

A2M-4.16-VR Replacement Circuit Breaker



GE-A2M-4.16-VR 1200A Shown

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

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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.

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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 an 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 A2M VR-Series circuit breaker. The Vacuum Replacement Circuit breakers (also referred to as VR-Series) are designed to be used in existing General Electric type A2M 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.

1.1 VISUAL INSTRUCTION BOOKLET ESSENTIALS

Eaton provides additional documentation designed to enhance the technical information provided in this instruction booklet for the VR-Series circuit breakers. The Visual Instruction Booklet Essentials (VIBE) is a digital supplemental booklet featuring user interactive content and informative videos intended to assist with the maintenance of the VR-Series circuit breaker. The VIBE document is available for immediate download at www.eaton.com/VR-Series.

1.2 QUICK RESPONSE CODE

VR-Series circuit breakers have a quick response code (QR Code) on the escutcheon of the circuit breaker cover. This QR Code is a matrix barcode that provides direct access to download VR-Series specific documentation, such as product instruction booklets and the VIBE documentation. See Figure 1.1 for the featured VR-Series QR Code.

Note: A smart phone with an adequate QR Code Scanner application must be used. Downloading content may incur data charges from the mobile service provider.

Figure 1.1. Quick Response Code

VR-Series QR Code



⚠ WARNING

SATISFACTORY PERFORMANCE OF THESE CIRCUIT 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 TRAINED ENGINEER OR TECHNICIAN.

VR-SERIES CIRCUIT 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 REPRESENTATIVE SHOULD BE CONTACTED.

1.3 AVAILABLE A2M-VR CIRCUIT BREAKERS

Refer to Table 1.

Table 1. A2M-VR Availability and Interchangeability

Circuit breaker Type	Nominal Voltage Class	Existing Circuit breaker Rating	Existing Circuit breaker Rated Continuous Current at 60 Hz	VR-Series Circuit breaker Rating	Rated Voltage Factor	Rated Withstand ANSI Test Voltage		Rated Short-Circuit	Maximum Sym. Interrupting Capability	Closing and Latching / Momentary Capabilities
	kV	MVA	Amps	MVA	K	Low Freq. kV RMS	Impulse kV Peak	I kA RMS	KI kA RMS	kA RMS / Peak
A2M-VR	4.16	250	1200 / 2000	250	1.24	19	60	29	36	58 / 97

A2M-4.16-VR
Replacement Circuit Breaker

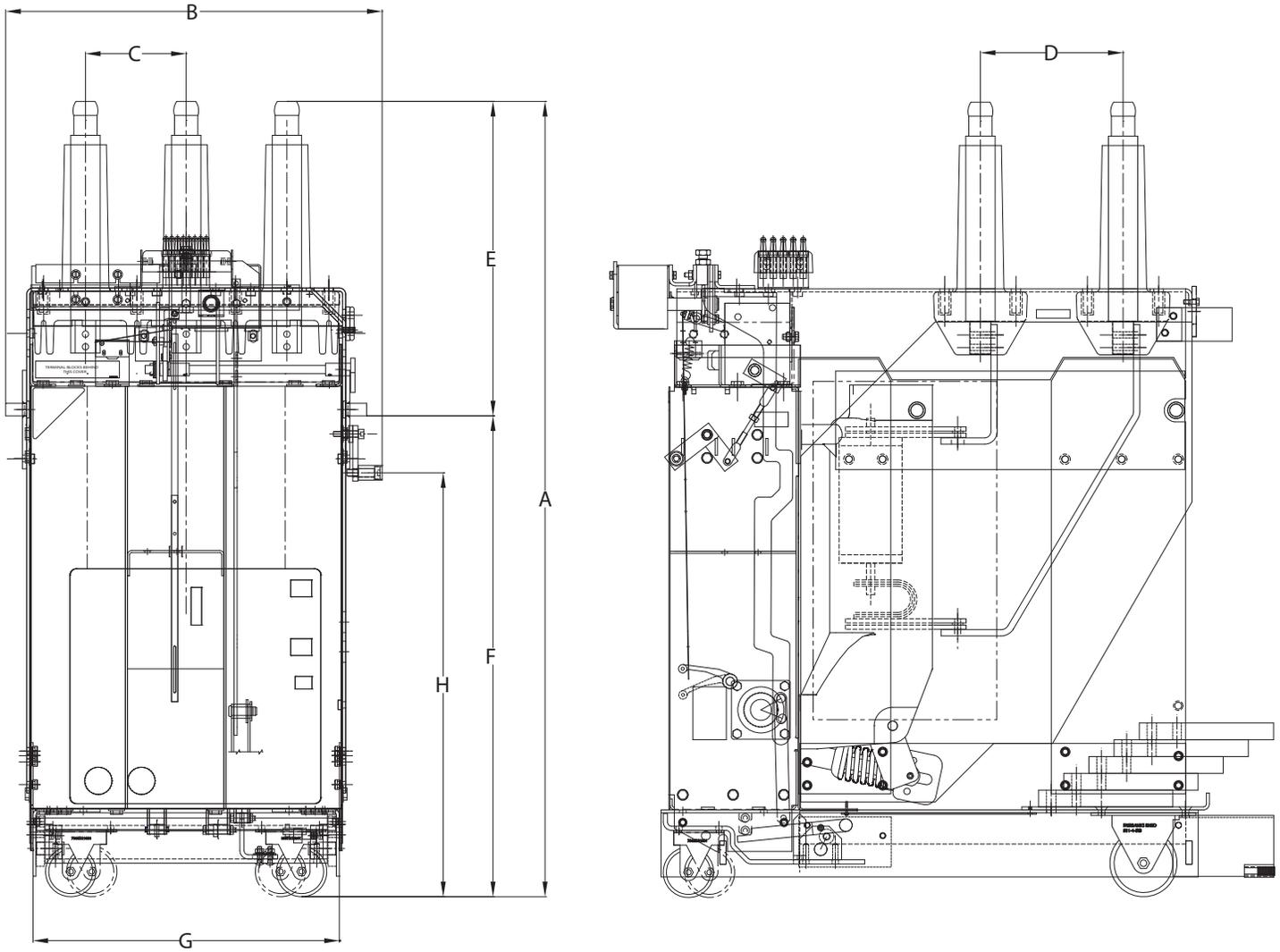


Table 2. A2M-VR Dimensions (A2M-4.16-250 Shown)

Circuit Breaker Type	Existing Circuit Breaker Rated Continuous Current at 60 Hz (Amps)	A	B	C	D	E	F	G	H
A2M-4.16-VR 250	1200 / 2000	47.38	22.43	6.00	8.50	18.75	28.63	18.25	25.23

SECTION 2: SAFE PRACTICES

VR-Series circuit 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 CIRCUIT 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 circuit breakers.
- Read these instructions carefully before attempting any installation, operation or maintenance of these circuit breakers.
- Always remove the circuit breaker from the enclosure before performing any maintenance. Failure to do so could result in electrical shock leading to death, severe personnel injury and/or property damage.
- Do not work on a circuit breaker with the secondary test coupler engaged. Failure to disconnect the test coupler could result in an electrical shock leading to death, personnel injury and/or property damage.
- Do not work on a closed circuit breaker or a circuit breaker with closing springs charged. The closing spring should be discharged and the main contacts open before working on the circuit 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. Lower the circuit 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 circuit breaker in an intermediate position in the cell. Always have the circuit breaker either in the Disconnect/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 circuit breaker after charging the closing springs.
- Circuit 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 A2M 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, cell code plate, (if applicable) etc. are shipped with the circuit breaker.

3.1 RECEIVING

Until the circuit breaker is ready to be delivered to the switchgear site for installation, DO NOT remove it from the shipping crate. If the circuit 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 circuit breaker for any signs of shipping damage such as broken, missing or loose hardware, damaged or deformed insulation and other components. If damaged or loss is detected, file claims immediately with the carrier and notify an Eaton representative.

Tools and Accessories

Maintenance Tool / Manual Charge Handle: This tool is used to manually charge the closing spring. One maintenance tool is provided with each vacuum unit replacement circuit breaker.

Secondary Connection Block Extension Cable: The extension cable can be used to connect the circuit breaker to a "test cabinet" or to the switchgear cell's secondary receptacle block so that the circuit breaker can be electrically operated while not installed in the switchgear cell. The original OEM extension cable will interface with the VR-Series replacement circuit breaker therefore an additional extension cable is not included as part of the vacuum replacement circuit breaker.

Figure 3.1. Typical Maintenance Tool / Manual Charge Handle



3.2 HANDLING

⚠ WARNING

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

VR-Series circuit breaker shipping containers are designed to be handled either by use of an 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 circuit 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 the circuit breaker is ready for installation, a lifting harness in conjunction with an overhead lift or portable floor lift can be used to move the circuit breaker. If the circuit breaker is to be lifted, position the lifting device over the circuit breaker and insert the lifting harness hooks into the circuit breaker side lifting points and secure (lifting straps should have at least a 500lbs lift capacity over the approximate circuit breaker weight). Be sure the hooks are firmly attached before lifting the circuit breaker. Stand a safe distance away from the circuit breaker while lifting and moving.

Figure 3.2. Lifting A2M-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 circuit breaker is free from shipping damage and is in satisfactory operating condition.

The circuit breaker is shipped with its contacts open and closing springs discharged. The indicators on the front panel should confirm this. Insert the end of the maintenance tool into the manual charge socket opening and charge the closing springs by moving the handle up and down the full range of motion. When charging is complete the ratchet will no longer advance and the spring charged / discharged indicator displays "charged". (Figure Set 3.3). Remove the maintenance tool. Push the "manual close" button. The circuit breaker will close as shown by the circuit breaker contacts "closed" indicator. Push the "manual trip" button. The circuit breaker will trip as shown by the circuit breaker contacts "open" indicator. After completing this initial check, leave the closing springs "discharged" and circuit 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.

