Instruction Book **IB182035EN**

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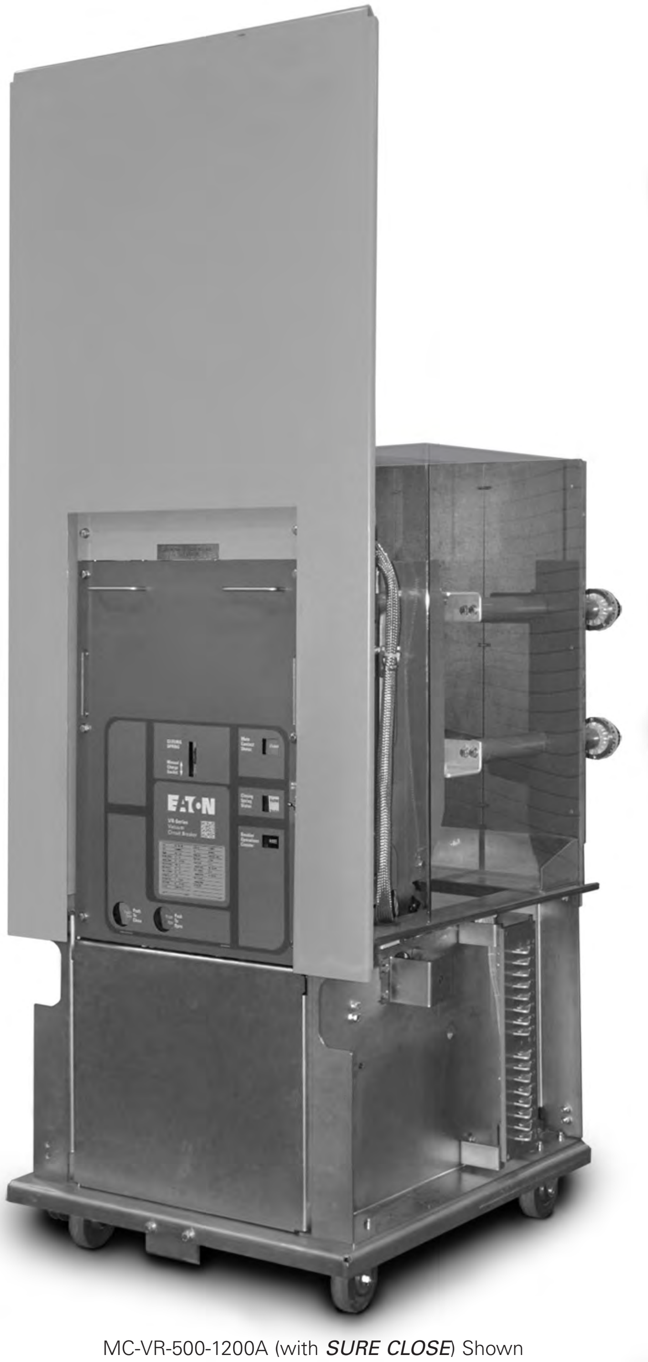
# MC-VR
# Replacement Circuit Breaker



MC-VR-500-1200A (with ***SURE CLOSE***) Shown

*Powering Business Worldwide*

## DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY



**⚠ WARNING**

**IMPROPERLY INSTALLING OR MAINTAINING THESE PRODUCTS CAN RESULT IN DEATH, SERIOUS PERSONAL INJURY OR PROPERTY DAMAGE.**

**READ AND UNDERSTAND THESE INSTRUCTIONS BEFORE ATTEMPTING ANY UNPACKING, ASSEMBLY, OPERATION OR MAINTENANCE OF THE CIRCUIT BREAKERS.**

**INSTALLATION OR MAINTENANCE SHOULD BE ATTEMPTED ONLY BY QUALIFIED PERSONNEL. THIS INSTRUCTION BOOK SHOULD NOT BE CONSIDERED ALL INCLUSIVE REGARDING INSTALLATION OR MAINTENANCE PROCEDURES. IF FURTHER INFORMATION IS REQUIRED, YOU SHOULD CONSULT EATON'S ELECTRICAL SERVICES & SYSTEMS.**

**THE CIRCUIT BREAKERS DESCRIBED IN THIS BOOK ARE DESIGNED AND TESTED TO OPERATE WITHIN THEIR NAMEPLATE RATINGS. OPERATION OUTSIDE OF THESE RATINGS MAY CAUSE THE EQUIPMENT TO FAIL, RESULTING IN DEATH, BODILY INJURY AND PROPERTY DAMAGE.**

**ALL APPLICABLE CODES, SAFETY STANDARDS AND/OR REGULATIONS RELATED TO THIS TYPE OF EQUIPMENT MUST BE STRICTLY FOLLOWED.**

**THESE VACUUM REPLACEMENT CIRCUIT BREAKERS ARE DESIGNED TO BE INSTALLED PURSUANT TO THE AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI). SERIOUS INJURY, INCLUDING DEATH, CAN RESULT FROM FAILURE TO FOLLOW THE PROCEDURES OUTLINED IN THIS MANUAL.**

This product was manufactured by Eaton at the Power Breaker Center (PBC): 310 Maxwell Avenue, Greenwood, SC 29646.

All possible contingencies which may arise during installation, operation or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of particular equipment, contact a Eaton representative.

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## SECTION 1: INTRODUCTION

The purpose of this book is to provide instructions for receiving and handling, storage, installation, operation and maintenance of the Allis-Chalmers* type MC VR-Series circuit breaker. The Vacuum Replacement Circuit Breakers (also referred to as VR-Series) are designed to be used in existing MC metal-clad switchgear and provide equal or superior electrical and mechanical performance as compared to the design ratings of the original circuit breaker. VR-Series Circuit Breakers provide reliable control, protection and performance, with ease of handling and maintenance. Like ratings are interchangeable with each other.

This book is intended to be used in conjunction with the technical information provided with the original equipment order which includes, but is not limited to electrical control schematics and wiring diagrams, outline diagrams, installation plans, and procedures for installation and maintenance of accessory items.

Satisfactory performance is dependant upon proper application, correct installation, and adequate maintenance. It is strongly recommended that this instruction book be carefully read and followed in order to realize optimum performance and long useful life of the circuit breaker.

**Note:** * Allis-Chalmers may also be designated as Siemens-Allis or Siemens.

### ⚠ WARNING

**SATISFACTORY PERFORMANCE OF THESE BREAKERS IS CONTINGENT UPON PROPER APPLICATION, CORRECT INSTALLATION AND ADEQUATE MAINTENANCE. THIS INSTRUCTION BOOK MUST BE CAREFULLY READ AND FOLLOWED IN ORDER TO OBTAIN OPTIMUM PERFORMANCE FOR LONG USEFUL LIFE OF THE CIRCUIT BREAKERS. IT IS FURTHER RECOMMENDED THAT THE INSTALLATION BE PERFORMED BY A EATON CORPORATION TRAINED ENGINEER OR TECHNICIAN.**

**VR-SERIES BREAKERS ARE PROTECTIVE DEVICES, AS SUCH, THEY ARE MAXIMUM RATED DEVICES. THEREFORE, THEY SHOULD NOT UNDER ANY CIRCUMSTANCE BE APPLIED OUTSIDE THEIR NAMEPLATE RATINGS.**

**ALL POSSIBLE CONTINGENCIES WHICH MIGHT ARISE DURING INSTALLATION, OPERATION, OR MAINTENANCE, AND ALL DETAILS AND VARIATIONS OF THIS EQUIPMENT ARE NOT COVERED BY THESE INSTRUCTIONS. IF FURTHER INFORMATION IS DESIRED BY THE PURCHASER REGARDING A PARTICULAR INSTALLATION, OPERATION, OR MAINTENANCE OF THIS EQUIPMENT, THE LOCAL EATON'S ELECTRICAL SERVICES & SYSTEMS REPRESENTATIVE SHOULD BE CONTACTED.**

### 1.1 AVAILABLE MC-VR CIRCUIT BREAKERS

Refer to Table 1.1

**Table 1. MC-VR Availability and Interchangeability**

| Breaker Type | Nominal Voltage Class (kV) | Existing Breaker MVA Rating | Existing Breaker Rated Continuous Current at 60 Hz (Amps) | MVA Designation of VR-Series Breaker | Rated Voltage Factor K | Rated Withstand ANSI Test Voltage | | Rated Short-Circuit kA RMS at Rated Max kV | Closing and Latching / Momentary Capabilities |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Low Freq. kV RMS | Impulse kV Crest | | kA RMS/Peak |
| MC-VR | 13.8 | 500 | 1200 | 500 | 1.3 | 36 | 95 | 18 | 37 / 62 |

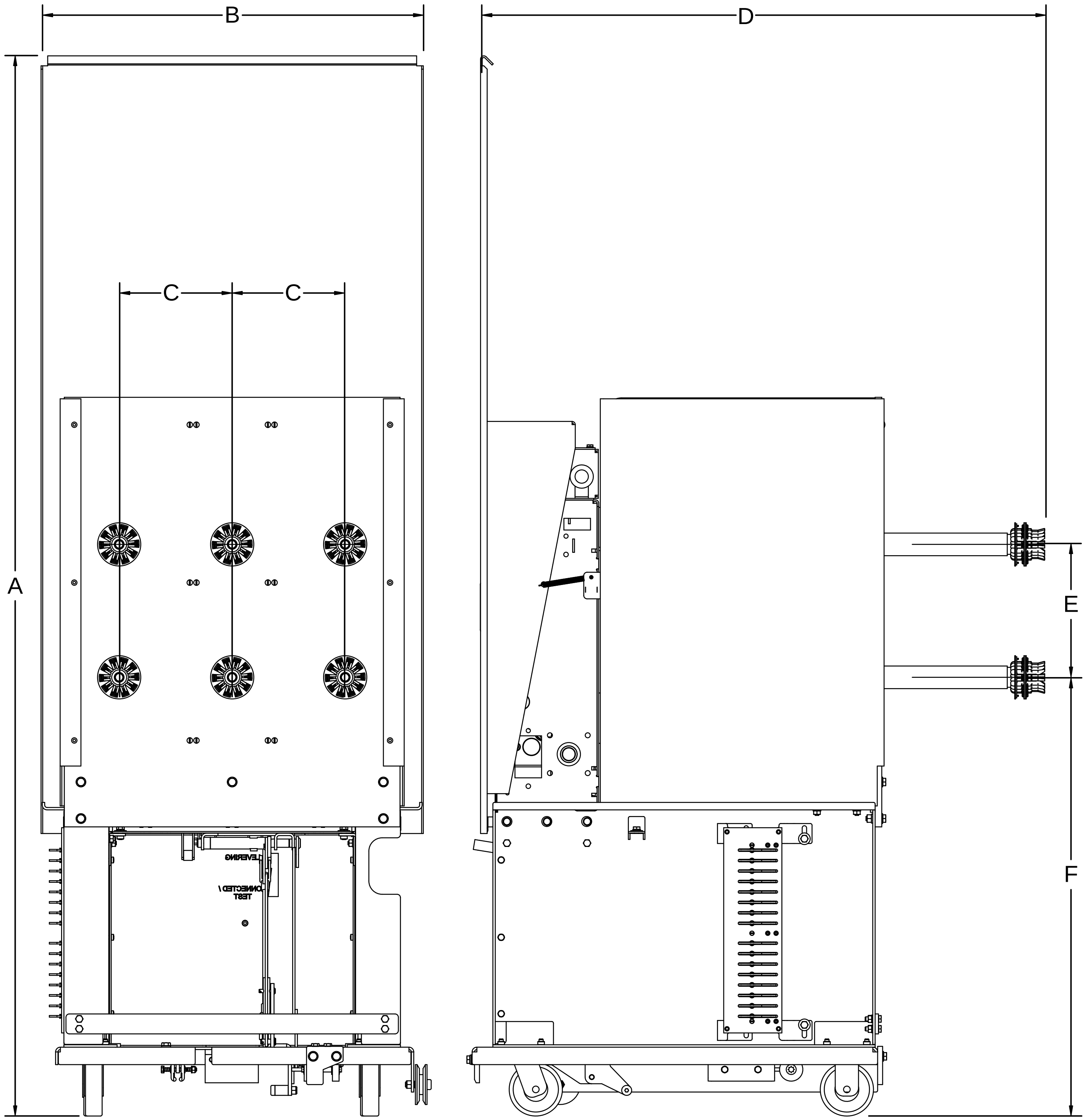



**Table 2. MC-VR Dimensions (Without *SURE CLOSE*)**

| Breaker Type | Existing Breaker Rated Continuous Current at 60 Hz (Amps) | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|
| MC-VR-500 | 1200 | 79.75 | 28.75 | 8.50 | 42.43 | 10.00 | 33.00 |

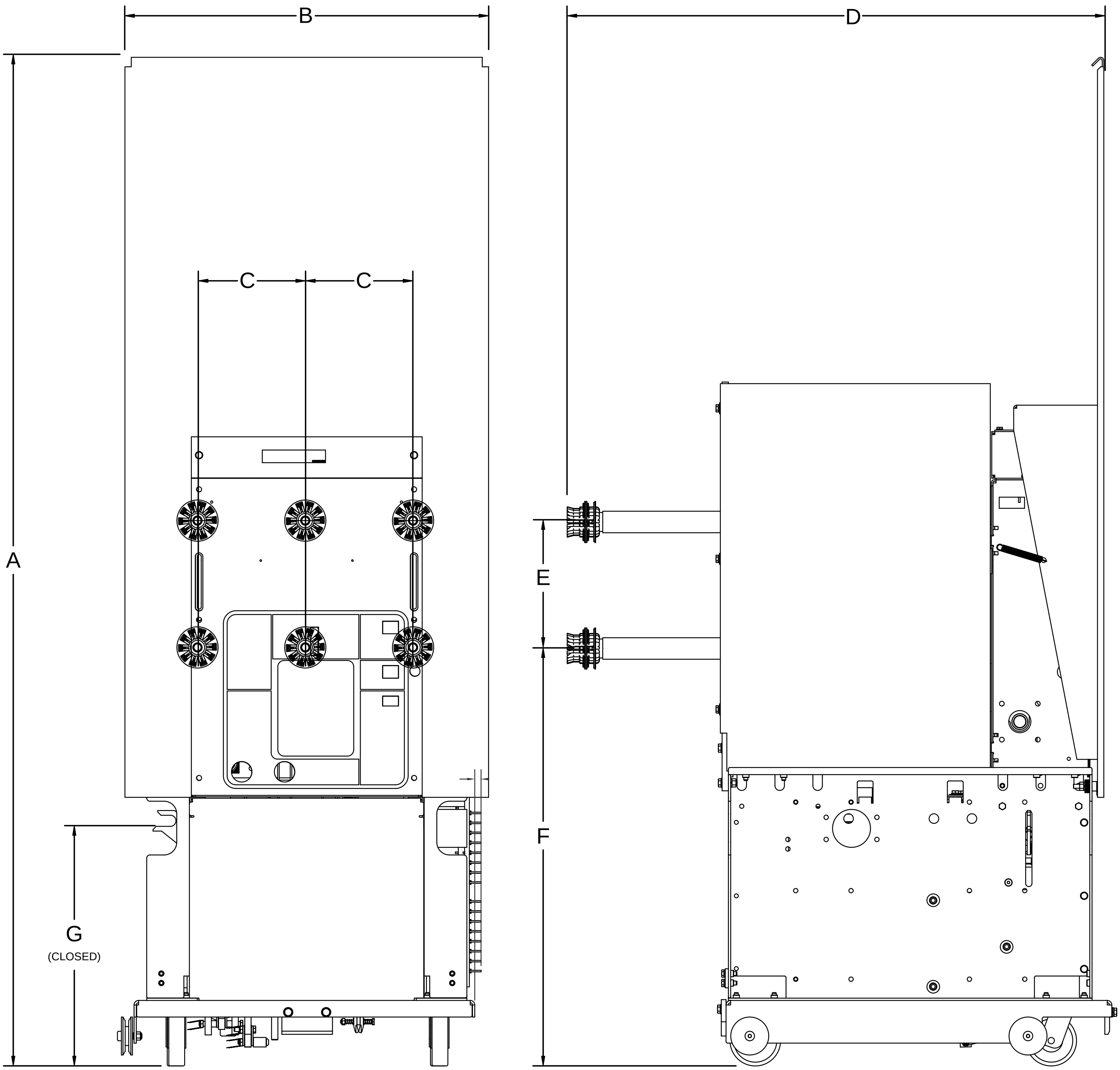



**Table 3. MC-VR Dimensions (With *SURE CLOSE*)**

| Breaker Type | Existing Breaker Rated Continuous Current at 60 Hz (Amps) | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|
| MC-VR-500 | 1200 | 79.75 | 28.75 | 8.50 | 42.43 | 10.00 | 33.00 | 18.94 |

## SECTION 2: SAFE PRACTICES

VR-Series breakers are equipped with high speed, high energy operating mechanisms. They are designed with several built-in interlocks and safety features to provide safe and proper operating sequences.

**⚠ DANGER**

**TO PROTECT THE PERSONNEL ASSOCIATED WITH INSTALLATION, OPERATION, AND MAINTENANCE OF THESE BREAKERS, THE FOLLOWING PRACTICES MUST BE FOLLOWED:**

- **Only qualified persons, as defined in the National Electrical Safety Code, who are familiar with the installation and maintenance of medium voltage circuits and equipment, should be permitted to work on these breakers.**
- **Read these instructions carefully before attempting any installation, operation or maintenance of these breakers.**
- **Always remove the breaker from the enclosure before performing any maintenance. Failure to do so could result in electrical shock leading to death, severe personnel injury or property damage.**
- **Do not work on a breaker with the secondary test coupler engaged. Failure to disconnect the test coupler could result in an electrical shock leading to death, personnel injury or property damage.**
- **Do not work on a closed breaker or a breaker with closing springs charged. The closing spring should be discharged and the main contacts open before working on the breaker. Failure to do so could result in cutting or crushing injuries.**
- **Do not use a circuit breaker by itself as the sole means of isolating a high voltage circuit. Remove the breaker to the Disconnect position and follow all lockout and tagging rules of the National Electrical Code and any and all applicable codes, regulations and work rules.**
- **Do not leave the breaker in an intermediate position in the cell. Always have the breaker either in the Test or Connected position. Failure to do so could result in a flash over and possible death, personnel injury or property damage.**
- **Always remove the maintenance tool from the breaker after charging the closing springs.**
- **Breakers are equipped with safety interlocks. Do not defeat them. This may result in death, bodily injury or equipment damage.**

# SECTION 3: RECEIVING, HANDLING, AND STORAGE

Type MC VR-Series circuit breakers are subjected to complete factory production tests and inspection before being packed. They are shipped in packages designed to provide maximum protection to the equipment during shipment and storage and at the same time to provide convenient handling. Accessories such as the maintenance tool, etc. are shipped with the breaker (Figure 3.1).

