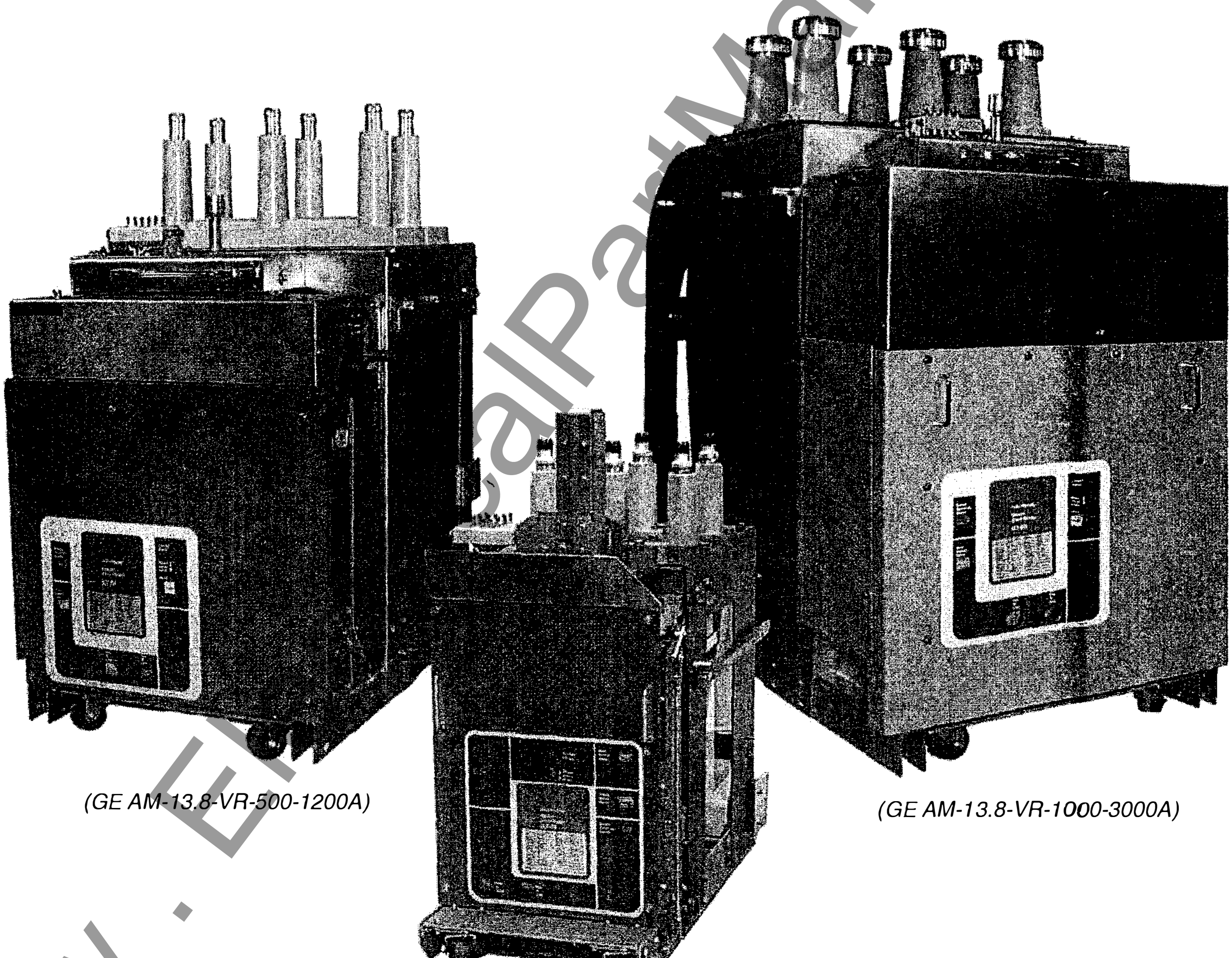
EATON

# I.B. 94A2990R17

Instructions for VR-Series Replacement Breakers for General Electric Type AM-4.16, AM-7.2, AM-13.8, and AM-15



(GE AM-13.8-VR-500-1200A)

(GE AM-13.8-VR-1000-3000A)

(GE AM-4.16-VR-250-1200A)

## 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 NAME-PLATE 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
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*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.*

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## SECTION 1: INTRODUCTION

The purpose of this book is to provide instructions for receiving and handling, storage, installation, operation and maintenance of GE-AM Type Vacuum Replacement Circuit Breakers (also referred to as VR-Series). The vacuum unit replacement breakers are designed to be used in existing General Electric type AM-4.16, AM-7.2, AM-13.8, and AM-15 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.

**WARNING**

**SATISFACTORY PERFORMANCE OF THESE BREAKERS IS CONTINGENT UPON PROPER APPLICATION, CORRECT INSTALLATION AND ADEQUATE MAINTENANCE. THIS INSTRUCTION BOOK MUST BE CAREFULLY READ AND FOLLOWED IN ORDER TO OBTAIN OPTIMUM PERFORMANCE FOR LONG USEFUL LIFE OF THE CIRCUIT BREAKERS.**

**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.**

### 1.1 AVAILABLE GE AM-VR BREAKERS

Refer to Table 1.1

| 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 | Impulse kV Crest | Rated Short-Circuit kA RMS at Rated Max kV | Maximum Sym. Interrupting Capabilities kA RMS | Closing and Latching / Momentary Capabilities kA RMS/Peak |
|---|---|---|---|---|---|---|---|---|---|
| 4.16 | 150-250 | 1200<br>2000 | 250 | 1.24 | 19 | 60 | 29 | 36 | 58 / 97 |
| 4.16 | 250 | 1200<br>2000<br>2500* | 250U | 1.19 | 19 | 60 | 41 | 49 | 78 / 132 |
| 4.16 | 350 | 1200<br>2000<br>3000 | 350 | 1.19 | 19 | 60 | 41 | 49 | 78 / 132 |
| 7.2 | 500 | 1200<br>2000 | 500 | 1.25 | 36 | 95 | 33 | 41 | 66 / 111 |
| 13.8 | 500 | 1200<br>2000 | 500 | 1.3 | 36 | 95 | 18 | 23 | 37 / 62 |
| 13.8 | 500 | 1200<br>2000 | 500U | 1.3 | 36 | 95 | 28 | 36 | 58 / 97 |
| 13.8 | 500 | 1200<br>2000 | 500XU | 1.3 | 36 | 95 | 37 | 48 | 77 / 130 |
| 13.8 | 750 | 1200<br>2000 | 750 | 1.3 | 36 | 95 | 28 | 36 | 58 / 97 |
| 13.8 | 750 | 1200<br>2000 | 750U | 1.3 | 36 | 95 | 37 | 48 | 77 / 130 |
| 13.8 | 1000 | 1200<br>2000<br>3000<br>3750* | 1000 | 1.3 | 36 | 95 | 37 | 48 | 77 / 130 |

** Cell Modifications including additional ventilation and cooling fans are required. Consult factory for more information.*

**Table 1.1 - GE AM-VR Vacuum Circuit Breaker Availability and Interchangeability**

# Instructions for VR-Series Replacement Breakers for GE AM-4.16, 7.2, 13.8, & 15



Table 1.2 - GE AM-VR Dimensions in Inches

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| AM-4.16-250/250U 1200/2000A/2500 | 40.25 | 22.00 | 6.00 | 8.50 | 22.25 | 18.00 | 18.38 | 24.13 |
| AM-4.16-350 1200/2000A | 52.50 | 22.00 | 6.00 | 8.50 | 36.25 | 16.25 | 18.38 | 32.88 |
| AM-4.16-350 3000A | 52.47 | 33.00 | 9.13 | 8.50 | 36.13 | 16.34 | 28.76 | 32.86 |
| AM-13.8-500/750 1200/2000A | 54.25 | 32.92 | 9.75 | 8.50 | 36.25 | 18.00 | 26.81 | 32.88 |
| AM-13.8-750T 1200/2000A | 62.25 | 32.92 | 9.75 | 8.50 | 44.25 | 18.00 | 26.81 | 37.63 |
| AM-13.8-1000 1200/2000A | 67.00 | 32.92 | 9.75 | 8.50 | 48.00 | 18.00 | 26.81 | 45.62 |
| AM-13.8-1000 3000A | 67.00 | 37.25 | 11.00 | 10.875 | 49.00 | 18.00 | 30.38 | 45.00 |
| AM-15-500 1200/2000A | 54.19 | 32.68 | 9.75 | 8.50 | 36.25 | 18.00 | 27.88 | 37.42 |

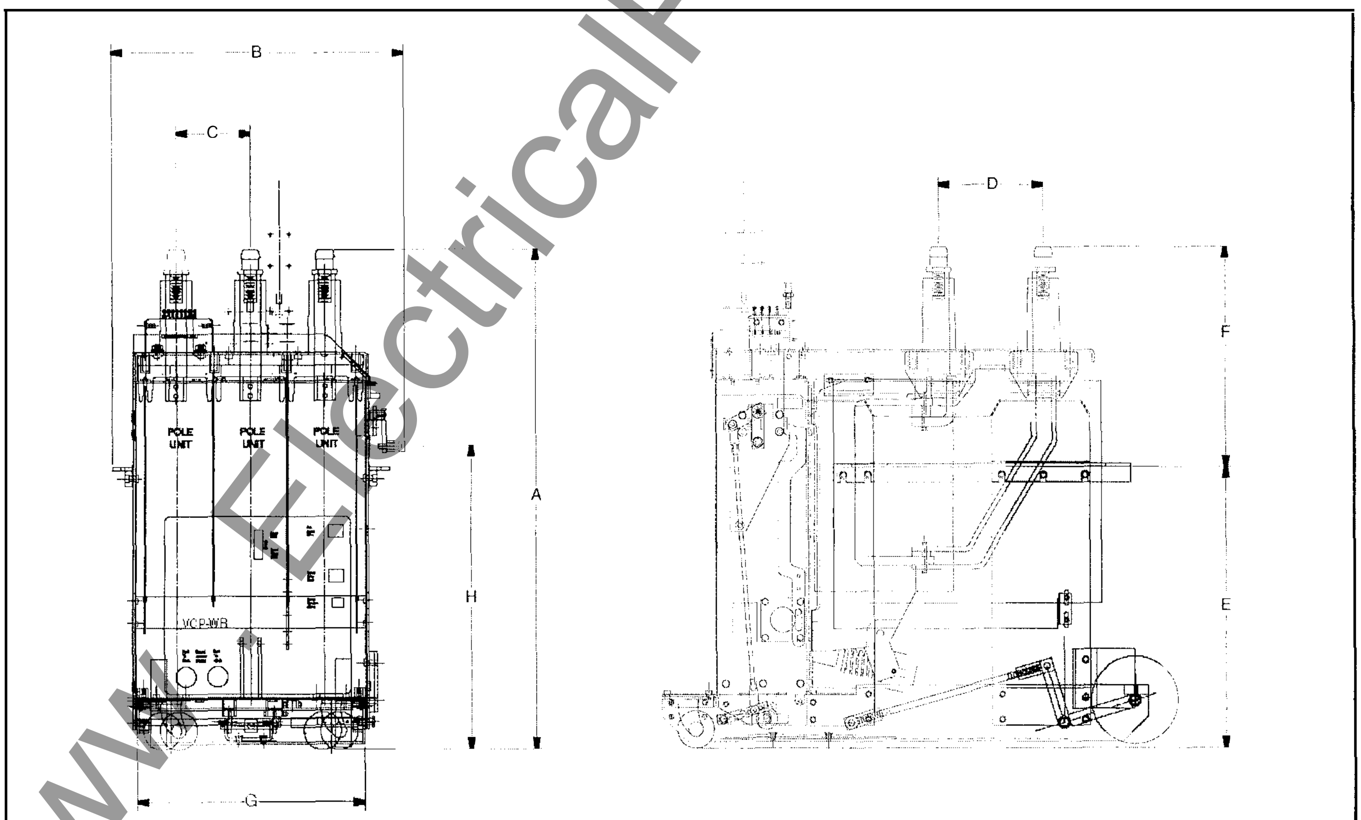



*Figure 1-1 Outline and Dimensions in inches (AM-4.16-VR shown)*

## 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 AM-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) (Figure 3-1)

**Secondary Connection Block Extension Cable:** The extension cable can be used to connect the circuit breaker to a "test cabinet" or to the switchgear cell's secondary receptacle block so that the breaker can be electrically operated while not installed in the switchgear cell. This extension cable is the same one provided with the General Electric breaker and is therefore not included as part of the vacuum replacement breaker.

**Test Position MOC Operator:** This device can be used to test the MOC operator in the breaker's test position. (Figure 3-1)

### 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 WORK-BENCH CAPABLE OF SUPPORTING THE BREAKER TYPE.**

*Figure 3-1 Typical Vacuum Replacement Tools and Accessories (Tools not shown to scale)*

GE AM-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 3-2a, 3-2b, 3-3c)

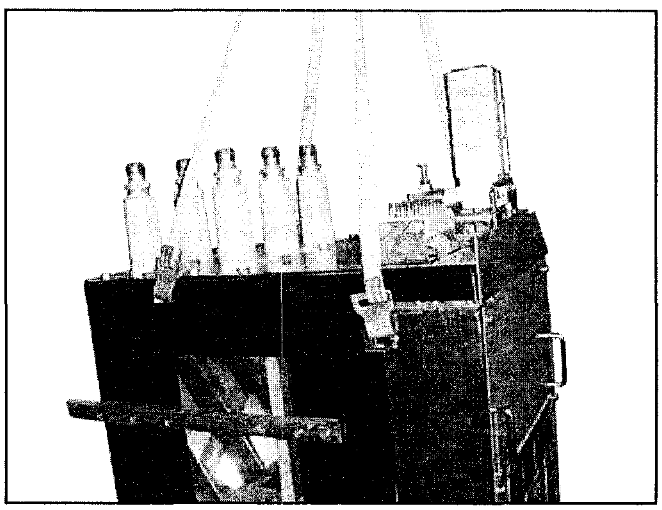


*Figure 3-2a Overhead Lifting of GE-AM (AM-4.16-VR shown)*

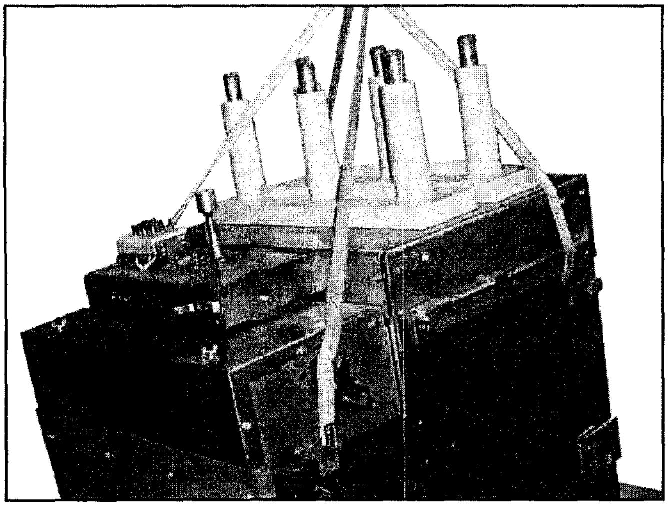


*Figure 3-2b Overhead Lifting of GE-AM (AM-13.8-VR shown)*

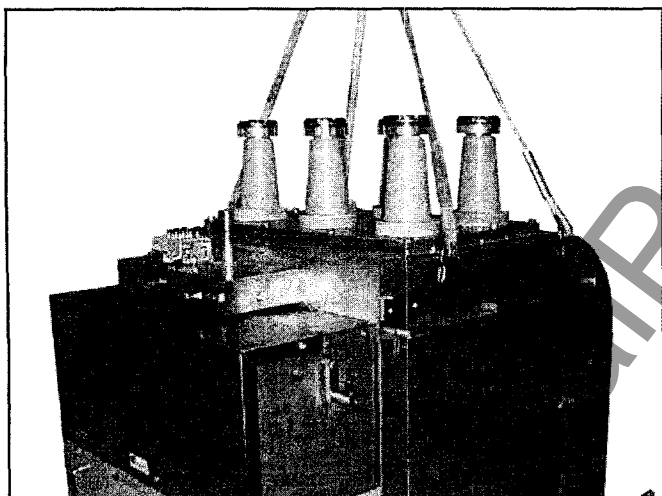


*Figure 3-2c Overhead Lifting of GE-AM (AM-13.8-VR-1000 3000A)*

### 3.3 STORAGE

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

The breaker is shipped with its contacts open and closing springs discharged. The indicators on the front panel should confirm this. Insert the maintenance tool in the manual charge socket opening (Figure 3-3 and 3-4). 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.

