Lecture 03:

Circuit Breakers-II

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Air-Blast Circuit Breakers

- *Arc quenching medium (Air-Blast)*
- *Blast valve is used to in rush the air*
- *Cooling and sweep away the arcing products*
- *Rapid increase in dielectric strength of arcing path*

Advantages over an oil circuit breaker:

- *Elimination of fire risk*
- *Regular oil replacement is avoided, Arcing products are completely removed*
- *Size is small, due to high rate of dielectric strength increase, small gap of contacts required*
- *Arcing time is very small, so is the small energy of arcing*
- *Due to lesser arc energy, these are suitable for conditions where frequent operation is required*
- *Arc extinction mechanism is independent of interrupting current*

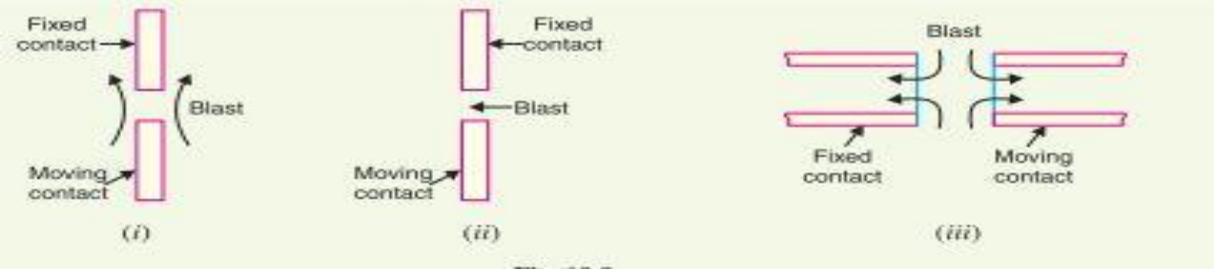
Air-Blast Circuit Breakers

Disadvantages:

- *Air has relatively inferior arc extinguishing properties*
- *Very sensitive to the rate of rise of re-striking voltage*
- *Maintenance of compressor to supply air for air blast valve*
- *Beyond a voltage level of 110kV , these breakers are used*

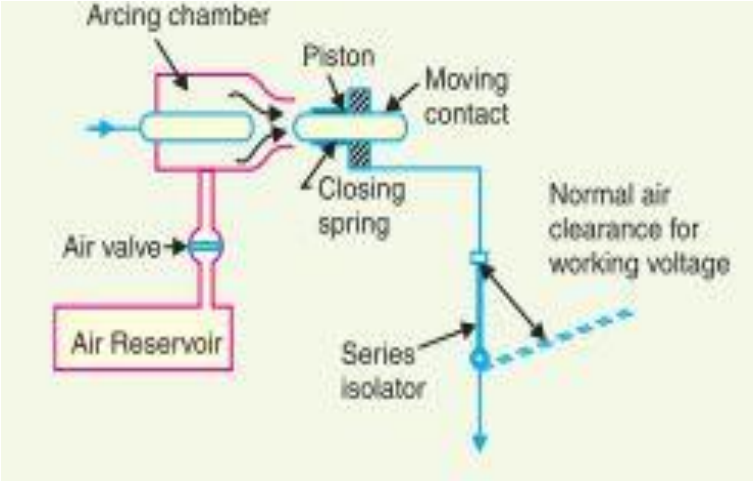
Types of air-blast circuit breakers:

(a) Axial-Blast type (b) Cross-Blast type (c) Radial-Blast type



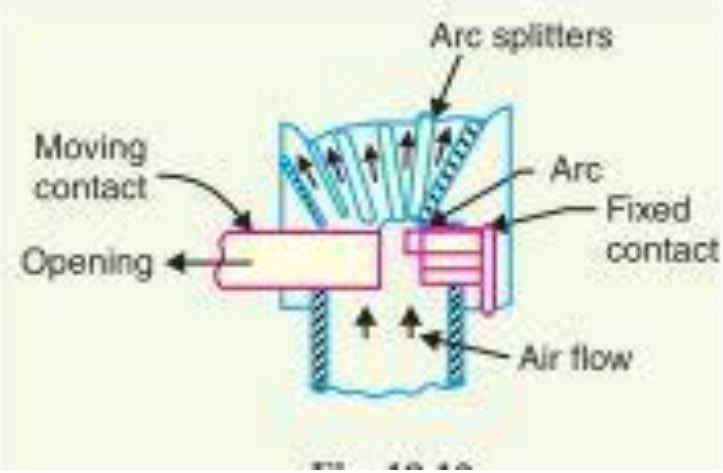
Air-Blast C.Bs: Axial-Blast C.Bs

- *Tripping impulse opens the air valve*
- *High pressure air pushes moving contact against spring pressure*
- *Contact separation is of 1.75cm for interruption to take place, so to avoid any possible current an isolating switch is installed separately, which opens immediately after fault interruption for necessary clearance of insulation.*



