UNIT 5
Apparatus Protection and Circuit Breakers

1.1 Three Phase generator or Alternator Protection

A generator is a most important and costely equipment in the power system. As it is accompanied by prime mover, excitation syatem, voltage regulator, cooling system, etc. Its protection becomes very complex and elaborate. It is subjected to more types of troubles than any other equipment. A modern generating set is generally provided with the following the following protective schemes

1. Stator protection
    - Percentage differential protection
    - Protection against stator inter-turn faults
    - Stator-overheating protection
2. Rotor Protection
    - Field ground fault protection
    - Loss of excitation protection
    - Protection against rotor overheating because of unbalanced three phase stator currents
3. Miscellaneous
    - Overvoltage protection
    - Overspeed protection
    - Protection against motoring
    - Protection against vibration
    - Bearing-overheating protection
    - Protection against auxiliary failure
    - Protection against voltage regulator failure

But before going ahead it is required for us to know about the faults generally occur in Alternators.

1.12 Types of Faults in an Alternator

An Alternator is vulnerable to many types of faults. Each of these faults can cause major damage which can be expensive to rectify and result in loss of generation.

The common faults are

- Stator Faults
- Rotor Faults
- Operational Faults

Stator Faults

Stator faults are those which occur on the stator of the Alternator. These faults can be categorized into

- Phase-to-Phase Faults which occur between two phases
- Phase-to-Earth faults which occur between a phase and the ground and
- Inter-turn Faults which occur between the turns of a winding of the same phase. Stator faults occur due to failure of the winding insulation. The heat generated by these faults can cause serious damage to the laminated core of the Stator. This may require expensive re-insulation and rebuilding.

Rotor faults

Rotor Faults on the Alternator when the rotor winding gets grounded or short circuited. The rotor winding is usually ungrounded; hence the first earth fault is not always obvious. However, if a second earth fault occurs on the rotor, the fault becomes a virtual short-circuit through the rotor body.

Operational Faults are

Overloading: Overloading causes the flow of high currents which causes the stator winding to heat up.

Reverse Power: This occurs due to failure of the prime mover and insufficient torque supplied to the generator.

Under excitation: Under excitation occurs when the excitation to the generator is cut off and the Power factor goes to the leading side. This can lead to the failure of the diodes on the rotor and pole slipping.

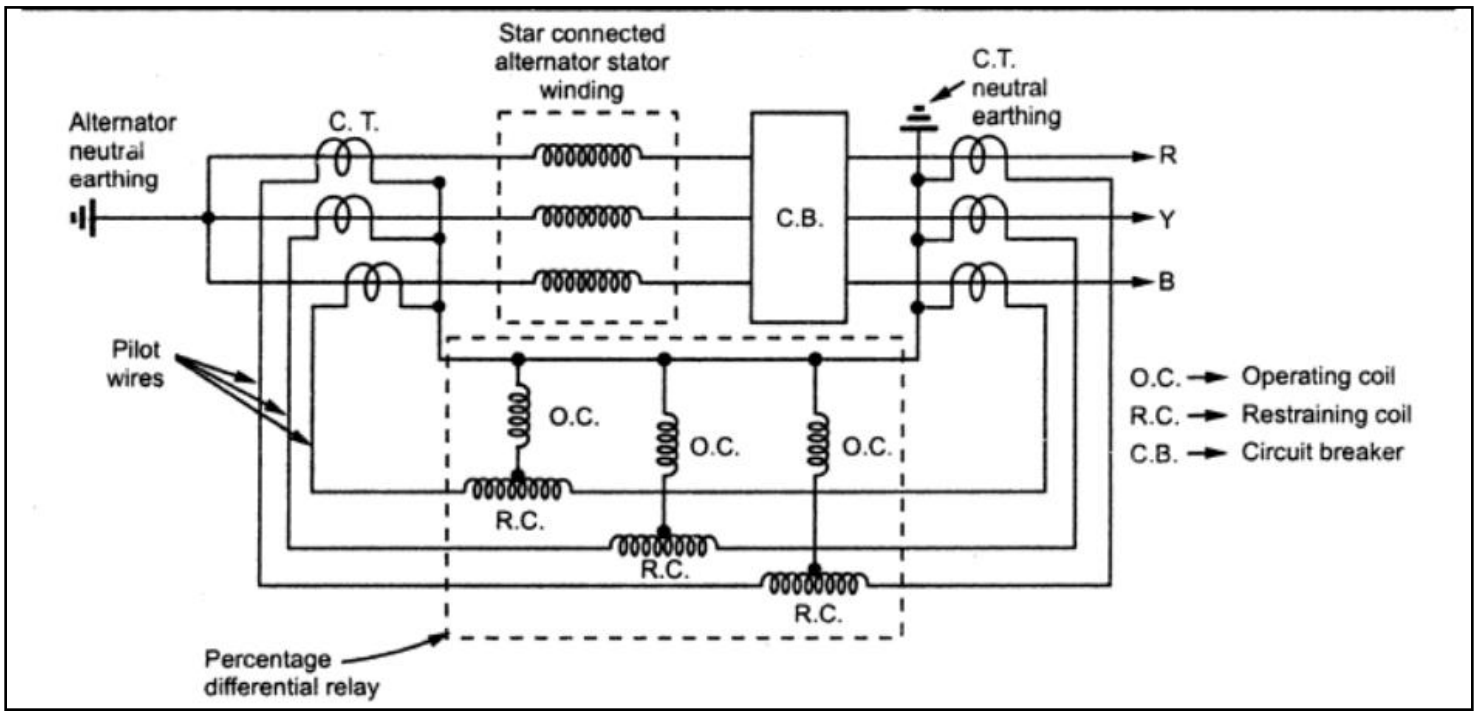
Negative Phase Sequence: Negative Phase sequence occurs when the Alternator is loaded in an unbalanced manner. That is, the current on the three phases are not balanced. This results in heating of the Alternator rotor.

