Instructions for Installation, Operation and Maintenance of Type VCP-W 38kV Vacuum Circuit Breakers

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

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

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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.

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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, application, operation and maintenance of the VCP-W Vacuum Circuit Breakers. It is provided as a guide for authorized and qualified personnel only. Please refer to the specific WARNING and CAUTION in Section 1-1.2 before proceeding. 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 38kV Vacuum Circuit Breakers. They are horizontal drawout, roll on the floor type removable interrupting elements ideal for use in new metal-clad switchgear, as well as for modernization and life extension of existing switchgear. Designed to ANSI Standards for reliable performance, ease of handling, and simplified maintenance, VCP-W 38kV Vacuum Circuit Breakers provide reliable control and protection for electrical equipment and circuits. In addition, these technologically advanced circuit breakers provide higher insulation levels in less space, thus reducing the overall switchgear size.

WARNING

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

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

Identification	Rated Values																					
Circuit Breaker Type	Nominal Voltage Class	Voltage		Insulation Level		Current		Inter-rupting Time ④	Maximum Permis-sible 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 (Momen-tary) (2.7 K Times Rated Short Circuit Current)	Low Inductive Switching	Out of Phase Switching	Capacitor Switching Ratings							
															General Purpose			Definite Purpose				
				Power Frequency (1 Minute)	Impulse ③		3 Second Short Time Current Carrying Capability								Overhead Line Current	Cable Charging Current	Isolated Shunt Capac-itor Bank Current	Overhead Line Current	Isolated Shunt Capac-itor Bank Current	Back to Back Capacitor Switching		
																				Cable Charging Current	Capacitor Bank Current ⑤	
		E	K				I		Y													
	kV Class	kV rms		kV rms	kV Peak	Amperes, rms	kA rms	Cycles	Seconds	kV Peak	µs	kA Peak	Amperes, rms	kA	Amperes, rms			Amperes, rms				
380 VCP-W 16	34.5	38	1.0 ②	80	170	600 1200 1600 2000	16	5	2	71	125	43 ②	15	4	5	50	100	5	250	50	250	
380 VCP-W 25	34.5	38	1.0 ②	80	170	600 1200 1600 2000	25	5	2	71	125	68 ②	15	6.3	5	50	100	5	250	50	250	
380 VCP-W 32	34.5	38	1.0 ②	80	170	600 1200 1600 2000	31.5	5	2	71	125	85 ②	15	7.9	5	50	100	5	250	50	250	
380 VCP-W 21	34.5	38 ⑥	1.65	80	170	1200 2000	21 ⑥	5	2	71	125	95	15	5.3	5	50	100	5	250	50	250	

① *KEMA tested to applicable ANSI Standards C37.04 - 1979, C37.09 - 1979, Proposed C37.06 - 199X, (operating duty, sequence CO-15 seconds-CO). Typical operating time values: opening 45 ms, closing 75 ms, and reclosing 18 cycles.*

② *K=1.0, therefore E=E/K and I=KI, consult Application Data 32-265 for further information.*

③ *The ANSI standard requires 150 kV BIL, all ratings tested to 170 kV BIL.*

④ *3-cycle interrupting time capability is available.*

⑤ *Tested at 20 kA, 4.4 kHz inrush current. Higher currents available, consult Cutler-Hammer.*

⑥ *At Rated maximum voltage divided by K=23 kV rms, Rated maximum symmetrical interrupting capability=KI=35 kA rms.*

WARNING

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

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1-4 OUTLINES AND DIMENSIONS

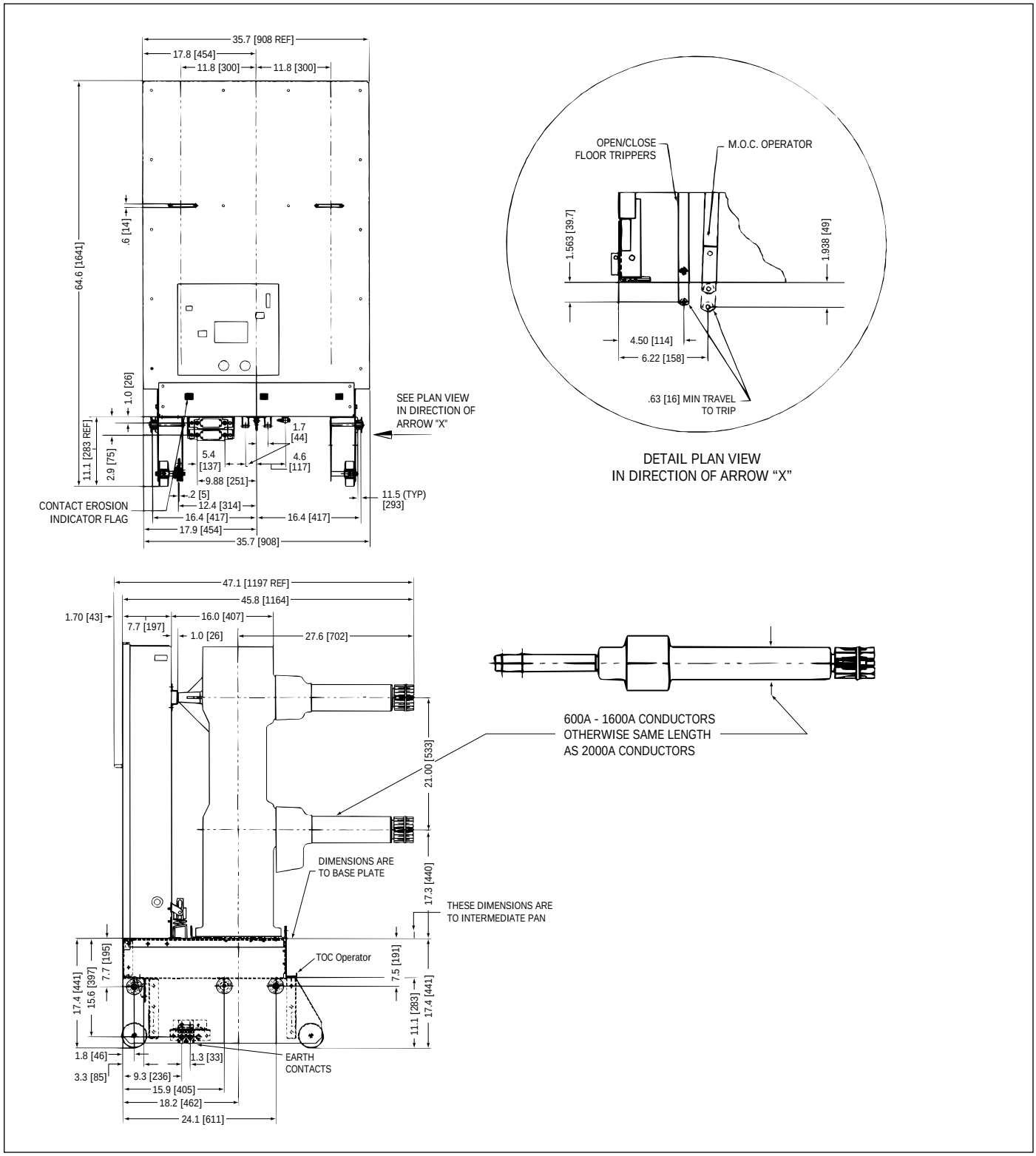


Figure 1-1 Type VCP-W 38kV Circuit Breaker Outlines and Dimensions (inches and [mm])

SECTION 2: SAFE PRACTICES

2-1 RECOMMENDATIONS

Type VCP-W Vacuum Circuit Breakers are equipped with high speed, high energy operating mechanisms. They are designed with several built-in interlocks and safety features to provide safe and proper operating sequences. Cell interlocks used with drawout circuit breakers are meant to interact with the appropriate cell interface and levering mechanism.

⚠ WARNING

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

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

3-2 RECEIVING

If the circuit breaker 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 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.

NOTICE

The VCP-W 38kV shipping container and pallet were specifically designed to facilitate removal of the circuit breaker from its pallet and container. Before proceeding, installation personnel should be familiar with the procedures outlined in Paragraph 3-3 entitled "Handling."

3-3 HANDLING

WARNING

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

VCP-W 38kV Vacuum Circuit Breakers are shipped mounted to a skid specially designed to facilitate removal of the breaker. Refer to Figures **3-1** and **3-2** and proceed with the following steps:

WARNING

AFTER REMOVING THE BRACKETS USED TO HOLD THE CIRCUIT BREAKER SECURELY TO THE SHIPPING SKID AND ALL DURING THE PROCESS OF MOVING THE CIRCUIT BREAKER OFF OF THE SHIPPING SKID AND DOWN THE RAMP TO THE FLOOR, TAKE SPECIAL PRECAUTIONS TO INSURE THAT THE CIRCUIT BREAKER IS MOVED SLOWLY

Figure 3-1 Circuit Breaker Shown Mounted with Ramp Still in Shipping Position

AND UNDER CONTROL TO AVOID ANY ACCIDENTS. THE CIRCUIT BREAKER IS A LARGE DEVICE WHICH COULD CAUSE SERIOUS BODILY INJURY IF IT IS TIPPED OVER OR PERMITTED TO ROLL IN AN UNCONTROLLED MANNER.

Step 1: Remove the vertically mounted ramp from the shipping skid and place it on the floor next to the skid. It should be positioned with the highest part of the ramp next to the side of the skid with the front of the circuit breaker.

Step 2: Remove the shipping brackets used to hold the circuit breaker to the skid. Use the same shipping brackets and hardware to attach the ramp to the shipping skid.

Step 3: Slowly move the circuit breaker forward and down the ramp. Make certain that the circuit breaker moves down the ramp slowly and straight in line with the ramp. Once the circuit breaker is on the floor, it can be easily maneuvered via its integral wheels.

3-4 STORAGE

If the circuit breaker 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 circuit breaker is free from shipping damage and is in satisfactory operating condition.

The circuit breaker is shipped with its contacts open and closing springs discharged. The indicators on the front panel should confirm this. Insert the maintenance tool in the manual charge socket opening (Figure **3-7**). 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. Push the “manual close” button. The circuit breaker will close as shown by the circuit breaker contacts “closed” (red) indicator. Push the “manual trip” button. The circuit breaker will trip as shown by the circuit breaker contacts “open” (green) indicator. After completing this initial

Figure 3-2 Circuit Breaker Shown Being Moved Carefully Down Attached Ramp

Figure 3-3 Optional Fifth Wheel Shown in Use

check, leave the closing springs “discharged” and circuit breaker contacts “open”.

Outdoor storage is NOT recommended. If unavoidable, the outdoor location must be well drained and a temporary shelter from sun, rain, snow, corrosive fumes, 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.

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

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

Fifth Wheel (Optional): Used to maneuver a circuit breaker on a flat, hard surface (Figure **3-3**).

