



Instructions for Installation, Operation and Maintenance of Type VCP-W Outdoor Vacuum Circuit Breaker Element



**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 CONTACT CUTLER-HAMMER.

**WARNING**

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

ALL 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 AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) C37.09. 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.

Cutler-Hammer

Power Distribution Components Division

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Pittsburgh, PA 15220

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.

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SECTION 1: INTRODUCTION

1-1 PRELIMINARY COMMENTS AND SAFETY PRECAUTIONS

This technical document is intended to cover most aspects associated with the installation, operation and maintenance of Type VCP-W Outdoor Vacuum Circuit Breaker Elements. It is provided as a guide for authorized and qualified personnel only. Please refer to the specific WARNING and CAUTION in Paragraph 1-1.2 before proceeding past Section 1. If further information is required by the purchaser regarding a particular installation, application or maintenance activity, a Cutler-Hammer representative should be contacted.

1-1.1 WARRANTY AND LIABILITY INFORMATION

NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OF MERCHANTABILITY, OR WARRANTIES ARISING FROM COURSE OF DEALING OR USAGE OF TRADE, ARE MADE REGARDING THE INFORMATION, RECOMMENDATIONS AND DESCRIPTIONS CONTAINED HEREIN. In no event will Cutler-Hammer be responsible to the purchaser or user in contract, in tort (including negligence), strict liability or otherwise for any special, indirect, incidental or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information and descriptions contained herein.

1-1.2 SAFETY PRECAUTIONS

All safety codes, safety standards and/or regulations must be strictly observed in the installation, operation and maintenance of this device.



WARNING

THE WARNINGS AND CAUTIONS INCLUDED AS PART OF THE PROCEDURAL STEPS IN THIS DOCUMENT ARE FOR PERSONNEL SAFETY AND PROTECTION OF EQUIPMENT FROM DAMAGE. AN EXAMPLE OF A TYPICAL WARNING LABEL HEADING IS SHOWN ABOVE IN REVERSE TYPE TO FAMILIARIZE PERSONNEL WITH THE STYLE OF PRESENTATION. THIS WILL HELP TO INSURE

THAT PERSONNEL ARE ALERT TO WARNINGS, WHICH MAY APPEAR THROUGHOUT THE DOCUMENT. IN ADDITION, CAUTIONS ARE ALL UPPER CASE AND BOLDFACE AS SHOWN BELOW.



CAUTION

COMPLETELY READ AND UNDERSTAND THE MATERIAL PRESENTED IN THIS DOCUMENT BEFORE ATTEMPTING INSTALLATION, OPERATION OR APPLICATION OF THE EQUIPMENT. IN ADDITION, ONLY QUALIFIED PERSONS SHOULD BE PERMITTED TO PERFORM ANY WORK ASSOCIATED WITH THE EQUIPMENT. ANY WIRING INSTRUCTIONS PRESENTED IN THIS DOCUMENT MUST BE FOLLOWED PRECISELY. FAILURE TO DO SO COULD CAUSE PERMANENT EQUIPMENT DAMAGE.

1-2 GENERAL INFORMATION

The purpose of this book is to provide instructions for unpacking, storage, use, operation and maintenance of Type VCP-W Outdoor Vacuum Circuit Breaker Elements. These circuit breaker elements can be used in outdoor housings when the customer provides the appropriate housing and interface with the VCP-W element.

NOTICE

It is the customer's responsibility to perform the tests required by appropriate standards to prove the overall design validity.

The VCP-W Outdoor Vacuum Circuit Breaker Element is a fixed type interrupter element ideal for use in new installations as well as modernization and life extension of existing equipment. Designed to ANSI Standards for reliable performance and simplified maintenance, VCP-W Outdoor Vacuum Circuit Breaker Elements provide reliable control and protection for electrical equipment and circuits. In addition, these technologically advanced circuit breaker elements are compact, thus permitting the overall installation size to be significantly smaller than previously available equipment.



WARNING

SATISFACTORY PERFORMANCE OF THESE CIRCUIT BREAKER ELEMENTS IS CONTINGENT UPON PROP-

ER 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 BREAKER ELEMENTS.

ATE WITHIN THEIR NAMEPLATE RATINGS. OPERATION OUTSIDE OF THESE RATINGS MAY CAUSE THE EQUIPMENT TO FAIL, RESULTING IN DEATH, BODILY INJURY AND PROPERTY DAMAGE.

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



WARNING

THE CIRCUIT BREAKER ELEMENTS DESCRIBED IN THIS BOOK ARE DESIGNED AND TESTED TO OPER-

1-3 TYPE VCP-W OUTDOOR VACUUM CIRCUIT BREAKER ELEMENT RATINGS (TABLE 1.1)

Table 1.1 Type VCP-W Outdoor Vacuum Circuit Breaker Element on Symmetrical Current Rating Basis ① ⑤

Identification Circuit Breaker Type	Rated Values															
	Voltage		Insulation Level		Current		Interrupting Time ②	Maximum Permissible Tripping Delay	Transient Recovery Voltage (TRV)		Current Values					
	Maximum Voltage	Voltage Range Factor	Withstand Test Voltage		Continuous Current at 60 Hz	Short Circuit Current			E2	T2 Rise Time	Closing Latching Capability (Momentary) (2.7K Times Rated Short Circuit Current)	Capacitor Switching Ratings				
			Power Frequency (1 Minute)	Impulse			3 Second Short Time Current Carrying Capability	General-Purpose				Definite-Purpose				
E	K	kV rms	kV Peak	Amperes	kA rms	Cycles	Seconds	kV Peak	µs	kA Peak	Amps	Amps	Amps	Amps	Amps	
155 VCP-W 12		1	50	110	600 1200	12.5	5	2	29	36	34	2	400	100	400	400
155 VCP-W 16		1	50	110	600 1200	16	5	2	29	36	43	2	400	100	400	400
155 VCP-W 20		1	50	110	600 1200	20	5	2	29	36	54	2	400	100	400	400
155 VCP-W 25		1	50	110	600 1200	25	5	2	29	36	68	2	400	100	400	400

- ① KEMA tested to applicable ANSI Standards C37.04, C37.09, C37.06. (Standard operating duty, CO-15 seconds-CO.) Operating time values; opening 30-45 ms, closing 45-60 ms, and reclosing 300 ms (18 cycles).
- ② 3-cycle interrupting time capability is available.
- ③ Tested with 20 kA peak inrush current at 4.2 kHz.
- ④ 600A also available.
- ⑤ Low inductive tests were performed at 4.1A.

1-4 OUTLINES AND DIMENSIONS

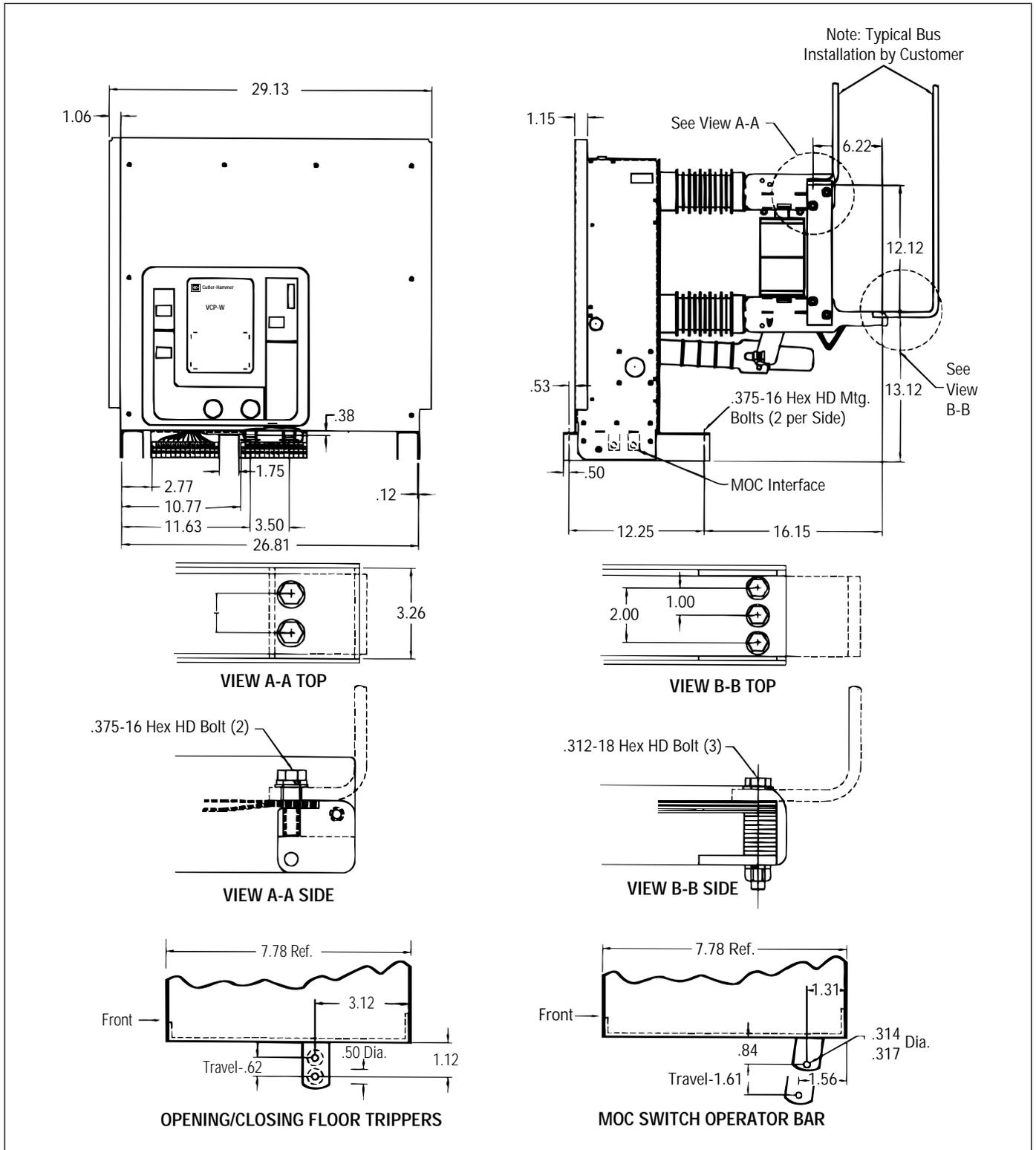


Figure 1-1 Type VCP-W Outdoor Circuit Breaker Outlines and Dimensions (inches)

SECTION 2: SAFE PRACTICES

2-1 RECOMMENDATIONS

Type VCP-W Outdoor Vacuum Circuit Breaker Elements 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. Details of the outdoor breaker element are shown in Figure 1-1 with interfacing details discussed in Section 6. It is the customer's responsibility to insure that all such interfaces are supplied and appropriate tests performed to adequately prove proper functioning and operation.