## 3.1 RECEIVING

Until the breaker is ready to be delivered to the switchgear site for installation, DO NOT remove it from the shipping crate. If the breaker is to be placed in storage, maximum protection can be obtained by keeping it in its crate.

Upon receipt of the equipment, inspect the crates for any signs of damage or rough handling. Open the crates carefully to avoid any damage to the contents. Use a nail puller rather than a crow bar when required.

When opening the crates, be careful that any loose items or hardware are not discarded with the packing material. Check the contents of each package against the packing list.

Examine the breaker for any signs of shipping damage such as broken, missing or loose hardware, damaged or deformed insulation and other components. File claims immediately with the carrier if damaged or loss is detected and notify the nearest Eaton's Electrical Services & Systems office.

### Tools and Accessories

**Maintenance Tool:** This tool is used to manually charge the closing spring. One maintenance handle is provided with each vacuum unit replacement breaker. (Style# 8064A02G01)

**Racking Handle:** The racking handle is used to drive the racking mechanism which moves the circuit breaker into and out of the cell. If necessary, additional racking handles may be purchased directly from Eaton. (Style# 94A3102G24)

**Anti-rotation bracket:** An anti-rotation bracket is required for the MC circuit breaker compartment. See Figure 5.1 and Section 5.1.2. (Style# 94A3102G92)

**Figure 3.1.a. Typical Tools and Accessories**

**Figure 3.1.b. Typical Tools and Accessories**

## 3.2 HANDLING

**⚠ WARNING**

**DO NOT USE ANY LIFTING DEVICE AS A PLATFORM FOR PERFORMING MAINTENANCE, REPAIR OR ADJUSTMENT OF THE BREAKER OR FOR OPENING, CLOSING THE CONTACTS OR CHARGING THE SPRINGS. THE BREAKER MAY SLIP OR FALL CAUSING SEVERE PERSONAL INJURY. ALWAYS PERFORM MAINTENANCE, REPAIR AND ADJUSTMENTS ON A WORKBENCH CAPABLE OF SUPPORTING THE BREAKER TYPE.**

MC-VR circuit breaker shipping containers are designed to be handled either by use of a rope sling and overhead lifting device or by a fork lift truck. If containers must be skidded for any distance, it is preferable to use roller conveyors or individual pipe rollers.

Once a breaker has been inspected for shipping damage, it is best to return it to its original shipping crate until it is ready to be installed in the Metal-clad Switchgear.

When a breaker is ready for installation, a lifting harness in conjunction with an overhead lift or portable floor lift can be used to move a breaker, if this is preferable to rolling the breaker on the floor using self contained wheels. If the breaker is to be lifted, position the lifting device (lifting straps should have at least a 1600 pound capacity) over the breaker and insert the lifting harness hooks into the breaker side openings and secure. Be sure the hooks are firmly attached before lifting the breaker. Stand a safe distance away from the breaker while lifting and moving.

**Figure 3.2. Lifting MC-VR**

### 3.3 STORAGE

If the circuit breaker is to be placed in storage, maximum protection can be obtained by keeping it in the original shipping crate. Before placing it in storage, checks should be made to make sure that the breaker is free from shipping damage and is in satisfactory operating condition.

The breaker is shipped with its contacts open and closing springs discharged. The indicators on the front panel should confirm this. Insert the maintenance tool in the manual charge socket opening (Figure 3.3). Charge the closing springs by pumping the handle up and down about 36 times until a crisp metallic "click" is heard. This indicates that the closing springs are charged and is shown by the closing spring "charged" (yellow) indicator. Remove the maintenance tool. Push the "manual close" button. The breaker will close as shown by the breaker contacts "closed" (red) indicator. Push the "manual trip" button. The breaker will trip as shown by the breaker contacts "open" (green) indicator. After completing this initial check, leave the closing springs "discharged" and breaker contacts "open".

Outdoor storage is NOT recommended. If unavoidable, the outdoor location must be well drained and a temporary shelter from sun, rain, snow, corrosive fumes, dust, dirt, falling objects, excessive moisture, etc. must be provided. Containers should be arranged to permit free circulation of air on all sides and temporary heaters should be used to minimize condensation. Moisture can cause rusting of metal parts and deterioration of high voltage insulation. A heat level of approximately 400 watts for each 100 cubic feet of volume is recommended with the heaters distributed uniformly throughout the structure near the floor.

Indoor storage should be in a building with sufficient heat and circulation to prevent condensation. If the building is not heated, the same general rule for heat as for outdoor storage should be applied.

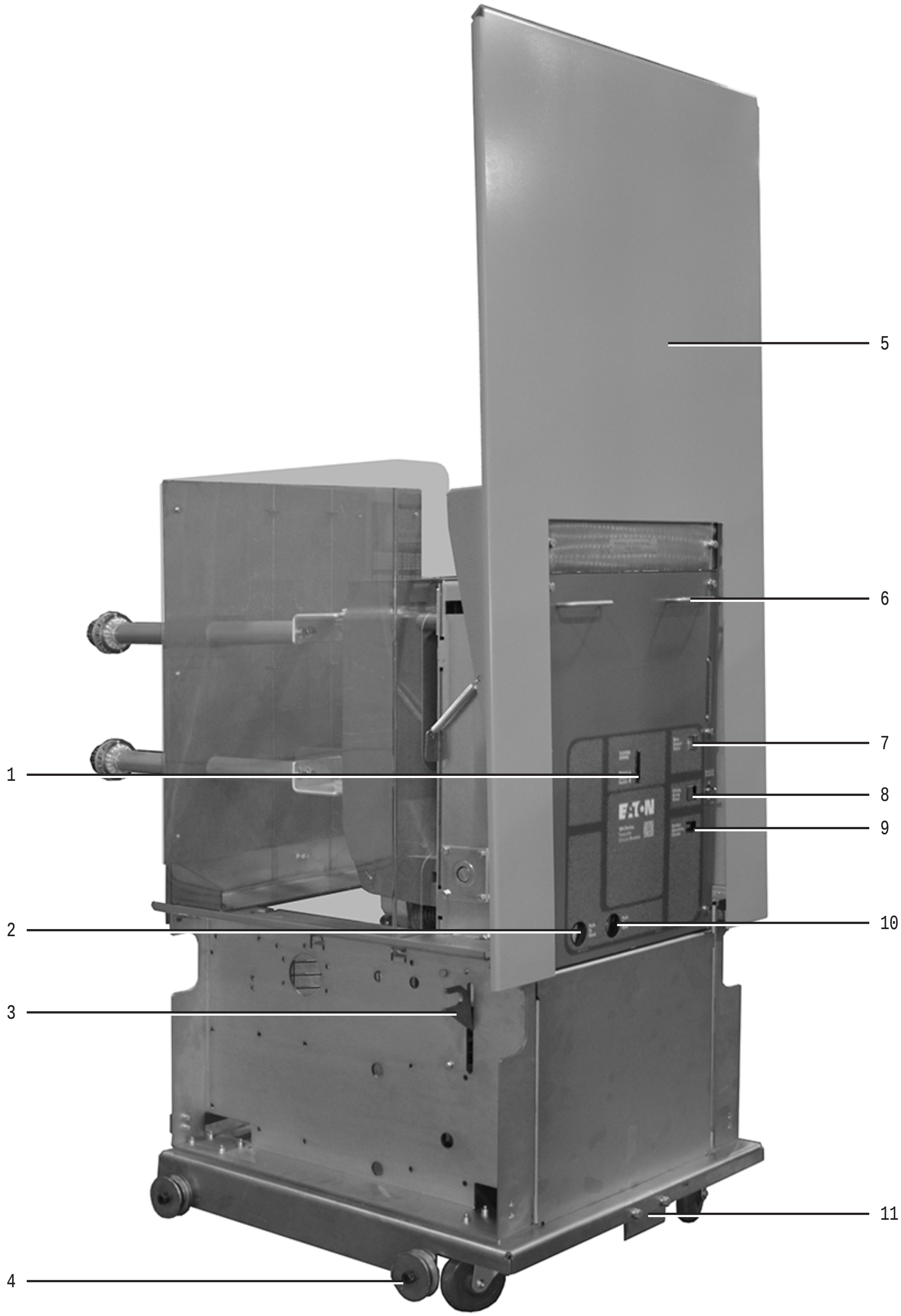
### 3.4 MC-VR APPROXIMATE WEIGHTS

Refer to Table 3.

**Table 4. Maximum Weight by Type**

| Type | Amperes | LBs |
| --- | --- | --- |
| MC-VR-500 | 1200 | 655 |

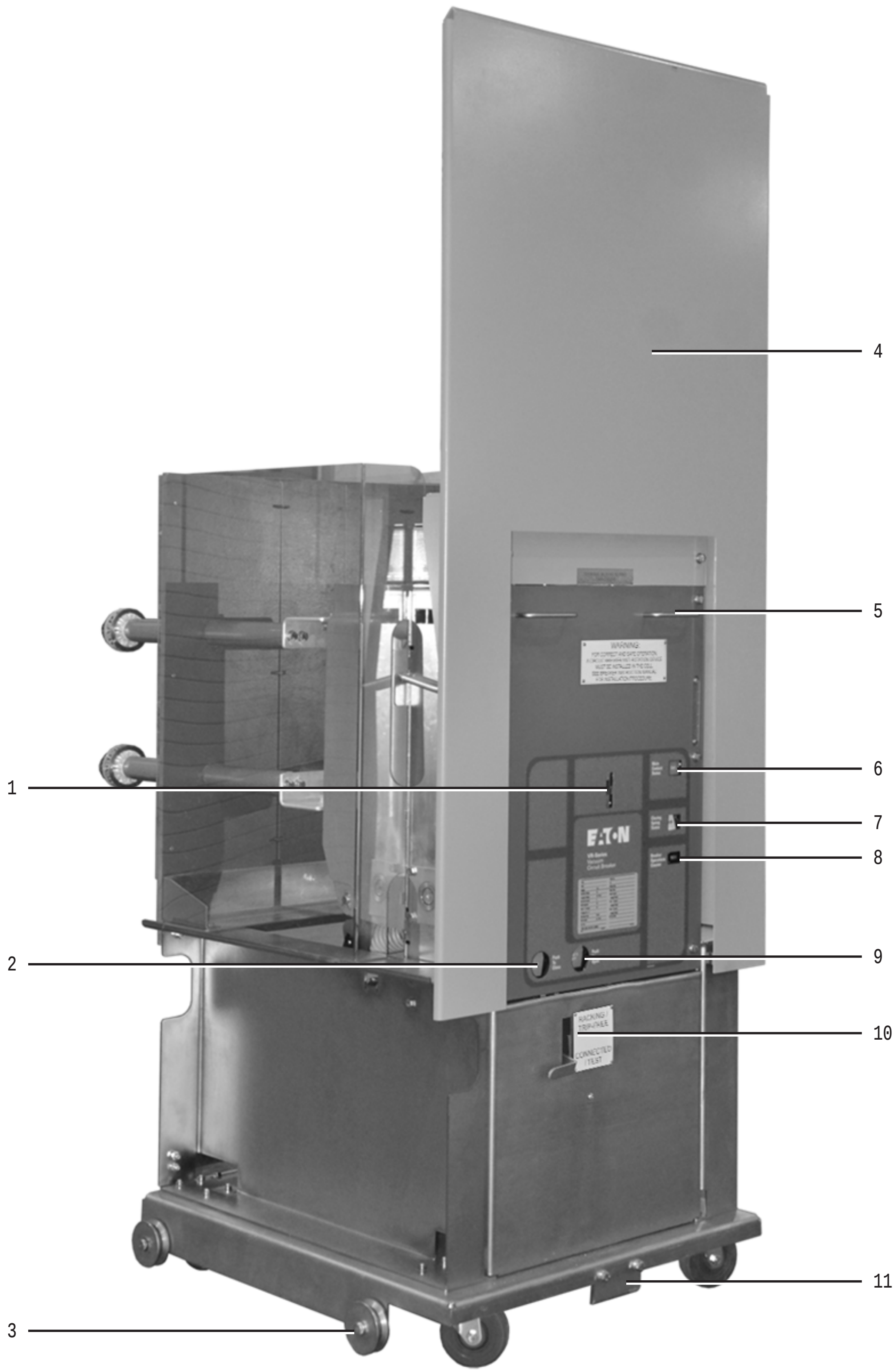
**Figure 3.3.a. Front External View of MC-VR (With *SURE CLOSE*)**




**Front External View**

| | | | | | |
|---|---|---|---|---|---|
| 1 | Manual Charging Socket | 5 | Upper Front Breaker Cover | 9 | Operations Counter |
| 2 | Push To Close Button | 6 | Pull / Push Handle | 10 | Push To Open Button |
| 3 | MOC Operator | 7 | Breaker Contacts Indicator | 11 | Racking Interface Plate |
| 4 | Guide Wheel | 8 | Spring Charged / Discharged Indicator | | |

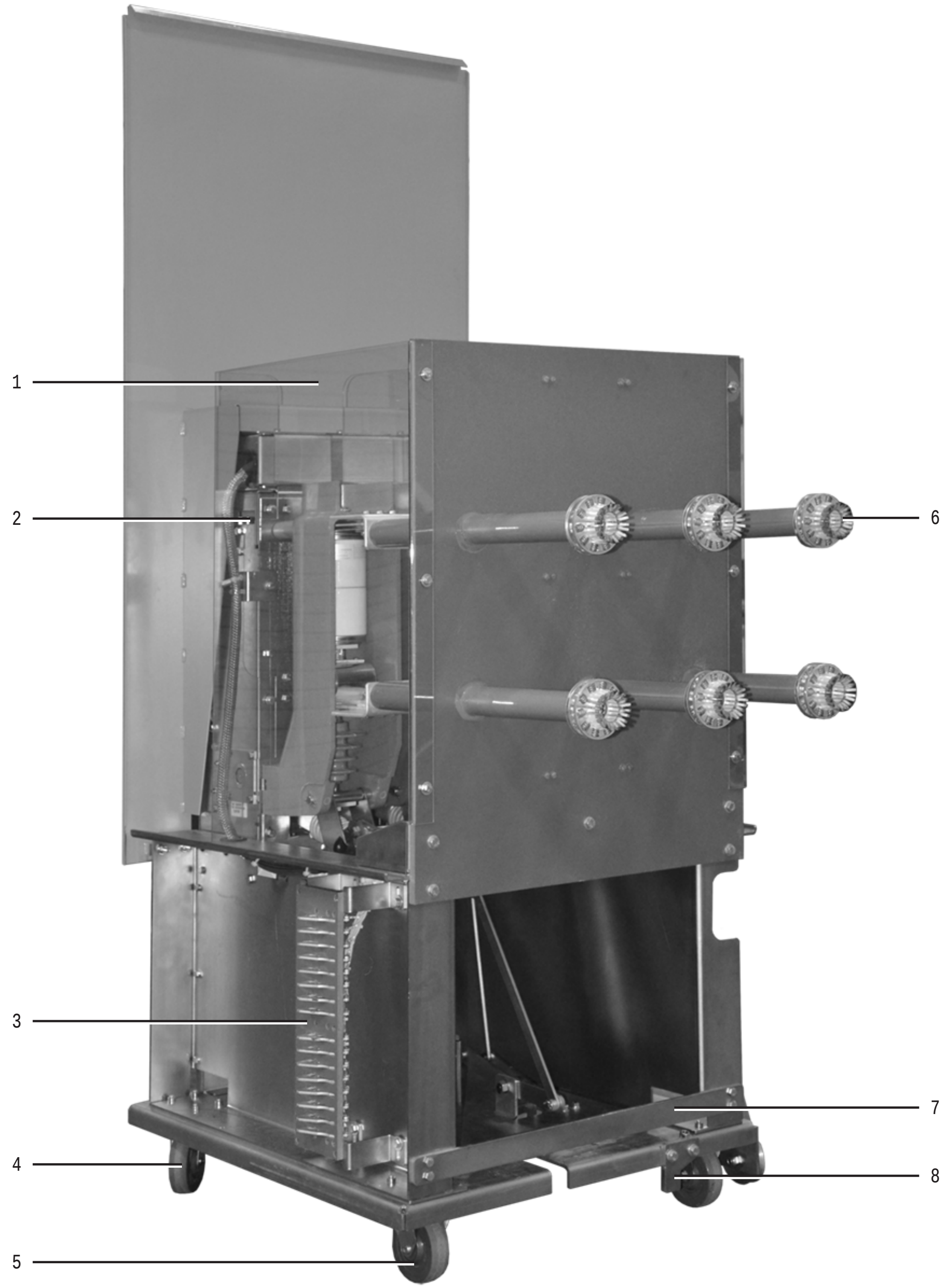
**Figure 3.3.b. Front External View of MC-VR (Without *SURE CLOSE*)**




**Front External View**

| | | | | | |
|---|---|---|---|---|---|
| 1 | Manual Charging Socket | 5 | Upper Front Breaker Cover | 9 | Operations Counter |
| 2 | Push To Close Button | 6 | Pull / Push Handle | 10 | Push To Open Button |
| 3 | MOC Operator | 7 | Breaker Contacts Indicator | 11 | Racking Interlock Handle |
| 4 | Guide Wheel | 8 | Spring Charged / Discharged Indicator | | Racking Interface Plate |

**Figure 3.3.c. Rear External View of MC-VR (Without *SURE CLOSE*)**




**Rear External View**

| | | | | | |
|---|---|---|---|---|---|
| 1 | Outer Lexan Phase Barrier | 4 | Swivel Casters | 7 | Anti-Lift Bar |
| 2 | Lifting Access Point | 5 | Rigid Casters | 8 | Code Plate |
| 3 | Secondary Disconnect | 6 | Primary Disconnects | | |

## SECTION 4: DESCRIPTION AND OPERATION

VR-Series vacuum replacement breakers are designed to be used with existing installations of equivalent air-magnetic metal-clad switchgear breaker. The front mounted spring type stored energy mechanism facilitates inspection and provides improved access to components for servicing. The long life characteristics of the vacuum interrupters and proven high reliability of spring-type stored energy mechanisms assure long, trouble-free service with minimum maintenance.

The MC-VR circuit breaker is available in two forms, one form without ***SURE CLOSE*** that features an interlocking handle to manually mechanically lock the circuit breaker into the circuit breaker compartment. A second model features the ***SURE CLOSE*** system to operate the MOC operator in the circuit breaker compartment. The models with ***SURE CLOSE*** also automatically mechanically lock the circuit breaker in the circuit breaker compartment and do not require an interlocking handle. Determine the style of MC-VR circuit breaker you have and use the instructions below that are appropriate for that style.

