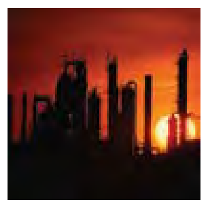

IB-77120 PowlVac-ND® MA 5kV Replacement Vacuum Circuit Breaker

Replacement for Allis Chalmers (Siemens) Type MA Air Circuit Breaker

Powered by Safety®

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Signal Words

As stated in ANSI Z535.4-2002, § 4.13-4.13.3 the signal word is a word that calls attention to the safety sign and designates a degree or level of hazard seriousness. The signal words for product safety signs are **"Danger"**, **"Warning"**, and **"Caution"**. These words are defined as:

> ⚠ **DANGER**
>
> ***DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.***

> ⚠ **WARNING**
>
> ***WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.***

> ⚠ **CAUTION**
>
> ***CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.***

Not stated in ANSI Z535.4-2002, § 4.13-4.13.3 as a signal word but used in this manual is **"IMPORTANT"**. This is defined as:

> ⚠ **IMPORTANT**
>
> ***IMPORTANT indicates a section of the manual covering a non hazardous situation, but one where Powell feels proper attention is warranted.***

Qualified Person

For the purposes of this manual, a qualified person, as stated in NFPA 70®, is one familiar with the construction and operation of the equipment and the hazards involved.

In addition to the above qualifications, one must also be:

1) trained and authorized to energize, deenergize, clear, ground, and tag circuits and equipment in accordance with established safety practices.
2) trained in the proper care and use of personal protective equipment (PPE) such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.
3. trained in rendering first aid if necessary.

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WARNING

The equipment described in this document may contain high voltages and currents which can cause serious injury or death.

The equipment is designed for use, installation, and maintenance by knowledgeable users of such equipment having experience and training in the field of high voltage electricity. This document and all other documentation shall be fully read, understood, and all warnings and cautions shall be abided by. If there are any discrepancies or questions, the user shall contact Powell immediately at 1.800.480.7273.

WARNING

Before any adjustment, servicing, part replacement, or any other act is performed requiring physical contact with the electrical working components or wiring of this equipment, the power supply must be disconnected. Failure to follow this warning may result in injury or death.

IMPORTANT

The information in this instruction bulletin is not intended to explain all details or variation of the PowlVac-ND MA 5kV replacement circuit breaker, nor to provide for every possible contingency or hazard to be met in connection with installation, testing, operation, and maintenance of the equipment. For additional information and instructions for particular problems which are not presented sufficiently for the user's purposes contact Powell at 1.800.480.7273.

I. INTRODUCTION

A. SCOPE

The information in this instruction bulletin describes the following PowlVac-ND MA 5kV replacement circuit breakers:

05PV36MAX3 - 1200A & 2000A
05PV50MAX3 - 1200A & 2000A

B. PURPOSE

The information in this instruction bulletin is intended to provide information required to properly operate and maintain the PowlVac-ND MA 5kV replacement circuit breakers described in Section A. SCOPE.

This instruction bulletin provides:

1) Safety guidelines
2) General descriptions of the operation and maintenance of the PowlVac-ND MA 5kV replacement circuit breaker
3) Instructions for installation and placing the circuit breaker into service
4) Instructions for part replacement
5) Information for ordering renewal parts
6) Procedure for critical adjustments
7) Illustrations, photographs, and description of the circuit breaker

The illustrations contained in this document may not represent the exact construction details of each particular type of replacement circuit breaker. The illustrations in this document are provided as general information to aid in showing component locations.

To the extent required, the products described herein meet the applicable ANSI, IEEE, and NEMA Standards; however, no such assurance is given with respect to local codes and ordinances which may vary greatly.

C. INSTRUCTION BULLETINS AVAILABLE ELECTRONICALLY

For more information visit www.powellind.com. To contact the Powell Service Division call 1.800.480.7273 or 713.944.6900, or email info@powellservice.com.

II. SAFETY

A. SAFE WORK CONDITION

The information in Section A is quoted from *NFPA 70E 2004 - Article 120, 120.1 Establishing an Electrically Safe Work Condition.*

<u>120.1 Process of Achieving an Electrically Safe Work Condition</u>

1) Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

2) After properly interrupting the load current, OPEN the disconnecting device(s) for each source.
3) Wherever possible, visually verify that all blades of the disconnecting devices are fully OPEN or that drawout type circuit breakers are withdrawn to the fully disconnected position.
4) Apply lockout/tagout devices in accordance with a documented and established policy
5) Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are deenergized. Test each phase conductor or circuit part both phase-to-phase, and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.
6) Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being deenergized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

B. SAFETY GUIDELINES

Study this instruction bulletin and all other associated documentation before uncrating the replacement circuit breakers.

Each user has the responsibility to instruct and supervise all personnel associated with usage, installation, operation, and maintenance of this equipment on all safety procedures. Furthermore, each user has the responsibility of establishing a safety program for each type of equipment encountered.

The replacement circuit breakers described in this instruction bulletin are operated by a high-energy, high-speed mechanism that is interlocked to provide specific operating sequences. It is mandatory that the following rules be observed to ensure the safety of personnel associated with usage, installation, operation, and maintenance of these circuit breakers.

The safety rules in this instruction bulletin are not intended to be a complete safety program. The rules are intended to cover only some of the important aspects of personnel safety related to PowlVac-ND® MA 5kV replacement circuit breakers.

C. GENERAL

1) Only supervised and qualified personnel trained in the usage, installation, operation, and maintenance of the circuit breaker shall be allowed to work on this equipment. It is mandatory that this instruction bulletin, any supplements, and service advisories be studied, understood, and followed.
2) Maintenance programs must be consistent with both customer experience and manufacturer's recommendations, including service advisories and instruction bulletin(s). A well-planned and executed routine maintenance program is essential for circuit breaker's reliability and safety.
3) Service conditions and circuit breaker applications shall also be considered in the development of safety programs. Variables include ambient temperature; humidity; actual continuous current; thermal cycling; number of operations; interrupting duty; and any adverse local conditions including excessive dust, ash, corrosive atmosphere, vermin, and insect infestations.

D. SPECIFIC

1) **DO NOT WORK ON AN ENERGIZED CIRCUIT BREAKER.** If work must be performed on a circuit breaker, remove it from service and remove it from the metal-clad switchgear.
2) **DO NOT WORK ON A CIRCUIT BREAKER WITH THE CONTROL CIRCUIT ENERGIZED.**
3) **EXTREME CARE MUST BE EXERCISED TO KEEP ALL PERSONNEL, TOOLS, AND OTHER OBJECTS CLEAR OF MECHANISMS WHICH ARE TO BE OPERATED, DISCHARGED, OR RELEASED.** These circuit breakers utilize stored energy mechanisms. These mechanisms must be serviced only by skilled and knowledgeable personnel capable of releasing each spring load in a controlled manner. Detailed information regarding these mechanisms is found in this instruction bulletin.
4. **DO NOT ATTEMPT TO CLOSE THE CIRCUIT BREAKER MANUALLY ON AN ENERGIZED CIRCUIT.**
5. **DO NOT USE AN OPEN CIRCUIT BREAKER AS THE SOLE MEANS OF ISOLATING A HIGH VOLTAGE CIRCUIT.** For complete isolation, the circuit breaker shall be in the disconnected position or shall be withdrawn completely.
6. **ALL COMPONENTS SHALL BE DISCONNECTED BY MEANS OF A VISIBLE BREAK AND SECURELY GROUNDED FOR SAFETY OF PERSONNEL PERFORMING MAINTENANCE OPERATIONS ON THE CIRCUIT BREAKERS.**
7. Interlocks are provided to ensure the proper operating sequences of the circuit breakers and for the safety of the user. If for any reason an interlock does not function as described, do not make any adjustments, modification, or deform the parts. **DO NOT FORCE THE PARTS INTO POSITION. CONTACT POWELL FOR INSTRUCTIONS.**

E. X-RAYS

When high voltage is applied across the contacts of a vacuum interrupter, there is the possibility of generation of X-rays. The intensity of the X-radiation is dependent on the peak voltage and the contact gap. At the normal operating voltage for this type of equipment, the radiation levels are negligible. At the voltages specified for testing, test personnel shall be in front of the circuit breaker such that the two layers of steel used in the frame and front cover construction are between the test personnel and the vacuum interrupters, and that the test personnel be no closer than one meter (3') from the front of the circuit breaker. **THE CIRCUIT BREAKER SHALL BE EITHER FULLY OPEN, OR FULLY CLOSED WHEN MAKING HIGH POTENTIAL TESTS. DO NOT TEST WITH CONTACTS PARTIALLY OPEN.**

F. SAFETY LABELS

The equipment described in this document has **DANGER**, **WARNING, CAUTION,** and instruction labels attached to various locations. All equipment **DANGER**, **WARNING, CAUTION,** and instruction labels shall be observed when the circuit breaker is handled, operated, or maintained.

> ⚠ ***IMPORTANT***
>
> ***Danger, Warning, and Caution labels are located in various places in and on the switchgear and on the circuit breaker removable element. Always observe these warnings and caution labels. Do NOT remove or deface any of these labels.***

III. DESCRIPTION

A. GENERAL

The PowlVac-ND® MA 5kV replacement circuit breaker, (Figure 1) is a special version of the PowlVac-ND® vacuum circuit breaker. It is designed to replace an Allis Chalmers Type MA circuit breaker of equivalent rating in metal-clad switchgear. It is mounted on a frame similar to the frame of the type MA circuit breaker and is equipped with primary disconnecting contacts, a secondary contact plug, interlocks, and wheels. The entire assembly will fit into a metal-clad switchgear compartment designed for an Allis Chalmers/Siemens circuit breaker without modification to that compartment. All interlocking provided on the Allis Chalmers/Siemens circuit breaker is also provided on the PowlVac-ND MA 5kV vacuum circuit breaker.

The primary current path side of the circuit breaker is considered the rear of the circuit breaker. The side with the cover containing the various indicators and manual operators is considered the front of the circuit breaker. The operating mechanisms of the circuit breaker are exposed by removing the front cover. The stored energy mechanism assembly provides motion to each of the vacuum interrupter moving contact assemblies through contact operating pushrods. The circuit breaker levering-in device and interlocks are located in the same compartment as the stored energy mechanism and control the movement of the circuit breaker between the test/disconnected and connected positions. The levering-in device provides the motion to engage or disengage the primary disconnecting devices and to open or close the shutters in metal-clad switchgear.

B. THE STORED ENERGY MECHANISM

1) *Mechanical Description*

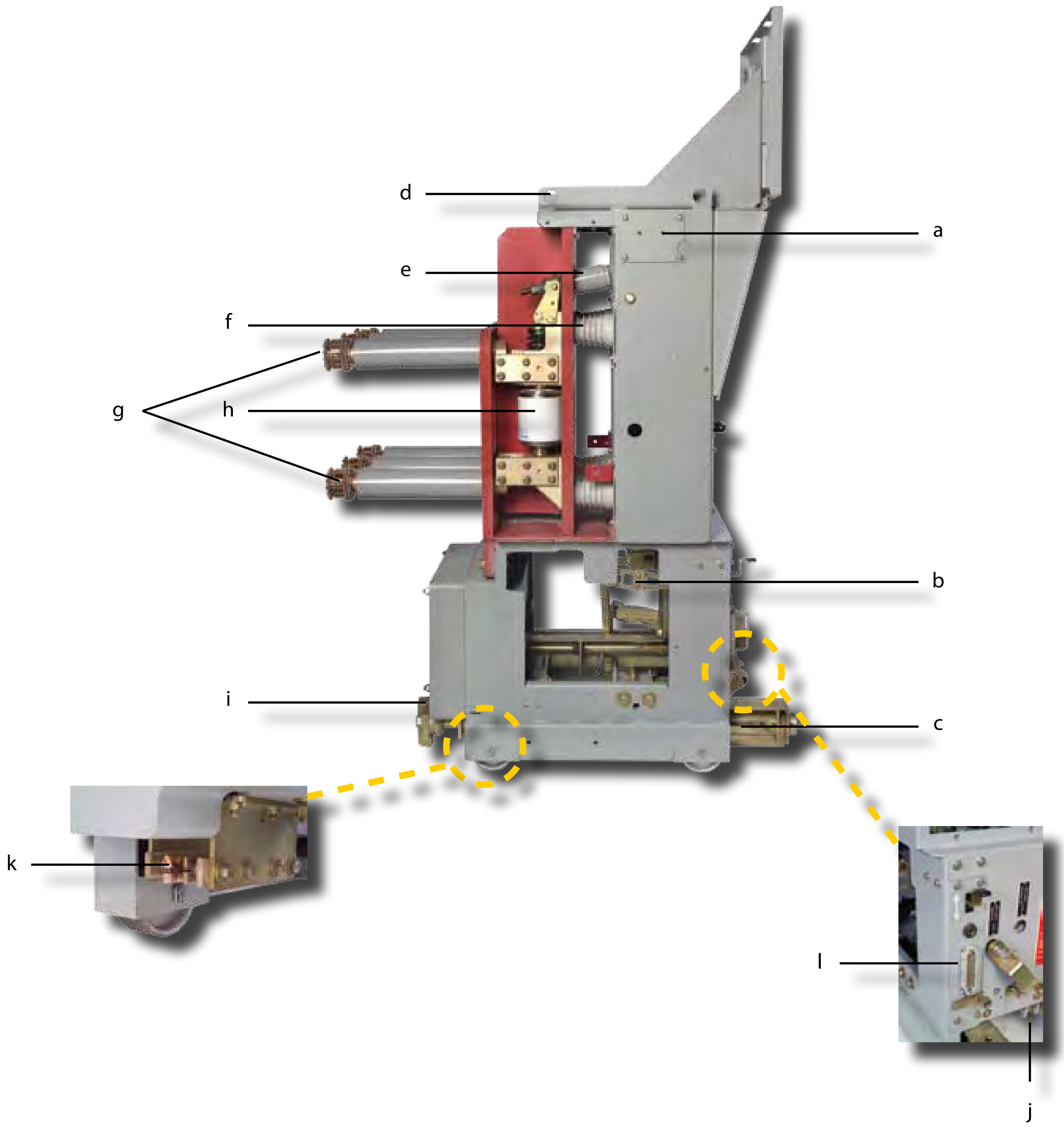
The stored energy mechanism is located in the front of the circuit breaker behind the front cover. The front cover is held in place by ten (10) cover bolts. The bolts may be removed to allow access to the stored energy mechanism and its interlocks, auxiliary switches, and other control devices. It is very important to ensure that the circuit breaker is in the **"OPEN"** position and the main closing spring (Figure 3, c) is fully discharged before removing the front cover. **FAILURE TO DO THIS MAY RESULT IN PERSONAL INJURY.**

On the escutcheon of the stored energy mechanism, there are two (2) indicators that show the various states of operation of the mechanism and two (2) manual operators that will open or close the stored energy mechanism. The circuit breaker nameplate (Figure 2, j) is located on the mechanism escutcheon.

