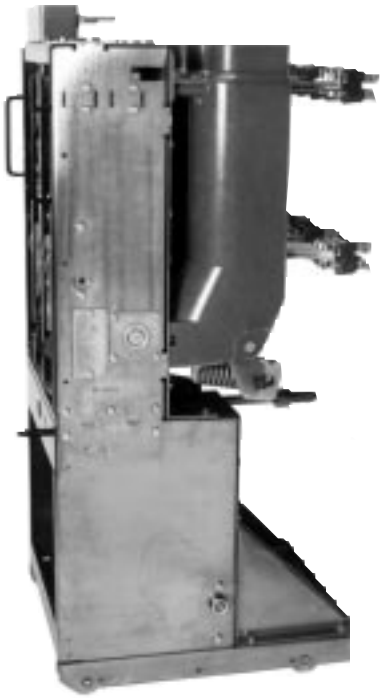
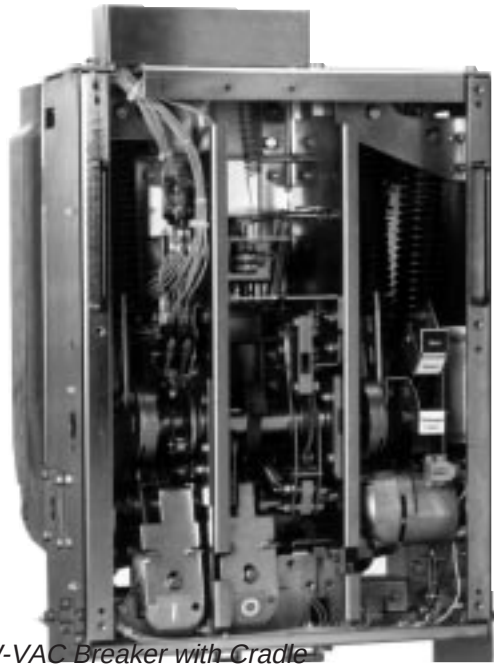
Instructions for Installation, Operation and Maintenance of Type W-VAC Vacuum Circuit Breakers

W-VAC Breaker Element



W-VAC Breaker with Carriage Assembly for SIngle Tier Switchgear



W-VAC Breaker with Cradle Assembly for Double Tier Switchgear

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 THE AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI). SERIOUS INJURY, INCLUDING DEATH, CAN RESULT FROM FAILURE TO FOLLOW THE PROCEDURES OUTLINED IN THIS MANUAL. THESE CIRCUIT BREAKER ELEMENTS ARE SOLD PURSUANT TO A NON-STANDARD PURCHASING AGREEMENT WHICH LIMITS THE LIABILITY OF THE MANUFACTURER.

Cutler-Hammer

Power Distribution Components Division

Five Parkway Center

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.

TABLE OF CONTENTS

SECTION 6 INSPECTION AND MAINTENANCE

SECTION 7 RENEWAL PARTS

FIGURES

TABLES

SECTION 1: INTRODUCTION

The purpose of this book is to provide instructions for unpacking, storage, installation, operation and maintenance of Type W-VAC Vacuum Circuit Breakers. Type W-VAC is a horizontal drawout type removable interrupting element design. It was designed specifically to IEC 56 Standards for reliable performance, ease of handing, and simplified maintenance. Type W-VAC can be applied in both single tier or double tier switchgear applications, with the basic breaker element applicable to retrofitting. Reliable control and protection for medium voltage equipment and circuits are achieved though the use of Type W-VAC Vacuum Circuit Breakers.

1-1 TYPE W-VAC BREAKER RATINGS

Refer to Table 1.1

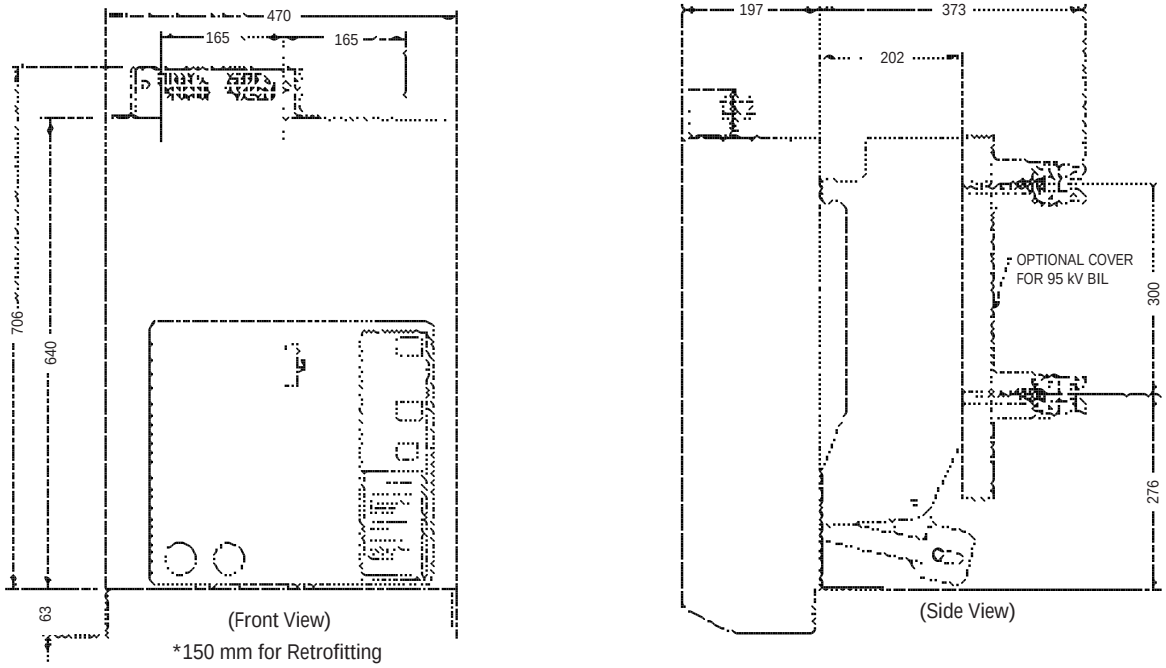
WARNING

SATISFACTORY PERFORMANCE OF THESE BREAKERS IS CONTINGENT UP-ON 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.

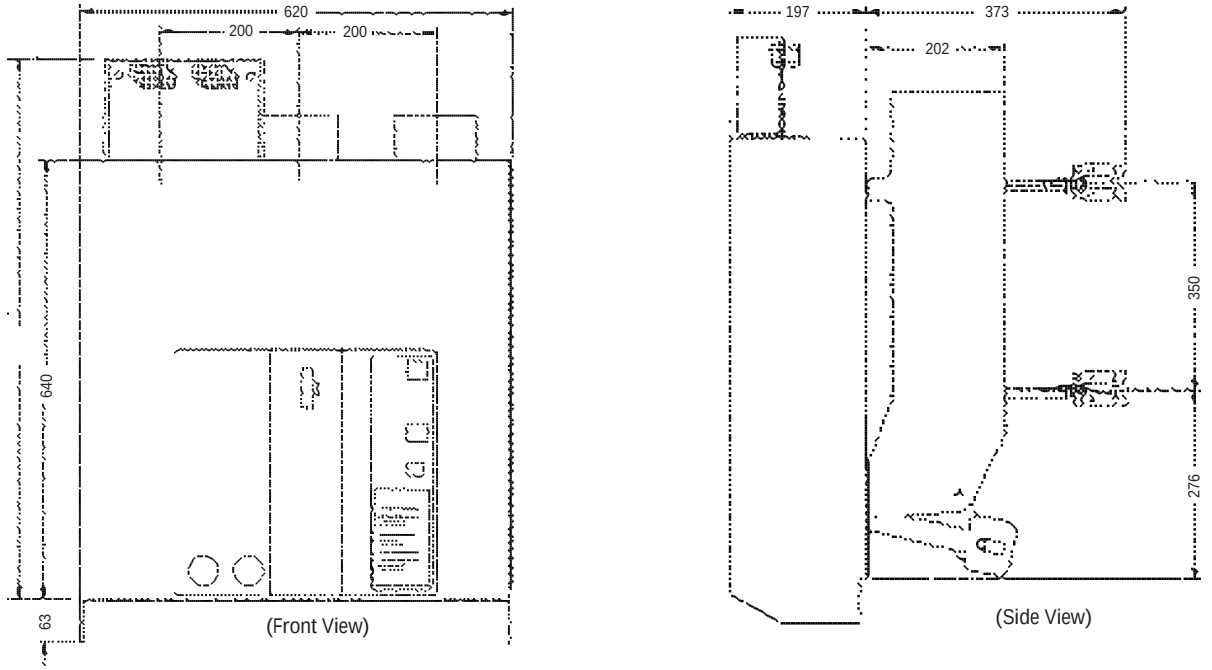
TYPE W-VAC BREAKERS ARE PROTECTIVE DEVICES, AS SUCH, THEY ARE MAXIMUM RATED DEVICES. THEREFORE, THEY SHOULD NOT UNDER ANY CIRCUMSTANCES BE APPLIED OUTSIDE THEIR NAMEPLATE RATINGS.

Table 1.1 Type W-VAC Vacuum Circuit Breaker Ratings

Circuit Breaker Type	Rated Voltage at 50-60HZ	Frequency	Rated Short Circuit Breaking Current & Short Circuit Duration		Rated Insulation Level		Rated Short Circuit Making Current	Rated Nominal Current
					Lighting Pulse Withstand Voltage	Power Frequency Withstand Voltage		
	kV	Hz	kA	Sec	kV	kV	kA	(Peak) Amperes
36W-VAC25	3.6	50/60	25	3	40	10	63	630, 1250, 2000
72W-VAC16	7.2	50/60	16	3	60	20	40	630, 800, 1250
72W-VAC20	7.2	50/60	20	3	60	20	50	630, 800, 1250, 1600
72W-VAC25	7.2	50/60	25	3	60	20	63	630, 800, 1250, 1600, 2000
72W-VAC32	7.2	50/60	31.5	3	60	20	79	1250, 2000
120W-VAC16	12	50/60	16	3	75	28	40	630, 800, 1250
120W-VAC20	12	50/60	20	3	75	28	50	630, 800, 1250, 1600
120W-VAC25	12	50/60	25	3	75	28	63	630, 800, 1250, 1600, 2000
120W-VAC32	12	50/60	31.5	3	75	28	79	1250, 2000
120W-VAC40	12	50/60	40	3	75	28	100	1250, 2000
150W-VAC16	15	60	16	3	95	36	40	630, 800, 1250
150W-VAC20	15	60	20	3	95	36	50	630, 800, 1250, 1600
150W-VAC25	15	60	25	3	95	36	63	630, 800, 1250, 1600, 2000
150W-VAC32	15	60	31.5	3	95	36	79	1250, 2000

