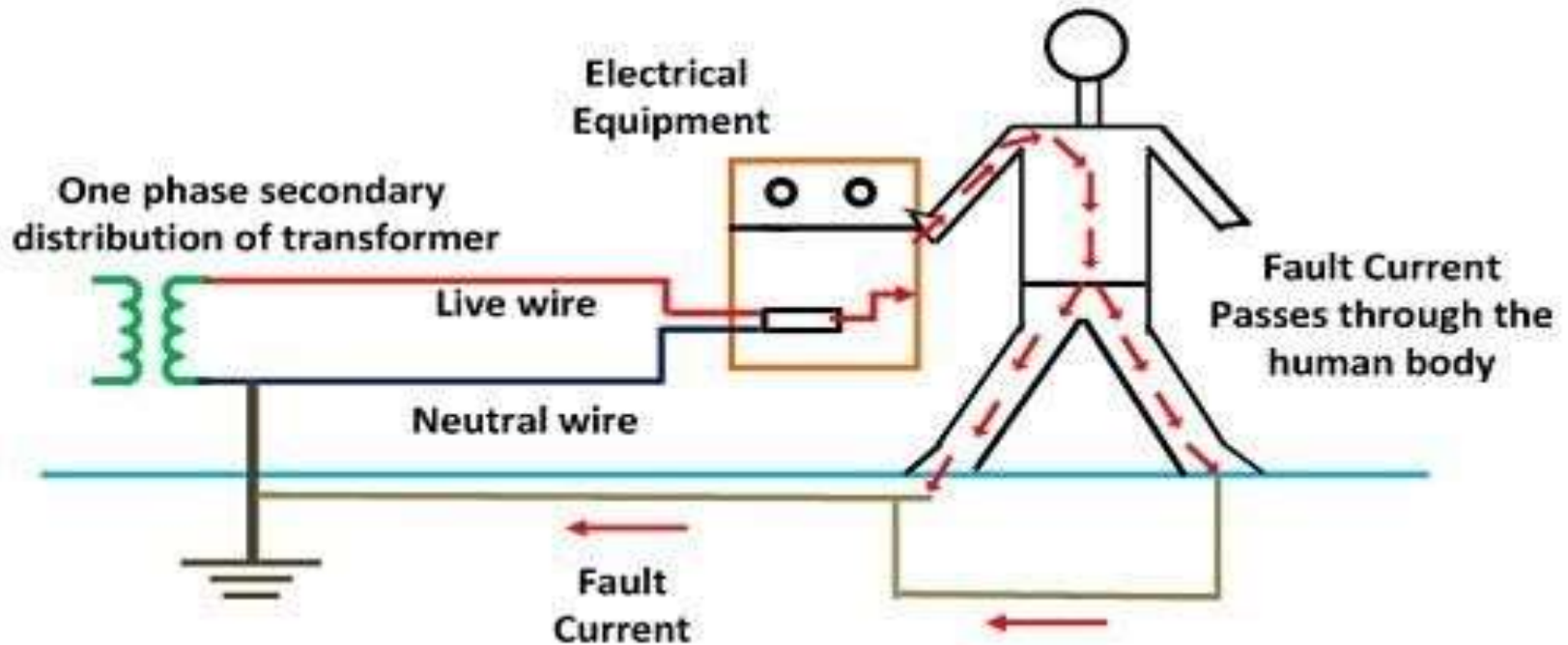
## Importance for Earthing

An Electrical equipment is considered dead when

- At or about zero potential
- Disconnected/ Isolated from live system
- Disconnection alone not adequate
  - Can retain stored charge
  - Can acquire a static charge
  - Can accidentally be made alive
  - Nearby live conductors may induce voltage