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

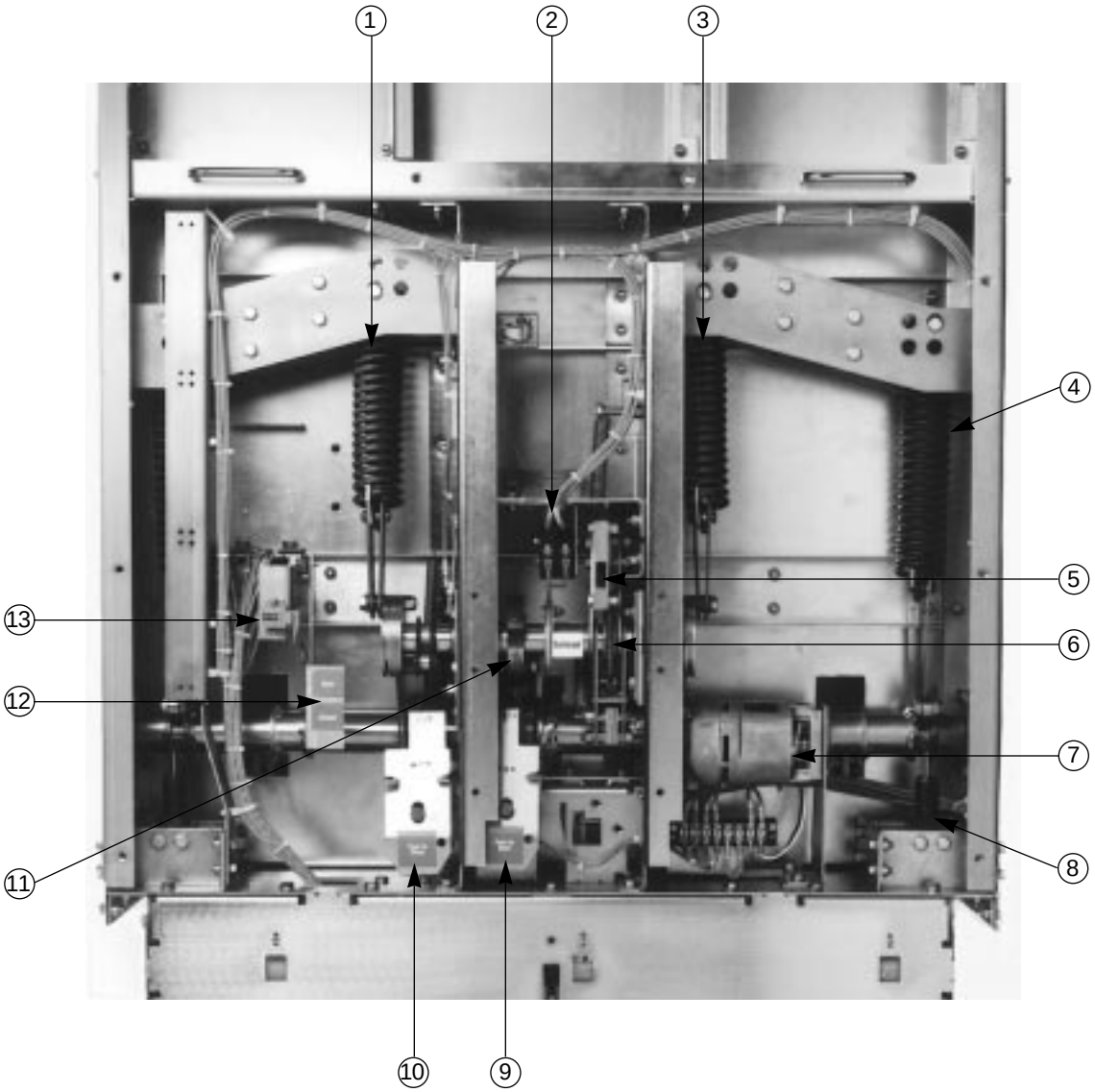
Table 3.1 VCP-W Circuit Breaker Weights ①

Rating		Pounds
380 VCP-W 16	600	1070
	1200	1080
	1600	1090
	2000	1140
380 VCP-W 25	600	1070
	1200	1080
	1600	1090
	2000	1140
380 VCP-W 32	600	1070
	1200	1080
	1600	1090
	2000	1140
380 VCP-W 20	1200	1080
	2000	1140

① *Does not include shipping carton.*

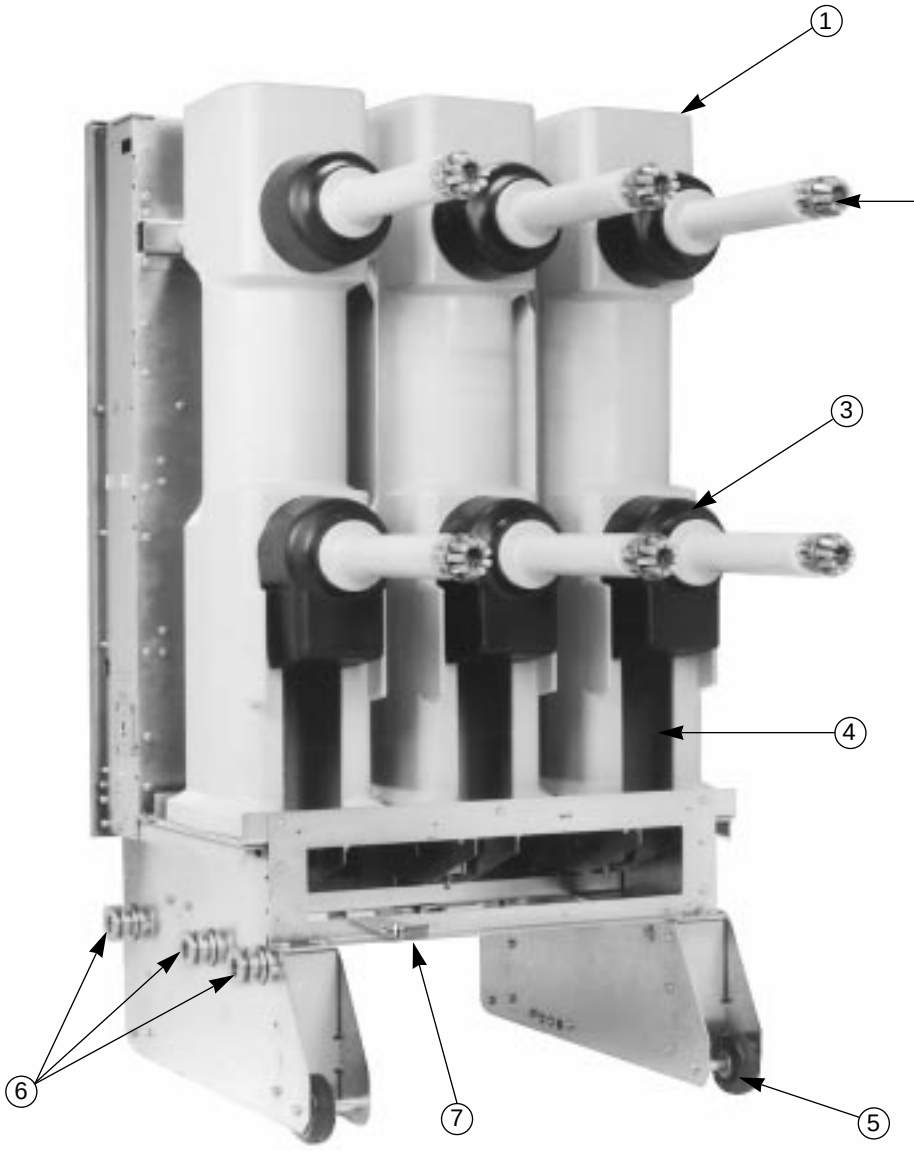
1. Front Cover
2. Lift/Pull Handle
3. Contact Erosion Indicator Flags
4. Circuit Breaker Wheel
5. Secondary Contact Block
6. Alignment Rollers

Figure 3-4 Front View VCP-W 38kV Vacuum Circuit Breaker



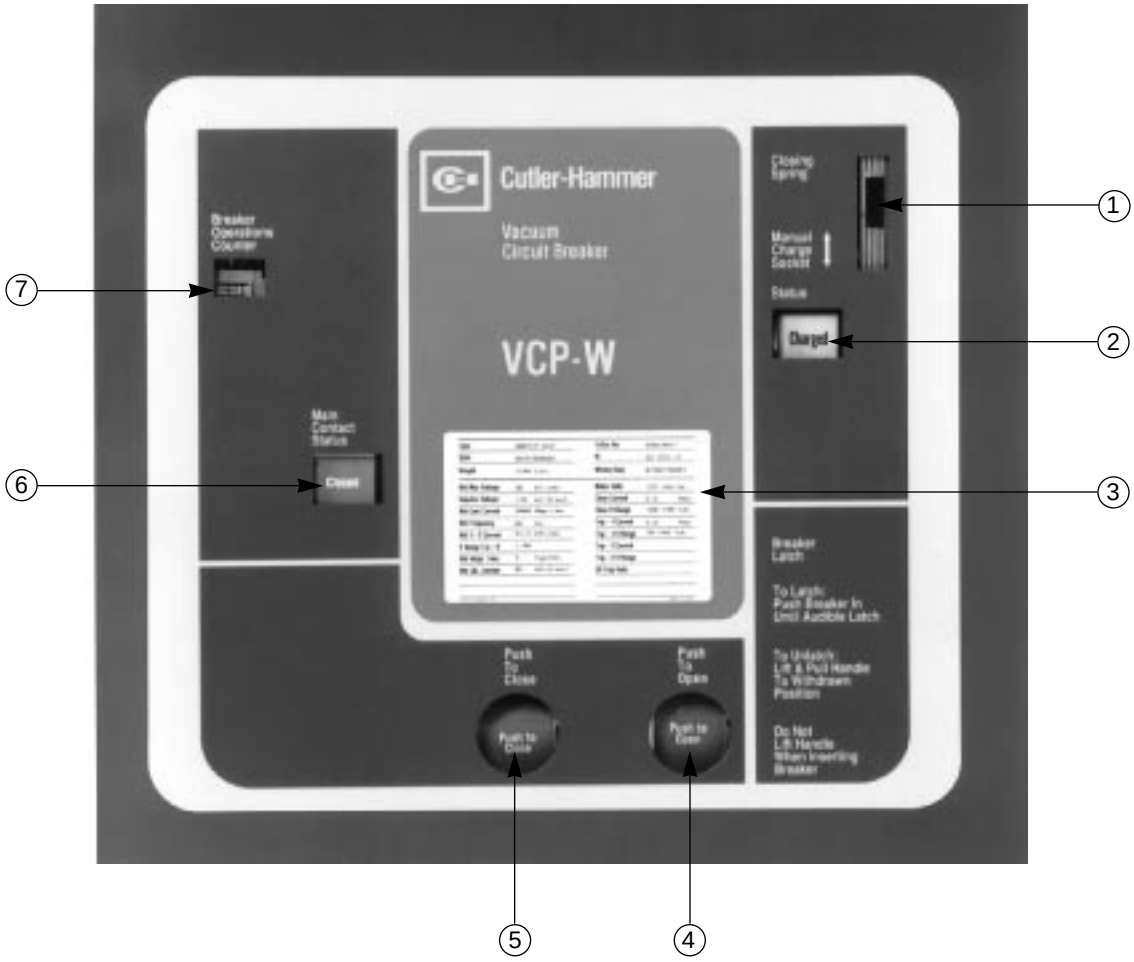
1. L.H. Closing Spring
2. Motor Cutoff Switch
3. R.H. Closing Spring
4. Opening Spring
5. Manual Charge Socket
6. Ratchet Wheel
7. Charging Motor
8. Shock Absorber
9. Shunt Trip Assembly
10. Spring Release (Close Coil) Assembly
11. Closing Cam
12. Open/Close Indicator
13. Operations Counter

Figure 3-5 VCP-W 38kV Vacuum Circuit Breaker with Front Cover Removed



1. Pole Unit
2. Primary Disconnect
3. Insulation Shroud
4. Opening to View Contact Erosion Mark
5. Circuit Breaker Wheel
6. Alignment Rollers
7. TOC Operator

Figure 3-6 Rear View VCP-W 38kV Vacuum Circuit Breaker



1. Manual Charge Socket
2. Spring Charged/Discharged Indicator
3. Rating Nameplate
4. Manual Open Button
5. Manual Close Button
6. Open/Close Indicator
7. Operations Counter

Figure 3-7 Typical VCP-W 38kV Escutcheon

SECTION 4: INITIAL INSPECTION AND INSTALLATION

4-1 INTRODUCTION

WARNING

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

Before attempting to put a circuit breaker in service, it should be carefully examined and operated manually and electrically. 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 Figures **3-6** and **4-1** 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 circuit breaker, no click is heard at the end of charging operation. Discontinue charging and remove the maintenance tool as soon as “Charged” flag is fully visible. Continued attempts to charge further may result in damage to the mechanism.