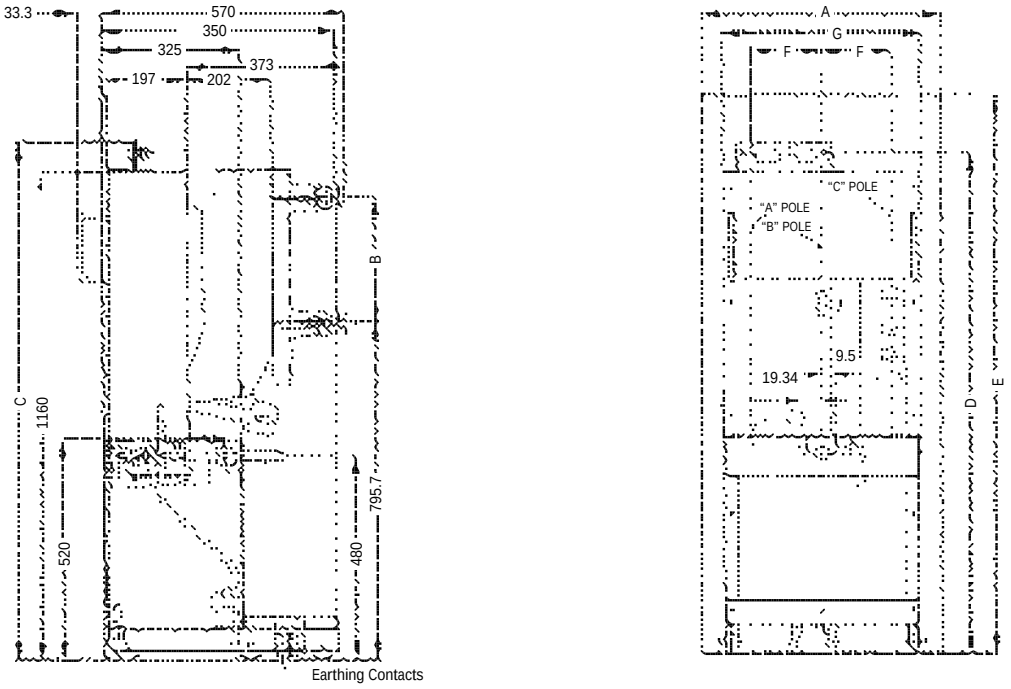


Breaker Element: Up to 1250A
630A Element: 115kg, 800A/1250A Element: 121kg

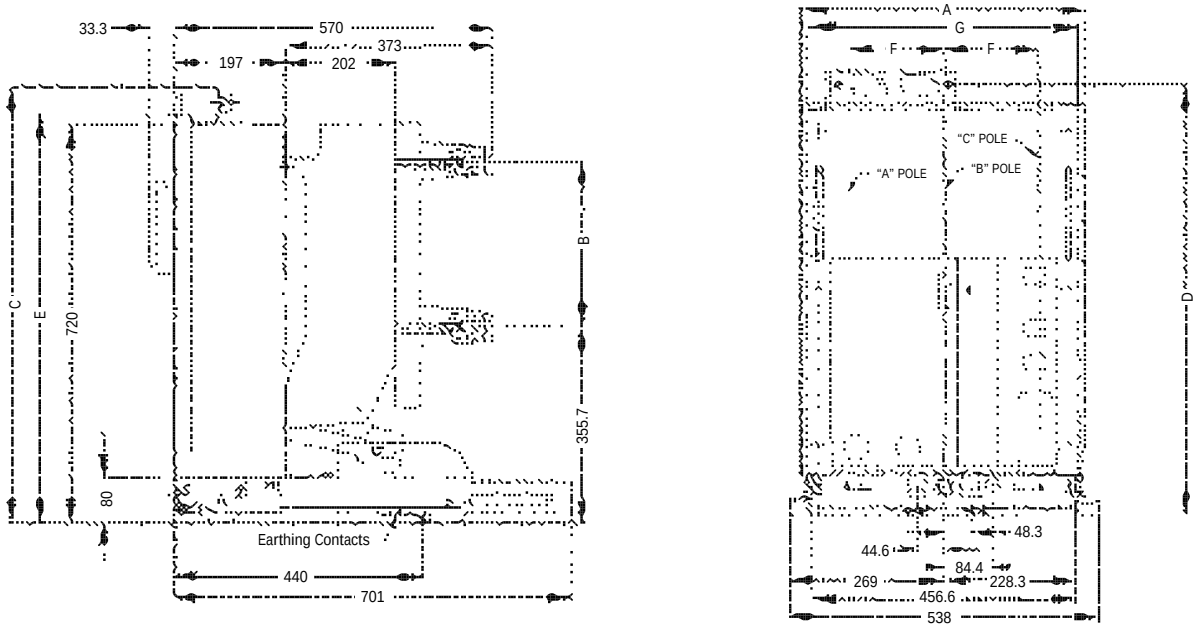


Breaker Element: 1600A and 2000A
1600/2000A Element: 160kg

Figure 1-1 Type W-VAC breaker element only outline dimensions (millimeters) and weights (kilograms).



Rating	A	B	C	D	E	F	G	Weight Carriage
Up to 15 kV/Up to 1250A to 40kA	570	300	1226	1202	1340	165	470	29
Up to 15 kV/1600A and2000A/Up to 40 kA	719	350	1299	1275	1340	200	620	33



Rating	A	B	C	D	E	F	G	Weight Carriage
Up to 15 kV/Up to 1250A to 40kA	490	300	786	762	738	165	470	23
Up to 15 kV/1600A and2000A/Up to 40 kA	640	350	856	835	736	200	6200	25

Figure 1-2 Outline and Dimensions (mm) Type W-VAC breaker element with carriage assembly and cradle assembly

SECTION 2: SAFE PRACTICES

Type W-VAC breakers are equipped with high speed, high energy operating mechanisms. They are designed with several built-in interlocks and safety features to provide safe and proper operating sequences.

WARNING

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

- Only qualified persons, as defined in the local electrical code who are familiar with the installation and maintenance of medium voltage circuits and equipment, should be permitted to work on these breakers.

- Read these instructions carefully before attempting any installation, operation or maintenance of these breakers.

- Always remove the breakers from the 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 breaker with the 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 breaker or a breaker with closing springs charged. The closing spring should be discharged and the main contacts open before working on the breaker. Failure to do so could result in cutting or crushing injuries.

- Do not use a circuit breaker by itself as the sole means of isolating a high voltage circuit, Remove the breaker to the Disconnect position and follow good lockout and tagging rules, as well as all applicable codes, regulations and work rules.

- Do not leave the breaker in an intermediate position in the cell. Always have the breaker either in the Test or Connected position. Failure to do so could result in a flash over and possible death, personal injury or property damage.

- Always remove the maintenance tool from the breaker after charging the closing springs.

- Breakers are equipped with safety interlocks. Do not defeat them. This may result in death, bodily injury or equipment damage.

SECTION 3: RECEIVING, HANDLING AND STORAGE

Type W-VAC circuit breakers are subjected to complete factory production tests and inspection before being packed. They are shipped in packages designed to provide maximum protection to the equipment during shipment and storage, and, at the same time, to provide convenient handing. Accessories, such as the maintenance tool and levering crank are shipped separately.

3-1 RECEIVING

Until the breaker is ready to be delivered to the switchgear site for installation, DO NOT remove it from its container. If the breaker is to be placed in storage, maximum protection can be obtained by keeping it in its container.

Upon receipt of the equipment, inspect the container for any signs of damage or rough handing. Open the container carefully to avoid any damage to the contents.

When opening the container, be careful that any loose items or hardware are not discarded with the packing material. Check the contents of each package against the packing list.

Examine the breaker for any signs of shipping damage such as broken, missing or loose hardware, damaged or deformed insulation and other components. File claims immediately with the carrier if damage or loss is detected and notify the nearest Westinghouse Sales Office.

Tools and Accessories

Maintenance Tool: Used to charge the closing springs. (Style 8064A02G01)

Lifting Yoke: Optional item used to lift the breaker. (Style 8794C67G01 for up to 1250A breakers) (Style 8794C68G01 for 1600A, 2000A breakers)

Primary Disconnect Plier: Used to install and remove breaker primary disconnects. (Style 591C901G02)

Figure 3-1 Typical W-VAC tools with lifting yoke shown in use

3-2 HANDING

WARNING

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

Type W-VAC breaker shipping containers are designed to be handled either by use of a rope sling and overhead lifting device or by a fork truck. If containers must be skidded for any distance, it is preferable to use roller conveyors or individual pipe rollers.

Once a breaker has been inspected for shipping damage, it is best to return it to its original shipping container until it is ready to be installed in the Metal-Clad Switchgear.

When a breaker is ready for installation, a lifting yoke in conjunction with an overhead lifter or portable floor lifter can be used to move a breaker. In some instances, this is preferable to rolling the breaker on the floor using self contained wheels on the cradle or carriage. If the breaker is to be lifted, position the lifting yoke over the breaker and insert lifters into the breaker side openings with the lifting hole toward the interrupters. Once the lifting yoke is securely seated in the lifting holes, the breaker can be carefully lifted and moved.

3-3 STORAGE

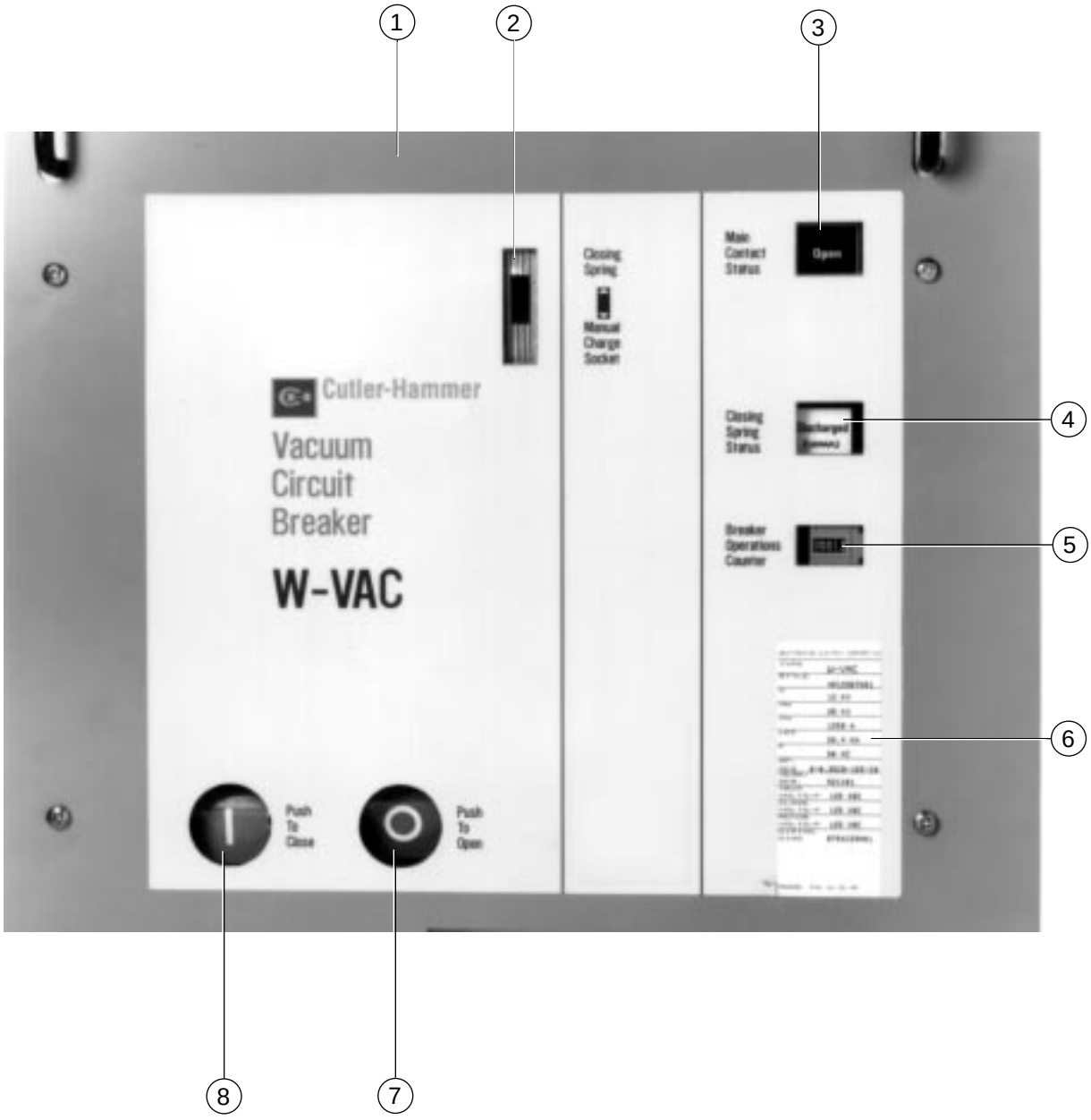
If the circuit breaker is to be placed in storage, maximum protection can be obtained by keeping it in the original container.

Before placing it in storage, checks should be made to make sure that the breaker is free from shipping damage and is in satisfactory operating condition.

