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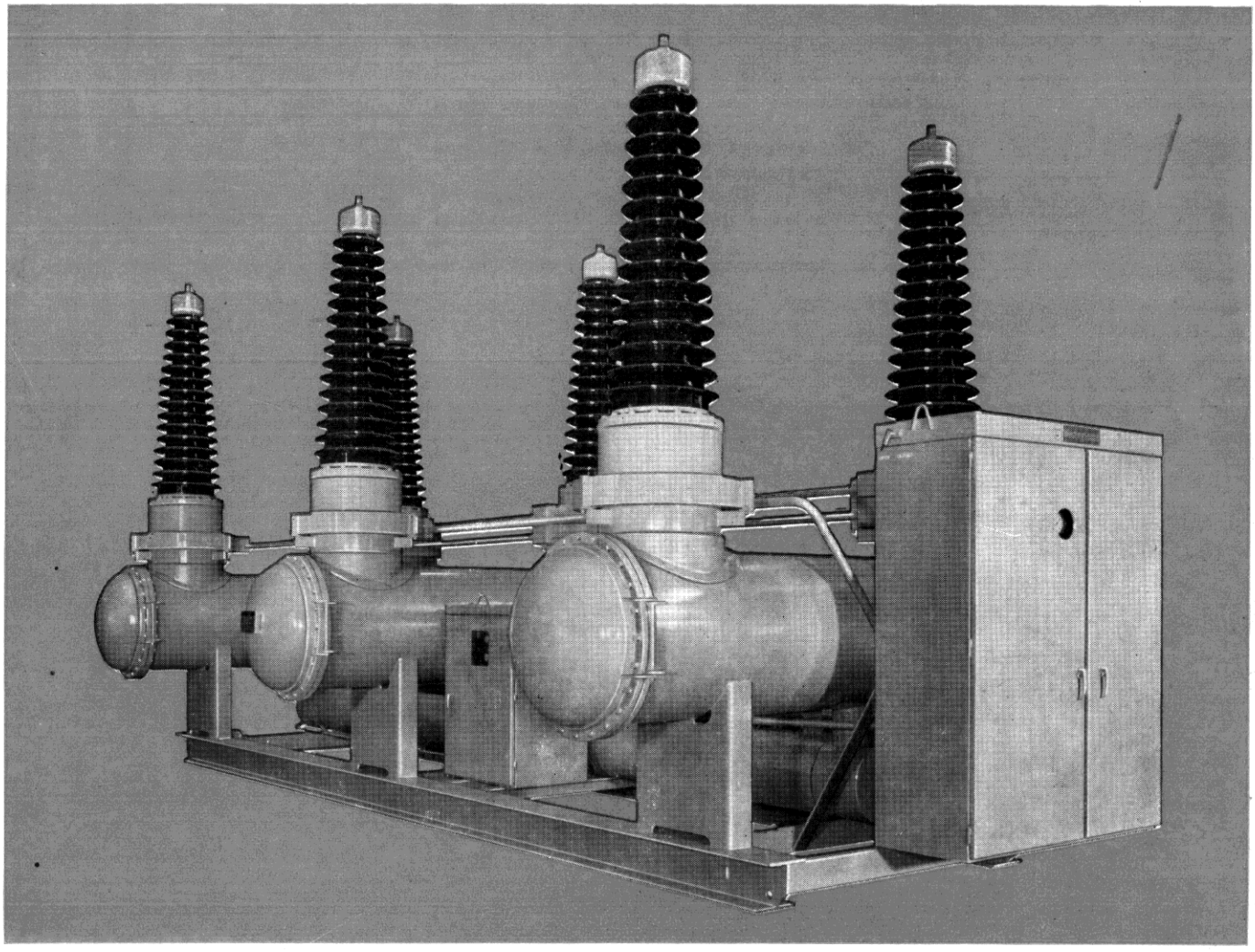
SF_6 Gas Filled Breakers Type SF, High Capacity

Dead Tank Construction



Application

Type SF gas filled breakers are designed for use on high voltage line circuits and may be installed in existing substations. These breakers meet USASI and NEMA Standards for power circuit breaker ratings.

Advantages

• **Dead Tank Construction:** Complete safety provided, with three-pole units, mechanism and gas system housing mounted on common base.

• **Reduced Weight:** SF_6 breakers are approximately 60% lighter in weight than comparably rated oil circuit breakers.

