Electrical Installation

Electrical Installations

Ques: What do you ~~mean by electrical~~ switch gear? How will you categorize it?

Ans: Switch gear:-

In an electrical power system, the apparatus used for controlling, regulating, switch 'on' or 'off' the electrical circuit is called switch gear.

The switches, fuses, circuit breakers, isolators, relays, current & potential transformers & control panels are examples of switch gear.

- Switch gear system is directly linked to the supply system. It is placed in both the high & low voltage side of power transformer.
- It is used for de-energizing the equipment for testing, maintance & clearing the fault.
- When fault occurs in the power system, heavy current flow through the equipment, due to which equipment can get damaged.

→ So to protect the lines, generators, transformers and other electrical equipments from damage, automatic protective devices are used. They are called switch gear

The basic function of switch gear is protection

The automatic protective switch gear consists of relays & circuit breakers. When the fault occurs in any one section of system, the relay of that section comes into operation & close the trip circuit of the breaker which disconnects the fault section. The healty section continues supply the load as usual, & thus there is no damage to equipment & no complete interrupt.

Switch gear can be classified into 3 types

1. HV switch gear :-

HV switch gear deals with voltage about 33kV. High voltage circuit breaker, is the main component of HV switch gear.

2. HV switch gear :- The switch gear system which is to handle the voltage b/w 3kV & 33kV

3. LV Switch gear :- Electrical switch gear rated upto 1kV is termed as LV switch gear. The LV switch gear includes — low voltage circuit breakers, switches, HRC fuse, MCB, MCCB, earth leakage circuit breaker (ELCB)

Ques: What do you mean by LV switchgear?

Low voltage switch gear :-

In LV switch gear, electrical appliances are protected against short circuit & overload condition by electrical fuse or electrical circuit breaker.

For protection of humans, earth leakage circuit breakers are also used. This operates on low leakage current. as low as 100mA.

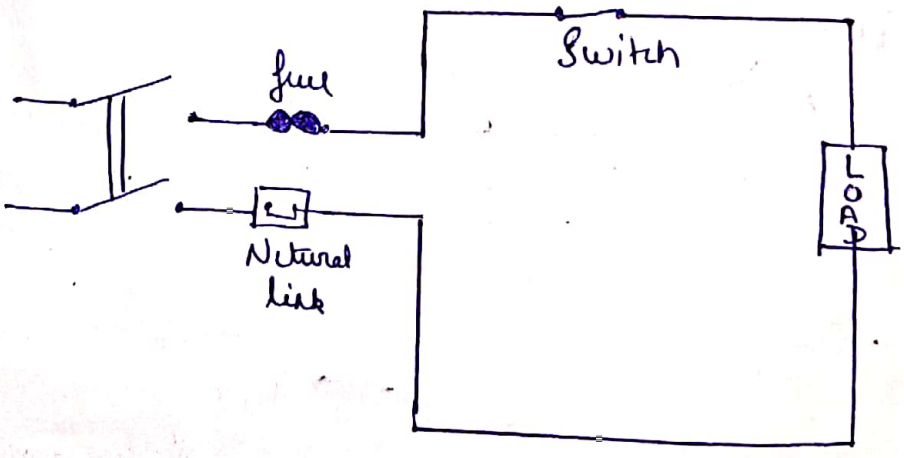
Most popular switch gear devices are fuse, SFU, MCB, ELCB, MCCB.

Ques: What is fuse? Give various advantages and disadvantages of fuse.

Ans:

Fuse :-

A short piece of metal wire, ~~piece~~ inserted in series with the circuit, which melts when predetermined value of current flows through it, & breaks the circuit is called fuse.



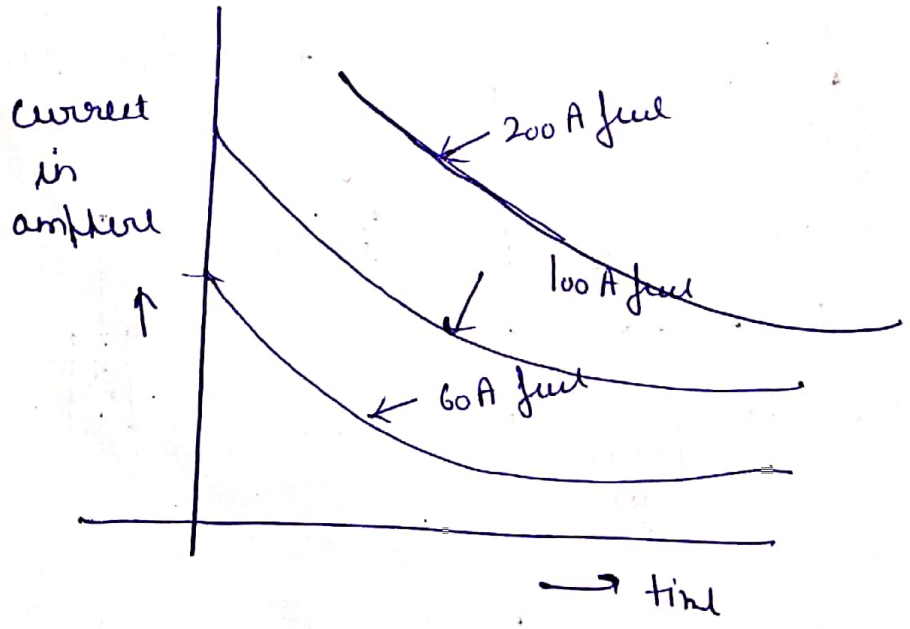
Circuit with fuse

A fuse is connected in series with circuit. Under the normal condition, circuit is to be protected with fuse & carries the load current without overheating itself. Under abnormal condition, an excessive current flow through it, This raises the temperature of fuse wire to that extent, it melts & open the circuit. This protects the machine or apparatus from damage.

Time - Current characteristics of fuse:-

The time required to blow out the fuse depends upon the mag. of excessive current.

