









Instruction Bulletin - 01.4IB.65121 PowlVac 38™ ARM Series 4 Vacuum Circuit Breaker

38kV, 40kA, 1200A & 2000A



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Signal Words

As stated in ANSI Z535.4-2007, the signal word is a word that calls attention to the safety sign and designates a degree or level of hazard seriousness. The signal words for product safety signs are "Danger", "Warning", "Caution" and "Notice". These words are defined as:

A DANGER

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

A WARNING

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

A CAUTION

CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

CAUTION

CAUTION, used without the safety alert symbol, is used to address practices not related to personal injury.

NOTICE

NOTICE is used to address practices not related to personal injury.

Qualified Person

For the purposes of this manual, a qualified person, as stated in NFPA 70E®, is one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved. In addition to the above qualifications, one must also be:

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



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Ch 1 General Information

A WARNING

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

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

WARNING

Prior to adjustments, servicing, maintenance, or any act requiring the operator to make physical contact with the equipment, the power source must be disconnected and the equipment grounded. Failure to do so may result in death or serious injury.

NOTICE

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

NOTICE

Powell reserves the right to discontinue and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.



A. SCOPE

The information in this instruction bulletin describes the following PowlVac 38™ ARM (Automatic Racking Mechanism) Series 4 vacuum circuit breakers:

38PV40ARMM-4 1200A & 2000A
 38PV40ARMX-4 1200A & 2000A
 38PV40ARMS-4 1200A & 2000A

B. PURPOSE

The information in this instruction bulletin is intended to provide details required to properly operate and maintain the PowlVac 38 ARM Series 4 circuit breakers described in *Ch 1 General Information, A. Scope.*

This instruction bulletin provides:

- 1. Safety guidelines
- General descriptions of the operation and maintenance of the PowlVac 38 ARM Series 4 circuit breakers
- 3. Instructions for installation and placing the circuit breaker into service
- 4. Instructions for part replacement
- 5. Information for ordering renewal parts
- 6. Procedure for critical adjustments
- 7. Illustrations, photographs, and description of the circuit breaker

The illustrations contained in this document may not represent the exact construction details of the PowlVac 38 ARM Series 4 circuit breaker. The illustrations in this document are provided as general information to aid in showing component locations only.

All illustrations and photos are shown using deenergized equipment.

A WARNING

Follow the appropriate safety precautions while handling any of the equipment. Failure to do so may result in death or serious injury.

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

C. Instruction Bulletins Available Electronically



Changes to the instruction bulletin may be implemented at any time and without notice.

Go to powellind.com to ensure use of the current instruction bulletin for Powell equipment.

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

For specific questions or comments pertaining to this instruction bulletin email *documents@powellind.com* with the IB number in the subject line.

D. Associated Instruction Bulletins

- 01.4IB.65203 PowlVac 38 Metal-Clad Switchgear
- 01.4IB.65202D PowllVac 38-AR Arc Resistant Metal-Clad Switchgear
- 01.4IB.49001 PowlVac Series 4 Test Cabinet
- 01.4IB.48030C Sentry Control Unit









Ch 2 Safety

A. SAFE WORK CONDITION

The information in Section A is quoted from NFPA 70E 2018 - Article 120, 120.5 Establishing an Electrically Safe Work Condition.

120.5 Process or Establishing and Verifying an Electrically Safe Work Condition. Establishing and verifying an electrically safe condition shall include all of the following steps, which shall be performed in the order presented, if feasible:

- 1. Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
- 2. After properly interrupting the load current, open the disconnecting device(s) for each source.
- Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position.
- 4. Release stored electrical energy.
- 5. Release or block stored mechanical energy.
- Apply lockout/tagout devices in accordance with a documented and established procedure.
- 7. Use an adequately rated portable test instrument to test each phase conductor or circuit part to verify it is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source.

- Exception No. 1: An adequately rated permanently mounted test device shall be permitted to be used to verify the absence of voltage of the conductors or circuit parts at the work location, provided it meets the all following requirements: (1) It is permanently mounted and installed in accordance with the manufacturer's instructions and tests the conductors and circuit parts at the point of work; (2) It is listed and labeled for the purpose of verifying the absence of voltage; (3) It tests each phase conductor or circuit part both phase-to-phase and phase-toground; (4) The test device is verified as operating satisfactorily on any known voltage source before and after verifying the absence of voltage.
- **N** Exception No. 2: On electrical systems over 1000 volts, noncontact test instruments shall be permitted to be used to test each phase conductor.
 - Informational Note No. 1: See UL 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements, for rating, overvoltage category, and design requirements for voltage measurement and test instruments intended for use on electrical system 1000 volts and below.
- N Informational Note No. 2: For additional information on rating and design requirements for voltage detectors, refer to IEC 61243-1, Live Working Voltage Detectors Part 1: Capacitive type to be used for voltages exceeding 1kV a.c., or IEC 61243-2, Live Working Voltage Detectors Part 2: Resistive type to be used for voltages of 1kV to 36kV a.c., or IEC 61243-3, Live Working Voltage Detectors Part 3: Two-pole voltage type.



- 8. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the following:
 - a.. Placement. Temporary protective grounding equipment shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to a shock hazard (i.e., hazardous differences in electrical potential). The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the employer's job planning.
 - Capacity. Temporary protective grounding equipment shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
- N Informational Note: ATSM F855, Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment, is an example of a standard that contains information on capacity of temporary protective grounding equipment.
 - c. Impedance. Temporary protective grounding equipment and connections shall have an impedance low enough to cause immediate operation of protective devices in case of unintentional energizing of the electric conductors or circuit parts.

B. SAFETY GUIDELINES

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. Furthermore, each user has the responsibility of establishing a safety program for each type of equipment encountered.

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

The safety rules in this instruction bulletin are not intended to be a complete safety program. The rules are intended to cover only some of the important aspects of personnel safety related to PowlVac 38™ ARM Series 4 vacuum circuit breakers.









C. GENERAL

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

D. SPECIFIC

- 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.
- DO NOT USE AN OPEN CIRCUIT BREAKER
 AS THE SOLE MEANS OF ISOLATING A
 HIGH VOLTAGE CIRCUIT. For complete
 isolation, the circuit breaker shall be in
 the disconnected position or shall be
 withdrawn completely.
- 6. ALL COMPONENTS SHALL BE DISCONNECTED BY MEANS OF A VISIBLE BREAK AND SECURELY GROUNDED FOR SAFETY OF PERSONNEL PERFORMING MAINTENANCE OPERATIONS ON THE CIRCUIT BREAKERS.
- Interlocks are provided to ensure the proper operating sequences of the circuit breakers and for the safety of the user. If for any reason an interlock does not function as described, do not make any adjustments, modification, or deform the parts. DO NOT FORCE THE PARTS INTO POSITION. CONTACT POWELL FOR INSTRUCTIONS.



E. X-Rays

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

F. SAFETY LABELS

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



Warning and Caution labels are located in various places. Do not remove or deface any of these warning/caution labels.









Ch 3 Equipment Description

A. GENERAL



Powell is committed to continuous product improvement.

