



PowIVac-ND[®] Vacuum Circuit Breaker

Installation

Maintenance

Renewal Parts



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WARNING

THIS EQUIPMENT MAY CONTAIN HIGH VOLTAGES AND CURRENTS WHICH CAN CAUSE SERIOUS INJURY OR DEATH.

THE EQUIPMENT IS DESIGNED FOR USAGE, INSTALLATION, AND MAINTENANCE BY QUALIFIED 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 AND UNDERSTOOD, AND ALL WARNINGS AND CAUTIONS SHALL BE ABIDED BY. IF THERE ARE ANY DISCREPANCIES OR QUESTIONS, THE USER SHALL CONTACT POWELL ELECTRICAL MANUFACTURING COMPANY IMMEDIATELY AT 1-800-480-7273.

CAUTION

Before any adjustments, servicing, parts 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.



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These instructions do not purport to cover all details or variations of the circuit breakers, nor to provide for every possible contingency or hazard to be met in connection with usage, installation, testing, operation, and maintenance of the equipment. Should further information be desired or should particular problems arise which are not covered sufficiently for the user's purposes, the matter should be referred to Powell Electrical Manufacturing Company or call 1-800-480-7273.

I. INTRODUCTION

A. SCOPE

This instruction bulletin describes the following PowlVac-ND® vacuum circuit breakers:

05PV36SNDX, 05PV50SNDX

B. PURPOSE

This instruction bulletin is intended to provide the information required to properly operate and maintain the circuit breakers described in the Scope.

This instruction bulletin provides:

1. Guidelines for safety.
2. General descriptions of the operation and maintenance of the circuit breakers.
3. Instructions for installation and placing the circuit breakers into service.
4. Instructions for part replacement.
5. Renewal parts lists.

It should also be noted that some of the illustrations contained herein may not represent the exact construction details of each particular type. These illustrations 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 because they vary greatly.

C. INSTRUCTION BULLETINS AVAILABLE ELECTRONICALLY

Many Powell Electrical Manufacturing Company Instruction Bulletins are posted on the company website at www.powellservice.com. For more information contact Powell Apparatus Service Division (PASD) at 1-800-480-7273, 713-944-6900, or info@powellservice.com.

II. SAFETY

Study this instruction bulletin and all other associated documentation before uncrating the 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 which must be observed. Furthermore, each user has the responsibility of devising a complete safety program for each type of equipment encountered.



The circuit breakers described in this instruction bulletin are operated by high energy, high speed mechanism interlocked to provide specific operating sequences. To ensure the safety of personnel associated with usage, installation, operation, and maintenance of these circuit breakers it is mandatory that the following rules be observed. **THESE RULES ARE NOT INTENDED TO BE A COMPLETE SAFETY PROGRAM, BUT ARE INTENDED TO COVER ONLY THE IMPORTANT ASPECTS OF PERSONNEL SAFETY RELATED TO POWLVAC® CIRCUIT BREAKERS.**

A. GENERAL

1. Only supervised and qualified personnel trained in the usage, installation, operation, and maintenance of power circuit breakers 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 the instruction bulletin(s). A well-planned and executed routine maintenance program is essential for circuit breaker reliability and safety.
3. Service conditions and circuit breaker applications shall also be considered in the development of such programs, including such variables as ambient temperature and humidity, actual continuous current, thermal cycling, number of operations, interrupting duty, and any unusual local conditions such as excessive dust, ash, corrosive atmosphere, vermin or insect problems.

B. 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 THE 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 ELECTRICAL MANUFACTURING COMPANY FOR INSTRUCTIONS.**

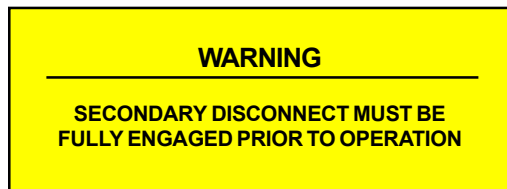
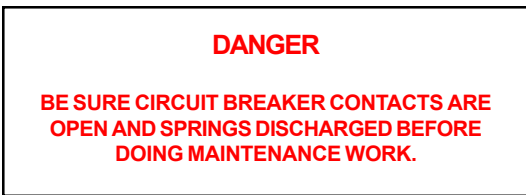
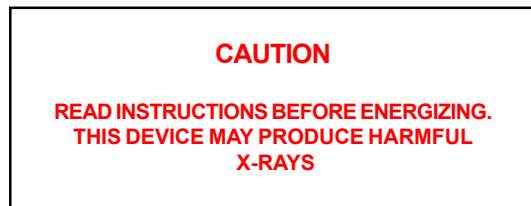
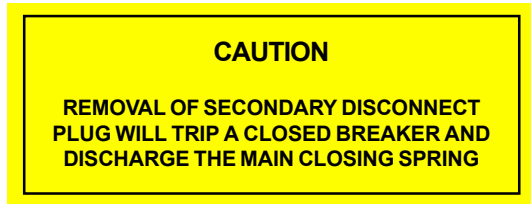
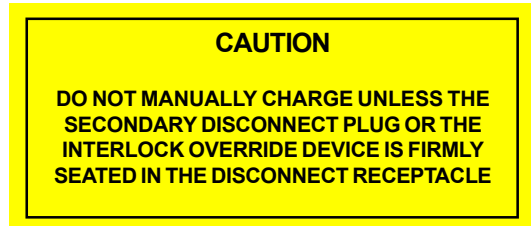


C. X-RAYS

When high voltage is applied across the contacts of a vacuum interrupter, there is the possibility of generation of X-rays. The intensity of this 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 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.**

D. SAFETY LABELS

The circuit breaker has warning and caution labels attached to various locations. Whenever the circuit breaker is handled or maintained, all warning and caution labels shall be observed.



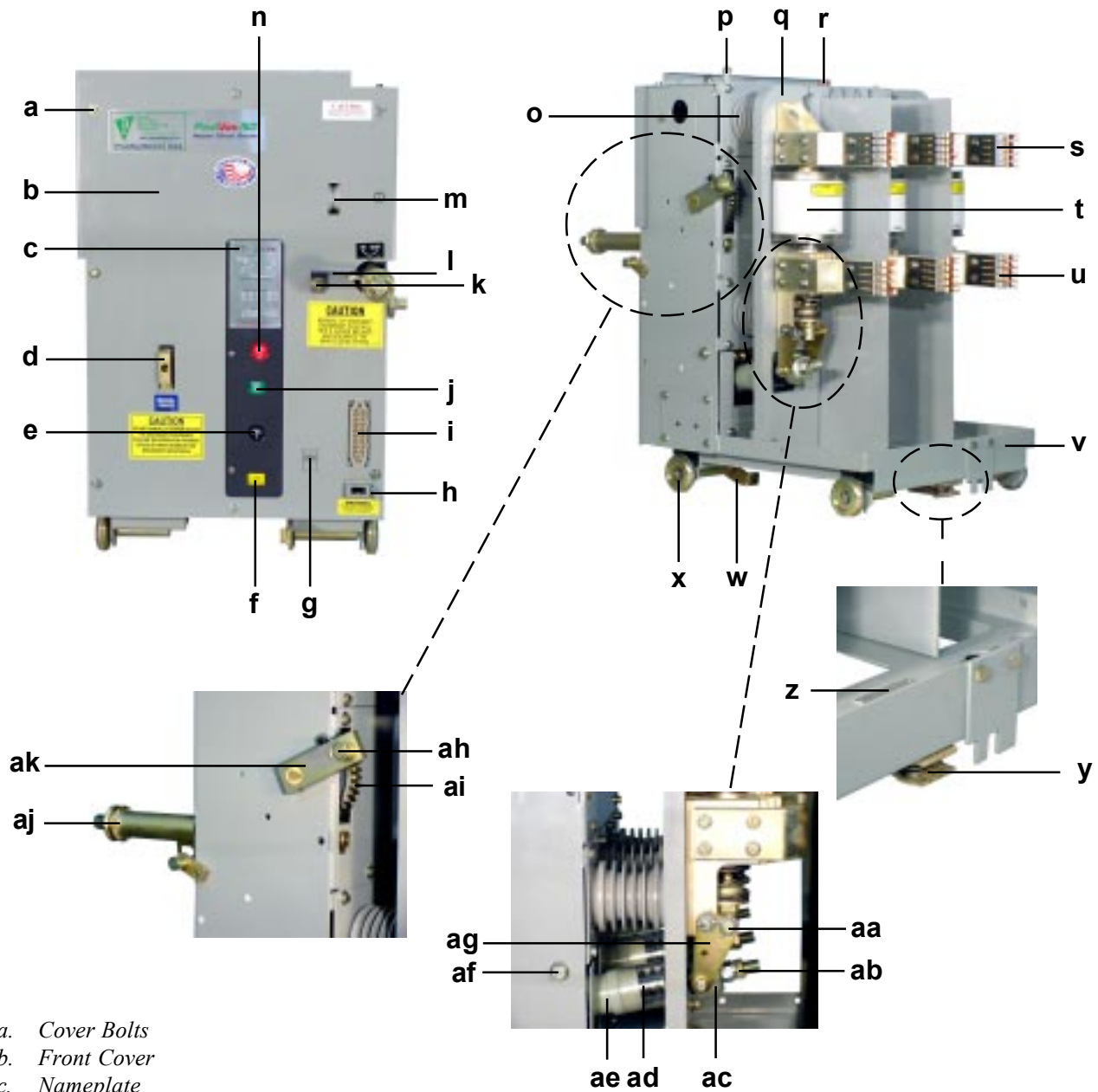


III. EQUIPMENT DESCRIPTION

A. GENERAL DESCRIPTION

PowlVac-ND® Vacuum Circuit Breakers use sealed vacuum interrupters (fig 1 [t]) to control the primary circuit. The primary connections to the associated metal-clad switchgear are made by parallel copper busbars terminating in multiple contact fingers of the primary disconnecting devices (fig 1 [s], [u]). The primary disconnecting devices, busbars, and vacuum interrupter assemblies are supported by insulating supports (fig 1 [o], [q]) specifically designed for the application.

The primary current path side of the circuit breaker is considered the rear of the circuit breaker, while the side with the cover containing the various indicators and manual operators is considered the front of the circuit breaker. By removing the front cover, the operating mechanisms of the circuit breaker are exposed. The stored-energy mechanism assembly provides motion to each of the vacuum interrupter moving contact assemblies through operating pushrods (fig 1 [ae]). In the same metal enclosed compartment as the stored-energy mechanism is the circuit breaker racking mechanism and interlocks which control the movement of the circuit breaker between the test/disconnected and connected positions. The racking mechanism (fig 8) provides the motion to engage/disengage the primary disconnecting devices and to open/close the shutters in metal-clad switchgear.

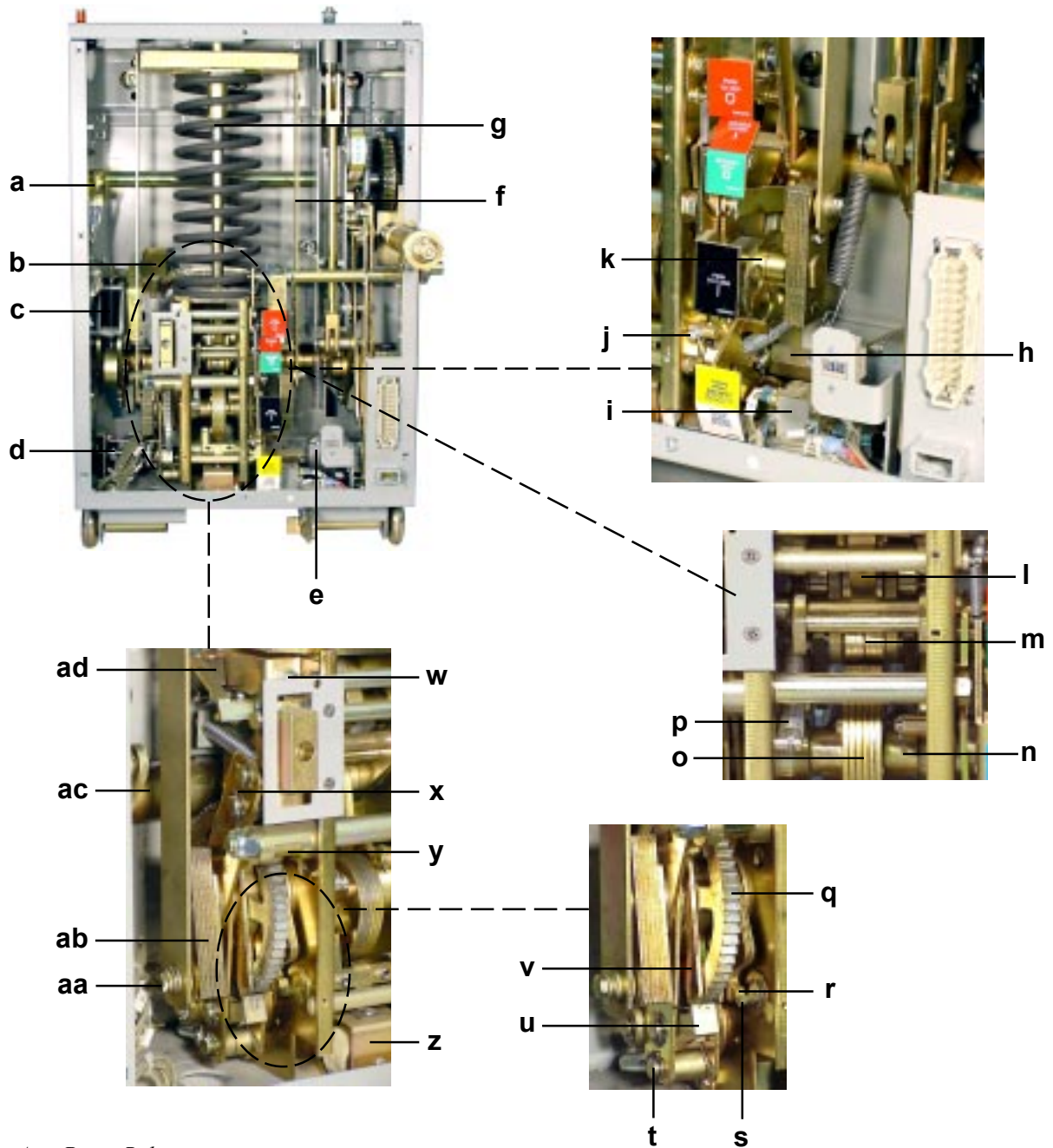


- a. Cover Bolts
- b. Front Cover
- c. Nameplate
- d. Manual Charging Crank
- e. Manual Close Operator
- f. Spring Charge Indicator
- g. Operations Counter
- h. Secondary Disconnect Spring Latch
- i. Secondary Disconnect Receptacle
- j. Circuit Breaker Open/Closed Indicator
- k. Padlock Provision - Stationary Clip
- l. Padlock Provision - Movable Arm
- m. Breaker Position Indicator
- n. Manual Trip Operator
- o. Standoff Insulator