The breaker is shipped with its contacts open and closing springs discharged. The indicator on the front panel should confirm this. Insert the maintenance tool in the manual charge socket opening (Figures **3-2** and **4-1a**). Charge the closing springs by pumping the handle up and down about 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 breaker will close as shown by the breaker contacts "closed" indicator. Push the "manual trip" button. The breaker will trip as shown by the breaker contacts "open" indicator. After completing this initial check, leave the closing springs "discharged" and breaker contacts "open" (Figures **3-2, 4-1c and d**).

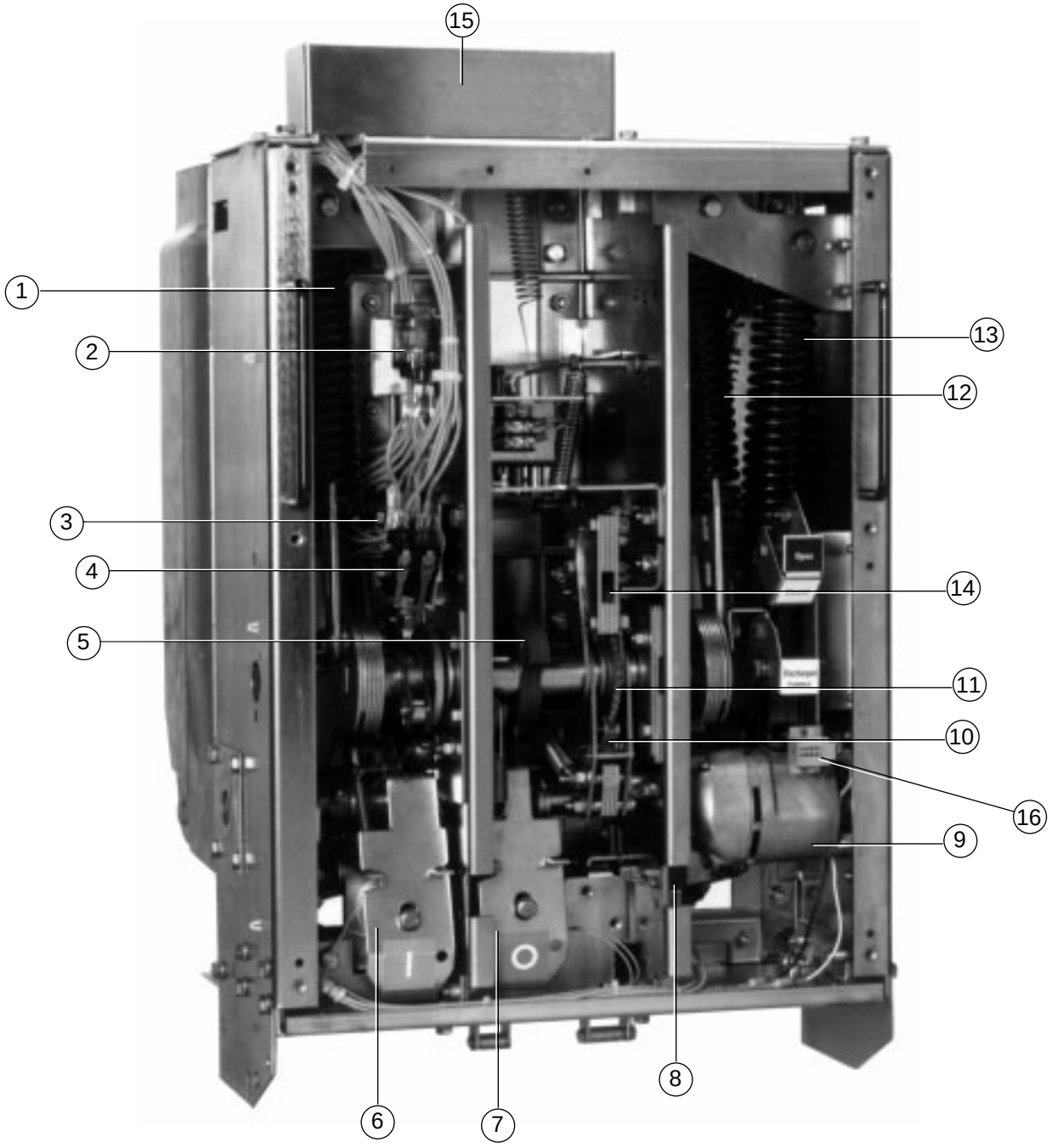
Outdoor storage is NOT recommended. If unavoidable, the outdoor location must be well drained and a temporary shelter from sun, rain, snow, corrosive fumes, dust, dirt falling objects and excessive moisture must be provided. Containers should be arranged to permit free circulation of air on all sides 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 3 cubic meters of volume is recommended with the heaters distributed uniformly throughout the structure near the floor.

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



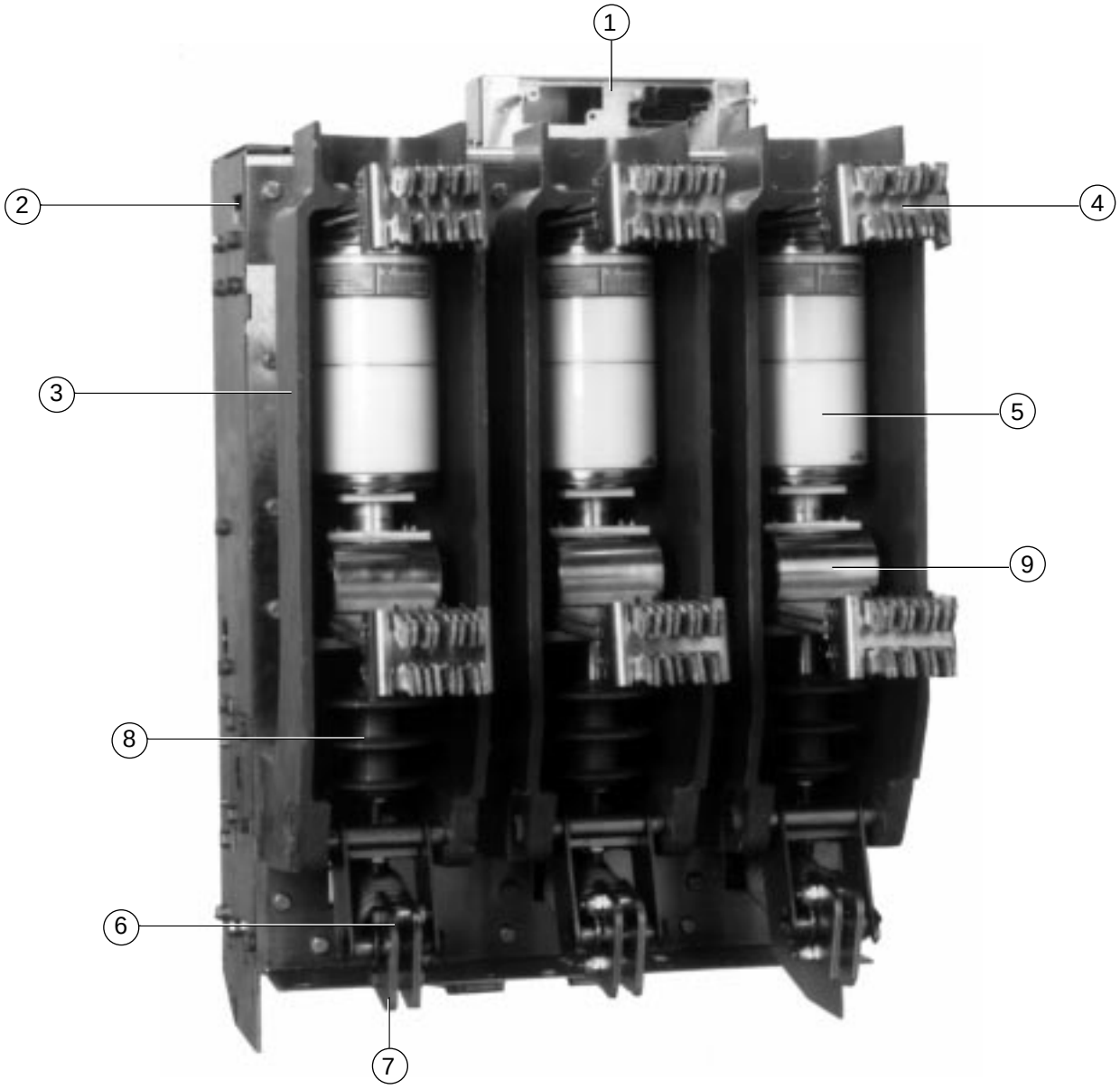
① Front Panel
② Manual Charge Socket
③ Open-Closed Indicator
④ Spring Charged/Discharged Indicator
⑤ Operation Counter
⑥ Rating Nameplate
⑦ Manual Open Button
⑧ Manual Close Button

Figure 3-2 Type W-VAC breaker element faceplate



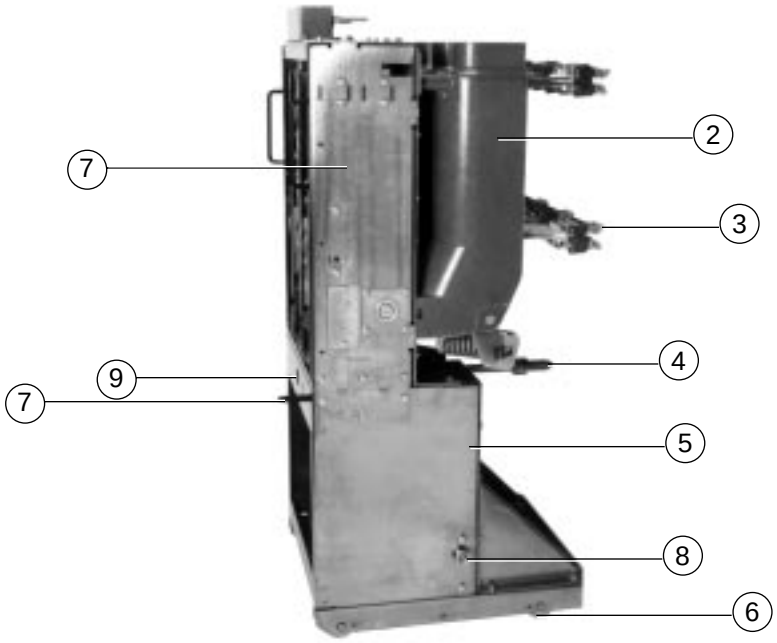
① L.H. Closing Spring
② Anti-pump Relay
③ Auxiliary Switch
④ Motor Cutoff Switch
⑤ Closing Cam
⑥ Spring Release (Close Coil) Assembly
⑦ Shunt Trip Assembly
⑧ Position Switch
⑨ Charging Motor
⑩ Charging Pawl
⑪ Ratchet Wheel
⑫ R.H. Closing Spring
⑬ Opening Spring
⑭ Manual Charge Socket
⑮ Secondary Disconnect
⑯ Operation Counter

Figure 3-3 Front external view of W-VAC breaker element

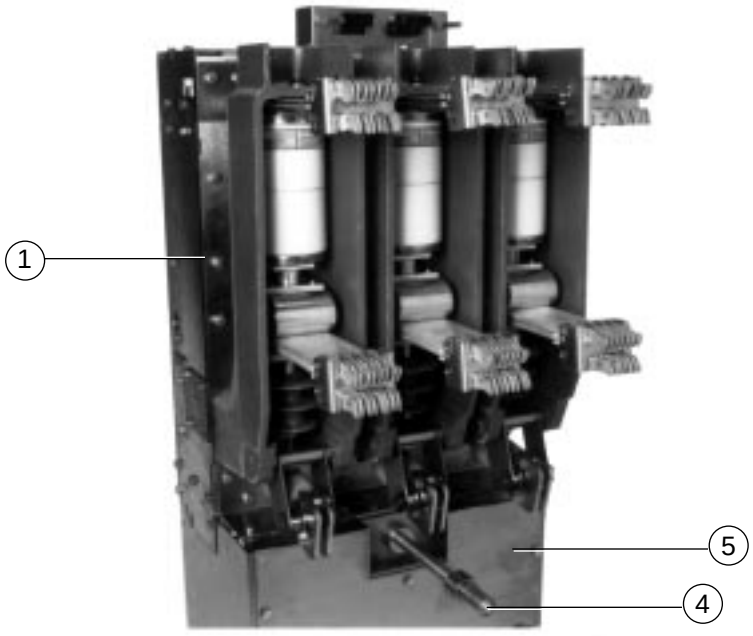


① Secondary Disconnect
② Lifter Yoke Opening
③ Support Insulator
④ Primary Disconnect
⑤ Vacuum Interrupter
⑥ Contact Loading Spring “Wipe Spring”
⑦ Operating Rod
⑧ Drive Insulator
⑨ Flexible Connector