It is possible that improvements occurred between revisions to this document and therefore, may not be described in these instructions. If the equipment does not resemble the photographs and descriptions contained herein, contact Powell before attempting to perform any actions.

The PowlVac 38™ ARM Series 4 vacuum circuit breaker (Figure 1) uses sealed vacuum interrupters (Figure 2, f) to control the primary circuit. Primary connections to the associated metal-clad switchgear are made by tubular busbars terminating in the finger clusters of the primary disconnecting devices (Figure 2, a & g). The primary disconnecting devices, busbars, and vacuum interrupter assemblies are supported by high voltage insulators (Figure 2, i) 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 mechanism of the circuit breaker is exposed. The stored energy mechanism assembly provides motion to each of the vacuum interrupters moving contact assemblies through contact operating pushrods. 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 provides the motion to engage/disengage the primary disconnecting devices and to open/close the shutters in metal-clad switchgear.

B. THE STORED ENERGY MECHANISM

1) Mechanical Description

The stored energy mechanism is located in the front of the circuit breaker behind the front cover. The front cover is held in place with cover bolts (9) (Figure 1, i). The bolts may be removed to allow access to the stored energy mechanism and its interlocks, auxiliary switches, and other control devices.

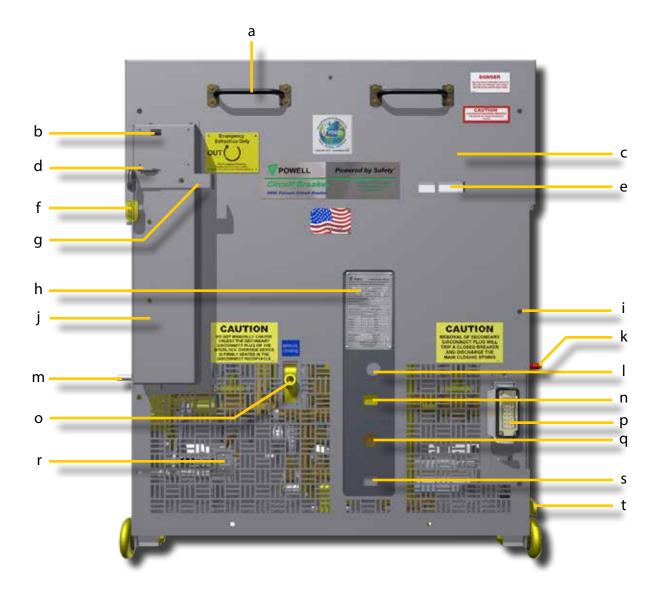
A CAUTION

Prior to removing the front cover, ensure the circuit breaker is in the OPEN position and the main closing spring is fully discharged. Failure to do so may result in injury.

On the escutcheon plate 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 (*Figure 1, h*) 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 (*Figure 2, m*) permanently affixed to the rear of the circuit breaker frame prior to installing the escutcheon.



Figure 1 Front View of PowlVac 38™ ARM Circuit Breaker with Cover



- a. Handle
- b. Circuit Breaker Monitor IR Window
- c. Front Cover
- d. Emergency Racking Drive Shaft Shutter
- e. Breaker Position Indicator
- f. Padlock Seal
- g. Padlock Provision Movable Arm
- h. Nameplate
- i. Cover Bolt (9)
- j. Interlock Window Assembly

- k. TOC Actuator
- I. Manual Trip Operator
- m. MOC Actuator
- n. Circuit Breaker Open/Closed Indicator
- o. Manual Charging Crank
- p. Secondary Disconnect Receptacle
- g. Manual Close Operator
- r. Operations Counter
- s. Spring Charge Indicator
- t. Anti-Rollout Latch

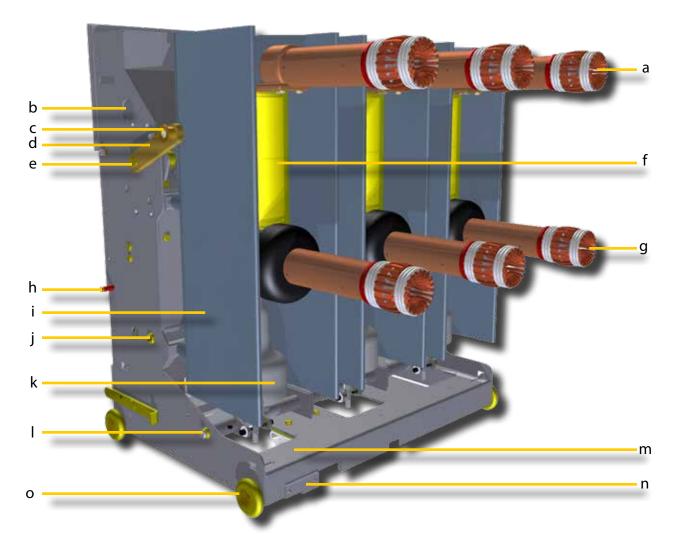








Figure 2 Rear View of PowlVac 38™ ARM Circuit Breaker



- a. Upper Primary Disconnecting Device (3)
- b. Lifting Points (2)
- c. Crank Arm Roller
- d. Racking Crank Arm
- e. Racking Shaft
- f. Vacuum Interrupter (3)
- g. Lower Primary Disconnecting Device (3)
- h. TOC Switch Actuator
- i. High Voltage Insulator (3)
- j. Jackshaft Pin
- k. Operating Pushrod (3)
- I. Main Shaft Pin
- m. Engraved Serial Number Plate
- n. Interference Plate
- o. Wheel



Figure 3 Operating Pushrod Assembly of PowlVac 38™ ARM Circuit Breaker

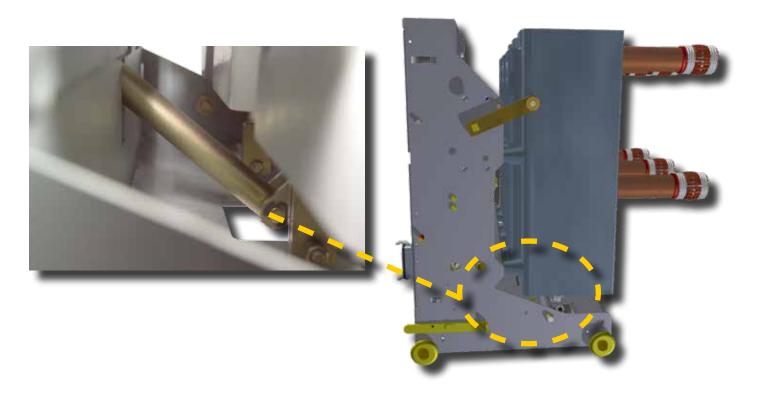
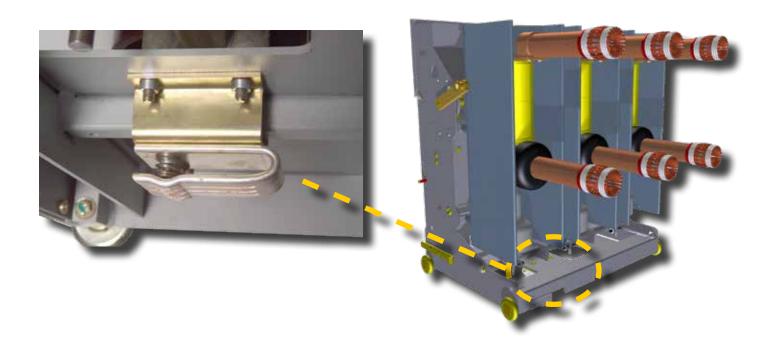


Figure 4 Ground Connection of PowlVac 38™ ARM Circuit Breaker











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

The charging motor (Figure 5, m), located on the bottom right of the base pan, is assembled to the circuit breaker by a bracket that is bolted to the base pan. 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 (Figure 6, p). The drive pawl (Figure 6, m), which is supported by the arms, engages with the ratchet wheel and drives the ratchet wheel one tooth at a time. To prevent backwards motion of the ratchet wheel, a spring-loaded holding pawl is used to latch the ratchet wheel after each advance from the drive pawl.