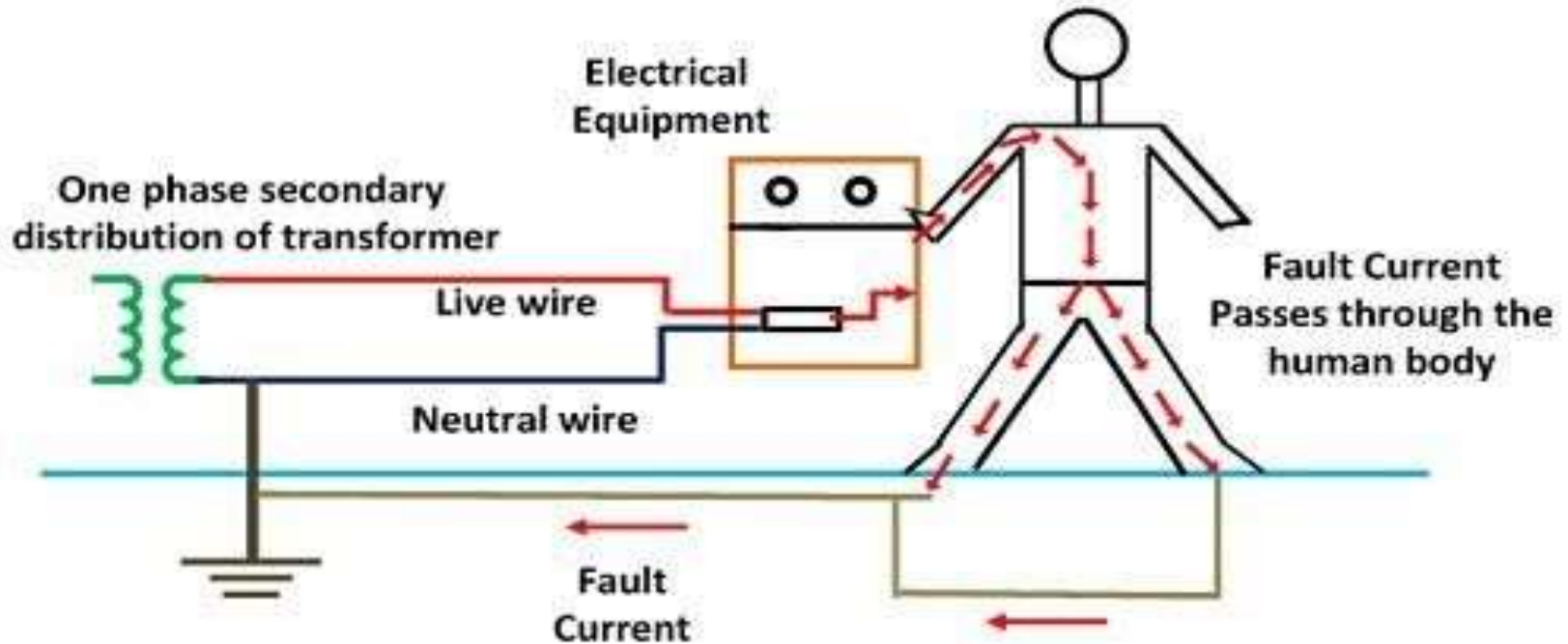
# IMPORTANCE OF EARTHING



Electrical System Without Earthing



# IMPORTANCE OF EARTHING

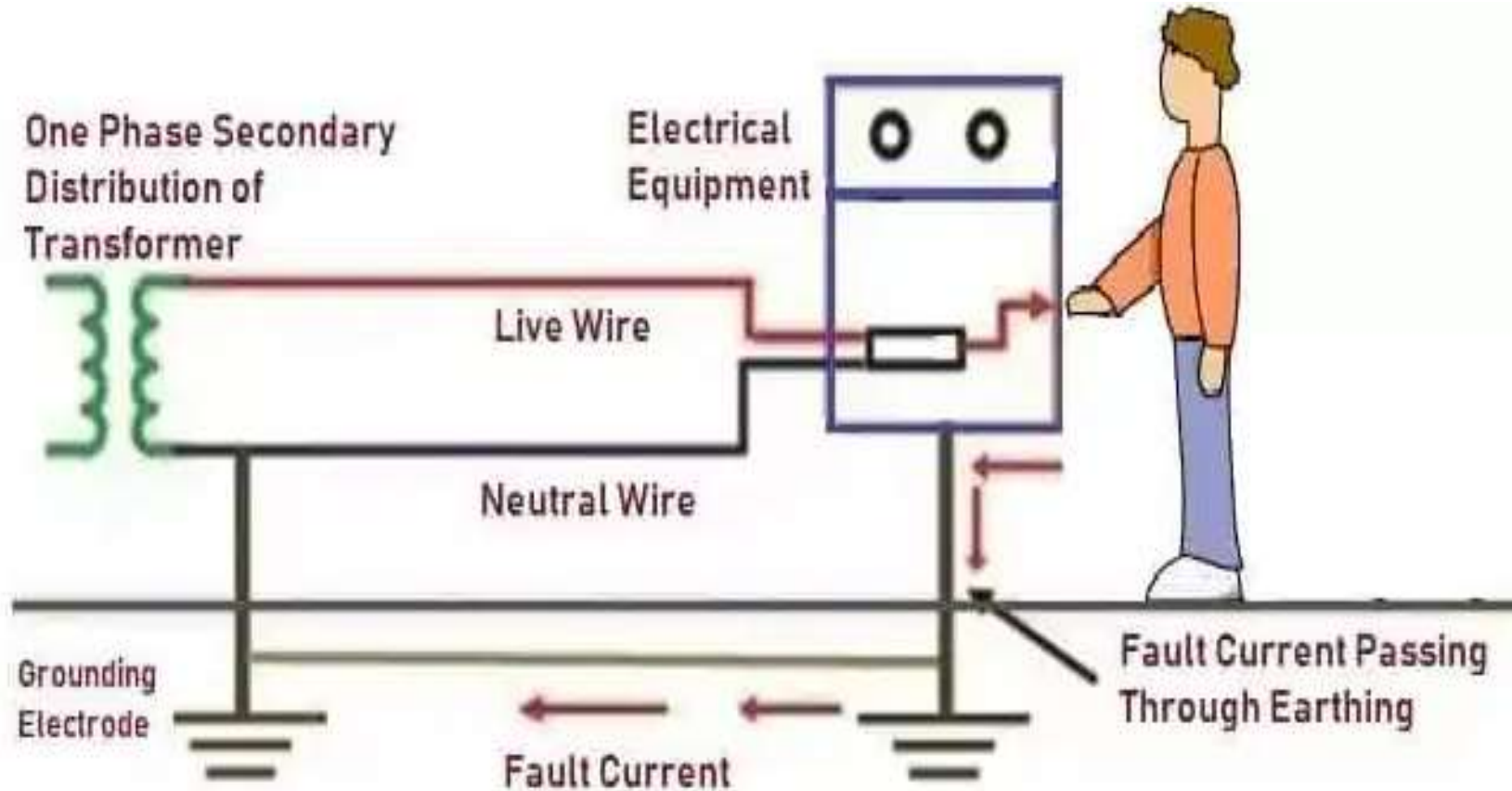


Electrical System Without Earthing





# IMPORTANCE OF EARTHING

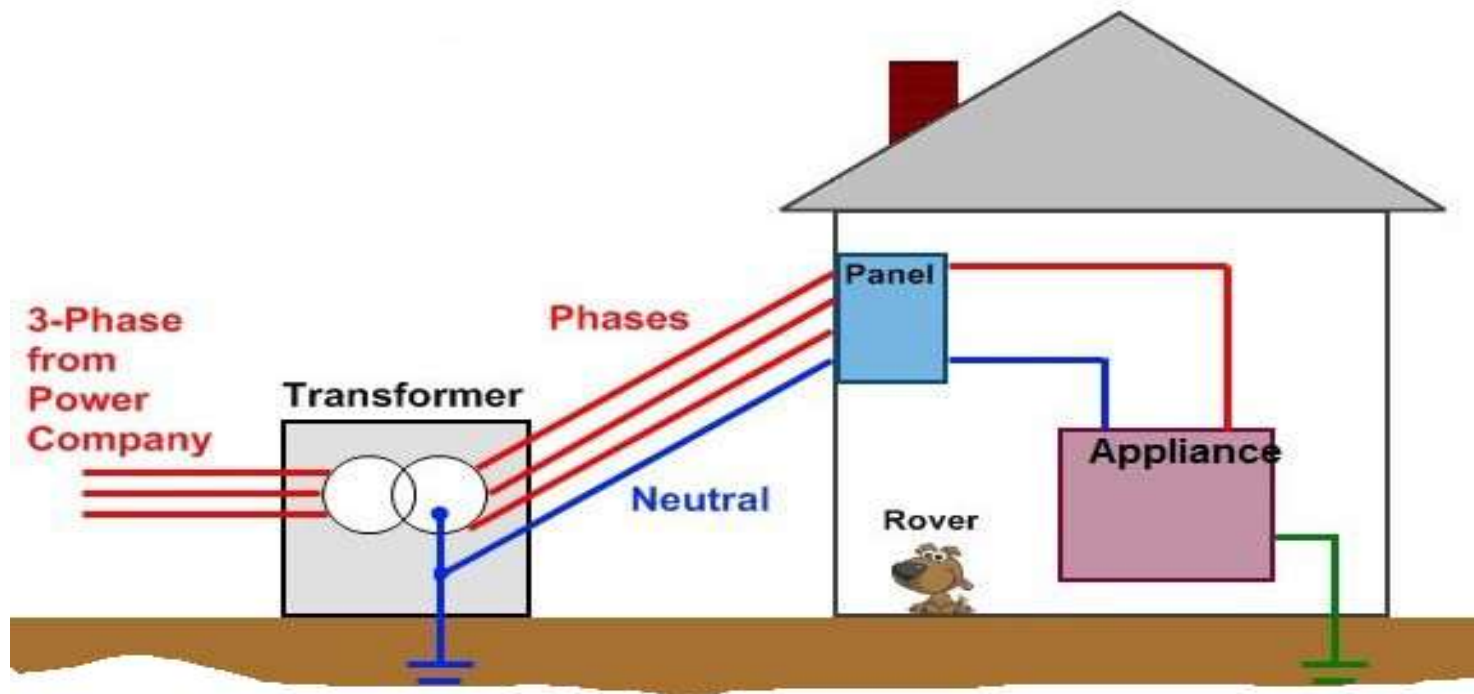




# TYPES OF GROUNDING

These three systems are:

- Ungrounded Systems
- Resistance Grounded Systems
- Solidly Grounded Systems

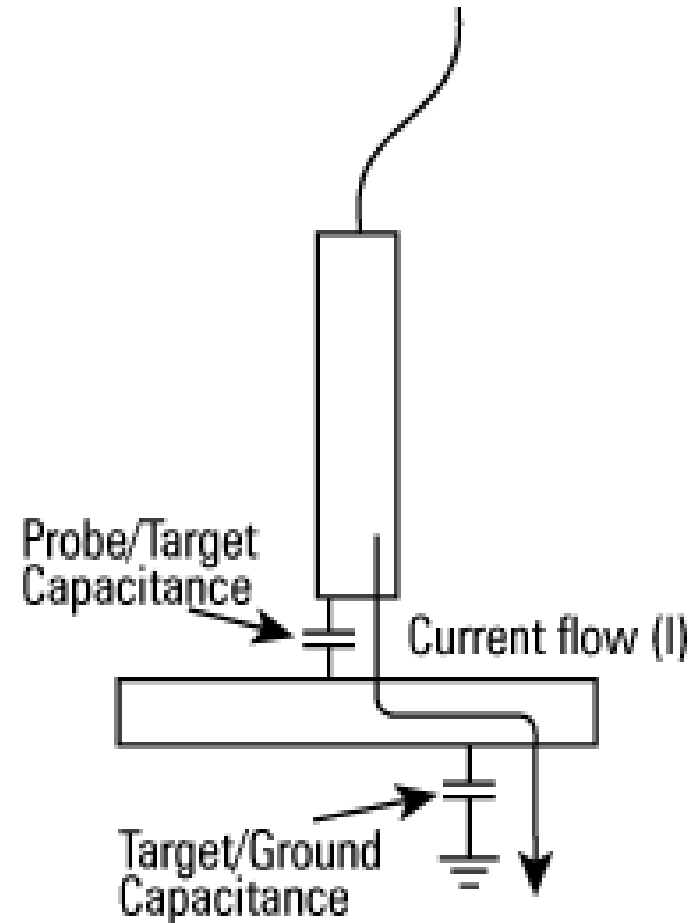




# UNGROUNDING SYSTEM

An ungrounded system isn't really ungrounded. Electrically, system is connected to ground through the capacitance between the lines and the earth, that it's a capacitance grounded system.

It ungrounded because of convention, and because there isn't a direct physical connection between any of the power lines and the ground.

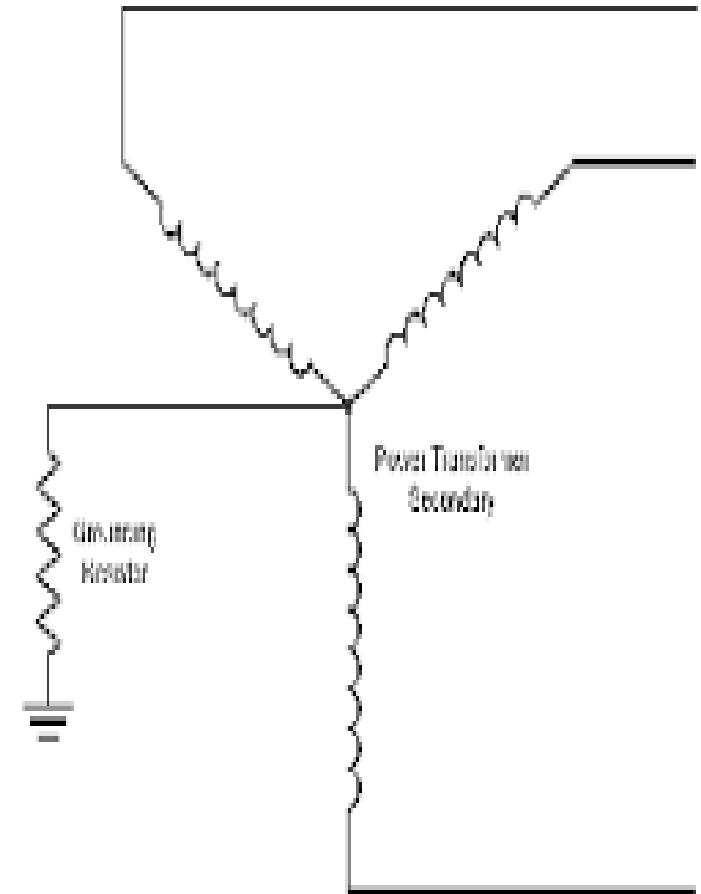




# RESISTANCE GROUNDING SYSTEM

Resistance grounding is when a connection between neutral line and the ground through a resistor. This resistor is used to **limit the fault current** through your neutral line:

if voltage doesn't change, then current is dependent on the size of the **resistor according to Ohm's law** ( $V=IR$ ).





# ADVANTAGES OF RESISTANCE GROUNDING



Because the current in the neutral is controlled instead of negligible, system over voltages are also controlled.

This reduced current and reduced overvoltage means reduced heat, which keeps the wear and tear of electrical system to a minimum.

This is especially important for keeping motors safe, since the reduced current will not damage the magnetic iron of the motor (which is costly to repair). The reduced currents also reduce the risk of shock and arc flash/blast hazards.



# TYPES OF RESISTIVE GROUNDING

There are two types of Resistive Grounding

- High Resistance Grounding
- Low Resistive Grounding

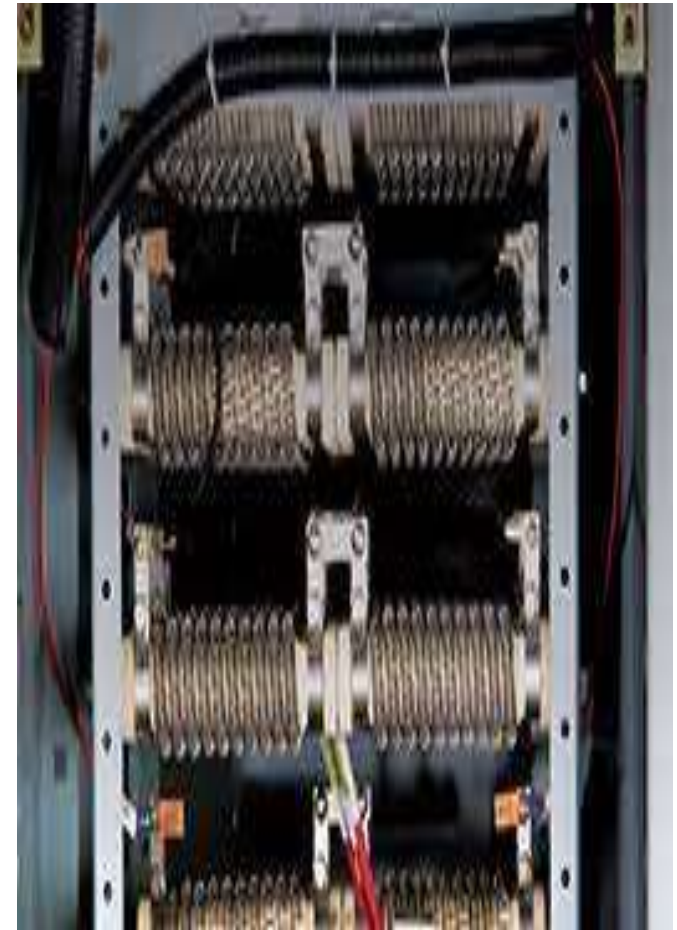




# HIGH RESISTIVE GROUNDING

High resistance grounding is typically used to limit ground fault current to  $< 10$  amps.