- p. MOC Actuator
- q. Vacuum Interrupter Support
- r. TOC Actuator
- s. Upper Primary Disconnecting Device
- t. Vacuum Interrupter
- u. Lower Primary Disconnecting Device
- v. Frame
- w. Anti-Rollout Latch
- x. Wheel
- y. Ground Connection
- z. Serial Number Plate

- aa. Operating Pin
- ab. Lock Nut
- ac. Spring Yoke
- ad. Contact Loading Spring
- ae. Operating Pushrod
- af. Jackshaft Pin
- ag. Bell Crank
- ah. Crank Arm Roller
- ai. Worm Gear
- aj. Racking Drive Shaft Extension
- ak. Racking Crank Arm

Figure 1. PowlVac-ND® Circuit Breaker - Exterior View (Interphase Barriers Removed)



- | | | |
|-------------------------------|----------------------|-----------------------------|
| a. Anti-Pump Relay | m. Main Cam Roller | w. Secondary Trip Prop |
| b. Primary Shunt Trip Coil | n. Camshaft | Adjusting Screw |
| c. Shock Absorber (Dashpot) | o. Main Closing Cam | x. Holding Pawl Support Arm |
| d. Auxiliary Switch | p. Reset Spring | y. Holding Pawl |
| e. Charging Motor | q. Ratchet Wheel | Adjusting Eccentric |
| f. Connecting Rod | r. Close Latch Arm | z. Closing Coil |
| g. Main Closing Spring | s. Close Latch Shaft | aa. Crank Pin |
| h. Charging Motor Drive Shaft | t. Pawl Support Arm | ab. Crank Arm |
| i. Motor Cutoff Switch | u. Drive Pawl | ac. Jackshaft |
| j. Close Bar Adjusting Screw | v. Pawl Lift Plate | ad. Latch Check Switch |
| k. Motor Cutoff Cam | | |
| l. Secondary Trip Prop | | |

Figure 2. PowVac-ND® Circuit Breaker - Interior View (Front Cover Removed)



B. THE STORED-ENERGY MECHANISM

i. 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 eight (8) cover bolts that may be removed, allowing access to the stored-energy mechanism and its interlocks, auxiliary switches, racking mechanism, and other control devices. It is very important to ensure that the circuit breaker is in the “**OPEN**” position and the main closing spring (fig 2 [g]) is fully discharged before removing the front cover. **FAILURE TO DO THIS MAY RESULT IN 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/close the stored-energy mechanism. The circuit breaker nameplate (fig 1 [c]) is also located on the mechanism escutcheon. If for any reason the escutcheon is removed from the circuit breaker, it shall be verified that the serial number contained on the nameplate matches the engraved serial number plate (fig 1 [z]) permanently affixed to the rear of the circuit breaker frame prior to installing the escutcheon.

The mechanism employed in the circuit breaker is a stored-energy system which uses a charging motor to compress the main closing spring. During the closing operation the energy stored in the main closing spring is released. This 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 (fig 2 [e]), located on the bottom right of the floor pan, is assembled to the circuit breaker by a cover plate that is bolted to the circuit breaker right 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 left side of the mechanism.

When the charging motor is energized, the eccentric drive shaft rotates and causes the pawl support arms to pivot about the camshaft (fig 4 [g]). 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 adjustable by the holding pawl adjusting eccentric (fig 2 [y]) located at the left 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 (fig 2 [q]) has projections from its side faces which engage the drive plates as it rotates. These drive plates are attached to the camshaft, thus causing the camshaft to rotate. Attached to the ends of the camshaft are crank arms (fig 2 [ab]). Crank pins (fig 2 [aa]) are assembled to the crank arms, which point outward. The crank arms engage the bottom ends of the connecting rods (fig 2 [f]). The pins that project from the spring yoke, which straddles the main closing spring, engage the top ends of the connecting rods. As the camshaft rotates the connecting rods will pull the spring yoke downward, compressing the main closing spring.

The ratchet wheel will drive the camshaft so that the connecting rods go down to their lowest position, and then start to move upward. At a certain point, the spring force will overcome 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 (fig 2 [v]) and the motor cutoff switch is operated.

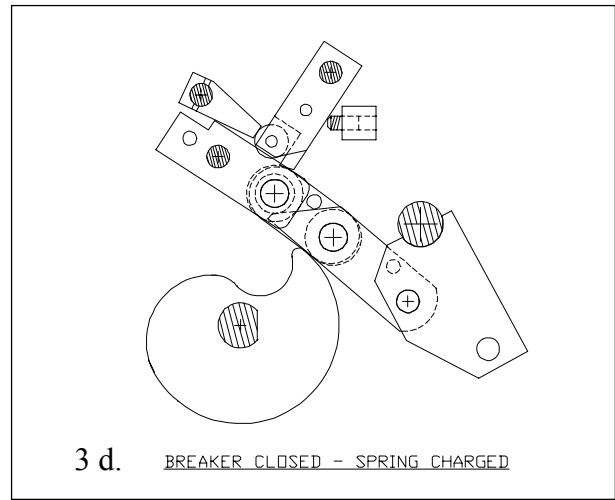
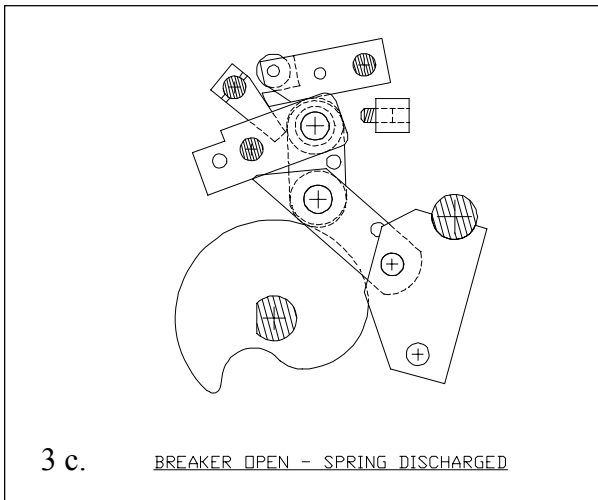
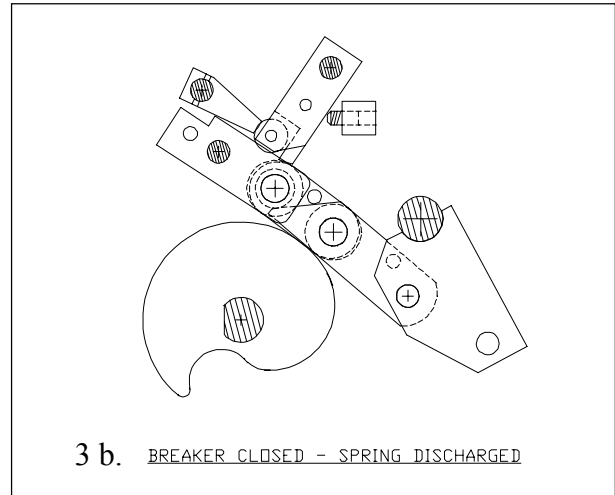
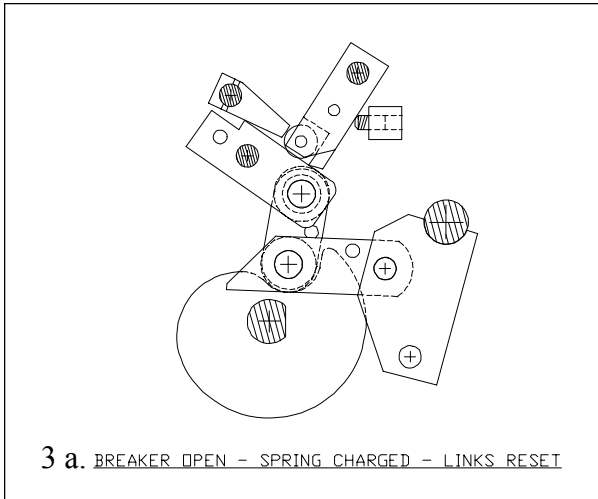
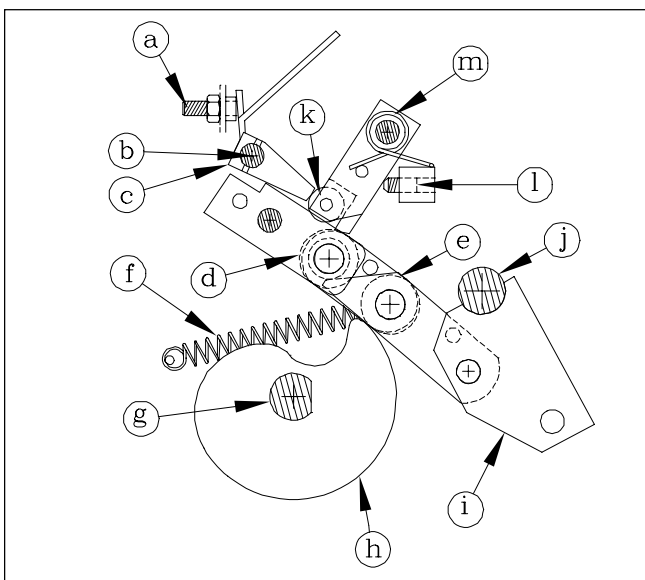


Figure 3. Cam and Fundamental Linkage Positions



- 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

Figure 4. Mechanism and Trip Linkages



The motor cutoff switch (fig 2 [i]), located at the right of the mechanism, is operated by the spring charge indicator and motor cutoff cam (fig 2 [k]). The spring charge indicator (fig 1 [f]) will display that the mechanism is charged.

The camshaft would continue to rotate, except that it is restrained by the close latch arm (fig 2 [r]) engaging against the close latch shaft (fig 2 [s]). The main closing cam, located between the mechanism side sheets, is now 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 upward thus rotating the main closing cam and driving the fundamental linkage into the closed position. This causes the main linkage to rotate the jackshaft such that the operating pushrods (fig 1 [ae]) are driven toward the current carrying side of the circuit breaker.

Each operating pushrod assembly has a recess at each end which encloses a contact loading spring (fig 1 [ad]). At the end of this spring is a spring yoke (fig 1 [ac]), 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 even more and produces a gap between the face of the spring yoke and the lock nut.

For each phase, bell cranks (fig 1 [ag]) are located on the outside of the lower primary disconnecting devices (fig 1 [u]) and are supported by bearings. Each bell crank is connected to an operating pin, which passes through a slot in the lower primary disconnecting devices and engage an extension to the vacuum interrupter assembly thus moving the vacuum interrupter contact. The bell cranks give an approximate 3 to 1 multiplication of the contact loading spring force, enabling 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 cam and fundamental linkage positions shown in figures 3b and 3d, 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 side sheets. 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 upward, 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 downward and permits the primary trip prop to rotate upward, thus permitting the main linkage to move upward and the jackshaft to rotate, opening the circuit breaker. The left jackshaft levers engage a shock absorber (fig 2 [c]), 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 (fig 2 [p]) and the primary and secondary trip props can fall 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 (fig 2 [ad]), operated by a lever on the trip shaft, will close as the secondary trip prop reaches the fully reset position.



ii. Electrical Description

a. Charging Motor

The function of charging motor (fig 2 [e]) 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 bottom right of the base pan, is assembled to the circuit breaker by a cover plate that is bolted to the circuit breaker frame right side sheet.

b. Motor Cutoff Switch

The motor cutoff switch (fig 2 [i]) provides an electrical break in the control circuit supplying the charging motor when the main closing spring is fully charged and the stored-energy mechanism is ready for a closing operation. It is located at the bottom right of the mechanism, and is supported by a bracket which is bolted to the circuit breaker base pan.

c. Anti-Pump Relay

The anti-pump relay (fig 2 [a]) 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, inside the circuit breaker left frame side sheet, and is supported by two screws.

d. Operating Solenoids

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

The closing coil (fig 2 [z]) is an operating solenoid that is located at the bottom center of the mechanism, and is assembled to the circuit breaker base pan by bolts accessible from underneath the circuit breaker.

The primary shunt trip coil (fig 2 [b]) is located at the top left 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 will be located at the top right side of the mechanism, installed on the lower frame channel. Only one of these two operating solenoids may be furnished on any one circuit breaker, as both devices are located in the same space.

