SQUARE D

Instruction Bulletin

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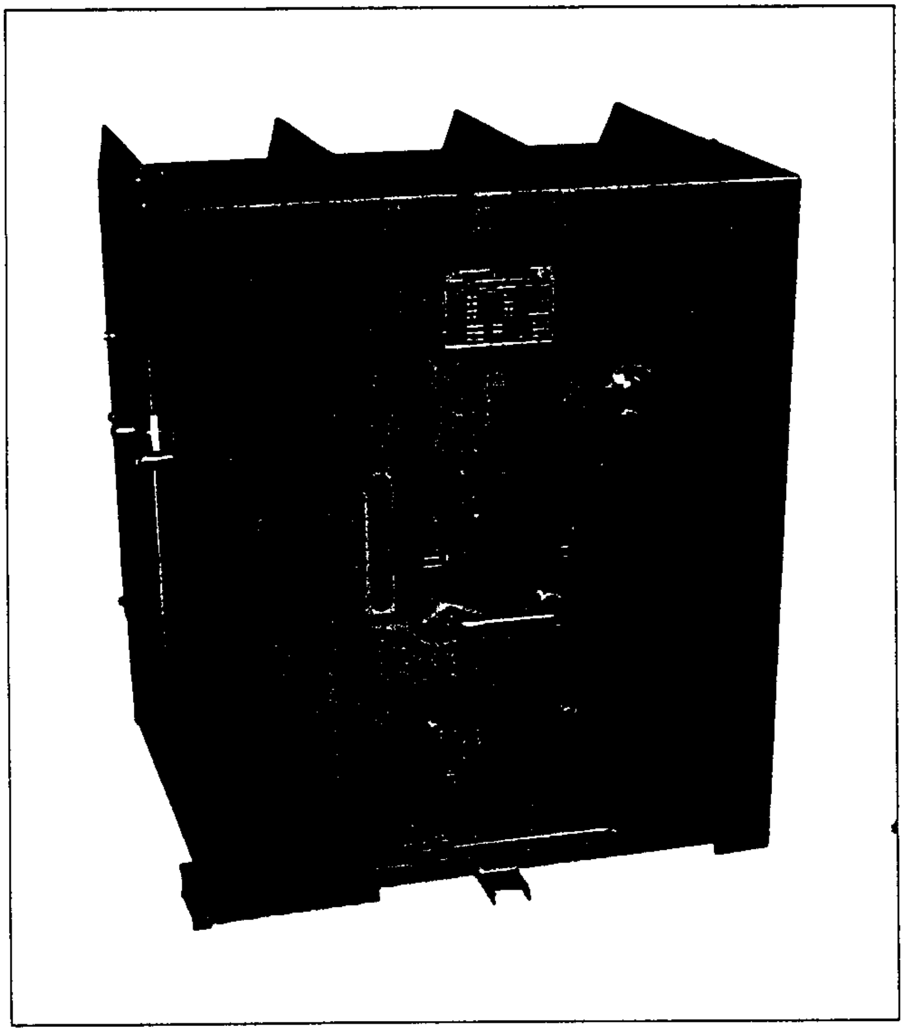
Smyrna, TN, U.S.A.

Vacuum Circuit Breaker Type VAD-2

Series 2



NOTICE

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this bulletin to warn of potential hazards and to call attention to additional information which clarifies or simplifies a procedure.

⚠ DANGER
Used where there is a hazard of severe bodily injury or death. Failure to follow a "DANGER" instruction ***will*** result in electric shock, ***severe*** bodily injury, or death.

⚠ WARNING
Used where there is a hazard of bodily injury or death. Failure to follow a "WARNING" instruction may result in bodily injury or death.

⚠ CAUTION
Used where there is a hazard of equipment damage. Failure to follow a "CAUTION" instruction may result in damage to equipment.

NOTE
Provides additional information to clarify or simplify a procedure.

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SECTION 1—INTRODUCTION

General

This bulletin provides installation, operation, and maintenance instructions for all models of VAD-2 horizontal drawout vacuum circuit breakers. Available in all standard ratings, these circuit breakers provide three-cycle interruption, long switching life, and ease of operation and maintenance. They meet or exceed all applicable industry standards.

Statement Of Use

VACARC® medium voltage vacuum circuit breakers are designed and tested in accordance with ANSI C37.04, C37.06, and C37.09. Used in conjunction with switchgear designed and tested to ANSI C37.20, circuit breakers can be applied as general purpose devices.

Users can install VACARC circuit breakers over a wide range of applications and system parameters. The IEEE Color Book series provides guidance to industry practices for usage.

Pay special attention when using this circuit breaker in conjunction with old or aging distribution systems. Distribution systems can be exposed to lightning or switching surges. Older or aging systems may be more susceptible to damage due to aging insulation or from being built to less stringent standards.

Recognizing this, Square D encourages users to consider adding metal oxide surge arresters to circuitry on the load side of the terminals of VACARC circuit breakers used in retrofit applications. Install the arrestors in the switchgear or at the equipment being protected, not on the circuit breaker.

Metal oxide arrestors limit the magnitude of prospective overvoltages but do not affect the rate of rise (di/dt) of surge transients. Consider surge capacitors for this additional protection.

SECTION 2—SAFETY PRECAUTIONS

This equipment is constructed and tested in accordance with safety-related requirements of ANSI C37.04, C37.06, and C37.09. Square D is not responsible for special design requirements of local codes and ordinances not specified in the purchase documents. Each user is responsible for implementing a safety program commensurate with local codes and the types of hazards involved.

Due to the nature of electrical power and circuit breakers of this type, certain risks exist. Known potential hazards of this equipment include electrocution, burns from arcing equipment, and pinching from the discharge of stored mechanical energy.

Implementation of an appropriate safety program covering installation, operation, and servicing of the equipment is the user's responsibility. Because of the various conditions which may exist at any site, the following safety precautions are not intended to be all-encompassing.

⚠ DANGER

HAZARD OF BODILY INJURY OR EQUIPMENT DAMAGE.

- All personnel involved in handling, site preparation, installation, testing, operation, and maintenance should be thoroughly familiar with the information in this instruction bulletin and in provided customer drawings ***before*** working on this equipment. They must have a thorough understanding of high voltage equipment in general, the specific operation of this particular equipment, and the types and severity of potential injuries.
- Always assume that all high voltage parts are energized until you are certain they are de-energized.
- Check interconnection diagrams; make sure there are no potential backfeed sources.
- Do not open a circuit breaker door unless the circuit breaker is tripped.
- Use out-of-service tags and padlocks when working on equipment. Leave the tags in place if you leave the area, or until the work is completed and the equipment is ready for service again.

Never use liquid fire extinguishers or water on electrical fires! Before extinguishing fires within the assembly, be absolutely certain the main power source is disconnected, and the main and all feeder circuit breakers are tripped.

(continued on next page)

⚠ DANGER

(continued from previous page)

- Perform all maintenance in accordance with local codes and under the following conditions:
  - The circuit breaker must be removed from its cell and isolated from the high voltage.
  - Control voltage must be removed from the controls.
  - The circuit breaker must be in the *open* position.
  - Operation and maintenance of this equipment should be well-planned and in accordance with safety practices. Have adequate safety equipment and appropriate maintenance tools readily available.
- Never work on or near electrically energized parts where accidental contact is possible.
- Be certain the circuit breaker mechanism is discharged or blocked before working on the circuit breaker; release of stored spring energy can result in serious personal injury.
- Use only test equipment rated for the service intended. Never use instruments or multimeters rated for low voltage service on high voltage circuits; incorrect use of such instruments can result in an explosion and serious personal injury.
- ***When in doubt, stop!*** Re-read the instruction bulletin or refer to the customer drawings before proceeding. Eliminate dangerous and costly human errors!
- This instruction manual does not cover all possible equipment combinations or details thereof. Nor does it cover field conditions that may exist or arise during handling, site preparation, installation, testing, operation, or maintenance. For additional information, or if unusual site conditions exist or unforeseen problems arise, contact your local Square D field office.

