



R. C. Patel College of Engineering & Polytechnic, Shirpur



Department of Electrical Engineering

Name of Subject: - **SWITCHGEAR AND PROTECTION (SGP)**

Course Code: - **315334**

Scheme:- **EE-5K**

Semester:- **Fifth**

Unit No. 02- Circuit Interrupting Devices

CO1 - Select the suitable switchgears for different applications.

Unit	Title	COs	Learning hours	R Level	U Level	A Level	Total Marks
I	Circuit Interrupting Devices	CO2	10	2	8	6	16

THEORY SYLLABUS CONTENT

- 2.1 Isolators- Vertical break, Horizontal break and Pantograph type with its advantages and disadvantages
- 2.2 HRC fuses – Construction, types, working, Inverse time current characteristics, characteristics of fuse element, Fuse current rating, Minimum fusing current, Fusing factor, Prospective current, Cut off Current.
- 2.3 Terms related to Arc interruption process of fuse pre-arcing time, cut off value, arcing time, total operating time, peak of prospective current and applications
- 2.4 Arc formation process, methods of arc extinction (High resistance and Low resistance).
- 2.5 Arc voltage, Recovery voltage, Re-striking voltage, Rate of rise of restricting voltage (RRRV).
- 2.6 HT circuit breakers: Vacuum circuit breaker, Sulphur-hexa Fluoride (SF₆) - Working, construction, specifications and applications
- 2.7 L.T. circuit breaker: Miniature circuit breakers (MCB), Molded case circuit breakers (MCCB), Motor Protection Circuit Breaker (MPCB) , Residual Current Circuit Breaker (RCCB) and Earth leakage circuit breaker(ELCB), Air circuit breakers (ACB) Construction, Working and applications
- 2.8 Selection of LT and HT circuit breakers 2.9 Isolator, fuses and circuit breaker: Comparison
- 2.10 Gas insulated switchgear 2.11 Insulation Coordination: Type1 & Type2 coordination 2.12 Ring Main Unit Switchgear: Introduction, classification based on: type of insulation (gas, oil, air), installation (outdoor, indoor).
- 2.13 Air Insulated Substation (AIS) : Concept, Advantages , Disadvantages ; Gas Insulated Substation (GIS)

Subject Incharge

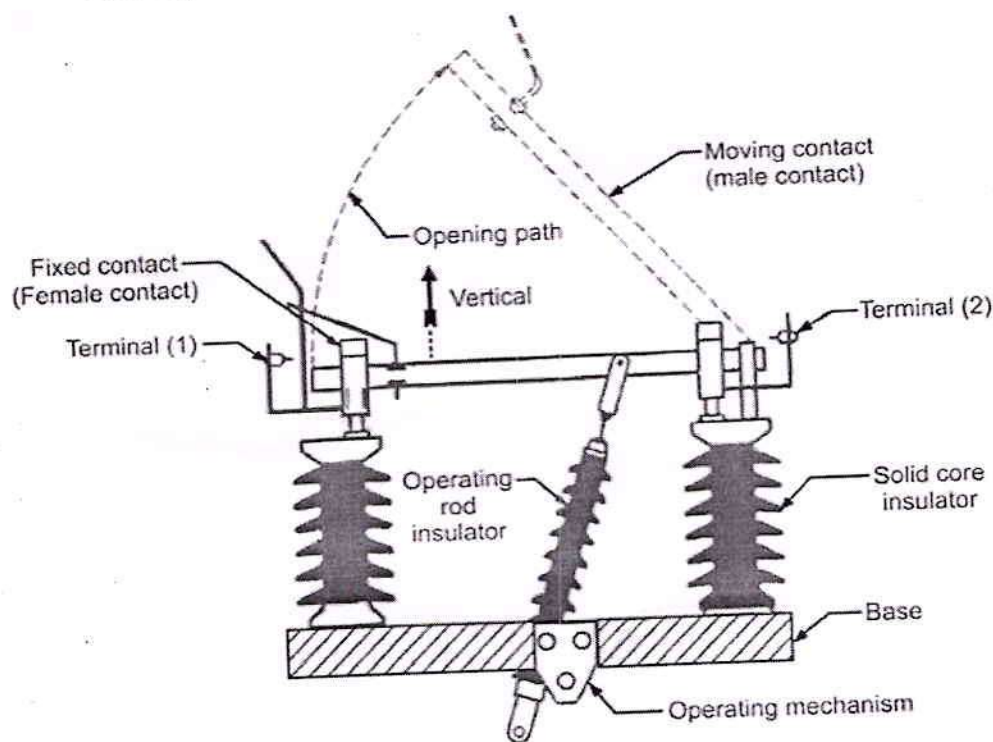
Mr. N. S. Borse

circuit Interrupting Devices

- Isolator: 1) Isolator are used with circuit breaker and are provided on each side of C.B. to provide isolation during maintenance.
- 2) It operates under no-load condition
- 3) It does not have any breaking or making capacity,
- 4) In power system isolator are of three pole type.
- 5) Sequence of operation while opening or closing circuit is
- a) while opening
 - i) open C.B.
 - ii) open isolator
 - iii) close the earthing switch
 - b) while closing
 - i) open the earthing switch
 - ii) close isolator
 - iii) close C.B.
- 6) Isolator having three types on the basis of construction.
- A) Vertical break
 - B) Horizontal break
 - c) Pantograph type.

A] Vertical break Isolator:

- These are outdoor air break switch.
- Having rating upto 7 kv.
- It can provide isolation to c.B., transformer surge arrester, line section.



