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Smyrna, TN, USA

Instruction Bulletin

POWERSUB™ Vacuum Substation Circuit Breaker, Type FVR

15 kV to 38 kV, 200 kV BIL, 1200 A, Class 6065

SQUARE D

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FIGURES

TABLES

SECTION 1—INTRODUCTION

This bulletin contains instructions for installation, operation, and maintenance of the POWERSUB™ Type FVR series circuit breaker (200 kV BIL) manufactured by Square D Company.

It is important to read and understand this bulletin completely before performing the installation, operation, and maintenance steps provided. Electrical equipment should be installed and serviced only by qualified electrical personnel. Qualified personnel should establish procedures that ensure the safety of personnel and equipment.

The Type FVR circuit breaker is designed for outdoor substation applications and provides interrupting capability for medium voltage systems up to 38 kV. Circuits in which these circuit breakers are placed are capable of overvoltages. Complex medium voltage systems may require a detailed overvoltage system analysis and the addition of overvoltage protection.

The 200 kV BIL, Type FVR circuit breaker has been designed with an arc-resistant enclosure.

The differences between the 200 kV BIL circuit breaker and all other Type FVR circuit breakers are as follows:

- The 200 kV BIL circuit breaker enclosure is larger.
- The 200 kV BIL circuit breaker uses two vacuum interrupters in series on each pole.
- The 200 kV BIL circuit breaker uses a rotating operating shaft instead of a cross bar design.
- The 200 kV BIL circuit breaker enclosure has four side vent housings as compared to two on the 110 kV to 150 kV BIL.

NOTE: For more information on operating and maintaining the other Type FVR circuit breakers (110 kV to 150 kV BIL), refer to Square D instruction bulletin no. 6065-10.

Catalog Numbers

The following is an explanation and sample of the catalog numbering scheme:

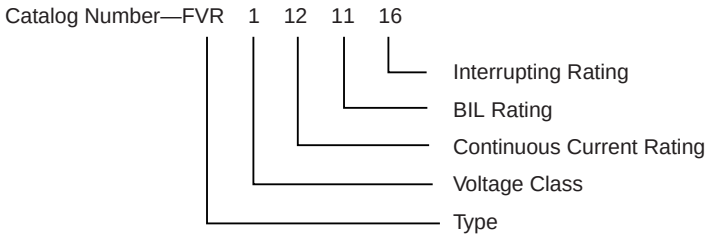


Table 1: Catalog Numbering Scheme

Type	Voltage Class	Continuous Current Rating	BIL Rating	Interruption Rating	Series Designation
FVR—Vacuum	1 = 15 kV 2 = 27 kV 3 = 38 kV	06 = 600 A 08 = 800 A 12 = 1200 A 20 = 2000 A 30 = 3000 A	11 = 110 kV 12 = 125 kV 15 = 150 kV 20 = 200 kV	12 = 12 kA 16 = 16 kA 20 = 20 kA 25 = 25 kA 31 = 31.5 kA 40 = 40 kA	A

NOTE: Not to be used for ordering.

SECTION 2—SAFETY PRECAUTIONS

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Only qualified electrical personnel familiar with medium voltage circuits are to perform work described in this set of instructions. Workers must understand the hazards involved in working with or near medium voltage equipment.
- Perform such work only after reading and understanding all of the instructions contained in this bulletin.
- Before performing visual inspections, tests, or maintenance on this device, disconnect all sources of electric power. Assume all circuits are live until they are completely de-energized, tested, grounded, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that power is off.
- Replace all devices, doors, and covers before turning on the power to this equipment.
- Handle this equipment carefully and install, operate and maintain it correctly in order for it to function properly. Neglecting fundamental installation and maintenance requirements may lead to personal injury, as well as damage to electrical equipment or other property.
- Be aware of potential hazards, wear personal protective equipment, and take adequate safety precautions.
- Do not make any modifications to the equipment or operate the system with interlocks removed. Contact your local Square D Company representative for additional instructions if the equipment circuit breaker does not function as described in this manual.
- Carefully inspect your work area and remove any tools and objects left inside the equipment.
- All maintenance must be performed in accordance with local codes and under the following conditions:
  - — The circuit breaker must be isolated from all power sources.
  - — Control voltage must be removed from the controls.
  - — The circuit breaker must be in the open position.
  - — All circuit breaker springs must be discharged.
- All instructions in this manual are written with the assumption that the customer has taken these measures before performing maintenance or testing.

Failure to follow these instructions will result in death or serious injury.

SECTION 3—RECEIVING, HANDLING, AND STORAGE

Receiving

Upon receipt, check the packing list against the equipment received to ensure the order and shipment are complete. Claims for shortages or errors must be made in writing to Square D Company within 15 days after delivery. Failure to give such notice will constitute unqualified acceptance and a waiver of all such claims by the purchaser.

Immediately inspect the equipment for any damage which may have occurred in transit. If damage is found or suspected, file a claim with the carrier immediately and notify Square D Company. Delivery of equipment to a carrier at any of the Square D Company plants or other shipping points constitutes delivery to the purchaser regardless of freight payment and title. All risk of loss or damage pass to the purchaser at that time.

Handling

Lifting eyes (see Figure 2 on page 9) are provided on the roof of the Type FVR circuit breaker for lifting by crane. **Do not lift by forklift.** Use load-rated cables or chains with safety hooks or shackles. A spreader bar may be necessary to maintain proper angles for lifting. To prevent structure damage, rig so that the minimum angle between lifting cables or chains and equipment top is 45° and maximum interior angle is 90° (see Figure 1).

⚠ CAUTION

IMPROPER LIFTING OF EQUIPMENT CAN DAMAGE LIFTING EYES

The interior angle of lifting sling should not exceed 90°. Angles greater than 90° apply greater inward pressure on lifting eyes which can damage and dislodge eyes from switchgear.

Failure to follow this instruction can result in injury or equipment damage.

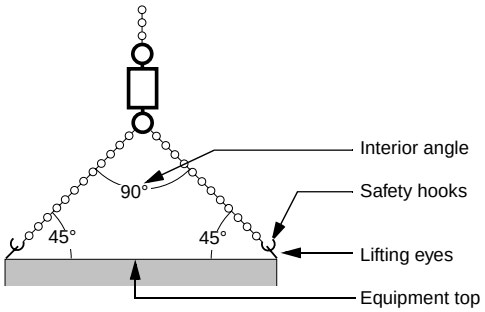


Figure 1: Lifting Sling

CAUTION

DO NOT LIFT CIRCUIT BREAKER BY SIDE VENT HOUSINGS

Damaged vent housings can constrict proper air flow and expose interior of high voltage compartment to weather.

Failure to follow this instruction can result in equipment damage.

Meters and relays may be damaged by rough handling. Handle the equipment with care. Protect the bushings from rough treatment to avoid chipping.

View the OPEN-CLOSED indicator (see Figure 4 on page 11) to verify the mechanism/breaker position. The Type FVR circuit breaker is shipped with the breaker in the closed position.

Storage

If the circuit breaker must be stored before operation, keep it in a clean, dry, corrosion-free area protected from damage. Inspect the circuit breaker regularly when stored for prolonged periods.

NOTE: The Type FVR circuit breaker is equipped with strip heaters that must be energized during storage to prevent condensation within the circuit breaker housing. Verify that the heater thermostat is set at 75 °F (24 °C).