Failure to observe these precautions will result in severe personal injury, death, or equipment damage!

SECTION 3—RECEIVING, HANDLING, AND STORAGE

Receiving

Inspect each box for external damage or indications of rough handling before accepting the shipment. If there is external damage, or if the correct number of crates is not received, make note of the problem on the shipping papers before signing them. Immediately file a formal damage claim with the carrier. Notify your local Square D field office about the extent of damages or shortages, and attach a copy of the formal damage claim.

Handling

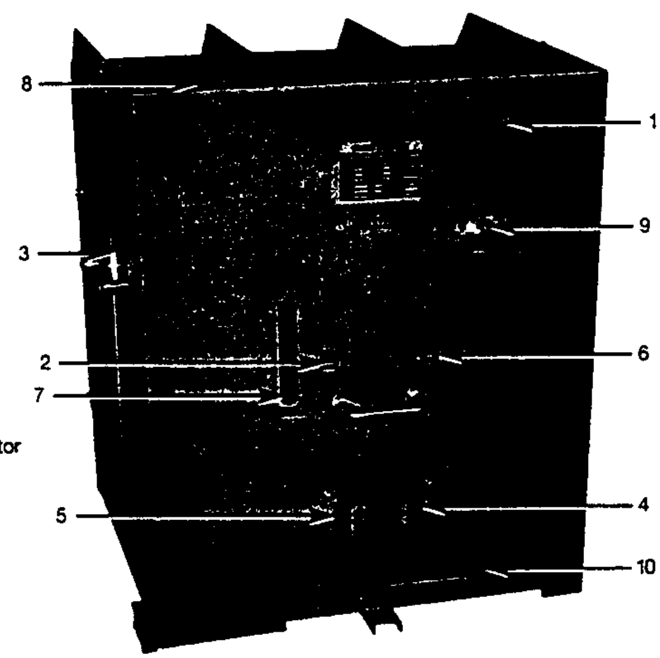
Use care when uncrating and handling the circuit breaker. *Never use the primary disconnects as handles.* Roll and maneuver the circuit breaker by grasping the handle holes at the top of the front mechanism cover (figure 1). When using a fork lift or hoist, lift by the lifting brackets at the top of the circuit breaker frame to prevent damage.

Storage

If the circuit breaker is stored prior to installation, it *must* be kept in a place that is clean, dry, and free of corrosive elements and mechanical abuse. Coat all bare metal surfaces with suitable lubricants to prevent rust or corrosion. See table 1, **Lubrication Methods**, page 22.

Square D recommends installing the circuit breaker as soon as possible. If the circuit breaker is installed in outdoor switchgear, make sure power is available and heaters are operating.

Inspect stored circuit breakers regularly for rusting and overall condition. Lubricate when necessary.



1. Front Mechanism Cover
2. Charge-Discharge Indicator
3. Racking Arm
4. Open (Trip) Lever
5. Close Lever
6. Open-Close Indicator
7. Manual Charging Arm
8. Handles
9. Racking Shaft
10. Secondary Slide Handle

Figure 1: Type VAD-2 Series 2 vacuum circuit breaker

SECTION 4—VACUUM CIRCUIT BREAKER DESCRIPTION

Vacuum Interrupters

Vacuum interrupters, mounted vertically within the circuit breaker frame (figure 2), perform interruption in the vacuum circuit breaker. These interrupters consist of a pair of butt contacts, one moveable and one fixed, hermetically sealed in a high vacuum. They require only a short contact gap for circuit interruption. The resulting high operating speed allows the entire operating sequence, from fault to clear, to be consistently performed in three cycles or less.

Primary Disconnects

The primary connection to the associated switchgear is made through the six primary disconnects (figure 3) mounted horizontally at the rear of the circuit breaker. Make certain the primary disconnects are not roughly handled. *Never use the primary disconnects as handles when moving the circuit breaker.*

