Module 5

.Domestic Wiring

. Equipment safety measures

. Personal safety measures

Electricity Bill

DOMESTIC WIRING:
Requirements of a Good Wiring System

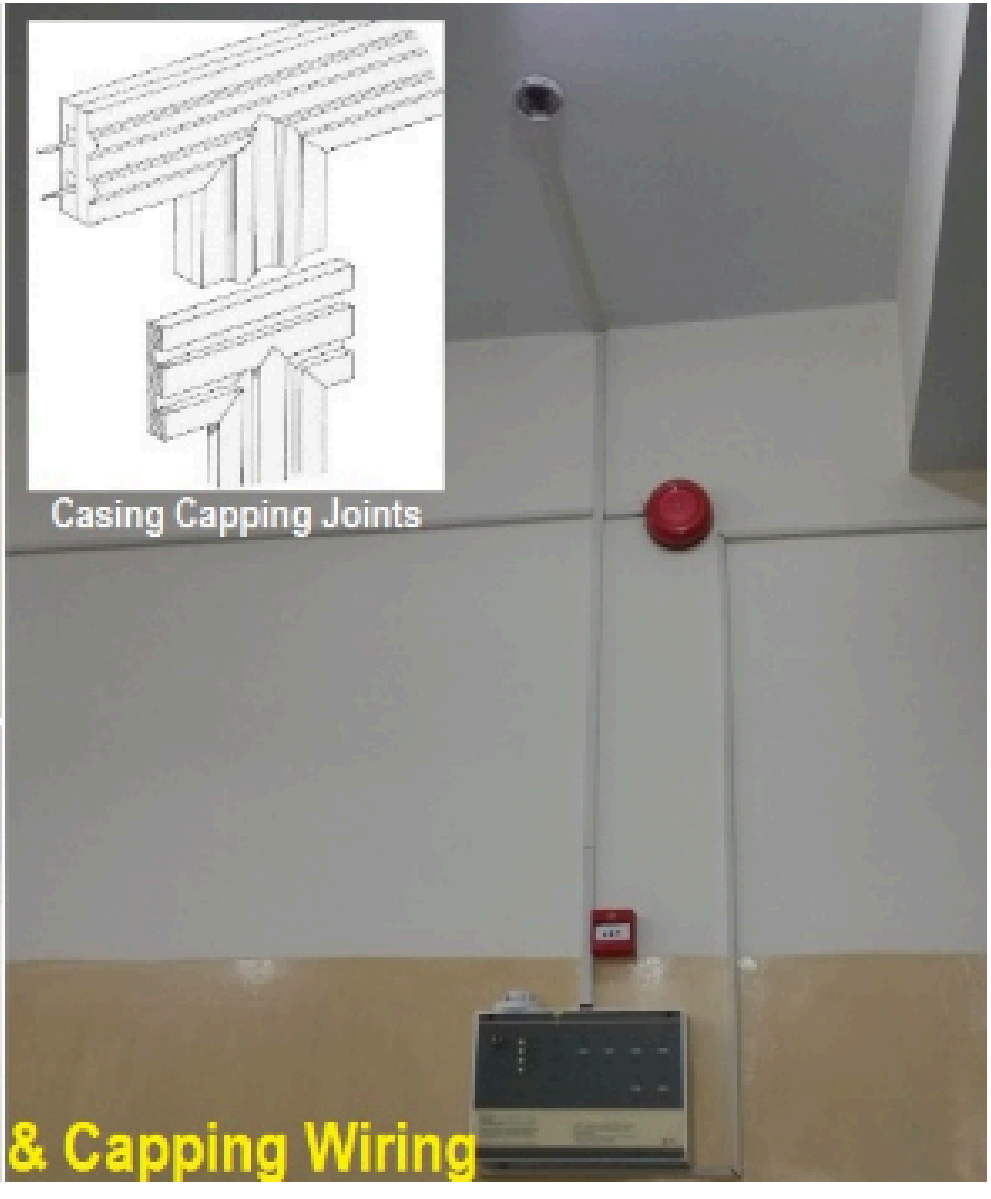
1. Safety:
Proper Insulation: All wires should be well-insulated to prevent accidental contact and electrical shocks. (use ISI mark cables)
Grounding: Effective grounding helps prevent electrical fires and protects from electrical shocks.
Overload Protection: Use of circuit breakers, fuses, and RCDs to protect against overloads and short circuits.
2. Durability:
Quality Materials: Use high-quality wires and components that can withstand wear and tear.
Corrosion Resistance: Materials should be resistant to corrosion, especially in environments with high humidity.
3. Adequate Capacity:
Amp rating: Wires should be able to handle the expected electrical load without overheating.
Future-proofing: Consider potential future electrical needs and ensure the wiring can accommodate additional loads.

4. Accessibility:
Ease of Maintenance: Wires should be easily accessible for inspection, repairs, and upgrades.
Conduit System: Use conduits to protect wires and simplify future modifications.
5. Aesthetics:
Neat Installation: Proper routing and organization of wires to maintain a clean and professional appearance.
Concealment: Whenever possible, conceal wiring within walls, floors, or ceilings for a tidy look.
6. Compliance:
Standards and Codes: Adhere to local electrical codes and standards to ensure safety and legality.
7. Labeling:
Clear Identification: Label all wires and components for easy identification and troubleshooting.

Types of Domestic Wiring

- **Casing and Capping**
- Conduit Wiring
  - Surface Conduit Wiring
  - Concealed Conduit Wiring

Casing and Capping



Casing & Capping Wiring

- The cables were carried through the wooden casing enclosures. The casing is made up of a strip of wood with parallel grooves cut length wise so as to accommodate VIR or PVC cables.
- The grooves were made to separate opposite polarity. the capping (also made of wood) used to cover the wires and cables installed and fitted in the casing.

Advantages of Casing Capping Wiring:

- It is cheap wiring system as compared to sheathed and conduit wiring systems.
- It is strong and long-lasting wiring system.
- Phase and Neutral wire is installed in separate slots, therefore repairing is easy.
- Long life
- Safe from oil, Steam, smoke and rain.
- No risk of electric shock

Disadvantages Casing Capping Wiring:

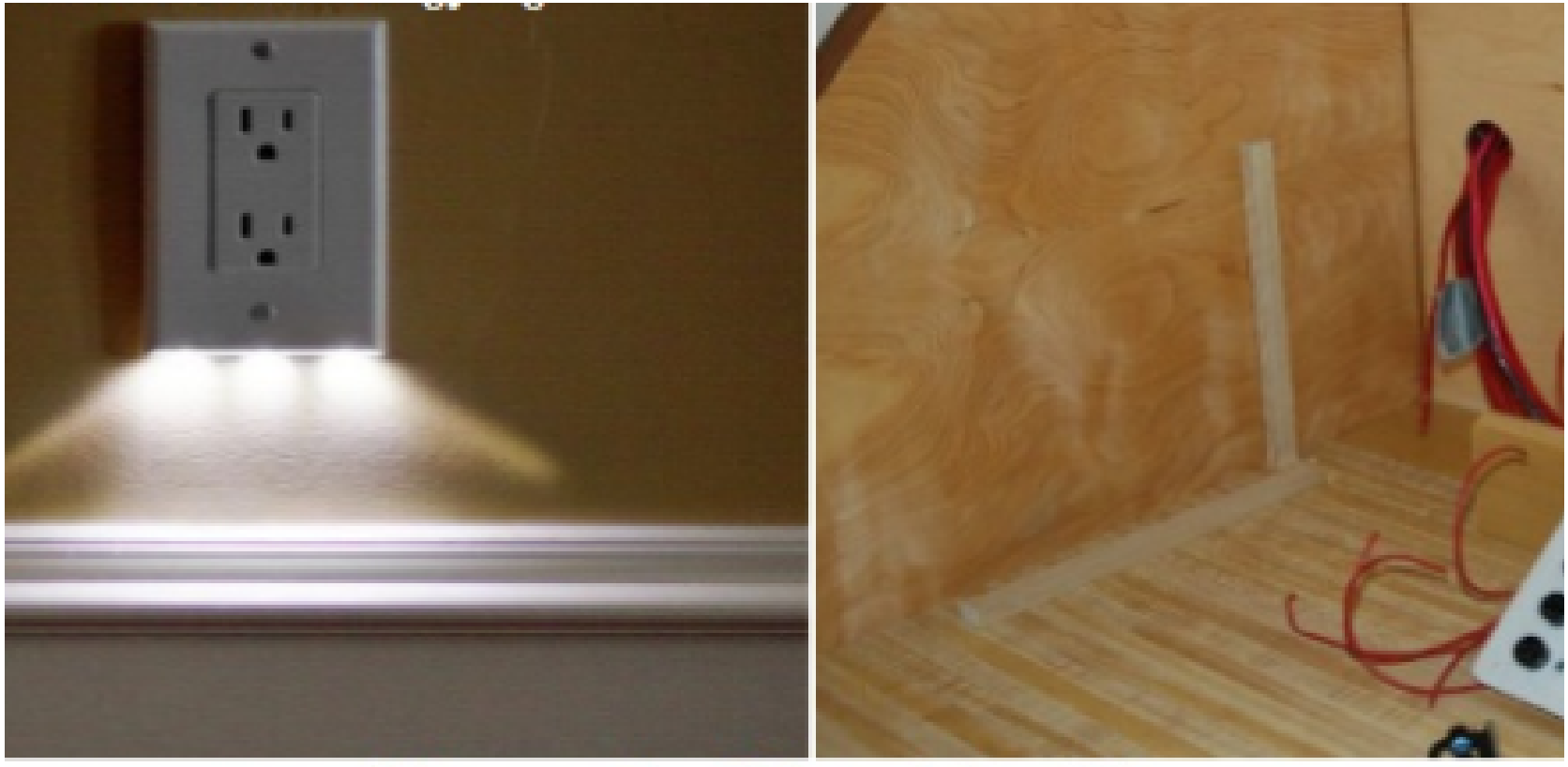
- There is a high risk of fire in casing & capping wiring system.
- Not suitable in the acidic, alkalies and humidity conditions
- Costly repairing and need more material.
- Material can't be found easily in the contemporary
- White ants may damage the casing & capping of wood.

Surface Conduit Wiring

Surface Conduit Wiring

Concealed Conduit wiring

- The electrical wiring system inside wall, roof or floor with the help of plastic or metallic piping is called concealed conduit wiring.
- It is the **most popular, beautiful, stronger and common electrical wiring system** nowadays.



Concealed Conduit wiring

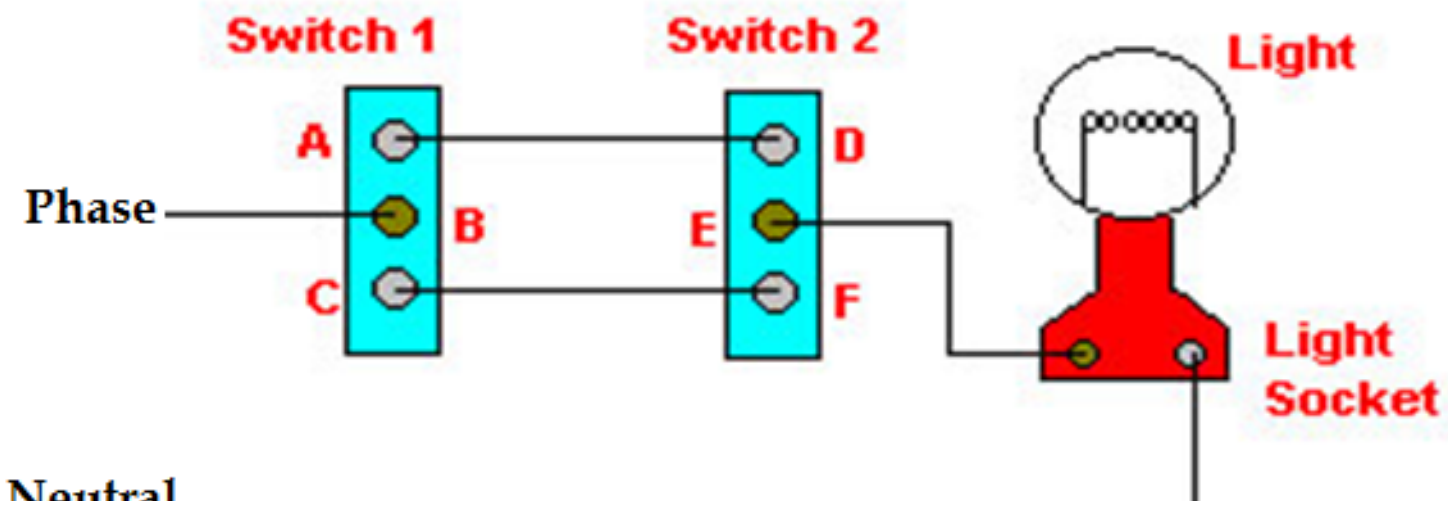
Advantages:

- Safe
- Appearance is good
- No risk of fire and mechanical wear & tear
- No risk of electric shock
- Long life
- Reliable and popular wiring system
- can be used even in humidity , chemical effect and smoky areas.

