I.B. 94A3990R12

Instructions for VR-Series Replacement Breakers for Allis-Chalmers Type MA

(MA-VR-250-1200A shown)

(MA-VR-250-1200A with optional Internal Racking shown)

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.

WARNING

ALL SAFETY CODES, SAFETY STANDARDS AND/OR REGULATIONS AS THEY MAY BE APPLIED TO THIS TYPE OF EQUIPMENT MUST BE STRICTLY ADHERED TO.

THESE CIRCUIT BREAKER ELEMENTS 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. THESE CIRCUIT BREAKER ELEMENTS ARE SOLD PURSUANT TO A NON-STANDARD PURCHASING AGREEMENT WHICH LIMITS THE LIABILITY OF THE MANUFACTURER.

Eaton's Electrical
Services & Systems
Power Breaker Center
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 Cutler-Hammer representative at Eaton Corporation.

Table of Contents

SECTION 1: INTRODUCTION 5
1.1 AVAILABLE MA-VR BREAKERS 5
SECTION 2: SAFE PRACTICES 7
SECTION 3: RECEIVING, HANDLING AND STORAGE 8
3.1 RECEIVING 8
3.2 HANDLING 8
3.3 STORAGE 9
3.4 MA-VR APPROXIMATE WEIGHTS 9
4.2 ANTI-ROTATION SYSTEM ADJUSTMENT (For all breakers) 13
4.3 OPERATIONAL POSITIONS 13
SECTION 4: INSTALLATION AND INSPECTION 13
4.1 EXAMINATION FOR DAMAGE 13
4.1.1 NAMEPLATE VERIFICATION 13
4.4 LEVERING HANDLE RACKING 13
4.4.1 INSERTION PROCEDURE 13
4.4.2 REMOVAL PROCEDURE 15
4.5 INTERNAL ROTARY RACKING (Optional) 15
4.5.1 INSERTION PROCEDURE 15
4.5.2 REMOVAL PROCEDURE 16
4.6 MANUAL OPERATIONAL CHECK 17
4.7 VACUUM INTEGRITY TEST 17
4.8 LOW FREQUENCY WITHSTAND TEST (INSULATION CHECK) 17
4.9 CONTACT EROSION AND STROKE, CONTACT WIPE 18
4.10 PRIMARY CIRCUIT RESISTANCE TESTS 18
4.11 ELECTRICAL OPERATIONAL CHECKS 18
4.12 SURE CLOSE MECHANISM ADJUSTMENT 18
SECTION 5: DESCRIPTION AND OPERATION 20
5.1 VACUUM INTERRUPTER 20
5.1.1 THE INTERRUPTER ASSEMBLY 20
5.1.2 CONTACT EROSION INDICATOR 20
5.1.3 CONTACT WIPE AND STROKE 21
5.2 PHASE BARRIERS 21
5.3 BUSHINGS AND DISCONNECTING CONTACT ASSEMBLIES 21
5.4 STORED ENERGY MECHANISM 21
5.4.1 CLOSING SPRING CHARGING 22
5.4.2 CLOSING OPERATION 22
5.4.3 TRIPPING OPERATION 22
5.4.4 TRIP-FREE OPERATION 22
5.5 CONTROL SCHEMES 22
5.6 SECONDARY CONNECTION BLOCK 23
5.7 INTERLOCKS 23
5.7.1 ANTI-CLOSE INTERLOCK 23
5.7.2 RACKING SYSTEM TRIP AND SPRING RELEASE INTERLOCKS 23
5.7.2.1 LEVERING HANDLE RACKING 23
5.7.2.2 INTERNAL ROTARY RACKING 23
5.7.3 SHUTTER INTERLOCK 23
5.8 MOC (Mechanically Operated Contacts) OPERATOR 23
5.9 TOC (Truck Operated Contacts) OPERATOR 28
5.10 LEVERING MECHANISM 28
5.10.2 INTERNAL ROTARY RACKING 28
SECTION 6: INSPECTION AND MAINTENANCE 29
6.1 INTRODUCTION 29
6.2 FREQUENCY OF INSPECTION 29
6.3 INSPECTION AND MAINTENANCE PROCEDURES 30
6.4 VACUUM INTERRUPTER INTEGRITY TEST 31
6.5 CONTACT EROSION AND WIPE 31
6.6 INSULATION 32
6.7 INSULATION INTEGRITY CHECK 32
6.8 PRIMARY CIRCUIT RESISTANCE CHECK 33
6.9 MECHANISM CHECK 33
6.9.1 CLOSURE™ TEST 33
6.10 LUBRICATION 38
SECTION 7: REPLACEMENT PARTS 41
7.1 GENERAL 41
7.1.1 ORDERING INSTRUCTIONS 41

Tables

Table 1.1 - MA-VR Vacuum Circuit Breaker Availability and Interchangeability 5
Table 1.2 - MA-VR Dimensions in Inches 6
Table 3.1 - Weight by Breaker Type 9
Table 5.1 - Time Per Event 22
Table 6.1 - Voltages 31
Table 6.2 - CloSure™ Tool Mounting/Testing Locations by Circuit Breaker Type 37
Table 6.3 - Proper Lubrication Times Per Rating 38
Table 6.4 - Troubleshooting Chart 38

Figures

Figure 1-1 Outline and Dimensions in inches of Type MA-VR Breakers 6
Figure 3-1 Typical MA-VR Tools and Accessories 8
Figure 3-2 Overhead Lifting of MA250-VR 8
Figure 3-3 Front External View of MA-VR Breaker 10
Figure 3-4 Front External View of MA-VR Breaker (Internal Rotary Racking) 11
Figure 3-5 Back External View of MA-VR Breaker 12
Figure 4-1 Shutter Guide Bracket 13
Figure 4-2 Adjustment for Anti-Rotation Bosses 13
Figure 4-3 Alignment of MA-VR 14
Figure 4-4 Insertion of MA-VR 14
Figure 4-5 MA-VR Test Position 15
Figure 4-6 Rack-In Position of Handle 16
Figure 4-7 Rack-Out Position of Handle 16
Figure 4-8 Rotary Racking Mechanism (Cover Removed For Clarity) 17
Figure 4-9 Using The Racking Handle 17
Figure 4-10 Connected Position 18
Figure 4-11 Disconnect Position 18
Figure 4-12 MOC Operator 19
Figure 4-13 SURE CLOSE Spring Adjustment Setting 19
Figure 4-14 SURE CLOSE Spring Adjustment 19
Figure 4-15 Measuring With Spring Force Gauge 19
Figure 5-1 MA-VR Interrupter 20
Figure 5-2 MA-VR Interrupter Assembly 20
Figure 5-3 MA-VR Vacuum Element - Front Faceplate Removed 24
Figure 5-4 Closing Cam and Trip Linkage 25
Figure 5-5 Charging Schematic 26
Figure 5-6 Typical AC/DC Schematic 27
Figure 5-7 Levering Handle Engaging Cell Floor 28
Figure 5-8 Rotary Racking Handle Engaging Internal Racking Shaft 28
Figure 6-1 Lubrication Areas 29
Figure 6-2 Vacuum Interrupter Showing Contact Erosion Indicator With Breaker Open 32
Figure 6-3 Vacuum Interrupter Showing Contact Erosion Indicator With Breaker Closed 32
Figure 6-4 The Arrow Shows The “T” Contact Wipe Indicator - Example with Blue Spring 33
Figure 6-5 Wipe Indication Procedure (performed Only with Breaker Closed) 33
Figure 6-6 Status Indicators 34
Figure 6-7 Wrapping Tape Around Cam 34
Figure 6-8 Attaching CloSure™ Test Tool at Hole “A” & “B” 35
Figure 6-9 Manually Charging Closing Springs 35
Figure 6-10 Make a Clear and Heavy Mark 35
Figure 6-11 With Marker in Hole “C”, While Closing Breaker 35
Figure 6-12 Move the Sharpie® 15° Left and Right 35
Figure 6-13 Top view of Cam and Marker Interface 36
Figure 6-14 Evaluate the CloSure™ Performance 36
Figure 6-15 Determining the Distance Traveled 36
Figure 6-16 Illustrative Testing Tape Sample 36
Figure 6-17 Front View of CloSure™ Tool Showing Mounting / Testing Hole Locations 36
Figure 6-18 Typical Circuit Breaker Front View with CloSure™ Tool Attached 37

SECTION 1: INTRODUCTION

The purpose of this book is to provide instructions for receiving and handling, storage, installation, operation and maintenance of MA Type Vacuum Replacement Circuit Breakers (also referred to as VR-Series). The vacuum unit replacement breakers are designed to be used in existing Allis-Chalmers type MA metal-enclosed switchgear. VR-Series Circuit Breakers provide reliable control, protection and performance, with ease of handling and maintenance. Like ratings are interchangeable with each other.

1.1 AVAILABLE MA-VR BREAKERS

Refer to Table 1.1

WARNING

SATISFACTORY PERFORMANCE OF THESE BREAKERS IS CONTIGENT 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.

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.

Nominal Voltage Class (kV)	Existing MVA Rating	Rated Continuous Current at 60 Hz (Amps)	MVA Designation of VR-Series Breaker	Rated Voltage Factor K	Rated Withstand ANSI Test Voltage Low Freq. kV RMS	Rated Withstand ANSI Test Voltage Impulse kV Crest	Rated Short-Circuit kA RMS at Rated Max kV	Closing and Latching / Momentary Capabilities kA RMS/Peak
4.16	250	1200 2000	250	1.24	19	60	29	58/97
4.16	250	1200 2000	250U	1.19	19	60	41	78/132
4.16	350	1200 2000	350	1.19	19	60	41	78/132

Table 1.1 - MA-VR Vacuum Circuit Breaker Availability and Interchangeability

Table 1.2 - MA-VR Dimensions in Inches

Rating	A	B	C	D	E	F	G
MA-VR-250/250U/350 1200/2000A	12.00	26.00	33.00	20.38	22.25	66.38	7.00

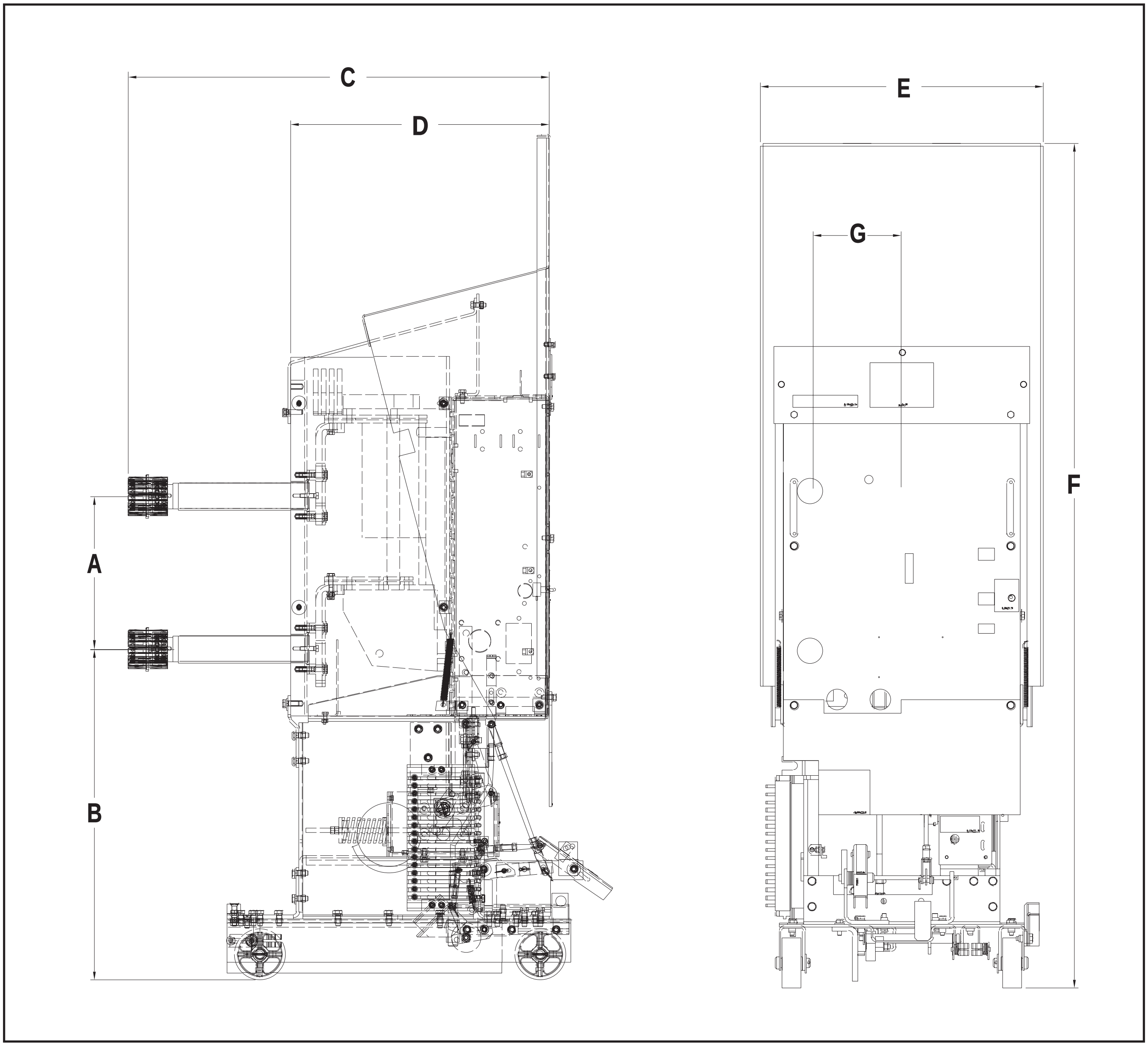


Figure 1-1 Outline and Dimensions in inches of Type MA-VR Breakers

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.

WARNING

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 MA-VR 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 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 damage or loss is detected and notify the nearest Eaton's Electrical Services & System 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)

Levering Handle: The levering handle is used to assist in moving the circuit breaker into and out of the cell. This levering handle is the same as the one provided with the original Allis-Chalmers breaker racking mechanism and is therefore not provided as part of the vacuum replacement breaker.