The mechanism employed in the circuit breaker is a stored energy system which uses a charging motor to compress the main closing spring. The energy stored in the main closing spring is released during the closing operation. The released energy allows the mechanism to close the vacuum interrupter contacts, compress the contact loading springs, charge the opening springs, and overcome frictional forces. When the circuit breaker is opened, the energy stored in the opening and contact loading springs is released, and the vacuum interrupter contacts are opened.

The charging motor (Figure 3, a), located at the interior top left frame is assembled to the circuit breaker by a cover plate that is bolted to the circuit breaker left frame side sheet. The charging motor drive shaft inserts into the eccentric drive shaft. The eccentric drive shaft is supported by needle roller bearings in the mechanism frame side sheets and transmits the motor torque to the right side of the mechanism.

Figure 1 - Side View of PowlVac-ND MA 5kV Replacement Circuit Breaker



a.	*Mechanism Housing*	*g.*	*Primary Disconnect Contacts*
b.	*MOC Switch Actuator*	*h.*	*Vacuum Interrupter*
c.	*Rail Latch*	*i.*	*Levering in Nut Housing*
d.	*Lift Point*	*j.*	*Guide Rail*
e.	*Main Insulating Operating Arm (Push Rod)*	*k.*	*Ground Connection*
f.	*Support Insulator (Wishbone)*	*l.*	*Secondary Disconnect Receptacle*

When the charging motor is energized, the eccentric drive shaft rotates and causes the pawl support arms to pivot about the camshaft (Figure 3, j). The drive pawl, which is supported by the arms, engages with the ratchet wheel and drives the ratchet wheel one tooth at a time. To prevent backwards motion of the ratchet wheel, a spring-loaded holding pawl is used to latch the ratchet wheel after each advance from the drive pawl.

To ensure correct synchronization of the drive and holding pawl, the position of the holding pawl support arms are adjusted by the holding pawl adjusting eccentric (Figure 3, r), located at the interior right front of the mechanism. When the mechanism is operated manually, the top pawl becomes the drive pawl and the bottom pawl becomes the holding pawl.

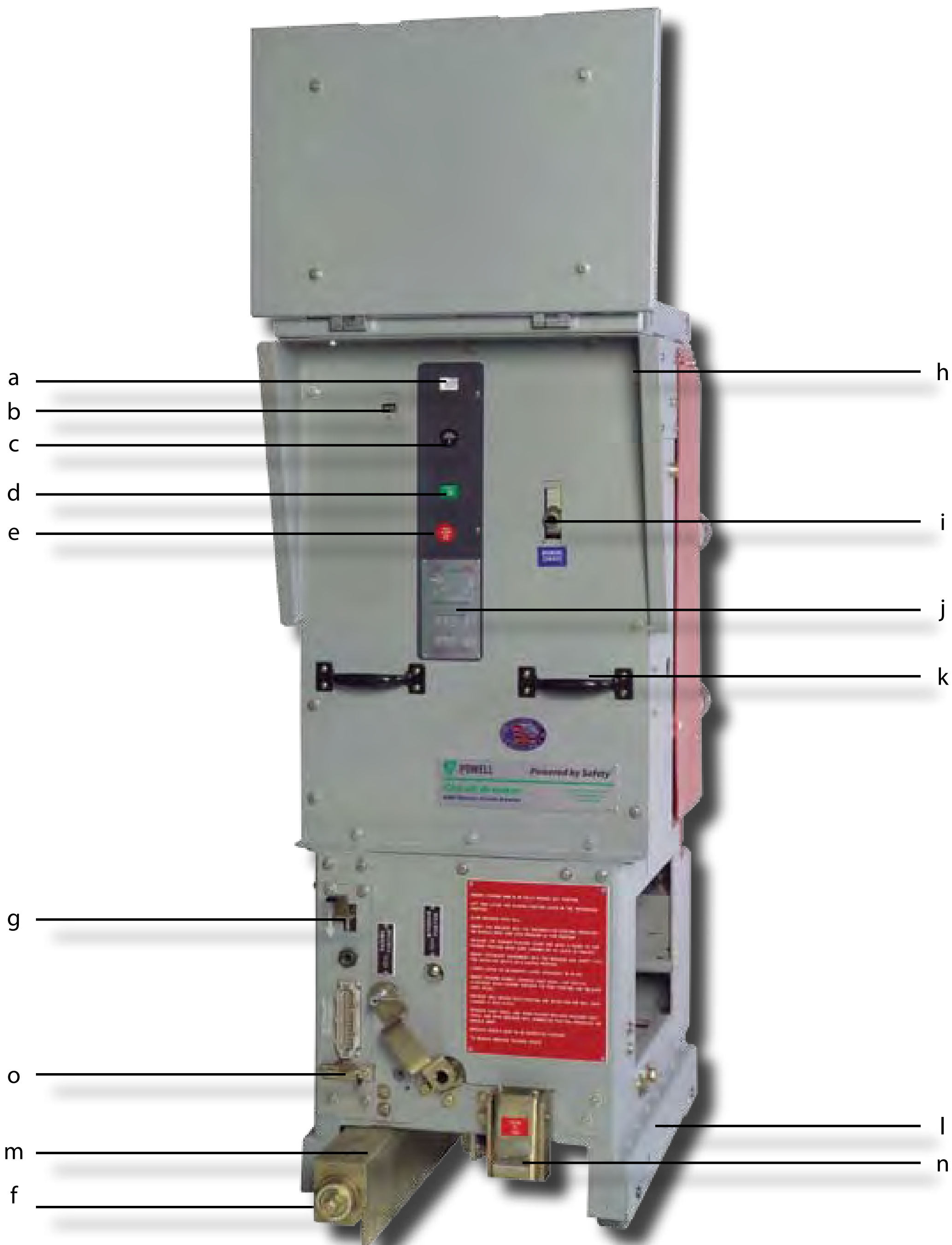
The ratchet wheel (Figure 3, o) has projections from its side faces which engage the drive plates as it rotates. The drive plates are attached to the camshaft, and cause the camshaft to rotate. Crank arms (Figure 3, p) are attached to the ends of the camshaft. Crank pins (Figure 3, q) are assembled to the crank arms, which point outward. The crank arms engage the ends of the connecting rods (Figure 3, b). The pins that project from the spring yoke, which straddles the main closing spring, engage the opposite ends of the connecting rods. As the camshaft rotates the connecting rods pull the spring yoke upward, compressing the main closing spring.

The ratchet wheel drives the camshaft so that the connecting rods go to their highest position, and then start to move downward. At a certain point, the spring force overcomes friction and resistance and start to rotate the camshaft. At the same time, the pawls are uncoupled from the ratchet wheel by the pawl lift plate (Figure 3, n), and the motor cutoff switch is operated. The motor cutoff switch (Figure 3, h), located at the left interior of the mechanism, is operated by the spring charge indicator and motor cutoff cam (Figure 3, i). The spring charge indicator (Figure 2, a) displays that the mechanism is charged.

The camshaft is restrained by the close latch arm engaging against the close latch shaft. The main closing cam, located between the interior mechanism side sheets, is in a position where the fundamental linkage can move to the reset position.

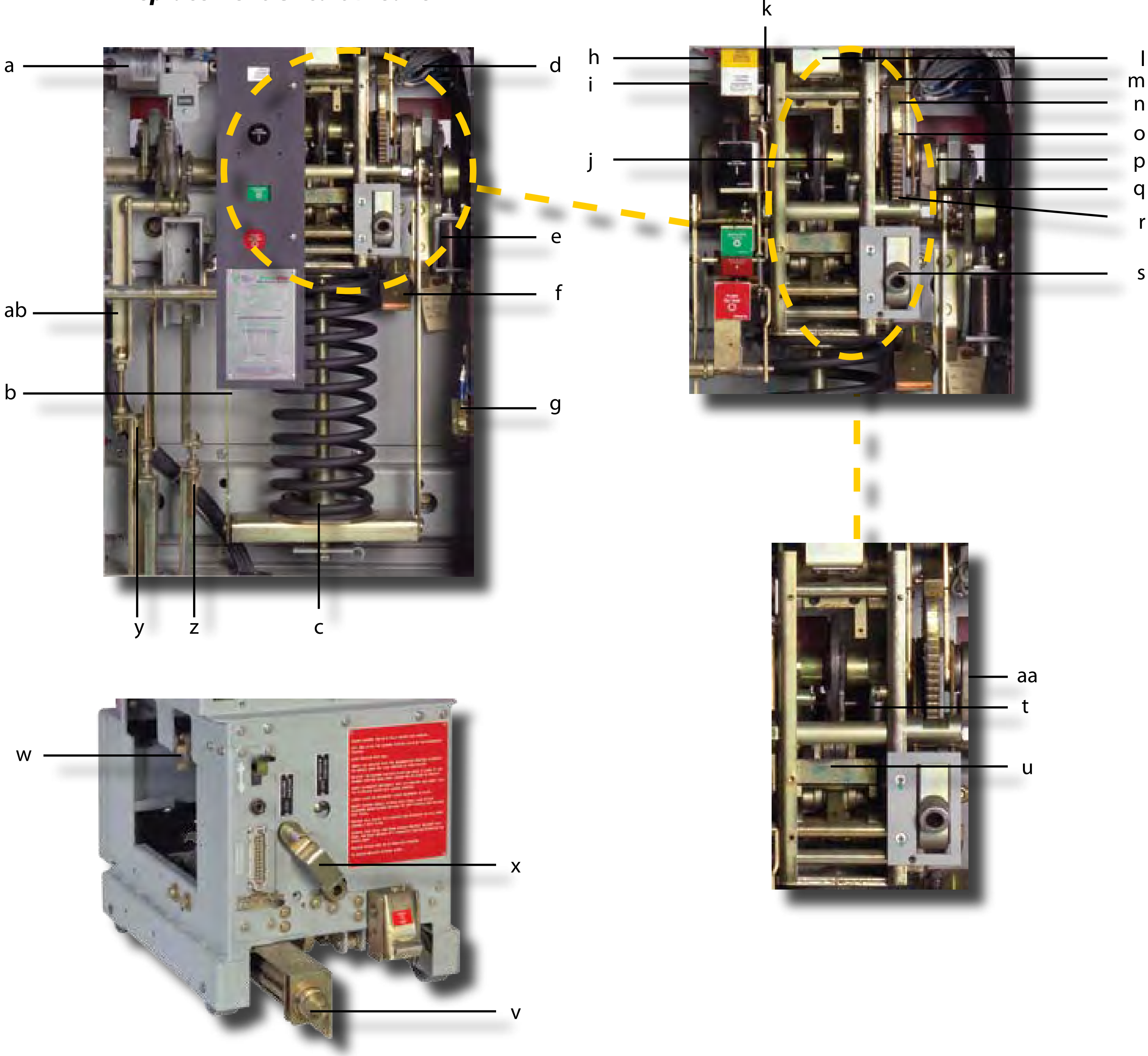
The close latch, when released either by the closing coil or the manual close operator, allows the main closing spring to pull the crank arms downward. As the crank arm moves downward it rotates the main closing cam and drives the fundamental linkage into the closed position. This action causes the main linkage to rotate the jackshaft to drive the operating pushrods (Figure 1, e) toward the current carrying side of the circuit breaker.

Figure 2 - Front View PowlVac-ND MA Replacement Circuit Breaker with Cover



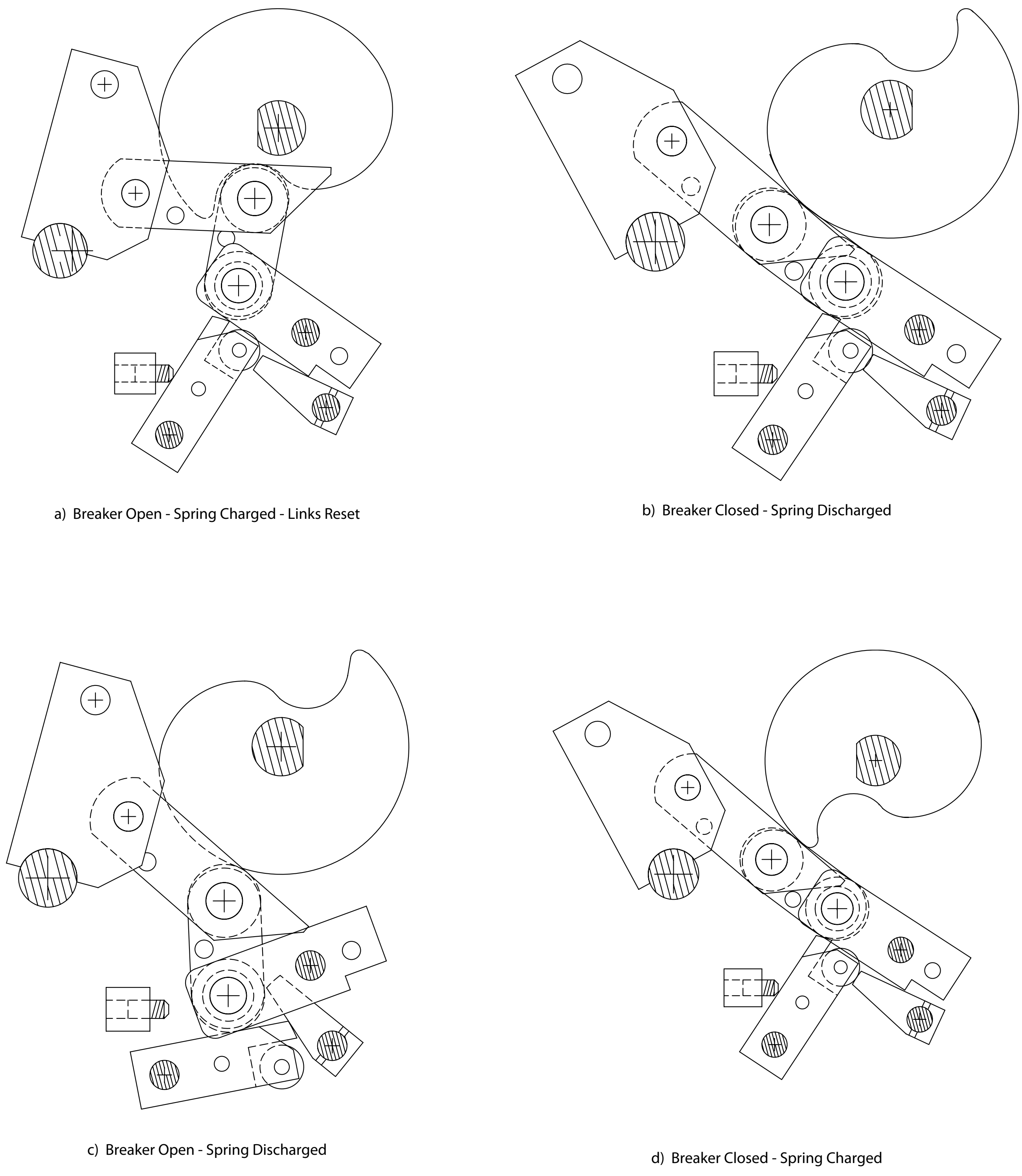
a. Spring Charge Indicator
b. Operation Counter
c. Manual Close Paddle
d. Circuit Breaker Open/Close Indicator
e. Manual Trip Paddle
f. Levering In Device Operating Shaft
g. Secondary Disconnect Interlocking Lever
h. Front Cover Attachment Bolts
i. Manual Charging Crank
j. Nameplate
k. Handle
l. Shutter Ramp Location
m. Circuit Breaker Racking Mechanism
n. Breaker Release Foot Pedal
o. Secondary Disconect Latch