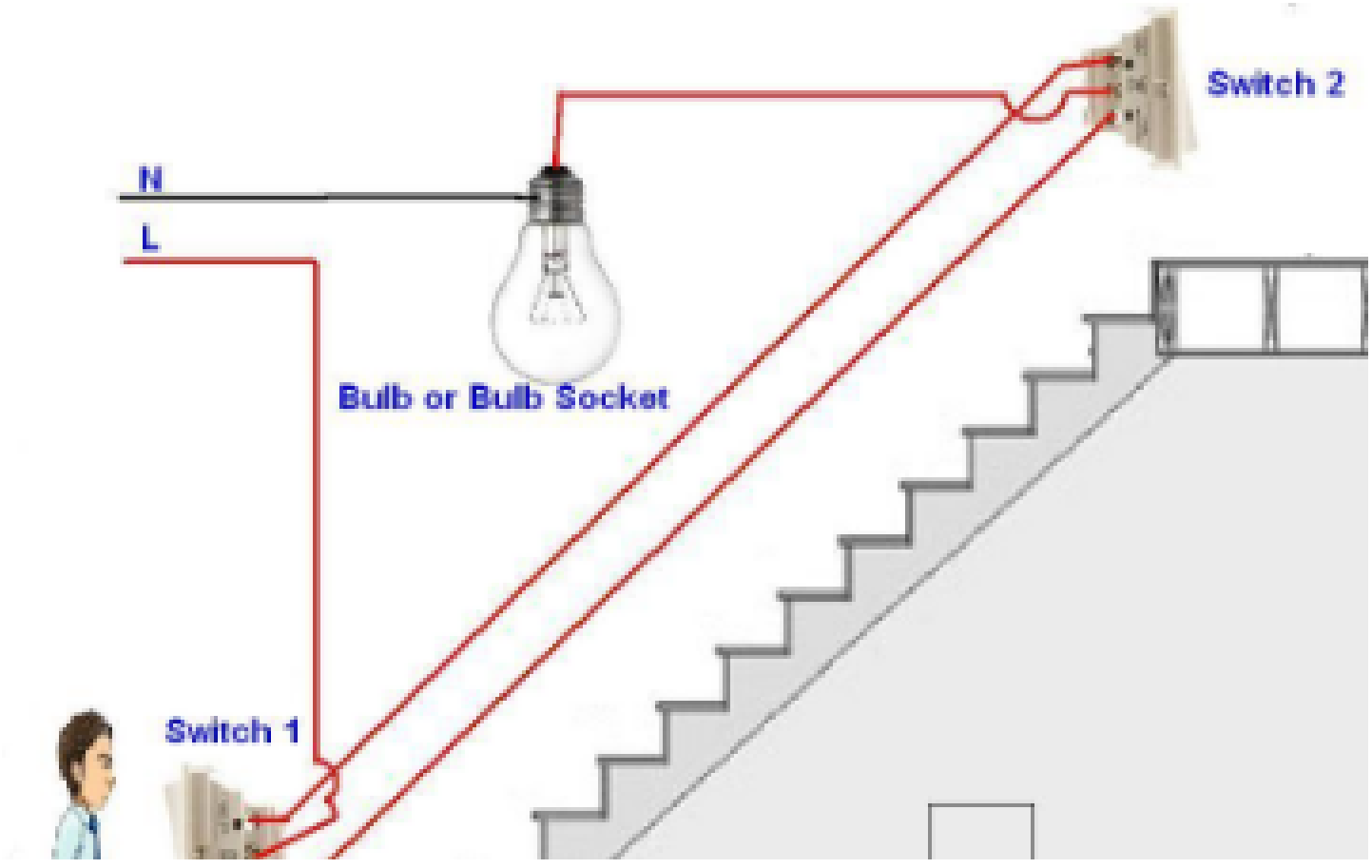
Disadvantages

- It is expensive wiring system
- Very hard to find the defects in the wiring.
- installation is not easy and simple.
- Very complicated to manage additional connection in the future.

Two-way Control of lamp



Switch S1	Switch S2	Light
A	D	ON
A	F	OFF
C	D	OFF
C	F	ON

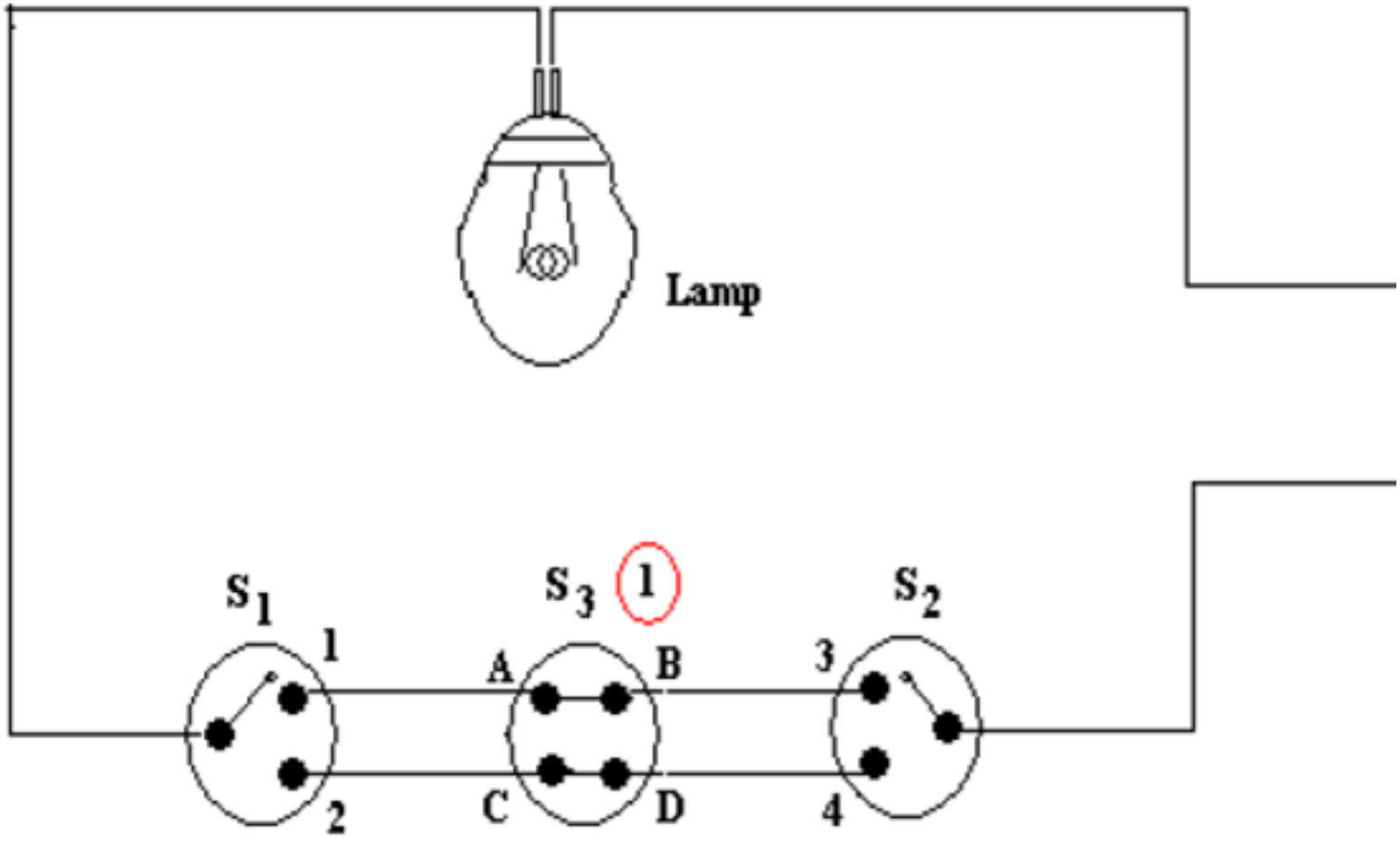


- **The lamp can be controlled from two different points: one at the top and the other at the bottom – using two- way switches**
- **They are also used in Stair case, bedrooms, big halls and large corridors**

