



Westinghouse Electric Corporation  
Power Circuit Breaker Division  
Trafford, PA 15085

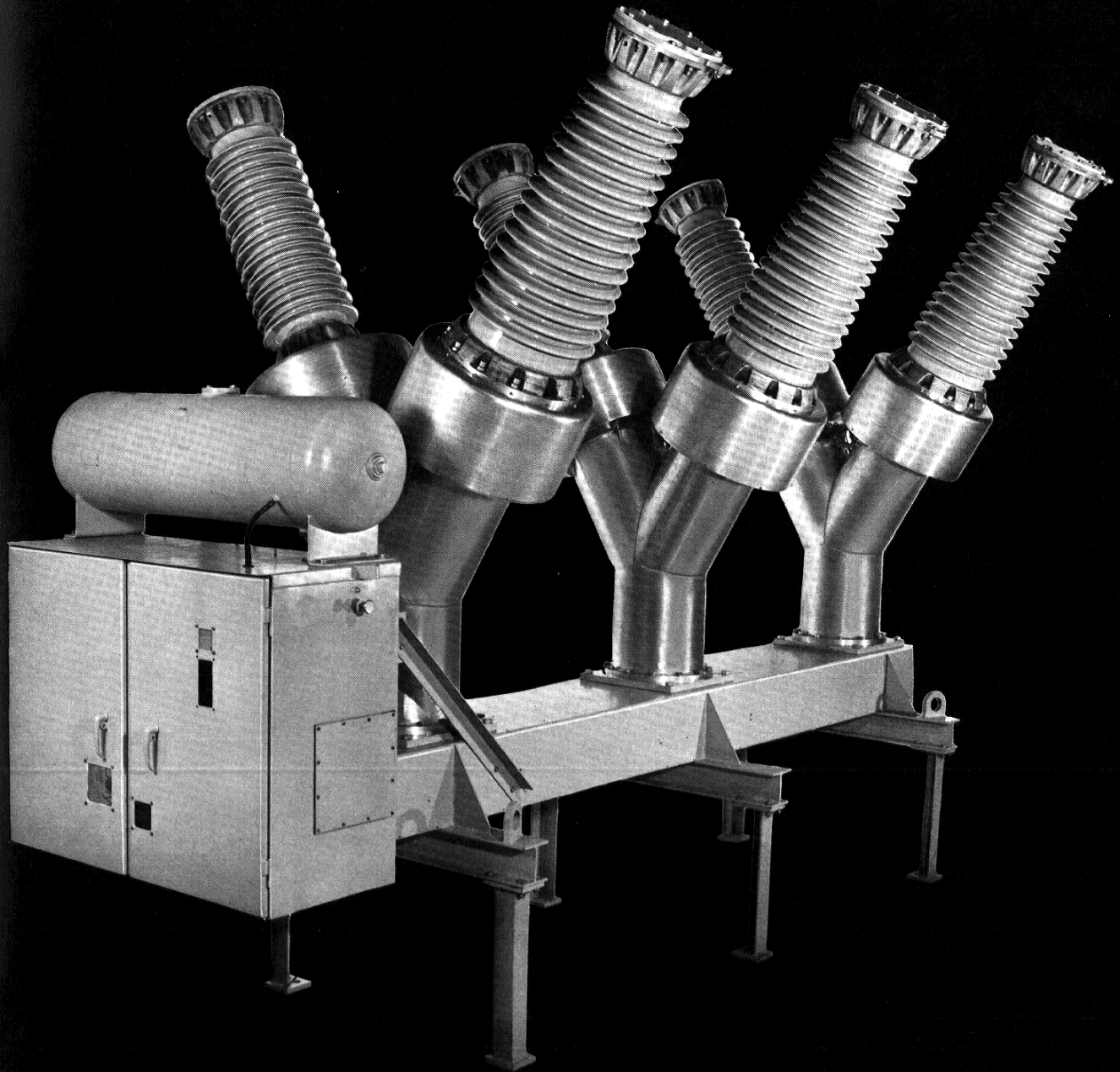
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New Information  
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General- and Definite- Purpose Breakers  
121 kV through 169 kV

## Type DWE SF<sub>6</sub> Puffer Power Circuit Breaker



### Application

Westinghouse type DWE breakers are designed as general-purpose breakers for 3-phase transmission application at voltages of 121, 145, and 169 kV. These breakers have an interrupting-current rating of 40 kA with continuous-current ratings of 2,000, 2,500, and 3,000 amperes.

Type DWE breakers meet the latest applicable standards of ANSI, IEEE, NEMA, and IEC for power circuit breaker ratings.

### Description of DWE Breakers

#### General

The type DWE power circuit breaker is a pneumatic operated dead-tank puffer breaker utilizing SF<sub>6</sub> gas in a sealed system at a single pressure (nominally 75 pounds per square inch, gauge). The type DWE has only one interrupting unit per phase. The interrupter is on one side of each phase unit and a porcelain bushing on the other side. The interrupting unit is essentially the same for DWE breakers of all voltage ratings.

The three phase units of the DWE breaker are mounted on a common support frame. The control and compressor cabinet is located on one end of the breaker frame.

Two externally mounted current transformers are provided for each phase. Additional current transformer can be supplied if required.

#### Modular Components

The DWE breaker is part of a family of SF<sub>6</sub> puffer breakers from Westinghouse which include the type LWE and LWER breakers which makes use of standard elements many of which are common to all ratings across the board.

### Main features

1. Simplicity of design and attractive appearance.
2. Single-pressure SF<sub>6</sub> gas system.
3. Dead-tank construction.
4. No internal adjustments required.
5. Designed and tested in accordance with latest applicable IEC and ANSI standards.
6. Unit manufacturing and production testing.
7. Light weight.
8. Small quantity of SF<sub>6</sub> gas required.
9. No gas service trailer or recovery unit is required.
10. Mechanism for open and close operations is pneumatic.
11. Minimal auxiliary equipment required.
12. Both SF<sub>6</sub>-gas and pneumatic systems operate at relatively low pressure.
13. Each phase has its own grounded tank for positive phase isolation.

### Resulting benefits

- Fast installation, no gas-handling equipment required
- Low operating cost
- Reduced frequency of maintenance
- Reliable performance
- No oil-fire hazard
- No need for oil containment pits
- See page 14 for more benefits and complete summary.

### Sulfur hexafluoride gas

Sulfur hexafluoride gas has superior dielectric characteristics. It is nonflammable, nontoxic and odorless. During interruption, the heat of the arc disassociates some SF<sub>6</sub> molecules into elemental products. Following extinction of the arc, practically all these products reform into SF<sub>6</sub> gas, quickly restoring dielectric strength.

### SF<sub>6</sub> technological leadership

Westinghouse has shipped over 3,000 SF<sub>6</sub> gas breakers since 1957. The resulting experience is translated into highly reliable SF<sub>6</sub> interrupters, sealing systems, and mechanical components.

The Westinghouse SF<sub>6</sub> experience has been recognized by the industry as demonstrated by the following facts:

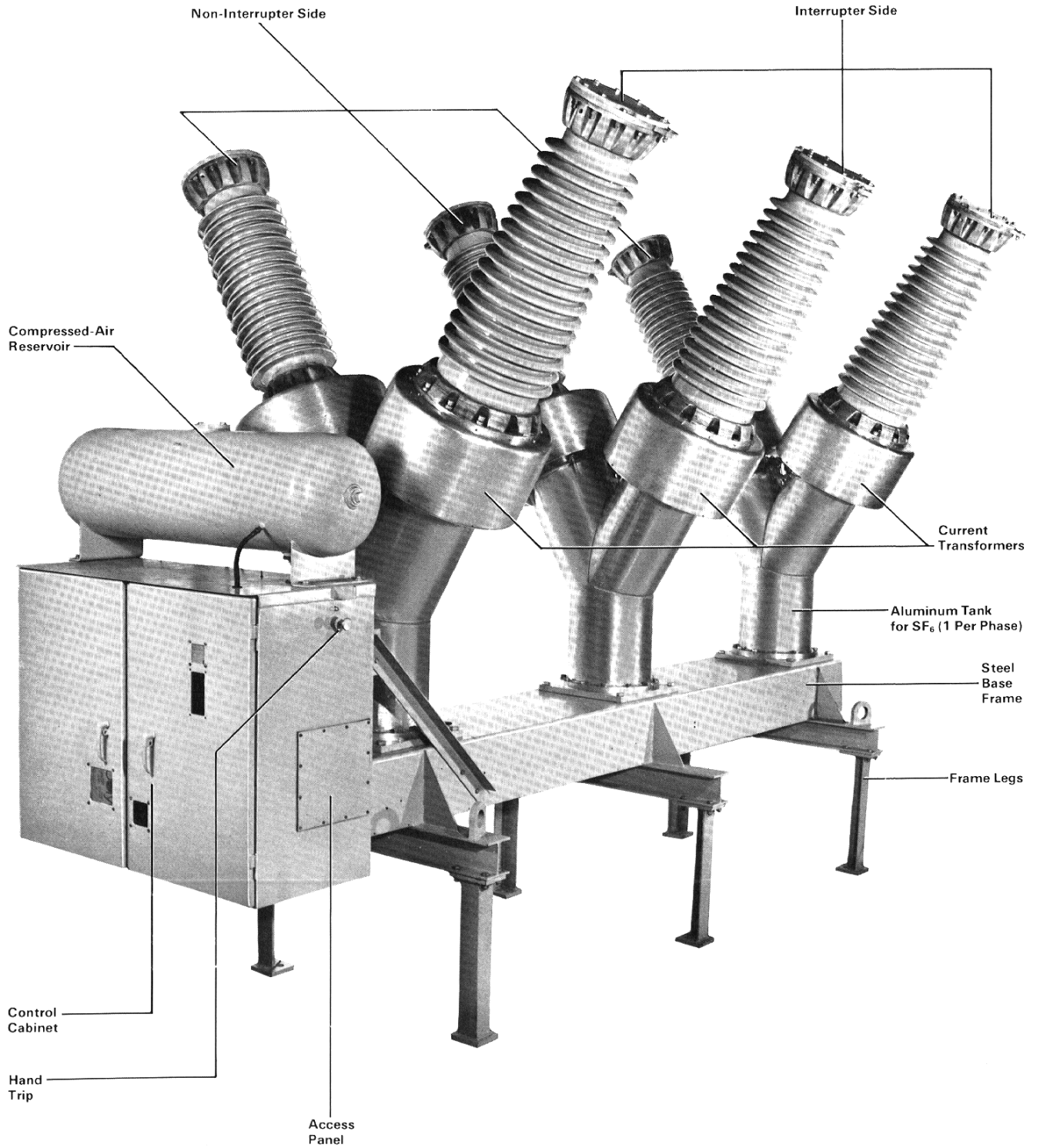
1. Westinghouse holds the original U.S. patent for the use of SF<sub>6</sub> gas as an interrupting medium and has been awarded over 300 SF<sub>6</sub> patents.
2. Westinghouse has shipped more SF<sub>6</sub> interrupters than all U.S. suppliers combined.
3. Prominent manufacturers, worldwide, have purchased SF<sub>6</sub>-technology license rights from Westinghouse.
4. Westinghouse has a long list of SF<sub>6</sub> firsts, including the first commercial SF<sub>6</sub> breaker, the first 550-kV SF<sub>6</sub> breaker, the first 90-kA SF<sub>6</sub> breaker and the world's first puffer SF<sub>6</sub> breaker.

### Reliability

The high reliability of DWE breakers is achieved and ensured through a carefully planned and coordinated program that includes four principal activities: design evaluation and modification, laboratory testing, environmental testing and supplier evaluation and monitoring.

### Manufacturing and testing

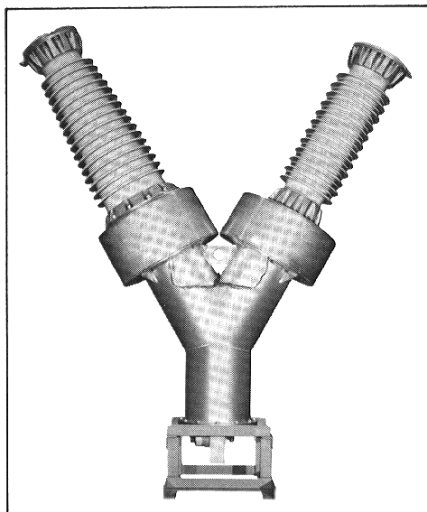
The DWE breaker is one of a family of breakers utilizing common components. Components are assembled into modules and tested using a manufacturing approach specially designed for these breakers. This approach has been successfully demonstrated by Westinghouse with the Type SP sub-transmission puffer breaker manufacturing line and also with the Type LWE EHV breaker manufacturing line.



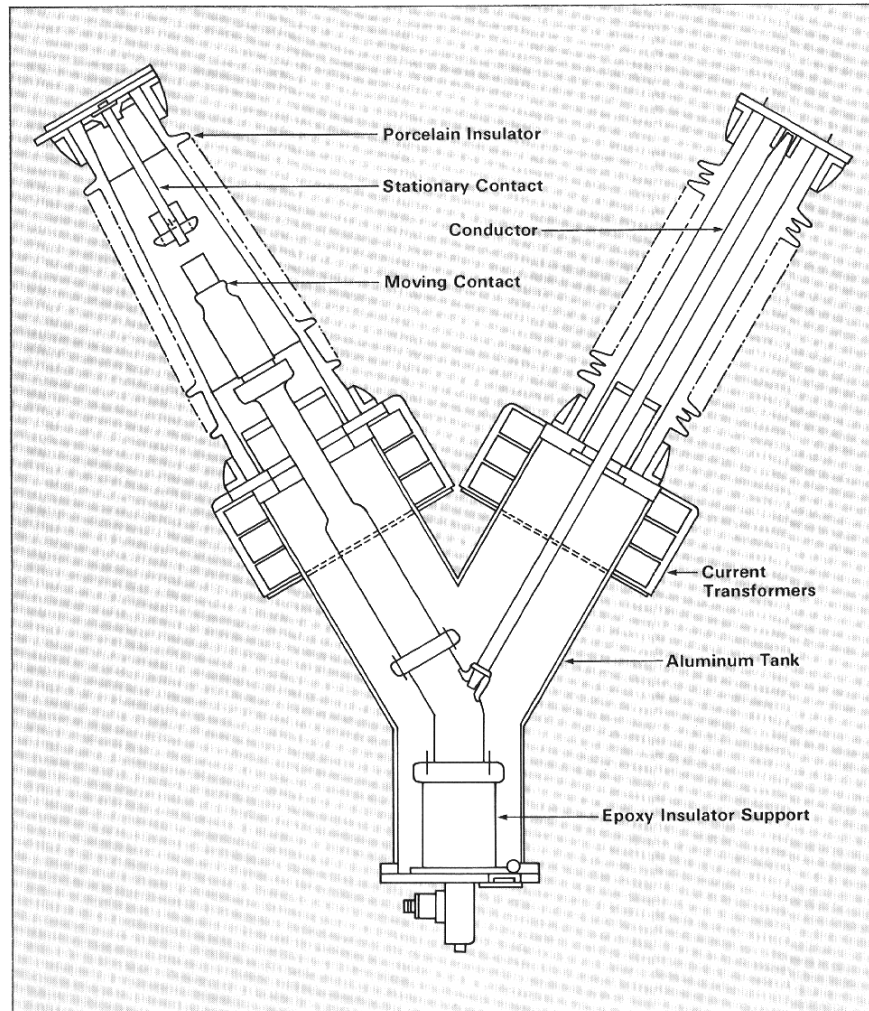
**Components Descriptions**

**Phase Unit**

Each type DWE phase unit consists of two porcelain enclosures — one contains the interrupter and the other contains the conductor to the non-interrupter opposite side terminal. These porcelain enclosures are mounted on a Y-shaped aluminum tank which contains the SF<sub>6</sub> insulating and interrupting gas. To make up a complete breaker, three of these phase units are mounted on a rectangular steel frame which acts as a lever box and housing for the linkages that operate the interrupters. The opening and closing force of the mechanism is transferred to the moving contact of the interrupter by the operating rod connected to the lever interphase connecting linkage which is coupled to the pneumatic operating mechanism.