↑ current, smaller is the time taken to blow out the fuse.



- Advantages:-

1) The cost of this protective device is very low
2) It requires no maintance.
3) It interrupts the heavy current without noise or smoke.

Disadvantage

1) Considerable time is lost in re-wiring or replacing fuses after any operation.

Ques: What do you mean by SFU?

Ans.

Switch fuse Unit:-

SFU consists of various porcelain rewirable fuses or HRC fuse fitting complete with their conducting parts. The switch is fitted with sturdy side operating handle with quick break type mechanism.

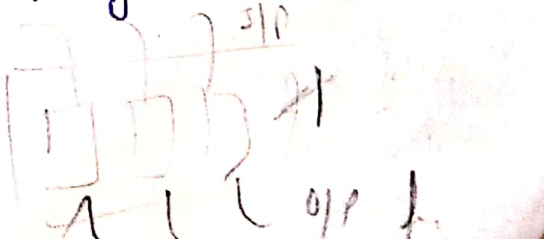
Contacts are made of electrolytic copper silver plated. The fixed contacts are provided with removable shields.

SFU are provided with rewirable fuse or HRC fuse links.

All these parts are assembled in an enclosure.

The enclosure is made of sheet steel duly phosphatised & powder coated.

Door interlock is provided to prevent opening when switch is in 'ON' condition.



Ques: Explain the construction and working of MCB.

Ans:

Miniature Circuit Breaker (MCB)!-

MCB is a device that ensure definite protection of the wiring system & electrical equipment against over current & short circuit.

Construction of MCB!-

The construction of MCB can be explained by considering the following parts.

① **Outer body!-** The outer body is made from special glass fibre reinforced polyster with help of injection moulding technique.

- The outer body & other polyster parts are fire resistant, and is water resistant.
- These polyster parts have ability to withstand high temperature & mechanical impacts.

② **Contacts!-** The contacts of an MCB are made of pure silver. This provide definite advantage - long contact life, low contact resistance, ensures quick arc removal & low heat generation.

③ **Operating Mechanism!-** All the components of the operating mechanism are made of special plastic, that they are self lubricating & eliminate wear & tear, rust & corrosion. They are very light in weight & tough.

(4) Arch extinguishing Contacts

The arc produced during breaking & making of contacts is extinguished in this chamber.

(5) Fixing Arrangement :- There are chip type construction at the back of MCB to easily attaches it to Din-Bar & can be easily removed by screw drivers. Mechanical

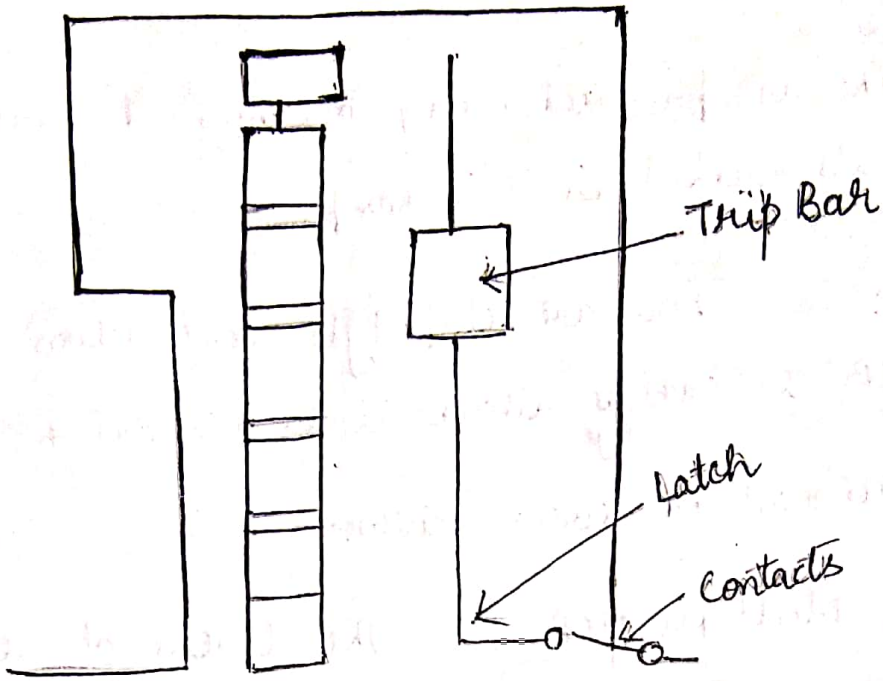
(6) Interlocking of Multiple MCBs :- The levers of all the MCBs are interlocked (connected internally) so that all the MCBs trip off simultaneously even if fault occur in any one of the phase.

