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34.5 Kv High Voltage Metal-Clad Switchgear, with Type SFP Magnetic Puffer Circuit Breakers

23 to 34.5 Kv
1500 Mva Interrupting Capacity

Application

Westinghouse 34.5 kv high voltage metal-clad switchgear, with drawout Type 345-SFP1500 magnetic puffer circuit breakers, provides at higher voltages all of the control and protection features long associated with metal-clad switchgear at 5 and 15 kv. This high voltage metal-clad switchgear is available for application on systems with voltages from 23 to 34.5 kv with a maximum interrupting capacity of 1500 mva.

Typical applications include electric utility systems, and industrial, municipal, or transportation systems where power is obtained or distributed at 23 to 34.5 kv.

Advantages

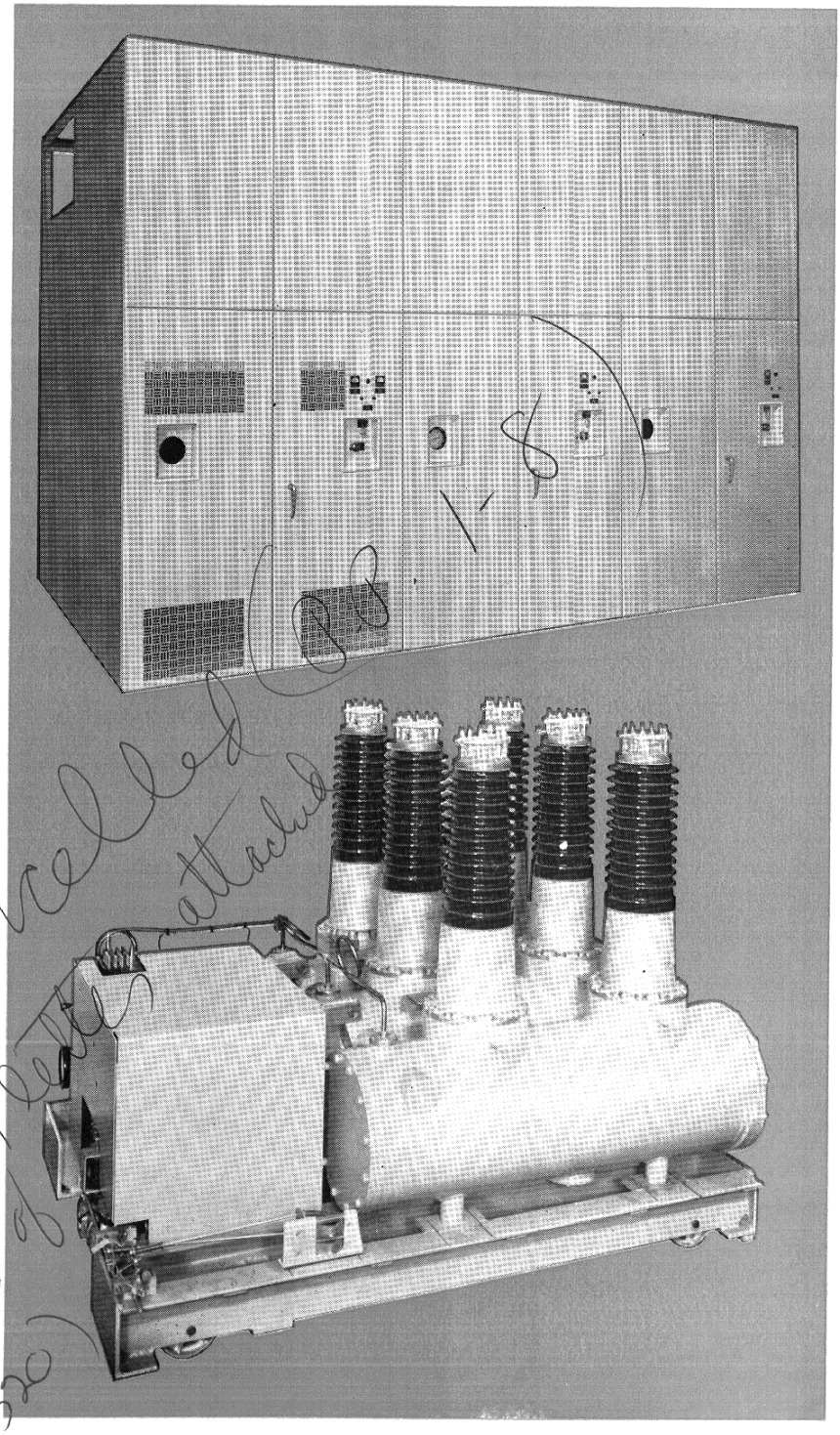
Greatly Reduced Floor Area

Drawout Construction

Low Pressure SFP Magnetic Puffer Circuit Breaker:
- Completely Enclosed Interrupters
- No External Auxiliaries
- Quiet Operation
- 3 Cycle Interrupting Time