Figure 3-4 Rear external view of W-VAC breaker element



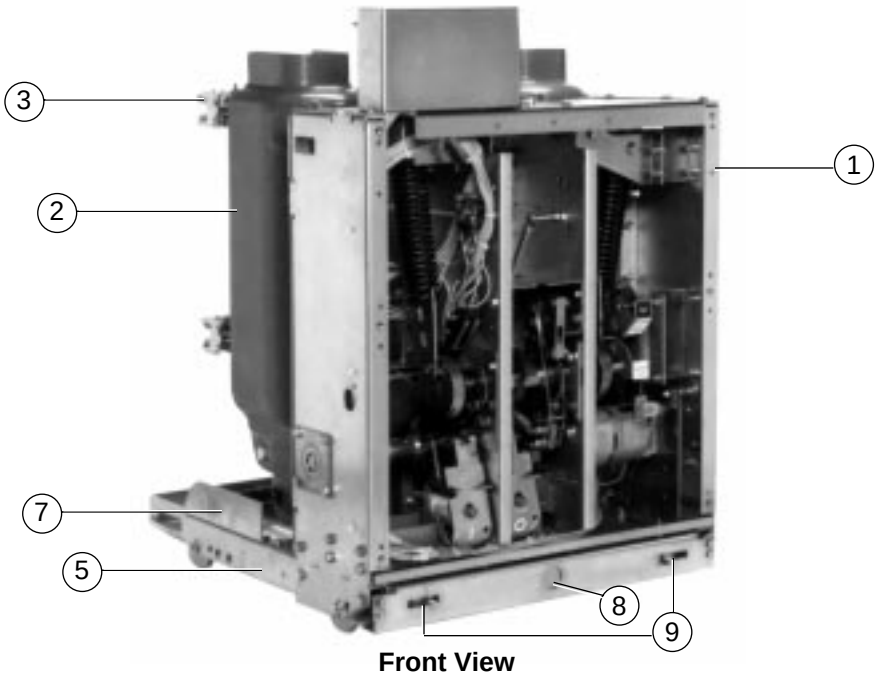
Side View



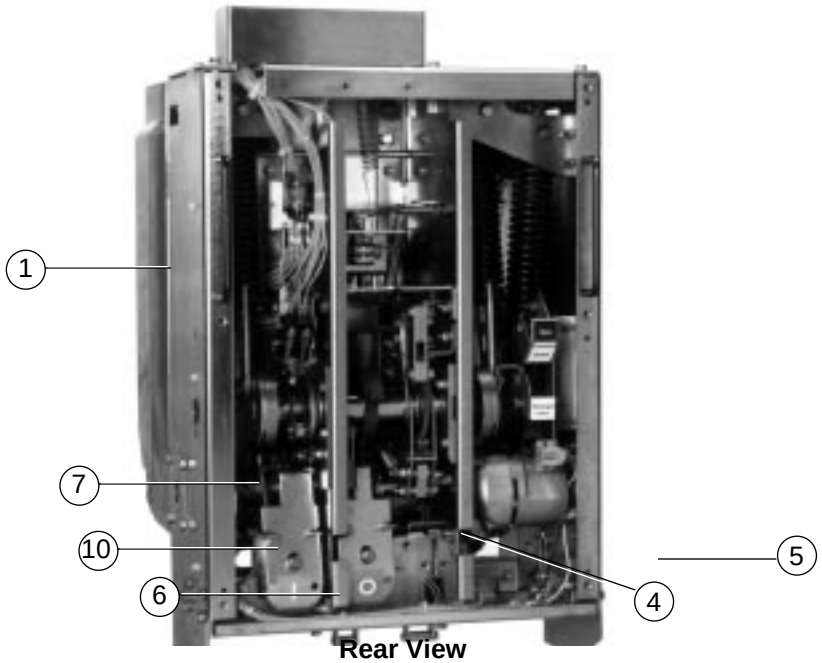
Rear View

① Mechanism Enclosure
② Support Insulator
③ Primary Disconnect
④ Levering in Screw
⑤ Carriage
⑥ Carriage Wheel
⑦ Shoot Bolt Lever
⑧ Shutter Operator
⑨ Levering Device Socket

Figure 3-5 Side and rear external view W-VAC breaker with carriage assembly for single tier switchgear



Front View



Rear View

① Mechanism Enclosure
② Support Insulator
③ Primary Disconnect
④ Levering in Screw
⑤ Cradle
⑥ Cradle Wheel
⑦ Shutter Operator
⑧ Levering Device Socket
⑨ Shoot Bolt Lever
⑩ Earthing Contact

Figure 3-6 Front and rear external view W-VAC breaker with cradle assembly for double tier switchgear

SECTION 4: INSTALLATION

WARNING

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

4-1 INITIAL INSPECTION AND OPERATION

Before attempting to put the breaker in service, it should be carefully examined and operated manually and electrically. Examine a breaker for loose or obviously damaged parts.

4-2 MANUAL OPERATION CHECK

Place the maintenance tool into the manual charge socket opening and charge the closing springs with about 3 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, no click is heard at the end of charging operation. Discontinue charging and remove the maintenance tool as soon as "Charged" flag is fully visible. Continued attempts to further charge may result in damage to the mechanism. Remove the maintenance tool. Close and trip the breaker several times (Figure 4.1).

4-3 VACUUM INTERRUPTER INTEGRITY

Using a dry lint free cloth or paper towel, clean all the insulating surfaces of the pole units. Conduct a vacuum interrupter integrity check as described in Section 6.4.

4-4 INSULATION

Check breaker primary and secondary insulation per Section 6.7.

4-5 CONTACT EROSION AND WIPE

Manually charge the closing springs and close the breaker. Check contact erosion and wipe as described in Section 6.5.

4-6 PRIMARY CIRCUIT RESISTANCE

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

4-7 NAMEPLATE

Compare the breaker nameplate information with switchgear drawings for compatibility.

4-8 ELECTRICAL OPERATIONS CHECK

After going through the above steps, the breaker is now ready to be operated electrically. It is preferred that this check be made with the breaker in a test position or by using a test cable.

CAUTION

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

WARNING

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

When testing the breaker electrically, a TEST position is accomplished using several methods. The method used depends on the switchgear structure approach being utilized.

a1) If the breaker is being used in the behind the door configuration, the structure mounted secondary contact blocks can be manually engaged with the breaker's secondary contacts. This is accomplished with the breaker still inside the structure and the primary contacts disconnected.

a2) If the breaker is being used in a flushmounted configuration, the breaker must be moved to the disconnected position for testing. It is recommended that a test cable be used to connect the female and male sec-

a. Inserting the maintenance tool into the manual charging socket

b. Lifting shoot lever permits insertion of levering crank

c. Manually closing the breaker

d. Manually tripping the breaker

Figure 4-1 Type W-VAC breaker manual operation (single tier breaker shown)

ondary contacts when in the disconnected position. The structure mounted secondary contact blocks are permanently mounted and cannot be moved out for direct connection with the breaker mounted secondary contacts.

b) For the behind the door configuration, carefully load the breaker into the structure until it reaches the Test position. For the flush mounted configuration, carefully move the breaker toward the structure until it reaches the Test position.

c) If a lifting yoke was used to move and/or load the breaker, remove the yoke at this time.

d) For the behind the door configuration, manually engage the secondary contact blocks by pulling the movable blocks forward as far as possible. For the flush mounted configuration, connect the test cable to both the breaker and structure secondary contact blocks. As soon as control power is available, the motor will charge the closing springs.

e) Close and trip the breaker several times to verify the closing and tripping operations

f) Conclude by closing the breaker.

4-9 BREAKER / COMPARTMENT INTERFACE CHECK

The assembly is provided with the following interlocks to insure safe and correct operation:

a) Floor Tripping and Spring Release Interlock:
This optional interlock closes and trips the breaker if the closing springs are charged as the breaker is moved from the Test position to the Withdrawn position and vice versa.

b) Levering Interlocks:
1. Carriage Assembly Version: This version is used for single tier switchgear configurations. The levering crank can only be engaged when the breaker is open and the shoot bolt lever is lifted (Figure **4-1b**) The breaker will not close manually or electrically while the levering crank is engaged.

2. Cradle Assembly Version: This version is used for double tier switchgear configurations. The levering crank can only be engaged when the breaker is open and the horizontal shoot bolts are engaged (fully extended). The breaker will not close manually or electrically while the levering crank is engaged.

c) Anti-Close Interlock: This interlock prevents releasing the closing springs electrically or manually if the breaker is already closed.

d) Anti-Latch Interlock: This interlock prevents the breaker from being closed between the Connected and Test positions.

e) Shutter Drive Interlock:
The metallic switchgear shutters are independently operated permitting them to be locked in the open position for servicing the primary disconnects. The locking system is disabled when the breaker is being connected permitting the shutters to operate in the normal manner.

f) Earthing Drive Interlock:
If the switchgear is equipped with an earthing switch, the breaker can only be inserted into the switchgear if the earthing switch is open.

Check for the correct operation of the interlocks just described by starting with the breaker in the Test position and completing the following steps:

Step 1: Engagement of Levering Crank:
1. For the single tier configuration carriage assembly version, the shoot bolt should be fitted into the first slot of the interlock plate located on the floor of the switchgear. Charge the closing springs and close the breaker. The slider cannot be pushed far enough to engage the levering crank.

2. For the double tier configuration cradle assembly version, the horizontal shoot bolts should be fitted into the slots of interlock plates located at the sides of the switchgear. Charge the closing springs and close the breaker. The slider cannot be pushed far enough to engage the levering crank.

Step 2 :
Open the breaker, engage the levering crank and lever the breaker into the Connected position. Remove the levering crank.

Step 3:
Close the breaker. The motor starts charging the closing springs if control power is available.

Step 4:
Open the breaker, engage the levering crank and attempt to close the breaker manually or electrically. The breaker will go trip free (spring discharge but breaker does not close).

Step 5:
Lever the breaker out approximately half way towards the Test position. Remove the levering crank and attempt to close the breaker by pushing the manual close button. The breaker will go trip free. Lever the breaker all the way into the Test position. The secondary disconnects will disengage automatically.

Step 6: Withdraw Breaker from Test Position:

1. For the single tier configuration carriage assembly version, lift the shoot bolt lever and pull the breaker out. The breaker will close and trip as it comes out from the Test position.

2. For the double tier configuration cradle assembly version, retract the horizontal shoot bolts and pull the breaker out. The breaker will close and trip as it comes out from the Test position.

SECTION 5: DESCRIPTION AND OPERATION

Cutler-Hammer Type W-VAC breakers are horizontal drawout vacuum circuit breakers. They are designed specifically to IEC 56 and KEMA certified to IEC Standards, including their earthing system.

Type W-VAC breakers are available in three mounting configurations. These include single tier designs and double tier designs for use in medal-clad switchgear, and a basic element design for use in retrofitting. For the single tier design, the basic breaker element is mounted on a carriage assembly. The basic breaker element is mounted on a cradle assembly for the double-tier design. The carriage assembly and the cradle assembly both incorporate the racking mechanism and required safety interlocks.