Identification

The rating nameplate is located on the inside of the rear low voltage door and includes the following information:

- Catalog Number
- Weight (lbs)
- Rated Max. Voltage (kV RMS)
- Reclosing time (cycles)
- Duty Cycle (O - CO - CO)
- Closing Coil Voltage
- Serial Number
- Factory Order Number
- Rated Frequency (hz)
- Full Wave BIL (kV Pk)
- Charging Motor Voltage
- Manufacture Date
- Maintenance Manual Number
- Interrupt Time (cycles)
- 1 Minute Withstand (kV RMS)
- Rated Short Circuit (kA RMS)
- Spare Aux. Switch Contacts
- Customer PO Number
- Control Diagram Number
- Closing Time (cycles)
- Close and Latch (kA RMS)
- Tripping Coil Voltage

SECTION 4—DESCRIPTION

The Type FVR circuit breaker enclosure contains two separate compartments; a high voltage compartment (see Figure 2) and a low voltage compartment (see Figure 2).

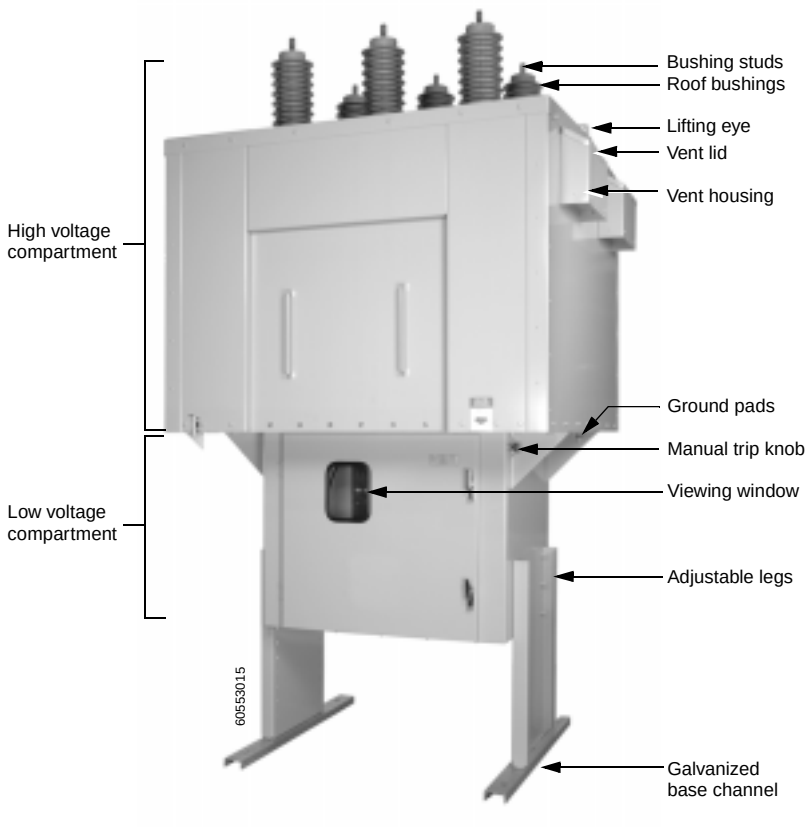


Figure 2: 200 kV BIL, Type FVR Vacuum Circuit Breaker, Front View

High Voltage Compartment

The primary circuit connection to the circuit breaker is made through the roof bushings (see Figure 2 on page 9) located on the top of the high voltage compartment.

Vacuum Interrupters

Vacuum interrupters (see Figure 3), mounted within the high voltage compartment, perform interruption in a Type FVR circuit breaker. The vacuum interrupters consist of a pair of contacts—one contact is movable and one contact is fixed. The vacuum interrupters require only a short gap to provide the dielectric withstand capability of the interrupter.

The 200 kV BIL Type FVR circuit breaker uses two vacuum interrupters in series on each pole. These two bottles are actuated by the linkages to provide simultaneous motion. No simultaneity adjustment is required by the user.

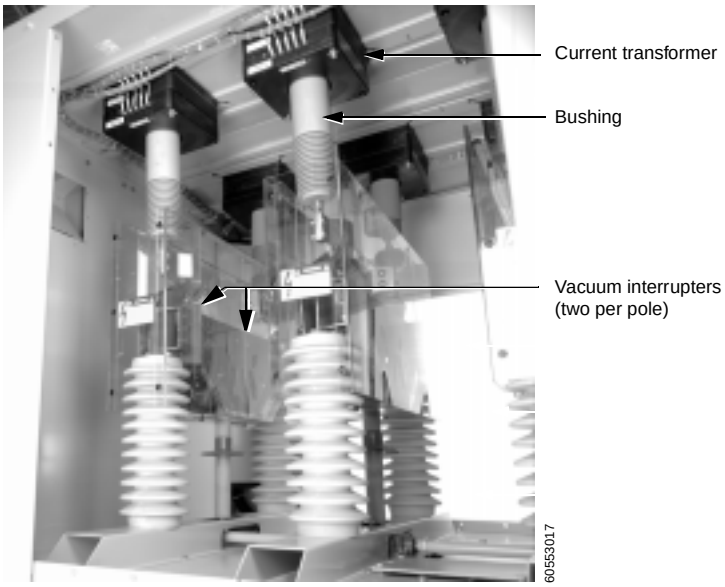


Figure 3: High Voltage Compartment Interior

NOTE: Some vacuum interrupter assembly equipment shown in Figure 3 may vary on circuit breakers.

Current Transformers

When specified by the customer, current transformers (see Figure 3) are mounted around the bushings on the inside of the roof. Current transformer (CT) circuit wiring extends from the CT case to the shorting type terminal blocks located in the low voltage compartment. The CTs are selected based on the electrical needs of each application.

Low Voltage Compartment

The operating mechanism, indicators, controls, relays, meters and miscellaneous accessories are housed within the low voltage compartment.

Operating Mechanism

The Type FVR circuit breaker uses a stored-energy operating mechanism (see Figure 4) in which charged springs open and close the circuit breaker. The operating mechanism contains all controls and interlocks. The mechanism is mounted in the low voltage compartment so it can be accessed easily for inspection and servicing.

NOTE: To remove the mechanism cover (see Figure 4), carefully unclip the back of the cover from the mechanism frame.