Figure 3 - Close Up Front View PowlVac-ND® MA Replacement Circuit Breaker



a. Charging Motor
b. Connecting Rod
c. Main Closing Spring
d. Auxiliary Switch
e. Shock Absorber (Dashpot)
f. Primary Shunt Trip
g. Anti Pump Relay
h. Motor Cutoff Switch
i. Motor Cutoff Cam
j. Camshaft
k. Close Bar Adjusting Screw
l. Closing Coil
m. Drive Pawl
n. Pawl Lift Plate
o. Ratchet Wheel
p. Crank Arm
q. Crank Pin
r. Holding Pawl Adjusting Eccentric
s. Manual Charge Crank
t. Reset Spring
u. Secondary Trip Prop
v. Levering Shaft
w. MOC Operating Shaft
x. Racking Position Lever shown in "Racking Position"
y. Spring Release Interlock Link
z. Open Interlock Link
aa. Close Latch Arm
ab. MOC Actuator Link

Figure 4 - Cam and Fundamental Linkage Positions



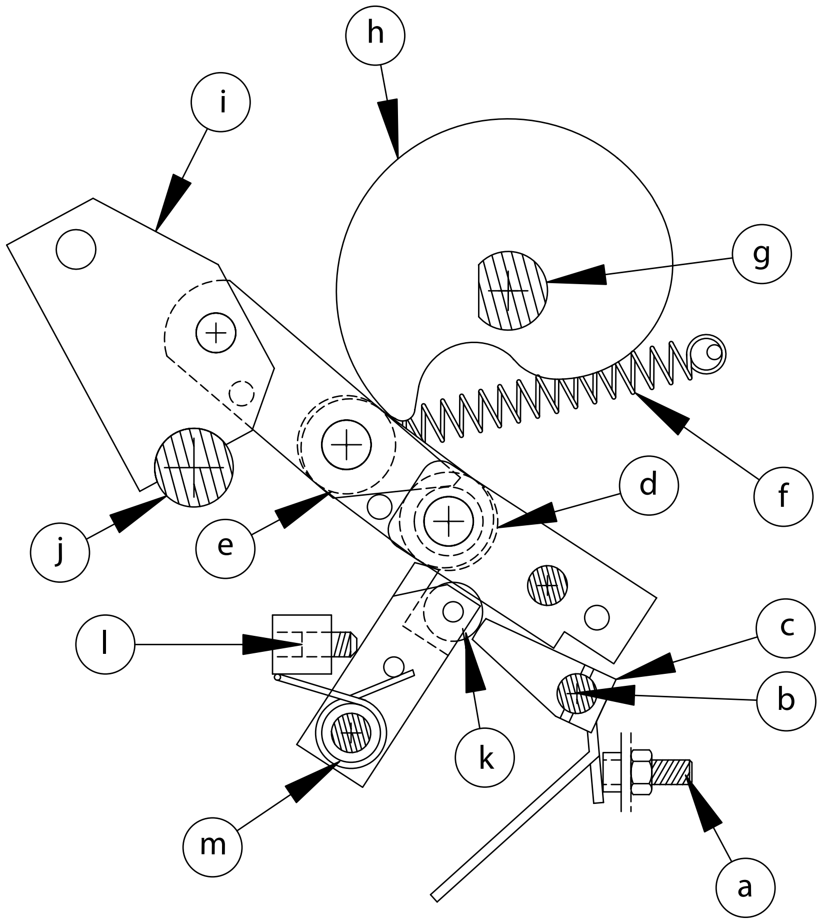
a) Breaker Open - Spring Charged - Links Reset

b) Breaker Closed - Spring Discharged

c) Breaker Open - Spring Discharged

d) Breaker Closed - Spring Charged

Figure 5 - Mechanical and Trip Linkages



a. Secondary Trip Prop Adjusting Screw
b. Secondary Trip Prop Shaft
c. Secondary Trip Prop
d. Secondary Linkage Roller
e. Main Cam Roller
f. Reset Spring
g. Camshaft
h. Main Closing Cam
i. Center Phase Operating Lever
j. Jackshaft
k. Primary Trip Prop Roller
l. Primary Trip Prop Adjusting Screw
m. Primary Trip Prop

Each operating pushrod assembly has a recess at each end which encloses a contact loading spring. At the end of this spring is a spring yoke, which connects with bell cranks. The spring yoke is restrained by a lock nut on a stud which passes through the contact loading spring and is attached to the operating pushrod assembly. The contact loading spring has initial compression such that as soon as the vacuum interrupter contacts touch, the springs are preloaded to a value sufficient to resist vacuum interrupter contact separation under the highest electromagnetic forces exerted by the rated short-circuit current. Further movement of the operating pushrod assembly compresses the contact loading spring and produces a gap between the face of the spring yoke and the lock nut.

For each phase, bell cranks are located on the outside of the upper primary conductor casting and are supported by bearings. Each bell crank is connected to an operating pin, which engage an extension to the vacuum interrupter assembly and moves the vacuum interrupter contact. The bell cranks give an approximate 3 to 1 multiplication of the contact loading spring force, which enables a lower spring rate to be used. It also multiplies the contact movement by a factor of approximately 3, so that the mechanism linkages have relatively large movements and are less critical.

In the closing cam and fundamental linkage positions shown in Figure 4b & 4d, the contact loading springs and the main opening springs are both acting to compress the three (3) main mechanism links. The jackshaft extends from the left to the right side of the circuit breaker frame and is supported at the main circuit breaker frame side sheets and by the mechanism. The outer operating levers on the jackshaft have connections to the circuit breaker auxiliary switch and MOC operating linkage.

The fundamental linkage is restrained from movement by the secondary trip prop acting on the primary trip prop roller. A component of force tends to make the primary trip prop rotate downward, but it is restrained by the secondary trip prop face acting on the primary trip prop roller. The clearance between the primary trip prop roller and the secondary trip prop is controlled by the primary trip prop adjusting screw. When the trip shaft is rotated by the action of the manual trip operator or the primary shunt trip coil, the secondary trip prop face moves upward and permits the primary trip prop to rotate downward, thus permitting the main linkage to move downward and the jackshaft to rotate, opening the circuit breaker. The right jackshaft levers engage a shock absorber (Figure 3, e), which controls the rebound of the vacuum interrupter contacts on an opening operation.

With the standard electrical control scheme, as soon as the main closing spring is discharged on a closing operation, the charging motor is switched on to recharge the springs. This leaves the main closing cam in a position where a tripped linkage can reset under the action of the reset spring (Figure 3, t) and the primary and secondary trip props can move into the reset position. The reset spring stretches between an extension of the main cam roller pin and a spring support pin located on the left mechanism side sheet. The latch check switch, operated by a lever on the trip shaft, will close as the secondary trip prop reaches the fully reset position.

2) Electrical Description

a) Charging Motor

The function of charging motor (Figure 3, a) is to compress the main closing spring of the stored energy mechanism, thus providing the necessary energy to close the circuit breaker. The charging motor, located at the interior top left, is assembled to the circuit breaker by a cover plate that is bolted to the circuit breaker interior left frame side sheet.

b) Motor Cutoff Switch

The motor cutoff switch (Figure 3, h) provides an electrical break in the control circuit that supplies the charging motor when the main closing spring is fully charged and the stored energy mechanism is ready for a closing operation. The motor cutoff switch is located at the top left side of the mechanism, and is supported by a bracket which is bolted to the circuit breaker top cover.

c) Anti-Pump Relay

The anti-pump relay (Figure 3, g) provides a logic function for the control circuit which prevents a continuous electrical close signal from causing the circuit breaker to continuously re-close after a trip signal. The anti-pump relay is located on the circuit breaker frame, to the right of the connecting rod, and is supported by two screws.

d) Operating Solenoids

Electrical operation of the circuit breaker is accomplished using operating solenoids.

The closing coil (Figure 3, l) is an operating solenoid located at the top center of the mechanism and is assembled to the circuit breaker top cover by bolts accessible from the above circuit breaker.

The primary shunt trip coil (Figure 3, f) is located at the bottom right side of the mechanism and is assembled to the lower frame channel by two bolts.

Either a secondary shunt trip coil or an undervoltage device may be furnished as an option. When furnished, either of these devices is located to the right of the mechanism and is supported from the lower frame channel. Only one of these two auxiliary trip devices may be furnished on any one circuit breaker, as both devices are located in the same space.

e) Control Circuit

The control scheme of any particular circuit breaker may differ depending on the user's requirements, operating solenoids, and the control devices furnished with that circuit breaker.

Circuit breaker mounted auxiliary contacts not used in the control circuit are brought out for control and indication functions. The metal-clad switchgear equipment may provide a circuit breaker MOC (Mechanism Operated Cell Switch) for additional contacts.

C. RACKING MECHANISM

1) General Description

The levering in device is the mechanical assembly that facilitates moving the circuit breaker between the test/disconnect and the connected positions in the circuit breaker cell. The main levering in device components for the PowlVac-ND MA circuit breakers are shown and described in the following sections:

a) Interlocks

PowlVac-ND MA circuit breakers are provided with several interlocks that operate in conjunction with the circuit breaker cell to ensure the proper operation of the circuit breaker. Do NOT attempt to modify or bypass these interlocks, as they are necessary for the safe operation of the circuit breaker.

Circuit breaker interlocking will be described in the following sections. The combined sections make up the complete circuit breaker interlocking scheme.

Circuit breaker interlocking is primarily achieved by means of a movable racking screw mating with the machined nut, the open/closed position of the stored energy mechanism, and the tripping linkage assembly under the frame of the circuit breaker which interfaces with the circuit breaker cell.

The following describes the interlocking for the PowlVac-ND MA circuit breakers:

1. Continuous Current Interlock

   The continuous current interlock functions to ensure breakers and cubicles of like continuous rating are applied, and that circuit breakers with dissimilar continuous current ratings are excluded from cubicles of unlike current ratings.

2) Circuit Breaker Racking Mechanism

The circuit breaker racking mechanism (Figure 2, m) enables moving the circuit breaker to one of three positions in the secondary compartment of the switchgear: **DISCONNECTED**, **TEST**, and **CONNECTED**.

A rugged interlock bar has positive stops in the disconnected, test and operating positions to regulate safe and controlled movement of the circuit breaker in the cubicle. Interlocks prevent:

a) movement of the circuit breaker when it is closed and
b) closing of the circuit breaker unless the primary disconnecting devices are in full contact or separated by a safe distance.

Located on the circuit breaker, this interlock bar engages close-fitting slots along the guide track on the switchgear cubicle floor for the disconnect (or storage), test and operating positions. The circuit breaker cannot be moved while the interlock is engaged. The breaker release foot pedal (Figure 2, n) on the circuit breaker must be manually depressed to release the interlock, permitting the circuit breaker to be moved. During transition from one position to another, the interlock rides on the guide track between slots holding the breaker in the "trip-free" position.

Positive straight-line, in-and-out movement of the circuit breaker is assured by the guide track. Failure of the guide follower to enter the guide track prohibits entry of the circuit breaker into the cubicle.

When the breaker is inserted, it is rolled into the cubicle and pushed until it stops and automatically locks in the disconnected position. The breaker release foot pedal must be depressed to move it to the test and operating position.

⚠ CAUTION

Cranking in or out the racking screw without pressing the breaker release pedal will damage the racking mechanism.

The breaker release foot pedal (Figure 2, n) is located on the front, lower right side of the circuit breaker housing. The pedal is a spring-controlled lever that works in conjunction with the racking drive shaft. The purpose of the pedal is to allow the circuit breaker to be closed ONLY in one of three positions in the compartment: **DISCONNECTED, TEST,** and **CONNECTED.**

The floor discharge linkage is provided with rollers on the bottom side of the breaker. This prevents a circuit breaker from being inserted into or removed from a compartment with the main closing spring charged.

Operating the breaker release foot pedal also operates the tripping mechanism of the circuit breaker. Once the pedal is fully depressed, it will operate a link in the mechanism that holds the circuit breaker in the "Trip-free" position.

⚠ CAUTION

Depressing the breaker release foot pedal while the breaker is closed will cause the breaker to trip (open).

a) Disconnected Position

A metallic shutter covers the openings of the stationary primary disconnect devices which prevents contact. In this position, the secondary disconnect device can be engaged and disengaged.

b) Test Position

In the **TEST** position, the primary disconnect devices are disengaged and the shutters are closed. The secondary disconnect device is connected so the breaker may be electrically or manually operated.

The interlock prevents racking from DISCONNECTED to TEST position of the circuit breaker unless the secondary disconnect device is engaged.

⚠ CAUTION

When operating the racking mechanism, make sure the secondary disconnect device is engaged. Failure to do so will result in damage to the interlock linkages.

c) Connected Position

In the **CONNECTED** position, the movable primary disconnects and stationary primary disconnects are engaged, the shutters are open and the secondary disconnect device are engaged.

Interlocks deter the movement of a circuit breaker from one position to another, unless the circuit breaker is in the open position. The interlocks also deter closing the circuit breaker between positions.

D. CIRCUIT BREAKER COMPARTMENT INTERFACES

1) *Primary Disconnecting Contacts*

There are six primary disconnecting contacts on the circuit breaker. They are arranged two per phase with the upper device connected to the moving end of the vacuum interrupter, and the lower device connected to the stationary end of the vacuum interrupter assembly.

Each primary disconnecting contact (Figure 1, g) has multiple contact fingers which will mate with the stationary primary disconnecting contacts in the circuit breaker cell. **DO NOT HANDLE OR MOVE THE CIRCUIT BREAKER BY THE PRIMARY DISCONNECTING CONTACTS, AS DAMAGE MAY OCCUR.**

2) *Secondary Disconnecting Contacts*

Control power is transferred from the metal-clad switchgear to the circuit breaker by means of the secondary disconnecting contacts. The secondary contact receptacle (Figure 1, l) is mounted on the lower left front side of the circuit breaker. The secondary contact plug is mounted on the left front wall of the circuit breaker cell. As the secondary disconnecting contacts are fully engaged, the control circuits are complete. When the circuit breaker is withdrawn from the Test to the Disconnected position, the secondary disconnecting contacts will remain engaged. Removing the circuit breaker from the compartment will require removal of the plug manually.

To engage the secondary disconnecting contacts while the circuit breaker is in the disconnected position, lift the secondary disconnect interlocking lever (Figure 2, g) until it locks in place. Then push the secondary disconnect plug into the secondary disonnect receptacle. Secure the latch (Figure 2, o) on the lower side of the secondary disconnect receptacle to lock the plug to the circuit breaker.