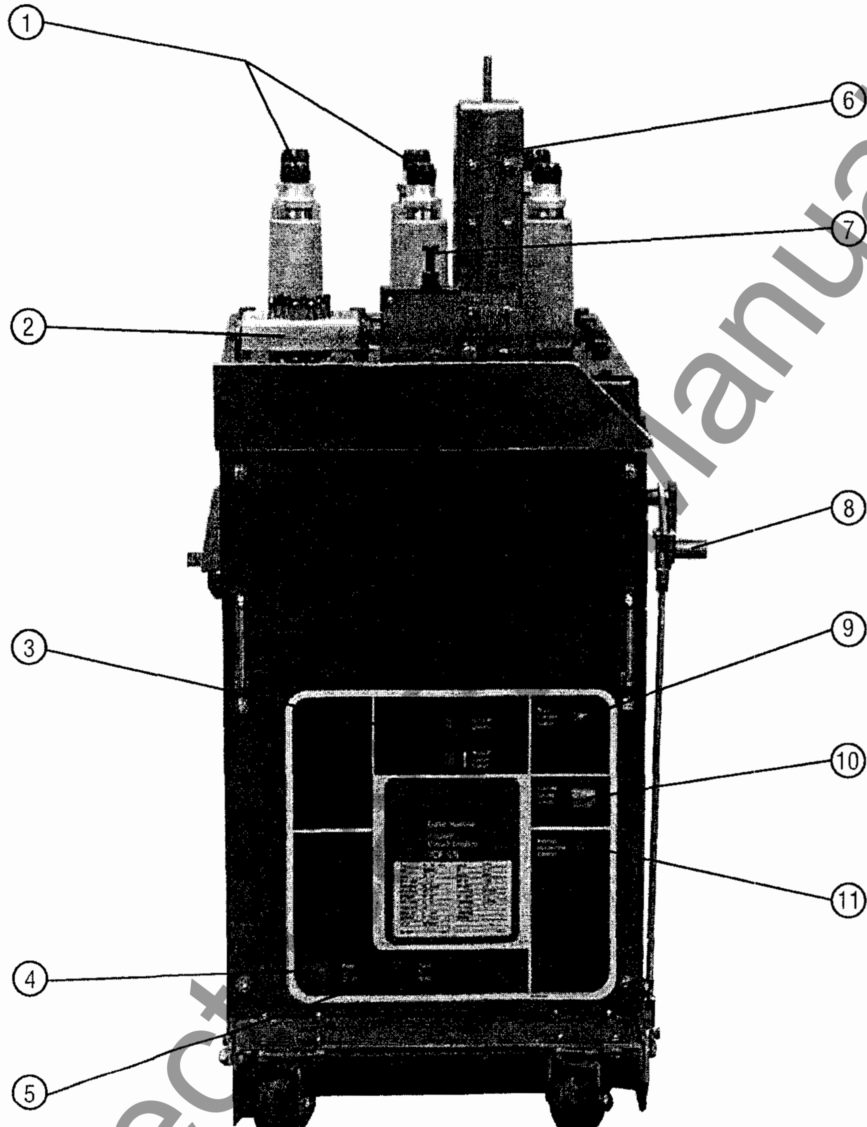
Indoor storage should be in a building with sufficient heat and circulation to prevent condensation. If the building is not heated, the same general rule for heat as for outdoor storage should be applied.

### 3.4 GE-AM-VR APPROXIMATE WEIGHTS

Refer to Table 3.1

**Table 3.1 - Weight by Breaker Type**

| Circuit Breaker Type | Amperes | LBs. |
|---|---|---|
| AM-4.16-VR250/250U | 1200, 2000 | 750 |
| AM-4.16-VR350 | 1200, 2000 | 950 |
| AM-4.16-VR350 | 3000 | 1550 |
| AM-7.2-VR500 | 1200, 2000 | 950 |
| AM-13.8-VR500 | 1200, 2000 | 950 |
| AM-13.8-VR750 | 1200, 2000 | 1000 |
| AM-13.8-VR1000 | 1200, 2000 | 1350 |
| AM-15-VR500 | 1200, 2000 | 1400 |
| AM-13.8-VR1000 | 3000 | 2500 |




1. Primary Bushings
2. Secondary Disconnect
3. Manual Charging Socket
4. Push To Open Button
5. Push To Close Button
6. ***SURE CLOSE*** Mechanism
7. MOC Operator
8. Active Interlock
9. Breaker Contacts Indicator
10. Spring Charged/Discharged Indicator
11. Operations Counter

*Figure 3-3 Front External View of GE-AM-VR Breaker (AM-4.16-VR shown)*

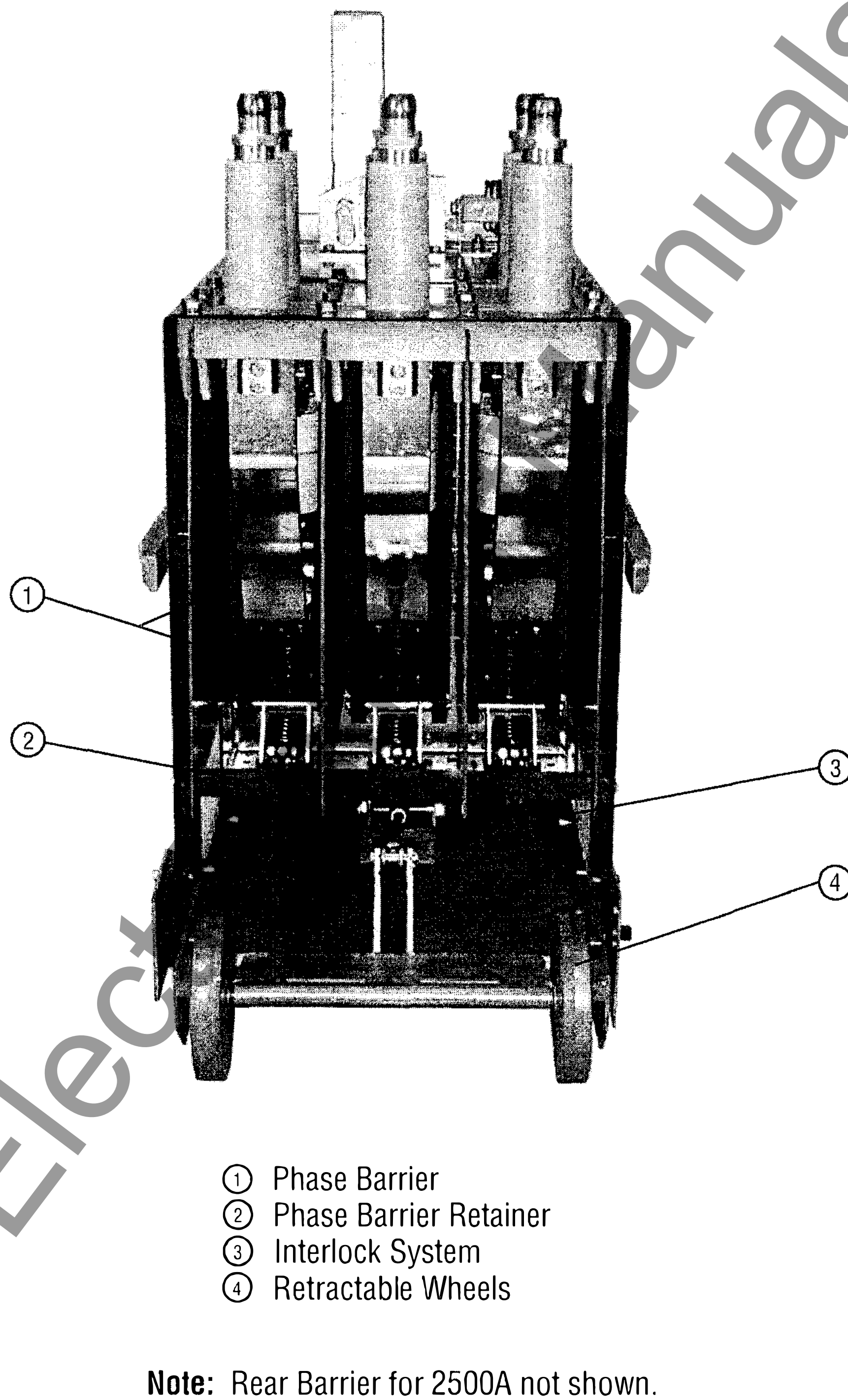
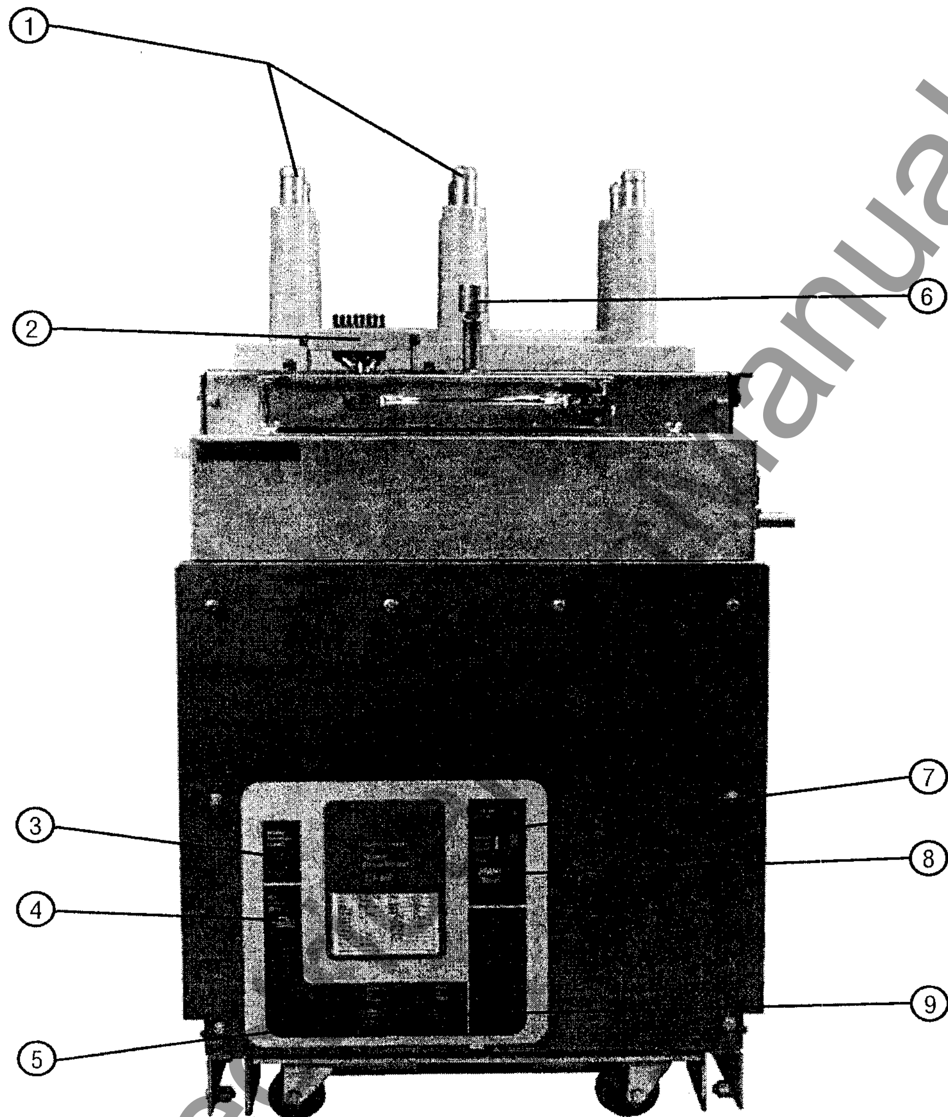
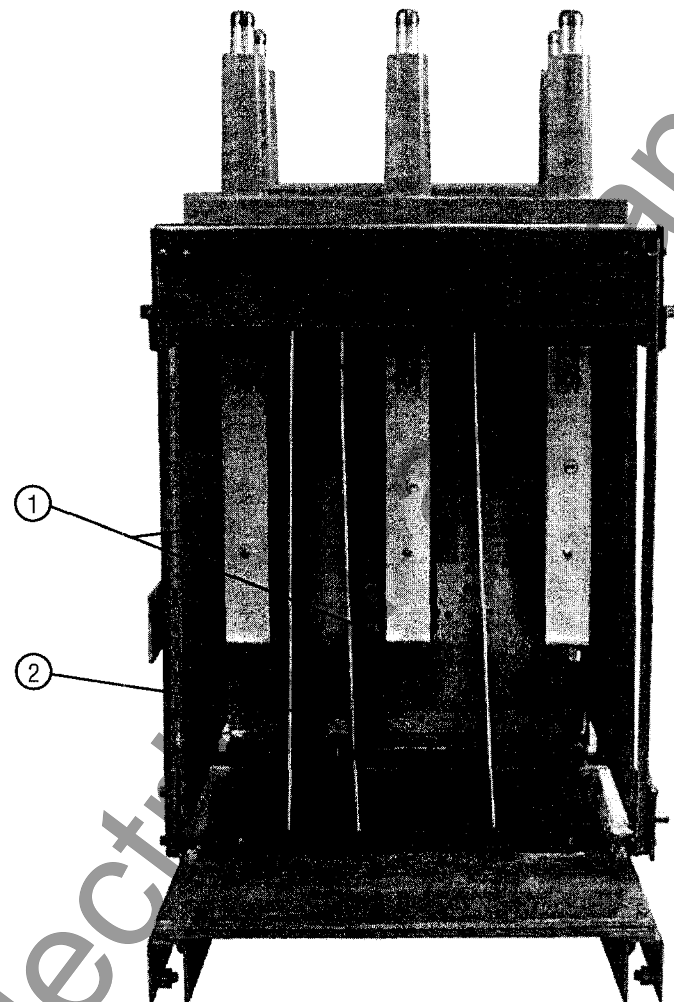



*Figure 3-4 Back External View of GE-AM-VR Breaker (AM-4.16-VR shown)*



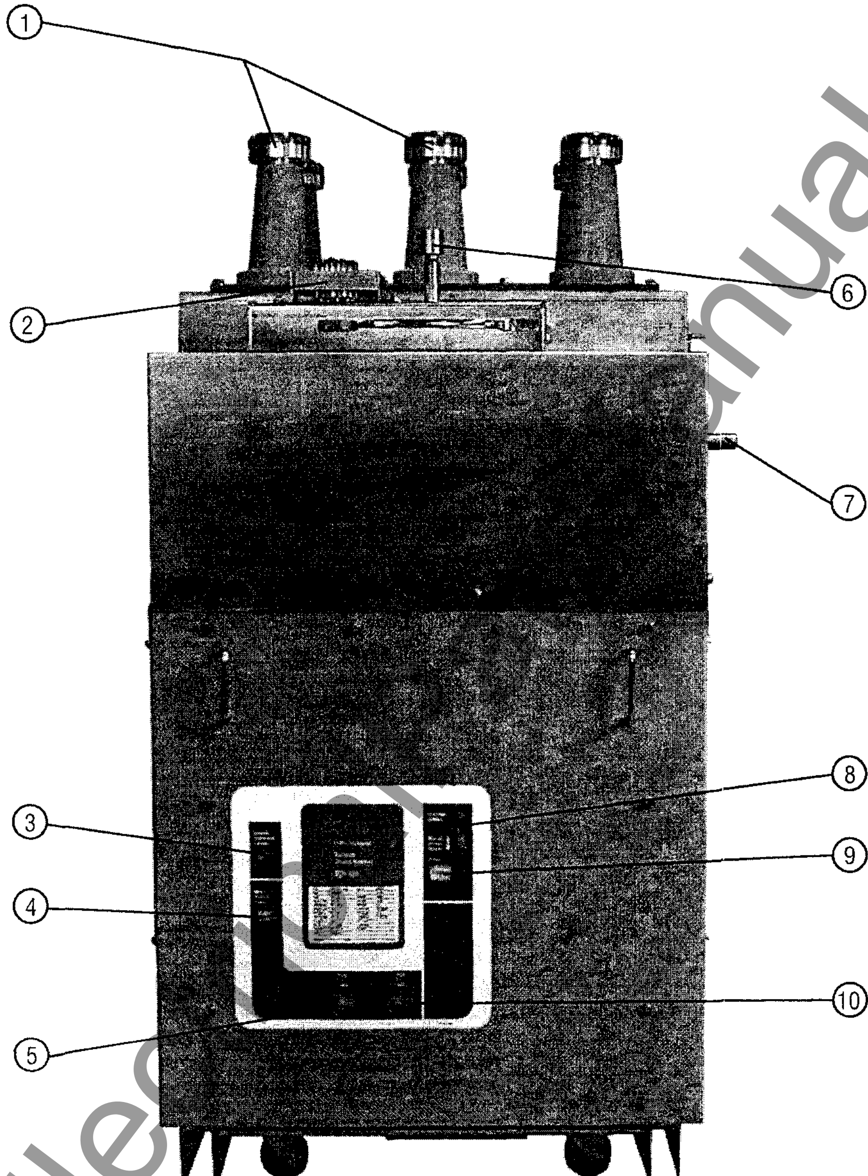

① Primary Bushings
② Secondary Disconnect
③ Operations Counter
④ Breaker Contacts Indicator
⑤ Push To Close Button
⑥ MOC Operator
⑦ Manual Charging Socket
⑧ Spring Charged/Discharged Indicator
⑨ Push To Open Button