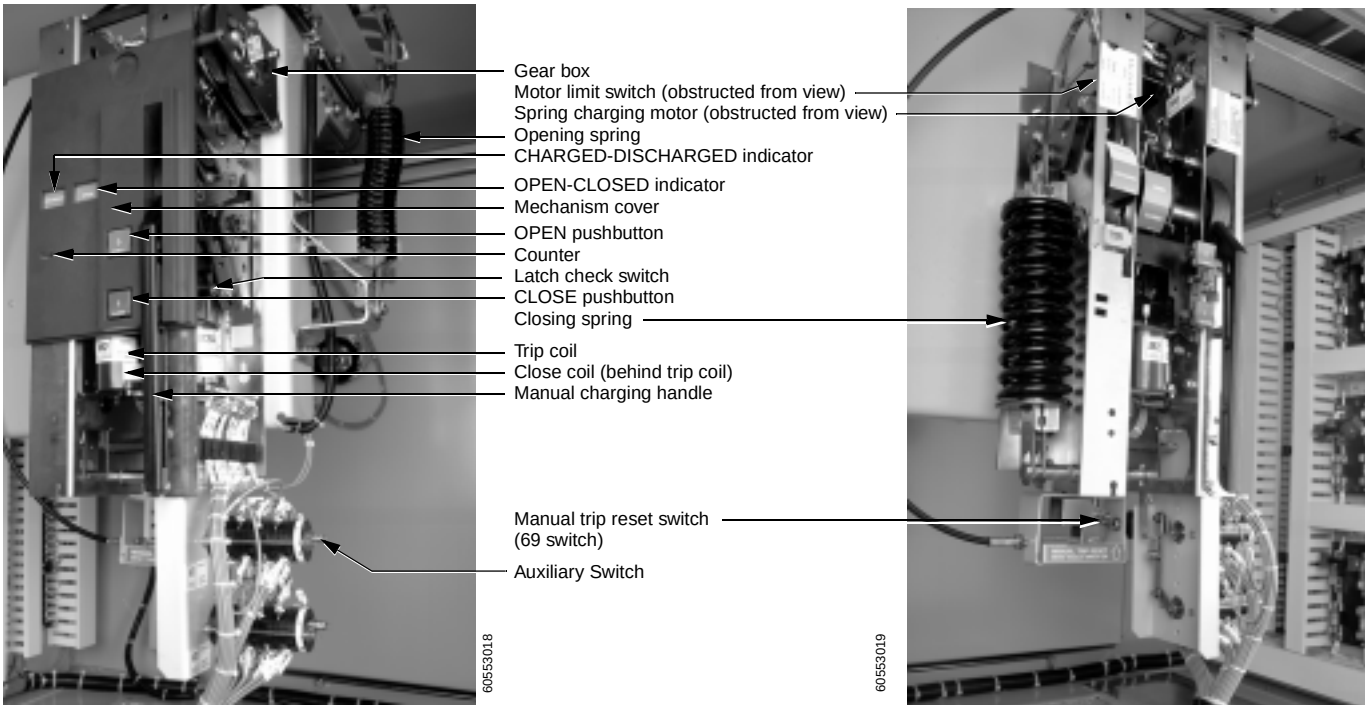


Figure 4: Operating Mechanism (Two Views With and Without Mechanism Cover)

Indicators

The operating mechanism has three indicators. The OPEN-CLOSED indicator (see Figure 4) shows the position (open or closed) of the vacuum interrupter contacts. The CHARGED-DISCHARGED indicator (see Figure 4) displays the state (charged or discharged) of the closing springs. The COUNTER (see Figure 4) indicates the number of trip (open) operations the breaker has performed.

Closing Springs

The closing springs (see Figure 4 on page 11) close the circuit breaker when the CLOSE pushbutton is pressed or when the closing coil is energized. These springs are charged (compressed) either manually with the charging handle or electrically by the spring charging motor.

When control power is applied to the circuit breaker, the spring charging motor is energized. The charging motor turns the gears that drive the ratchet assembly up and down.

The ratchet assembly (see Figure 8 on page 17) rotates the drive shaft compressing the closing springs. As the spring loads pass top-dead center, the drive shaft rotates a few degrees until the closing latch roller engages the closing latch. The drive shaft can rotate no further; the closing springs are held in this charged position until a closing operation is initiated by depressing the CLOSE pushbutton or closing coil.

Opening Spring

The opening spring (see Figure 4 on page 11) opens the circuit breaker when the OPEN pushbutton is pressed or the trip coil is energized. The spring is charged (compressed) whenever the circuit breaker is in the closed position.

Control Circuit

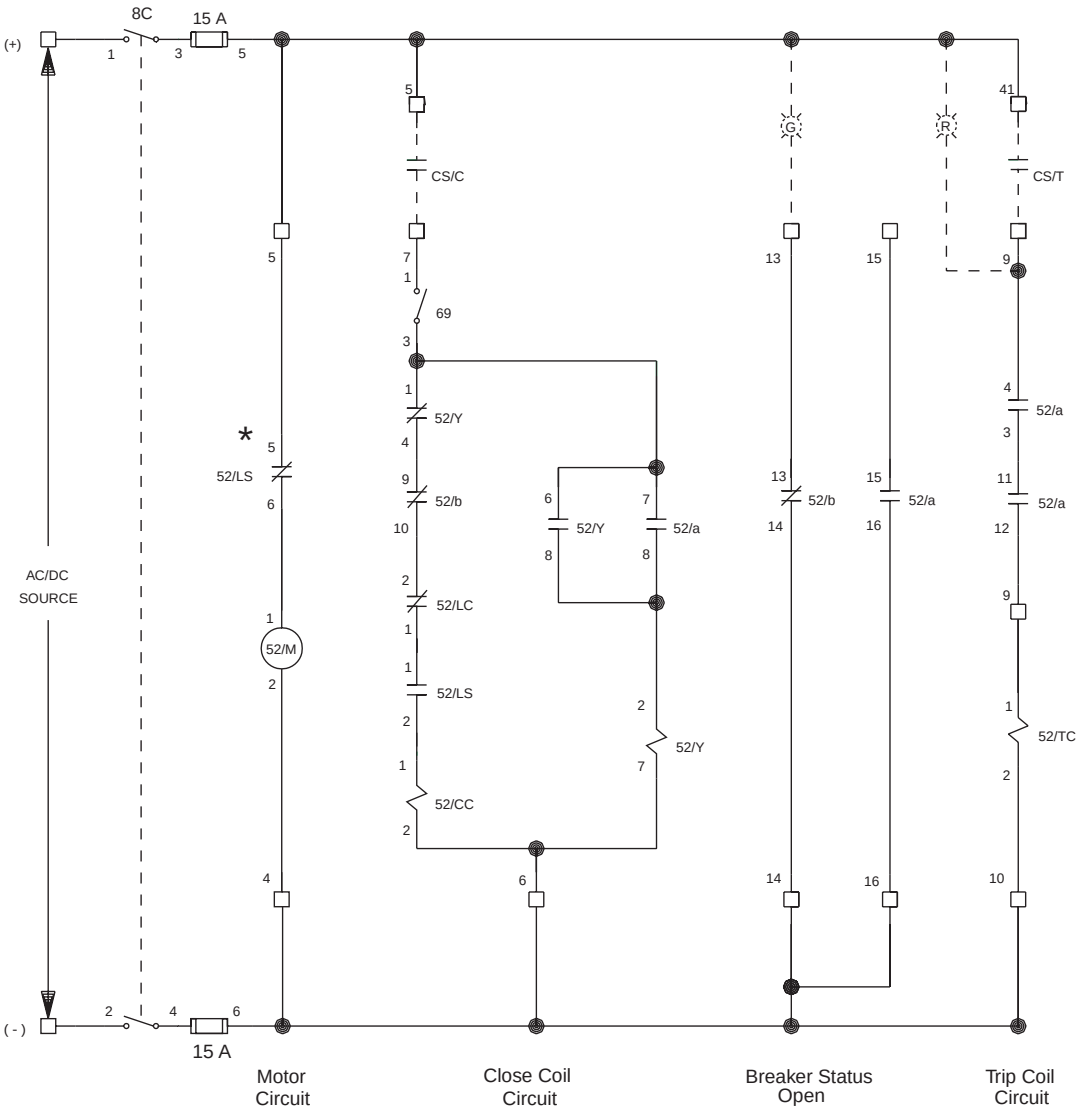
A typical schematic diagram for the control circuit of the Type FVR circuit breaker is shown in Figure 5 on page 13. A copy of the exact schematic diagram(s) and wiring diagram(s) for the circuit breaker are located in the manual holder on the rear door of the low voltage compartment. The remaining paragraphs in this section discuss the function of the control circuit components.

