5.2 DC and AC circuit breaking:

5.2.1 D.C Circuit Breaking:

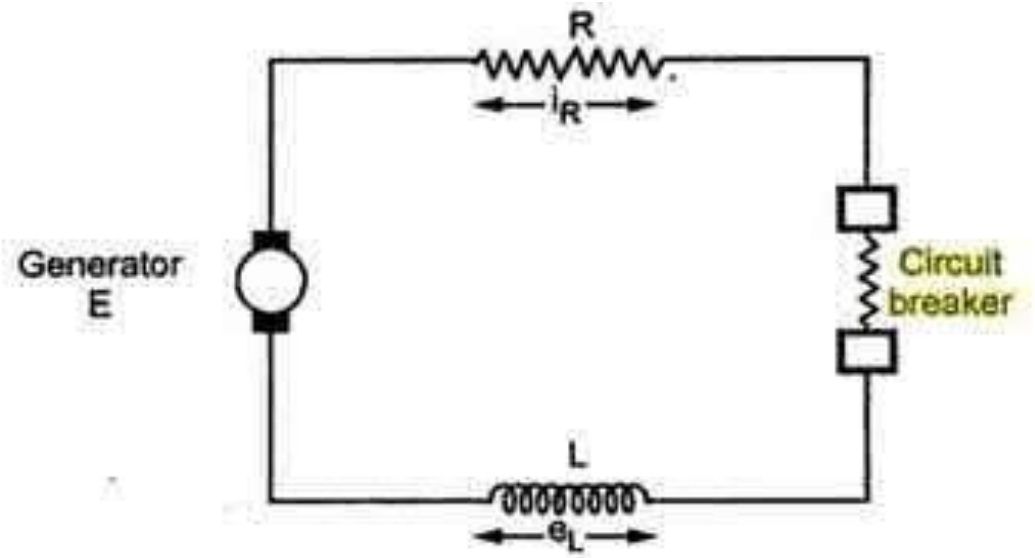

Figure 5.2.1 D.C Circuit Breaker

[Source: "Switchgear and Protection'" by Sunil S.Rao, Page: 676]

- The breaking of d.c circuits can be explained as follows: consider a circuit which will consists of Generator with voltage E, resistance R, inductor L and the circuit breaker as shown in fig.
- The contact of the DC breaker separate and the arc is transferred from contacts to the runners where it rises upwards and extinguishes on its own.
- The two basic problem in d.c circuit breaking are; the natural zero current does not occur as in the case of a.c circuit breakers.
- The amount of energy to be dissipated during short interval of breaking is very high as compared to conventional a.c circuit breakers.