WARNING

TO PROTECT THE PERSONNEL ASSOCIATED WITH INSTALLATION, OPERATION, AND MAINTENANCE OF THESE CIRCUIT BREAKER ELEMENTS, THE FOLLOWING PRACTICES MUST BE FOLLOWED:

- Only qualified persons, as defined in the National Electrical Safety Code, who are familiar with the installation and maintenance of medium voltage circuits and equipment, should be permitted to work on these circuit breaker elements.
- Read these instructions carefully before attempting any installation, operation or maintenance of these circuit breaker elements.
- Always remove all power to the circuit breaker element before performing any maintenance. Failure to do so could result in electrical shock leading to death, severe personal injury or property damage.
- Do not work on a closed circuit breaker element or a breaker element with closing springs charged. The closing springs should be discharged and the main contacts open before working on the breaker element. Failure to do so could result in cutting or crushing injuries.
- Always remove the maintenance tool from the breaker after charging the closing springs.
- Circuit breaker elements are equipped with safety interlocks. **Do Not** remove, interfere with or in any manner defeat them. This may result in death, bodily injury or equipment damage.
- If a circuit breaker element is removed from its fixed position in a structure, do not work on the circuit breaker element suspended from a lifting yoke or chains. Maintenance work should be performed on a solid work surface, such as the floor.

SECTION 3: RECEIVING, HANDLING AND STORAGE

3-1 GENERAL

Type VCP-W Outdoor Vacuum Circuit Breaker Elements are subjected to complete factory production tests in accordance with ANSI C37.09 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. Tools, such as the maintenance tool, are shipped separately.

3-2 RECEIVING

If the circuit breaker element is not to be used immediately but is to be placed in storage; maximum protection can be obtained by keeping it packed as shipped.

Upon receipt of the equipment, inspect the containers for any signs of damage or rough handling. Open the containers carefully to avoid any damage to the contents. Use a nail puller rather than a crow bar when required. When opening the containers, be careful to save any loose items or hardware that may be otherwise discarded with the packing material. Check the contents of each package against the packing list.

Examine the circuit breaker element 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 Cutler-Hammer Office.

3-3 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 CIRCUIT BREAKER ELEMENT MAY SLIP OR FALL CAUSING SEVERE PERSONAL INJURY. ALWAYS PERFORM MAINTENANCE, REPAIR AND ADJUSTMENTS ON A SOLID WORK SURFACE CAPABLE OF SUPPORTING THE BREAKER ELEMENT.

When a breaker element is ready for installation in an outdoor housing, a lifting yoke in conjunction with an overhead lifter or portable floor lifter can be used to move a breaker element. When a breaker element is to be lifted, position the lifting yoke over the breaker element and insert lifters into the breaker element side openings with the lifting hole toward the interrupters. Once the lifting yoke is securely seated in the holes, the breaker element can be carefully lifted and moved.

3-4 STORAGE

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

The circuit breaker element is shipped with its contacts open and closing springs discharged. The indicators on the front panel should confirm this. Insert the maintenance tool in the manual charge socket opening (Figure 3-3). Charge the closing springs by pumping the handle up and down approximately 38 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. Operate the push-to-close button. The breaker element will close as shown by the breaker contacts “closed” (red) indicator. Operate the push-to-open button. The breaker element 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 of the breaker element is NOT recommended. If unavoidable, the outdoor location must be well drained and a temporary shelter from sun, rain, snow, corrosive fumes, dirt, falling objects and excessive moisture 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 air circulation to prevent condensation. If the building is not heated, the same general rule for heat as for outdoor storage should be applied.

3-5 TOOLS AND ACCESSORIES

Several tools and accessories, both standard and optional are available for use with the circuit breaker element.

Maintenance Tool (Standard): Used to charge closing springs.

Lifting Yoke (Optional): Used to lift breaker element with overhead lifting device.

3-6 TYPE VCP-W OUTDOOR VACUUM CIRCUIT BREAKER ELEMENT WEIGHTS (TABLE 3.1)

Table 3.1 VCP-W Outdoor Breaker Weights^①

Rating		Pounds
155 VCP-W 12	600 1200	325
155 VCP-W 16	600 1200	325
155 VCP-W 20	600 1200	325
155 VCP-W 25	600 1200	325

^① Does not include shipping carton.