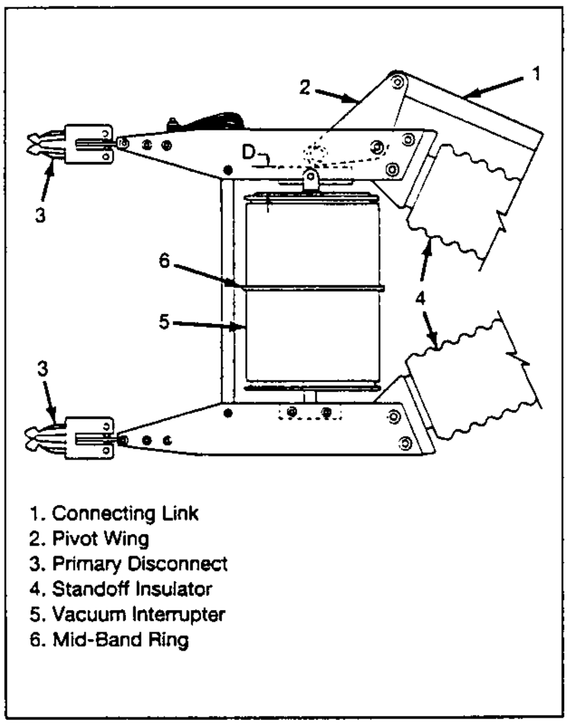


Figure 2: Vacuum interrupter assembly

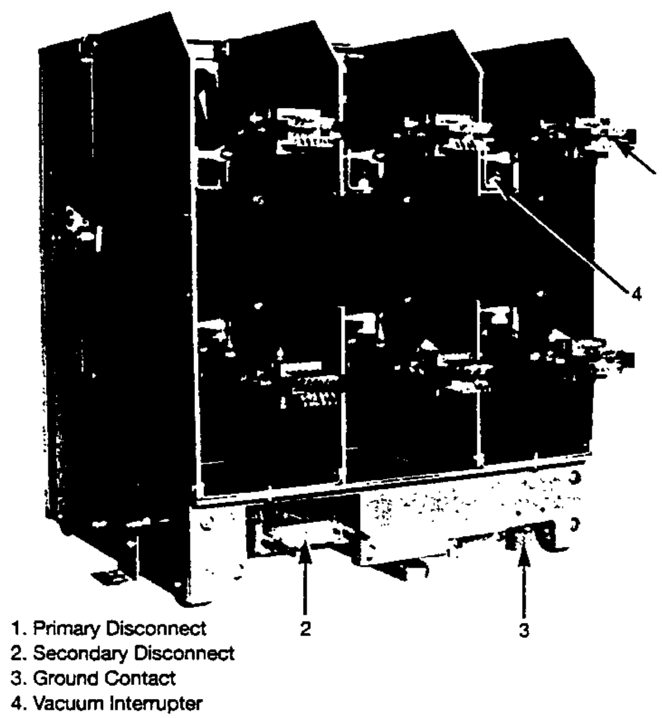


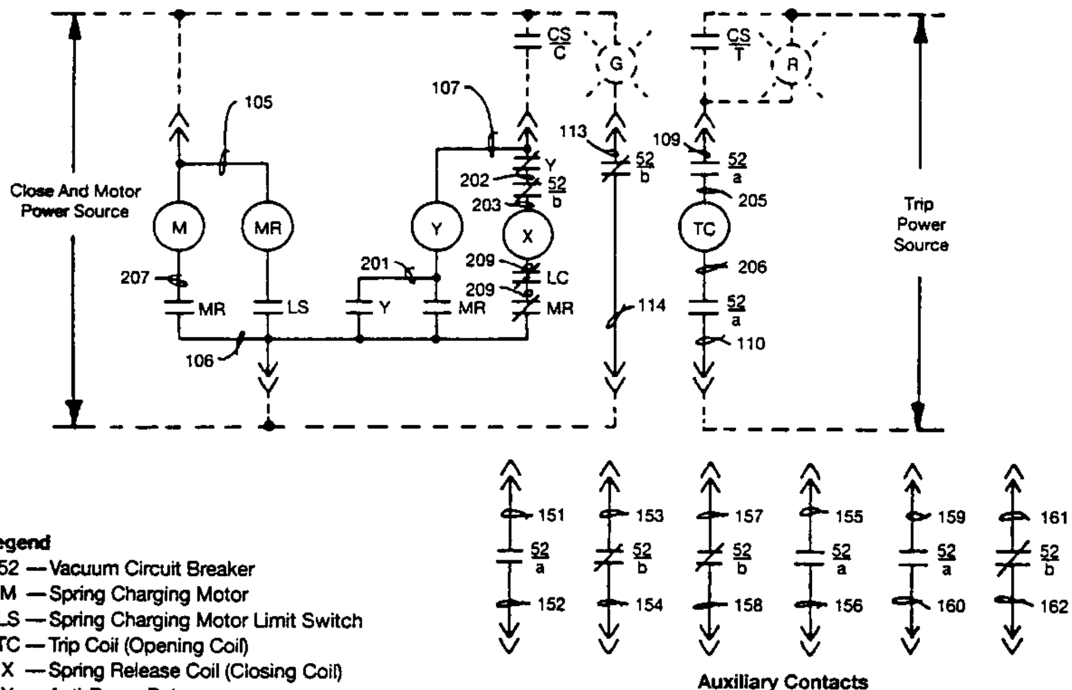
Figure 3: Rear view of circuit breaker

Operating Mechanism

The operating mechanism is of the stored energy type; charged springs perform circuit breaker opening and closing functions. The operating mechanism contains all necessary controls and interlocks. It is mounted at the front of the circuit breaker so that it can be easily accessed for inspection and servicing. Opening and closing can be performed electrically or manually. See page 12 for a description of the operating mechanism.

Control Circuitry

Figures 4 and 5 show typical control circuit schematics. Operation of the various components of the circuit breaker control circuitry is described in the following paragraphs

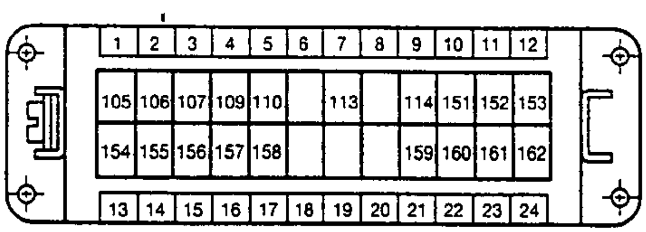


Legend

52 — Vacuum Circuit Breaker
M — Spring Charging Motor
LS — Spring Charging Motor Limit Switch
TC — Trip Coil (Opening Coil)
X — Spring Release Coil (Closing Coil)
Y — Anti-Pump Relay
MR — Motor Relay
G — Green Indicating Light
R — Red Indicating Light
CS — Control Switch
-<< — Indicates Secondary Disconnect Point
LC — Latch Check Switch

Note:

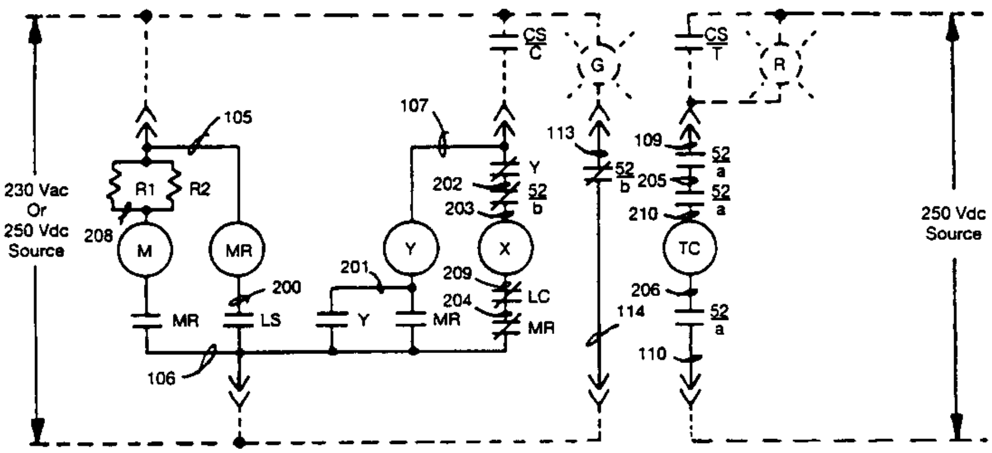
1) 52/b open when breaker is closed.
2) 52/a open when breaker is open.
3) Dashed lines indicate user supplied circuitry and components.



Secondary Disconnect Wiring
(Circuit Breaker Side Connection View)

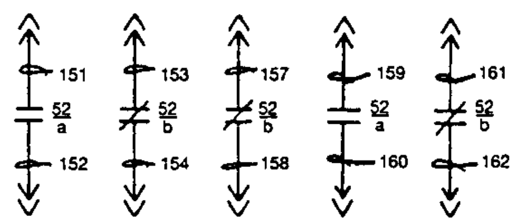
Figure 4: Control circuitry schematic for ac and dc application (except 250 Vdc)

Control Circuitry (cont.)



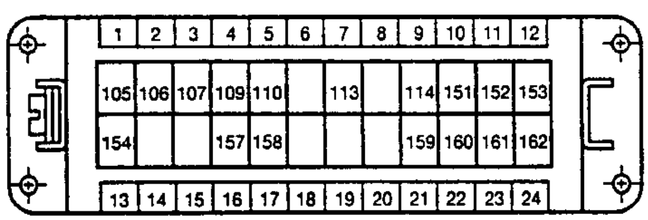
Legend

52 — Vacuum Circuit Breaker
M — Spring Charging Motor
LS — Spring Charging Motor Limit Switch
TC — Trip Coil (Opening Coil)
X — Spring Release Coil (Closing Coil)
Y — Anti-Pump Relay
MR — Motor Relay
G — Green Indicating Light
R — Red Indicating Light
CS — Control Switch
R1, R2 — Current Limiting Resistor, 56Ω, 250W
-<< — Indicates Secondary Disconnect Point
LC — Latch Check Switch



Auxiliary Contacts

Note:
1) 52/b open when breaker is closed.
2) 52/a open when breaker is open.
3) Dashed lines indicate user supplied circuitry and components.



Secondary Disconnect Wiring
(Circuit Breaker Side Connection View)

Figure 5: Control circuitry schematic for 250 Vdc application

Auxiliary Switch

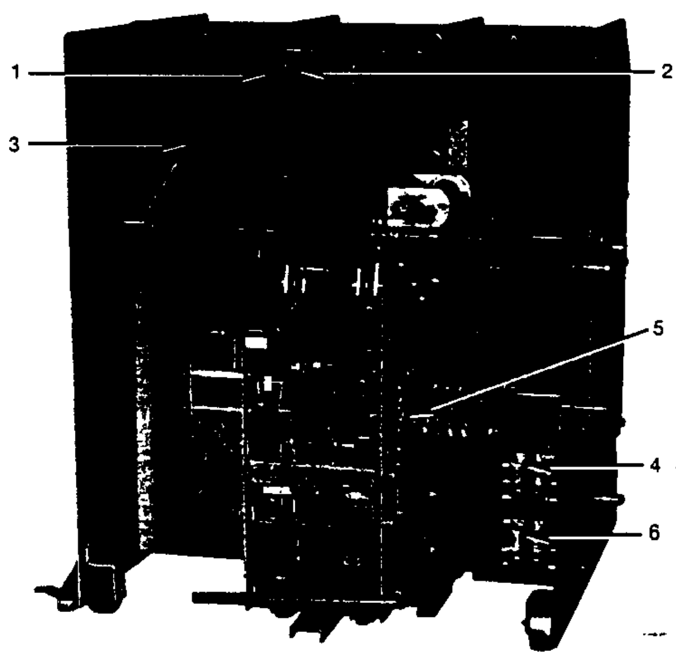
The auxiliary switch (figure 6) is a multi-stage switch used to operate circuits dependent upon the position of the circuit breaker contacts. Figures 4 and 5 show how each of the auxiliary switch stages interconnect with the circuit breaker circuitry. The function of each stage is discussed below.