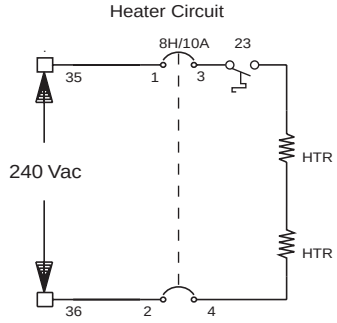
- Motor Limit Switch

  The motor limit switch (see Figure 4 on page 11) energizes the spring charging motor when a closing spring charging operation is required. In turn, it de-energizes the spring charging motor when the closing springs are fully charged. The motor limit switch is connected to the spring charging motor. When the closing springs are in the discharged position, the motor limit switch cam actuates the motor limit switch. This energizes the motor and disables the closing coil. Once the closing springs are charged fully, the cam allows the switch to open, de-energizing the spring charging motor.

- Spring Charging Motor

  When energized by the closing of the motor limit switch, the spring charging motor (see Figure 4 on page 11) drives the series of connected gears and cam. The cam then raises and lowers the ratchet assembly and rotates the drive shaft. As the drive shaft rotates, the closing springs compress to the charged position. When the closing springs are fully charged, the motor limit switch contacts open, de-energizing the spring charging motor.





(Each heater rated 240 V, 500 W)

* Breaker in open position, springs discharged.

LEGEND			
52/M	Spring Charging Motor	52/LC	Latch Check Switch
52/Y	Anti-pump Relay	52/LS	Motor Limit Switch
CS	Circuit Breaker Control Switch	52/CC	Close Coil
52/a	Auxiliary Switch (Open When Circuit Breaker is Open)	52//TC	Trip Coil
		8C	Control Power Switch
52/b	Auxiliary Switch (Closed When Circuit Breaker is Open)	69	Manual Trip Reset Switch (69 Switch)
23	Heater Thermostat	8H	Heater Power Switch

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Figure 5: Typical Control Schematic—Breaker in Open Position, Springs Discharged.

- Auxiliary Switch

  The auxiliary switch (see Figure 4 on page 11) is a multi-stage switch used to operate circuits that are dependent upon the position of the circuit breaker contacts. The schematic diagram indicates how each of the auxiliary switch stages interconnect with the circuit breaker circuitry. The following describes the function of each stage:

  — The two sets of a-type contacts, connected in series with the trip coil (52/TC), de-energize the trip coil when the circuit breaker is in the open position.

  — The b-type contact, connected in series with the closing coil (52/CC), de-energizes the closing coil when the circuit breaker contacts are in the closed position.

  — For user convenience additional a- and b-type contacts are included for optional use.

- Trip and Close Coils

  The trip and close coils (see Figure 4 on page 11) are located in the lower center of the operating mechanism. When energized by the switchgear or remote circuitry, these coils release the open or close latches located inside the mechanism.

- Anti-Pump Relay

  An anti-pump relay (see Figure 6 on page 15) is provided to inhibit multiple close-open operations in the event that a continuous close signal is applied. The circuit breaker will not reclose until the closing signal is removed and then reapplied.

  The circuit breaker control switch (see Figure 5 on page 13) energizes the closing coil when turned to the closed position. If this switch remains closed, the anti-pump relay prevents the closing springs from being continuously charged and discharged. The anti-pump relay performs this function by only allowing the closing coil to be energized if:

  — The control switch is closed.

  — The closing springs have reached the fully charged position.

  — The spring charging motor has been de-energized.

- Latch Check Switch

  The latch check switch (see Figure 4 on page 11) allows the circuit breaker to be used for reclosing applications. When the trip latch moves out of its normal position, it activates the latch check switch. The closing circuit cannot be energized until the trip latch fully returns to its normal position and the mechanism is in position to allow a close operation.

- Heater Circuitry

  In normal configurations, two strip heaters (see Figure 6) are mounted at the lower rear of the operating mechanism to reduce condensation. For colder temperatures, two additional strip heaters are mounted in the upper portion of the low voltage compartment. In some applications, higher wattage heaters may be used.

- Heater Power Switch

  When opened, the heater power switch (see Figure 5 on page 13) completely disconnects the heater circuitry from the control power.

- Thermostat

  The thermostat controls the temperature within the circuit breaker housing. The thermostat is shipped set at 75 °F (24 ºC) and should not be field adjusted.

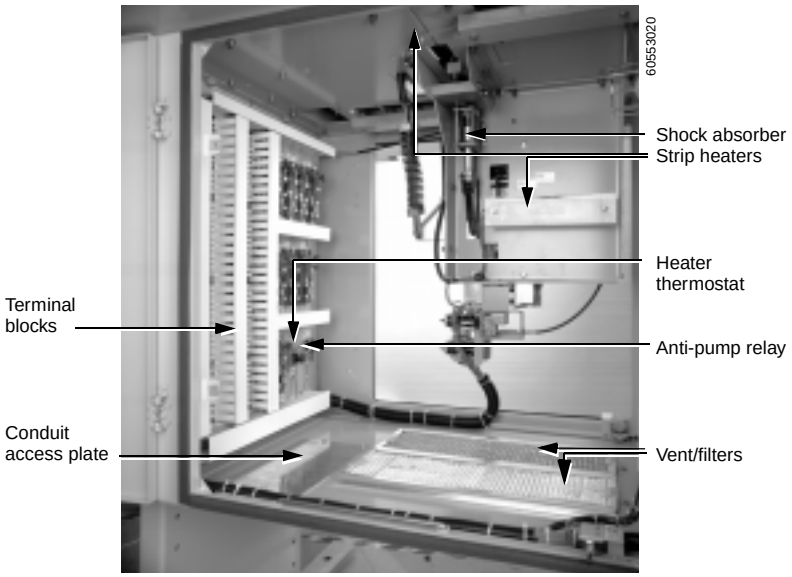

Figure 6: Low Voltage Compartment, Rear View

Low Voltage Instrument Door (Optional)

When specified by the customer, Type FVR circuit breakers are equipped with an instrument door located inside the rear door of the low voltage compartment. This panel allows for local electrical operation of the circuit breaker.

The low voltage instrument door has indicator lights and a breaker control switch. The low voltage instrument door can be customized to include auxiliary components when specified by the customer. Refer to auxiliary component manufacturer's instruction materials for proper operation of devices not included in this manual.

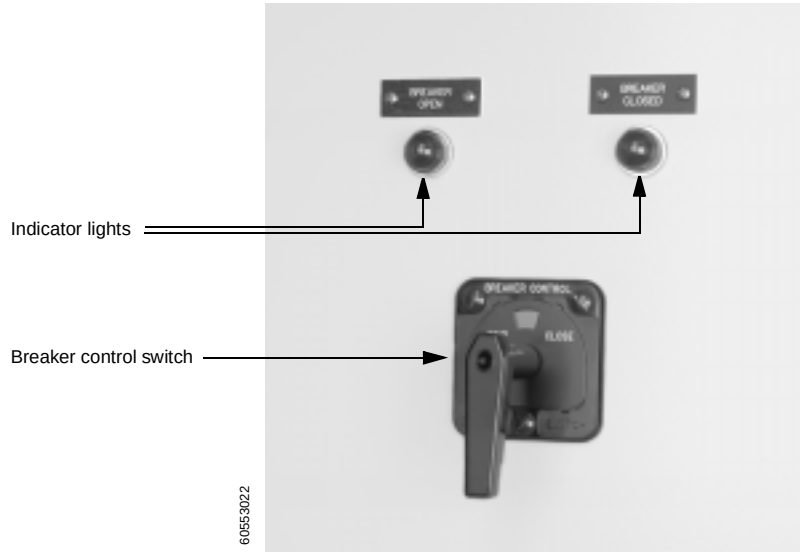

Figure 7: Low Voltage Instrument Door (Optional)

Indicator Lights

Red (closed) and green (open) indicator lights located on the low voltage instrument door indicate the status of the circuit breaker.