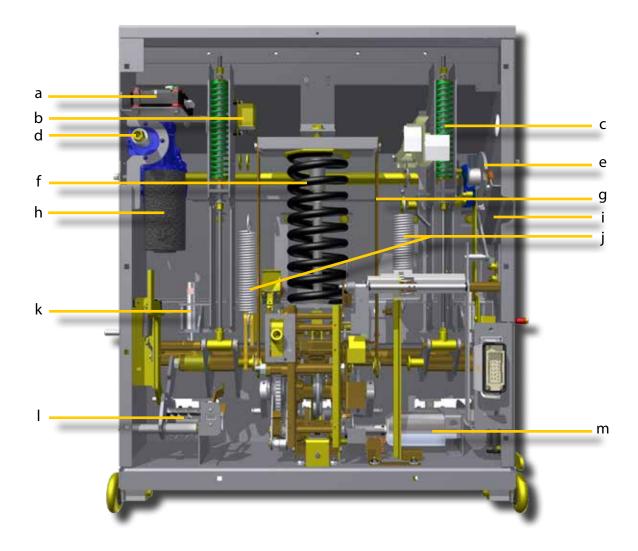
To ensure correct synchronization of the drive and holding pawl, the position of the holding pawl support arms are adjusted by the holding pawl adjusting eccentric (Figure 6, f), located at the left front of the mechanism. When the mechanism is operated manually, the top pawl becomes the drive pawl and the bottom pawl becomes the holding pawl.

The ratchet wheel (Figure 6, i) 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. Crank arms (Figure 6, h) are attached to the ends of the camshaft. Crank pins (Figure 6, g) are assembled to the crank arms, which point outward. The crank arms engage the bottom ends of the connecting rods (Figure 5, q). 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 pull the spring yoke downward, compressing the main closing spring.

The ratchet wheel drives 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 overcomes friction and resistance and starts to rotate the camshaft. At the same time, the pawls are uncoupled from the ratchet wheel by the pawl lift drive plate (Figure 6, j), and the motor cutoff switch is operated. The motor cutoff switch (Figure 6, t), located to the right of the mechanism, is operated by the spring charge indicator and motor cutoff cam (*Figure 6, q*). The spring charge indicator (Figure 1, s) displays that the mechanism is charged.



Figure 5 Front View of PowlVac 38™ ARM Circuit Breaker without Cover



- a. Circuit Breaker Monitor (**Optional**)
- b. Anti-Pump Relay
- c. Opening Spring
- d. Emergency Racking Drive Shaft
- e. Interlock Racking Cam
- f. Main Closing Spring
- g. Connecting Rod
- h. Racking Motor
- i. Interlock Cam Striker Arm
- j. Opening Anti-Bellows Springs
- k. Shock Absorber
- I. Auxiliary Switch
- m. Charging Motor

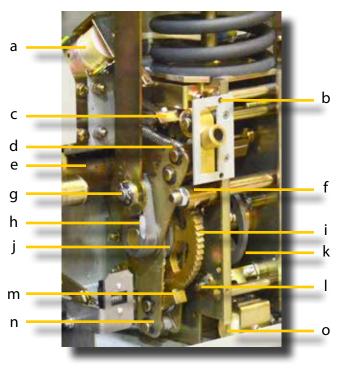


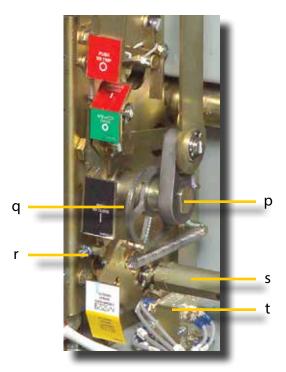


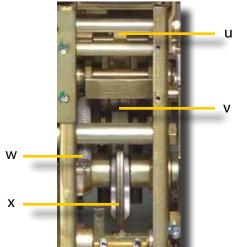




Figure 6 Close-Up Front View of PowlVac 38™ ARM Circuit Breaker Mechanism





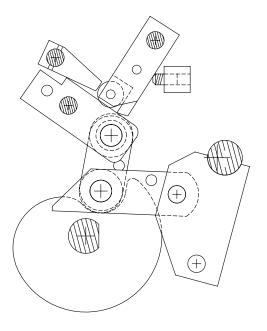


- a. Primary Shunt Trip Coil
- b. Secondary Trip Prop Adjusting Screw
- c. Latch Check Switch Operator
- d. Holding Pawl Support Arm
- e. Jackshaft
- f. Holding Pawl Adjusting Eccentric
- g. Crank Pin
- h. Crank Arm
- i. Ratchet Wheel
- j. Pawl Lift Drive Plate
- k. Close Latch Arm
- Close Latch Shaft

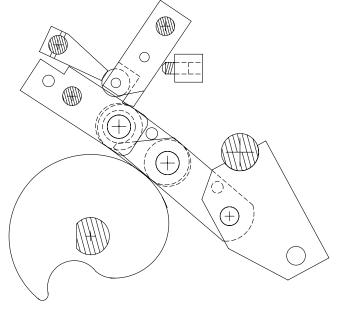
- m. Drive Pawl
- n. Pawl Support Arm
- o. Closing Coil
- p. Camshaft
- *a.* Motor Cutoff Cam
- r. Close Bar Adjusting Screw
- s. Charging Motor Drive Shaft
- t. Motor Cutoff Switch
- u. Secondary Trip Prop
- v. Main Cam Roller
- w. Reset Spring
- x. Main Closing Cam



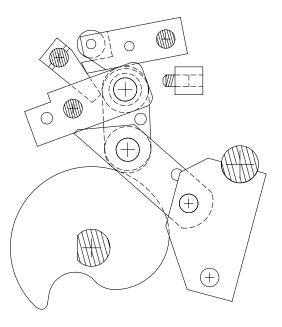
Figure 7 Cam and Fundamental Linkage Positions