**⚠ DANGER**

**DETERMINE THE STYLE OF MV-VR FURNISHED. THE OPERATING INSTRUCTIONS FOR EACH IS SLIGHTLY DIFFERENT. FAILURE TO FOLLOW THE APPROPRIATE INSTRUCTIONS CAN LEAD TO PROPERTY DAMAGE, BODILY INJURY, OR DEATH.**

### 4.1 VACUUM INTERRUPTER

Vacuum interrupters offer the advantages of enclosed arc interruption, small size and weight, longer life, reduced maintenance, minimal mechanical shock, and elimination of contact degradation caused by environmental contamination.

In the closed position, current flows through the interrupter moving and fixed stems and the faces of the main contacts. As the contacts part, an arc is drawn between the contact surfaces. The arc is rapidly moved away from the main contacts to the slotted contact surfaces by self-induced magnetic effects. This minimizes contact erosion and hot spots on the contact surfaces. The arc flows in an ionized metal vapor and as the vapor leaves the contact area, it condenses into the metal shield which surrounds the contacts.

At current zero, the arc extinguishes and vapor production ceases. Very rapid dispersion, cooling, recombination, and deionization of the metal vapor plasma and fast condensation of metal vapor causes the vacuum to be quickly restored and prevents the transient recovery voltage from causing a restrike across the gap of the open contacts.

#### 4.1.1 THE INTERRUPTER ASSEMBLY

Each interrupter is assembled at the factory as a unit to assure correct dimensional relationships between working components. The interrupter assembly consists of a vacuum interrupter, a molded glass polyester stand-off insulator, upper and lower clamps, flexible shunts, bell crank, operating rod, and contact load spring. The vacuum interrupter is mounted vertically with the fixed stem upward and the moving stem downward. The upper and lower glass polyester stand-off insulator and clamps support the interrupter and are fastened to the breaker's stored energy mechanism frame. Upper and lower flexible shunts provide electrical connections from each interrupter to the breaker's primary bushings while providing isolation from mechanical shock and movement of the interrupter's moving stem. The operating rod, loading spring, and bell crank transfer mechanical motion from the breaker's operating mechanism to the moving stem of the interrupter. A vacuum interrupter contact erosion indicator is located on the moving stem of the interrupter. It is visible when the breaker is withdrawn and is viewed from the rear of the breaker. (See Figure 6.2 and Figure 6.3)

**Figure 4.1. MC-VR Interrupter Assembly (36kA 1200A Design Shown)**


**Figure 4.2. MC-VR Interrupter Assembly (36kA 1200A Design Shown) (All Three Poles)**

### 4.1.2 CONTACT EROSION INDICATOR

The purpose of the contact erosion indicator is to monitor the erosion of the vacuum interrupter contacts, which is very minimal over time with Eaton vacuum interrupters utilizing copperchrome contact material. A contact erosion indicator mark is located on the moving stem of the interrupter (Figure 6.2 and 6.3).

In order to determine if the contacts have eroded to the extent that the interrupter must be replaced, close the breaker and observe the erosion mark placed on each moving stem from the rear of the breaker. If the mark on the interrupter stem is visible, the interrupter is satisfactory. If the mark is no longer visible, the interrupter assembly must be replaced.

The erosion indicator is easily viewed from the rear on the 7.5 or 15kV designs. Because of the nature of the 5kV 20-WR element inverted design, the erosion indicator is not easily viewed, although it is possible with the use of a light and a dental type mirror.

**⚠ DANGER**

**FAILURE TO REPLACE THE INTERRUPTER ASSEMBLY WHEN INDICATED BY THE CONTACT EROSION INDICATOR COULD CAUSE THE BREAKER TO FAIL, LEADING TO DEATH, PERSONAL INJURY OR PROPERTY DAMAGE.**

### 4.1.3 CONTACT WIPE AND STROKE

Contact wipe is the indication of (1) the force holding the vacuum interrupter contacts closed and (2) the energy available to hammer the contacts open with sufficient speed for interruption.

Stroke is the gap between fixed and moving contacts of a vacuum interrupter with the breaker open.

The circuit breaker mechanism provides a fixed amount of motion to the operating rods. The first portion of the motion is used to close the contacts (i.e. stroke) and the remainder is used to further compress the preloaded wipe spring. This additional compression is called wipe. Wipe and stroke are thus related to each other. As the stroke increases due to the erosion of contacts, the wipe decreases. A great deal of effort and ingenuity has been spent in the design of VR-Series breakers, in order to eliminate any need for field adjustment of wipe or stroke.

**⚠ WARNING**

**THERE IS NO PROVISION FOR IN-SERVICE ADJUSTMENTS OF CONTACT WIPE AND STROKE. ALL SUCH ADJUSTMENTS ARE FACTORY SET AND SHOULD NOT BE ATTEMPTED IN THE FIELD.**

## 4.2 PHASE BARRIERS

Phase barriers are sheets of insulation located between the interrupter pole assemblies and on the sides of the element. The phase barriers are designed to isolate energized conductor components in each phase from the adjacent phase and ground.

**⚠ DANGER**

**ALL PHASE BARRIERS MUST BE IN PLACE BEFORE PLACING THE CIRCUIT BREAKER INTO SERVICE. FAILURE TO HAVE THEM IN POSITION CAN CAUSE DEATH, SERIOUS PERSONNEL INJURY AND/OR PROPERTY DAMAGE.**

## 4.3 BUSHINGS AND DISCONNECTING CONTACT ASSEMBLIES

The line and load bushing assemblies, which are the primary circuit terminals of the circuit breaker, consist of six fluidized epoxy silver-plated cylindrical copper conductors. Multiple finger type primary disconnecting contacts at the ends of the conductors provide means for connecting and disconnecting the breaker to the bus terminals in the switchgear compartment.

## 4.4 STORED ENERGY MECHANISM

The spring-type stored energy operating mechanism is mounted on the breaker frame and in the front of the breaker. Manual closing and opening controls are at the front panel (Figure 3.3). They are accessible while the breaker is in any of its four basic positions. (See Section 5.8)

The mechanism stores the closing energy by charging the closing springs. When released, the stored energy closes the breaker, charges the wipe and resets the opening springs. The mechanism may rest in any one of the four positions shown in Figure 4.8 as follows:

a. Breaker open, closing springs discharged.

b. Breaker open, closing springs charged.

c. Breaker closed, closing springs discharged.

d. Breaker closed, closing springs charged.

The mechanism is a mechanically “trip-free” design. Trip-free is defined later in this section.

In normal operation the closing spring is charged by the spring charging motor, and the breaker is closed electrically by the switchgear control circuit signal to energize the spring release coil. Tripping is caused by energizing the trip coil through the control circuit.

For maintenance inspection purposes the closing springs can be charged manually by using the maintenance tool and the breaker can be closed and tripped by pushing the “Push to Close” and “Push to Open” buttons on the front panel.

**⚠ DANGER**

**KEEP HANDS AND FINGERS AWAY FROM BREAKER’S INTERNAL PARTS WHILE THE BREAKER CONTACTS ARE CLOSED OR THE CLOSING SPRINGS ARE CHARGED. THE BREAKER CONTACTS MAY OPEN OR THE CLOSING SPRINGS DISCHARGE CAUSING CRUSHING INJURY. DISCHARGE THE SPRINGS AND OPEN THE BREAKER BEFORE PERFORMING ANY MAINTENANCE, INSPECTION OR REPAIR ON THE BREAKER.**

**THE DESIGN OF THIS CIRCUIT BREAKER ALLOWS MECHANICAL CLOSING AND TRIPPING OF THE BREAKER WHILE IT IS IN THE “CONNECT” POSITION. HOWEVER, THE BREAKER SHOULD BE CLOSED MECHANICALLY ONLY IF THERE IS POSITIVE VERIFICATION THAT LOAD SIDE CONDITIONS PERMIT. IT IS RECOMMENDED THAT CLOSING THE BREAKER IN THE “CONNECT” POSITION ALWAYS BE DONE WITH THE CUBICLE DOOR CLOSED. FAILURE TO FOLLOW THESE DIRECTIONS MAY CAUSE DEATH, PERSONAL INJURY, OR PROPERTY DAMAGE.**

**ELECTRICAL TRIPPING CAN BE VERIFIED WHEN THE BREAKER IS IN THE “TEST” POSITION.**

### 4.4.1 CLOSING SPRING CHARGING

Figure 4.7 shows schematic section views of the spring charging parts of the stored energy mechanism.

The major component of the mechanism is a cam shaft assembly which consists of a shaft to which are attached two closing spring cranks (one on each end), the closing cam, drive plate, and a free-wheeling ratchet wheel.

The ratchet wheel (6) is actuated by an oscillating ratchet lever (12) and drive pawl (10) driven by the motor eccentric cam. As the ratchet wheel rotates, it pushes the drive plates which in turn rotate the closing spring cranks and the closing cam on the cam shaft. The motor will continue to run until the limit switch “LS” contact disconnects the motor.

The closing spring cranks have spring ends connected to them, which are in turn coupled to the closing springs. As the cranks rotate, the closing springs get charged.

The closing springs are completely charged, when the spring cranks go over dead center and the closing stop roller (9) comes against the spring release latch (1). The closing springs are now held in the fully charged position.

The closing springs may also be charged manually as follows: Insert the maintenance tool in the manual charging socket. Move it up and down several times (about 36) until a clicking sound is heard and closing spring status indicator shows "charged" (Figure 3.3). Any further motion of the maintenance tool will result in free wheeling of the ratchet wheel and will not result into advance of charging.

### 4.4.2 CLOSING OPERATION

Figure 4.8 shows the positions of the closing cam and tripping linkage for four different operational states. In Figure 4.8a the breaker is open and the closing springs are discharged. In this state, the trip latch is disengaged from the trip "D" shaft (unlatched). After the closing springs become charged, the trip latch snaps into the fully reset or latched position (Figure 4.8b)

When the spring release clapper (Figure 4.7, Item 13) 4.16.b, Item 5), moving the main link (2), rotating the pole shaft (4) (which charges the opening spring). This moves the three operating rods (3), closes the main contacts and charges the contact loading springs (not shown). The operational state immediately after the main contacts close but before the spring charging motor recharges the closing springs is illustrated in Figure 4.8c. Interference of the trip "D" shaft with the trip latch prevents the linkage from collapsing, and holds the breaker closed.

Figure 4.8d shows the breaker in the closed state after the closing springs have been recharged. The recharging of the spring rotates the closing cam one half turn. In this position the main link roller rides on the cylindrical portion of the cam, and the main link does not move out of position.

### 4.4.3 TRIPPING OPERATION

When the trip bar "D" shaft (Figure 4.7, Item 9) is turned by movement of the shunt trip clapper (11), the trip latch will slip past the straight cut portion of the trip bar shaft and will allow the banana link and main link roller to rise. The energy of the opening spring and contact loading springs is released to open the main contacts. The mechanism is in the state illustrated (Figure 4.8b) after the breaker is tripped open.

### 4.4.4 TRIP-FREE OPERATION

When the manual trip button is held depressed, any attempt to close the breaker results in the closing springs discharging without any movement of the pole shaft or vacuum interrupter stem.

## 4.5 CONTROL SCHEMES

There are two basic control schemes for each series of Type VCP-WR breakers, one for DC control and one for AC control voltages (Figure 4.6). Specific wiring schematics and diagrams are included with each breaker.

There may be different control voltages or more than one tripping element, but the principal mode of operation is as follows:

As soon as the control power is applied, the spring charging motor automatically starts charging the closing spring. When the springs are charged, the motor cut off LS1/bb switch turns the motor off. The breaker may be closed by making the control switch close (CS/C) contact. Automatically upon closing of the breaker, the motor starts charging the closing springs. The breaker may be tripped any time by making the control switch (CS/T) contacts.

Note the position switch (PS1) contact in the spring release circuit in the scheme. This contact remains made while the breaker is being levered between the TEST and CONNECTED positions for appropriately retrofitted breakers. Consequently, it prevents the breaker from closing automatically, even though the control close contact may have been made while the breaker is levered to the CONNECTED position.

When the CS/C contact is made, the SR closes the breaker. If the CS/C contact is maintained after the breaker closes, the Y relay is picked up. The Y/a contact seals in Y until CS/C is opened. The Y/b contact opens the SR circuit, so that even though the breaker would subsequently open, it could not be reclosed before CS/C was released and remade. This is the anti-pump function.

**Table 4. Time Per Event**

| Event | Milliseconds / Maximum |
|---|---|
| Closing Time<br>(From Initiation of Close Signal to Contact Make) | 75 |
| Opening Time<br>(Initiation of Trip Signal to Contact Break) | 45 |
| Reclosing Time<br>(Initiation of Trip Signal to Contact Make) | 190 |

## 4.6 SECONDARY CONNECTION BLOCK

The breaker control circuit is connected to the switchgear control through secondary connection block, located at the lower right side of the breaker. The contacts engage automatically when the breaker is racked into the "test" and "connect" positions.

## 4.7 SHUTTER OPERATING MECHANISM

Each breaker cell is equipped with a shutter to shield the high voltage stabs in the cubicle when the breaker is not in the cubicle. The shutter is regulated by the shutter operating mechanism located in the rear of the cell. This mechanism opens the shutter as the breaker is racked in and out of the cell.

## 4.8 INTERLOCKS

There are several interlocks built into the VR-Series vacuum replacement breakers. Each of these interlocks, though different in form, duplicate or exceed in function that of the original breaker. These interlocks exist to safeguard personnel and equipment. The basic premise behind the interlocking arrangement on the vacuum replacement breaker is that the breaker must not be inserted into or removed from a live circuit while the main contacts are closed. Also considered in the interlocking is that the breaker should pose no greater risk than necessary to the operator in or out of the cell. In addition to the original interlocks, VR-Series breakers provide an anti-close interlock.

**⚠ DANGER**

**INTERLOCKS ARE PROTECTIVE DEVICES FOR PERSONNEL AND EQUIPMENT. DO NOT BYPASS, MODIFY, OR MAKE INOPERATIVE ANY INTERLOCKS. DOING SO COULD CAUSE DEATH, SERIOUS PERSONAL INJURY, AND/OR PROPERTY DAMAGE.**

### 4.8.1 ANTI-CLOSE INTERLOCK

The anti-close interlock prevents discharging of the closing springs if the breaker is already closed (Figure 4.7, Item 11). When the breaker is closed, the interlock component moves away from the spring release clapper so that it cannot lift the spring release latch (9).

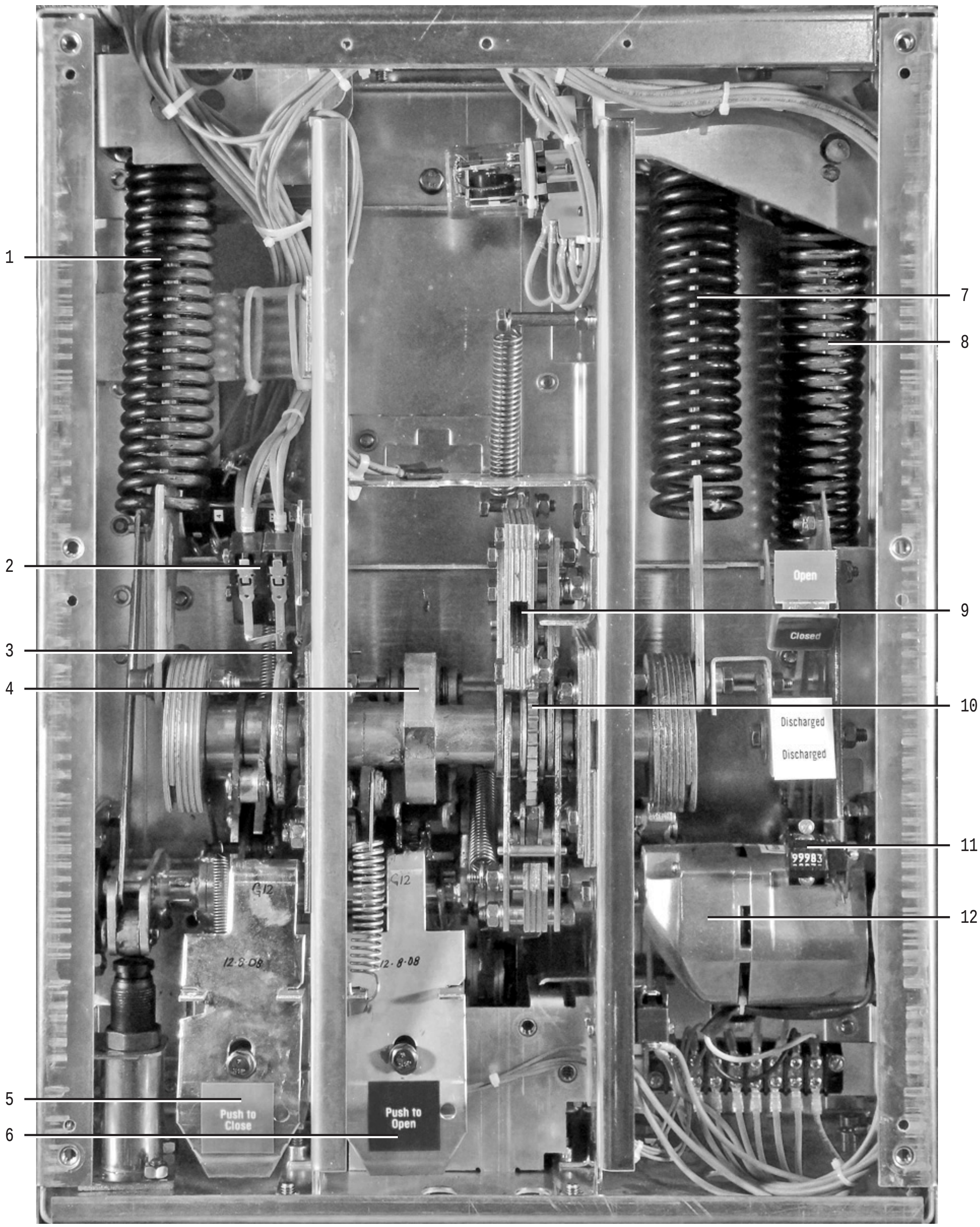
### 4.8.2 RACKING SYSTEM TRIP AND SPRING RELEASE INTERLOCKS

The racking interlock prevents engaging or disconnecting a shut breaker with live cell buss work or removing a mechanically hazardous breaker from the cell. The basic premise of this interlock is that no breaker should be connected to or removed from cell primary circuitry when shut and no breaker should be removed from the cell with charged open or closing springs. The racking interlock accomplishes this by providing a mechanical trip to the breaker automatically from the racking mechanism interlock cams whenever the breaker is in an intermediate position in the cell and adding a close signal between the DISCONNECT and WITHDRAWN positions to render the breaker trip-free prior to leaving the cell (close and open springs discharged).

## 4.9 GROUNDING CONTACT

The grounding contact is an assembly of copper contacts with compression springs which ground the breaker frame (static ground) by engaging the switchgear cell grounding bus when the breaker is racked into the cell. The ground contact assembly is located underneath the base of the breaker frame.