Pole Unit



Pole Unit Details



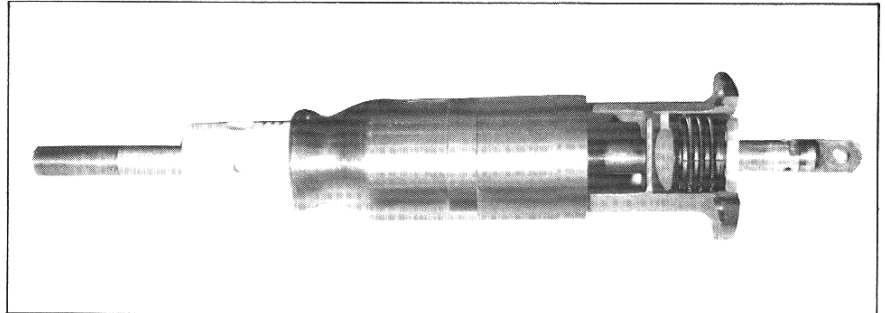
### Interrupter

The interrupters are single-pressure units, each composed of a stationary contact, a combination moving contact with associated gas-compressing cylinder and piston, Teflon arcing chamber, and current-carrying fingers. These interrupting components are identical for all 121-kV, 145-kV and 169-kV DWE breakers and also the same as for all LWE and LWER EHV breakers.

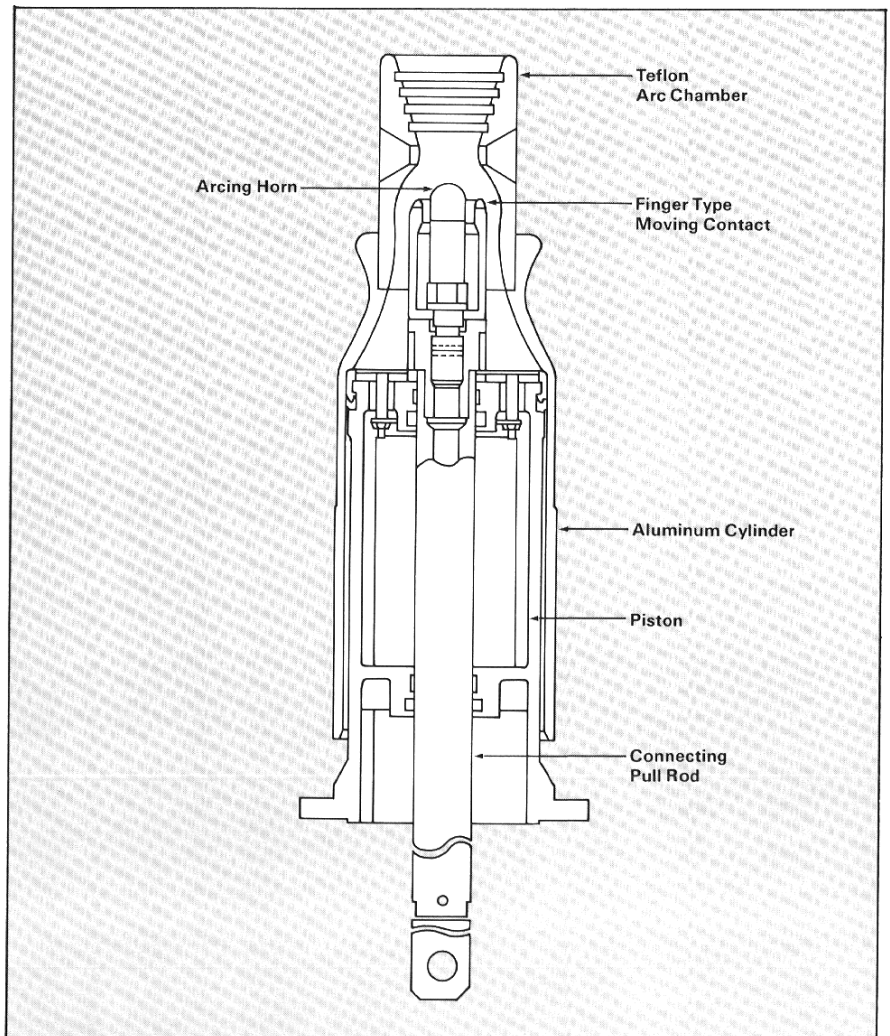
Each phase unit contains SF<sub>6</sub> gas at the low pressure of approximately 75 pounds per square inch gauge. At this gas pressure the clearances within the module are designed to support impulse-withstand voltages. At atmospheric pressures, these clearances will support 1.5 times normal line-to-ground system voltage.

The interrupter contacts are designed and constructed to minimize arc erosion of the contact parts that conduct current when the breaker is closed. The moving contact consists of a set of contact fingers, arranged concentrically about an arcing horn that extends beyond the fingers. On opening, the moving fingers break contact with the stationary contact and the arc quickly transfers to the arc-resistant tip of the stationary contact and the arc-resistant tip of the moving arcing horn. All arcing contacts are tipped with copper tungsten, an arc-resistant material used for years in all Westinghouse SF<sub>6</sub> breakers.

During production, each interrupter module is evacuated and filled with SF<sub>6</sub> gas to 75 pounds per square inch gauge and tested to verify gas-tight construction. At the conclusion of the test, the module's gas pressure is reduced to five pounds per square inch gauge for shipment. This procedure not only verifies gas-tight construction but has the additional advantage of permitting field installation without vacuum pumps and a gas trailer. No seals are made in the field.