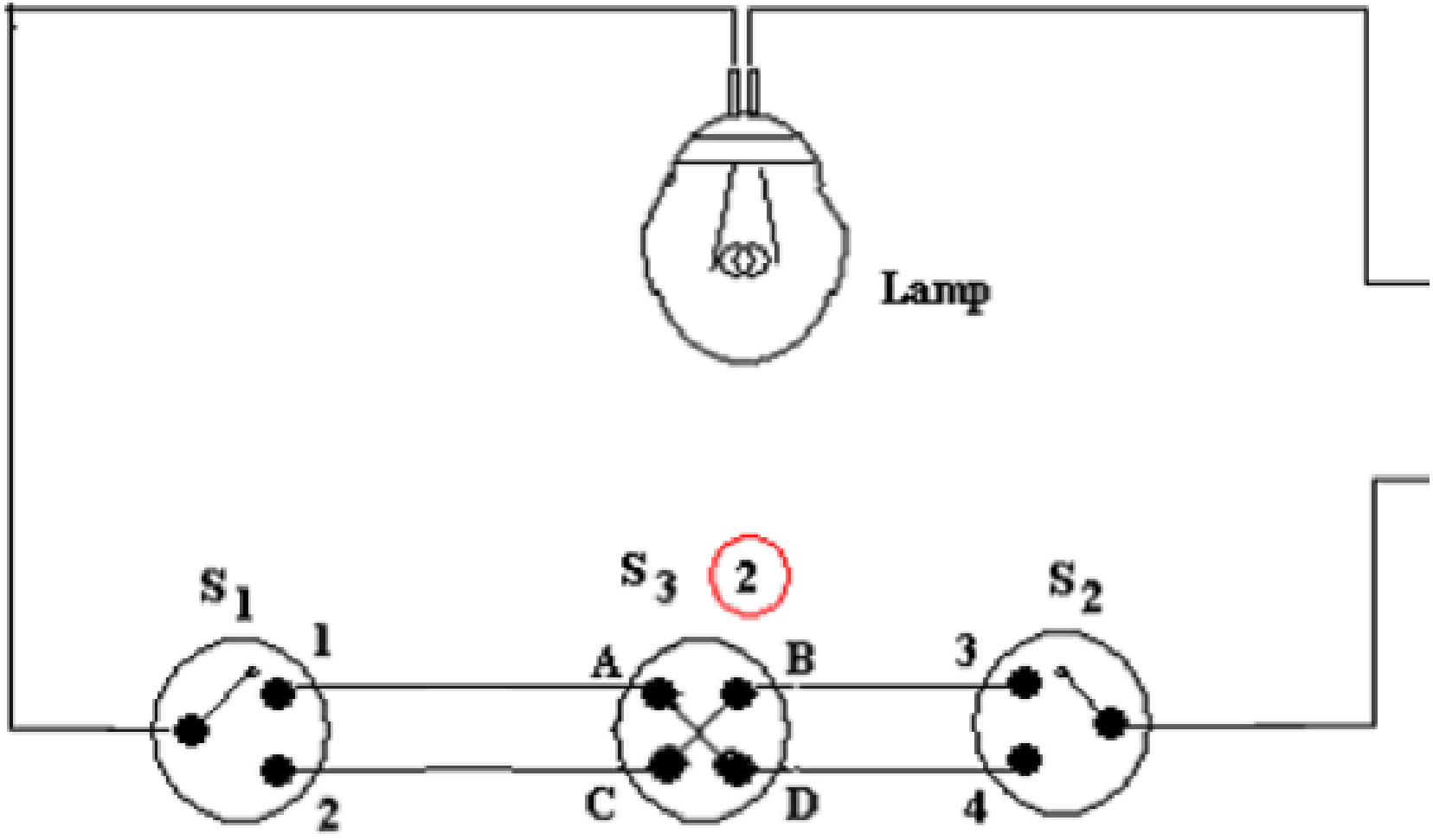
Three- way Control of lamp

- In case of very long corridors it may be necessary to control the lamp from 3 different points. In such cases, the circuit connection requires two; two-way switches **S1**and **S2** and an intermediate switch **S3**.
- An intermediate switch is a combination of two, two way switches coupled together. It has 4 terminals ABCD. It can be connected in two ways

Three -way control of lamp



Straight connection



Cross connection

Sl No	Position of Switch S1	Position of Intermediate Switch S3	Position of Switch S2	Lamp ON or OFF
1	1	AB	3	ON
2	1	AB	4	OFF
3	2	CD	3	OFF
4	2	CD	4	ON
5	1	AD	3	OFF
6	1	AD	4	ON
7	2	CB	3	ON
8	2	CB	4	OFF

Protective Devices

- Fuses
- Relays
- Miniature circuit breakers (MCB)
- Earth leakage circuit breakers (ELCB)

Fuse

Fuse is a safety device connected in series with the circuit . Whenever current exceeds the rated value due to overload or short circuit condition, it blows out and protects the apparatus.

Rated Current:

Maximum current that a fuse can carry safely without getting heated and melted

Fusing current: Minimum current at which fuse element melts

Fusing Factor defined ratio of fusing current to rated current

. Equipment safety measures

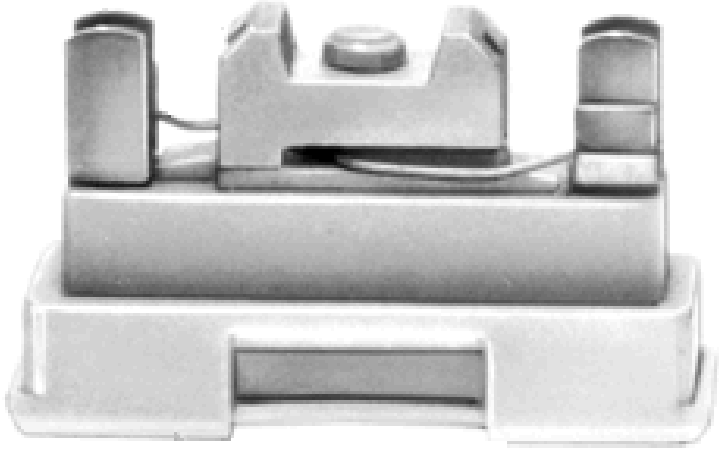
Fuse

- A fuse is a piece of conducting wire having a low melting point. It is rated for a certain current. Whenever the current in a subcircuit exceeds the rated current, the fuse melts and breaks the circuit. Never use a fuse of rating higher than the appliance.
- Smaller current rating fuse (less than 10A) are made of lead–tin alloy.
- For higher current ratings (> 10A) it is made of copper, zinc, lead aluminium etc.
- Once melts the fuse element must be replaced. The cost of replacement is very less (around Rs 25)
- But the installation of fuse, takes lot of space and always posses a threat of fire hazard.