*Figure 3-5 Front External View of GE-AM-VR Breaker (AM-13.8-VR shown)*




① ***SURE CLOSE*** Spring
② Phase Barrier

*Figure 3-6 Back External View of GE-AM-VR Breaker (AM-13.8-VR shown)*




1. Primary Bushings
2. Secondary Disconnect
3. Operations Counter
4. Breaker Contacts Indicator
5. Push To Close Button
6. MOC Operator
7. Interlock Lever
8. Manual Charging Socket
9. Spring Charged/Discharged Indicator
10. Push To Open Button

*Figure 3-7 Front External View of GE-AM-VR Breaker (AM-13.8-VR3000A shown)*

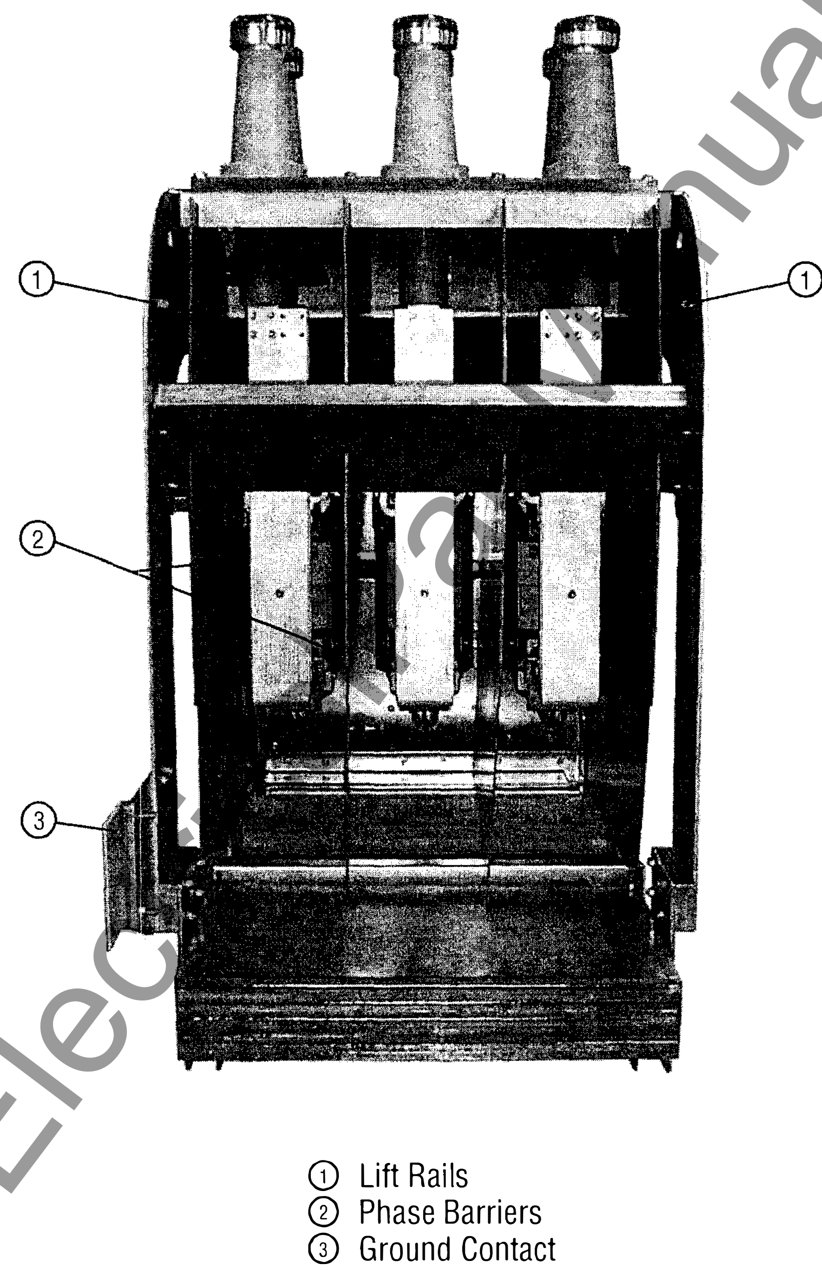



*Figure 3-8 Back External View of GE-AM-VR Breaker (AM-13.8-VR3000A shown)*

## 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.

### 4.2 CODE PLATE INSTALLATION

The following breakers have the code plate system:

GE4.16-VR-250/250U-1200/2000A

GE13.8-VR-500/500U/500XU/750/750U/1000-1200/2000A

### 4.2.1 CODE PLATE ON BREAKER

All code plates are assembled on each breaker at the factory. No changes need to be made in the field.

### 4.2.2 CODE PLATE IN CUBICLE

For GE4.16-VR-250U-1200/2000A breakers, the code plate in the cell MUST be modified before installed.

**NOTICE**

**ALL OTHER BREAKERS REQUIRE NO MODIFICATIONS TO THE CUBICLE CODE PLATE.**

1. Remove hardware attaching code plate to cubicle. (Figure 4.1)

2. Flip the code plate and reattach using the original hardware as shown in Figure 4.2 - 1200A and Figure 4.3 - 2000A.

3. For 1200A - As a check, measure to the center of the slot in the codeplate from the cell floor. This measurement should be approximately 4.875 inches which measures the same as the distance from the floor to the codeplate pin on the breaker.

4. For 2000A - As a check, measure to the center of each slot in the codeplate. From the floor to the bottom slot should be 4.25 inches and from the floor to the top slot should be 6.375 inches.

### 4.3 OPERATIONAL POSITIONS

This instructional manual covers the GE-AM-VR line of Cutler-Hammer vacuum replacement breakers. Each breaker has three basic operational positions:

1. **Breaker withdrawn from the cell**. In this position, the breaker may be tested manually or electrically. Electrical testing is done by using the secondary block extension cable. If possible, tests should be conducted in this position.

2. **Breaker in the cell in the disconnect/test position**. In this position, the breaker is in the cell resting on the cell floor. The breaker may be tested electrically or manually. Electrical testing in this position may be performed by using the secondary block extension cable. The MOC can be tested using the optional test flag. (Figure 3-1)

3. **Breaker in the connect position**. Once the breaker has been raised from the disconnect position, the breaker remains trip free until it reaches the connect position and the elevating mechanism is disengaged. This corresponds to the position when the breaker cannot be raised any further into the cell.

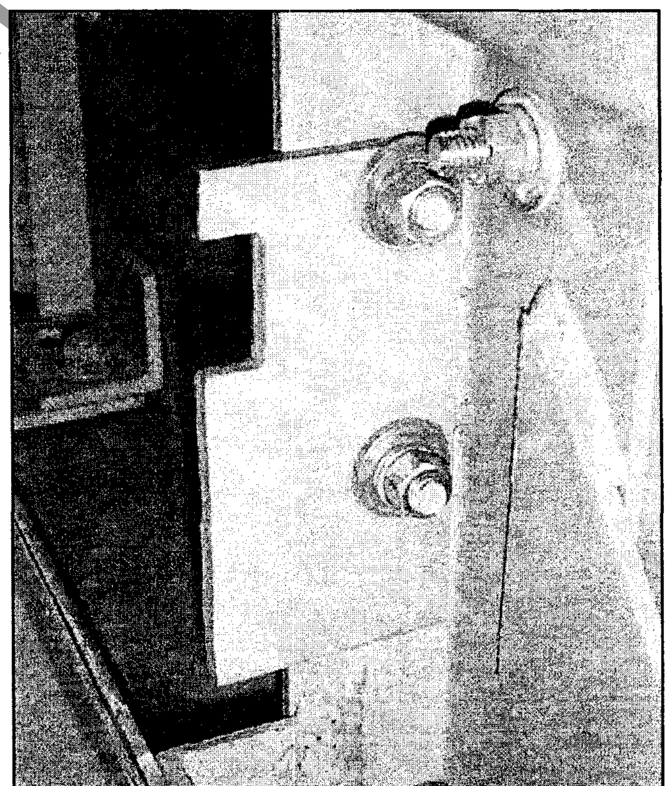


*Figure 4-1 Remove Codeplate Hardware*

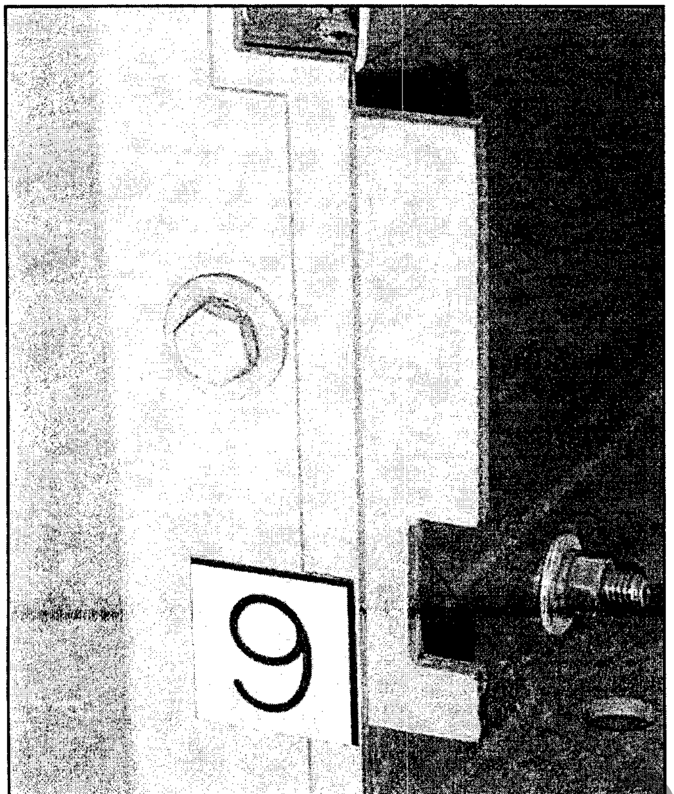



*Figure 4-2 GE-AM-4.16-VR-250U-1200A Codeplate (Flipped)*

#### 4.4 INITIAL SETUP AND ADJUSTMENT

The Cutler-Hammer vacuum replacement breaker is inserted into its cubicle in exactly the same manner as was the original breaker. This procedure should be completed by a service engineer or technician familiar with Cutler-Hammer vacuum replacement breakers.

After complying with the checks described in section 4.7 through 4.13, a small amount of contact lubricant may be applied to the silvered portion of the primary bushing studs to form a thin coating for lubricating purposes. However, the studs come pre-lubricated from the factory with a wax based lubricant, and therefore additional lubricant is not required. Do not use grease.

Prior to placing the breaker into service, a few simple but critical adjustments must be checked and adjusted if necessary. These adjustments should performed in sequence as follows:

1. Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered position. After first assuring that the breaker is in the open position, the wheels on the breaker should be aligned with the tracks in the cubicle.

When alignment is correct, the breaker should then enter the housing freely. Push the breaker into the cell using the handle far enough to observe the lateral position of the grounding contact with respect to the cell's grounding contact receptacle. All cell contacts should be set the same to ensure interchangability.

Adjust lateral position of the grounding contact of the breaker by adding or removing associated shims so that the contact centers with the cell's receptacle.

When the grounding contact alignment is correct, the breaker should be pushed completely into the cell until it rests against the rear of the front lifting saddle of the elevating mechanism. Care must be taken to assure that stoppage is not due to the breaker binding on sides of the cubicle. If the breaker is still aligned correctly but has stopped, this is the disconnect position.

With the breaker in the disconnect position, check that the active interlock roller rests vertically in the rear of the gear motor slide and as near to the gear motor slides as possible.

If the active interlock roller is in the proper position, proceed to step number 2. If roller does not rest in the rear of the notch of the cell gear motor slide, adjust the back stop bolt of the breaker.

Tighten back stop adjustment bolt jam nut. Check the active interlock rotates freely without binding.

**WARNING**

**UN-PLUG THE GEAR MOTOR TO ENSURE THE GEAR MOTOR CANNOT OPERATE DURING THE FOLLOWING TESTS.**

2. a. While in the disconnected position with the breaker fully rolled into the cell, close the breaker (by charging the breaker and pushing the "PUSH TO CLOSE" button of Figure 3-3 or Figure 3-4).

b. Pull the clutch handle of the lifting motor forward. It should not be possible to engage the lifting motor clutch with the breaker closed without tripping (opening) the circuit breaker.

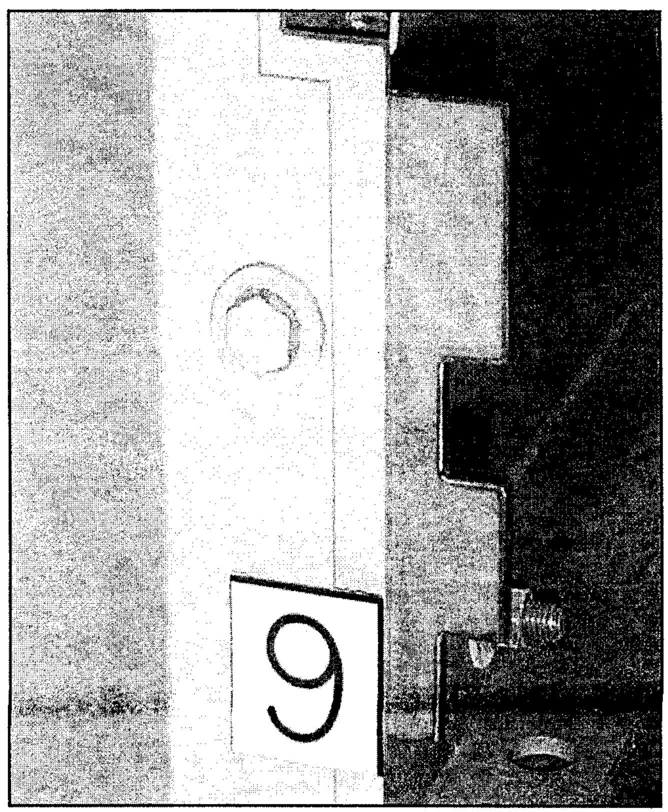



*Figure 4-3 GE AM-4.16-VR-250U-2000A Codeplate*

3. With the breaker in the open position, recharge the breaker. Engage the motor clutch (motor still disconnected electrically) and attempt to close the breaker using the "Push to Close" button. The breaker should go through a trip-free operation without closing and the contacts should not touch.

3b. If a test flag has been purchased, the MOC operator can be checked for proper operation. With the breaker in the test position, place the socket end of the test flag on the MOC operator bolt. Loosen the lock nut and lower the MOC switch interface so that it clears the MOC switch and can be vertically positioned vertically underneath it. Raise the interface until it engages the MOC switch. Tighten the lock nut. The MOC switch is now ready for test. Operate the breaker several times electrically or mechanically and verify that the MOC switch contacts change state appropriately.

4. Plug in the lifting motor. Charge the breaker and engage the cell lifting mechanism to raise the breaker. Check that the closing springs discharge when the gravity discharge mechanism swings down.

5. While observing all safety precautions set forth in sections 3 and 5, raise the breaker until the secondary contact block is close enough to observe that the studs align with their respective cell sockets. Adjust secondary contact block vertically and horizontally as necessary. If sufficient adjustment is not available on the breaker, adjust cell as required.