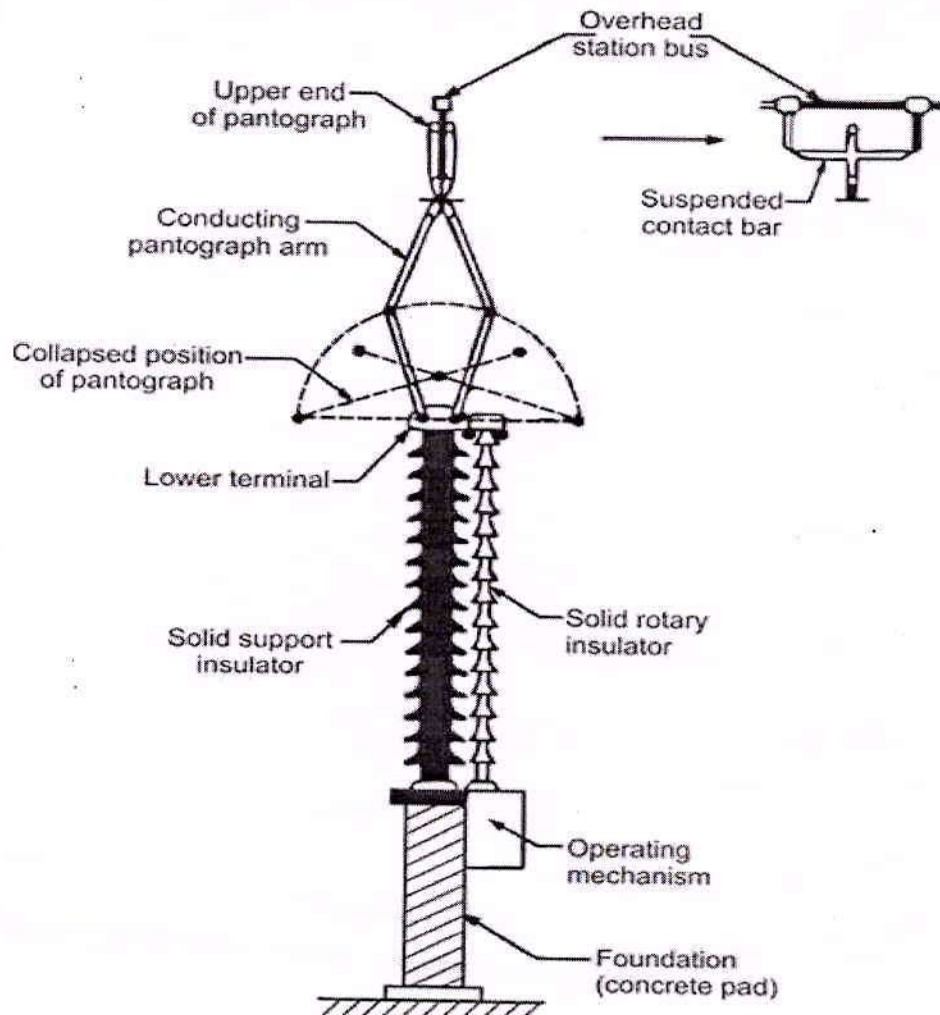
B] Horizontal break Isolator:

- It consist of 3 pole, out of this center pole is rotating.
- Which rotate in a horizontal direction
- other two insulator are fix at each end to base.
- This isolator use upto 245 kv.

C] pantograph type Isolator:

- ctn is carried by upper busbar to the lower busbar through conducting part of pantograph.
- while opening, rotating insulator is rotated about it's own axis, thereby pantograph

blades collapse in vertical direction or plan and isolation is obtain.



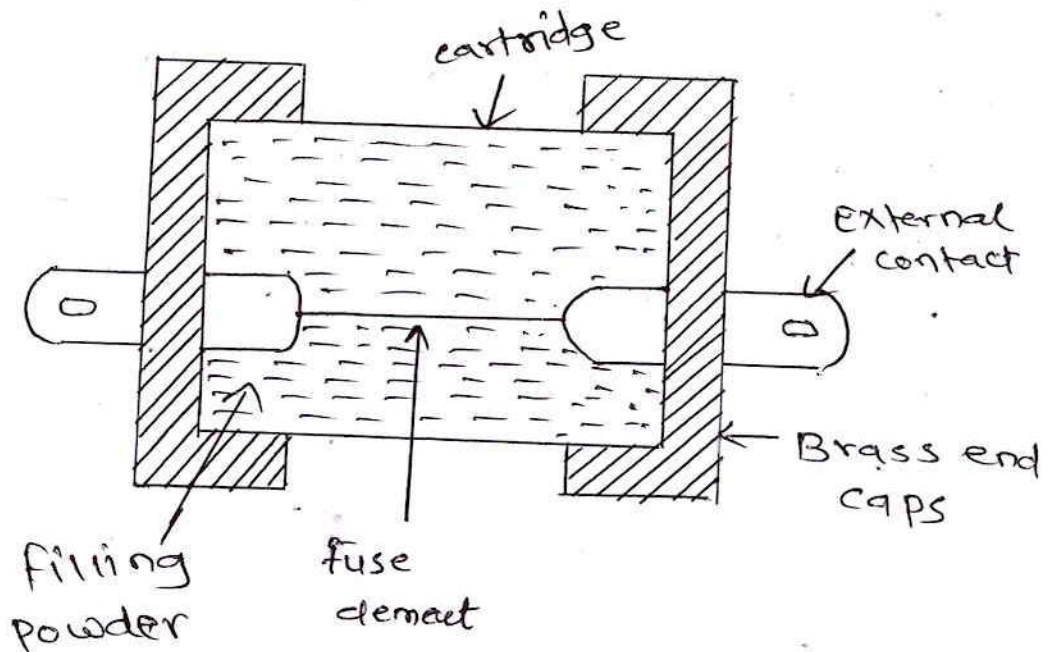
- * Advantages :
- 1) provide safety
 - 2) visible isolation
 - 3) simple construction
 - 4) low cost
 - 5) improve system reliability.
 - 6) long service life.

- Disadvantages:
- 1) cannot operate under load
 - 2) No protection against fault
 - 3) Requires C.B.
 - 4) Manual operation
 - 5) Not suitable for emergency switching.

* Distinguish betⁿ C.B. and Isolator:

Isolator	Circuit Breaker
1) Operates under no-load conditions.	1) can operate under load & fault conditions.
2) used for isolation & safety	2) used for protection & switching
3) No arc-extinguishing mechanism	3) Has arc extinguishing mechanism
4) Manual operation in most cases	4) can be manual or automatic.
5) simple in construction	5) complex in construction
6) higher Lower cost	6) lower Higher cost
7) Ex. vertical break, Horizontal break	7) Ex. MCB, MCCB, SF6, Vacuum C.B.

* High Rupturing Capacity (HRC) Fuse:
construction & Working:



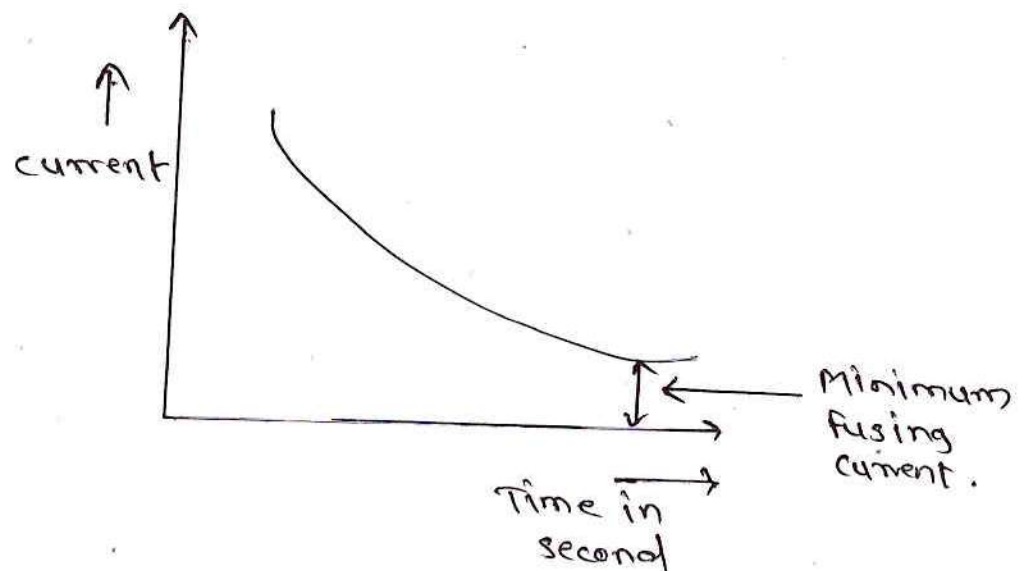
- Fig. shows essential part of HRC fuse.
- HRC Fuse consist of heat resistance ceramic body.
- Both ends of ceramic body consist of metal end caps.
- A silver cln carrying element is fitted in between these metal end caps.
- cln carrying element / Fuse element is surrounded by filling powder.
- Filling powder may be pop, chalk powder, marble dust or quartz crystal.
- Filling material act as arc quenching and cooling medium.
- Under normal condition, the fuse element is at temp below it's melting pt. Therefore it carries normal cln without overheating.

- When fault occurs, the ctn increases and Δ heat produces which is sufficient to melt fuse element.
- The element get overheated & results in vapourisation of silver element.
- This vapourised silver element chemically react with filling powder and result in formation of high resistance substance and act as arc quenching medium.

* Advantages: 1) speed of operation is very high.
 2) Maintenance cost is zero.
 3) operation is reliable
 4) cheaper in cost
 5) Capable of clearing high as well as low fault current.

⇒
 * Disadvantages: 1) After each operation replacement is required
 2) Heat produce by arc may be affect the associated switches.

* characteristics of Fuse Element:



- From the above characteristics, the fault c/n & operating time is inversely proportional to each other.
- The minimum current below which fuse does not operate is minimum fusing c/n.
- chara. of fuse, varies as per fuse element because melting pt. of each metal is different.

* Definitions:

1) Fuse current rating / Rated current:

- The current which is carry without fusing is known as rated current of fuse.
- Min c/n that fuse carry continuously

2) Minimum fusing current:

- It is the minimum current at which fuse element is melt.
- Minimum fusing c/n depends on
 - 1) Material, length, shape & size, area of cross section, location.

3) fusing factor:

- It is the ratio of minimum fusing c/n to the rated c/n.

$$\text{Factor} = \frac{\text{Min. fusing c/n}}{\text{Rated c/n}}$$

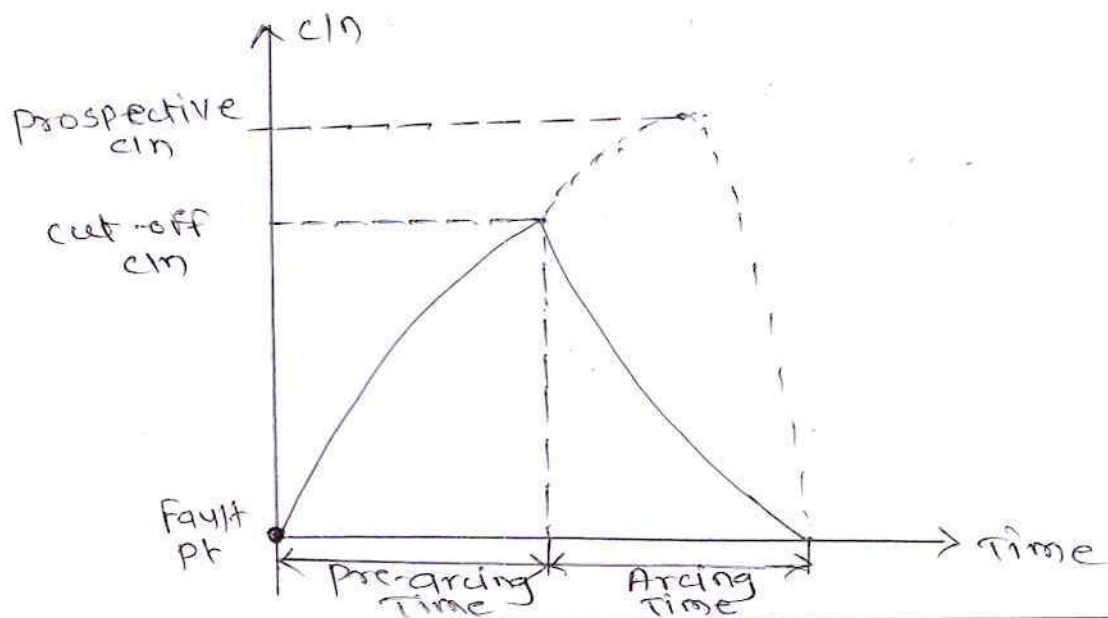
- The fusing factor is always greater than 1.
- lower fusing factor indicate a more sensitive fuse
- typical value ranges from 1.25 to 2.

4) prospective current:

- It is the maximum current which would flow in a circuit under fault condition.
- It is the highest possible fault current available at a particular point in an electrical system.
- It is greater than fusing current.

5) cut-off current:

- It is a current ^{at} which fuse element blows off or melt is called cut off c/n



6) Pre-arcing Time: (Melting Time)

- The time taken from instant of fault to the instant of cut-off is called pre-arcing time.

or - A Time required from fault point to the formation of arc.

7) Arcing Time:

- The time from instant of cut off to the instant of arc extinguish is called arcing time.

or - A Time between arc formation and arc extinguish.

8) Total operating time:

- It is the summation of pre arcing time and arcing time.

9) Peak of prospective current:

- It is the highest instantaneous value reached by prospective fault current during the first cycle after a short circuit occurs.