Complete Interrupter Assembly



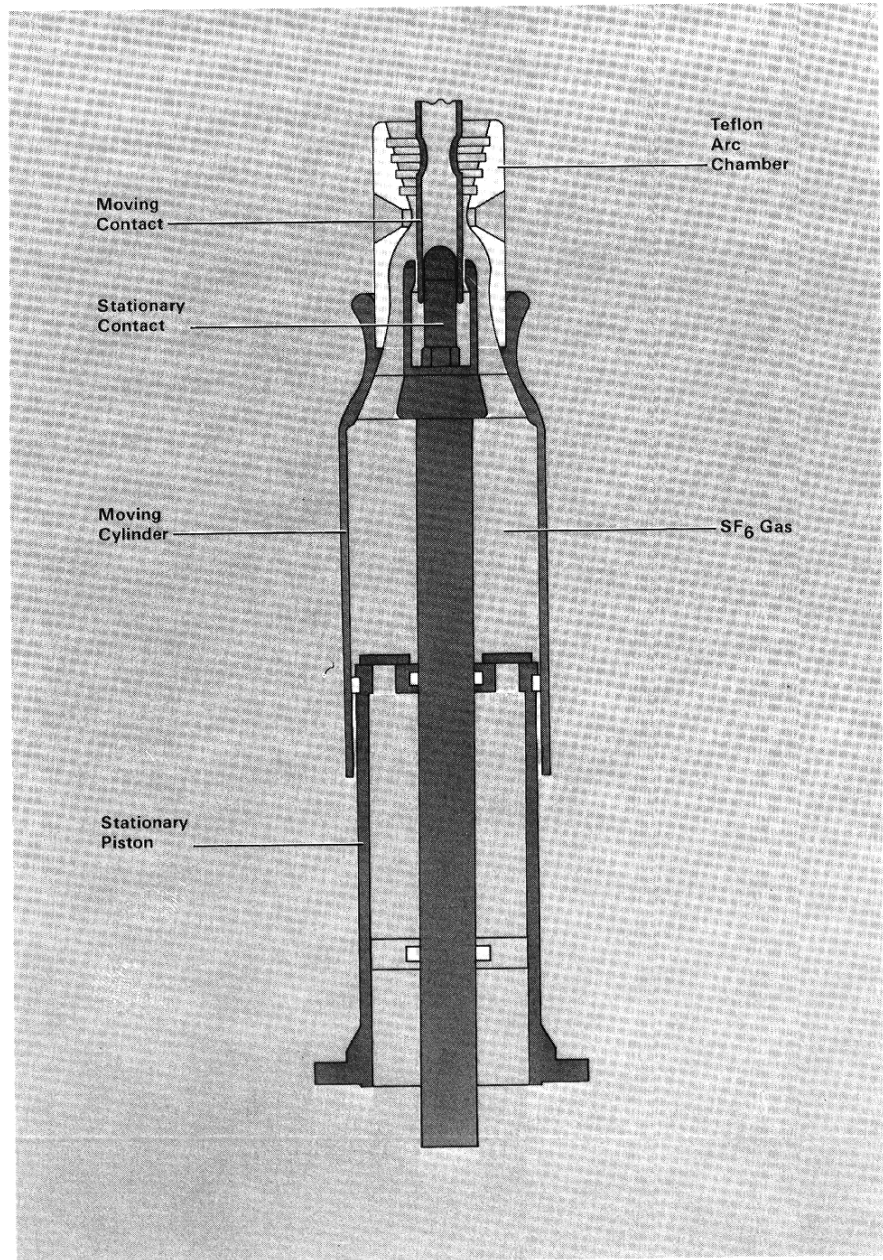
Interrupter Assembly Details

**Interrupter operation**

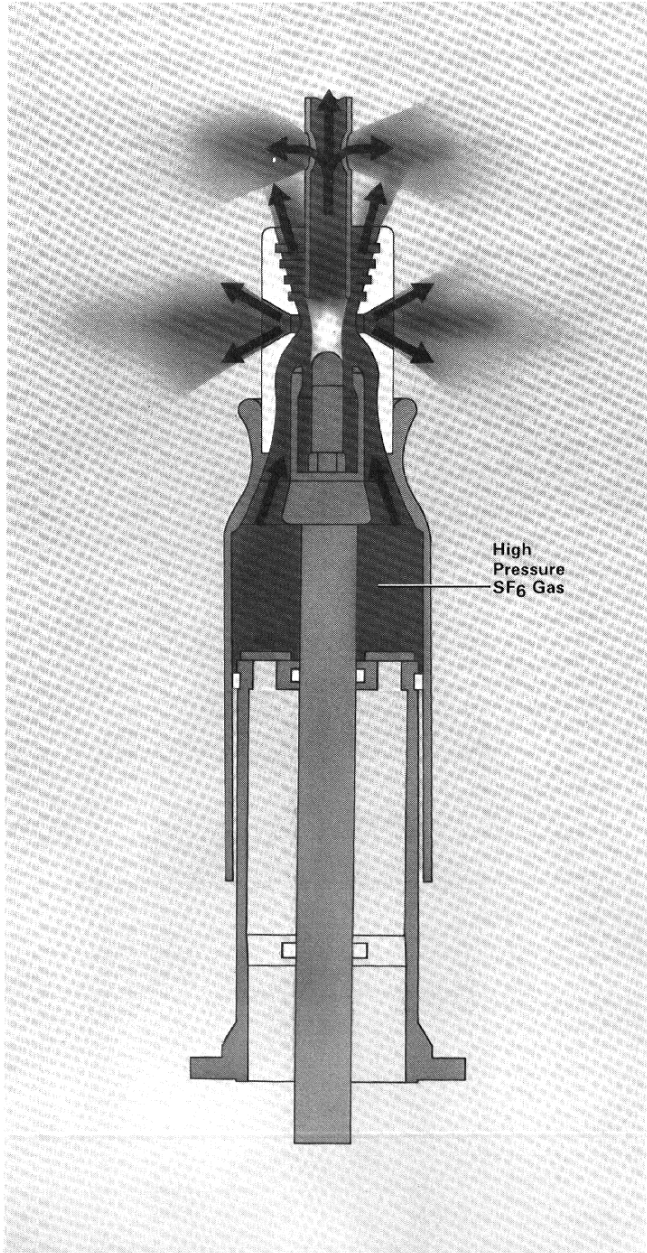
The SF<sub>6</sub> gas pressure required to interrupt the arc is generated by operating the moving contact assembly. No additional moving parts or valves are required. With the breaker closed, the SF<sub>6</sub> gas pressures inside and outside the moving contact cylinder are identical. When the contacts part, the resulting arc limits the flow of SF<sub>6</sub> gas out of the moving cylinder. The movement of the cylinder generates SF<sub>6</sub> gas pressure inside the cylinder between the arc and the stationary piston. Because the minimum interrupting pressure is proportional to the intensity of the arc, an automatic regulation of the SF<sub>6</sub> gas pressure is provided. The actual flow of compressed SF<sub>6</sub> gas sweeps away the hot arc gases, stretching, cooling and extinguishing the arc. At the end of this sequence of events, the SF<sub>6</sub> gas reverts to the single low pressure, ready for the next operation.

The stationary piston contains a flapper valve. This stays closed during the contact-opening motion of the moving cylinder but opens on the closing motion of the cylinder to permit SF<sub>6</sub> gas to quickly refill the moving cylinder during the closing operation.

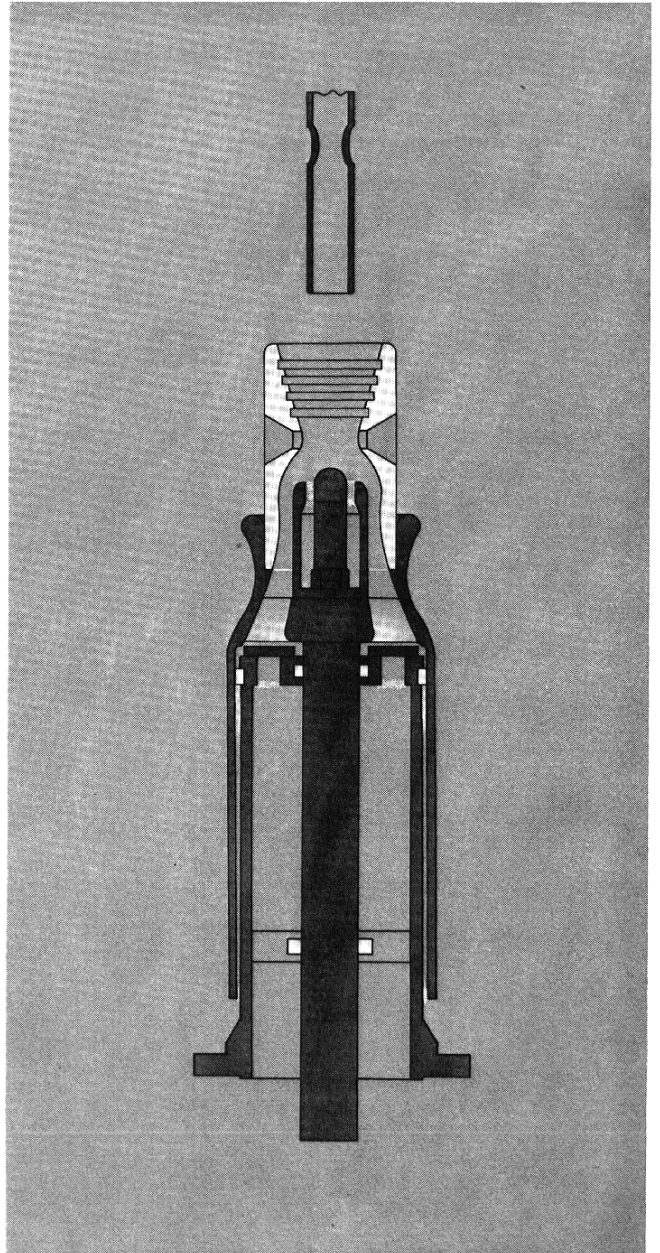
All mechanical parts are tested and adjusted at the factory to minimize the time required to put the breaker into service.