**Figure 4.5. 18WR Vacuum Element - Front Faceplate Removed**

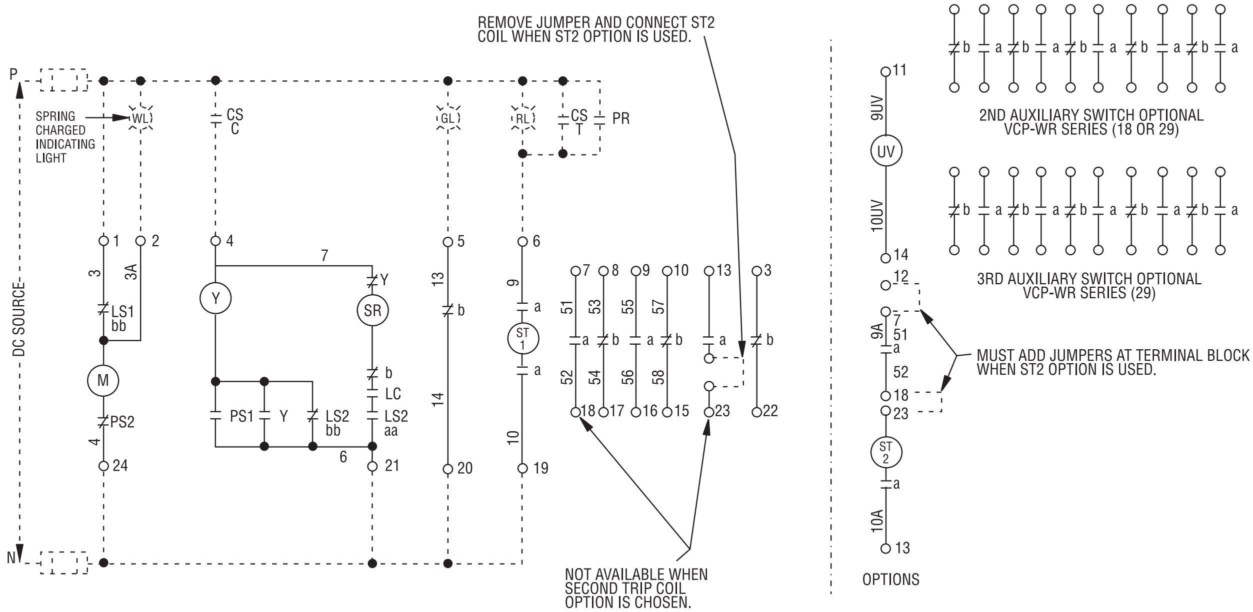



**18WR Vacuum Element**

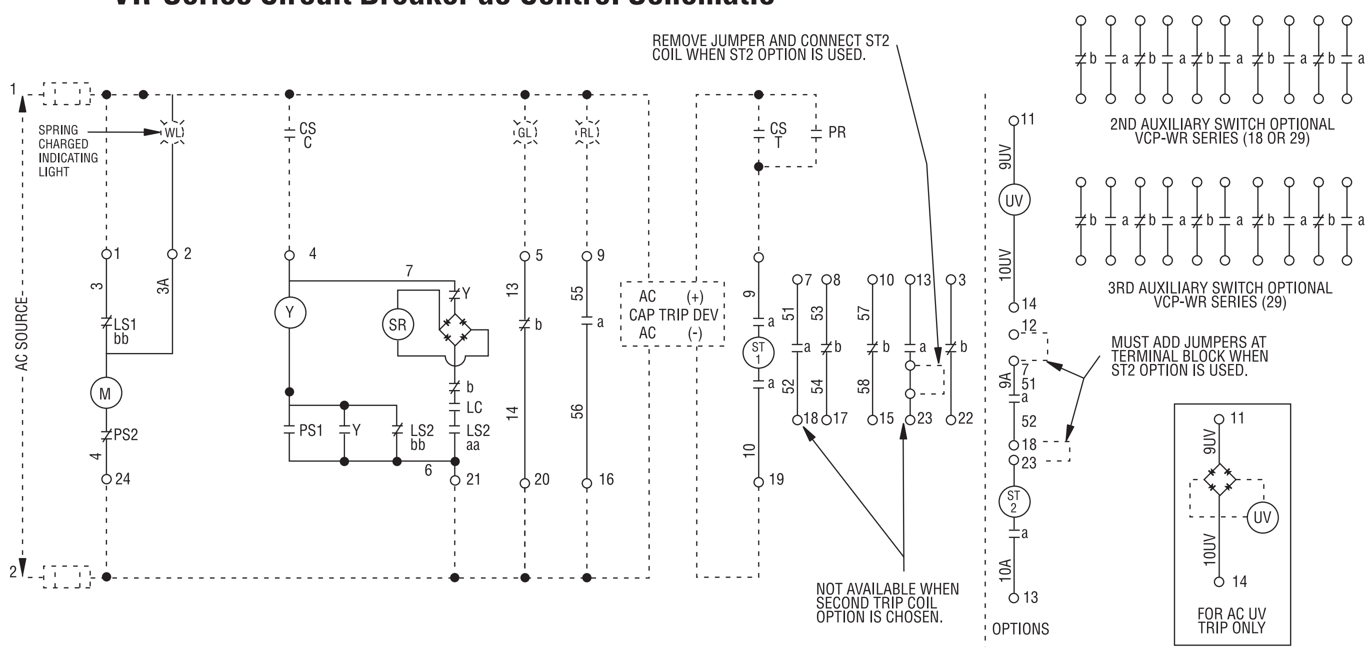
| | | | | | |
|---|---|---|---|---|---|
| 1 | LH Closing Spring | 5 | Spring Release Assembly | 9 | Manual Charge Socket |
| 2 | Motor Cutoff Switch | 6 | Shunt Trip Assembly | 10 | Ratchet wheel |
| 3 | Latch Check Switch (Rear) | 7 | RH Closing Spring | 11 | Operations Counter |
| 4 | Closing Cam | 8 | Reset Opening Spring | 12 | Charging Motor |

**Figure 4.6. Typical AC/DC Schematic**

## VR-Series Circuit Breaker dc Control Schematic




## VR-Series Circuit Breaker ac Control Schematic

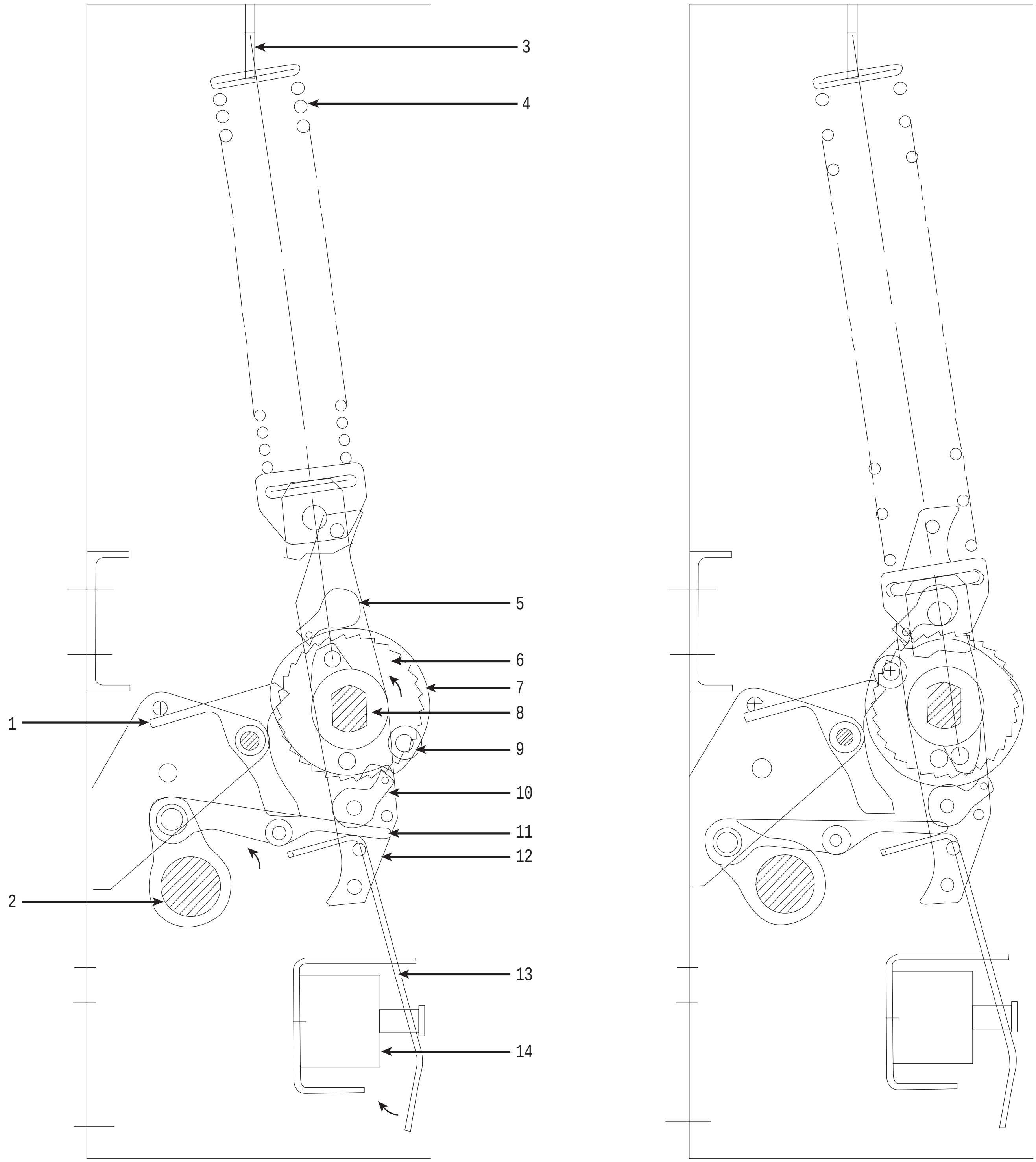



- CS/C - Breaker Control Switch - close
- CS/T - Breaker Control Switch - trip
- Y - Anti Pump Relay
- SR - Spring Release Coil (Close Coil)
- M - Spring Charging Motor
- ST - Shunt Trip Coil
- PR - Protective Relay
- O - Terminal Block or Accessible Terminal
- PS1 - Position Switch 1
- PS2 - Position Switch 2

| | OPERATION |
|---|---|
| LS1/bb | Closed until springs are fully charged |
| LS2/aa | Open until springs are fully charged |
| LS2/bb | Closed until springs are fully charged |
| LC | Open until mechanism is reset |
| PS1 | Open in all except between 'Test' and'Connect' positions |
| PS2 | Closed in all except between 'Test' and 'Connect' positions |

| SWITCH TERMINAL | |
|---|---|
| 'C' and 'NO' | Brown Switch |
| 'C' and 'NC' / 'C' and 'NO' | Black Switch |
| 'C' and 'NO' / 'C' and 'NC' | Black Switch |
| 'C' and 'NO' | Brown Switch |

**Figure 4.7. Closing Cam and Trip Linkage**



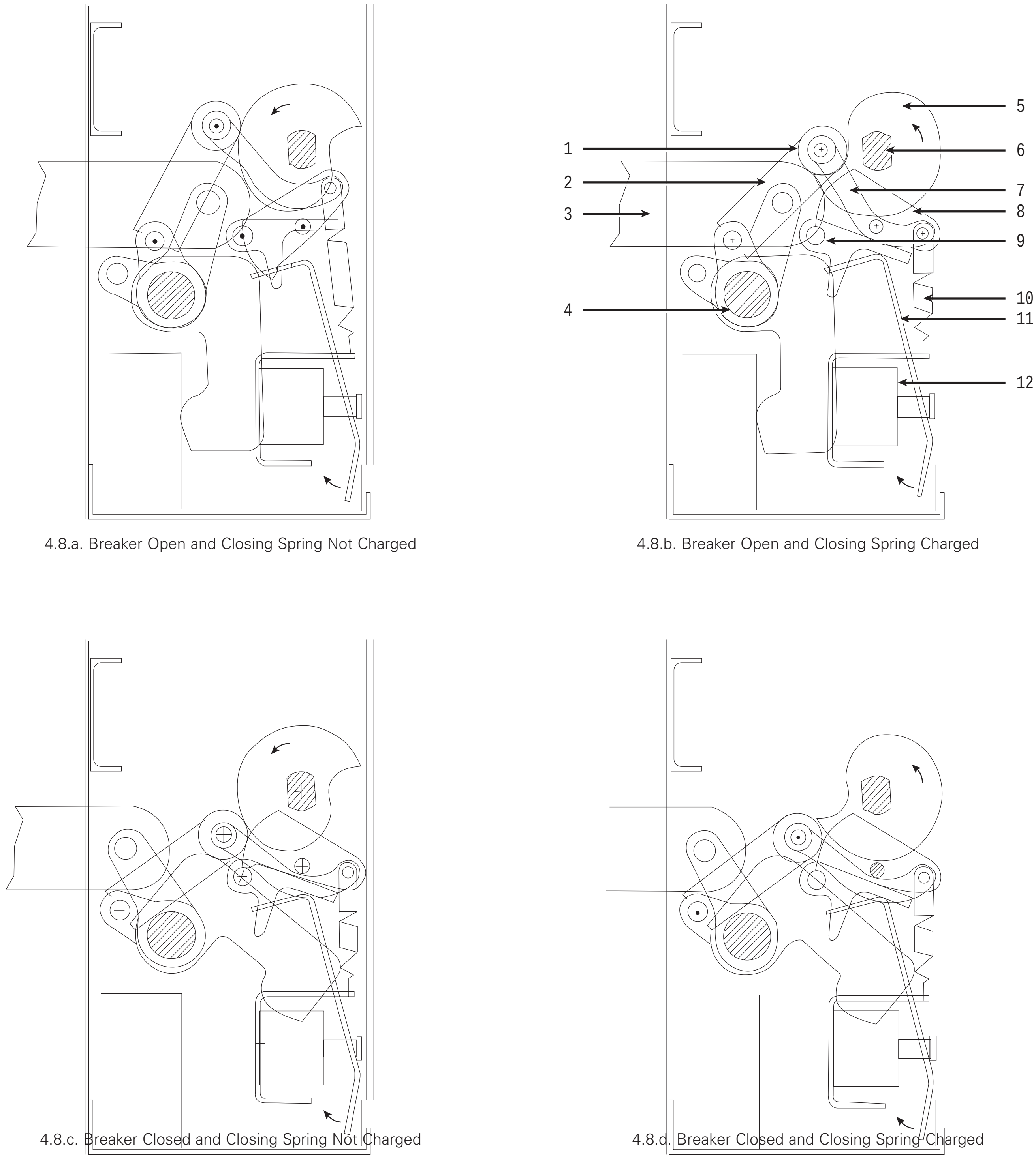

Breaker Open, Springs Discharged

Breaker Closed, Springs Charged

**Closing Cam and Trip Linkage**

| | | | | | |
|---|---|---|---|---|---|
| 1 | Spring Release (Close) Latch | 6 | Ratchet Wheel | 11 | Anti-Close Interlock |
| 2 | Pole Shaft | 7 | Spring Crank | 12 | Motor Ratchet Lever |
| 3 | Closing Spring Fixed End | 8 | Cam Shaft | 13 | Spring Release (Close) Clapper |
| 4 | Closing Spring | 9 | Spring Release Latch (Close Roller) | 14 | Spring Release (Close) Coil |
| 5 | Holding Pawl | 10 | Drive Pawl | | |

**Figure 4.8. Charging Schematic**




4.8.a. Breaker Open and Closing Spring Not Charged

4.8.b. Breaker Open and Closing Spring Charged

4.8.c. Breaker Closed and Closing Spring Not Charged

4.8.d. Breaker Closed and Closing Spring Charged

**Charging Schematic**

| | | | | | |
|---|---|---|---|---|---|
| 1 | Main Link Roller | 5 | Closing Cam | 9 | Trip Bar “D” Shaft |
| 2 | Main Link | 6 | Cam Shaft | 10 | Trip Latch Reset Spring |
| 3 | Operating Rod | 7 | Banana Link | 11 | Shunt Trip Lever |
| 4 | Pole Shaft | 8 | Trip latch | 12 | Shunt Trip Coil |

# SECTION 5: INSPECTION & INSTALLATION

**⚠ DANGER**

**BEFORE PLACING THE CIRCUIT BREAKER IN SERVICE, VERIFY THE STYLE OF MC-VR FURNISHED. IF THE MC-VR IS THE TYPE WITHOUT *SURE CLOSE*, USE THE OPERATION AND RACKING PROCEDURES OUTLINED FOR THAT STYLE. IF THE MC-VR IS THE *SURE CLOSE* TYPE, USE THE OPERATION AND RACKING PROCEDURES OUTLINED FOR THAT STYLE. ALSO FOLLOW THE SAFE PRACTICES SET FORTH IN SECTION 2. FAILURE TO USE THE CORRECT PROCEDURE FOR OPERATION AND INSTALLATION MAY RESULT IN INCORRECT CIRCUIT BREAKER OPERATION AND ALIGNMENT LEADING TO PROPERTY DAMAGE, BODILY INJURY, OR DEATH.**

When the breaker is first commissioned into service and each time the breaker is returned to service, it should be carefully examined and checked to make sure it is operating correctly.

## 5.1 EXAMINATION FOR DAMAGE

Examine the breaker for loose or obviously damaged parts. Never attempt to install nor operate a damaged breaker.

### 5.1.1 NAMEPLATE VERIFICATION

Verify the information on the new VR-Series nameplate matches the information on the purchase order. If any discrepancies exist, notify Eaton's Electrical Services & Systems for resolution prior to proceeding.

**Figure 5.1. Anti-Rotation Device**

### 5.1.2 BREAKER ANTI-ROTATION DEVICE

To reduce the possibility of new vacuum replacement circuit breakers from rotating forward during a short circuit event that could allow the circuit breaker primary disconnects to pull away from the stationary primaries, it is mandatory that an anti-rotation or hold-down bracket be installed in the circuit breaker compartment before installing the new vacuum circuit breaker. Note that should it be necessary to re-install the original air magnetic circuit breaker, it is not necessary to remove the anti-rotation bracket.