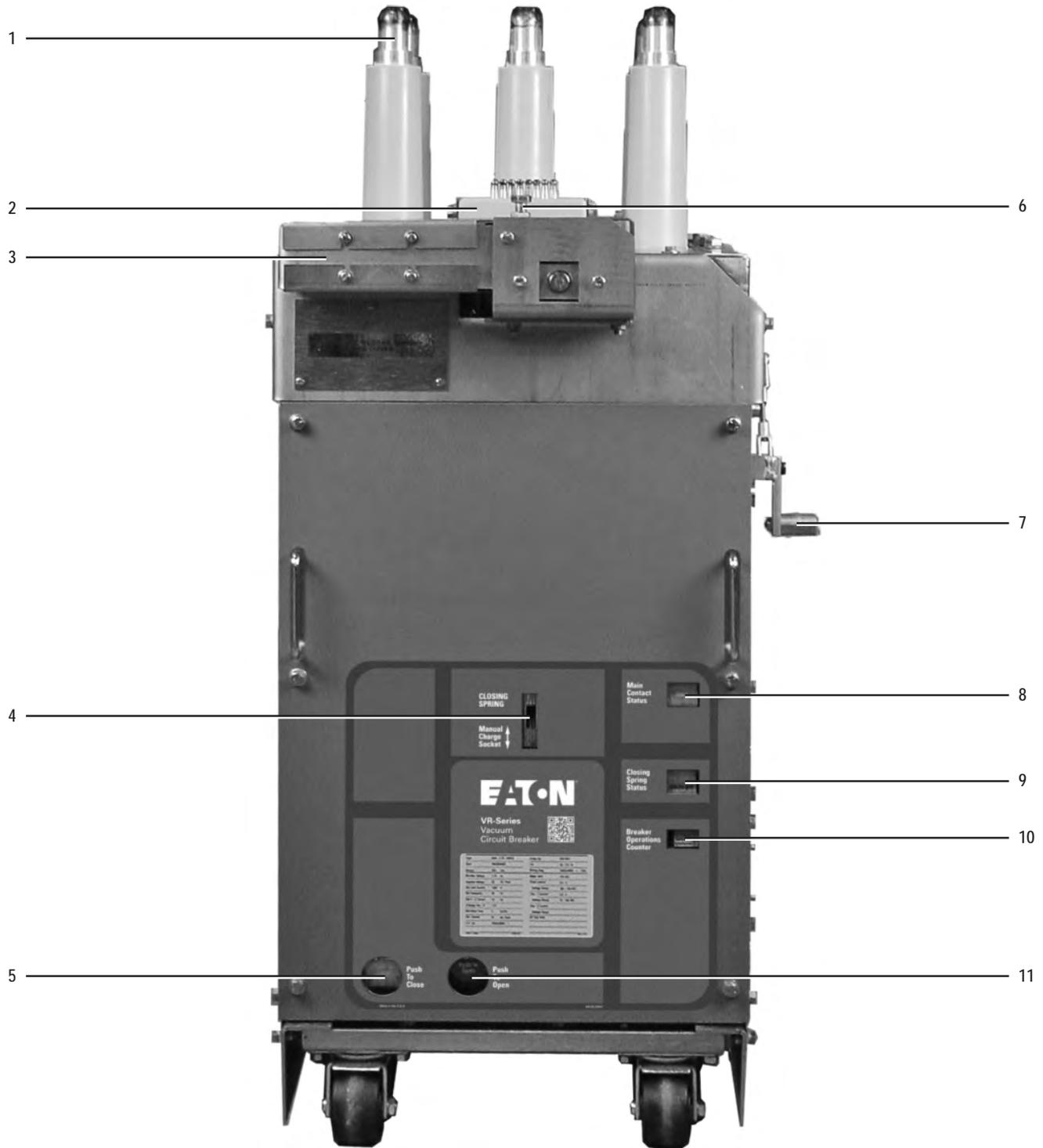
3.4 APPROXIMATE WEIGHT BY TYPE

Table 3. Approximate Weight by Type

Type	Amperes	LBs
A2M-4.16-VR 250	1200 / 2000	875

A2M-4.16-VR Replacement Circuit Breaker

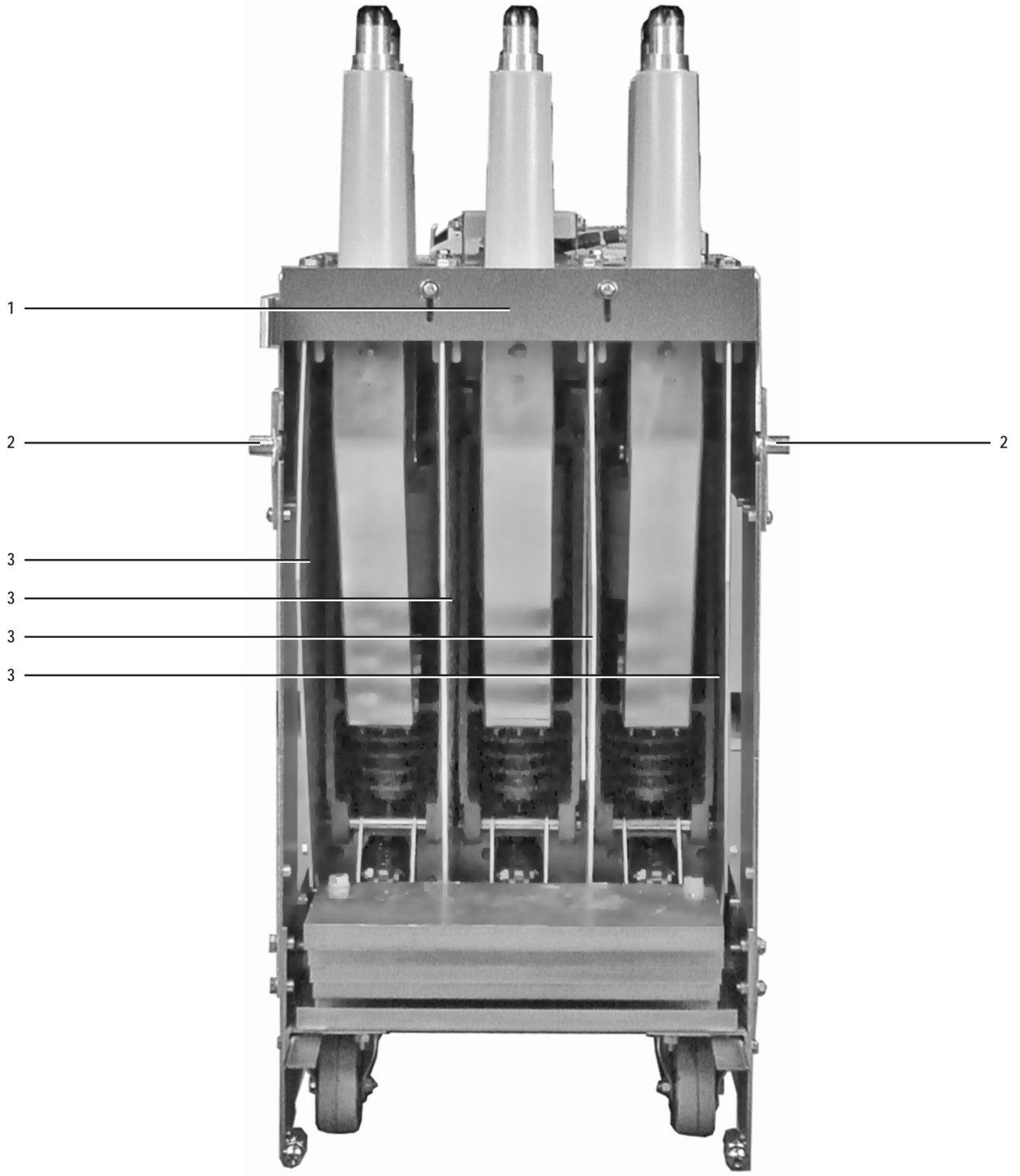
Figure 3.3.a. Front External View of A2M-4.16-VR



Front External View

1	Primary Disconnect	5	Push To Close Button	9	Spring Charged / Discharged Indicator
2	Secondary Disconnect	6	MOC Operator	10	Operations Counter
3	SURE CLOSE Mechanism	7	Active Interlock		Push To Open Button
4	Manual Charging Socket	8	Circuit breaker Contact Status Indicator		

Figure 3.3.b Rear External View of A2M-4.16-VR



Rear External View

1 Phase Barrier Retainer

2 Lift Rails

3 Phase Barriers

SECTION 4: DESCRIPTION AND OPERATION

VR-Series vacuum replacement circuit breakers are designed to be used with existing installations of equivalent air-magnetic metal-clad switchgear circuit breakers. 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.

VR-Series element designation is easily identified by the mechanism chassis width. See Table below.

VR-SERIES ELEMENT DESIGNATION	APPROXIMATE MECHANISM CHASSIS WIDTH (INCH)
18WR	18
20WR	20
29WR	27

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 circuit breaker's stored energy mechanism frame. Upper and lower flexible shunts provide electrical connections from each interrupter to the circuit 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 circuit 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 circuit breaker is withdrawn and is viewed from the rear of the circuit breaker. (See Figure 6.1 and Figure 6.2)

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 copper-chrome contact material. A contact erosion indicator mark is located on the moving stem of the interrupter (Figure 6.1 and 6.2).

In order to determine if the contacts have eroded to the extent that the interrupter must be replaced, close the circuit breaker and

Figure 4.1. 18WR Interrupter Assembly



Figure 4.2. 18WR Interrupter Assembly (All Three Pole Units)



observe the erosion mark placed on each moving stem from the rear of the circuit 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 5kV, 7.5kV or 15kV designs.

⚠ DANGER

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

4.1.3 CONTACT WIPE AND STROKE

Contact wipe is the indication of the force holding the vacuum interrupter contacts closed and 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 circuit 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 circuit 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 circuit breaker frame. 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 silver plated conductors. Solid stab type primary disconnecting contacts at the ends of the conductors provide means for connecting and disconnecting the circuit 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 circuit breaker frame and in the front of the circuit breaker. Manual closing and opening controls are at the front panel (Figure Set 3.3). They are accessible while the circuit breaker is in any of its basic installation positions. (See Section 5 in this manual)

The mechanism stores the closing energy by charging the closing springs. When released, the stored energy closes the circuit breaker, charges the wipe and resets the opening springs. The mechanism

may rest in any one of the four positions shown in Figure 4.9 as follows:

- Circuit breaker open, closing springs discharged.
- Circuit breaker open, closing springs charged.
- Circuit breaker closed, closing springs discharged.
- Circuit 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 springs are charged by the spring charging motor, and the circuit 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 circuit 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 CIRCUIT BREAKER'S INTERNAL PARTS WHILE THE CIRCUIT BREAKER CONTACTS ARE CLOSED OR THE CLOSING SPRINGS ARE CHARGED. THE CIRCUIT BREAKER CONTACTS MAY OPEN OR THE CLOSING SPRINGS DISCHARGE CAUSING CRUSHING INJURY. DISCHARGE THE SPRINGS AND OPEN THE CIRCUIT BREAKER BEFORE PERFORMING ANY MAINTENANCE, INSPECTION OR REPAIR ON THE CIRCUIT BREAKER.

THE DESIGN OF THIS CIRCUIT BREAKER ALLOWS MECHANICAL CLOSING AND TRIPPING OF THE CIRCUIT BREAKER WHILE IT IS IN THE "CONNECT" POSITION. HOWEVER, THE CIRCUIT BREAKER SHOULD BE CLOSED MECHANICALLY ONLY IF THERE IS POSITIVE VERIFICATION THAT LOAD SIDE CONDITIONS PERMIT. IT IS RECOMMENDED THAT CLOSING THE CIRCUIT 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 CIRCUIT BREAKER IS IN THE "DISCONNECT / TEST" POSITION.

4.4.1 CLOSING SPRING CHARGING

Figure 4.8 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 end of the maintenance tool into the manual charge socket opening and charge the closing springs by moving the handle up and down the full range of motion. When charging is complete the ratchet will no longer advance and the spring charged / discharged indicator displays "charged". (Figure Set 3.3). Any further motion of the maintenance tool will not result into advance of charging.

4.4.2 CLOSING OPERATION

Figure 4.9 shows the positions of the closing cam and tripping linkage for four different operational states. In Figure 4.9.a the circuit 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 4.9.b)

When the spring release clapper (Figure 4.8, Item 13) moves into the face of the spring release coil (electrically or manually), the upper portion of the clapper pushes the spring release latch (1) upward. When the spring release latch moves, the cam shaft assembly is free to rotate. The force of the closing cam (Figure 4.9.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 4.9.c. Interference of the trip “D” shaft with the trip latch prevents the linkage from collapsing, and holds the circuit breaker closed.