The low ground-fault current also means that, just like an ungrounded system, It can continue to operate the system on a single line-to-ground fault. The low current will typically not trip your protective devices during a single line-to-ground fault.

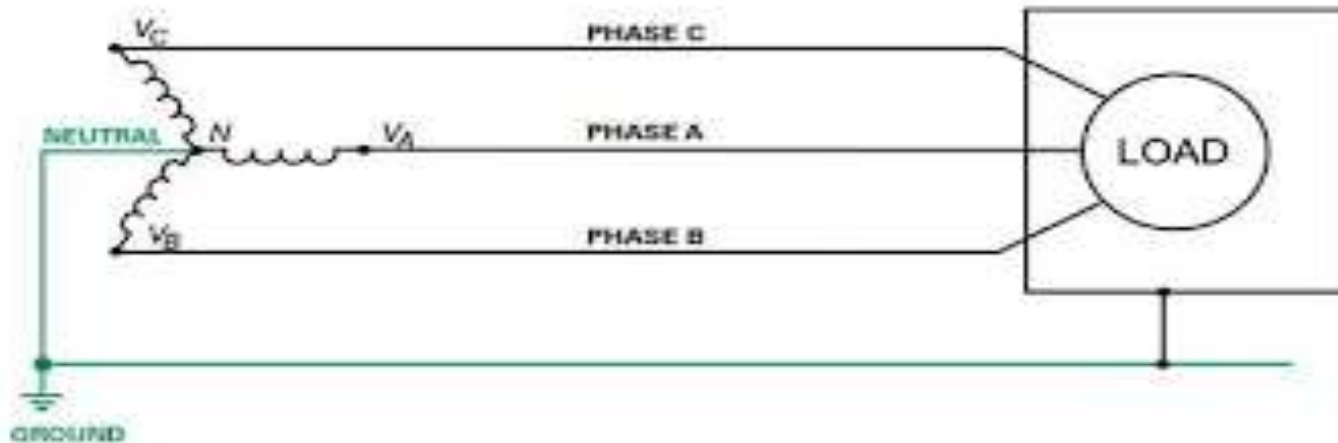




# LOW RESISTIVE GROUNDING

Low resistance grounding typically limits ground fault current to between 100 and 1000 amps.

Low resistance grounding also reduces overvoltage, and is used in medium voltage systems of 15kV or less, typically where big generators/motors are used.







# SOLID GROUNDING



Solid grounding is connect, **without any sort of resistance in the way**. The ground is typically connected to the system at a neutral point, like the neutral terminal of a generator or transformer.

**Solid grounding has two main uses:**

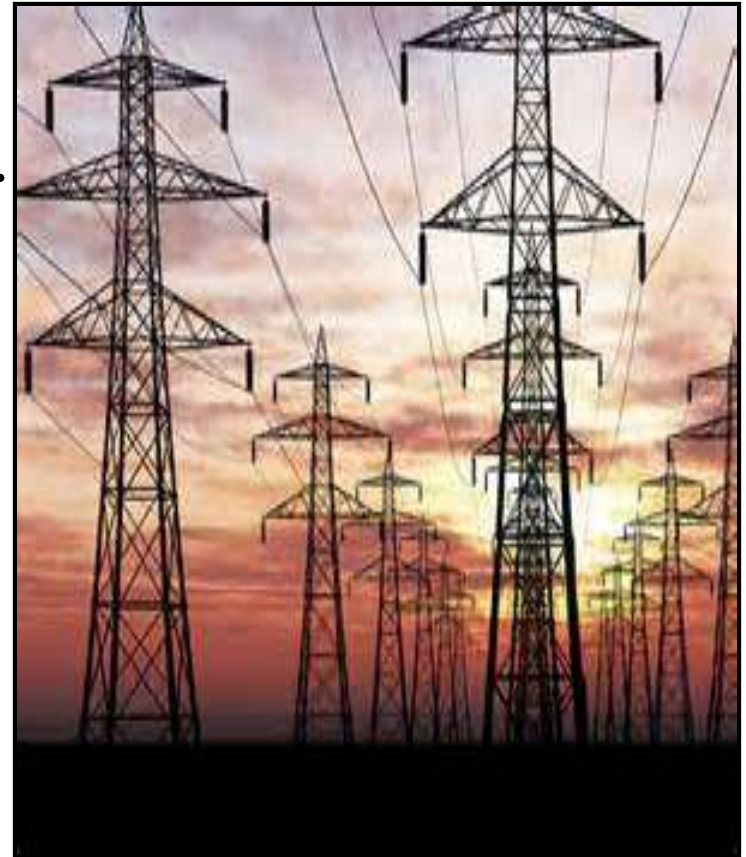
- In systems with voltages of 600V or less, solid grounding can be used if it is not necessary to maintain operation of a faulted circuit.
- In systems with voltages of 15kV or greater, solid grounding can be used if high ground fault currents are desirable of any reason, such as quick ground fault detection



# CAUSES OF ELECTRICAL ACCIDENTS

## Top 5 Causes of Electrical Accidents

- Cords and Plugs.
- Misuse of Electrical Appliances.
- Faulty Wiring System.
- Wet Areas/GFCI.
- Ignoring Safety Precautions.





# CAUSES OF ELECTRICAL ACCIDENTS

## BE SAFE

- **B**urns
- **E**lectrocution
- **S**hock
- **A**rc flash/arc blast
- **F**ire
- **E**xplosions