3) *Mechanism Operated Cell (MOC) Switch*

The mechanism operated cell switch (MOC) is an auxiliary switch operated by linkages in the compartment, which operates in conjunction with the circuit breaker mechanism.

The MOC switch actuator assembly is connected to the jackshaft using linkages. The MOC switch actuator is located at the lower left side of the circuit breaker. Before installing the circuit breaker, check the assembly to assure it has not been damaged during shipment and is tight. The assembly should have enough freedom to slide freely and smoothly when operated. After racking the circuit breaker in and before closing, check the position of the MOC actuator in relation to the MOC operating rod, which is attached to the compartment. The rod should be centered in the slot of the MOC actuator. Adjustments to the MOC actuator position are made by adjusting the length of the MOC actuator link (Fig 3, ab).

4) *Truck Operated Cell Switch (TOC) Actuator*

The TOC actuator is the circuit breaker frame itself. The TOC operates the auxiliary switch on the right side of the compartment when the circuit breaker is racked in. All adjustments to the TOC are made on the compartment linkage.

5) *Ground Connection*

The ground connection is an assembly of spring loaded fingers that ground the circuit breaker frame as it is inserted into the compartment. The ground connection (Figure 1, k) is located at the left rear wheel of the circuit breaker truck. An extension of the metal-clad switchgear ground bus is secured to the compartment floor and engages the ground contact as the circuit breaker is placed into the disconnected position. The ground connection remains engaged in all subsequent positions of the circuit breaker until the circuit breaker is removed from the compartment.

6) *Shutter Ramp*

As the circuit breaker travels between the test/disconnected and connected positions the shutter ramp (Figure 2, l) engages the shutter operating cam attached in the compartment. This action drives the cell shutters to open/close which allows the primary disconnecting contacts to connect/disconnect. The horizontal movement of the shutter ramp along the shutter operating cam will move the shutters to the fully open position while the circuit breaker travels toward the connected position.

E. VACUUM INTERRUPTER CONNECTIONS

Connection to the vacuum interrupter stems is made by means of copper contact blocks. The bottom stem of the vacuum interrupter is threaded and a copper contact block is screwed onto this stem. The contact block is assembled to the lower primary disconnecting contact of the circuit breaker. Another copper contact block with a primary disconnecting contact surrounds the upper or moving stem of the vacuum interrupter. The sliding contact assembly inside the upper contact block makes contact with this block and the moving stem of the vacuum interrupter. The multiple parallel paths of the sliding contact assembly keep the current density low.

F. OPERATING SOLENOIDS

The closing coil solenoid (Figure 3, l), located on top of the mechanism, is attached to the breaker top pan by two screws accessible from underneath the breaker.

The primary shunt trip solenoid (Figure 3, f) is to the right of the mechanism and is supported from the upper frame channel.

Either a second shunt trip solenoid or an undervoltage trip device may be furnished as an option. When furnished, either of these devices is located to the left of the mechanism and is supported from the upper frame channel. Only one of these two auxiliary trip devices may be furnished on any one circuit breaker, as both types are located in the same space.

G. THE ANTI-PUMP RELAY

The anti-pump relay is located on the breaker frame to the right of the connecting rod and is held by two screws (Figure 3, g).

H. MOTOR CUTOFF SWITCH

The motor cutoff switch, which is located at the left of the mechanism, is attached to a bracket which is bolted to the circuit breaker top pan (Figure 3, h).

I. VACUUM INTERRUPTERS

For a listing of the vacuum interrupters used in Type MA circuit breakers, see Table C. A label that shows the part number is attached to each vacuum interrupter. Replacement vacuum interrupters must have the same part number as the original vacuum interrupter.

IV. INSTALLATION

A. RECEIVING

When the circuit breaker is received, check for signs of damage. If damage is found or suspected, file claims as soon as possible with the transportation company and notify the nearest Powell representative.

B. HANDLING

The circuit breaker is equipped with four wheels so that it may be rolled easily on level floors.

After the circuit breaker has been removed from its shipping pallet it may be rolled on its own wheels on a level surface. This is the preferred way of handling the circuit breaker. When rolling the circuit breaker, it should be pushed and steered by the steel frame or the front cover. **DO NOT HANDLE OR MOVE THE CIRCUIT BREAKER BY THE PRIMARY DISCONNECTING CONTACTS AS DAMAGE MAY OCCUR.**

If necessary, the circuit breaker can be moved by an overhead crane. To lift the circuit breaker with an overhead crane, use the four lifting points (Fig 1, d) which have been provided for hooks at the top of the circuit breaker frame.

C. STORAGE

It is recommended that the circuit breaker be put into service immediately in its permanent location. If this is not possible, the following precautions must be taken to assure the proper storage of the circuit breaker:

1. Since dampness has an adverse effect on the insulating parts, the breaker should be carefully protected against condensation, preferably by storing it in a warm, dry room of moderate temperature, such as 40°-100°F. Circuit breakers for outdoor metal-clad switchgear should be stored in the equipment only when power is available and the heaters are in operation to prevent condensation.
2. The breaker should be stored in a clean location, free from corrosive gases or fumes. Particular care should be taken to protect the equipment from moisture and cement dust, as this combination has a very corrosive effect on many parts.
3. Unplated surfaces of the operating mechanism, such as rollers and latches, should be coated with grease to prevent rusting.

If the breaker is stored for any length of time, it should be inspected periodically to see that rusting has not started and to insure it is in good mechanical condition. If the breaker is stored under unfavorable atmospheric conditions, it should be clean and dry before being placed into service.

D. PLACING THE CIRCUIT BREAKER INTO SERVICE

Before shipment from our factory, all circuit breaker functions are thoroughly checked. The user must verify functions after receipt. Powell recommends that the tests be performed in the sequence listed below:

1. High Voltage Insulation Integrity
2. Vacuum Integrity
3. Control Voltage Insulation Integrity
4. Mechanical Operation Check
5. Electrical Operation Check
6. Dimensional Check

1) High-Voltage Insulation Integrity

The primary circuit insulation on the circuit breaker may be checked phase-to-phase and phase-to-ground using a 2500V insulation resistance tester. Since definite limits cannot be given for satisfactory insulation values when testing with an insulation resistance tester, a record should be kept of the insulation resistance tester readings as well as the temperature and humidity readings. This record should be used to detect any weakening of the insulation system from one check period to the next.

To check insulation integrity, the AC high potential test described below is strongly recommended. Using DC testing is not the preferred method; however, values are provided due to the availability of DC test sets.

⚠ CAUTION

If DC high potential testing (HIPOT) is required, the DC high potential test machine must not produce instantaneous peak voltages exceeding 20kV.

⚠ WARNING

After the high potential is removed, an electrical charge may be retained by the vacuum interrupters. Failure to discharge this residual electrostatic charge could result in an electrical shock. All six primary disconnecting devices of the circuit breaker and the metallic mid-band ring, if present, should be grounded and remain grounded for at least one minute to reduce this electrical charge before coming into contact with the primary circuit.

⚠ CAUTION

Remove all grounding conductors applied for this test before placing the circuit breaker back into service.

The circuit breaker insulation should be tested with the circuit breaker vacuum interrupter contacts in the **CLOSED** position. Test each pole of the circuit breaker separately, with the other 2 poles and the frame grounded. Perform the field dielectric test described in ANSI Standard C37.20.2, at the voltage level appropriate for the equipment. (See Table A.) This test will have checked all of the primary phase-to-ground and phase-to-phase insulation.

The tests described in this section are the only tests required to ascertain insulation integrity. Because of the design of the PowlVac® insulation system, no valid data can be obtained utilizing other types of high-voltage insulation tests.

(Table A) Field Dielectric Test Values	
Rated Maximum Voltage (kV rms)	**Power Frequency Withstand (kV rms)**
4.76	14.25

CAUTION

Applying abnormally high voltages across a pair of contacts in the vacuum, may produce x-radiation. The radiation may increase with increased voltage and/or decreased contact spacing.

The x-radiation, produced during this test with the voltage specified in Table A and normal contact spacing, is extremely low and well below the maximum permitted by standards.

Do NOT apply voltage that is higher than the recommended value. Do NOT use contact separation that is less than the normal open position separation of the circuit breaker contacts.

2) *Vacuum Integrity*

Powell recommends AC testing for reliable verification of vacuum integrity. All PowlVac-ND MA circuit breakers shall be tested with a minimum of 25kVAC applied across fully open contacts for 10 seconds. No dielectric breakdown during the test period constitutes a successful test.

CAUTION

High voltages across the open gaps of the vacuum interrupter can produce x-radiation. When conducting high voltage test, personnel should stand at least one meter (3') away from the circuit breaker with the covers in place. Vacuum Integrity Test voltages should not exceed 25kVAC (35kVDC) for circuit breaker with a rated maximum voltage of 4.76kV.

Note: *The AC test does not replace the AC high potential testing (Hipot) used to determine "High voltage insulation integrity." For more details, see Section IV. INSTALLATION, D. PLACING THE CIRCUIT BREAKER INTO SERVICE, 1) High Voltage Insulation Integrity.*

Powell offers a compact and lightweight **PowlVac Vacuum Integrity Tester** designed specifically for PowlVac circuit breakers. If this device is used, refer to the instruction bulletin provided with the vacuum integrity tester.

Powell recognizes the widespread use of DC hipot equipment in the field and the desire to use this equipment to verify vacuum integrity. However, the capacitive component of the vacuum interrupter during DC testing may yield false negative test results, which are often misinterpreted as vacuum interrupter failure. When DC testing is performed, a test set providing a full wave rectified 35kVDC hipot voltage can be applied for 5 seconds as a "go - no go" test.

Recording the leakage readings is not necessary, as a dielectric breakdown will trip all portable DC hipot test sets. If a

DC test breakdown occurs, the test must be repeated after reversing the DC high voltage test supply connection across the vacuum interrupter. The working condition of a vacuum interrupter should be questioned only if it has failed both tests.

⚠ CAUTION

When testing with DC, use a DC high potential test (HIPOT) set with FULL WAVE rectification. Many DC high potential test sets us HALF-WAVE rectification. Do not use these half-wave rectifiers. The capacitance of the vacuum interrupter in combination with the leakage currents in the rectifiers and its DC voltage measuring equipment, may result in applying peak voltages as much as three times the measured voltage. These abnormally high voltages may give a false indication of a defective vacuum interrupter, and may produce abnormal x-radiation.

⚠ CAUTION

If DC high potential testing is performed, the DC high potential test machine must not produce instantaneous peak voltages exceeding 35kV.

No attempt should be made to try to compare the condition of one vacuum interrupter with another, nor to correlate the condition of any vacuum interrupter with low values of DC leakage current. There is no significant correlation.

3) *Control Voltage Insulation Integrity*

If the user wishes to check the insulation integrity of the control circuit, it may be done with a 500V or 1000V insulation resistance tester or with an AC high potential tester. The AC high potential test should be made at 1125 volts, 50 or 60 Hz for one minute. The charging motor must be disconnected prior to testing the control circuit. The charging motor itself may be similarly tested at a voltage not to exceed 675 volts, 50 or 60 Hz. Be sure to remove any test jumpers and reconnect the charging motor after the tests are complete.

⚠ CAUTION

Remove all grounding conductors applied for field dielectric test before placing the circuit breaker back into service.

4) *Mechanical Operation Check*

The mechanical operation of the circuit breaker is checked by inserting the manual charging handle into the manual charging crank and pulling up until a metallic click is heard. (The click indicates that the holding pawl has dropped into place on the ratchet wheel.) The procedure is repeated until the spring charge indicator indicates **"Closing Spring Charged".** This requires about 60 operations of the handle. Remove the handle.

Push the manual close paddle (Figure 2, c) inward and the circuit breaker will close. The circuit breaker open/closed indicator, located below the manual close operator will now display, **"Breaker Closed".** Push the manual trip paddle (Figure 2, e) inward, which is located at the bottom of the escutcheon and the circuit breaker open/closed indicator will now display **"Breaker Open".**

5) Electrical Operation Check

The PowlVac-ND® MA replacement circuit breaker uses a different type of secondary disconnect connection than that of the original circuit breaker.

The umbilical cord supplied along with the breakers is required to be installed on the switchgear side before inserting the breaker in the switchgear. The umbilical cord is required to be installed in such a way that it should not obstruct the path of the breaker in the breaker compartment. The length of the umbilical cord provided is sufficient for this consideration. If there is extra length on the cord suitable means to hang the cord should be provided on the breaker compartment door side if necessary.

To check the electrical operation of the circuit breaker, use the umbilical cord with the breaker. Remove the control fuses in the compartment. Connect the umbilical cord as stated in Section III DESCRIPTION, D. CIRCUIT BREAKER COMPARTMENT INTERFACES, 2) Secondary Disconnecting Contacts. Then the motor mechanism automatically charges the stored energy closing springs. Operate the closing switch on the front door of the compartment to close the circuit breaker. The circuitry is normally arranged to cause the motor to operate again and charge the closing spring. Operate the electrical trip switch on the front door to open the circuit breaker.

An alternate method to perform these functions is to connect the circuit breaker to a test cabinet.

E. INSERTING THE CIRCUIT BREAKER INTO THE SWITCHGEAR EQUIPMENT

⚠ CAUTION

Before installing any circuit breaker into a cell, the user must verify that the circuit breaker rating meets the metal-clad switchgear rating.

Most original MA type circuit breakers do not have a racking mechanism and are inserted using a special racking lever. Use the new handle provided with the replacement breaker and do not use the existing racking lever.

The breaker is shipped with the racking screw arrangement in retracted position. Follow the steps below to prepare the breaker for inserting in the cell and racking it in the connected position:

1. While the breaker is outside the compartment, move the racking position lever to the "racking position". Insert the racking handle and fully extend the racking screw by rotating it counterclockwise (out-direction).
2. Move the racking position lever to the "withdraw position". This will ensure the interlock weldment (which is at the rear and lower side of the breaker) is rotated and lifted, thus it will not interfere with the guide rails in the compartment while inserting the breaker.
3. Align the breaker with the compartment.
4. Push the breaker in the compartment. The interlock bar should drop in the first slot on the guide rail and will lock the breaker in this disconnected position. Observe the foot pedal which will spring back to the original position when the interlock bar is dropped in the first slot.
5. Move the racking position lever to the "racking position". This will drop the

interlock weldment (which is at the rear and lower side of the breaker) to engage in the space at the end of the guide rail.

> ⚠ **IMPORTANT**
>
> ***To avoid damage to the racking arrangement and other interlocks, it is very important to make sure that it drops completely and the interlock lever locks in the "racking position".***

6. Insert secondary disconnect into the breaker (see Section III. DESCRIPTION, D. CIRCUIT BREAKER COMPARTMENT INTERFACES, 2) Secondary Disconnecting Contacts) and verify that the secondary disconnect interlocking lever moves into the lower position (locked position).
7. Secure the latch on the lower side of the secondary disconnect to lock the secondary disconnect to the circuit breaker.