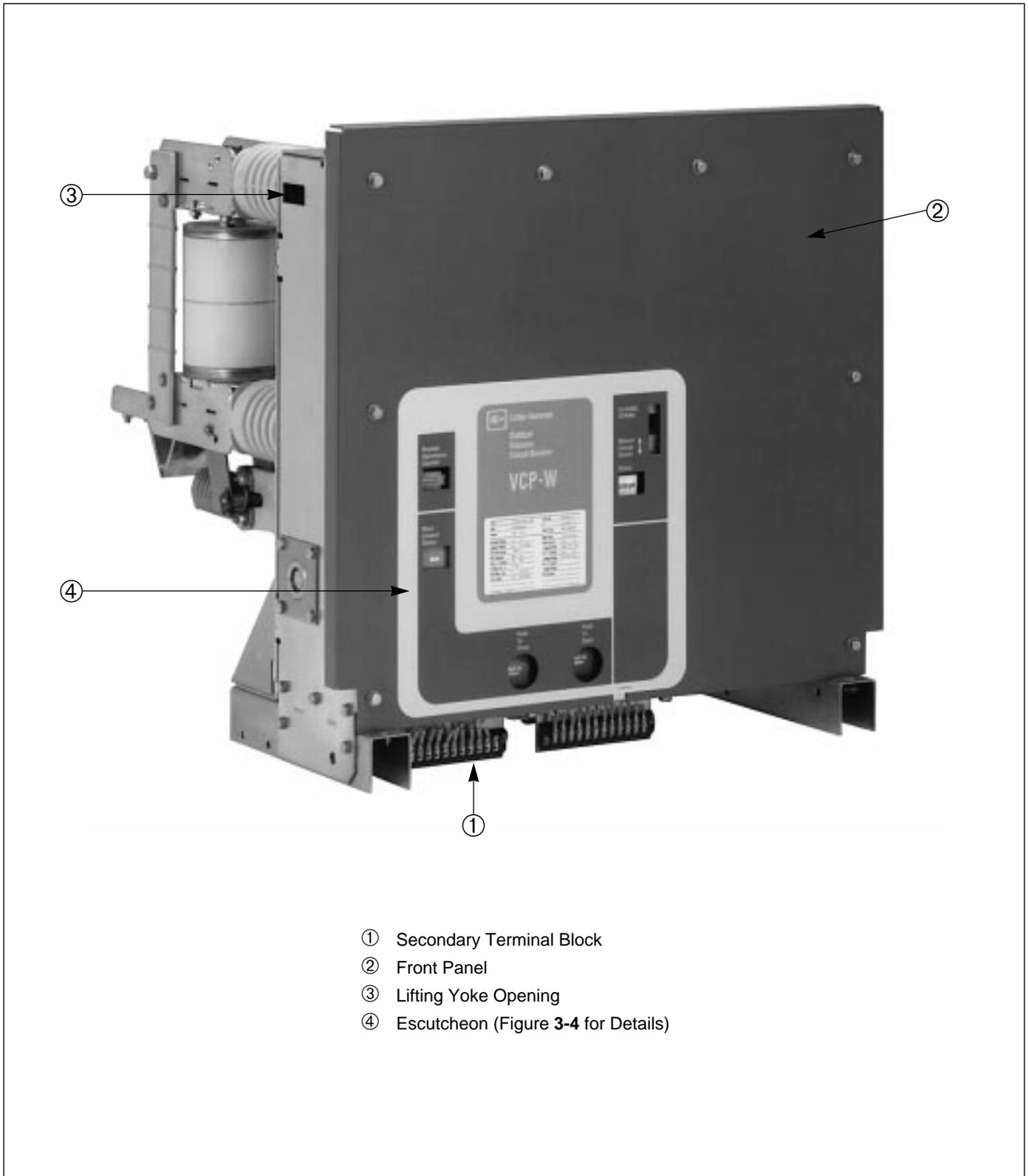
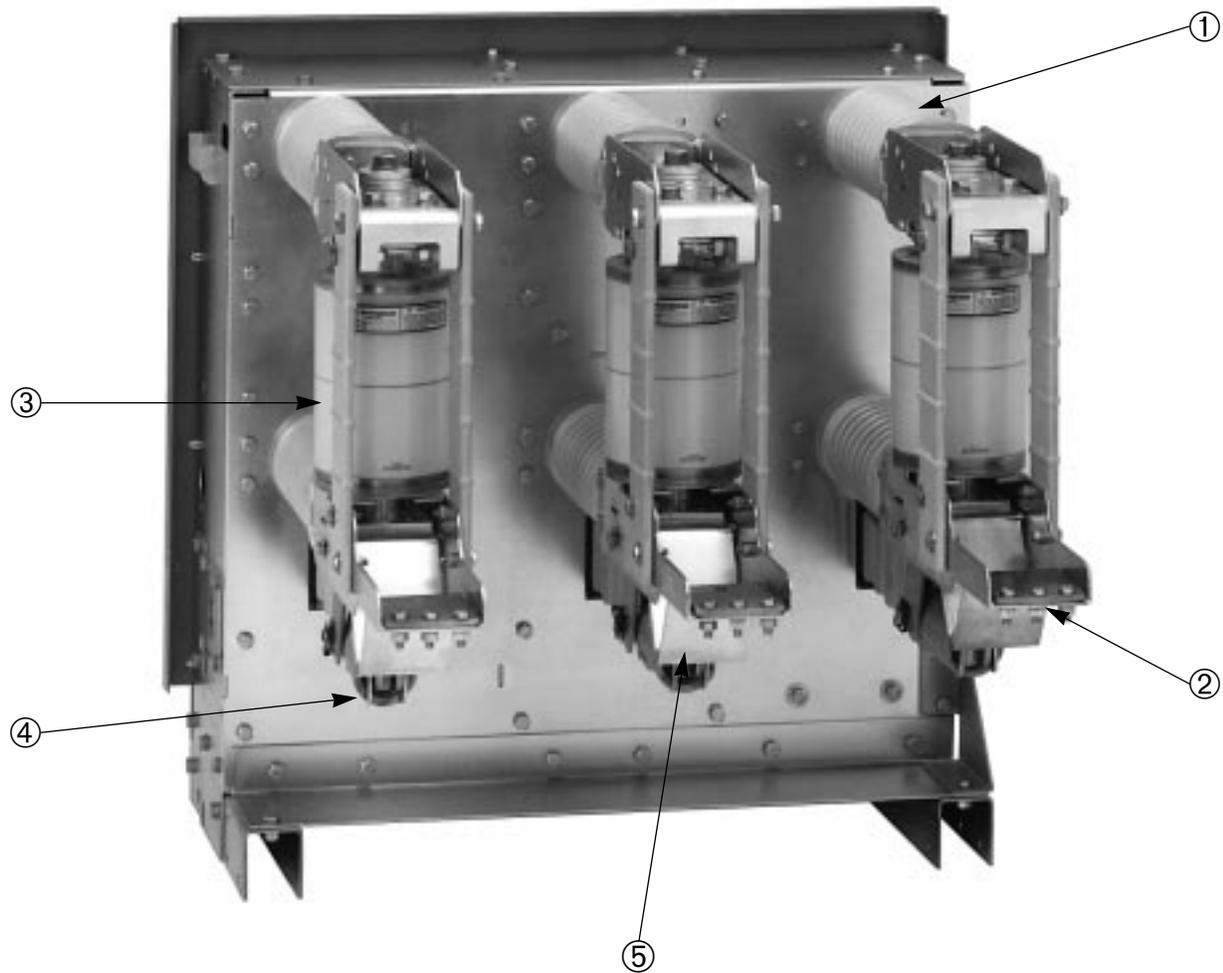
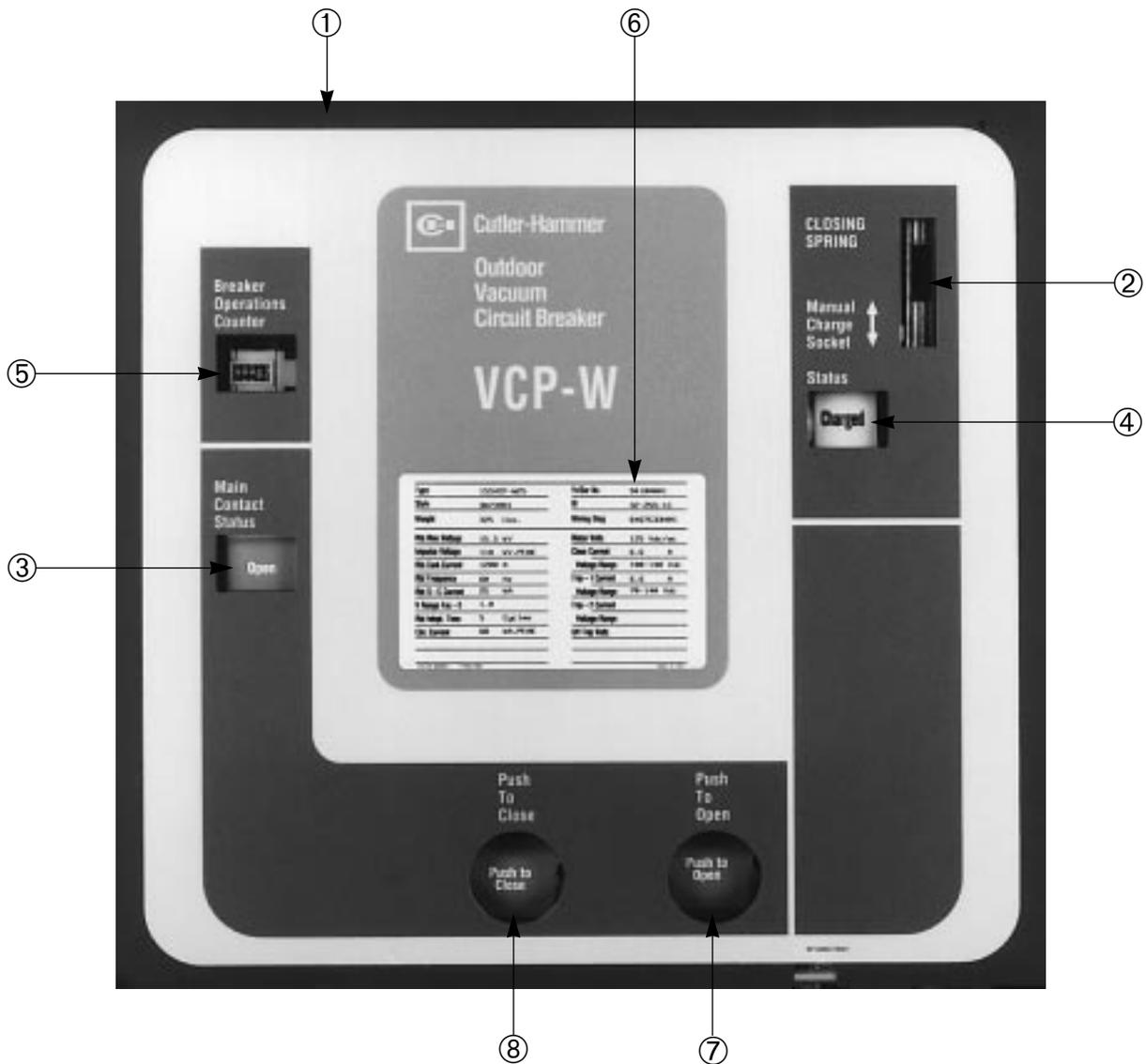


Figure 3-1 Front View VCP-W Outdoor Vacuum Circuit Breaker Element



- ① Standoff Insulator
- ② Primary Conductor Interface
- ③ Vacuum Interrupter
- ④ Contact Loading Spring (Wipe Spring)
- ⑤ Flexible Connector

Figure 3-2 Rear View VCP-W Outdoor Vacuum Circuit Breaker Element



- ① Front Panel
- ② Manual Charge Socket
- ③ Open-Closed Indicator
- ④ Spring Charged/Discharged Indicator
- ⑤ Operation Counter
- ⑥ Nameplate
- ⑦ Manual Open Button
- ⑧ Manual Close Button

Figure 3-3 Typical VCP-W Outdoor Breaker Element Escutcheon

SECTION 4: INITIAL INSPECTION AND INSTALLATION

4-1 INTRODUCTION



WARNING

BEFORE INSTALLING THE BREAKER ELEMENT IN ITS STRUCTURE, CAREFULLY FOLLOW THE INSTALLATION PROCEDURE GIVEN BELOW. NOT FOLLOWING THE PROCEDURE CAN FAIL TO UNCOVER SHIPPING DAMAGE THAT MAY RESULT IN INCORRECT BREAKER ELEMENT OPERATION LEADING TO DEATH, BODILY INJURY, AND EQUIPMENT DAMAGE.

Before attempting to install a circuit breaker element in its structure, it should be carefully examined and operated manually. In addition, carefully examine the breaker for loose or obviously damaged parts. The following information is a guide for performing recommended checks and tests.

4-2 MANUAL OPERATION CHECK

Refer to Figure 3-3 and then proceed by placing the maintenance tool into the manual charge socket opening. Charge the closing springs with about 38 up and down strokes of the handle. When charging is complete the closing crank goes over center with an audible CLICK and the springs Charged/ Discharged indicator shows "Charged."

NOTICE

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

Remove the maintenance tool. Close and trip the circuit breaker element. Repeat several times.

4-3 VACUUM INTERRUPTER INTEGRITY

Using a dry, lint free cloth or paper towel, clean all the accessible insulating surfaces of the pole units. Conduct a vacuum interrupter integrity check as described in Section 7.

4-4 INSULATION

Check the breaker element's primary and secondary insulation as described in Section 7.

4-5 CONTACT EROSION AND WIPE

Manually charge the closing springs and close the breaker element. Check contact erosion and wipe as described in Section 7.

4-6 PRIMARY CIRCUIT RESISTANCE

Check the primary circuit resistance as described in Section 7. The resistance should not exceed the values specified. Record the values obtained for future reference.

4-7 NAMEPLATE

Compare the breaker element nameplate information with drawings for compatibility.