Closed Position



Partially Open



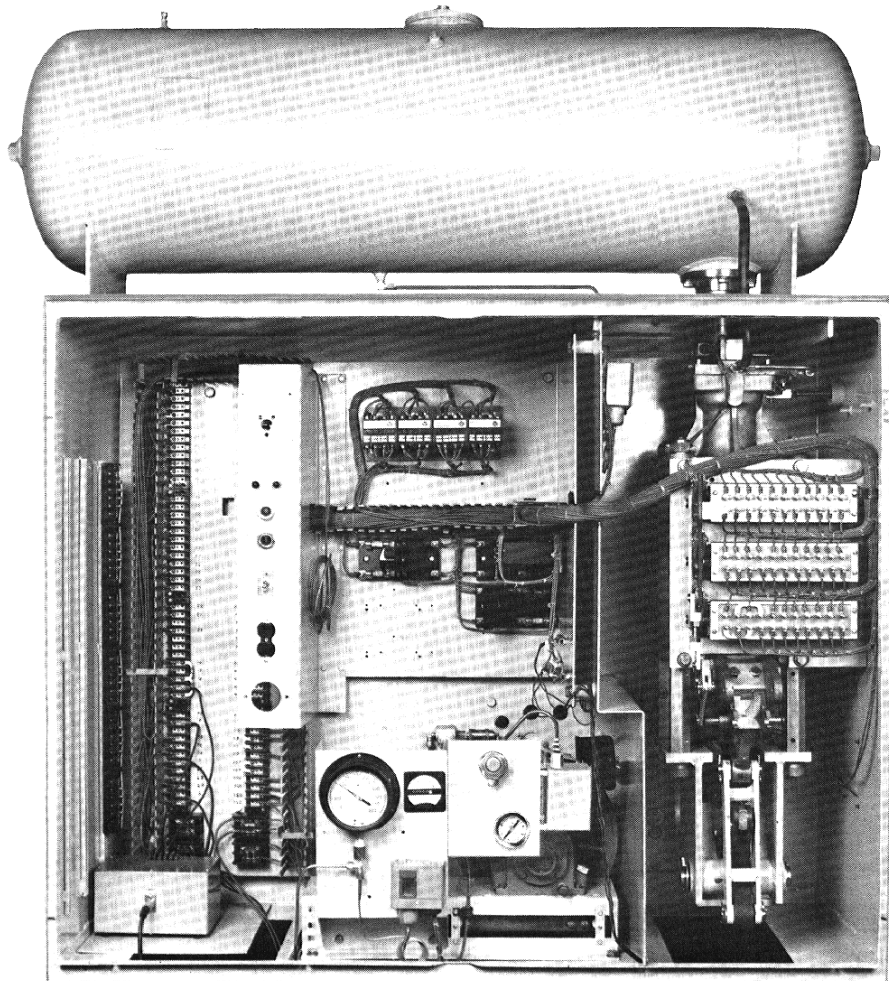
Open Position

**Control cabinet**

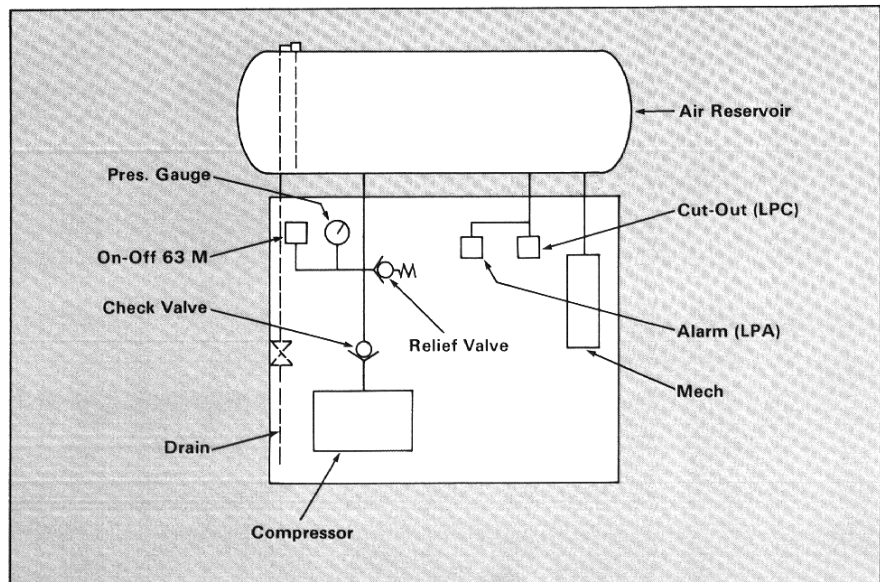
The control cabinet is designed for accessibility by maintenance personnel. It is mounted, at a convenient working height, at the end of the breaker, and has 2 doors that swing fully open. All components are spaced and arranged for convenient access.

The cabinet (see dimension drawings) contains various control relays, a timer for adjusting breaker reclosing, a control switch for closing and tripping the breaker, a set of terminal blocks for wiring connections and knife switches for disconnecting the control auxiliary power supplies. Cabinet heaters inside the control cabinet prevent condensation.

The cabinet also contains the controls and air supply system which produces the high pressure air that is stored in the reservoir which provides the force to open and close the breaker. A compressor and electric motor maintain the compressed air levels in the air reservoir mounted on top of the control cabinet. The total air system, including the air compressor, motor and all controls are similar to the components used in the Westinghouse AA10 mechanisms, which have been supplied for years with all 121- and 145-kV oil circuit breakers.



Control cabinet with mechanism mounted in right hand compartment.



Air System Schematic.



### SF<sub>6</sub> gas system

The low-pressure, low-volume gas design of the Westinghouse type DWE single-pressure breaker permits a minimum of gas handling during installation and maintenance. For all DWE breakers, the nominal SF<sub>6</sub> gas pressure is 75 pounds per square inch gauge. The complete 121- and 145-kV DWE breakers contain only 145 pounds of SF<sub>6</sub> gas (169-kV breakers contain 170 pounds).

All DWE single-pressure breakers are designed to minimize the possibility of losing SF<sub>6</sub> gas pressure. To meet this objective, the breaker's designers made use of static seals where possible, and used field-proven shaft seals where moving seals were unavoidable.

The breakers are shipped with a partial SF<sub>6</sub> gas pressure of five pounds per square inch gauge. This procedure has several advan-

tages. It eliminates the need for evacuation of the assembly at installation. In addition, the overall reliability of the breaker is enhanced because no internal component is subjected to moisture or contaminants during installation. The units are leak checked at the factory, eliminating any need for seals to be made in the field.

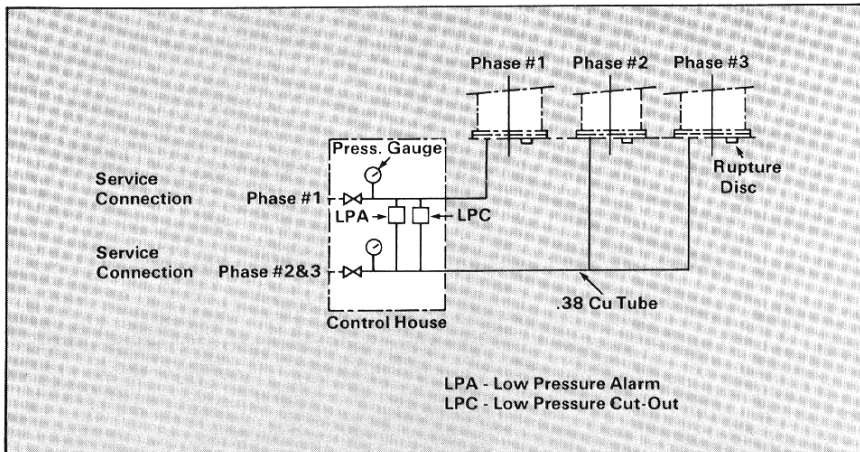
No vacuum pumps or gas carts are required to fill the breaker for service. Gas filling can be done very easily through convenient service connections. No special tools are required. To put SF<sub>6</sub> gas into the breaker, it is necessary only to connect a hose between the breaker and a cylinder of SF<sub>6</sub> gas.

When the breaker is in service, SF<sub>6</sub> gas pressure is monitored by a gauge and by a set of differential pressure switches that will energize alarm and cut-out circuits upon pressure loss.

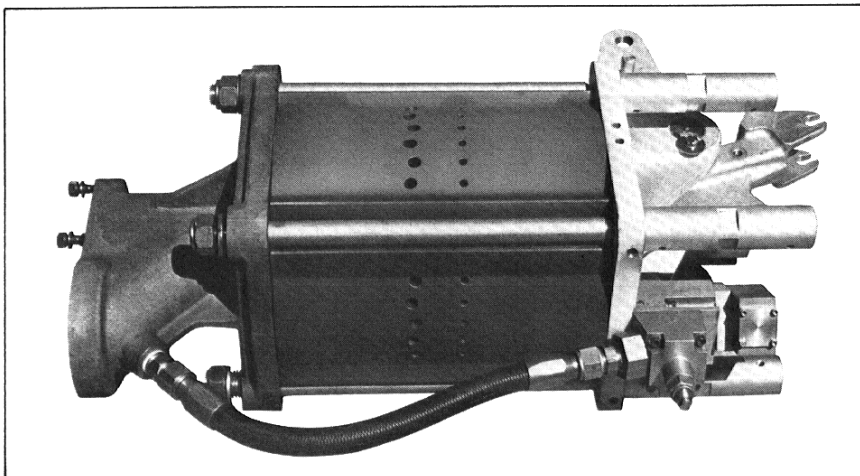
The Westinghouse Type DWE single-pressure breakers will continue to withstand 1.5 times line-to-ground voltage in the rare event that SF<sub>6</sub> gas pressure drops to one atmosphere.