Overvoltage: Overvoltage occurs due to failure of the excitation control system. If the excitation input to the alternator does not match the voltage. It can result in the voltage rising above normal levels and the risk of the winding insulation getting damaged.

Over speeding: Over speeding is an extremely serious and dangerous condition. This occurs when the speed controller regulating the speed of the prime mover fails. When the speed of the alternator rises above the nominal speed, the centrifugal forces developed within the Alternator are so enormous that the poles of a salient pole rotor can get damaged and can come out of the rotor. This can then hit the stator and the alternator will be severely damaged.

1.13 Merz-price Protection of Generator or Alternator

This is the most commonly used scheme for the stator windings. The scheme is also called biased differential protection and percentage differential protection.



In this method the currents at the two ends of the protected section are sensed using current transformer secondary are called pilot wires.

Under normal condition, when there is no fault in the windings, the current in the pilot wires fed from C.T. secondary are equal. The differential current $i_1 - i_2$ through the operating coil of the relay is zero hence the relay is inoperative and system is said to be balanced.

When the fault occurs inside the protected section of the stator windings, the differential current $i_1 - i_2$ flows through the operating coil of the relay. Due to the current, the relay

operates. This trips the generator circuit breaker to isolate the faulty section. The field is also disconnected and is discharged through a suitable impedance.

3.1 SF_6 Circuit Breaker

A circuit breaker in which the current carrying contacts operate in sulphur hexafluoride or SF_6 gas is known as an SF_6 Circuit Breaker.

SF_6 has excellent insulating property. SF_6 has high electro-negativity. That means it has high affinity of absorbing free electron. Whenever a free electron collides with the SF_6 gas molecule, it is absorbed by that gas molecule and forms a negative ion. The attachment of electron with SF_6 gas molecules may occur in two different ways,

$$SF_6 + e = SF_6^-$$
$$SF_6 + e = SF_5^- + F$$

These negative ions obviously much heavier than a free electron and therefore over all mobility of the charged particle in the SF_6 gas is much less as compared other common gases. We know that mobility of charged particle is majorly responsible for conducting current through a gas.

Hence, for heavier and less mobile charged particles in SF_6 gas, it acquires very high dielectric strength. Not only the gas has a good dielectric strength but also it has the unique property of fast recombination after the source energizing the spark is removed. The gas has also very good heat transfer property. Due to its low gaseous viscosity (because of less molecular mobility) SF_6 gas can efficiently transfer heat by convection. So due to its high dielectric strength and high cooling effect SF_6 gas is approximately 100 times more effective arc quenching media than air. Due to these unique properties of this gas **SF_6 circuit breaker** is used in complete range of medium voltage and high voltage electrical power system. These circuit breakers are available for the voltage ranges from 33KV to 800KV and even more.

Sulphur Hexafluoride symbolically written as SF_6 is a gas which satisfy the requirements of an ideal arc interrupting medium. So SF_6 is extensively used these days as an arc interrupting medium in circuit breakers ranging from 3 kv upto 765 kv class. In addition to this SF_6 is used in many electrical equipments for insulation. Here first we discuss in brief, some of the essential properties of SF_6 which is the reason of it's extensive use in circuit breakers

- SF_6 gas has high dielectric strength which is the most important quality of a material for use in electrical equipments and in particular for breaker it is one of the most desired properties. Moreover it has high Rate of Rise of dielectric strength after arc extinction. This characteristics is very much sought for a circuit breaker to avoid restriking.
- SF_6 is colour less, odour less and non toxic gas.
- SF_6 is an inert gas. So in normal operating condition the metallic parts in contact with the gas are not corroded. This ensures the life of the breaker and reduces the need for maintenance.
- SF_6 has high thermal conductivity which means the heat dissipation capacity is more. This implies greater current carrying capacity when surrounded by SF_6 .
- The gas is quite stable. However it disintegrates to other fluorides of Sulphur in the presence of arc. but after the extinction of the arc the SF_6 gas is reformed from the decomposition.
- SF_6 being non-flammable so there is no risk of fire hazard and explosion.

Disadvantages of SF_6 CB

The SF_6 gas is identified as a greenhouse gas, safety regulation are being introduced in many countries in order to prevent its release into atmosphere. Puffer type design of SF_6 CB needs a high mechanical energy which is almost five times greater than that of oil circuit breaker.