Remove the maintenance tool. Close and trip the circuit breaker. 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 6.

4-4 INSULATION

Check the circuit breaker’s primary and secondary insulation as described in Section 6.

4-5 CONTACT EROSION AND WIPE

Manually charge the closing springs and close the circuit breaker. Check contact erosion and wipe as described in Section 6.

4-6 PRIMARY CIRCUIT RESISTANCE

Check the primary circuit resistance as described in Section 6. The resistance should not exceed the values specified. Record the values obtained for future reference.

4-7 NAMEPLATE

Compare the circuit breaker nameplate information with switchgear drawings for compatibility.

Figure 4-1 Type VCP-W Circuit Breaker Manual Charging Handle in Use

4-8 ELECTRICAL OPERATION CHECK

After having completed all previous checks and tests, the circuit breaker is ready to be operated electrically. It is preferred that this check be made with the circuit breaker in a TEST position or by using a test cable, if the circuit breaker is outside the cell structure.

CAUTION

BEFORE INSERTING THE CIRCUIT BREAKER EXAMINE THE INSIDE OF THE CELL STRUCTURE FOR EXCESSIVE DIRT OR ANYTHING THAT MIGHT INTERFERE WITH THE CIRCUIT BREAKER MOVEMENT.

WARNING

EXTREME CAUTION MUST BE EXERCISED TO INSURE THAT PRIMARY CIRCUITS ARE NOT ENERGIZED WHILE CHECKS ARE PERFORMED IN THE CIRCUIT BREAKER COMPARTMENT. FAILURE TO DO SO MAY RESULT IN PERSONAL INJURY OR DEATH.

The circuit breaker is normally tested electrically in its cell structure in the TEST position. To achieve the TEST position, the circuit breaker must first be placed in the cell structure and the secondary contacts engaged. To complete this testing procedure, the operator should first be familiar with inserting and removing the circuit breaker into and from the cell structure.

4-8.1 CIRCUIT BREAKER INSERTION AND REMOVAL

The circuit breaker is designed to be in one of three different positions within the structure with the door closed, DISCONNECT, TEST and CONNECTED. While in the structure, the circuit breaker should never be allowed to remain at an intermediate position between two of the three above mentioned designed positions.

Position the circuit breaker squarely in front of the structure. Integrally mounted wheels facilitate circuit breaker movement outside of and into the structure. Once the side mounted circuit breaker alignment rollers are aligned with structure mounted alignment rails, push the circuit breaker into the structure as far as it will move. The levering latch must be fully engaged or the circuit breaker will not be able to be inserted. This first position is the DISCONNECT position. Without moving the circuit breaker, manually engaging the secondary contacts now makes this the TEST position.

To engage the secondary contacts, grasp the structure mounted secondary disconnect cage handle located below the left side of the circuit breaker, and pull it forward as far as possible to make the secondary engagement. As soon as control power is available, the motor will charge the closing springs.

To move the circuit breaker to the CONNECTED position, engage the levering crank with the structure mounted levering shaft and begin turning the handle in a clockwise direction. Keep in mind that the levering crank cannot be engaged with the circuit breaker closed. Structure mounted positive guidance rails interface with the circuit breaker alignment rollers to insure proper primary and secondary connections.

NOTICE

The circuit breaker includes all necessary interlocks that when interfaced with a compatible structure will render the circuit breaker mechanism mechanically and electrically trip-free during the levering process into or out of the structure. For detailed information pertaining to individual circuit breaker interlocks, refer to Paragraph 4-9 in this section.

As the handle is turned, the circuit breaker will move slowly toward the rear of the structure and the integrally mounted floor movement wheels will be lifted from the floor of the structure. Eventually, the integrally mounted wheels are separated from the structure floor by approximately 1/8 inch, and the circuit breaker is suspended in the structure. This design insures positive primary and secondary connections, even if the assembly's mounting conditions are less than ideal.

When the circuit breaker reaches the CONNECTED position, it will become impossible to continue turning the levering crank in the clockwise direction. The secondary contacts will automatically engage in the CONNECTED position, if not already engaged manually in the TEST position.

To remove the circuit breaker from the structure, reverse the procedure just described by turning the levering crank in a counterclockwise direction. Keep in mind that safety interlocks may cause the circuit breaker to open and/or springs discharge during the removal procedure. It depends on what condition the circuit breaker was in as removal began.

4-8.2 OPERATION CHECK PERFORMANCE

Move the circuit breaker to the TEST position and engage the secondary contacts following the procedure described in Paragraph 4-8.1. As soon as control power becomes available, the motor will charge the closing springs with this condition indicated by a Spring Charged/Discharged Indicator on the front of the circuit breaker (Figure **3-7**). In addition, the status of the main contacts, open or closed, is indicated on the front of the circuit breaker.

Using the close and trip buttons on the front of the circuit breaker, close and trip the circuit breaker several times to verify the closing and tripping operations. Conclude the check by closing the circuit breaker.

4-9 BREAKER/STRUCTURE INTERFACING

Type VCP-W Vacuum Circuit Breakers are supplied with a series of interlocks to insure safe and proper interfacing between the circuit breaker and a compatible structure compartment. The specific interlocks are described in the next paragraph to provide the proper familiarization. Once the interlocks are reviewed, an interfacing check can be performed as described in Paragraph 4-9.2.

4-9.1 INTERFACE INTERLOCKS

Each circuit breaker is supplied with the following interlocks to insure safe and proper operation (Figure **4-2**):

Code Plates

Code plates are mounted at the bottom of the circuit breaker to prevent the insertion of a circuit breaker into a structure of higher power rating. A set of two code plates on the circuit breaker and two in the compartment form this interlock.

NOTICE

Code plates do not block out control voltage or scheme incompatibility.

Close and Trip Floor Trippers

Mounted on the bottom of the circuit breaker, these interlocks interface with compatible structure interlocks to render the circuit breaker mechanism mechanically and electrically trip free during the levering process.

Anti-Close Interlock

This interlock prevents releasing the closing springs electrically or manually if the circuit breaker is already closed (Figure **5-5**). On a closed circuit breaker, the interlock lever moves toward the rear. In this position, the movement of the spring release clapper does not lift the lever and thus the spring release latch cannot be moved.

4-9.2 INTERFACING CHECK

Keep in mind that an interfacing check will be made with a compatible structure. As such, the instructions provided with the assembly will suggest other interfacing conditions that should be observed and/or checked, such as primary shutter operation, MOC/TOC operation and levering handle insertion. A complete, coordinated interface check, therefore, will be a blend of the circuit breaker instructions and those provided with the structural assembly. Together all required standards are met and the ultimate in safety is achieved.

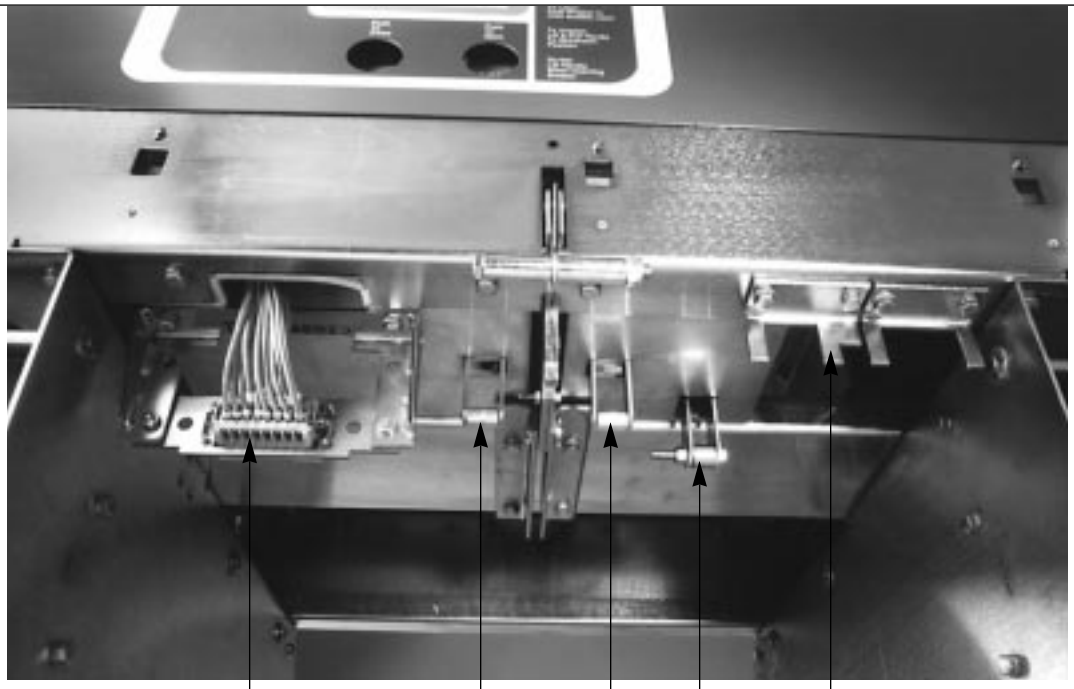
Insert the circuit breaker into the structure and lever it into and out of each different position by following the procedures described in Paragraph 4-8.1.

When the secondary contacts are manually engaged in the TEST position, the motor will charge the closing springs. Close the circuit breaker. Attempt to engage the levering crank to begin moving the circuit breaker to the CONNECTED position. It will first be noticed that the levering crank cannot be engaged with the breaker closed. In addition, charged springs will be discharged as the circuit breaker starts to move.

Once in the CONNECTED position, remove the levering handle, close the circuit breaker and the motor will begin charging the closing springs if control power is available. Once again engage the levering handle which can only be accomplished with the circuit breaker open.

Lever the circuit breaker toward the TEST position. The circuit breaker will be in a trip-free condition. Continue to lever the circuit breaker all the way to the TEST position and the secondary contacts will be disengaged, now making it the DISCONNECT position

Manually engage the secondary contacts and the motor will charge the closing springs. Close the circuit breaker and begin to remove the circuit breaker to the WITHDRAWN position by lifting and pulling on the Lift/Pull handle. The circuit breaker will trip, close and trip as it moves from the TEST position.



1. Secondary Disconnect Plug
2. Close Floor Tripper
3. Trip Floor Tripper
4. MOC Operator
5. Code Plates

Figure 4-2 Type VCP-W Circuit Breaker (Bottom View)

The suggested combination of interface checks outlined in the circuit breaker manual and structural assembly manual are intended to verify safe and proper operation. If observed conditions are not as described, contact Cutler-Hammer for assistance.

