CIRCUIT INTERRUPTION TECHNIQUES

Advantages of Federal Pacific Circuit Interruption Technique

The Federal Pacific Auto-jet® Switch is unsurpassed in the industry for its switching capability as an air-insulated load interrupter. It passes the ANSI standards C37.20.3, C37.57, C37.58 and all the optional and preferred ratings in IEEE C37.74. UL® listed at 5kV and 15 kV and used extensively in MSHA approved equipment. Interrupter switches available today utilize one of four (4) interrupting/insulating medium technologies: (1) gas (SF6), (2) liquid (oil), (3) vacuum, and (4) air.

Gas (SF6)

It is an excellent interrupting/insulating medium. However, it is risky since it is on the UN (Kyoto Treaty) list of contaminants as the worst greenhouse gas. It is also very expensive and production capabilities have been reduced, increasing the cost. It is difficult to recapture if it is leaking and tank evacuation for repair requires special handling to avoid contamination and an equally costly storage housing. Arcing in SF6 creates carcinogenic materials, which must be handled and disposed of in a secure manner. Pressure gauges and gas-fill ports are required.

Liquid (Oil)

It is also a good interrupting/insulating medium, but not as good as SF6. It can be vulnerable to ignition when used as the interrupting medium. Even the biodegradeable types are not perfectly absorbed. In addition, the containers may leak and make for messy, costly handling, clean up and disposal. Testing is necessary to verify the integrity of the liquid dielectric.

Vacuum

Vacuum is also an excellent interrupting/insulating medium, but involves a sophisticated technology. However, vacuum bottles are also expensive. You cannot see the interrupting contacts so there is no visible disconnect, which is a security requirement for many users. The vacuum contacts also wear and will need to be serviced. Vacuum circuit breakers may require control power for operation such as a battery, which is another maintenance headache.

Again, these three technologies are approximately 20% more expensive than our technology, which originated in Europe. In addition, we have added many more improvements to survive in the rugged North and South American and Caribbean markets. Our technology also has none of the risks associated with SF6, oil, and vacuum.

Air

We use this technology. It is plentiful, easy to control, and has no negative by-products. For this technology, there are two types of circuit-interrupting techniques, namely, ablative and puffer. You are all familiar with the ablative type that uses knife blades that are less robust and therefore not as durable, so they may require maintenance.

For example, the ablative switch depends on eroding (consuming) the arc chute or arc compressor (that surround the blade) to generate the gases required to cool and extinguish the arc. That means the arc chute is producing a build-up of carbon inside each time it operates. At some point, it will not be able to generate the necessary gas, which typically will occur in only 10-20 operations.

The Federal Pacific Auto-jet® load-interrupter switch employs a unique, reliable method of circuit interruption. The switch is available in ratings to 1200 amperes continuous and interrupting and is designed to provide three-time duty-cycle fault-closing and momentary ratings to 40,000 amperes asymmetrical. A one-time duty-cycle fault-closing rating of 61,000 amperes asymmetrical is also available. By employing a simple puffer mechanism combined with air as a renewable arc-interrupting medium, the Auto-jet® switch is unsurpassed in the industry with its complete range of switching capabilities. The switch is capable of 100 full-load circuit interruptions at 600 amperes without maintenance.

The performance of the switch is insured by its rugged, heavy-duty quick-make, quick-break stored-energy mechanism, which provides high-speed opening and closing independent of the speed of the switch-operating handle. Spring loaded interrupting contacts add increased speed of separation at the point of arc formation to reduce contact wear and to increase the dielectric gap at the instant contacts separate.

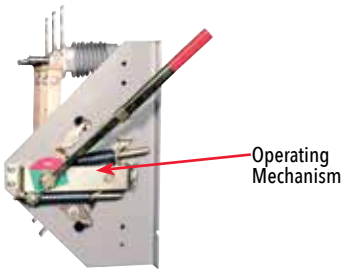
The heavy-duty construction of the switch blades, contacts, insulators and support frame provides the ruggedness necessary to withstand – through multiple operations – the electrical, mechanical and magnetic forces generated during all types of switching operations. This capability makes the Auto-jet® switch the ideal choice for manual, remote-controlled, and automatic switching in pad-mounted and metal-enclosed switchgear.

Comparison – Puffer Technology vs. Ablative Technology

- The puffer interrupter is capable of 100 full-load circuit interruptions at 600 amperes without maintenance compared to the only 10-20 operations for ablative switches.
- The puffer interrupter is rated at three (3) time duty-cycle fault-closing at 40,000 amperes without maintenance compared to just one or two-time fault closing at only 22,400 amperes for some ablative switches. Some puffer interrupters have even performed through four fault-closings, which the ablative switches have not. In addition, the puffer interrupter has been tested to 1200 amperes continuous and interrupting with a one-time duty-cycle fault-closing rating of 61,000 amperes asymmetrical.
- The puffer interrupter has a capability beyond 1000 mechanical operations without requiring service.