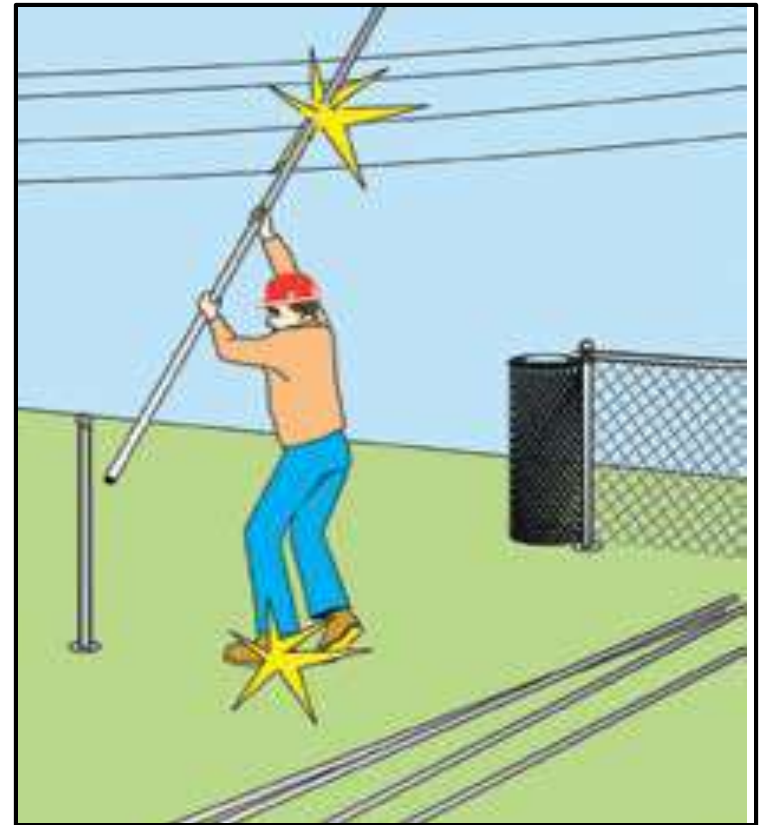
# CAUSES OF ELECTRICAL ACCIDENTS

## Contact with overhead power lines:

Overhead and buried power lines carry extremely high voltage

### Risks

- Electrocution (main risk)
- Burns and falls





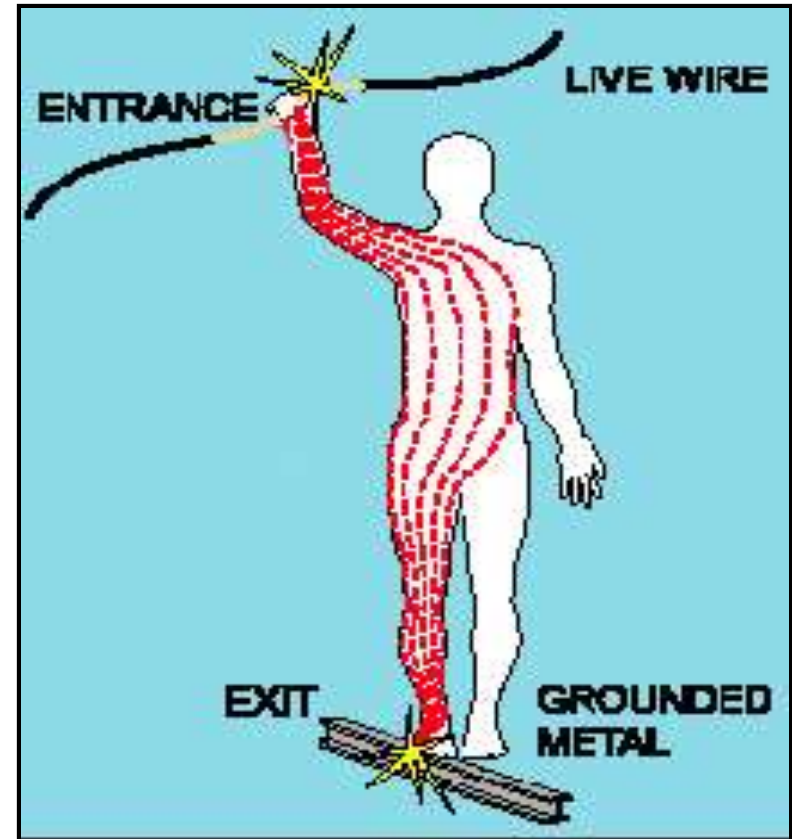
# CAUSES OF ELECTRICAL ACCIDENTS

Contact with energized sources:

## Live parts

The major hazards

- Electrical shock and burns
- Electrical shock occurs when the body becomes part of the electric circuit





# CAUSES OF ELECTRICAL ACCIDENTS

## Damaged Or Bare Wires:

Fault current may travel through a body, causing electrical burns or death, if

- Power supply is not grounded
- Path has been broken
- There are live parts or bare wires

Extreme conditions and rough treatment can change electrical equipment from safe to hazardous





# ELECTRICAL SAFETY

- Never carry a tool by the cord.
- Never yank the cord to disconnect it.
- Keep cords away from heat, oil, and sharp edges.
- Disconnect when not in use and when changing accessories such as blades and bits.

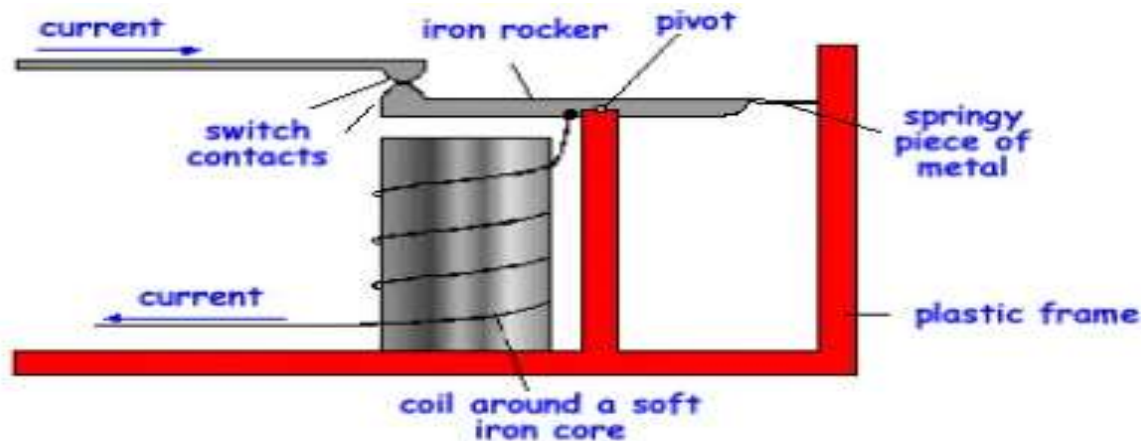




# CIRCUIT BRAKERS

An electrical circuit breaker is a switching device which can be operated manually and automatically for controlling and protecting an electrical power system.

As the modern power system deals with huge currents, special attention should be given during designing of a circuit breaker to ensure it is able to safely interrupt the arc produced during the closing of a circuit breaker. This was the basic definition of circuit breaker.