Rotary Racking Handle: (Optional) The racking handle is used with the screw racking system to move the breaker into and out of the cell. It is supplied with the optional screw racking mechanism.

Secondary Connection Block Extention 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 breaker can be electrically operated while not installed in the switchgear cell. This extension cable is the same one provided with the Allis-Chalmers breaker and is therefore not included as part of the vacuum replacement breaker.

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.

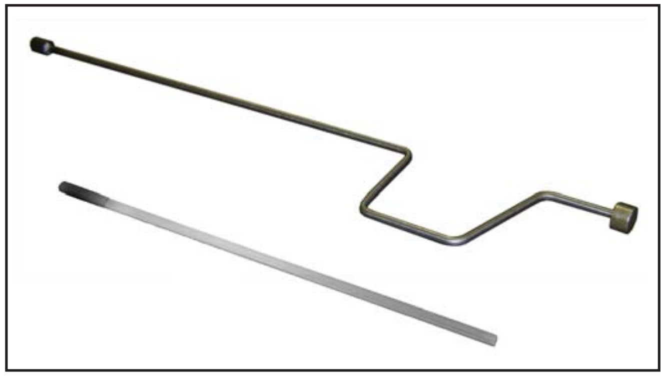


Figure 3-1 Typical MA-VR Tools and Accessories

MA-VR 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.

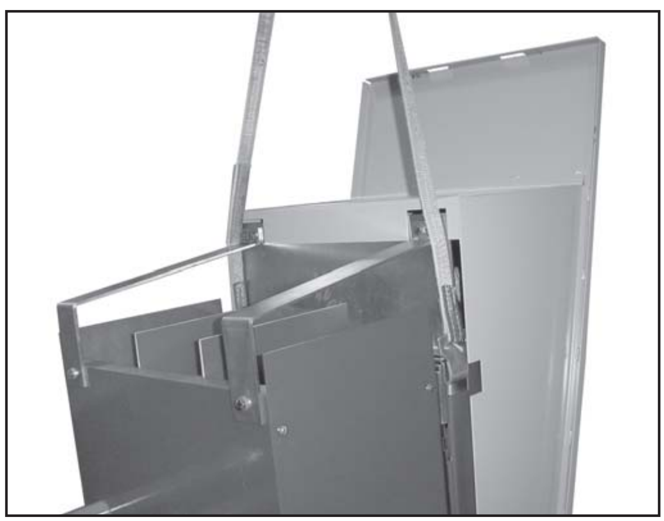


Figure 3-2 Overhead Lifting of MA250-VR

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 3-2). 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.

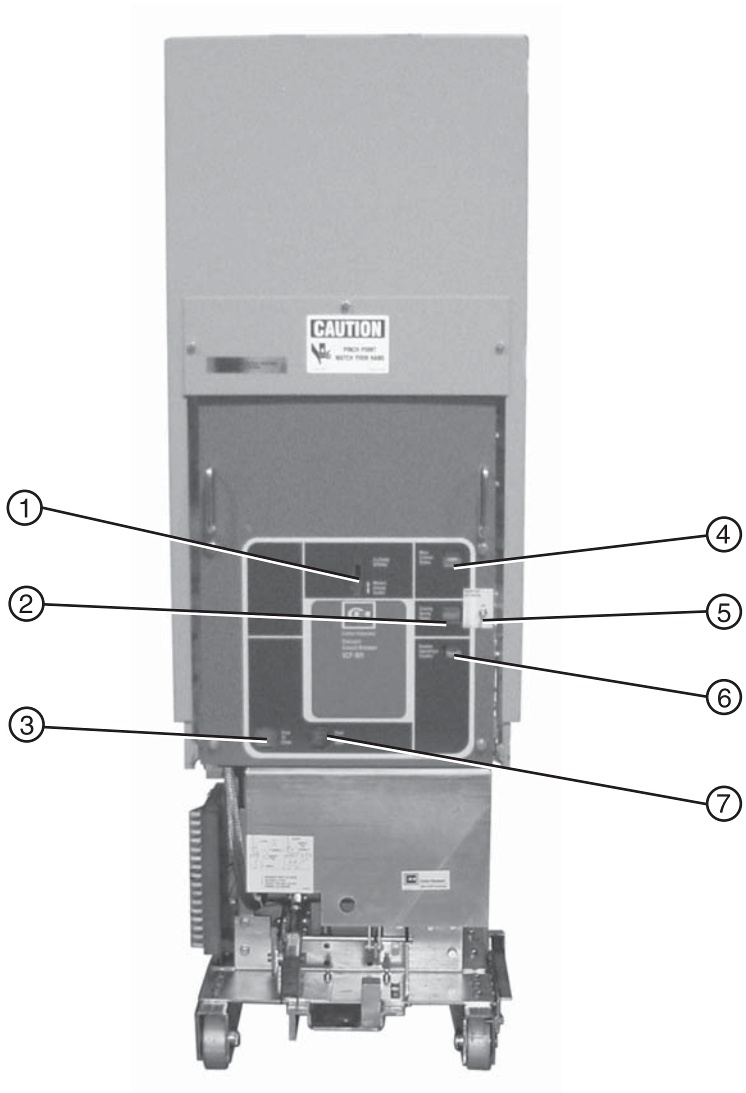
3.4 MA-VR APPROXIMATE WEIGHTS

Refer to Table 3.1

Table 3.1 - Weight by Breaker Type

Circuit Breaker Type	*Amperes*	*LBs.**
MA-VR 250	1200	665*
MA-VR 250	2000	745*
MA-VR 250U	1200	700*
MA-VR 250U	2000	780*
MA-VR 350	1200	700*
MA-VR 350	2000	780*

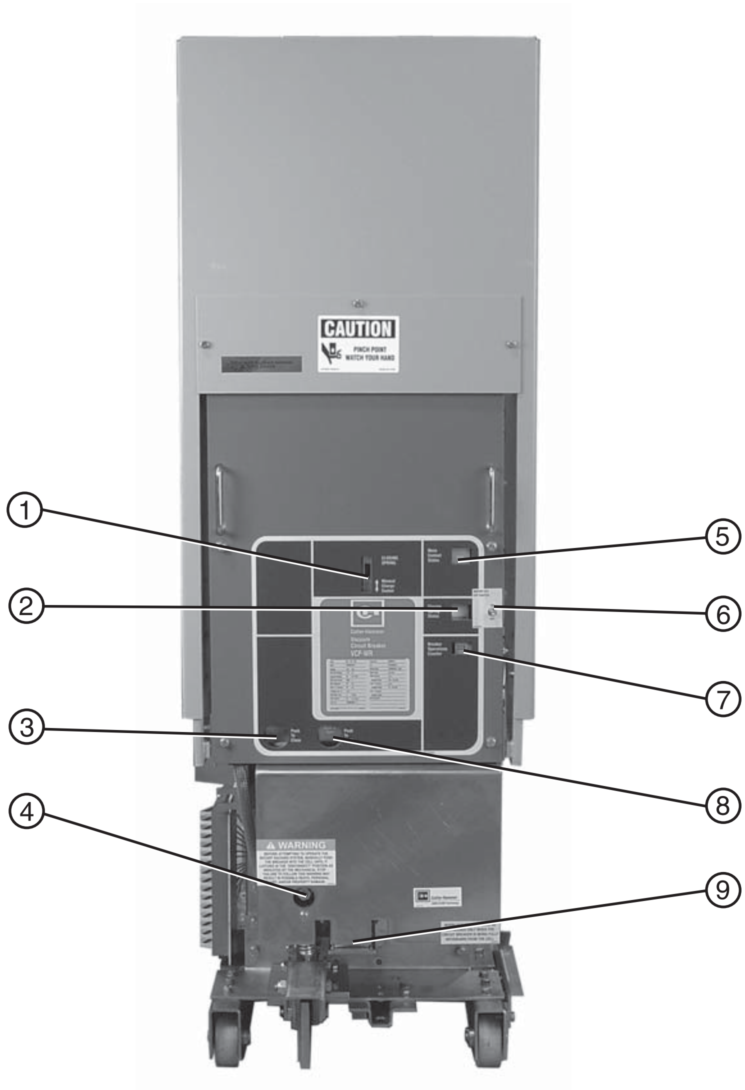
* - *An additional 75lbs is added with the optional Internal Rotary Racking system.*



① Manual Charging Socket
② Spring Charged/Discharged Indicator
③ Push To Close Button
④ Breaker Contacts Indicator
⑤ Manual Motor Cut-Off Switch
⑥ Operations Counter
⑦ Push To Open Button

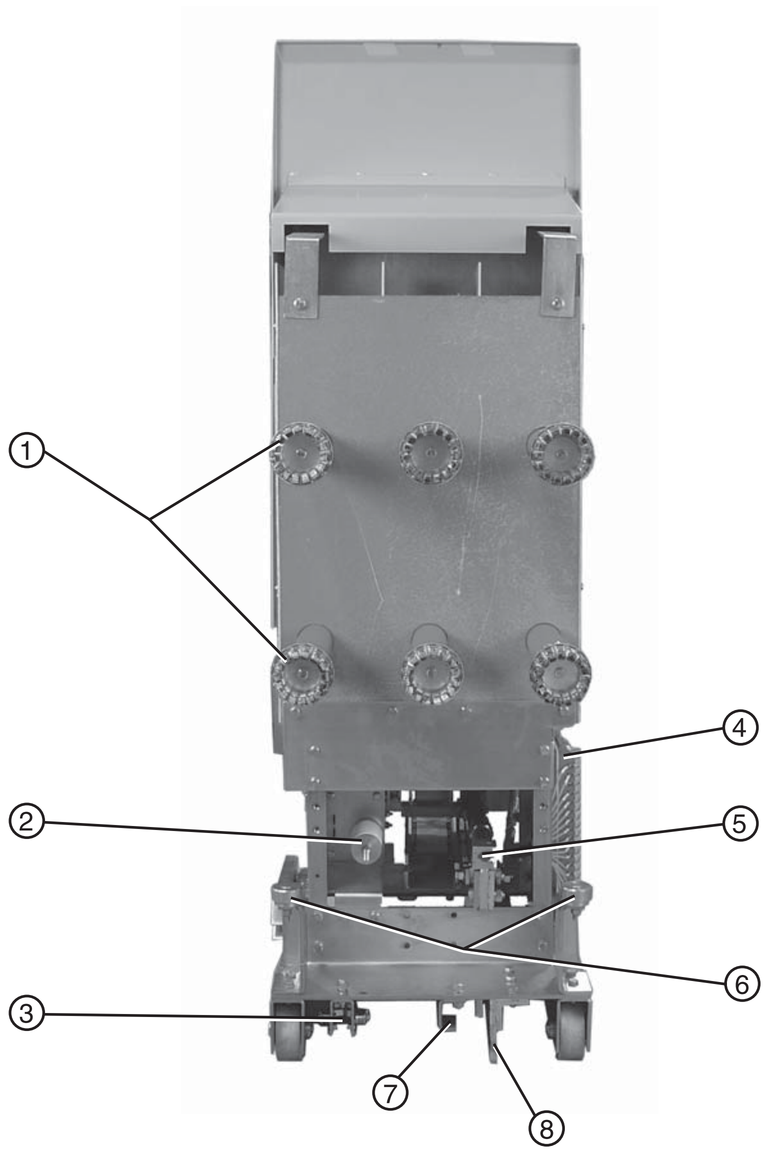
(Optional Internal Rotary Racking not shown)

Figure 3-3 Front External View of MA-VR Breaker



1 Manual Charging Socket
2 Spring Charged/Discharged Indicator
3 Push To Close Button
4 Racking Insertion Point
5 Breaker Contacts Indicator
6 Manual Motor Cut-Off Switch
7 Operations Counter
8 Push To Open Button
9 Rotary Racking Decal

Figure 3-4 Front External View of MA-VR Breaker (Internal Rotary Racking)



1 Primary Disconnect
2 ***Sure Close*** Spring
3 Ground Contact
4 Secondary Disconnect
5 Optional Internal Rotary Racking
6 Anti-Rotation Bosses
7 Code Plate
8 Guide Channel

Figure 3-5 Back External View of MA-VR Breaker

SECTION 4: INSTALLATION AND INSPECTION

WARNING

BEFORE PLACING THE 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 BREAKER OPERATION LEADING TO DEATH, BODILY INJURY, AND PROPERTY DAMAGE.

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.

4.1 EXAMINATION FOR DAMAGE

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

4.1.1 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.