Working :

- carries normal current without heating
- When fault occurs, current increases, heat produces and fuse element melts.
- Chemical reaction between silver vapour and filling powder results in formation of high arc resistance – arc gets quenched easily

Rewireable fuse (kit kat fuse)



HRC Fuses

(High Rupture Capacity)


KEW
HRC FUSE LINK


400 A
KEW
Superfuse
92cnt.→ 20A to 630A

. Equipment safety measures

MCB

- MCB (miniature circuit breaker) is a neat and clean device, which simply trips off itself whenever the current in the circuit exceeds its rating.
- After correcting the electrical fault, MCB can be simply reused by switching it ON again.
- MCB's are bit expensive when compared to Fuses (costing about 150 RS and more)
- MCB's work on the principle of "solenoid"

Miniature Circuit Breaker or MCB

- It automatically switches off the electrical circuit during abnormal condition. The fuse does not sense but **MCB** does it in more reliable way.
- MCB is much more sensitive to over current than fuse.
- During tripping the switch operating knob comes at its off position, the faulty zone of the electrical circuit can easily be identified. But in case of fuse, fuse wire should be checked by opening fuse grip or cutout from fuse base, for confirming the blow of fuse wire.

- In the case of MCB, quick restoration is possible by just switching on operation but it is not possible in fuse
- Handling MCB is more electrically safe than fuse

Earth Leakage Circuit Breaker (ELCB)

- **A**n Earth Leakage Circuit Breaker (ELCB) is a device used to directly detect currents leaking to earth from an installation and cut the power

- **Personal safety measures**

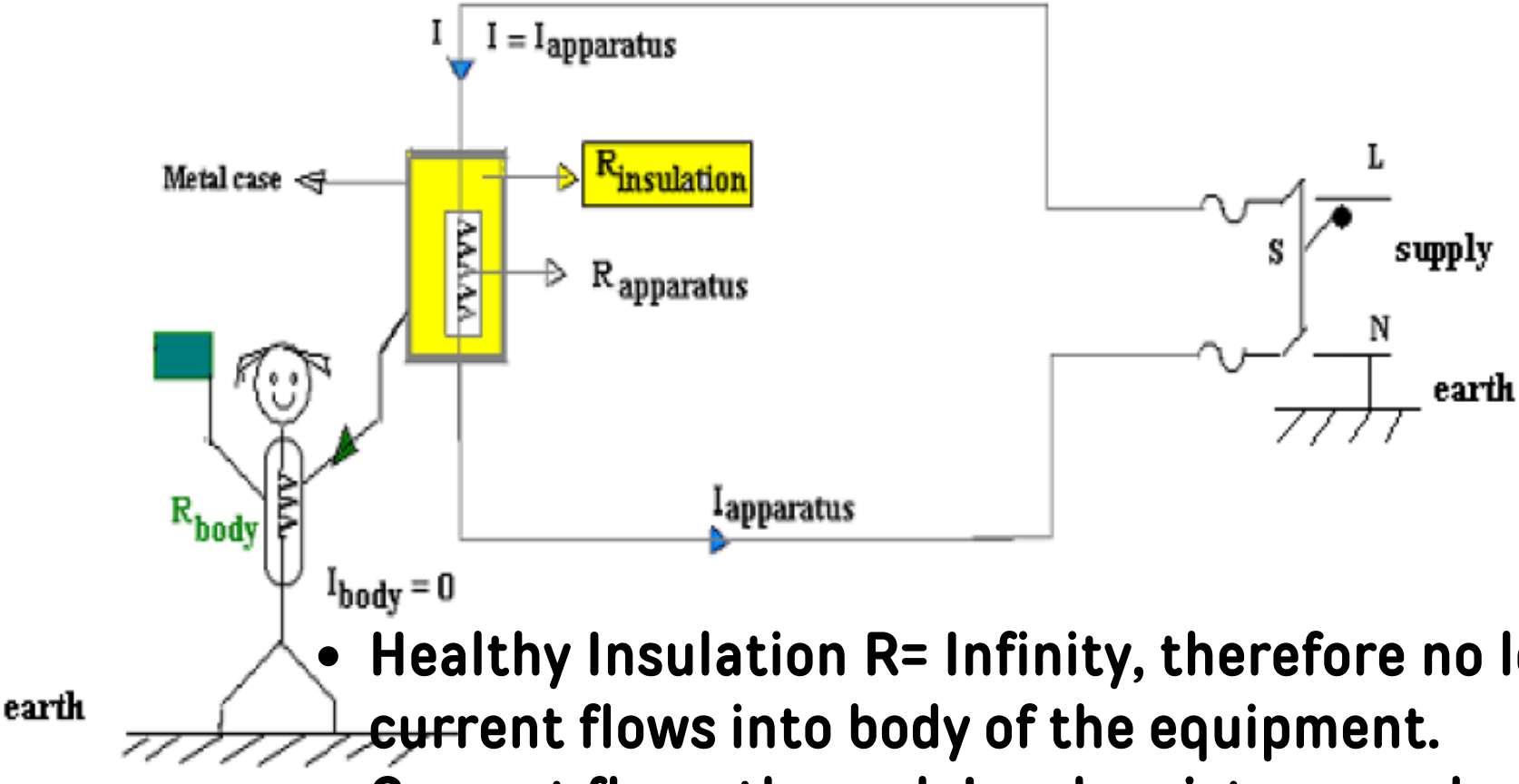
Earthing

- The potential of the earth is considered to be at **ZERO** for all practical purposes as the generator (supply) neutral is always earthed.
- The body of any electrical equipment is connected to the earth by means of a wire of negligible resistance to safely discharge electric energy, which may be due to failure of the insulation, line coming in contact with the casing etc.
- Earthing brings the potential of the body of the equipment to **ZERO** i.e. to the earth's potential, thus protecting the operating personnel against