4-8 INTERFACE VERIFICATION

The Type VCP-W Outdoor Vacuum Circuit Breaker Element is supplied for fixed installation in an outdoor enclosure appropriately designed by the customer. In addition, it is the customer's responsibility to provide all necessary interface details and make all secondary and primary connections. The customer is also responsible for the performance of all required testing to adequately prove proper functioning and operation in keeping with applicable standards. Refer to Section 6 of this manual for circuit breaker element interfacing information.

SECTION 5: DESCRIPTION AND OPERATION

5-1 INTRODUCTION

The Type VCP-W Outdoor Vacuum Circuit Breaker Element is a vacuum type interrupting element designed for value added construction. The breaker element is a fixed design intended for outdoor application in a customer designed enclosure.

NOTICE

The VCP-W Outdoor Vacuum Circuit Breaker Element was successfully tested to specific ratings in one particular enclosure with specific size interphase barriers unique to that enclosure design. Circuit breaker elements are not supplied to the customer with enclosures or interphase barriers. The enclosure, necessary mechanical and electrical interfaces with the circuit breaker element, interphase barriers and testing in keeping appropriate standards are the customer's responsibility. Section 6 of this manual provides information specific to the circuit breaker element to assist the customer.

The circuit breaker element is operated by a motor charged spring type stored energy mechanism, charged normally by an electric motor or manually by a manual charging tool. The primary connections are bolted silver plated copper. VCP-W Circuit Breaker Elements are of a modular type construction containing a front accessible mechanism with unobstructed access to control components (Figure 5-1). Circuit breaker duty vacuum interrupters are used to open and close the primary circuit.

The primary insulation used in the circuit breaker element design is cycloaliphatic epoxy. Type SIS, AWG #14 control wire with cross-linked polyolefin insulation is used throughout the control circuits with all terminals being of the screw type.

This section describes the overall operation of the circuit breaker element as well as the function and operation of all major sub-assemblies and/or parts.

5-2 INTERRUPTER ASSEMBLY

Vacuum interrupters are mounted vertically and supported from the fixed stem which is clamped to the top conductor. The exclusive current transfer system consists of a series of plated, high-conductivity copper leaf conductors that are pressed on the movable interrupter stem. This design pro-

vides a multipoint contact resulting in low electrical and thermal resistance. Utilizing this non-sliding current transfer system between the movable stem and the breaker main conductor eliminates maintenance (Figure 5-2).

Direct acting insulated operating rods in conjunction with the breaker element's mechanism provide a fixed amount of interrupter movable stem motion. This motion is directly related to the interrupter's "Wipe" and "Stroke," each of which is discussed in detail later in this section.

5-2.1 VACUUM INTERRUPTER

Type VCP-W Outdoor Vacuum Circuit Breaker Elements utilize vacuum interrupters for interruption and switching functions. The vacuum interrupters use copper chrome contacts for superior dielectric strength, better performance characteristics, and lower chop current. Vacuum interruption provides the advantages of enclosed interrupters, reduced size and weight, short interrupting time, long life, reduced maintenance, and environmental compatibility.

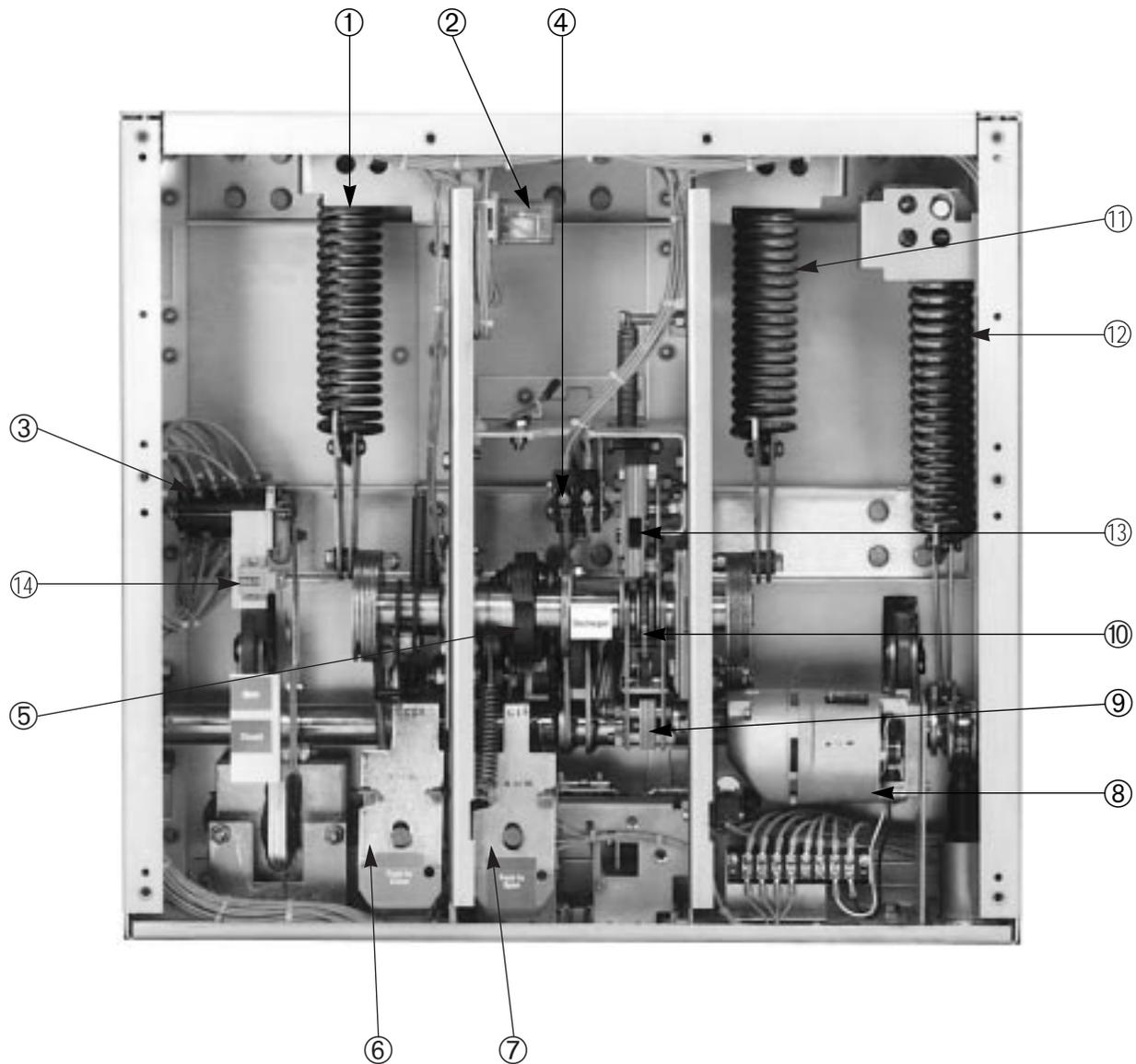
Arc interruption is simple and fast (Figure 5-3). In the closed position, current flows through the interrupter. When the contacts are opened, the arc is drawn between the contact surfaces. It is moved rapidly around the slotted contact surfaces by a self-induced magnetic force which prevents gross contact erosion as well as the formation of hot spots on contact surfaces. The arc burns in an ionized metal vapor which continually leaves the contact area and condenses on the surrounding metal shield.

At current zero, the arc is extinguished and vapor production ceases. Very rapid dispersion, cooling, recombination, and deionization of the metal vapor plasma, together with the fast condensation of metal vapor products, cause the vacuum to be quickly restored. Hence, the opened contacts withstand the transient recovery voltage.

5-2.2 CONTACT EROSION INDICATION

The purpose of a contact erosion indicator is to monitor the erosion of the vacuum interrupter contacts, which is very minimal over time with 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 (Figures 7-2 and 7-3).

In order to determine if the contacts have eroded to the extent that the interrupter must be replaced, observe the erosion mark placed on each moving stem from the rear



- ① L.H. Closing Spring
- ② Anti-Pump Relay
- ③ Auxiliary Switch
- ④ Motor Cutoff Switch
- ⑤ Closing Cam

- ⑥ Spring Release (Close Coil) Assembly
- ⑦ Shunt Trip Assembly
- ⑧ Charging Motor
- ⑨ Charging Pawl
- ⑩ Ratchet Wheel

- ⑪ R. H. Closing Spring
- ⑫ Opening Spring
- ⑬ Manual Charge Socket
- ⑭ Operation Counter

Figure 5-1 Typical Front Mounted Mechanism

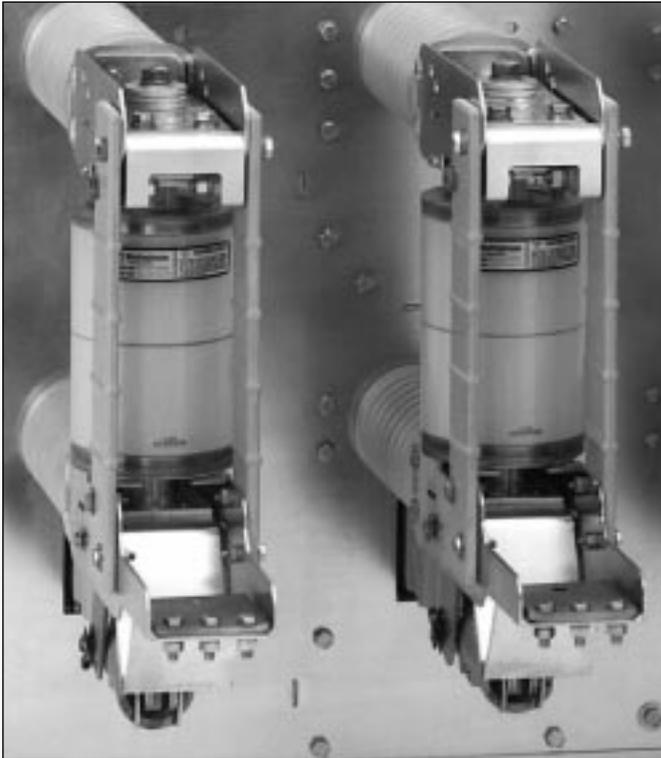


Figure 5-2 Circuit Breaker Element Rear View Showing Vacuum Interrupters and Current Carrying System

of the breaker with the breaker closed. The interrupter is satisfactory if the mark on the stem is visible with the breaker closed. The entire interrupter assembly must be replaced if the mark is no longer visible.