1. It is strongly suggested that the primary and secondary circuits be fully de-energized using an approved lock-out, tag out scheme prior to installation of the anti-rotation bracket. If primary circuit de-energization is not possible, follow the requirements in paragraph 'h' below. Take care to avoid the stationary secondary disconnects in the circuit breaker compartment during all aspects of this procedure.
2. This procedure requires removal of the circuit breaker from the circuit breaker compartment.
3. Locate the racking cover channel centered in the floor of the MC circuit breaker compartment. Remove the two 3/8 x 16 bolts and washers that secure the racking channel cover to the racking channel. The anti-rotation device will form the new cover for the racking channel.
4. Place the anti-rotation device on the racking channel. Slide it rearward to allow the angle welded to the device to drop down behind and below the sides of the racking channel.
5. Slide the anti-rotation device forward so that the angle welded at the back slips under the top part of the C-shaped racking channels on each side.
6. Secure the anti-rotation device with the 3/8x16 x 1" button-head bolts, flat washers and lock washers provided.
7. It is necessary to drill a hole in the rear steel barrier at the breaker compartment which will allow the 'bayonet' of the anti-rotation device to enter as the racking channel moves rearward during racking.
8. If the primary circuit has not been de-energized, perform the following procedure to disable the shutter mechanism to allow the shutter to continue to cover the primaries during this part of the procedure:
   i. Remove the compression clip that secures the shutter lift rod from the shutter actuator on the racking channel.
   ii. Move the rod aside slightly, resting it on the floor of the circuit breaker compartment so that it continues to support the shutter in a position that conceals the stationary primary disconnects.
9. Move aside the racking access lever to expose the square end of the racking screw. Turn the racking screw clockwise until the anti-rotation bayonet contacts the rear steel barrier between the circuit breaker compartment and the rear bus compartment. Make sure that the bayonet makes and obvious mark on the rear barrier. DO NOT force the racking system to the point that damage to the anti-rotation device and bayonet occur.
10. Turn the racking screw counter-clockwise to back the racking channel and anti-rotation device to the fully disconnected position. Use a center punch to provide a depression at the mark left by the bayonet so that this area can be drilled.
11. Drill a 17/32" (0.531) hole at the center punched mark through the rear barrier. Remove metal shavings from the circuit breaker compartment after drilling.
12. Check the alignment of the anti-rotation bayonet by racking the racking channel fully to the connected position. The bayonet should encounter and pass through the drilled hole easily without binding. Rack the racking channel back to the fully disconnected position.
13. To prevent rusting of the drilled hole apply any acceptable lubricant to the drilled hole and the bayonet.
14. Re-attach the shutter assembly lift rod to the racking lifting mechanism using a new compression clip (not provided).
15. When all other circuit breaker compartment work is complete, re-energize the primary and secondary circuits clearing all lock-out, tag out devices.
16. The new circuit breaker may be installed at this time.

The anti-lift bar (Figure 3.4, Item 7) of the circuit breaker will be captured by the anti-rotation device to keep it from rotating forward during a short circuit event. The anti-rotation device welded angle and bayonet engage the racking channel and switchgear frame to secure the anti-rotation device securely in the circuit breaker compartment.

### 5.1.3 CELL CODE PLATE

A breaker code plate is factory installed on VR-Series circuit breakers.

## 5.2 MANUAL OPERATIONAL CHECK

Manual operational checks must be performed before the breaker is connected to a live circuit. Tests must be performed with the breaker in the disconnect position, place the maintenance handle into the manual charging opening and charge the closing spring.

Approximately 36 up and down strokes of the handle are required to cause the "Charging Spring Status" indicator to show "Charged." Remove the maintenance handle.

**⚠ WARNING**

**ALWAYS REMOVE THE MAINTENANCE HANDLE AFTER CHARGING THE SPRING. FAILURE TO REMOVE THE MAINTENANCE HANDLE FROM THE BREAKER COULD CAUSE INJURY TO PERSONNEL AND/OR EQUIPMENT DAMAGE IF THE BREAKER WAS TO CLOSE.**

Close and trip the breaker by pushing the close lever then the trip lever (Figure 3.3).

Repeat the charge, close, and trip procedure several times to confirm that the mechanism operates consistently and reliably.

**⚠ WARNING**

**DO NOT ATTEMPT TO INSTALL OR OPERATE A VACUUM CIRCUIT BREAKER UNTIL THE TESTS OF SECTION 5.3 THROUGH 5.8 ARE SUCCESSFULLY PERFORMED.**

Remove the breaker from the cell and move to an area with adequate room for the following tests:

### 5.3 *SURE CLOSE* MECHANISM ADJUSTMENT

**⚠ DANGER**

**FOR ALL TYPE BREAKER HOUSINGS EQUIPPED WITH MECHANISM OPERATED CELL (MOC) SWITCHES, THE STEPS OUTLINED IN THIS SECTION MUST BE PERFORMED BEFORE INSTALLING A REPLACEMENT VR-SERIES CIRCUIT BREAKER. FAILURE TO COMPLY COULD CAUSE SEVERE PERSONAL INJURY, DEATH, EQUIPMENT DAMAGE AND/OR IMPROPER OPERATION**

MC-VR breakers with MOC operators are available with the ***SURE CLOSE*** mechanism to control kinetic energy transfer and closely mimic the dynamics and velocities of older breakers. It is imperative that this mechanism be adjusted to compensate for the force of the MOC switch mounted in the cell.

The breaker ***SURE CLOSE*** MOC operator is factory adjusted to a force of 35-40 lbf. This force has been proven to successfully operate a well-maintained Allis-Chalmers 8-9 stage MOC switch provided it does not have excessive pitting or arcing on its contacts. The parameters for the existing MOC switch should be verified and adjustments made to the cell switch mounting location. Do not attempt to insert or operate a MC-VR replacement breaker in a cell containing an MOC until after the switch has been properly adjusted.

**⚠ DANGER**

**MEASUREMENTS AND ADJUSTMENTS SHOULD NEVER BE ATTEMPTED IN AN ENERGIZED STRUCTURE. IF THE STRUCTURE CAN NOT BE DE-ENERGIZED, THEN PROPER PERSONAL PROTECTIVE EQUIPMENT PER NFPA 70E MUST BE WORN AT ALL TIMES WHILE GATHERING MOC SWITCH DATA, ADJUSTING OR SERVICING THE MOC SWITCH. FAILURE TO COMPLY WITH THIS WARNING COULD CAUSE SEVERE PERSONAL INJURY, DEATH, EQUIPMENT DAMAGE AND/OR IMPROPER OPERATION.**

Locate the cell mounted MOC. Two functional versions of the MOC interface are known to exist. One operates the MOC switch in the connected position only and the other will operate in either the "TEST" or "CONNECTED" positions. Figures 5.2.a shows the MOC switch that can operate in the "TEST" or "CONNECTED" positions.

To insure the proper operation of the ***SURE CLOSE*** mechanism, the MOC assembly should be cleaned and inspected for worn parts, lubricated and properly secured in the cell as indicated in Figure 5.2.b before proceeding. A spring force gauge should be used to measure the forces needed to move the switch to the fully closed position prior to inserting the breaker.

**Step 1:** Attach a spring force gauge to the round operating rod as shown (Figure 5.2.b) and pull vertically until the switch contacts have all changed state. Do not "over-pull" on the gauge. Measure and record the force. It should be approximately 27-32 lbf for a properly maintained and adjusted Allis-Chalmers MOC switch with 8-9 stages. The force will be higher for switches with more stages or if improperly maintained.

**Step 2:** Place the breaker at a safe distance from the cell structure and on a level surface. If the cell structure is energized, be sure the breaker is beyond the Arc Flash Boundary. Chock the wells to prevent movement. Use the maintenance tool to charge the stored energy mechanism and manually press the "PRESS TO CLOSE" device to close the circuit breaker.

**Step 3:** Attach the spring force gauge as shown in Figure 5.5 and pull down vertically (approximately .125 - .25") to measure the ***SURE CLOSE*** MOC operator force. It should measure between 35-40 lbf. This provides a minimum margin/differential of approximately 5 lbf to operate the MOC switch. If the differential force between the ***SURE CLOSE*** MOC operator and the MOC switch is less than 5 lbf, then the ***SURE CLOSE*** MOC operator force should be increased to obtain a 5 lbf differential between the force measure in the cell and the output force of the breaker with the breaker being the greater of the two forces. Proceed with the following steps to increase the breaker ***SURE CLOSE*** MOC operator force:

**Step 4:** Open the circuit breaker by depressing the "PUSH TO OPEN" operator. Locate the ***SURE CLOSE*** MOC drive spring (Figure 5.3 & 5.4). It is located in the lower portion of the breaker as viewed from the primary bushing side of the breaker.

**Step 5:** Loosen the outer jam nut on the ***SURE CLOSE*** spring and turn the inner nut clockwise to compress the spring an additional .25 inch. Measure and record the length of the compressed

**Figure 5.2.a. Cell Mounted MOC Operator**

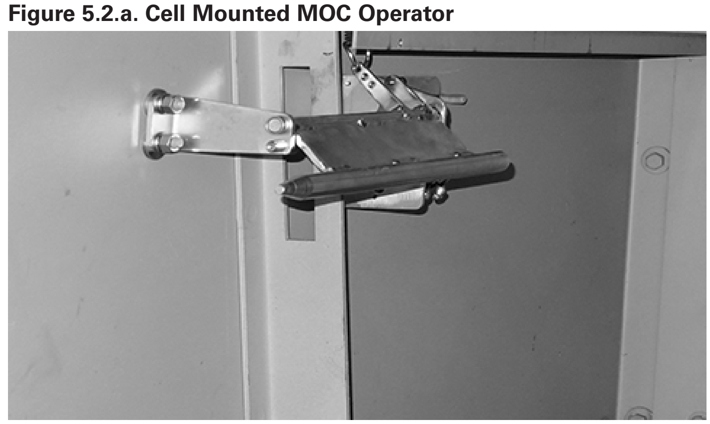


**Figure 5.2.b. Cell MOC Force Measurement**

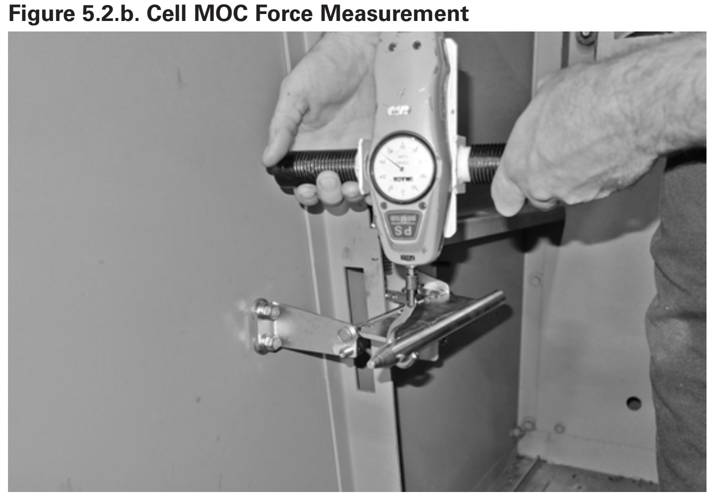


**Figure 5.3. *SURE CLOSE* Spring Compression Setting**

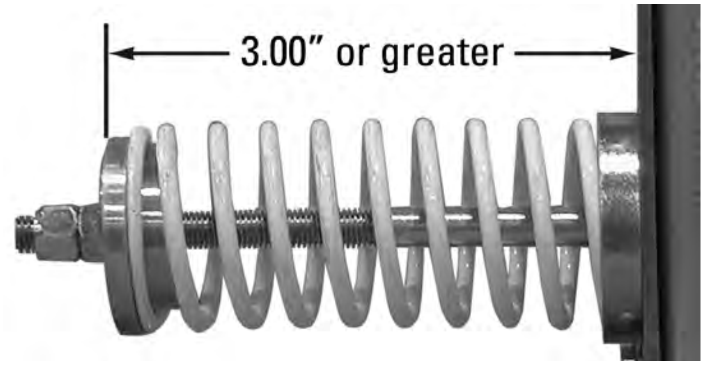



**Figure 5.4. *SURE CLOSE* Spring Compression Setting**

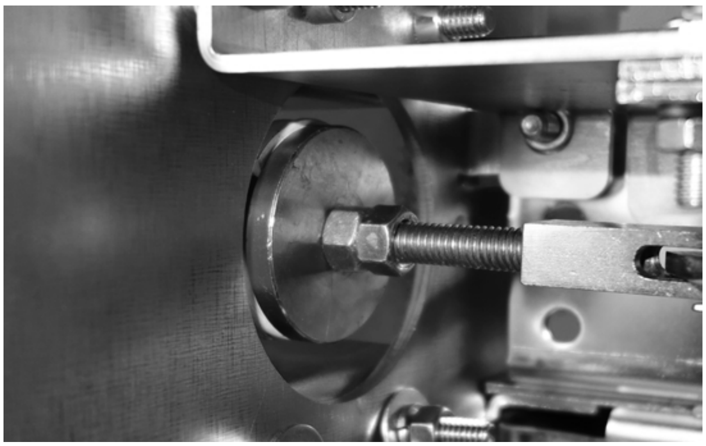


**Figure 5.5. Measuring With Spring Force Gauge**

length of the spring. It should never be compressed to less than 3.00 inches. Charge the breaker's stored energy mechanism using the "maintenance tool" and close the breaker by depressing the "PUSH TO CLOSE" operator.

**Step 6:** With the breaker still out of the cell and in the closed position, measure the output of the MOC drive as described in Step 3. The MOC drive force should exceed the MOC cell force requirement by a minimum of 10 lbf. If not, repeat Steps 4 - 6 until the required margin is achieved. Do not compress the spring beyond 3.00 inches as referenced in Figure 5.3 and Step 5.

**Step 7:** Manually charge and close the breaker 2-3 times to stabilize the reactions of the breaker components. Close the breaker and measure the MOC output force as described in Step 3. If the force margin remains adequate, proceed to the next step. If not, repeat adjustment Steps 4 - 6. Tighten the jam nut (Figure 5.3) when adjustments are completed.

**Step 8:** Insert into the cell following the instructions for the correct vintage (See Section 4).

**Step 9:** Operate the breaker to verify the MOC operator force is sufficient when driving all the MOC system components.

**Step 10:** Repeat Steps 3 - 8 until acceptable operation is achieved.

**Step 11:** Anytime an adjustment is made, make sure the new compressed spring length (measured in the open position) is recorded if different from the dimension as received from the factory.

**Step 12:** After an adjustment is made, always verify that all nuts are secured in place, prior to returning to service.

## 5.4 VACUUM INTEGRITY TEST

Check the vacuum integrity of the interrupters of the three pole units by conducting the applied potential test described in Section 6.3.

## 5.5 LOW FREQUENCY WITHSTAND TEST (INSULATION CHECK)

Perform insulation integrity tests as described in Section 6.6.

## 5.6 CONTACT EROSION AND STROKE, CONTACT WIPE

Close the breaker. Check all three vacuum interrupter erosion indicator marks as described in Section 6.4 and illustrated in Figures 6.1 and 6.2 to verify that contact erosion is not greater than the service limit of 1/8". Check contact wipe as described in Section 6.4 and illustrated in Figure 6.1 through 6.4.

## 5.7 PRIMARY CIRCUIT RESISTANCE TESTS

Check the primary circuit resistance of the three pole units as described in Section 6.7. The resistance should not exceed the values specified. Record the values for future reference.

## 5.8 ELECTRICAL OPERATIONAL CHECKS

These checks can be performed with the breaker in its disconnect position and connecting the breaker to a test cabinet or to the switchgear cell's secondary receptacle using the special extension cable designed for this purpose and described in section 3.

Perform electrical operations checks. Close and trip the circuit breaker electrically several times to verify that the operation is reliable and consistent. Check that the operation of the spring charging motor is reasonably prompt and that the motor makes no unusual noise.

**⚠ DANGER**

**DO NOT PERFORM ELECTRICAL OPERATION CHECKS WITH THE BREAKER IN THE "CONNECT" POSITION BECAUSE OF THE POSSIBILITY OF CONNECTING DE-ENERGIZING LOAD CIRCUITS TO THE ELECTRICAL POWER SOURCE, RESULTING IN DEATH, PERSONNEL INJURY OR EQUIPMENT DAMAGE.**

## 5.9 OPERATIONAL POSITIONS

The breaker has four basic operational positions:

1. Breaker in the 'withdrawn position' (Figure 5.8): In the 'withdrawn' or 'out' position, the circuit breaker racking parts are disengaged from the circuit breaker compartment racking parts. For the circuit breaker style without ***SURE CLOSE***, the MC-VR can be installed in the circuit breaker compartment only if the racking interlock handle extending from the front lower cover is in the 'Racking/Trip Free' position. If it is necessary to charge the circuit breaker closing springs and close the MC circuit breaker outside the cell, the racking interlock handle must be in the 'Connected/Test' position. For MC-VR models with the ***SURE CLOSE*** feature, there is no racking interlock handle; the circuit breaker may be inserted by pushing it into place. It may also be charged, closed and tripped without having to reposition any operators. If close and tripping

**Figure 5.6. Insertion Into Cell**


operations are performed outside the circuit breaker compartment, stay clear of the moving MOC operator on ***SURE CLOSE*** equipped models as this part moves at high speed which can cause personal injury and equipment damage.

2. Breaker in the circuit breaker compartment in the 'disconnect' position (Figure 5.7): As the breaker is pushed into the cell and the racking interlock plate on the bottom of the breaker frame engages in the central racking mechanism; this is confirmed by an audible click. At this point the breaker is in the 'disconnect' position and held in the cell.

3. Breaker in the circuit breaker compartment in the 'test' position (Figure 5.8): In the 'test' position, the circuit breaker secondary disconnects are engaged with the breaker compartment secondary disconnects and the switchgear grounding system. This position is indicated by the frame of the circuit breaker aligning with the racking position label on the floor. The primary disconnects, however, are not connected, and the stationary primary disconnect shutters are not open. In this position the circuit breaker spring charging motor may charge the closing springs if control power is on. Manual and electrical close and trip operation tests can be performed to confirm the operation of the circuit breaker in this position.

4. Breaker in the 'connect' position (Figure 5.9): In the 'connect' position, the primary disconnects are fully engaged on the circuit breaker compartment primary connections. Primary disconnect shutters open between 'test' and 'connect'. When the position indicator reaches or moves slightly past the 'connect' position, the racking screw will not allow further clockwise rotation and shall not be forced. The 'connect' position is the operating position of the circuit breaker where it connected to primary current and the load the circuit breaker is feeding.

### 5.10 INSERTION PROCEDURE FOR MC-VR

**Figure 5.7. Disconnect Position**


**Figure 5.8. Test Position**

**Figure 5.9. Connect Position**


**⚠ WARNING**

**DO NOT USE ANY TOOL TO LEVER THE BREAKER FROM TEST OR CONNECTED POSITION OTHER THAN THE RACKING HANDLE**

### 5.10.1 INSERTION PROCEDURE FOR MC-VR (WITHOUT *SURE CLOSE)*

During the installation process, great care should be exercised. Follow the guidelines of your local authority having jurisdiction on safe racking practices. Throughout the racking process, the circuit breaker is prevented from closing both mechanically and electrically. The circuit breaker can be closed in the 'test' or 'connect' positions only after lowering the interlock handle to the 'Connected / Test' position.