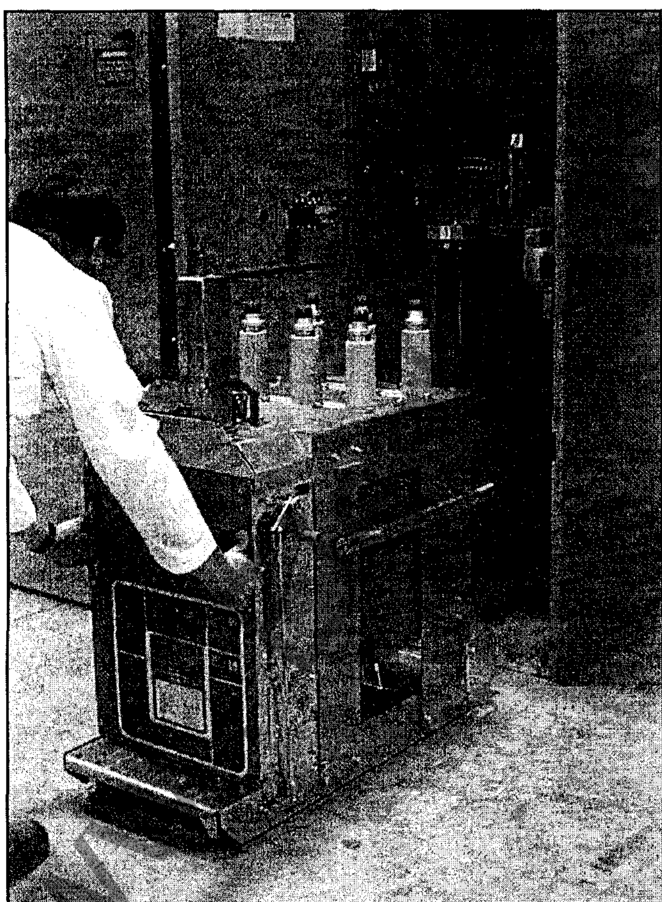


*Figure 4-4 Alignment of AM-VR (AM-4.16-VR-250-1200A shown)*

*Figure 4-5 Insertion of AM-VR (AM-4.16-VR-250-1200A shown)*

6. Continue to raise the breaker until the MOC plunger (if equipped) of the breaker is close enough to observe it's alignment with respect to the MOC switch of the cell. The plunger of the breaker should be nearly centered with respect to the cell switch mating shaft and adjusted so that a gap exists between the two of approximately .000 - .125". If sufficient adjustment is not available on the breaker, adjust the cell switch as required.

#### 4.5 INSERTION PROCEDURE

The layout of the Cutler-Hammer vacuum replacement breaker is shown in Figure 3-3, 3-4, 3-5, 3-6. All principal elements are clearly labeled. The vacuum replacement breaker will be lifted into the cell in the same manner in which the original GE vertical lift breaker was and should be completed by a service engineer or technician familiar with Cutler-Hammer vacuum replacement breakers.

The breaker rating should be checked against the unit rating and under no circumstances should the breaker to be inserted into a cell of a different rating than the breaker.

Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered position. The breaker should then enter the housing freely. After first assuring that the breaker is open, the wheels on the breaker should be aligned with the tracks in the cubicle (Figure 4-4). When alignment is correct, the breaker should be pushed completely into the cell (Figure 4-5) until the lift points of the breaker are aligned with the corresponding lifting saddles of the elevating mechanism. Care must be taken to assure that stoppage is not due to the breaker binding on sides of the cubicle. This is the disconnect / test position.

All tests which must be conducted within the cell, must be conducted with the breaker in this position. In the test position, control power can be available through the secondary test jumper, but the primary contacts are far from the primary stabs in the cubicle and the cubicle shutter is closed (Figure 4-6).

**WARNING**

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

To elevate the breaker, position the elevating control selector switch on the elevating motor to "RAISE". Engage the elevating motor by pulling the clutch handle just above the elevating motor forward until the motor limit switch closes and the motor clutch engages to raise the breaker (Figure 4-7). The engagement of the gear motor activates the active interlocking system to hold the breaker trip-free as long as the motor is engaged. While elevating, ensure that the shutter slides open and the bushings center with respect to the primary bottle openings of the cell or injury to the contacts may result. Careful attention should also be directed to the secondary disconnect to insure correct mating is obtained.

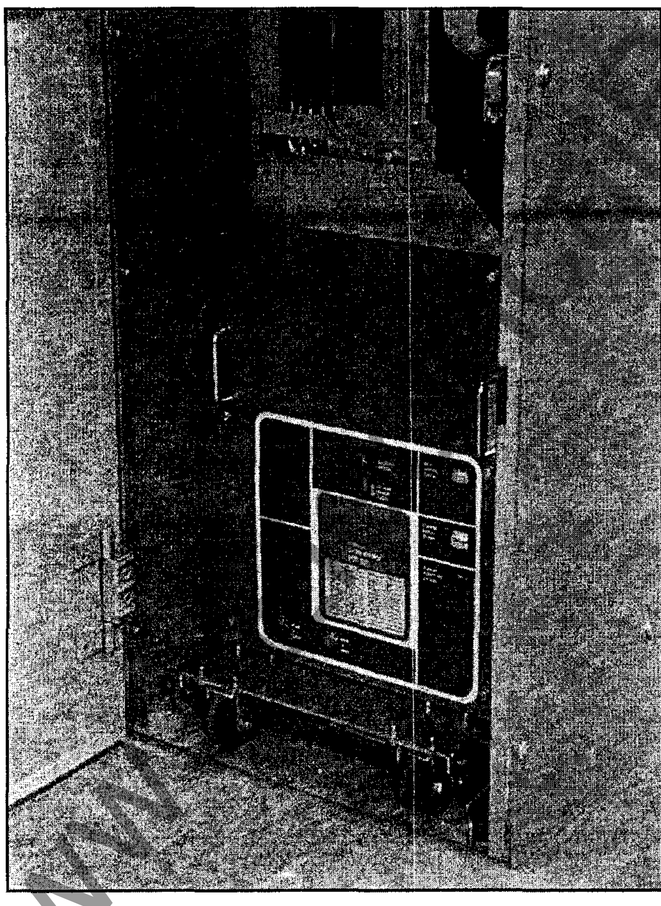


*Figure 4-6 AM-VR Disconnect / Test Position (AM-4.16-VR-250-1200A shown)*

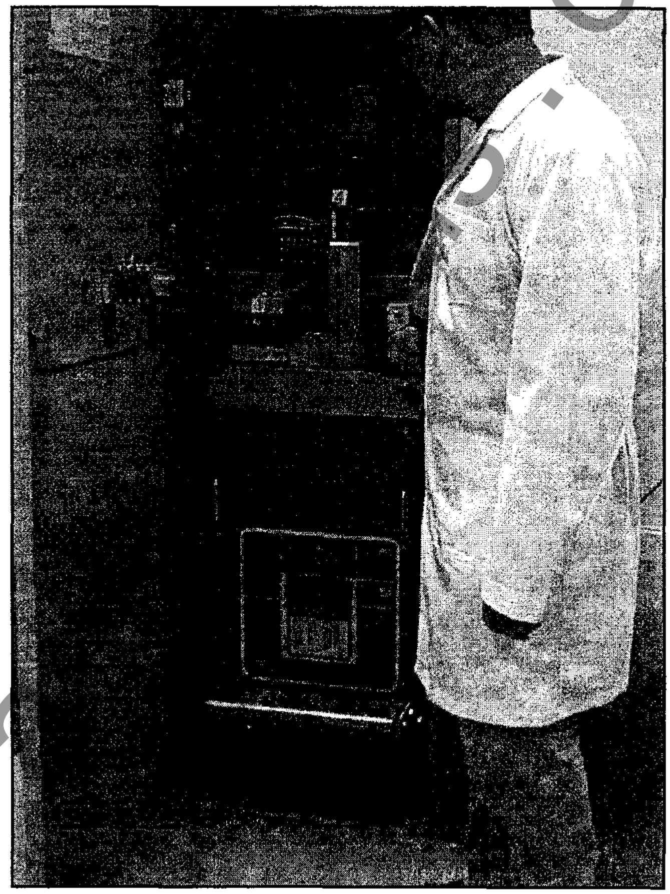


*Figure 4-7 Lifting AM-VR into Connected position (AM-4.16-VR-250-1200A shown)*

The clutch handle is held in the forward position until a limit switch on the cell opens to stop the motor at the end of the upward travel of the breaker (Figure 4-8). Release the clutch handle. The motor selector switch must not be used to energize or interrupt the motor circuit.

When the breaker is fully elevated the clearance between the breaker lift rail and the upper stop bolts (Figure 4-9) should not be more than 1/8" and not less than 3/32".

The active interlock roller should be centered in the upper "VEE" and the interlock roller should have 1/16" clearance to the stationary interference plate directly under it (Figure 4-10).

The breaker is now in the connect position (Figure 4-11 and 4-12).

### 4.6 REMOVAL PROCEDURE

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

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

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

### 4.7 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 or in the disconnect position. With the breaker withdrawn or in the disconnect position, place the maintenance handle into the manual charging opening and charge the closing spring. Approximately 36 up and down strokes of the handle are required to cause the "Charging Spring Status" indicator to show "Charged." Remove the maintenance handle.

**WARNING**

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

Close and trip the breaker by pushing the close lever then the trip lever (Figure 3-3 or Figure 3-4).

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

**WARNING**

**DO NOT ATTEMPT TO INSTALL OR OPERATE A VACUUM CIRCUIT BREAKER UNTIL THE TESTS OF SECTION 4.7 THROUGH 4.13 ARE SUCCESSFULLY PERFORMED.**


*Figure 4-8 Clutch Handle Held in the Forward Position*

*Figure 4-9 Upper Stop Bolt*

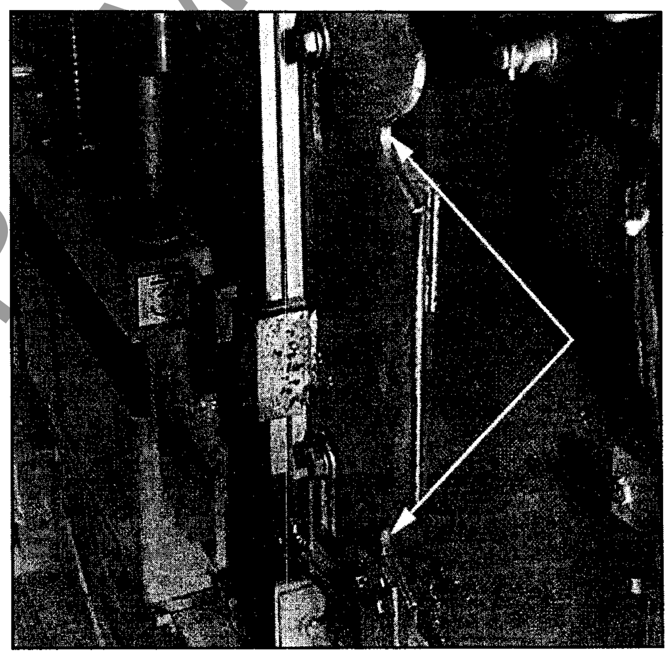


*Figure 4-10 "VEE"*

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

### 4.8 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.

### 4.9 LOW FREQUENCY WITHSTAND TEST (INSULATION CHECK)

Perform insulation integrity tests as described in Section 6.7.

**4.10 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 mark is visible, if not the vacuum interrupter must be replaced. Check contact wipe as described in Section 6.5 and illustrated in Figure 6-5.

**4.11 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.

**4.12 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.**

**4.13 *SURE CLOSE* MECHANISM ADJUSTMENT**

**WARNING**

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

All type AM-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. If the adjustment is made on the AM-VR breaker to be compatible with force of the MOC switches, make sure the adjustment is checked and compatible if the breaker is moved to a different housing.

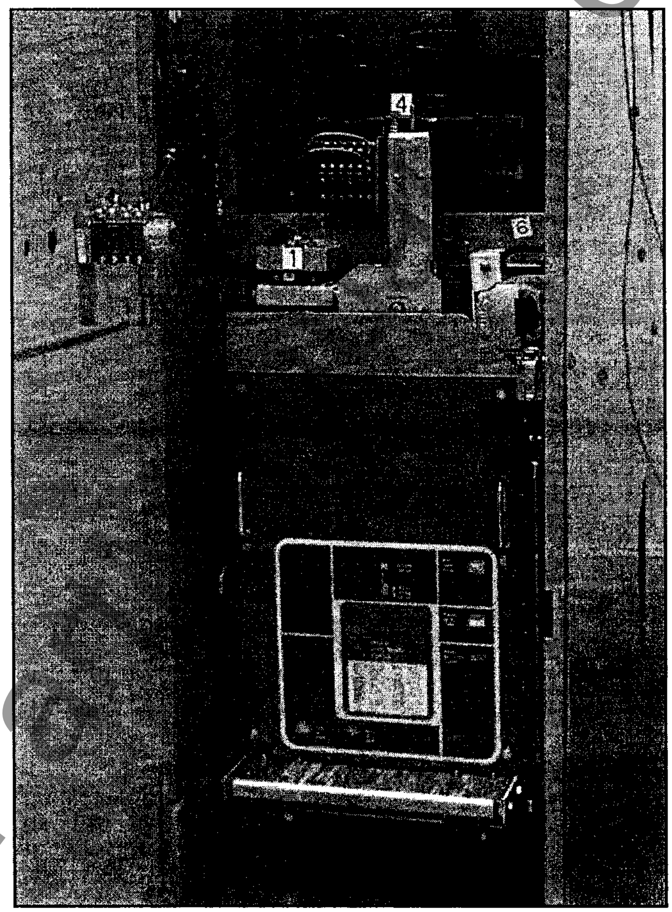



*Figure 4-11 AM-VR in Connected Position (AM-4.16-VR-250-1200A shown)*

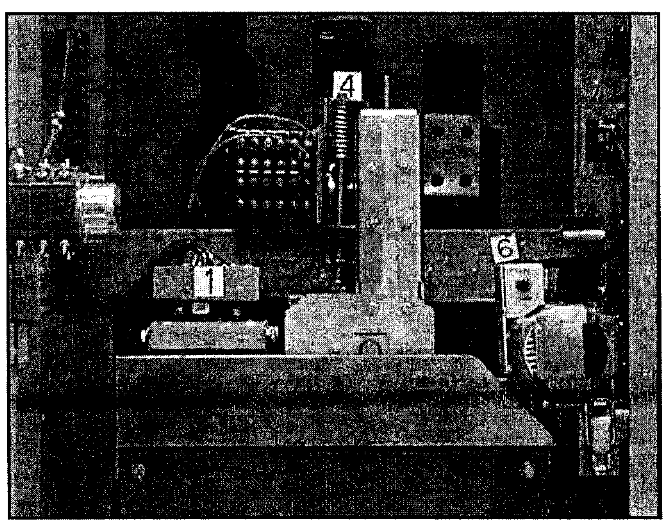



*Figure 4-12 AM-VR Connect Position (AM-4.16-VR-250-1200A shown)*

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

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

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

**Step 1:** Locate the MOC drive spring (Figure 3-3 or 3-6). It is located on the upper left portion of the AM-4.16-VR breaker behind the metal cover as viewed from the front or between Phase "B" and "C" barriers on the AM-13.8-VR.

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

**Step 3:** Loosen the jam nut on the ***Sure Close*** spring and compress the spring an additional .25 inches. Do not exceed the minimum dimension shown in Figures 4-13 through 4-15. Close the breaker.

**NOTE:** For GE AM-4.16 see Figure 4-14 and 4-15, for GE AM-13.8 see Figure 4-13.

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

**Step 5:** Insert into the cell.

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

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

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

**Step 9:** After an adjustment is made, make sure that all nuts are secured in place, prior to returning to service.

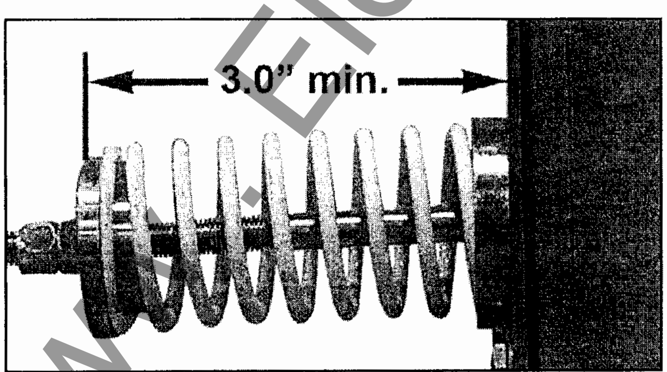



*Figure 4-13* ***SURE CLOSE*** *Spring for GE-AM-7.2 / 13.8-VR*

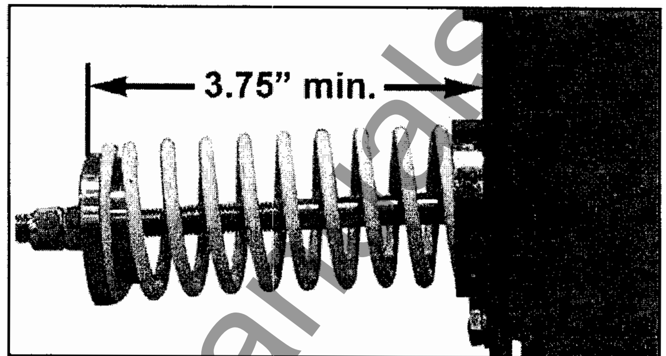



*Figure 4-14* ***SURE CLOSE*** *Spring for GE-AM-4.16-VR-3000A*

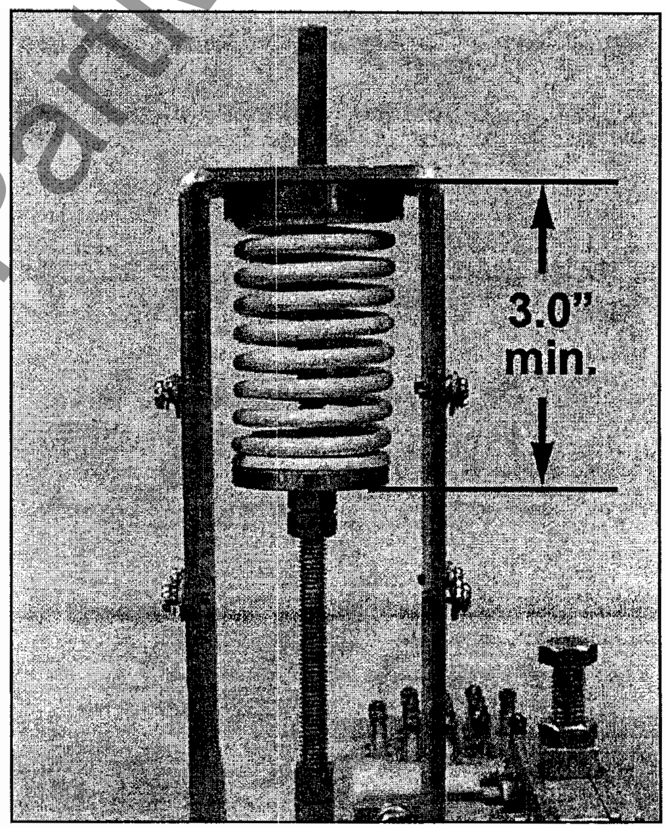



*Figure 4-15* ***SURE CLOSE*** *Spring with Cover Removed for GE-AM-4.16-VR 250 / 250U / 350 and GE-AM-13.8-VR1000-3000A*

## SECTION 5: DESCRIPTION AND OPERATION

Cutler-Hammer vacuum replacement breakers, VR-Series, are draw-out vacuum circuit breakers. They are designed to be used with existing installations of the original manufacturer of the metal-clad switchgear specified in this manual. 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 services with minimum maintenance.