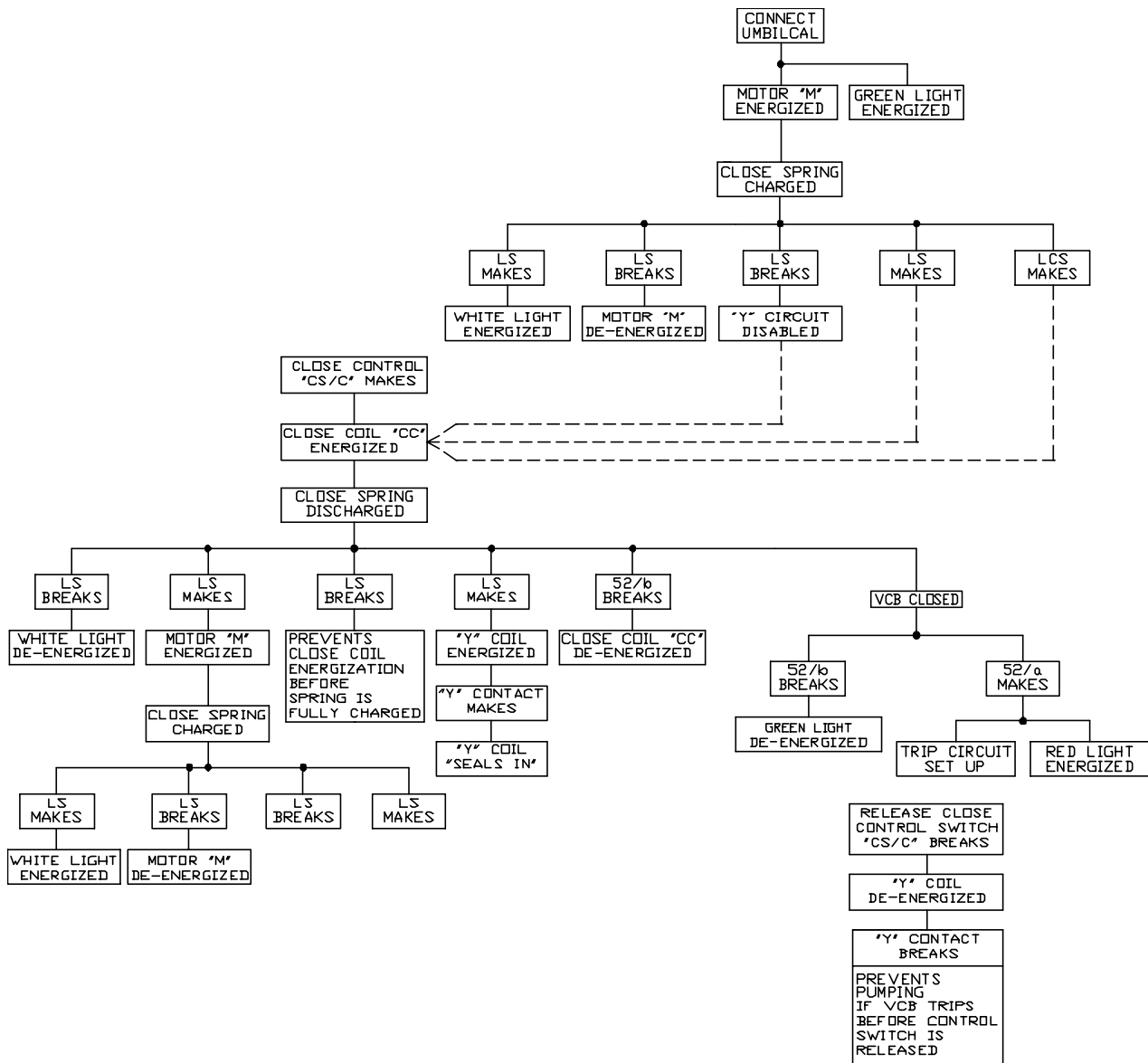


e. Control Circuit

Typical ac and dc electrical control schemes are shown in figure 6 and figure 7. The control scheme of any particular circuit breaker may differ from these typical schemes depending on the user's requirements, operating solenoids, and the control devices furnished with that circuit breaker.

The sequence of operation for all control schemes is shown in figure 5. 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 Contact) for additional contacts.

Figure 5. Operation Sequence



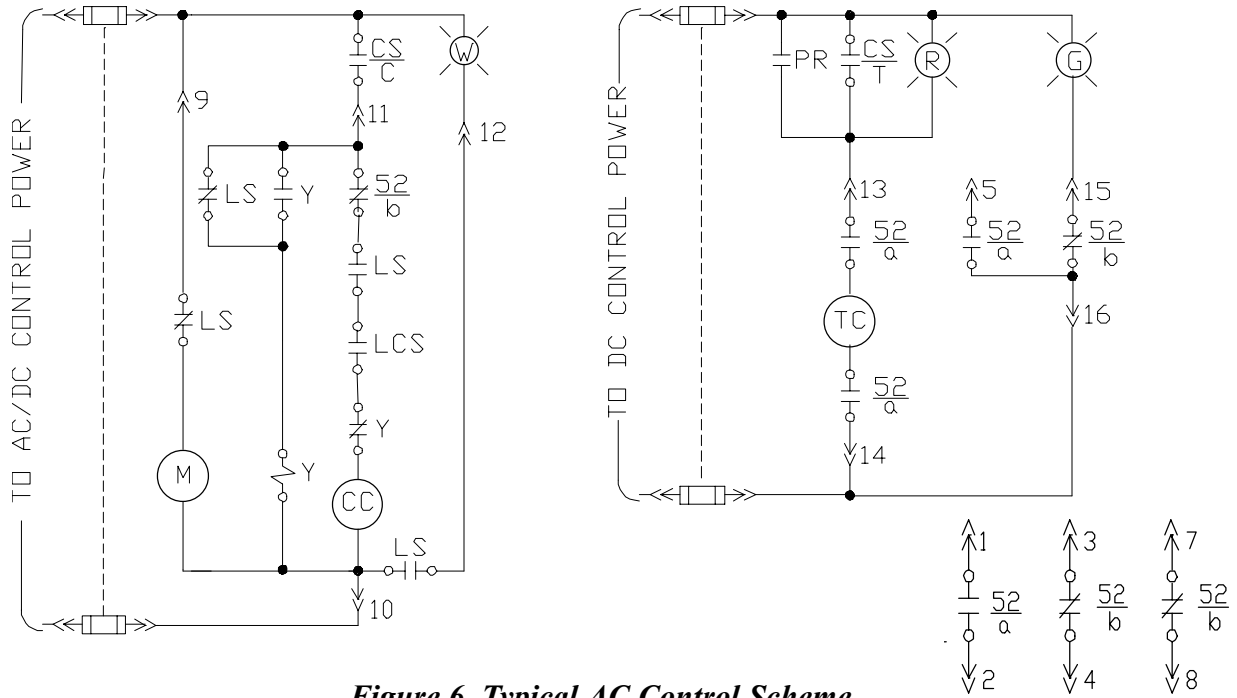
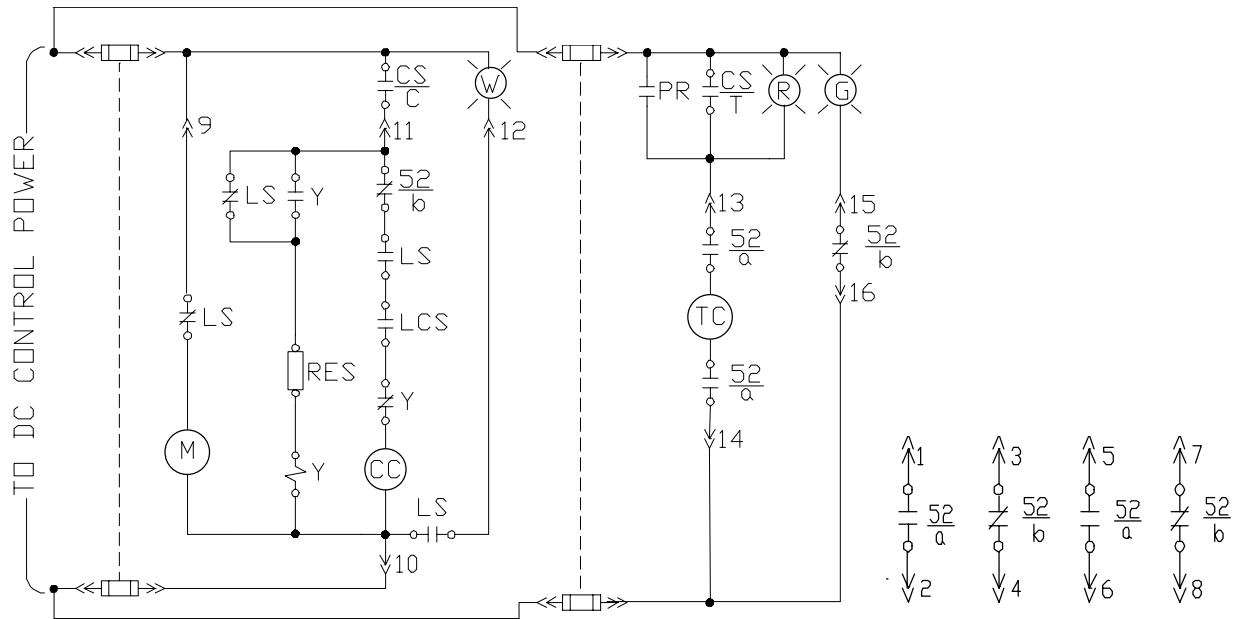


Figure 6. Typical AC Control Scheme



LEGEND

- ◁▷ --- PULL-APART FUSE BLOCK
- LS --- SPRING CHARGE LIMIT SWITCH. SHOWN WITH BKR. CLOSING SPRINGS DISCHARGED.
- (M) --- BKR. CLOSING SPRINGS CHARGING MOTOR.
- 52/b --- NORMALLY CLOSED BKR. AUXILIARY SWITCH CONTACT
- 52/a --- NORMALLY OPEN BKR. AUXILIARY SWITCH CONTACT
- Y --- ANTI-PUMP RELAY

- 52/LCS --- LATCH CHECK SWITCH
- PR --- PROTECTIVE RELAYING
- 52/CS/T --- BREAKER CONTROL SWITCH TRIP CONTACT
- (TC) --- BKR. TRIP COIL
- (CC) --- BKR. CLOSING COIL
- 52/CS/C --- BREAKER CONTROL SWITCH CLOSE CONTACT
- RES --- VOLTAGE DROPPING RESISTOR (250VDC ONLY)

Figure 7. Typical DC Control Scheme



C. RACKING MECHANISM

i. General Description

The racking mechanism is the mechanical assembly that facilitates moving the circuit breaker between the breaker test/disconnected and the connected positions in the circuit breaker compartment. The main racking mechanism components for the PowlVac-ND® Circuit Breakers are shown and described in the following sections:

a. Breaker Position Indicator

The breaker position indicator (fig 1 [m]) is visible through an opening in the circuit breaker front cover. The indicator displays whether the circuit breaker is in the connected or the test/disconnected positions. When the breaker position indicator displays “**CONN**”, and this is fully visible in the aperture, the circuit breaker is in the connected position. When the breaker position indicator displays “**TEST**”, and this is fully visible in the aperture, the circuit breaker is in the test/disconnected position. In positions other than the connected and test/disconnected positions, the breaker position indicator does not display an indication. Refer to the section “Inserting the Circuit Breaker into the Circuit Breaker Compartment” for more information.

b. Interlocking

PowlVac® circuit breakers are provided with several interlocks that operate in conjunction with the circuit breaker compartment 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. The following describes the interlocking for both the standard circuit breaker, and the closed door racking circuit breaker.

The purpose of the interlocks is to ensure:

- i. The circuit breaker cannot be moved from the test/disconnected to the connected position unless the main circuit breaker contacts are opened and the secondary control circuitry from the compartment to the circuit breaker is completed, and the circuit breaker cannot be removed from the connected to the test/disconnected position unless the main contacts are opened.
- ii. The control circuits cannot be broken when the circuit breaker is in the connected position.
- iii. The circuit breaker cannot be removed from the circuit breaker compartment with the circuit breaker closed or with the main closing spring charged.



1. Closed Door Racking Circuit Breaker Interlocking

Closed door racking circuit breaker interlocking is primarily achieved by means of an interlock bar acting upon the racking drive shaft extension, an interlock bar attached to the secondary disconnect receptacle, and a tripping linkage and roller on the right side of the frame of the circuit breaker that interfaces with the circuit breaker compartment.

An interlock bar prevents the rotation of the racking drive shaft extension whenever the circuit breaker is closed or the secondary disconnect plug is removed. This prevents movement of the circuit breaker when the circuit breaker is closed, or when the control circuits are disconnected.

Racking the circuit breaker in from the test/disconnected position to the connected position also rotates a cam attached to the racking shaft. A cam follower, attached to a lever pivoted on the circuit breaker frame, drives a secondary disconnect locking bar downward. The locking bar engages a slot in the interlock bar attached to the secondary disconnect plug. The cam profile is arranged so that the lever can only be in its upward position when the racking crank arms are fully in the test/disconnected position.

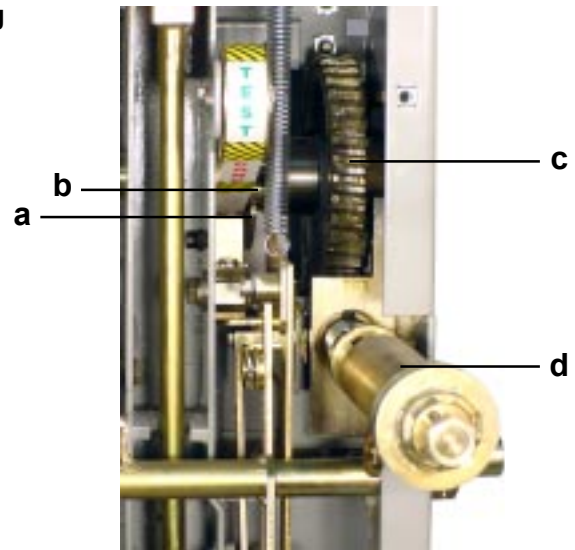
This ensures that the control circuits cannot be disconnected in any position except the test/disconnected position. The tripping linkage and roller on the side of the circuit breaker frame follows a cam mounted in the circuit breaker compartment. The cam, in all intermediate positions between the test/disconnected and connected position, depresses the tripping roller. Depressing the tripping roller actuates the manual trip operator which holds the breaker in a trip free condition. The manual trip operator also actuates the latch check switch, thus blocking any electrical closing signal.

The interlock bar attached to the secondary disconnect also actuates the secondary trip prop shaft and the close latch upon removal from the circuit breaker. This final interlock ensures that the circuit breaker is in the open position and the main spring is discharged prior to removal from the compartment.

ii. Closed Door Racking Mechanism

The closed door racking mechanism consists of a racking shaft (fig 8 [a]) with racking crank arms (fig 1 [ak]) at each end, which are supported by the frame side sheets. The racking shaft also supports a worm gear assembly (fig 8 [c]) at the right end just inside the right side sheet. In addition, the racking crank arms have rollers attached to each end of the racking shaft, which engage the vertical slots of the racking cams in the circuit breaker compartment. Rotation of the racking crank arms will drive the circuit breaker into or out of the connected position. This action also operates the compartment shutters. As the racking drive shaft rotates, the worm rotates the worm gear until the threaded plate which moves along the racking shaft encounters either a front or back sleeve attached to the shaft is prevented by any further rotation. At this time, the breaker position indicator on the front of the circuit breaker will display “CONN”, or “TEST”.