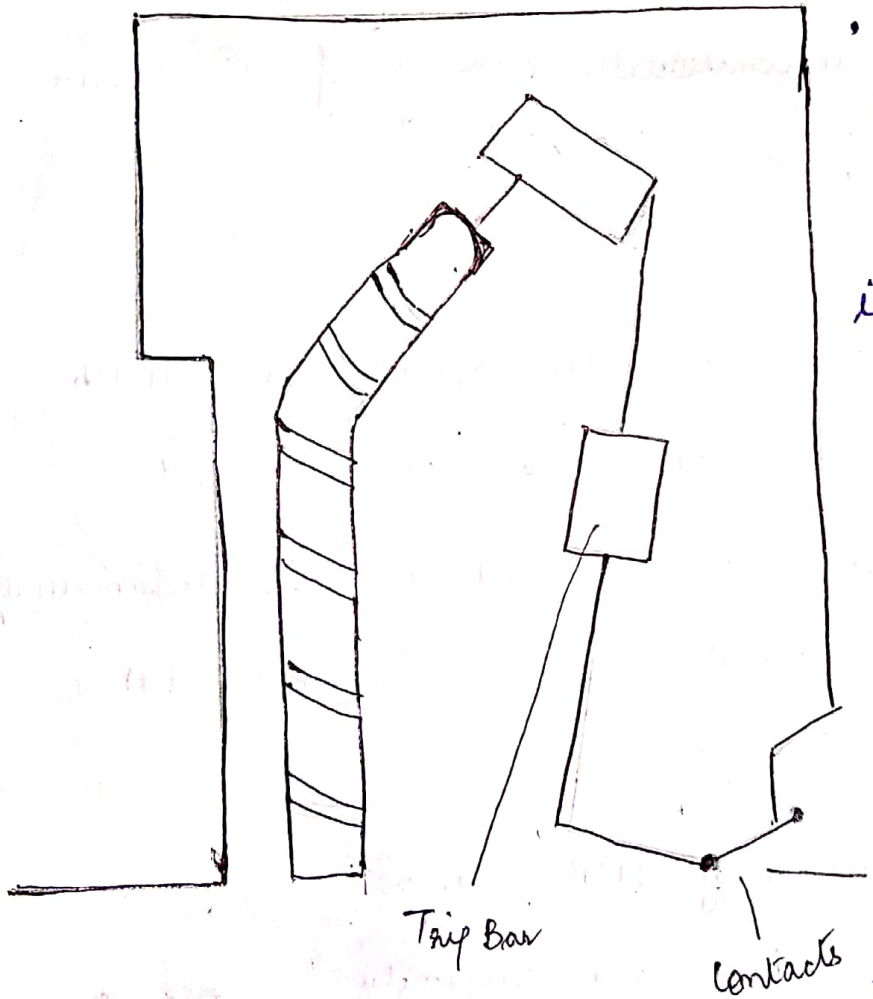
Working of MCBs :-

- Under the normal condition, MCB operates as switch (manual one) to make the circuit 'ON' or 'OFF'
- Under overload or short circuit condition, it automatically operates or trips so that current interruption takes place in a load circuit.

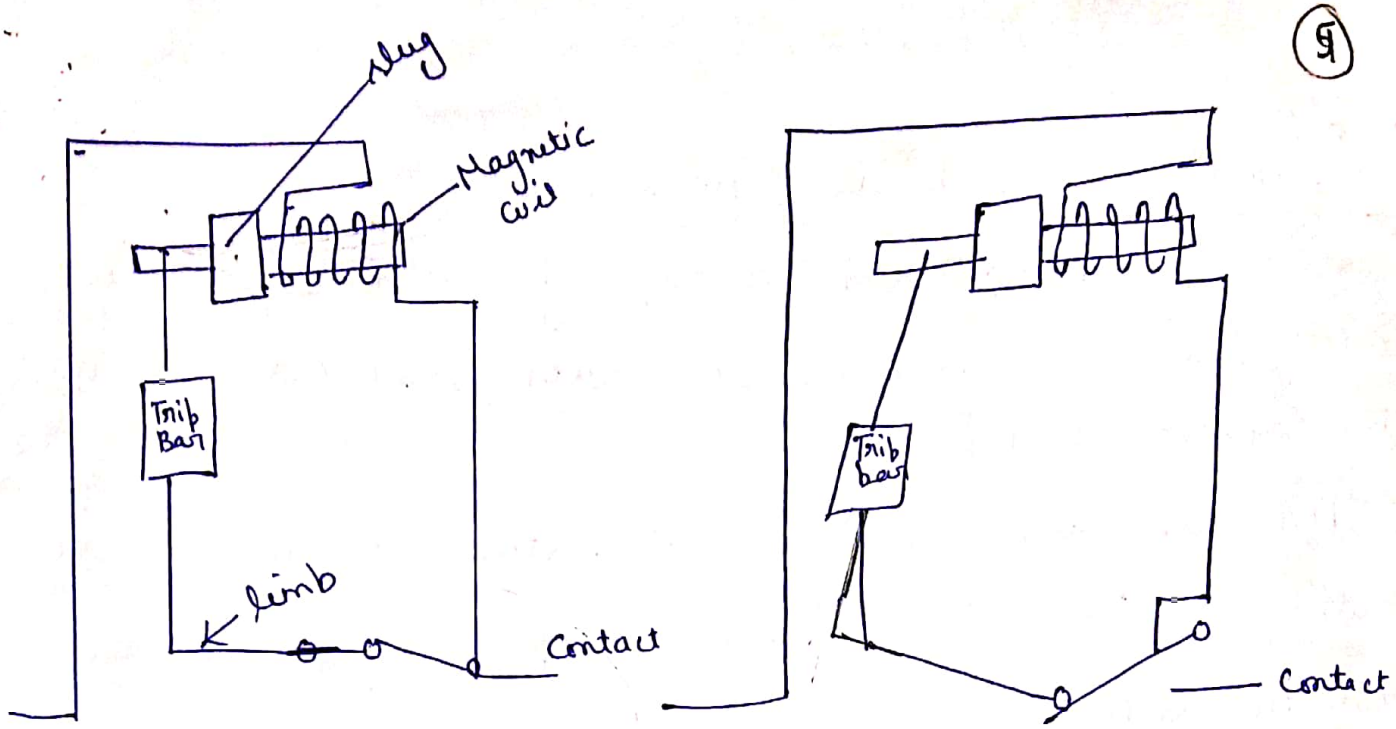
The automatic operation of MCB can be obtained in two ways - because there are magnetic tripping or thermal tripping in MCBs. OR

Working of MCB under over load condition





- Under over load condition, As the current through bimetallic strip increases, it causes more heat & it causes bending of bimetallic strip due to different thermal expansion of both metals.
- This deflection pulls ~~releases~~ ~~road~~ releases the trip latch & hence the contact gets separated



In some MCB magnetic field genrated by the coil causes / develops pull on the trip bar so that the contact get open.

Under the normal condition, slug is held in position under light spring pressure because the magnetic field genrated by the coil is not sufficient to attract the latch.

When fault current flows, the large magnetic field is genrated by the coil. It is sufficient to ovn come the spring force. Hence slug moves & activate the tripping mechanism.