The basic breaker element, the breaker element with a carriage assembly, and the breaker element with a cradle assembly are designed to accept a variety of faceplates or covers. This permits the breakers to be very flexible with respect to the type of structure used to form the final switchgear assembly.

Possibility 1 : The basic breaker element, by itself, is used for retrofitting purposes (Figures **3-3 and 3-4**).

Possibility 2: The basic breaker element combined with a carriage assembly is used for single tier switchgear. The breaker and carriage combination, however, can be utilized in a flush mounted configuration (Figure **5-1**) or a behind the door configuration. The flush mounted design cover forms a deadfront design with the structure, once the breaker is racked into the fully connected position.

Possibility 3 : The basic breaker element combined with a cradle assembly is used for double tier switchgear. This combination is only for use in a behind the door configuration (Figure **5-2**).

W-VAC breakers utilize Westinghouse vacuum interrupters to close and open the primary circuit. The mechanism is a front mounted, spring stored energy type, which is common to all ratings. This one front mounted mechanism is easy to inspect, accessible for servicing and requires a minimum of spare parts. Because of the inherent long life characteristics of the vacuum interrupters and the highly reliable spring stored energy mechanism, W-VAC circuit breakers provide long trouble free service with a minimum of maintenance.

Figure 5-1 Flush mounted configuration.

The primary insulation used throughout the W-VAC design is flame retardant and track resistant glass polyester.

5-1 INTERRUPTER ASSEMBLY

Vacuum interrupters are mounted vertically and supported from the fixed stem clamped to the top conductor (Figure **5-3**). The current transfer system consists of a series of tin-plated, high-conductivity copper leaf conductors that are pressed onto the movable interrupter stem.This provides a multipoint contact resulting in low electrical and thermal resistance. Since the current transfer from the movable stem to the breaker main conductor is a non-sliding design, no maintenance is required.

5-1.1 VACUUM INTERRUPTER

Type W-VAC breakers utilize vacuum interrupters for interruption and switching functions. Vacuum interruption offers the advantages of enclosed interrupters, reduced size and weight, short interrupting time, long life, reduced maintenance, and environmental compatibility.

Figure 5-2 Behind the door configuration.

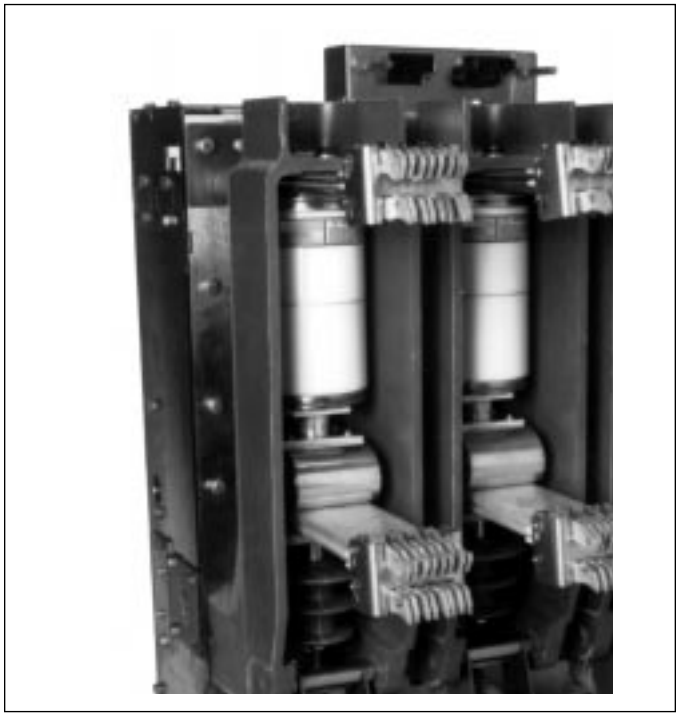


Figure 5-3 Closeup of Type W-VAC breaker vacuum interrupters and current carrying system.

Arc interruption is simple and fast. In the closed position, current flows through the interrupter. When the contacts are opened, the arc is drawn between the contact surfaces. It is rapidly moved 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 the 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.

5-1.2 CONTACT EROSION INDICATOR

The purpose of the contact erosion indicator is to monitor the erosion of the vacuum interrupter contacts, which is very minimal over time with Westinghouse 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 **6-2 and 6-3**). In order to determine if the contacts have eroded to the extent that the interrupter must be replaced, close the breaker and observe the erosion mark placed on each moving stem from the rear of the breaker. If the mark on the interrupter stem is visible, the interrupter is satisfactory. If the mark is no longer visible, the interrupter assembly must be replaced.

5-1.3 "T" CUTOUT LOADING SPRING INDICATOR

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

5-1.4 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 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 Westinghouse vacuum 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.

5-1.5 POLE UNIT SUPPORT MOLDING

WARNING

DO NOT PLACE THE BREAKER IN ITS COMPARTMENT WITHOUT ALL PARTS OF THE POLE UNIT SUPPORT MOLDING BEING IN PLACE. THE ABSENCE OF A COVER ON ALL 95 KV BIL RATED BREAKERS FROM 630 THROUGH AND INCLUDING 1250 AMPERES CAN CAUSE A CATASTROPHIC FAILURE RESULTING IN DEATH, SEVERE PERSONAL INJURY OR PROPERTY DAMAGE.

The W-VAC design utilizes continuous glass polyester moldings to support individual pole units. All 95 KV BIL 630 through 1250 ampere rated breakers require an additional cover to be added to the support molding, resulting in the support molding being enclosed on all four vertical sides (Figure **5-4**).

5-2 STORED ENERGY MECHANISM

WARNING

KEEP HANDS AND FINGERS AWAY FROM THE BREAKER'S INTERNAL PARTS WHILE THE BREAKER CONTACTS ARE CLOSED OR THE CLOSING SPRINGS ARE CHARGED. THE BREAKER CONTACTS MAY OPEN OR THE CLOSING SPRINGS DISCHARGE CAUSING A CRUSHING INJURY. DISCHARGE THE SPRINGS AND OPEN THE BREAKER BEFORE PERFORMING ANY BREAKER MAINTENANCE, INSPECTION OR REPAIR.

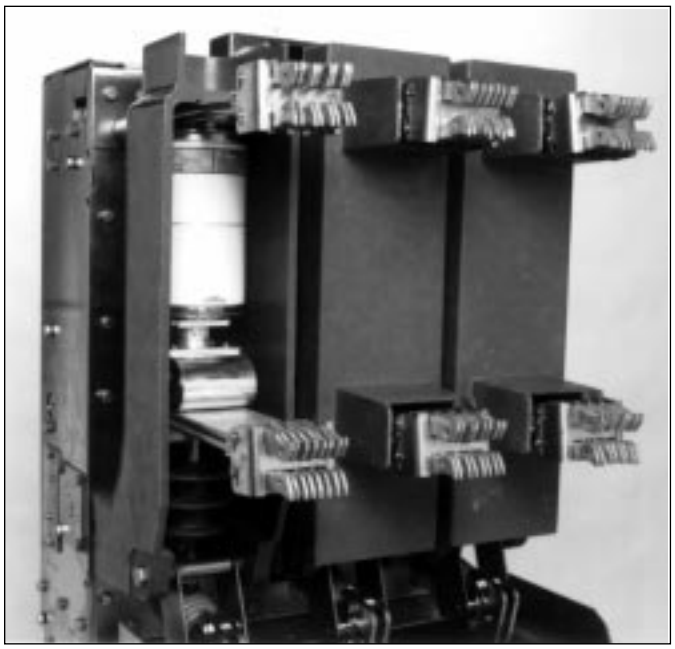


Figure 5-4 Type W-VAC 95 kV BIL breaker shown with left hand cover removed for clarity purposes. All three covers must be in place before application.

The spring stored energy operating mechanism is arranged vertically in front of all W-VAC breakers. It includes all the elements for storing the energy, closing and tripping of the 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.

5-2.1 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 5.5* and as follows:

a. Breaker open, closing springs discharged

b. Breaker open, closing springs charged

c. Breaker closed, closing springs discharged

d. Breaker closed, closing springs charged

5-2.2 CHARGING

Figure **5-6** 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 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 (Figure 4.1a). 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.

5-2.3 CLOSING OPERATION

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

The closing springs can be released to close the 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 breaker.

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

Figure **5-5d** shows the 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 W-VAC breakers.

5-2.4 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 **5-5a**).

5-2.5 TRIP FREE OPERATION

When the manual trip button is held depressed, any attempt to close the breaker results in the closing springs discharging without any movement of the pole shaft or vacuum interrupter stem.

5-3 CONTROL SCHEME

There are two basic control schemes for Type W-VAC breakers, one for DC control and one for AC control voltages or more than one tripping element, but the principal mode of operation is as follows:

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

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

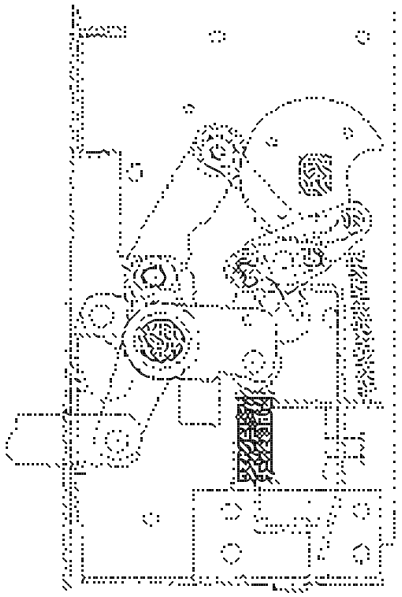


Figure 5-5a Breaker open and closing spring discharged

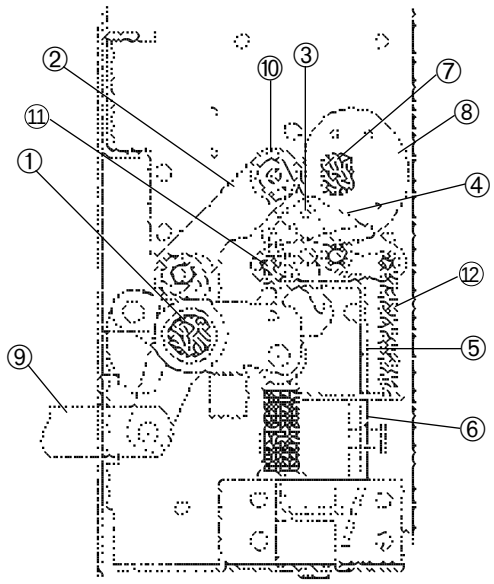


Figure 5-5b Breaker open and closing spring discharged

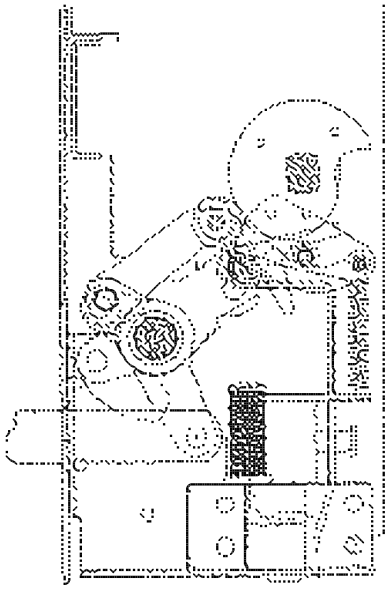


Figure 5-5c Breaker closed and closing spring discharged

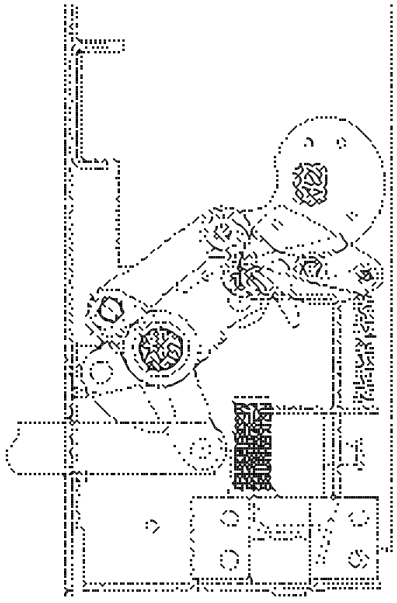
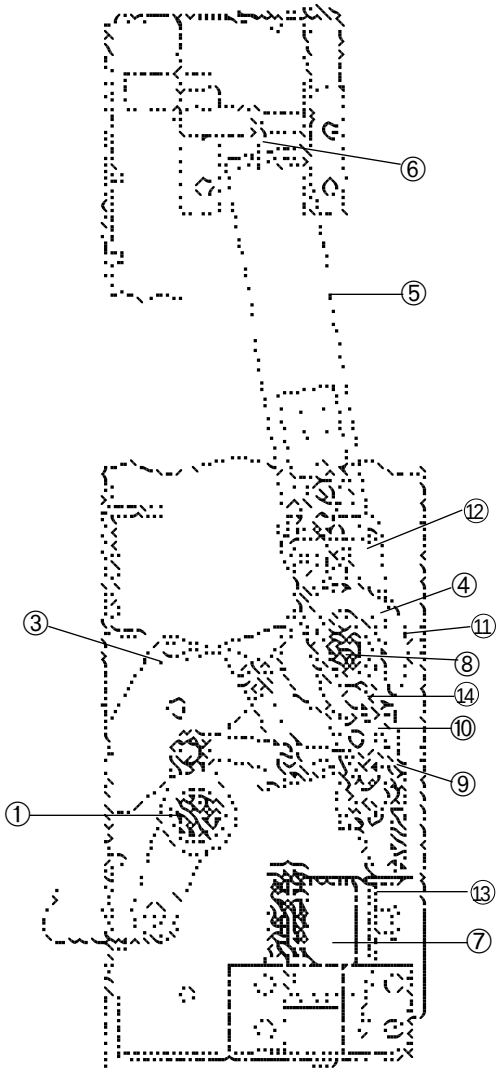


Figure 5-5d Breaker closed and closing spring charged

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

Figure 5-5 Closing cam and trip linkage



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 5-6 Charging schematic

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.

5-3.1 TIMING

The opening and closing times for the circuit breakers vary depending upon the control voltage and the power rating. However, the typical values are as follows in Table **5.1**.

Table 5.1 Typical Opening and Closing Times

Event	Time in Milliseconds
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

5-3.2 SECONDARY DISCONNECTS

The breaker control wiring is arranged to connect a 25 point male plug as standard with a corresponding female plug mounted in the switchgear compartment. An additional 25 point plug is optional and can be supplied when an additional auxiliary switch beyond the standard is supplied.

The breaker plugs are mounted in small enclosure located on the upper left front portion of the basic breaker element (Figure **3-4**). This male plug automatically connects or disconnects with a structure mounted female plug as the breaker is racked into or out of the connected position.

If the breaker is being used in a flush mounted configuration, the breaker must be moved to the disconnected position for testing. It is recommended that a test cable be used to connect the female and male secondary contacts when in the disconnected position. The structure mounted secondary contact blocks are permanently mounted and cannot be moved out for direct connection with the breaker mounted secondary contacts.

The behind the door design utilizes movable carriage mounted female plugs in the structure. A "TEST" position is available within the structure. Once the breaker is racked out to the test position, the structure mounted secondary plug carriage can be manually unlatched, and pulled forward until the female plugs mate with the breaker mounted male plugs. To disengage the secondary plugs from the "TEST" position, simply push the carriage to the rear.

5-3.3 UNDERVOLTAGE TRIP DEVICE

The undervoltage trip device for W-VAC breakers is an electromechanical device that operates to open the breaker at 35% or less of the voltage rating of the trip coil. The device does not open the breaker at values above 70% of the voltage rating of its trip coil. It may operate, however, to open the breaker when the voltage across the trip coil is greater than 35%, but less than 70% of the voltage rating of its trip coil. The 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, and 250VDC.

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

1.) With the 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 breaker trips open.

4.) As the breaker opens, the reset lever (8) connected to the pole shaft lever (7) operates to reset the moving clapper. As long as the breaker remains open, the reset lever holds down the moving clapper to the yoke.

5.) When the breaker closes, the reset lever moves away from 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.

5-4 INTERLOCKS

WARNING

NEVER DISABLE OR DEFEAT ANY INTERLOCKS. HAZARDOUS VOLTAGES WILL CAUSE DEATH, SEVERE PERSONAL INJURY OR PROPERTY DAMAGE.

All W-VAC breakers are equipped with several interlocks. These interlocks permit proper and safe breaker operation.

5-4.1 FLOOR TRIPPING, SPRING RELEASE AND ANTI-LATCH INTERLOCKS

These interlocks are operated by the inter- action between the floor tripper rollers on the breaker bottom and the carriage or cradle assemblies. The functions performed are as follows:

1. The breaker is held mechanically trip free during racking. The latch check switch is also held open, thus preventing any electrical close signal from closing the breaker.
2. The breaker is permitted to be with drawn in the safe mode (breaker open, springs discharged) when bringing the breaker to the Withdrawn position or to the Connected position.

The outlined functions are accomplished by pushing up the tripper rollers, which in turn rotates the Trip D Shaft or Spring Release Latch.

5-4.2 LEVERING INTERLOCK

The purpose of this interlock is to prevent the levering crank from being engaged when the breaker is closed. An interference device on the cradle or carriage, which is positioned by the breaker operating shaft, prevents the levering crank from being inserted with the breaker in the Closed position.

5-4.3 ANTI-CLOSE INTERLOCK

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

5-4.4 EARTHING DRIVE INTERLOCK

The earthing drive mechanism operates an interference device to prevent insertion of the breaker when the earthing switch is closed.

5-5 MISCELLANEOUS

5-5.1 EARTHING CONTACT

The earthing contact is an assembly of spring loaded fingers providing a means for earthing the breaker chassis when it is inserted into the switchgear compartment. An extension of the switchgear earth bus is secured to the compartment in such a position to engage the earthing contact when the breaker is racked into the structure. It remains engaged until the breaker is withdrawn.

5-5.2 OPERATIONS COUNTER

All breakers 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 (Figures **3-2 and 3-3**).

5-6 LEVERING MECHANISM

The purpose of the levering device is to move the breaker into and out of the CONNECTED position. For W-VAC breakers, the mechanism is comprised of a drive screw and nut. The mechanism is a part of the carriage assembly or the cradle assembly, not the basic breaker element (Figures **3-5 and 3-6**).

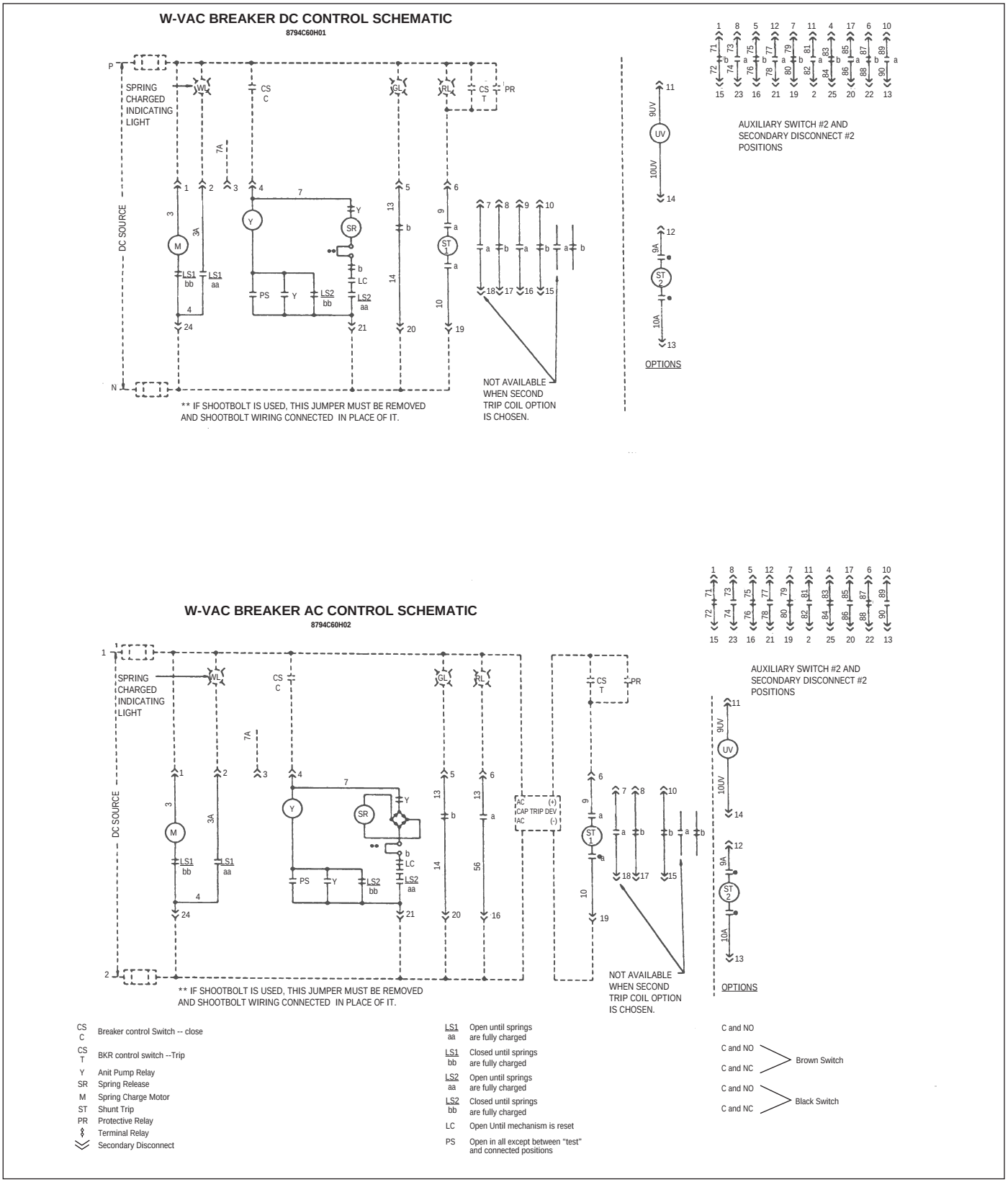
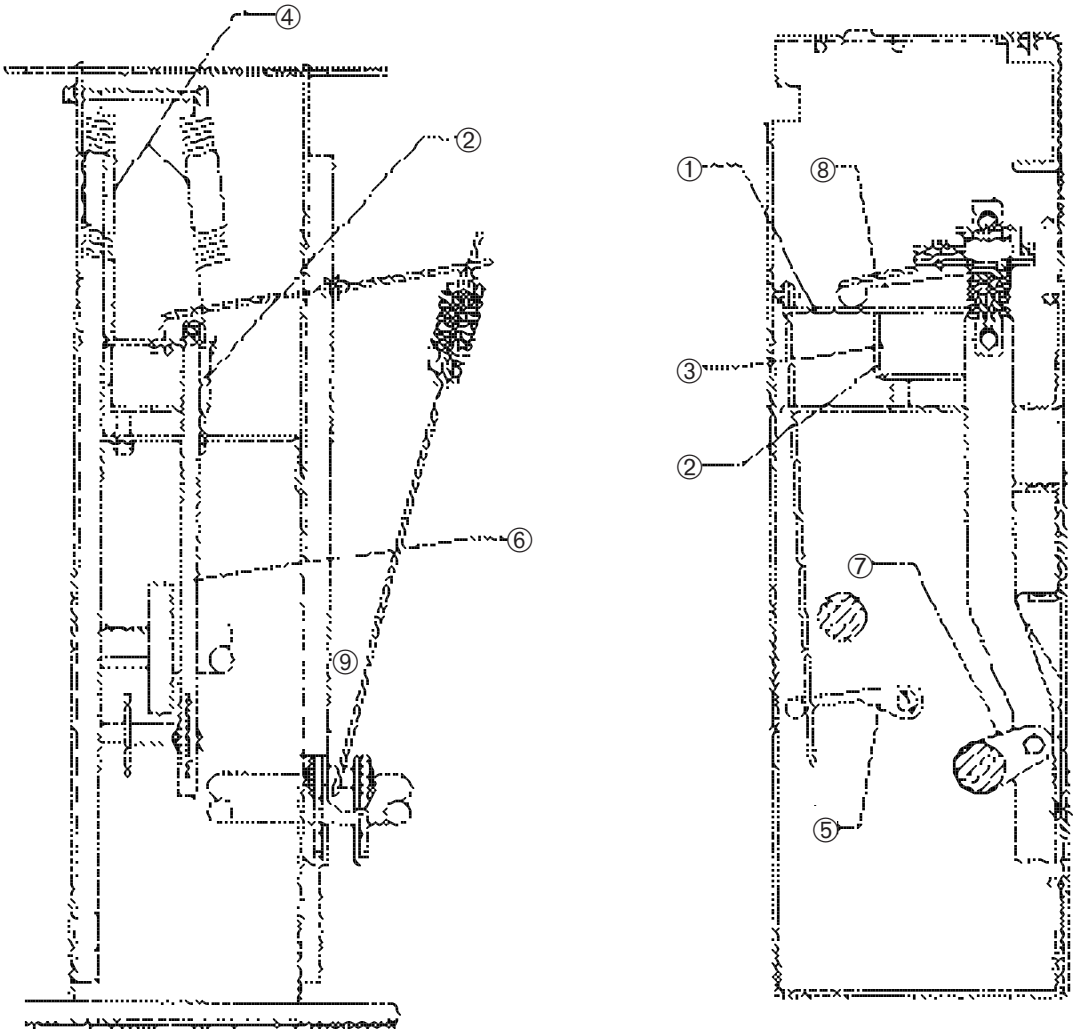