In addition, a bolt on the left side sheet serves as a backup to the threaded plate, providing a positive stop to the left crank arm. This positive stop prevents further rotation of the racking shaft, thus stopping circuit breaker travel. At this time, the breaker position indicator on the front of the circuit breaker will display “CONN”.



- a. Racking Shaft
- b. Interlock Cam
- c. Worm Gear
- d. Racking Drive Shaft Extension

Figure 8. Closed Door Racking Mechanism and Interlock



D. CIRCUIT BREAKER COMPARTMENT INTERFACES

i. Primary Disconnecting Devices

There are six primary disconnecting devices on the circuit breaker. They are arranged, two per phase, with the upper device connected to the stationary end of the vacuum interrupter, and the lower device connected to the moving end of the vacuum interrupter assembly. Each primary disconnecting device (fig 1 [s], [u]) has multiple contact fingers which will mate with the stationary primary disconnecting devices in the circuit breaker compartment. **DO NOT HANDLE OR MOVE THE CIRCUIT BREAKER BY THE PRIMARY DISCONNECTING DEVICES, AS DAMAGE MAY OCCUR.**

ii. Secondary Disconnecting Devices

Control power is transferred from the metal-clad switchgear to the circuit breaker by means of the secondary disconnect device. The secondary disconnect receptacle (fig 1 [i]) is located on the bottom right side of the circuit breaker. The secondary disconnect plug is attached to the switchgear and is located on the right side wall of the circuit breaker compartment. This arrangement allows the secondary connection to be visible in all positions of the circuit breaker.

iii. MOC (Mechanism-Operated Contact) Actuator

The MOC, located in the switchgear, is operated by a lever which extends from the circuit breaker operating mechanism. Movement of the MOC actuator (fig 1 [p]) is directly related to the movement of the circuit breaker mechanism and contacts.

iv. TOC (Truck-Operated Contact) Actuator

The TOC, located in the switchgear, is operated by circuit breaker truck position. To accomplish this, a TOC actuator (fig 1 [r]) is located on the top left of the circuit breaker frame and it is designed to strike the TOC as the circuit breaker travels to the connected position.

v. Ground Connection

The ground connection is an assembly of spring-loaded fingers that effectively grounds the circuit breaker frame as it is inserted into the circuit breaker compartment. The ground connection (fig 1 [y]) is located at the rear edge of the floor pan of the circuit breaker centered on the middle pole of the circuit breaker. An extension of the metal-clad switchgear ground bus is secured to the circuit breaker compartment floor and engages the ground connection as the circuit breaker is placed into the disconnected position. The ground connection system remains engaged in all subsequent positions of the circuit breaker until the circuit breaker is removed from the compartment.

vi. Shutter Rollers

The circuit breaker travels between the test/disconnected and connected positions as the crank arm rollers (fig 1 [ah]) engage the vertical slots of the racking cams attached in the circuit breaker compartment. This action also drives the compartment shutters to open/close which allows the primary disconnecting devices to connect/disconnect. Downward movement of the crank arm rollers in the slots will move the shutters to the fully open position before the circuit breaker travels towards the connected position.

vii. Anti-Rollout Latch

The circuit breaker is equipped with an anti-rollout latch (fig 1 [w]) which prevents inadvertent removal from the circuit breaker compartment by engaging a block in the circuit breaker compartment.



E. VACUUM INTERRUPTERS

PowlVac-ND® circuit breakers utilize sealed vacuum interrupters to control the primary circuit. Some vacuum interrupters appear to be identical in size and shape externally, but types vary in ratings due to the differences in their internal construction. For a listing of the vacuum interrupters used in PowlVac-ND® circuit breakers see Table V. **VACUUM INTERRUPTERS MUST BE REPLACED ONLY WITH NEW VACUUM INTERRUPTERS OF THE SAME PART NUMBER.**

F. VACUUM INTERRUPTER CONNECTION

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

IV. INSTALLATION

A. RECEIVING

When the circuit breaker is received check for any sign of damage. If damage is found or suspected, file all claims immediately with the transportation company and notify the nearest representative of Powell Electrical Manufacturing Company.

Estimated size and weight for shipping a PowlVac-ND® on a pallet:

Size: 42" width x 42" depth x 47" height
Weight: 400 lbs.

Figure 9 shows the circuit breaker enclosed in the carton used for shipment. The carton is attached to the shipping pallet by two metal bands. Remove these bands and lift the carton from the pallet so that the circuit breaker is visible. The circuit breaker is attached to the pallet by three metal shipping brackets. When these are removed the circuit breaker may be removed from the shipping pallet. Refer to Section B. Handling for more information.

When a metal-clad switchgear assembly is installed in a Power Control Room, a circuit breaker housed in the lower circuit breaker compartment may be shipped installed in the equipment. In these cases, the circuit breaker will be in the test/disconnected position and it will be bolted to the compartment floor by use of a shipping bracket. The horizontal leg of the bracket is bolted to the compartment floor and the vertical leg is bolted to the front of the circuit breaker using the lower cover bolts. Remove these four bolts, discard the shipping angle, and replace the four bolts.



Figure 9. Circuit Breaker in Shipping Carton



B. HANDLING

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 DEVICES, AS DAMAGE MAY OCCUR.**

If necessary, the circuit breaker can be moved by a fork lift truck or an overhead crane. When using a fork lift truck take care to avoid components located under the circuit breaker floor pan. The forks on the truck should be set for a dimension over the forks of 18 inches. The forks should then ride under the wheel axles. The circuit breaker can also be lifted by an overhead crane using the two lifting holes which have been provided for hooks at the top of the circuit breaker frame side sheets (fig 10).



Figure 10. Circuit Breaker and Crane

C. STORAGE

It is recommended that the circuit breaker be placed into service immediately in its permanent location after completing the commissioning tests. If this is not possible, the following precautions must be taken to ensure the proper storage of the circuit breaker:

1. Since moisture has an adverse effect on the insulating parts, the circuit 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 used in outdoor metal-clad switchgear should be stored in the equipment only when power is available and the anti-condensation heaters are in operation.
2. The circuit 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 corrosive effect on many parts.
3. Unplated surfaces, such as, rollers, latches, etc., should be coated with grease/oil to prevent rusting.

If the circuit breaker is stored for any length of time, it should be inspected periodically to see that rusting has not started and to ensure good mechanical condition. Should the circuit breaker be stored under unfavorable atmospheric conditions, it should be cleaned and dried before attempting the commissioning tests and before placing the circuit breaker into service.



D. PLACING THE CIRCUIT BREAKER INTO SERVICE

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

- i. High Voltage Insulation Integrity
 - ii. Vacuum Integrity
 - iii. Control Voltage Insulation Integrity
 - iv. Mechanical Operation Check
 - v. Electrical Operation Check
 - vi. Racking Mechanism Check
 - vii. High Voltage Insulation Integrity
-
- i. High Voltage Insulation Integrity

CAUTION

HIGH VOLTAGES ACROSS THE OPEN GAPS OF THE VACUUM INTERRUPTER CAN PRODUCE RADIATION. PERSONNEL SHOULD STAND AT LEAST ONE METER AWAY FROM THE CIRCUIT BREAKER WITH THE COVERS IN PLACE WHEN CONDUCTING HIGH VOLTAGE TEST. TEST VOLTAGES SHOULD NOT EXCEED 15 KV AC (27KV DC) FOR CIRCUIT BREAKER WITH A RATED MAXIMUM VOLTAGE OF 4.76 KV.

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. 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 IS PERFORMED, THE DC HIGH POTENTIAL TEST MACHINE MUST NOT PRODUCE INSTANTANEOUS PEAK VOLTAGES EXCEEDING 50kV.

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.

Table I. Field Dielectric Test Values

Rated Maximum Voltage (kV rms)	Power Frequency Withstand (kV rms)
4.76	15



This test will have checked all of the primary phase-to-ground and phase-to-phase insulation.

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 IN TO CONTACT WITH THE PRIMARY CIRCUIT.

CAUTION: REMOVE ALL GROUNDING CONDUCTORS APPLIED FOR THIS TEST BEFORE PLACING THE CIRCUIT BREAKER BACK INTO SERVICE.

The tests described above 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.

ii. **Vacuum Integrity**

CAUTION

APPLYING ABNORMALLY HIGH VOLTAGE ACROSS A PAIR OF CONTACTS IN VACUUM MAY PRODUCE X-RADIATION. THE RADIATION MAY INCREASE WITH INCREASED VOLTAGE AND/OR DECREASED CONTACT SPACING.

X-RADIATION PRODUCED DURING THIS TEST WITH THE VOLTAGE SPECIFIED IN TABLE I. 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.

Powell recommends ac testing for reliable verification of vacuum integrity. All PowlVac® 5kV and 15kV circuit breakers shall be tested with a minimum of 25kV ac applied across fully open contacts for 10 seconds. No dielectric breakdown during the test period constitutes a successful test.

Note, this test does not replace the ac high potential testing (Hipot) used to determine “High voltage insulation integrity.” See the “High voltage insulation integrity” section.

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 50kV dc 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. 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 USE 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 (HIPOT) IS REQUIRED, THE DC HIGH POTENTIAL TEST MACHINE MUST NOT PRODUCE INSTANTANEOUS PEAK VOLTAGES EXCEEDING 50kV.

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.

CAUTION: 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 IN TO CONTACT WITH THE PRIMARY CIRCUIT.



iii. Control Voltage Insulation Integrity

If the user wishes to check the insulation integrity of the control circuit, it may be done with a 500-volt or 1000-volt 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 when the tests are complete.

CAUTION

REMOVE ALL GROUNDING CONDUCTORS APPLIED FOR THIS TEST BEFORE PLACING THE CIRCUIT BREAKER BACK INTO SERVICE.

iv. Mechanical Operation Check

The contacts of the vacuum interrupter during normal operation cannot be closed unless the secondary disconnect plug is inserted into the secondary disconnect receptacle. To check the circuit breaker outside of the circuit breaker compartment, it is necessary to simulate the connection of secondary disconnecting device by inserting the secondary disconnect override device in the secondary disconnect receptacle. This device must be removed after testing and before the circuit breaker is inserted into the compartment. The mechanical operation of the circuit breaker is checked by inserting the manual charging handle into the manual charging crank and pushing down until a metallic click is heard. (This indicates that the holding pawl has dropped into place on the ratchet wheel.) Lift the handle until it is horizontal and then depress. The procedure is repeated until the spring charge indicator indicates “**CLOSING SPRING CHARGED**”. This requires about 60 operations of the handle. Remove the handle.

CAUTION: CARE MUST BE EXERCISED TO KEEP PERSONNEL, TOOLS AND OTHER OBJECTS CLEAR OF MECHANISM WHICH ARE TO BE OPERATED OR RELEASED.

Push the manual close operator (fig 1 [e]) inward and the circuit breaker will close. The circuit breaker open/closed indicator located above the manual close operator will now display “**BREAKER CLOSED**”. Push the manual trip operator (fig 1 [n]) inward, which is located at the top of the escutcheon and the circuit breaker open/closed indicator will now display “**BREAKER OPEN**”.

v. Electrical Operation Check

To check the basic electrical operation of the circuit breaker, a circuit breaker test cabinet must be used. Connect the secondary disconnect from the test cabinet to the circuit breaker to be tested. The test cabinet provides control voltage via a secondary disconnect plug to the circuit breaker and the appropriate control switches to verify the close and open functions of the circuit breaker. Specialized versions of the test cabinet may also contain circuits for circuit breakers equipped with dual shunt trip coils, undervoltage devices, or other options. With the secondary disconnect plug installed in the circuit breaker under test, operate the power switch on the test cabinet. The charging motor will automatically charge the stored-energy mechanism's main closing springs. Operation of the control switch on the front door of the test cabinet to the “close” position will cause the circuit breaker to close. **WARNING: THE MOC ACTUATOR IS EXPOSED WHEN THE CIRCUIT BREAKER IS OUTSIDE THE METAL-CLAD SWITCHGEAR AND CAN CAUSE SERIOUS INJURY IF THE TEST PERSONNEL OR ANY OBJECT IS IN THE TRAVEL PATH DURING OPERATION. CARE SHOULD BE TAKEN TO ISOLATE THE TOP OF THE CIRCUIT BREAKER FOR THESE TESTS.** The circuitry is arranged to cause the charging motor to operate again and charge the main closing spring. Operating the control switch on the front door of the test cabinet to the “open” position will cause the circuit breaker to open.



Alternatively, a test jumper cable may be used to electrically operate the circuit breaker using the control circuitry of the circuit breaker compartment. Caution must be exercised if this option is chosen to ensure that operation of the control circuitry of the compartment used for test does not cause undesirable effects or unintended operation of other interconnected equipment such as supervisory controls, SCADA, or automatic transfer schemes.

First, remove the control fuses in the compartment. Connect the jumper cable to the secondary disconnect plug in the compartment and to the circuit breaker. Insert the fuses. The charging motor will automatically charge the stored-energy mechanism's main closing springs. Operation of the breaker control switch on the front door of the compartment will cause the circuit breaker to close. The circuitry is arranged to cause the charging motor to operate again and charge the main closing spring. Operating the breaker control switch on the front door will cause the circuit breaker to open.

vi. Racking Mechanism Check

The closed door racking design racking mechanism may be checked outside the circuit breaker compartment by inserting the secondary disconnect override device into the secondary disconnect receptacle.

a. Closed Door Racking Design

Insert the racking handle onto the racking drive shaft extension. The racking crank arms at the sides of the circuit breaker should be in the fully withdrawn position and point towards the primary disconnecting devices. The breaker position indicator on the front of the circuit breaker should display, "**TEST**". Rotate the racking handle in a clockwise direction. The racking crank arms will move downward and rotate until the breaker position indicator displays "**CONN**". Positive stop bolts that prevent the racking cranks arms from rotating prevent further rotation of the racking shaft. Once the breaker position indicator displays "**CONN**", the racking mechanism will have reached the end of its travel and a significant increase in the amount of resistance encountered will indicate that further force should not be exerted. In this position, the racking handle may be removed from the racking drive shaft extension. It will not be possible to remove the secondary disconnect override device due to the operation of the interlocks as described in "Closed Door Racking Circuit Breaker Interlocking" under the Interlocking section.