- A combination of both magnetic & thermal mechanisms are found in all the MCB.
- When the contacts starts sparating, arc is produced. This arc is forced into arc splitter plates (are also called arc chuter). Here arc is splitted into series of arcs, thus energy is taken out of arc & it extinguished.

Ques: What do you mean by MCCB? How it is different from MCB.

Ans:

Moulded case circuit breaker (MCCB):-

MCCB are the type of electrical protection devices that are commonly used when load current exceeds the capacity of MCB

- They are also used in applications of any current rating that require adjustable trip settings which are not available in MCB.

Main distinction b/w MCCB & MCB is that MCCB can have current rating of upto 2500 Amp & trip setting is normally adjustable.

MCCB has 3 main functions

① Protection against overload:- Current above the rated value that last longer than what is normal for application

② Protection against electrical faults:- During a fault, such as short circuit or lis fault, there are high currents that must be interrupted immediately.

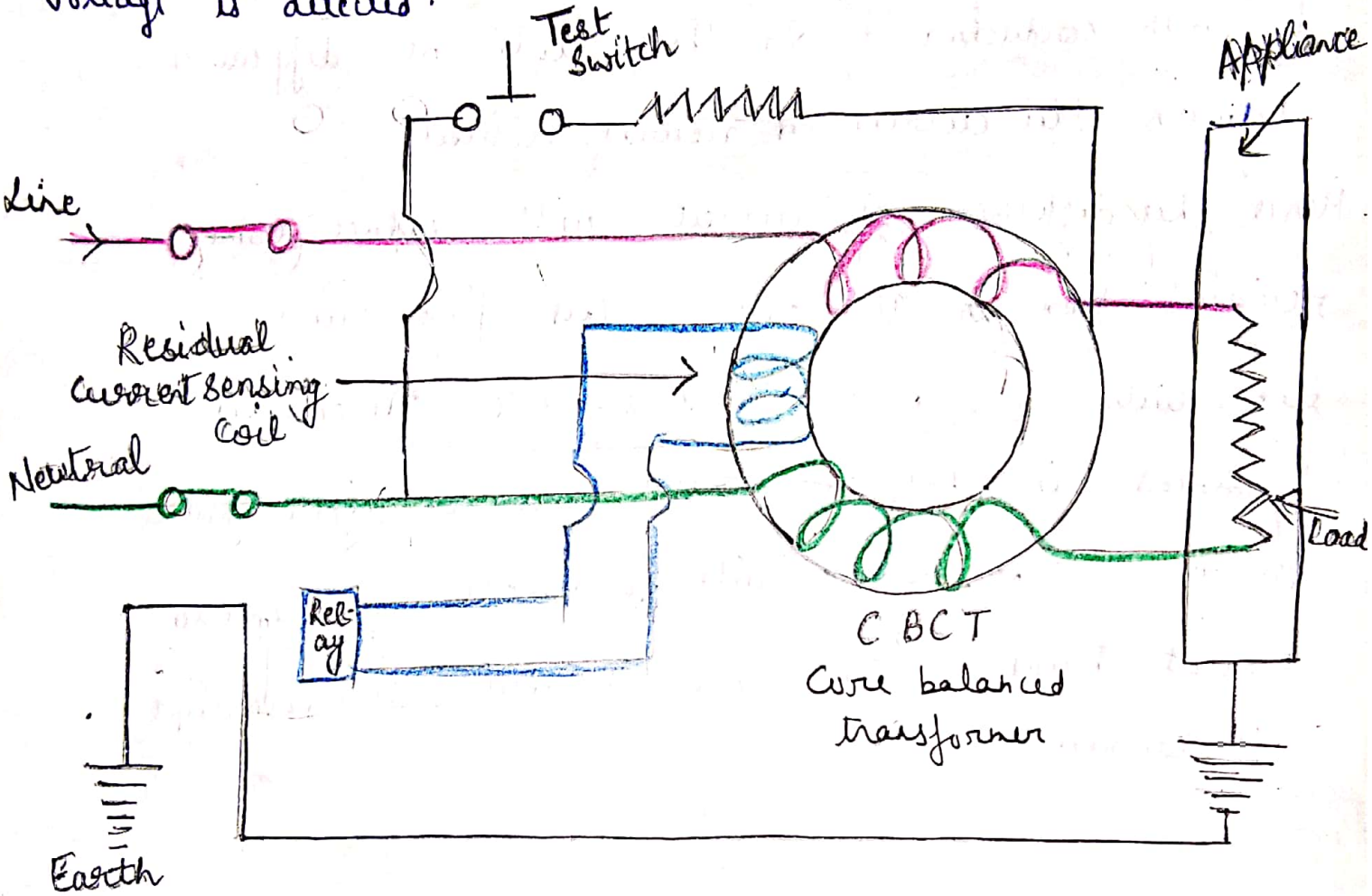
③ Switching a circuit ON or off:- This is a less common function of circuit breaker. But they can be used for this purpose if there is not an adequate manual switch.

Ques: Explain the working of ELCB. (6)

Ans: Earth leakage circuit Breaker (ELCB)

It is a safety device used in electrical installations, it has high earth inpedance to prevent shock.

- It detects small stray voltage on metal enclosure of electrical equipment and interrupts the circuit if a dangerous voltage is detected.



Case 1:- Everything is fine (Under normal condition):-

- Current entering the line conductor is equal to current leaving the neutral conductor. Both the direction will be opposite, According to flaming's law, emf will be induced in the circuit, but direction is opposite

what they will eliminate the effect of each other & hence there will be no ~~zero~~ residual flux in core of CBCT. No flux means — no current in core.

Now let us consider that wire touches the equipment body. In this case, some current will be grounded by earth conduction. So there will be difference between line current & neural current.

Hence this difference of current will induce some residual flux in the core. This flux will link with residual current sensing coil. The current produced in that coil will work as signal for relay. The relay will send operating signal to circuit breaker. The circuit breaker will interrupt the current.