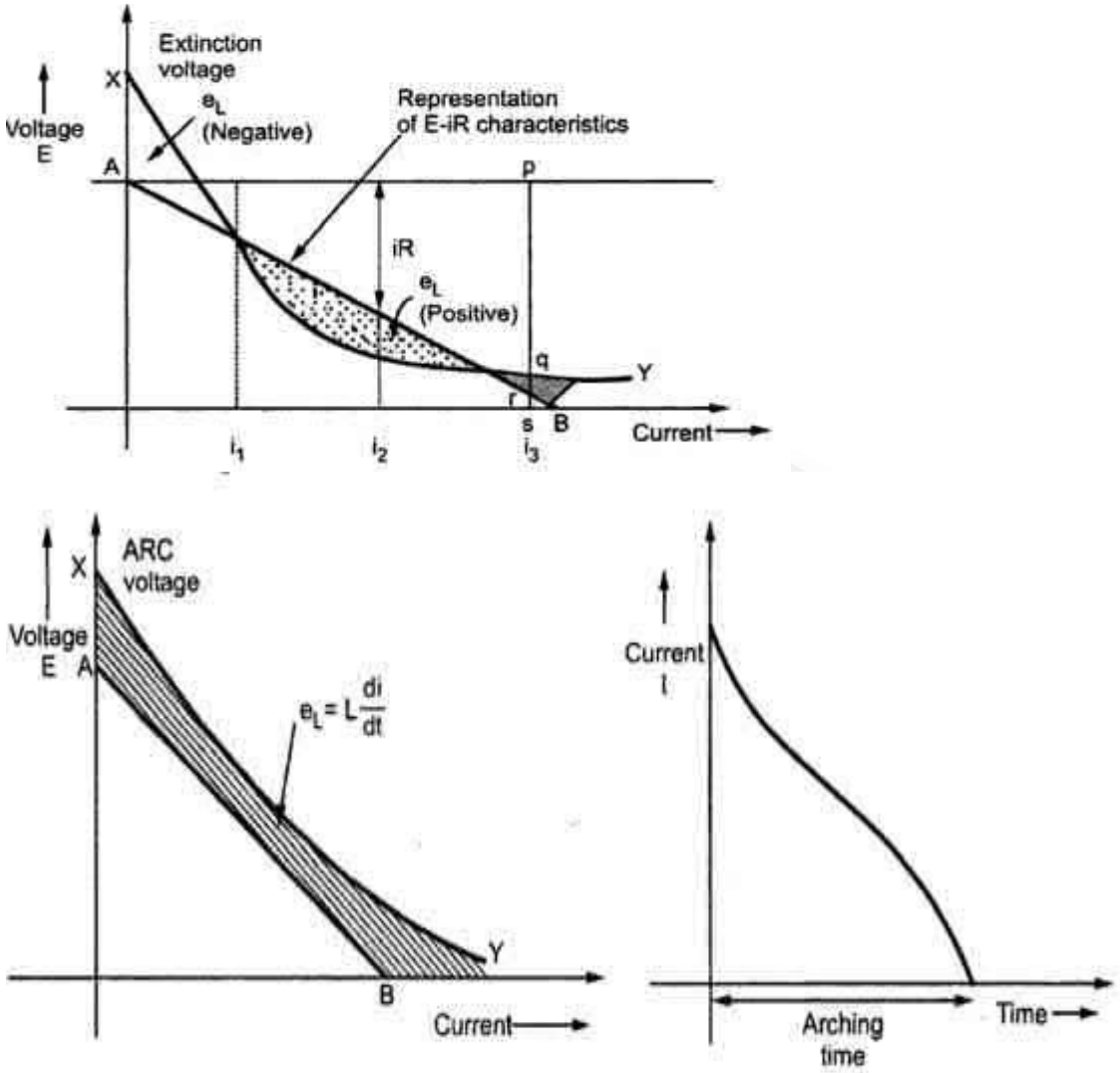

Figure 5.2.2 Characteristics of breaker

[Source: "Switchgear and Protection'" by Sunil S.Rao, Page: 677]

- Curve AB represents the voltage E-iR, i is nothing but current at any instant. The curve XY represents the voltage – current characteristics of the arc for decreasing current.
- When the circuit breaker starts opening it carries the load current I=E/R.The current is shown to be reduced to i1,i2 and i3respectively.
- Pr portion represents voltage drop i3R
- Qs represents arc voltage which is greater than available voltage
- The arc becomes unstable and the difference in voltage is supplied by inductance L across which the voltage is e_L=Ldi/dt.
- For decreasing values of currents this voltage is negative so it maintains the arc.

5.2.2 AC circuit breaking:

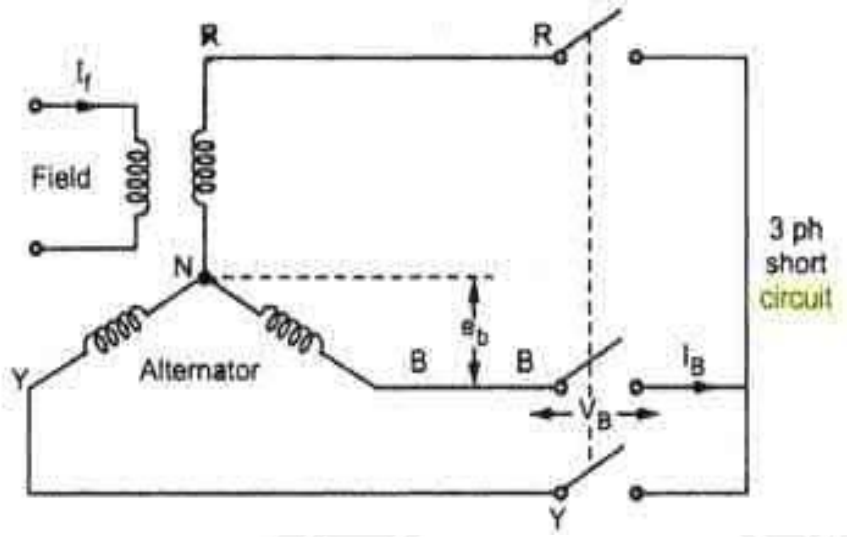

Figure 5.2.3 A.C. Circuit breaker

[Source: "Switchgear and Protection'" by Sunil S.Rao, Page: 679]