SECTION 5: DESCRIPTION AND OPERATION

5-1 INTRODUCTION

The Type VCP-W 38kV Vacuum Circuit Breaker is a horizontal drawout roll on the floor design for use in new switchgear, as well as for modernization and life extension of existing switchgear. VCP-W 38kV Circuit Breakers meet or exceed all applicable ANSI and IEEE Standards.

The circuit breaker 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 disconnecting contacts are self-aligning, silver plated copper. VCP-W Circuit Breakers are of a modular type construction containing a front accessible mechanism with unobstructed access to control components. Self-contained vacuum interrupter pole unit assemblies are removable as complete individual units.

The primary insulation used in the circuit breaker 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 as well as the function and operation of all major sub-assemblies and/or parts.

5-2 INTERRUPTER ASSEMBLY

The VCP-W 38kV design utilizes three individually mounted and removable pole units. Each pole unit is enclosed in a four sided continuous chimney type cycloaliphatic epoxy support molding. Black insulating shrouds cover and seal the openings where upper and lower primary conductors enter and exit the cycloaliphatic epoxy enclosure (Figure **5-1**). The disconnecting ends of the primary conductors utilize round, floating type primary disconnecting finger clusters for interfacing with the switchgear structure mounted primary conductors.

The rear portion of the circuit breaker truck, on which the pole units are mounted, utilizes a bolted on plate to cover a rectangular opening in the truck for circuit breakers above 1600 amperes. Closure of the opening provides for proper air circulation up through each pole unit enclosure on 2000 ampere and above circuit breakers (Figure **5-2**).

Figure 5-1 Rear View Showing Pole Unit Enclosure

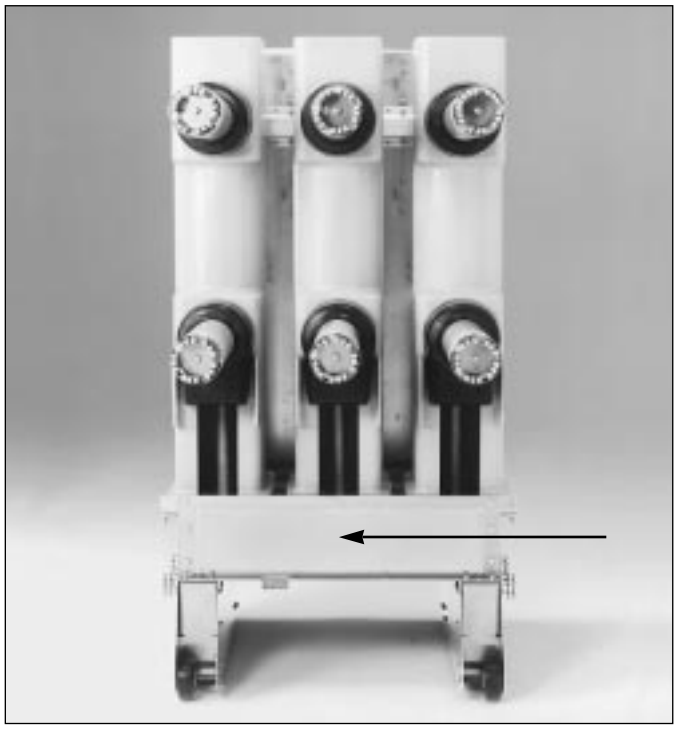


Figure 5-2 Plate Over Rear Truck Opening 2000A Breakers and Above

CAUTION

THE PLATE BOLTED TO THE REAR RECTANGULAR OPENING ON ALL 2000 AMPERE AND ABOVE CIRCUIT BREAKERS AND IDENTIFIED IN FIGURE 5-2 MUST BE BOLTED IN POSITION BEFORE PLACING A CIRCUIT BREAKER IN SERVICE TO INSURE PROPER OPERATION WITHIN TEST PROVEN PARAMETERS.

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 provides a multipoint contact resulting in low electrical and thermal resistance. Utilizing this non-sliding current transfer system between the movable stem and the circuit breaker main conductor eliminates maintenance of this joint.

Direct acting insulated operating rods in conjunction with the circuit breaker'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.

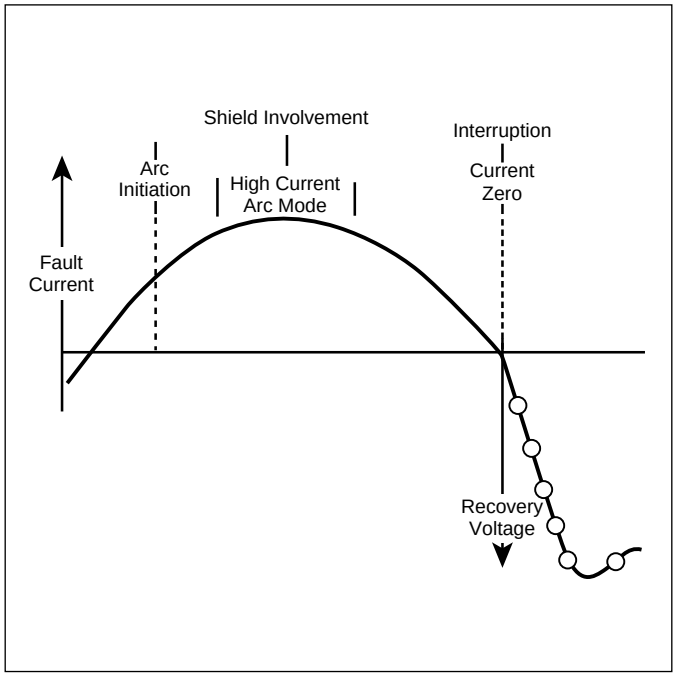


Figure 5-3 Graphic Representation of Arc Interruption

5-2.1 VACUUM INTERRUPTER

Type VCP-W 38kV Vacuum Circuit Breakers utilize vacuum interrupters for interruption and switching functions. The vacuum interrupters use axial-magnetic, 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. Two different contact erosion indicators are provided for maximum user convenience.

NOTICE

Each phase of the circuit breaker is monitored independently by either of the two types of contact erosion indicators.

The first contact erosion indicator is monitored from the rear of the circuit breaker. It provides a very accurate indication of contact erosion, and is the primary determinant of contact condition. A contact erosion indicator mark is located on the insulated operating rod of each interrupter (Figures **6-2** and **6-3**).

A second more convenient indicator is located on the front of the circuit breaker (Figure **3-4**). Small viewing windows located on the front lower portion of the circuit breaker truck provide a green and red “Go” or “No Go” flag indication of each vacuum interrupter’s contact erosion condition. This indicator is provided as a convenient reference when the circuit breaker is installed in its cubicle. As long as the line in the window is in the green portion of the indicator, the contacts are satisfactory. When the line reaches the red portion of the indicator, the interrupter assembly must be replaced.

5-2.3 LOADING SPRING INDICATION

The contact loading spring indicator is an additional method provided to indicate conditions within the vacuum interrupter, as well as the overall system condition. The visible indication, on each phase, is used to indicate whether the contact loading springs are maintaining the proper contact pressure to keep the contacts closed. Severe contact erosion or an adjustment need after an interrupter assembly replacement would result in an unacceptable indication from this indicator (Figures **6-4** and **6-5**).

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.

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

The circuit breaker mechanism provides a fixed amount of motion to the operating rods. The first portion of the motion is used to close the contacts (i.e. stroke) and the remainder is used to further compress the preloaded wipe spring. This additional compression is called wipe. Wipe and Stroke are thus related to each other. As the stroke increases due to the erosion of contacts, the wipe decreases. A great deal of effort has been spent in the design of all Cutler-Hammer vacuum circuit breakers, in order to eliminate 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 CIRCUIT BREAKER’S INTERNAL PARTS WHILE THE CIRCUIT BREAKER CONTACTS ARE CLOSED OR THE CLOSING SPRINGS ARE CHARGED. THE CIRCUIT BREAKER CONTACTS MAY OPEN OR THE CLOSING SPRINGS DISCHARGE CAUSING A CRUSHING INJURY. DISCHARGE THE SPRINGS AND OPEN THE CIRCUIT BREAKERS BEFORE PERFORMING ANY CIRCUIT BREAKER MAINTENANCE, INSPECTION OR REPAIR.

The spring stored energy operating mechanism is arranged vertically in front of all VCP-W circuit breakers (Figure **3-5**). It includes all the elements for storing the energy, closing and tripping of the circuit breaker, 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:

a. Circuit breaker open, closing springs discharged
b. Circuit breaker open, closing springs charged
c. Circuit breaker closed, closing springs discharged
d. Circuit breaker 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.

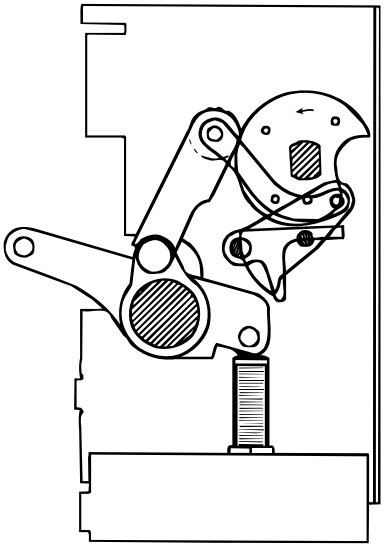


Figure 5-4a *Breaker open and closing spring discharged*

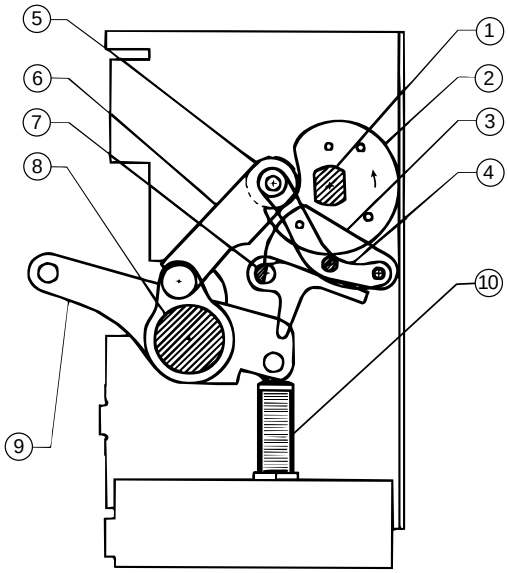


Figure 5-4b *Breaker open and closing spring charged*

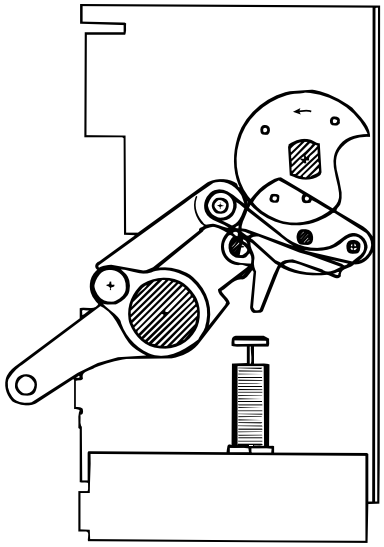


Figure 5-4c *Breaker closed and closing spring discharged*

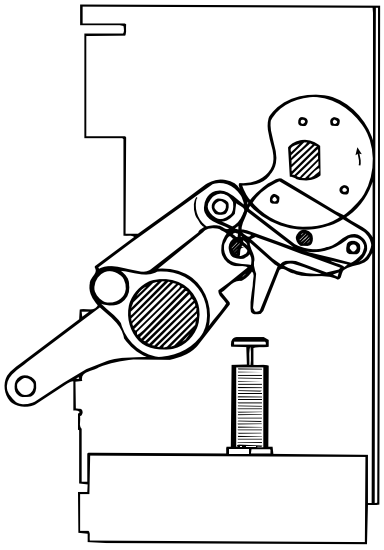


Figure 5-4d *Breaker closed and closing spring charged*

1. Cam Shaft
2. Closing Cam
3. Trip Latch
4. Banana Link
5. Main Link Roller
6. Main Link
7. Trip Bar “D” Shaft
8. Pole Shaft
9. Pole Unit Actuating Lever
10. Shock Absorber

Figure 5-4 Closing Cam and Trip Linkage

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 circuit breaker 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 circuit breaker 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 circuit breaker.