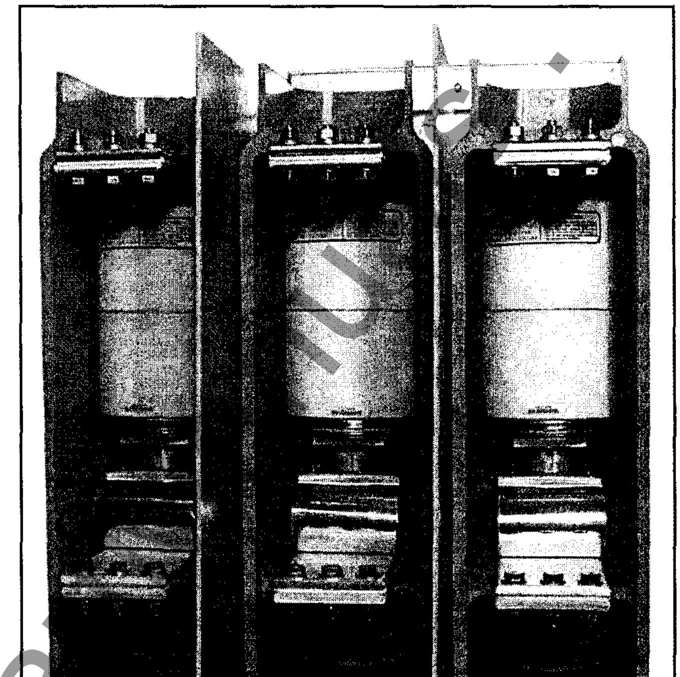


*Figure 5-1 GE AM-4.16-VR (18WR) Interrupter Assembly (1200A shown)*

### 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 both 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, upper and lower glass polyester insulators, buss connections, 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 glass polyester stand off insulator and clamps support the interrupter and are fastened to the breaker's stored energy mechanism frame. Upper and lower buss work provide electrical connections from each interrupter to the breaker's modified original primary bushings while flexible shunts provide 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)

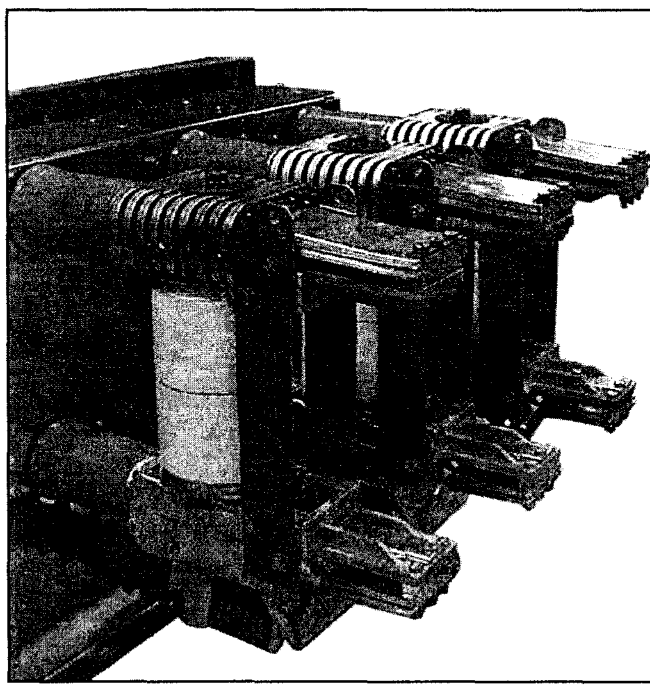


*Figure 5-2 GE AM-4.16-VR (29WR) Interrupter Assembly (2000A)*

#### 5.1.2 CONTACT EROSION INDICATOR

The purpose of the contact erosion indicator is to monitor the erosion of the vacuum interrupter contacts, which is very minimal over time with Cutler-Hammer vacuum interrupters utilizing copper-chrome contact material. If contact erosion reaches 1/8 inch, the interrupter must be replaced. A contact erosion indicator mark is located on the moving stem of the interrupter (Figure 6-2 and 6-3).

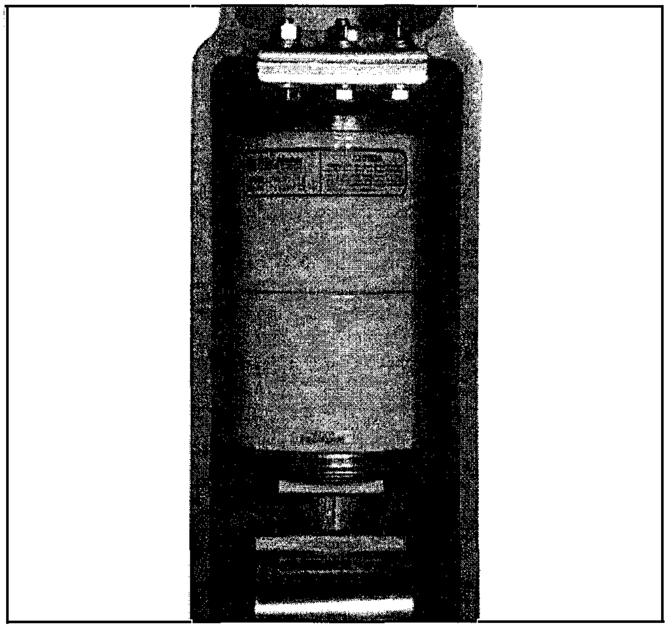


*Figure 5-3 Interrupter 18WR (1200A)*

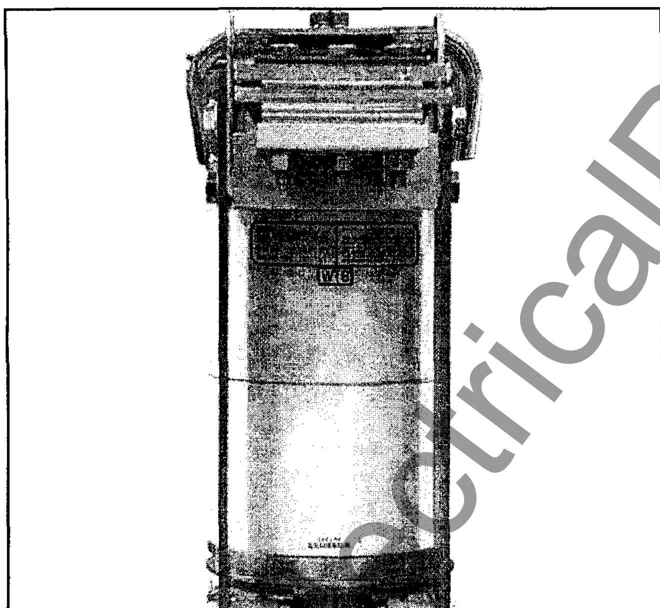


*Figure 5-4 Interrupter 29WR (2000A)*

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

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

**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

Contact wipe is a indication of (1) force to hold the 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 Type 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. (See Figure 3-5 and 3-6) Barriers between interrupter assemblies are confined by a separator attached to the breaker frame and confined by the bushing assemblies. The side barriers are confined by the bushing mold and a support attached to the breaker truck frame.

**WARNING**

**ALL PHASE BARRIERS MUST BE IN PLACE BEFORE PLACING THE CIRCUIT BREAKER INTO SERVICE. FAILURE TO HAVE THEM IN POSITION CAN CAUSE DEATH, SERIOUS PERSONAL 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 cubicle 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 above the breaker frame and in the front of the breaker. Manual closing and opening controls are at the front panel (Figure 3-3 and 3-4) so that they are accessible while the breaker is in any of its three basic positions. (See Section 4.3)

The mechanism stores the closing energy by charging the closing springs. When released, the stored energy closes the breaker, charges the wipe and resets springs. The mechanism may rest in any one of the four positions shown in Figure 5-7 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 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 5-6 shows schematic views of the spring charging parts of the stored energy mechanism.

The major component of the mechanism is cam shaft assembly which consists of a hex 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 the fully charged position.

The closing springs may also be charged manually as follows: Insert the maintenance tool in the manual charging socket. Move it up and down several times (about 36) until a clicking sound is heard and the closing spring status indicator shows "charged". 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 5-7 shows the positions of the closing cam and tripping linkage for four different operational states. Refer to figure 5-7b for the following discussion of section 5.4.2 unless otherwise noted. In Figure 5-7a 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 5-7b).

When the spring release clapper (13 of Figure 5-6) moves into the face of the spring release coil (electrically or manually), the upper portion of the clapper pushes the spring release latch (3 of Figure 5-6) 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 5-7c. Interference of the trip "D" shaft with the trip latch prevents the linkage from collapsing, and holds the breaker closed.

Figure 5-7d 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 of Figure 5-7) 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

**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 |

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 5-7b) 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 lifted, any attempt to close the breaker will discharge the closing springs, without any movement of the pole shaft or vacuum interrupter stem. The trip-free condition is achieved automatically when moving the breaker within the cell in any position other than "test" or "connect".

### 5.5 ELECTRICAL CONTROL

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 5-5).

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

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

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

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

### 5.6 SECONDARY CONNECTION BLOCK

The breaker control circuit is connected to the switchgear control through a multi-contact block (See Section 3 for component location). The movable secondary control contacts mounted on the breaker are self-aligning, line-contact, slip-type connectors. The multiple finger arrangement on the breaker makes contact with a stationary mounted element. The contact surfaces on the stationary element are recessed to prevent accidental short-circuiting of the control circuits.

Mechanical stops prevent over-travel and avoid damage to the disconnecting devices when the circuit breaker is levered into operating position.

### 5.7 INTERLOCKS

There are several interlocks built into the Cutler-Hammer vacuum replacement of the G.E. vertical lift breakers. Each of these interlocks performs similar functions as it did on the original G.E. breaker. These interlocks exist to safeguard personnel and equipment. The basic premise behind the interlocking arrangement on the Cutler-Hammer vacuum replacement breaker is that the breaker must not be inserted into or removed from a live circuit while the main contacts are closed. In addition to the original G.E. interlocks, the Cutler-Hammer type Vacuum Replacement breakers also provide an automatic gravity operated spring discharge feature and an anti-close interlock.

**WARNING**

**INTERLOCKS ARE PROTECTIVE DEVICES FOR PERSONNEL AND EQUIPMENT. DO NOT DEFEAT OR MODIFY ANY INTERLOCKS.**

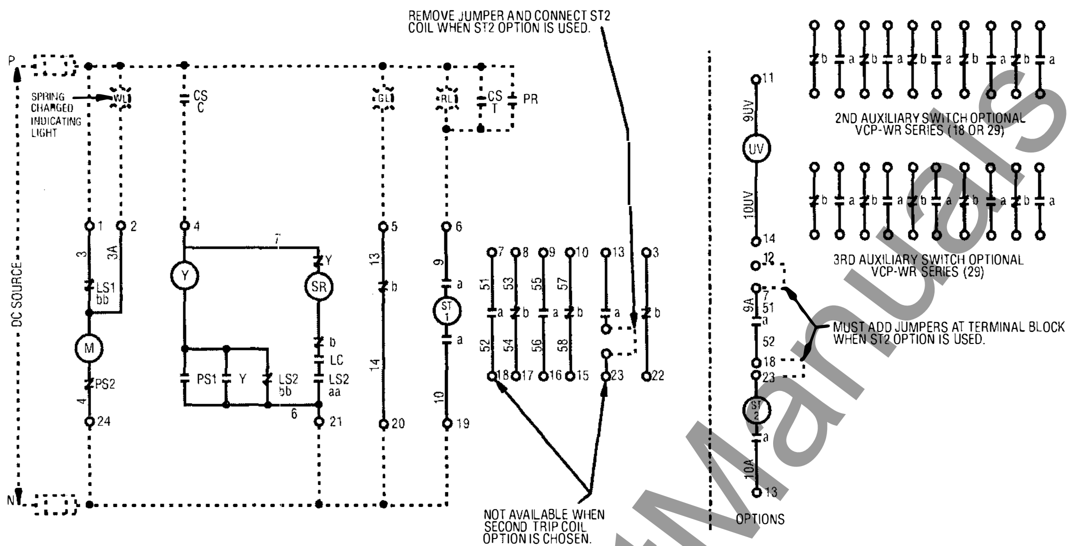
#### 5.7.1 ANTI-CLOSE INTERLOCK

The anti-close interlock prevents discharging of the closing springs if the breaker is already closed (Figure 5-6, 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).

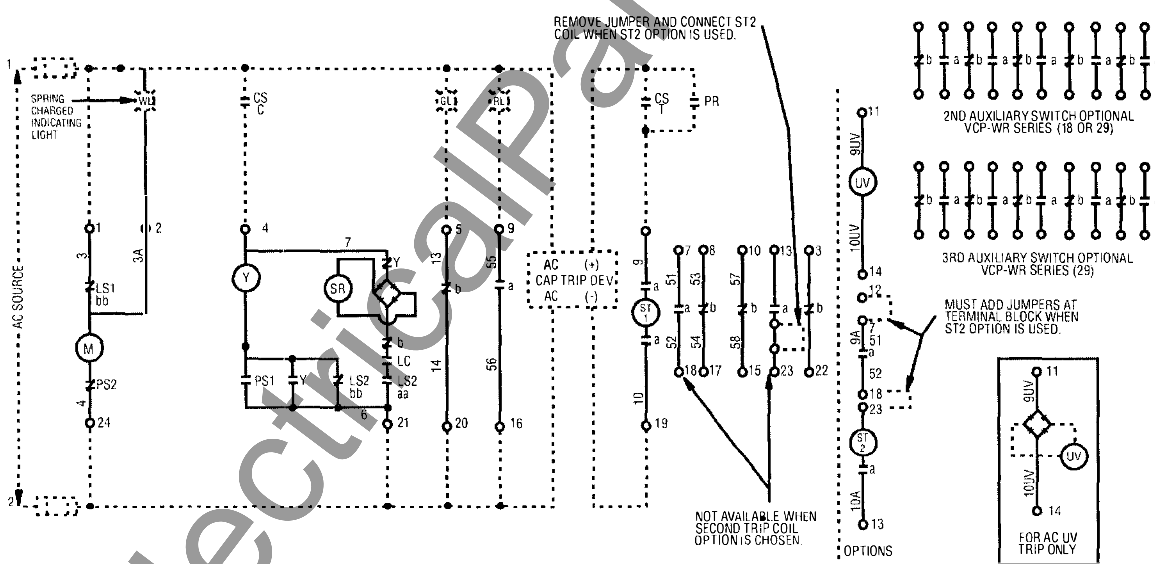
#### 5.7.2 GRAVITY OPERATED AUTOMATIC SPRING DISCHARGE INTERLOCK

The gravity discharge interlock consists of a pair of wheels attached to a weighted axle assembly, actuating stud and a cam follower/linkage assembly.