Figure 5-7 Typical DC and AC control schemes



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 AND MAINTENANCE

6-1

WARNING

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

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

•DO NOT WORK ON A BREAKER WITH SPRINGS CHARGED OR CONTACTS CLOSED.

•DO NOT DEFEAT ANY SAFETY INTERLOCKS.

•DO NOT LEAVE MAINTENANCE TOOL IN THE SOCKET AFTER CHARGING THE CLOSING SPRINGS.

•DO NOT STAND LESS THAN ONE METER AWAY FROM THE BREAKER WHEN TESTING FOR VACUUM INTEGRITY.

FAILURE TO FOLLOW ANY OF THESE INSTRUCTIONS MAY CAUSE DEATH, SERIOUS BODILY INJURY, OR PROPERTY DAMAGE. SEE SECTION 2-SAFE PRACTICES FOR MORE INFORMATION.

6-2 FREQUENCY OF INSPECTION

Inspect the breaker once a year when operating in a clean, non corrosive environment. For a dusty and corrosive environment, inspection should be performed twice a year. Additionally, it is recommended to inspect the breaker every time it interrupts fault current.

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

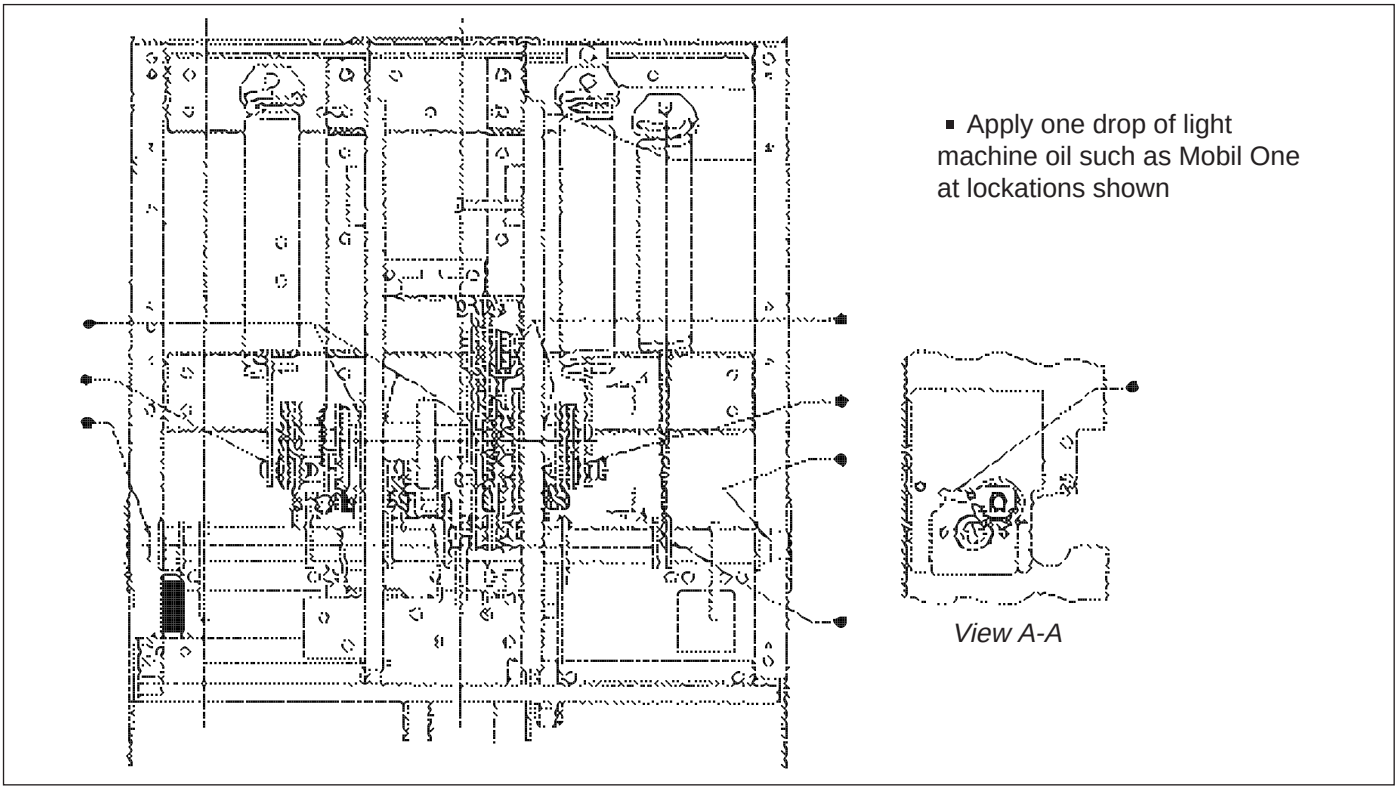


Figure 6-1 Lubrication points

6-3 INSPECTION AND MAINTENANCE PROCEEDURES

No./Section	Inspection Item	Criteria	Inspection Method	Corrective Action
1. Insulation	Drive Insulator and Molded Pole Unit Support	No dirt	Visual Check	Clean with lint-free cloth
		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
	Controls Circuit to Ground	Withstand	Hipot Tester	Clean and retest or replace
2. Power Elements	Vacuum Interrupters	Contact Erosion Visibility of Mark	Visual-Close the breaker and look for green mark on moving stem from the rear of the breaker (see Figure **6-2 & 6-3**)	If mark is not visible, replace pole unit assembly
		Contact wipe visible	Visual (Figures **6-4 & 6-5**)	Replace pole unit assembly
		Adequate Vacuum	See Section 6-4	Replace pole unit assembly
		Dirt on ceramic body	Visual Check	Clean with dry lint-free cloth
	Primary Disconnects	No burning or damage	Visual Check	Replace if burned, damaged or eroded
3. Control Circuit	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	If required	Functional Test	Replace brushes
	Tightness of Hardware	No loose or missing parts	Visual and tighten with appropriate tools	Tighten or reinstate if necessary
4. Operating Mechanism	Dust or Foreign Matter	No dust or foreign matter	Visual Check	Clean as necessary
	Lubrication	Smooth operation and no excessive wear	Sight and feel	Lubricate very sparingly with light machine oil
	Deformation or Excessive Wear	No excessive deformation or wear	Visual and operational	Remove cause and replace parts
	Manual Operation	Smooth operation	Manual charging closing and tripping	Correct per trouble-shooting chart if necessary

6-4 VACUUM INTERRUPTER INTEGRITY TEST

Vacuum interrupters used in Type W-VAC circuit breakers are highly reliable interrupting elements. Satisfactory performance of these devices is dependent upon the integrity of the vacuum in the interrupter and the internal dielectric strength. Both of these parameters can be readily checked by a one minute ac high potential test. (See Table **6.1** for appropriate test voltage.) During this test, the following warning must be observed:

WARNING

APPLYING ABNORMALLY HIGH VOLTAGE ACROSS A PAIR OF CONTACTS IN VACUUM MAY PRODUCE X-RADIATION. THE RADIATION MAY INCREASE WITH THE INCREASE IN VOLTAGE AND/OR DECREASE IN CONTACT SPACING. X-RADIATION PRODUCED DURING THIS TEST WITH RECOMMENDED VOLTAGE AND NORMAL CONTACT SPACING IS EXTREMELY LOW AND WELL BELOW MAXIMUM PERMITTED BY STANDARDS. HOWEVER, AS A PRECAUTIONARY MEASURE AGAINST POSSIBILITY OF APPLICATION OF HIGHER THAN RECOMMENDED VOLTAGE AND/OR BELOW NORMAL CONTACT SPACING, IT IS RECOMMENDED THAT ALL OPERATING PERSONNEL STAND AT LEAST ONE METER AWAY IN FRONT OF THE BREAKER.

With the breaker open and securely sitting on the floor, connect all top primary studs (bars) together and 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.

Successful withstand indicates that all interrupters have satisfactory vacuum level. If there is a breakdown, the defective interrupter or interrupters should be identified by an individual test and replaced before placing the breaker in service.

After the high potential is removed, discharge any electrical charge that may be retained, particularly from the center shield of vacuum interrupters. To avoid any ambiguity in the ac high potential test due to leakage or displacement (capacitive) current, the test unit should have sufficient volt-ampere capacity. It is recommended that the equipment be capable of delivering 25 milliamperes for one minute.

Although an ac high potential test is recommended, a dc test may be performed if only a dc test unit is available. In this case the equipment must be capable of delivering 5 milliamperes for one minute to avoid ambiguity due to field emission or leakage currents and the test voltage shall be as shown in Table **6.1**.

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

WARNING

SOME DC HIGH POTENTIAL UNITS, OPERATING AS UNFILTERED HALF-WAVE RECTIFIERS, ARE NOT SUITABLE FOR USE TO TEST VACUUM INTERRUPTERS BECAUSE THE PEAK VOLTAGE APPEARING ACROSS THE INTERRUPTERS CAN BE SUBSTANTIALLY GREATER THAN THE VALUE READ ON THE METER.

Table 6.1 Test Voltage

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

6-5 CONTACT EROSION AND WIPE

Since the contacts are contained inside the interrupter, they remain clean and require no maintenance. However, during high current interruptions there may be a minimum amount of erosion from the contact surfaces. Maximum permitted erosion is 3 mm. 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 **6-2 and 6-3**).

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, the entire vertical portion of the indicator "T" will be visible along with all or a portion of the horizontal part of the indicator "T" (Figures **6-4 and 6-5**). If none of the horizontal portion shows with the breaker closed, the wipe is not adequate, and the pole unit assembly must be replaced.