5-2.3 “T” CUTOUT LOADING SPRING INDICATOR

The “T” cutout contact spring indicator is an additional method provided to indicate conditions within the interrupter. The visible “T” indicator is used to indicate whether the contact springs are maintaining the proper contact pressure to keep the contacts closed. Severe contact erosion would result in an unacceptable indication from the “T” indicator (Figures 7-4 and 7-5). Depending upon the structural design, a small mirror may be required to inspect all three poles.

5-2.4 CONTACT WIPE AND STROKE

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

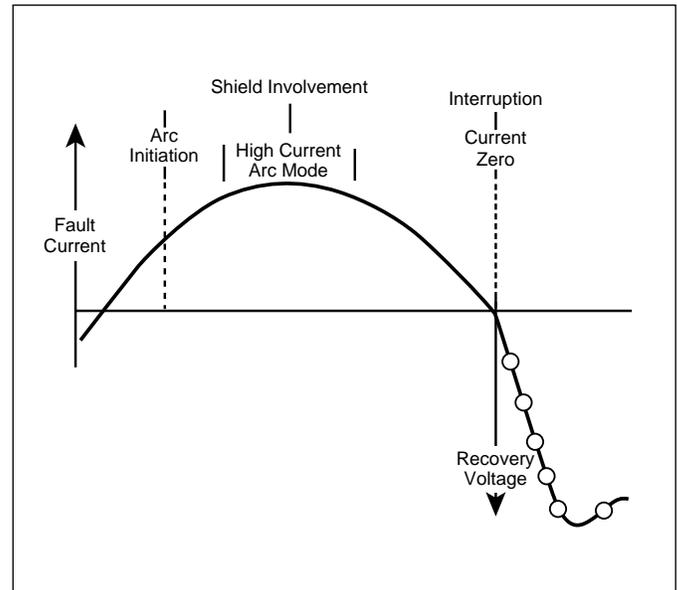


Figure 5-3 Graphic of Arc Interruption

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

The circuit breaker element mechanism provides a fixed amount of motion to the operating rods. The first portion of the motion is used to close the contacts (i.e. stroke) and the remainder is used to further compress the pre-loaded wipe spring. This additional compression is called wipe. Wipe and Stroke are thus related to each other. As the stroke increases due to the erosion of contacts, the wipe decreases. A great deal of effort has been devoted to eliminating the need for field adjustments of wipe or stroke.



CAUTION

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.

5-3 STORED ENERGY MECHANISM



WARNING

KEEP HANDS AND FINGERS AWAY FROM THE BREAKER'S INTERNAL PARTS WHILE THE BREAK-

ER CONTACTS ARE CLOSED OR THE CLOSING SPRINGS ARE CHARGED. THE BREAKER ELEMENT CONTACTS MAY OPEN OR THE CLOSING SPRINGS DISCHARGE CAUSING A CRUSHING INJURY. DISCHARGE THE SPRINGS AND OPEN THE ELEMENT BEFORE PERFORMING ANY ELEMENT MAINTENANCE, INSPECTION OR REPAIR.

The spring stored energy operating mechanism is arranged vertically in front of all VCP-W breaker elements. It includes everything required for storing the energy, closing and tripping of the breaker element, as well as manual and electrical controls. The manual controls are all front accessible. Motion to close and open the interrupter contacts is provided through operating rods connecting the mechanism pole shaft to the bell cranks of the interrupter assemblies.

5-3.1 OPERATION OF STORED ENERGY MECHANISM

The mechanism stores the closing energy by charging the closing springs. The mechanism may rest in any one of the four positions shown in Figure 5-4 and as follows:

- Breaker element open, closing springs discharged
- Breaker element open, closing springs charged
- Breaker element closed, closing springs discharged
- Breaker element closed, closing springs charged

5-3.2 CHARGING

Figure 5-5 is a schematic view of the spring charging parts of the stored energy mechanism.

The major component of the mechanism is a cam shaft assembly which consists of a drive shaft to which are attached two closing spring cranks (one on each end), the closing cam, drive plates, and a free-wheeling ratchet wheel. The ratchet wheel is actuated by an oscillating mechanism driven by the motor eccentric. As the ratchet wheel rotates, it pushes the drive plates which in turn rotate the closing spring cranks and the closing cam with it.

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

Closing springs may also be charged manually. Insert the maintenance tool in the manual charging socket.

Move it up and down approximately 38 times until a clicking sound is heard, and the closing springs charging indicator indicates "Charged." Any further motion of the maintenance tool will result in free wheeling of the ratchet wheel.

5-3.3 CLOSING OPERATION

Figure 5-4 shows the position of the closing cam and tripping linkage. Note that in Figure 5-4a in which the breaker element is open and the closing springs are discharged, the trip "D" shaft and trip latch are in the unlatched position.

Once charged, the closing springs can be released to close the breaker element by moving the spring release latch out of the way. This is done electrically or manually by depressing the spring release lever, which turns the spring release latch out of the way of the closing stop roller. The force of the closing spring rotates the cam shaft through the spring cranks. The closing cam, being attached to the cam shaft, in turn rotates the pole shaft through the main link to close the breaker element.

In Figure 5-4c the linkage is shown with the breaker element in the closed position before the closing springs have been recharged. Interference of the trip "D" shaft with the trip latch prevents the linkage from collapsing, and the breaker element is held closed.

Figure 5-4d shows the breaker element in the closed position after the closing springs have been recharged. Note that the spring charging rotates the closing cam by one half turn. Since the cam surface in contact with the main link roller is cylindrical in this region, the spring charging operation does not affect the mechanism linkage.

Since the primary contacts are completely enclosed in the vacuum interrupter and not adjustable in any way, a "Slow Close" capability is not provided with VCP-W breaker elements.

5-3.4 TRIPPING OPERATION

When the trip "D" shaft is turned either by the trip button or trip coil, all links return to the original "open" condition shown in Figure 5-4a.

5-4 CONTROL SCHEMES

There are two basic control schemes for VCP-W outdoor breaker elements, one for DC control and one for

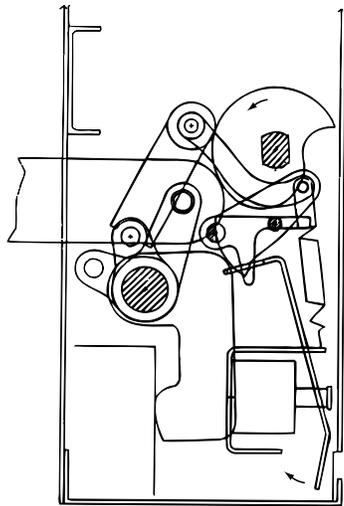


Figure 5-6a Breaker open and closing spring discharged.

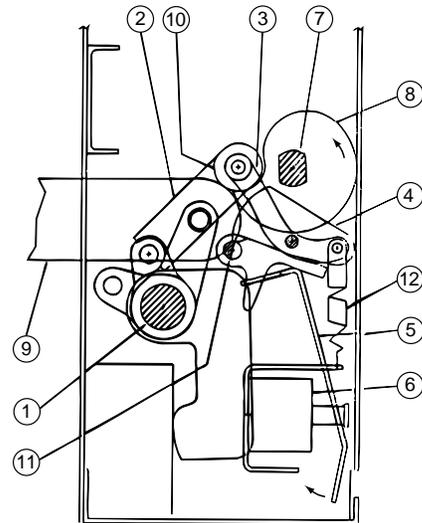


Figure 5-6b Breaker open and closing spring charged.