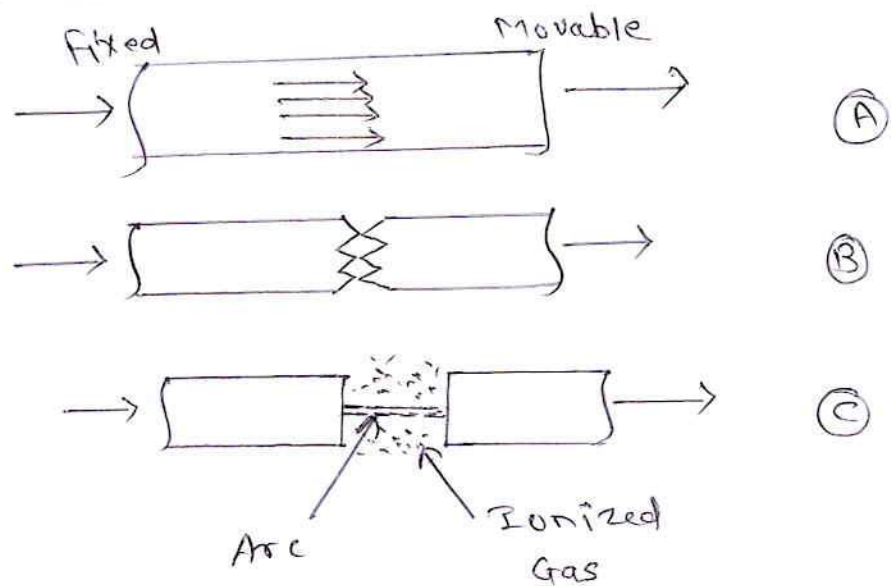
* Arc quenching - cooling & de-ionizing the arc using air, oil, vacuum & SF_6 gas

* Arc Extinguishing - CB interrupt the I_n & stop the arc.

* Arc Extinction - arc disappears completely & insulation betⁿ contact is restored.

* Arc formation process:

- The C.B. has two contacts i.e. fixed and moving contact.
- When fault occurs on the system, the C.B. is start to open.
- Moving contact get separated from the fixed
- The contact area is decreases.



- The large c/n is flows through the contacts with increasing c/n & Temp.
- The heat produce in betⁿ contacts, which is sufficient to ionized the medium between the contact.
- The ionize air act as a conductor and arc is form between the contacts.
- The potential difference betⁿ the contact is small and is sufficient to maintain the arc.
- The arc provide low resi path & circuit remains ~~unt~~ uninterrupted as long as the arc is persist.

* Methods of Arc extinction:

Mainly two factors are responsible for Arc

- i) Ionize Particals betⁿ the contact.
- ii) potential difference betⁿ the contact.

Following are the different methods for extinction of arc.

A) potential difference betⁿ the contact

B) Ionize Particals betⁿ the contacts

c) High Resistance method

- lengthening of arc by arc runner
- splitting of arc
- cooling of arc

D) Low Resistance method.

A] Potential diffⁿ betⁿ the contacts:

- When the distⁿ betⁿ separated contact is small, then the potential difference betⁿ them is sufficient to maintain the arc.
- To extinguish the arc betⁿ contact, the contact can be separated to such distance that potential difference become insufficient to maintain the arc.
- In high voltage system, this method is not practical.

B] Ionized particales betⁿ contacts:

- When the medium get ionised the arc is form. This ionised medium is maintain the arc.
- To extinguish the arc, deionise the arc path.

- This is achieved by cooling the arc or removing the ionised particles from contact space.

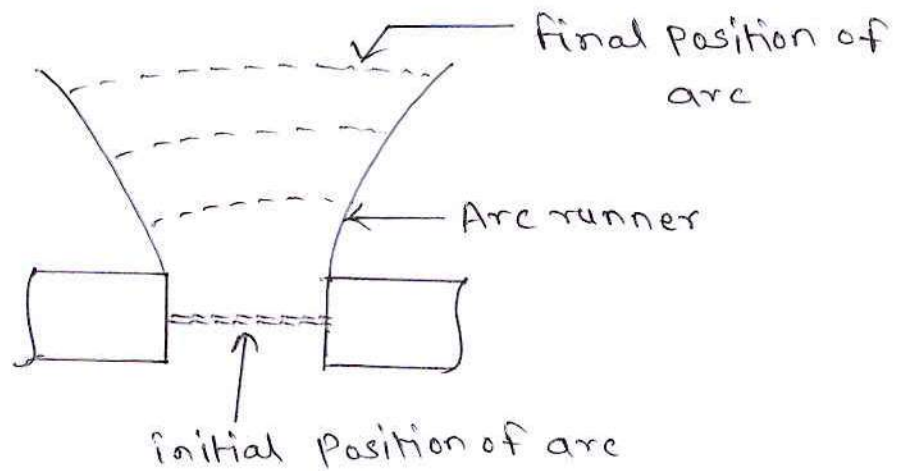
c] High Resistance Method:

- By increasing the resistance of the arc, arc interruption can be obtained.
- The resistance is given by

$$R_{arc} = \frac{V_{arc}}{I_{arc}}$$

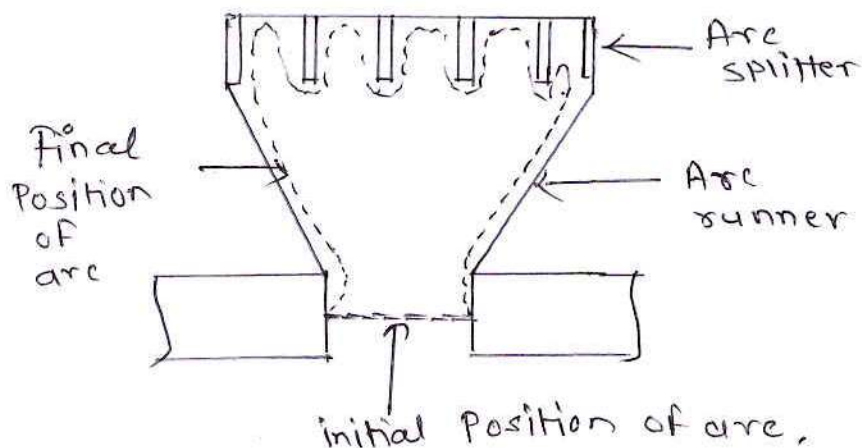
- Assuming the arc length to be constant then the resistance of arc can be increased by increasing voltage of arc.
- By increasing voltage of arc, resistance also increases.
- By increasing length of arc, arc voltage can be increased and hence arc resistance is also increased.
- Vltg of arc is increased till it becomes more than system vltg, then the arc is extinguished.
- This method is used in DC C.B. and low capacity AC C.B.
- Arc resistance is increased by
 - i) lengthening of arc
 - ii) splitting of arc
 - iii) cooling of arc.

i) lengthening of arc by arc runners:



- arc runners are blades of conducting material
- arc runner are connected to contact of C.B., in V-shape.
- Arc goes upward by electromagnetic force.
- length of arc is increased & arc get extinguish.

ii) splitting of arc:



- Arc Splitter made up of plate of resin bounded fiberglass.
- Arc splitter placed in perpendicular to the arc and arc is pulled into them by electromagnetic force.
- It get enlarged, split and cooled.

iii) cooling of the arc;

- By removing heat from the arc surface, cooling takes place.
- Cooling of the arc takes place by recombination of ionised particles.
- It develops high dielectric strength of medium betⁿ two contacts of C.B.