• **Minimum Foundation Stress and Cost:** There is negligible energy transfer to foundation during interruption; this, combined with lighter breaker weight, allows simplified, less expensive, foundation construction.

• **Quiet Operation:** Closed gas system keeps noise level, even at full rated interruption, approximately same as oil breaker of comparable rating operating at no load.

• **Simplified Maintenance:** Extremely stable, SF_6 gas has negligible decomposition, assuring long life of this insulating and interrupting medium. Interrupter assembly can be removed conveniently at ground level for inspection and maintenance. Contacts all tied together mechanically affording simple adjustment, synchronization of contacts and positive position indication. Contacts are designed for exceptionally long life and correspondingly less frequent maintenance.

• **Ease of Installation:** These self-contained breakers are shipped completely assembled.

May, 1969
Supersedes Descriptive Bulletin 33-553, dated November, 1960
E, C/1950/DB

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Sulfur-Hexafluoride Gas

This gas, used in type SF power circuit breakers, has proved to be remarkably inert with excellent interrupting and insulating properties.

Chemically, SF_6 is one of the most stable compounds and, in the pure state or under normal service conditions, is inert, non-flammable, non-toxic and odorless.

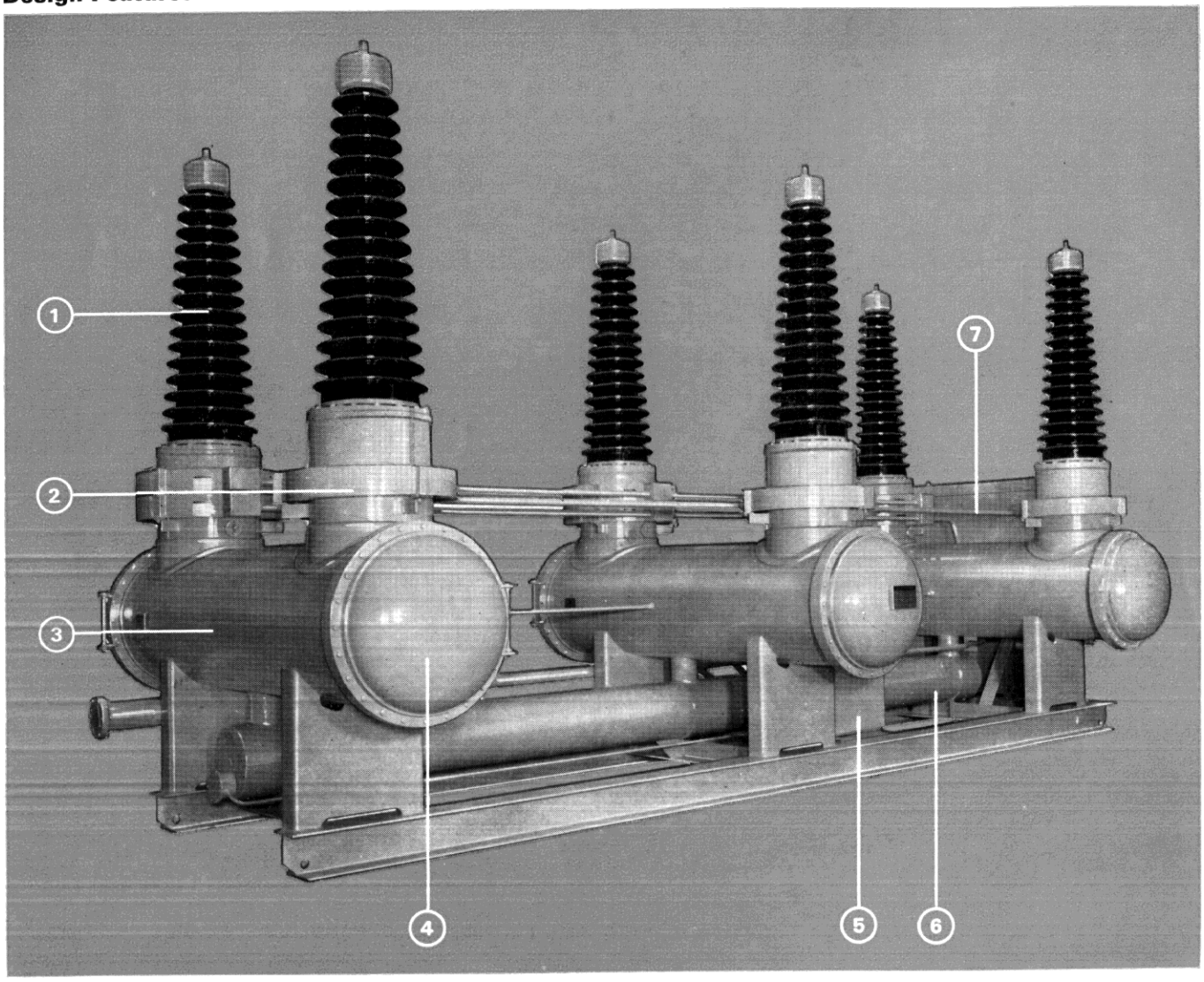
At only 2-3 atmospheres (15-30 psig) pressure, the dielectric strength of SF_6 exceeds that of air or oil.