Types of SF_6 Circuit Breaker

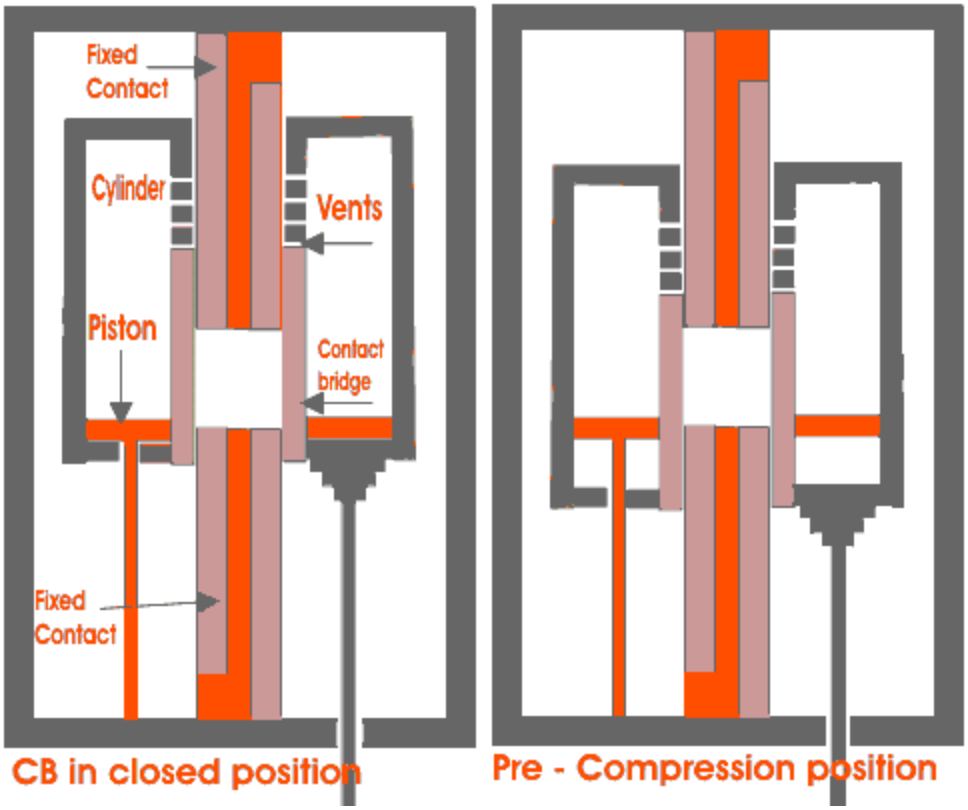
There are mainly three types of SF_6 CB depending upon the voltage level of application-

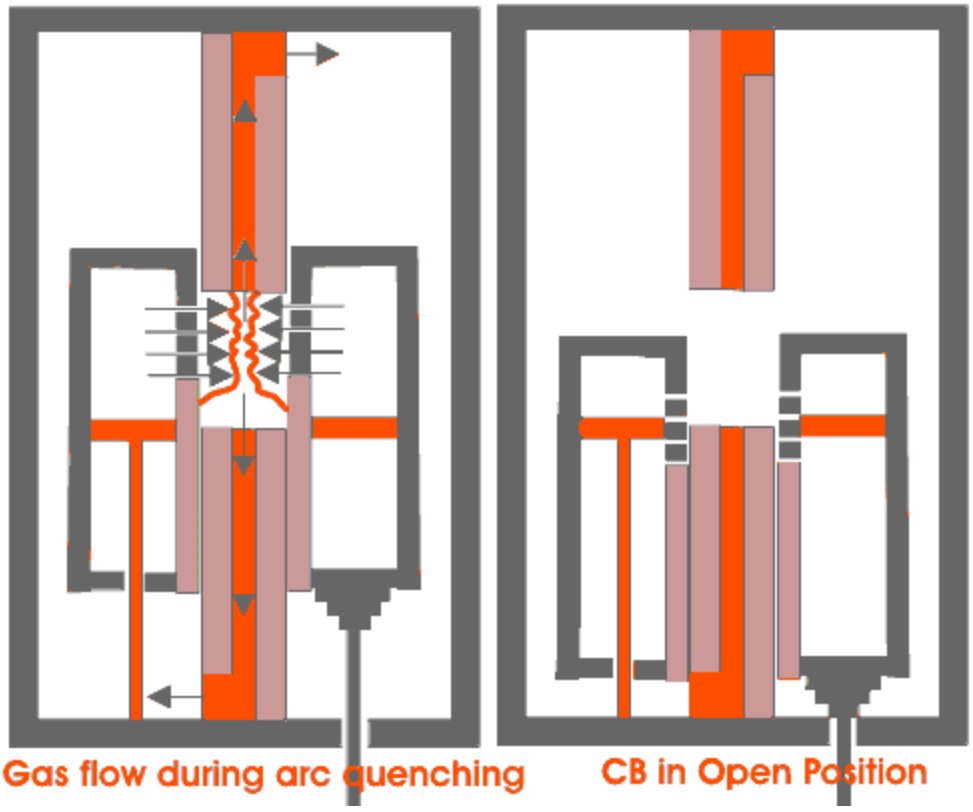
1. Single interrupter SF_6 CB applied for up to 245 KV(220 KV) system.
2. Two interrupter SF_6 CB applied for up to 420 KV(400 KV) system.
3. Four interrupter SF_6 CB applied for up to 800 KV(715 KV) system.

Working of SF_6 Circuit Breaker

The working of SF_6 CB of first generation was quite simple it is some extent similar to air blast circuit breaker. Here SF_6 gas was compressed and stored in a high pressure reservoir. During operation of SF_6circuit breaker this highly compressed gas is released through the arc in breaker and collected to relatively low pressure reservoir and then it pumped back to the high

pressure reservoir for re utilize. The working of SF_6 circuit breaker is little bit different in modern time. Innovation of puffer type design makes operation of SF_6 CB much easier. In buffer type design, the arc energy is utilized to develop pressure in the arcing chamber for arc quenching.