- Two a-type auxiliary contacts (three for 250 Vdc control) are connected in series with the trip coil (TC, figures 4 and 5). Since these stages are open when the circuit breaker is in the *open* position, the auxiliary contacts prevent the trip coil from being energized when the circuit breaker is in the *open* position.

  The b-type auxiliary contact, connected in series with the closing coil (X, figures 4 and 5), disables the closing coil when the circuit breaker contacts are in the *closed* position.

- For user convenience in indicating the position (open or closed) of the circuit breaker contacts, figures 4 and 5 indicate how a green light (contacts open) and a red light (contacts closed) can be connected to the circuit breaker control circuitry.

- Typically, three b-type contacts and three a-type contacts are connected to the secondary disconnect for optional use (figures 4 and 5). Other variations can occur depending upon latch check switch and other optional requirements; consult figures 4 and 5 as required.

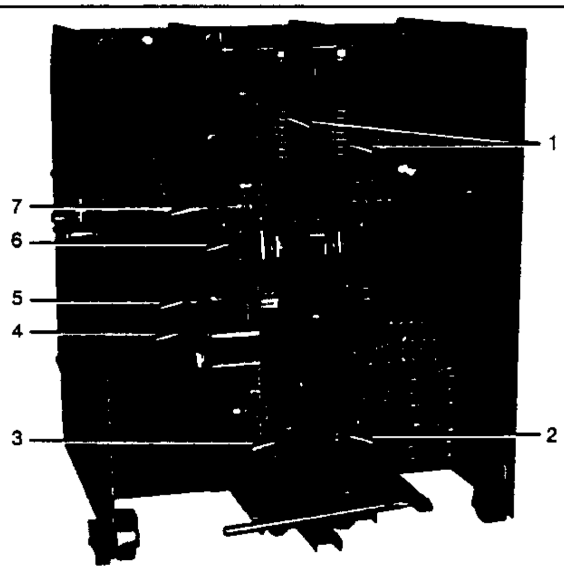


1. Opening Spring Stop
2. Shock Absorber
3. Drive Connecting Link
4. Motor Relay
5. Auxiliary Switch
6. Anti-Pump Relay

Figure 6: Front view of circuit breaker mechanism (left side)

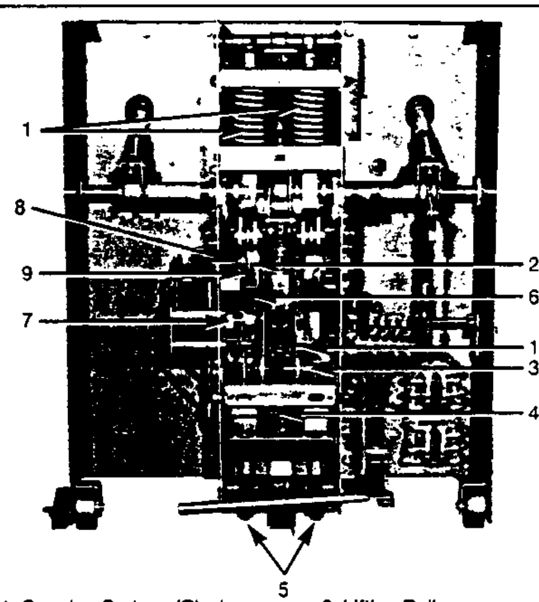
Charging Motor Limit Switch

The charging motor limit switch (figure 7) energizes the motor relay (figure 6) when a closing spring charging operation is required and de-energizes the motor relay when the closing springs (figure 8) reach the fully charged position. As shown in the schematics (figures 4 and 5), the charging motor limit switch (LS) is connected in the normally open position. Whenever the closing springs are not fully charged, the charging motor limit switch cam (figure 7) actuates the charging motor limit switch. Once the closing springs are fully charged, the cam allows the switch to assume its normally open position.



1. Opening Springs
2. Opening (Trip) Coil
3. Closing Coil
4. Charging Motor Limit Switch
5. Charging Motor Limit Switch Cam
6. Drive Shaft
7. Main Shaft

Figure 7: Front view of circuit breaker mechanism (right side)



1. Opening Springs (Closing Springs Located Behind)
2. Lift Arm
3. Trip Open Arm
4. Charging Motor
5. Spring Discharge Interlocks
6. Lifting Roller
7. Closing Cam
8. Drive Lever
9. Trip Closing Roller
10. Latch Check Switch

Figure 8: Front view of circuit breaker (cover removed)

Motor Relay

When energized by the closing of the spring charging motor limit switch (LS, figure 4 and 5), the motor relay (MR) energizes the spring charging motor through a pair of normally open contacts, and disables the closing coil through a pair of normally closed contacts.

Anti-Pump Relay

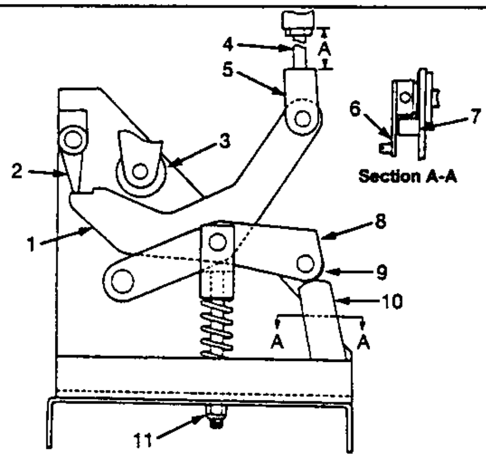
The control switch (CS/C), separately mounted in the switchgear assembly, energizes the closing coil. The anti-pump relay ensures that, if the control switch (CS/C, figures 4 and 5) is maintained continuously in the *closed* position, the springs will not be continuously charged and discharged. The anti-pump relay accomplishes this by allowing the closing coil to be energized only if the control switch (CS/C) is closed after the closing springs have reached the fully charged position and the motor relay (MR) has been de-energized.

Anti-Pump Relay (cont.)

If the control switch (CS) is closed and the motor rely (MR) is energized, the anti-pump relay is energized. If the control switch is held continuously, the anti-pump relay latches in the energized position after the motor relay is de-energized by a pair of its own normally open contacts. When the anti-pump relay is energized, a pair of its normally closed contacts, in series with the closing coil, ensures that the closing coil cannot be energized by the control switch. The closing coil cannot be energized unless the control switch is first opened (de-energizing the anti-pump relay), then closed again.

Latch Check Switch

This feature, once optional, is now standard. The latch check switch permits the circuit breaker to be used for instantaneous reclosing. The contacts of the latch check switch are connected in series with the closing coil (X). The latch check switch is actuated by the trip opening cam (figure 9) only when the cam is in its normal reset position as shown in figure 9. Thus, the closing circuit cannot be re-energized until the trip opening cam has fully returned to its normal reset position.



1. Toggle Cam
2. Catch
3. Closing Spring Bearing
4. Drive Linkage Shaft
5. Drive Linkage
6. Trip Open Arm
7. Trip Open Eccentric
8. Toggle Sub-Assembly
9. Toggle Bearing
10. Trip Open Cam
11. Toggle Sub-Assembly Retainer Nut

Figure 9: Toggle mechanism assembly

Permissive Close Device (Optional)

When specified, a permissive close device can be supplied. This safety feature is sometimes desired by users who employ remote control or automatic reclosing schemes. The permissive close device is a toggle switch whose contacts are connected in series with the closing coil (X). A manual trip operation will mechanically cause these normally closed contacts to open. The permissive close device must be manually reset to complete the electrical closing circuit again. It is accessed through the optional cutout labeled "Emergency/Manual Trip Reset" in the front mechanism cover.