In Figure **5-4c** the linkage is shown with the circuit breaker 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 circuit breaker is held closed.

Figure **5-4d** shows the circuit breaker 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 circuit breakers.

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 38kV VCP-W circuit breakers, one for DC control and one for 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 may be closed by making the control switch close (CS/C) contact. Automatically upon closing of the circuit breaker, the motor starts charging the closing springs. The circuit breaker may be tripped any time by making the control switch trip (CS/T) contact.

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

The position switch (PS2) contact is in the motor circuit. It prevents the motor from starting until the fully CONNECTED position is reached and the secondary contacts are firmly engaged.

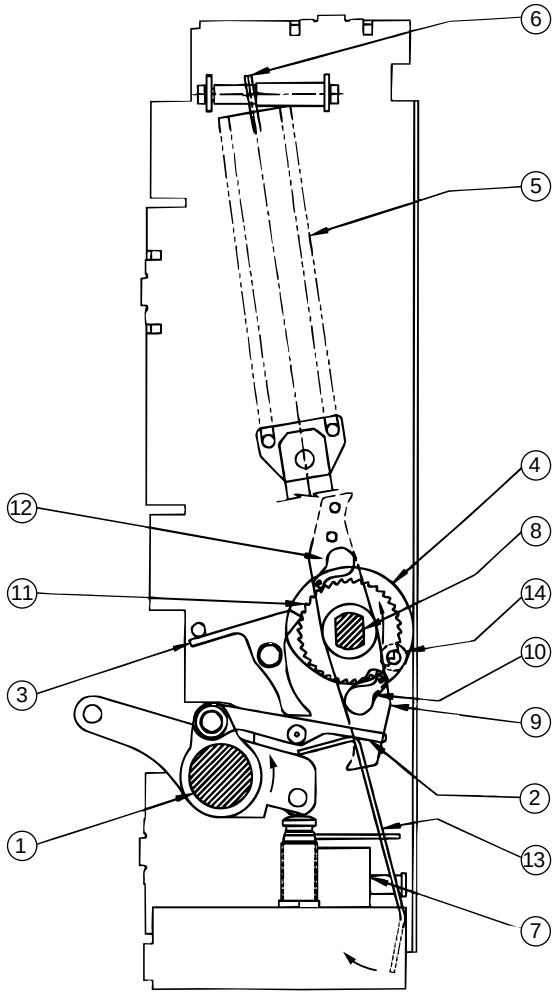
When the CS/C contact is made, the SR closes the circuit breaker. If the CS/C contact is maintained after the circuit breaker closes, the Y relay is picked up. The Y/a contact seals in Y until CS/C is opened. The Y/b contact opens the SR circuit, so that even though the circuit breaker would subsequently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

5-4.1 TIMING

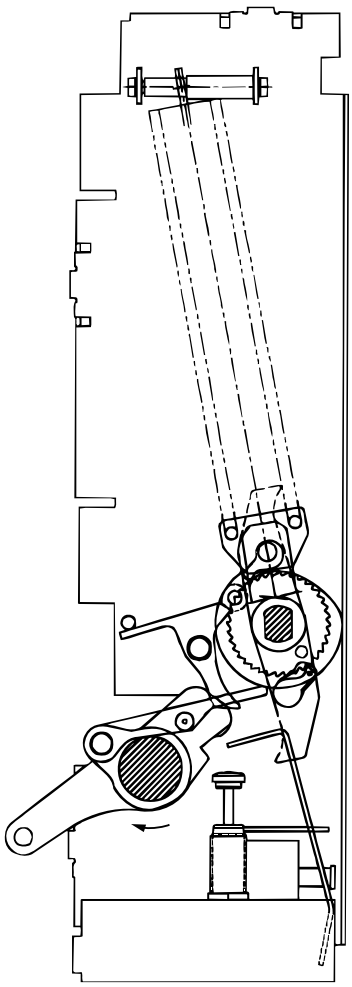
The opening and closing times for the circuit breakers vary depending upon the control voltage and the power rating. Typical values for 38kV VCP-W circuit breakers are shown in Table **5.1**.

5-4.2 SECONDARY DISCONNECTS

The circuit breaker control wiring is arranged to connect



Breaker Open, Springs Discharged



Breaker Closed, Springs Charged

1. Pole Shaft
2. Anti-Close Interlock
3. Spring 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 5-5 Charging Schematic

BREAKER DC CONTROL SCHEMATIC

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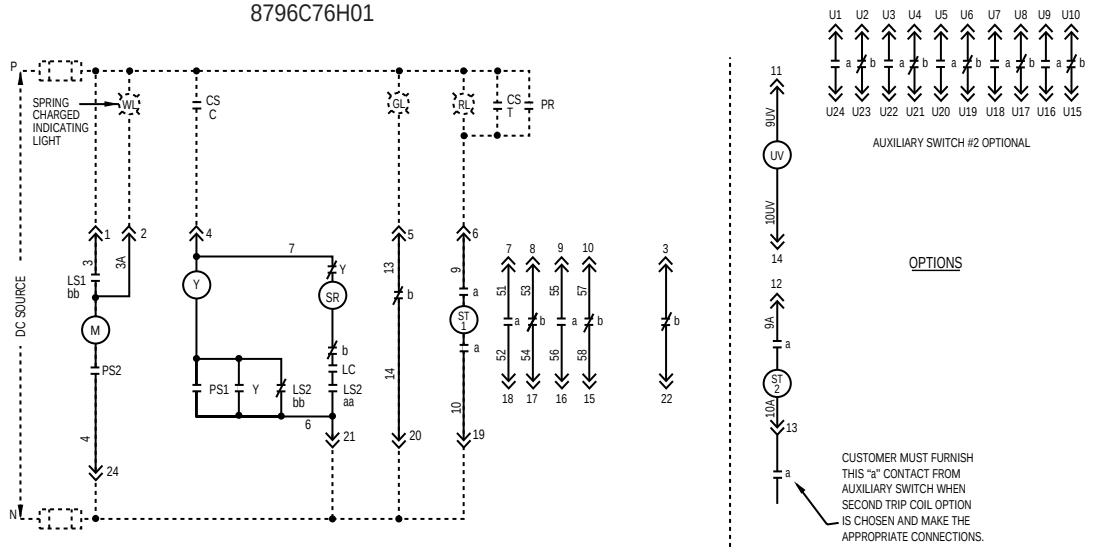

BREAKER AC CONTROL SCHEMATIC

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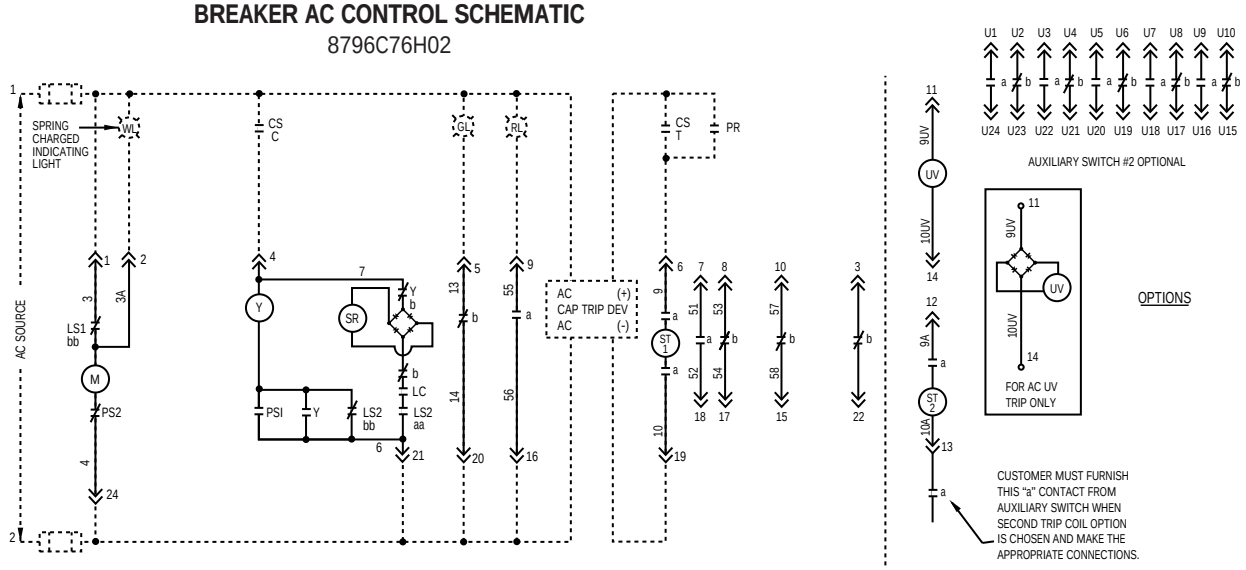


CS C	–	Breaker Control Switch – close
CS T	–	Breaker Control Switch – trip
Y	–	Anti Pump Relay
SR	–	Spring Release Coil (Close Coil)
M	–	Spring Charging Motor
ST	–	Shunt Trip
PR	–	Protective Relay
⩓	–	Secondary Disconnect

	OPERATION	SWITCH TERMINAL
LS1 aa	Open until springs are fully charged	'C' and 'NC' (Brown Switch)
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'
PS2	Closed in all except between 'Test' and 'Connected' positions	'C' and 'NO'

Figure 5-6 Typical 38kV VCP-W "DC" and "AC" Control Schematics

a standard 24 point male plug with a corresponding switchgear compartment mounted female plug. An additional 24 point plug is optional.

Type VCP-W 38kV circuit breakers utilize fixed mounted male plugs located under the left bottom portion of the circuit breaker truck. When two 24 point plugs are supplied, they are mounted in a stacked arrangement (Figure **5-7**). Fixed mounted circuit breaker secondary plugs connect to corresponding movable female plugs mounted in the bottom of the switchgear compartment.

The switchgear compartment mounted secondaries are of a movable carriage design. Once the circuit breaker is in the TEST position, the structure mounted secondary plug carriage can be manually unlatched and pulled forward until mating with the circuit breaker mounted male plugs. To disengage the secondary plugs from the TEST position, simply push the carriage to the rear. Secondary connections are automatically engaged or disengaged when moving into or out of the CONNECTED position.

5-4.3 UNDERVOLTAGE TRIP DEVICE

The undervoltage trip device for VCP-W circuit breakers is an electromechanical device that operates to open the circuit breaker at 30% or less of the voltage rating of the trip coil. The device does not open the circuit breaker at values above 60% of the voltage rating of its trip coil. It may operate, however, to open the circuit breaker when the voltage across the trip coil is greater than 30%, but less than 60% of the voltage rating of its trip coil. The circuit breaker can be closed as long as the voltage to the trip coil is maintained at 85% or above the rated level. The undervoltage trip device is available only as an instantaneous type with rated voltages of 48VDC, 125VDC, 250VDC 120VAC and 240VAC.