Figure 4.9.d shows the circuit 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 4.9.b, 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 4.9.b) after the circuit breaker is tripped open.

4.4.4 TRIP-FREE OPERATION

When the manual trip button is held depressed, any attempt to close the circuit 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 VR-Series circuit breaker, one for DC control and one for AC control voltages (Figure 4.5). Specific wiring schematics and diagrams are included with each circuit 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 circuit breaker may be closed by closing the control switch close (CS/C) contact. Automatically upon closing of the circuit breaker, the motor starts charging the closing springs. The circuit breaker may be tripped any time by closing the control switch (CS/T) contacts.

Note the position switch (PS1) contact in the spring release circuit in the scheme. This contact remains closed while the circuit breaker is being lifted between the disconnect / test and connected positions for vacuum replacement circuit breakers. Consequently, it prevents the circuit breaker from closing automatically, even though the control close contact may have been closed while the circuit breaker is lifted to the connected position.

When the CS/C contact is closed, the SR closes the circuit breaker. If the CS/C contact is maintained after the circuit 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 circuit breaker would subsequently open, it could not be reclosed before CS/C was released and reclosed. This is the anti-pump function.

4.5.1 TIMING

The opening and closing times for the circuit breakers vary depending upon the control voltage, power rating, environment and test equipment. Differences in timing are expected between initial factory measurements and field inspections. Circuit breaker timing can be measured by service personnel using available equipment before installation and in conjunction with regular maintenance periods to assist in tracking the general health of the circuit breaker. Typical ranges as observed using nominal control voltages are listed in the “Time Per Event” table.

Table 4. Time Per Event

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

4.6 SECONDARY CONNECTION BLOCK

The circuit breaker control circuit is connected to the switchgear control through secondary connection block, located at the top of the circuit breaker (Figure Set 3.3). The contacts engage automatically when the circuit breaker is racked into the “connect” position. The socket half of the connection is located in the cubicle and a jumper of multiconductor cable can complete the control connections (for testing) when the circuit breaker is withdrawn from the cell or in the disconnect / test position.

4.7 INTERLOCKS

⚠ 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.

There are several interlocks built into the VR-Series vacuum replacement circuit breakers. Each of these interlocks, though different in form, duplicate or exceed the function of the original circuit breaker’s interlocks. These interlocks exist to safeguard personnel and equipment. The basic premise behind the interlocking arrangement on the vacuum replacement circuit breaker is that the circuit 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 circuit breaker should pose no greater risk than necessary to the operator in or out of the cell.

4.7.1 ANTI-CLOSE INTERLOCK

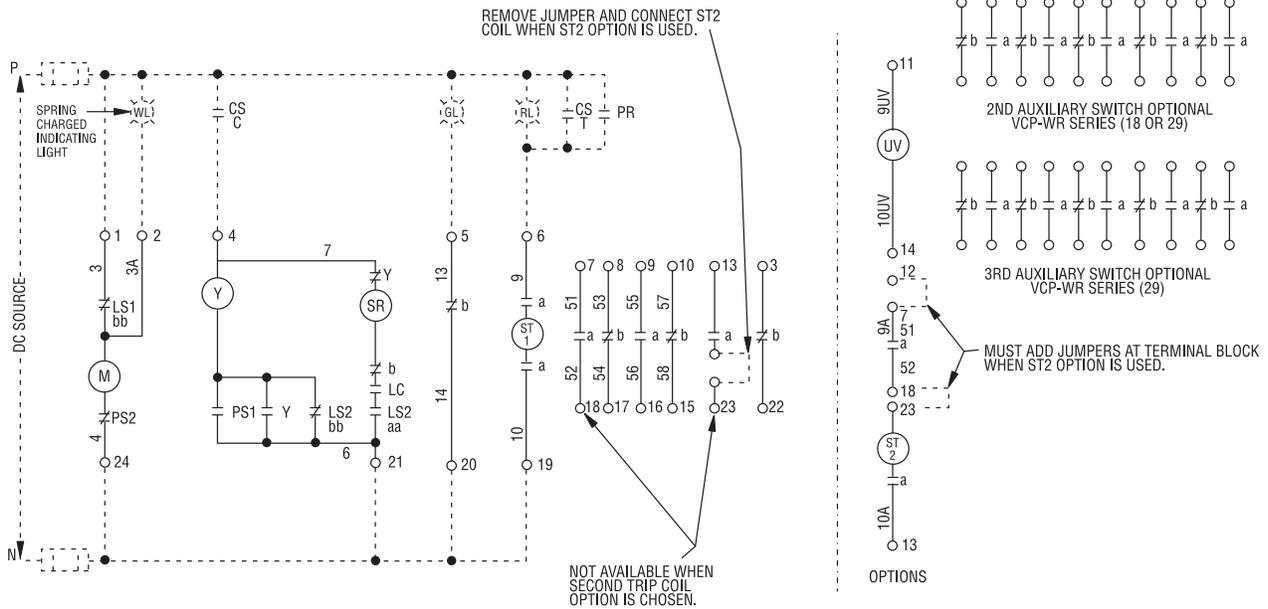
The anti-close interlock prevents discharging of the closing springs if the circuit breaker is already closed (Figure 4.8, Item 11). When the circuit breaker is closed, the interlock component moves away from the spring release clapper so that it cannot lift the spring release latch (9).

4.7.2 SHUTTER OPERATING MECHANISM

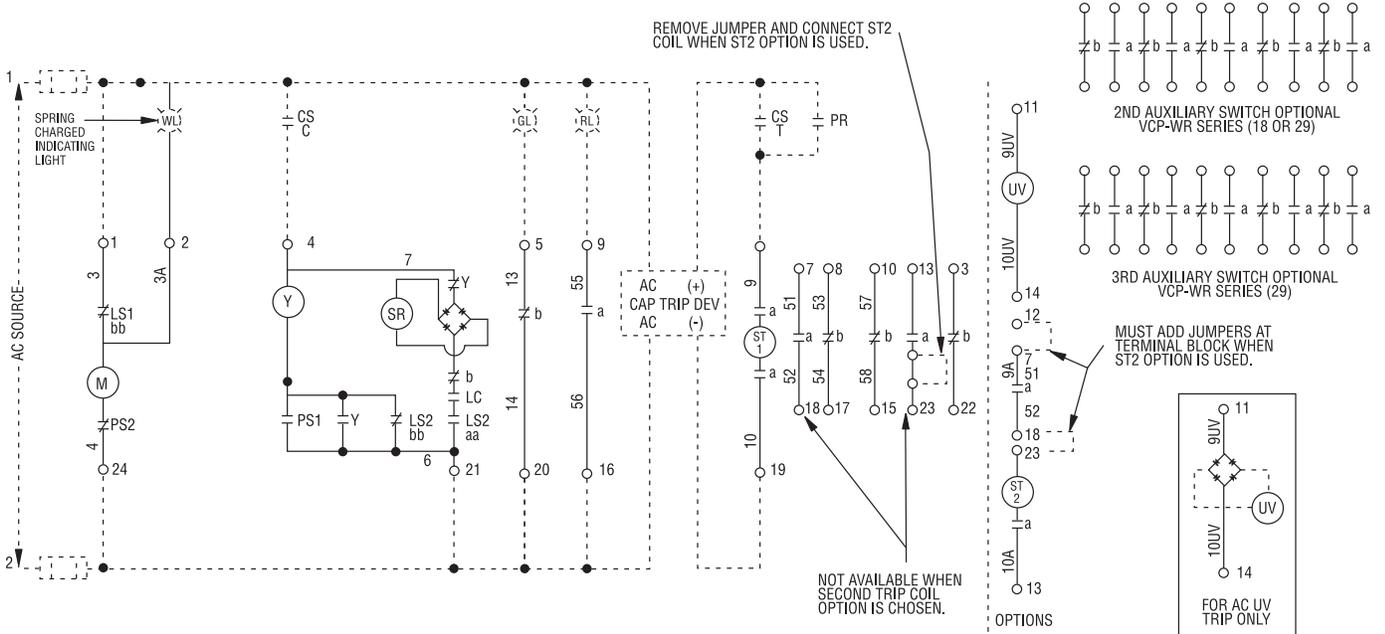
Each circuit breaker cell is equipped with a shutter to shield the high voltage stabs in the cubicle when the circuit breaker is not in the cubicle. The shutter is regulated by the shutter operating mechanism located on the right side of the circuit breaker. This mechanism opens the shutter as the circuit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

Figure 4.5. Typical AC/DC Schematic

VR-Series Circuit Breaker dc Control Schematic



VR-Series Circuit Breaker ac Control Schematic



- CS** - Circuit breaker Control Switch - close
- C**
- CS** - Circuit breaker Control Switch - trip
- T**
- 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' - Black Switch
 - 'C' and 'NO' - Black Switch
 - 'C' and 'NC' - Black Switch
 - 'C' and 'NO' - Brown Switch

A2M-4.16-VR Replacement Circuit Breaker

4.8 MOC (Mechanically Operated Contacts) OPERATOR

The MOC operator located on the circuit breaker frame is linked to the circuit breaker main pole shaft. When the circuit breaker closes, regardless of whether it is in the cubicle, the MOC linkage of the circuit breaker will cause the exterior MOC operator to rapidly rise. Care should be exercised to avoid contact with this mechanism. Inside the cubicle, there is a lever system connected to a MOC switch. If the circuit breaker is in the "connected" position the MOC operator will operate the MOC switch when the circuit breaker closes. The MOC switch contains contacts which are used to interlock the circuit breaker with other external devices and can provide circuit breaker status indication.

WARNING

EXTREME CARE SHOULD BE TAKEN TO AVOID PERSONNEL OR EQUIPMENT CONTACT WITH THE MOC SYSTEM WHEN OPERATING THE CIRCUIT BREAKER DUE TO THE ASSOCIATED MECHANICAL FORCE. CONTACT WITH THE MOC OPERATOR DURING OPERATION COULD RESULT IN INJURY.

4.9 TOC (Truck Operated Contacts) OPERATOR

The TOC switch, normally located on the right rear side of the cubicle, is operated by the circuit breaker truck frame. If the circuit breaker is fully racked into the cell, the truck frame operates the paddle of the TOC switch. The TOC switch contains contacts which are used to interlock the circuit breaker with other external devices and provide remote indication of circuit breaker position (Figure 5.3). Adjust TOC switch as necessary for proper operation prior to inserting any replacement circuit breaker.