Ques: What are the different types of wiring & cables?

Ans:

Types of Wires & Cables :-

- Before considering the various type of wiring system suitable for any installation, it is required to know about various types of cables which are used for internal wiring system.

- **Cable :-** A solid conductor covered with insulation is known as a cable.
- The cable may be single core or multiple core depending upon the number of conductors.

The cable may be classified as

- V.I.R. cables (Vulcanised Indian Rubber)
- P.V.C cables (Poly - Vinylchloride)
- T.R.S cables (Tough Rubber sheathed) or C.T.S. cables (Cab Tire sheathed)
- Leather sheathed cables
- Weather Proof cables

Types of Wiring :-

The type of wiring employed in residential buildings, commercial ~~buildi~~ buildings & industries are

1. Cleat Wiring
2. Casing & Capping wiring
3. C.T.S or T.R.S wiring
4. Metal sheathed wiring
5. Conduit wiring

① Cleat Wiring :- • In this type of wiring, V.I.R or P.V.C. conductors are employed.

• The conductors are supported in porcelain cleats which are placed at least 6mm above the wall.

• The porcelain cleats are made of two parts – Base & Cap

• Lower one is base having two or three grooves for accomodation of conductors & upper one is known as cap.

• The conductors are run in the grooves & cap is placed over the base & whole assembly is fixed on the wall with help of wooden screws & gutties already cemented in the wall.

Advantages :- 1) It is cheapest system to wiring

2) A little skill is required to lay the wiring

3) The wiring can be installed quickly.

Disadvantages :- 1) It gives a rubbish look.

2) It is ~~used~~ rarely employed for permanent job

~~3) At the time of white wash over the walls~~

(2)

Casing & Capping Wiring :-

- In this type of wiring, usually V.I.R. wires are employed.
- The casing is just a base that consists of rectangular wooden block of teak wood & has usually two grooves to accomodate wires
- The casing is fixed on wall with help of wooden screws & gutties already erected in walls.
- The casing is placed 3mm apart from the walls by means of porcelain discs in order to protect the casing from dampness.

After placing the wires in the grooves of casing at the top is covered by rectangular strip of seasoned wood of same width as casing known as capping with help of wooden screws.

Advantages :
- It gives better appearance than cleat wiring
- It is easily to install
- Its cost is quite low as compared to other system of wiring except cleat wiring

Disadvantage :-
- It is not suitable in damp situations
- There is a risk of wire.

③ C.T.S. on T.R.S. Wiring :- In this type of wiring C.T.S on T.R.S. conductors are employed. The conductors are run on well seasoned, perfectly straight & well varnished teak wood batten of thickness 13mm. The width of batten is depending upon the number of wires to be run on it.

In this type of wiring, the batten is fixed on to the wall by means of wooden screws & gutties already erected in the wall. The wires are held on batten with help of clips fixed on batten with the help of nails.

Advantages · 1) It is easy to install & repair
2) It gives nice appearance
3) It is fire proof up to some extent

Disadvantages ① The conductors are open & liable to mechanical injury, ∴ this type of wiring cannot be used in workshop.
② Its use in places open to rain & rain is restricted.

④ Metal Sheathed Wiring :-

· In this type of wiring, V.I.R. conductors covered with metal sheathed cable are used. The metal sheathed cable are run on wooden batten. The batten is fixed on the wall by means of screws & gutties already concreted into the wall.

Advantages :- ① The conductors are protected against mechanical injury.

② It gives better appearance

③ It can employed suitably under damp condition

Disadvantages :- ① The metal sheathed cables are costlier than C.T.S. or T.R.S. wires

② In case of leakage, there is risk of shock.

③ Skilled labour and proper supervision is required.

⑤ Conduit Wiring :- · In this system of wiring, V.I.R or T.R.S. conductors are run in metallic or P.V.C. tubes called conduit.

· The conduit can either be supported over the walls by means of saddle or can be buried under plaster.

According there are two types of conduit wiring

(1) Surface conduit wiring

(2) Concealed " "

① In surface conduit wiring :- the conduit is run over wall supported by means of saddles

② Concealed conduit wiring :- The conduit is embedded in walls & ceiling by placing it in the pre made cavity in them. After placing the conduit, insulated conductors are drawn into them by means of G.I wire known as pilot wire

Advantages :- ① Conduit provides protection against mechanical injury & fire.
② This wiring has far better look
③ It has a longer life

Disadvantages ① It is costly system of wiring
② It requires highly skilled labour

Que: What is earthing? Explain its purpose. (10)

Ans:

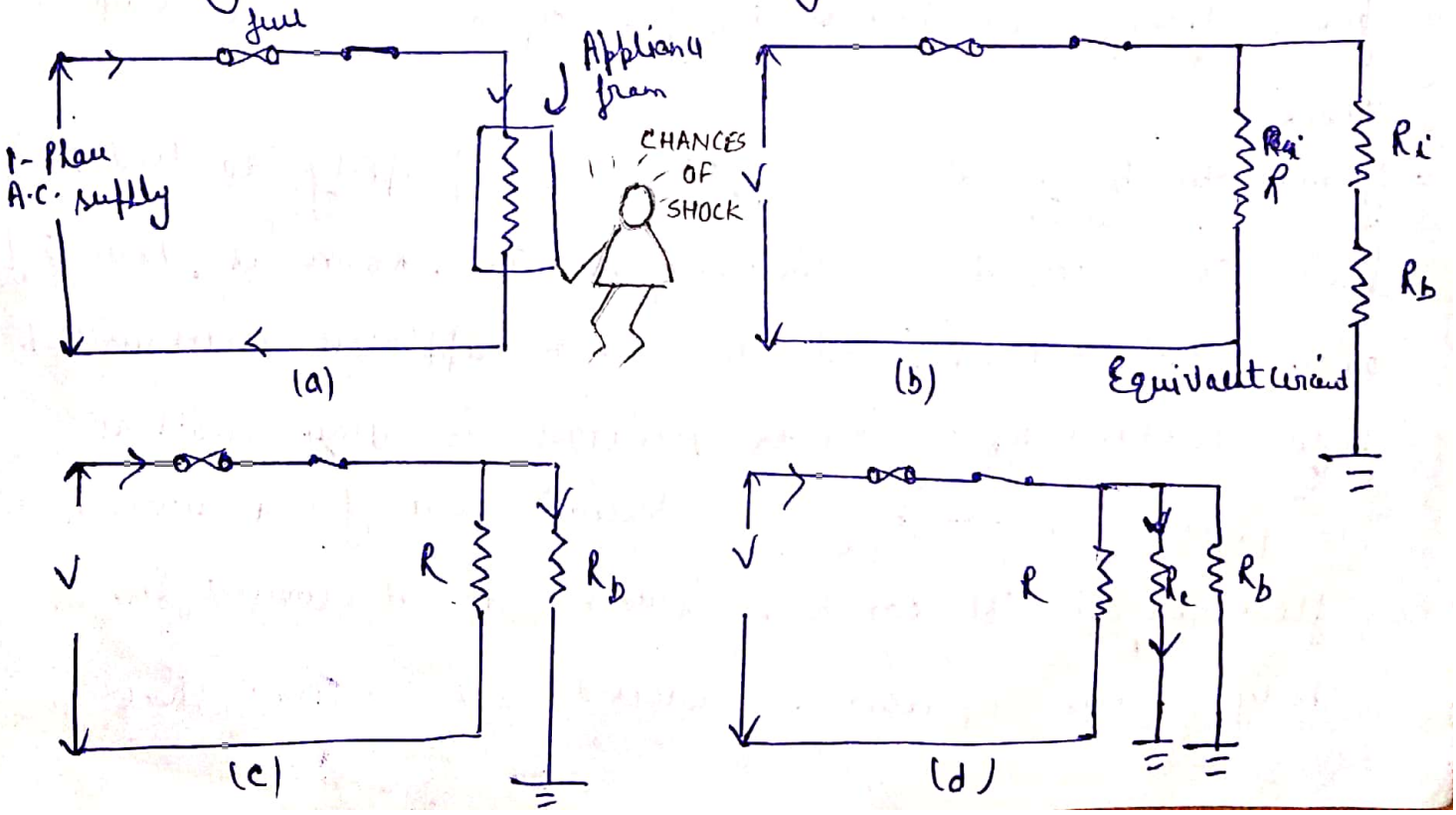
Earthing:- The process of connecting metallic bodies of all the electrical apparatus & equipment to the huge mass of earth by a wire of negligible resistance is called earthing.

When body is earthed, it is basically connected to the huge mass of earth by a wire having negligible resistance This ensures that when a live conductor comes in contact with outer body, the charge is relase to the earth.

Purpose of earthing:-

The basic purpose of earthing is to protect human body from shock.

How earthing protects the human body:-



The electrical appliance of resistance R is connected to supply through a fuse & a switch. When an operator touches the metallic body of the apparatus as shown in fig (a) having perfect insulation. The equivalent circuit is shown in fig (b).

- In case of perfect insulation, → the resistance of insulation ↓ two parallel paths are formed ↗

R_i is very high as compared to appliance resistance R, whole of the current flows through appliance resistance & no current flows through human body resistance

When fault occurs & Hot wire directly connected to outer body & insulation resistance reduces to zero & heavy current flows through the human body & operator gets a severe shock

- If metallic body of the appliance is properly earthed under fault condition & the circuit will be shown as shown in fig(b) Earth resistance R_e is in parallel with appliance resistance & body resistance R_b. Earth resistance is very small as compared to human body resistance. Whole of the current flows through the earth resistance & no current human body. Thus operator is protected from electric shock.

System Earthing :-

For proper earthing of heavy power equipment, double earthing system has to be adopted. Moreover, number of apparatus must be connected in parallel to the earth.

Double earthing :- Two separate earth wires from two separate earth electrodes are connected to same metallic body of the equipment at different points to provide better safety is known as double earthing.

Double earthing is essential as per Indian electricity Rule for metallic body of large rating equipment such as transformer, motors etc, working at 400V & above.

Methods of Earthing

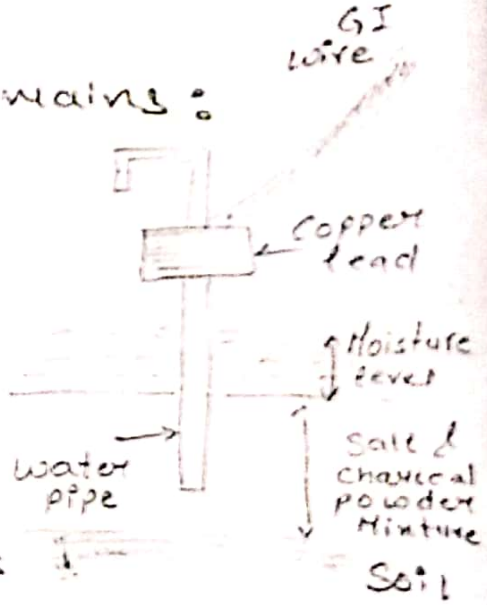
⇒ Earthing : Connect metallic bodies of the apparatus with the general mass of earth by a wire of negligible resistance.

Various Methods of Earthing are :

1. Strip Earthing : In this method of earthing, strip electrodes of cross-section not less than 25mm × 1.6mm is buried in a horizontal trenches of a minimum depth of 0.5m. The length of conductor buried in the ground would give a sufficient earth resistance and this length should not be less than 15m. This type of earthing is used where the earth bed has a rocky soil and excavation work is difficult.