For a basic understanding of the operation of the undervoltage trip device refer to the specific items identified in Figure **5-8** and the following operation description.

1. With the circuit breaker closed and sufficient voltage on the Undervoltage Trip Device coil, the moving clapper (1) is held to the stationary yoke (2) by the magnetic force produced by the coil (3) against the extension springs (4) pulling the moving clapper apart from the yoke.

2. The moving clapper is connected to the mechanism Trip D Shaft Lever (5) by a slotted link (6).

3. When the voltage to the Undervoltage Trip Coil goes down as described earlier, the extension springs force overcomes the reduced magnetic force and pulls the moving clapper up. The slotted link in turn upsets the Trip D Shaft and the circuit breaker trips open.

4. As the circuit breaker opens, the reset lever (8) connected to the pole shaft lever (7) operates to reset the moving clapper. As long as the circuit breaker

Table 5.1 Circuit Breaker Timing

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

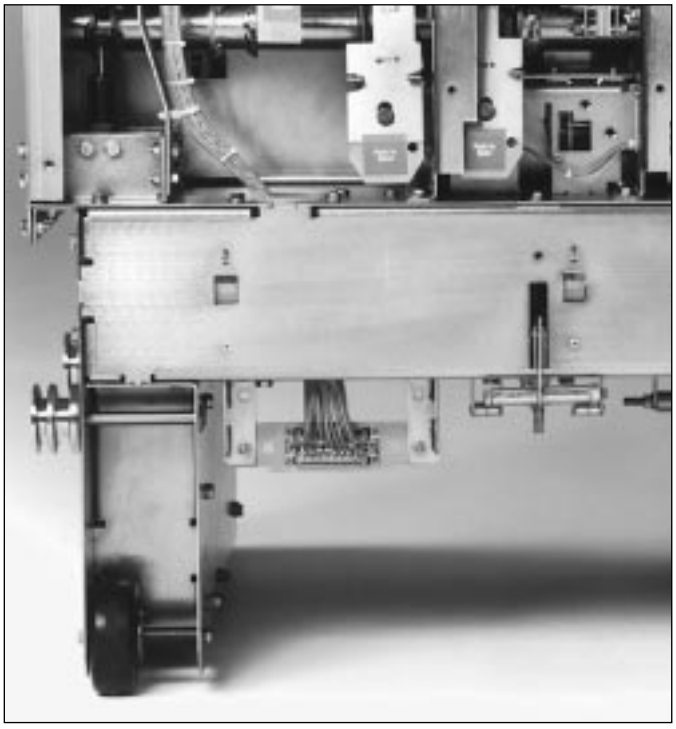


Figure 5-7 Secondary Circuit Breaker Plug Shown Mounted Lower Left

remains open, the reset lever holds down the moving clapper to the yoke.

5. When the circuit breaker closes, the reset lever moves away from the moving clapper. If the Undervoltage Trip Device coil has at least 85% of the rated voltage applied, the moving clapper is held to the yoke by the magnetic force, even though the reset lever has moved up.

5-5 INTERLOCKS AND INTERFACING

Refer to Paragraph 4-9 of this manual for detailed information concerning circuit breaker interlocks and their interfacing with a switchgear structure compartment. In addition, refer to the instruction manual supplied with the switchgear assembly.

5-6 LEVERING MECHANISM

The purpose of the levering mechanism is to move the circuit breaker into and out of the CONNECTED position within the assembly structure. The levering mechanism used to move the 38kV VCP-W circuit breaker is a minimum effort recirculating ball drive design, and is part of the assembly structure cradle. 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.

5-7 OPERATIONS COUNTER

All circuit breakers are equipped with a mechanical operations counter. As the circuit breaker opens, the linkage connected to the pole shaft lever advances the counter reading by one (Figure **3-7**).

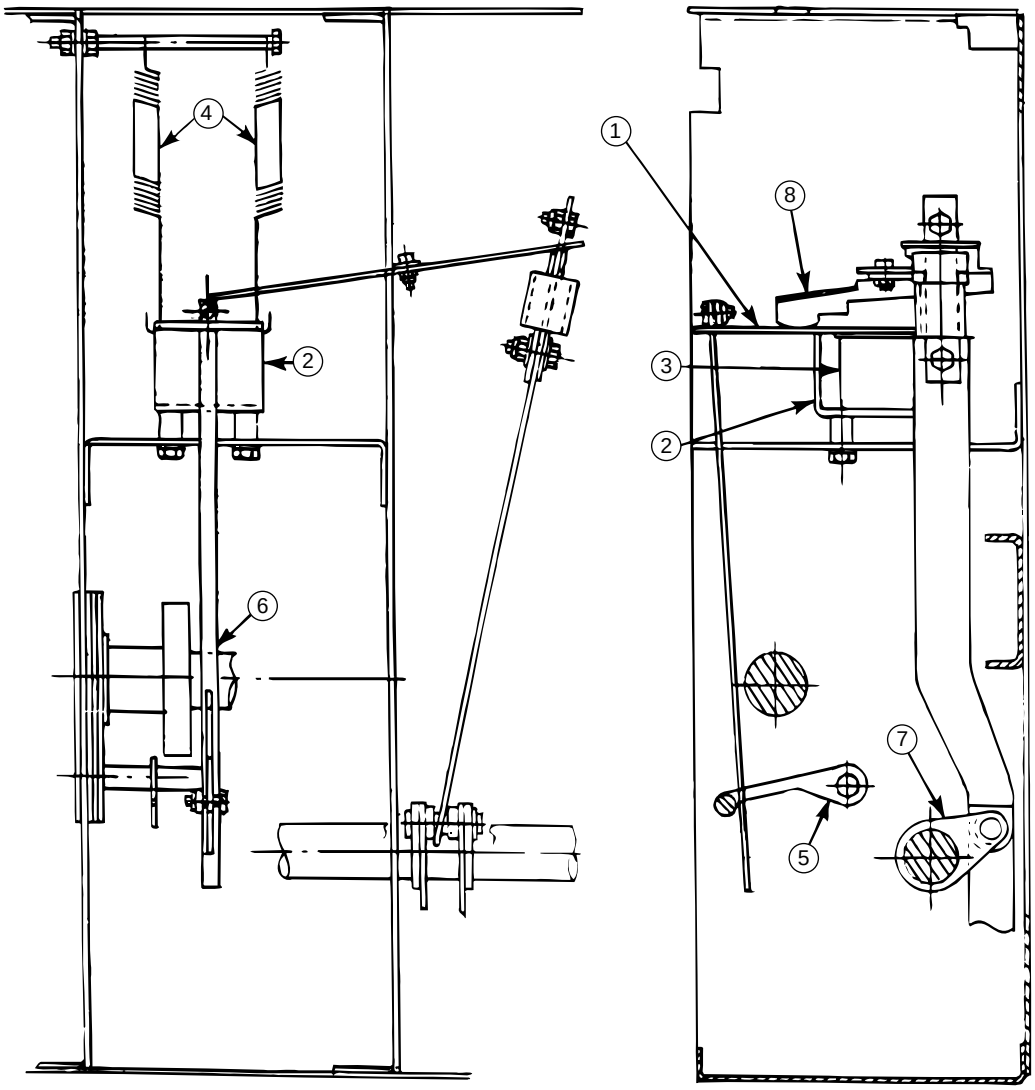
5-8 GROUND CONTACT

The ground contact is an assembly of spring loaded fingers providing a disconnectable means for grounding the circuit breaker chassis, after it has been inserted into a switchgear structure. The ground contact is located on the lower left portion of the truck chassis. An extension of the switchgear ground bus is secured to the cell floor in such a position to engage the ground contact automatically, when the circuit breaker is moved into the DISCONNECT/TEST position. It remains engaged in all other circuit breaker positions within the cell.

5-9 MOC AND TOC SWITCH OPERATIONS

A MOC operator integral to the circuit breaker engages an operating lever of the Mechanism Operated Cell Switch (MOC) located in the switchgear cell. This MOC operator permits the contacts of the MOC Switch to be correlated with the circuit breaker’s contact position.

The cell mounted Truck Operated Cell Switch (TOC) is operated by movement of the circuit breaker truck into or out of the CONNECTED position.



1. Moving Clapper
2. Stationary Yoke
3. UV Trip Device Coil
4. Extension Springs
5. Trip D Shaft Lever
6. Slotted Link
7. Pole Shaft Lever
8. Reset Lever

Figure 5-8 Undervoltage Trip Device Configuration

SECTION 6: INSPECTION, MAINTENANCE AND TROUBLESHOOTING

6-1 INTRODUCTION

WARNING

- **DO NOT WORK ON A CIRCUIT BREAKER IN THE "CONNECTED" POSITION.**
- **DO NOT WORK ON A CIRCUIT BREAKER WITH SECONDARY DISCONNECTS ENGAGED.**
- **DO NOT WORK ON A CIRCUIT BREAKER WITH SPRINGS CHARGED OR CONTACTS CLOSED.**
- **DO NOT DEFEAT ANY SAFETY INTERLOCKS.**
- **DO NOT LEAVE MAINTENANCE TOOL IN THE SOCKET AFTER CHARGING THE CLOSING SPRINGS.**
- **DO NOT STAND LESS THAN FOUR METERS 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 AND MAINTENANCE

Periodic inspections and associated maintenance are essential to the safe and reliable operation of VCP-W Vacuum Circuit Breakers. 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 annually or every 500 operations, which ever comes first.

2. For special conditions such as frequent circuit breaker operation, contaminated environments, and high temperature/humidity conditions, the inspection frequency should be twice a year.

3. Inspect a circuit breaker every time it interrupts fault current.

4. Follow the steps presented in Paragraph 6-3 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 breakers, loose hardware or discolored insulation.

6-2.1 QUALIFIED PERSONNEL

For the purpose of operating switchgear equipment and associated circuit breakers, 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.

6-2.2 HELPFUL TOOLS AND ACCESSORY ITEMS

To simplify the performance of inspection and maintenance programs, the items described in Section 3-5 are recommended.