### Operating mechanism

The operating mechanism is a pneumatic system having a double-action piston to open and close the breaker. The piston is moved by compressed air from the reservoir. Pneumatic operation provides required pressure throughout the opening and closing strokes, resulting in smooth breaker operation. A hydraulic dashpot system dampens the mechanical forces after air operation.



Gas Control Schematic



Operating Mechanism (on side)

**Opening sequence**

Tripping is initiated by energizing the pilot-valve trip coil. This permits air to flow through the pilot valve and force the opening valve open to allow compressed air to flow from the reservoir thus moving the main piston. When the main piston passes the first set of exhaust holes ('closing exhaust port'), air is trapped providing a dashpot action to help cushion the mechanical forces. This trapped air exhausts through an opening (not shown) at the other end of the mechanism, so there is no air pressure on that side of the piston when the breaker is in the "full-open" position. This motion of the mechanism piston moves the levering system and operating rod, opening the breaker contacts and interrupting the arc.

When the piston passes the other set of exhaust ports, the compressed air above the piston is rapidly exhausted so the closing stroke can be initiated without delay. At this point, the mechanism lever has moved past toggle and the breaker stays in the open position without the use of latches.

**Closing sequence**

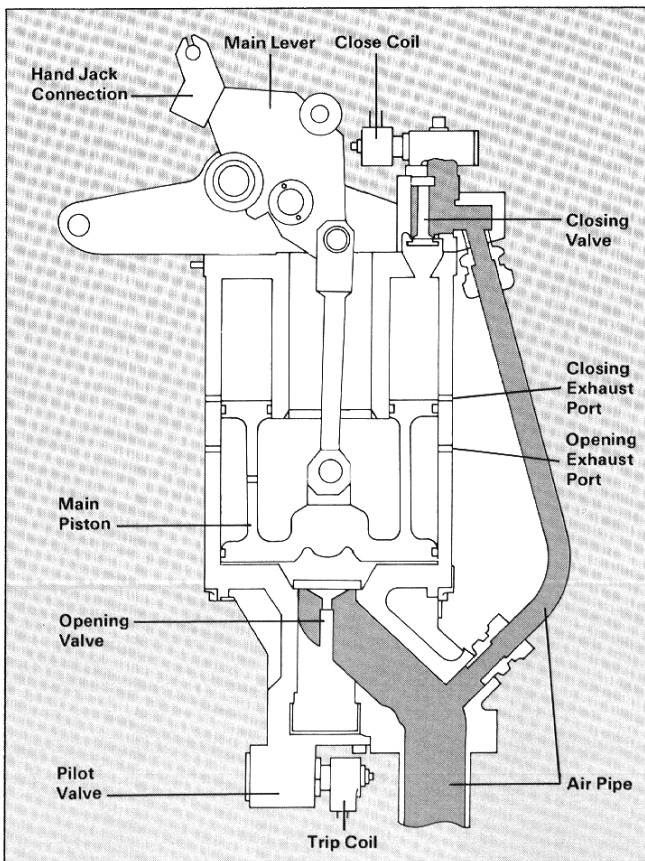
The closing operation is similar to the opening operation. Energizing the pilot-valve closing coil permits compressed air to flow into the main closing valve. When this valve opens, compressed air from the reservoir flows against the main piston moving it toward the closed position along with the breaker contacts, the levering system and the operating rod. As the mechanism reaches its closed position the closing air is exhausted through the ports in the cylinder wall and ports in the three way main close valve. A spring holds the mechanism and breaker in the closed

position. A position indicator in each mechanism shows the position of the main piston and, in effect, the position of the breaker contacts.

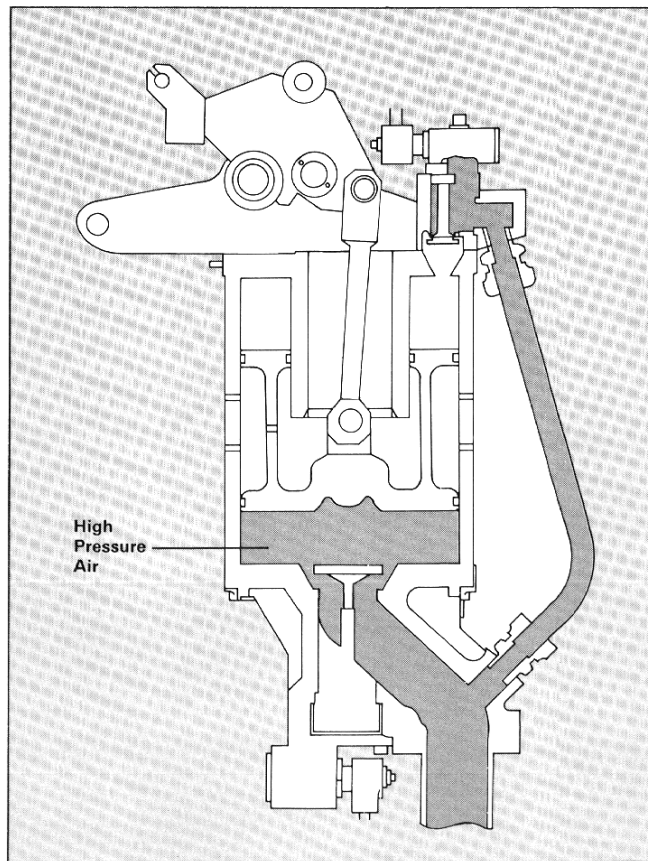
The mechanism housing contains the required 11-pole auxiliary switch plus heaters to prevent condensation within the mechanism unit. Compressed-air pressure is maintained by the compressor in the control cabinet.

The type DWE mechanism incorporates the accumulated design and engineering experience from thousands of Westinghouse type AA and type AH mechanisms mounted on oil and SF<sub>6</sub> gas breakers.

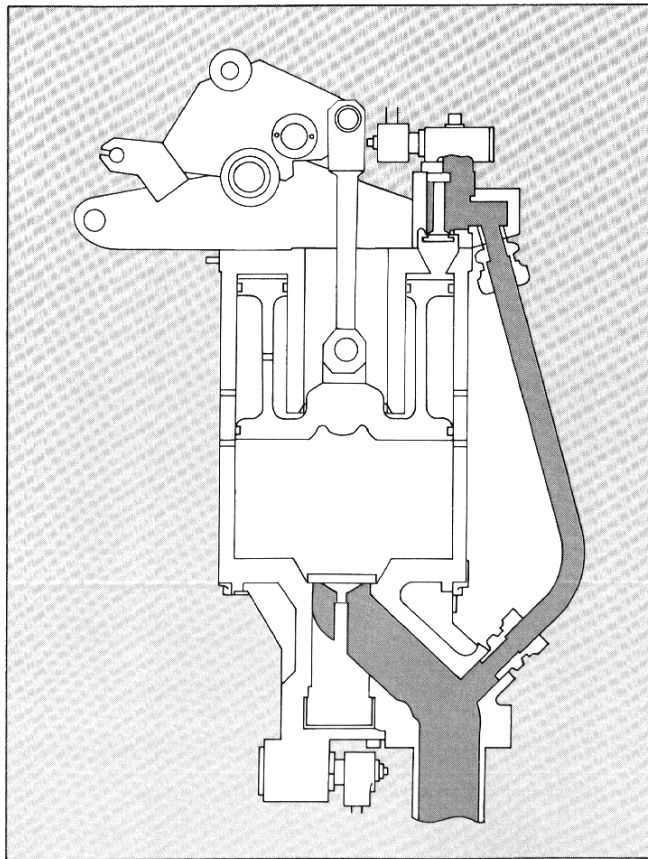
The mechanism sequence shown for the closed, opening, open, and closing positions are for the LWE breaker which is the same mechanism used on the DWE breaker.