Once again, insert the racking handle onto the racking drive shaft extension and rotate in a counter-clockwise direction until the racking crank arms are once more in the fully withdrawn position and the breaker position indicator displays "**TEST**". With the racking crank arms in this position, the secondary disconnect override device may be removed from the secondary disconnect receptacle.

The above procedures will check the basic operation of the racking mechanisms and associated interlocks.

**CAUTION**

POLE UNIT PARTS ARE ENERGIZED AT FULL CIRCUIT VOLTAGE WHEN THE CIRCUIT BREAKER IS IN THE CONNECTED POSITION. BEFORE MOVING THE CIRCUIT BREAKER INTO THAT POSITION, MAKE SURE THE MAIN BARRIER ASSEMBLY HAS BEEN PROPERLY FASTENED IN PLACE. FAILURE TO DO THIS MAY CAUSE SERIOUS DAMAGE OR INJURY.

E. INSERTING THE CIRCUIT BREAKER INTO THE METAL-CLAD SWITCHGEAR

- i. **Racking the PowlVac-ND® Circuit Breaker**
- ii. **Power Racking**

Refer to the metal-clad switchgear instruction bulletin and drawings produced specifically for the installed equipment for additional information and cautions before attempting to insert the circuit breakers into the metal-clad switchgear equipment. **BE SURE THAT THE RACKING CRANK ARMS AT THE SIDES OF THE CIRCUIT BREAKER POINT IN THE DIRECTION OF THE PRIMARY DISCONNECTING DEVICES AND THE CIRCUIT BREAKER POSITION INDICATOR DISPLAYS BREAKER TEST/DISCONNECTED.**

Each circuit breaker and metal-clad switchgear is provided with interference plates which are designed to ensure that no circuit breaker with less than the required voltage, continuous current, or interrupting current rating is placed in the incorrect circuit breaker compartment. If you attempt to insert an improperly rated circuit breaker into the circuit breaker compartment, these plates will interfere with each other and deter further insertion. The interference will occur before the circuit breaker reaches the disconnected position. Do not attempt to force the circuit breaker past the compartment interference plate or remove the interference plates from either the compartment or the circuit breaker. Remove the incorrect rated circuit breaker and insert a properly rated circuit breaker into the metal-clad switchgear.

Before inserting the circuit breaker into the circuit breaker compartment:**a. Check the Primary Disconnecting Devices and Circuit Breaker Compartment**

Examine the primary disconnecting devices for any signs of damage and contamination. Check to see that none are bent out of alignment. If contamination is found refer to sections **Inspection and Cleaning** and **Lubrication** under **Section V. Maintenance** for cleaning and lubrication procedures. If the primary disconnecting devices are damaged make no attempt to repair. Contact Powell Electrical Manufacturing Company for further information.

Examine the circuit breaker compartment to see that it is clean and clear of debris that might interfere with circuit breaker travel.

b. Racking the Circuit Breaker into the Circuit Breaker Compartment

The described racking procedures apply only for indoor type and non arc-resistant constructions. For all other constructions, refer to the appropriate instructions or instruction bulletin(s) for the applicable racking procedures.

Racking a circuit breaker into the circuit breaker compartment may be accomplished by several similar methods.

The **PowlVac-ND® Circuit Breaker** may be racked manually or electrically using the optional **Power Racking** device. The following describes each method of racking as applicable to the type of circuit breaker.



The **PowlVac-ND® circuit breaker** is designed to be manually racked into the circuit breaker compartment with the compartment door closed. The optional **Power Racking** device may be fitted on the closed circuit breaker compartment door to eliminate manual operation.

NOTE: THE DESCRIBED RACKING PROCEDURES ARE FOR RACKING THE CIRCUIT BREAKER INTO THE LOWER CIRCUIT BREAKER COMPARTMENT ONLY. TO RACK THE CIRCUIT BREAKER INTO AN UPPER CIRCUIT BREAKER COMPARTMENT, REFER TO THE METAL-CLAD SWITCHGEAR INSTRUCTION BULLETIN FOR DETAILED INFORMATION.

CAUTION: BEFORE INSERTING ANY CIRCUIT BREAKER INTO A COMPARTMENT, THE USER MUST VERIFY THAT THE CIRCUIT BREAKER RATING MEETS OR EXCEEDS THE METAL-CLAD SWITCHGEAR RATING.

CAUTION: BEFORE INSERTING A CIRCUIT BREAKER INTO THE CIRCUIT BREAKER COMPARTMENT, BE SURE THAT THE INDICATOR FLAG ON THE FRONT COVER OF THE CIRCUIT BREAKER DISPLAYS “TEST”.

CAUTION: BEFORE ATTEMPTING TO RACK A CIRCUIT BREAKER IN OR OUT OF A CIRCUIT BREAKER COMPARTMENT EQUIPPED WITH A KEY INTERLOCK, MAKE SURE THAT THE INTERLOCK IS UNLOCKED AND IN THE OPEN POSITION.

CAUTION: THE ILLUSTRATIONS SHOWN FOR ALL RACKING 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 RACKING PROCEDURE, REVIEW SECTION II.

i. Racking the PowlVac-ND® Circuit Breaker

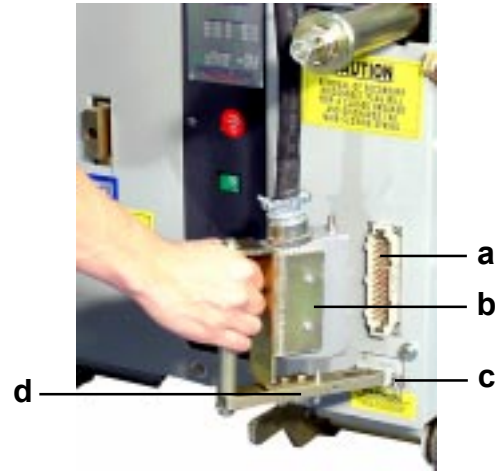
Racking the Circuit Breaker to the Connected Position

- a. Verify that the circuit breaker open/closed indicator displays **“BREAKER OPEN”** and if not, press the manual trip operator to open the circuit breaker.
- b. To insert the circuit breaker into the lower circuit breaker compartment, open the compartment door and align the wheels with the floor pan channels of the compartment. Verify that the floor pan channels are free of debris prior to inserting the circuit breaker.
- c. Roll the circuit breaker in the compartment until the racking crank arms contact with the vertical slots in the compartment. The anti-rollout latch under the circuit breaker will engage the block in the compartment, preventing accidental removal of the circuit breaker from the compartment. Verify full insertion into the circuit breaker compartment by reading the racking position label attached to the switchgear circuit breaker mounting pan right side flange. The edge of the front cover of the circuit breaker should line up with the strip delineating “test/disconnected” on the label. If the line does not appear, the circuit breaker should be manually pushed towards the primary disconnecting devices until the strip appears even with the edge of the circuit breaker front cover.

This is the **Disconnected Position**.



- d. Insert the circuit breaker compartment's secondary disconnect plug into the circuit breaker's secondary disconnect receptacle. Be sure to insert the plug fully and ascertain that the spring latch (fig 11 [c]), located on the side of the secondary disconnect interlock, has engaged the secondary disconnect interlock bar (fig 11 [d]).

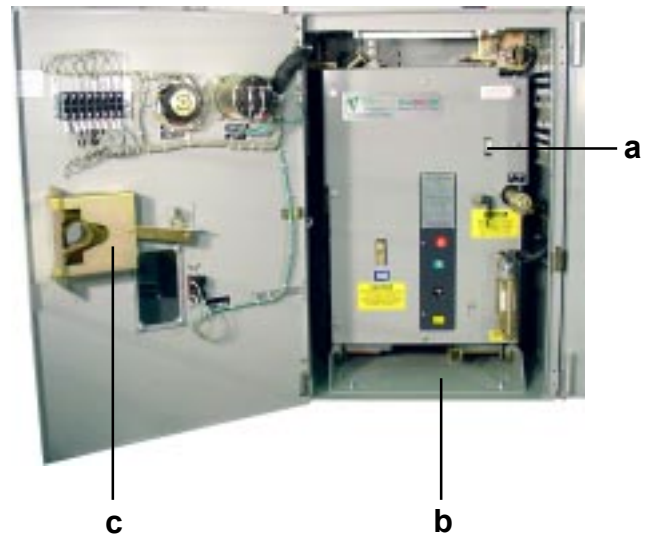


- a. Secondary Disconnect Receptacle
- b. Secondary Disconnect Plug
- c. Spring Latch
- d. Interlock Bar

Figure 11. Secondary Disconnecting Device

- e. Manually extend the racking drive shaft extension of the circuit breaker approximately 1" to ensure engagement with the racking mechanism retainer assembly. Close and latch the circuit breaker compartment door.

This is the **Test Position**.



- a. Breaker Position Indicator
- b. Test Position
- c. Racking Mechanism Retainer Assembly

Figure 12. PowlVac-ND® Circuit Breaker - Test Position



- f. Insert the racking handle onto the racking drive shaft extension.



- a. Racking Handle
b. Racking Drive Shaft Extension

Figure 13. Racking Handle Insertion

- g. Turning the racking handle clockwise will begin to rack the circuit breaker into the compartment. When the circuit breaker is racked into the compartment, the force needed to rotate the racking handle will be low at the beginning of motion as the movement of the racking crank arms is only opening the shutters. Once the shutters are open, the circuit breaker begins to move toward the stationary primary disconnecting devices. When the movable primary disconnecting devices of the circuit breaker engage with the stationary primary disconnecting devices of the compartment, the force required to rotate the racking handle will increase appreciably. This force will decrease as the primary disconnecting devices spread and engage fully. Continuing rotation of the racking handle will cause the circuit breaker to travel further into the compartment insuring wipe or overlap of the primary disconnecting devices. Continue racking until the breaker position indicator displays “CONN” as observed through the compartment door view window. This will be approximately 22 rotations from the starting point. When the circuit breaker reaches the end of the racking travel, the operator will notice an increased amount of force. If the user continues to apply force, a torque limiter on the racking handle will produce a sharp clicking sound indicating the torque limit is reached at 35-lb•ft. Should the operator continue to apply force, the torque limiter will continue to operate with no further buildup of torque on the circuit breaker racking mechanism.
- h. Once the circuit breaker has reached the connected position remove the racking handle, and operate the circuit breaker as required.



Figure 14. Racking the PowlVac-ND® Circuit Breaker

This is the **Connected Position**.



Racking the Circuit Breaker to the Test Position

- Verify that the circuit breaker open/closed indicator displays “**BREAKER OPEN**” and if not, operate the circuit breaker control switch to open the circuit breaker.
- Place the racking handle socket onto the racking drive shaft extension.
- Turn the racking handle counterclockwise until the breaker position indicator displays “**TEST**”.
- Remove the racking handle.

This is the **Test Position**.

Removing the Circuit Breaker from the Compartment

- Open the circuit breaker compartment door.
- Lift the secondary disconnect latch (fig 11 [c]) and remove the circuit breaker compartment’s secondary disconnect plug. Store the plug so it will not be damaged while withdrawing the circuit breaker.
NOTE – REMOVING THE SECONDARY DISCONNECT PLUG WILL TRIP A CLOSED BREAKER AND DISCHARGE THE MAIN CLOSING SPRING.
- Press the anti-rollout latch to release the circuit breaker and pull the circuit breaker out of the circuit breaker compartment. See figure 15.

ii. Power Racking

This is an alternative to the manual racking procedures described above utilizing a motor driven mechanism and electric control, allowing the user to perform the racking function without being located in front of the circuit breaker compartment. It is applicable to the PowlVac-ND® Circuit Breakers. The **Power Racking Device (optional)** mounts onto the compartment door when the circuit breaker is racked with the compartment door closed. Refer to the instruction bulletin provided with the **Power Racking Device** for the proper operational procedure use.



a. *Anti-Rollout Latch*

Figure 15. Circuit Breaker Removal - Applying the Anti-Rollout Latch



Contact **Powell Apparatus Service Division** for assistance in performing maintenance or setting up a maintenance program at www.powellservice.com, or call 1-800-480-7273.

V. MAINTENANCE

CAUTION

PRIOR TO BEGINNING ANY MAINTENANCE PROCEDURES MAKE CERTAIN THAT THE CONTROL CIRCUITS ARE DE-ENERGIZED 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 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 ELECTRICAL MANUFACTURING COMPANY IMMEDIATELY.

A. GENERAL DESCRIPTION

i. Introduction

A regular maintenance schedule must be established to obtain the best service and reliability from the circuit breaker. PowlVac-ND® 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.

Actual inspection and maintenance will depend upon individual application conditions such as number of operations, magnitude of currents switched, desired overall system reliability, and 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. Some atmospheric conditions such as extremes of dust, moisture, or corrosive gases might indicate inspection and maintenance at more frequent intervals. Very clean and dry conditions combined with low switching duty will justify longer times between inspection and maintenance operations. With experience, each user can set an inspection and maintenance schedule that is best suited for use.

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 if it has been more than one year since the last vacuum integrity test.



A permanent record of all maintenance work should be kept, the degree of detail depending upon on 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 energization, and all data should be graphed as a function of time to ensure a proper maintenance cycle is being scheduled.

Because of extensive quality control tests made at the factory, the operations counter on a new circuit breaker will normally register over 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.

WHEN ANY MAINTENANCE PROCEDURE REQUIRES OPENING OR CLOSING OF THE CIRCUIT BREAKER OR CHARGING OF ANY OF THE MECHANISM SPRINGS, EXERCISE EXTREME CARE TO MAKE SURE THAT ALL PERSONNEL, TOOLS, AND OTHER OBJECTS ARE KEPT WELL CLEAR OF ALL MOVING PARTS OR CHARGED SPRINGS.

ii. Inspection and Cleaning

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 MECHANICAL PROPERTIES OF THE INSULATION.