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



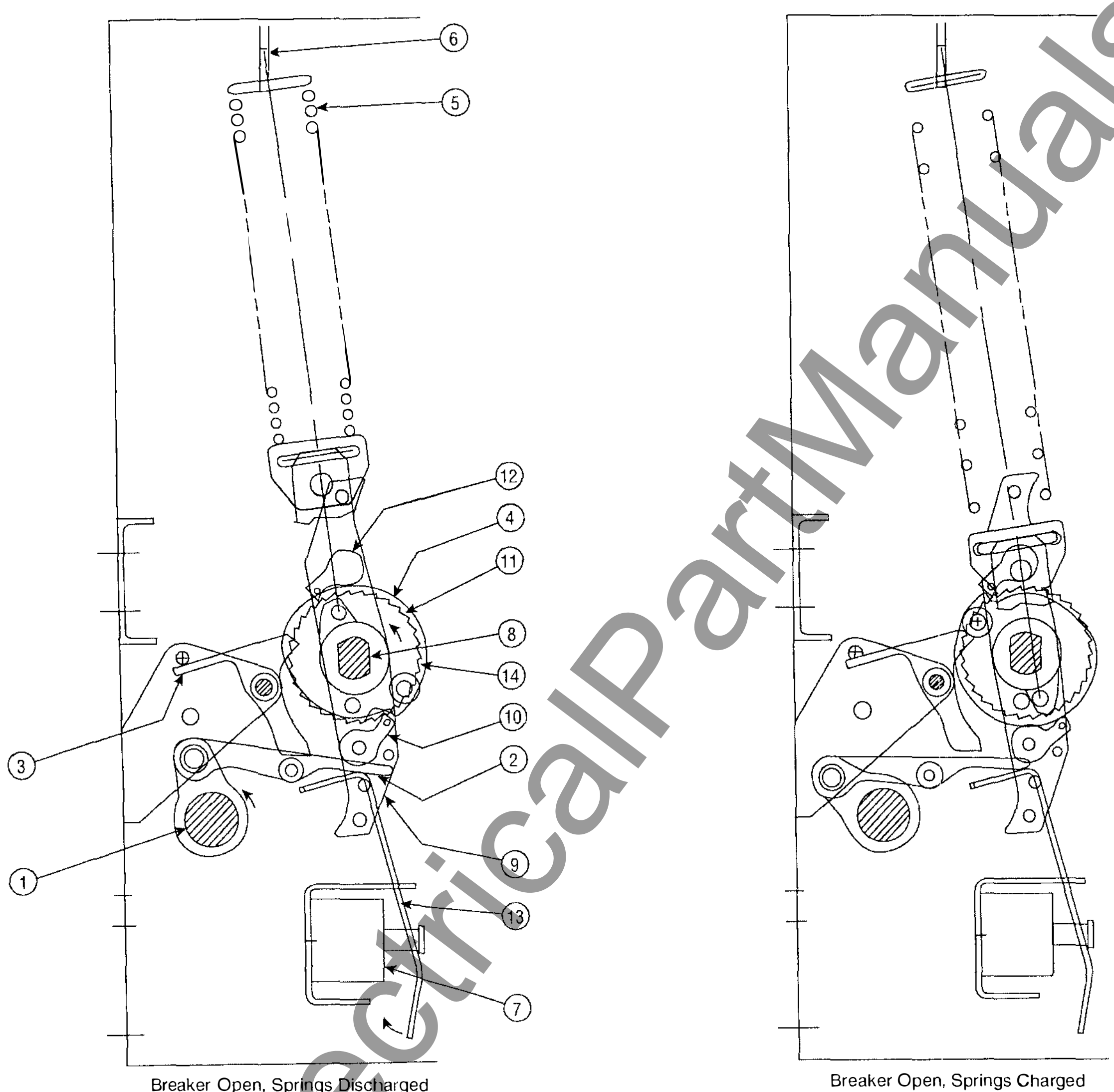

## VCP-WR (18, 20, 29) BREAKER AC CONTROL SCHEMATIC




- 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 5-5 Typical AC/DC Schematic*




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 5-6 Closing Cam and Trip Linkage*

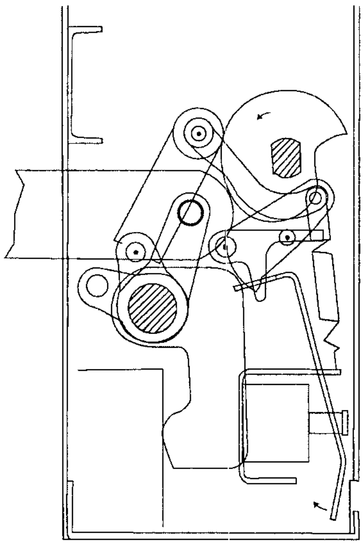


Figure 5-7a Breaker Open and Closing Spring Not Charged

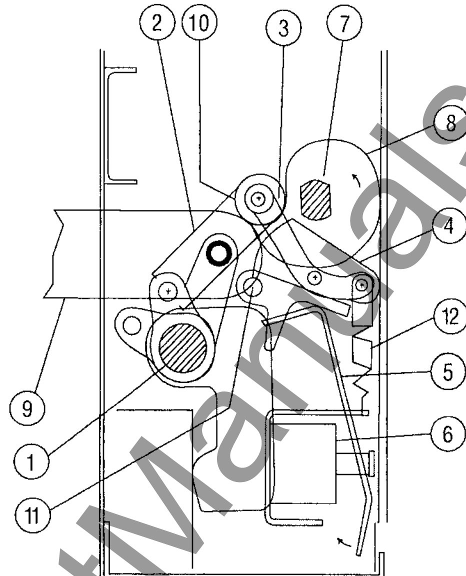



Figure 5-7b Breaker Breaker Open and Closing Spring Charged

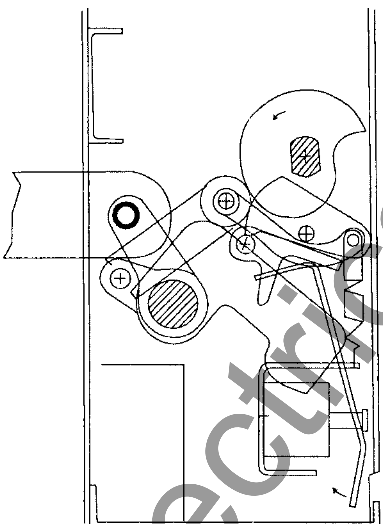


Figure 5-7c Breaker Closed and Closing Spring Not Charged

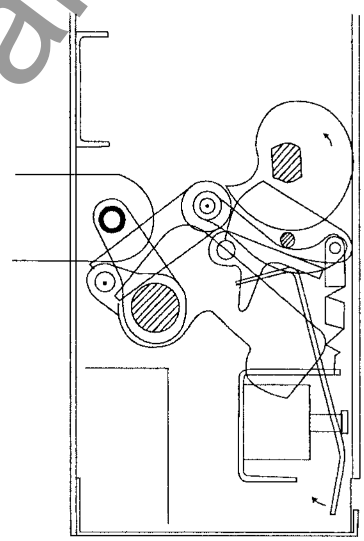


Figure 5-7d Breaker Closed and Closing Spring Charged

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 5-7 Charging Schematic*

The axle assembly is designed to swing downward due to gravity as the breaker is lifted and to be pushed upward as the wheels meet the cell floor when lowering to the disconnect position. Movement of the axle assembly transmits motion to the element trip and close interface rollers to simultaneously activate the close and trip linkages of the element and discharge the stored energy of the breaker.

The activation of the close and trip linkages renders the breaker trip-free during activation and assures the breaker will be open and discharged prior to entering the connect position when raising or the disconnect position when lowering.

### 5.7.3 ACTIVE INTERLOCK

The active interlock functions to prevent raising or lowering a breaker except when the primary contacts are open. It also prevents closing primary contacts when the breaker is being raised or lowered.

Engaging the elevating motor to raise the breaker forces the active interlock roller back via a notched slide on the side of the cubical. Connecting linkage transmits motion through the pawl lock lever to rotate a cam under the element and trip the breaker. When closed, the right interlock roller will open the breaker when moved between the “disconnect” and “connect” positions because of interference with the elevating motor slide on the right side of the cubical. This roller and slide causes the breaker to remain open between the “inserted” and “connect” positions. It should be noted that movement of the elevating motor engagement linkage will not discharge the closing springs inside the breaker; it will only trip a closed breaker. Also, when the elevating motor is engaged, the breaker cannot be closed.

### 5.7.4 SHUTTER INTERLOCK

Each GE vertical lift cell is equipped with a shutter to shield the high voltage stabs in the cubicle when the breaker is not in the cubicle. The shutter is regulated by the racking mechanism that opens the shutter as the breaker is racked up into the cell and closes the shutter as the breaker is racked down and out of the cell.

### 5.8 MOC OPERATOR (If Equipped)

The MOC switch is external to the circuit breaker and mounted within the confines of the switchgear cubicle. The breaker's MOC operator interfaces with the cell MOC switch in the same manner as the original breaker being replaced. All Cutler-Hammer VR-Series breakers, which are supplied with MOC operators, are engineered with patented ***SURE CLOSE*** Technology. This technology decouples the MOC operator from the main breaker operating mechanism. This prevents the MOC switch from stalling the circuit breaker during a closing operation, preventing damage to the cell MOC components, and extends the life of the MOC switch.

## 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.

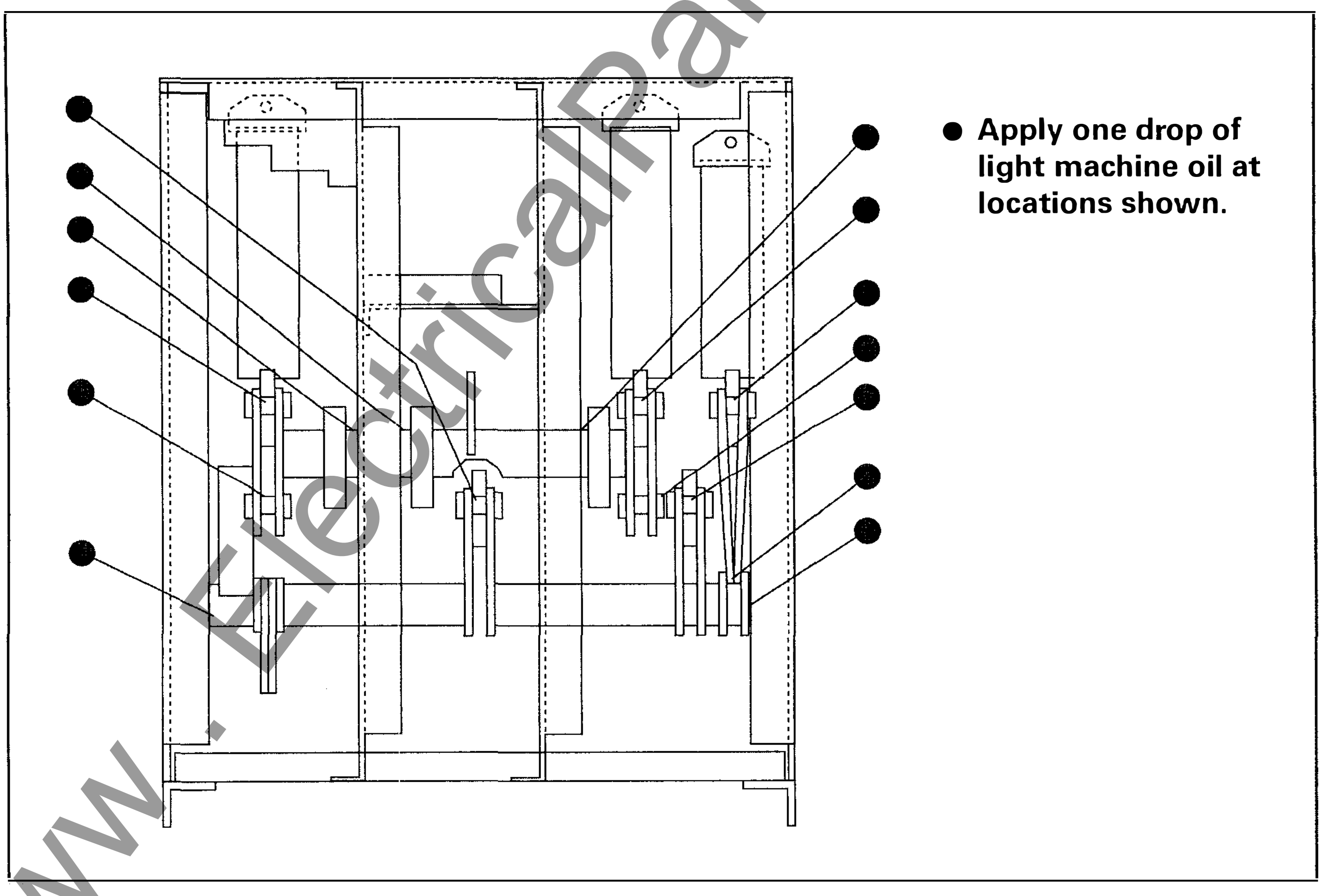



*Figure 6-1 Lubrication Areas*

### 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 |
| | Bushing Knobs (If Applicable) | Loose | Torque Check | 1200A / 2000A - 60ft / lbs 3000A - 75ft / lbs |
| 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 INTEGRITYTEST

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. If the wipe is not adequate, the vacuum interrupter assembly (Pole Unit) must be replaced. Field adjustment is not possible.

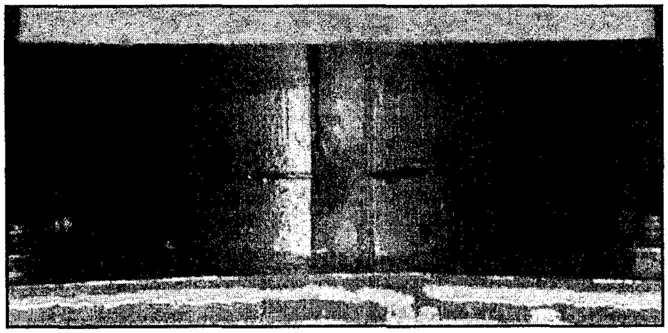


*Figure 6-2 Vacuum Interrupter Showing Contact Erosion Indicator With Breaker Open (Shown here for clarity purposes only)*

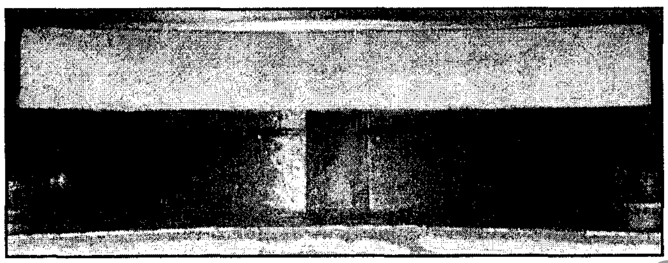


*Figure 6-3 Vacuum Interrupter Showing Contact Erosion Indicator With Breaker Closed (Indicators are checked only when breaker is closed.)*

**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.

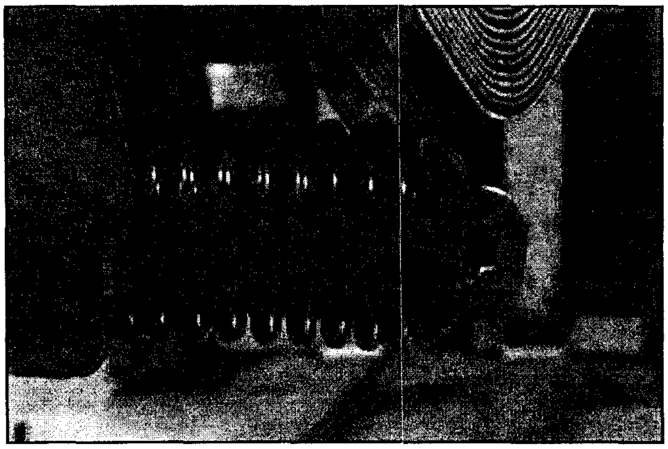


*Figure 6-4 "T" Contact Wipe Indicator Example with Blue Spring (if the "T" or any portion of its visible as shown with the breaker closed, the wipe is satisfactory, See Next Figure for Graphic of All Possibilities).*

**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**

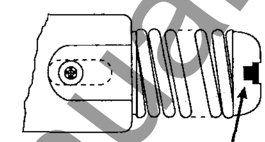
Make a careful visual inspection of the mechanism for any loose parts such as bolts, nuts, pins, rings, etc. Check for excessive wear or damage to the breaker components. Operate the breaker several times manually and electrically. Check the closing and opening times to verify that they are in accordance with the limits in Table 5.1.