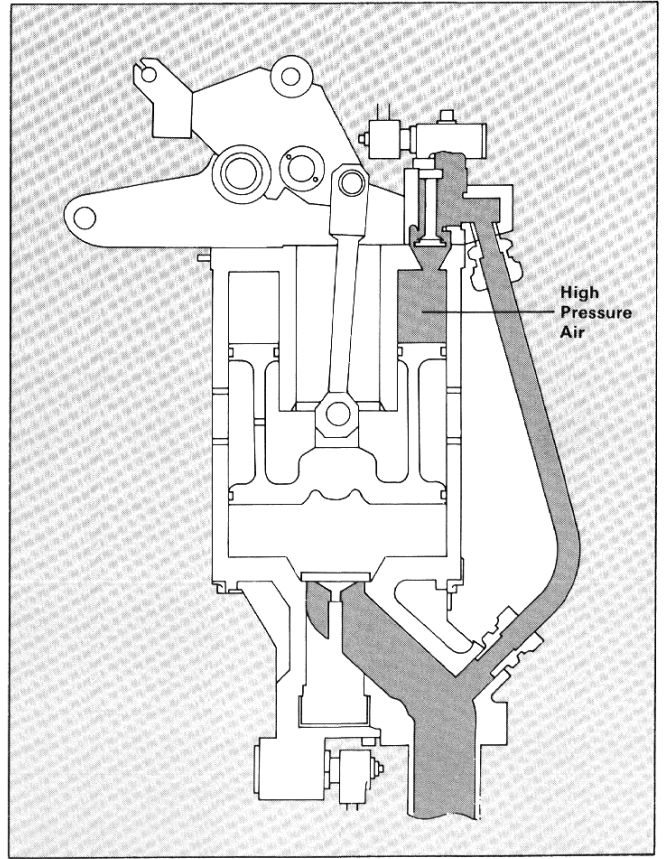
Closed



Opening



Open



Closing

**DWE Circuit Breaker Ratings** — For other values contact Westinghouse

	121 DWE 40	145 DWE 40	169 DWE 40
Rated maximum voltage (kV)	121	145	169
Rated voltage range factor (k)	1.0	1.0	1.0
Rated low-frequency insulation withstand voltage (rms-kV)	260	310	365
Rated full-wave impulse insulation withstand voltage (crest kV)	550	650	750
Continuous-current rating (A)	2000, 2500 or 3000	2000, 2500 or 3000	2000, 2500 or 3000
Normal frequency (cycles)	60	60	60
Closing and latching current capability (kA)	64	64	64
Short-time current-carrying capability (kA)	40	40	40
Rated short-circuit current-interrupting rating at maximum kV (kA)	40	40	40
Maximum asymmetrical interrupting current capability (kA)	48	48	48
Percent of current rating for 15-second reclosing duty cycle (%)	100	100	100
Opening time from energizing of trip coil to main contact parting (ms)	18	18	18
Closing time (ms)	90	90	90
Maximum interrupting time (cycles)	3	3	3
Net weight of circuit breaker (approximate)			
with SF <sub>6</sub> (lbs)	10,000	10,000	11,000
without SF <sub>6</sub> (lbs)	9,850	9,850	10830

**Specification Details**

**Type DWE Breakers**

**Includes the following Bill of Material:**  
 Breaker for mounting on a welded base and structural steel subframe painted ANSI No. 70 light gray with the required charge of SF<sub>6</sub> Gas.

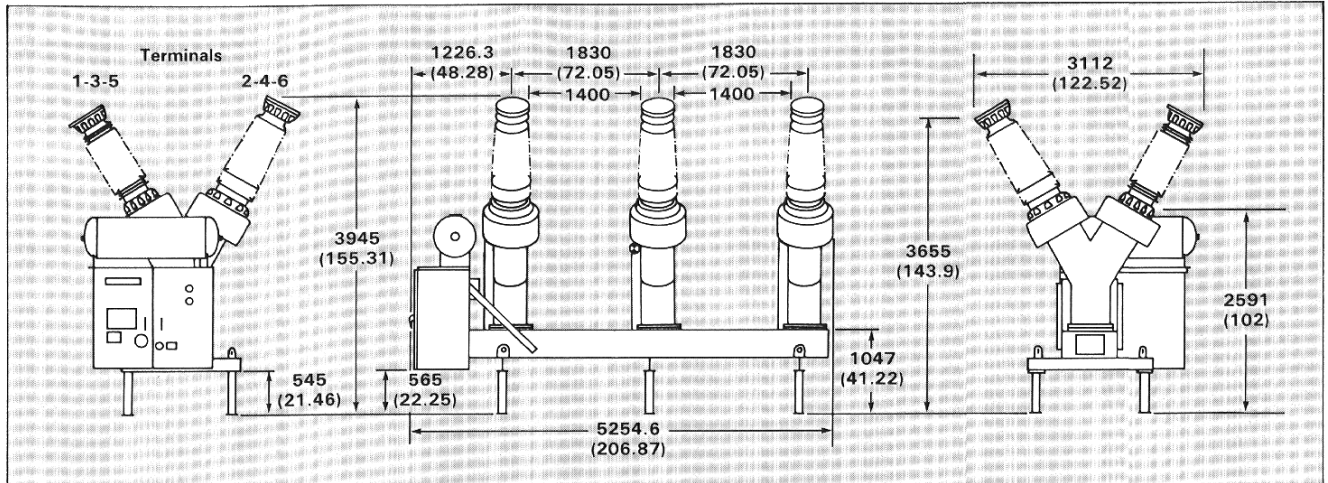
- 1 — ANSI No. 70 Light Gray Subframe
- 6 — Porcelain casings, ANSI No. 70 light gray.
- 3 — Interrupters (one per phase).
- 6 — Multi-ratio relaying accuracy current transformers.
- 1 — "Open" and "closed" position indicator.
- 2 — SF<sub>6</sub> gas service connection fittings.
- 2 — Ground pads.

**Weatherproof mechanism housing containing:**

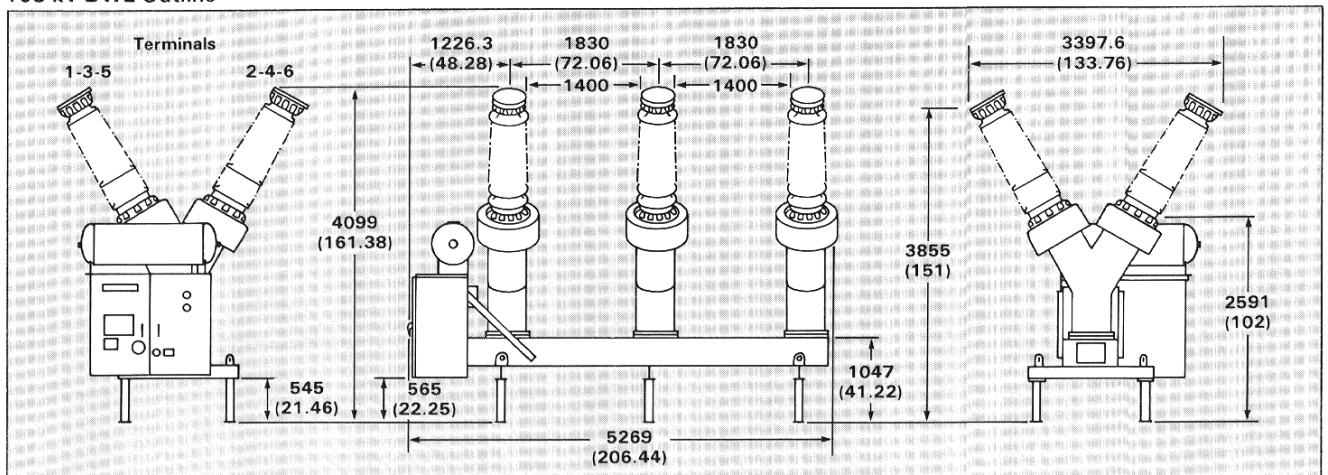
- 1 — Set of gas control equipment with pressure gauges and differential pressure switches for low pressure alarm and cut-out.
- 1 — Pneumatic closing mechanism, suitable for use at a specified voltage of 48, 125 or 250 volt DC operation. (Specify)
- 1 — Shunt trip coil, suitable for use at a specified voltage of 48, 125 or 250 volt DC operation. (Specify)
- 1 — Set terminal blocks for current transformer secondary leads.
- 1 — Set of terminal blocks for user's auxiliary power and control connections.
- 1 — Air compressor and reservoir, compressor motor single-phase 115 or 230 volt AC operation, as specified.
- 1 — Pneumatic system pressure gauge and window.
- 1 — Pneumatic system low pressure alarm.
- 1 — Pneumatic system low pressure cutout switch.
- 1 — Pneumatic system governor.
- 1 — Set space heaters, one arranged for continuous operation, and one controlled by a non-adjustable thermostat. (Heater guards provided)
- 2 — Eleven-pole auxiliary switches.
- 1 — Operation counter.
- 1 — Set of control relays.
- 3 — Two-pole fused knife switches, one for DC control power, one for single-phase auxiliary power, and one for compressor motor circuit.
- 1 — External hand trip device.
- 1 — Set of special maintenance hand tools per station.