Ease of Field Assembly

Full Metal-Clad Switchgear Integrity



August, 1967
New Information
E, D, C/1942/DB

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Ratings

The Type 345SFP1500 circuit breaker is rated as follows (by the methods of ASA Standards, Symmetrical Basis of Rating):

Nominal Voltage Class.....34.5 Kv
Nominal 3-Phase Mva.....1500
Rated Maximum Voltage.....38 Kv
Rated Voltage Range Factor.....1.65
Rated Withstand Test Voltage
  Low Frequency, rms.....80 Kv
  Impulse, Crest.....150 Kv
Rated Continuous Current
  at 60 HZ.....1200 and 3000A
Rated Short Circuit Current
  at Rated Maximum Kv....22,800A rms
Rated Interrupting Time.....3 cycles
Rated Permissible Tripping Delay...2 sec.
Rated Maximum Voltage Divided
  by Voltage Range Factor.....23 Kv
Maximum Symmetrical
  Interrupting Capability.....37,600A rms
3-Second Short-time
  Carrying Capability.....37,600A rms
Closing and Latching
  Capability.....60,200A rms

Magnetic Puffer Interrupter

The type SFP single pressure gas filled circuit breaker utilizes a new concept for arc interruption called the magnetic puffer. The interrupter consists of a pair of separable contacts, a piston and a cylinder all mounted in a tank containing SF_6 gas at 75 psig. As the contacts are parted, the piston moves to drive the gas in the cylinder thru the arc to interrupt it. Under fault conditions, the short circuit current itself provides most of the driving force necessary to operate the interrupter.

Three magnetic coils are incorporated in the interrupter, one stationary and two moving. One moving coil forms part of the piston which drives SF_6 gas thru an orifice to extinguish the arc. The other moving coil called the driver coil is connected to the piston coil by connecting rods. When the breaker is closed, the driver coil is close to the stationary coil and the piston coil is approximately 7 inches from the stationary coil. The coils are wound in such a way that as the breaker starts to open and the current starts to flow thru the coils, a force of repulsion is developed between the stationary coil and the driver coil and a force of attraction is developed between the stationary coil and the piston coil.

A mechanical and electrical schematic of the main parts of the interrupter with the contacts in the closed position is shown in Figure 1. Figure 2 is similar except that the contacts are parted slightly as they would be during an interruption. The arrows on the electrical schematics indicate the current path through the interrupter.

When the contacts are in the closed position, the three magnetic coils are not in the circuit because the arcing contacts (5) are open. During an interruption arcs are first drawn on the main contacts (2 and 4) maintaining the same current path shown in Figure 1. As the contacts move, the arc on the front main contacts (2) quickly transfers to the arcing contacts (5) and the arc on the rear main contacts (4) is extinguished since the current path through the main contacts is then paralleled by the lower impedance current path shown in Figure 2. After the transfer, the current path is through the arc across the arcing contacts (5) and then through the three magnetic coils (7, 9 and 12). With this circuit established, the magnetic forces are developed which assist the motion of the interrupter piston.

In addition to the basic interrupting ability of the magnetic puffer interrupter, there are several other advantages to this type of construction. There is complete freedom from fire hazard, because the interruption takes place in an atmosphere of SF_6 gas. Since the interruption takes place inside a sealed pressure vessel, there is very little interruption noise. The SF_6 gas system is self-contained and sealed so no separate tanks, external piping, compressors, or blast valves are required.

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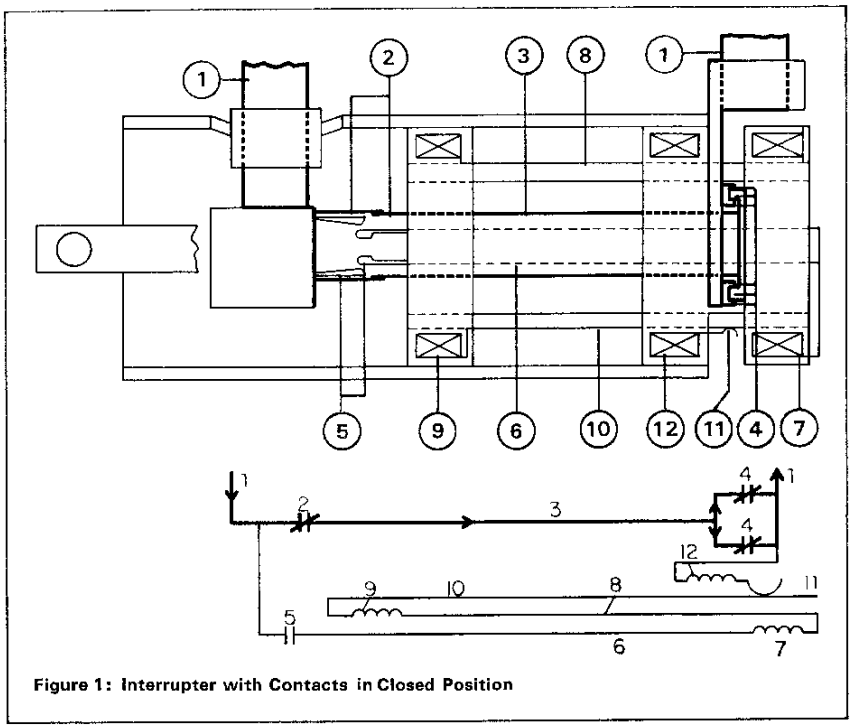