**6.9.1 CLOSURE™ TEST**

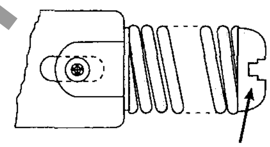
**Introduction:** The CloSure™ Test is a simple yet extremely effective means to determine and monitor the ability of the mechanism to close the breaker contacts fully. It provides a quantitative measure of the extra energy available in terms of over travel in inches to close the breaker contacts to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

**White Contact Springs**

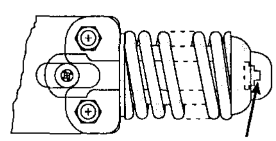


Any part of Red or Gray Indicator Visible
"Wipe" Satisfactory

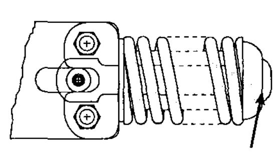


Red or Gray Indicator Not Visible
"Wipe" Unsatisfactory

**Blue or Red Contact Springs**



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



"T" Shape Indicator Not Visible
"Wipe" Unsatisfactory

*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 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**).

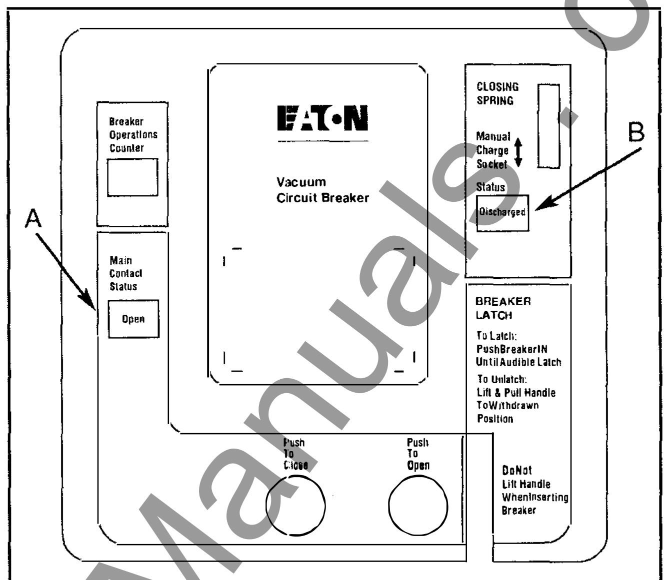



*Figure 6-6 Status Indicators ("A" shows the contact status indication and "B" shows the spring indication.)*

***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° 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**".

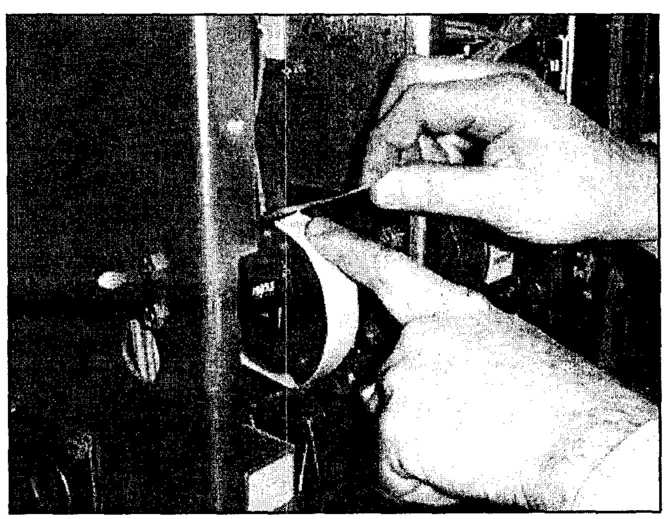


*Figure 6-7 Wrapping Tape Around Cam*

***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. Fleassemble the front cover onto the circuit breaker. Return the circuit breaker to it's original configuration and setup.

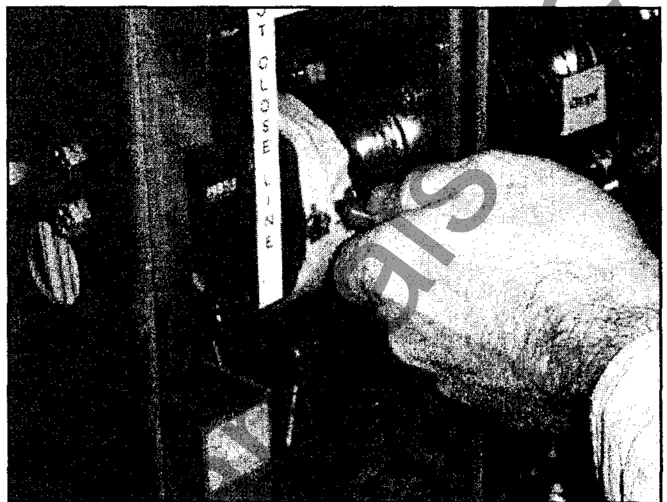


*Figure 6-10 Make a Clear and Heavy Mark*

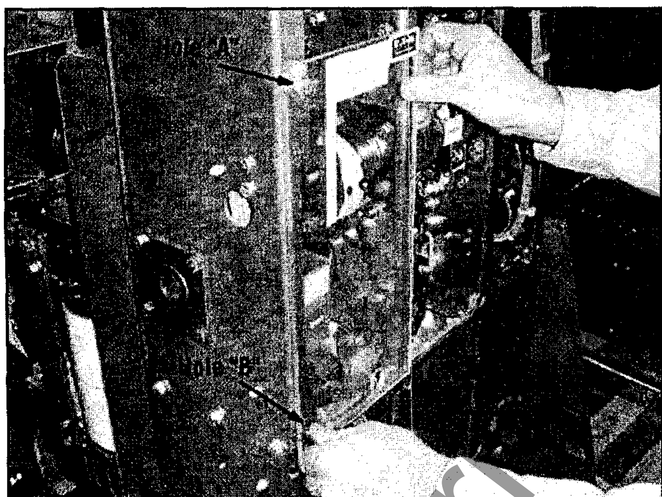


*Figure 6-8 Attaching CloSure™ Test Tool at Hole "A" & "B"*

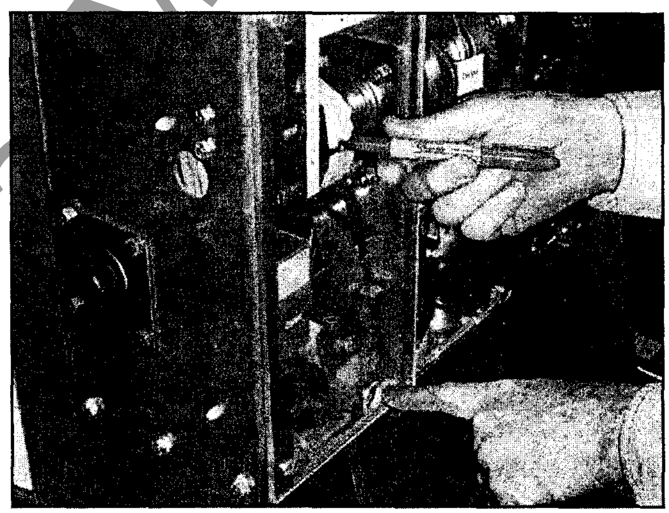


*Figure 6-11 With Marker in Hole "C", While Closing Breaker*

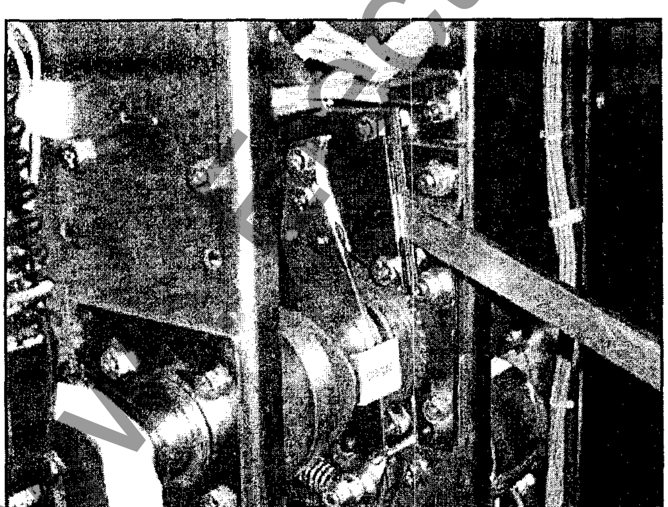


*Figure 6-9 Manually Charging Closing Springs*

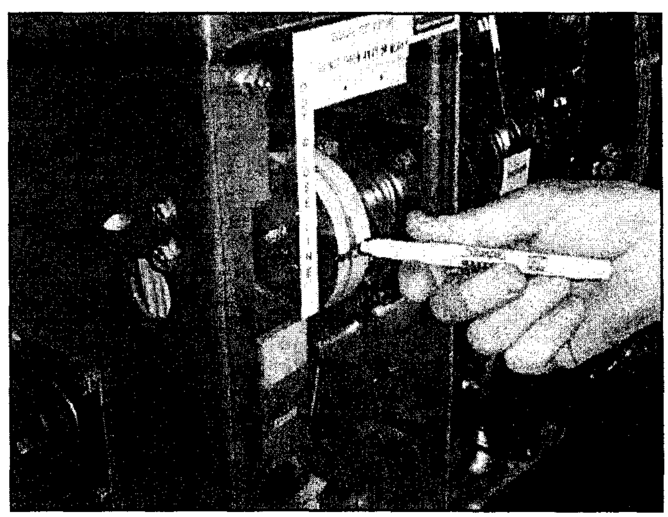


*Figure 6-12 Move the Sharpie® 15° Left and Right*

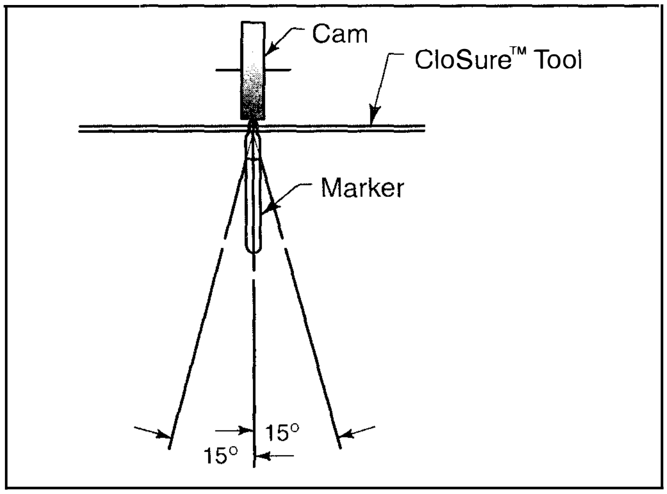



Figure 6-13 Top view of Cam and Marker Interface


Figure 6-14 Evaluate the CloSure™ Performance

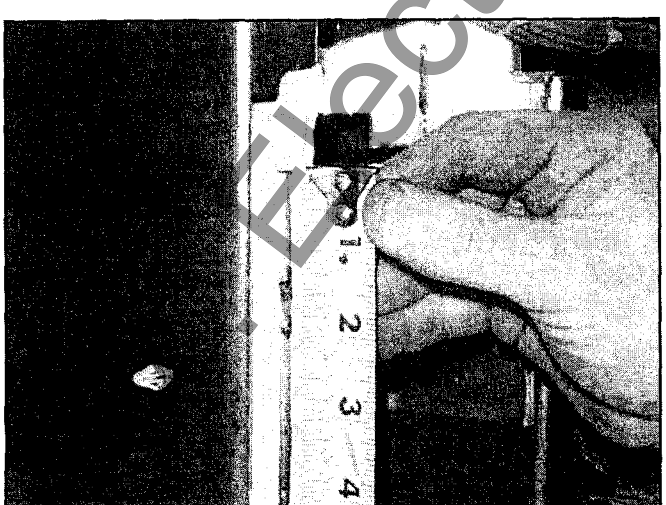


Figure 6-15 Determining the Distance Traveled

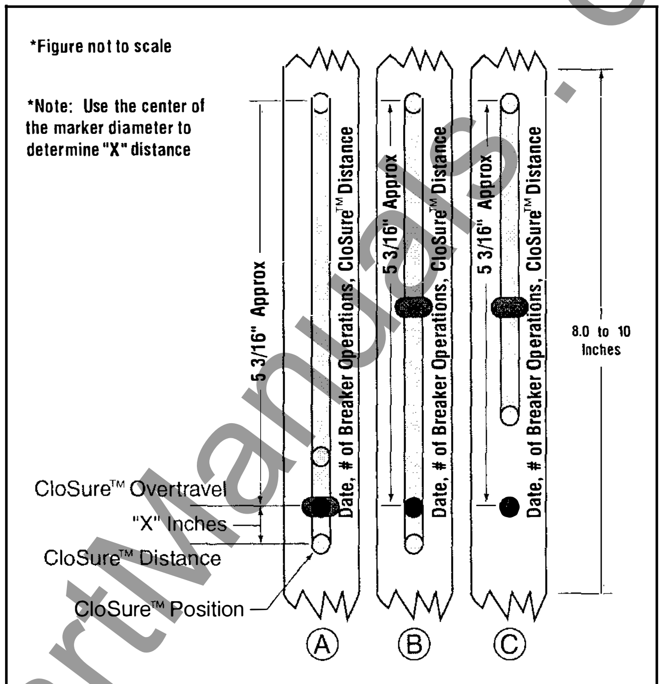



Figure 6-16 Illustrative Testing Tape Sample

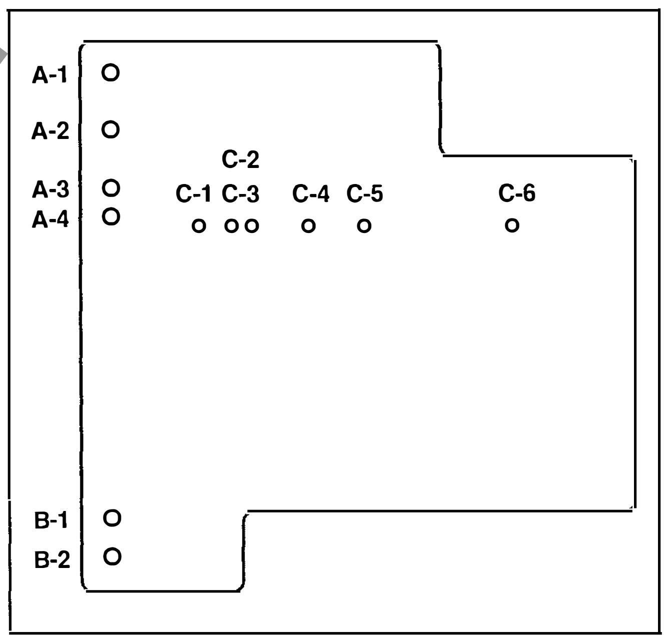



Figure 6-17 Front View of CloSure™ Tool Showing Mounting / Testing Hole Locations (6352C49H01)

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

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

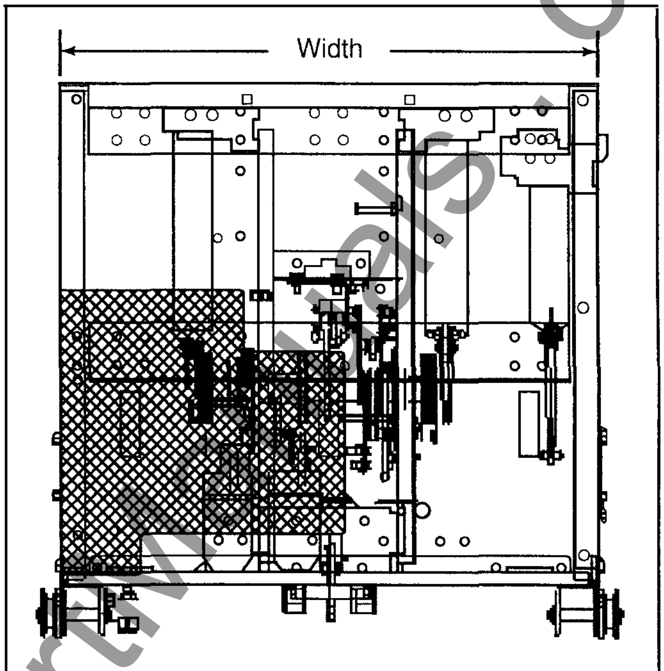



*Figure 6-18 Typical Circuit Breaker Front View with CloSure™ Tool Attached (approximate mechanism chassis width)*

