SF6 Circuit Breaker

In these circuit breakers, Sulpher hexafluoride gas (SF6) is used as the arc quenching medium. The SF6 is an electronegative gas and has a strong tendency to absorb free electrons. The contacts of the breaker are opened in a high pressure flow of SF6 gas and an arc is struck between them.

The attachment of electron with SF6 gas molecules may occur in two different ways,

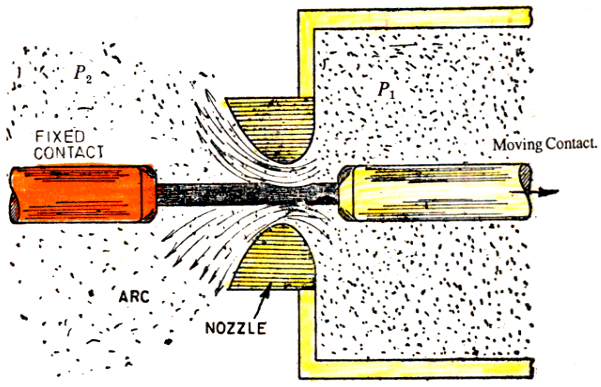
1) $SF_6 + e = SF_6^-$
2) $SF_6 + e = SF_5^- + F$

These negative ions obviously much heavier than a free electron and therefore over all mobility of the charged particle in the SF6 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.

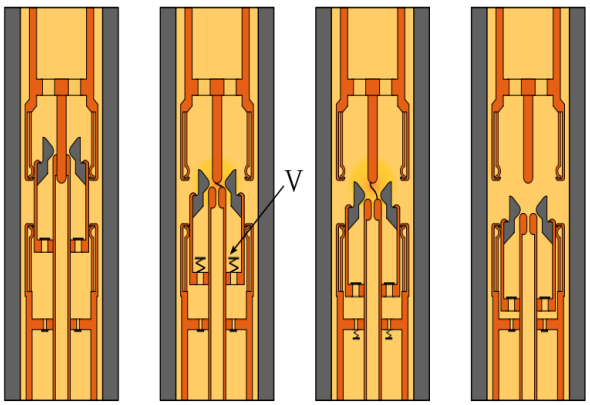
The **conducting free electrons in the arc are rapidly captured by the gas to form relatively immobile negative ions.** This loss of conducting electrons in the arc quickly builds up enough insulation strength to extinguish the arc. The SF6 circuit breakers have been found to be very effective for high power and high voltage services.

The excellent insulating properties of SF6 gas make it possible to design circuit breakers with smaller overall dimensions, shorter contact gaps, which help in the construction of outdoor breakers with fewer interrupters.

These circuit breakers are available for complete range of medium voltage and high voltage application up to 800 kV and above. This medium is most suitable for metal-clad and hybrid HV sub-stations. Although the share of SF6 circuit breakers in medium voltage application is gradually shrinking, this technology is still emerging as the only choice in the HV range.



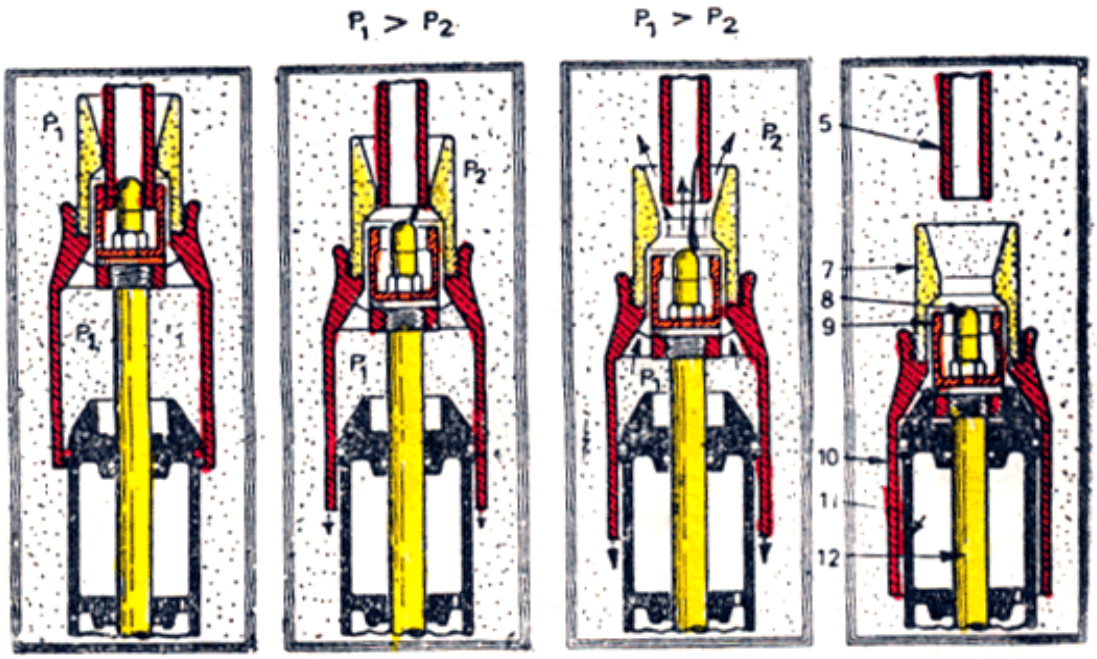
(*a*) Arc extinction in gas flow circuit-breakers (Gas flow from high pressure P_1 to low pressure P_2 *via* an insulating nozzle)



Self-blast circuit breaker chamber
(1) closed, (2) interrupting low current,
(3) interrupting high current, and (4) open.