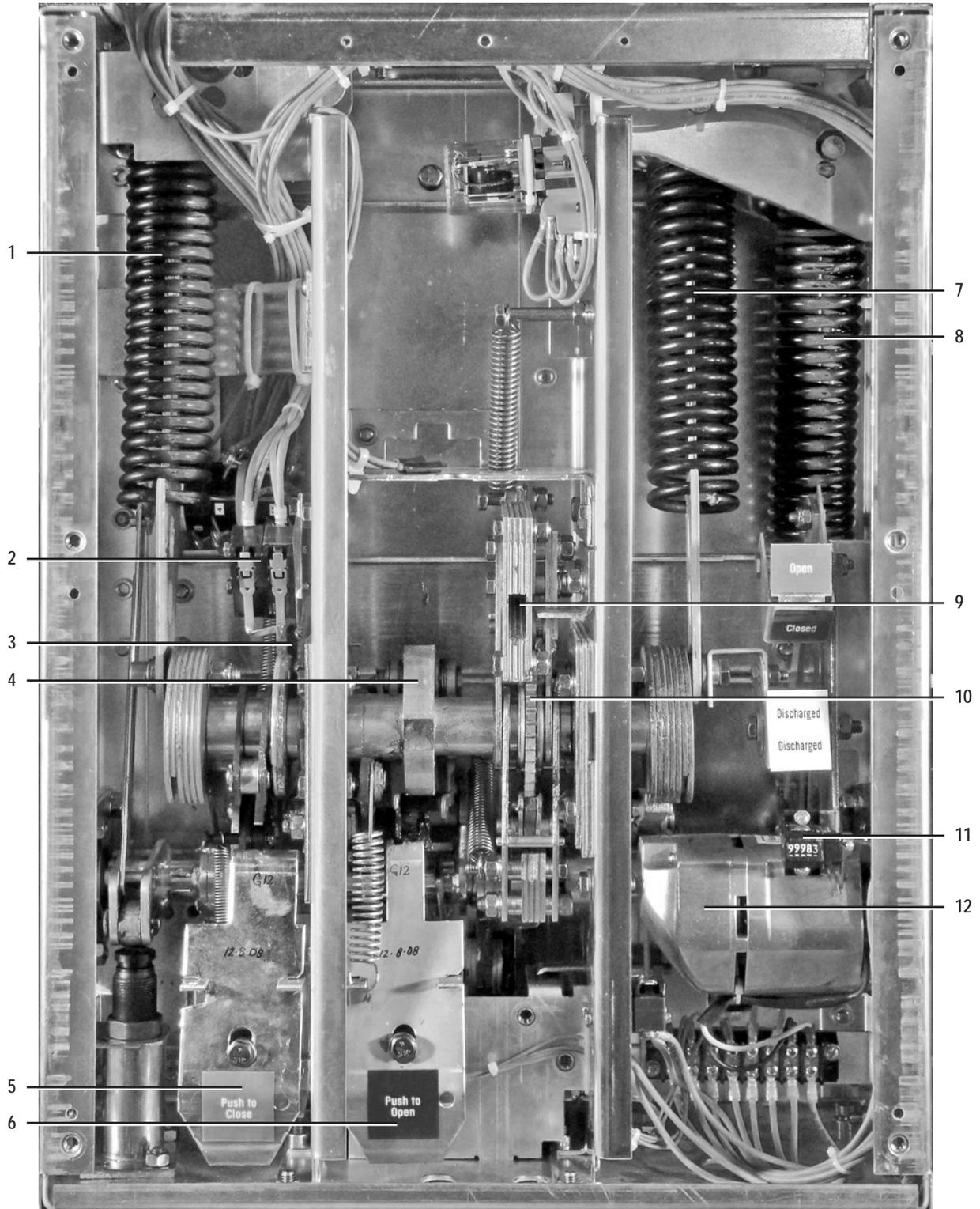
WARNING

DO NOT FORCE THE CIRCUIT BREAKER INTO THE CELL. DOING SO MAY DAMAGE PARTS THEREBY RISKING DEATH, PERSONAL INJURY, AND/OR PROPERTY DAMAGE.

4.10 GROUNDING CONTACT

The grounding contact is a copper blade which grounds the circuit breaker frame (static ground) by engaging the switchgear cell grounding sleeve when the circuit breaker is racked into the cell.

Figure 4.6. 18WR Vacuum Element - Front Faceplate Removed

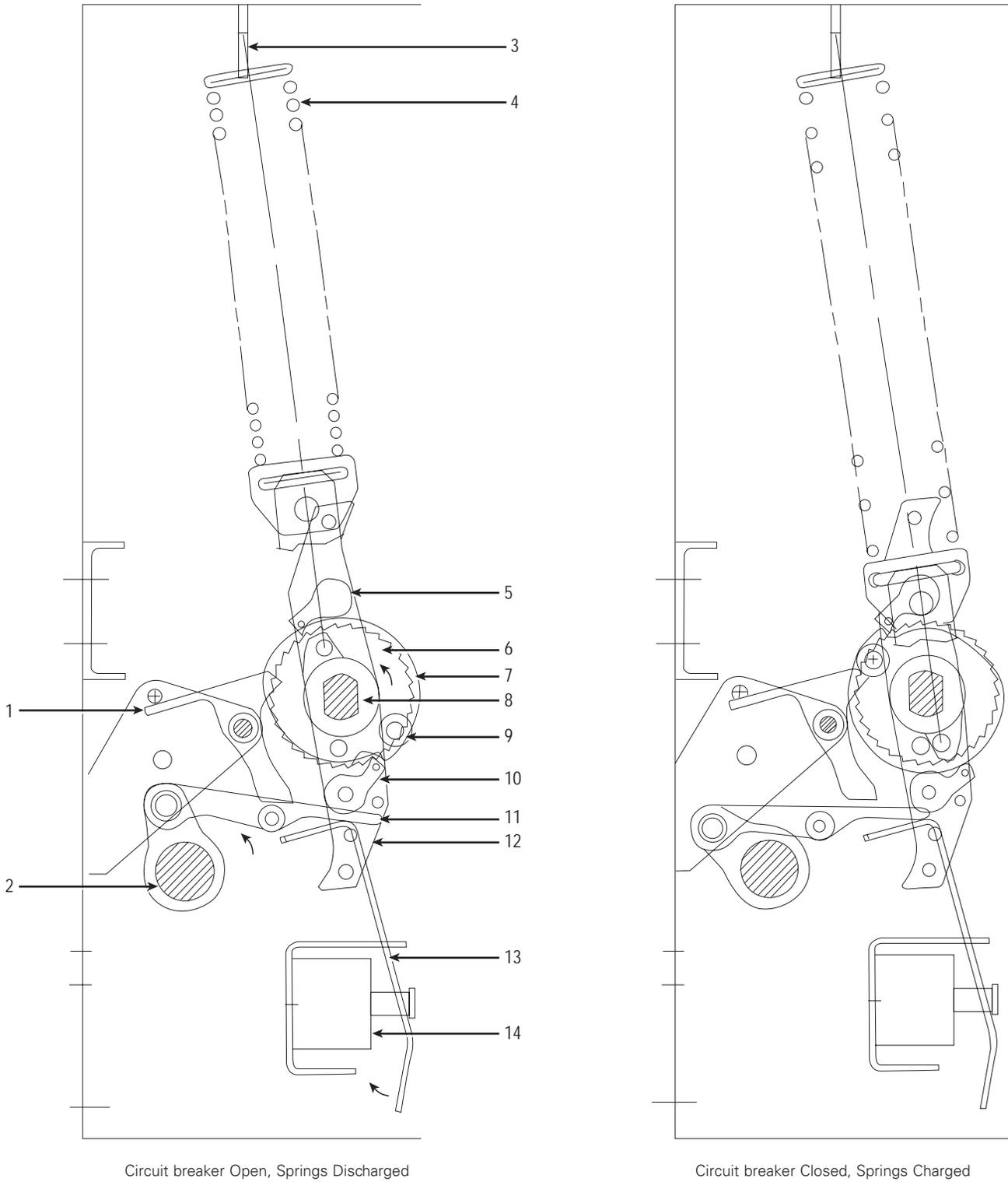


18WR Vacuum Element

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

A2M-4.16-VR
Replacement Circuit Breaker

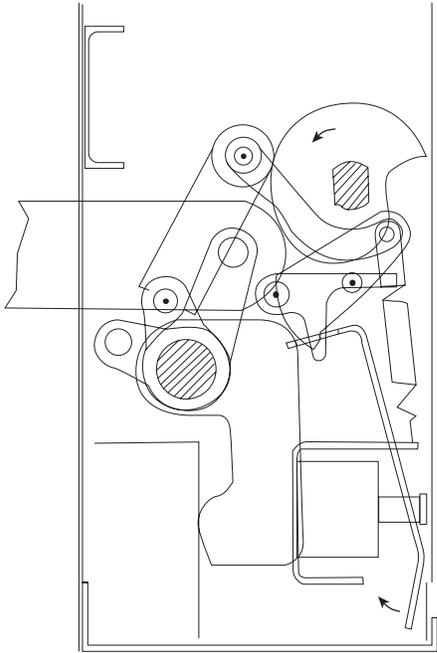
Figure 4.8. Closing Cam and Trip Linkage



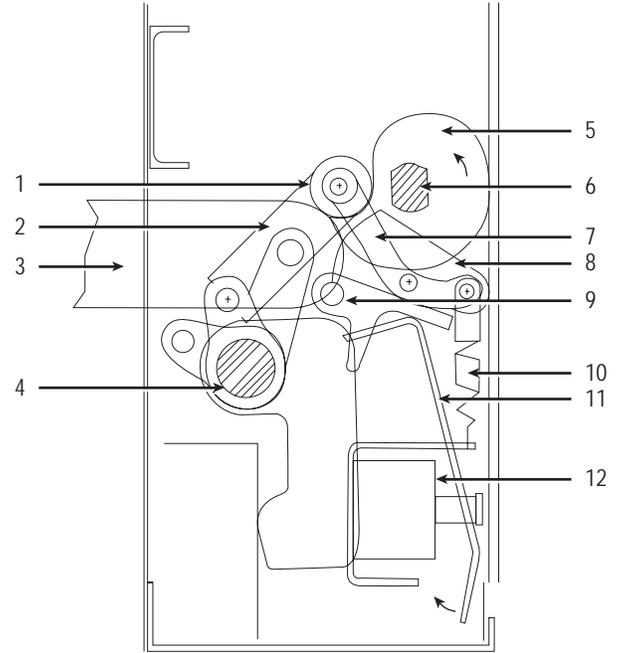
Closing Cam and Trip Linkage

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 (Electrical Charging) / Drive Pawl (Manual Charging)	10	Drive Pawl (Electrical Charging) / Holding Pawl (Manual Charging)		

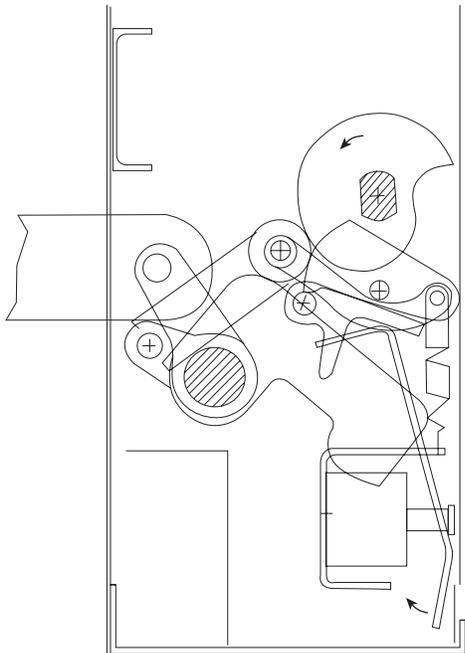
Figure 4.9. Charging Schematic



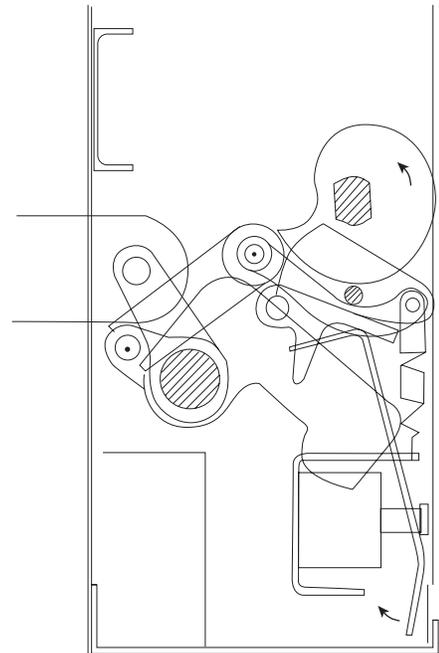
4.9.a. Circuit breaker Open and Closing Spring Discharged



4.9.b. Circuit breaker Open and Closing Spring Charged



4.9.c. Circuit breaker Closed and Closing Spring Discharged



4.9.d. Circuit 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, CAREFULLY FOLLOW THE INSTALLATION PROCEDURE BELOW AND THE SAFE PRACTICES SET FORTH IN SECTION 2. NOT FOLLOWING THE PROCEDURE MAY RESULT IN INCORRECT CIRCUIT BREAKER OPERATION LEADING TO DEATH, BODILY INJURY, AND PROPERTY DAMAGE.