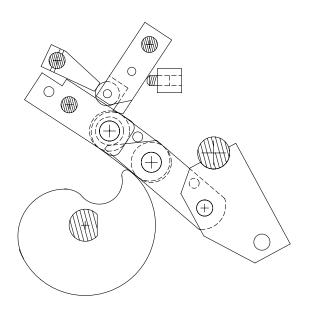
a) Breaker Open - Spring Charged - Links Reset



b) Breaker Closed - Spring Discharged



c) Breaker Open - Spring Discharged



d) Breaker Closed - Spring Charged

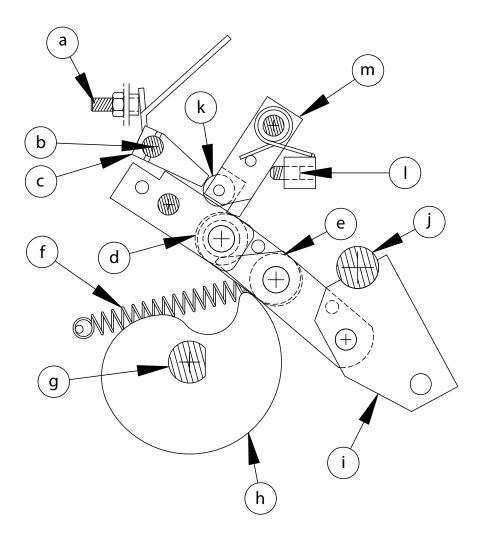








Figure 8 Mechanical and Trip Linkages



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



The camshaft (Figure 6, p) is restrained by the close latch arm engaging against the close latch shaft. The main closing cam, located between the mechanism side sheets, is in a position where the fundamental linkage can move to the reset position.

The close latch shaft, when released either by the closing coil or the manual close operator, allows the main closing spring to pull the crank arms upward. As the crank arm moves upward it rotates the main closing cam and drives the fundamental linkage into the closed position. This action causes the main linkage to rotate the jackshaft to drive the operating pushrod (Figure 3) toward the current carrying side of the circuit breaker.

Each operating pushrod assembly (Figure 2, k) encloses a contact loading spring. At the end of this spring is a pivot block. The pivot block is restrained by a lock nut on a stud which passes through the contact loading spring and is attached to the operating pushrod assembly. The contact loading spring has initial compression such that as soon as the vacuum interrupter contacts touch, the springs are preloaded to a value sufficient to resist vacuum interrupter contact separation under the highest electromagnetic forces exerted by the rated short circuit current. Further movement of the operating pushrod assembly compresses the contact loading spring and produces a gap between the face of the pivot block and the lock nut. This nut-gap is used to evaluate the erosion of the vacuum interrupter contacts.

In the closing cam and fundamental linkage positions shown in (Figure 7, b & d), the contact loading springs and the main opening springs are both acting to compress the three (3) main mechanism links. The jackshaft extends from the left to the right side of the circuit breaker frame and is supported at the main circuit breaker frame side sheets and by the mechanism. The outer operating levers on the jackshaft have connections to the circuit breaker opening springs (Figure 5, c & j).

The fundamental linkage is restrained from movement by the secondary trip prop (Figure 8, c) acting on the primary trip prop roller (Figure 8, k). 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 (Figure 8, I). 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 jackshaft levers engage the shock absorber (Figure 5, k), which controls the rebound of the vacuum interrupter contacts on an opening operation.

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With the standard electrical control scheme, as soon as the main closing spring is discharged on a closing operation, the charging motor is switched on to recharge the springs. This leaves the main closing cam in a position where a tripped linkage can reset under the action of the reset spring (Figure 6, w) and the primary and secondary trip props can move into the reset position. The reset spring stretches between an extension of the main cam roller pin and a spring support pin located on the left mechanism side sheet. The latch check switch, operated by a lever on the trip shaft, will close as the secondary trip prop reaches the fully reset position.

2) Electrical Description

a. Charging Motor

The function of the charging motor (Figure 5, m) 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 bracket that is bolted to the base pan.

b. Motor Cutoff Switch

The motor cutoff switch (Figure 6, t) provides an electrical break in the control circuit that supplies the charging motor when the main closing spring is fully charged and the stored energy mechanism is ready for a closing operation. The motor cutoff switch is located at the bottom right side 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 (Figure 5, b) provides a logic function for the control circuit which prevents a continuous electrical close signal from causing the circuit breaker to continuously reclose after a trip signal. The anti-pump relay is located on the circuit breaker frame, to the left of the connecting rod, and is supported by two screws.

d. Operating Solenoids

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

The closing coil (Figure 6, o) is an operating solenoid located at the bottom center of the mechanism and is assembled to the circuit breaker base pan by bolts accessible from underneath circuit breaker.

The primary shunt trip coil (Figure 6, a) 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 assembly or an undervoltage device may be furnished as an option. When furnished, either of these devices are located to the top right side of the mechanism and is supported from 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.