> ⚠ **IMPORTANT**
>
> ***To avoid damage to the racking arrangement and other interlocks, it is very important to make sure that the secondary disconnect is inserted fully and locked in place before racking the breaker.***

8. Depress the foot pedal to lift the interlock bar from the slot. This will unlock the breaker from disconnected position.
9. Insert the racking handle while keeping the foot pedal depressed. Rotate the handle clockwise (in-direction), thus beginning the racking in of the circuit breaker to the test position and release the foot pedal. The foot pedal will remain depressed until the breaker reaches the "test position".
10. After a few rotations, the breaker will reach the test position and the interlocking bar will drop in the second slot on the guide rail, locking the breaker in the test position. When the breaker reaches the test position the foot pedal will spring back to its original position. This will ensure that the breaker is in the test position.
11. Depress the foot pedal again and begin racking in the circuit breaker. After a few rotations release the foot pedal. The foot pedal will remain in depressed position. When the breaker reaches the connected position, the interlocking bar will drop in the next slot on the guide rail. The foot pedal will spring back to its original position, thus ensuring the breaker is now locked in the connected position.

F. REMOVING THE CIRCUIT BREAKER FROM THE SWITCHGEAR EQUIPMENT

Follow the steps below to remove the breaker from the cell:

1. Ensure the circuit breaker is tripped and in the open position.
2. While the breaker is in the connected position, press the foot pedal to lift the interlock bar from the slot.
3. Insert the racking handle while keeping the foot pedal depressed, rotate the handle counterclockwise (out-direction), thus racking the circuit breaker towards the test position and release the foot pedal. The foot pedal will remain depressed until the breaker reaches the test position.
4. When the breaker is moving from the connected position to the test position, the closing spring will discharge if it is charged.
5. To move the breaker from the test position to the disconnected position, ensure the breaker is open and press the foot pedal again to lift the interlocking bar from the slot. Insert and rotate the racking handle counterclockwise until the breaker reaches the disconnected position. The foot pedal will spring back to its original position when the breaker reaches the disconnected position.

6. When the breaker is in the disconnected position remove the secondary disconnect by unlocking the lower latch and lifting the interlocking lever.
7. Rotate the racking position lever to the "withdraw position". This will rotate and lift the interlock lever weldment which is at the rear and lower side of the circuit breaker. Lock the interlock lever in the "withdraw position".
8. Pull the breaker out of the cubicle.

The racking screw is extended out of the breaker. To retract the racking screw arrangement, please ensure the interlock lever is back in the "racking position" before cranking in the racking handle. This will avoid any damage to the racking screw assembly.

⚠ IMPORTANT

The illustrations shown for all levering procedures are provided to show device locations and are intended only as a guideline. These illustrations may NOT be representative of site-specific safety practices for performing the procedure. Before attempting any levering procedure, review Section II.

⚠ CAUTION

Keep hands off the top edge of the front cover when inserting the circuit breaker into the cell to avoid injury.

V. MAINTENANCE

Note: Contact ***Powell Service Division*** for assistance in performing maintenance or setting up a maintenance program either by phone (1.800.480.7273), by email (info@powellservice.com), or by visiting our website (www.powellind.com).

⚠ CAUTION

Prior to beginning any maintenance procedures, make certain that the control circuits are deenergized and the circuit breaker is resting securely outside the circuit breaker compartment. Do not work on a closed circuit breaker or a circuit breaker with the main closing spring charged.

⚠ IMPORTANT

Before attempting any maintenance work, it is important to study and fully understand the safety practices outlined in Section II of this instruction bulletin. If there is any reason to believe there are any discrepancies in the descriptions contained in this instruction bulletin, or if they are deemed to be confusing and/or not fully understood, contact Powell immediately.

A. GENERAL DESCRIPTION

1) Introduction

A regular maintenance schedule must be established to obtain the best service and reliability from the circuit breaker. PowlVac-ND® Type MA circuit breakers are designed to comply with industry standards requiring maintenance every 1000 or 2000 operations depending upon the rating of the circuit breaker, or once a year.

The need for scheduled inspection and maintenance depends on equipment application conditions such as the number of operations, magnitude of currents switched, desired overall system reliability, and the operating environment. Any time the circuit breaker is known to have interrupted a fault current at or near its rating, it is recommended that the circuit breaker be inspected and the necessary maintenance be performed as soon as practical. Inspection and maintenance may be required at more frequent intervals in some atmospheric conditions such as extremes of dust, moisture, or corrosive gases.

Very clean and dry conditions combined with low switching duty will justify longer times between inspection and maintenance operations. An inspection and maintenance schedule can be developed by the user according to the service requirements and conditions of the specific circuit breaker.

If maintenance is performed at longer time intervals than one year, the vacuum integrity test should be performed each time the circuit breaker is removed from the metal-clad switchgear for reasons other than scheduled circuit breaker maintenance.

A permanent record of all maintenance work should be kept, the degree of detail depends upon the operating conditions. The record will be a valuable reference for subsequent maintenance work and for station operation. It is also recommended that the record include reports of tests performed, the condition of circuit breakers, and any repairs or adjustments that were performed. This record should begin with tests performed at the time of installation and energizing, and all data should be graphed as a function of time to ensure a proper maintenance cycle is scheduled.

Because of extensive quality control tests made at the factory, the operations counter on a new circuit breaker will normally register over a hundred operations. The reading of the operations counter should be recorded when the circuit breaker is placed into service and when any maintenance work is performed.

⚠ CAUTION

When any maintenance procedures require opening or closing of the circuit breaker or charging of any of the mechanism springs, exercise extreme care to make sure all personnel, tools and other objects are kept well away from all moving parts or charged springs.

⚠ CAUTION

When cleaning the circuit breaker insulating supports and bus insulation, use only denatured alcohol or isopropyl alcohol to remove foreign material. Failure to do so may damage the dielectric and/or the mechanism properties of the insulation.

2) *Inspection and Cleaning*

Visually check the circuit breaker for loose or damaged parts. Tighten or replace loose or missing hardware. Any damaged parts that will interfere with the normal operation of the circuit breaker should be replaced. The inspection will be easier if the front cover and interphase barrier assembly are removed.

Clean the circuit breaker by removing any loose dust and dirt. Do not use compressed air to clean dirt from the circuit breaker. This may result in blowing loose dirt or grit into bearings or other critical parts, thus causing excessive wear on these parts. To clean the circuit breaker, remove dirt with a vacuum cleaner, or wipe dirt away with a dry, lint-free cloth or an industrial-type wiper. Do not use solvents, de-greasers, or any aerosol products to clean in the area of any mechanisms. Refer to Section V. MAINTENANCE, B. MECHANISM AREA, 2) Lubrication, for instructions on cleaning the lubricated areas for the stored energy mechanism and other specified parts.

Primary insulation, including the vacuum interrupter supports and the operating rods, should be cleaned. Wipe the insulation clean with a dry, lint-free cloth or an industrial type wiper. If dirt adheres and cannot be removed by wiping, remove it with distilled water or a mild solvent such as denatured alcohol. Be sure that the circuit breaker is dry before returning it to service. Do not use any type of detergent to wash the surface of the insulators because detergent may leave an electrically conducting residue on the surface as it dries.

B. MECHANISM AREA

1) *Mechanical Operation*

Remove the circuit breaker front cover to expose the stored energy mechanism. Make a careful visual inspection of the mechanism for loose, damaged, or excessively worn parts.

Note: If timing tests are performed as in, Section V. MAINTENANCE, D. OPTIONAL MAINTENANCE PROCEDURES, do not operate the circuit breaker until these tests are completed. Operation of the mechanism may alter the "As found" operating condition of the circuit breaker's stored energy mechanism.

For further details, see Section IV. INSTALLATION, D. PLACING THE CIRCUIT BREAKER INTO SERVICE, 4) Mechanical Operation Check.

2) *Lubrication*

⚠ *WARNING*

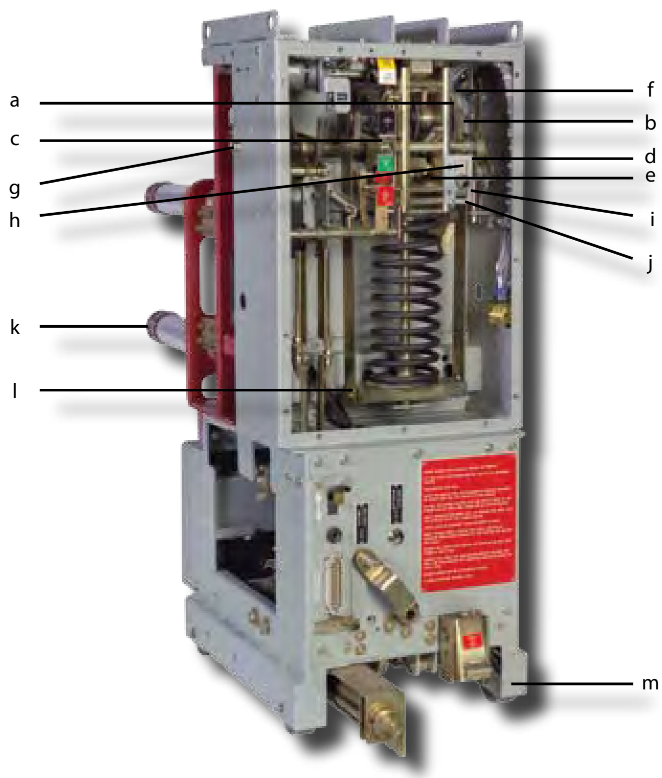
Before applying any type of lubrication to the circuit breaker, the stored energy mechanism should be in the open position, and all springs should be discharged.

Powell offers a complete lubrication kit (Powlube-102) which contains all the lubricants required for maintaining the circuit breakers. Powlube-102 contains Rheolube 368A grease, Anderol 456 oil, and Mobilgrease 28.

Rheolube 368A grease should be lightly applied to those bearing surfaces that are accessible. Inaccessible surfaces, such as bearings, may be lubricated with a light synthetic machine oil such as Anderol 456 oil. Mobilgrease 28 should be applied to the electrical contact surfaces.

Lubricate the stored energy mechanism and other specified parts in accordance with Table B. Lubrication. See Figures 6 and 7 for labeled lubrication photographs.

Figure 6 - Lubrication



a. *Close Latch Shaft Face*

b. *Ratchet Wheel*

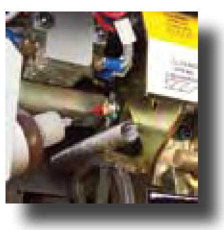
c. *Jackshaft Lever Pin*

d. *Pawl Support Arm*

e. *Fundamental Linkage Pin*

f. *Pawls*

g. *Jackshaft Outer Bearing Support*

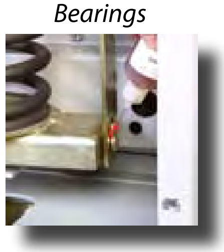


h. *Motor Drive Shaft Roller Needle Bearings*

i. *Jackshaft Support*

j. *Trip Shaft Bearing*

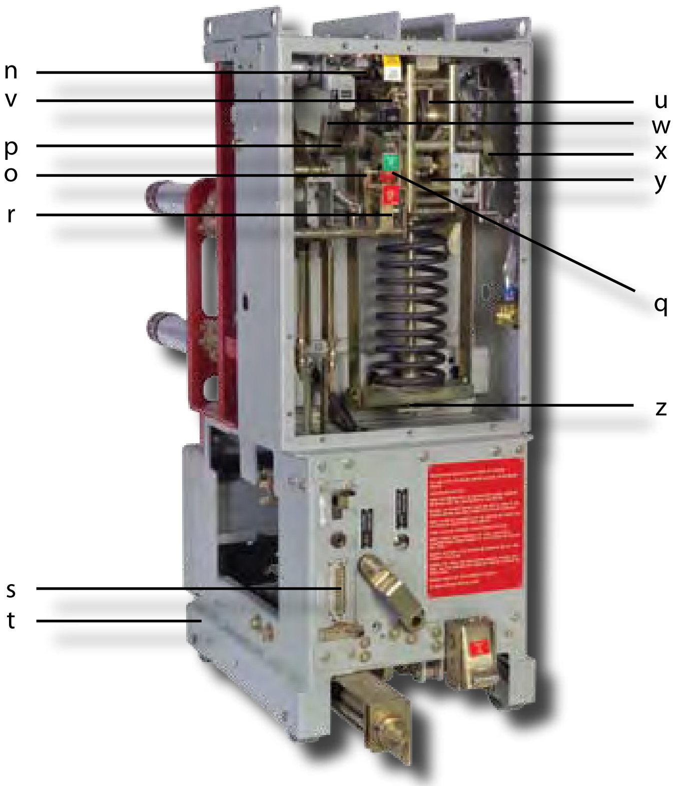
k. *Primary Disconnecting Contact*



l. *Spring Yoke Pin*

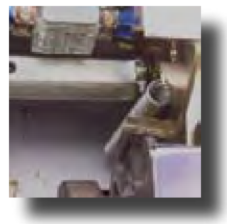
m. *Wheel*

Figure 7 - Lubrication (cont)