1. Inspect the circuit breaker compartment to confirm that shutters are closed and that there is no foreign material in the circuit breaker compartment. Key interlocking in the circuit breaker compartment, if any, must also be cleared. Confirm that there are no pad locks on the racking padlock provisions.
2. The cell mounted racking screw must be fully racked to the 'disconnect' position, which is the position reached when the racking handle is rotated fully counterclockwise until resistance is reached, do not force.
3. The circuit breaker must be open with the closing springs discharged. If the closing springs are charged, push the manual trip operator. While pushing the trip operator, push the manual close operator. This will discharge the closing springs. Eaton recommends hearing protection while performing this operation.
4. Lift the racking interlock handle to the 'Racking / Trip-Free' position and move it into its retaining slot. Please note that anytime this handle is lifted to the 'Racking / Trip-Free' position, the circuit breaker will be tripped if it is closed.

**Figure 5.10. Racking Access Lever**

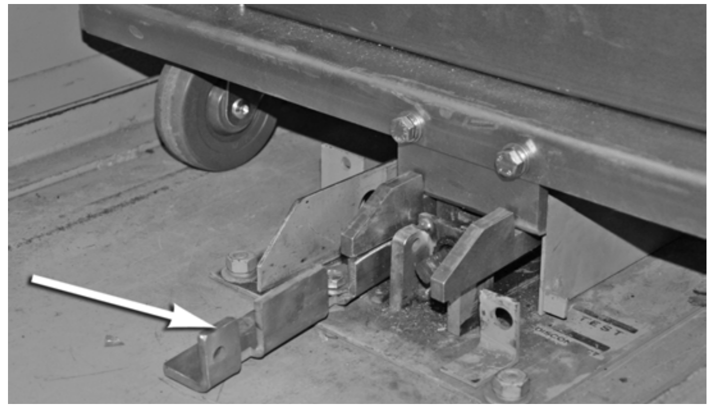


**Figure 5.11. Racking The Breaker**

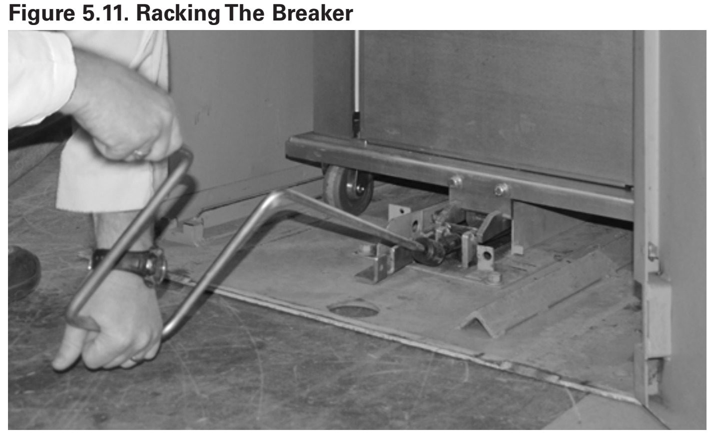
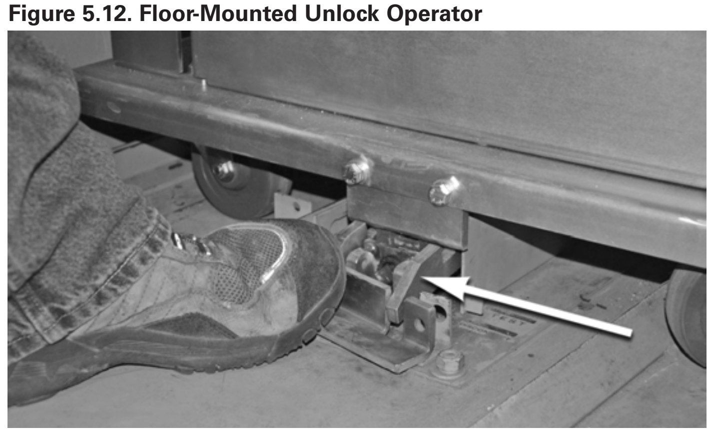


**Figure 5.12. Floor-Mounted Unlock Operator**



5. Align and push the circuit breaker so that it engages the rails in the floor of the circuit breaker compartment. The guide wheel on the left side of the breaker must align with the guide track in the cell. The circuit breaker must be pushed into its compartment until the racking interface plate on the bottom of the breaker frame is engaged in the central racking mechanism; this is confirmed by an audible click. This is the 'disconnect' position for the circuit breaker. Continue to step 6 with compartment door open.
6. Move aside the racking access lever (Figure 5.10) which blocks access to the racking provisions to gain access to the racking shaft.

7. Engage the racking handle on the square racking shaft and rotate the racking handle clockwise until the circuit breaker reaches the test position, as indicated by the racking position indication in the cell (Figure 5.11). In the 'test' position, the circuit breaker secondary disconnects are engaged with the breaker compartment secondary disconnects. The closing springs charge when the circuit breaker reaches the 'test' position. The circuit breaker ground connections are also connected to the circuit breaker compartment grounding parts. The primary disconnects are not connected in the 'test' position. See Figure 5.8.
8. If circuit breaker tests are planned in the 'test' position, the racking interlock handle must be re-positioned to the 'Connected / Test' position to allow manual or electrical closing spring charging. If control power is available, the closing springs will charge when the interlock handle is moved to the 'Connected / Test' position. Moving the racking interlock handle to the 'Connected / Test' position also allows the breaker to be closed. Following any desired testing, move the interlock handle to the 'Racking / Trip-Free' position to allow racking to the 'connect' position.
9. Reconnect the racking handle and continue turning clockwise. Racking effort increases as the circuit breaker primary disconnects engage the stationary primaries. The position of the circuit breaker is indicated by the racking position indicator. When the circuit breaker reaches or moves slightly past the 'connect' position, the racking screw will not allow further clockwise rotation. Do not force as this may damage the racking system.
10. Move the interlock handle to the 'Connected / Test' position. Swing the racking access lever over until it again blocks the racking shaft. Close the circuit breaker compartment door. The circuit breaker may now be placed in service when it is allowed to do so.

### 5.10.2 INSERTION PROCEDURE FOR MC-VR (WITH *SURE CLOSE)*

During the installation process, great care should be exercised. Follow the guidelines of your local authority having jurisdiction on safe racking practices. Throughout the racking process, the circuit breaker is prevented from closing both mechanically and electrically. The circuit breaker can be closed in the 'test' or 'connect' positions only after lowering the interlock handle to the 'Connected / Test' position.

1. Inspect the circuit breaker compartment to confirm that shutters are closed and that there is no foreign material in the circuit breaker compartment. Key interlocking in the circuit breaker compartment, if any, must also be cleared. Confirm that there are no pad locks on the racking padlock provisions.
2. The cell mounted racking screw must be fully racked to the 'disconnect' position, which is the position reached when the racking handle is rotated fully counterclockwise until resistance is reached, do not force.
3. The circuit breaker must be open with the closing springs discharged. If the closing springs are charged, push the manual trip operator. While pushing the trip operator, push the manual close operator. This will discharge the closing springs. Eaton recommends hearing protection while performing this operation.
4. Align and push the circuit breaker so that it engages the rails in the floor of the circuit breaker compartment. The guide wheel on the left side of the breaker must align with the guide track in the cell. The circuit breaker must be pushed into its compartment until the racking interface plate on the bottom of the breaker frame is engaged in the central racking mechanism; this is confirmed by an audible click. This is the 'disconnect' position for the circuit breaker. Continue to step 6 with compartment door open.
5. Move aside the racking access lever (Figure 5.10) which blocks access to the racking provisions to gain access to the racking shaft.
6. Engage the racking handle on the square racking shaft and rotate the racking handle clockwise until the circuit breaker reaches the test position, as indicated by the racking position indication in the cell (Figure 5.11). In the 'test' position, the circuit breaker secondary disconnects are engaged with the breaker compartment secondary disconnects. The closing springs charge when the circuit breaker reaches the 'test' position. The circuit breaker ground connections are also connected to the circuit breaker compartment grounding parts. The primary disconnects are not connected in the 'test' position. See Figure 5.8.
7. If circuit breaker tests are planned in the 'test' position, they may be performed at this time. If control power is available, the closing springs will charge when the circuit breaker reaches the test position.
8. Reconnect the racking handle and continue turning clockwise. Racking effort increases as the circuit breaker primary disconnects engage the stationary primaries. The position of the circuit breaker is indicated by the racking position indicator. When the circuit breaker reaches or moves slightly past the 'connect' position, the racking screw will not allow further clockwise rotation. Do not force as this may damage the racking system.
9. Close the circuit breaker compartment door. The circuit breaker may now be placed in service when it is allowed to do so.

## 5.11 REMOVAL PROCEDURE FOR MC-VR

### 5.11.1 REMOVAL PROCEDURE FOR MC-VR (WITHOUT *SURE CLOSE*)

1. During the removal process, great care should be exercised. Follow the guidelines of your local authority having jurisdiction on safe racking practices. Throughout the racking process, the circuit breaker is prevented from closing both mechanically and electrically.
2. Open the circuit breaker compartment door when authorized to do so.
3. Locate the interlock handle and move it to the 'Racking / Trip-Free' position. This action will hold the circuit breaker trip free. Swing the racking access lever to the left to reveal the racking shaft.
4. Install the racking handle and rotate the handle counter-clockwise to move the circuit breaker from the 'connect' to the 'test' position. Testing cannot be performed until the racking interlock handle is moved to the 'Connected / Test' position.
5. The circuit breaker may be parked at the test position or moved on to the 'disconnect' position as required. The racking interlock handle must be in the 'Racking / Trip-Free' position to move the circuit breaker to the disconnect position. Automatic spring discharge will occur between the 'disconnect' and 'withdrawn' positions.
6. The circuit breaker can be parked in the 'disconnect' position. Close the circuit breaker compartment door.
7. If it is necessary to remove the circuit breaker from the breaker compartment, rack the breaker to 'disconnect' position. Step on the Floor Mounted Unlock Operator (Figure 5.12), then pull the breaker out from the cell using the circuit breaker handles.

### 5.11.2 REMOVAL PROCEDURE FOR MC-VR (WITH *SURE CLOSE*)

1. During the removal process, great care should be exercised. Follow the guidelines of your local authority having jurisdiction on safe racking practices. Throughout the racking process, the circuit breaker is prevented from closing both mechanically and electrically.
2. Open the circuit breaker compartment door when authorized to do so.

3. Swing the racking access lever to the left to reveal the racking shaft.
4. Install the racking handle and rotate the handle counter-clockwise to move the circuit breaker from the 'connect' to the 'test' position.
5. The circuit breaker may be parked at the test position or moved on to the 'disconnect' position as required. Automatic spring discharge will occur between the 'disconnect' and 'withdrawn' positions.
6. The circuit breaker can be parked in the 'disconnect' position. Close the circuit breaker compartment door.
7. If it is necessary to remove the circuit breaker from the breaker compartment, rack the breaker to 'disconnect' position. Step on the Floor Mounted Unlock Operator (Figure 5.12), then pull the breaker out from the cell using the circuit breaker handles.

# SECTION 6: INSPECTION & MAINTENANCE

**⚠ WARNING**

**DO NOT WORK ON A BREAKER IN THE “CONNECTED” POSITION.**

**DO NOT WORK ON A BREAKER WITH SECONDARY DISCONNECTS ENGAGED.**

**DO NOT WORK ON A BREAKER WITH SPRINGS CHARGED OR CONTACTS CLOSED.**

**DO NOT DEFEAT ANY SAFETY INTERLOCKS.**

**DO NOT LEAVE MAINTENANCE TOOL IN THE SOCKET AFTER CHARGING THE CLOSING SPRINGS.**

**⚠ DANGER**

**STAND AT LEAST ONE METER AWAY FROM THE BREAKER WHEN TESTING FOR VACUUM INTEGRITY.**

**FAILURE TO FOLLOW ANY OF THESE INSTRUCTIONS MAY CAUSE DEATH, SERIOUS BODILY INJURY, OR PROPERTY DAMAGE. SEE SECTION 2 - SAFE PRACTICES FOR MORE INFORMATION.**

## 6.1 INSPECTION FREQUENCY

Inspect the breaker once a year when operating in a clean, non corrosive environment. For a dusty and corrosive environment, inspection should be performed twice a year. Additionally, it is recommended to inspect the breaker every time it interrupts fault current.

**Note:** Refer to the table below for maintenance and inspection check points.

## 6.2 INSPECTION AND MAINTENANCE PROCEDURES

| NO. / SECTION | INSPECTION ITEM | CRITERIA | INSPECTION METHOD | CORRECTIVE ACTION IF NECESSARY |
|---|---|---|---|---|
| 1. Insulation | Stand Off Insulators, Operating Rods, Tie-Bars and Barriers | No Dirt | Visual Check | Clean With Lint-Free Cloth |
| | | No Cracking | Visual Check | Replace Cracked Unit |
| Vacuum Integrity | Between Main Circuit With Terminals Ungrounded | Withstand<br>27k 60Hz For 1 Minute | Hipot Tester | Clean And Retest Or Replace |
| Insulation Integrity | Main Circuit To Ground | Withstand<br>15kV, 60Hz For 1 Minute<br>(5kV Rating)<br>27kV, 60Hz For 1 Minute<br>(15kV Ratings) | Hipot Tester | Clean And Retest Or Replace |
| | Control Circuit To Ground<br>(Charging Motor Disconnected) | Withstand<br>1125V, 60Hz For 1 Minute | Hipot Tester | Clean And Retest Or Replace |
| 2. Power Element | Vacuum Interrupters | Contact Erosion Visibility Of Mark | Visual - Close The Breaker And Look For Green Mark On Moving Stem From The Rear Of The Breaker<br>(See Figure 6.1 and 6.2) | If Mark Is Not Visible, Replace Interrupter Assembly |
| | | Contact Wipe Visible | Visual (Figure 6.3 and 6.4) | Replace VI Assembly |
| | | Adequate Vacuum | See Section 6.3 | Replace Interrupter Assembly<br>If Vacuum Is Not Adequate |
| | | Dirt On Ceramic Body | Visual Check | Clean With Dry Lint-Free Cloth |
| | Primary Disconnects | No Burning Or Damage | Visual Check | Replace If Burned, Damaged Or Eroded |
| 3. Control Circuit Parts | Closing And Tripping Devices Including Disconnects | Smooth And Correct Operation By Control Power | Test Closing And Tripping Of The Breaker Twice | Replace Any Defective Device-<br>Identify Per Trouble-Shooting Chart |
| | Wiring | Securely Tied In Proper Place | Visual Check | Repair Or Tie As Necessary |
| | Terminals | Tight | Visual Check | Tighten Or Replace If Necessary |
| | Motor | Smooth And Correct Operation By Control Power | Test Closing And Tripping Of The Breaker Twice | Replace Brushes Or Motor |
| | Tightness Of Hardware | No Loose Or Missing Parts | Visual And Tightening With Appropriate Tools | Tighten Or Reinstate If Necessary |
| 4. Operating Mechanism | Dust Or Foreign Matter | No Dust Or Foreign Matter | Visual Check | Clean As Necessary |
| | Lubrication | Smooth Operation And No Excessive Wear | Sight And Feel | Lubricate Very Sparingly<br>With Light Machine Oil |
| | Deformation Or Excessive Wear | No Excessive Deformation Or Wear | Visual And Operational | Remove Cause And Replace Parts |
| | Manual Operation | Smooth Operation | Manual Charging Closing<br>And Tripping | Correct Per Trouble-Shooting Chart<br>If Necessary |
| | CloSure Test | ≥ 0.6 Inch Over Travel | CloSure Test 6-9.1 | If < 0.6 Contact P.B.C.<br>At 1-877-276-9379 |

| **BOLT SIZE** | 8 - 32 | 10 - 32 | .25 - 20 | .31 - 18 | .38 - 16 | .50 - 13 |
|---|---|---|---|---|---|---|
| **TORQUE Lb. In.** | 24 | 36 | 72 | 144 | 300 | 540 |

### 6.3 VACUUM INTERRUPTER INTEGRITY TEST

Vacuum interrupters used in Type VR-Series circuit breakers are highly reliable interrupting elements. Satisfactory performance of these devices is dependent upon the integrity of the vacuum in the interrupter and the internal dielectric strength. Both of these parameters can be readily checked by a one minute AC high potential test. (See Table 6.1 for appropriate test voltage.) During this test, the following warning must be observed:

**⚠ WARNING**

**APPLYING ABNORMALLY HIGH VOLTAGE ACROSS A PAIR OF CONTACTS IN VACUUM MAY PRODUCE X-RADIATION. THE RADIATION MAY INCREASE WITH THE INCREASE IN VOLTAGE AND/OR DECREASE IN CONTACT SPACING. X-RADIATION PRODUCED DURING THIS TEST WITH RECOMMENDED VOLTAGE AND NORMAL CONTACT SPACING IS EXTREMELY LOW AND WELL BELOW MAXIMUM PERMITTED BY STANDARDS. HOWEVER, AS A PRECAUTIONARY MEASURE AGAINST POSSIBILITY OF APPLICATION OF HIGHER THAN RECOMMENDED VOLTAGE AND/OR BELOW NORMAL CONTACT SPACING, IT IS RECOMMENDED THAT ALL OPERATING PERSONNEL STAND AT LEAST ONE METER AWAY IN FRONT OF THE BREAKER.**

With the breaker open and securely sitting on the floor, connect all top/front primary studs (bars) together and the high potential machine lead. Connect all bottom/rear studs together and the high potential return lead. Do not ground them to the breaker frame. Start the machine at zero potential, increase to appropriate test voltage and maintain for one minute.

Successful withstand indicates that all interrupters have satisfactory vacuum level. If there is a breakdown, the defective interrupter or interrupters should be identified by an individual test and replaced before placing the breaker in service.

After the high potential is removed, discharge any electrical charge that may be retained, particularly from the center shield of vacuum interrupters. To avoid any ambiguity in the AC high potential test due to leakage or displacement (capacitive) current, the test unit should have sufficient volt-ampere capacity. It is recommended that the equipment be capable of delivering 25 milliamperes for one minute.

Although an AC high potential test is recommended, a DC test may be performed if only a DC test unit is available, but is not recommended.

In this case the equipment must be capable of delivering 5 milliamperes for one minute to avoid ambiguity due to field emission or leakage currents and the test voltage shall be as shown in Table 6.1.

The current delivery capability of 25 mA AC and 5 mA DC apply when all three VI's are tested in parallel. If individual VI's are tested, current capability may be one third of these values.