Figure 9 Operation Sequence

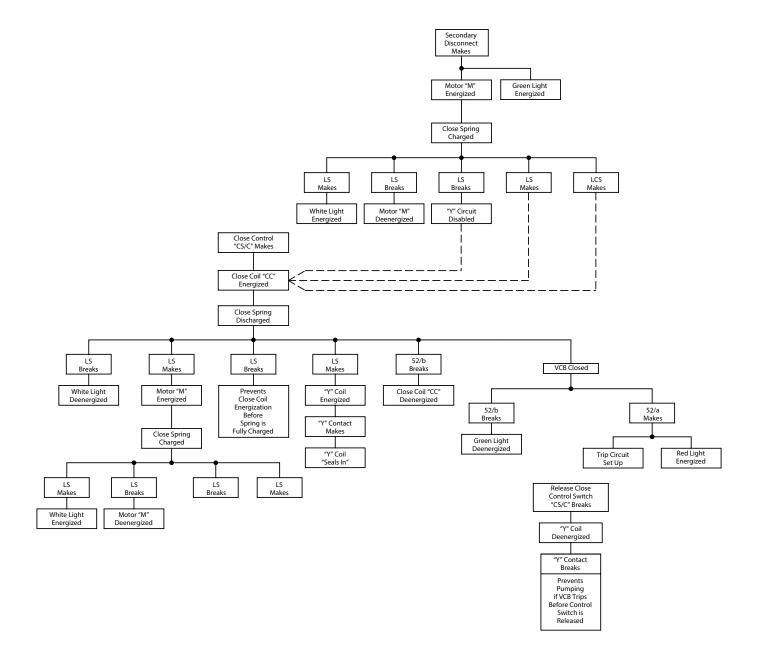


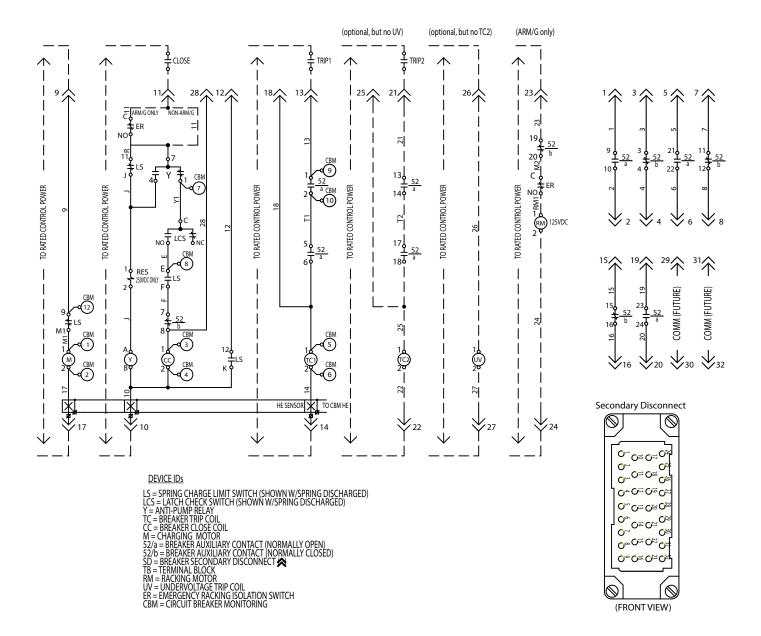








Figure 10 Typical Control Scheme





e. Control Circuit

The typical electrical control scheme is shown in *Figure 10*. The control scheme of any particular circuit breaker may differ depending on the user's requirements, operating solenoids, and the control devices furnished with that circuit breaker.

The sequence of operation for all control schemes is shown in *Figure 9*. Circuit breaker mounted auxiliary contacts not used in the control circuit are brought out for control and indication functions. The metal-clad switchgear equipment may provide a circuit breaker MOC (Mechanism Operated Cell Switch) for additional contacts.

C. AUTOMATIC RACKING MECHANISM

The racking mechanism is the mechanical assembly that facilitates moving the circuit breaker between the breaker test/disconnected and connected positions in the circuit breaker compartment. The main racking mechanism components for the PowlVac 38™ ARM Series 4 circuit breaker are described in the following sections:

1) Breaker Position Indicator

The breaker position indicator (Figure 1, e) 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 "BREAKER CONNECTED", and this is fully visible in the aperture, the circuit breaker is in the connected position. When the breaker position indicator displays

"BREAKER TEST/ DISCONNECTED", 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 Ch 4 Installation, E. Inserting the Circuit Breaker into the Circuit Breaker Compartment for more information.

2) Interlocking

PowlVac 38 ARM Series 4 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 purpose of the interlocks is to ensure:

- 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. Also, the circuit breaker cannot be removed from the connected to the test/disconnected position unless the main contacts are opened.
- The control circuits cannot be broken when the circuit breaker is in the connected position.
- The circuit breaker cannot be removed from the circuit breaker compartment with the circuit breaker closed or with the main closing spring charged.









The PowlVac 38™ ARM Series 4 circuit breaker interlocking is primarily achieved by means of an interlock cam striker arm (Figure 5, i) acting upon the interlock racking cam (Figure 5, e) attached to the racking drive shaft. Upon initial insertion of the circuit breaker into the compartment, a position interlock prevents moving the circuit breaker from the disconnected position to the test position without the secondary disconnect inserted.

Racking the circuit breaker in from the test/disconnected position to the connected position also rotates the interlock cam (Figure 5, e) attached to the racking shaft. A cam follower, attached to a lever pivoted on the circuit breaker frame, drives a secondary disconnect locking slider downward. The secondary disconnect locking slider 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 disconnected position.

The tripping linkage and roller under the breaker frame follow a cam mounted in the circuit breaker compartment. The cam, in all intermediate positions between the test/disconnected and connected position, lifts the tripping roller. Lifting 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.

3) Blocking Interlock

Access to the emergency racking drive is controlled by a blocking interlock. The emergency racking access shutter can only be opened with the circuit breaker open. Moving the emergency racking drive shaft shutter downward prevents the closing of the circuit breaker by operating a linkage which blocks the mechanism. If the breaker is not in the open position, the shutter cannot be opened enough to insert the racking handle. This interlock ensures that the circuit breaker is open when it is manually racked into the compartment. Once the circuit breaker reaches the operating position and the shutter mechanism is released, the circuit breaker can now be closed. When the circuit breaker is in the closed position, the shutter is no longer free to move. This blocks the operation of the emergency racking drive shaft, deterring any attempt to remove a closed circuit breaker from the compartment.

4) Racking Mechanism

The racking mechanism consists of a racking shaft (Figure 2, e) with racking crank arms (Figure 2, d) at each end, which are supported by the frame side sheets. The racking motor (Figure 5, h) is located at the left end of the racking shaft, inside the circuit breaker frame. 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.



Electrical sensors control the stopping position of the circuit breaker. The sensors are located in the circuit breaker compartment.

Bolts on the left and right side sheets provide a backup mechanical stop to the crank arms. 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 "BREAKER CONNECTED".

D. CIRCUIT BREAKER COMPARTMENT INTERFACES

1) Primary Disconnecting Devices

There are six primary disconnecting devices (Figure 2, a & g) 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 has multiple contact fingers which will mate with the stationary primary disconnecting devices in the circuit breaker compartment.

A CAUTION

Do not handle or move the circuit breaker by the primary disconnecting devices, as damage may occur.

2) Secondary Disconnecting Devices

Control power is transferred from the metal-clad switchgear to the circuit breaker by means of the secondary disconnecting devices. The secondary disconnect receptacle (Figure 1, p) 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.

3) MOC (Mechanism Operated Cell Switch)
Actuator

The MOC, located in the switchgear, is an auxiliary switch operated by a lever which extends from the circuit breaker operating mechanism. Movement of the MOC actuator (Figure 1, m) is directly related to the movement of the circuit breaker mechanism and contacts.

4) TOC (Truck Operated Cell Switch) Actuator

The TOC, located in the switchgear, is operated by the circuit breaker truck position. To accomplish this, a TOC actuator (Figure 1, k) is located on the middle, right side of the circuit breaker frame and it is designed to strike the TOC as the circuit breaker travels to the connected position.









5) Ground Connection

The ground connection (Figure 4) is an assembly of spring loaded fingers that grounds the circuit breaker frame as it is inserted into the compartment. The ground connection is located on the bottom side of the circuit breaker between the B and C phases. 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.

6) Shutter Rollers

The circuit breaker travels between the test/disconnected and connected positions as the crank arm rollers (Figure 2, c) 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.

7) Anti-Rollout Latch

The circuit breaker is equipped with an anti-rollout latch (Figure 1, t) which prevents inadvertent removal of the circuit breaker from the compartment by engaging a tab in the compartment.

E. VACUUM INTERRUPTERS

PowlVac® 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 rating due to the differences in their internal construction. Refer to *Table E, Primary Current Path* for a listing of vacuum interrupters used in PowlVac 38™ Series 4 circuit breakers.

F. VACUUM INTERRUPTER CONNECTIONS

The top stem of the vacuum interrupter utilizes a pad that is bolted to the upper primary assembly. The lower vacuum interrupter stem has a copper block threaded onto it and is the movable end of the assembly. Fastened to the copper block is a flexible copper shunt that is attached to a stationary lower bus connector. An electrostatic shield which covers the shunt and another primary disconnecting device is attached to the lower bus connector.