Figure 1: Interrupter with Contacts in Closed Position

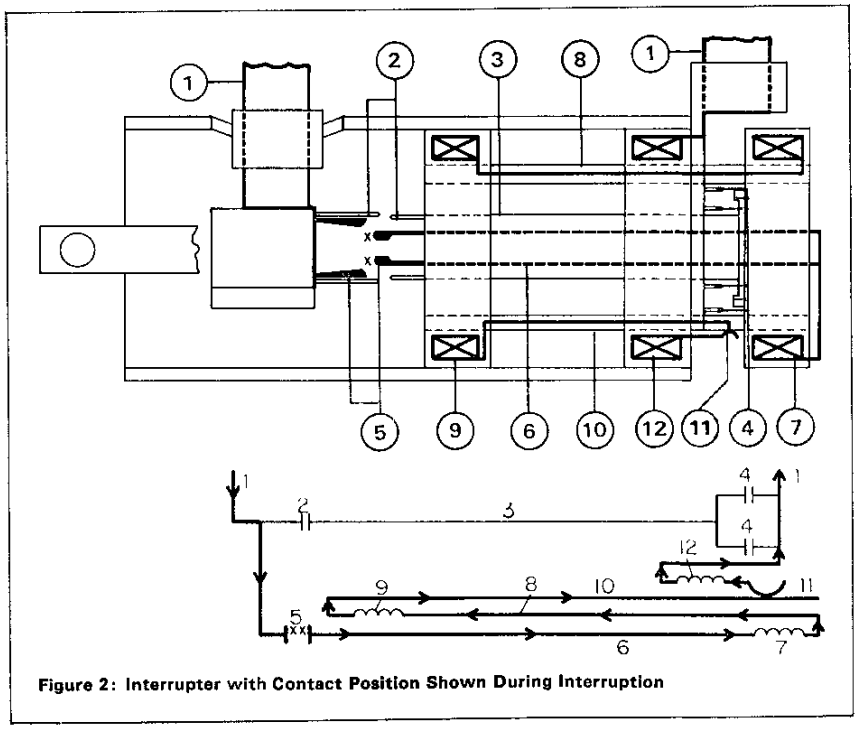

Figure 2: Interrupter with Contact Position Shown During Interruption

Legend

1. Primary Bushings
2. Front Main Contacts
3. Main Moving Contact Tube
4. Rear Main Contacts
5. Arcing Contacts
6. Moving Arcing Contact Tube
7. Driver Coil (Moving)
8. Upper Guide Rod
9. Piston Coil (Moving)
10. Lower Guide Rod
11. Sliding Ball Contact
12. Cylinder Coil (Stationary)

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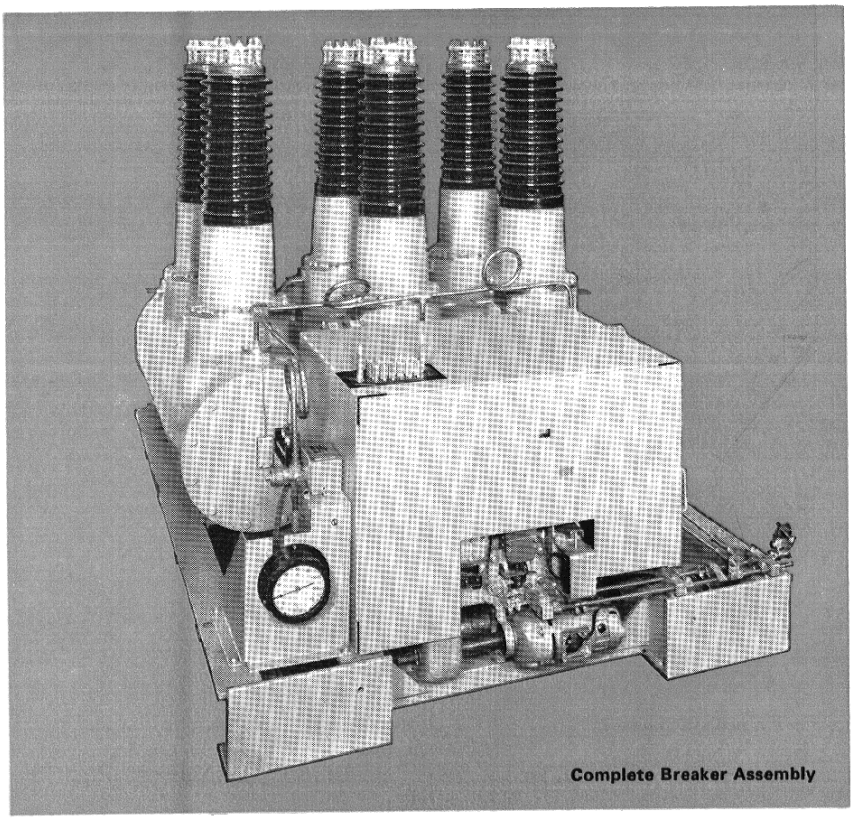