When the circuit breaker is first commissioned into service and each time the circuit 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 circuit breaker for loose or obviously damaged parts. Never attempt to install or operate a damaged circuit 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.

⚠ WARNING

ARC FLASH INCIDENCES WITH MV SWITCHGEAR CAN OCCUR DURING THE PROCESS OF INSERTING AND REMOVING POWER CIRCUIT BREAKERS IN SWITCHGEAR CUBICLES. IT IS STRONGLY RECOMMENDED THAT PROPER PPE (PERSONAL PROTECTIVE EQUIPMENT) BE WORN BY PERSONNEL WHO RACK CIRCUIT BREAKERS. EATON CORPORATION PROVIDES A UNIVERSAL REMOTE POWER RACKING SYSTEM (RPR-2) WHICH IS COMPATIBLE WITH THE INTERNAL ROTARY RACKING CIRCUIT BREAKERS. THIS SYSTEM ALLOWS PERSONNEL TO WEAR A LOWER LEVEL OF PPE SINCE INSERTION OR REMOVAL CAN BE DONE FROM OUTSIDE THE FLASH PROTECTION BOUNDARY.

5.2 OPERATIONAL POSITIONS

The VR-Series circuit breaker has three definable positions.

- 1. Withdrawn Position.** In this position, the circuit breaker may be tested manually or electrically. Electrical testing is done by using the secondary block extension cable. If possible, tests should be conducted in this position.
- 2. Disconnect/Test Position.** In this position, the circuit breaker is in the cell resting on the cell floor. The circuit breaker may be tested electrically or manually. Electrical testing in this position may be performed by using the secondary block extension cable.
- 3. Connect position.** Once the circuit breaker has been raised from the disconnect/test position, the circuit breaker remains trip free until it reaches the connect position and the elevating mechanism is engaged. This corresponds to the position when the circuit breaker cannot be raised any further into the cell and lift power is removed via the cell limit switches.

⚠ WARNING

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

5.3 MANUAL OPERATIONAL CHECK

Perform manual operational checks. To perform these checks, the circuit breaker must be out of the cell, but if necessary, the circuit breaker can be set in either the "test" or "withdrawn" position with the interlock handle in the "LOCK" position. Place the maintenance tool into the manual charge socket opening and charge the closing

springs. Approximately 36 up and down strokes of the handle are required to cause the "Charging Spring Status" indicator to show "Charged". When charging is complete, the closing crank goes over center with an audible "click" and the springs Charged/Discharged Indicator shows "Charged".

Note: If the springs are to be charged on a closed circuit breaker, no click is heard at the end of charging operation. Discontinue charging and remove the maintenance tool as soon as "Charged" flag is fully visible. Continued attempts to further charge may result in the damage to the mechanism.

Remove the maintenance tool.

⚠ WARNING

ALWAYS REMOVE THE MAINTENANCE HANDLE AFTER CHARGING THE SPRING. FAILURE TO REMOVE THE MAINTENANCE HANDLE FROM THE CIRCUIT BREAKER COULD CAUSE DAMAGE TO THE CIRCUIT BREAKER MECHANISM, AND CAN BE HAZARDOUS TO PERSONNEL IF THE CIRCUIT BREAKER WERE TO CLOSE.

Close and trip the circuit breaker by pushing the close lever then the trip lever (See Figure 3-3). Repeat the charge, close, 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 5.4 THROUGH 5.9 ARE SUCCESSFULLY PERFORMED.

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

5.4 VACUUM INTEGRITY TEST

Using a dry lint-free cloth or a paper towel, clean all the insulating surfaces of the pole units. Check the vacuum integrity of the interrupters of three pole units by conducting the applied potential test described in Section 6 of this book.

5.5 APPLIED POTENTIAL TEST (INSULATION CHECK)

Check circuit breaker primary and secondary insulation integrity as described in Section 6.

5.6 CONTACT EROSION AND STROKE, CONTACT WIPE

Manually charge the closing springs and close the circuit breaker. Check all three vacuum interrupter erosion indicator marks as described in Section 6 and Illustrated in Figure 6.2 to verify that contact erosion is not greater than the service limit. Check contact wipe as described in Section 6 and illustrated in Figure 6.4.

5.7 PRIMARY CIRCUIT RESISTANCE TESTS

Check the primary circuit resistance of the three pole units as described in Section 6. 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 circuit breaker in its withdrawn or disconnect/test position and connecting the circuit 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.

⚠ WARNING

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

5.9 SURE CLOSE MECHANISM ADJUSTMENT

⚠ WARNING

FOR ALL CIRCUIT BREAKER HOUSINGS EQUIPPED WITH MECHANISM OPERATED CONTACTS (MOC), 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.

All type A2M-VR circuit breakers with MOC operators utilize the **SURE CLOSE** mechanism to control MOC velocity and closely mimic the dynamics and velocities of older circuit breakers. It is imperative that this mechanism be adjusted to match the force of MOC switches mounted in the cell. If the adjustment is made on the A2M-VR circuit breaker to be compatible with force of the MOC switches, make sure the adjustment is checked and compatible if the circuit breaker is moved to a different housing.

The circuit breaker has been factory adjusted to operate a mechanism operated cell (MOC) switch in the cell. This means that for a properly maintained MOC switch, no adjustment is needed.

The **SURE CLOSE** mechanism provides an effective way to evaluate the condition of the MOC in the cell. If the **SURE CLOSE** drive spring is properly adjusted, but the MOC does not fully open or close, it is time to maintain the MOC in the cell. Maintenance usually means cleaning and lubricating the MOC mechanism. If the MOC has seen a large number of cycles, however, worn components may have to be replaced.

⚠ WARNING

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.

To adjust the **SURE CLOSE** drive spring for more output force, proceed with the following steps:

Step 1: Locate the MOC operator drive spring (Figure 3.3). It is located on the upper left portion of the A2M-4.16-VR circuit breaker behind the metal cover as viewed from the front.

Step 2: From the factory, the drive spring comes set with adequate force to exceed the MOC requirement by 10%. This should operate the MOC if not, an adjustment is required.

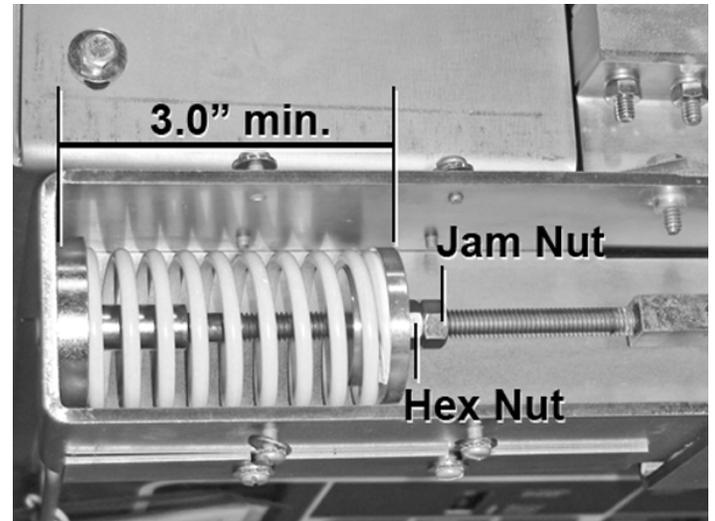
Step 3: Remove the cover the loosen the jam nut on the **SURE CLOSE** spring and compress the spring by tightening the Hex Nut an additional .25 inches. Do not exceed the minimum dimension shown in Figure 5.1. Close the circuit breaker.

Step 5: Measure the MOC output spring force in the closed position, compare to the force required to operate the MOC switch at the point of interface. If the force exceeds the MOC requirement, go to step 5. If not, then repeat step 3-4 until the MOC forces are adequate.

Step 5: Insert into the cell.

Step 6: Operate the circuit breaker to verify the new setting.

Figure 5.1. **SURE CLOSE** Spring Compression Setting



Step 7: Repeat steps 3-6 until acceptable operation is achieved.

Step 8: Anytime an adjustment is made, make sure the new compressed spring length (measured in the open position) is recorded.

Step 9: After an adjustment is made, make sure that all nuts are secured in place and the cover has been installed, prior to returning to service.

Note: Minimum adjustment as shown in Figure 5.1

5.10 LEVERING THE A2M-4.16-VR INTO THE CELL

Figure 5.2. A2M-4.16-VR Withdrawn from Switchgear



A2M-4.16-VR Replacement Circuit Breaker

- Place the circuit breaker in the withdrawn position out of the cell. (Figure 5.2)
- From the withdrawn position, insure the circuit breaker is open.
- Check that the contact status indicator reads "OPEN". Manually open/trip the circuit breaker as needed to obtain this status.
- Push the circuit breaker into the cell until all the stops engage the rear of the cell floor and the circuit breaker halts. (Figure 5.3) This is the disconnect/test position. At this point the primary contacts, secondary block, and ground contact should all be properly aligned before proceeding.

5.11 INSERTION PROCEDURE

Figure 5.3 A2M-4.16-VR in Test Position



Eaton's VR-Series circuit breaker will be lifted into the cell in the same manner as the original GE vertical lift circuit breaker. These steps should be completed by a service engineer or technician familiar with Eaton's vacuum circuit breaker designs.

The circuit breaker rating should be checked against the unit rating and under no circumstances should the circuit breaker be inserted into a cell with protective relay settings that will not properly protect the circuit breaker.

Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered position. The circuit breaker should then enter the housing freely. After first assuring that the circuit breaker is open, the wheels on the circuit breaker should be aligned

with the tracks in the cubicle. When alignment is correct, the circuit breaker should be pushed completely into the cell (Figure 5.3) until the lift points of the circuit breaker are aligned with the corresponding lifting saddles of the elevating mechanism. Care must be taken to assure that stoppage is not due to the circuit breaker binding on sides of the cubicle. This is the disconnect/test position.

All tests which must be conducted within the cell must be conducted with the circuit breaker in this position. In the test position, control power can be made available through the secondary test jumper, but the primary contacts are far from the primary stabs in the cubicle and the cubicle shutter is closed.