Breaker Control Switch

The breaker control switch (see Figure 7) allows local operation of the circuit breaker without direct exposure to the low voltage compartment.

SECTION 5—OPERATION

⚠ WARNING

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

Only qualified electrical personnel familiar with medium voltage circuits should operate this equipment.

Failure to follow this instruction can result in death or serious injury.

Charging the Closing Spring

The closing springs—located on the left side of the mechanism—can be charged manually by moving the charging handle up and down or electrically with control power. The closing springs are fully charged when the CHARGED/DISCHARGED indicator reads CHARGED and the charging handle can no longer be raised.

When control power is applied to the circuit breaker, the spring charging motor will be energized automatically. As the motor gears (see Figure 8) turn, the drive shaft rotates, compressing the closing springs until the spring loads pass top-dead center. At this point, the closing roller engages the closing cam. The drive shaft can rotate no further and the motor limit switch de-energizes the spring charging motor. The closing springs are held in this charged position until a closing operation is initiated.

Closing Operation

After charging the springs, close the circuit breaker by pressing the CLOSE pushbutton or energizing the closing coil electrically. The CLOSE pushbutton releases the closing spring latch and allows the closing springs to discharge. The mechanism (see Figure 8) pulls the connecting rod downward rotating the operating shaft and raising the pushrods. The pushrods, through additional linkages, close the two vacuum bottles per pole simultaneously.

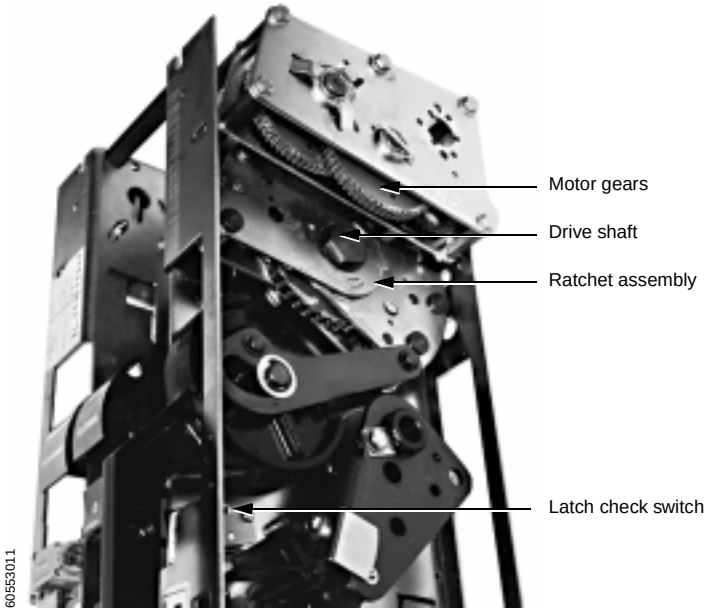

Figure 8: Gear and Ratchet Detail

Opening Operation

The opening spring becomes charged (or compressed) automatically when the circuit breaker is in the closed position. If the OPEN pushbutton is pressed or the opening (trip) coil is energized, the mechanism releases the opening latch and allows the opening spring to discharge. The opening spring rotates the operating shaft, opening the vacuum interrupter contacts.

Manual Opening Operation

An opening operation can be initiated manually.

Mechanical Operation

The circuit breaker can be opened (tripped) mechanically either by the external manual trip knob (see Figure 2 on page 9) or the OPEN pushbutton located on the operating mechanism inside the low voltage compartment (see Figure 4 on page 11). The external manual trip knob allows the circuit breaker to be manually tripped without requiring entry through the low voltage compartment door.

Electrical Operation

The circuit breaker can be opened electrically by the breaker control switch located on the low voltage instrument door (see Figure 7 on page 16).

Manual Trip Reset Switch

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Turn off all the power supplying this equipment before working on or inside.
- Replace all devices, doors, and covers before turning on the power to this equipment.

Failure to follow these instructions will result in death or serious injury.

When a manual trip operation is performed, the manual trip reset switch (69 switch) opens automatically, disabling the closing circuit. The manual trip reset switch, located directly under the operating mechanism (see Figure 4 on page 11), needs to be manually reset before an electrical closing operation can occur. To reset the manual trip reset switch follow the steps below:

1. Turn off all power to the circuit breaker.
2. Reset the manual trip reset switch by moving the toggle switch upwards.
3. Replace all devices, doors, and covers before turning on the power to the equipment.
4. Reapply the power to the circuit breaker.

SECTION 6—INSTALLATION

Foundation

The Type FVR circuit breaker is designed for installation on a concrete pad. The pad must be flat, level, and free of debris for proper operation.

The following diagram shows the 200 kV BIL, Type FVR plan view:

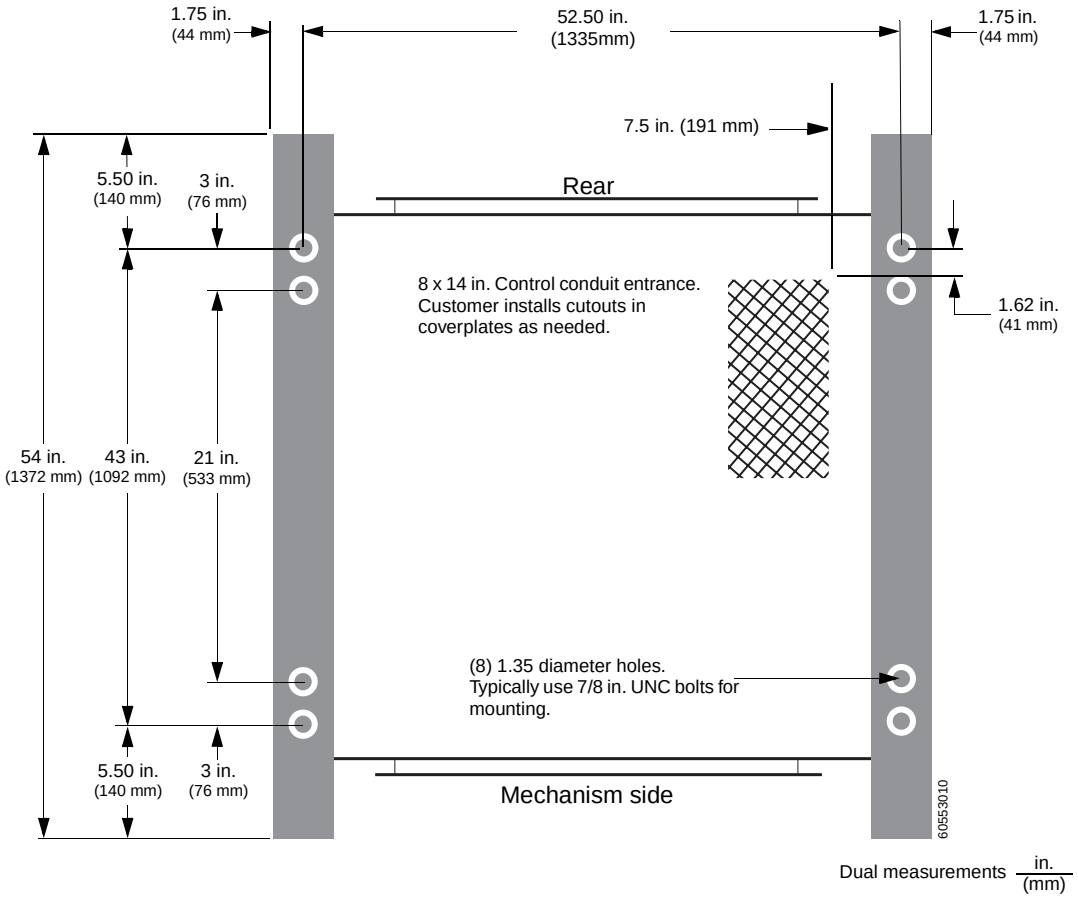

Figure 9: Plan View for 200 kV BIL, Type FVR Circuit Breaker

Lifting the Circuit Breaker

Lifting eyes (see Figure 2 on page 9) are provided on the roof of the Type FVR circuit breaker for lifting by crane. **Do not lift by forklift.** Use load-rated cables or chains with safety hooks or shackles. A spreader bar may be necessary to maintain proper angles for lifting. To prevent structure damage, rig so that the minimum angle between lifting cables or chains and equipment top is 45° and maximum interior angle is 90° (see Figure 10).

⚠ CAUTION

IMPROPER LIFTING OF EQUIPMENT CAN DAMAGE LIFTING EYES

The interior angle of lifting sling should not exceed 90°. Angles greater than 90° apply greater inward pressure on lifting eyes which can damage and dislodge eyes from switchgear.

Failure to follow this instruction can result in injury or equipment damage.

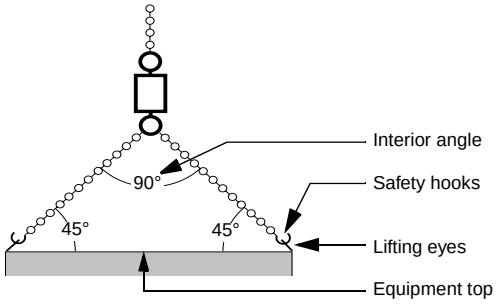

Figure 10: Lifting Sling

CAUTION

DO NOT LIFT CIRCUIT BREAKER BY SIDE VENT HOUSINGS

Damaged vent housings can constrict proper air flow and expose interior of high voltage compartment to weather.

Failure to follow this instruction can result in equipment damage.

Grounding

Connect the circuit breaker ground pads (see Figure 2 on page 9) to the substation grounding grid. Use the ground pad hardware provided.

Initial Circuit Breaker Preparation

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all the power supplying this equipment before working on or inside.
- Isolate and ground both the line and the load side of the circuit breaker.
- Always use a properly rated voltage sensing device to confirm that the power is off.
- Make sure the breaker is in the OPEN position before inspecting this equipment or connecting the circuit breaker to your system.
- Replace all devices, doors, and covers before turning on the power to this equipment.

Failure to follow these instructions will result in death or serious injury.

Before connecting the Type FVR vacuum substation circuit breaker to the primary circuit, prepare it for operation as follows:

1. Check the indicators to verify that the circuit breaker is in the open position with all springs discharged. If it is not in this position, press the OPEN pushbutton, the CLOSE pushbutton, and then the OPEN pushbutton (see Figure 4 on page 11).

   NOTE: The circuit breaker is normally shipped in the closed position.
2. Examine the entire circuit breaker for damage, dirt, and moisture.
3. Use a clean, dry cloth to remove dirt and moisture that may have collected on the insulating parts.
4. Cycle the circuit breaker manually several times, checking for proper operation. To do so, move the charging handle (see Figure 4 on page 11) up and down until the closing springs are fully charged. A full charge is indicated when the charging handle can no longer be raised and the CHARGED-DISCHARGED indicator reads “charged”. Close the circuit breaker by pressing the CLOSE pushbutton, and then open it by pressing the OPEN pushbutton.
5. Verify that the heater thermostat (see Figure 6 on page 15) is set at 75 °F (24 °C).
6. Inspect and remove all loose parts, tools, and miscellaneous construction items left inside the circuit breaker before the power is energized.
7. Replace all doors and covers and fasten them securely. **For arc-resistant protection all doors must be closed and covers installed.**

Arc-Resistance

The 200 kV BIL, Type FVR circuit breaker has been designed with an arc-resistant enclosure. For proper operation of this feature, the following is required:

- High voltage panels installed and mounting bolts tightened.
- Low voltage doors shut with all door handles latched closed.
- Ensure that the glass polyester vent covers (see Figure 11) are in place with the mounting springs relaxed. The springs offer the required spacing for ventilation and also allow the cover to close the opening should an arc occur.
- Ensure vent deflectors (see Figure 11) are installed and in good repair. Vent deflectors are part of the high voltage side sheets. They are used to fold into the vent housing forcing the exhaust through the vent lids (see Figure 12) if an arc occurs. If these parts are removed or broken during shipment, a replacement should be ordered.

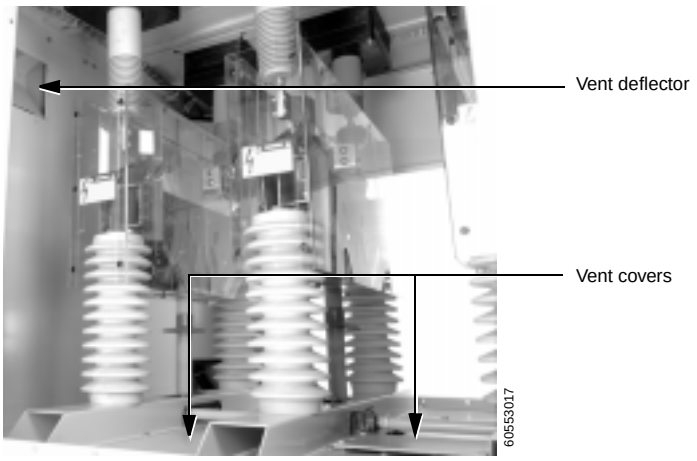

Figure 11: Vent Deflectors and Vent Covers

- Ensure that vent lids (see Figure 12) are in good repair. Do not caulk around the vent lids. The lid is designed to open quickly and allow the pressure from an arc to exhaust. If the lid is damaged enough to jeopardize the seal, a replacement should be ordered.

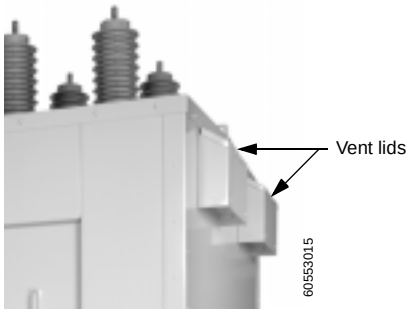

Figure 12: Vent Lids

Cable Connection

The Type FVR circuit breaker is connected to the primary circuit through aerial lugs which are not included unless specified by the customer. Follow the instructions below when attaching the aerial lugs to the circuit breaker bushing studs.