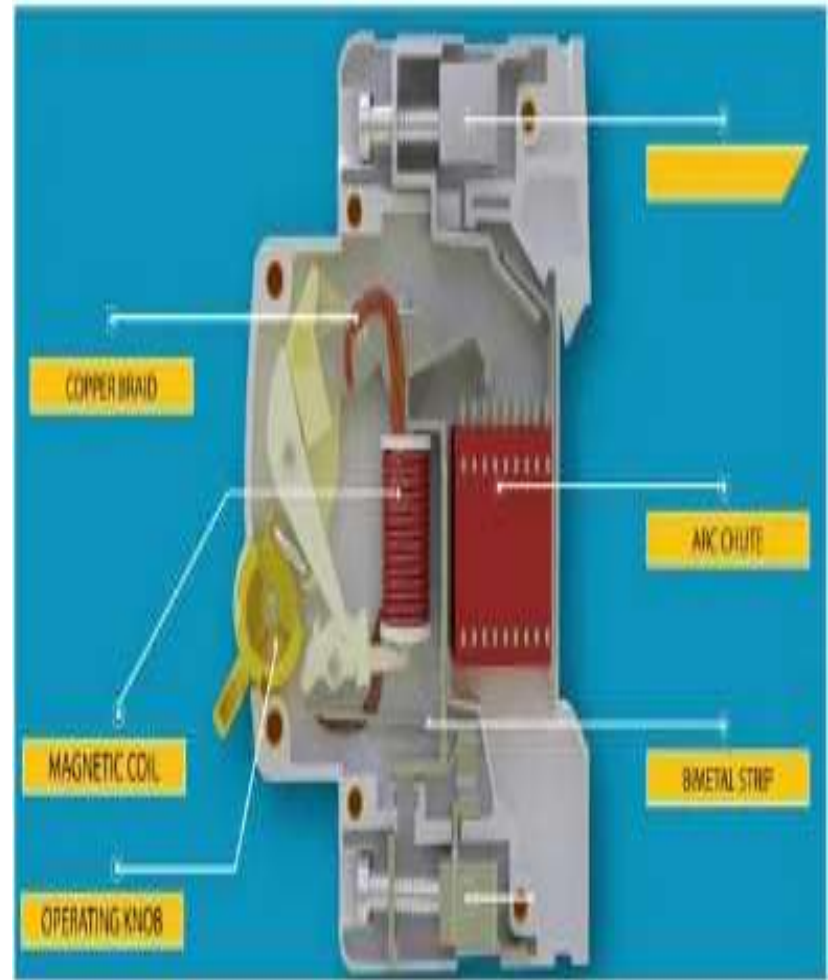




# CIRCUIT BRAKERS- MCB

A Miniature Circuit Breaker (MCB) is an automatically operated electrical switch used to protect low voltage electrical circuits from damage caused by excess current from an overload or short circuit.

MCBs are typically rated up to a current up to 125 A, do not have adjustable trip characteristics, and can be thermal or thermal-magnetic in operation.





# MCB VS FUSES

The **MCB** has many advantages compared to a fuse:

- It automatically switches off the electrical circuit during the abnormal conditions of the **network** (both overload and fault conditions). The MCB is much more reliable in the detection of such conditions, as it is more sensitive to change in current.
- The **handling of an MCB is more electrically safe** than a fuse.





# MCB VS FUSES

➤ As the switch operating knob comes at its off position during tripping, **the faulty zone of the electrical circuit can easily be identified.** But in case of a fuse, the fuse wire should be checked by opening fuse grip or cutout from fuse base, for confirming the blow of fuse wire. **Thus is it much detect if an MCB has been operated compared to a fuse.**

➤ **Quick restoration of supply can not be possible in case of fuse, as fuses have to be rewirable or replaced for restoring the supply.** But in the case of an MCB, quick restoration is possible by (literally) flipping a switch.

➤ **MCBs can be controlled remotely,** whereas fuses can not

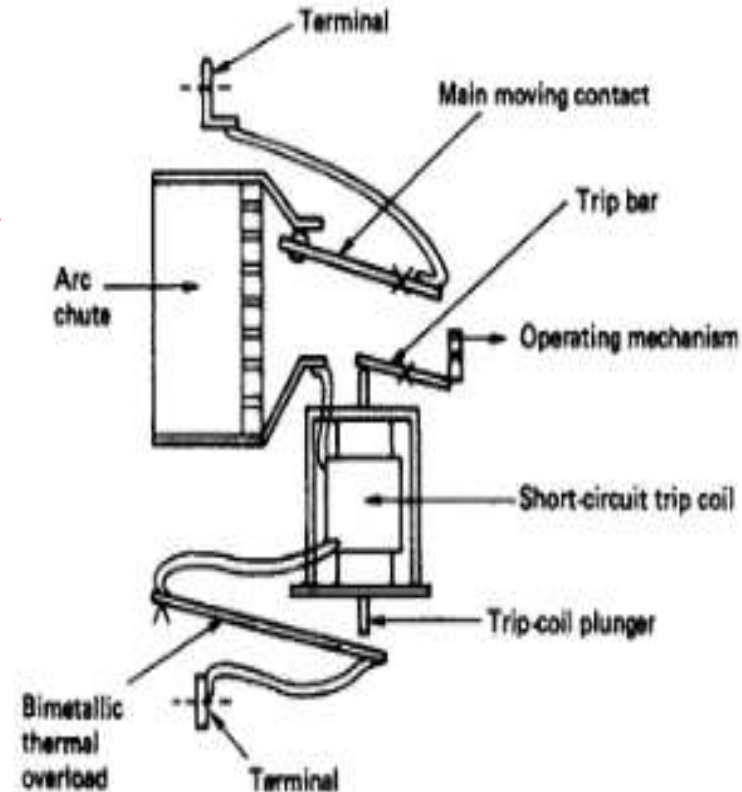


# WORKING PRINCIPLE OF MCB

➤ There is two arrangement of operation of a miniature circuit breaker.

➤ One due to the thermal effect of over current and other due to electromagnetic effect of over current.

➤ The thermal operation of the miniature circuit breaker is achieved with a bimetallic strip whenever continuous overcurrent flows through **MCB**, the bimetallic strip is heated and deflects by bending.





# EARTH LEAKAGE CIRCUIT BRAKER (ELCB)

➤ An ELCB (Earth Leakage Circuit Breaker) is an electrical safety device used to directly detect currents leaking to earth from an installation and interrupt the power supply.

➤ The main purpose of the ELCB is to detect earth leakages and protect personal safety from electrical shocks and fires that are caused by short circuits.