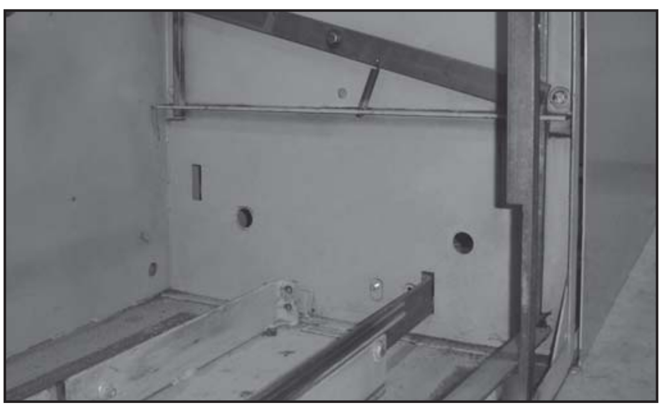


Figure 4-1 Shutter Guide Bracket

4.2 ANTI-ROTATION SYSTEM ADJUSTMENT (For all breakers)

Measure from the floor of the cell to the bottom of the shutter guide bracket and record measurement. With the breaker out of the cell, measure from the floor to the top of the bosses and record measurement. Using the supplied shims, adjust the bosses to achieve a gap between the shutter guide and the anti-rotation bracket of 0.00 - 0.032 inches. (See Figure 4-2)

4.3 OPERATIONAL POSITIONS

The breaker has four basic operational positions:

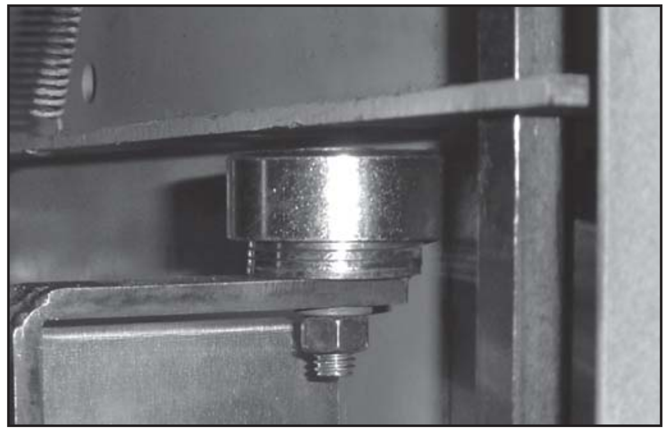


Figure 4-2 Adjustment for Anti-Rotation Bosses

(1) **Breaker withdrawn from cell**. (Figure 4-3)

(2) **Breaker in the cell in the disconnect position.** (Figure 4-11)

(3) **Breaker in the test position.** (Figure 4-5)

(4) **Breaker in the connect position.** (Figure 4-10)

WARNING

ARC FLASH INCIDENCIES WITH MV SWITCHGEAR 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 BREAKERS USING THE MANUAL LEVERING HANDLE OR THAT ROTARY RACKING HANDLE. EATON CORPORATION PROVIDES A UNIVERSAL REMOTE POWER RACKING SYSTEM (RPR-2) WHICH IS COMPATIBLE WITH THE INTERNAL ROTARY RACKING 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.

4.4 LEVERING HANDLE RACKING

WARNING

DO NOT USE ANY TOOL TO LEVER THE BREAKER TO OR FROM THE CONNECTED POSITION OTHER THAN THE LEVERING HANDLE.

4.4.1 INSERTION PROCEDURE

a. Place the breaker in the withdrawn position (Figure 4-3). The levering handle is not required for this position and the levering system interlocks are not automatic outside the cell. The breaker can be operated in this position and extreme care should be exercised to avoid inadvertent operation and possible injury or equipment damage.

WARNING

THE BREAKER CAN BE OPERATED IN THE WITHDRAWN POSITION AND EXTREME CARE SHOULD BE EXERCISED TO AVOID INADVERTENT OPERATION AND POSSIBLE INJURY OR EQUIPMENT DAMAGE.

b. From the withdrawn position, align the guide bar of the breaker with the guide rails of the cell.

c. Check that the closing spring status indicator reads “DISCHARGED” and that the main contact status indicator reads “OPEN”. Manually trip, close, and trip the breaker as needed to obtain this status.

d. Push the circuit breaker into the cell until all the wheels are on the floor and the spring discharge linkage has not cycled. No mechanical stop will be reached. In this position the breaker can still be operated because there is no interface of the cell floor and breaker interlocks. No cell labeling is provided to verify this position.

e. Push the breaker further into the cell. The pressing of the interlock pedal will make this operation easier but due to the cell design, pressing of the pedal is not required at this stage.

Figure 4-3 Alignment of MA-VR

Figure 4-4 Insertion of MA-VR

f. Once movement has started, the interlock pedal should be released if pressed. An audible click of the interlock pedal engaging the interlock rail will be heard at about 9 inches travel from the withdrawn to the disconnect position. The interlock pedal will travel down at the beginning of movement and rapidly rise a short distance to lock the breaker in the disconnect position at the end of the normal travel from withdrawn to disconnect. The movement of the pedal provides an open signal that remains throughout all intermediate breaker positions and the floor trip will be used during the first 4 inches of inward travel along with a closing signal to discharge the closing springs. The breaker remains tripped until the test position is reached. The disconnect position can be verified by the inability to move the breaker in or out, the interlock pedal has slightly risen, and the cell label “disconnect” is indicate on the right side of the cell. The breaker is still held open with further forward motion halted and rearward motion inhibited by the floor interlock plunger. This is the “disconnect” position and the breaker cannot be operated because of the interface of the interlock plunger and interlock pedal with the breakers trip linkage.

g. From the disconnect position, depress the interlock pedal and push the breaker another 1.5 inches to reach the test position. The test position can be verified by the inability to move the breaker in or out, the interlock pedal is in the full up position, and the cell label “test” is indicated on the right side of the cell. In the “test” position, the breaker can be operated manually and electrically, thus allowing maintenance tests or checks. The shutter operator will engage the shutter lift pin and begin to raise the shutter in the test position. Although slightly raised, the steel shutters still cover the

Figure 4-5 MA-VR Test Position

primary stabs, isolating the breaker from the source. The secondary control block is engaged automatically as the breaker advances from the disconnect to the test position and remains connected throughout further inward movement. The spring charging motor will begin to run and charge the closing spring as the trip interlock is released. The breaker is now in the "test" position, with control voltage applied, and ready for electrical or manual testing.

NOTICE

Once the secondary disconnect block is engaged in the "test" position, it will remain connected throughout further inward movement as the breaker advances from the "test" to the "connect" position.

The spring charging motor will begin to run, if the motor cut-off switch is in the "on" position, and charge the closing spring as the secondary connection is made as long as control power is available. The breaker is now in the "test" position, with control voltage applied and ready for electrical or manual testing.

h. To advance from the test position, depress the interlock pedal and push the breaker about 7 inches until the cell floor levering angle is visible. During this time, any attempt to mechanically close the breaker will cause a trip-free operation. As you continue to advance the breaker into the cell the primary voltage source shutters will fully open allowing the breaker stabs to engage with the source. To install the breaker in the connected position the levering handle will have to be used. Insure the breaker is open and engage the levering handle with the breaker and floor angle (See Figure 4-6).

i. Lever the breaker into the connect position by shifting the levering handle forward. The closing springs may be in the charged state but the internal PS switch will open circuit the close spring release coil (preventing an electrical close).

j. Continue moving the breaker into the cell for about 9 inches of total travel from the test position until a mechanical stop is reached.

This is the fully engaged or connected position. The connect position can be verified by the inability to move the breaker in or out, the interlock pedal is fully up, the trip mechanism and has been released, and the cell label "operate" is indicated on the right side of the cell. The breaker is now ready for service.

WARNING

DO NOT ATTEMPT TO REMOVE A CLOSED CIRCUIT BREAKER. VERIFY THE BREAKER IS IN THE OPEN POSITION PRIOR TO PROCEEDING.

4.4.2 REMOVAL PROCEDURE

To remove the breaker from the cell it must be in the open position. Insure the breaker is open and engage the levering handle. The interlock pedal must be depressed which will raise the trip mechanism and trip the breaker. Move the breaker out using the levering handle. The breaker will start coming out of the cell before the main stabs are disconnected and will be in a non-operable mode. The breaker will go through a trip-free operation if any attempt to close it is made in the intermediate position. The shutters will start to close after the main stabs have cleared, isolating the breaker from its source. Continue removing the breaker until the position indicator on the right side of the cell shows test and the pedal rises to lock the breaker in position. The breaker is in the test position and ready to be operated either electrically or mechanically

To remove the breaker to the disconnect position, depress the interlock pedal and pull outward until the disconnect position stop halts outward travel. To further remove the breakers, the interlock pedal must be again depressed. As the breaker travels outward the last 4 inches in the cell, a floor close signal will combine with the trip signal from the interlock pedal to force a trip-free condition. This will casue the charging springs to discharge leaving the breaker in the open position and the closing springs discharged.

Once the breaker is withdrawn past the floor trip activation area, it is in the withdrawn position. The breaker is ready to be removed from the cell if desired.

4.5 INTERNAL ROTARY RACKING (Optional)

4.5.1 INSERTION PROCEDURE

a. Place the breaker in the withdrawn position (Figure 4-3); verify the breaker position decal indicates the breaker is in the disconnect position.

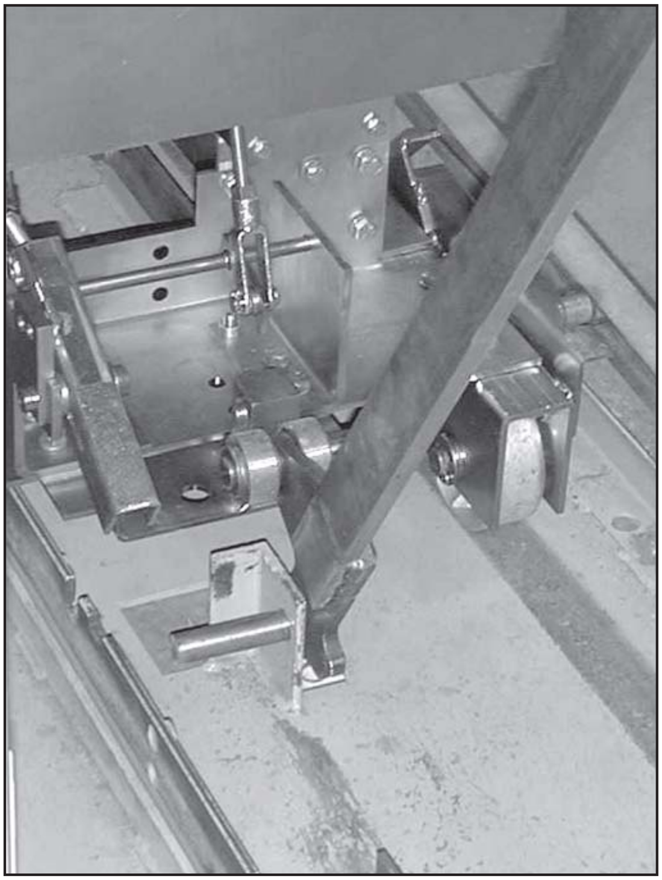


Figure 4-6 Rack-In Position of Handle

WARNING

THE BREAKER CAN BE OPERATED WHEN WITHDRAWN FROM THE CELL, HOWEVER, THE ROTARY RACKING HANDLE MUST BE USED TO RACK THE BREAKER TO THE TEST POSITION, AS SHOWN ON THE BREAKER POSITION DECAL. THE BREAKER MUST BE RACKED TO THE DISCONNECT POSITION, AS SHOWN ON THE BREAKER POSITION DECAL, BEFORE INSERTING IT INTO THE CELL.

b. From the withdrawn position, align the guide bar of the breaker with the guide rails of the cell.

c. Check that the closing spring status indicator reads "DIS-CHARGED" and that the main contact status indicator reads "OPEN".

d. Push the circuit breaker into the cell until the mechanical stop is reached, as indicated by an audible click. In this position the breaker cannot be operated. Verify the breaker position decal, as well as the cell position decal, both indicate the breaker to be in the disconnect position.

e. Rack the breaker further into the cell using the rotary racking handle. The breaker may be stopped in the test position, as indicated by the breaker and cell position decals, if electrical or manual testing is to be performed.

NOTICE

Once the secondary disconnect block is engaged in the "TEST" position, it will remain connected throughout further inward movement as the breaker advances from the "TEST" to the "CONNECT" position.

The spring charging motor will begin to run, if the motor cut-off switch is in the "ON" position, and charge the closing springs as the secondary connection is made as long as control power is available.

f. From the test position, the breaker can be advanced to the connect position using the rotary racking handle. Connect position is reached when the rotary racking handle can no longer be turned with normal force, and the breaker and cell position decals indicate the connect position.

4.5.2 REMOVAL PROCEDURE

a. To remove the breaker from the cell, it must be in the open position; interlocking will prevent removal if the breaker is closed. Engage the rotary racking handle into the racking shaft until it interfaces with the racking linkage. Rotate the rotary racking handle counter-clockwise to move the breaker out of the cell. The shutters will start to close after the primary stabs have cleared, isolating the breaker from its source. Continue rotating racking

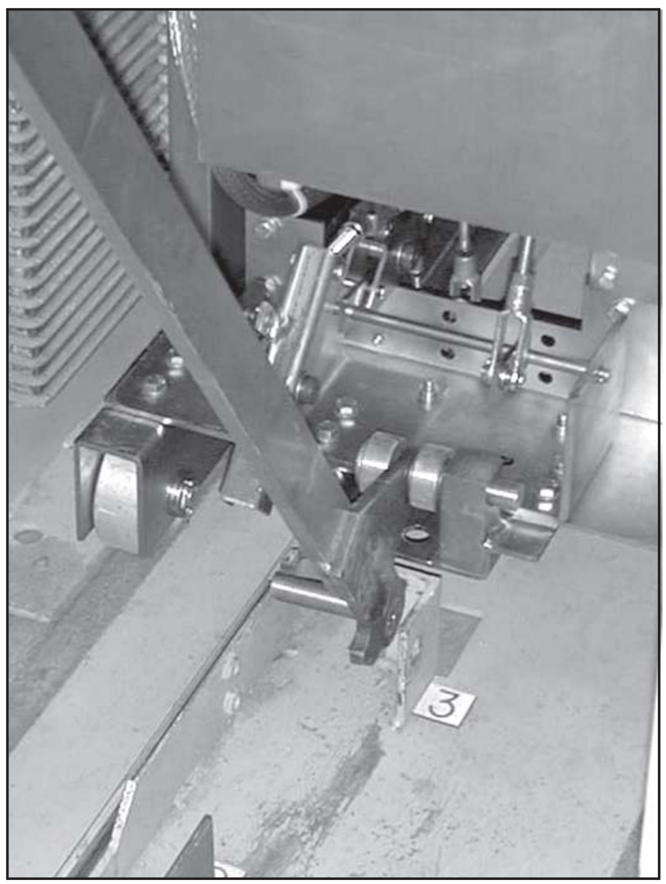


Figure 4-7 Rack-Out Position of Handle

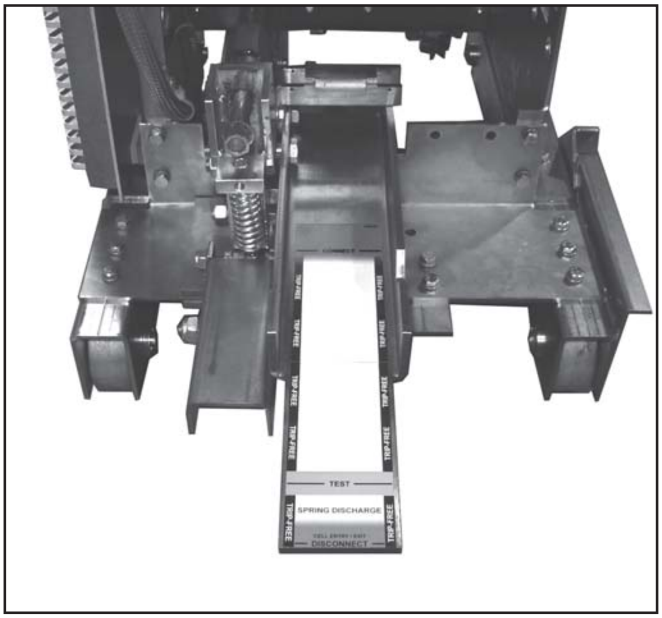


Figure 4-8 Rotary Racking Mechanism (Cover Removed For Clarity)

handle counter-clockwise until the position decals on the breaker and cell indicate test position. In test position the breaker is ready to be operated either electrically or mechanically.

b. To further remove the breaker to the disconnect position continue turning the rotary racking handle in the counter-clockwise direction. ***If the breaker was inadvertently left charged in the test position, the springs will discharge as the breaker is levered to the disconnect position, resulting in a loud noise.*** The breaker will be in the disconnect position when the rotary racking handle can no longer be turned with normal force, and the breaker and cell position decals indicate disconnect position. At this point, the breaker will automatically be open and all spring stored energy will be discharged.

c. If the breaker is to be withdrawn from the cell, depress the interlock pedal while pulling the breaker out of the cell using the handles on each side of the front of the breaker.