⚠ CAUTION

HAZARD OF EQUIPMENT DAMAGE

BE CAREFUL NOT TO OVERTIGHTEN**.** It is critical that the aerial lug is not overtightened. Always loosen aerial lug counter-clockwise to align lug pad properly.

Failure to follow this instruction can result in equipment damage.

1. Spin the aerial lug onto the bushing stud.
2. After the aerial lug bottoms out, rotate the lug counter-clockwise to align the lug pad properly.
3. Tighten lug bolts alternately and evenly to 45 ft-lb (61 N•m).
4. Connect line and load cables to aerial lugs. Torque hardware to 55 ft-lb (75 N•m). Minimize cable stress.

Pre-Operation Tests

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

When performing the hi-pot test:

- Do not exceed the voltages specified in Table 2.
- Keep all persons at least 6 ft (1.8 m) away from the circuit breaker being tested.
- Discharge the bushings and vacuum interrupter mid-band rings to ground after each test. These areas can retain a static charge after a hi-pot test.

Failure to follow these instructions will result in death or serious injury.

☢ WARNING

HAZARD OF RADIATION (X-RAY) EXPOSURE

This device may emit x-rays if voltage higher than rated maximum is applied across the open contacts, or if contacts are spaced less than rated stroke. In such a case, personnel must be protected with appropriate shielding.

Failure to follow this instruction can result in death or serious injury.

Perform a hi-pot (dielectric) test to verify that circuit breaker is in good working condition.

1. With the circuit breaker in the open position, perform a hi-pot test across the bushings of each pole.
2. With the circuit breaker in the closed position, perform a phase-to-ground and phase-to-phase hi-pot test for each pole.
3. Gradually increase the voltage to the levels indicated in Table 2.

Table 2: Hi-Pot Test Voltages

Equipment Rating	Field Test Voltage	
	AC	DC
15 kV	38 kV	54 kV
27 kV	45 kV	63 kV
38 kV	60 kV	85 kV

4. Verify that the circuit breaker sustains the specified voltage without flashover for one minute. If it does not, inspect the insulators for leakage paths. If necessary, clean the surface of each insulator and repeat steps 1–3. Consistent unacceptable test results may indicate a loss of vacuum. Contact Square D Company for technical assistance.
5. After each hi-pot test, discharge the bushings and vacuum interrupter mid-band rings to ground.

SECTION 7—MAINTENANCE

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside.
- Always use a properly rated voltage sensing device to confirm that the power is off.
- Replace all devices, doors, and covers before turning on the power to this equipment.
- All maintenance must be performed in accordance with local codes and under the following conditions:
  - — The circuit breaker must be isolated from all power sources.
  - — Control voltage must be removed from the controls.
  - — The circuit breaker must be in the open position.
  - — All circuit breaker springs must be discharged.
- All instructions in this manual are written with the assumption that the customer has taken these measures before performing maintenance or testing.
- Open the circuit breaker and discharge all springs by pressing the OPEN and CLOSE pushbuttons in the order OPEN-CLOSE-OPEN.
- Qualified electrical personnel should establish procedures that ensure the safety of personnel and equipment.

Failure to follow these instructions will result in death or serious injury.

Because of wide variations in operating uses and environments, a maintenance schedule should be developed for the particular end use. Until a schedule is determined, inspect Type FVR circuit breakers every two years or 2000 operations, whichever occurs first.

Inspect Type FVR circuit breakers after several (10 max) full-rated fault conditions and record any contact erosion (see “Contact Erosion” on page 27). The following paragraphs are Square D recommended inspection and maintenance procedures.

General Inspection

Visually inspect the entire circuit breaker and operating mechanism for obvious loose parts or connections. Examine the circuit breaker for evidence of overheating or excessive dirt or moisture.

Insulating Surfaces

Use a clean, dry cloth to remove all dirt and moisture from the outside of the vacuum interrupters and from all insulating parts.

Air Filters

Thoroughly clean or replace the air filters. Air filters are located on the floor of the low voltage compartment and inside the side vent housings (see Figure 13). Install air filters correctly to ensure proper air flow.

NOTE: To maintain proper air flow, replace only with identical filter elements.

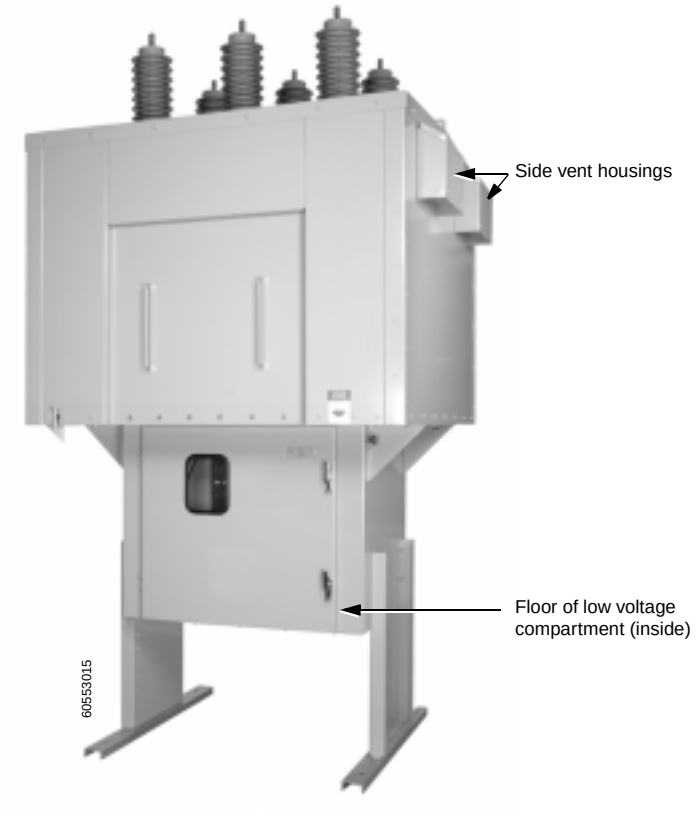

Figure 13: Air Filter Locations

Vacuum Interrupters

*NOTE: **This topic is included for information only.** Adjustments to a new circuit breaker are not necessary, nor are they required for routine maintenance.*

To monitor the condition of the vacuum interrupters, perform the following checks. If interrupter measurements differ from target values consistently, contact Square D Company for corrective procedures.

Contact Erosion

Contact erosion is the difference between the E-gap currently measured and the initial E-gap factory measurement. When contact erosion exceeds 0.12 in. (.305 mm), the vacuum interrupter needs to be replaced. Contact Square D Company for replacement procedure.

E-Gap

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Turn off all power supplying this equipment before working on or inside.
- Always use a properly rated voltage sensing device to confirm that the power is off.
- Replace all devices, doors, and covers before turning on the power to this equipment.

Failure to follow these instructions will result in death or serious injury.

To measure E-gap (see Figure 14), follow the 10 steps outlined in this section:

1. Turn off all the power supplying this equipment before working on or inside.
2. Remove high voltage door to gain access to the high voltage compartment.
3. Remove the two clear polycarbonate barriers from around vacuum interrupters. Barriers are angled at 45° and are held in place by their shape, without fasteners.
4. Close the circuit breaker.
5. Use pin gauges, feeler gages, or drill bits to measure the space between the washer and the flat surface of the bracket. Accuracy should be in the order of 0.015 in. (1/64 in.) or 0.5 mm. Repeat this measuring process for the other side of the pole and record the smaller of the two as that pole's E-gap measurement. E-gap measurements may vary as contacts may erode at different rates.