Complete Breaker Assembly

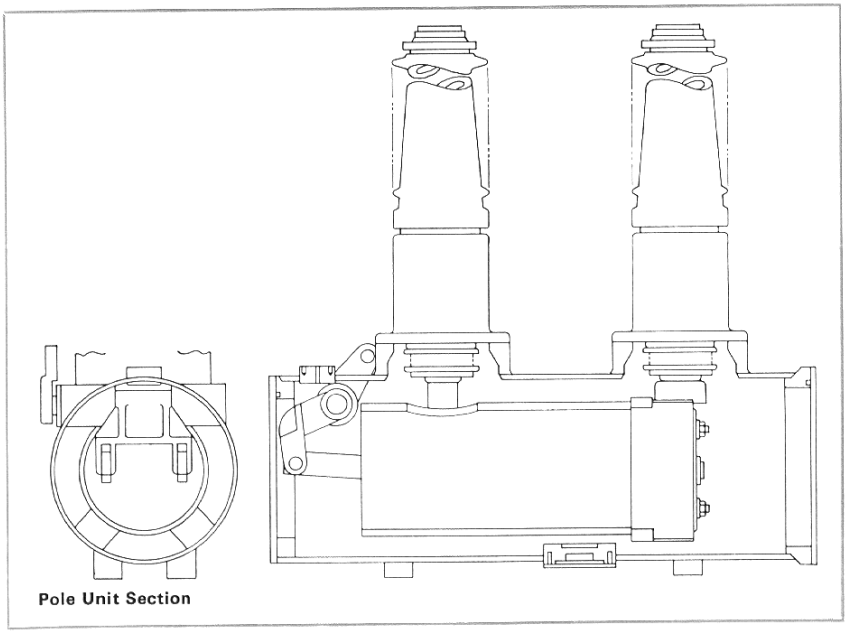
Breaker Assembly

A complete Type SFP circuit breaker assembly consists of three pole units, an operating mechanism, and the associated controls and interlocks mounted on a welded angle iron frame. It is the drawout element for use in high voltage metal-clad switchgear, and is designed to roll on the floor for ease of handling.

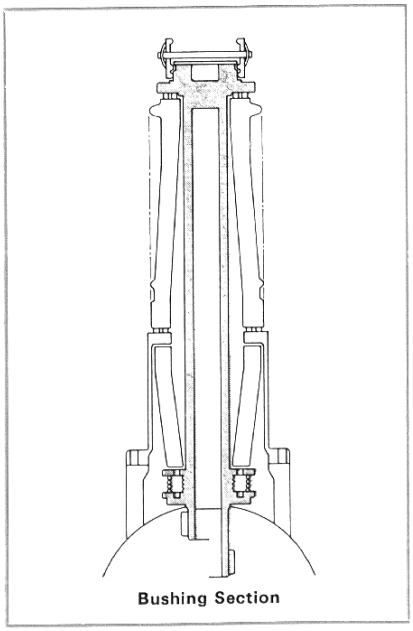
Pole Unit Assembly

Each phase of the SFP circuit breaker is enclosed in its own grounded metal tank which forms a pressure vessel containing SF_6 gas, the interrupting medium.

Current is brought into the tank to the interrupter through two SF_6 insulated bushings with porcelain cases.