D] Low Resistance method or zero point extinction;

- This method is used in AC C.B.
 - As AC c/n passed through zero after every half cycle.
 - When c/n is zero, arc is extinguish for brief moment (small time).
 - Arc is restrike again with rising c/n.
 - In this method, at zero c/n instant fresh unionized medium is introduced betⁿ space of contacts.
 - Due to this unionized medium, dielectric strength of contact space increases to such extent arc does not continue after zero point.
 - If the dielectric strength is less, then the arc is reestablished.
 - In such case arc continues for next half cycle & get extinguished at next zero instant.
- Limitation: 1) Use in A.C. C.B. only. 2) Difficult to find zero crossing point 3) At c/n zero vltg is max^m, therefore chance of restriking.

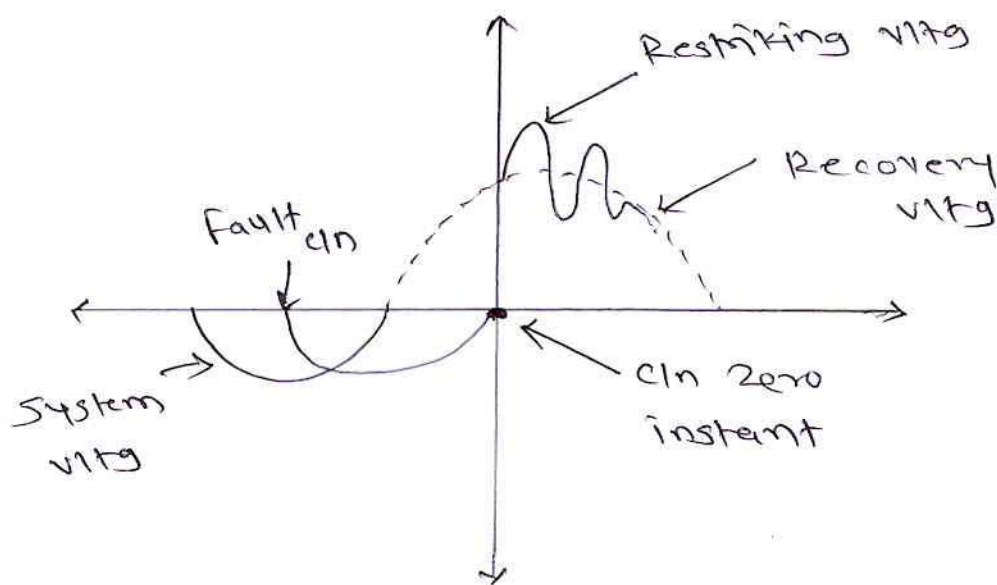
Definitions related to Arc:

1) Arc voltage:

- The vltg appear across the contact of CB during the arcing period.
- The magnitude of arc vltg. is low, except for the instant of zero pt current,
- At c/n zero position, arc voltage increases rapidly to the pick value.

2) Recovery voltage:

- It is the voltage appear across the contact of CB after final arc extinction.
- or - The normal ~~freq~~ RMS vltg that appear across the contact of C.B. after final arc extinction
- It is approximately equal to system vltg.



3) Restriking Voltage:

- It is the transient voltage that appears across the contact at current zero during arcing period.
- An interruption is dependent on restriking voltage.
- If the restriking voltage increases rapidly than the dielectric strength between contact, the arc will exist for another half cycle.

4) Rate of rise of restriking voltage (RRRV):

- The RRRV is the rate at which the transient voltage across the contact of a CB.
- The high RRRV may cause the arc to strike again

$$RRRV = \frac{\Delta V}{\Delta t}$$

ΔV = change in restriking voltage

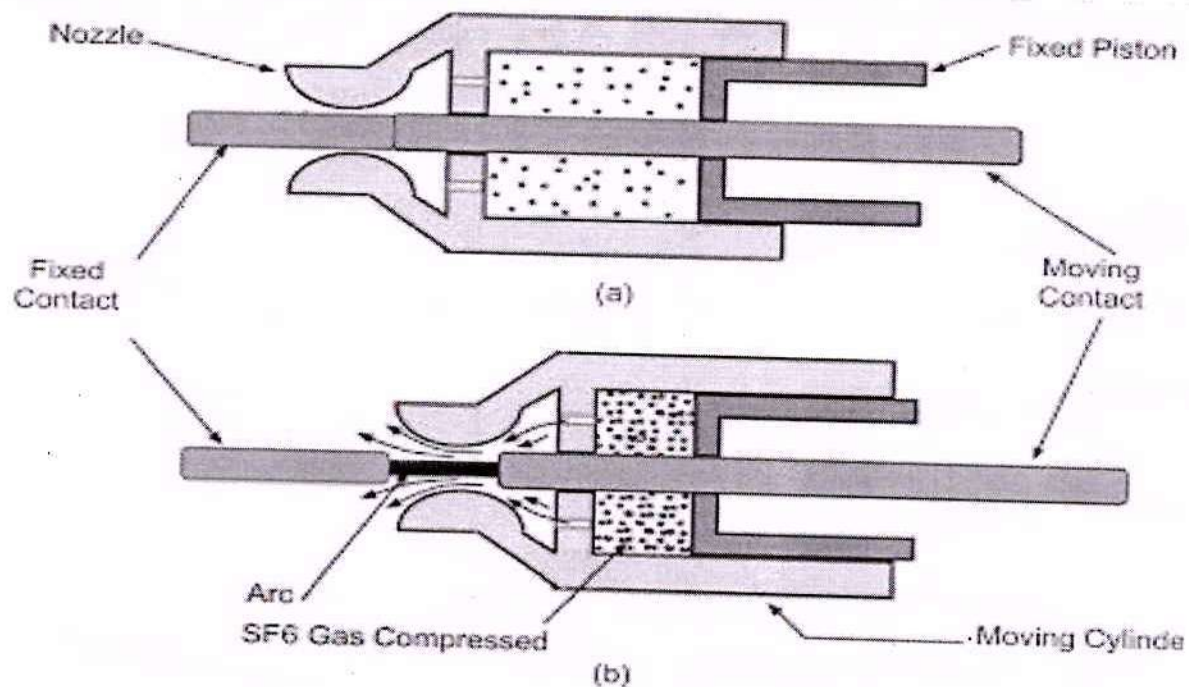
Δt = time taken for that change.

* HT circuit Breaker:

1) Sulphur-hexa fluoride (SF_6) circuit Breaker:

- SF_6 is an inert, heavy gas having good dielectric and arc extinguishing properties.
- The dielectric strength of gas increases with pressure.
- It is colourless, odourless, Non-toxic and non-inflammable gas.

Construction and working:



- This CB works on the principle of Puffer action.
- It consists of moving cylinder coupled with moving contact against fixed piston.
- Relative motion between moving cylinder & fixed piston, gas is compressed.
- This compressed gas is released through nozzle.

- This high pressure gas extinguish the arc between contact.
- The entire space between contact filled with cooled and fresh gas at current zero instant and arc get extinguish.