Here the breaker is filled with SF_6 gas at rated pressure. There are two fixed contact fitted with a specific contact gap. A sliding cylinder bridges these to fixed contacts. The cylinder can axially slide upward and downward along the contacts. There is one stationary piston inside the cylinder which is fixed with other stationary parts of the SF_6 circuit breaker, in such a way that it cannot change its position during the movement of the cylinder. As the piston is fixed and cylinder is movable or sliding, the internal volume of the cylinder changes when the cylinder slides.

During opening of the breaker

the cylinder moves downwards against position of the fixed piston hence the volume inside the cylinder is reduced which produces compressed SF_6 gas inside the cylinder. The cylinder has numbers of side vents which were blocked by upper fixed contact body during closed position. As the cylinder move further downwards, these vent openings cross the upper fixed contact, and become unblocked and then compressed SF_6 gas inside the cylinder will come out through this vents in high speed towards the arc and passes through the axial hole of the both fixed contacts. The arc is quenched during this flow of SF_6 gas.

During closing of the circuit breaker

the sliding cylinder moves upwards and as the position of piston remains at fixed height, the volume of the cylinder increases which introduces low pressure inside the cylinder compared to the surrounding. Due to this pressure difference SF_6 gas from surrounding will try to enter in the cylinder. The higher pressure gas will come through the axial hole of both fixed contact and enters into cylinder via vent and during this flow; the gas will quench the arc.

4.1 Oil Circuit Breaker

Mineral oil has better insulating property than air. In oil circuit breaker the fixed contact and moving contact are immerged inside the insulating oil. Whenever there is a separation of current carrying contacts in the oil, the arc in circuit breaker is initialized at the moment of separation of contacts, and due to this arc the oil is vaporized and decomposed in mostly hydrogen gas and ultimately creates a hydrogen bubble around the arc. This highly compressed gas bubble around the arc prevents re-striking of the arc after current reaches zero crossing of the cycle. The oil circuit breaker is the one of the oldest type of circuit breakers.

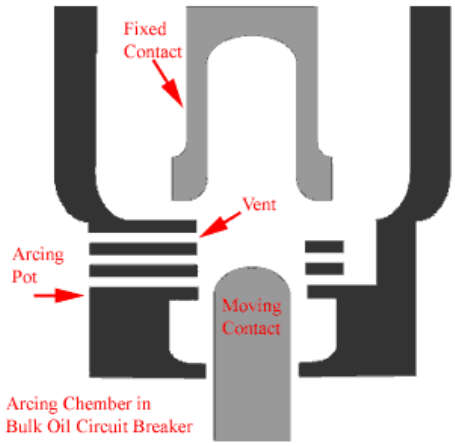
Operation of Oil Circuit Breaker

The operation of oil circuit breaker is quite simple let's have a discussion. When the current carrying contacts in the oil are separated an arc is established in between the separated contacts. Actually, when separation of contacts has just started, distance between the current contacts is small as a result thevoltage gradient between contacts becomes high. This high voltage gradient between the contacts ionized the oil and consequently initiates arcing between the contacts. This arc will produce a large amount of heat in surrounding oil and vaporizes the oil and decomposes the oil in mostly hydrogen and a small amount of methane, ethylene and acetylene. The hydrogen gas can not remain in molecular form and its is broken into its atomic form releasing lot of heat. The arc temperature may reach up to 5000° K. Due to this high temperature the gas is liberated surround the arc very rapidly and forms an excessively fast growing gas bubble around the arc. It is found that the mixture of gases occupies a volume about one thousand times that of the oil decomposed. From this figure we can assume how fast the gas bubble around the arc will grow in size. If this growing gas bubble around the arc is compressed by any means then rate of de –ionization process of ionized gaseous media in between the contacts will accelerate which rapidly increase the dielectric strength between the contacts and consequently the arc will be quenched at zero crossing of the current cycle. This is the basic operation of oil circuit breaker. In addition to that cooling effect of hydrogen gas surround the arc path also helps, the quick arc quenching in oil circuit breaker.

Types of Oil Circuit Breakers

There are mainly two **types of oil circuit breakers** available-

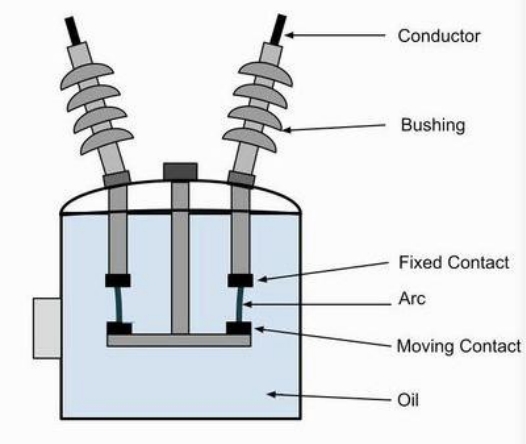
- **Single Break Bulk Oil Circuit Breaker**



In single break bulk oil circuit breaker there is one pair of current carrying contacts for each phase of power circuit. The each pair of current carrying contacts in this bulk oil circuit breaker consists of one fixed contact and one moving contact. Fixed contact is stationary contact and moving contact moves away from fixed contact during opening of the circuit breaker. As the moving contact is being moved away from fixed contact the arc is produced in between the contacts and it is extinguished during zero crossing of the fault current.