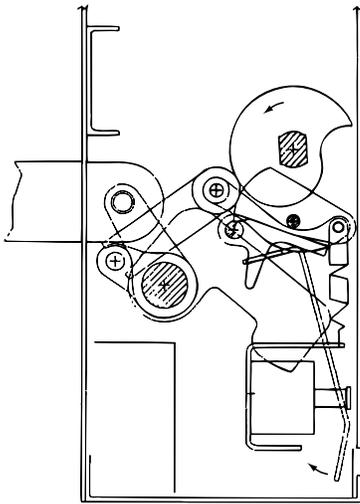


Figure 5-6c Breaker closed and closing spring discharged

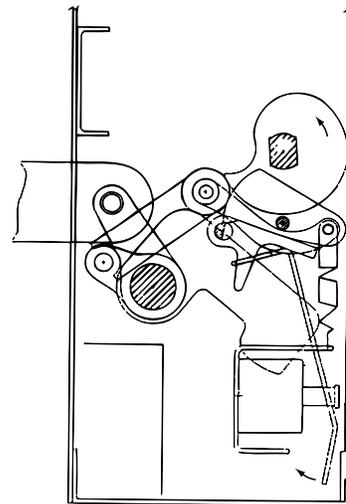
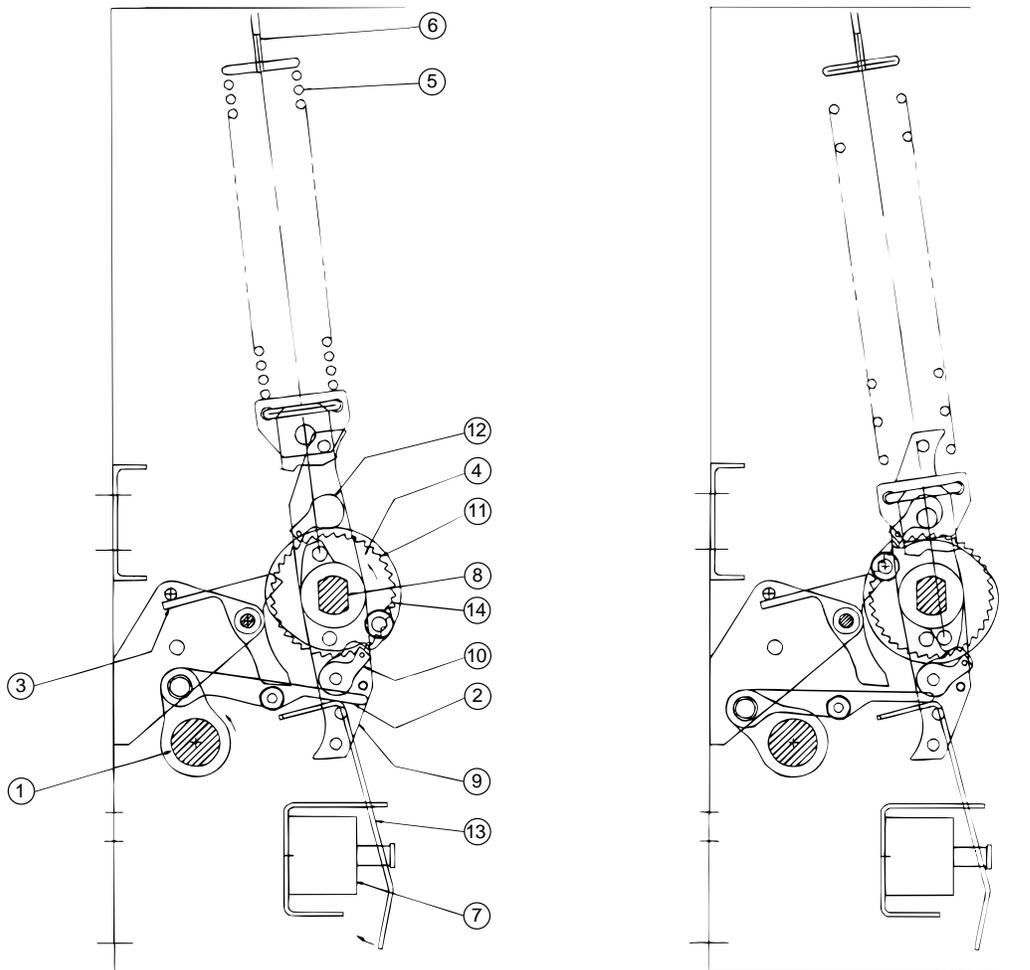


Figure 5-6d Breaker closed and closing spring charged

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

Figure 5-4 Closing Cam and Trip Linkage



Breaker Open, Springs Discharged

Breaker Closed, Springs Charged

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

Figure 5-5 Charging Schematic

AC control voltages (Figure 5-6). 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 springs. When the springs are charged, the motor cut off LS1/bb switch turns the motor off. The circuit breaker element may be closed by making the control switch close (CS/C) contact. Automatically upon closing of the breaker element, the motor starts charging the closing springs. The breaker element may be tripped any time by making the control switch trip (CS/T) contact.

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.

5-4.1 TIMING

The opening and closing times for the circuit breakers vary depending upon the control voltage and the power

rating. Typical values for VCP-W outdoor breaker elements are shown in Table 5.1.

5-4.2 TERMINAL BLOCKS

All VCP-W outdoor breaker elements are supplied with 2 12-point secondary control terminal blocks for simple secondary control access (Figure 5-7). A number of points are used for breaker operation with a number of spare contacts for customer use. Refer to the control schemes of Figure 5-6 for exact contact usage and availability.

For additional information concerning the levering mechanism, refer to the instruction manual supplied with the switchgear assembly. Paragraph 4-8.1 of this manual provides details concerning the use of the levering mechanism to move the circuit breaker into and out of the CONNECTED position within the assembly structure.

5-5 OPERATIONS COUNTER

All breaker elements are equipped with a mechanical operations counter. As the breaker opens, the linkage connected to the pole shaft lever advances the counter reading by one (Figure 3-3).

Table 5.1 Breaker Timing

Event	Milliseconds (maximum)
Closing Time (From Initiation of Close Signal to Contact Make)	60
Opening Time (Initiation of Trip Signal to Contact Break)	45
Reclosing Time (Initiation of Trip Signal to Contact Make)	165



Figure 5-7 Standard Secondary Terminal Blocks Shown Mounted

SECTION 6: BREAKER ELEMENT INTERFACING

6-1 INTRODUCTION



WARNING

- **THE CUSTOMER SHOULD READ AND UNDERSTAND THE WARNINGS AND CAUTIONS PRESENTED IN THIS INSTRUCTION BOOK BEFORE ANY ATTEMPT IS MADE TO ALTER, ADD TO OR INTERFACE WITH THE BREAKER ELEMENT AS SUPPLIED BY CUTLER-HAMMER.**
- **IT IS IMPERATIVE THAT APPLICABLE ANSI STANDARDS BE COMPLIED WITH IN EVERY RESPECT AND THAT NO COMPROMISES ARE MADE WITH RESPECT TO ITS GUIDELINES OR INTENT.**
- **ADDITIONS TO THE BREAKER ELEMENTS AS SUPPLIED BY CUTLER-HAMMER CAN BE MADE IN KEEPING WITH ANSI STANDARDS AND THE INSTRUCTIONS PRESENTED IN THIS INSTRUCTION BOOK. UNDER NO CIRCUMSTANCES, HOWEVER, SHOULD ALTERATIONS TO THE CUTLER-HAMMER SUPPLIED BREAKER ELEMENT BE MADE UNLESS THE ALTERATION IS SPECIFICALLY ADDRESSED AND PERMITTED BY THIS INSTRUCTION BOOK.**

6-2 GENERAL GUIDELINES

This section addresses interfacing guidelines for the VCP-W outdoor breaker element with the structure. General guidelines are presented first. Specific guidelines are presented after the general guidelines. Read, understand and follow all the guidelines presented.

6-2.1 ELECTRICAL CLEARANCES

It is the responsibility of the customer to insure that the proper electrical clearances are maintained on the circuit breaker element, in the outdoor structure and between the circuit breaker element and its structure. These required electrical clearances must be in keeping with the appropriate ANSI Standard and the specific BIL level of application. The BIL Rating associated with a particular breaker element is a function of the overall tested design, which is the customer's responsibility. The ratings achieved with the original Cutler-Hammer design, which includes the enclosure and interphase barriers, are not necessarily applicable to all designs. The customer must prove their design ratings through testing.

6-2.2 INTERPHASE BARRIERS

ANSI standards requires specific minimum air space clearances between poles for specific BIL application levels. It is the customer's responsibility to insure that proper interphase barriers are in place on all circuit breaker elements prior to placing it in service.

Interphase barriers must be designed to fulfill the ANSI requirements. They must be constructed of an appropriate insulating material, such as a one eighth inch thick high strength, track resistant glass-mat polyester.

6-2.3 FRONT COVER (FACEPLATE)

All VCP-W outdoor breaker elements are supplied with a front cover faceplate already installed (Figure 3-1). The front cover is constructed of a heavy gauge steel and solidly attached to the breaker element. The front cover, as supplied, prevents front access to the breaker mechanism and primary voltage parts. A breaker element specific nameplate and operational windows are also a part of the front cover (Figure 3-3).

If a new front cover must be constructed for a specific circuit breaker design or application, all of the above mentioned features of the original faceplate must be carried over to the new faceplate. The new faceplate must reflect the following as a minimum (Figure 6-1):

- A front cover should clearly indicate all of the information presented on the original nameplate.
- A front cover should prevent front access to the breaker's operating mechanism and any primary voltage parts once the breaker is installed.
- A front cover should include properly placed and sized windows so that operational indicators, such as main contact status and closing spring status, are clearly visible.
- A front cover should include properly placed and sized windows for access to breaker operating devices, such as manual open/close buttons and the manual charging socket.

6-2.4 COMPARTMENT INTERFACE VERIFICATION

Refer to Paragraph 4-8 and Figure 1-1 in this instruction book for details. In addition, refer to applicable ANSI Standards.



Figure 6-1 Typical VCP-W Front Cover, Nameplate and Operational Indicators

SECTION 7: INSPECTION, MAINTENANCE AND TROUBLESHOOTING

7-1 INTRODUCTION



WARNING

- DO NOT WORK ON A BREAKER ELEMENT WITH PRIMARY POWER APPLIED.
- DO NOT WORK ON A BREAKER ELEMENT WITH SECONDARY CONTACTS CONNECTED.
- DO NOT WORK ON A BREAKER ELEMENT 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.
- DO NOT STAND LESS THAN FOUR METERS AWAY FROM THE BREAKER ELEMENT 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.

7-2 FREQUENCY OF INSPECTION AND MAINTENANCE

Periodic inspections and associated maintenance are essential to the safe and reliable operation of VCP-W Outdoor Vacuum Circuit Breaker Elements. The inspection frequency and associated maintenance recommended are intended to insure the best possible ongoing service. It is imperative that an established schedule be followed. To establish an exact schedule for a specific installation, use the following guidelines:

1. In a clean, non-corrosive environment, inspect and maintain each circuit breaker element annually or every 500 operations, whichever comes first.
2. For special conditions such as frequent circuit breaker element operation, contaminated environments, and high temperature/humidity conditions, the inspection frequency should be twice a year.
3. Inspect a circuit breaker element every time it interrupts fault current.

4. Follow the steps presented in Paragraph 7-3 entitled "Inspection and Maintenance Procedures" for scheduled programs.
5. Create and maintain a dated permanent record of all inspections, maintenance performed, actions taken, observations made, and measurements taken. Not only will this provide valuable historical information, it can help to establish whether or not the present schedule needs to be adjusted.
6. Perform ongoing visual inspections, when possible, of all equipment on a regular basis. Be alert for an accumulation of dirt in and around the circuit breaker elements, loose hardware or discolored insulation.