Ch 4 Installation

A. RECEIVING

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

Estimated size and weight for shipping a PowlVac 38™ ARM Series 4 circuit breaker on a pallet:

Size: 42" width x 42" depth x 47" height

Weight: 750 lbs.

Figure 11 shows the circuit breaker enclosed in the carton used for shipment. The carton is attached to the shipping pallet by 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 metal shipping brackets. When these are removed the circuit breaker may be removed from the shipping pallet. Refer to Ch 4 Installation, 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/disconnect 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 11 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 handles 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 lift truck or an overhead crane. When using the lift truck, load the circuit breaker front first onto the lift and ensure that it is secured to the lift truck. The circuit breaker can also be lifted by an overhead crane using the two lifting points (Figure 12) which have been provided for hooks at the top of the circuit breaker frame side sheets. The circuit breaker will tilt backward when it is lifted by a crane. Therefore, when setting down the circuit breaker, it will be necessary to guide the circuit breaker to ensure that all four wheels are placed on a level surface. Use the front handles or top front frame to guide the circuit breaker to an upright position on a level surface.

Figure 12 Lifting the Circuit Breaker by Crane



C. STORAGE

Shipping and storage of electrical equipment requires measures to prevent the deterioration of the apparatus over a long unused period. The mechanical and dielectric integrity must be protected. Electrical equipment is designed for use in a variety of environments.

When the equipment is in transit and storage, these design considerations are not fully functional. In general, the following measures must be considered.

- 1. Equipment designed for indoor installation must be stored indoors in a climate controlled environment to prevent condensation of moisture. Exposure to rain and the elements, even for a short period, can permanently damage the equipment. Space heaters within the equipment should be energized, if so equipped. Humidity controlling desiccant materials should be utilized when space heaters are not provided or cannot be energized. The temperature should be kept above 33°F/1°C and below 140°F/60°C. The relative humidity should be kept below 60% or a dew point of 15°C/59°F. The equipment should be stored in such a manner as to leave all doors and panels accessible for inspection. The equipment must be inspected on a routine basis to assure operational integrity.
- 2. Equipment designed for outdoor exposure may be stored either in indoor or outdoor storage locations. The equipment must be protected from airborne external contaminates if stored outdoors. Outdoor storage will also require additional care to maintain temporary covers over the openings and shipping splits. The equipment must be provided with control power to facilitate the energization of space heaters, as well as other temperature and humidity controlling equipment. The temperature should be kept above freezing (>33°F/1°C) and below (<140°F/60°C). The relative humidity should be kept below 60% or a dew point of 15°C/59°F. The equipment should be stored in such a manner as to leave all doors and panels accessible for inspection. The equipment must be inspected on a routine basis to assure its integrity.



3. The auxiliary control devices, ship loose material and protective relays must also be protected. This includes items such as battery chargers, UPS systems, lighting, installation hardware and air conditioning. If prolonged storage is anticipated, humidity controlling desiccant materials should be utilized. Desiccant packets should be installed in all compartments and packing containers.

D. PLACING THE CIRCUIT BREAKER INTO SERVICE

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

1) High Voltage Insulation Integrity

A 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 tests. Test voltages should not exceed 60kVAC (85kVDC) for the 38kV rated circuit breaker.

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

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

CAUTION

If DC high potential testing is performed, the DC high potential test machine must not produce instantaneous peak voltages exceeding 85kV.

The circuit breaker insulation should be tested with the circuit breaker vacuum interrupter contacts in the CLOSED position.

The racking mechanism should be operated to place the racking arms in the "connected" position (rotated to the front of the breaker, away from the primary disconnecting devices) prior to performing the dielectric testing. It is necessary that a secondary disconnect override device be used to permit rotating the racking shaft. See Ch 4 Installation, D. Placing the Circuit Breaker Into Service, 4) Mechanical Operation Check.

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 A Field Dielectric Test Values).

Table A Field Dielectric Test Values		
Rated Maximum Voltage (kV rms)	Power Frequency Withstand (kV rms)	
38	60	









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

A 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 should be grounded and remain grounded for at least one minute to reduce this electrical charge before coming into contact with the primary circuit.

CAUTION

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

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

2) Vacuum Integrity

A CAUTION

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

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

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

Powell recommends AC testing for reliable verification of vacuum integrity. All PowlVac 38™ ARM Series 4 circuit breakers shall be tested with a minimum of 40kVAC applied directly across fully open contacts for 10 seconds. No dielectric breakdown during the test period constitutes a successful test.

Note: The AC test does not replace the AC high potential testing (Hipot) used to determine "High voltage insulation integrity." For more details, see Ch 4 Installation, D. Placing the Circuit Breaker Into Service, 1) High Voltage Insulation Integrity.

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



Powell recognizes the widespread use of DC hipot equipment in the field and the desire to use this equipment to verify vacuum integrity. However, the capacitive component of the vacuum interrupter during DC testing may yield false negative test results, which are often misinterpreted as vacuum interrupter failure. When DC testing is performed, a test set providing a full wave rectified 40kVDC hipot voltage can be applied for 5 seconds as a "go - no go" test.

Recording the leakage readings is not necessary, as a dielectric breakdown will trip all portable DC hipot test sets. If a DC test breakdown occurs, the test must be repeated after reversing the DC high voltage test supply connection across the vacuum interrupter. The working condition of a vacuum interrupter should be questioned only if it has failed both tests.

A CAUTION

When testing with DC, use a DC high potential test (hipot) set with full wave rectification. Do not use 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.

A CAUTION

If DC high potential testing is performed, the DC high potential test machine must not produce instantaneous peak voltages exceeding 57kV.

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.

A 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 should be grounded and remain grounded for at least one minute to reduce this electrical charge before coming into contact with the primary circuit.

3) Control Voltage Insulation Integrity

If the user wishes to check the insulation integrity of the control circuit, it may be done with a 500V or 1000V insulation resistance tester or with an AC high potential tester. The AC high potential test should be made at 1125V, 50Hz or 60Hz for one minute. The charging motor and CBM (Figure 5, a), if present, must be disconnected prior to testing the control circuit. The charging motor itself may be similarly tested at a voltage not to exceed 675V, 50Hz or 60 Hz. Be sure to remove any test jumpers and reconnect the charging motor after the tests are complete.

CAUTION

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









4) Mechanical Operation Check

The 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 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.

A CAUTION

Keep personnel, tools, and other objects clear of mechanisms that are to be operated or released. Failure to do so may result in equipment damage and/or minor or moderate injury.

Push the manual close operator (Figure 1, q) inward and the circuit breaker will close. The circuit breaker open/closed indicator (Figure 1, n), located above the manual close operator will now display, "Breaker Closed". Push the manual trip operator (Figure 1, I) inward, which is located at the top of the escutcheon and the circuit breaker open/closed indicator will now display "Breaker Open".

5) Electrical Operation Check

To check the basic electrical operation of the circuit breaker, a circuit breaker test cabinet should 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 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 test cabinet to the "CLOSE" position will cause the circuit breaker to close.

A CAUTION

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 its travel path during operation. Care should be taken to isolate the MOC side 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.