- **Double Break Bulk Oil Circuit Breaker**

Various improvements in the design of bulk oil circuit breaker have been suggested to satisfactory and safe arc interruption especially at currents below the rated maximum. One solution to this problem is to use an intermediate contact between tow current carrying contacts. The arc is here split into two parts in series. The aim here is to extinguish the second arc quickly by using the gas pressure and oil momentum due to the first arc. In double break bulk oil circuit breaker, there are two fixed contact and are bridged by one moving contact. The moving contact is fitted with driving mechanism of the oil circuit breaker by means of an insulated rod. As the moving contact bridge moves downwards the contact gaps are created with fixed contacts at both end of the intermediate moving contact bridge. Hence arcs are produced at both contacts gap.



- **Bulk Oil Circuit Breaker or BOCB**

Bulk oil circuit breaker or BOCB is such types of circuit breakers where oil is used as arc quenching media as well as insulating media between current carrying contacts and earthed parts of the breaker. The oil used here is same as transformer insulating oil.

- **Minimum Oil Circuit Breaker or MOCB**

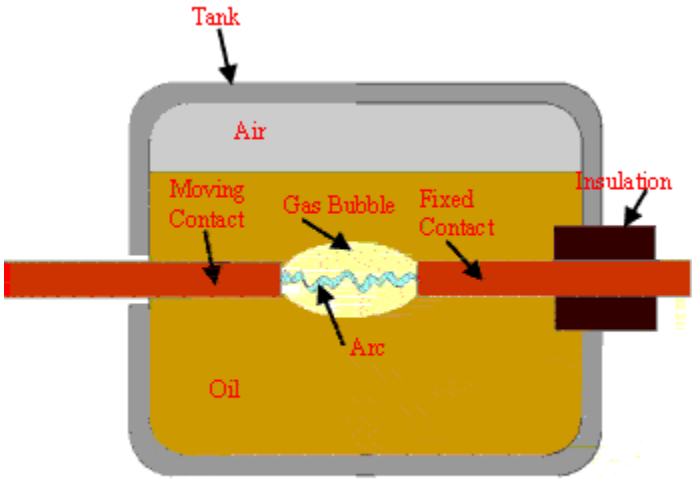
These types of circuit breakers utilize oil as the interrupting media. However, unlike bulk oil circuit breaker, a minimum oil circuit breaker places the interrupting unit in insulating chamber at live potential. The insulating oil is available only in interrupting chamber. The features of designing MOCB are to reduce requirement of oil, and hence these breaker are called minimum oil circuit breaker**.**

Construction of Oil Circuit Breaker

The basic construction of bulk oil circuit breaker is quite simple. Here all moving contacts and fixed contacts are immerged in oil inside closed iron vessel or iron tank. Whenever the current carrying contacts are being open within the oil the arc is produced in between the

separated contacts. The large energy will be dissipated from the arc in oil which vaporizes the oil as well as decomposes it. Because of that a large gaseous pressure is developed inside the oil which tries to displace the liquid oil from surrounding of the contacts. The inner wall of the oil tank has to withstand this large pressure of the displaced oil. Thus the oil tank of bulk oil circuit breaker has to be sufficiently strong in construction. An air cushion is necessary between the oil surface and tank roof to accommodate the displaced oil when gas forms around the arc. That is why the oil tank is not totally filled up with oil it is filled up to certain level above which the air is tight in the tank. The breaker tank top cover should be securely bolted on the tank body and total breaker must be properly locked with foundation otherwise it may jump out during interruption of high fault current. In these type of equipment where expansible oil is enclosed in an air tight vessel (oil tank) there must be a gas vent fitted on the tank cover. Naturally some form of gas vent always is provided on the cover of bulk oil circuit breaker tank. This is very basic features for construction of bulk oil circuit breaker.

Arc Quenching in Bulk Oil Circuit Breaker



Conceptual view of Bulk Oil Circuit Breaker

When the current carrying contacts in the oil are separated an arc is established in between the separated contacts. This arc will produce rapidly growing gas bubble around the arc. As the moving contact move away from fixed contact the length of arc is increased as a result the resistance of the arc increases. The increased resistance causes lowering the temperature and hence reducing the formation of gasses surround the arc. The arc quenching in bulk oil circuit breaker takes place when current passes through zero crossing. If we go through the arc quenching phenomenon more thoroughly we will find many other factors effects the arc quenching in bulk oil circuit breaker. As the gas bubble is enclosed by the oil inside the totally air

tight vessel, the oil surround it will apply high pressure on the bubble, which results highly compressed gas around the arc. As the pressure is increased the de – ionization of gas increases which helps the arc quenching. The cooling effect of hydrogen gas also helps in arc quenching in oil circuit breaker.

5.1 Vacuum Circuit Breaker

A vacuum circuit breaker is such kind of circuit breaker where the arc quenching takes place in vacuum. The technology is suitable for mainly medium voltage application. For higher voltage vacuum technology has been developed but not commercially viable. The operation of opening and closing of current carrying contacts and associated arc interruption take place in a vacuum chamber in the breaker which is called vacuum interrupter. The vacuum interrupter consists of a steel arc chamber in the centre symmetrically arranged ceramic insulators. The vacuum pressure inside a vacuum interrupter is normally maintained at 10^{-6} bar.