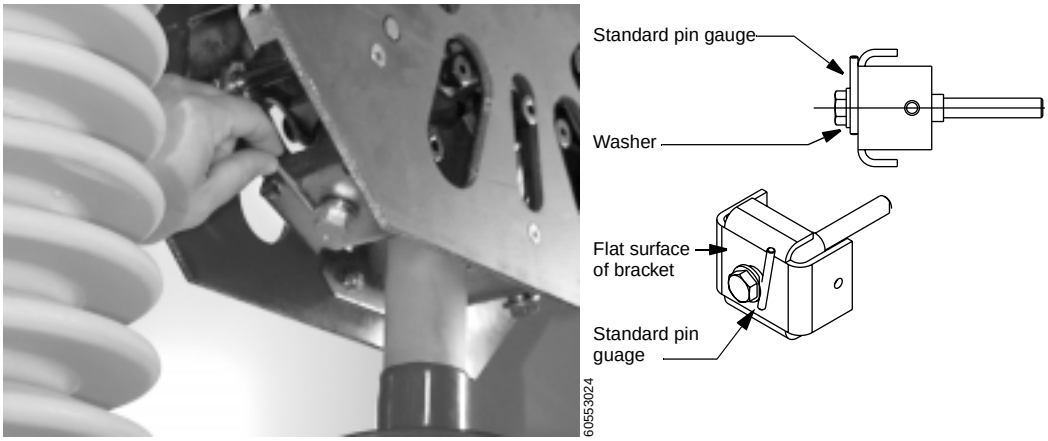

Figure 14: Measuring E-Gap

6. Measure remaining pole(s) as described in Step 5 above. You should have an E-gap measurement for each pole.
7. If the E-gap measurement for either pole reaches the end-of-life dimension, the vacuum interrupter bottle will need to be replaced. The end-of-life E-gap is shown on a label mounted to the floor of the high voltage compartment. **Do not reset E-gap**. Contact Square D Company for assistance.
8. Reinstall the polycarbonate barriers. Barriers are required to maintain the 200 kV BIL rating of the circuit breaker.
9. Open the breaker.
10. Replace all devices, doors, and covers before turning on the power to this equipment.

Hi-Pot (Dielectric) Test

Hi-pot (high potential) tests need to be performed as part of a series of pre-operational tests (see “Pre-Operation Tests” on page 24), regular maintenance, and as a method of determining adequacy against breakdown of insulating materials and spacings under normal conditions. Consistent unacceptable test results may indicate a loss of vacuum. Contact Square D Company for technical assistance.

Resistance Measurement

The resistance measurement from the line side bushing to the load side bushing of the 200 kV BIL circuit breaker should not exceed 150 micro-ohms. Readings exceeding these values using a micro-ohmmeter indicates a high resistance. Either a loose connection exists or the vacuum interrupter needs to be replaced. Contact Square D Company for replacement procedure.

Lubrication

The location of each lubrication point and the method of lubrication required is shown in Table 3. Under normal conditions, lubricate after two years or 2000 operations, whichever occurs first. More adverse conditions may require more frequent lubrication intervals and different procedures. Variations should be based on the experience of the operating company.

Use Mobil® 28 red grease, Square D part number 1615-100950, or approved equivalent. Always wipe the area clean before applying lubrication.

Table 3: Lubrication Chart

Lubrication Point During Maintenance Period	Method of Lubrication
Gear teeth	Wipe clean and apply lubricant. Use Mobil® 28 red grease, Square D part number 1615-100950, or approved equivalent.
Contact surfaces on guide cams and trip latch	
Shock absorber mounting slot	
Motor eccentric and eccentric roller	

SECTION 8—REPLACEMENT PARTS

Table 4 lists factory-recommended replacement parts. Each replacement part is shipped with complete assembly and adjustment instructions.

Ordering Instructions

When ordering replacement parts:

- Always specify the complete rating information, circuit breaker serial number, and factory order number.
- Specify part number, description of part, and operating voltage for electrical components.

Table 4: Replacement Parts

Description	Replacement Kit Number	Rated Voltage	*Cross Reference Part Number
Charging Motor and Gear Box Assembly	46011-659-50	48 Vdc	891063FB
	46011-659-51	125 Vdc	891063FC
	46011-659-52	250 Vdc	891063FD
	46011-659-51	120 Vac	891063FC
	46011-659-52	240 Vac	891063FD
Anti-pump Relay	46011-671-50	48 Vdc	8501KPD12V56
	46011-671-51	125 Vdc	8501KPD12V63
	46011-671-52	250 Vdc	8501KPD12V63
	46011-671-53	120 Vac	8501KP12V20
	46011-671-54	240 Vac	8501KP12V24
Closing Coil	46011-672-53	48 Vdc	887191HL
	46011-672-51	125 Vdc	887191HH
	46011-672-51	250 Vdc	887191HH
	46011-672-53	120 Vac	887191HL
	46011-672-51	240 Vac	887191HH
Trip Coil	46011-673-50	24 Vdc	887191HQ
	46011-673-54	48 Vdc	887191HN
	46011-673-52	125 Vdc	887191HM
	46011-673-53	250 Vdc	887191HJ
	46011-673-54	120 Vac	887191HN
	46011-673-55	240 Vac	887191HL
Dual Trip Coil	46011-674-50	24 Vdc	887190CQ
	46011-674-51	48 Vdc	887190CN
	46011-674-52	125 Vdc	887190CM
	46011-674-53	250 Vdc	887190CJ
	46011-674-51	120 Vac	887190CN
	46011-674-55	240 Vac	887190CL
Undervoltage Trip Coil	46011-684-50	24 Vdc	888513AA
	46011-684-51	48 Vdc	888513AD
	46011-684-52	125 Vdc	888513AH
	46011-684-53	250 Vdc	—
	46011-684-51	120 Vac	—
	46011-684-55	240 Vac	—

*The part identified in the “Cross Reference Part Number” column is included in the corresponding replacement kit.

NOTE: Standard hardware components are not listed and should be purchased locally. Fasteners must be Grade 5 or better.

Table 4: Replacement Parts (continued)

Description	Replacement Kit Number	Rating	*Cross Reference Part Number
Air Filters High Voltage Compartment	46011-680-52	1200 A	46012-170-01
Air Filters Low Voltage Compartment	46011-681-50	1200 A	46011-591-01
Auxiliary Switch	46011-676-50	All Ratings	44068-071-01
Latch Check Switch	46011-675-50	All Ratings	25711504
Mechanism Cover	46011-679-50	All Ratings	888459
Motor Limit Switch	46011-677-50	All Ratings	888539
Type RI Mechanism**	46011-669-50	All Ratings	46011-927-50
Vacuum Interrupter	46011-666-50	200 kV BIL, 1200 A	46040-693-01
Bushing	46011-664-53	200 kV BIL, 1200 A	44081-312-03

*The part identified in the “Cross Reference Part Number” column is included in the corresponding replacement kit.
**Basic mechanism (Order motor and coils separately, if needed.)

NOTE: Standard hardware components are not listed and should be purchased locally. Fasteners must be Grade 5 or better.

SECTION 9—MAINTENANCE LOG

DATE	INITIALS	ACTION

Square D Company
330 Weakley Road
Smyrna, TN 37167 USA
(615) 459-5026
www.squared.com

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