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. This inspection will be much 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 the circuit breaker. This may result in loose dirt or grit being blown into bearings or other critical parts, thus causing excessive wear. Use a vacuum cleaner, or wipe with a dry lint-free cloth or an industrial-type wiper to clean the circuit breaker. Do not use solvents, de-greasers, or any aerosol products to clean in the area of any mechanisms. Refer to Section B. ii. Lubrication MECHANISM AREA 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 pushrods, should be cleaned. Wipe 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 as detergent may leave an electrically conducting residue on the surface as it dries.



B. MECHANISM AREA

i. 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 under Section D. OPTIONAL MAINTENANCE PROCEDURES are to be performed 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.

Operate the racking mechanism through one or two complete cycles and check for the smoothness of operation. It will be necessary to insert the secondary disconnect override device into the secondary disconnect receptacle to perform this operation.

See the sections headed “Mechanical Operation Check” and “Racking Mechanism Check” under the heading “PLACING THE CIRCUIT BREAKER INTO SERVICE” for further details.

ii. Lubrication

CAUTION: BEFORE APPLYING ANY TYPE OF LUBRICATION TO THE CIRCUIT BREAKER, THE STORED-ENERGY MECHANISM SHOULD BE IN THE OPEN POSITION, AND ALL SPRINGS 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 Lubrication Table IV.

Table IV. shows the location of all surfaces that should be lubricated together with the type of lubricant and method of application. The guiding rule in lubrication is to lubricate regularly, use lubricant sparingly and remove all excess lubricant. There is no necessity to disassemble the mechanism for lubrication. Tilting the circuit breaker will facilitate the entry of the lubricant to the bearing surfaces.

iii. Main Closing Spring Removal, Slow Closing of Mechanism, and Latch Check Switch Adjustment

Disassembly of the stored-energy mechanism is not required for routine lubrication; however, for major overhaul removal of the main closing spring is necessary. Removal of the spring permits slow closing of the mechanism and the vacuum interrupter contacts. The procedure for spring removal is as follows:

With the main closing spring discharged and the circuit breaker contacts open, remove the circuit breaker top cover, then remove the screw at the top of the spring rod together with the flat washer, and lock washer. Remove the horizontal bracket at the top of the main closing spring, by unfastening the two attachment screws. Remove the spacer from below the bracket. Turn the bracket 90°, and replace it on top of the spring yoke. Place the spacer on top of the bracket with the flat washer above it. Insert screw and tighten until the tension is taken off the connecting rods.



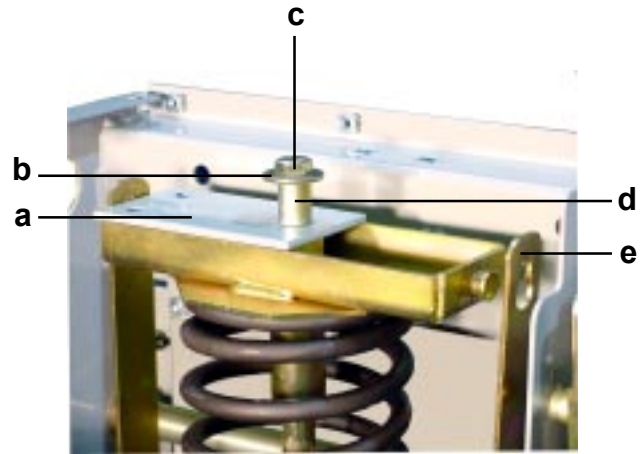
With a slight rocking motion of the main closing spring assembly, the connecting rods (fig 16 [e]) can now be unhooked from the spring yoke pins and the main closing spring assembly can be removed.

Care should be taken on reassembly to ensure correct location of the flat washer, lock washer and spacer. See figure 17.

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

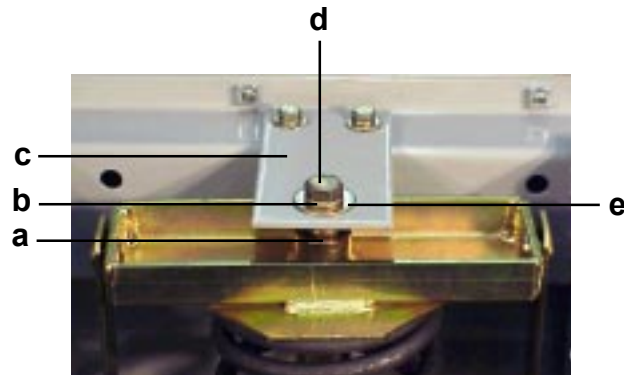
With the main closing spring assembly removed, rotate the camshaft so that the crank arms are pointing downward. The fundamental linkage will now move into the reset position. Push the manual close operator inward and hold in while operating the manual charging handle to rotate the camshaft. Once the 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. Continue to operate the manual charging handle until the crank arms point upward. The circuit breaker will now be closed and there will be a gap between the operating pushrod lock nuts and the contact spring yokes.

Return the circuit breaker to the open position by depressing the manual trip operator. To install the main closing spring assembly reverse the preceding removal procedure.



- a. Bracket
- b. Flat Washer
- c. Screw
- d. Spacer
- e. Connecting Rod

Figure 16. Main Closing Spring Assembly Compressed for Removal



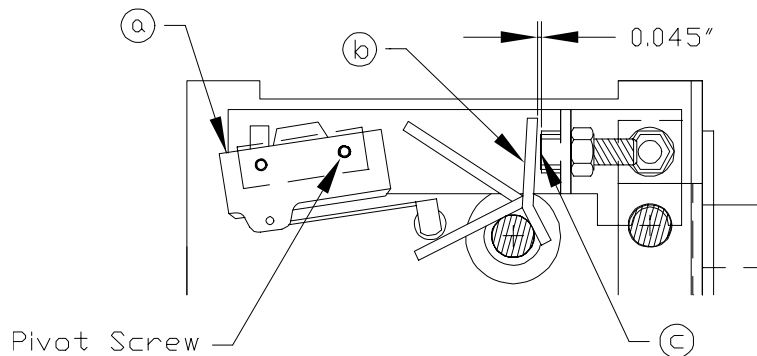
- a. Bracket
- b. Screw
- c. Spacer
- d. Flat Washer
- e. Lock Washer

Figure 17. Main Closing Spring Assembly Installed



The latch check switch adjustment described is not required for routine maintenance; however, the latch check switch may need to be adjusted after major overhaul or removal of the mechanism. The latch check switch adjustment is as follows:

1. Remove the main closing spring as described in this section.
2. Insert and secure the secondary disconnect override device into the secondary disconnect receptacle.
3. Rotate the crank arms until the spring charge indicator displays, "**CLOSING SPRING CHARGED**".
4. Loosen the two screws which secure the latch check switch and rotate the latch check switch about the pivot screw downward to the lowest position allowed. The latch check switch contacts are now open.
5. Insert a 0.045 inch gauge between the secondary trip prop adjusting screw and latch check operator. Rotate the latch check switch upwards 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.
6. 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, then slowly withdraw the manual trip operator and the latch check switch contacts will close as the latch check operator is a maximum of 0.045 inches away from the secondary trip prop adjusting screw.)
7. Depress the manual close operator and rotate the crank arm until resistance is felt.
8. Depress and hold the manual trip operator inward and rotate the crank arms until the spring charge indicator displays, "**CLOSING SPRING DISCHARGED**".
9. Remove the secondary disconnect override device and reinstall the main closing spring.



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

Figure 18. Latch Check Switch Adjustment



iv. Mechanism Adjustments

WARNING

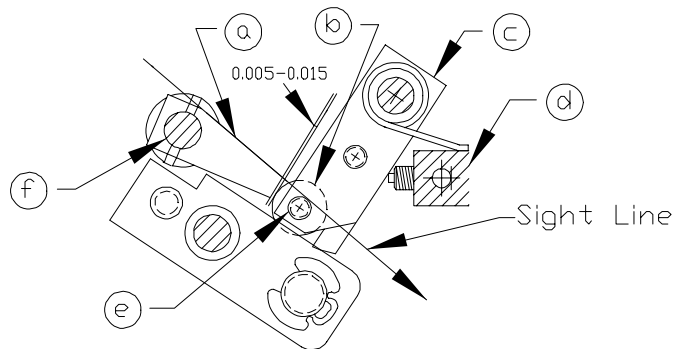
WHEN ANY MAINTENANCE PROCEDURE REQUIRES THE OPENING OR CLOSING OF THE CIRCUIT BREAKER OR THE CHARGING OF ANY OF THE STORED-ENERGY MECHANISM SPRINGS, EXERCISE EXTREME CAUTION TO MAKE SURE THAT ALL PERSONNEL, TOOLS, AND OTHER OBJECTS ARE KEPT WELL CLEAR OF THE MOVING PARTS OR THE CHARGED SPRINGS. FAILURE 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 major overhaul or removal of the mechanism.

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 (fig 2 [x]) is adjusted by the holding pawl adjusting eccentric (fig 2 [y]). 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, remove the escutcheon to gain access to the head of the bolt holding the adjusting eccentric. Loosen the bolt slightly. Grip the eccentric with a pair of slip-joint pliers or a similar tool and rotate the stop slightly. Tighten the holding bolt with the eccentric in the new position. While charging the main closing spring, using the charging motor to drive the mechanism observe the ratcheting operation for improvement. If the ratcheting operation has not improved, repeat the preceding sequence until the ratcheting operation is smooth. This may require several charging cycles. 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 and Secondary Trip Prop

Adjust the secondary trip prop adjusting screw (fig 2 [w]) so that the secondary trip prop top edge is in the line of sight with the top of the rivet of the primary trip prop roller as shown in figure 19 [b].

- 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

Figure 19. Primary and Secondary Trip Prop Adjustment



Adjust the primary trip prop adjusting screw (fig 4 [l]) so that with the fundamental linkage in the reset position, the clearance between the primary trip prop roller and the secondary trip prop is 0.005-0.015 inch. The primary trip prop adjusting screw is accessible from the rear of the stored-energy mechanism and is located inside the hole beside the lower middle insulator supporting the live part assembly, see figure 20.

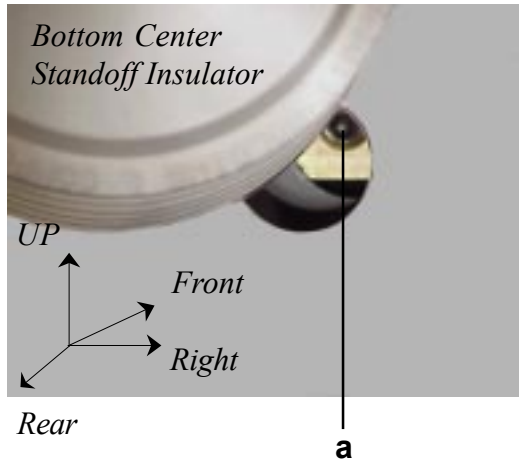
c. Adjustment of Close Latch Shaft

The close latch shaft (fig 2 [s]) passes through the side sheets of the stored-energy mechanism frame at the front of and below the camshaft. The left end of the shaft is shaped to make a latch face and interferes with the close latch arm (fig 2 [r]), which is fixed to the camshaft. The other end of the close latch shaft is on the right side of the mechanism and a small lever attached to it is positioned by a close bar adjusting screw (fig 2 [j]). To adjust the close latch shaft:

1. Insert and secure the secondary disconnect override device into the secondary disconnect receptacle.
2. Remove the escutcheon.
3. Loosen the locking nut from the close bar adjusting screw while holding the position of the close bar adjusting screw with a screw driver.
4. Back out the close bar adjusting screw by turning the screw counterclockwise 2 full turns.
5. Manually charge the circuit breaker main closing spring with a manual charging handle until the spring charge indicator displays, “**CLOSING SPRING CHARGED**”.
6. Turn the close bar adjusting screw clockwise until the main closing spring discharges, then depress the manual trip operator to open the circuit breaker.
7. Turn the close bar adjusting screw 2-1/2 full turns counterclockwise. Retighten the locking nut holding the screw.
8. Repeat step 5. Close and open the circuit breaker to ensure proper operation.
9. Replace the escutcheon and remove the secondary disconnect override device.

v. 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 the section headed “Electrical Operation Check” under the “Placing the Circuit Breaker into Service” heading in this instruction bulletin.



a. Primary Trip Prop Adjusting Screw

Figure 20. Primary Trip Prop Adjusting Screw



C. VACUUM INTERRUPTER AND CONTACT AREA

i. 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 1/2 to 5/8 inch between the contact loading spring yoke and the lock nut on the operating pushrod stud. As 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 lower 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 reaches the end-of-life value given on this label, the vacuum interrupter should be replaced. Detailed instructions for vacuum interrupter replacement are given in this instruction bulletin.

ii. Sliding Contact Wear

The PowlVac-ND® circuit breaker uses a multi-contact assembly located inside the lower contact block and in direct contact between the moving stem of the vacuum interrupter and lower contact block. Each lower 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 lower contact block and shielded from the outside atmosphere by the polymer bushings, no scheduled preventative maintenance is required for the sliding contacts.

iii. Vacuum Integrity

Refer to the section "PLACING THE CIRCUIT BREAKER INTO SERVICE" for information on vacuum integrity and testing of vacuum interrupters.

iv. 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. C. i. Vacuum Interrupter Assembly Replacement Procedures for further details.

D. OPTIONAL MAINTENANCE PROCEDURES

i. 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. See the section of this instruction bulletin headed "PLACING THE CIRCUIT BREAKER INTO SERVICE" for details of these procedures.

**ii. Timing**

At normal control voltage, operate the test source to the “close” position to close the circuit breaker and record the closing time. The closing time from energizing the closing coil to vacuum interrupter contact touch should not exceed the values in the timing table. Again, at normal control voltage, 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 in the timing table.

Table II. Timing

	Closing Time	Tripping Time
3 cycle	80 ms	< 35 ms

iii. Primary Resistance Check

This 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 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.

When making this test, be sure that the test current passes through both main horizontal primary disconnecting devices of each pair, or the resistance measurement will be affected. This may be done by connecting the current source leads to two blocks of full round edge copper 1 inch thick by 3 or 4 inches wide by 4 inches long, and pressing these blocks into the upper and lower primary disconnecting devices of the circuit breaker. The blocks should be silver- or tin-plated to simulate the primary disconnecting devices in the circuit breaker compartment. The voltage drop measurement may be made between these two blocks.