Indicators

Two indicators are provided on the operating mechanism. The *open/close* indicator (figure 1) designates the position of the vacuum interrupter contacts. The *charge/discharge* indicator (figure 1) displays the state (charged or discharged) of the closing springs (figure 8).

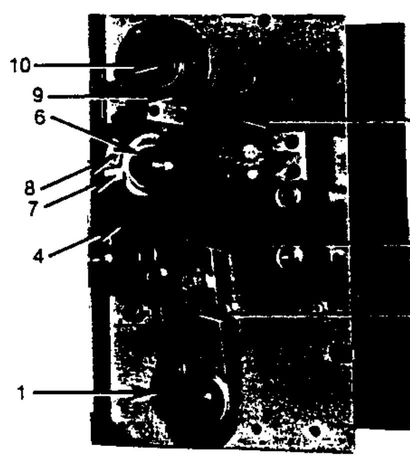
SECTION 5—OPERATING MECHANISM DESCRIPTION

General

In the following description of the operating mechanism, the operating mechanism is referred to as the front of the circuit breaker. The terms *left* and *right* are used as if facing the operating mechanism. The terms *clockwise* and *counterclockwise* are used as if facing the left side of the circuit breaker.

Drive Spring Charging

Assume that the interrupter contacts are open and the closing springs (figure 8) and opening springs (figure 7) are discharged. When power is supplied to the circuit breaker control circuitry (figures 4 and 5), the charging motor (figure 8) is energized. The motor eccentric (figure 10), mounted on the charging motor shaft, drives the ratchet arm assembly (figure 10) backward and forward. With each forward stroke of the ratchet arm, the spring loaded drive pawl (figure 10) mounted on the ratchet arm engages a tooth on the gear (figure 10) and advances the gear a few degrees counterclockwise. The holding pawl (figure 10) holds the gear in position while the drive pawl makes its reverse stroke to engage another tooth. The gear is free to rotate on the gear shaft (figure 10). As the gear is advanced, the drive block, mounted on the outside face of the gear (figure 10), engages the gear on the drive hub and rotates the drive hub. A roll pin connects the drive hub to the gear shaft (figure 10) and drive lever (figure 8) assembly. The gear shaft and drive lever assembly thus rotates with the drive hub.



1. Motor Eccentric	6. Gear Shaft
2. Rachet Arm Assembly	7. Drive Hub
3. Drive Pawl	8. Drive Block
4. Gear	9. Pawl Lift Slide
5. Holding Pawl	10. Drive Shaft

Figure 10: Charging gear assembly

As the drive lever rotates, the lifting roller (figure 8) on the drive lever contacts the lift arm (figure 8) on the drive shaft (figure 10) and pushes the lift arm up, rotating the drive shaft counterclockwise. The counterclockwise drive shaft rotation compresses the closing springs until the spring load against the drive lever passes top dead center and attempts to discharge. At

Drive Spring Charging (cont.)

this point, the drive lever rotates a few degrees until the closing roller (figure 8) on the drive lever can rotate no further; the closing springs are held in this *charged* position until a closing operation is initiated.

When the closing springs reach the fully charged position, the charging motor limit switch cam (figure 7) allows the charging motor limit switch (figure 7) to open, de-energizing the charging motor. Simultaneously, the pawl lift slide (figure 10) is pushed forward by the cam lobe on the drive hub so that the drive pawl rides on the pawl lift slide and does not engage the gear. This arrangement allows the charging motor and ratchet assembly to coast smoothly to a stop.

Closing Operation

Once the closing springs (figure 8) are charged, the circuit breaker can be closed by lifting the close lever (figure 1), or by energizing the closing coil (figure 7). Either method disengages the closing cam (figure 8) from the closing roller (figure 8) and allows the closing springs to discharge. The discharging closing springs rotate the drive shaft (figure 10) clockwise. The clockwise rotation of the drive shaft moves the closing spring bearing (figure 9) in a downward motion. The closing spring bearing engages the toggle cam (figure 9), rotating the front of the toggle cam up and the rear of the toggle cam down under the catch. The front of the toggle cam is connected to the main shaft (figure 7) by the drive linkage (figure 9). The upward motion of the front of the toggle cam thus rotates the main shaft counterclockwise and compresses the opening springs (figure 7).

The drive connecting links (figure 6) transform the rotary motion of the main shaft into a linear motion which closes the vacuum interrupter contacts. The trip open cam (figure 9) forces the entire toggle assembly to remain latched in this position.

When the closing springs discharge, rotating the drive shaft in a counterclockwise direction, the descending lift arm rotates the drive lever such that the drive lever rotates back to its initial position; there it can again perform a closing spring charging operation.

The gear shaft and drive hub rotate with the drive lever. The drive hub rotates out of contact with the drive block. Since the gear (figure 10) rotates freely on the gear shaft, the gear remains stationary. The rotation of the drive hub is such that the pawl lift slide moves back below the gear teeth, permitting the drive pawl (figure 10) to engage the gear. The charging motor limit switch cam (figure 7) rotates with the gear shaft and closes the charging motor limit switch (figure 7). This energizes the charging motor (figure 8) which once again charges the closing springs.

Opening (Trip) Operation

With the opening springs (figure 7) charged, the operating mechanism is ready to perform an opening operation. If the open lever (figure 1) is lifted or if the opening (trip) coil (figure 7) is energized, the trip open cam (figure 9) is rotated clockwise out from under the toggle bearing (figure 9). The force of the charged opening springs pushing down on the front of the toggle cam (figure 9) causes the toggle sub-assembly (figure 9) to rotate clockwise. When the rear of the toggle cam clears the catch (figure 9), the opening springs completely discharge, rotating the main shaft (figure 7) and the toggle cam clockwise. The clockwise rotation of the main shaft is transformed to a linear motion by the drive connecting links (figure 6). The drive connecting links connect to the vacuum interrupters (figure 2) and their motion opens the vacuum interrupter contacts.

Spring Discharge Interlocks

The spring discharge interlocks (figure 8) are located directly below the opening (trip) and closing coils (figure 7). Three cams located on the cell floor engage the spring discharge interlocks so that the primary disconnects (figure 3) cannot be engaged or disengaged with the interrupter contacts closed; all springs are automatically discharged whenever a circuit breaker is inserted into or removed from its cell.

SECTION 6—INITIAL CIRCUIT BREAKER PREPARATION

Follow these steps to prepare the circuit breaker for installation into its enclosure:

1) Examine the entire circuit breaker.
2) Using a clean, dry cloth, remove any dirt or moisture from the outside of the vacuum interrupters (figure 2) and all insulating parts.
3) Manually operate the circuit breaker through several cycles; check for proper operation. To do so, use the manual charging handle supplied with the circuit breaker to move the manual charging arm (figure 1) up and down until the closing springs (figure 8) are fully charged. The closing springs are fully charged when the *charged/discharged* indicator (figure 1) reads *charged* and manual charging arm can no longer be raised.
4) Electrically operate the circuit breaker several times; check for proper operation. (Use the *Test* position of the switchgear assembly or the optional test cabinet, if provided.)
5) To ensure that damage has not occurred during shipment, perform a hi-pot test across the open contacts of each vacuum interrupter. Then with the circuit breaker closed, perform a phase-to-ground and phase-to-phase hi-pot test on each pole.

   Gradually raise the hi-pot test voltage to the proper level. For a 4.76 kV class circuit breaker, the test voltage should be 14 kVac (20 kVdc). For an 8.25 kV or 15 kV class circuit breaker, use 27 kVac (38 kVdc). The circuit breaker should withstand the test voltage for one minute.