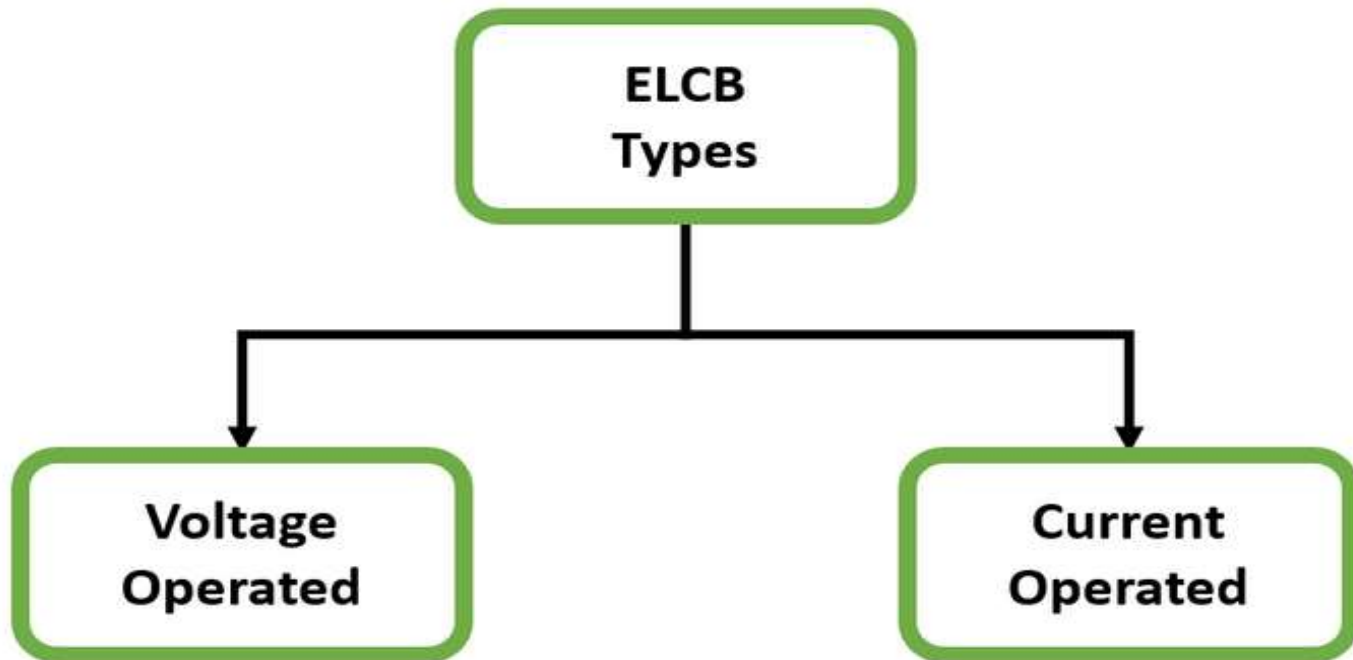




# EARTH LEAKAGE CIRCUIT BRAKER (ELCB)

Types of ELCB:

The ELCB can be classified into two types

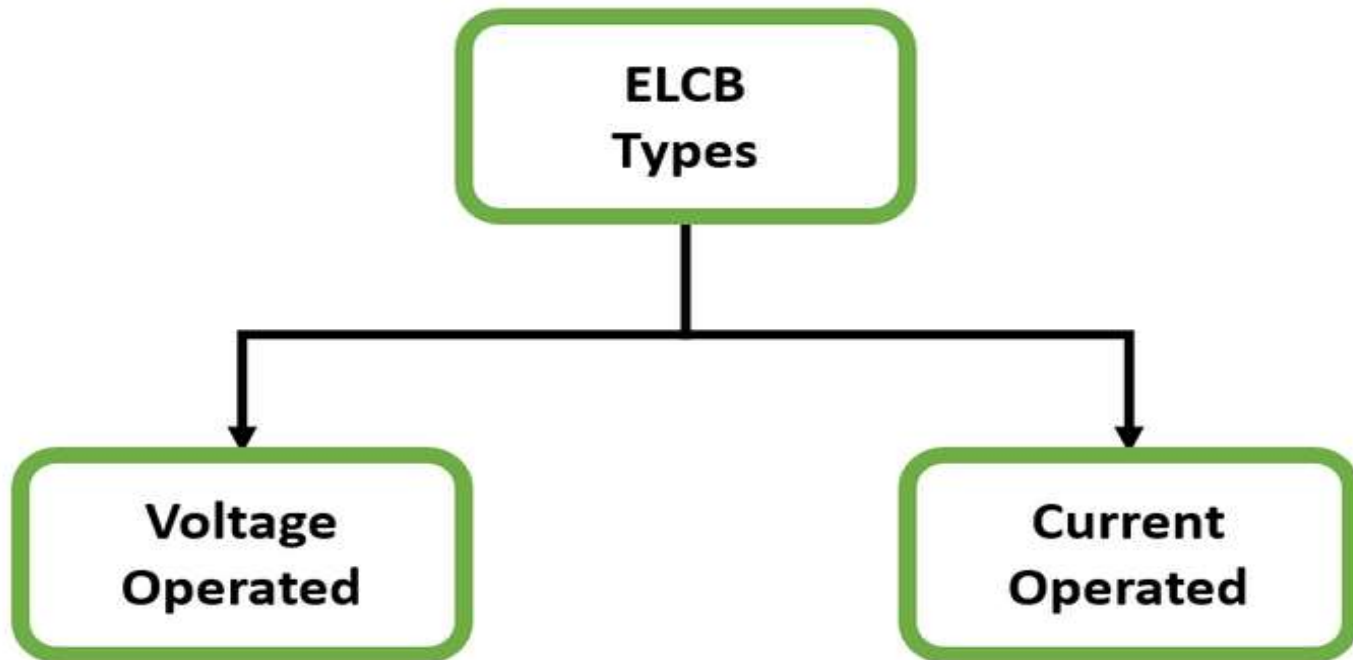




# EARTH LEAKAGE CIRCUIT BRAKER (ELCB)

Types of ELCB:

The ELCB can be classified into two types





# EARTH LEAKAGE CIRCUIT BREAKER (ELCB)



## Advantages:

- Voltage-operated ELCB is less sensitive to fault conditions, therefore has fewer nuisance trips.
- They do not detect faults that are don't pass current through the circuit protective conductor (CPC) to the earth rod.
- Current operated ELCB is not affected by parallel earth.





# EARTH LEAKAGE CIRCUIT BRAKER (ELCB)



## Disadvantages:

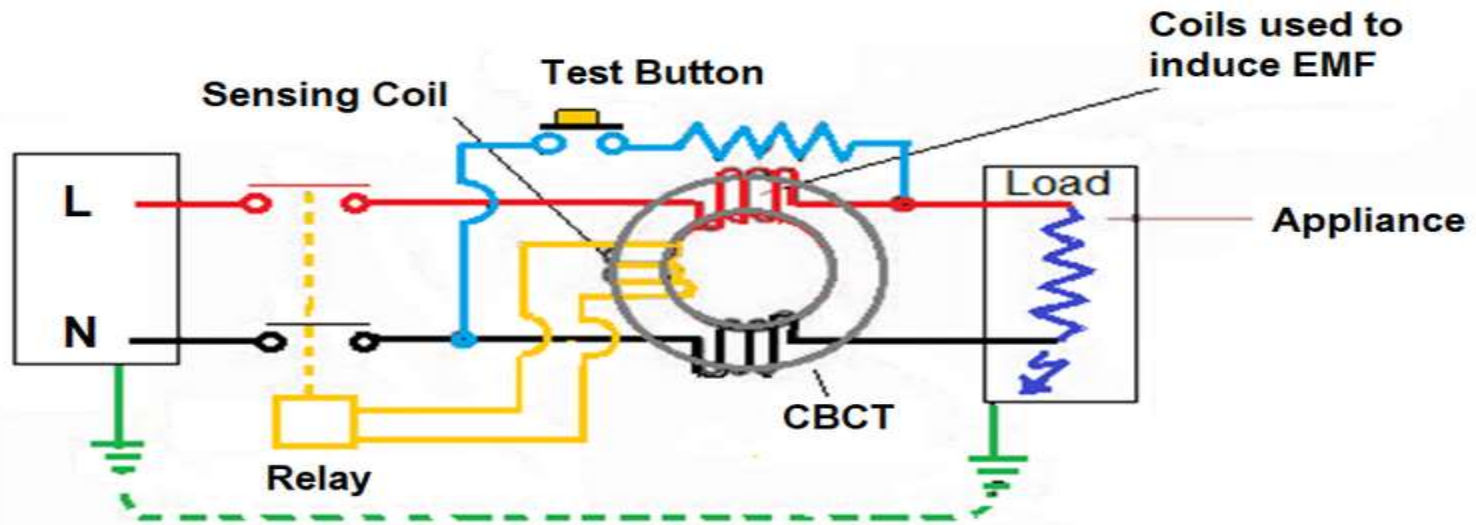
- Voltage-based ELCB devices are not used in the present days due to their drawbacks as if the fault is between phase and circuit earth, they will isolate the supply.
- Voltage ELCBs are not recommended over current ELCB (RCCB) and no longer available because of old technology.
- Voltage ELCBs detect faults that flow back through the main earth line.