Advantages: 1) SF_6 CB is simple, less costly, maintenance free & compact.

- 2) Gas is inflammable, there is no danger of fire.
- 3) Requirement of gas is small.
- 4) This CB is silent & does not make sound during operation.
- 5) Ability to interrupt low & high c/n.
- 6) No over voltage problem.

Disadvantages: 1) Sealing problems arise.

- 2) Moisture in SF_6 gas is very harmful, which cause failure of operation.
- 3) SF_6 CB have low speed of operation due to friction.
- 4) Special transportation facility is required for transferring the gas & maintaining the quality of gas.

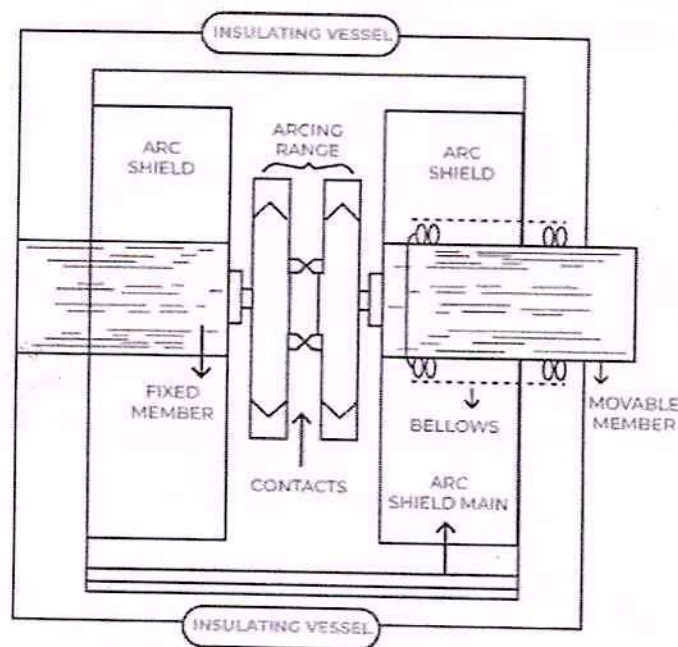
Applications: 1) used for switching & protection of transmission line at high voltage,

- 2) Electrical substations & power plants.
- 3) Gas insulated substations (GIS)
- 4) Industrial power distribution systems.
- 5) Underground & urban power networks.

* Vacuum circuit Breaker:

- Vacuum has high dielectric strength.
- It uses for arc quenching.

Construction:



- It consists of fixed & moving contact and arc shield mounted inside vacuum CB.
- Moving contact is connected to the control mechanism by bellows.
- This enables the permanent sealing of vacuum.
- Insulating vessel is used as the outer insulating glass.
- Arc shield prevents the deterioration of internal dielectric strength.

- Arcing contact open after the main contact open & arc is drawn betⁿ them.
- The arc is force upward by electromagnetic force
- Arc travel along with arc runner.
- It goes into arc splitter & split by arc splitter.
- Arc is extinguished by lengthening, splitting & cooling.

2] Miniature circuit Breaker (MCB) :

- It consist of
 - 1) Actuator Mechanism - Force the contact together or apart.
 - 2) contact - Allow c/n when touching and break c/n when move apart.
 - 3) Terminals -
 - 4) Bimetallic strip
 - 5) Magnetic coil.

construction Features:

- 1) Housing - The housing of MCB is made up of thermo plastic polyster, gray colour as per international code.
- 2) contacts - The contact made up of copper, which ensure longer life of contact, having low resistance & low power loss.
- 3) operating mechanism - It has quick make and break circuit
- 4) Mounting Arrangement : MCB are install on distribution board & control panel. Hence save time to install or removal.

Working principle:

- It based on thermal magnetic technology.
- The protection is provided by combining temp sensitive device & c/s sensitive electromagnetic device.
- MCB is design base c/s limiting technology.
- It work by wound winding around the piece of iron, this makes electromagnet,
- The bigger the c/s, stronger electromagnetic field.
- The electromagnet positioned so that it pulls a switch that can break the circuit.

3] Molded case circuit Breaker [MCCB]:

- MCCB is a protective device used to protect electrical circuit from overload, short ckt and earth fault.
- It enclosed in a strong insulating molded case.
- It consist of five main component.
 - i) Molded case or frame
 - ii) operating Mechanism
 - iii) Arc Extinguisher
 - iv) contacts
 - v) Trip units.

i) Frame:- The function of frame is to provide insulated housing to mount CB components. It prevent direct contact with CB. The size & design depends upon Specification of CB.

ii) Operating Mechanism:

- MCCB consist CB with electronic trip unit.
- It consist handle which make contact open or close also known as quick make and quick break.
- The handle position indicates the status of contact i.e. open, close or trip. When contact are trip handle is at mid position.

iii) Arc extinguisher:

- The function of arc extinguisher to quench the arc.
- It consist of steel plate, when arc is form arc move to steel plate with increase the length of arc & arc get extinguish.

iv) Trip unit:

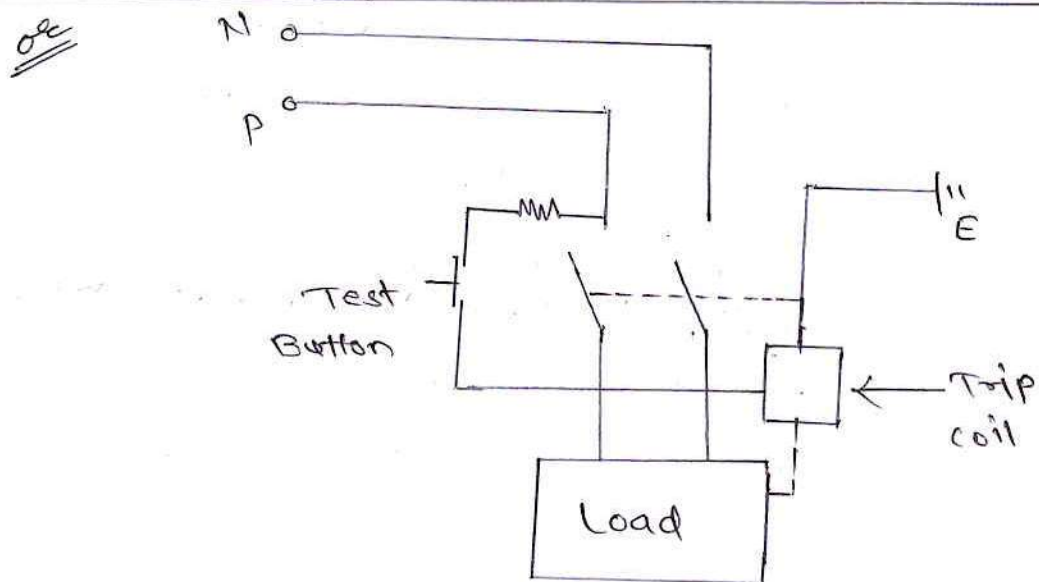
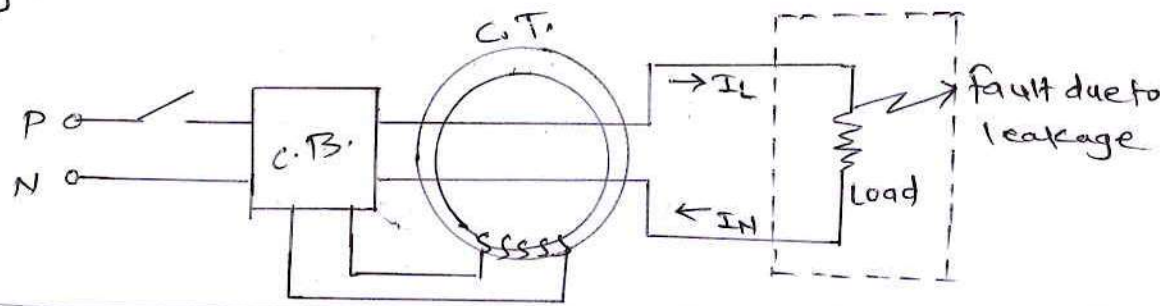
- The trip unit is brain of CB.
- The function of trip unit is to trip operating mechanism in case of short circuit.
- protection is combination of temp. sensitive device with c/n sensing electromagnetic device.
- Most MCCB utilize one or more different trip element to provide circuit protection.
- Trip element protect against thermal overload, short circuit and arcing ground fault.