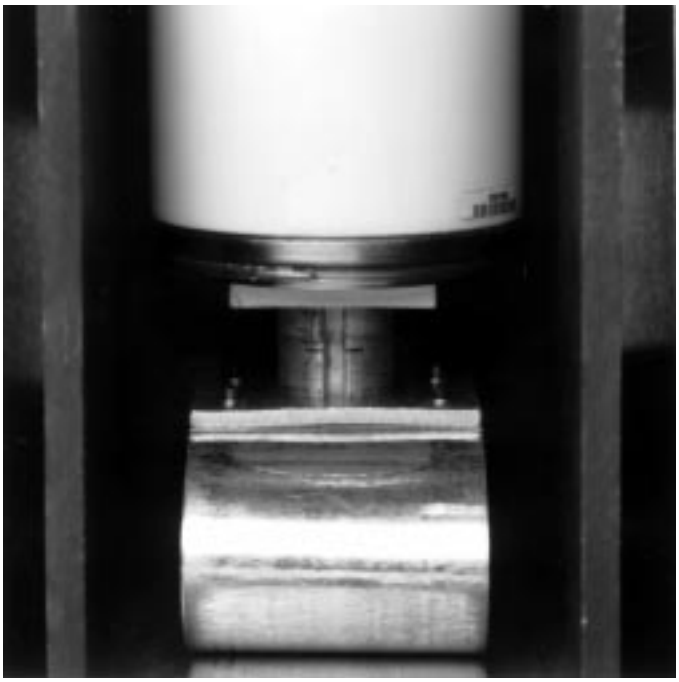


Figure 6-2 Vacuum interrupter showing contact erosion indicator with breaker open (shown here for clarity purposes only).

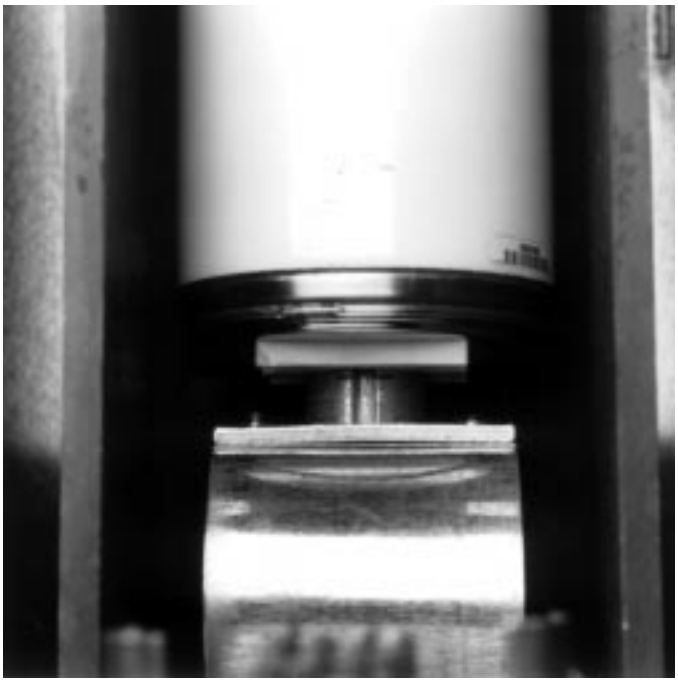


Figure 6-3 Vacuum interrupter showing contact erosion indicator with breaker closed (indicators are checked only when breaker is closed).

WARNING

FAILURE TO REPLACE A 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.

6-6 INSULATION

In W-VAC breakers, insulation maintenance primarily consists of keeping all insulating surfaces clean. This can be done by wiping off all insulating surfaces with a dry lint free cloth of 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 requires inspection for tightness of all connections and damage to insulation.

6-7 INSULATION INTEGRITY CHECK

Primary Circuit:
The integrity of primary insulation may be checked by the AC high potential test. The test voltage depends upon the maximum rated voltage of the breaker. For the breakers rated 12 kV and 15 kV the test voltages are 21 kV and 27 kV rms respectively.
Conduct the test as follows:

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

If a DC high potential machine is used, make certain that the peak voltage does not exceed the peak of the corresponding AC RMS test voltage.

Secondary Circuit:
Isolate the motor by pulling apart the two insulated quick disconnecting terminals in the two motor leads provided for this purpose. Connect all points of the secondary

Figure 6-4 "T" contact wipe indicator.

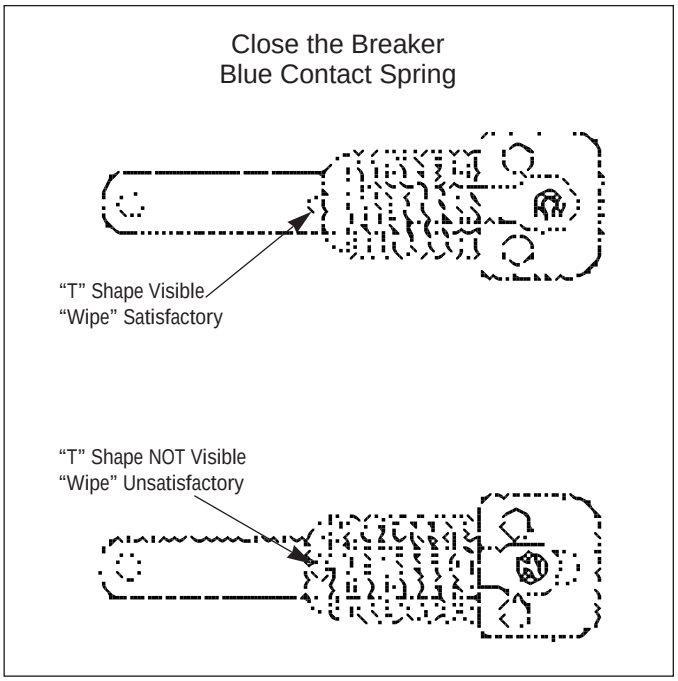


Figure 6-5 Wipe indicaton.

disconnect pins with a shooting wire. Connect this wire to the high potential lead of the test machine. Ground the breaker frame. Starting with zero, increase the voltage to 1500 volts rms. Maintain the voltage for one minute. Successful withstand indicates satisfactory insulation strength of the secondary control circuit. Remove the shooting wire and reconnect the motor leads.

6-8 PRIMARY CIRCUIT RESISTANCE CHECK

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

If desired, the DC resistance of the primary circuit maybe measured as follows: close the breaker, pass at least 100 amps DC current through the breaker. With the low resistance instrument, measure resistance across the studs on the breaker side of the disconnect for each pole. The resistance should not exceed the values shown in Table **6.2**.

6-9 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**.

6-10 LUBRICATION

All parts that require lubrication have been lubricated during the assembly with molybdenum disulphide grease. Cutler-Hammer M No. 53701QB. Over a period of time, this lubricant may be pushed out of the way of degrade. Proper lubrication at regular intervals is essential for maintaining the reliable performance of the mechanism. Once a year or every 2000 operations whichever comes first, the 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 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. Don not use carbon tetracholride. 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 6.2 Typical Resistance Measurements

Rated Continuous Current (amperes)	Resistance (microohms)
630	46
800	39
1250	39
1600	26
2000	26

6-11 TROUBLESHOOTING CHART

SYMPTOM	INSPECTION AREA	CONTROL 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)

SYMPTOM	INSPECTION AREA	CONTROL DEFECTS
Fails To Close		
• Closing Springs charged but 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) • Pole Shaft (Not open fully) • Trip Latch Reset Spring (Damaged or Missing)
	• Closing Sound but no close	• 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
Undesirably Closes		
	• Control Circuit	• Close Circuit (CS/C Getting Shorted) • Close Release Latch (Fails to reset)
	• Mechanism	• Close Floor Tripper (Fails to reset)

SYMPTOM	INSPECTION AREA	CONTROL DEFECTS
Fails to Trip		
• No Trip Sound	• Control Circuit	• Control Power (Fuse blown or switch off) • Secondary Disconnect • Auxiliary Switch (a contact no making, poor or burned) • Trip Coil (Burned or open) • Terminals and Connections (Poor or burned or open)
	• Trip Mechanism	• Trip Clapper (Jammed) • Trip Bar, Trip Latch (Jammed)
• Trip Sound	• Trip Mechanism	• Pole Shaft (Jammed) • Operating Rod Assembly (Broken or pins out)
	• Vacuum Interrupter (One or more Welded)	
Undesirably Trips		
	• Control Circuit	• Control Power (SD/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.

7-2 ORDERING INSTRUCTIONS

a.) Always specify the breaker rating information and shop order number.

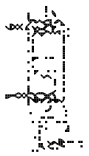
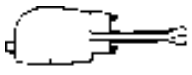
b.) Describe the item, give the style number, and specify the quantity required.

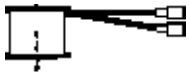
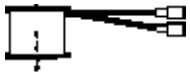
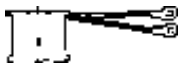
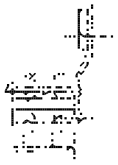
c.) Specify the voltage for electrical components.

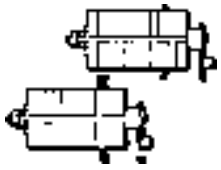
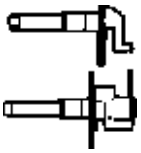
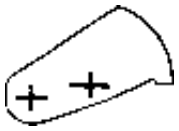
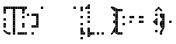
d.) Specify the method of shipping desired.

e.) Send all orders or correspondence to the nearest Cutler-Hammer sales office.

Table 7.1 Recommended W-VAC Spare Parts

Line No.	Description	Style	Qty	
1.	Pole Unit Assy, 630A, Up to 12 kV, 25 kA, 75 kV BIL	4D13307G01	3	
2.	Pole Unit Assy, 1250A, Up to 12 kV, 25 kA 75 kV BIL	4D13307G02	3	
3.	Pole Unit Assy, 1250A, Up to 12 kV, 31.5 and 40 kA, 75 kV BIL	4D13307G03	3	
4.	Pole Unit Assy, 2000A, Up to 12 kV, 31.5 and 40 kA, 75 kV BIL	4D13307G04	3	
5.	Pole Unit Assy, 630A, Up to 15 kV, 25 kA, 95 kV BIL (Plus) Cover	4D13307G01 4D13343H01	3 3	
6.	Pole Unit Assy, 1250A, Up to 15 kV, 31.5 kA, 95 kV BIL (Plus) Cover	4D13307G02 4D13343H01	3 3	
7.	Pole Unit Assy, 1250A, Up to 15 kV, 25 kA, 95 kV BIL (Plus) Cover	4D13307G03 4D13343H01	3 3	
8.	Pole Unit Assy, 2000A, Up to 15 kV, 31.5 kA and 95 kV BIL	4D13307G04	3	
9.	Charging Motor 48 VDC 100/125 VDC-110/120 VAC-50/60 Hz 220/250 VDC-220/240 VAC-50/60 Hz	 699B196G03 699B196G01 699B196G02	 1 1 1	
10.	Motor Brush Kit	803A77G01	1	

Line No.	Description	Style	Qty	
11.	Spring Release Coils 48 VDC 110/125 VDC-110/120 VAC-50/60 Hz 220/250 VDC-220/240 VAC-50/60 Hz	 3759A76G01 3759A76G02 3759A76G03	 1 1 1	
12.	Rectifier 110-120/220-240 VAC	 3759A79G01	 1	
13.	Anti-Pump Relay 48 VDC 110/125 VDC 220/250 VDC 110/120 VAC 50/60 Hz 220/240 VAC 50/60 Hz	 3759A74G03 3759A74G04 3759A74G05 3759A74G01 3759A74G02	 1 1 1 1 1	
14.	Shunt Trip Coils 48 VDC 110-125 VDC/110-125 VAC Cap trip 220-250 VDC/220-250 VAC Cap trip	 3759A76G01 3759A76G02 3759A76G03	 1 1 1	
15.	UV Trip Coils 48 VDC 110/125 VDC 220/250 VDC	 8067A19G01 8067A19G02 8067A19G03	 1 1 1	
16.	Motor Cut-Off Switch	5677B02G01	1	
17.	Latch Check Switch	699B147G01	1	
18.	Position Switch	3759A93H01	1	

Line No.	Description	Style	Qty	
19.	Auxiliary Switch (Push On) Auxiliary Switch (Screw Type)	698B822H01 8293A01H01	1 1	
20.	Trip D-Shift Standard UV	 691C662G01 691C666G01	 1 1	
21.	Trip Latch (Hatchet)	699B040G01	1	
22.	Cluster Assembly 630A 800/1250A 1600/2000A	 699B104G01 508B022G01 5677B328G01	 1 1 1	
23.	Shock Absorber	5677B26H01	1	

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