The excellent insulating properties of SF_6 gas makes possible the use of a pole-unit tank having minimum clearances between electrically live parts within the tank and ground. At atmospheric pressure these clearances are adequate to support approximately twice the normal line-to-ground system voltage.

Its outstanding characteristic, however, is its arc-quenching ability. In a plain-break interrupter, about 100 times as much current can be extinguished in SF_6 as in air. When the SF_6 is blown through the arc, even at low velocities, the effectiveness as compared to plain break is further multiplied up to hundreds of times.

While there is some depreciation of the gas after extended periods of arcing, such decomposition is very slight and has no effect upon dielectric strength and arc interrupting ability. Furthermore, the solid arc products formed at arc temperatures are the metallic fluorides which are good insulators. Gaseous arc products are readily absorbed by filters incorporated within the breakers.

Design Features



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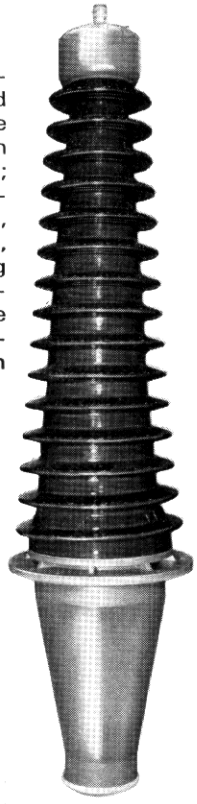
1 Bushings

Newly designed bushings, thoroughly tested in the Westinghouse High Power and High Voltage Laboratories; consist of a lead, mounting flange arrangement, insulating porcelains, and compression spring assembly for sealing purposes. SF_6 gas in the bushing is in communication with the gas in the tank.



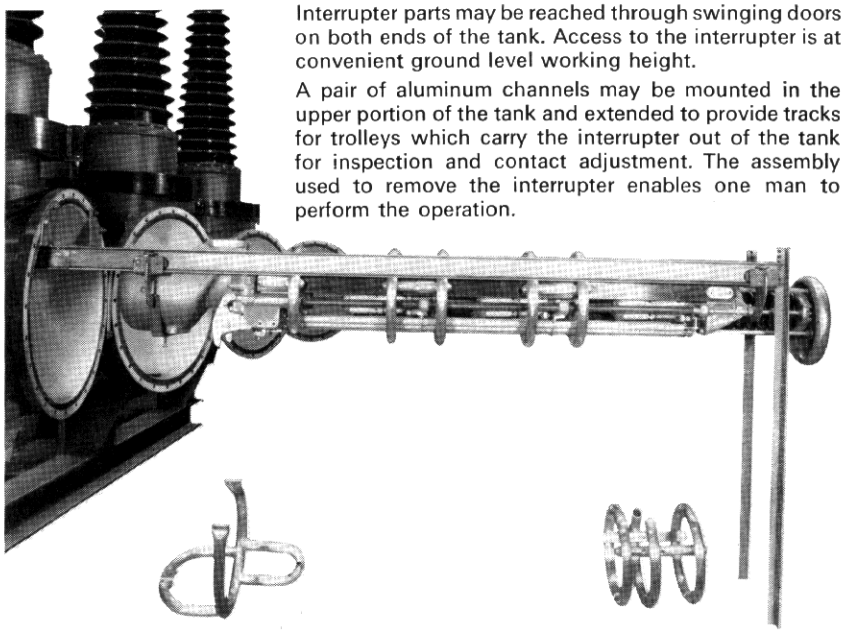
2 Current Transformers

The current transformers are embedded in epoxy within a metal shell supported around the bushings by projecting arms mounted on the breaker tank. Since the transformer compartments are not in the gas chamber, no special seals are necessary to bring out the secondary leads to the mechanism cabinet. Conventional 10L800 accuracy is obtained with these multi-ratio transformers. Space is available for three transformers per bushing.