4.6 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 withdrawn from the cell. ***Breakers with Levering Handle Racking will operate in the withdrawn position. Breakers with Internal Rotary Racking must be levered into the test position, as shown on the breaker position decal, prior to performing manual operation checks. After testing is complete, breakers with Internal Rotary Racking must be racked to the disconnect position, as shown on the breaker position decal, before insertion into the cell.***

When the breaker is ready for testing, 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 SPRINGS. FAILURE TO REMOVE THE MAINTENANCE HANDLE FROM THE BREAKER COULD CAUSE INJURY TO PERSONNEL AND/OR EQUIPMENT DAMAGE IF THE BREAKER WAS TO CLOSE OR TRIP.

Close and trip the breaker by pushing the close lever then the trip lever (Figure3-13). Repeat the charge, close, and trip procedure several times to confirm the mechanism operates consistently and reliably. ***After testing is complete, breakers with Internal Rotary Racking must be racked to the disconnect position, as shown on the breaker position decal, before insertion into the cell.***

WARNING

DO NOT ATTEMPT TO INSTALL OR OPERATE A VACUUM CIRCUIT BREAKER UNTIL THE TESTS OF SECTION 4.7 THROUGH 4.12 ARE SUCCESSFULLY PERFORMED.

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

4.7 VACUUM INTEGRITY TEST

Check the vacuum integrity of the interrupters of the three pole units by conducting the applied potential test described in Section 6.4 of this book.

4.8 LOW FREQUENCY WITHSTAND TEST (INSULATION CHECK)

Perform insulation integrity tests as described in Section 6.7.

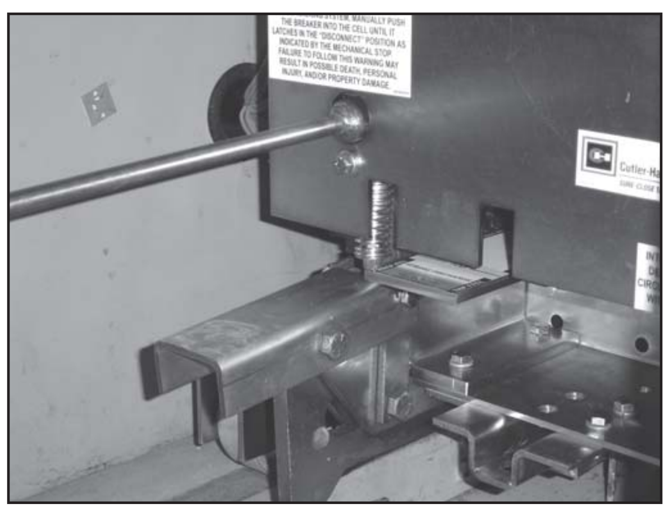


Figure 4-9 Using The Racking Handle

Figure 4-10 Connected Position

4.9 CONTACT EROSION AND STROKE, CONTACT WIPE

Close the breaker. Check all three vacuum interrupter erosion indicator marks as described in Section 6.5 and illustrated in Figure 6-3 to verify that contact erosion indicator is visible. Check contact wipe as described in Section 6.5 and illustrated in Figure 6-5.

4.10 PRIMARY CIRCUIT RESISTANCE TESTS

Check the primary circuit resistance of the three pole units as described in Section 6.8. The resistance should not exceed the values specified. Record the values for future reference.

4.11 ELECTRICAL OPERATIONAL CHECKS

These checks can be performed with the breaker in its withdrawn or 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.

WARNING

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

4.12 *SURE CLOSE* MECHANISM ADJUSTMENT

WARNING

FOR ALL TYPE 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 MA-VR Breakers with MOC operators utilize the ***SURE CLOSE*** mechanism to control MOC velocity and closely mimic the dynamics and velocities of older breakers. It is imperative that this mechanism be adjusted to match the force of MOC switches mounted in the cell.

Figure 4-11 Disconnect Position

The breaker has been factory adjusted to operate a mechanism operated contact (MOC) in the cell. This means that for applications with either no MOC switch or one MOC switch, no field adjustments should be required.

The breaker has been factory adjusted to a force of 37-52 lbs., which would normally operate a well-maintained MOC assembly, with one switch.

To insure the proper operation of the ***SURE CLOSE*** mechanism, the MOC assembly should be cleaned and inspected for worn parts and then lubricated. 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 (See Figure 4-15). The differential force of the assembly and the breaker should be a minimum of 10 lbs. with the breaker having the higher recorded force. Should the forces be less than that, proceed with the following steps to increase the breaker force:

Step 1: Locate the MOC drive spring (Figure 3-3). It is located in the left lower portion of the breaker as viewed from the top rear of the breaker.

Step 2: From the factory, the drive spring comes set with adequate force to operate the MOC, however, more force can be generated. Refer to Figure 4-14 to see how that adjustment would look. Notice that there is a nut and a jam nut on the threaded rod to make the adjustment easy.

Step 3: With the breaker out of the cell, close the breaker and measure the output of the MOC drive with a spring gauge immediately after force has been recorded, open the breaker. The MOC drive force should exceed the MOC cell force requirement by a minimum of 10lbs. If not, an adjustment is required.

Step 4: Loosen the jam nut on the ***SURE CLOSE*** spring and compress the spring an additional .25 inch. Close the breaker. The minimum dimension that the spring can be tightened to is 3.00 inches as measured per figure 4-13.

Step 5: Remeasure the MOC output spring force in the closed position. Repeat until the MOC forces are adequate.

Step 6: Insert into the cell.

Step 7: Operate the breaker to verify the new setting.

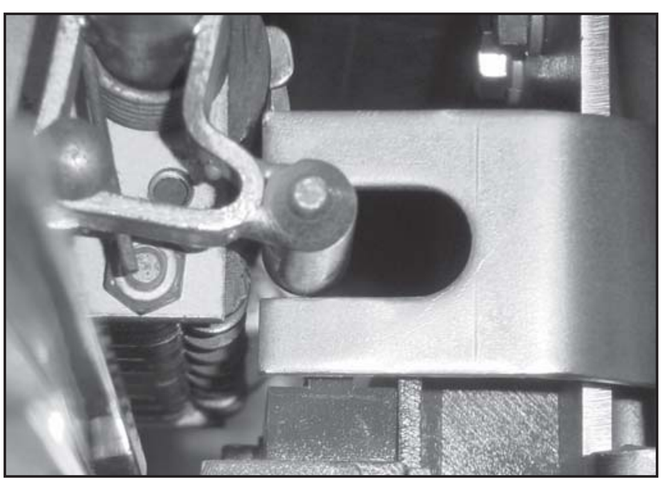


Figure 4-12 MOC Operator

Step 8: Repeat steps 3-8 until acceptable operation is achieved.

Step 9: Anytime an adjustment is made, make sure the new compressed spring length (measured in the open position) is recorded if different than the dimension in this instruction book.

Step 10: After an adjustment is made, make sure that all nuts are secured in place, prior to returning to service.

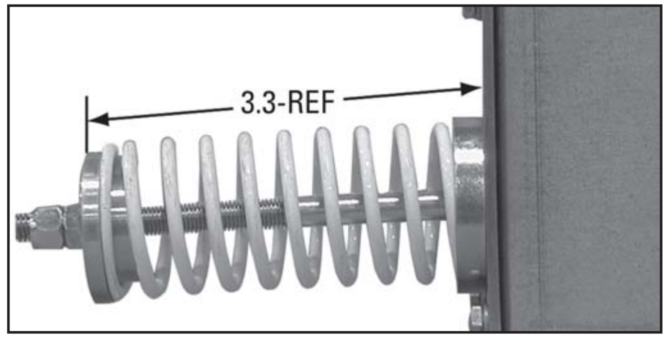


Figure 4-13 ***SURE CLOSE*** *Spring Adjustment Setting*

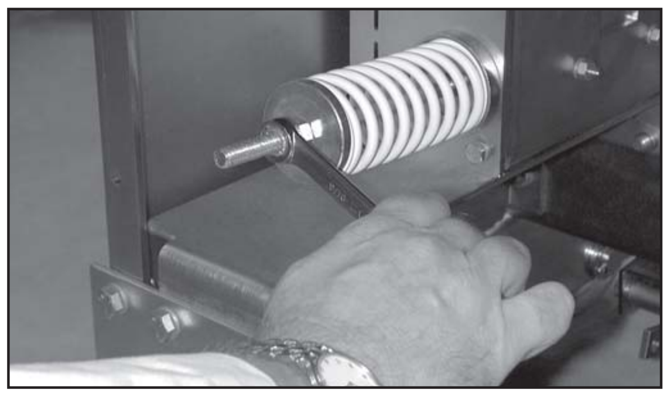


Figure 4-14 ***SURE CLOSE*** *Spring Adjustment*

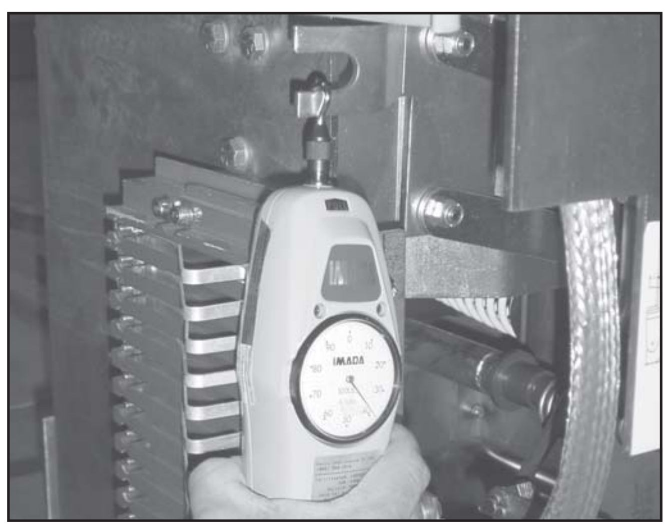


Figure 4-15 Measuring With Spring Force Gauge

SECTION 5: 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.

5.1 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.

5.1.1 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 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 6-3)

5.1.2 CONTACT EROSION INDICATOR

When contact erosion reaches 1/8 inch, the interrupter assembly must be replaced. The contact erosion indicator is a horizontal line marked on the moving stem of the interrupter (See Figure 6-2 and 6-3).

To judge erosion, close the breaker and view the erosion mark on each vacuum interrupter moving stem. When the vacuum interrupter is new, the mark is approximately 1/8 inch below the stem guide. If the mark is no longer visible (because it has moved under the stem guide), the interrupter is at the end of its allowable wear, and the complete interrupter assembly must be replaced.

Figure 5-1 MA-VR Interrupter

Figure 5-2 MA-VR Interrupter Assembly

WARNING

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.

5.1.3 CONTACT WIPE AND STROKE

Wipe is a measure of (1) force to hold vacuum interrupter contacts closed and (2) energy to hammer the contacts open with sufficient speed for safe and clean interruption.

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

The circuit breaker mechanism provides a fixed amount of motion to the operating rods. 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 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. Thus, there is no provision for adjustments.

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.

5.2 PHASE BARRIERS

Phase barriers are flat sheets of insulation placed between the interrupter assemblies and on the sides of the breaker frame. Barriers between interrupter assemblies are two pieces with the forward piece being confined by a separator attached to the breaker frame and the rear inner barriers being confined by the bushing assemblies and a retainer bolted to the back of the bushing supports. The side barriers are attached to vertical components of the front cover and original retainers bolted to the back of the bushing supports.

WARNING

ALL SIX 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.

5.3 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. 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.

5.4 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) so that they are accessible while the breaker is in any of its four basic positions. (See Section 4.2)

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 5-5 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” type. This means that if an electrical or mechanical trip signal is present at the same time as a close signal, the closing spring will discharge without causing a closing direction movement in the primary circuit contacts.

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.

WARNING

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

WARNING

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.

5.4.1 CLOSING SPRING CHARGING

Figure 5-4 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 (11) is actuated by an oscillating ratchet lever (9) 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 (14) comes against the spring release latch (3). The closing springs are now held in 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.

5.4.2 CLOSING OPERATION

Figure 5-5 shows the positions of the closing cam and tripping linkage for four different operational states. In Figure 5-5a 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 5-5b).