The micro-ohm values of resistance must not exceed the following limits:

Table III. Primary Resistance

Breaker Type	Rated kV	Rated Continuous Current A	Resistance Micro-ohms
05PV36SNDX	4.76	1200	35
05PV36SNDX	4.76	2000	30
05PV50SNDX	4.76	1200	35
05PV50SNDX	4.76	2000	30



Table IV. Lubrication

Location	Ref. Figure	Lubricant	Method
Electrical Parts			
Primary Disconnecting Device	fig 21 [b]	Mobilgrease 28	Wipe clean. Apply lubricant only to actual contact surface.
Ground Connection	fig 22 [u]	Mobilgrease 28	Wipe clean. Apply lubricant only to actual contact surface.
Secondary Disconnect Receptacle	fig 21 [k]	Mobilgrease 28	Wipe clean. Apply lubricant only to actual contact surface.
Mechanical Parts			
Spring Yoke Pin	fig 21 [a]	Anderol 456 Oil	
Trip Shaft Bearing	fig 21 [c]	Anderol 456 Oil	
Jackshaft Support	fig 21 [d]	Anderol 456 Oil	
Pawl Support Arm	fig 21 [e]	Anderol 456 Oil	
Crank Pin	fig 21 [f]	Anderol 456 Oil	
Motor Drive Shaft Roller Needle Bearings	fig 21 [g]	Anderol 456 Oil	
Pawls	fig 21 [h]	Anderol 456 Oil	
Close Latch Shaft Face	fig 21 [i]	Rheolube 368A Grease	Apply a light coating of grease and remove all excess.
Ratchet Wheel	fig 21 [j]	Rheolube 368A Grease	
Jackshaft Lever Pins passing through Operating Pushrods	fig 21 [l]	Anderol 456 Oil	Avoid lubricant on operating pushrods.
Fundamental Linkage Pin	fig 21 [m]	Anderol 456 Oil	Apply to penetrate where pin passes through end link.
Racking Drive Shaft Extension	fig 21 [n]	Rheolube 368A Grease	Wipe clean. Extend and apply Rheolube 368A Grease to the exposed surface.
Main Closing Spring Guide Rod	fig 22 [o]	Anderol 456 Oil	
Racking Mechanism	fig 22 [p]	Anderol 456 Oil Rheolube 368A Grease	Apply Anderol 456 Oil to the crank arm rollers and racking crank arms. Wipe clean. Apply Rheolube 368A Grease to worm gear.
Primary Trip Prop	fig 22 [q]	Anderol 456 Oil	
Open-Close Flag Drive Lever Pin at Jackshaft	fig 22 [r]	Anderol 456 Oil	
Flag Support Pin	fig 22 [s]	Anderol 456 Oil	
Jackshaft Outer Bearings Support	fig 22 [t]	Anderol 456 Oil	
Motor Drive Shaft Coupling	fig 22 [v]	Anderol 456 Oil	
Wheel	fig 22 [w]	Anderol 456 Oil	
Motor Drive Shaft Support Bearings	fig 22 [x]	Anderol 456 Oil	
Camshaft Needle Bearings	fig 22 [y]	Anderol 456 Oil	
Close Shaft Support Bearing	fig 22 [z]	Anderol 456 Oil	
Motor Cutoff Cam	fig 22 [aa]	Rheolube 368A Grease	Apply to peripheral surface only.
Fundamental Linkage	fig 22 [ab]	Anderol 456 Oil	Apply to penetrate where pins pass through lines.



a. Spring Yoke Pin



b. Primary Disconnecting Device



c. Trip Shaft Bearing



d. Jackshaft Support



e. Pawl Support Arm



f. Crank Pin



g. Motor Drive Shaft Roller Needle Bearings



h. Pawls



i. Close Latch Shaft Face



j. Ratchet Wheel



k. Secondary Disconnect Receptacle



l. Jackshaft Lever Pin



m. Fundamental Linkage Pin



n. Racking Drive Shaft Extension

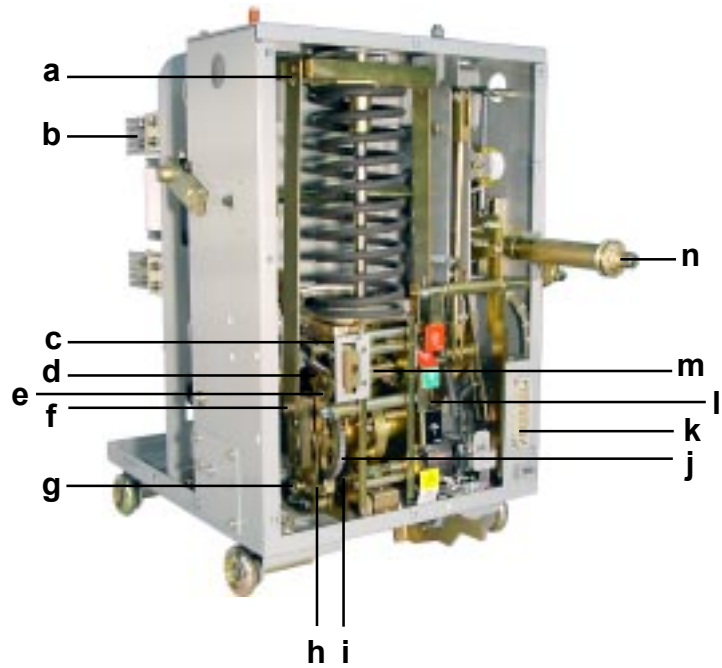


Figure 21. Lubrication

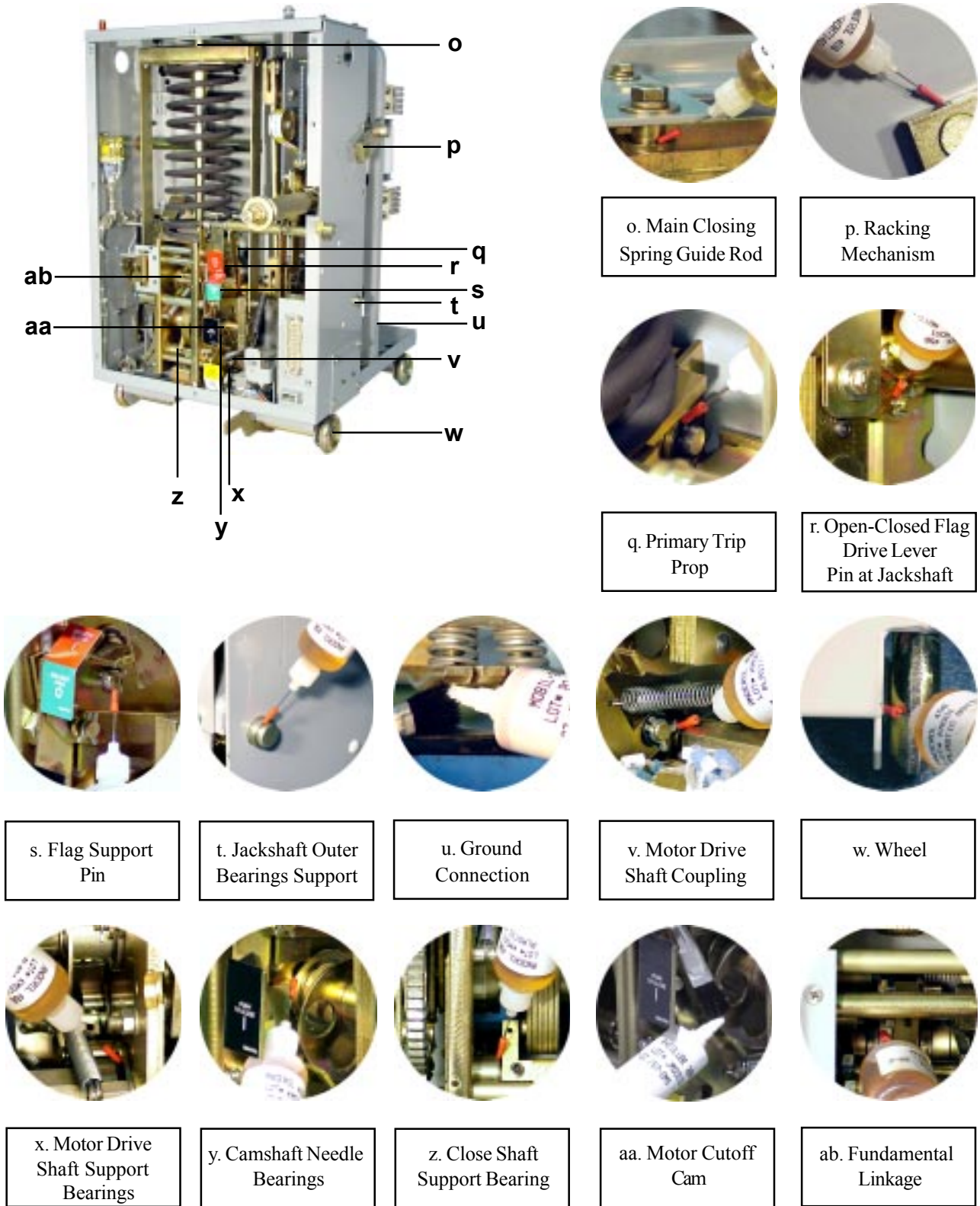


Figure 22. Lubrication



VI. RECOMMENDED RENEWAL PARTS AND REPAIR PROCEDURES

A. ORDERING INSTRUCTIONS

- i. Order **Renewal Parts** from **Powell Apparatus Service Division (PASD)** at **www.powellservice.com** or call **1-800-480-7273**.
- ii. Always specify complete nameplate information, including:
 - a. Breaker Type
 - b. Serial Number
 - c. Rated Voltage
 - d. Rated Amps
 - e. Impulse Withstand
 - f. Control Voltage (for control devices and coils)
- iii. 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, a photo or simply submit a sketch showing the part needed.

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 greater amount of renewal parts should be stocked, the quantity depending on the severity of the service and the time required to secure replacements.

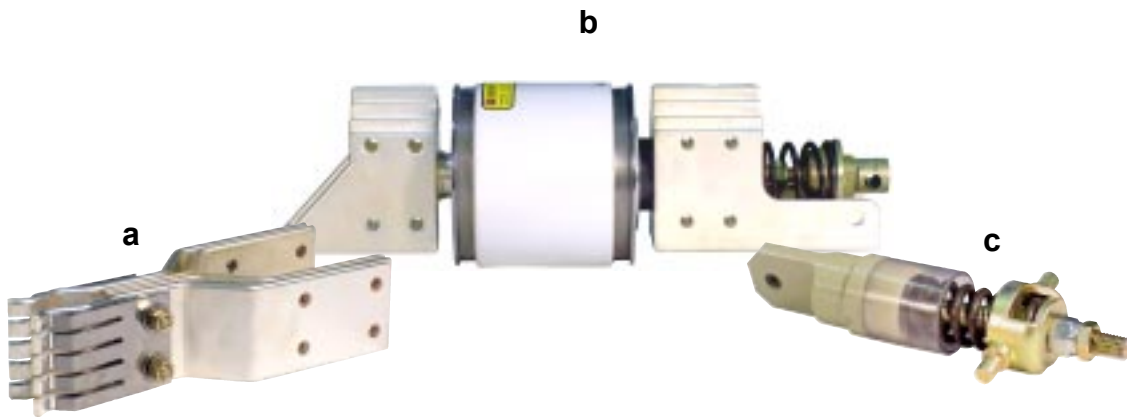
Spare or replacement parts which are furnished may not be identical to the original parts since improvements are made from time to time. The parts which are furnished, however, will be interchangeable. Tables found in this instruction bulletin list the recommended spare parts to be carried in stock by 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 fraction thereof.

Powell Electrical Manufacturing Company 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.



Table V. Primary Current Path

Breaker Type k factor = 1	Rated kV	Rated Continuous Current A	Vacuum Interrupter Assembly	Primary Disconnecting Device Assembly	Operating Pushrod Assembly
05PV36SNDX	4.76	1200	77014G01P	77018G01P	77017G01P
05PV36SNDX	4.76	2000	77014G01P	77018G01P	77017G01P
05PV50SNDX	4.76	1200	77014G03P	77018G01P	77017G02P
05PV50SNDX	4.76	2000	77014G03P	77018G01P	77017G02P



- a. Primary Disconnecting Device Assembly
- b. Vacuum Interrupter Assembly

- c. Operating Pushrod Assembly

Figure 23. Primary Current Path

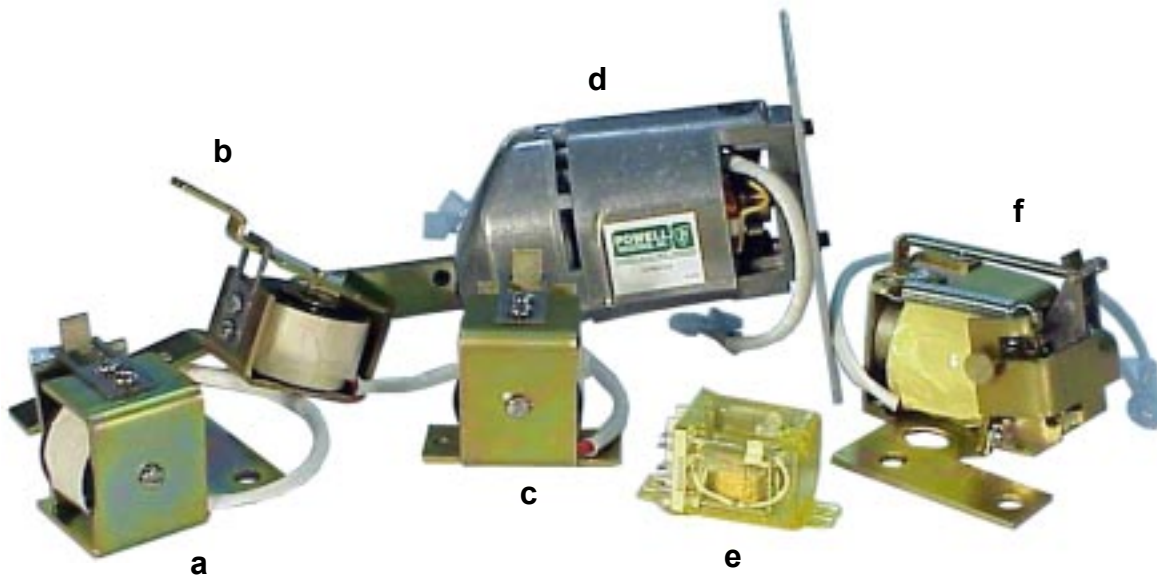


Table VI. Control Devices (1)

Control Voltage	Closing Coil Assembly	Primary Shunt Trip Coil Assembly 3 cycle (2)	Secondary Shunt Trip Coil Assembly (1,3)	Undervoltage Device Assembly	Charging Motor Assembly	Anti-Pump Relay Assembly (5)
48Vdc	77026G01P	77027G01P	50042G01P	(4)	77318G01P	RR2BA-US-DC 48V
125Vdc	77026G03P	77027G02P	50042G03P	(4)	77318G02P	RR2BA-US-DC 110V
250Vdc	77026G04P	77027G03P	50042G04P	(4)	77318G03P	RR2BA-US-DC 110V
120Vac	77026G05P	77027G01P	50042G01P	N/A	77318G02P	RR2BA-US-AC 120V
240Vac	77026G02P	77027G06P	50042G02P	N/A	77318G03P	RR2BA-US-AC 240V
Capacitor Trip (6)	N/A	50027G04P	50042G05P	N/A	N/A	N/A

Notes for Table VI. The numbers in () indicate that there is a reference note from below.