3 Tanks

Three steel tanks are mounted parallel to each other and horizontally for minimum shipping head room clearance and accessibility to interrupter. Each tank contains sulfur-hexafluoride gas at a pressure of approximately 45 psig. A multi-break type of interrupter is mounted coaxially within each tank and supported from the lower ends of two bushings projecting vertically from the ends of the tank.

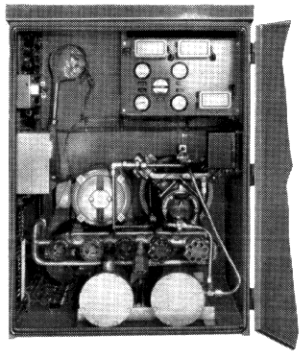
4 Access Door



Interrupter parts may be reached through swinging doors on both ends of the tank. Access to the interrupter is at convenient ground level working height.

A pair of aluminum channels may be mounted in the upper portion of the tank and extended to provide tracks for trolleys which carry the interrupter out of the tank for inspection and contact adjustment. The assembly used to remove the interrupter enables one man to perform the operation.

5 Gas System Housing



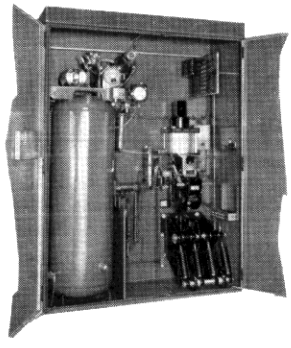
The gas handling system is located in a housing mounted on the side of the breaker between number one and number two poles.

6 Gas Storage Tank

A thermally insulated auxiliary reservoir is located beneath the breaker to provide sufficient gas for four full rating interrupting capacity operations. Additional operations may be obtained at reduced ratings.

To keep the SF_6 gas above the liquefaction temperature, a thermostatically controlled heater is located within the tank well.

7 Pneumatic Mechanism



A standard type AA-10 pneumatic mechanism, mechanically and electrically trip free, closes the contacts and compresses the springs which provide the energy for opening the breaker. Operating rods between the pole units are connected to the contact operating linkage to mechanically tie the contacts together and insure the synchronous operation of the pole units. (See Descriptive Bulletin 33-350.)