Pole Unit Section



Bushing Section

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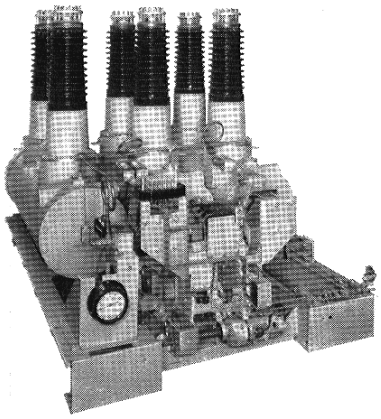
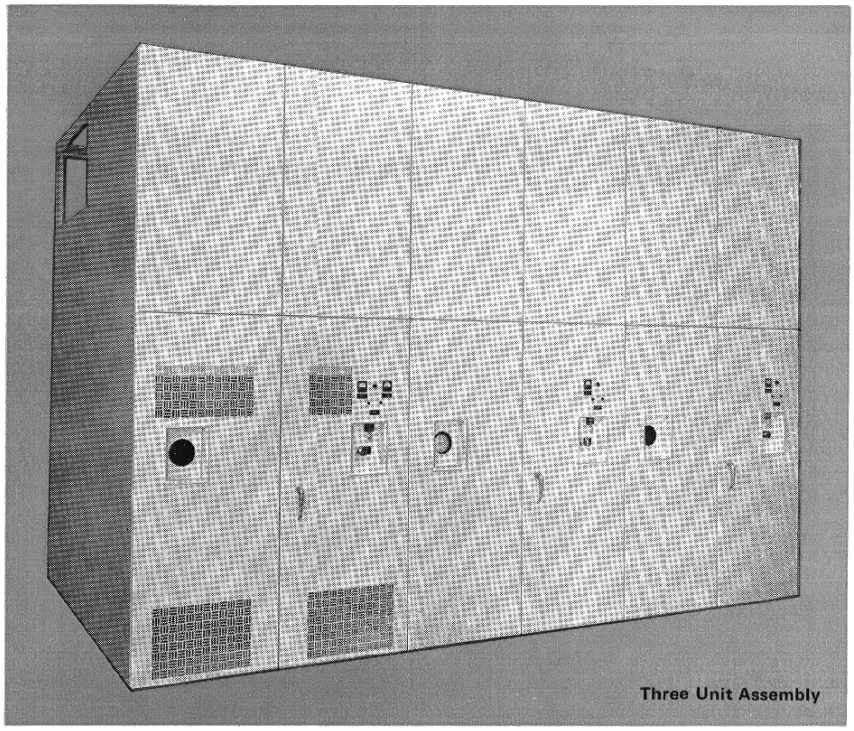


Construction



Three Unit Assembly

Operating Mechanism

The operating mechanism of the type SFP circuit breaker is of the spring stored energy type. The mechanism is used to close the breaker and to open it under no load and light load conditions. When the breaker is opening under fault conditions, the mechanism assists the magnetic coils. As the interrupting duty on the breaker increases, the force produced by the current flowing in the magnetic coils goes up, increasing the opening speed of the breaker. With a full fault on the breaker, the contact speed of the breaker is about 3 times the no load speed.

The closing spring of the mechanism is charged by an electric motor. The charging operation takes approximately 10 seconds. The mechanism control is arranged in such a way that when the breaker is closed, the motor will immediately recharge the closing spring. A closed and energized breaker has stored in the mechanism the energy required for one closing operation.

The opening or tripping spring is compressed during the closing operation of the breaker.

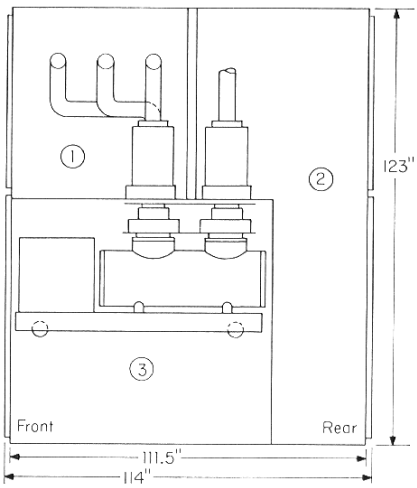
Stationary Housing

The switchgear housing in which the type SFP breakers are applied meets all the requirements of metal-clad construction, with full compartmentation and insulated bus. Each section is 60" wide, 114" deep and 123" high. Steel sheets form the barriers between the three compartments (breaker, bus and line).

The stationary sections are constructed of steel members and formed sections of hot rolled, smooth, flat sheet steel welded together. Barriers between primary compartments are #11 gauge. The supporting structures are completely enclosed. The resulting units are rigid and self-supporting. The metal-clad structure is so designed that units may be readily added in the future.

The cell is arranged for vertically lifting the breaker with the bus compartment above the breaker and the line compartment to the rear of the unit, making it possible to accommodate all of the most common cell requirements in a minimum of floor space.

The cells are small enough that three or four units may be shipped as an assembled group.