When the spring release clapper (5) moves into the face of the spring release coil (electrically or manually), the upper portion of the clapper pushes the spring release latch (4) upward. When the spring release latch moves, the cam shaft assembly is free to rotate. The force of the closing cam (8), moving the main link (2), rotating the pole shaft (1) (which charges the opening spring). This moves the three operating rods (9), 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 5-5c. Interference of the trip "D" shaft with the trip latch prevents the linkage from collapsing, and holds the breaker closed.

Figure 5-5d 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.

5.4.3 TRIPPING OPERATION

When the trip bar "D" shaft (11) is turned by movement of the shunt trip clapper (5), 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 5-5b) after the breaker is tripped open.

5.4.4 TRIP-FREE OPERATION

During the normal closing process, the position of the trip latch (4) and banana link (3) causes the main link roller (10) to move in a fixed arc such that the main link can drive the pole shaft. If the trip latch is released by rotation of the trip bar "D" shaft before or during the closing process, the main link roller rises to a position which prevents the main link from driving the pole shaft (trip free operation). When the manual trip button is held depressed or the trip linkage is raised, any attempt to close the breaker will discharge the closing springs, without any movement of the pole shaft or vacuum interrupter stem.

5.5 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 5-6). 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.

Table 5.1 - 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

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.

5.6 SECONDARY CONNECTION BLOCK

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

5.7 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.

WARNING

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.

5.7.1 ANTI-CLOSE INTERLOCK

The anti-close interlock prevents discharging of the closing springs if the breaker is already closed (Figure 5-4, Item 2). When the breaker is closed, the interlock component moves away from the spring release clapper so that it cannot lift the spring release latch (3).

5.7.2 RACKING SYSTEM TRIP AND SPRING RELEASE INTERLOCKS

5.7.2.1 LEVERING HANDLE RACKING

The interlock plunger prevents engaging a shut breaker with live cell buss work or removing a potentially hazardous breaker from the cell. The foot lever (Interlock Pedal) operates the interlock plunger as well as the trip mechanism. Depressing the lever trips the breaker and raises the plunger sufficiently to release the breaker allowing it to be moved in the cubicle. The interlock is in proper adjustment when the plunger is positioned to 1-11/16" to 1-13/16" above the floor line, and causes tripping of the breaker when it is raised to a level of not more than 2-1/16" above the floor line.

5.7.2.2 INTERNAL ROTARY RACKING

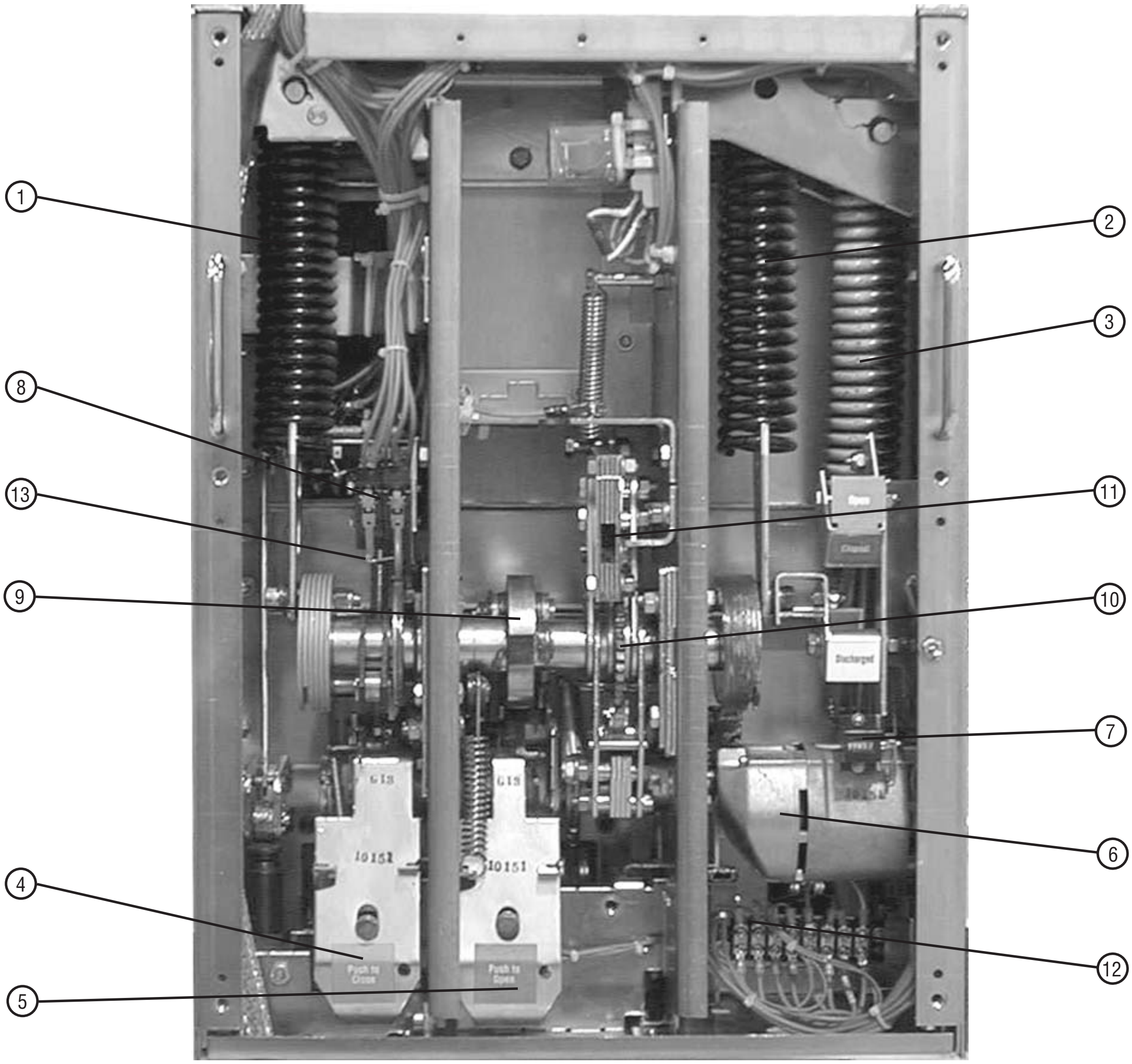
An active interlock is provided to keep the breaker in a trip free position when the breaker is between the test and fully connected position; no adjustments are necessary. In addition to the active interlock, two passive interlocks are provided; one to prevent engaging the rotary racking handle into the breaker when the breaker is closed, and one to prevent turning the rotary shaft in the breaker when the breaker is closed.

5.7.3 SHUTTER INTERLOCK

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 an operator located on the breaker that opens the shutter as the breaker is racked into the cell and closes the shutter as the breaker is racked out of the cell.

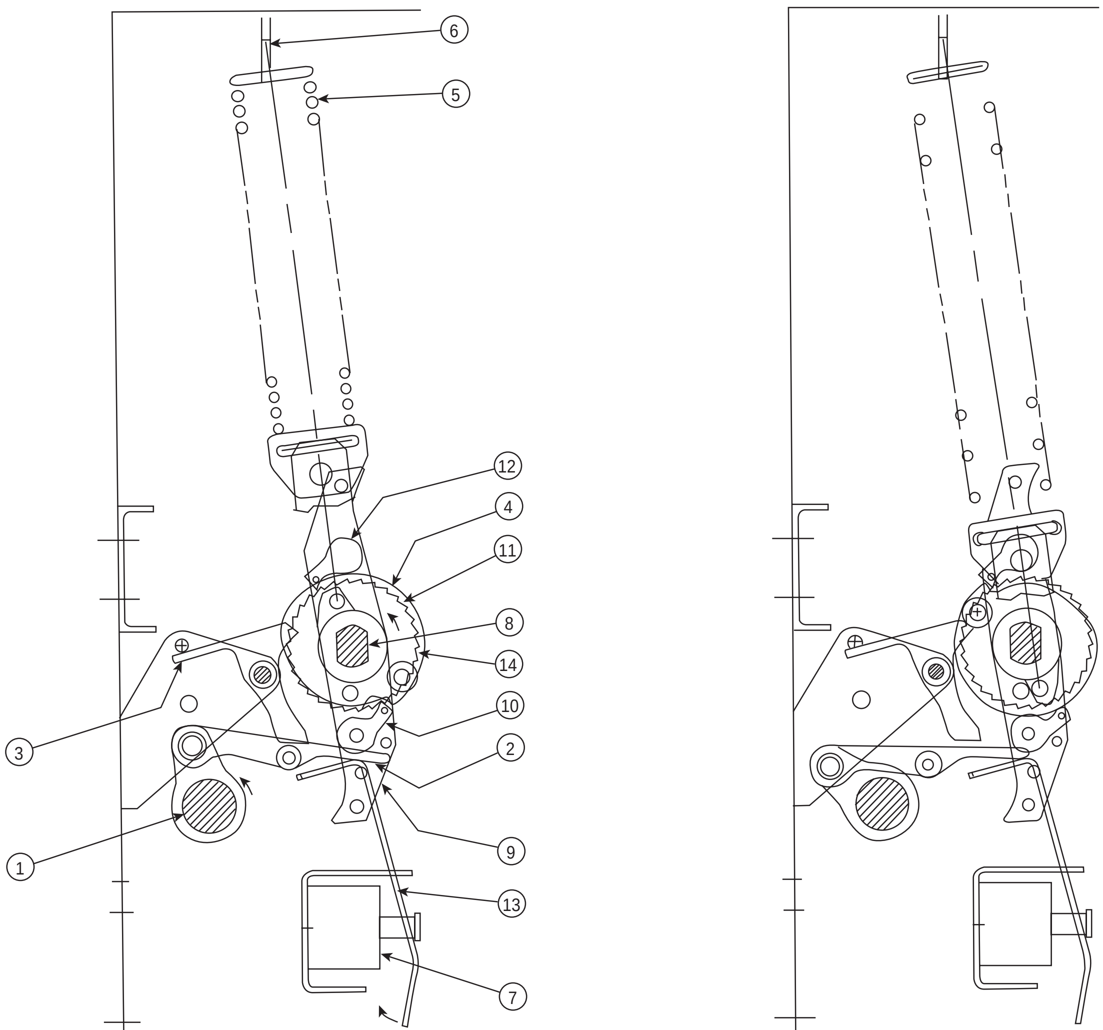
5.8 MOC (Mechanically Operated Contacts) OPERATOR

The MOC operator located on the breaker is linked to the MOC operator inside the VCP-WR element. When the breaker closes, regardless of whether it is in the cubicle, the MOC linkage of the 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 breaker is in the "test" or "connected" position the MOC operator will operate the MOC switch when the breaker closes. The MOC switch contains contacts which are used to interlock the circuit breaker with other external devices and can provide breaker status indication.



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

Figure 5-3 MA-VR Vacuum Element - Front Faceplate Removed



Breaker Open, Springs Discharged

Breaker Open, Springs Charged

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

Figure 5-4 Closing Cam and Trip Linkage

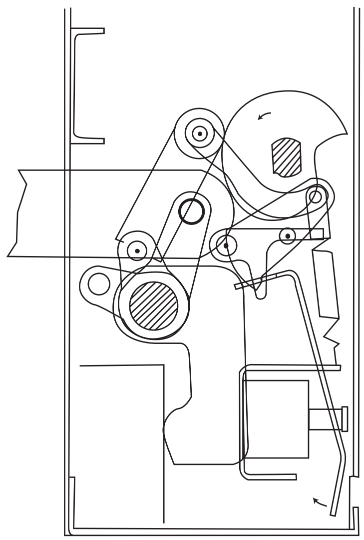


Figure 5-5a Breaker Open and Closing Spring Not Charged

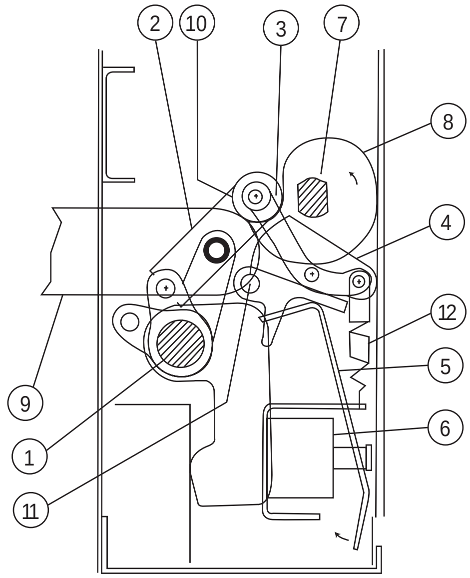


Figure 5-5b Breaker Breaker Open and Closing Spring Charged

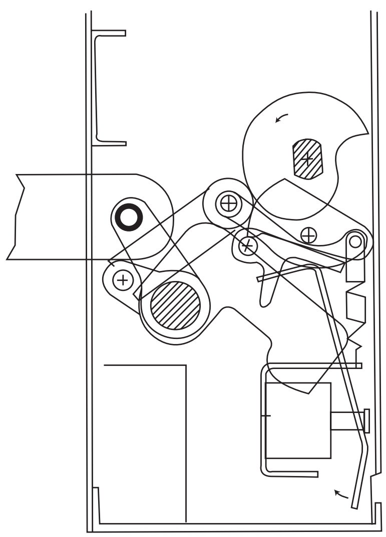


Figure 5-5c Breaker Closed and Closing Spring Not Charged

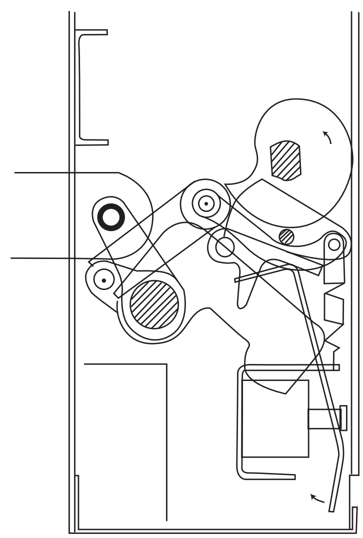
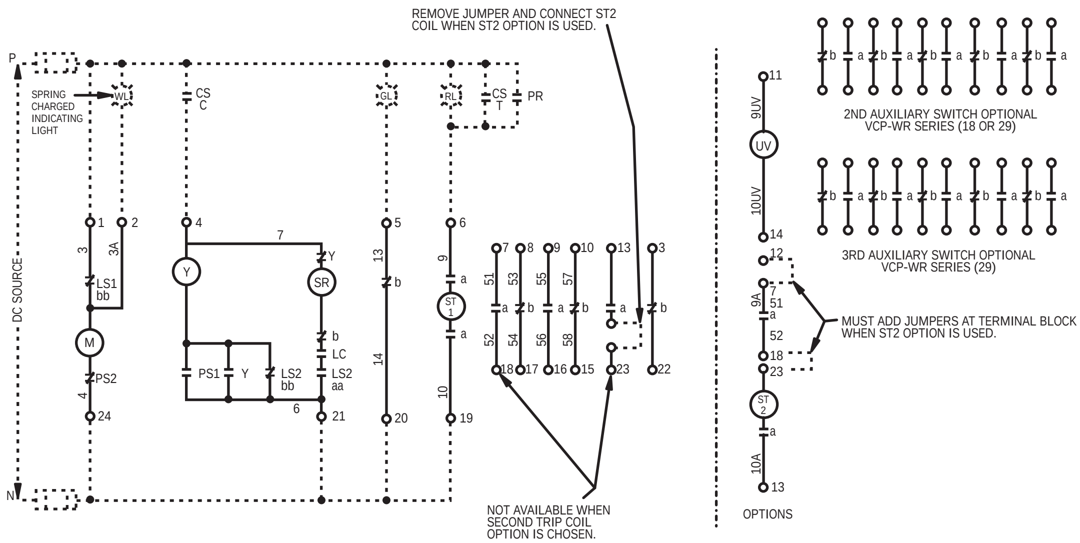