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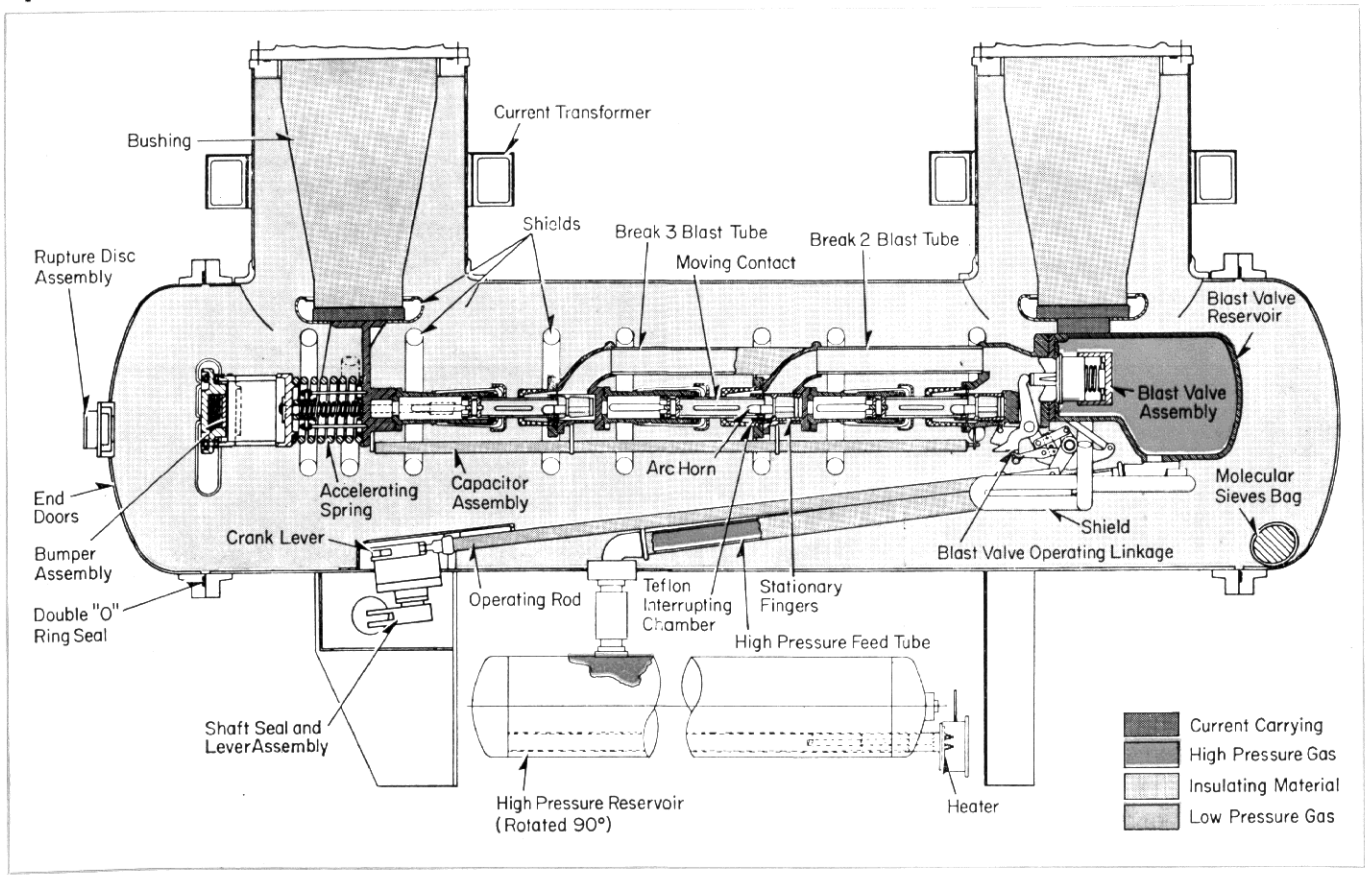
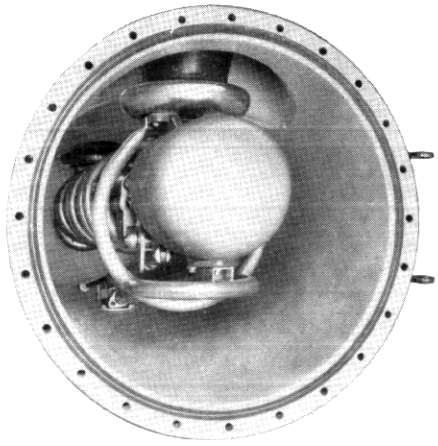
Operation



Interrupter

The interrupter is a three-break double pressure unit consisting of a high pressure gas reservoir, single blast valve, passages for conducting gas from blast valve to the axial flow interrupter units, and an accelerating spring to activate moving contacts to the open position. Insulating bars, extending the full length of the interrupter provide the main structural support of the interrupter assembly. The moving contacts are mounted on a pair of parallel insulating pull rods for simultaneous operation.

The contact construction of the interrupter minimizes the erosion due to arcing on the portions which conduct the current in the closed position of the breaker. The current path is through the side wall of the moving contact and into a cluster of fingers. An arcing horn, located within the finger cluster, projects a short distance beyond the end of the fingers and into the center of the hollow moving contact. Upon opening, the arc quickly transfers from the end of the finger cluster to the centrally located arcing contact into the end of the moving contact, both surfaces being faced with arc-resistant material. This contact arrangement has been subjected to large numbers of fault interruptions in the High Power Laboratory with a minimum amount of erosion. This construction extends maintenance period intervals.