An alternate method for the electrical operation check is to use a test jumper cable to electrically operate the circuit breaker using the control circuitry of the circuit breaker compartment. If this method is used, ensure that the operation of the control circuitry of the compartment being used for testing 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 to "CLOSE", 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 to "TRIP", on the front door of the compartment, will cause the circuit breaker to open.

6) Emergency Racking Mechanism Check

The emergency racking mechanism may be checked outside the circuit breaker compartment.

The emergency racking drive shaft can be accessed by moving the emergency racking drive shaft shutter (*Figure 1, d*) downward.

Note: The emergency racking drive shaft shutter cannot be moved downward unless the secondary disconnect is engaged and the main contacts are OPEN.

Insert the racking handle onto the racking drive shaft. 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, "BREAKER TEST/DISCONNECTED". Rotate the racking handle in a counterclockwise direction. The racking crank arms will move downward and rotate until the breaker position indicator displays "BREAKER CONNECTED". Stop bolts on the side sheet of the circuit breaker prevent further rotation of the racking drive shaft. Once the breaker position displays "BREAKER CONNECTED", 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. Once factory torque limits are reached a torque limiting clutch on the racking handle will engage and disallow any further racking. In this position, the racking handle may be removed from the racking drive shaft and the racking drive shaft shutter will spring back to the closed position.

Once again, depress the racking drive shaft shutter, insert the racking handle onto the racking drive shaft and rotate in a clockwise direction until the racking crank arms are once more in the fully withdrawn position and the breaker position indicator displays "BREAKER TEST/DISCONNECTED".









E. INSERTING THE CIRCUIT BREAKER INTO THE CIRCUIT BREAKER COMPARTMENT

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 breaker into the metal-clad switchgear equipment.

NOTICE

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 circuit breaker compartment 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 circuit breaker compartment. If an attempt to insert an improperly rated circuit breaker into the circuit breaker compartment is made, 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 incorrectly rated circuit breaker and insert a properly rated circuit breaker into the circuit breaker compartment.

1) Prior to 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 Ch 5 Maintenance, A. General Description, 2) Inspection and Cleaning and Ch 5 Maintenance, B. Mechanism Area, 2) Lubrication for cleaning and lubrication procedures. If the primary disconnecting devices are damaged make no attempt to repair. Contact Powell 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 the PowlVac® ARM Series 4 circuit breaker. For all other constructions, refer to the appropriate instructions or instruction bulletin(s) for the applicable racking procedures.

The circuit breaker is designed to be electrically racked into the circuit breaker compartment from a remote location with the compartment door closed. The ARM circuit breaker may also be manually racked using the emergency override option with the compartment door open.



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 "BREAKER TEST/DISCONNECTED".

NOTICE

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 Chapter 2.

2) Inserting the Circuit Breaker to the Test/Disconnected Position

A CAUTION

Prior to inserting the circuit breaker into the circuit breaker compartment, make sure that the control circuits are deenergized.

CAUTION

Use only the racking tools provided by Powell for inserting and removing the circuit breaker. The use of other tools such as electric drills, impact drill, etc., may damage the racking mechaninsm and render it inoperative.

CAUTION

Before racking a circuit breaker in or out of the compartment, make sure that any position interlocks are unlocked and in the position to allow racking. Otherwise, the racking mechanism may be damaged.

- 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 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.
- Roll the circuit breaker into the compartment until the position interlock bar and roller contacts a positive stop.

Note: This is the Disconnected Position.

- d. Insert the circuit breaker compartment's secondary disconnect plug (Figure 13, c) into the circuit breaker secondary disconnect receptacle (Figure 13, b). Once the plug is fully inserted, move the secondary disconnect latch (Figure 13, a) from left to right until it has engaged the housing of the secondary disconnect plug (Figure, 13, c).
- e. Roll the circuit breaker into the compartment until the racking crank arms contact with the vertical slots in the compartment.

Note: This is the Test Position.









The anti-rollout latch on the right side of the circuit breaker will engage the block in the compartment, preventing accidental removal of the circuit breaker from the compartment.

Figure 13 Secondary Disconnecting Devices



- a. Secondary Disconnect Latch
- b. Secondary Disconnect Receptacle
- c. Secondary Disconnect Plug
- d. Interlock Bar
- 3) Inserting the Circuit Breaker to the Connected Position

NOTICE

The preferred method of racking the ARM Series 4 circuit breaker is electrically from a remote location via Sentry remote controller. Refer to the instruction bulletin provided with the controller for detailed information on the automatic racking procedures.

4) Emergency Racking In Procedure

NOTICE

In the event of an emergency, such as loss of control power, the ARM circuit breaker is equipped with an emergency racking mechanism which enables racking the circuit breaker into or out of the connected position.

CAUTION

Use only the racking tools provided by Powell for inserting and removing the circuit breaker. The use of other tools such as electric drills, impact drill, etc., may damage the racking mechaninsm and render it inoperative.

The following emergency racking procedure is intended to be used only in the event of loss of control power, or failure of the Sentry remote controller, or failure of the circuit breaker racking motor to operate electrically.

For instructions on inserting the circuit breaker into the compartment refer to Ch 4 Installation, E. Inserting the Circuit Breaker into the Circuit Breaker Compartment, 2) Inserting the Circuit Breaker to the Test/Disconnected Position.

A CAUTION

Prior to inserting the circuit breaker into the circuit breaker compartment, make sure that the control circuits are deenergized.

a. Verify 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 connected position, remove the padlock seal (Figure 1, f), open the emergency racking drive shaft shutter (Figure 1, d) and place the racking handle socket onto the emergency racking drive shaft. The racking handle socket may be used to push down the shutter to gain access to the racking drive shaft.
- c. Turning the racking handle counterclockwise 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 ensuring wipe or overlap of the primary disconnecting devices. Continue racking until the breaker position indicator displays "BREAKER CONNECTED". When the circuit breaker reaches the end of the racking travel, the operator will notice an increased amount of force. If the operator 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-ft-lbs. At this time, cease from racking in any further.
- d. Once the circuit breaker has reached the connected position, remove the racking handle, visually verify that the emergency racking drive shaft shutter has returned to its normal position, close the compartment door, and operate the circuit breaker as required.

Note: This is the Connected Position.

F. REMOVING THE CIRCUIT BREAKER FROM THE CIRCUIT BREAKER COMPARTMENT

A CAUTION

Prior to removing the circuit breaker from the circuit breaker compartment, make sure that the control circuits are deenergized.

A CAUTION

Prior to removing the circuit breaker from the circuit breaker compartment, make sure the circuit breaker is in the open position and all springs are discharged.

 Removing the Circuit Breaker from the Connected to the Test/Disconnected Position

NOTICE

The preferred method of racking the ARM Series 4 circuit breaker is electrically from a remote location via Sentry remote controller. Refer to the instruction bulletin provided with the controller for detailed information on the automatic racking procedures.









2) Removing the Circuit Breaker from the Test/Disconnected Position out of the Circuit Breaker Compartment

A CAUTION

Prior to removing the circuit breaker from the circuit breaker compartment, make sure that the control circuits are deenergized.