Figure 5-5d Breaker Closed and Closing Spring Charged

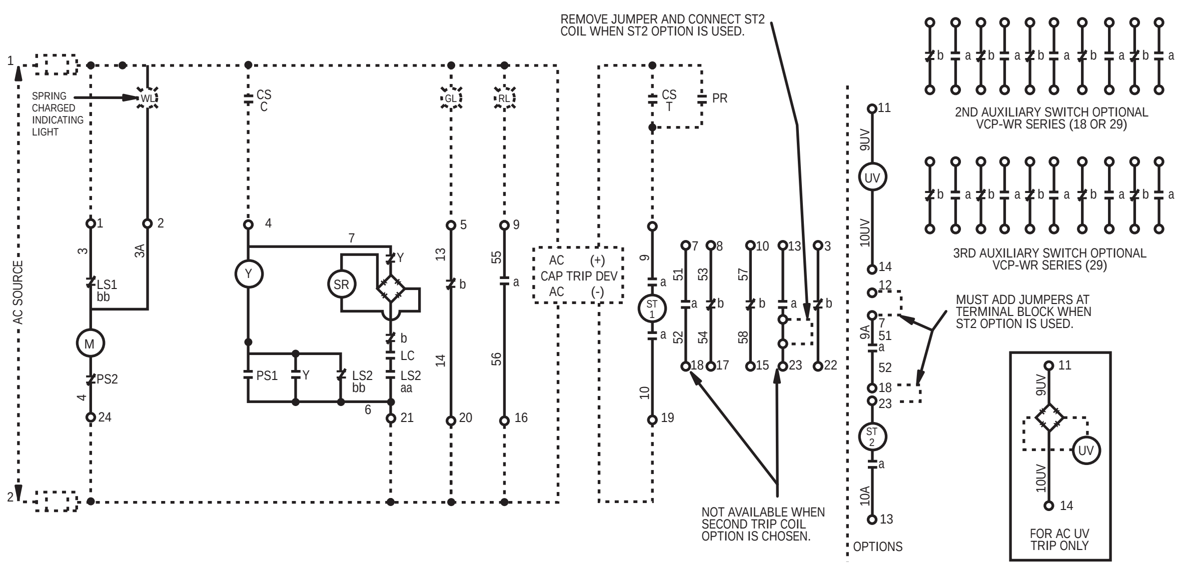
1 Pole Shaft
2 Main Link
3 Banana Link
4 Trip Latch
5 Shunt Trip Lever
6 Shunt Trip Coil
7 Cam Shaft
8 Closing Cam
9 Operating Rod
10 Main Link Roller
11 Trip Bar "D" Shaft
12 Trip Latch Rest Spring

Figure 5-5 Charging Schematic

VCP-WR (18, 20, 29) BREAKER DC CONTROL SCHEMATIC



VCP-WR (18, 20, 29) 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	SWITCH TERMINAL	
LS1/bb	Closed until springs are fully charged	'C' and 'NO'	Brown Switch
LS2/aa	Open until springs are fully charged	'C' and 'NC'	Black Switch
LS2/bb	Closed until springs are fully charged	'C' and 'NO'	Black Switch
LC	Open until mechanism is reset	'C' and 'NO'	
PS1	Open in all except between 'Test' and 'Connected' positions	'C' and 'NC'	Black Switch
PS2	Closed in all except between 'Test' and 'Connected' positions	'C' and 'NO'	Brown Switch

Figure 5-6 Typical AC/DC Schematic

WARNING

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

5.9 TOC (Truck Operated Contacts) OPERATOR

The TOC switch, located on the right side of the cubicle, is operated by the breaker truck frame. If the 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 breaker position.

5.10 LEVERING MECHANISM

5.10.1 LEVERING HANDLE RACKING

The levering system moves the circuit breaker the final inches between the “test” and “connect” positions. When levering, the levering handle provides leverage enough to overcome the resistance to movement from the primary disconnects and moving the shutters.

The levering handle attaches to the front of the breaker and engages with the cell floor to push the breaker into the cell or draw the breaker from the cell. A very large mechanical advantage is realized because of the long length of the levering handle relative to the driving arm that engages the floor of the cell. Figure 5-7 illustrates the orientation of the levering handle with the breaker and cell. Minimal effort is required to move the breaker from “disconnect” to “connect” position. Care and experience is needed in order to determine whether a more than usual force is required to lever the breaker into a cell, as this might be an indication of a mechanical interference or misalignment of components. If unusual force is noted, the breaker should be withdrawn from the cell and re-examined to determine the reason.

5.10.2 INTERNAL ROTARY RACKING

The internal rotary racking levering system advances the breaker from the disconnect position to the test position to the connect position, and vice versa. The rotar racking handle engages the breaker (Figure 5-8) and turning it in a counter-clockwise position will advance the breaker handle cannot turn with normal force when the breaker is advanced into the connect position or, when the breaker is removed to the disconnect position.

WARNING

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

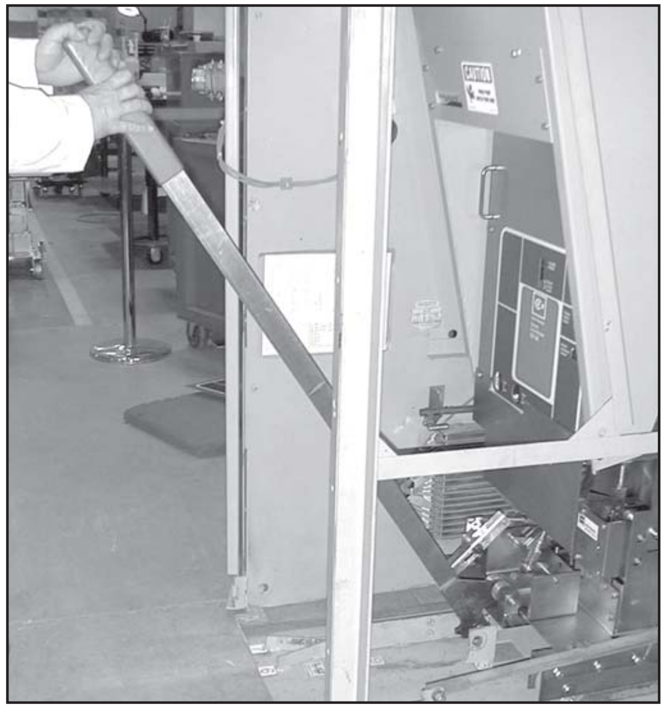


Figure 5-7 Levering Handle Engaging Cell Floor

5.11 GROUNDING CONTACT

The grounding contact is an assembly of spring loaded fingers which ground the breaker frame by engaging the switchgear cell grounding bus when the breaker is racked into the cell. The ground contact is located at the rear of the breaker near the floor and visible from the back of the breaker when out of the cell.

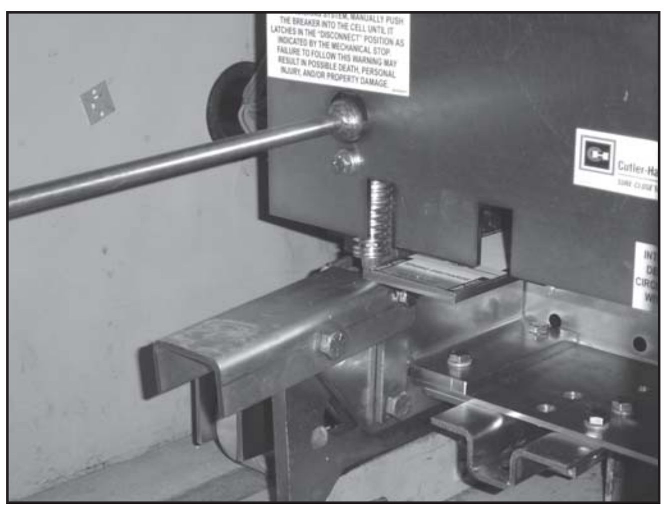


Figure 5-8 Rotary Racking Handle Engaging Internal Racking Shaft

SECTION 6: INSPECTION AND MAINTENANCE

6.1 INTRODUCTION

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.**
- **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.**

6.2 FREQUENCY OF INSPECTION

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.

Refer to the table on following page for maintenance and inspection check points.

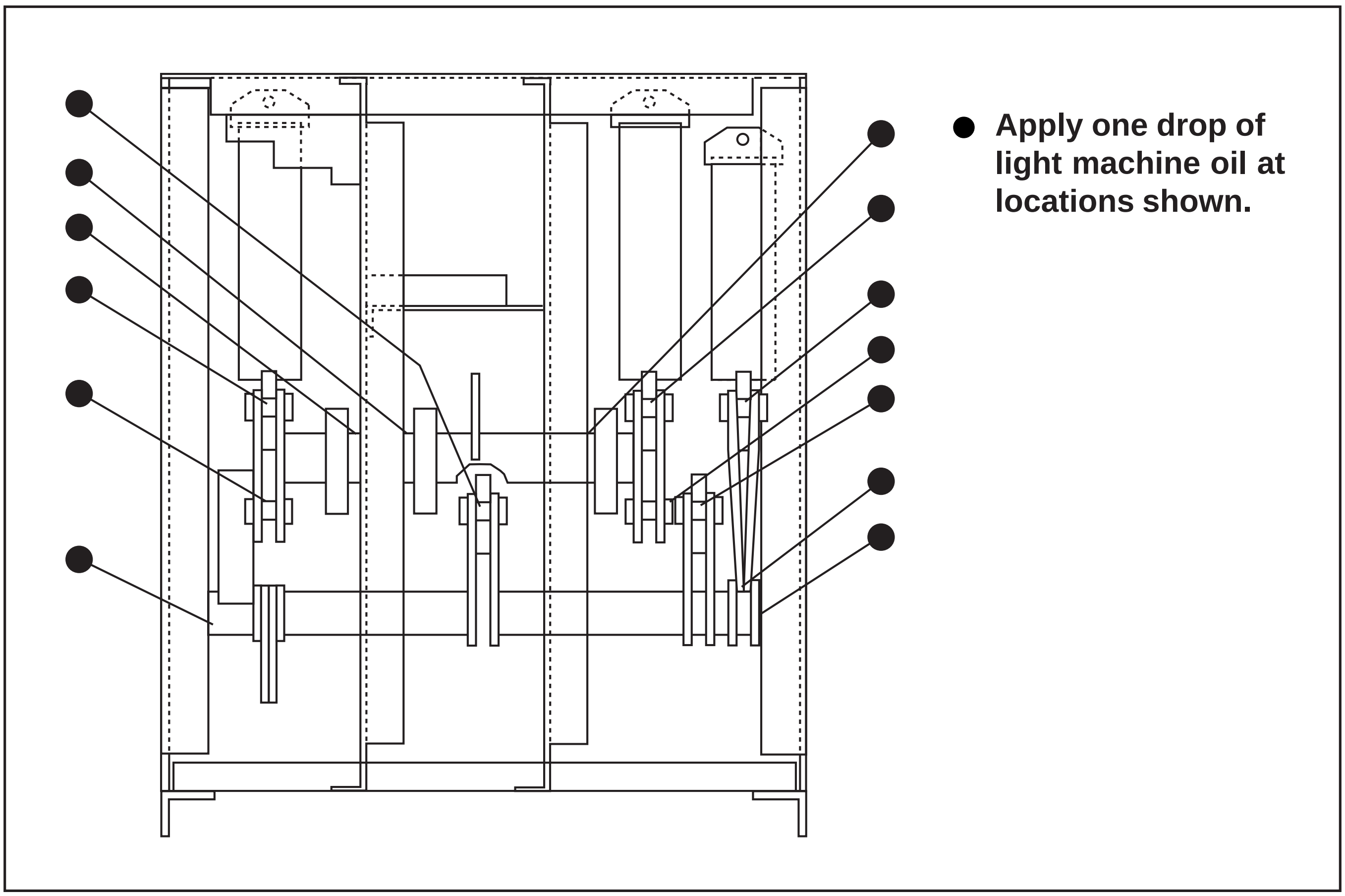


Figure 6-1 Lubrication Areas

6.3 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
Insulation Integrity	Between Main Circuit With Terminals Ungrounded	Withstand 27K 60Hz for 1 minute	Hipot Tester	Clean and retest or replace
	Main Circuit to Ground	Withstand 15kV, 60Hz for 1 minute (5kV Ratings) 27kV, 60Hz for 1 minute (15kV Ratings)	Hipot Tester	Clean and retest or replace
	Control Circuit to Ground	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 breaker and look for green mark on moving stem from the rear of the breaker (See Figure 6-2 and 6-3)	If mark is not visible, replace interrupter assembly.
		Contact wipe visible	Visual (Figure 6-4 and 6-5)	Replace VI assembly
		Adequate Vacuum	See Section 6.4	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 breaker twice	Replace any defective device-Identify per trouble-shooting chart
	Wiring			Repair or tie as necessary
	Terminals			Tighten or replace if necessary
	Motor			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	
	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 6-9.1	If <0.6 contact P.I.C. at 412-787-6518

Bolt Size	8-32	10-32	.25-20	.31-18	.38-16	.50-13
Torque Lb. In.	24	36	72	144	300	540

6.4 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. 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.