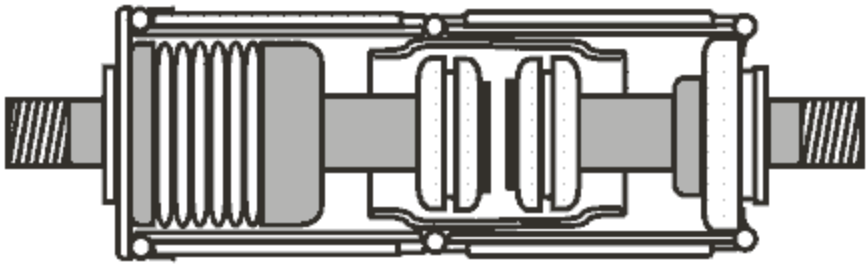
The material used for current carrying contacts plays an important role in the performance of the vacuum circuit breaker**.** CuCr is the most ideal material to make VCB contacts. Vacuum interrupter technology was first introduced in the year of 1960. But still it is a developing technology. As time goes on, the size of the vacuum interrupter is being reducing from its early 1960's size due to different technical developments in this field of engineering. The contact geometry is also improving with time, from butt contact of early days it gradually changes to spiral shape, cup shape and axial magnetic field contact. The vacuum circuit breaker is today recognized as most reliable current interruption technology for medium voltage switchgear. It requires minimum maintenance compared to other circuit breaker technologies.

Advantages of Vacuum Circuit Breaker or VCB

Service life of vacuum circuit breaker is much longer than other types of circuit breakers. There is no chance of fire hazard as oil circuit breaker. It is much environment friendly than SF_6 Circuit breaker. Beside of that contraction of VCB is much user friendly. Replacement of vacuum interrupter (VI) is much convenient.

Operation of Vacuum Circuit Breaker

The main aim of any circuit breaker is to quench arc during current zero crossing, by establishing high dielectric strength in between the contacts so that reestablishment of arc after current zero becomes impossible. The dielectric strength of vacuum is eight times greater than that of air and four times greater than that of SF_6 gas. This high dielectric strength makes it possible to quench a vacuum arc within very small contact gap. For short contact gap, low contact mass and no compression of medium the drive energy required in vacuum circuit breaker is minimum. When two face to face contact areas are just being separated to each other, they do not be separated instantly, contact area on the contact face is being reduced and ultimately comes to a point and then they are finally de-touched. Although this happens in a fraction of micro second but it is the fact. At this instant of de-touching of contacts in a vacuum, the currentthrough the contacts concentrated on that last contact point on the contact surface and makes a hot spot. As it is vacuum, the metal on the contact surface is easily vaporized due to that hot spot and create a conducting media for arc path. Then the arc will be initiated and continued until the next current zero.At current zero this vacuum arc is extinguished and the conducting metal vapor is re-condensed on the contact surface. At this point, the contacts are already separated hence there is no question of re-vaporization of contact surface, for next cycle of current. That means, the arc cannot be reestablished again. In this way vacuum circuit breaker prevents the reestablishment of arc by producing high dielectric strength in the contact gap after current zero.



Cross section of Vacuum Interrupter

There are two types of arc shapes. For interrupting current up to 10 kA, the arc remains diffused and the form of vapor discharge and cover the entire contact surface. Above 10 kA the diffused arc is constricted considerably by its own magnetic field and it contracts. The phenomenon gives rise over heating of contact at its center. In order to prevent this, the design of the contacts should be such that the arc does not remain stationary but keeps travelling by its own magnetic field. Specially designed contact shape of vacuum circuit breaker make the constricted

stationary arc travel along the surface of the contacts, thereby causing minimum and uniform contact erosion.

6.1 Air Circuit Breaker

This type of circuit breakers, is those kind of circuit breaker which operates in air at atmospheric pressure. After development of oil circuit breaker, the medium voltage air circuit breaker (ACB) is replaced completely by oil circuit breaker in different countries.

Working Principle of Air Circuit Breaker

The working principle of this breaker is rather different from those in any other types of circuit breakers. The main aim of all kind of circuit breaker is to prevent the reestablishment of arcing after current zero by creating a situation where in the contact gap will withstand the system recovery voltage. The air circuit breaker does the same but in different manner. For interrupting arc it creates an arc voltage in excess of the supply voltage. Arc voltage is defined as the minimum voltage required maintaining the arc. This circuit breaker increases the arc voltage by mainly three different ways,

1. It may increase the arc voltage by cooling the arc plasma. As the temperature of arc plasma is decreased, the mobility of the particle in arc plasma is reduced, hence more voltage gradient is required to maintain the arc.
2. It may increase the arc voltage by lengthening the arc path. As the length of arc path is increased, there resistance of the path is increased, and hence to maintain the same arc current more voltage is required to be applied across the arc path. That means arc voltage is increased.
3. Splitting up the arc into a number of series arcs also increases the arc voltage.

Types of ACB

There are mainly two types of ACB are available.

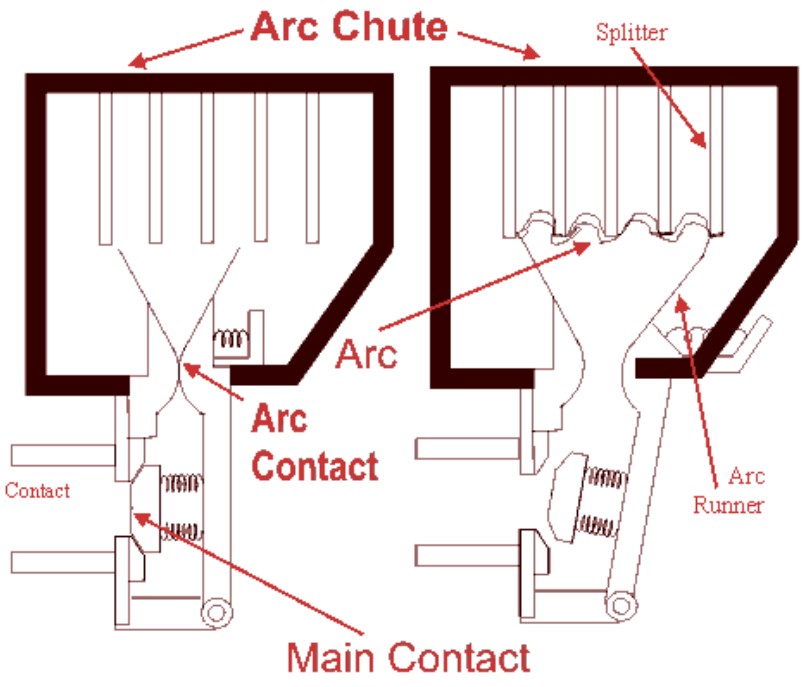
1. Plain air circuit breaker.
2. Air blast Circuit Breaker.