6-2.3 GENERAL TORQUE GUIDELINES

Bolts and screws must be properly torqued. This is especially true if parts and/or accessories are added or replaced. Table **6.1** 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 6.1 Torque Guidelines

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

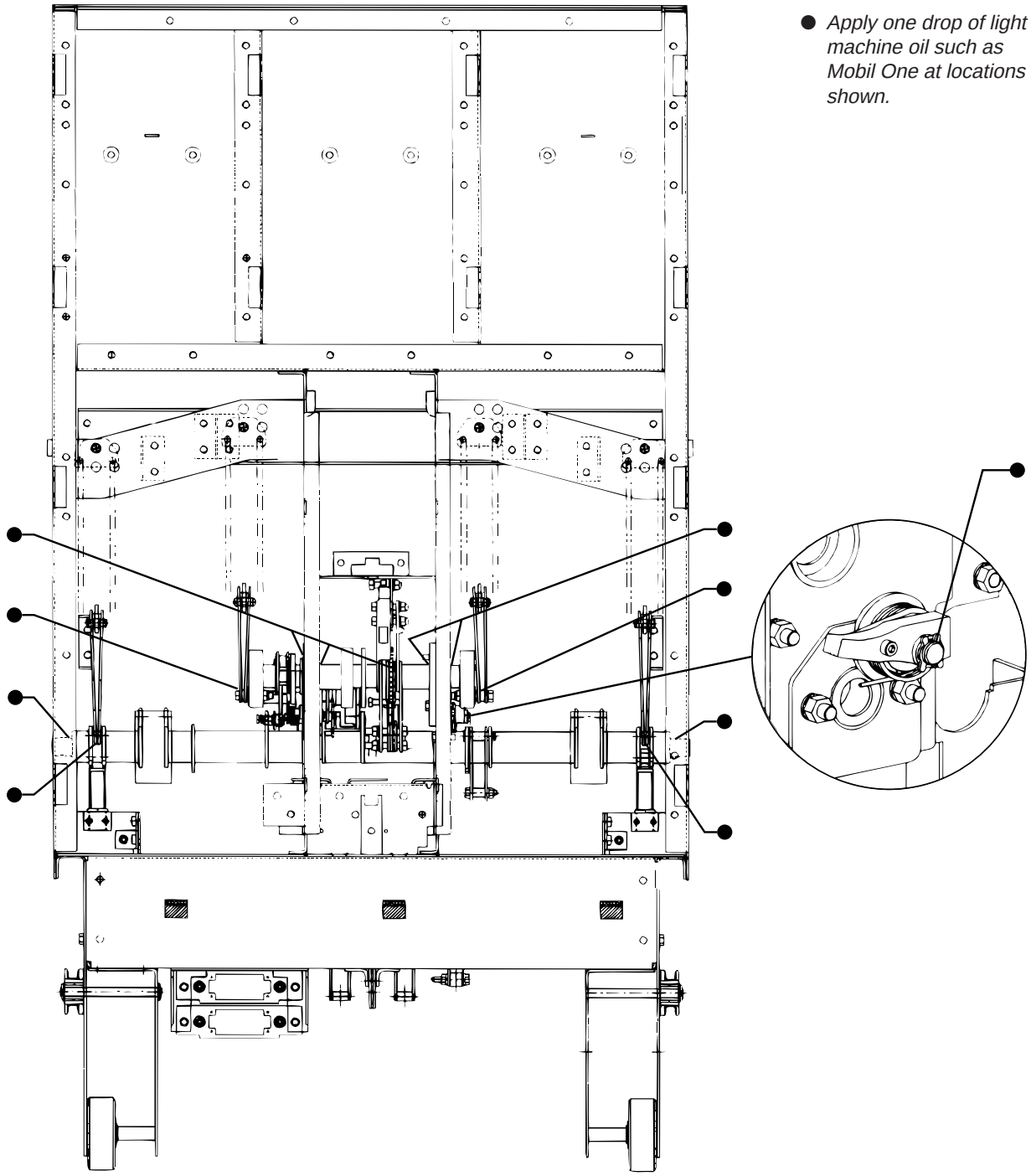


Figure 6-1 Lubrication Points

6-3 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 No cracking	Visual Check Visual Check	Clean with lint-free cloth or 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 circuit breaker and observe if all 3 front indicator marks are in green area, and then proceed as described in Paragraph 6-5	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 6-6	If measurement is not acceptable, replace pole unit assembly
		Adequate Vacuum	Proceed with integrity check as described in Paragraph 6-4	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 circuit breaker twice	Replace any defective device. Identify per trouble-shooting chart
	Wiring	Securely tied in proper place	Visual Check	Repair or tie as necessary
	Terminals	Tight	Visual Check	Tighten or replace if necessary
	Motor	Smooth, 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 **6.1** 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 **6-1**, Paragraph 6-11 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

6-4 VACUUM INTERRUPTER INTEGRITY TEST

Vacuum interrupters used in Type VCP-W 38kV Vacuum 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. Refer to Table **6.2** 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 CIRCUIT BREAKER.

With the circuit breaker open and sitting solidly on the floor or secured in a fixed position, 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 circuit 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 circuit 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. 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 **6.2**.

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.

6-5 CONTACT EROSION

In order to determine if the contacts have eroded to the extent that the interrupter must be replaced, close the circuit breaker and observe the erosion mark on each operating rod from the rear of the circuit breaker. If the mark on the interrupter stem is measured to be more than 12 inches from the base of the interrupter, the interrupter is satisfactory. If the mark is 12 inches or less, the interrupter assembly must be replaced (Figures **6-2** and **6-3**).

6-6 CONTACT WIPE

The adequacy of contact wipe can be determined by a simple measurement of each loading spring indicator with the circuit breaker closed. Refer to Figures **6-4** and **6-5** and measure the indicator distance shown for each interrupter. If the measurement taken is in the range of 0.91 to 1.22 inches, the contact wipe is adequate.

Table 6.2 Test Voltage

Circuit Breaker Rated Maximum Voltage	Vacuum Interrupter Integrity Test Voltage	
	ac 60 Hz	dc
38 kV rms	60 kV rms	85 kV

Figure 6-2 Rear Measurement for Contact Erosion Being Made (Circuit Breaker Closed)

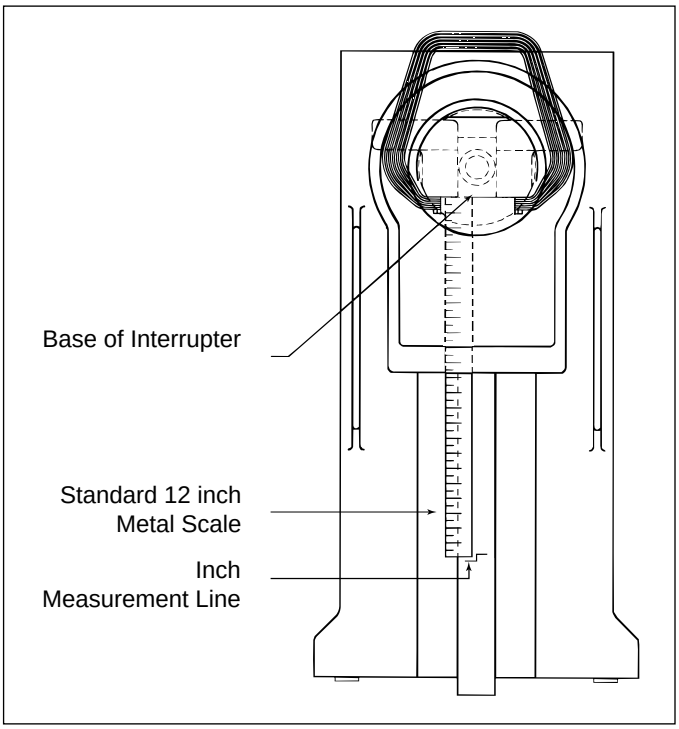


Figure 6-3 Graphical Representation of Contact Erosion Measurement (Circuit Breaker Closed)

6-7 INSULATION

Type VCP-W 38kV Vacuum Circuit Breakers primarily utilize cycloaliphatic epoxy insulation except, for example, the black insulating shrouds. 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 circuit 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.

6-8 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 circuit breaker. For circuit breakers rated 38kV the test voltage is 60kV rms. Conduct the test as follows:

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

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 circuit breaker frame. Starting with zero, increase the voltage to 1125 volts rms. Maintain the voltage for one minute. Successful withstand indicates satisfactory insulation strength of the secondary control circuit. Remove the shooting wire.

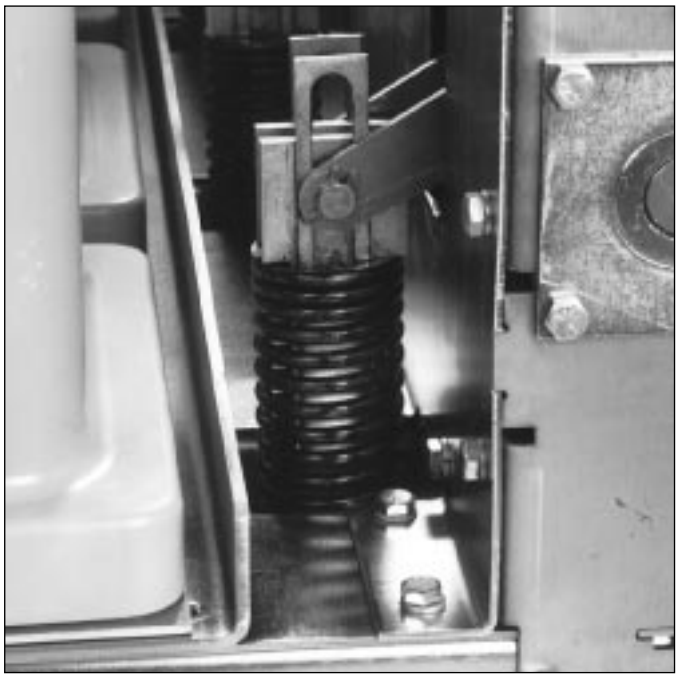


Figure 6-4 Side View of Loading Spring Indicator (Circuit Breaker Closed)

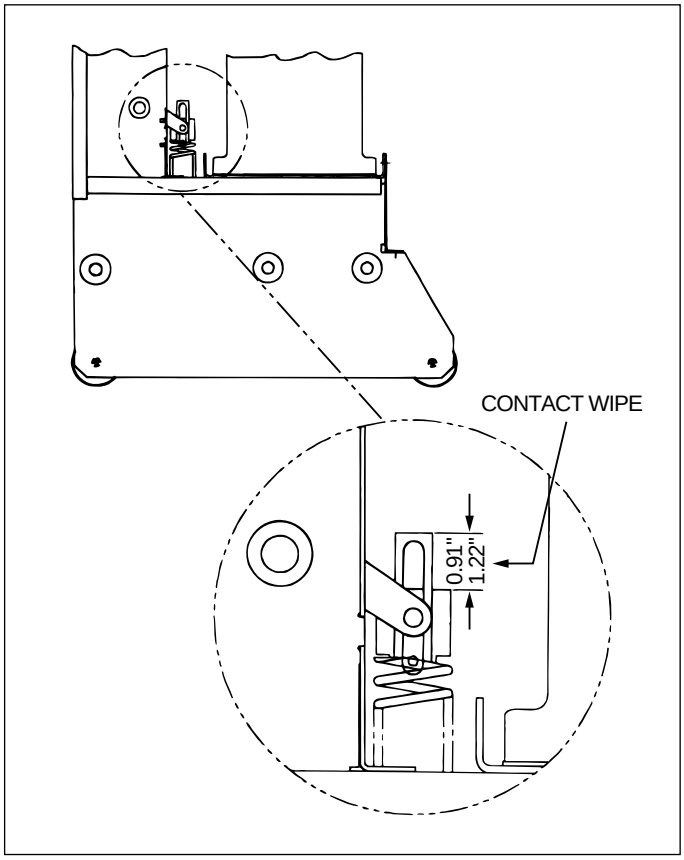


Figure 6-5 Graphical Representation of Contact Wipe Measurement of Loading Spring Indicator (Circuit Breaker Closed)

6-9 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 circuit 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 circuit breaker, pass at least 100 amps DC current through the circuit breaker. With a low resistance instrument, measure resistance across the studs on the circuit breaker for each pole. The resistance should not exceed the values shown in Table **6.3**.

6-10 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 circuit breaker components. Operate the circuit breaker several times manually and electrically. Check the closing and opening times to verify that they are in accordance with the limits in Table **5.1**.

6-11 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 circuit breaker should be relubricated. The locations shown in Figure **6-1** should be lubricated with a drop of light machine oil.

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

Roller bearings are used on the pole shaft, the cam shaft, the main link and the motor eccentric. These bearings are packed at the factory with a top grade slow oxidizing grease which normally should be effective for many years. They should not be disturbed unless there

is definite evidence of sluggishness, dirt or parts are dismantled for some reason.