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.

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

Table 6.1 - Voltages

6.5 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. Maximum permitted erosion is 1/8 inch. 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 6-2 and 6-3).

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 6-4 and 6-5 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.

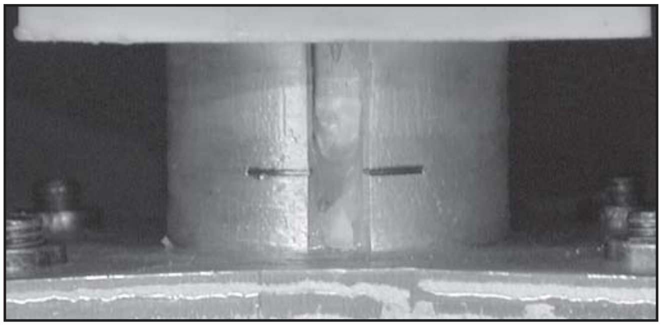


Figure 6-2 Vacuum Interrupter Showing Contact Erosion Indicator With Breaker Open (Shown here for clarity purposes only)

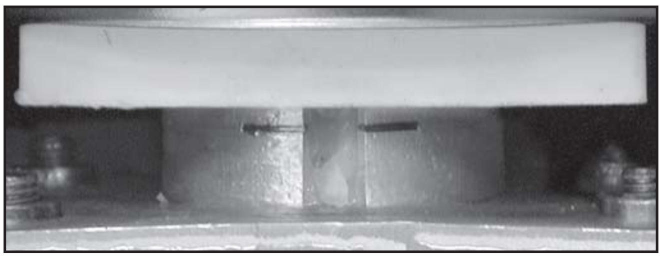


Figure 6-3 Vacuum Interrupter Showing Contact Erosion Indicator With Breaker Closed (Indicators are checked only when breaker is closed.)

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.

6.6 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 Stoddard's Solvent Cutler-Hammer 55812CA or commercial equivalent. Secondary control wiring requires inspection for tightness of all connections and damage to insulation.

6.7 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, 27 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 pulling apart the two insulated quick disconnecting terminals in the two motor leads provided for this purpose. 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.

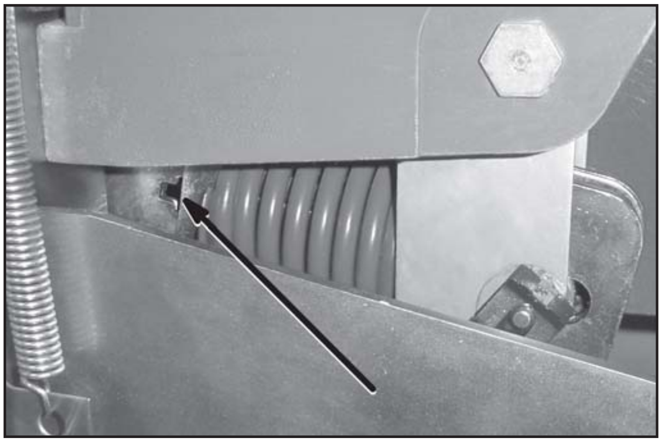


Figure 6-4 The Arrow Shows The "T" Contact Wipe Indicator - Example with Blue Spring (if the "T" or any portion of its visible as shown with the breaker closed, the wipe is satisfactory, See Next Figure for Graphic of All Possibilities).

6.8 PRIMARY CIRCUIT RESISTANCE CHECK

Since the main contacts are inside the vacuum chamber they remain clean and require no maintenance at any time. Unlike most typical circuit breaker designs, VR-Series breakers do not have sliding contacts at the moving stem either. Instead they use a highly reliable and unique flexible clamp design that eliminated the need for lubrication and inspection for wear.

If desired, the DC resistance of the primary circuit may be measured as follows: close the breaker, pass at least 100 amps DC current through the breaker. With the low resistance instrument, measure resistance across the studs on the breaker side of the disconnects for each pole. The resistance should not exceed the test levels by more than 15%. Factory test levels are recorded on the Circuit Breaker Test Form.

6.9 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 5.1**.**

6.9.1 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.

At times, circuit breakers are called upon to operate MOC switches (Mechanism Operated Control switches) that place extra load upon

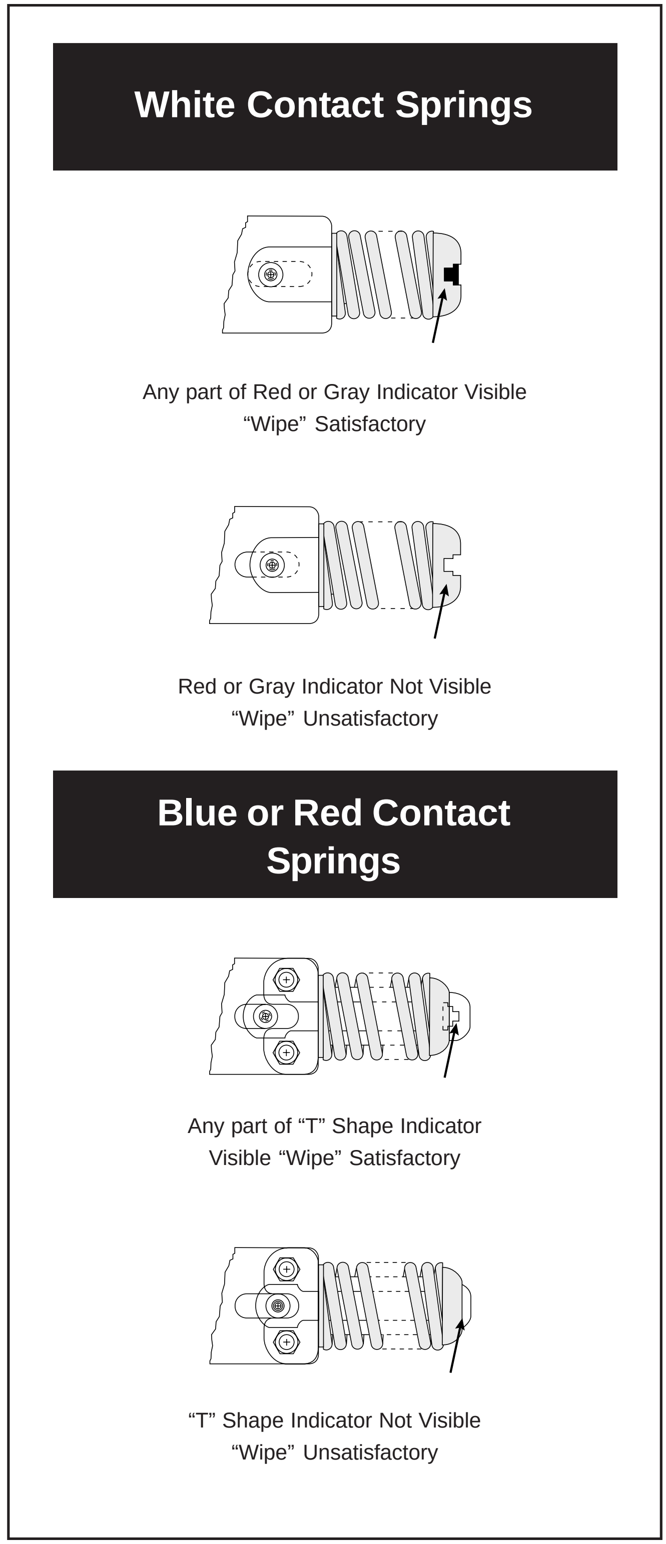


Figure 6-5 Wipe Indication Procedure (performed Only with Breaker Closed)

the closing mechanism of the circuit breaker. If this load is excessive, it can prevent the circuit breaker from closing fully. In such a case, it is important to determine that the circuit breaker will close fully. The CloSure™ Test provides this assurance.

General Information: The CloSure™ Test can be performed on the VCP-W, VCP-WR, VCPW-ND, DHP-VR, W-VACR, and W-VAC lines of vacuum circuit breakers. Refer to Table **6-4** for a list of circuit breakers. If the CloSure™ travel obtained is as specified, the mechanism performance is satisfactory. If the CloSure™ travel does not conform as shown in Figure **6-16**, 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.

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 breaker is safely pulled out to the Test/Disconnect position in the enclosure or placed on the workbench, follow this procedure to perform the CloSure™ Test. For further instructions on the disconnecting the circuit breaker consult section 4 of this manual. If the enclosure is equipped with the MOC operating in the test position also, make certain that the MOC is connected to operate.

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 6-6).

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

Step 3 - Cut a piece of one inch wide drafting/masking tape approximately 8 to 10 inches long.

Step 4 - Place the tape around the cam starting from the bottom up. Make certain that the tape adheres well to the cam surface. (See Figure **6-7**).

Step 5 - Mount the transparent CloSure™ Test Tool with two bolts and washers. Refer to Figure **6-8** and Table **6.2** for appropriate mounting holes. Hand tighten the bolts (Figure **6-8**).

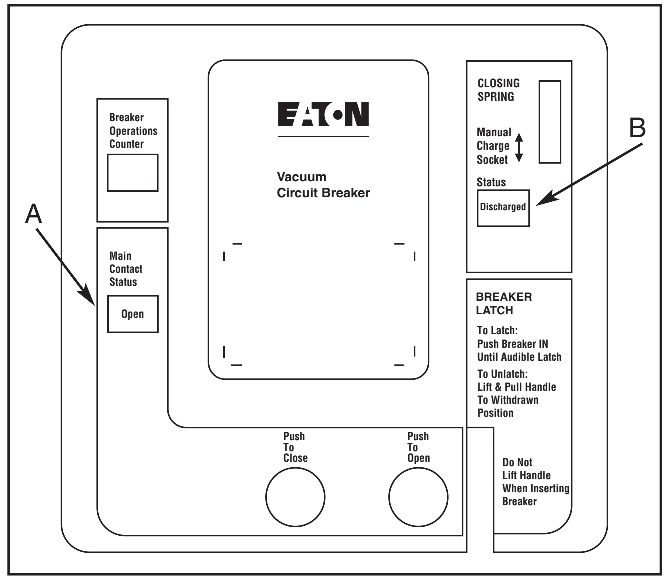


Figure 6-6 Status Indicators ("A" shows the contact status indication and "B" shows the spring indication.)

Step 6 - A Sanford® Sharpie® black fine point permanent marker, item no. 30001, is recommended for this next step. Place the marker tip in the proper hole ("**C**"). Make a heavy mark on the tape as shown in Figure **6-10.**

Step 7 - Charge the closing springs with the maintenance tool. Continue charging the closing springs until a "click" is heard and the status indicator shows "CHARGED" (Figure **6-9**).

Step 8 - While holding the marker tip on the tape, close the breaker (Figure **6-11**).

Step 9 - Move the marker back and forth horizontally approximately 15^{o} in both directions to create a line on the tape that identifies the closed rest position (Figures **6-12** and **6-13**).

Step 10 - Remove the marker from hole "**C**".

Figure 6-7 Wrapping Tape Around Cam

Step 11 - Push the “Push to Open” clapper to open the circuit breaker.

Step 12 - Inspect the circuit breaker to assure it is in the open position and the closing springs are discharged. Remove the transparent CloSure™ Tool. Remove the tape from the cam and stick the tape on the front right side sheet of the circuit breaker. Record the date of the test and the operations counter reading on the tape (Figures **6-14** and **6-15**).

Step 13 - Evaluate the CloSure™ performance by comparing the test tape with illustrations in Figure **6-16**. If the marking is similar to **6-16A**, measure the over travel “x”: If “x” is greater than or equal to 0.6 inches, the circuit breaker performance is satisfactory. If “x” is less than 0.6 inches or if the marking is similar to **6-16B** or **6-16C**, immediately contact the Production Integrity Center for Technical Support at (412) 787-6518.

Step 14 - Remove the CloSure™ Tool. Reassemble the front cover onto the circuit breaker. Return the circuit breaker to it’s original configuration and setup.