   Some hi-pot test sets may indicate low values of leakage current during the hi-pot test. There is no significant correlation between the vacuum interrupters and low leakage current values.

⚠ WARNING

HAZARD OF ELECTRICAL SHOCK OR BURN.

Observe these precautions during hi-pot testing:

- Do not exceed the voltage specified above.
- Keep all personnel at least 6 feet away from the circuit breaker being tested.
- Perform tests only with all insulating parts installed.
- Discharge to ground the primary disconnects (figure 3) and vacuum interrupter mid-band ring (figure 2) before handling. These areas can retain a static charge after a hi-pot test.

Failure to follow these precautions can result in bodily injury, death, or equipment damage.

6) Insert the circuit breaker into its enclosure. See **Section 7—Operation** for a description of the circuit breaker drawout and racking in procedures.

7) With the main power *off*, cycle the circuit breaker several times; check for proper operation.

8) The circuit breaker is now ready for normal operation.

SECTION 7—OPERATION

Manual Charging

Manual charging is considered a maintenance or emergency operation; it is not normally required under usual operating conditions.

Use the manual charging handle, supplied with the circuit breaker, to manually charge the closing springs (figure 8). Move the manual charging arm (figure 1) up and down until the closing springs are fully charged. The closing springs are fully charged when the *charged/discharged* indicator (figure 1) reads *charged* and the manual charging arm can no longer be raised.

Slow Closing Feature

For some maintenance functions it may be desirable to manually slow close the circuit breaker. For this reason, the operating mechanism provides a built-in slow close feature.

⚠ WARNING

HAZARD OF PERSONAL INJURY.

Only qualified personnel should slow close the circuit breaker. Stored energy in the closing springs and sudden operation of the operating mechanism can cause serious bodily harm.

Failure to follow this precaution can result in severe personal injury.

Follow these steps to manually slow close the circuit breaker:

1) Ensure the circuit breaker is in the *open* position and the closing springs are charged. Check to see that the green "OPEN" flag appears in the circuit breaker position window and the yellow "CHARGED" indicator is showing in the closing springs condition window. If the closing springs are not charged, use the manual charging procedure, above, to charge the closing springs.
2) Remove the front operating mechanism cover. Locate the two closing spring guide ends behind the opening springs (figure 8). With the closing springs charged, the closing spring guides extend through the top of the mechanism; holes will be visible in each of the spring guides. Insert the closing spring guide blocking pins (supplied with the circuit breaker) into the holes on each of the closing spring guides.

⚠ CAUTION

HAZARD OF EQUIPMENT DAMAGE.

Never attempt to use only one blocking pin. The operating mechanism could be seriously damaged by the unbalanced loading one blocking pin would produce.

Failure to follow this precaution can result in equipment damage.

Slow Closing Feature (cont.)

3) Manually operate the *close* lever (figure 1) to discharge the closing springs against the blocking pins. Do not operate the *open* (trip) lever at this time.
4) Using the manual spring charging handle, slowly operate the spring charging mechanism to close the main contacts.
5) The slow close operation can be terminated at any point by operating the *open* (trip) lever (figure 1).
6) Normal operation can be restored by fully recharging the closing springs and removing **both** spring guide blocking pins. The circuit breaker will be closed at this point; operating the *open* (trip) lever will open the circuit breaker.
7) Disarm the circuit breaker by operating the *close* lever and then the *open* lever. The circuit breaker opens and the closing springs are fully discharged. Replace the front cover prior to returning the circuit breaker to service.

Drawout Operation

⚠ CAUTION

HAZARD OF EQUIPMENT DAMAGE.

The racking mechanism is interlocked with the circuit breaker operating mechanism such that the racking mechanism will not operate unless the circuit breaker is in the *open* position. *Never* force the racking mechanism. Always ensure the circuit breaker is open before attempting to rack the circuit breaker in or out. Follow the appropriate racking instructions below to rack the circuit breaker in or out.

Failure to follow these precautions can result in equipment damage.

Racking In Procedure—To rack in the circuit breaker, follow these steps:

1) Check that the circuit breaker racking arms (figure 1) are in the drawout position before inserting the circuit breaker into the cell. In the drawout position the racking arms extend horizontally toward the rear of the circuit breaker and rest on their eccentric stops.

   If necessary, move the racking arms to the drawout position. To do so, follow these steps:

   a. Place the circuit breaker in the *open* position.
   b. Insert the racking handle into the racking shaft (figure 1).
   c. Rotate the racking handle counterclockwise until the racking mechanism comes to a stop. **Do not overtorque.**

Drawout Operation (cont.)

2) Insert the circuit breaker into the cell until the rollers on the racking arms come into contact with the slots in the sides of the cell.
3) Rotate the racking handle clockwise until the racking mechanism stops. **Do not overtorque.**

Racking Out Procedure—To rack out the circuit breaker, follow these steps:

1) Place the circuit breaker in the *open* position.
2) Insert the racking handle into the racking shaft (figure 1).
3) Turn the racking handle counterclockwise until the racking mechanism stops. **Do not overtorque.**
4) Lift the foot pedal latch at the lower left side of the circuit breaker; roll the circuit breaker out of the cell.

Test Position Operation

The secondary disconnect (figure 3) is mounted on a retractable slide so that it can be connected to the control circuit of the cell while the cell shutters are down and primary connections have not been made. This *test* position provides a convenient and safe method for electrically testing the operation of the circuit breaker mechanism and control circuit. To connect the secondary disconnect with the circuit breaker in the *test* position, follow these steps:

1) Move the circuit breaker into the *test* position of the cell by following steps 1–3 of the **Racking In Procedure** on page 18. Do not rack the circuit breaker into the cell.
2) Pull the secondary slide handle (figure 1) out of its retaining clip and rotate it so it protrudes straight out from the circuit breaker.
3) Lift slightly on the secondary slide handle; push it into the circuit breaker until connection is made.
4) The control circuit of the circuit breaker is now connected with the cell control circuit.
5) To retract the secondary disconnect, reverse the above procedure.

SECTION 8—MAINTENANCE

> ⚠ **WARNING**
>
> **HAZARD OF ELECTRICAL SHOCK OR PINCHING.**
>
> For safety, always remove the circuit breaker from its cubicle and discharge or block the closing springs (figure 8) and the opening springs (figure 8) before performing any maintenance or repair work.
>
> **Failure to follow this precaution can result in severe personal injury, death, or equipment damage.**

Because of the wide variations in operating uses and environments, each operating company should develop a maintenance schedule, based on operating experience, to keep the circuit breaker in proper condition. Until such a schedule is determined, Square D recommends inspecting circuit breakers after one year or every 3,000 operations, whichever occurs first. Also inspect circuit breakers after severe fault operations. Hi-pot test the circuit breaker and also check contact erosion (see **Vacuum Interrupters**, below).

Vacuum Interrupters

To ensure reliable interruption, perform the following two checks:

- **Contact Erosion**—Any contact erosion results in a reduction of the spring overtravel (see **Spring Overtravel**, page 25). Contact erosion can therefore be determined by closing the circuit breaker and measuring the spring overtravel. The difference between this measurement and the original spring overtravel setting represents contact erosion. The factory setting for spring overtravel is 3/16" with tolerances of +1/16" and –1/32" (4.8 mm +1.6 mm/–0.8 mm). When the spring overtravel has been reduced to less than 1/16", the vacuum interrupter must be replaced.

> ⚠ **WARNING**
>
> **HAZARD OF ELECTRICAL SHOCK OR BURN.**
>
> Observe these precautions during hi-pot testing:
>
> - Do not exceed the voltage specified above.
> - Keep all personnel at least 6 feet away from the circuit breaker being tested.
> - Perform tests only with all insulating parts installed.
> - Discharge to ground the primary disconnects (figure 3) and vacuum interrupter mid-band ring (figure 2) before handling. These areas can retain a static charge after a hi-pot test.
>
> **Failure to follow these precautions can result in bodily injury, death, or equipment damage.**

- **Hi-pot Test**—Perform a hi-pot test across the open contacts of each vacuum interrupter.