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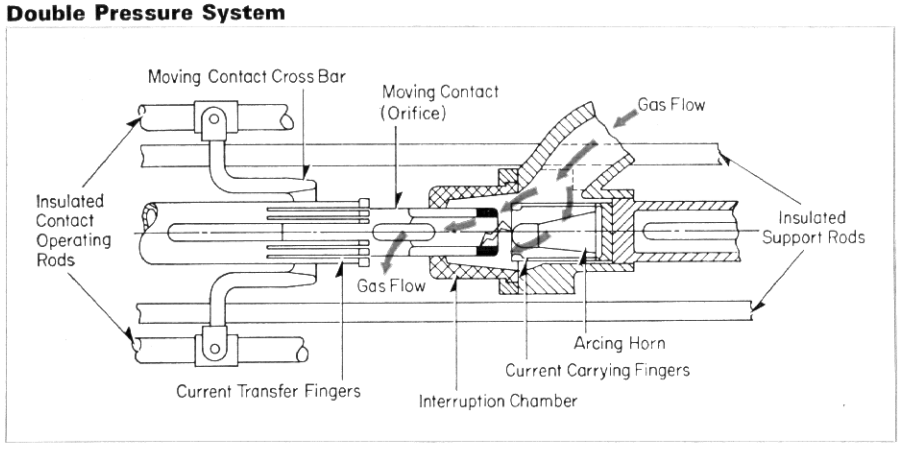
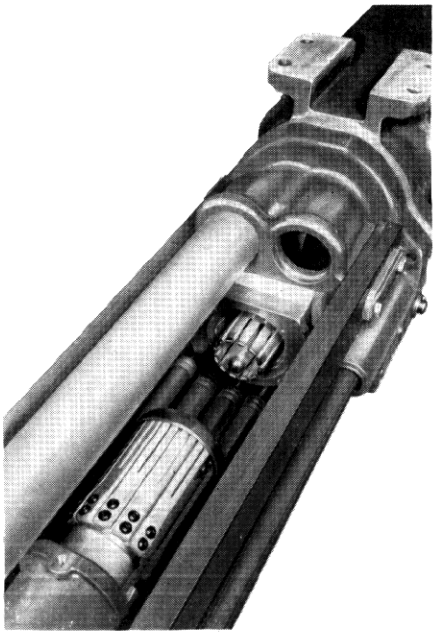
Double Pressure System





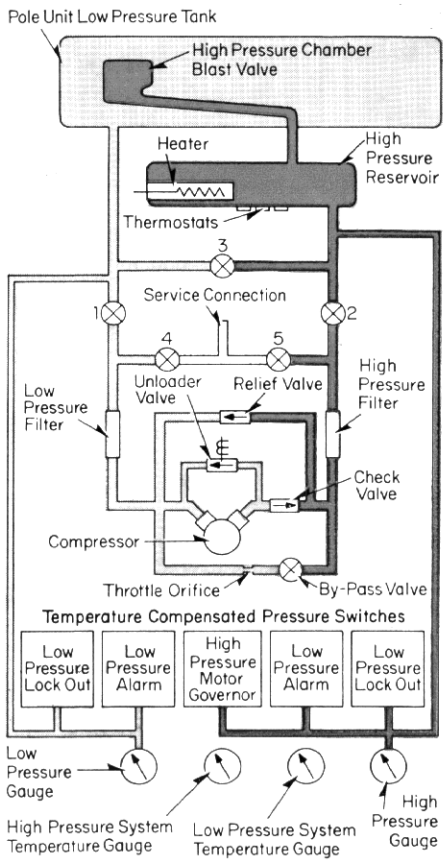
In the double pressure interrupter, the gas in the large tank is at 45 psig, which is adequate for dielectric strength to insulate live parts from ground, while the gas in the blast valve reservoir is stored at 240 psig When the moving contact starts to move, the blast valve is opened to permit the high pressure gas to blast through the arc stream and out the orifice into the main tank. The pressure in the high pressure system decreases while the pressure in the main tank increases slightly. However, it is necessary only to recompress the gas from the low pressure back to the high pressure system in order to restore the original pressure differential. There are four operations stored in the high pressure system without compressor operation. This is a closed system, and there is no gas lost during the operation.

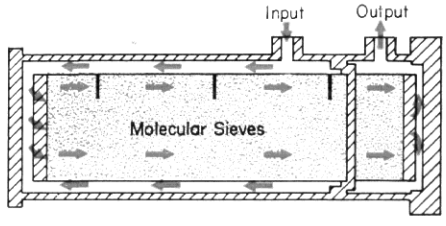
Gas System

Basically, the operation of the type SF breaker is a flow of gas from high pressure to low pressure, with the gas used during each operation reclaimed and restored to proper high pressure.

On the three-pole breaker, auxiliary equipment for handling the gas is located in the gas system housing. This equipment consists of a filter system for removing the small amount of gaseous arc decomposition products in the gas, a compressor for circulating and storing gas, a relief valve for maintaining high pressure within required limits, hand valves, and control and indicating instruments for maintaining proper pressure temperature relationships.

Schematic Diagram: Sulfur Hexafluoride System





Cross section view of molecular sieves filter showing gas flow through the desiccant.