7-2.1 QUALIFIED PERSONNEL

For the purpose of operating this type of equipment, only individuals thoroughly trained in the operation of power circuit breakers and associated equipment, and having knowledge of connected loads may be considered to be qualified. Refer to further definitions in the National Electrical Safety Code.

For the purpose of inspecting and maintaining such equipment, a qualified person must also be trained in regard to the hazards inherent to working with electricity and the proper way to perform such work. Such an individual should be able to de-energize, clear and tag circuits in accordance with established safety practices. In addition, these individuals should have access to and be trained in the use of protective equipment, such as rubber gloves and flash clothes.

All personnel should be familiar with and understand the material presented in this instruction manual and other related manuals.

7-2.2 GENERAL TORQUE GUIDELINES

Bolts and screws must be properly torqued. This is especially true if parts and/or accessories are added or replaced. Table 7.1 provides guidelines on torque levels. The table is intended as a general guideline and should be applied in conjunction with the experience and good judgment of the individual performing the work.



CAUTION

OVER TORQUING CAN CAUSE PERMANENT DAMAGE WHILE UNDER TORQUING WILL NOT PROVIDE THE PROPER CLAMPING FORCE AND MAY EVENTUALLY WORK LOOSE.

Table 7.1 Torque Guidelines

Bolt Size	Torque (LB-IN)
8 - 32	24
10 - 32	36
1/4 - 20	72
5/16 - 18	144 (12 lb-ft)
3/8 - 16	300 (25 lb-ft)
1/2 - 13	540 (45 lb-ft)

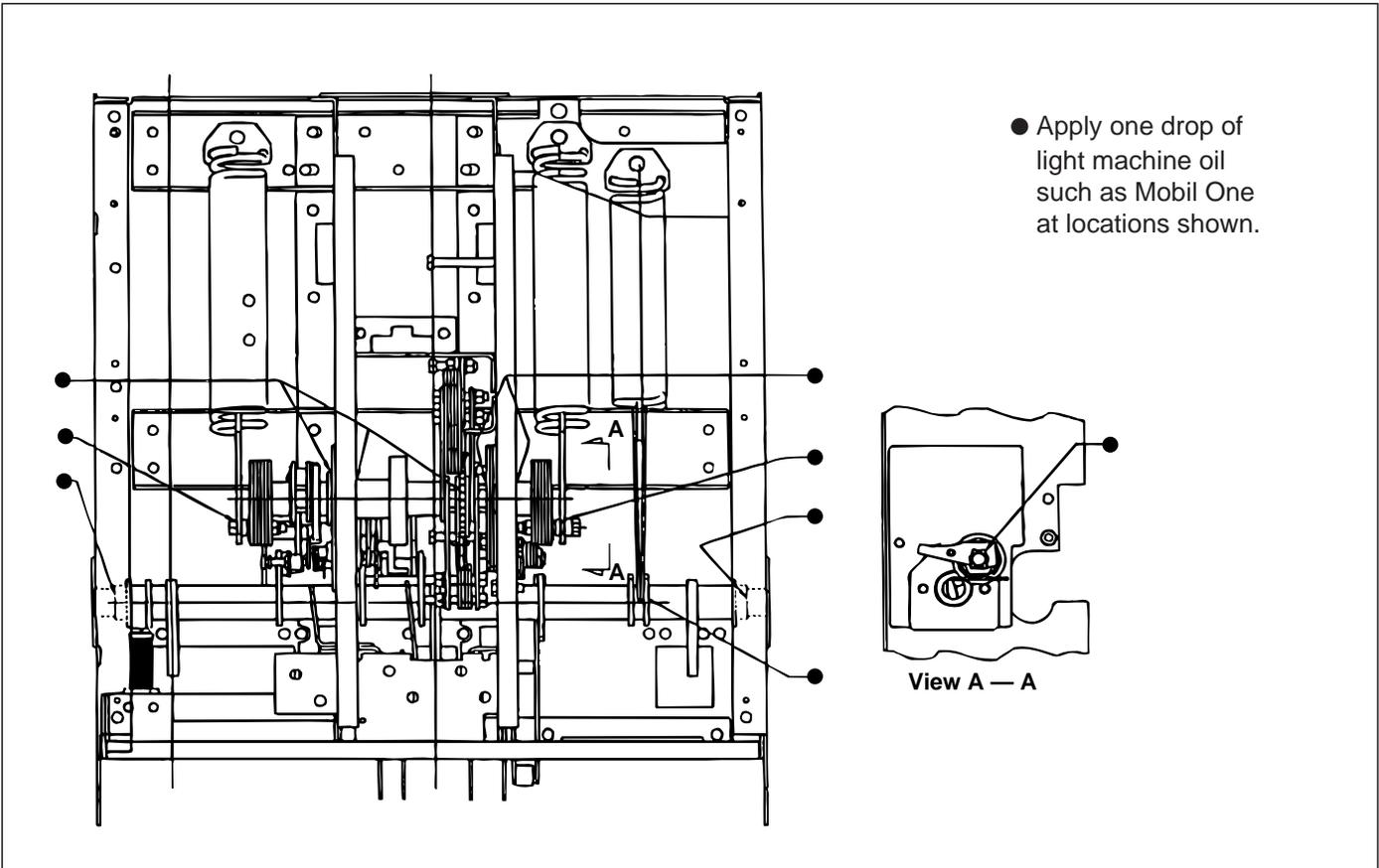


Figure 7-1 Lubrication Points

7-3 INSPECTION AND MAINTENANCE PROCEDURES

No./Section	Inspection Item	Criteria	Inspection Method	Corrective Action	
1. Insulation	Drive Insulator and Molded Pole Unit Support	No dirt and	Visual Check	Clean with lint-free cloth and	
		No cracking	Visual Check	Replace cracked unit	
	Insulation Integrity	Main Circuit to Ground	Withstand	Hipot Tester	Clean and retest or replace
		Between Main Circuit Terminals	Withstand	Hipot Tester	Clean and retest or replace
	Control Circuit to Ground	Withstand	Hipot Tester	Clean and retest or replace	
2. Power Elements	Vacuum Interrupters	Visibility of 3 front Contact Erosion Marks and Precise Measurement from rear	Visual/Measurement - Close the breaker and observe if all 3 front indicator marks are in green area, and then proceed as described in Paragraph 7-5	If the front indicator marks are in the red area and the rear measurement is not acceptable, replace pole unit assembly	
		Contact wipe measurement	Measurement of Loading Spring as described in Paragraph 7-5	If measurement is not acceptable, replace pole unit assembly	
		Adequate Vacuum	Proceed with integrity check as described in Paragraph 7-4	If integrity check is not satisfactory, replace pole unit assembly	
	Primary Disconnects	No burning or damage	Visual Check	Replace if burned, damaged or eroded	
3. Control Circuit Parts	Closing and Tripping Device 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	Securely tied in proper place	Visual Check	Repair or tie as necessary	
	Terminals	Tight	Visual Check	Tighten or replace if necessary	
	Motor	Smooth, Normal Operation	Functional Test	Replace brushes or motor	
4. Operating Mechanism	Tightness of Hardware	No loose or missing parts	Visual and by feel	Refer to Table 7.1 and tighten or reinstate if necessary with appropriate tools	
	Dust or Foreign Matter	No dust or foreign matter	Visual Check	Clean as necessary	
	Lubrication	Smooth operation and no excessive wear	Sight, feel and per maintenance schedule	Refer to Figure 7-1, Paragraph 7-10 and lubricate very sparingly with light machine oil	
	Deformation or Excessive Wear	No excessive deformation or wear	Visual and operational	Remove cause and replace parts	
	Manual Operation	Smooth operation	Manual charging, closing and tripping	Correct per troubleshooting chart if necessary	

7-4 VACUUM INTERRUPTER INTEGRITY TEST

Vacuum interrupters used in Type VCP-W Outdoor Vacuum Circuit Breaker Elements 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. Refer to Table 7.2 for the 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 FOUR METERS AWAY IN FRONT OF THE BREAKER ELEMENT.

With the breaker element open, connect all top primary studs (bars) together and to the high potential machine lead. Connect all bottom studs together and ground them along with the breaker frame. Start the machine at zero potential, increase to appropriate test voltage and maintain for one minute.

A successful withstand indicates that all interrupters have a 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. 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.

Table 7.2 Test Voltage

Breaker Rated Maximum Voltage	Vacuum Interrupter Integrity Test Voltage	
	ac 60 Hz	dc
Up to and including 15.5 kV	27 kV	40kV

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 7.2.

The current delivery capability of 25 ma ac and 5 ma dc apply when all three VIs are tested in parallel. If individual VIs are tested, current capability may be one third of these values.



CAUTION

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.

7-5 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 minimum 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 pole unit assembly must be replaced (Figures 7-2 and 7-3).

The adequacy of contact wipe can also be determined by simply observing the indicator on the drive rod toward the front of the closed breaker. If the wipe is adequate, some portion of the indicator "T" will be visible (Figures 7-4 and 7-5). If no portion shows with the breaker closed, the wipe is not adequate, and the pole unit assembly must be replaced.