Vacuum Interrupters (cont.)

Gradually raise the hi-pot test voltage to the proper level. For a 4.76 kV class circuit breaker, the test voltage should be 14 kVac (20 kVdc). For an 8.25 kV or 15 kV class circuit breaker, use 27 kVac (38 kVdc). The vacuum interrupter should withstand the test voltage for one minute.

Some hi-pot test sets may indicate low values of leakage current during the hi-pot test. There is not significant correlation between the vacuum interrupters and low leakage current values.

Insulating Surfaces

Using a clean, dry cloth, remove any dirt and moisture from the outside of the vacuum interrupters (figure 2) and from all insulating parts.

Mechanism

Inspect the entire circuit breaker and operating mechanism for loose hardware and worn or broken parts. Check all wiring for loose connections and damaged insulation. Inspect all bearings and contact surfaces for damage or excessive wear. Examine the shock absorber for evidence of leakage. Verify proper mechanism adjustments as specified in **Section 9—Adjustments**, page 24.

Lubrication

All bearings used in this series of vacuum circuit breakers are sealed; no lubrication is required.

The lubrication chart below provides the locations of all lubrication points, the type of lubrication required, and the two methods of lubrication. Method I shows the periodic lubrication required after one year or 3,000 operations, whichever occurs first. Method II shows the lubrication required whenever the circuit breaker is overhauled or disassembled.

Severe operating conditions may warrant different lubrication intervals and procedures. Variations should be based on the experience of the operating company.

Operate the circuit breaker several times after lubrication; check for proper operation.

NOTE

Important: Never apply grease to the machined surface of the trip closing cam (figure 8), the trip opening cam (figure 9), or their respective cam followers.

Lubrication (cont.)

Table 1: Lubrication Methods

Lubrication Point	Method 1 Lubrication at Maintenance Period	Method II Lubrication at Overhaul
Gear teeth	Wipe clean and apply lubricant ①	Disassemble, wipe clean, and apply lubricant ①
Contact surfaces on lift arm (figure 8), toggle cam (figure 9), opening spring connecting block (figure 12), catch (figure 9), etc.	Wipe clean and apply lubricant ①	Disassemble, wipe clean, and apply lubricant ①
Gear shaft (figure 10) and drive shaft (figure 10)	No lubrication required	Disassemble, wipe clean, and apply lubricant to contact surfaces ①
Rachet arm (figure 10)	No lubrication required	Disassemble, wipe clean, and apply lubricant to bronze bushing and all contact surfaces ①
Contact and pivot points of all linkages	Wipe clean and apply lubricant ①	Disassemble, wipe clean, and apply lubricant ①
Closing spring assembly	No lubrication required	Do not disassemble. Wipe clean and apply lubricant to center shaft ①
Motor eccentric (figure 10) and eccentric roller	Wipe clean and apply lubricant to slot in ratchet arm ①	Disassemble, wipe clean, and apply lubricant ①
All shafts, sleeves, spacers, and bushings	No lubrication required	Disassemble, wipe clean, and apply lubricant ①
Silver plated primary disconnect (figure 3) contacts, grounding contacts, and secondary contacts	Wipe clean and apply a high quality conductive contact lubricant ②	Wipe clean and apply a high quality conductive contact lubricant ②

① Use Mobilgrease 28, Square D part no. 1615-100950, or equivalent.
② Use Mobilux EP-1, Square D part no. 1615-100790, or equivalent.

Electrical

Ensure that all electrical connections are clean and tight. Clean the relay and auxiliary switch contacts using a high quality contact cleanser.

Overhaul

After 10,000 operations, thoroughly overhaul the circuit breaker, replacing all components which have been excessively worn. The overhaul may require disassembly of the operating mechanism. During an overhaul, lubricate parts per method II on the **Lubrication Methods** table, page 22. Check all bearings; replace if necessary. Check for proper adjustments per instructions on page 24.

⚠ CAUTION

HAZARD OF EQUIPMENT DAMAGE.

Major repairs or maintenance requiring disassembly of the mechanism or pole assembly should be done by qualified and trained personnel. Contact your local Square D field office.

Failure to observe this precaution can result in equipment damage.

SECTION 9—ADJUSTMENTS

All adjustments are factory set; checking them before placing a new circuit breaker into service is not necessary.

During periodic inspections and when a circuit breaker part is repaired or replaced, check the following settings to determine whether adjustments are necessary. To perform these adjustments, first remove the circuit breaker from its cell, and then remove the front mechanism cover (figure 1).

> **⚠ WARNING**
>
> **HAZARD OF PINCHING.**
>
> When checking a setting with the drive springs in the charged position, the closing springs ***must*** be blocked. To do so, place the blocking pins in the holes at the upper end of the closing spring center shafts. The blocking pins are shipped in the envelope containing the instruction bulletin.
>
> **Failure to observe this precaution can result in severe bodily injury or equipment damage.**

Trip Open Eccentric

The trip open eccentric positions the trip open cam, figure 9, in the correct relation to the the cam follower roller (toggle bearing), figure 9. If the stop is positioned too far forward, the circuit breaker may not stay closed. If the stop is positioned too far to the rear, the trip open cam requires too much force to operate and the circuit breaker may not trip at the specified minimum control voltage. The trip open eccentric setting is designed so that the circuit breaker remains closed on closing and still operates at the specified minimum control voltage.

The vertical free movement of the opening coil plunger (figure 7) before it engages the trip open arm (figure 9) should be 1/8" ± 1/16" (3.2 mm ± 1.6 mm). Do not attempt to set the trip open eccentric by dimension alone; the setting must be checked functionally as well as dimensionally.

Toggle Bearing Clearance

With the circuit breaker in the *open* position and the closing springs (figure 8) charged, the clearance between the toggle bearing (figure 9) and the trip opening cam (figure 9) should be 1/32" +1/32"/– 0" (0.8 mm +0.8 mm/– 0). If adjustment is necessary, turn the toggle sub-assembly retainer nut (figure 9) clockwise to increase clearance and counterclockwise to decrease clearance.

Charging Motor Limit Switch

Actuated by the charging motor limit switch cam (figure 7), the charging motor limit switch (figure 7) energizes the charging motor (figure 8) during a closing spring charging operation, and de-energizes the charging motor when the closing springs (figure 8) reach the fully charged position. The charging motor limit switch is properly adjusted if its contacts are open when the closing springs are in the fully charged position and closed when the closing springs are discharged. Use a continuity tester to determine the position of the charging motor limit switch contacts. If adjustment is necessary, loosen the two screws securing the charging motor limit switch. Move the switch up or down as required; tighten the two screws.

Adjustments Affecting Vacuum Interrupters

NOTE

Circuit breakers manufactured after 1987 have a solid drive link with *no* jam nut(s); the drive linkage is not adjustable.

Drive Linkage—Distance *A* (figure 9) for the drive linkage should be 1-5/8" ±1/16" (41.3 mm ±1.6 mm) for circuit breakers with a maximum interrupting rating of 36 kA or less. For circuit breakers with a maximum interrupting rating above 36 kA, distance A should be 1-9/16" ±1/32" (39.7 mm ±0.8 mm). If adjustment is performed, be certain to tighten the jam nut(s) when completed.