* MCCB should be selected by considering

i) c/n rating ii) Breaking capacity

iii) Type of protection iv) system voltage

4] * Earth leakage circuit Breaker [ELCB]:-



- ELCB works on the principle of electrical circuit, the incoming c/n is equal to outgoing c/n.
- It consist of core balance transformer having primary winding, secondary winding & relay.
- primary winding is connected in series with supply & load.
- secondary winding connected to the sensitive relay.
- Under normal condition, magnetizing effect of c/n carrying conductor cancel each other,

- There is no residual magnetic field that induced vltg in secondary winding.
- The flow of leakage c/n in the ckt, an imbalance is created in the ckt which gives rise to leakage flux in the core.
- This leakage flux generates an electrical signal that sensed by relay & it trips & disconnect the supply.

Advantages: 1) protect against electric shock

2) prevent electrical fires

3) Fast operation

4) Improve electrical safety

5) Easy fault indication

Disadvantages:

1) Does not protect against overloads or short circuit.

2) Small leakage c/n from appliances can cause unwanted trips

3) Higher cost

4) Regular testing required.

5] Motor Protection Circuit Breaker [MPCB]:

- A MPCB is a specialized electromechanical device that combines a low-voltage CB with thermal overload relay.
- It is specially designed to safely start, stop and protect electric motors from overloads, short circuit, phase losses and voltage fluctuations.
- It is an advanced device design to protect electric motor from electric fault & overloads.
- They feature automatic reconnection and manual disconnection.
- MPCB integrated with contactors and under-voltage protectors.

Functions: 1) protect against electrical fault like S.C, L-G & L-L Fault.

2) Motor overload protection

3) protection against phase unbalances & phase loss.

4) Thermal protection

5) fault signaling

6) Automatic reconnection.

Applications: 1) Rooftop A.C., chiller, compressor

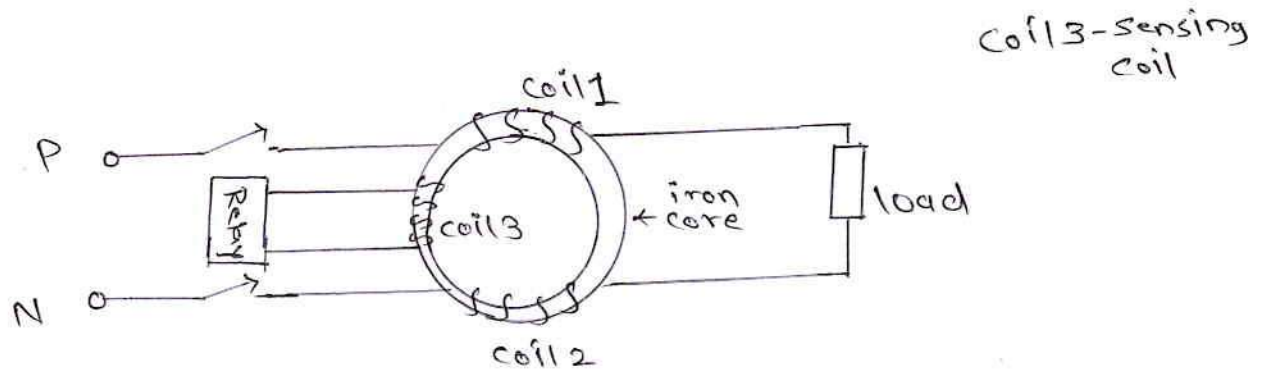
2) Water pumping system

3) Elevators

4) Industrial conveyor belt

5) Manufacturing process.

6] Residual current circuit Breaker [RCCB]:



- A RCCB is a critical electrical safety device designed to prevent electric shock and fires caused by current leakage.
- It constantly monitors the balance of electric current flowing through live and neutral wires and instantly cuts power if an imbalance is detected.
- In normal condition, the incoming c/n in the live wire must exactly equal to outgoing c/n in the neutral wire.
- The RCCB sense the difference in residual current and trips the ckt instantly.
- It consist of circular core balance current x'mer.
- coil 1 & 2 are connected in series with load. Both coil are wound in opposite way. The fluxes produced by these coils are in opposite direction.
- Relay may operated by residual c/n device.
- RCCB is actually combination of MCB and residual current device.

* Comparison

Sr. No.	Point of comparison	Fuse	Circuit Breaker
1)	function	Perform detection & interruption function.	It perform only interruption function.
2)	operation	Automatic (simple)	relay req ^d for automatic oper ⁿ (complex)
3)	Breaking capacity	Small	Very large
4)	operating time	Very small	More than fuse
5)	Replacement	req ^d after each operation	No replacement after operation
6)	space required	less	More
7)	cost	less	More
8)	Reliability	less	More
9)	safety	less	More

* Selection of LT and HT circuit Breaker:

Sr. No.	Rated Voltage	Choice of circuit Breaker
1)	Below 1 kV	ACB, VCB, SF ₆ CB
2)	3.3 kV - 33 kV	VCB, MOCB, SF ₆
3)	132 kV - 230 kV	SF ₆ , ABCB, MOCB
4)	400 kV - 760 kV	SF ₆ , ABCB

* Gas Insulated Switchgear:

* Properties of gas - Highly electronegative gas,

- high dielectric strength
- colorless, odorless & non-flammable
- better cooling characteristics
- outstanding arc quenching properties
- greater heat transfer capability

* Applications - used in HV switchgear, cables voltage stabilizer, X-ray apparatus

- used in transformer & microwave equip^{ts}
- SF₆ is used in Gas insulated substation & Gas insulated cables.