Case I

Healthy insulation

Apparatus not earthed

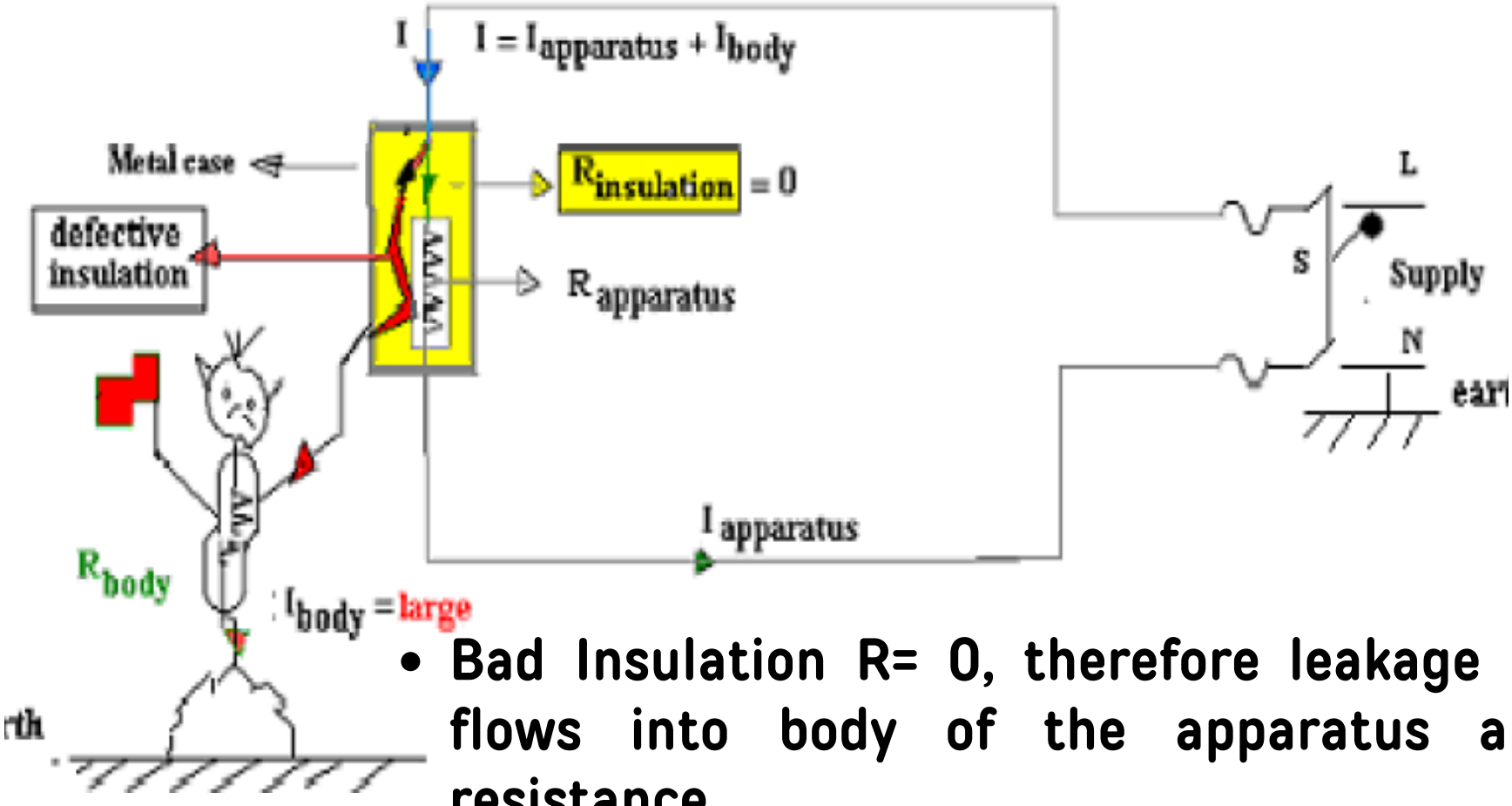


- Healthy Insulation R= Infinity, therefore no leakage current flows into body of the equipment.
- Current flows through Load resistance only
- Person is safe even if he touches body of the apparatus

Case II

Defective insulation

Apparatus not earthed

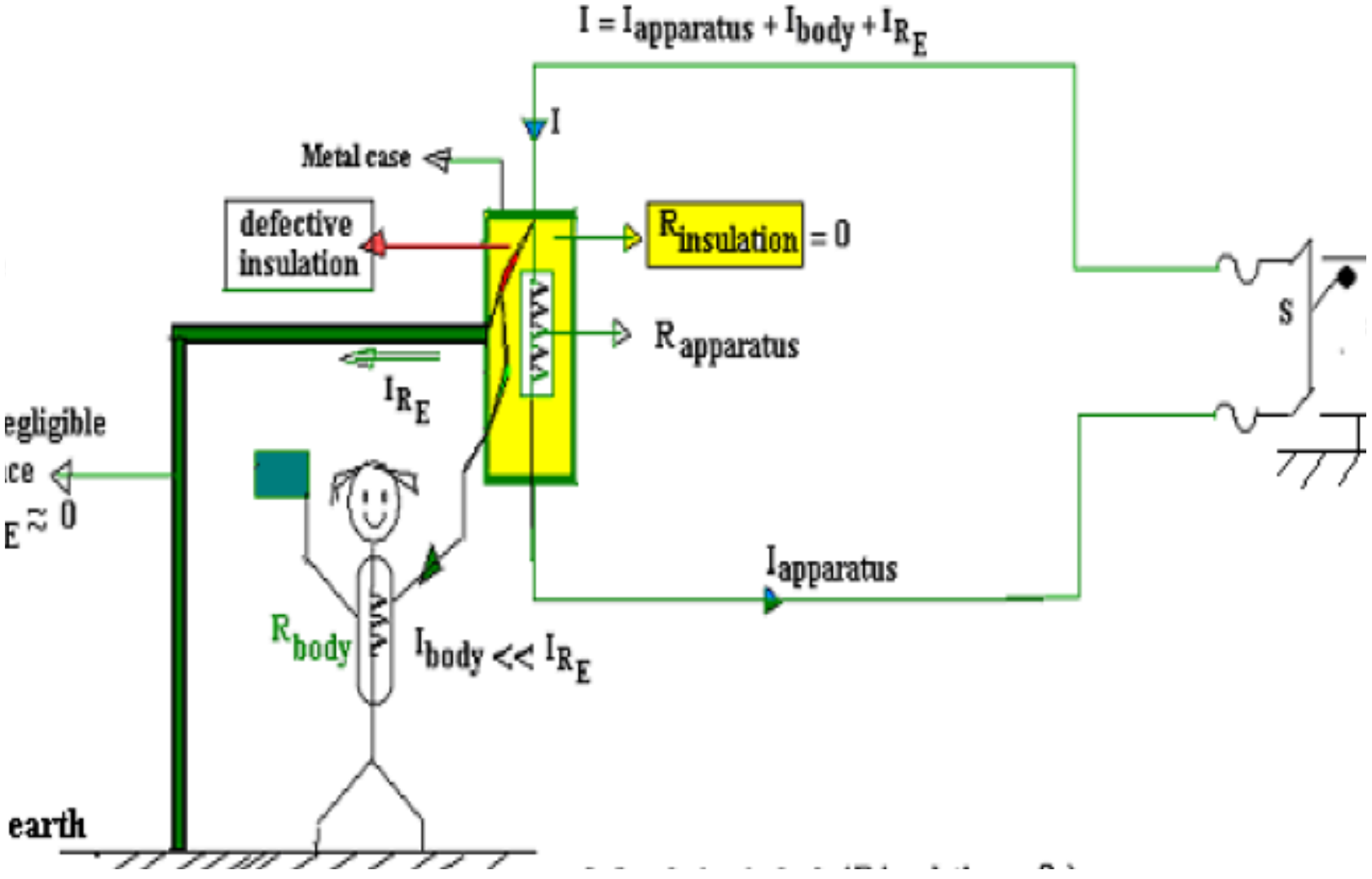


- Bad Insulation R= 0, therefore leakage current flows into body of the apparatus and load resistance.
- If Person comes in contact of the body of the apparatus, he experiences shock as the apparatus is not earthed

Case III

Defective insulation

Apparatus earthed



Apparatus is earthed

- Insulation is bad (R=0)
- Supply current divides into I apparatus, I body, and I earth
- Since earth resistance (negligible) is very less than body resistance, more current flows through earth
- Person in contact with apparatus body does not experience any shock .