NOTE

Make the following adjustments only when a vacuum interrupter is replaced. *Perform these adjustments in the order listed.*

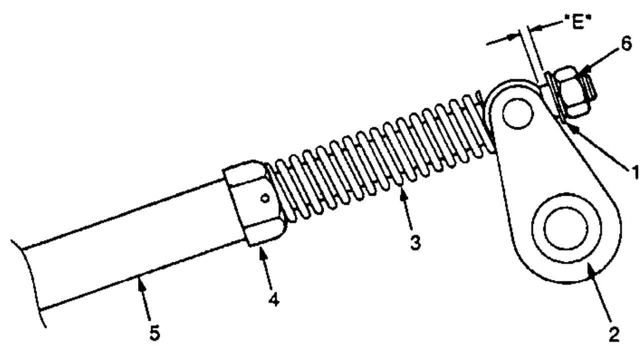
Spring Overtravel—When the circuit breaker is in the *closed* position with the closing springs charged, the spring overtravel (distance *E*, figure 11) for a new vacuum interrupter assembly should be 3/16" + 1/16" - 1/32" (4.8 mm + 1.6 mm - 0.8 mm). Follow these steps to adjust the setting:

1) Ensure that the circuit breaker is in the *closed* position and the closing springs are charged.
2) Check the spring overtravel. If adjustment is necessary, remove the nut (figure 11) at the end of the drive connecting link.
3) Insert the T-handle adjustment tool (part number T-1) into the slots in the end of the erosion indicator (figure 11); turn the erosion indicator clockwise to shorten or counterclockwise to lengthen the overtravel.

Adjustments Affecting Vacuum Interrupters (cont.)

NOTE

This spring overtravel setting is factory set. Because distance *E* is used to measure contact erosion, adjust this setting only when installing a new vacuum interrupter (see **Contact Erosion** under **Vacuum Interrupters**, page 20). Order special tool number T-1 from the factory.



1. Erosion Indicator
2. Mainshaft
3. Bias Spring
4. Bottom Spring Retainer
5. Connecting Link
6. Nut

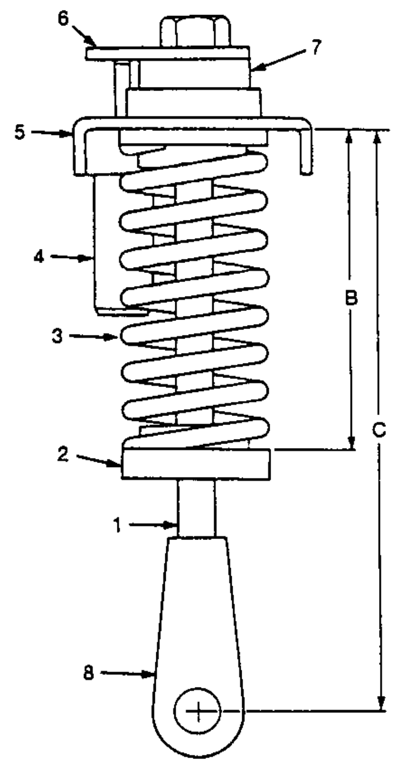
Figure 11: Spring overtravel adjustment

Primary Contact Gap—With the circuit breaker in the open position, the primary contact gap should be 0.500"- 0.625" (12.7–15.9 mm) for circuit breakers with a maximum interrupting rating of 23 kA and below. For circuit breakers with a maximum interrupting rating of 36 kA and above or any circuit breaker rated 3000 amperes continuous current, the primary contact gap should be 0.450"- 0.530" (11.4–13.5 mm). To determine the primary contact gap, measure distance *D* (figure 2) with the circuit breaker in the *open* position, then with the circuit breaker in the *closed* position. The difference between these two measurements is the primary contact gap.

Use the opening spring stops (figure 12) to adjust the primary contact gap. Turn the stops clockwise (viewed from above) to decrease the primary contact gap, and counterclockwise to increase the primary contact gap. *Both stops must be adjusted simultaneously and equally.* The opening spring stops can be turned easily if the locking nuts are loosened and the circuit breaker is in the *closed* position. Use caution since the opening springs (figure 12) are in the charged position (see WARNING notice at the beginning of this section).

Adjustments Affecting Vacuum Interrupters (cont.)

After performing the adjustment, tighten the locking nuts against the stops. Open and close the circuit breaker, then re-measure the primary contact gap. Repeat the procedure until the correct primary contact gap is obtained. (To facilitate this adjustment after replacing opening springs, distance C, figure 12, should initially be 9-1/8" [232 mm] when the circuit breaker is in the *open* position. The final C dimension is established by the primary contact gap adjustment.)



1. Opening Spring Shaft
2. Opening Spring Adjustable Retainer
3. Opening Spring
4. Shock Absorber
5. Opening Spring Mounting Box
6. Shock Absorber Pad
7. Opening Spring Stop
8. Opening Spring Connecting Block

Figure 12: Opening spring settings

Adjustments Affecting Vacuum Interrupters (cont.)

Opening Spring Pre-Loading Setting—Distance *B*, figure 12, represents the opening spring pre-load setting. This distance is factory set to provide the correct contact velocities and **should not be changed.** However, if disassembly is ever required, the setting may be altered and thus require adjustment. Note the setting before disassembly and readjust to the same distance upon reassembly. To adjust distance *B*, turn the adjustable retainer (figure 12) clockwise (viewed from above) to increase distance *B*, and counterclockwise to decrease distance *B*.

Shock Absorber—The shock absorber (figure 6) limits the overtravel of the moving vacuum interrupter shaft and bellows assembly. The shock absorber is adjustable; it is normally set at #6. Adjust by rotating the adjustment ring of the shock absorber and aligning the indicator pin to the desired setting. Tighten the setscrew after adjustment. The shock absorber is normally mounted so that the exposed body bottom length is 3" (76 mm). These adjustments are factory set using a travel recorder. Do not alter them unless the shock absorber is replaced.

Contact Compression—Once the above adjustments are made, cycle the circuit breaker open and closed 25 times to compress the contacts of the newly installed vacuum interrupter(s). After cycling the circuit breaker, re-measure spring overtravel, primary contact gap, and opening spring pre-load settings; adjust as necessary.

Pole Resistance—The vacuum interrupter and pole assembly resistance is typically measured at 100 amperes dc. Connect the current test leads directly to the circuit breaker terminals (run backs). A new pole assembly has a resistance of 20 to 35 micro-ohms. The recommended maximum limit of the resistance of a used pole assembly is 70 micro-ohms. If resistance values are above 70 micro-ohms, consult the factory.

SECTION 10—REPLACEMENT PARTS

Minimum Requirements

Keep sufficient renewal parts in stock to ensure prompt replacement of worn, broken, or damaged parts. A list of factory-recommended renewal parts is provided below.

Because of wide variations in operating uses and environments, recommended renewal part quantities are presented only as minimum requirements. Each operating company should develop its own renewal parts stock, based on operating experience, to ensure proper circuit breaker condition.

Vacuum Interrupter Module replacement parts are available from the factory. Interrupters, parts, and components vary depending on voltage, current and interrupting ratings. Consult your local Square D field sales office or a Customer Service representative at the factory regarding vacuum interrupter replacement requirements.

Table 2: Recommended Replacement Parts

Part No.	Description	Min. Qty.
46011-056-XX	Trip Coil (L.H. Leads)	1
46011-055-XX	Close Coil (R.H. Leads)	1
44071-186-XX	Spring Charging Motor	1
44068-069-XX	Anti-Pump Relay	1
44071-057-50	Motor Limit Switch	1
44069-082-01	Auxiliary Switch	1
44068-069-XX	Motor Relay	1

XX—Specify suffix number (if known) and operating voltage.

Ordering Instructions

When ordering renewal parts, include the following information:

- complete rating information
- circuit breaker serial number
- part number of each part being ordered
- part description
- figure number (if provided)
- the document from which the above information was gathered
- operating voltage (for electrical components)

Standard hardware components are not listed; purchase them locally.

ɹare D Company
330 Weakley Road
Smyrna, TN 37167 U.S.A.

Order No. 6055IM9301 January 1994 FP 1M 1/94

SQUARE D

Part No. 6055-3
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