### 121/145 kV DWE Outline



### 169 kV DWE Outline



Dimensions in millimeters  
( ) = inches

Above dimensions are approximate and not to be used for construction purposes without approval.

**Summary of DWE breaker design features:**

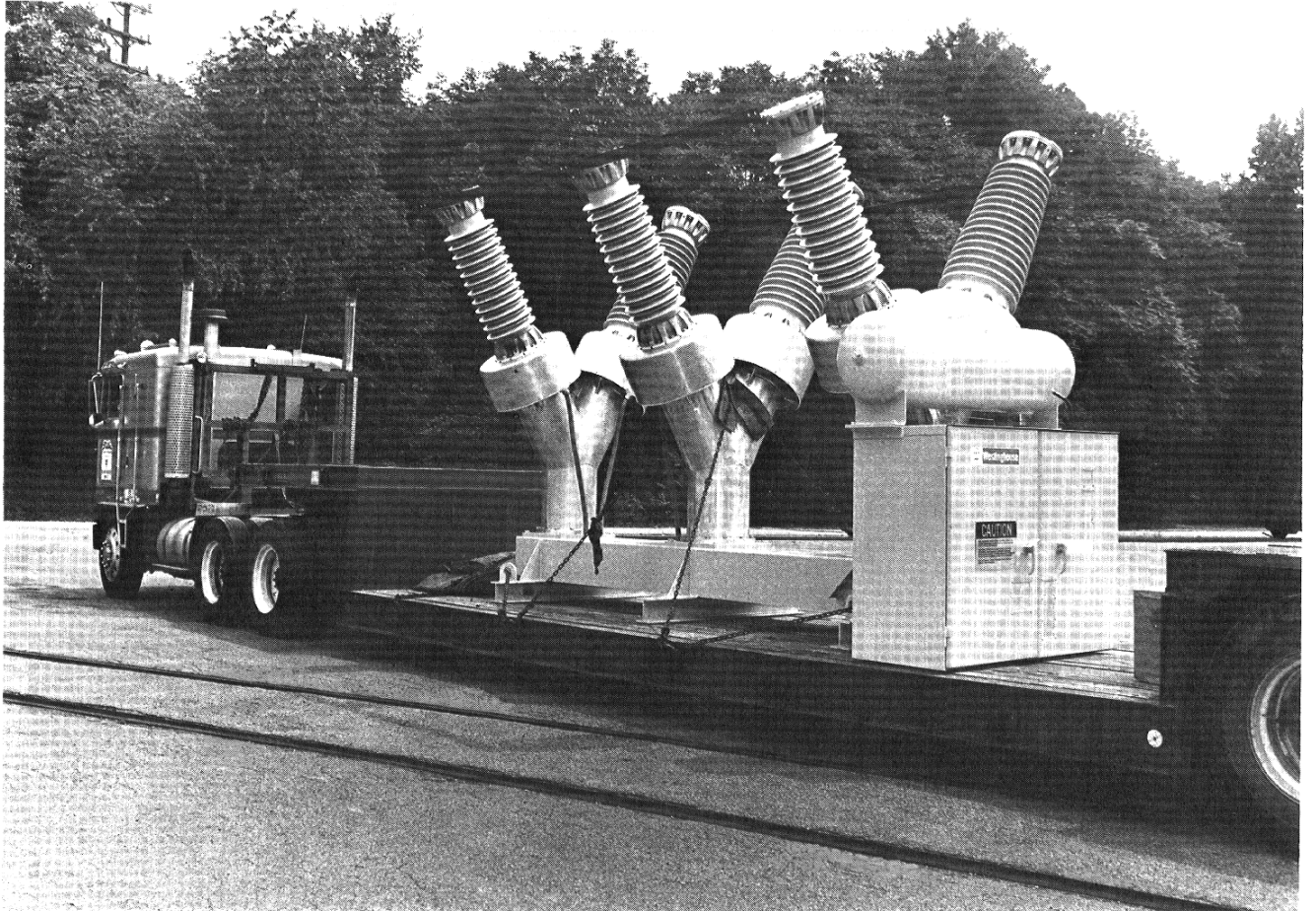
1. Simplicity of design and eye-appealing appearance.
2. Dead-tank construction.
3. Light weight.
4. Minimum dimensions.
5. Low profile.
6. Small quantity of SF<sub>6</sub> gas required.
7. Both the SF<sub>6</sub> and the pneumatic systems operate at relatively low pressure.
8. Pneumatic mechanism for open and close operations.
9. Minimal auxiliary equipment is required.
10. Simple double-acting pneumatic mechanism has no latches — contacts are biased closed by springs and held open by toggle linkage and springs.
11. Rigid mechanical connections between the interrupting elements and the operating mechanism ensures simultaneous operation of the phase units.
12. No internal adjustments required
13. Operation of the breaker does not impose a dynamic load on the foundation. Since the breaker is lightweight, it requires only a minimal foundation.
14. Unit manufacturing and production testing.
15. Designed and tested in accordance with latest applicable IEC and ANSI standards.
16. The integrity of gas seals is not disturbed during installation: the modular components are sealed and leak checked at the factory and shipped and installed without pulling a vacuum and removing the SF<sub>6</sub>.
17. Three grounded metal tanks provide positive phase isolation (which single tank designs cannot provide).
18. Externally mounted current transformers.

**Summary of benefits derived from DWE design features:**

1. Pleasing appearance makes the DWE breaker particularly suitable for substations in semi-residential areas.
2. Low foundation cost because of reduced foundation shock.
3. Reduced installation time and low overall installation cost.
4. Low operating cost because of minimum auxiliary power with fewer and faster routine inspections and servicing than would be required by oil, compressed-air or two-pressure SF<sub>6</sub> breakers.
5. Reduced frequency of major maintenance.
6. Reliable operation — outstanding insulation and arc-quenching properties of SF<sub>6</sub> gas minimize the degradation of arcing components.
7. Maximum operating protection and reliability — breaker withstands 1.5 times line-to-ground voltage at one atmosphere gas pressure.
8. No pre-striking excessive pressure in the arcing chamber when closing on short circuit conditions or switching capacitor banks.
9. Interruption of magnetizing currents without excessive over voltage.
10. Restrike-free switching of capacitance currents — the result of the quick dielectric recovery rate of the SF<sub>6</sub> gas and DWE puffer interrupter design characteristics.
11. Quick interruption of fault currents: 3 cycles on 60-Hz basis, without derating for high-speed reclosing as required on oil breakers.
12. Eliminates the potential fire hazard associated with oil breakers.
13. No need for oil containment pits, oil handling equipment or oil test equipment.
14. DWE modular construction reduces costs associated with inventory of spare parts. Most components are common to the full line of breakers at EHV and the DWE ratings — interrupting elements, insulator, control panels, frames, etc.
15. Sealed design eliminates the potential for moisture contamination during transportation.
16. No gas handling service trailer or gas recovery facilities are required.
17. No SF<sub>6</sub> seals to make in the field, therefore less chance of leaks.
18. Because each phase is contained in a separate grounded tank, any internal breaker faults will be single-phase-to-ground faults. This benefit alone justifies the DWE in comparison to equivalent single-tank breakers in which single-phase-to-ground internal breaker faults are virtually certain to become the more-serious three-phase faults.

**User Selection**

The DWE breaker, with its many beneficial design features, provides more short-term and long-term savings than typical previous transmission-class breaker models. These features and benefits have been summarized to aid in selecting the most economical breaker to purchase. Your Westinghouse salesman will give more details, on specific inquiry.



Although the transportation mode may be different for specific shipments, a typical truck shipment will be as shown above.