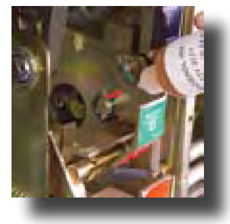


n. Motor Cutoff Cam

o. Open Closed Flag Drive Lever Pin at Jackshaft



p. Motor Drive Shaft Coupling



q. Flag Support Pin

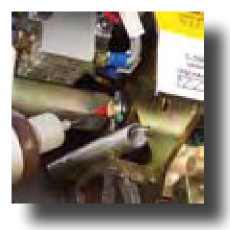
r. Primary Trip Prop

s. Secondary Disconnect Contact

t. Ground Connection

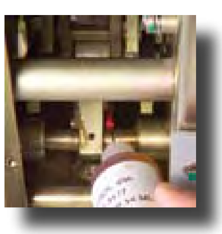
u. Close Shaft Support Bearing

v. Camshaft Needle Bearings



w. Motor Drive Shaft Bearings

x. Crank Pin

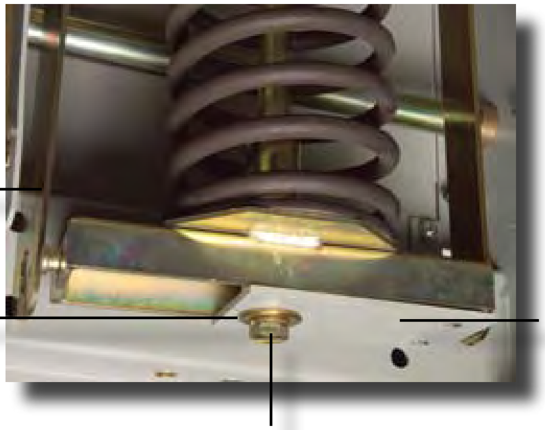


y. Fundamental Linkage

z. Main Closing Spring Guide Rod

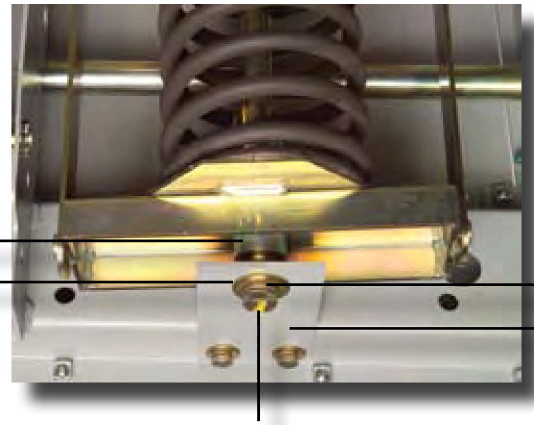
(Table B) Lubrication			
Location	**Reference Figure**	**Lubricant**	**Method**
Electrical Parts			
Primary Disconnecting Device	Fig 6 (k)	Mobilgrease 28	Wipe clean. Apply lubricant only to actual contact surface.
Ground Connection	Fig 7 (t)	Mobilegrease 2	Wipe clean. Apply lubricant only to actual contact surface.
Secondary Disconnect Receptacle	Fig 7 (s)	Mobilgrease 28	Wipe clean. Apply lubricant only to actual contact surface.
Mechanical Parts			
Spring Yoke Pin	Fig 6 (l)	Anderol 456 Oil	
Trip Shaft Bearing	Fig 6 (j)	Anderol 456 Oil	
Jackshaft Support	Fig 6 (i)	Anderol 456 Oil	
Pawl Support Arm	Fig 6 (d)	Anderol 456 Oil	
Crank Pin	Fig 6 (x)	Anderol 456 Oil	
Motor Drive Shaft Roller Needle Bearings	Fig 6 (h)	Anderol 456 Oil	
Pawls	Fig 6 (f)	Anderol 456 Oil	
Close Latch Shaft Face	Fig 6 (a)	Rheolube 368A Grease	Apply a light coating of grease and remove all excess.
Ratchet Wheel	Fig 6 (b)	Rheolube 368A Grease	
Jackshaft Lever Pins passing through Operating Pushrods	Fig 6 (c)	Anderol 456 Oil	Avoid lubricant on operating pushrods.
Fundamental Linkage Pin	Fig 6 (e)	Anderol 456 Oil	Apply to penetrate where pin passes through end link.
Main Closing Spring Guide Rod	Fig 7 (z)	Anderol 456 Oil	
Primary Trip Prop	Fig 7 (r)	Anderol 456 Oil	
Open-Close Flag Drive Lever Pin at Jackshaft	Fig 7 (o)	Anderol 456 Oil	
Flag Support Pin	Fig 7 (q)	Anderol 456 Oil	
Jackshaft Outer Bearings Support	Fig 6 (g)	Anderol 456 Oil	
Motor Drive Shaft Coupling	Fig 7 (p)	Anderol 456 Oil	
Wheel	Fig 6 (m)	Anderol 456 Oil	
Motor Drive Shaft Bearings	Fig 7 (w)	Anderol 456 Oil	
Camshaft Needle Bearings	Fig 7 (v)	Anderol 456 Oil	
Close Shaft Support Bearings	Fig 7 (u)	Anderol 456 Oil	
Motor Cutoff Cam	Fig 7 (n)	Rheolube 368A Grease	Apply to peripheral surface only.
Fundamental Linkage	Fig 7 (y)	Anderol 456 Oil	Apply to penetrate where pins pass through links.

Figure 8 - Main Closing Spring Assembly Compressed for Removal



a. Connecting Rod
b. Flat Washer
c. Bracket
d. Bolt

Figure 9 - Main Closing Spring Assembly Installed



a. Spacer
b. Flat Washer
c. Lock Washer
d. Bolt
e. Bracket

Table B lists the location of all surfaces that should be lubricated, the type of lubricant to be used, and the method of applying the lubricant. The guiding rule in lubrication is to lubricate regularly, use lubricant sparingly and remove all excess lubricant. There is no need to disassemble the mechanism for lubrication. Tilting the circuit breaker will enable the lubricant to cover the bearing surfaces.

3) Closing Spring Removal

The closing spring must be removed in order to perform slow closing of mechanism.

Although main closing spring removal is not necessary for lubrication, it may be necessary for performing adjustments or major overhaul tasks. Furthermore, removal of the main closing spring permits slow closing of the mechanism and the vacuum interrupter contacts. For details, see Section V. MAINTENANCE B. MECHANISM AREA, 4) Slow Closing of Mechanism.

The procedure for spring removal is as follows:

1. With the main closing spring discharged and the circuit breaker contacts open, remove the screw at the bottom of the spring rod together with the flat washer, and lock washer.
2. Remove the horizontal bracket at the bottom of the main closing spring, by unfastening the two attachment screws.
3. Remove the spacer from above the bracket.
4. Turn the bracket 90˚, and replace it on the bottom of the spring yoke.

5. Place the spacer below the bracket with the flat washer below it.
6. Insert screw and tighten until the tension is taken off the connecting rods.
7. With a slight rocking motion of the main closing spring assembly, the connecting rods (Figure 8, a) can now be unhooked from the spring yoke pins and the main closing spring assembly can be removed.

Note: *Care should be taken on reassembly to ensure correct location of the flat washer, lock washer and spacer (Figure 9).*

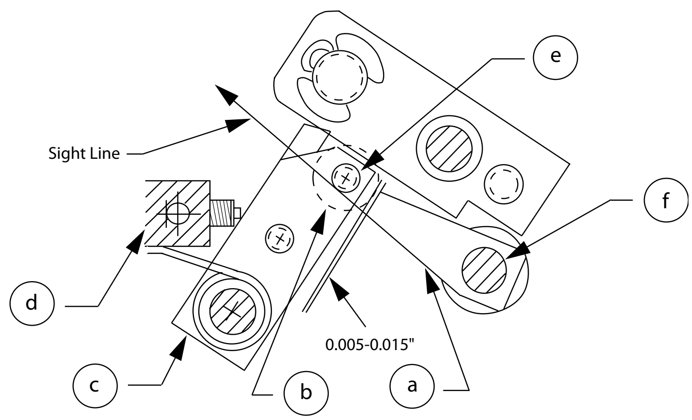
4) *Slow Closing of Mechanism*

The slow closing of mechanism described is not required for routine maintenance; however, it may be a useful procedure for troubleshooting circuit breaker misoperation.

For slow closing of mechanism, perform the following steps:

1. With the main closing spring assembly removed, rotate the camshaft so that the crank arms are pointing upward. The fundamental linkage will now move into the reset position.
2. Push the manual close operator inward and hold it in while operating the manual charging handle to rotate the camshaft.
3. When the close release latch arm is past the close shaft latch plate, the manual close operator may be released. As the main closing cam engages the main cam roller, the jackshaft will commence to rotate.

Figure 10 - Primary & Secondary Trip Prop Adjustment



a. Secondary Trip Prop (Top Edge)
b. Primary Trip Prop Roller
c. Primary Trip Prop
d. Primary Trip Prop Adjusting Screw
e. Rivet
f. Trip Bar

4. Continue to operate the charging handle until the crank arms point downward. The circuit breaker will now be closed and there will be a gap between the operating pushrod lock nuts and the contact spring yokes.
5. Return the circuit breaker to the open position by depressing the manual trip operator.
6. To install the main closing spring assembly reverse the preceding removal procedure.

5) Mechanism Adjustments

WARNING

When any maintenance procedure requires the opening or closing of the circuit breaker or the charging of any of the stored energy mechanism springs, exercise extreme caution to make sure that all personnel, tools, and other miscellaneous objects are kept well clear of the moving parts or the charged springs. Failure to do this may cause serious damage or injury to the circuit breaker or personnel.

Several factory adjustments in the stored energy mechanism are described below. **NO ADJUSTMENT OF THESE SETTINGS IS REQUIRED FOR ROUTINE MAINTENANCE**, but they may need to be adjusted after a major overhaul or removal of the mechanism.

Note: *Do NOT adjust these settings unnecessarily, as damage to the circuit breaker may occur.*

a) Adjustment of Ratchet Wheel Holding Pawl

The holding pawl support arm is adjusted by the holding pawl adjusting eccentric (Figure 3, r).

If the pawl is not properly adjusted, there will be a "knocking" noise when the ratchet mechanism is operating or the stored energy mechanism will not ratchet at all.

To adjust the pawl perform the following steps:

1. Remove the escutcheon to gain access to the head of the bolt holding the adjusting eccentric.
2. Loosen the bolt slightly.
3. Grip the eccentric with a pair of slip-joint pliers or a similar tool and rotate the stop slightly.
4. Tighten the holding bolt with the eccentric in the new position.
5. While charging the main closing springs, using the charging motor to drive the mechanism, observe the ratcheting operation for improvement.
6. If the ratcheting operation has not improved, repeat the preceding sequence until the ratcheting operation is smooth. This may require several charging cycles.
7. When the eccentric is properly set replace the escutcheon.

Be sure that the escutcheon is reinstalled on the proper circuit breaker, since the escutcheon contains the nameplate with the circuit breaker's rating and serial number information. The serial number of the circuit breaker is also attached to the circuit breaker frame near the ground connection on a stamped metal plate. The serial number found on the nameplate must match the number affixed to the frame.

b) Adjustment of Primary Trip Prop

Perform the following procedures to adjust the primary trip prop:

1. Remove the main closing spring. Refer to Section V, MAINTENANCE, B. MECHANISM AREA, 3) Closing Spring Removal.

2. Adjust the primary trip prop adjusting screw (Figure 10, d) so that with the fundamental linkage in the reset position, the clearance between the primary trip prop roller and the secondary trip prop is 0.005" to 0.015". The primary trip prop adjusting screw is accessible from the rear of the stored energy mechanism and is located inside the hole beside the upper middle insulator supporting the live part assembly (Figure 10,d).
3. Replace the main closing spring.

c) Tripping System Adjustment

To adjust the PowlVac® Tripping System perform the following steps:

1. Prior to performing this adjustment procedure, all high voltage components shall be deenergized, disconnected by means of a visible break and securely grounded, and ensure that the control circuits are deenergized.
2. Remove the circuit breaker front cover.
3. Loosen the secondary trip prop adjusting screw (Figure 5, a) locking nut several full turns.

CAUTION

Do not allow the secondary trip prop adjusting screw to turn while loosening the locking nut! Failure to observe this caution will severely damage the mechanism!

CAUTION

Prior to performing any adjustment or maintenance procedure, all high voltage components shall be deenergized, disconnected by means of a visible break, and securely grounded.

4. Manually charge the circuit breaker main spring.
5. Manually CLOSE the circuit breaker
6. Slowly turn the secondary trip prop adjusting screw clockwise in $^1/_8$ turn (45°) increments until the breaker trips (OPENS). Carefully not the rotational position of the tool used to turn the adjusting screw at the moment the breaker operates.

   DO NOT turn the screw any further clockwise after the breaker operates.
7. Turn the secondary trip prop adjusting screw counterclockwise 1 ½ full turns from the position noted in step 6.
8. While holding the secondary trip prop adjusting screw from turning, securely tighten the secondary trip prop adjusting screw locking nut.
9. Manually charge the main closing spring using the manual charge handle per Section IV, INSTALLATION, D. PLACING THE CIRCUIT BREAKER INTO SERVICE, 4) Mechanical Operation Check.
10. Manually CLOSE the circuit breaker.
11. Using leaf type feller gauges with a total of 0.090" thickness selected, position the feeler gauge as shown in Figure 11.

12. Slowly depress the trip coil armature using the manual charge handle. Depress the handle until the armature contact the feeler gauges. The circuit breaker should NOT trip.

Figure 11 - Feeler Gauge

Note: *Figure 11 is inverted. On the PowlVac-ND MA circuit breaker the feeler gauge will be to the right of the main closing spring.*

Tilting the armature by applying a load to the left of the feeler gauges will produce incorrect results.

13. Choose one of the following steps according to the TRIP status:

    i. If the circuit breaker TRIPPED during the test performed in step 12, increase the gap between the trip coil armature and the trip lever by bending the lever downwards slightly using channel lock pliers or a small crescent wrench. Repeat steps 9 through 12.

Note: *Bend the trip lever in very small increments. This process may take several attempts.*

    ii. If the circuit breaker did not TRIP during the test performed in step 12, reset the feeler gauges with 0.030" selected and position the feeler gauge.

14. Slowly depress the trip coil armature using the manual charge handle. Depress the handle until the armature contacts the feeler gauges. The circuit breaker should trip.

Note: *It is important to avoid "tilting" the trip coil armature. Tilting the armature by applying a load to the left of the feeler gauges will produce incorrect results.*

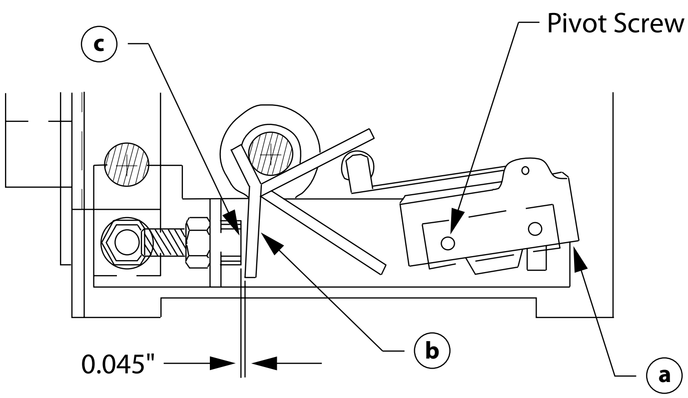
15. If the circuit breaker did NOT TRIP during the test performed in step 14, remove the feeler gauges and trip the breaker. Decrease the gap between the trip coil armature and the trip lever by bending the trip lever upwards slightly using channel lock pliers or a small crescent wrench. Repeat steps 9, 10, & 14.

Note: *Bend the trip lever in very small increments. This process may take several attempts.*

16. Repeat steps 9 through 15 until the breaker does NOT trip with the 0.090" gauge inserted in the trip coil armature gap and does trip with 0.030" gauge inserted into the trip coil armature gap.
17. Perform the latch check switch adjustment per the procedure found in Section V, MAINTENANCE, B. MECHANISM AREA, 4) Mechanism Adjustments, d) Latch Check Switch Adjustment.
18. Replace circuit breaker front cover.

d) Latch Check Switch Adjustment

Figure 12 - Latch Check Switch Adjustment



a. Latch Check Switch
b. Latch Check Operator
c. Secondary Trip Prop Adjusting Screw

The latch check switch adjustment (Figure 12) described is not required for routine maintenance; however, the latch check switch may need to be adjusted after major overhaul, removal of the mechanism, or tripping system adjustment.