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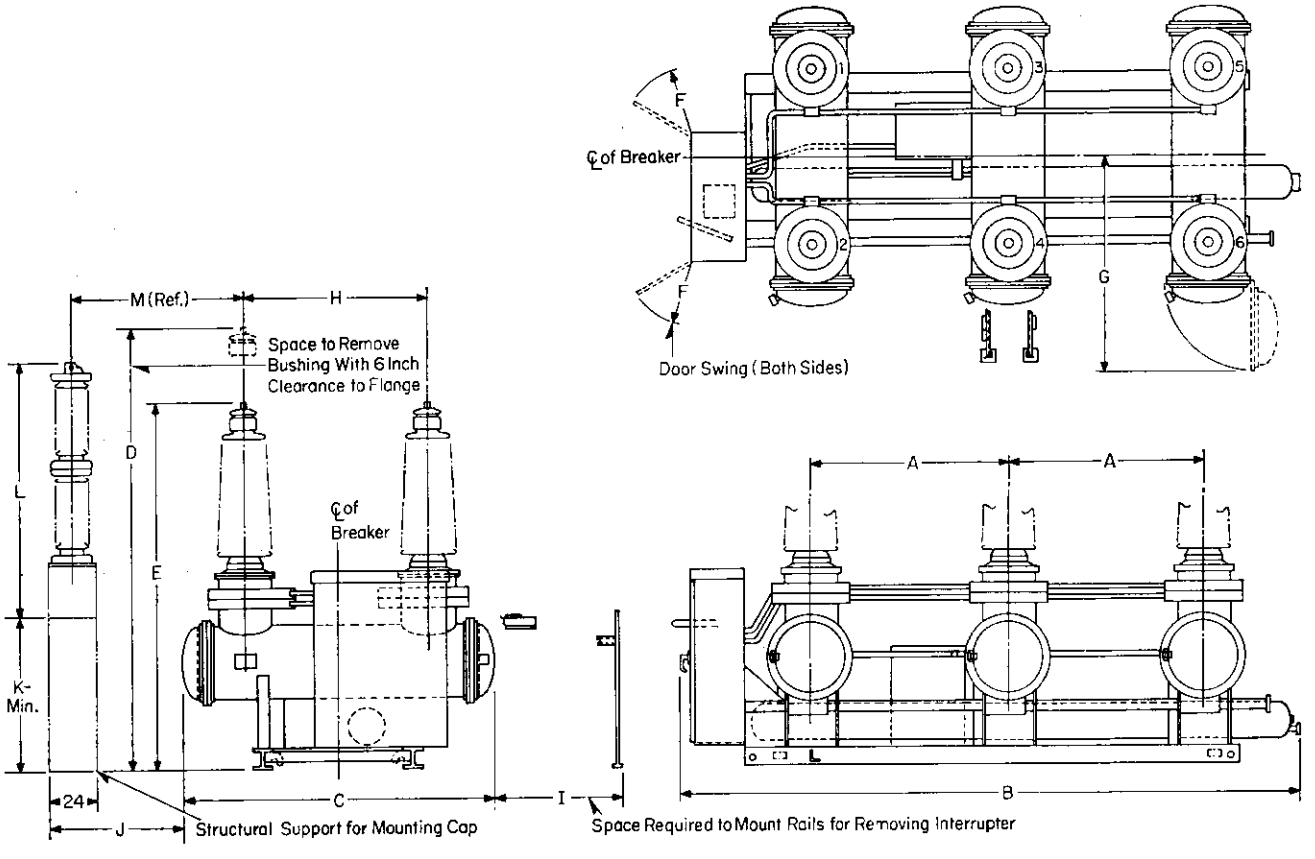
Test Data

Results of the thermal run indicated that the temperature attained by current carrying parts was less than the 65° rise allowed by standards.

Arcing times obtained during fault interruption tests ranged from 0.4 to 0.9 cycles with an average time of approximately 0.6 to 0.7 cycles.

In order to determine breaker performance under severe rate of rise of recovery voltage conditions existing when a fault occurs a short distance out from the breaker on the line side, tests were made using Pi sections to simulate the condition. Excellent interrupting performance and times less than 3 cycles were obtained even under these severe conditions.

Dimensions in Inches, Approximate



Breaker	Dimensions												
	A	B	C	D	E	F	G	H	I	J	K	L	M
2300SF15,000	96	301	150	220	182	34	108	90	125	..	..	..	..
2300SF20,000①	96	301	150	220	182	34	108	90	125	56①	76①	121①	75①

① Requires 4500 picofarads shunt capacitor per phase connected to line side of breaker.