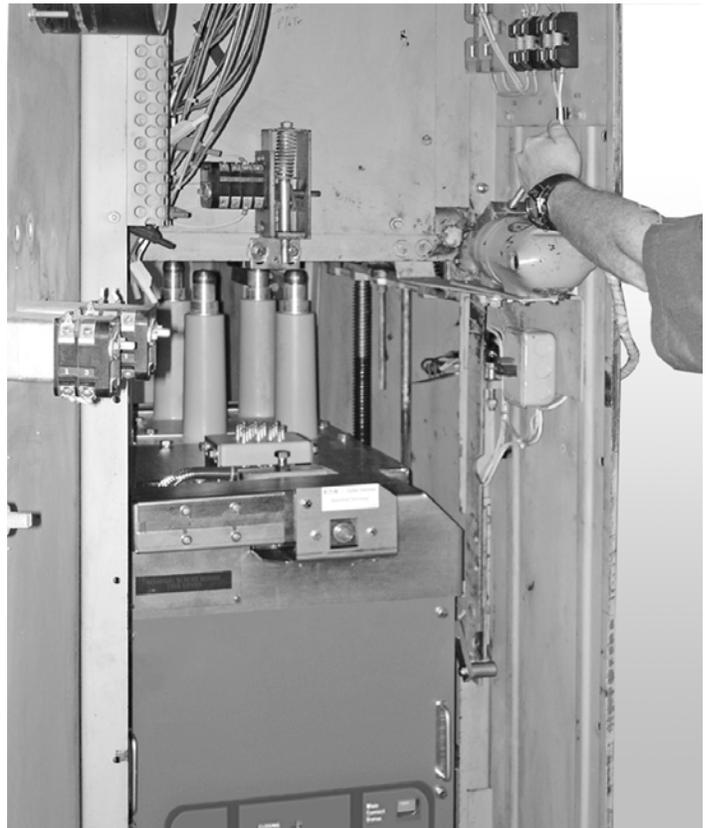
⚠ WARNING

THE CIRCUIT BREAKER SHOULD NEVER BE INSERTED OR WITHDRAWN FROM THE OPERATING POSITION WITH THE MAIN CONTACTS CLOSED.

To elevate the circuit breaker, position the elevating control selector switch on the elevating motor to "RAISE". Engage the elevating motor by pulling the clutch handle just above the elevating motor forward until the motor limit switch closes and the motor clutch engages to raise the circuit breaker (Figure 5.4). The engagement of the gear motor activates the active interlocking system to hold the circuit breaker trip-free as long as the motor is engaged. While elevating, ensure that the shutter slides open and the bushings center with respect to the primary bottle openings of the cell or injury to the contacts may result. Careful attention should also be directed to the secondary disconnect to insure correct mating is obtained.

The clutch handle is held in the forward position until a limit switch on the cell opens to stop the motor at the end of the upward travel of the circuit breaker (Figure 5.5). Release the clutch handle. The motor selector switch must not be used to energize or interrupt the motor circuit.

Figure 5.4 Clutch Handle held to lift the A2M-4.16-VR



When the circuit breaker is fully elevated the clearance between the circuit breaker lift rail stud and the upper stop bolts (Figure 5.5) should not be more than 1/8" and not less than 3/32".

The active interlock roller should be centered in the upper "VEE" and the interlock roller should have 1/16" clearance to the stationary interference plate directly under it (Figure 5.6).

The circuit breaker is now in the connect position.

5.12 REMOVAL PROCEDURE

To lower the circuit breaker, proceed the same way as for raising except operate the selector switch to "LOWER". The clutch must be held in the engaged position or a spring will return it to its normal position and open the electrical circuit to the motor.

The circuit breaker may be raised or lowered by an emergency hand crank which can be inserted after removing the elevating motor. The motor is removed by unlatching the motor assembly from its support and disconnecting the motor lead plug. After removing the motor, pull the clutch forward and insert the manual crank (supplied with the original switchgear) into the end of the clutch coupling. The circuit breaker must be open before the crank can be inserted and held in the clutch coupling.

The circuit breaker should never be inserted or withdrawn from the operating position with the contacts closed. Though interlocks should prevent this, care must be taken that this is never attempted.

Figure 5.5 Switchgear Upper Stop Bolt

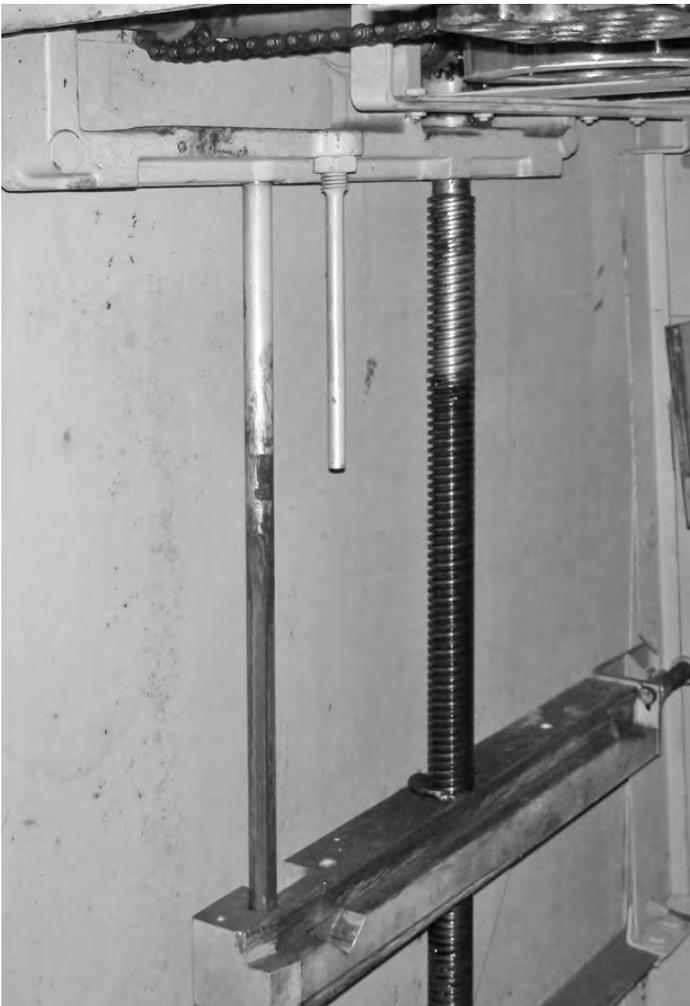
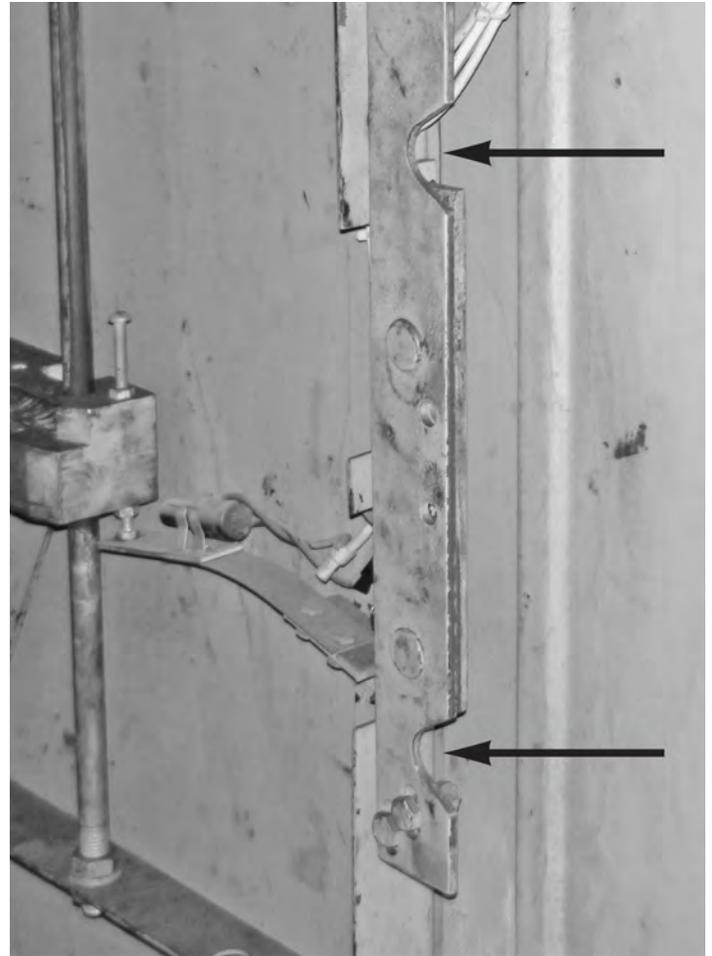


Figure 5.6 Switchgear "VEE" Slot



SECTION 6: INSPECTION & MAINTENANCE

⚠ DANGER

DO NOT WORK ON A CIRCUIT BREAKER IN THE "CONNECTED" POSITION.

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

DO NOT WORK ON A CIRCUIT 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 CIRCUIT 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 circuit 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 circuit 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 27k 60Hz For 1 Minute	Hipot Tester	Clean And Retest Or Replace	
	Insulation Integrity	Main Circuit To Ground	Withstand 15kV, 60Hz For 1 Minute (5kV Rating) 27kV, 60Hz For 1 Minute (15kV Ratings)	Hipot Tester	Clean And Retest Or Replace	
		Control Circuit To Ground (Charging Motor Disconnected)	Withstand 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 Circuit breaker And Look For Green Mark On Moving Stem From The Rear Of The Circuit breaker (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 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 Circuit breaker Twice	Replace Any Defective Device-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 Circuit 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 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 And Tripping	Correct Per Trouble-Shooting Chart If Necessary		
	CloSure™ Test	≥ 0.6 Inch Over Travel	CloSure™ Test 6.8.1	If < 0.6 Contact P.B.C. 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 warnings 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.

⚠ WARNING

DC HI-POTENTIAL TESTS ARE NOT RECOMMENDED BY EATON. DO NOT APPLY DC AT ANY LEVEL TO VR-SERIES POWER CIRCUIT BREAKERS

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.

The current delivery capability of 25 mA AC applies when all three VI's are tested in parallel. If individual VI's are tested, current capability may be one third of this value.

Breaker Rated Maximum Voltage	Vacuum Interrupter Integrity Test Voltage
	AC 60Hz
Up to and including 15.0 kV	27 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 circuit breaker and observe the vacuum interrupter moving stem from the rear of the circuit 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 circuit breaker. Figures 6.3 and 6.4 show the procedure for determining the contact wipe. It may be 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 CIRCUIT BREAKER TO FAIL TO INTERRUPT AND THEREBY CAUSE PROPERTY DAMAGE OR PERSONNEL INJURY.