Air-Blast C.Bs: Cross-Blast C.Bs

- *Arc splitters and baffles to lengthen the arc*
- *Blast pressure is same for all currents*
- *Contact gap for interruption is adequate*
- *Inefficiency at low current is eliminated, so no isolating switch is required as compared to that used in Axial-Blast C.Bs*



Sulphur Hexaflouride (SF6) C.Bs

SF6 gas is used as the arc quenching medium.

- *Electro-negative gas*
- *Tendency to capture free electrons*
- *Immobile negative ions*
- *Effective for high power and high voltage service*

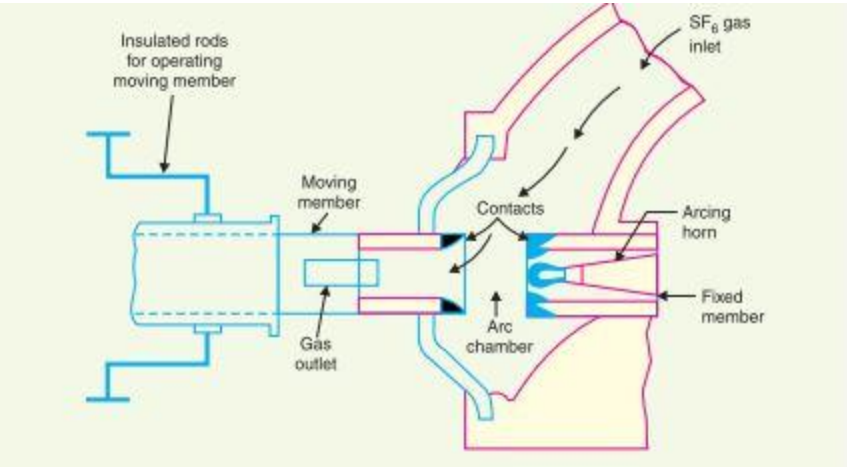
Construction:

- *Arc interruption chamber (Both contacts and SF6)*
- *Hollow current carrying fixed contact fitted with arc horn*
- *Hollow moving contact with rectangular holes to permit SF6*
- *Tips of fixed & moving contact and horns are coated with copper-tungsten arc resistant material.*
- *Reconditioning of SF6 after each operation (As it is very expensive)*

Sulphur Hexaflouride (SF6) C.Bs

Working operation:

- *Contacts surrounded by SF6 at a pressure of 2.8kg/cm3*
- *Synchronized movement of contact with opening of valve*
- *Valve allows SF6 at a pressure of 14kg/cm3 to arc interruption chamber*



Sulphur Hexaflouride (SF6) C.Bs

Advantages over oil and air circuit breakers:

- *Very short arcing time*
- *Can interrupt very current (Dielectric strength is 2 to 3 times that of air)*
- *Noiseless operation, no exhaust to atmosphere*
- *Closed gas enclosure keeps out the moisture*
- *No risk of fire, SF6 is non-flammable*
- *No carbon deposits, so no tracking or insulation problem*
- *Low maintenance, light foundation requirement, minimum auxiliary equipment*
- *Very suitable where explosion hazard exists e.g. coal mines*

Disadvantages:

- *Costly SF6*
- *Requires reconditioning of SF6 after every operation*
- *60kA, 50-80kV, 115kV to 230kV, 10MVA to 20MVA, interrupt in less than 3 cycles.*