**⚠ WARNING**

**SOME DC HIGH POTENTIAL UNITS, OPERATING AS UNFILTERED HALF-WAVE RECTIFIERS, ARE NOT SUITABLE FOR USE TO TEST VACUUM INTERRUPTERS BECAUSE THE PEAK VOLTAGE APPEARING ACROSS THE INTERRUPTERS CAN BE SUBSTANTIALLY GREATER THAN THE VALUE READ ON THE METER.**

| | Vacuum Interrupter Integrity Test Voltage | |
|---|---|---|
| **Breaker Rated Maximum Voltage** | **AC 60Hz** | **DC** |
| Up to and including 15.0 kV | 27 kV | 40 kV |

### 6.4 CONTACT EROSION AND WIPE

Since the contacts are contained inside the interrupter, they remain clean and require no maintenance. However, during high current interruptions there may be a minimal amount of erosion from the contact surfaces. To determine contact erosion, close the breaker and observe the vacuum interrupter moving stem from the rear of the breaker. If the mark on each stem is visible, erosion has not reached maximum value thus indicating satisfactory contact surface of the interrupter. If the mark is not visible, the vacuum interrupter assembly must be replaced (Figure 6.1 and 6.2).

The adequacy of contact wipe can be determined by simply observing the vacuum interrupter side of the operating rod assembly on a closed breaker. Figures 6.3 and 6.4 show the procedure for determining the contact wipe. It maybe necessary to use a small mirror and flashlight to clearly see the "T" shape indicator. If the wipe is not adequate, the vacuum interrupter assembly (Pole Unit) must be replaced. Field adjustment is not possible.

**⚠ WARNING**

**FAILURE TO REPLACE A VACUUM INTERRUPTER ASSEMBLY WHEN CONTACT EROSION MARK IS NOT VISIBLE OR WIPE IS UNSATISFACTORY, WILL CAUSE THE BREAKER TO FAIL TO INTERRUPT AND THEREBY CAUSE PROPERTY DAMAGE OR PERSONNEL INJURY.**

**Figure 6.1. Vacuum Interrupter Showing Contact Erosion Indicator With Breaker Open
(Shown here for clarity purposes only)**

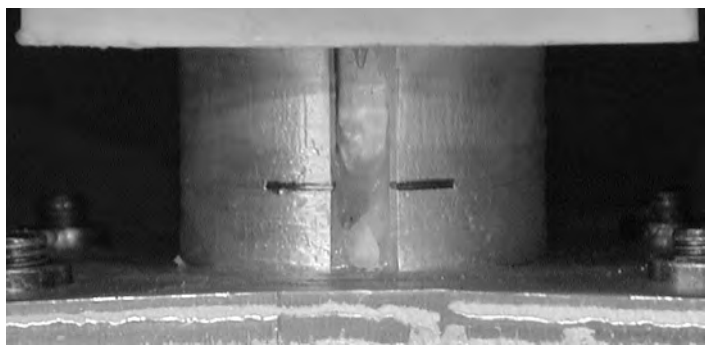


**Figure 6.2. Vacuum Interrupter Showing Contact Erosion Indicator With Breaker Closed
(Indicators are checked only when breaker is closed.)**

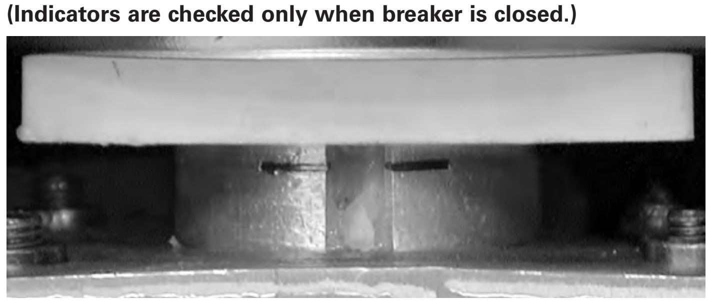
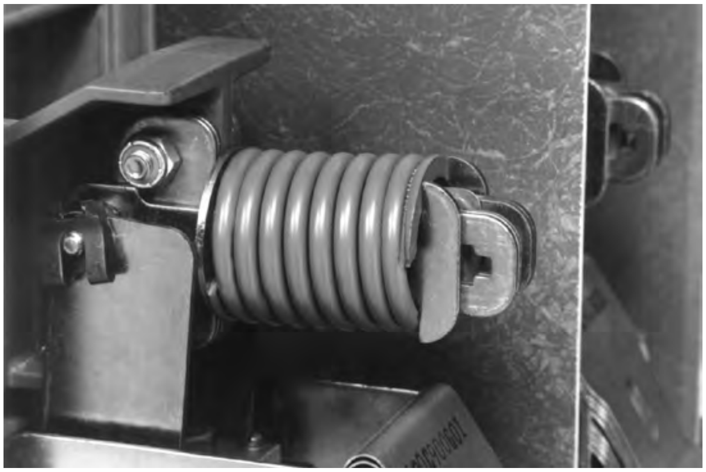


**Figure 6.3. The Arrow Shows The "T" Contact Wipe Indicator - Example with Blue Spring (If the "T" or any portion of its visible as shown with the breaker closed, the wipe is satisfactory) (See Next Figure for Graphic of All Possibilities)**



### 6.5 INSULATION

In VR-Series breakers, insulation maintenance primarily consists of keeping all insulating surfaces clean. This can be done by wiping off all insulating surfaces with a dry lint free cloth or dry paper towel. In case there is any tightly adhering dirt that will not come off by wiping, it can be removed with a mild solvent or distilled water. But be sure that the surfaces are dry before placing the breaker in service. If a solvent is required to cut dirt, use Isopropyl Alcohol or commercial equivalent. Secondary control wiring requires inspection for tightness of all connections and damage to insulation.

### 6.6 INSULATION INTEGRITY CHECK

PRIMARY CIRCUIT:

The integrity of primary insulation may be checked by the AC high potential test. The test voltage depends upon the maximum rated voltage of the breaker. For the breakers rated 4.76 kV, 8.25 kV and 15 kV the test voltages are 15 kV and 27 kV RMS, 60 Hz respectively. Conduct the test as follows:

Close the breaker. Connect the high potential lead of the test machine to one of the poles of the breaker. Connect the remaining poles and breaker frame to ground. Start the machine with output potential at zero and increase to the test voltage. Maintain the test voltage for one minute. Repeat for the remaining poles. Successful withstand indicates satisfactory insulation strength of the primary circuit.

Open the breaker. Connect the high potential lead of the test machine to one of the poles of the breaker. Connect the remaining poles and breaker frame to ground. Start the machine with output potential at zero and increase to the test voltage. Maintain the test voltage for one minute. Repeat for the remaining poles. Successful withstand indicates satisfactory insulation strength of the primary circuit.

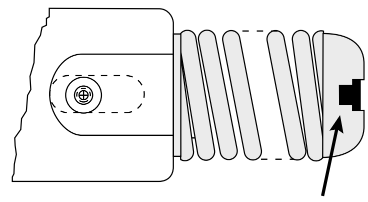
If a DC high potential machine is used, make certain that the peak voltage does not exceed the peak of the corresponding AC RMS test voltage.

SECONDARY CIRCUIT:

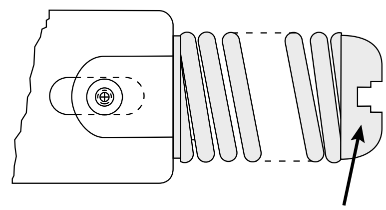
Isolate the motor by disconnecting the two motor leads from the terminal block. Connect all points of the secondary disconnect pins with a shooting wire. Connect this wire to the high potential lead of the test machine. Ground the breaker frame. Starting with zero, increase the voltage to 1125 RMS, 60 Hz. Maintain the voltage for one minute. Successful withstand indicates satisfactory insulation strength of the secondary control circuit. Remove the shooting wire and reconnect the motor leads.

**Figure 6.4. Wipe Indication Procedure (Performed Only With Breaker Closed)**

**White Contact Springs**

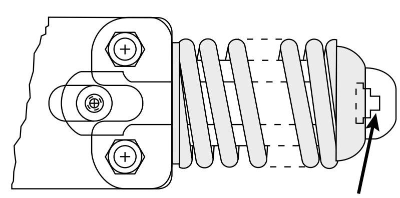


Any part of Red or Gray Indicator Visible
"Wipe" Satisfactory

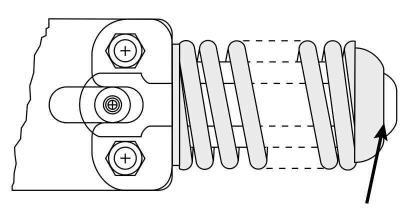


Red or Gray Indicator Not Visible
"Wipe" Unsatisfactory

**Blue or Red Contact Springs**



Any part of "T" Shape Indicator Visible
"Wipe" Satisfactory



"T" Shape Indicator Not Visible
"Wipe" Unsatisfactory

### 6.7 PRIMARY CIRCUIT RESISTANCE CHECK

The main contacts of the VR-Series circuit breaker are inside the vacuum chamber where they remain clean and require no maintenance at any time. Unlike most typical circuit breaker designs, the VR-Series design uses a highly reliable and unique flexible clamp design that eliminates the need for lubrication and inspection for wear.

The DC electrical resistance of the primary circuit may be calculated by measuring the voltage drop across the circuit. This test should be performed with a low voltage, direct current (DC) power supply capable of delivering no less 100A DC.

- To check the primary circuit resistance:
- Remove the circuit breaker from the switchgear
- Close the breaker
- Pass at least 100A DC from terminal to terminal of each pole unit in the closed position
- Measure the voltage drop across the terminals.

The resistance can be calculated from Ohm's Law and is expressed in micro-ohms. Repeat for the remaining two poles.

The resistance should not exceed the factory test levels more than 200%. Factory test levels are recorded on the circuit breaker test form, which is included with the breaker. If measurements exceeds 200%, contact the manufacturer.

<u>Resistance conversion for Temperature</u>

$R_{conversion} = R_{Factory}(1 + (T_{Field} - T_{Factory})\rho)$

$R_{conversion}$ = Resistance correction for temperature based from the factory resistance measurement.

$R_{Factory}$ = Resistance measurement from the factory.

$T_{Field}$ = Temperature measurement in the field.

$T_{Factory}$ = Temperature measurement from the factory.

$\rho$ = Copper resistivity temperature coefficient.

$\rho$ = 0.0039 Copper Resistivity Temperature Coefficient / Deg C

$\rho$ = 0.002167 Copper Resistivity Temperature Coefficient / Deg F

### 6.8 MECHANISM CHECK

Make a careful visual inspection of the mechanism for any loose parts such as bolts, nuts, pins, rings, etc. Check for excessive wear or damage to the breaker components. Operate the breaker several times manually and electrically. Check the closing and opening times to verify that they are in accordance with the limits in Table 4.1.

#### 6.8.1 CLOSURE™ TEST

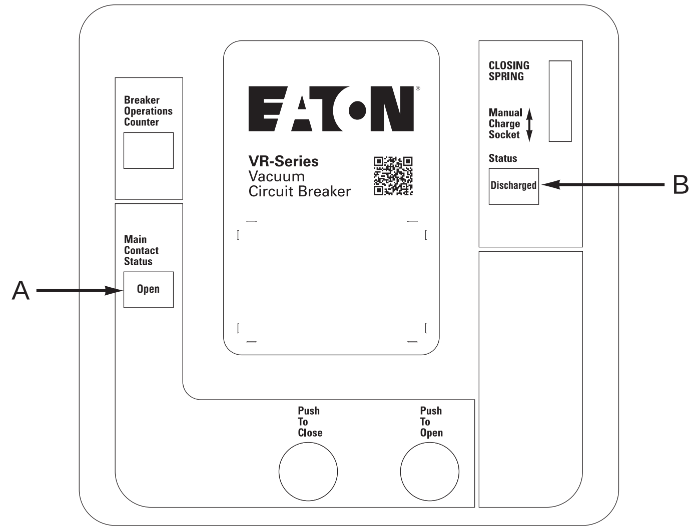
**Introduction:** The CloSure™ Test is a simple yet extremely effective means to determine and monitor the ability of the mechanism to close the breaker contacts fully. It provides a quantitative measure of the extra energy available in terms of over travel in inches to close the breaker contacts to their full extent. It may be used periodically to monitor the health of the mechanism.

**General Information:** The CloSure™ Test can be performed on all VR-Series circuit breakers. (Refer to Table 6.1.) If the CloSure™ travel obtained is as specified, the mechanism performance is satisfactory. If the CloSure™ travel does not conform as shown in Figure 6.15, contact Eaton's Electrical Services & Systems for further information. (See Step 13).

**⚠ WARNING**

**DO NOT ATTEMPT TO INSTALL OR PERFORM MAINTENANCE OR TESTS ON THE EQUIPMENT WHILE IT IS ENERGIZED. NEVER PUT YOUR HANDS NEAR THE MECHANISM WHEN THE CIRCUIT BREAKER IS IN THE CHARGED OR CLOSED POSITION. DEATH OR SEVERE PERSONAL INJURY CAN RESULT FROM CONTACT WITH ENERGIZED EQUIPMENT. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT BEFORE PROCEEDING WITH THE TASK, AND ALWAYS FOLLOW GENERALLY ACCEPTED SAFETY PROCEDURES.**

**Figure 6.5. Status Indicators ("A" shows the contact status indication and "B" shows the spring indication.)**




**Safety Precautions:** Read and understand these instructions before attempting any maintenance, repair or testing on the breaker. The user is cautioned to observe all recommendations, warnings and cautions relating to the safety of personnel and equipment.

The recommendations and information contained herein are based on Eaton Electrical experience and judgment, but should not be considered to be all-inclusive or covering every application or circumstance which may arise. If further information is required, you should consult Eaton's Electrical Services & Systems.

**Testing Procedures:** Assuming that the circuit breaker is safely removed from the switchgear enclosure and positioned in an area outside the arc fault boundary, follow this procedure to perform the CloSure™ test. For further instructions on removal of the circuit breaker from the switchgear, refer to the appropriate section of this manual.

**Step 1 -** On the front cover, identify the status indicators. Make sure the closing spring status indicates "DISCHARGED" and the main contact indicator shows "OPEN" (Figure 6.5).

**Step 2 -** Remove the circuit breaker front cover. Be sure to save the original fasteners for reassembly.

**Step 3 -** Charge the circuit breaker, close the circuit breaker, then open the circuit breaker. Alternately depress the Open and Close clappers a few times to ensure the circuit breaker is completely discharged.

**Step 4 -** Cut a piece of one inch wide drafting / masking tape approximately 8 to 10 inches long.

**Figure 6.6. Wrapping Tape Around Cam**

**Step 5 -** Clean the far left cam with a mild solvent such as alcohol. Place the tape around the cam starting from the bottom up. Make certain that the tape adheres well to the cam surface. (Figure 6.6).

**Step 6 -** Mount the transparent CloSure™ Test Tool (Figure 6.7b) with two bolts and washers. Refer to Figure 6.7a and Table 6.1 for approximate mounting holes. Hand tighten the bolts.

**Step 7 -** Using a red Sanford® Sharpie® fine point permanent marker (or equivalent), place the marker tip in the proper hole ("C") located over the cam and make a heavy mark on the tape by moving the marker as described in Figures 6.9, 6.11, and 6.12. Remove the marker from the hole.

**Step 8 -** Charge the closing springs with the maintenance tool (Charging handle). Continue charging the closing springs until a "click" is heard and the status indicator shows "CHARGED" (Figure 6.8).

**Step 9 -** Place the marker back in the hole. While holding the marker tip against the tape, close the breaker (Figure 6.10). Remove the marker from the hole.

**Step 10 -** While closely observing the pole shaft at the right side of the circuit breaker (Figure 6.11), recharge the closing springs with the maintenance tool. As the circuit breaker is recharged, there should be no movement of the pole shaft. If there is movement of the pole shaft while recharging, this indicates a problem with the circuit breker - stop the test and consult the factory.

**Step 11 -** Open the circuit breaker, then close it, then reopen it. Verify that the mark made in Step 7 is aligned with the pen opening. If it is not aligned, this indicates a problem with the circuit breaker - stop the test and consult the factory.

**Step 12 -** Inspect the circuit breaker to assure it is in the open position and the closing springs are discharged. Alternately depress the Open and Close clappers a few times to ensure the circuit breaker is completely discharged. Remove the transparent CloSure™ Tool.

**Step 13 -** Remove the tape from the cam and place it on a sheet of paper that can be kept as a record of the test. Record the date of the test, person conducting the test, circuit breaker serial number, and the operations counter on the tape or paper (Figures 6.14 and 6.15).

**Step 14 -** Evaluate the CloSure™ performance by comparing the test tape with the illustration in Figure 6.16. Measure the over travel "X". If "X" is not greater than or equal to 0.6", this indicates a problem with the circuit breaker - consult the factory.

**Step 15 -** Reassemble the front cover onto the circuit breaker. Return the circuit breaker to its original configuration and setup.