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

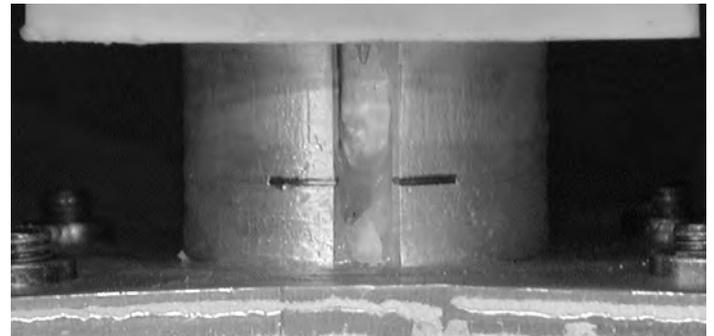
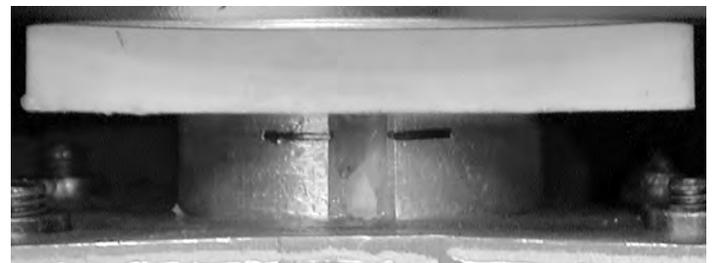


Figure 6.2. Vacuum Interrupter Showing Contact Erosion Indicator With Circuit breaker Closed (Indicators are checked only when circuit breaker is closed.)



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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 circuit breaker closed, the wipe is satisfactory) (See Next Figure for Graphic of All Possibilities)



6.5 INSULATION

In VR-Series circuit 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 circuit 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 circuit breaker. For the circuit breakers rated 4.76 kV, 8.25 kV and 15 kV the test voltages are 15 kV, 27 kV and 27 kV RMS, 60 Hz respectively. Conduct the test as follows:

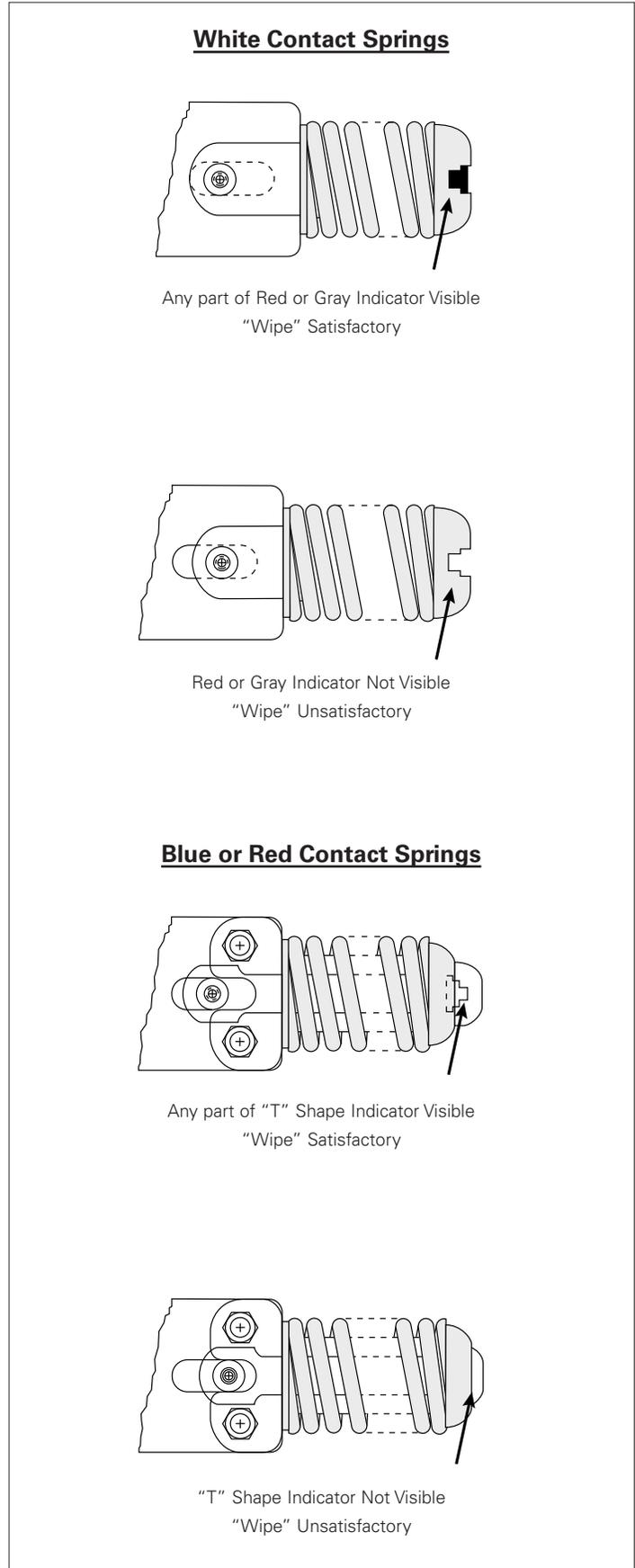
Close the circuit breaker. Connect the high potential lead of the test machine to one of the poles of the circuit breaker. Connect the remaining poles and circuit breaker frame to ground. Start the machine with output potential at zero and increase to the test voltage. Maintain the test voltage for one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

Open the circuit breaker. Connect the high potential lead of the test machine to one of the poles of the circuit breaker. Connect the remaining poles and circuit 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.

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 circuit 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 Circuit breaker Closed)



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 circuit 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 circuit breaker. If measurements exceeds 200%, contact the manufacturer.

Resistance conversion for Temperature

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

$R_{\text{conversion}}$ = 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.

ρ = 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 circuit breaker components. Operate the circuit 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

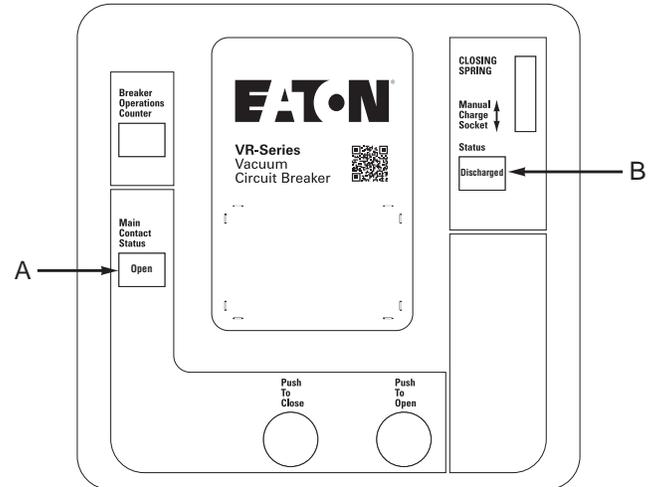
Introduction: The CloSure™ Test is a simple yet extremely effective means to determine and monitor the ability of the mechanism to close the circuit breaker contacts fully. It provides a quantitative measure of the extra energy available in terms of over travel in inches to close the circuit breaker 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).

⚠ DANGER

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 circuit 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



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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 circuit 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 breaker - 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"

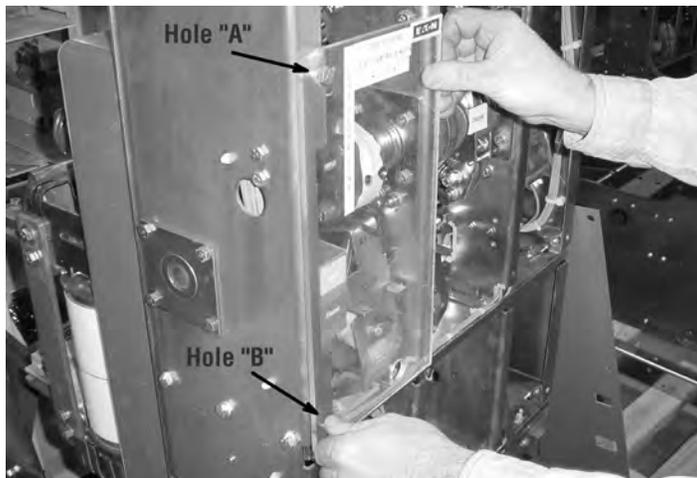


Figure 6.7.b. Front View of CloSure™ Tool Showing Mounting / Testing Hole Locations (6352C49H01)

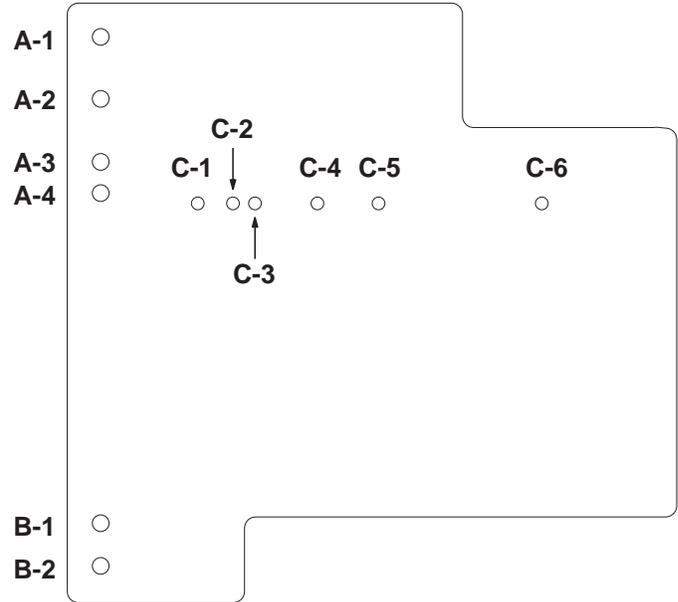


Table 6.1. CloSure™ Tool Mounting / Testing Locations by Circuit breaker Type

ELEMENT DESIGNATION	APPROXIMATE MECHANISM CHASSIS 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 6.7.c. Typical Circuit breaker Front View with CloSure™ Tool Attached (Approximate Mechanism Chassis Width)