- 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 assemblies are optional. See note 2-7.
- Primary shunt trip coil is a 3 cycle control device.
- Secondary shunt trip coil cannot be furnished with an undervoltage device assembly.
- Where furnished, cannot be present with secondary shunt trip coil assembly. Consult factory for replacement undervoltage device part numbers.
- For 250V dc applications, a dropping resistor 50747G02P is required in series with the anti-pump relay assembly.
- For use with capacitor trip units with 240V ac input. Consult factory for other circuit breaker ratings.
- All control devices are available with push-on terminals. Consult factory for control devices with screw terminals.



- a. Secondary Shunt Trip Coil Assembly
 b. Primary Shunt Trip Coil Assembly (3 cycle)
 c. Closing Coil Assembly

- d. Charging Motor Assembly
 e. Anti-Pump Relay Assembly
 f. Undervoltage Device Assembly

Figure 24. Control Devices



Table VII. Miscellaneous Parts

Description	Catalog No.	Illustration
Auxiliary Switch Push-on Terminals Screw Terminals	102108LN 102108LP	
Ground Connection 50kA	69433G01P	
Latch Check Switch	BA-2RV2-A2	
Motor Cutoff Switch Assembly	77034G01P	
PowlVac® Hardware Kit	60500G24	
PowlVac® Lubrication Kit	Powlube-102	



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.

MAKE CERTAIN THAT THE CONTROL CIRCUITS ARE DE-ENERGIZED AND THE CIRCUIT BREAKER IS RESTING SECURELY OUTSIDE THE METAL-CLAD SWITCHGEAR. 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 MAKE SURE THAT ALL PERSONNEL, TOOLS, AND OTHER OBJECTS ARE KEPT WELL CLEAR OF THE MOVING PARTS OR THE CHARGED SPRINGS.

CAUTION: THE REPLACEMENT OF THE VACUUM INTERRUPTER ASSEMBLY SHOULD ONLY BE REPLACED BY A QUALIFIED TECHNICIAN OR A PASD SERVICE TECHNICIAN. CONTACT POWELL ELECTRICAL MANUFACTURING COMPANY FOR FURTHER ASSISTANCE AT 1-800-480-7273.

i. Vacuum Interrupter Assembly

This assembly is located in between the upper and lower primary disconnecting devices. (See figure 1 [t].)

To replace it:

- a. Ensure all operating springs are discharged and the circuit breaker is open.
- b. Remove the interphase barrier assembly.
- c. Using a $\frac{3}{4}$ " hex open end wrench, loosen the $\frac{1}{2}$ " jam nut securing the vacuum interrupter adaptor to the bottom 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 lower contact block assembly and lower the operating pushrod to bottom of through slot in the vacuum interrupter support.
- f. Loosen the anti-bellows spring assembly from the vacuum interrupter by unscrewing counterclockwise as seen from the bottom of the lower contact block.
- g. Once the anti-bellows spring assembly has been removed from the bottom of the moving stem, loosen the $\frac{1}{2}$ " bolts anchoring the lower contact block to the lower standoff insulator and remove the two $\frac{5}{16}$ "x18 bolts from the back side of the insulating support plate securing the lower contact block above the lower standoff insulator.
- h. Remove the two $\frac{5}{16}$ "x18 bolts from the back side of the insulating support plate securing the upper contact block below the upper standoff insulator.
- i. Loosen the $\frac{1}{2}$ " bolts anchoring the upper contact block to the upper standoff insulator.
- j. Remove both upper and lower $\frac{1}{2}$ " bolts and remove the vacuum interrupter assembly from the insulating support plate.



Figure 25. Vacuum Interrupter Assembly



- k. Place the vacuum interrupter assembly on a suitable flat work surface and remove the 5/16"x18 bolts securing the primary disconnecting devices from the upper and lower contact blocks.
- l. Check the contents of the replacement vacuum interrupter kit. It should contain the following items:
 1. Vacuum interrupter assembly, complete with upper and lower blocks.
 2. X-washers.
 3. Metal tooth ty-wraps.
 4. 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 1/2" bolts in the upper contact block.
- o. Gently pull down the lower contact block until the lower 1/2" holes line up and insert the lower contact block bolts.
- p. Leaving both upper and lower 1/2" bolts loose, align and install the four 5/16"x18 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 (1/2" bolts to 40 lb-ft, 5/16" bolts to 20 lb-ft).
- 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 lower moving stem.
- 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 lower 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 3/4" 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 1/2 revolution. Ideal contact stroke for all PowlVac-ND® circuit breakers is between 0.350" and 0.400".
- y. Reinstall the interphase barriers.

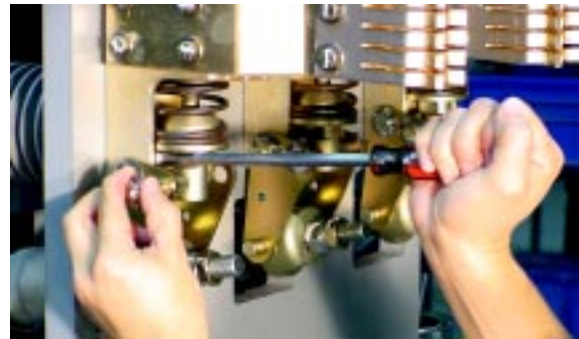


Figure 26. Vacuum Interrupter Linkage Pin

CAUTION: DO NOT USE THE LOWER BLOCK TO TURN THE VACUUM INTERRUPTER ASSEMBLY INTO THE UPPER BLOCK AS DAMAGE TO THE INTERRUPTER BELLOWS ASSEMBLY AND LOSS OF VACUUM MAY RESULT!



CAUTION: DO NOT FORCE THE LOWER CONTACT BLOCK DOWN FARTHER THAN REQUIRED TO ALIGN THE PIN, BELL CRANKS, AND OPERATING YOKE AS DAMAGE TO THE VACUUM INTERRUPTER BELLOWS AND LOSS OF VACUUM MAY RESULT.

1. With the circuit breaker closed, measure the gap between the lower 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 the “**Vacuum Integrity**” section under the **PLACING THE CIRCUIT BREAKER INTO SERVICE** section, and the primary resistance test in the “**Primary Resistance Check**” section under the **OPTIONAL MAINTENANCE PROCEDURES** section.

ii. Closing Coil Assembly

This assembly is located center and beneath the circuit breaker mechanism. See figure 2 [z]. To replace it:

- 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 base pan, and drop the assembly out of the bottom of the circuit breaker.
- d. Insert the new assembly into the circuit breaker from below 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.



Figure 27. Closing Coil Assembly

iii. Primary Shunt Trip Coil Assembly

This assembly is located at the top left side of the mechanism, just left of the main closing spring. See figure 2 [b]. To replace it:

- a. Remove the front cover of circuit breaker.
- b. Disconnect the primary shunt trip coil assembly wiring from the wiring harness. Measure and record the distance between the assembly armature and the trip lever. (See figure 29.)
- c. Remove the two bolts which holds the assembly to the circuit breaker frame and remove the assembly.
- d. Bolt the new assembly in place and reconnect it to the wiring harness.
- e. With the circuit breaker mechanism in the reset position, adjust the gap between the assembly armature and the trip lever to the dimension measured and recorded from step b. To achieve this setting bend the trip lever slightly. See figure 29.
- f. Trip the circuit breaker electrically several times to ensure that the primary shunt trip coil assembly is functioning properly.
- g. Replace the front cover.



Figure 28. Primary Shunt Trip Coil Assembly



iv. Secondary Shunt Trip Coil Assembly

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

NOTE: It will be easier to remove the secondary shunt trip coil assembly if the right connecting rod is removed. To remove the connecting rod see the “**Main Closing Spring Removal, Slow Closing of Mechanism, and Latch Check Switch Adjustment**” section, which is under the **MAINTENANCE** section of this instruction bulletin.

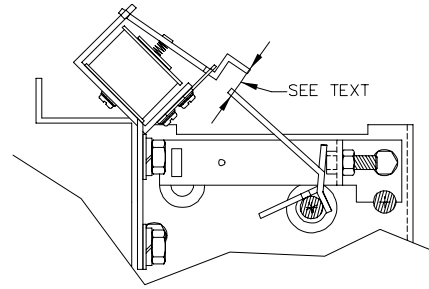


Figure 29. Trip Lever Gap Adjustment

- a. Remove the front cover of 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.

v. Undervoltage Device Assembly

Detailed instructions for replacing the undervoltage are supplied with the replacement device.

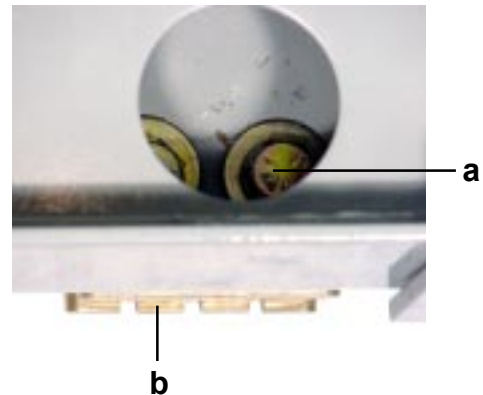


Figure 30. Undervoltage Device Assembly

vi. Ground Connection Assembly

This assembly is located at the rear edge of the floor pan of the circuit breaker, centered on the middle pole of the circuit breaker. See figure 31.

- a. Remove the bolts holding the ground connection to the circuit breaker frame.
- b. Slide the ground connection forward, and remove it from bottom of circuit breaker.
- c. Install the new ground connection in the reverse order. (Torque to 15-20 lb•ft)



- a. Holding Bolt
- b. Ground Connection

Figure 31 Ground Connection



vii. Charging Motor Assembly

This assembly is located at the bottom right of the floor pan of the mechanism. See figure 2 [e]. To replace it:

- 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 right frame side sheet and slide the motor to the right, 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 liberally 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.



Figure 32. Charging Motor Assembly

viii. Anti-Pump Relay Assembly

This assembly is located inside the left side sheet of the circuit breaker frame, near the top of the mechanism. See figure 2 [a]. To replace it:

- a. Remove the front cover of circuit breaker.
- b. Loosen the lower mounting screw of relay.
- c. Remove the upper mounting screw and lift the relay off lower screw.
- d. Disconnect the leads from the anti-pump relay assembly, being careful to 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 250V dc 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, 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.



Figure 33. Anti-Pump Relay Assembly



ix. Latch Check Switch

The latch check switch is located at the left side of the main mechanism frame, near the bottom of the main closing spring. See figure 2 [ad]. To replace and adjust the latch check switch, see the “**Main Closing Spring Removal, Slow Closing of Mechanism, and Latch Check Switch Adjustment**” section, which can be located under the **Maintenance** section of this instruction bulletin. In addition to those instructions,



Figure 34. Latch Check Switch

- a. Remove the two screws that secure the latch check switch to the mechanism. Do not loose 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 the “**Main Closing Spring Removal, Slow Closing of Mechanism, and Latch Check Switch Adjustment**” section.
- e. Operate the circuit breaker electrically several times to ensure that the latch check switch is working.

x. Motor Cutoff Switch Assembly

This assembly is located at the bottom right of the base pan of the mechanism, just to the right of the main mechanism. See figure 2 [i]. To replace it:



Figure 35. 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 floor pan 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. Disconnect the wires from the terminal block, being careful to identify each wire by the terminal number from which it was removed.
- f. Reconnect the wiring to the terminals on the new assembly from which it was removed.
- g. Install the new assembly and bolt it to the base pan.
- h. Install the operations counter on the new assembly.
- i. Operate the circuit breaker electrically several times to ensure that all components on the motor cutoff switch assembly are working properly.
- j. Replace the front cover.



xi. Auxiliary Switch

The auxiliary switch is located at the bottom left of the base pan of the mechanism area. See figure 2 [d]. To replace an 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 left 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 f. Be certain to orient the switch as noted in step f.
- 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.

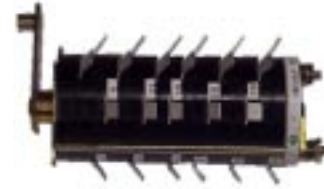
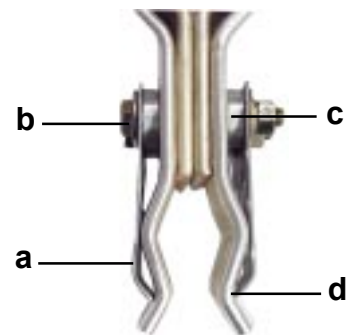


Figure 36. Auxiliary Switch

xii. Primary Disconnecting Device Spring Assembly

This assembly is located at the outer end of the primary disconnecting device. See figure 37.

- a. Remove the two bolts from the spring clips. Remove the spring clips and spacers from primary disconnecting devices.
- b. Replace with new spring clips and reinstall the two bolts.



- a. Spring Clip
- b. Bolts
- c. Spacer
- d. Primary Disconnecting Device

Figure 37. Primary Disconnecting Device Spring Assembly

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