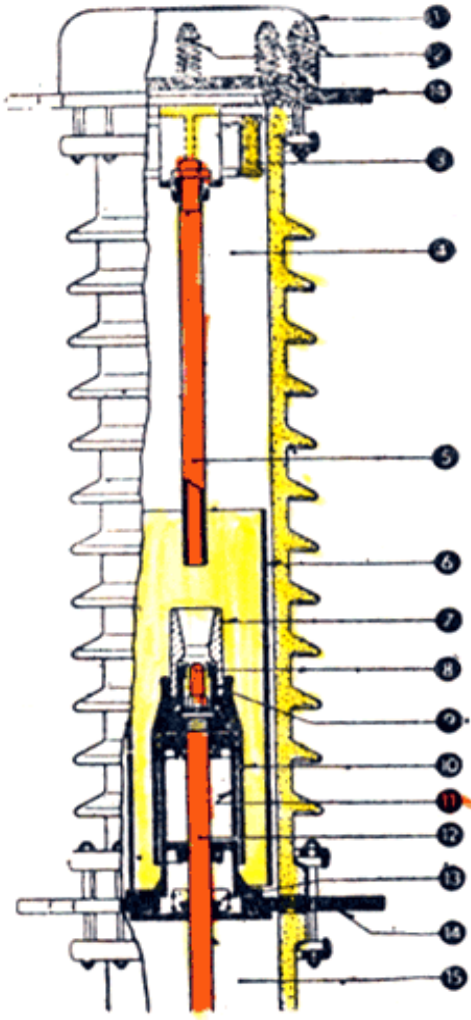
Applications :

SF6 circuit breakers find use in systems with voltages ranging in 115 kV to 230 kV, as they are designed for this range with power ratings of 10 MVA to 20 MVA and interrupting time less than 3 cycles.



Contact closed $P_1 = P_1$ | Contacts separate nozzle about to open | Nozzle open flow starts | Arc quenches breaker fully open

(a) Four stages of Puffer Action-Single Flow.



1	-Top cap
2	Springs
3	Activated Alumina
4	SF_6 Gas
5	Fixed contact
6	Protective tube
7	PTFE nozzle
8	Arcing contact tip
9	Finger contacts
10	Puffer cylinder
11	Fixed piston
12	Pull conductor
13	Sliding contacts
14	Lower support chamber.

(b) Cross-section of Puffer type SF_6 Interrupter.

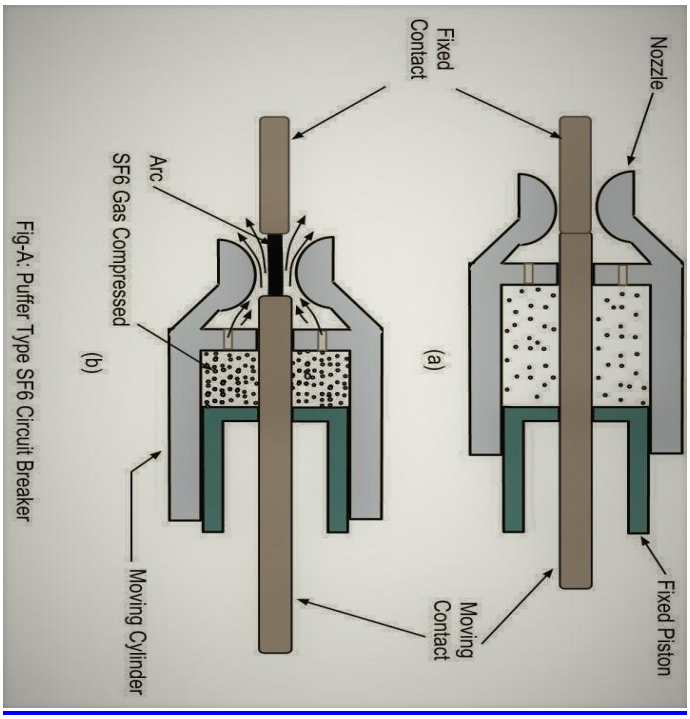


Fig-A: Puffer Type SF6 Circuit Breaker

Advantages:

1. Because of the high conductivity of the arc in the SF6 gas, the arc energy is low. (Arc voltage is between 150 and 200V.)
2. Due to the low energy the contact erosion is small.
3. The gaseous medium SF6 possesses excellent dielectric and arc quenching properties. After arc extinction, the dissociated gas molecules recombine almost completely to reform SF6. This means that practically no loss/consumption of the quenching medium occurs.
4. Due to the superior arc quenching property of the SF6 gas, such circuit breakers have very short arcing time. Furthermore, they can interrupt much larger current.
5. These breakers give noiseless operation due to its closed gas circuit and no exhaust to atmosphere unlike the air-blast circuit breaker.
6. The SF6 gas is not inflammable, so there is no risk of fire in SF6 breakers.
7. Since SF6 breakers are totally enclosed and sealed from the atmosphere, they are particularly suitable where explosion hazards exist, i.e. in coal mines.

Disadvantages:

1. These circuit breakers are expensive due to the high cost of SF6 gas.
2. Since SF6 gas has to be reconditioned after every operation of the breaker, additional equipment is required for this purpose.
3. The SF6 gas has been identified as a greenhouse gas, and safety regulations are being introduced in many countries in order to prevent its release into the atmosphere.

Therefore, the HV circuit breaker would be designed to ensure that there is minimum leakage during the service period and that the utilities let out the least amount of SF6 gas into the atmosphere during maintenance.

As SF6 gas has an impact 23 times stronger than the CO2 gas on the greenhouse effect, in order

to minimize the emission of SF6 gas, N2- SF6 and CF4- SF6 gas mixtures use may be more prominent in future as an alternative to using pure SF6 gas

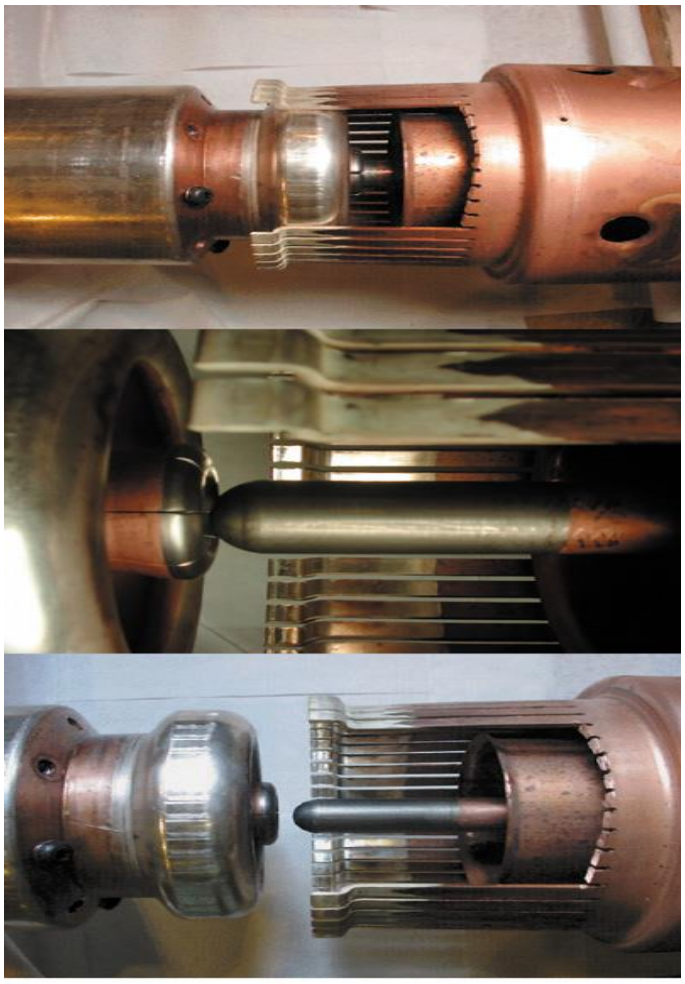


Fig 10b Contacts showed in Closed-Arc starting step-Opened position

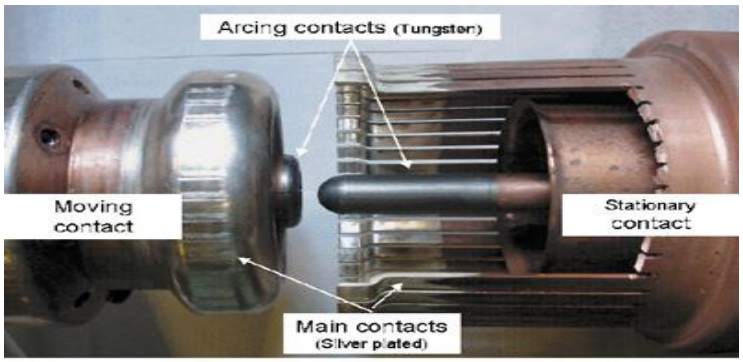


Fig 10a Tulip contacts in SF6 circuit breaker