Vacuum Circuit Breakers

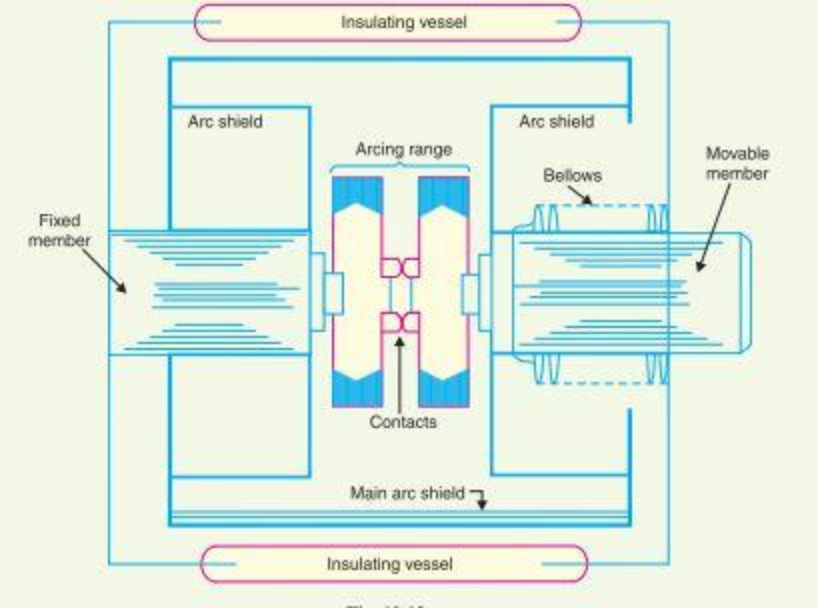
- *Degree of vacuum is of order of (10^-7 to 10^-5 Torr)*
- *Highest degree of insulation strength*
- *Interruption of current occurs at first current zero*
- *Dielectric strength builds up thousand times that of any other C.B*
- *Arc is produced due to ionization of metal vapors*
- *Rapid condensing of electrons and ions produced on C.B contacts results in rapid recovery of dielectric strength in vacuum*
- *Contact separation for arc extinction is 0.625cm in vacuum C.B*

Applications:

- *Outdoor applications ranging from 22kV to 66kV*
- *More suitable for remote and rural areas*
- *Power range for (60-100)MVA*

Vacuum Circuit Breakers

- *Compact, reliable, long life*
- *No fire hazard*
- *No gas generation*
- *Can interrupt any fault current*
- *Noiseless and little maintenance*
- *Low arc energy*
- *Withstands lightening surges*
- *Low inertia, requires less power for control mechanism*



The outstanding feature of VCBs is that it can break any heavy fault current perfectly just before the contacts reach the definite open position.

Switchgear Components

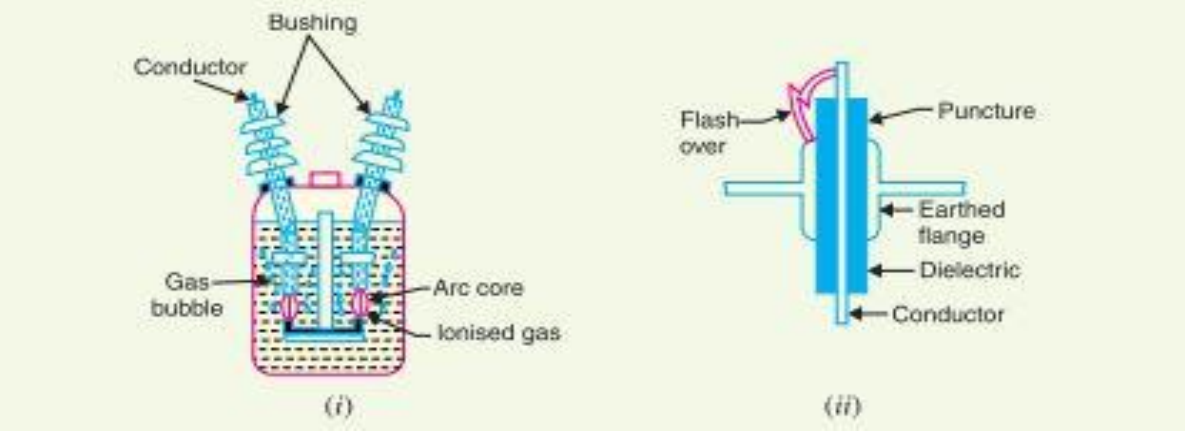
The following are some important components common to most of the circuit breakers:

- *Bushings*
- *Circuit breaker contacts*
- *Instrument transformers*
- *Bus-bars and conductors*

Switchgear Components: Bushings

The primary function of bushings is to prevent electrical breakdown between the enclosed conductor and the surrounding earthed metal work.