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Selector Guide

Standard Ratings USASI	Rated Voltage / Type	230 Kv 2300SF15000	230 Kv 2300SF20000①
Voltage Ratings			
Nominal Kv		230	230
Maximum Design Kv		242	242
Minimum Kv for Max. Sym. Interr. Rating Amps.		220	220
Current Ratings			
Continuous 60 Cycle Amp.		1600	1600
		2000	2000
		2500	2500
		3000	3000
		3500	3500
Close and Latch KA		58	76
3 Sec. KA		36	47
Interrupting Ratings			
Nominal 3-Phase MVA		15,000	20,000
Maximum Kv, Symmetrical KA		33	43
Minimum Kv, Symmetrical KA		36	47
Opening, Cycles		3	3
Insulation Level			
60 Cycle Test Kv		425	425
Impulse Withstand Kv		900	900
Components			
Bushing Current Transformers			
Relaying Accuracy		10L800	10L800
Std. Maximum Ratio		2000/5	2000/5
Additional Available Ratios		300	1100
		400	1200
		500	1500
		800	1600
Gas System			
Motor Size Hp, 3-Phase		3	3
Motor Current Amp.		10	10
Gas Heater Rating Watts		4500	4500
Weight and Gas Requirements			
Net Weight, lb.		32,000	32,000
Shipping Weight, lb.		33,000	33,000
Tank Diameter ID, in.		36	36
Gas Required 115 lb. Cylinders		7	7
Operating Currents			
Closing (125 Volts, Dc) Amp.		8	8
Tripping (125 Volts, Dc) Amp.		20	20
Motor (230 Volts, Ac, 3 Ph.) Amp.		6	6

① Requires 4500 picofarads shunt capacitor per phase connected to line side of breaker.

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Specifications

Included with Type SF Breaker:

Necessary SF_6 Gas

1 – Welded structural steel I-beam base

1 – High pressure reservoir complete with heaters

1 – Set of gas filled bushings with the outer end of the conductor threaded

1 – Set of terminals

1 – Set of weatherproof cases and supports for bushing transformers

1 – Set of weatherproof metal conduit for transformer leads

6 – Type BYM multi-ratio bushing current transformers

1 – Mechanical "open" and "closed" indicator

1 – Set of accelerating springs

1 – Ground pad per tank

Provision for installation of a time travel device

1 – Weatherproof mechanism housing within which is mounted:
- 1 – Type AA-10 125 volt dc controlled pneumatic closing mechanism
- 1 – 125 volt dc shunt trip coil
- 1 – Control relay panel upon which will be mounted electrically trip free control relay and three fused knife switches; one for control circuit, one for compressor motor, and one for heaters
- 1 – Air compressor and reservoir with automatic controls for 230 volt three phase operation
- 1 – Set of terminal blocks
- 1 – Type W rotary auxiliary switch, 11 pole
- 1 – Type W cutoff switch, 2 pole
- 1 – Latch checking switch
- 1 – Operation counter

1 – Set of heaters with thermostat

1 – Weatherproof gas housing within which is mounted:
- 1 – Compressor and 3 horsepower motor
- 2 – Molecular sieves filters, removable cartridge type
- 1 – Set of temperature compensated pressure switches including motor governor, two low pressure alarms, one in the low pressure system and one in the high pressure system, and low pressure cutout
- 1 – Pressure gauge for low pressure system
- 1 – Pressure gauge for high pressure system
- 1 – Temperature gauge for low pressure system
- 1 – Running time meter

Recommended Spare Parts:

1 – Set ① stationary contact

1 – Set ① moving contact

1 – Set ① Teflon arc chamber

1 – Blast valve

1 – Blast valve seat

1 – Set of O rings for the door gaskets, bushing flanges, blast valve, blast tube elbow, bushing porcelains, and shaft seal complete for 1 pole

1 – Set of shaft seal Teflon V rings

1 – Pawl

1 – Blast valve operating lever

1 – Spare bushing

1 – Gas compressor and V belts

1 – Air compressor and V belts

1 – Trip coil

1 – Set of control relay coils

1 – Pilot valve

1 – Set of control relay contacts

1 – Set of heaters

1 – Line starter coil for gas compressor motor

① Sufficient for one complete interruptor.

Further Information

Refer to Westinghouse

Westinghouse Electric Corporation
Power Circuit Breaker Division, Trafford, Pa. 15085
Printed in USA