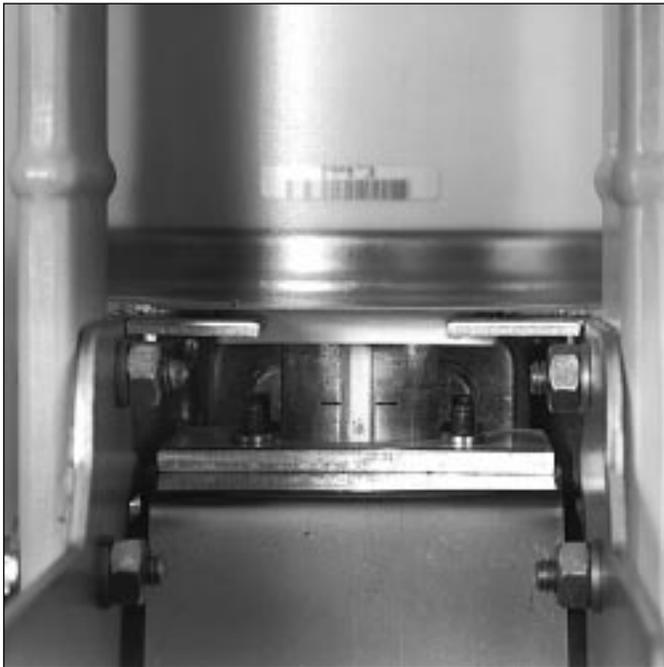


Figure 7-2 Vacuum Interrupter Showing Contact Erosion Indicator with Breaker Open (Shown Here for Clarity Purposes Only)



Figure 7-3 Vacuum Interrupter Showing Contact Erosion Indicator with Breaker Closed (Indicators are Checked Only When Breaker is Closed)

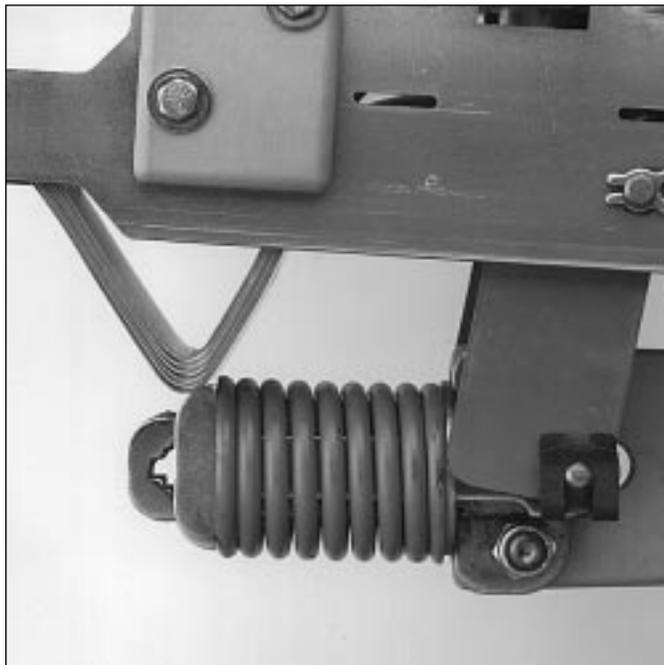


Figure 7-4 Typical "T" Contact Wipe Indicator

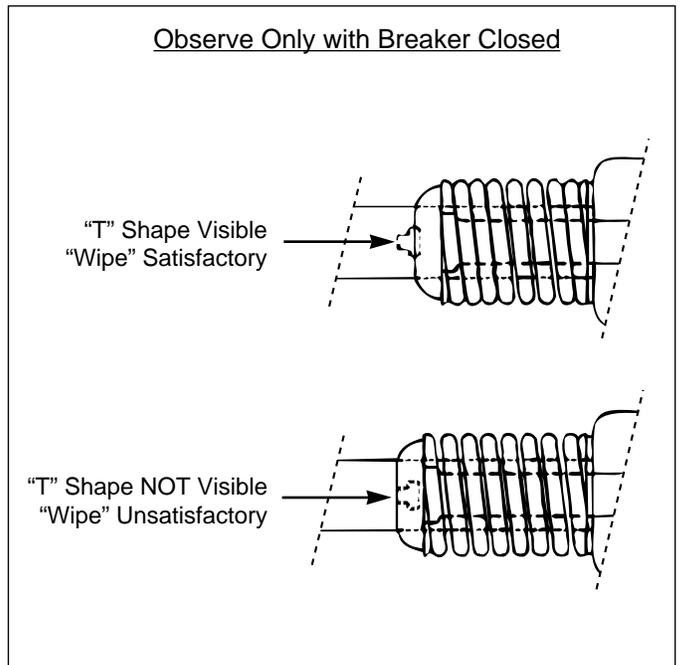


Figure 7-5 Typical Wipe Indication



WARNING

FAILURE TO REPLACE A POLE UNIT 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 PERSONAL INJURY.

7-6 INSULATION

Type VCP-W Outdoor Vacuum Circuit Breaker Elements primarily utilize cycloaliphatic epoxy insulation. 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. 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 also requires inspection for insulation damage.

7-7 INSULATION INTEGRITY CHECK

Primary Circuit:

The integrity of primary insulation may be checked by the 60Hz AC high potential test. The test voltage depends upon the maximum rated voltage of the breaker. For the breaker elements rated 15.5 kV the test voltage is 38.0 kV. 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.

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:

Connect all points of the secondary terminal block with 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 1200 volts rms. Maintain the voltage for one minute. Successful

withstand indicates satisfactory insulation strength of the secondary control circuit. Remove the shooting wire.

7-8 PRIMARY CIRCUIT RESISTANCE CHECK

Since the main contacts are inside the vacuum chamber, they remain clean and require no maintenance at any time. Unlike many typical circuit breaker designs, VCP-W breakers do not have sliding contacts at the moving stem either. Instead they use a highly reliable and unique flexible clamp design that eliminates 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 a low resistance instrument, measure resistance across the studs on the breaker for each pole. The resistance should not exceed the values shown in Table 7.3.

7-9 MECHANISM CHECK

Make a careful visual inspection of the mechanism for any loose parts such as bolts, nuts, pins and rings. 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.

7-10 LUBRICATION

All parts that require lubrication have been lubricated during the assembly with molybdenum disulphide grease (Cutler-Hammer Material 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. Once a year or every 500 operations whichever comes first, the breaker should be relubricated. The locations shown in Figure 7-1 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.

Table 7.3 Typical Resistance Measurements

Rated Continuous Current (amperes)	Resistance (microohms)
600	40
1200	40

7-11 TROUBLESHOOTING CHART (Continued Next Page)

SYMPTOM	INSPECTION AREA	PROBABLE DEFECTS
Fails To Close <ul style="list-style-type: none"> Closing Springs not charged 	<ul style="list-style-type: none"> Control Circuit 	<ul style="list-style-type: none"> Control Power (fuse blown or switch off) Secondary Disconnects Motor Cut-off Switch (Poor or burned contacts, Lever not operational) Terminals and connectors (Poor or burned contacts) Motor (Brushes worn or commutator segment open)
	<ul style="list-style-type: none"> Mechanism 	<ul style="list-style-type: none"> Pawls (Slipping or Broken) Ratchet Wheel (Teeth worn or broken) Cam Shaft Assembly (Sluggish or jammed) Oscillator (Reset spring off or broken)

7-11 TROUBLESHOOTING CHART (Continued Next Page)

SYMPTOM	INSPECTION AREA	PROBABLE DEFECTS
Fails To Close		
<ul style="list-style-type: none"> Closing Spring charged but breaker does not close 	<ul style="list-style-type: none"> No Closing Sound (Close Coil does not pick up) 	<ul style="list-style-type: none"> Control Power (Fuse blown or switch off) Secondary Disconnects Anti-Pump Relay (Y relay N. C. contact open or burned or relay picks up) Close Coil (Open or burned) Latch Check Switch (Contact open-bad switch or trip bar not reset) Auxiliary Switch (b contact open or burned) Motor Cut-off (Contacts open or burned) Trip Coil Assembly (Clapper fails to reset)
	<ul style="list-style-type: none"> Closing Sound but no close 	<ul style="list-style-type: none"> Pole Shaft (Not open fully) Trip Latch Reset Spring (Damaged or Missing) Trip Bar-D Shaft (Fails to remain reset) Trip Latch-Hatchet (Fails to remain reset) Trip Floor Tripper (Fails to remain reset) Close Latch (Binding) Close Latch Roller (Binding) Trip Circuit Energized

7-11 TROUBLESHOOTING CHART

SYMPTOM	INSPECTION AREA	PROBABLE DEFECTS
Undesirably Closes		
	<ul style="list-style-type: none"> Control Circuit 	<ul style="list-style-type: none"> Close Circuit (CS/C Getting Shorted)
	<ul style="list-style-type: none"> Mechanism 	<ul style="list-style-type: none"> Close Release Latch (Fails to reset) Close Floor Tripper (Fails to reset)
Fails To Trip		
<ul style="list-style-type: none"> No Trip Sound 	<ul style="list-style-type: none"> Control Circuit 	<ul style="list-style-type: none"> Control Power (Fuse blown or switch off) Secondary Disconnect Auxiliary Switch (a contact not making, poor or burned) Trip Coil (Burned or open) Terminals and Connections (Poor or burned or open)
	<ul style="list-style-type: none"> Trip Mechanism 	<ul style="list-style-type: none"> Trip Clapper (Jammed)
<ul style="list-style-type: none"> Trip Sound But No Trip 	<ul style="list-style-type: none"> Trip Mechanism 	<ul style="list-style-type: none"> Trip Bar, Trip Latch (Jammed) Pole Shaft (Jammed) Operating Rod Assembly (Broken or pins out)
	<ul style="list-style-type: none"> Vacuum Interrupter (One or more Welded) 	
Undesirably Trips		
	<ul style="list-style-type: none"> Control Circuit 	<ul style="list-style-type: none"> Control Power (CS/T Switch, remains made)
	<ul style="list-style-type: none"> Mechanism 	<ul style="list-style-type: none"> Trip Coil Clapper (Not resetting) Trip Bar or Trip Latch (Poor engagement of mating or worn surfaces) Trip Bar Reset Spring (Loss of torque)

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