* Gas Insulated Substation: (GIS)

- It is used where space is limited, higher cost than Air insulated substation.
- compact, multi-component assembly enclosed in a ground metallic housing.
- used for vltg rating of 72.5, 145, 220 & 420 kV.

- Various equipment like CB, Bus-bar, isolator, break switches, CT, PT, earthing switches etc. housed in metal enclosed modules filled with SF_6 gas.

Advantages: 1) compact size

2) High reliability

3) low maintenance

4) High safety

5) less environmental influence

6) long service life

7) Reduced outage

8) lower Noise

9) Better appearance

Disadvantages: 1) High initial cost

2) Handling & leak prevention is required

3) complex maintenance

4) Difficult future expansion

5) special testing required

6) long repair time

* Air insulated Substation (AIS):

- An AIS is a substation in which air is used as primary insulating medium.

- The equipment is installed in open air.

- It required large space to install.

- Low cost as compare to GIS.

- AIS is generally preferred for voltage level from 11KV upto 765 KV.

- * Advantages:
- 1) low initial cost
 - 2) simple construction
 - 3) Easy maintenance
 - 4) Easy future expansion
 - 5) No leakage problem
 - 6) suitable for rural & suburban Areas

- * Disadvantages:
- 1) Required a large land area.
 - 2) performance affected by dust, moisture pollution & weather.
 - 3) Required more maintenance than GIS
 - 4) lower reliability than GIS
 - 5) less suitable for highly populated area
 - 6) Exposed to environmental condition & lightning.

Feature	GIS	AIS
1) Space required	very small	Large
2) Initial cost	High	low
3) Maintenance	low	High
4) Reliability	very High	Moderate
5) Safety	High	Moderate
6) Pollution effect	very low	High
7) Installation time	short	longer
8) Environmental impact	sf6 gas concern	No sf6 gas

* Insulation coordination:

- It is the process of selecting a suitable values of insulation level of different components & equipment in electrical system, so that the insulation can withstand expected overvoltage.
- The insulation coordination means insulation level optimization. This reduces the cost.
- In simple words, insulation coordination is selecting appropriate insulation strength.
- There are two types of coordination;
i) Type 1 & ii) Type 2
- In case where the probability of experiencing a high current short circuit is low, type one coordination is sufficient
- Type two is recommended for application where there is significant risk of high current short circuit fault.
- Type one protection is design to protect operator and equipment during short circuit fault, but after it disconnect the motor, the starting device cannot be used again, The contact inside starter device is damaged due to short ckt current.
- Repair and replacement are required.
- Type two protection is design to protect operator & equipment, and it will be working without required expensive repair and replacement.

- In majority of the cases, even if short circuit current is carried by circuit, its value is lower in LT side, Hence type 1 coordination can be used.
- But in HT side, Fault current magnitude is high, in such cases type 2 coordination is used,

* Ring Main Unit (RMU) switchgear:

- RMU is a specific type of compact, medium-voltage switchgear designed for ring-type power distribution network.
- It provide uninterrupted supply by isolating fault & maintaining service through alternate paths,

Functions of RMU:

- Protection, metering & control of power distribution.
- Switching operations (load break & fault isolation)
- Ensure continuity of supply in ring type distribution network.
- can be connected to transformer, underground cables & overhead lines,

Advantages: 1> compact size

2> Easy maintenance

3> High reliability

4> save installation time

5> Cost saving in maintenance.

* Disadvantages: 1) limited Power rating

2) Required skilled person for installation, operation & Maintenance.

3) High initial cost.

* Applications: 1) Urban & industrial distribution network

2) Renewable energy connection

3) commercial buildings, data centers and substations.

* Classification of RMU:

Based on insulation 1) Gas insulated RMU

ii) oil insulated RMU

iii) Air insulated RMU

Based on installation iv) Indoor RMU

v) outdoor RMU

i) Gas insulated RMU (SF₆ gas insulation)

- uses SF₆ gas for insulating live parts.

- Advantage: compact size, high reliability
low maintenance

- Disadvantage: Environmental concern due to SF₆

- widely used in urban & space constrained areas.

ii) oil insulated RMU

- Uses mineral or synthetic oil for insulation and arc quenching.

- Advantage: Good dielectric strength, effective cooling.

- Disadvantages: Risk of fire, leakage and environmental hazard, required maintenance
- Used in older installation or in specific industry.

iii) Air insulated RMU

- use air as insulating medium
- Advantages: Environment friendly, safe, ^{low} cost
- Disadvantages: larger size compared to GI unit,
- Used in rural or open areas where space is not constraint.

iv) Indoor RMU

- installed inside building or electrical room
- Advantages: protection from weather, dust.
- Applications: commercial complex, data center, substation & industries.

v) outdoor RMU

- designed to withstand external environmental conditions.
- enclosed in weatherproof enclosures.
- Advantages: Suitable for remote or urban roadside installations.
- Applications: street side power distribution, wind/solar farms.

Question Bank

Unit 2 - Circuit Interrupting Devices,

- 1) state any two difference between fuse and circuit Breaker.
- 2) state any two difference between Air insulated and gas insulated substation.
- 3) with the help of wave form state the terms are voltage, restriking voltage and recovery voltage related to arc extinction phenomenon.
- 4) explain the low resistance arc extinction method.
- 5) with the help of neat diagram, explain the working of SF₆ CB. state there any four advantages.
- 6) state any four factor for the selection of CB.
- 7) define Fusing Factor. What should be the value of fusing factor while selecting fuse for protection purpose.
- 8) using neat sketch explain the construction of HRC Fuse.
- 9) state and explain different methods used for Arc extinction in circuit breaker.
- 10) Distinguish between circuit breaker & isolator.
- 11) compare fuse and MCCB on size, cost, reliability and replacement strategy.

- 12) Draw neat sketch of VCB. List any two advantages and disadvantages of VCB. Write any four important constitutional features of VCB.
- 13) Define the term "Insulation Coordination".
- 14) Define the terms: arc voltage, Recovery voltage, Restriking voltage and RRRV for circuit interrupting devices.
- 15) ~~Define and~~ with neat diagram explain the operation of Horizontal break isolator.
- 16) State the principle & working of single phase ELCB with neat circuit diagram.



Subject Teacher

Mr. N.S. Borse


HOD