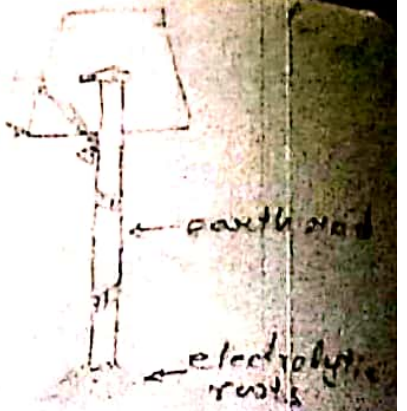
2. Earthing through water mains :

In this type of Earthing, a stranded copper lead is used which is rounded on the pipe with the help of steel binding wire and a properly designed earthing clip. Galvanised Iron (GI) pipes are used for earthing purpose. Earthing clamps are preferred to minimize the resistance for proper earthing connection.



3. Rod Earthing : It is the cheapest method of Earthing and is employed in sandy areas. In this method, a copper rod is hammered directly into the ground without excavation.

3. Pipe Earthing:



Rod → 12.5mm diameter of galvanized steel of length 2.5m are buried upright in the earth. The length of embedded electrodes in the soil reduces earth resistance to a desired value.

4. Pipe Earthing: A galvanized steel and a perforated pipe of approved length and diameter is placed vertically in a wet soil in this kind of system of earthing. It is most common system of earthing.

The size of pipe to use depends on the magnitude of current and the type of soil.

Dimension of pipe: length → 2.75 m
diameter → 40 mm, for ordinary soil.

5. Plate Earthing: In this method of earthing, a plate made up of copper with dimensions 60cm x 60 cm x 3.18 mm or galvanized iron of dimensions 60 cm x 60 cm x 6.35 mm is buried vertical in the earth which should not be less than 3m from the ground level. The layer (Alternate layer) of charcoal shall be placed immediately over the plate and thereafter successive layers of salt, and this alternative layers are laid to keep the surroundings sufficiently moist.

Q: Explain construction & working of lead acid storage battery.

Ans # BATTERY :

A series, parallel or series-parallel grouping of cells is called a battery.

or in another words

A number of cells connected in series placed in a single container is called a battery

→ A cell can deliver a small current at low voltage.

If higher voltage is required : cells are connected in series.

If higher current is required : cells are connected in parallel.

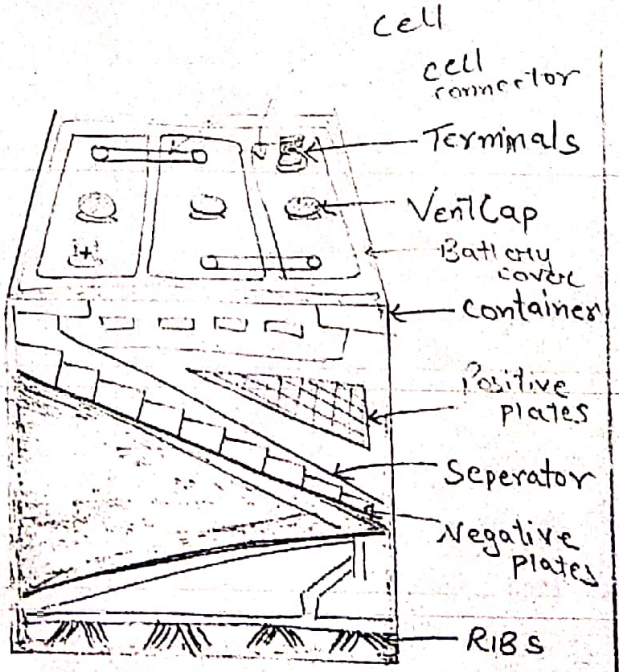
If large current at higher voltage is required. : cells are conneded in series further connected in parallel.

⇒ LEAD-ACID BATTERY :

Important parts of the battery

1) Container : It is the outer body of the battery.
material → hard rubber or plastic
prevent spilling of the electrolyte.

2) Plates : Alloy of lead-antimony sheets covered with lead-peroxide and spongy lead forming positive and negative plates respectively are used as electrolytes.



Cut-away view of 6V commercial lead-acid battery.

For higher capacity → more number of plates are used. Placed in a sandwitched structure and an insulator

(3) Separator : materia → rubber sheet with large number of small holes

It is used to reduce the resistance of the cell and to save the space, the plates are placed very close to each other. Separator is used to prevent the plates touching each other.

(4) Electrolyte : material → Dilute Sulphuric Acid (H_2SO_4)

It is added to water in such a proportion that with a fully charged battery, its specific gravity is about 1.28 to 1.29.

(5) Battery Cover : material → molded hard rubber

Joints between covers and container are sealed with an acid-resistance material.

(6) Vent Cap : It allows free exist of the gas formed in the cell during charging through vent hole.

It can be easily removed for : → Adding water.
→ Insert nozzle of hydrometer for checking specific gravity of electrolyte.

(7) Inter-cell Connector : Cells, placed in same container are connected in series with a lead alloy link called inter-cell connector.

(8) Cell terminals : material → lead

Each cell has two terminals :

. positive terminal → marked with a red color or by a large positive (+) sign.

: Negative terminal.

⇒ Capacity of a Battery :

The quantity of electricity which a battery can deliver during single discharge until its terminal voltage falls to 1.8V/cell is called the capacity of a battery.

→ expressed in ampere-hour (A-H)

→ Capacity of a battery or cell = $I_d T_d$ ampere-hour

→ where, I_d : Discharging current in ampere.

T_d : Discharging time of battery or cell in hour.

Ques: Explain the efficiency of battery.

⇒ Efficiency of a Battery :

(1) Quantity or A-H efficiency ⇒ The ratio of output ampere-hour during discharging to the input ampere-hour during charging of a battery.

$$\eta_{AH} = \frac{I_d T_d}{I_c T_c}$$

(2) Energy or W-H efficiency ⇒ The ratio of output watt-hour during discharging to the input watt-hour during charging of the battery.

$$\eta_{WH} = \frac{I_d T_d V_d}{I_c T_c V_c}$$

Where, I_d = discharging current in ampere.