- *High voltage conductor passes through the bushings (made up of porcelain or steatite)*
- *Failure of bushings (i.e. Puncture of bushings and flash-over)*

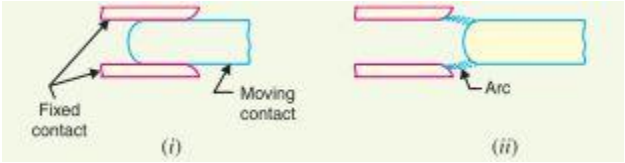


Switchgear Components: C.B Contacts

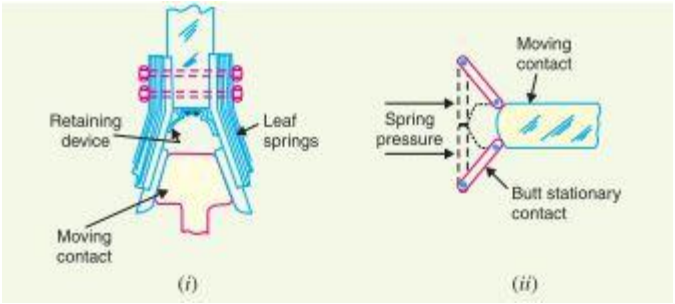
- *Should be able to carry normal and short circuit current*
- *Temperature and voltage drop must be within permissible limits*
- *Melting and vaporization by heat of arc and also due to EM forces*

There are following three types of C.B contacts:

- *Tulip type contacts (arc is confined to the region which are not in contact in fully engaged position)*



- *Finger and wedge contacts (used in low voltage OCB)*
- *Butt contacts*



Switchgear Components:
Instrument Transformers

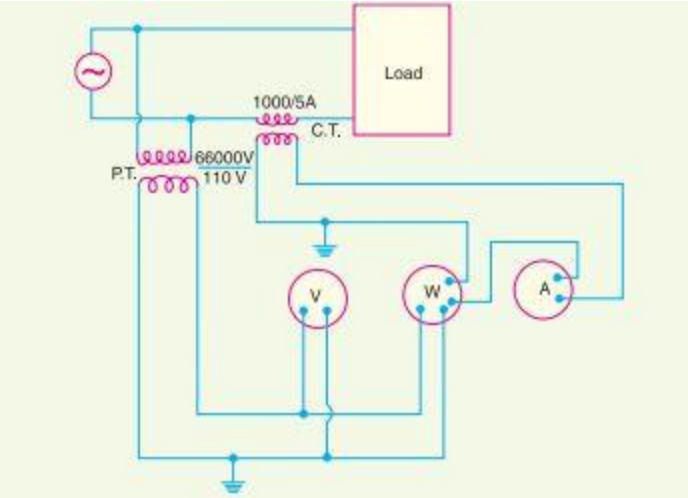
- *Current Transformer (C.T)*
- *Potential Transformer (P.T)*

The primary of these transformers is connected to power line and secondary provide current/voltage for the instruments and relays.

Followings are the advantages of instrument transformer:

- *Isolation of measuring instruments and relays from high-voltage power circuits*
- *At secondary of these transformers small size of wires and minimum insulation is required*

Switchgear Components:
Instrument Transformers



Switchgear Components: Bus-Bars and Conductors

- *For indoor switchgear the C.B are connected to Bus-Bars*
- *For outdoor switchgear the C.B are connected to overhead line conductors*

Circuit Breaker Ratings

Under fault conditions, a circuit breaker is required to perform the following duties:

- *Opening faulty circuit and breaking the fault current*
- *Capable of being closed on to a fault*
- *It must carry the fault current while another C.B (in series) is clearing the fault*

In view of the above duties the C.B have three types of ratings:

- *Breaking capacity*
- *Making capacity*
- *Short-time capacity*

Circuit Breaker Ratings

Breaking Capacity:

It is current (r.m.s) that a circuit breaker is capable of breaking at given recovery voltage under specified conditions (e.g. power factor, rate of rise of re-striking voltage).

Making Capacity:

The peak value of current (including d.c. component) during the first cycle of current wave after the closure of the C.B is known as making capacity.

Short-time rating:

It is the period for which the circuit breaker is able to carry fault current while remaining closed.

Normal current rating:

It is the r.m.s value of current which the C.B is capable of carrying continuously at its rated frequency under specified conditions.

Thank you !

For any query you can contact me through class group on Whatsapp or can call on my cell number from 10:00 AM to 04:00 PM.