Operation of ACB

The first objective is usually achieved by forcing the arc into contact with as large an area as possible of insulating material. Every air circuit breaker is fitted with a chamber surrounding the contact. This chamber is called 'arc chute'. The arc is driven into it. If inside of the arc chute is suitably shaped, and if the arc can be made conform to the shape, the arc chute wall will help to achieve cooling. This type of arc chute should be made from some kind of refractory material. High temperature plastics reinforced with glass fiber and ceramics are preferable materials for making arc chute.

The second objective that is lengthening the arc path, is achieved concurrently with fist objective. If the inner walls of the arc chute is shaped in such a way that the arc is not only forced into close proximity with it but also driven into a serpentine channel projected on the arc chute wall. The lengthening of the arc path increases the arc resistance.

The third technique is achieved by using metal arc slitter inside the arc chute. The main arc chute is divided into numbers of small compartments by using metallic separation plates. These metallic separation plates are actually the arc splitters and each of the small compartments behaves as individual mini arc chute. In this system the initial arc is split into a number of series arcs, each of which will have its won mini arc chute. So each of the split arcs has its won cooling and lengthening effect due to its won mini arc chute and hence individual split arc voltage becomes high. These collectively, make the over all arc voltage, much higher than the system voltage. This was working principle of air circuit breaker now we will discuss in details the operation of ACB in practice.



The air circuit breaker, operated within the voltage level 1 KV, does not require any arc control device. Mainly for heavy fault current on low voltages (low voltage level above 1 KV) ABCs with appropriate arc control device, are good choice. These breakers normally have two pairs of contacts. The main pair of contacts carries the current at normal load and these contacts are made of copper. The additional pair is the arcing contact and is made of carbon. When circuit breaker is being opened, the main contacts open first and during opening of main contacts the arcing contacts are still in touch with each other. As the currentgets, a parallel low resistive path through the arcing contact during opening of main contacts, there will not be any arcing in the main contact. The arcing is

only initiated when finally the arcing contacts are separated. The each of the arc contacts is fitted with an arc runner which helps, the arc discharge to move upward due to both thermal and electromagnetic effects as shown in the figure. As the arc is driven upward it enters in the arc chute, consisting of splitters. The arc in chute will become colder, lengthen and split hence arc voltage becomes much larger than system voltage at the time of operation of air circuit breaker**,** and therefore the arc is quenched finally during the current zero.
Although this type of circuit breakers have become obsolete for medium voltage application, but they are still preferable choice for high current rating in low voltage application.

7.1 Air Blast Circuit Breaker

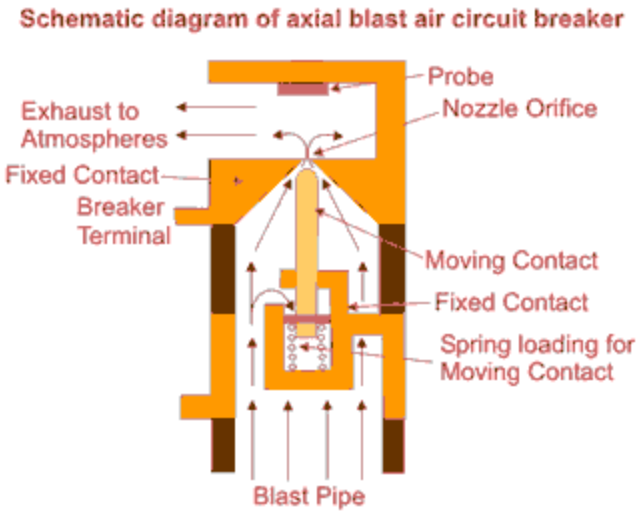
These types of air circuit breaker were used for the system voltage of 245 KV, 420 KV and even more, especially where faster breaker operation was required. Air blast circuit breaker has some specific advantages over oil circuit breaker which are listed as follows,

1. There is no chance of fire hazard caused by oil.
2. The breaking speed of circuit breaker is much higher during operation of air blast circuit breaker**.**
3. Arc quenching is much faster during operation of air blast circuit breaker**.**
4. The duration of arc is same for all values of small as well as high currents interruptions.
5. As the duration of arc is smaller, so lesser amount of heat realized from arc to current carrying contacts hence the service life of the contacts becomes longer.
6. The stability of the system can be well maintained as it depends on the speed of operation of circuit breaker.
7. Requires much less maintenance compared to oil circuit breaker.
   There are also some disadvantages of air blast circuit breakers-
8. In order to have frequent operations, it is necessary to have sufficiently high capacity air compressor.
9. Frequent maintenance of compressor, associated air pipes and automatic control equipments is also required.
10. Due to high speed current interruption there is always a chance of high rate of rise of re-striking voltageand current chopping.
11. There also a chance of air pressure leakage from air pipes junctions.