### 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 53701QB 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)<br>• Secondary Disconnects<br>• Motor Cut-off Switch (Poor or burned contacts. Lever not operational.)<br>• Terminals and connectors (Poor or burned contacts)<br>• Motor (Brushes worn or commutator segment open) |
| | • Mechanism | • Pawls (Slipping or broken)<br>• Ratchet Wheel (Teeth worn or broken)<br>• Cam Shaft Assy. (Sluggish or jammed)<br>• 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)<br>• Secondary Disconnects<br>• Anti Pump Relay (Y relay N.C. contact open or burned or relay picks up)<br>• Close Coil (Open or burned)<br>• Latch Check Switch (Contact open - Bad switch or trip bar not reset)<br>• Auxiliary Switch (b contact open or burned)<br>• Motor Cut-Off (Contacts open or burned)<br>• Trip Coil Assy. (Clapper fails to reset) |
| | • Closing Sound But no Close | • Pole Shaft (Not open fully)<br>• Trip Latch Reset Spring (Damaged or missing)<br>• Trip Bar-D Shaft (Fail to remain reset)<br>• Trip Latch-Hatchet (Fails to remain reset)<br>• Trip Floor Tripper (Fails to remain reset)<br>• Close Latch (Binding)<br>• Close Latch Roller (Binding)<br>• Trip Circuit Energized |
| **UNDESIRABLY CLOSES** | | |
| | • Control Circuit | • Close Circuit (CS/C Getting shorted) |
| | • Mechanism | • Close Release Latch (Fails to reset)<br>• Close Floor Tripper (Fails to reset) |

| SYMPTOM | INSPECTION AREA | PROBABLE DEFECTS |
|---|---|---|
| **FAILS TO CLOSE** | | |
| • No Trip Sound | • Control Circuit | • Control Power (Fuse blown or switch off)<br>• Secondary Disconnects<br>• Auxiliary Switch (a contact not making poor or burned)<br>• Trip Coil (Burned or open)<br>• Terminals and Connections (poor or burned or open) |
| | • Trip Mechanism | • Trip Clapper (Jammed) |
| • Trip Sound But no Trip | • Trip Mechanism | • Trip Bar, Trip Latch (Jammed)<br>• Pole Shaft (Jammed)<br>• Operating Rod Assembly (Broken or pins out) |
| | • Vacuum Interrupter (One or more Welded) | |
| **UNDESIRABLY TRIPS** | | |
| | • Control Circuit | • Control Power (CS/T Switch, remains made) |
| | • Mechanism | • Trip Coil Clapper (Not resetting)<br>• Trip Bar or Trip Latch (Poor engagement of mating or worm surfaces)<br>• Trip Bar Reset Sprint (Loss of torque) |

## SECTION 7: REPLACEMENT PARTS

### 7.1 GENERAL

In order to minimize production downtime, it is recommended that an adequate quantity of spare parts be carried in stock. The quantity will vary from customer to customer, depending upon the service severity and continuity requirements. Each customer should develop his own level based on operating experience. 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.

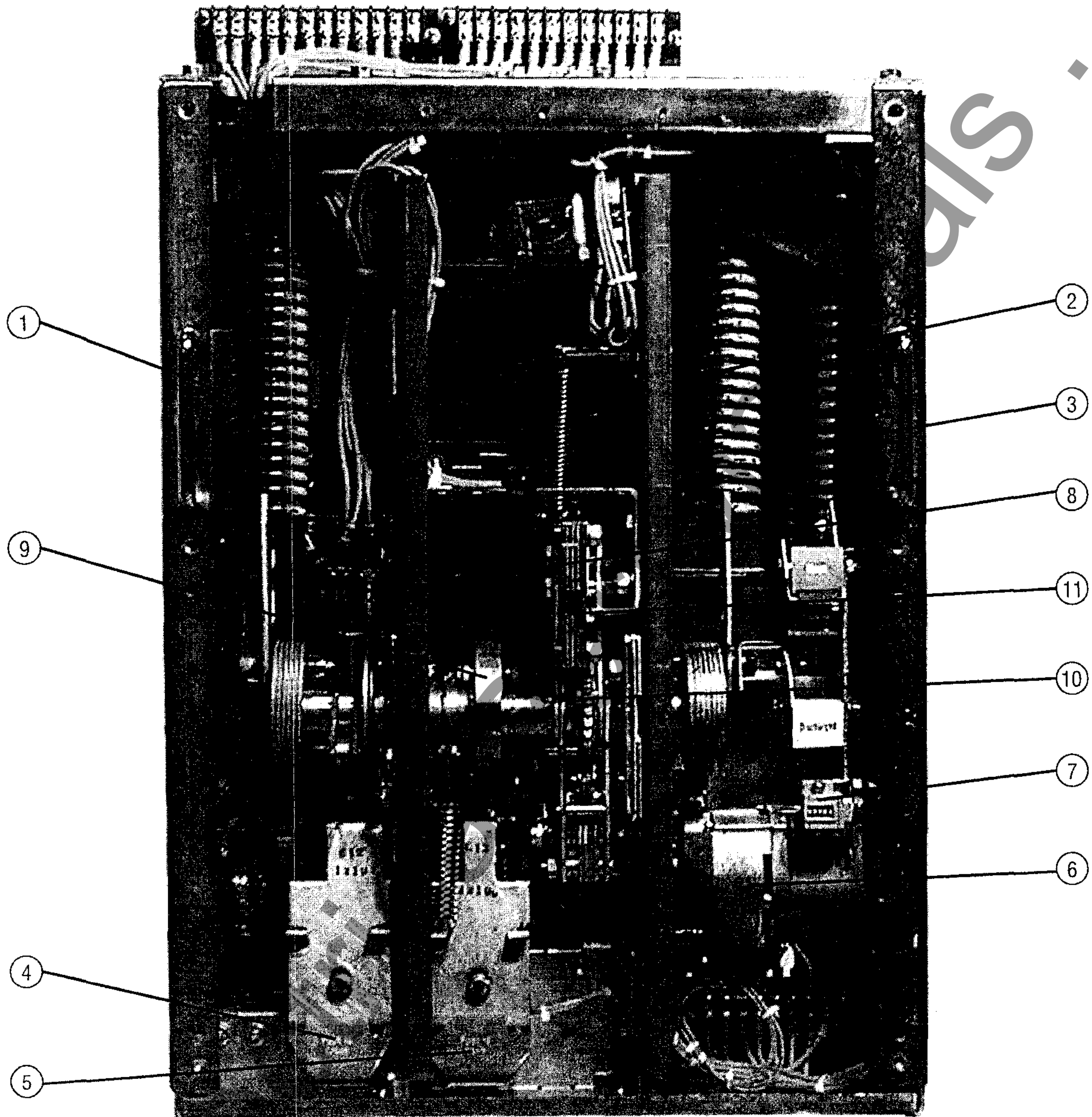
b. Describe the item, give the style number, and specify the quantity required.

c. Specify the voltage for electrical components.

d. Specify the method of shipping desired.

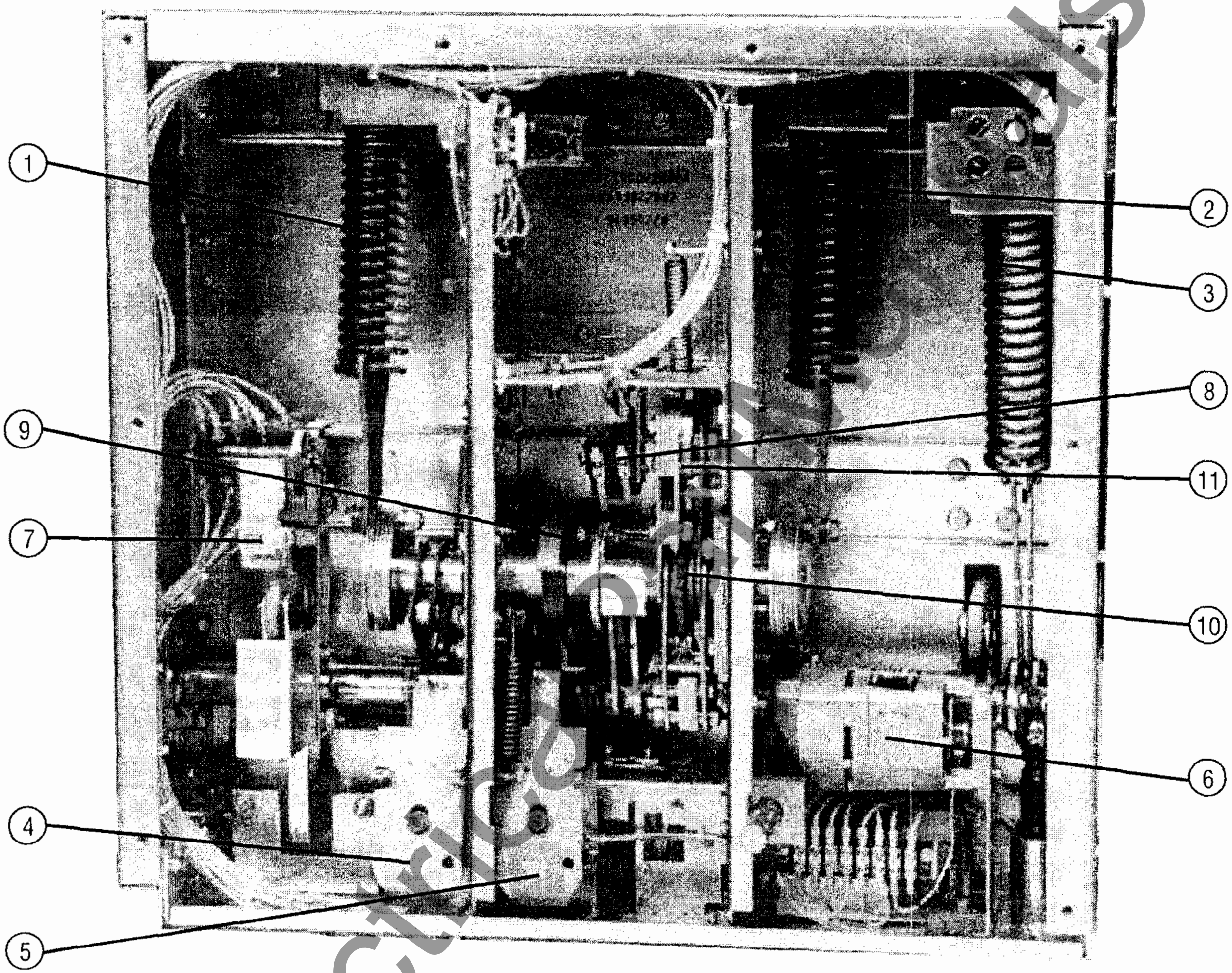
e. Send all orders or correspondence to the nearest Eaton's Electrical Services & Systems sales office.

f. Include negotiation number with order when applicable.




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

*Figure 5-8 GE AM-4.16-VR (18WR) Vacuum Element - Front Faceplate Removed*




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

*Figure 5-9 GE AM-VR (29WR) Vacuum Element - Front Faceplate Removed*

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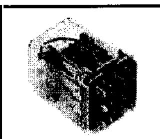
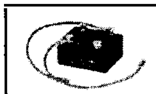
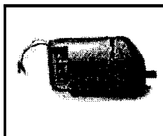
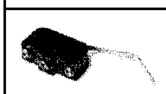
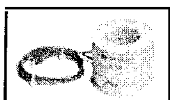
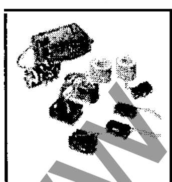
September 2004

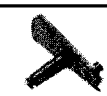
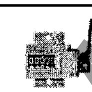
## Control Components

Table 1. Control Components

| Items | Descriptions | Current Cutler-Hammer Style Number |
|---|---|---|
| **Relays** | | |
|  | Anti-Pump (Y) Relay (48vDC)<br>Anti-Pump (Y) Relay (125vDC)<br>Anti-Pump (Y) Relay (250vDC) | 8237A27H03<br>8237A27H04<br>8237A27H05 |
| | Anti-Pump (Y) Relay (120vAC)<br>Anti-Pump (Y) Relay (240vAC) | 8237A27H01<br>8237A27H02 |
| **Rectifier** | | |
|  | Rectifier | 3759A79G02 |
| **Spring Charging Motors** | | |
|  | Spring Charging Motor (48vDC)<br>Spring Charging Motor (125vDC)<br>Spring Charging Motor (250vDC / 240vAC) | 699B196G06<br>699B196G04<br>699B196G05 |
| **Switches** | | |
|  | Breaker Auxiliary Switch | 5697B02G02 |
|  | Breaker Position Switch PS1 | 699B147H01 |
|  | Breaker Position Switch PS2 | 3759A93H01 |
|  | Latch Check Switch (LC) | 699B147H04 |
|  | Motor Cutoff Switch (LS) (20WR / 29WR) - (Shown)<br>Motor Cutoff Switch (LS) (18WR) | 699B199G04<br>5677B02G01 |
| **Coils or Shunt Trips** | | |
|  | Coil or Shunt Trip 24vDC<br>Coil or Shunt Trip 48vDC<br>Coil or Shunt Trip 125vDC / 120vAC<br>Coil or Shunt Trip 250vDC / 240vAC | 692C215G09<br>692C215G01<br>692C215G02<br>692C215G03 |
| **Control Components Kit** | | |
|  | 48vDC<br>125vDC<br>250vDC | 94C9525G01<br>94C9525G02<br>94C9525G03 |
| | 120vAC-C/M 48vDC-T<br>240vAC-C/M 48vDC-T<br>120vAC-C/M 120vAC-CT<br>240vAC-C/M 240vAC-CT | 94C9525G04<br>94C9525G05<br>94C9525G06<br>94C9525G07 |

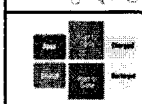
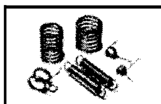
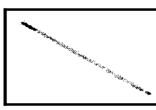
## Mechanical Devices

Table 2. Mechanical Devices

| Items | Descriptions | Current Cutler-Hammer Style Number |
|---|---|---|
| **Tripping Mechanisms** | | |
|  | Trip D Shaft Assembly | 694C638G02 |
|  | Trip Latch (Hatchet) | 699B040G03 |
| **Operations Counter** | | |
|  | Operations Counter | 592C040H01 |

## Accessories

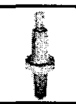
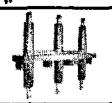
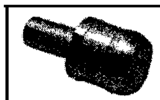
Table 3. Accessories

| Items | Descriptions | Current Cutler-Hammer Style Number |
|---|---|---|
| **Accessory Kits** | | |
|  | Fastener Kit | 8061A01G01 |
|  | Labels Kit | 8295A45G01 |
| **Small Spring Kits** | | |
|  | Small Spring Kit 5kV rating (18 Springs)<br>Small Spring Kit 7.5 and 15kV rating (18 Springs) | 3A75671G01<br>3A75671G02 |
| **Manual Charging Handle** | | |
|  | Manual Charging Handle | 8064A02G01 |
| **Breaker Mechanical Lubricant** | | |
|  | Breaker Mechanical Lubricant | 53701QB12J |

# VR-Series General Electric AM-4.16 / 7.2 / 13.8 / 15-VR Specific Replacement Parts

## Power Parts

Table 4. Power Parts

| Items | Descriptions | Current Cutler-Hammer Style Number |
|---|---|---|
| **Primary Bushings** | | |
|  | Single Universal Bushing 7.2, 7.5, 13.8, 15 - 1200A / 2000A | 2693B99H01 |
|  | Triple Bushing 4.16 - 250VR<br>Triple Bushing 4.16 - 250U / 350VR 1200A/2000A | 7960D10001<br>7960D10002 |
|  | Triple Bushing 7.2, 13.8 - 1200A | 94B2153G01 |
| **Primary Bushings** | | |
|  | Phase Barrier 4.16 - 250VR (Inner)<br>Phase Barrier 4.16 - 250VR (Outer)<br>Phase Barrier 4.16 - 250U/350VR (Inner)<br>Phase Barrier 4.16 - 250U/350VR (Outer)<br>Phase Barrier 7.2, 13.8, 15-1200A (Inner)<br>Phase Barrier 7.2, 13.8, 15-1200A (Outer)<br>Phase Barrier 7.2, 13.8, 15-2000A (Inner)<br>Phase Barrier 7.2, 13.8, 15-2000A (Outer) | 7960D95H07<br>7960D95H02<br>7960D95H06<br>7960D95H06<br>7960D33H01<br>7960D33H06<br>7960D33H05<br>7960D33H03 |
| **Primary and Secondary Disconnects** | | |
|  | Bushing Adapter (1200A)<br>Bushing Adapter (2000A) | 7960D38008<br>94B2126H01 |
|  | Secondary Contact Block | J1670G01 |

## Accessories

Table 5. Accessories

| Items | Descriptions | Current Cutler-Hammer Style Number |
|---|---|---|
| **Wheels** | | |
|  | Swivel Caster | 7960D21H01 |

**Note:** 24-hour Quick-Ship available. For additional information, call the Power Breaker Center toll free at 1-877-276-9379.

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