To adjust the latch check switch perform the following steps:

1. Remove the main closing spring as described in this section.
2. Rotate the crank arms until the spring charge indicator displays, CLOSING SPRING CHARGED.
3. Loosen the two screws which secure the latch check switch and rotate the latch check switch about the pivot screw upward to the highest position allowed. The latch check switch contacts are now OPEN.
4. Insert a 0.045" gauge between the secondary trip prop adjusting screw and latch check operator. Rotate the latch check switch downward until the contacts are closed. (An audible click of the contacts will be heard.) At the position where the click is heard hold the switch and retighten the two screws which secure the latch check switch. Remove the gauge.
5. To confirm that the latch check switch is properly set, slowly depress and release the manual trip operator to verify that the latch check switch OPENS and CLOSES properly. An audible click of the contacts will be heard. The latch check switch contacts will OPEN as the latch check operator is moved by the manual trip operator away from the secondary trip prop adjusting screw. Slowly withdraw the manual trip operator and the latch check switch contacts should close when the latch check operator is between 0.045" to 0.015" away from the secondary trip prop adjusting screw.
6. Depress the manual close operator and rotate the crank arm until resistance is felt.
7. Depress and hold the manual trip operator inward and rotate the crank arms until the spring charge indicator displays, CLOSING SPRING DISCHARGED.
8. Reinstall the circuit breaker main closing spring.

e) Adjustment of Close Latch Shaft

The close latch shaft (Figure 3, k) passes through the side sheets of the stored energy mechanism frame at the front of and above the cam shaft. The right end of the shaft is shaped to make a latch face and interferes with the close latch arm (Figure 3, aa), which is fixed to the cam shaft. The other end of the close latch shaft is on the left side of the mechanism and a small lever attached to it is positioned by a close bar adjusting screw (Figure 3,k).

To adjust the close latch shaft perform the following procedures:

1. Remove the escutcheon.
2. Loosen the locking nut from the close bar adjusting screw while holding the position of the close bar adjusting screw with a screw driver.
3. Back out the close bar adjusting screw by turning the screw counterclockwise 2 full turns.
4. Manually charge the circuit breaker main closing spring with a manual charging handle until the spring charge indicator displays CLOSING SPRING CHARGED.
5. Turn the close bar adjusting screw clockwise until the main closing spring discharges, then depress the manual trip operator to OPEN the circuit breaker.
6. Turn the close bar adjusting screw 3 to 3½ full turns counterclockwise. Retighten the locking nut holding the screw.
7. Repeat step 5. Then CLOSE and OPEN the circuit breaker to ensure proper operation.
8. Replace the escutcheon.

f) Open and Close Spring Release Lever Adjustment

If the circuit breaker has rolled over an obstruction on the floor which caused displacement of the open or close spring release lever, adjust the lever if necessary. The spring release interlock link (Figure 3, y) and the opening interlock link (Figure 3, z) need to be adjusted if required.

When the circuit breaker is withdrawn from the cell to the disconnected position, the close spring release lever operates and discharges the main springs in the mechanism.

The opening interlock link is connected to the foot pedal (Figure 2, n). When the foot pedal is pressed, the opening interlock link moves and trips the circuit breaker. This link may need adjustments as necessary.

6) Electrical Operation

After performing any necessary mechanical and lubrication maintenance, operate the circuit breaker electrically several times to ensure that the electrical control system works properly. See Section IV. INSTALLATION, D. PLACING THE CIRCUIT BREAKER INTO SERVICE, 5) Electrical Operation Check.

C. VACUUM INTERRUPTER AND CONTACT AREA

1) Vacuum Interrupter and Contact Erosion

At each inspection the vacuum interrupters should be checked for contact erosion. The circuit breaker must be closed for this check. Each new vacuum interrupter is set with a gap of about 1/4" to 5/8" between the contact loading spring yoke and the lock nut on the operating pushrod stud. As

(Table C) Primary Current Path					
Breaker Type	**Rated (kV)**	**Rated Continuous Current (Amps)**	**Vacuum Interrupter Assembly**	**Primary Disconnecting Device Assembly**	**Operating Pushrod Assembly**
05PV36MAX	4.76	1200	77015G01P	5UC.100.109	77017G01P
05PV36MAX	4.76	2000	77015G01P	5UC.100.107	77017G01P
05PV50MAX	4.76	1200	77015G01P	5UC.100.109	77017G02P
05PV50MAX	4.76	2000	77015G01P	5UC.100.107	77017G02P

Figure 13 - Primary Current Path

b

a

c

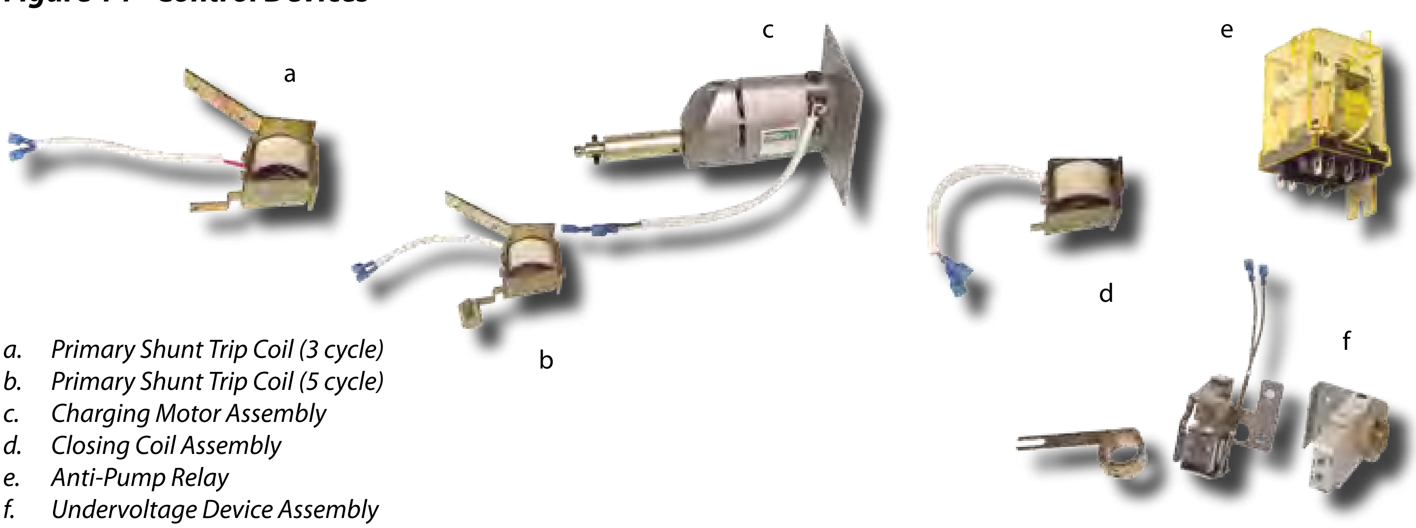
a. Primary Disconnecting Device Assembly
b. Vacuum Interrupter Assembly
c. Operating Pushrod Assembly

(Table D) Control Devices							
Control Voltage	**Closing Coil Assembly**	**Primary Shunt Trip Coil Assembly (3 cycle) (2)**	**Primary Shunt Trip Coil Assembly (5 cycle)**	**Secondary Shunt Trip Coil Assembly (1, 3)**	**Undervoltage Device Assembly**	**Charging Motor Assembly**	**Anti-Pump Relay Assembly (5)**
48VDC	77026G01P	77027G01P	50041G01P	50042G01P	(4)	77318G01P	RR2BA-US-DC-48V
125VDC	77026G03P	77027G02P	50041G02P	50042G03P	(4)	77318G02P	RR2BA-US-DC 110V
250VDC	77026G04P	77027G03P	50041G03P	50042G04P	(4)	77318G03P	RR2BA-US-DC 110V
120VAC	77026G01P	77027G01P	50041G05P	50042G01P	n/a	77318G02P	RR2BA-US-AC 120V
240VAC	77026G02P	77027G06P	50041G06P	50042G02P	n/a	77318G03P	RR2BA-US-AC 240V
Capacitor Trip (6)	n/a	50027G04P	50041G04P	50042G05P	n/a	n/a	n/a

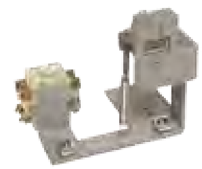
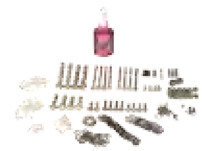
Notes:

1) *One required per circuit breaker if the circuit breaker was originally equipped with this item. All circuit breakers have a closing coil, primary shunt trip coil, charging motor, and an anti-pump relay assembly. Secondary shunt trip coils and undervoltage device assemblies are optional (see notes 2-7).*
2) *Primary shunt trip coil is available as a 3 cycle and 5 cycle control device. A circuit breaker with an original 5 cycle trip coil may not be replaced with a 3 cycle trip coil as damage to the circuit breaker may occur. A circuit breaker with an original 3 cycle trip coil may be replaced with a 5 cycle trip coil.*
3) *Secondary shunt trip coil cannot be furnished with an undervoltage device assembly.*
4) *Where furnished, cannot be present with secondary shunt trip coil assembly.*
5) *For 250VDC applications, a dropping resistor 50747G02P is required in series with the anti-pump relay assembly.*
6) *For use with capacitor trip units with 240VAC input. Consult factory for other circuit breaker ratings.*
7) *All control devices are available with push-on terminals. Consult factory for control devices with screw terminals.*

Figure 14 - Control Devices



a. Primary Shunt Trip Coil (3 cycle)
b. Primary Shunt Trip Coil (5 cycle)
c. Charging Motor Assembly
d. Closing Coil Assembly
e. Anti-Pump Relay
f. Undervoltage Device Assembly

(Table E) Miscellaneous Parts		
Description	**Catalog Number**	**Illustration**
Auxiliary Switch Push-on Terminals Screw Terminals	102108LN 102108LP	
Latch Check Switch	BA-2RV2-A2	
Motor Cutoff Switch Assembly	77034G01P	
PowlVac-ND Hardware Kit	60500G24	
PowlVac-ND Lubrication	Powlube-102	

the contacts erode with use, this gap will decrease. The factory setting of the lock nut gap varies for each vacuum interrupter.

The contact travel of the vacuum interrupter contacts is measured by subtracting the lengths between the upper contact block and the vacuum interrupter linkage pins in both the open and closed positions. A label is supplied on each vacuum interrupter with the original setting and end of life dimensions for that particular interrupter installed on each circuit breaker. When the gap measurement described in Section VI. RECOMMENDED RENEWAL PARTS AND REPAIR PROCEDURES, C. REPLACEMENT PROCEDURES, 1) Vacuum Interrupter Assembly reaches the end-of-life value given on this label, the vacuum interrupter should be replaced. Detailed instructions for vacuum interrupter replacements are given in this instruction bulletin.

2) *Sliding Contact Finger Wear*

The PowlVac-ND® MA 5kV circuit breaker uses a multi-contact assembly located inside the upper contact block and in direct contact between the moving stem of the vacuum interrupter and the upper contact block. Each upper contact block also uses polymer bushings to support and align the movement of the vacuum interrupter's moving stem. Because the current transfer mechanism is located inside the upper contact block and shielded from the outside atmosphere by the polymer bushings, no scheduled preventative maintenance is required for the sliding contacts.

3) *Vacuum Integrity*

Refer to the Section IV. INSTALLATION, D. PLACING THE CIRCUIT BREAKER INTO SERVICE for information on vacuum integrity and testing of vacuum interrupters.

4) *Mechanical Adjustment of Vacuum Interrupters*

There are no adjustments required for routine maintenance of a vacuum interrupter assembly. There are several factory adjustments which will vary over the operating life of the vacuum interrupter. **ADJUSTMENTS OF THESE SETTINGS IS ONLY NECESSARY WHEN REPAIR REQUIRES THE REMOVAL OR REPLACEMENT OF THE VACUUM INTERRUPTER. DO NOT ADJUST THESE SETTINGS UNNECESSARY AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT.** When it is necessary to remove or replace the vacuum interrupter, refer to Section VI. RECOMMENDED RENEWAL PARTS AND REPAIR PROCEDURES, C. REPLACEMENT PROCEDURES, 1) Vacuum Interrupter Assembly or contact the Powell Service Division.

D. OPTIONAL MAINTENANCE PROCEDURES

1) *High Potential Tests*

High potential tests are not required for routine maintenance but are recommended after a heavy fault interruption, any major circuit breaker repair that involves the primary current path or when the circuit breaker has been in storage for an extended time, especially in a damp location or other adverse environment. In these cases, both the High Voltage Insulation Integrity and Control Voltage Insulation Integrity tests should be performed. For details of maintenance procedures, see section IV. INSTALLATION, D. PLACING THE CIRCUIT BREAKER INTO SERVICE.

2) *Timing*

Perform **CLOSE** and **OPEN** timing tests at the nominal control voltage. The voltage is printed on the circuit breaker nameplate.

To measure **CLOSE** timing, operate the test source to the **CLOSE** position. When the circuit breaker closes, record the closing time. The closing time from energizing the closing coil to vacuum interrupter contact touch should not exceed the values in *Table F. Timing.*

(Table F) Timing		
Cycles	**Closing Time (ms)**	**Tripping Time (ms)**
3	<80	<35
5	<80	<55

To measure **OPEN** timing, operate the test source to the **OPEN** position. When the circuit breaker opens, record the closing time. Operate the test source to the **OPEN** position to open the circuit breaker and record the opening time. The opening time from energizing the shunt trip coil to vacuum interrupter contact part should not exceed the values listed in *Table F. Timing*.

3) *Primary Resistance Check*

The primary resistance check is not required for routine maintenance but it is recommended after any major maintenance that requires disassembly of any part of the primary current path.

To check the primary resistance, pass a minimum of 100A DC through the circuit breaker pole, with the circuit breaker closed. Measure the voltage drop across the primary contacts and calculate the resistance. The resistance should not exceed the values provided in this instruction bulletin for the specific type and rating of the circuit breaker being measured.

The micro-ohm values of resistance must not exceed the limits in *Table G, Primary Resistance*.

(Table G) Primary Resistance			
Breaker Type	**Rated (kV)**	**Continuous Current (Amperes)**	**Resistance (Micro-ohms)**
05PV36MAX-21	5	1200	100
05PV36MAX-22	5	2000	100
05PV50MAX-21	5	1200	80
05PV50MAX-22	5	2000	80

VI. RECOMMENDED RENEWAL PARTS AND REPAIR PROCEDURES

A. ORDERING INSTRUCTIONS

1. To order Renewal Parts from Powell, visit the website at www.powellind.com or call 800.480.7273.
2. Always specify the complete nameplate information including:

- Circuit Breaker Type
- Serial Number
- Rated Voltage
- Rated Amps
- Impulse Withstand
- Control Voltage (for control devices and coils)

3. Specify the quantity and description of the part and the instruction bulletin number. If the part is in any of the recommended renewal parts tables, specify the catalog number. If the part is not in any of the tables, a description should be accompanied by a marked illustration from this instruction bulletin or photo.