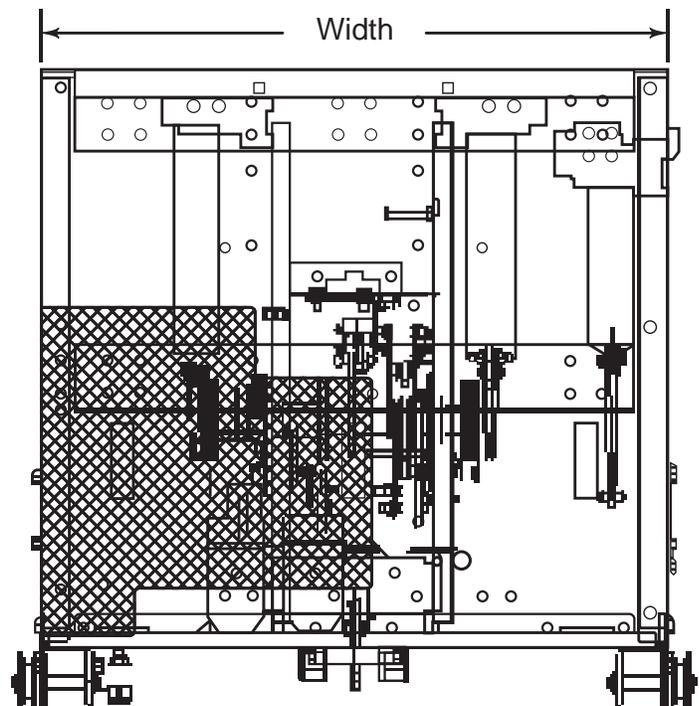


Figure 6.8. Manually Charging Closing Springs

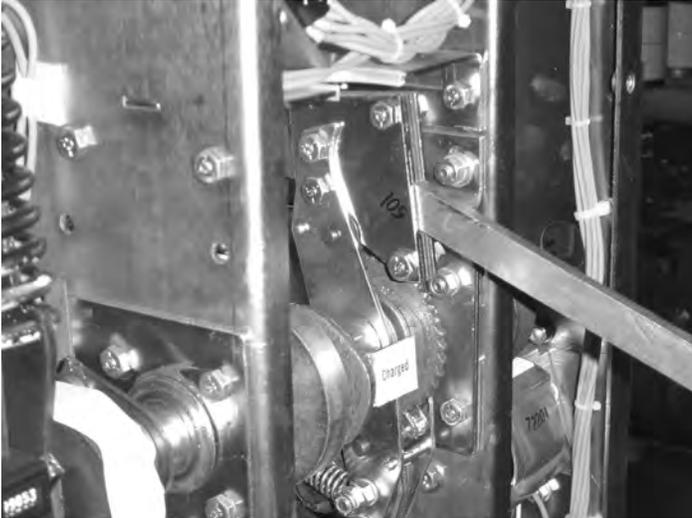


Figure 6.9. Make a Clear and Heavy Mark



Figure 6.10. With Marker in Hole "C", While Closing Circuit breaker



Figure 6.11. Pole Shaft Located On Right Side Of Circuit breaker

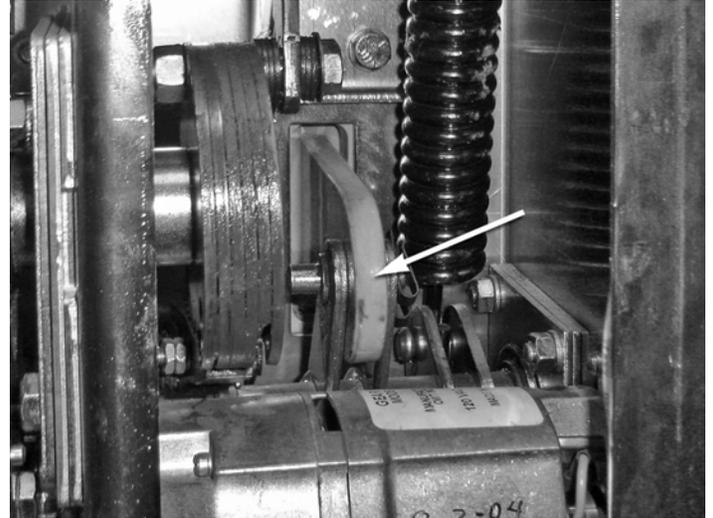


Figure 6.12. Move the Sharpie® 15° Left and Right



Figure 6.13. Top view of Cam and Marker Interface

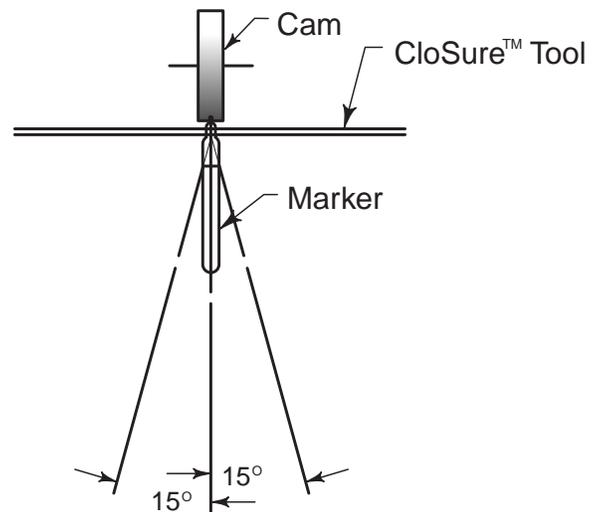


Figure 6.14. Evaluate the CloSure™ Performance

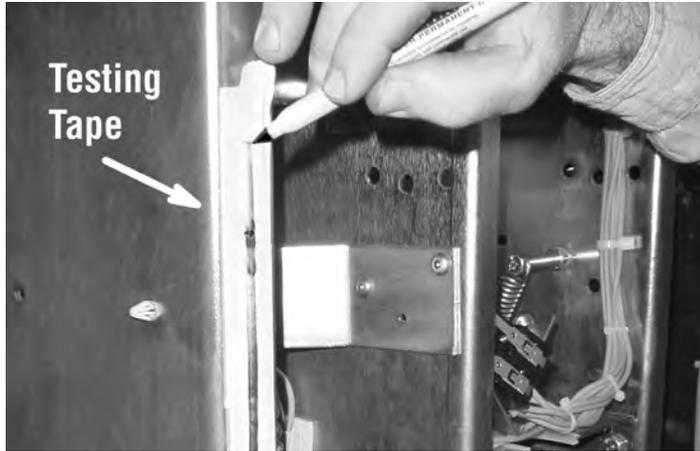
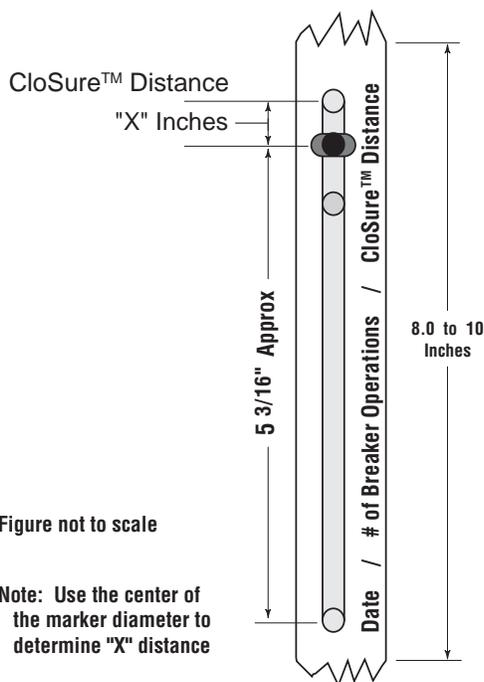


Figure 6.15. Determining the Distance Traveled



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 circuit 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 circuit breaker several times manually and electrically.

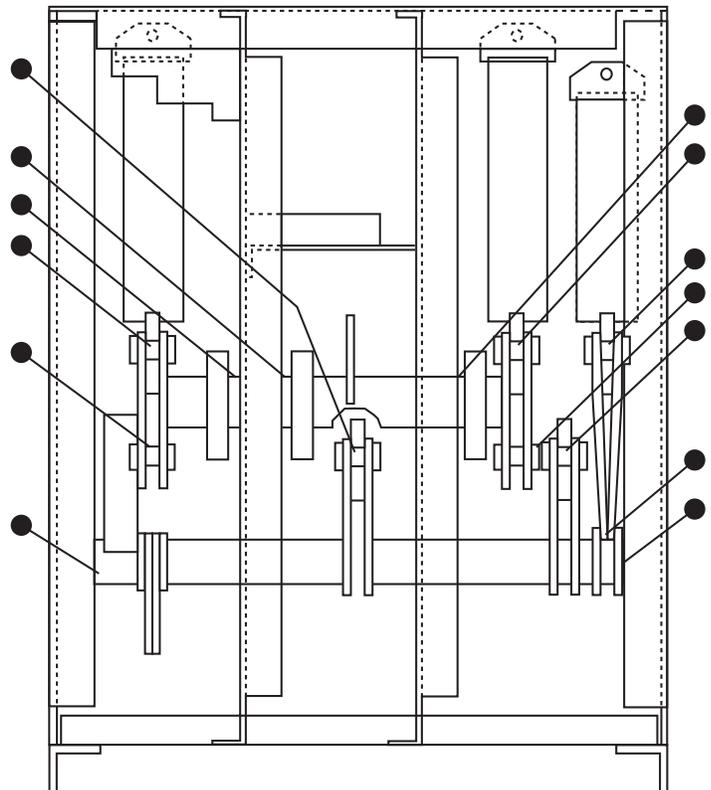
Roller bearings are used on the pole shaft, the cam shaft, the main link and the motor eccentric. These bearings are packed at the factory with a top grade slow oxidizing grease which normally should be effective for many years. They should not be disturbed unless there is definite evidence of sluggishness, 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	<ul style="list-style-type: none"> Control Power (Fuse Blown Or Switch Off) Secondary Disconnects Motor Cut-off Switch (Poor Or Burned Contacts. Lever Not Operational.) Terminals And Connectors (Poor Or Burned Contacts) Motor (Brushes Worn Or Commutator Segment Open)
	Mechanism	<ul style="list-style-type: none"> Pawls (Slipping Or Broken) Ratchet Wheel (Teeth Worn Or Broken) Cam Shaft Assembly (Sluggish Or Jammed) Oscillator (Reset Spring Off Or Broken)
Closing Springs Not Charged Circuit breaker Does Not Close	Control Circuit (Close Coil Does Not Pick Up)	<ul style="list-style-type: none"> Control Power (Fuse blown or switch off) Secondary Disconnects Anti Pump Relay (Y Relay N.C. Contact Open Or Burned Or Relay Picks Up) Close Coil (Open Or Burned) Latch Check Switch (Contact Open - Bad Switch Or Trip Bar Not Reset) Auxiliary Switch (B Contact Open Or Burned) Motor Cut-Off (Contacts Open Or Burned) Trip Coil Assembly (Clapper Fails To Reset)
	Closing Sound But No Close	<ul style="list-style-type: none"> Pole Shaft (Not Open Fully) Trip Latch Reset Spring (Damaged Or Missing) Trip Bar-D Shaft (Fail To Remain Reset) Trip Latch-Hatchet (Fails To Remain Reset) Trip Floor Tripper (Fails To Remain Reset) Close Latch (Binding) Close Latch Roller (Binding) Trip Circuit Energized
UNDESIRABLY CLOSES		
	Control Circuit	<ul style="list-style-type: none"> Close Circuit (CS/C Getting shorted)
	Mechanism	<ul style="list-style-type: none"> Close Release Latch (Fails To Reset) Close Floor Tripper (Fails To Reset)
FAILS TO CLOSE		
No Trip Sound	Control Circuit	<ul style="list-style-type: none"> Control Power (Fuse Blown Or Switch Off) Secondary Disconnects Auxiliary Switch (A Contact Not Making Poor Or Burned) Trip Coil (Burned Or Open) Terminals And Connections (Poor Or Burned Or Open) Trip Clapper (Jammed)
	Trip Mechanism	
Trip Sound But No Trip	Trip Mechanism	<ul style="list-style-type: none"> Trip Bar, Trip Latch (Jammed) Pole Shaft (Jammed) Operating Rod Assembly (Broken Or Pins Out)
	Vacuum Interrupter (One Or More Welded)	
UNDESIRABLY TRIPS		
	Control Circuit	<ul style="list-style-type: none"> Control Power (CS/T Switch, remains closed)
	Mechanism	<ul style="list-style-type: none"> Trip Coil Clapper (Not Resetting) Trip Bar or Trip Latch (Poor Engagement Of Mating Or Worm Surfaces) 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

- The style numbers in Table 7.1 should be sufficient to purchase control components for most applications. Some circuit breakers have special control schemes. Supply complete nameplate information for verification or if additional components are needed.
- Specify the method of shipping desired.
- Send all orders or correspondence to the nearest Eaton sales office or contact the PBC direct at 1-877-276-9379.
- Include negotiation number with order when applicable.

Table 7.1 Common Replacement Parts - Descriptions and Style Numbers

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



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