- The circuit breaker is open condition with its other side short circuited. When phase B voltage with respect to neutral is zero, the circuit breaker is closed.
- Under this condition the phase B current will have maximum D.C component and its current waveform will be unsymmetrical about normal zero axis. The short circuit making capacity of circuit breaker is expressed in peak value not in rms value like breaking capacity.
- Theoretically at the instant of fault occurrence in a system, the fault current can rise to twice of its symmetrical fault level. At the instant of switching on a circuit breaker in faulty condition, of system, the short circuit portion of the system connected to the source.
- The first cycle of the current during a circuit is closed by circuit breaker, has maximum amplitude. This is about twice of the amplitude of symmetrical fault current waveform.
- The breaker's contacts have to withstand this highest value of current during the first cycle of waveform when breaker is closed under fault. On the basis of this above mentioned phenomenon, a selected breaker should be rated with short circuit making capacity.

- As the rated short circuit making current of circuit breaker is expressed in maximum peak value, it is always more than rated short circuit breaking current of circuit breaker. Normally value of short circuit making current is 2.5 times more than short circuit breaking current.

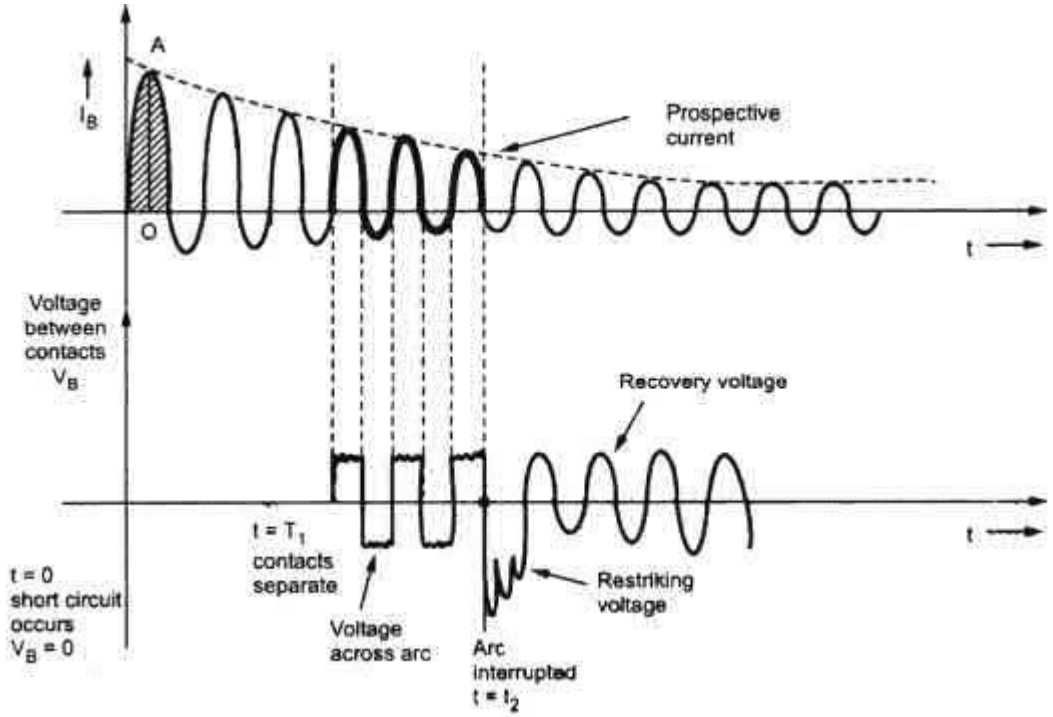

Figure 5.2.4 Characteristic of A.C breaker

[Source: "Switchgear and Protection'" by Sunil S.Rao, Page: 680]

- This is the maximum short circuit current which a circuit breaker can withstand before it, finally cleared by opening its contacts. When a short circuit flows through a circuit breaker, there would be thermal and mechanical stresses in the current carrying parts of the breaker.
- If the contact area and cross-section of the conducting parts of the circuit breaker are not sufficiently large, there may be a chance of permanent damage in insulation as well as conducting parts of the CB.
- Hence short circuit breaking capacity or short circuit breaking current of circuit breaker is defined as maximum current can flow through the breaker from time of occurring short circuit to the time of clearing the short circuit without any permanent damage in the CB. The value of short circuit breaking current is expressed in RMS