Breaker Unit Section

1. Main Bus Compartment
2. Line Compartment
3. Breaker Compartment

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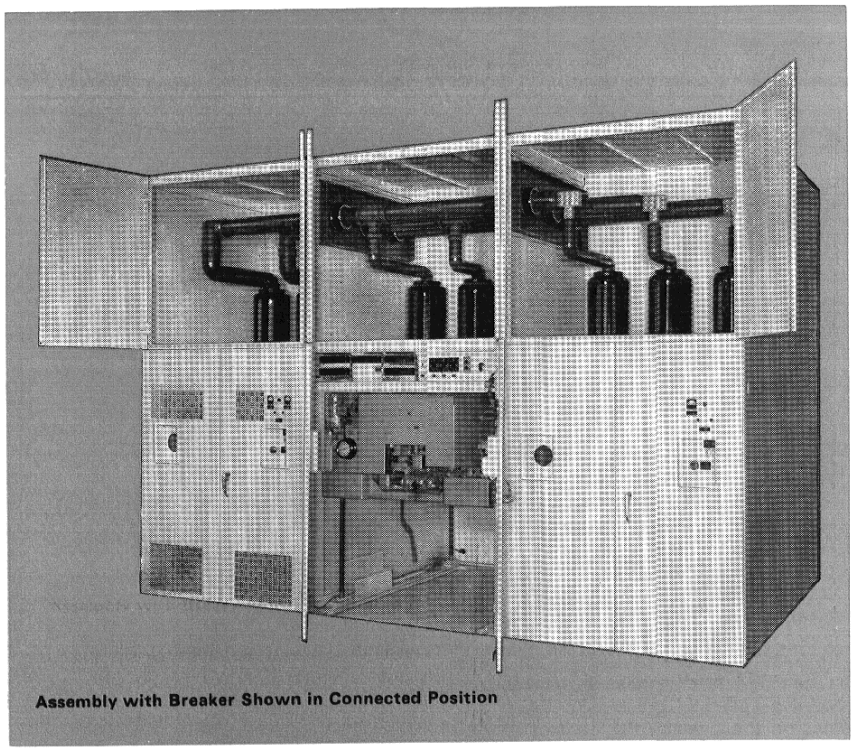
The breaker compartment contains the breaker lifting mechanism, the shutter and shutter operating mechanism, the current transformers and the control panel.

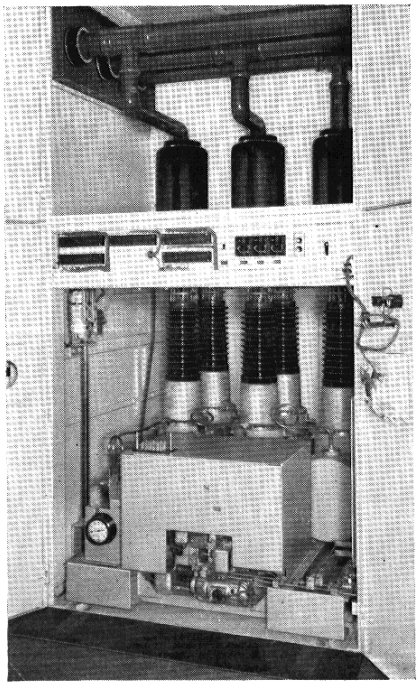
The breaker is raised to the engaged position in the cell by four jackscrews. These jackscrews are coupled together by a roller chain around the top of the cell. The lower ends of the jackscrews engage nuts which lift 2 channel shaped members which in turn lift the breaker to the engaged position. The lift mechanism and motor is in the upper left hand corner of the breaker compartment. Each stationary section includes limit switches and a control switch for operation of the elevating mechanism.

Each circuit breaker housing is equipped with an electrical interlock, which prevents lowering the breaker without tripping it open. The circuit breaker is held mechanically trip free when it is at any point between the connected and the lowered positions. By means of a sliding contact on the rear, the breaker is continuously grounded during the elevating process and when it is in the fully raised or lowered position.

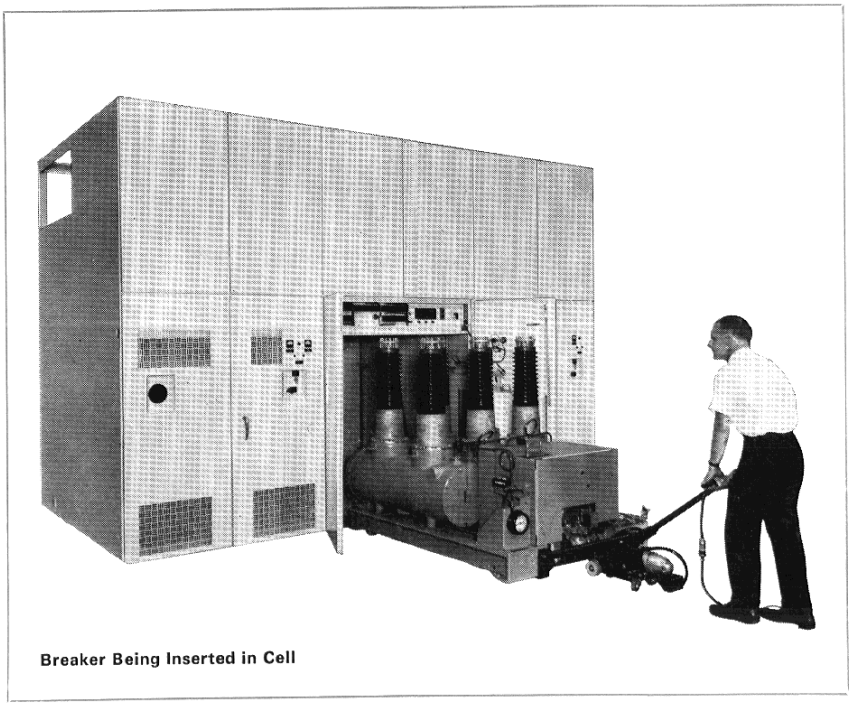
When a circuit breaker is removed from its housing, mechanical interlocks trip the breaker and discharge the closing spring. Thus no energy remains stored in the mech-