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

Table 6.3 Typical Resistance Measurements

Rated Continuous Current (amperes)	Resistance (microohms)
600	92
1200	90
1600	88
2000	72

6-12 TROUBLESHOOTING CHART (Continued Next Page)

SYMPTOM	INSPECTION AREA	PROBABLE DEFECTS
Fails To Close		
• Closing Springs not charged	• Control Circuit	• Control Power (fuse blown or switch off) • Secondary Disconnects • Motor Cut-off Switch (Poor or burned contacts, Lever not operational) • Terminals and connectors (Poor or burned contacts) • Motor (Brushes worn or commutator segment open)
	• Mechanism	• Pawls (Slipping or Broken) • Ratchet Wheel (Teeth worn or broken) • Cam Shaft Assembly (Sluggish or jammed) • Oscillator (Reset spring off or broken)

6-12 TROUBLESHOOTING CHART (Continued Next Page)

SYMPTOM	INSPECTION AREA	PROBABLE DEFECTS
Fails To Close		
• Closing Spring charged but circuit breaker does not close	• No Closing Sound (Close Coil does not pick up)	• Control Power (Fuse blown or switch off) • Secondary Disconnects • Anti-Pump Relay (Y relay N. C. contact open or burned or relay picks up) • Close Coil (Open or burned) • Latch Check Switch (Contact open-bad switch or trip bar not reset) • Auxiliary Switch (b contact open or burned) • Motor Cut-off (Contacts open or burned) • Trip Coil Assembly (Clapper fails to reset)
	• Closing Sound but no close	• Pole Shaft (Not open fully) • Trip Latch Reset Spring (Damaged or Missing) • Trip Bar-D Shaft (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

6-12 TROUBLESHOOTING CHART

SYMPTOM	INSPECTION AREA	PROBABLE DEFECTS
Undesirably Closes		
	• Control Circuit	• Close Circuit (CS/C Getting Shorted)
	• Mechanism	• Close Release Latch (Fails to reset) • Close Floor Tripper (Fails to reset)
Fails To Trip		
• No Trip Sound	• Control Circuit	• 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)
	• Trip Mechanism	• Trip Clapper (Jammed)
• Trip Sound But No Trip	• Trip Mechanism	• Trip Bar, Trip Latch (Jammed) • Pole Shaft (Jammed) • Operating Rod Assembly (Broken or pins out)
	• Vacuum Interrupter (One or more welded)	
Undesirably Trips		
	• Control Circuit	• Control Power (CS/T Switch, remains made)
	• Mechanism	• Trip Coil Clapper (Not resetting) • Trip Bar or Trip Latch (Poor engagement of mating or worn surfaces) • Trip Bar Reset Spring (Loss of torque)

SECTION 7: RENEWAL PARTS

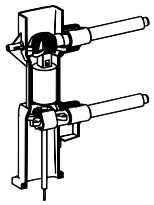
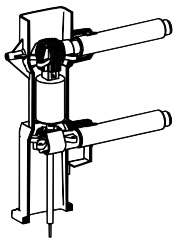
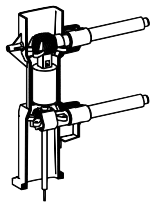
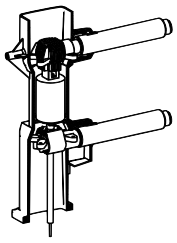
7-1 GENERAL

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 stock level based on operating experience. Refer to Table **7.1** for guidance.

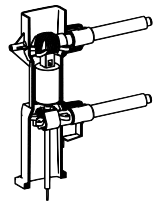
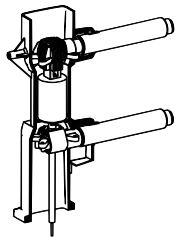
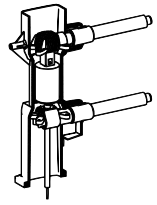
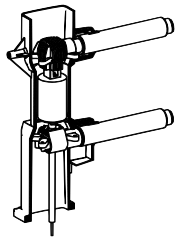
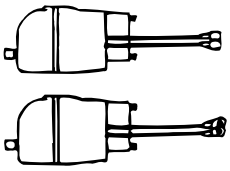
7-1.1 ORDERING INSTRUCTIONS

a. Always specify the breaker rating information and shop order number.
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 Cutler-Hammer sales office.

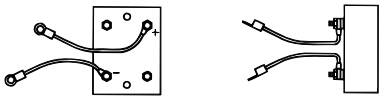
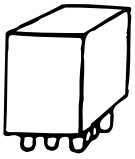
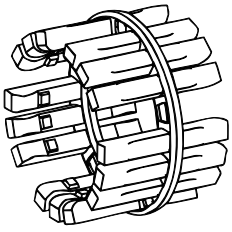
7.1 Recommended Renewal Parts for ANSI Rated Breakers (Continued Next Page)

LINE NO.	DESCRIPTION	STYLE NUMBER VCP-W	QTY	
	Interrupter Assembly			
1	380/16, 600A - 16kA	3A74837H01	3	
2	380/16, 1200A - 16kA	3A74838H01	3	
3	380/16, 1600A - 16kA	3A74839H01	3	
4	380/16, 2000A - 16kA	3A74840H01	3	
5	380/25, 600A - 25kA	3A74851H01	3	
6	380/25, 1200A - 25kA	3A74852H01	3	
7	380/25, 1600A - 25kA	3A74853H01	3	
8	380/25, 2000A - 25kA	3A74854H01	3	

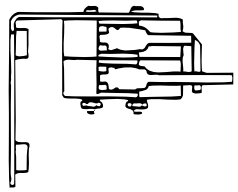
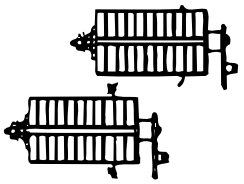
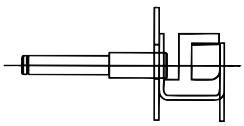
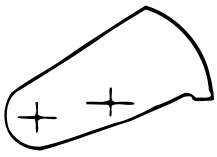
7.1 Recommended Renewal Parts for ANSI Rated Breakers (Continued Next Page)

LINE NO.	DESCRIPTION	STYLE NUMBER VCP-W	QTY	
9	380/32, 600A - 31.5kA	3A74858H01	3	
10	380/32, 1200A - 31.5kA	3A74859H01	3	
11	380/32, 1600A - 31.5kA	3A74860H01	3	
12	380/32, 2000A - 31.5kA	3A74861H01	3	
13	380/1500, 600A - 35kA	3A74865H01	3	
14	380/1500, 1200A - 35kA	3A74866H01	3	
15	380/1500, 1600A - 35kA	3A74867H01	3	
16	380/1500, 2000A - 35kA	3A74868H01	3	
	Charging Motor			
17	48VDC	699B196G06	1	
18	125VDC/120VAC	699B196G04	1	
19	250VDC/240VAC	699B196G05	1	
20	MOTOR BRUSH KIT	8063A77G01	1	

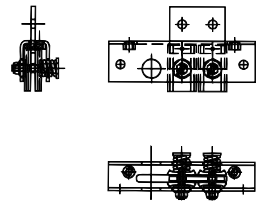
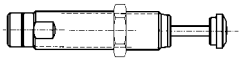
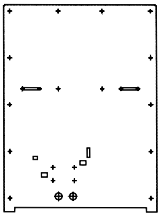
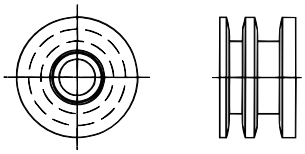
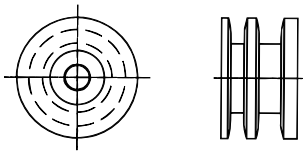
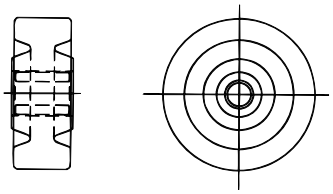
7.1 Recommended Renewal Parts for ANSI Rated Breakers (Continued Next Page)

LINE NO.	DESCRIPTION	STYLE NUMBER VCP-W	QTY	
	Spring Release Coils			
21	48VDC	3759A76G11	1	
22	125VDC/120VAC	3759A76G12	1	
23	250VDC/240VAC	3759A76G13	1	
24	RECTIFIER (120/240VAC)	3759A76G02	1	
	Anti Pump (Y) Relay			
25	48VDC	8237A27H03	1	
26	125VDC	8237A27H04	1	
27	250VDC	8237A27H05	1	
28	120VAC	8237A27H01	1	
29	240VAC	8237A27H02	1	
	Shunt Trip Coils			
30	24VDC	3759A76G14	1	
31	48VDC	3759A76G11	1	
32	125VDC/125VAC Cap Trip	3759A76G12	1	
33	250VDC/240VAC Cap Trip	3759A76G13	1	
	Primary Disconnects			
34	600A	5680B59G01	6	
35	1200A	5680B60G01	6	
36	1600A	5680B61G01	6	
37	2000A	692C037G03	6	
	UV Trip Coils			
38	48VDC	8064A19G01	1	
39	125VDC	8064A19G02	1	
40	250VDC	8064A19G03	1	
41	120VAC	8064A19G07	1	
42	240VAC	8064A19G08	1	

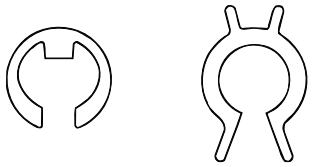
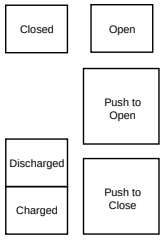
7.1 Recommended Renewal Parts for ANSI Rated Breakers (Continued Next Page)

LINE NO.	DESCRIPTION	STYLE NUMBER VCP-W	QTY	
43	Motor Cutoff Switch	699B199G04	1	
44	Latch Check Switch	699B147H04	1	
45 46	Position Switch Position Switch	699B147H01 3759A93H02	1 1	
47	Auxiliary Switch	5697B20H01	1	
48	Trip D-Shaft	694C638G01	1	
49	Trip Latch (Hatchet)	699B040G03	1	

7.1 Recommended Renewal Parts for ANSI Rated Breakers (Continued Next Page)

LINE NO.	DESCRIPTION	STYLE NUMBER VCP-W	QTY	
	Ground Contact Assy.			
50	16kA	8796C85G01	1	
51	25kA	8796C85G02	1	
52	31.5kA	8796C85G03	1	
53	21/35kA	8796C85G04	1	
54	Shock Absorber	5677B26H01	2	
55	Front Panel (w/o ESCN)	4D13655H02	1	
56	Breaker Rail Wheel	5680B22G01	4	
57	Shutter Drive Roller	5680B24H02	2	
58	Breaker Floor Wheel	3A74342H01	4	

7.1 Recommended Renewal Parts for ANSI Rated Breakers

LINE NO.	DESCRIPTION	STYLE NUMBER VCP-W	QTY	
59	Fastener Kit	8061A01G01	1	
60	Labels Kit	8295A45G01	1	
	Wiring Harness			
61	Repair Kit	8796C82G01	1	
	Complete Replacement			
62	STD	8796C82G02	1	
63	With #2 AUX SW	8798C82G03	1	
	Undervoltage Kit			
64	48VDC	8794C81G01	1	
65	125VDC	8794C81G02	1	
66	250VDC	8794C81G03	1	
67	120VAC	8794C81G04	1	
68	240VAC	8794C81G05	1	

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