B. RECOMMENDED RENEWAL PARTS

A sufficient amount of renewal parts should be stored to enable the prompt replacement of any worn, broken, or damaged part. A sufficient amount of stocked parts minimizes service interruptions caused by breakdowns and saves time and expense. When continuous operation is a primary consideration, a larger quantity of renewal parts should be stocked depending on the severity of the service and the time required to secure replacement parts.

Since parts may be improved periodically, renewal parts may not be identical to the original parts. Tables C, D, and E list the recommended spare parts to be carried in stock by the user. The recommended quantity is not specified. This must be determined by the user based on the application. As a minimum, it is recommended that one set of parts be stocked per ten circuit breakers or less.

Powell recommends that only qualified technicians perform maintenance on these units. If these circuit breakers are installed in a location where they are not maintained by a qualified technician, a spare circuit breaker should be on site ready for circuit breaker replacement. The malfunctioning unit can then be returned to the factory for reconditioning.

C. REPLACEMENT PROCEDURES

This section includes instructions for replacing the parts recommended as renewal parts. Before attempting any maintenance repair work, take note of the safety practices outlined in Section II. of this instruction bulletin.

⚠ CAUTION

Ensure that the control circuits are deenergized and the circuit breaker is deenergized, disconnected by means of a visible break, and securely grounded. Do NOT start to work on a closed circuit breaker or a circuit breaker with the main closing spring charged. When any maintenance procedure requires the opening or closing of the circuit breaker or the charging of any of the stored energy mechanism springs, exercise extreme caution to ensure that all personnel, tools, and other miscellaneous objects are kept clear of the moving parts of the charged springs.

1) *Vacuum Interrupter Assembly*

The vacuum interrupter assembly (Figure 13, b) should only be replaced by a qualified technician or a Powell Service Technician. For further assistance, please contact Powell at 800.480.7273.

This assembly is located between the upper and lower primary disconnecting contacts (see Figure 1, g).

Perform the following steps to replace the vacuum interrupter assembly:

a. Ensure all operating springs are discharged and the circuit breaker is in the open position.
b. Remove the interphase barrier assembly.

c. Using a ¾″ hex open end wrench, loosen the ½″ jam nut securing the vacuum interrupter adaptor to the top of the vacuum interrupter moving stem.
d. Using pliers, remove the X-washer retaining clips and thrust washers from the ends of vacuum interrupter linkage pins in the bell cranks.
e. Remove the linkage pins and the bell cranks from the upper contact block assembly.
f. Loosen the anti-bellows spring assembly from the vacuum interrupter by unscrewing counterclockwise as seen from the top of the upper contact block.
g. Once the anti-bellows spring assembly has been removed from the top of the moving stem, loosen the ½″ bolts anchoring the upper contact block to the upper standoff insulator and remove the two 5/16″-18 bolts from the back side of the insulating support plate securing the upper contact block above the upper standoff insulator.
h. Remove the two 5/16″-18 bolts from the back side of the insulating support plate securing the lower contact block below the lower standoff insulator.
i. Loosen the ½″ bolts anchoring the lower contact block to the lower standoff insulator.
j. Remove both lower and upper ½″ bolts and remove the vacuum interrupter assembly from the insulating support plate.
k. Place the vacuum interrupter assembly on a suitable flat work surface and remove the 5/16″ x 18″ bolts securing the primary disconnecting contacts from the lower and upper contact blocks.
l. Check the contents of the replacement vacuum interrupter kit. It should contain the following items:
   - Vacuum interrupter assembly, complete with lower and upper blocks
   - X-washers
   - Metal tooth ty-wraps
   - Powlube-102 lubricant kit
m. Remove the temporary shipping bracket from the rear of the contact blocks.
n. Place the vacuum interrupter assembly on the insulating support plate and insert the ½″ bolts in the lower contact block.
o. Gently pull up the upper contact block until the upper ½″ holes line up and insert the upper contact block bolts.
p. Leaving both lower and upper ½″ bolts loose, align and install the four 5/16″ -18 bolts from the back side of the insulating support plate.
q. Once all six bolts have been started and aligned, tighten all bolts to recommended specifications (½″ bolts to 40 ft.-lbs, 5/16″ bolts to 20 ft.-lbs)
r. Remove the anti-bellows spring from its assembly.
s. Compress the spring by hand or in a suitable vise such that the metal tooth ty-wraps compresses over the spring to a held compressed state. Be sure to use two or more ty-wraps to equally compress the spring.
t. Place the precompressed spring over the bell shaped retainer and screw the assembly into the tapped hole in the vacuum interrupter upper moving stem.

CAUTION

Do NOT use the upper block to turn the vacuum interrupter assembly into the lower block as damage to the interrupter bellows assembly and loss of vacuum may result.

u. Once the anti-bellows assembly has been installed to approximately the same position as it once was, by hand pressure only, cut the ty-wraps and remove from the anti-bellows assembly.
v. Install the vacuum interrupter linkage pins in the upper contact block and bottom end of the anti-bellows spring assembly with the bell cranks, thrust washers, and new X-washer retaining clips.
w. Once the vacuum interrupter linkage pins have been reinstalled, using a ¾" open end wrench, tighten the hex nut jamming the threads of the anti-bellows spring assembly into the moving stem of the vacuum interrupter.
x. Check the contact stroke and adjust the anti-bellows spring assembly as necessary. Screwing the assembly into the vacuum interrupter will lengthen the stroke, backing the assembly out will shorten the stroke. Contact movement will change approximately 0.040" per ½ revolution. The ideal contact stroke for all PowlVac-ND MA 5kV replacement breakers is between 0.350" and 0.040".
y. Reinstall the interphase barriers.

With the circuit breaker closed, measure the gap between the upper contact block and the vacuum interrupter linkage pin. Record this value in the space of the label on the vacuum interrupter marked "New". Deduct 0.100" from this dimension and record the result in the space marked "End-of-Life".

Perform the vacuum integrity test in Section IV. INSTALLATION, D. PLACING THE CIRCUIT BREAKER INTO SERVICE, 2) Vacuum Integrity, and the primary resistance test in Section V. MAINTENANCE, D. OPTIONAL MAINTENANCE PROCEDURES, 3) Primary Resistance Check.

2) Closing Coil Assembly

This assembly is located center and above the circuit breaker mechanism (see Figure 3, I).

CAUTION

Ensure that the control circuits are deenergized and the circuit breaker is deenergized, disconnected by means of a visible break, and securely grounded.

Perform the following steps to replace the closing coil assembly:

a. Remove the front cover of the circuit breaker.
b. Disconnect the closing coil assembly from the wire harness.
c. Remove the two bolts which hold the assembly to the circuit breaker top cover, and raise the assembly out of the top of the circuit breaker.
d. Insert the new assembly into the circuit breaker from above and bolt it in place. Reconnect the assembly to the wiring harness. No adjustment is required.
e. Close the circuit breaker several times electrically to ensure that the closing coil assembly is functioning properly.
f. Replace the front cover.

3) Primary Shunt Trip Coil Assembly

This assembly is located at the bottom right side of the mechanism, just right of the main closing spring (see Figure 3, f).

CAUTION

Ensure that the control circuits are deenergized and the circuit breaker is deenergized, disconnected by means of a visible break, and securely grounded.

Perform the following steps to replace the primary shunt trip coil assembly:

a. Remove the front cover of circuit breaker.
b. Remove the two bolts which holds the primary shunt trip coil assembly to the circuit breaker frame and remove the assembly.
c. Bolt the new primary shunt trip coil assembly in place and reconnect it to the wiring harness.
d. Perform the Tripping System Adjustment in Section V. MAINTENANCE, B. MECHANISM AREA, 4) Tripping System.
e. Trip the circuit breaker electrically several times to ensure that the primary shunt trip coil assembly is functioning properly.
f. Replace the circuit breaker front cover.

4) Secondary Shunt Trip Coil Assembly

This assembly is located at the bottom left side of the mechanism, just to the left of the main closing spring. The replacement procedure is identical to that of the primary shunt trip coil assembly, with the following additional information:

CAUTION

Ensure that the control circuits are deenergized and the circuit breaker is deenergized, disconnected by means of a visible break, and securely grounded.

Note: *It will be easier to remove the secondary shunt trip coil assembly if the left connecting rod is removed. To remove the connecting rod see Section V. MAINTENANCE, B. MECHANISM, 3) Closing Spring Removal.*

a. Remove the front cover of the circuit breaker.
b. Disconnect the secondary shunt trip coil assembly wiring from the wiring harness.
c. Remove the two bolts which holds the assembly to the frame and remove the assembly.
d. Bolt the new assembly in place and reconnect it to the wiring harness. No adjustment is required.
e. Reassemble the connecting rod and main closing spring, if previously removed.
f. Trip the circuit breaker several times electrically to ensure that secondary shunt trip coil assembly is functioning properly.
g. Replace the front cover.

5) Undervoltage Device Assembly

CAUTION

Ensure that the control circuits are deenergized and the circuit breaker is deenergized, disconnected by means of a visible break, and securely grounded.

Detailed instructions for replacing the undervoltage are supplied with the replacement device (Figure 14, f).

6) Charging Motor Assembly

This assembly is located at the top left of the circuit breaker top cover (see Figure 3, a).

CAUTION

Ensure that the control circuits are deenergized and the circuit breaker is deenergized, disconnected by means of a visible break, and securely grounded.

Perform the following steps to replace the charging motor assembly:

a. Remove the front cover of the circuit breaker.
b. Disconnect the charging motor assembly from the wiring harness.
c. Remove the four bolts which hold the charging motor cover plate to the left frame side sheet and slide the motor to the left, and disconnect the charging motor drive shaft from the mechanism's eccentric drive shaft. Remove the charging motor from the circuit breaker.
d. Lubricate the end of the shaft of the new charging motor generously with Rheolube 368A grease.
e. Position the new assembly in the circuit breaker. Verify that the pin on the end of the charging motor drive shaft engages the slot in the mechanism eccentric drive shaft.
f. Bolt the assembly to the frame side sheet and reconnect it to the wiring harness.
g. Operate the circuit breaker several times to ensure that the charging motor assembly operates smoothly.
h. Replace the front cover.

7) Anti-Pump Relay Assembly

This assembly is located inside the right side sheet of the circuit breaker frame, near the bottom of the mechanism (see Figure 3, g).

CAUTION

Ensure that the control circuits are deenergized and the circuit breaker is deenergized, disconnected by means of a visible break, and securely grounded.

Perform the following steps to replace the anti-pump relay assembly:

a. Remove the front cover of the circuit breaker.
b. Loosen the lower mounting screw of the relay.
c. Remove the upper mounting screw and lift the relay off the lower screw.
d. Disconnect the leads from the anti-pump relay assembly. Identify each wire by the terminal number from which it was removed.
e. Reconnect all wires to the proper terminals of the relay.
f. Place the new assembly over the lower screw and reinstall the upper screw, and tighten both screws.

g. Relays that are in 250VDC closing circuits are provided with voltage dropping resistors. The resistor is mounted adjacent to the relay. It may be replaced by disconnecting the resistor from the relay, unscrewing the mounting feet from the frame of the circuit breaker, and then replacing the resistor. Reassemble the new resistor back to the original location.
h. Operate the circuit breaker several times to ensure the anti-pump relay assembly functions properly.
i. Replace the front cover.

8) Latch Check Switch

The latch check switch is located at the right side of the main mechanism frame, near the top of the main closing spring. To replace and adjust the latch check switch, refer to Section V. MAINTENANCE, B. MECHANISM AREA, 3) Closing Spring Removal, and Section V. MAINTENANCE, B. MECHANISM AREA, 5) Mechanism Adjustments, d) Latch Check Switch Adjustment.

⚠ CAUTION

Ensure that the control circuits are deenergized and the circuit breaker is deenergized, disconnected by means of a visible break, and securely grounded.

In addition to those instructions, perform the following steps:

a. Remove the two screws that secure the latch check switch to the mechanism. Do not lose the nut plate into which these screws are threaded.
b. Disconnect the wires from the switch.
c. Reconnect the wires to the new switch and fasten the switch in place with the screws and the nut plate which was previously removed.
d. Adjust the latch check switch according to Section V. MAINTENANCE, B. MECHANISM AREA, 5) Mechanism Adjustments, d) Latch Check Switch Adjustment.
e. Operate the circuit breaker electrically several times to ensure that the latch check switch is working.

9) Motor Cutoff Switch Assembly

This assembly is located at the top left of the circuit breaker top cover just to the left of the main mechanism (see Figure 3, h).

⚠ CAUTION

Ensure that the control circuits are deenergized and the circuit breaker is deenergized, disconnected by means of a visible break, and securely grounded.

Perform the following steps to replace the motor cutoff switch assembly:

a. Remove the front cover of the circuit breaker.
b. Remove the two screws that hold the operations counter to the motor cutoff switch assembly and remove the operations counter from the assembly.
c. Remove the two bolts that hold the assembly to the circuit breaker top cover and remove the assembly.
d. Disconnect the wires from the motor cutoff switch assembly, being careful to identify each wire by the terminal number from which it was removed.

e. Reconnect the wiring to the terminals on the new assembly from which it was removed.
f. Install the new assembly and bolt it to the circuit breaker top cover.
g. Install the operations counter on the new assembly.
h. Operate the circuit breaker electrically several times to ensure that all components on the motor cutoff switch assembly are working properly.
i. Replace the front cover.

10) Auxiliary Switch

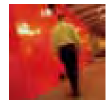
The auxiliary switch is located at the top right of the circuit breaker top cover (see Figure 3, d).

CAUTION

Ensure that the control circuits are deenergized and the circuit breaker is deenergized, disconnected by means of a visible break, and securely grounded.

Perform the following steps to replace the auxiliary switch:

a. Remove the front cover of the circuit breaker.
b. Remove the four bolts holding the auxiliary switch cover plate to the frame right side sheet.
c. Rotate the switch and cover plate slightly to expose the linkage connecting the switch to the mechanism jackshaft.
d. Remove the X-washer and disconnect the linkage from the jackshaft.
e. Disconnect the wires from the auxiliary switch, being careful to identify each wire by the terminal number from which it was removed.
f. Remove the two screws holding the switch to its mounting bracket, and remove the switch. Note the orientation of the switch terminals prior to removing the switch.
g. Insert the new switch and attach it to the mounting bracket with the two screws removed in step 6. Be certain to orient the switch as noted in step 6.
h. Insert the operating arm of the switch into the mounting bracket.
i. Reconnect the wiring. Be sure that the wires are connected to the same terminal numbers from which they were removed.
j. Reinsert the switch assembly inside the circuit breaker frame; reconnect the linkage to the mechanism jackshaft with an X-washer.
k. Secure the cover plate back to the frame side sheet with the four bolts provided.
l. Operate the circuit breaker electrically several times to ensure that the auxiliary switch is working.
m. Replace the front cover.



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PowlVac-ND® MA 5kV Replacement Vacuum Circuit Breakers

Replacement for Allis Chalmers (Siemens)
Type MA Air Circuit Breaker

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