Assembly with Breaker Shown in Connected Position



Breaker in Disconnect Position



Breaker Being Inserted in Cell

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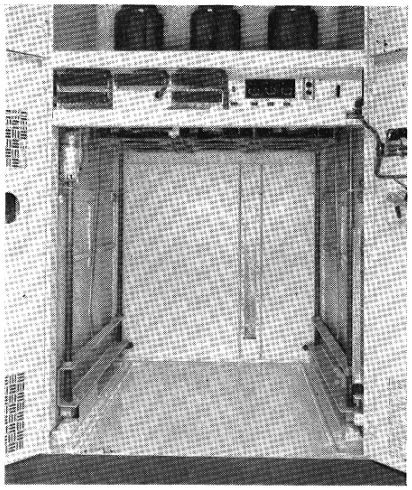
anism when a breaker is withdrawn from its cell.

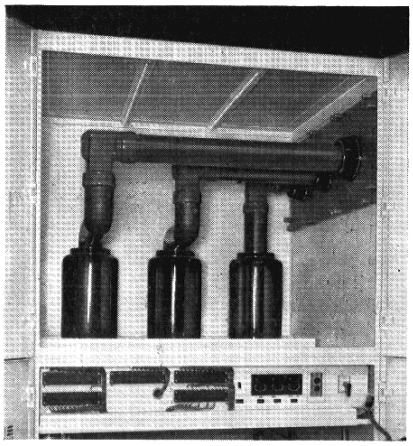
The housings and circuit breakers are so designed and constructed that a 3000 ampere breaker may be placed in either a 3000A or 1200A housing, but mechanical interference will prevent placing a 1200 ampere breaker in the operating position in a 3000 ampere housing.

Current Transformers

The current transformers are ring type mounted in the breaker compartment. The circuit breaker bushings pass through the current transformers when the breaker unit is elevated to the operating position. The current transformers are mounted outside the automatic shutters and may be easily removed and replaced without exposing primary connections. The current transformer supports are constructed of aluminum. A total of four current transformers per phase can be accommodated (two on each side of the breaker).



Breaker Cell with Breaker Removed



Bus Compartment

Primary Contacts

The primary circuit between the removable circuit breaker and the stationary unit is made by means of a set of contacts mounted on the circuit breaker terminals which engage with solid cylindrical contacts mounted within the tubular porcelain supports in the stationary structure. The lower ends of the tubes are covered automatically by metal shutters when the circuit breaker is lowered to the disconnect position.

The moving contacts consist of flexibly mounted, self-aligning assemblies of bridging segments backed by individual flat springs. The design insures that each segment makes high pressure contact, between the stationary contact in the housing and the circuit breaker terminal. The contact surfaces are silverplated to prevent reduction in current carrying capacity due to oxidation.

Secondary Contacts

The control circuits between the stationary units and the removable circuit breakers are made by means of automatic, self-aligning, multi-contact, plug type connectors. The receptacle is mounted in the housing and the plug is mounted on the circuit breaker. The contact surfaces of the receptacles are recessed to prevent accidental short circuiting of the control circuits. A control jumper is used to operate the breaker in the test position.

Bus Compartment

The primary contacts are inside the upper end of the porcelain contact supports or "bottles". The riser bars which extend from the "bottles" to the bus are welded conductor tubing with encapsulated epoxy resin insulation.

The main bus is made up of unit lengths of tubular conductor with Insuldur®-epoxy insulation. Tongue castings are welded into the sections where joints are made and the joints are insulated with an RTV silicone rubber compound. All bolted contact surfaces are silverplated.

Where the main bus passes through the cell wall to an adjacent unit, the bus sections are supported on porcelain through-type insulators which, in turn, are supported on glass polyester plates bolted to the cell wall.

Access to the bus compartment is through the two top doors on the front of the cell. These doors are normally bolted closed.

Line Compartment

The line compartment is located at the rear of the housing, and is separated from the bus and breaker compartments by steel barriers. Cables or bus can be brought into the line compartment through the roof or cables can be brought up through the floor of the cell. There is sufficient room in the line compartment for two, three conductor or six single conductor potheads.

Auxiliary Units

Auxiliary units can be provided as required for specific installations. These units are available for equipment such as disconnecting potential transformers and fuses, control power transformers and lightning arresters, which are too large to mount in circuit breaker units.

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Shelterfor-M® Construction

For outdoor installations of 34.5 kv high voltage metal-clad switchgear, Shelterfor-M construction is available.