As we said earlier that there are mainly two types of ACB, plain air circuit breaker and air blast circuit breaker. But the later can be sub divided further into three different categories.

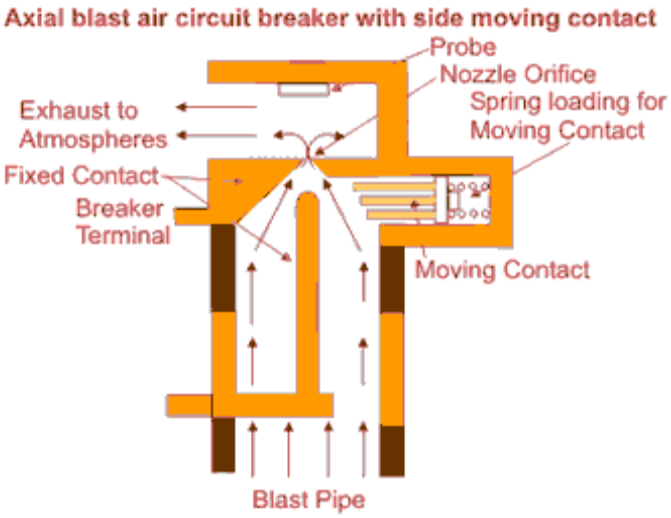
1. Axial Blast ACB.
2. Axial Blast ACB with side moving contact.
3. Cross Blast ACB.

Axial Blast Air Circuit Breaker



In axial blast ACB the moving contact is in contact with fixed contact with the help of a spring pressure as shown in the figure. There is a nozzle orifice in the fixed contact which is blocked by tip of the moving contact at normal closed condition of the breaker. When fault occurs, the high pressure air is introduced into the arcing chamber. The air pressure will counter the spring pressure and deforms the spring hence the moving contact is withdrawn from the fixed contact and nozzle hole becomes open. At the same time the high pressure air starts flowing along the arc through the fixed contact nozzle orifice. This axial flow of air along the arc through the nozzle orifice will make the arc lengthen and colder hence arc voltage become much higher than system voltage that means system voltage is insufficient to sustain the arc consequently the arc is quenched.

Axial Blast ACB with Side Moving Contact

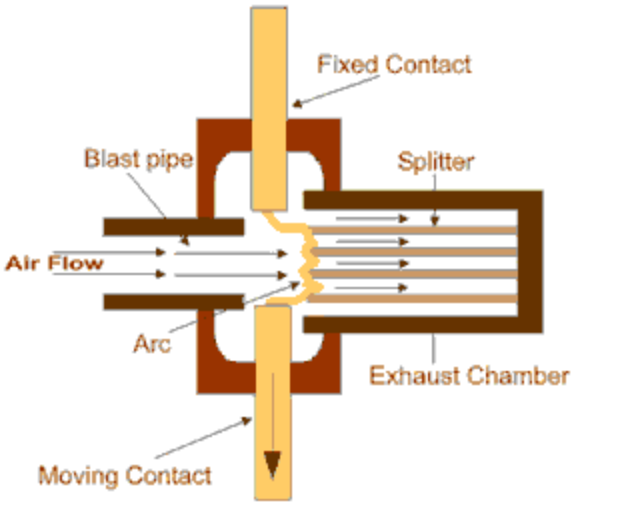


In this type of axial blast air circuit breaker the moving contact is fitted over a piston supported over a spring. In order to open the circuit breaker the air is admitted into the arcing chamber when pressure reaches to a predetermined value, it presses down the moving contact; an arc is drawn between the fixed and moving contacts. The air blast immediately transfers the arc to the arcing electrode and is consequently quenched by the axial flow of air.

Cross Blast Air Circuit Breaker

The working principle of cross blast air circuit breaker is quite simple. In this system of air blast circuit breaker the blast pipe is fixed in perpendicular to the movement of moving contact in the arcing chamber and on the opposite side of the arcing chamber one exhaust chamber is also fitted at the same alignment of blast pipe, so that the air comes from blast

pipe can straightly enter into exhaust chamber through the contact gap of the breaker. The exhaust chamber is spit with arc splitters. When moving contact is withdrawn from fixed contact, an arc is established in between the contact, and at the same time high pressure air coming from blast pipe will pass through the contact gap and will forcefully take the arc into exhaust chamber where the arc is split with the help of arc splitters and ultimately arc is quenched.



Principle of Cross Blast Air Circuit Breaker

IMPORTANT QUESTION

- Describe the construction and operation of a minium oil circuit breaker.
- Discurss in detail about a. d. c. circuit breaker with suitable diagram and waveforms.
- What are the faults generally occur in the alternators. Describe the MERZ PRICE protection of Alternator.
- What are the faults generally occur in the transformers. Discuss about the MERZ PRICE protection of three phase transformer.
- With the help of neat block diagram. Explain the construction, operating principle and advantages of **SF_6 circuit breaker**.(SF_6 circuit breakers are generally used in now a days)
- Describe the **Oil circuit breaker**. What is minimum and bulk oil circuit breaker?
- What are the difference between BULK and MINIUM oil circuit breaker?
- Explain the working of **Air blast** circuit breaker with a neat diagram
- Explain the working of **vacuum of circuit breaker**. What type of material is used for making the contacts of vacuum CBs.

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