**Figure 6.7. Attaching CloSure™ Test Tool at Hole "A" & "B"**

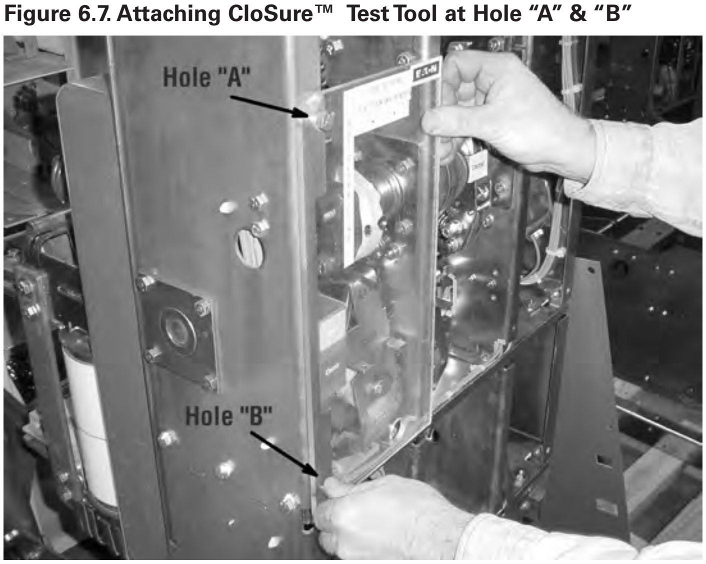



**Figure 6.7b. Front View of CloSure™ Tool Showing Mounting / Testing Hole Locations (6352C49H01)**

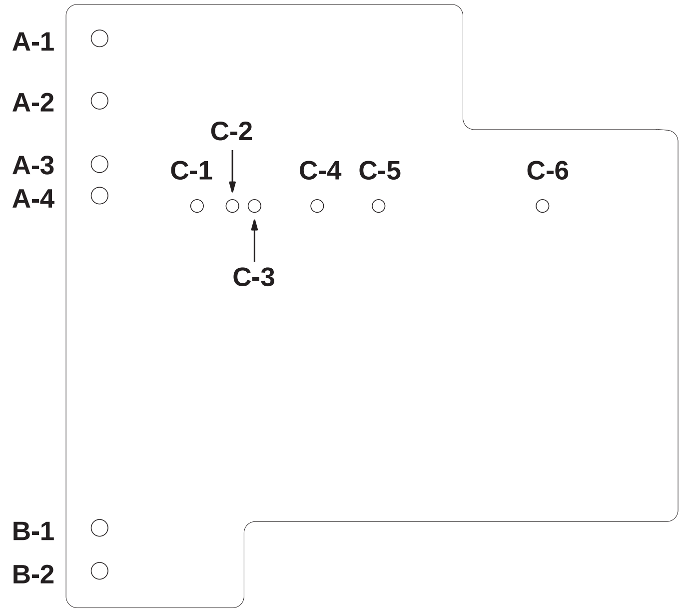



**Table 6.1. CloSure™ Tool Mounting/Testing Locations by Circuit Breaker Type**

| BREAKER LINE | APPROXIMATE MECHANISM CABINET WIDTH (INCH) | UPPER MOUNTING HOLE | LOWER MOUNTING HOLE | MARKER PLACEMENT HOLE |
|---|---|---|---|---|
| 18WR | 18 | A1 | B2 | C1 |
| 20WR | 20 | A1 | B2 | C2 |
| 29WR | 27 | A1 | B2 | C5 |

**Figure 6.7c. Typical Circuit Breaker Front View with CloSure™ Tool Attached (Approximate Mechanism Chassis Width)**

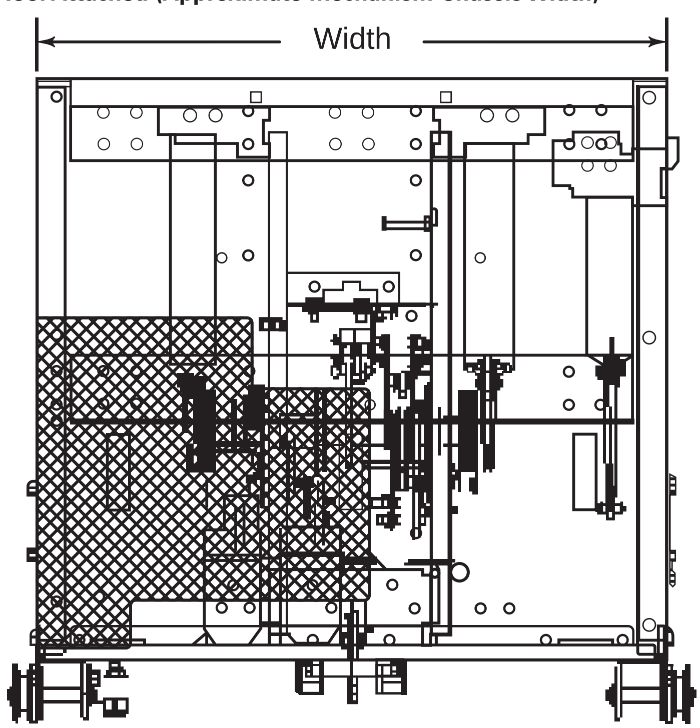


**Figure 6.8. Manually Charging Closing Springs**

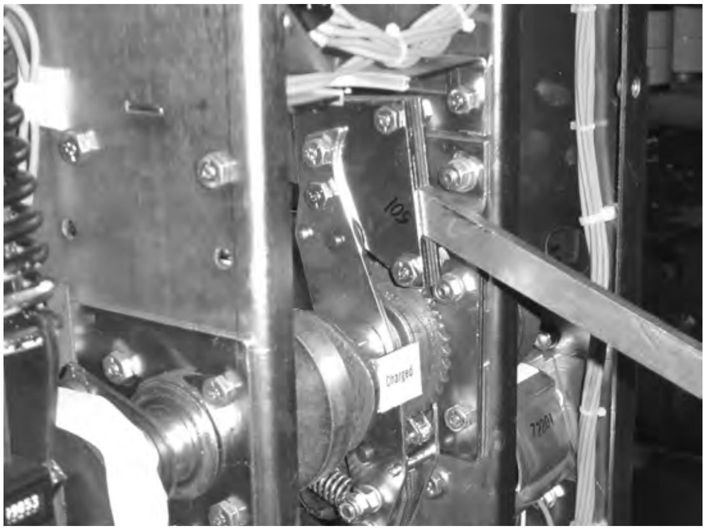


**Figure 6.9. Make a Clear and Heavy Mark**

**Figure 6.10. With Marker in Hole "C", While Closing Breaker**

**Figure 6.11. Pole Shaft Located On Right Side Of Circuit Breaker**

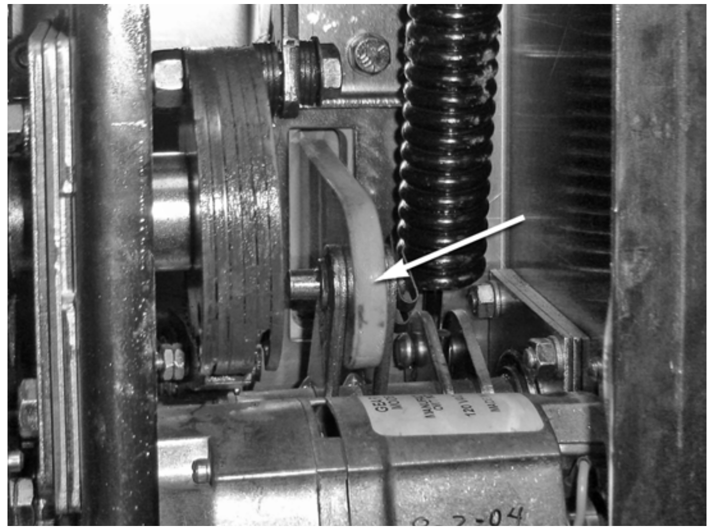


**Figure 6.12. Move the Sharpie® 15° Left and Right**

**Figure 6.13. Top view of Cam and Marker Interface**

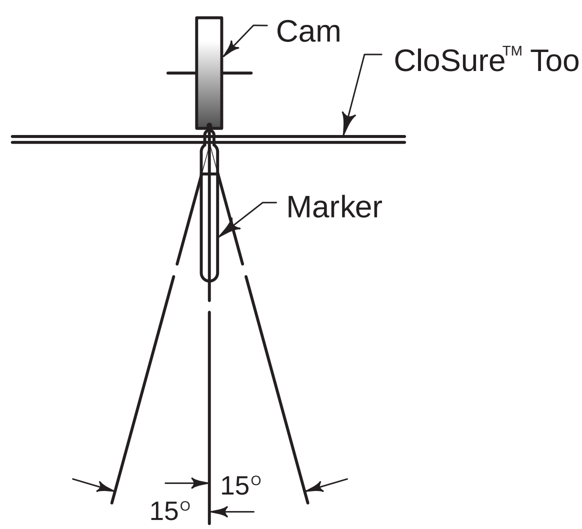


**Figure 6.14. Evaluate the CloSure™ Performance**

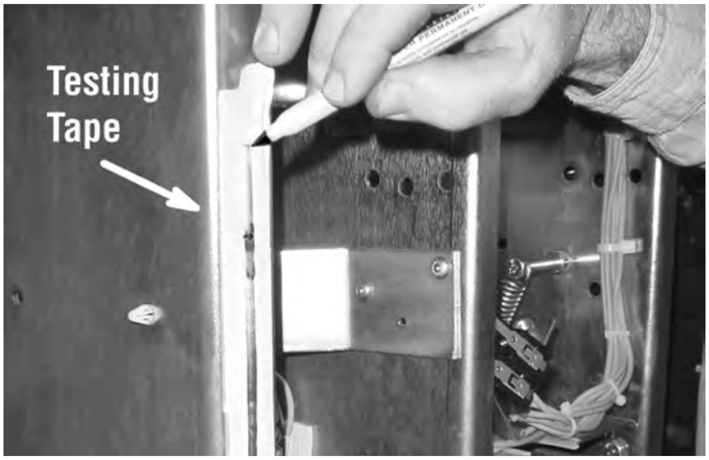
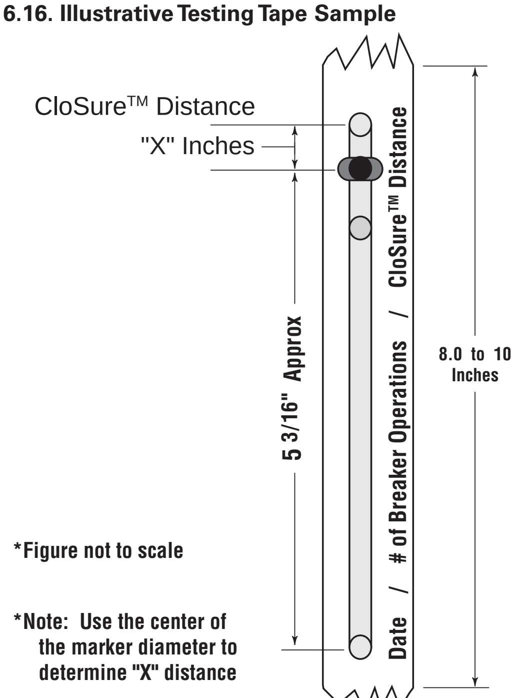



**Figure 6.15. Determining the Distance Traveled**

**Figure 6.16. Illustrative Testing Tape Sample**




## 6.9 LUBRICATION

All parts that require lubrication have been lubricated during the assembly with molybdenum disulphide grease. Eaton No. 53701QB. Over a period of time, this lubricant may be pushed out of the way or degrade. Proper lubrication at regular intervals is essential for maintaining the reliable performance of the mechanism. **The breaker should be relubricated once a year or per the operations table (Table 6.2), which ever comes first.** The locations shown in Figure 6.17 should be lubricated with a drop of light machine oil.

After lubrication, operate the breaker several times manually and electrically.

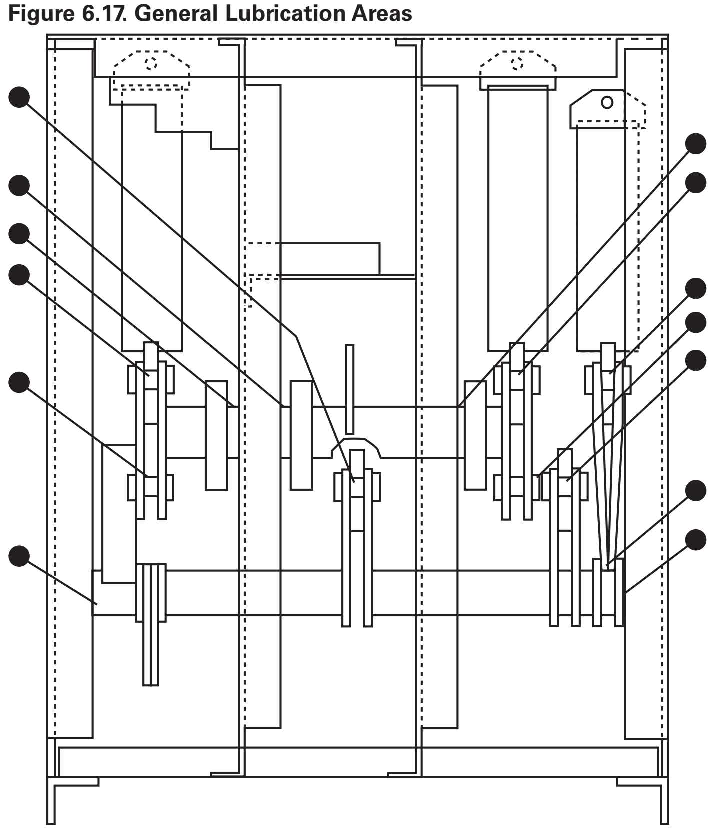
Roller bearings are used on the pole shaft, the cam shaft, the main link and the motor eccentric. These bearings are packed at the factory with a top grade slow oxidizing grease which normally should be effective for many years. They should not be disturbed unless there is definite evidence of sluggishness, dirt or parts are dismantled for some reason.

If it becomes necessary to disassemble the mechanism, the bearings and related parts should be thoroughly cleaned, remove old grease in a good grease solvent. Do not use carbon tetrachloride. They should then be washed in light machine oil until the cleaner is removed. After the oil has been drawn off, the bearings should be packed with Eaton Grease 53701 QB or equivalent.

**Table 6.2. Lubrication Per Number of Operations**

| RATINGS | OPERATIONS |
|---|---|
| 29kA and below | 750 |
| Above 29kA | 400 |
| 3000 Amp | 400 |

**Figure 6.17. General Lubrication Areas**



● **Apply one drop of non-synthetic light machine oil at locations shown.**

**Table 6.3. Troubleshooting Chart**

| SYMPTOM | INSPECTION AREA | PROBABLE DEFECTS |
|---|---|---|
| **FAILS TO CLOSE** | | |
| Closing Springs Not Charged | Control Circuit | • Control Power (Fuse Blown Or Switch Off)<br>• Secondary Disconnects<br>• Motor Cut-off Switch (Poor Or Burned Contacts. Lever Not Operational.)<br>• Terminals And Connectors (Poor Or Burned Contacts)<br>• Motor (Brushes Worn Or Commutator Segment Open) |
| | Mechanism | • Pawls (Slipping Or Broken)<br>• Ratchet Wheel (Teeth Worn Or Broken)<br>• Cam Shaft Assembly (Sluggish Or Jammed)<br>• Oscillator (Reset Spring Off Or Broken) |
| Closing Springs Not Charged<br>Breaker Does Not Close | Control Circuit<br>(Close Coil Does Not Pick Up) | • Control Power (Fuse blown or switch off)<br>• Secondary Disconnects<br>• Anti Pump Relay (Y Relay N.C. Contact Open Or Burned Or Relay Picks Up)<br>• Close Coil (Open Or Burned)<br>• Latch Check Switch (Contact Open - Bad Switch Or Trip Bar Not Reset)<br>• Auxiliary Switch (B Contact Open Or Burned)<br>• Motor Cut-Off (Contacts Open Or Burned)<br>• Trip Coil Assembly (Clapper Fails To Reset) |
| | Closing Sound But No Close | • Pole Shaft (Not Open Fully)<br>• Trip Latch Reset Spring (Damaged Or Missing)<br>• Trip Bar-D Shaft (Fail To Remain Reset)<br>• Trip Latch-Hatchet (Fails To Remain Reset)<br>• Trip Floor Tripper (Fails To Remain Reset)<br>• Close Latch (Binding)<br>• Close Latch Roller (Binding)<br>• Trip Circuit Energized |
| **UNDESIRABLY CLOSES** | | |
| | Control Circuit | • Close Circuit (CS/C Getting shorted) |
| | Mechanism | • Close Release Latch (Fails To Reset)<br>• Close Floor Tripper (Fails To Reset) |
| **FAILS TO CLOSE** | | |
| No Trip Sound | Control Circuit | • Control Power (Fuse Blown Or Switch Off)<br>• Secondary Disconnects<br>• Auxiliary Switch (A Contact Not Making Poor Or Burned)<br>• Trip Coil (Burned Or Open)<br>• Terminals And Connections (Poor Or Burned Or Open)<br>• Trip Clapper (Jammed) |
| | Trip Mechanism | |
| Trip Sound But No Trip | Trip Mechanism | • Trip Bar, Trip Latch (Jammed)<br>• Pole Shaft (Jammed)<br>• Operating Rod Assembly (Broken Or Pins Out) |
| | Vacuum Interrupter (One Or More Welded) | |
| **UNDESIRABLY TRIPS** | | |
| | Control Circuit | • Control Power (CS/T Switch, remains made) |
| | Mechanism | • Trip Coil Clapper (Not Resetting)<br>• Trip Bar or Trip Latch (Poor Engagement Of Mating Or Worm Surfaces)<br>• Trip Bar Reset Sprint (Loss Of Torque) |

# SECTION 7: REPLACEMENT PARTS

## 7.1 GENERAL

In order to minimize production downtime, it is recommended that an adequate quantity of spare parts be carried in stock. The quantity will vary from customer to customer, depending upon the service severity and continuity requirements. Each customer should develop his own level based on operating experience. However, when establishing a new operating record, it is a good practice to stock one set of control components for every six circuit breakers of the same control voltage. This quantity should be adjusted with time and frequency of operation of the circuit breakers.

## 7.2 ORDERING INSTRUCTIONS

a. The style numbers in Table 7.1 should be sufficient to purchase control components for most applications. Some breakers have special control schemes. Supply complete nameplate information for verification or if additional components are needed.

b. Specify the method of shipping desired.

c. Send all orders or correspondence to the nearest Eaton sales office or contact the PBC direct at 1-877-276-9379.

d. Include negotiation number with order when applicable.

**Table 7.1 Common Replacement Parts - Descriptions and Style Numbers**

| | | | |
|---|---|---|---|
| **1.** | ANTI-PUMP (Y) RELAY | (48vDC) | 94C9525H01 |
| | | (125vDC) | 94C9525H02 |
| | | (250vDC) | 94C9525H03 |
| | | (120vAC) | 94C9525H04 |
| | | (240vAC) | 94C9525H05 |
| **2.** | RECTIFIER | Rectifier | 94C9525G09 |
| **3.** | SPRING CHARGING MOTOR | (48vDC) | 94C9525G10 |
| | | (125vDC) | 94C9525G11 |
| | | (250vDC / 240vAC) | 94C9525G12 |
| **4.** | BREAKER AUXILIARY SWITCH | Breaker Auxiliary Switch | 94C9525G13 |
| **5.** | BREAKER POSITION SWITCH | Breaker Position Switch PS1 | 94C9525H06 |
| **6.** | BREAKER POSITION SWITCH | Breaker Position Switch PS2 | 94C9525H07 |
| **7.** | LATCH CHECK SWITCH | Latch Check Switch (LC) | 94C9525H08 |
| **8.** | MOTOR CUTOFF SWITCHES | (LS) (20WR/29WR) | 94C9525G14 |
| | | (LS) (18WR) | 94C9525G15 |
| **9.** | SPRING RELEASE COILS / SHUNT TRIPS | 24vDC | 94C9525G16 |
| | | 48vDC | 94C9525G17 |
| | | 125vDC / 120vAC | 94C9525G18 |
| | | 250vDC / 240vAC | 94C9525G19 |
| **10.** | CONTROL COMPONENTS KIT | 48vDC | 94C9525G01 |
| | | 125vDC | 94C9525G02 |
| | | 250vDC | 94C9525G03 |
| | | 120vAC-C/M 48vDC-T | 94C9525G04 |
| | | 240vAC-C/M 48vDC-T | 94C9525G05 |
| | | 120vAC-C/M 120vAC-CT | 94C9525G06 |
| | | 240vAC-C/M 240vAC-CT | 94C9525G07 |







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