In Shelterfor-M construction, standard indoor switchgear is located on a concrete pad and a weatherproof housing is erected to enclose it. The construction includes a covered aisle for handling the circuit breaker units. The aisle is wide enough to permit two circuit breakers to pass. Doors are provided at each end of the aisle and are equipped with "crash" hardware which permits opening the doors from the inside even while padlocked on the outside.

Although not illustrated, Shelterfor-M switchgear is also available in a common aisle design with two assemblies facing a common maintenance aisle. The depth for this arrangement is approximately 30 feet.

Reliability

Design Testing

The ratings of the 345SFP1500 circuit breaker and 34.5 kv high voltage metal-clad switchgear have been verified by a complete design test program. These tests include: interrupting, dielectric, momentary, short-time, thermal, current carrying ability, radio influence, mechanical operation and weatherproofing.

Production Testing

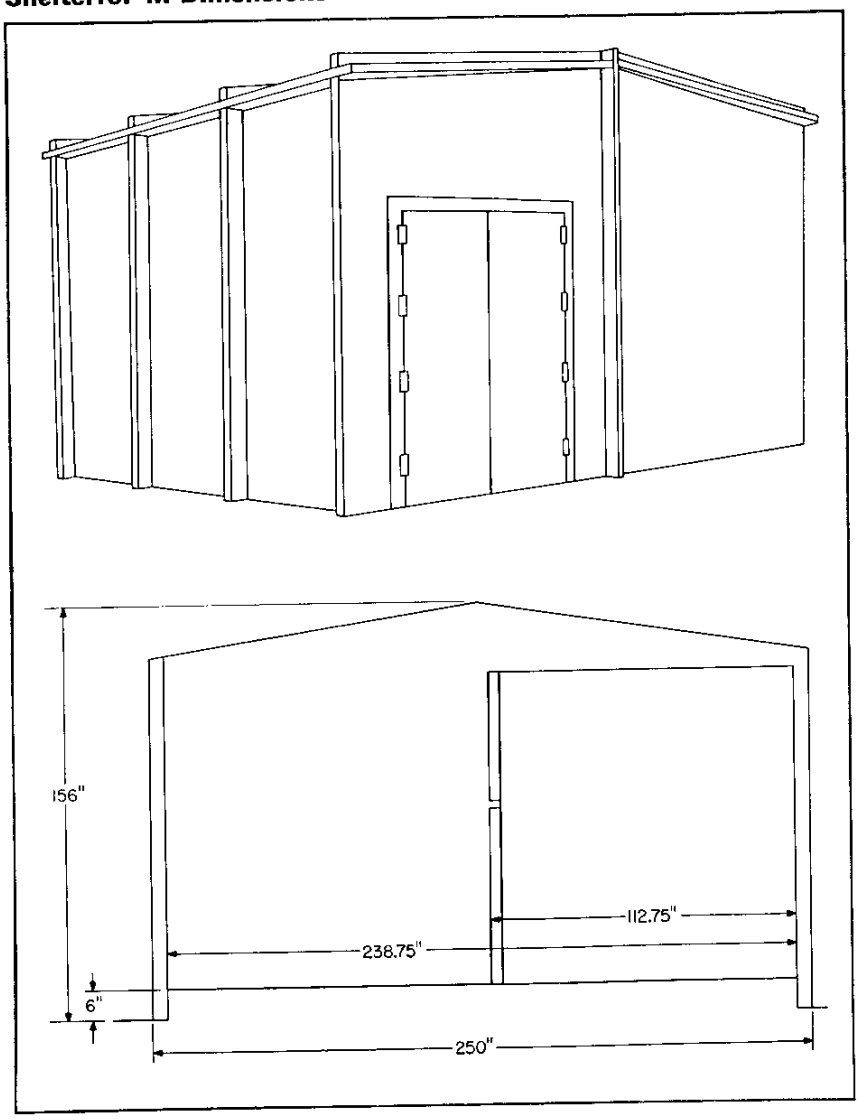
Every 34.5 kv high voltage metal-clad switchgear assembly is subjected to standard production tests at the factory prior to shipment. These production tests include 60 cycle dielectric tests, operation timing tests on each circuit breaker, and mechanical operation tests including shutters, elevating mechanisms, interlocks, and interchangeability of removable circuit breaker units.

Quality Control

All phases of the manufacture of 34.5 kv high voltage metal-clad switchgear and type SFP circuit breakers are subject to rigid quality control procedures. Each circuit breaker bushing is given a gas leak test before assembly into the pole unit. Each assembled pole unit is also given a gas leak test before assembly on the breaker.

The circuit breakers are assembled in jigs which accurately locate the contacts, holding device, and interlocks. Similar jigs are used in the construction of the housings so that each removable unit is interchangeable with any other unit of the same rating.

Shelterfor-M Dimensions



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