I_c = charging current in ampere.

T_d = Discharging time in hour.

T_c = charging time in hour.

V_d = Average terminal voltage during discharging

V_c = Average terminal voltage during charging

⇒ **Battery Back-Up :** The time (in hours) for which a battery can deliver the desired current is called battery back-up of the bank.

⇒ **Charging Indications of a lead-Acid Battery**

The charge condition of a battery or cell is usually checked by checking the specific gravity of the electrolyte (H_2SO_4) by using an instrument called hydrometer which works on Archmedeies principle.

Specific gravity	Condition
1.28 – 1.29	100% charged
1.23 – 1.25	75% charged
1.19 – 1.2	50% charged
1.15 – 1.16	25% charged
below 1.13	fully discharged

→ Only a d.c. voltage source is applied for recharging.

⇒ **Characteristics of lead-Acid Battery**

(1) Emf of fully charged cell is 2.2V and average e.m.f of cell is 2.0V.

(2) Internal resistance of cell is quite low.
→ η_{AH} is nearly 80%, and η_{WH} is 60%
→ Specific gravity of electrolyte is 1280 – 1290 but 1150 last when it is fully discharged

⇒ **Applications :**
→ Used in automobiles for starting and lighting.
→ Lighting on steam & diesel railway trains
→ Telephonic exchanges, hospitals, theatres, banks etc
→ Emergency lighting at generating stations, rural areas etc.

4. Power factor Improvement

Qus: Explain power factor improvement in detail.

Ans: Power factor:

Power factor measures the efficiency of a battery charger.

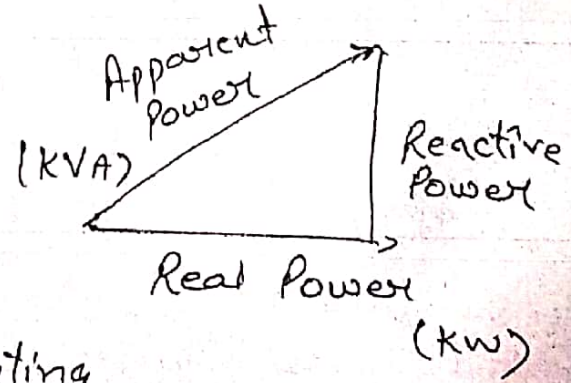
→ Power factor is the ratio of power drawn by the charger to the power actually utilized in charging. It is between 0 and 1 in value. The closer the value of power factor to 1, the higher the efficiency.

Components of Power factor: Battery charger is an inductive load. This means that it requires an electromagnetic field to sustain itself. As electromagnetic field is generated by passing electric current through a wire. So the power drawn by the charger is used to charge the battery (working Power) as well as sustain the electromagnetic field (Reactive Power).

In mathematical terms,

$$\text{Power factor} = \frac{\text{Working Power}}{\text{Reactive Power}}.$$

Power factor Correction:



Power factor can be improved by lowering amount of Power consumed for generating Reactive Power. This is called Power factor correction

→ Power factor correction is usually done by adding capacitors to the battery charger circuit. The capacitors generate the necessary electromagnetic induction require to sustain the charger. This decreases the Reactive Power Consumption.

→ Improving the efficiency of a battery charger has many advantages, like decreasing costs and improving charger performance.

Ques: Give calculation for energy consumption.

Ans:

Elementary Calculations for energy consumption:

To charge the electrical energy consumed by a consumer, an energy meter is installed to its quantity. The difference between the fresh reading and the previous reading tell about the consumption of electrical energy in that month.

This quantity of energy is multiplied by the rate fixed by the supplier to prepare an electricity bill. However, some other charges such as Meter rent, GST, other taxes applicable etc. are also added in the bill.

Q. A building has

(1) 12 light bulbs of 60 watt each burning 4 hours a day.

(2) A fan point of 75 watt each running 10 hours a day.

(3) A plug point for a 750 watt heater is used one hour a day.

(4) One radio 80 watt used 6 hour a day.

(5) a $\frac{1}{2}$ H.P. pump of 80% efficiency running 2 hours a day.

Calculate the total connected load in kilowatt, maximum possible current, the daily consumption of energy and monthly bill.

The supply is given at 230 volt and energy costs Rs. 5.15 per unit. The rent for a meter is Rs. 50 per month. Assume the month of 30 days.

Solution:

Load Points	Connected Load	Energy Consumption/Day kwh
1) 12 light bulb of 60 watt each, 4 hr/day	$12 \times 60 = 720W$	$\frac{720 \times 4}{1000} = 2.88$
2) 4 fan points of 75W each, 10hr/day	$4 \times 75 = 300W$	$\frac{300 \times 10}{1000} = 3.00$
3) 1 plug point of 750W 1hr/day	$1 \times 750 = 750W$	$\frac{750 \times 1}{1000} = 0.75$
4) 1 radio of 80W, 6hr/day	$1 \times 80 = 80W$	$\frac{80 \times 6}{1000} = 0.48$
5) $\frac{1}{2}$ HP. pump of 80% efficiency, 2hr/day	$\frac{1}{2} \times \frac{735.5}{80} \times 100 = 460W$	$\frac{460 \times 2}{1000} = 0.92$

1 Horse H.P = 735.5 Watt

Therefore,

Connected load : 2310 watt

= 2.31 kW

Maximum possible current : $I = \frac{P}{V}$

$I = \frac{2310}{230} = 10.043 A$

Energy consumption / day = 8.03 kwh

Energy consumption / month = 8.03 × 30

= 240.9 kwh.

Rate of energy / month = Rs. 5.15

Energy cost / month = 5.15 × 240.9

= Rs. 1240.60

Meter rent / month = Rs. 50.00

Therefore, Monthly bill = 50 + 1240.60

= Rs. 1290.60