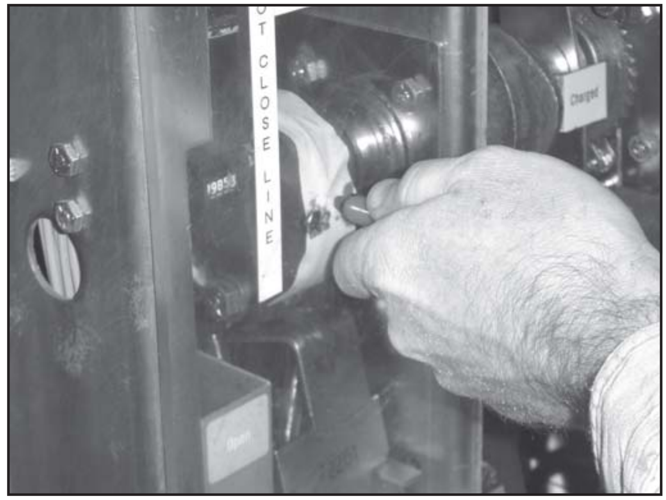


Figure 6-10 Make a Clear and Heavy Mark

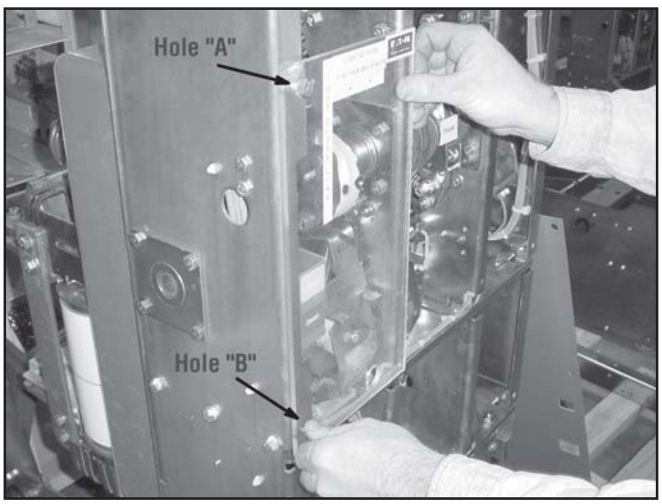


Figure 6-8 Attaching CloSure™ Test Tool at Hole “A” & “B”

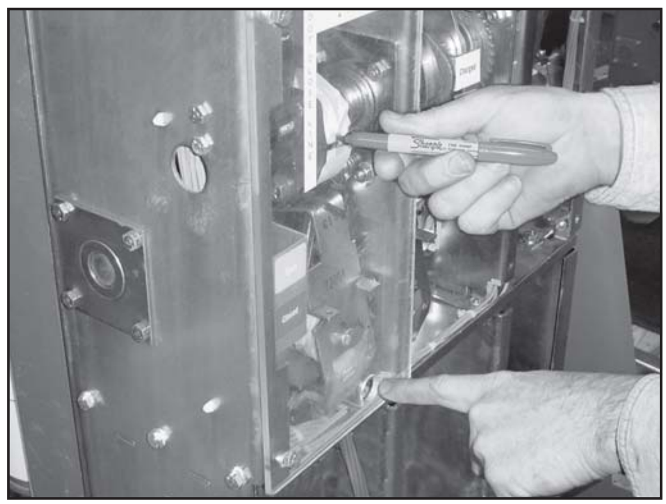


Figure 6-11 With Marker in Hole “C”, While Closing Breaker

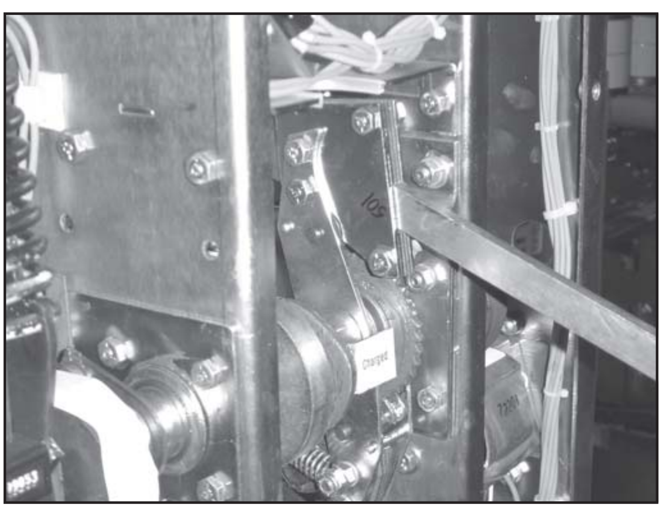


Figure 6-9 Manually Charging Closing Springs

Figure 6-12 Move the Sharpie® 15º Left and Right

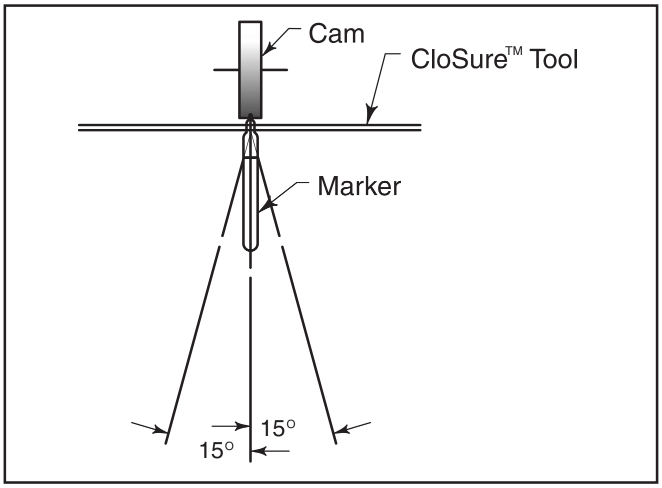


Figure 6-13 Top view of Cam and Marker Interface

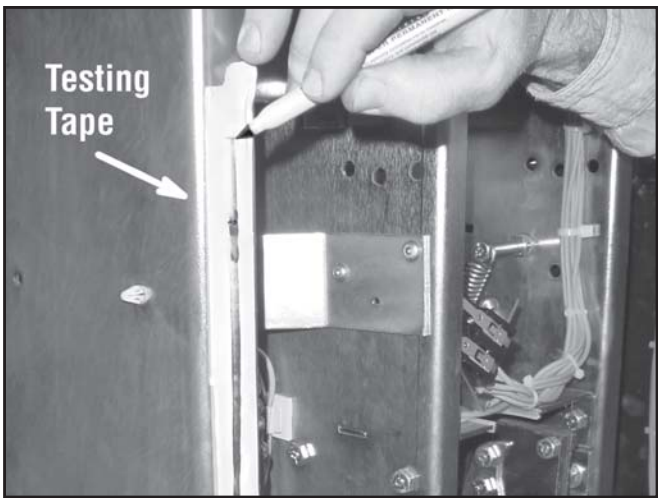


Figure 6-14 Evaluate the CloSure™ Performance

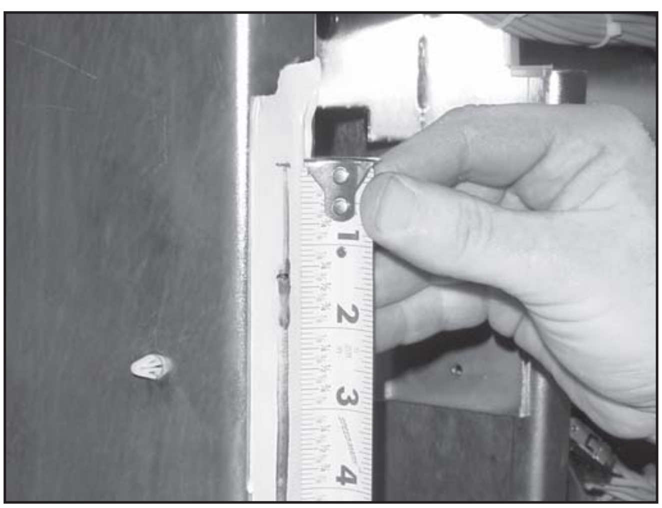


Figure 6-15 Determining the Distance Traveled

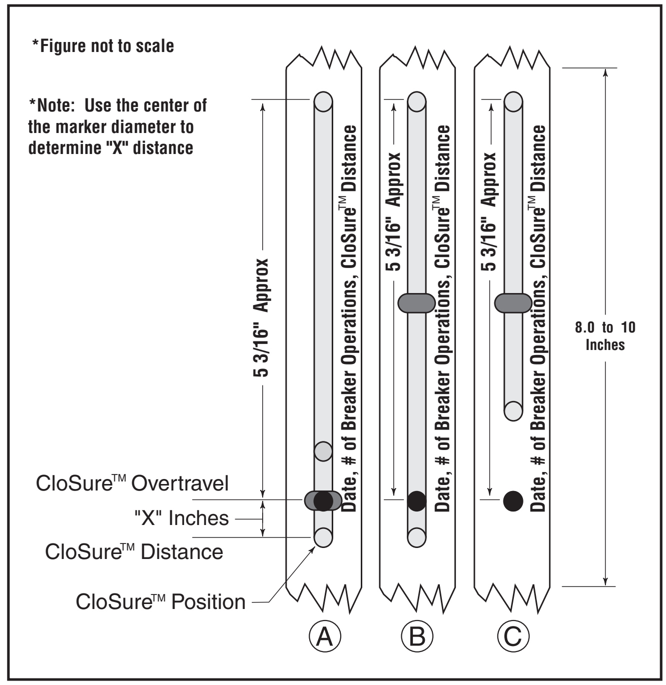


Figure 6-16 Illustrative Testing Tape Sample

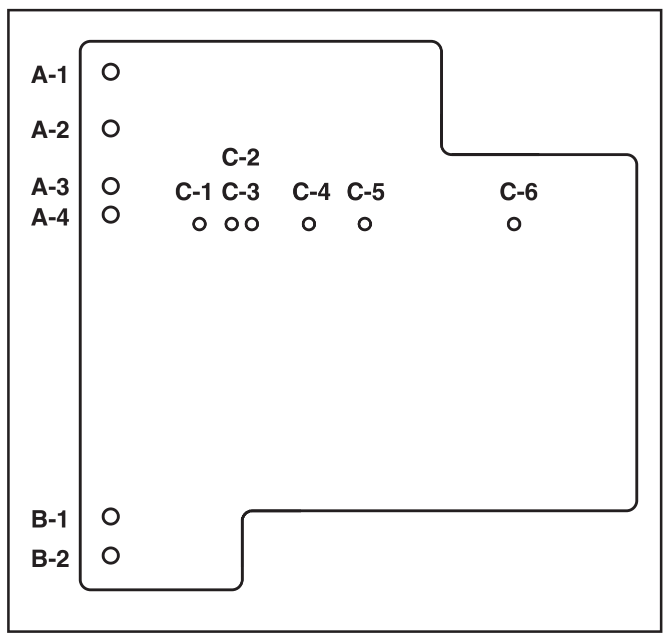


Figure 6-17 Front View of CloSure™ Tool Showing Mounting / Testing Hole Locations (6352C49H01)

Breaker Line	Approximate Mechanism Cabinet Width (inch)	Upper Mounting Hole	Lower Mounting Hole	Marker Placement Hole
DHP-VR	20 27	A1 A1	B2 B1	C2 C5
VCP-WR	18 20 27	A1 A1 A1	B2 B2 B2	C1 C2 C5

Table 6.2 - CloSure™ Tool Mounting/Testing Locations by Circuit Breaker Type

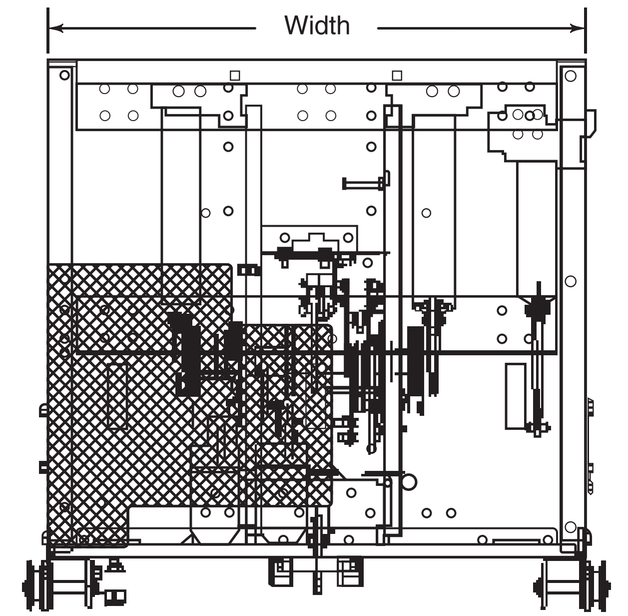


Figure 6-18 Typical Circuit Breaker Front View with CloSure™ Tool Attached (approximate mechanism chassis width)

6.10 LUBRICATION

All parts that require lubrication have been lubricated during the assembly with molybdenum disulphide grease. Cutler-Hammer 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 6.3), which ever comes first. The locations shown in Figure 6-1 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 Cutler-Hammer Grease 53701 QB or equivalent.

Ratings	*Operations*
29kA and below	**2000**
Above 29kA	**1000**
3000 Amp	**1000**

Table 6.3 - Proper Lubrication Times Per Rating

Table 6.4 - Troubleshooting Chart (Continued on next page)

SYMPTOM	INSPECTION AREA	PROBABLE DEFECTS
FAILS TO CLOSE		
• Closing Springs not charged	• Control Circuit	• 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	• Pawls (Slipping or broken) • Ratchet Wheel (Teeth worn or broken) • Cam Shaft Assy. (Sluggish or jammed) • Oscillator (Reset spring off or broken)

SYMPTOM	INSPECTION AREA	PROBABLE DEFECTS
FAILS TO CLOSE		
• Closing Springs not charged breaker does not close	• Control Circuit (Close Coil does not pick up)	• 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 Assy. (Clapper fails to reset)
	• Closing Sound But no Close	• 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	• Close Circuit (CS/C Getting shorted)
	• Mechanism	• Close Release Latch (Fails to reset) • Close Floor Tripper (Fails to reset)

SYMPTOM	INSPECTION AREA	PROBABLE DEFECTS
FAILS TO CLOSE		
• No Trip Sound	• Control Circuit	• 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 Mechanism	• Trip Clapper (Jammed)
• Trip Sound But no Trip	• Trip Mechanism	• 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	• Control Power (CS/T Switch, remains made)
	• Mechanism	• 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. A replacement parts data sheet (RPD) is included with each breaker.

7.1.1 ORDERING INSTRUCTIONS

a. Always specify the breaker rating information and general order number, from the nameplate.

b. Describe the item, give the style number, and specify the quantity required.

c. Specify the voltage for electrical components.

d. Specify the method of shipping desired.

e. Send all orders or correspondence to the nearest Eaton's Electrical Services & Systems sales office.

f. Include negotiation number with order when applicable.

This instruction booklet is published solely for information purposes and should not be considered all inclusive. If further information is required, you should consult Eaton's Electrical Services & Systems.

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