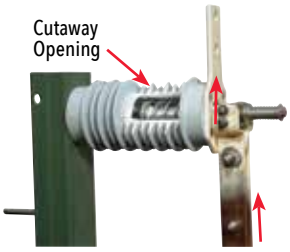
The operating sequence of the Federal Pacific Auto-jet® Load-Interrupter Switch is depicted in the accompanying photographic series.

1



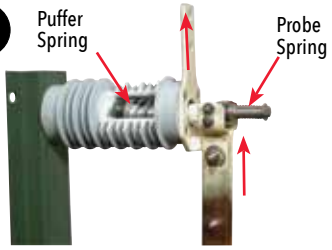
Switch closed. Normal current path through lower switch terminal, through switch blades to main-contact and out top terminal pad.

2



Quick-make quick-break mechanism on switch is charged using manual handle and discharges to open switch.

3



As switch blade starts to move, interrupting contacts (probe contact and tulip contact remain engaged) and puffer assembly starts to move. As puffer assembly starts to move, the spring surrounding the puffer assembly begins to compress, as does the spring at the back of the probe.

4

Switch opening. As switch blade continues to move, the probe and puffer springs are further compressed and the initial electrical change occurs as the switch blade starts to separate from the main-contact.

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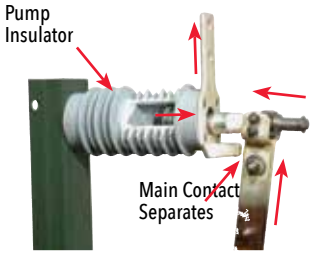
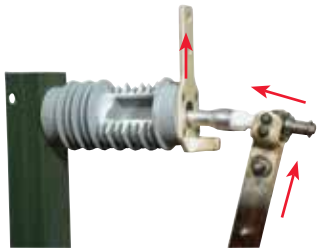


Air is being pulled into the chamber of the pump insulator. As the switch blade and main contact separate, current is now diverted through the probe contact, to the tulip contact, through the puffer housing, to the puffer spring, to the back of the main contact, and out the top of the terminal pad. Three and one-half cycles have elapsed.

6



The puffer spring and the probe spring continue to compress as the blade moves further away from the main contact. The springs are nearly fully compressed and air continues to be pulled into the chamber of the pump insulator. As the springs become fully compressed, the probe and the tulip contacts will start to separate.

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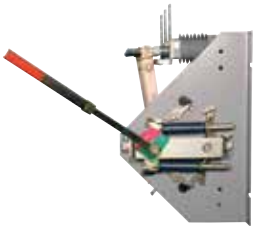
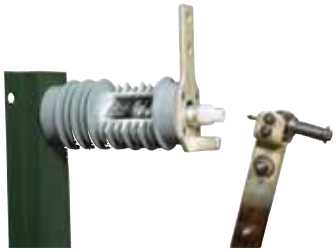


Interrupter contacts separate. As the springs are fully compressed, the probe and the tulip contacts will start to separate. The charged puffer spring now quickly pulls the puffer assembly, which includes the tulip contact, back into the pump-insulator chamber.

8

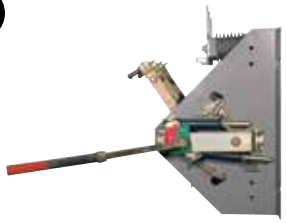


Air in the chamber is forced through the central core of the puffer into the arcing area at the tip of the tulip contact. Simultaneously, the probe spring pulls back the probe. Complete switch operation occurs in a total 5-cycle operating time.

9

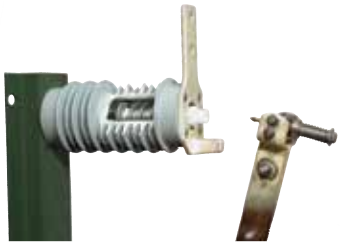
At the time of contact separation, not only is the discharging operating mechanism pushing the blade very fast, but the probe and puffer springs are applying energy to rapidly separate the interrupting contacts, which are only in the circuit for 1.5 cycles of the total operating time.

10



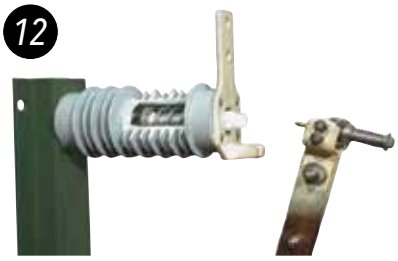
Switch Open. The switch blade has moved to the fully open position.

11



The process from the instant the switch blade starts to move until circuit interruption is achieved takes only 5 cycles.

12



The arc is extinguished and there is a full dielectric air gap between the switch blade and the main contact.