# EARTH LEAKAGE CIRCUIT BRAKER (ELCB)

## Applications:

- The voltage-operated E.L.C.B. is generally used where there are **poor earthing conditions** (for example, rocky or dry sub-soil).
- Current operated ELCB is a popular circuit breaker used in industrial, commercial, and household applications.

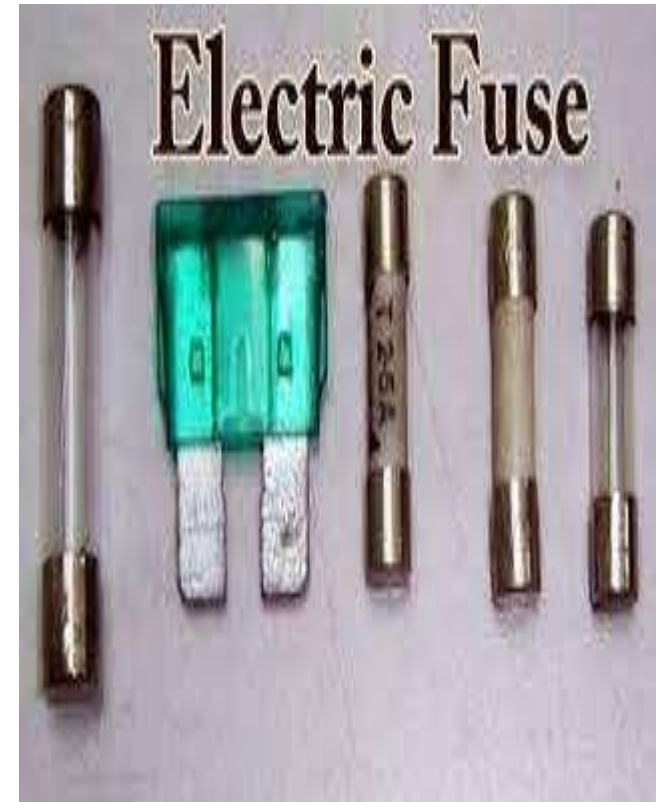




# ELECTRONIC FUSES

eFuses, or electronic fuses, are integrated circuits that can **replace larger conventional fuses or other protection devices such as resettable polymeric fuses.**

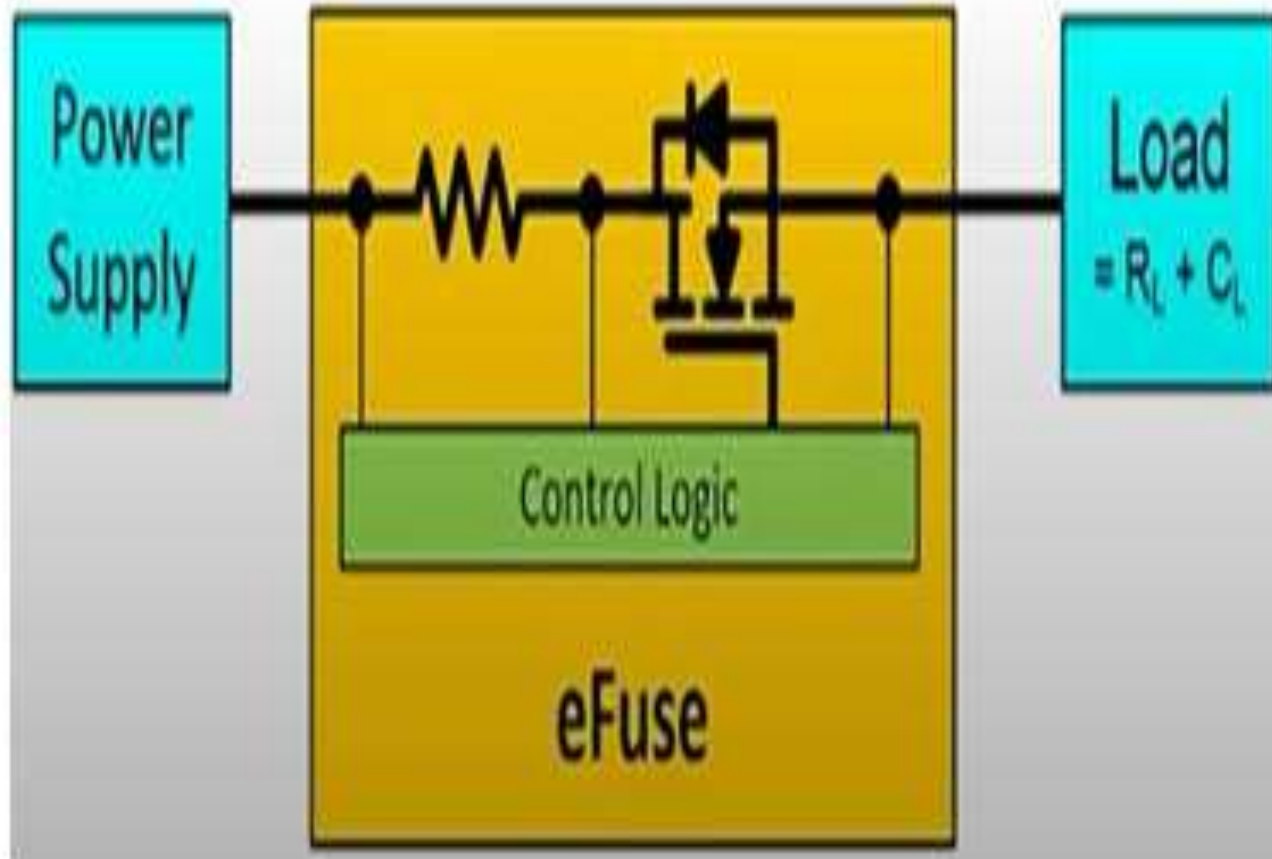
Housed in small plastic packages, such as DFN and Flip-chip, they integrate a control circuit and a power switch with low on-resistance, connecting the input port to the load.





# ELECTRONIC FUSES

## E FUSE





# ELECTRONIC FUSES

## Advantages:

➤ Due to less external components requirement, it saves board space. It is compact. It offers robust protection compare to discrete component based protection circuit. The eFuses are semiconductor ICs and hence offers rapid response during short circuits. It performs well over wide temperature range with minimal changes in its parameters. There is no change in its "ON resistance" even after faulty conditions in the circuit. It blocks the reverse current.



# ELECTRONIC FUSES



## Disadvantages:

- It houses more terminals. Basic architecture of efuse consists of three terminals viz. input, output and ground.
- It requires bias current to operate.
- It is complex in construction. Advancement in semiconductor domain has reduced its size



Thank  
you