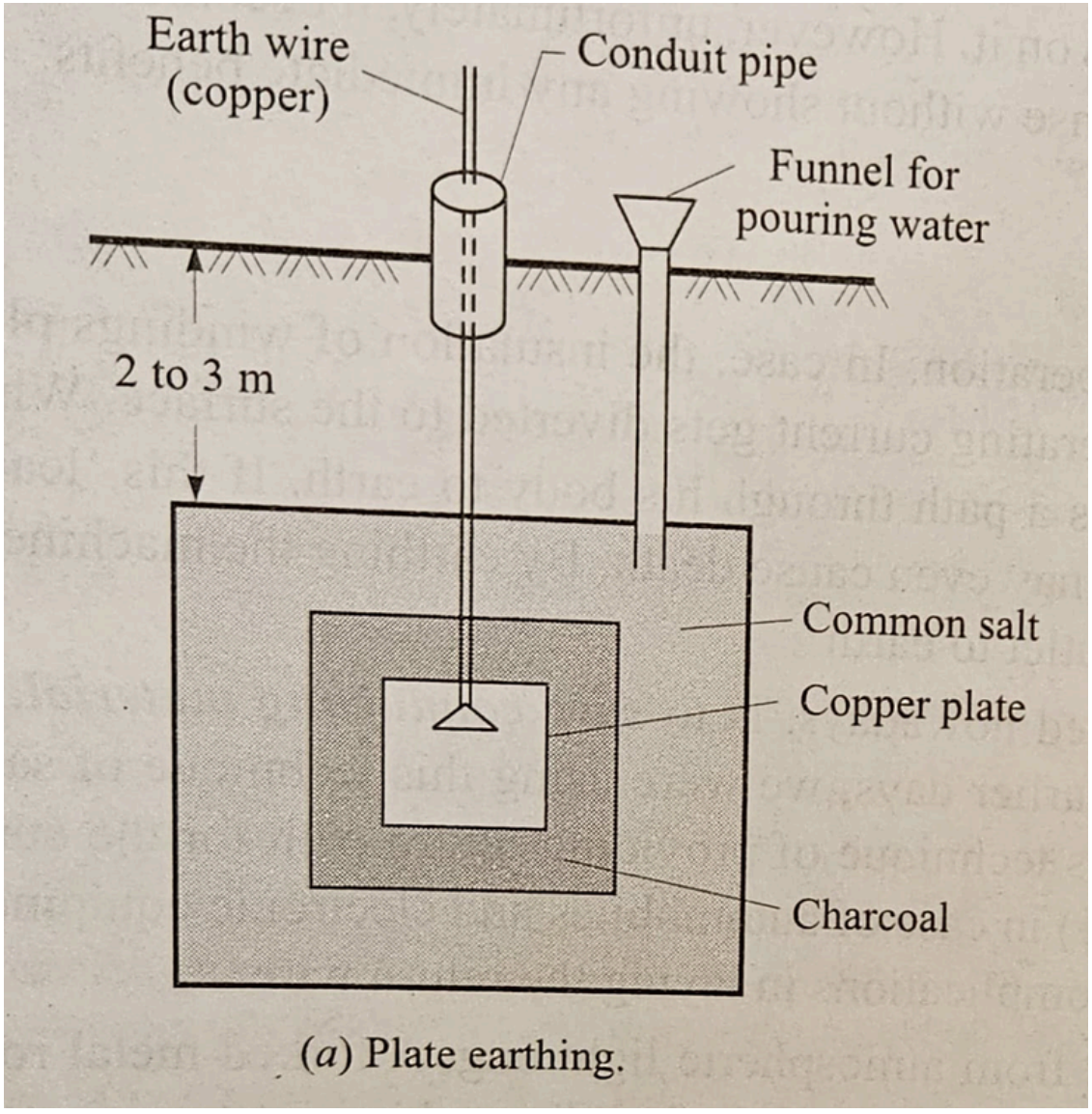
Necessity of Earthing

1. To protect the operating personnel from danger of shock in case they come in contact with the charged frame due to defective insulation.
2. To maintain the line voltage constant under unbalanced load condition.
3. Protection of the equipments
4. Protection of large buildings and all machines fed from overhead lines against lightning.

Methods of Earthing:

1. **Plate earthing**
2. **Pipe earthing**

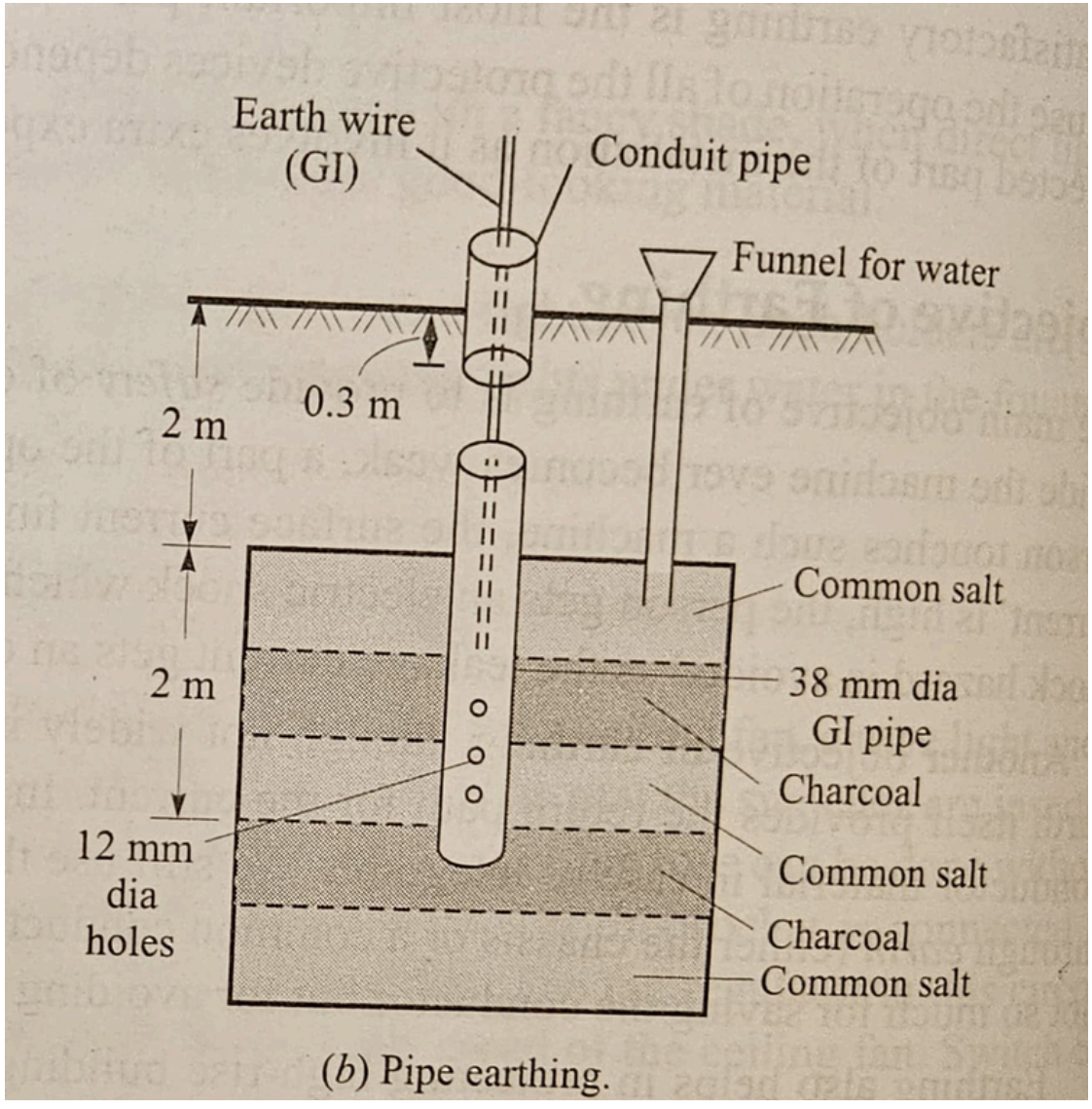
- The typical value of the earth resistance at powerhouse is 0. 5 ohm and that at substation is 1 ohm.
- Copper wire or GI wire can be used as earth wire



(*a*) Plate earthing.

Common salt thickness: 30–mm
Charcoal thickness : 80–mm

- In this method a copper plate of 60cm x 60cm x 3.18cm or a GI plate of the size 60cm x 60cm x 6.35cm is used for earthing.
- The plate is placed vertically down inside the ground at a depth of 3m and is embedded in alternate layers of charcoal and salt for a thickness of 80mm and 30 mm respectively.
- In addition, water is poured for keeping the earth electrode resistance value well below a maximum of 5 ohms.
- The earth wire is securely bolted to the earth plate. A cement masonry chamber is built with a cast iron cover for easy regular maintenance.



(*b*) Pipe earthing.

Common salt thickness: 30–mm
Charcoal thickness : 80–mm

- GI (galvanized) iron pipe of 38mm in diameter and length of 2m with 12mm holes on the surface is placed upright at a depth of 4.75m
- The area surrounding the GI pipe (15 cms) is filled with a mixture of salt and coal to reduce the earth resistance.
- The efficiency of the earthing system is improved by pouring water through the funnel periodically.
- The GI earth wires of sufficient cross- sectional area are run through a 12.7mm diameter pipe (at 60cms below) from the 19mm diameter pipe and secured tightly at the top

Electric Shock

- A person receives a shock when he comes in contact with the live wire
- Severity of the shock depends on the voltage of the wire and the resistance of the person
- The maximum current the human body can withstand for a short time (less than 25 millisecond) is 30mA
- If the body is totally wet, the body resistance is 1,000 Ω
- If the body is neither wet or dry, the body resistance is about 5 kΩ
- If the body is totally dry, then the body resistance

- Mild shocks produces nervousness
- Severe shock can cause unconsciousness and death
- Electric current passing through the body can cause cardiac arrest
- Damage caused by an electric shock depends on
  - Voltage level
  - Route of the current through body
  - person's health
  - Speed with which contact is removed and treatment given

Precautions against electric shock

- Do not touch the victim with bare hands when he is still in contact with electricity
- Shut off the supply immediately
- If supply cannot be switched off, use a non conducting object to push the victim away
- When victim is free, check his breathing and pulse and give the treatment

Prevention of Shocks

- Ground points must be properly provided to all the sockets to which electrical appliances are connected
- Proper earthing must be provided and periodically the earth resistance has to be checked and it does not exceed 3 to 5 Ω
- Install ground fault circuit interrupts (GFCIs) in wall outlets located in kitchen, bathroom, basement, garages etc
- Cover all electrical sockets with plastic safety caps
- Replace all the damaged cords and wirings
- Never use an electrical appliances like radio or an iron box near water
- Do not touch electrical appliances and switches with wet hands

Electricity Bill

Appliance Power Rating (Watts)*

1. Air Conditioner (1 Ton)800 – 1000
2. PC 100 – 450
3. Laptop30 – 100
4. Printer15 – 50
5. Iron Box1000 – 1500
6. Refrigerator200 – 800
7. Washing Machine500 – 1500
8. Water Heater1000 – 3000
9. Bulb – 100/60/40/18/9/4 W
10. Ceiling Fan (normal) -80W, BLDC fans (upto 32W)

* Approximate values

Electrical tariff

- Definition of unit: A unit of energy equal to the energy consumed by a load of one kilowatt over one hour.
- For example, if you use a 100-watt light bulb for 10 hours, it will consume 1 kWh of electrical energy (100 watts x 10 hours = 1000 watt-hours = 1 kWh).
- 1 unit = 1kWh

Calculation of electricity bill

The domestic power load in a house comprises the following:
Eight lamps of 100 Watt each, Three fans of 80 Watt each, one refrigerator of half HP, one water heater of 1000 Watts.

a. Calculate the total current taken from the supply of 230 volts
b. Calculate the energy consumed in a day if on an average only a quarter of the above load persists all the time.
c. What would be the monthly electricity cost If the per unit cost is rupees 7.5/–?

Solution:

Sl. No.	item	load
1	Eight lamps of 100 watt each	8 * 100 = 800 W
2	Three fans of 80 watt each	3 * 80 = 240 W
3	One refrigerator of half HP	1*(1/2) hp= (0.5)*746W=373 W
4	One water heater of 1000 Watt	1*1000=1000 W
	Total Load (P)	=2413 W

a. Current taken from the supply, I = P/V = 2413/230 =10.5 A

b. Energy consumed for a day = 2413 W * (1/4) * 24 = 14,478 Wh = 14.478 kWh

c. Cost of electricity per month, if the per unit cost is rupees 7.5/-
Cost of electricity = Units consumed in a month * Per unit cost
Cost of electricity = 14.478 * 30 days * 7.5 = Rupess 3,257.55 approx