A CAUTION

Prior to removing the circuit breaker from the circuit breaker compartment, make sure the circuit breaker is in the open position and all springs are discharged.

- a. Open the circuit breaker compartment door.
- b. Push the secondary disconnect latch (Figure 13, a) to the left. This will unlock the secondary disconnect plug, allowing it to be removed. Remove the secondary disconnect plug.

A CAUTION

Removal of the secondary disconnect plug will trip a closed breaker and discharge the main closing spring.

c. Press the anti-rollout latch (Figure 1, t) to release the circuit breaker and pull the circuit breaker out of the circuit breaker compartment using the handles.

3) Emergency Racking Out Procedure

NOTICE

In the event of an emergency, such as loss of control power, the ARM circuit breaker is equipped with an emergency racking mechanism which enables racking the circuit breaker into or out of the connected position.

CAUTION

Use only the racking tools provided by Powell for inserting and removing the circuit breaker. The use of other tools such as electric drills, impact drill, etc., may damage the racking mechaninsm and render it inoperative.

The following emergency racking procedure is intended to be used only in the event of loss of control power, or failure of the Sentry remote controller, or circuit breaker to operate electrically.

For instructions on removing the circuit breaker from the compartment refer to Ch 4 Installation, F. Removing the Circuit Breaker From the Circuit Breaker Compartment, 2) Removing the Circuit Breaker from the Test/Disconnected Position out of the Circuit Breaker Compartment.

A CAUTION

Prior to removing the circuit breaker from the circuit breaker compartment, make sure that the control circuits are deenergized.



- To remove the circuit breaker from the Connected position to the Test/ Disconnect position perform the following:
 - Verify that the circuit breaker open/closed indicator displays "BREAKER OPEN". If "CLOSED", operate the circuit breaker control switch to open the circuit breaker.
 - Open the compartment door. If the padlock seal is present, remove the seal. Open the emergency racking drive shaft shutter. Place the racking handle socket onto the racking drive shaft shutter. The racking handle socket may be used to push down the shutter to gain access to the racking drive.
 - Turn the racking handle clockwise until the breaker position indicator displays "BREAKER TEST/DISCONNECTED".
 - 4. Remove the racking handle and verify that the emergency racking drive shaft shutter has returned to its normal position.

Note: This is the Test Position.

- b. To remove the circuit breaker from the Test position out of the circuit breaker compartment perform the following:
 - 1. Push the secondary disconnect latch (Figure 13, a) to the left. This will unlock the secondary disconnect plug, allowing it to be removed. Remove the secondary disconnect plug.

A CAUTION

Removal of the secondary disconnect plug will trip a closed breaker and discharge the main closing spring.

- 2. Press the anti-rollout latch to release the circuit breaker and pull the circuit breaker out of the circuit breaker compartment using the handles.
- 3. Once the circuit breaker has been removed and service has been performed, replace the padlock seal.









Ch 5 Maintenance

A. GENERAL DESCRIPTION

A CAUTION

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

NOTICE

Before attempting any maintenance, it is important to study and fully understand the safety practices outlined in Chapter 2 of this instruction bulletin. If there is any reason to believe there are any discrepancies in the descriptions contained in this instruction bulletin, or if they are deemed to be confusing and/or not fully understood, contact Powell immediately.

1) Introduction

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

PowlVac 38™ ARM Series 4 circuit breakers are designed to comply with industry standards requiring maintenance every 500 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 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 a hundred operations. The reading of the operations counter should be recorded when the circuit breaker is placed into service and when any maintenance work is performed.

2) 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 mechanism 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. The inspection will be easier if the front cover is removed.

Clean the circuit breaker by removing any loose dust and dirt. Do not use compressed air to clean dirt from the circuit breaker. This may result in 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 Ch 5 Maintenance, B. Mechanism Area, 2) Lubrication for instructions on cleaning the lubricated areas for the stored energy mechanism and other specified parts.

Primary insulation, including the vacuum interrupter supports and the operating 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 a mild solvent such as denatured alcohol. Be sure that the circuit breaker is dry before returning it to service. Do not use any type of detergent to wash the surface of the insulators because detergent may leave an electrically conducting residue on the surface as it dries.









B. MECHANISM AREA

A WARNING

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

1) Mechanical Operation

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

Note: For circuit breakers without a CBM.

If timing tests are performed as in,
Ch 5 Maintenance, D. Optional
Maintenance Procedures, do not
operate the circuit breaker until these
tests are completed. Operation of the
mechanism may alter the "As found"
operating condition of the circuit
breaker's stored energy mechanism.

For further details, see Ch 4 Installation, D. Placing the Circuit Breaker Into Service, 4) Mechanical Operation Check.

2) 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 should be discharged.

Powell offers a complete lubrication kit (Powlube-104) which contains all the lubricants required for maintaining the circuit breakers. Powlube-104 consists of (1) A-grease, (1) B-grease, and (1) C-oil. Prior to March 2014, Powell provided Powlube-101 and Powlube-102 which contained (1) tube of Anderol 757 or Rheolube 368A, (1) tube of Mobilgrease 28 and (1) bottle of Anderol A456 oil.

A – 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 C - Oil. B – Grease should be applied to the electrical contact surfaces.

Lubricate the stored energy mechanism and other specified parts in accordance with *Table B, Lubrication*. See *Figures 14 and 15* for labeled lubrication photographs.

Table B, Lubrication lists the location of all surfaces that should be lubricated, the type of lubricant to be used, and the method of applying the lubricant. The guiding rule in lubrication is to lubricate regularly, use lubricant sparingly and remove all excess lubricant. Tilting the circuit breaker will enable the lubricant to cover the bearing surfaces.



		Table B Lubi	rication
Location	Reference Figure	Lubricant	Method
Electrical Parts			
Primary Disconnecting Device	Figure 14, b	B - Grease	Wipe clean. Apply lubricant only to actual contact surface.
Secondary Disconnect Receptacle	Figure 14, g	B - Grease	Wipe clean. Apply lubricant only to actual contact surface.
Ground Connection	Figure 15, ac	B - Grease	Wipe clean. Apply lubricant only to actual contact surface.
Mechanical Parts			
Spring Yoke Pin	Figure 14, a	C- Oil	
Primary Trip Prop Bearing	Figure 14, c	C - Oil	Remove main closing spring.
Primary Trip Prop Roller	Figure 15, q	C - Oil	Remove main closing spring.
Trip Shaft Bearing	Figure 14, d	C - Oil	
Jackshaft Support	Figure 14, f	A - Grease	
Pawl Support Arm	Figure 14, i	C - Oil	
Crank Pin	Figure 14, h	A - Grease	
Motor Drive Shaft Roller Needle Bearings	Figure 14, m	C - Oil	
Pawls	Figure 14, j	C - Oil	
Close Latch Shaft Face	Figure 14, n	A - Grease	Apply a light coating of grease and remove all excess.
Ratchet Wheel	Figure 14, k	A - Grease	
Fundamental Linkage Pin	Figure 14, e	C - Oil	Apply to penetrate where pin passes through end link.
Racking Mechanism	Figure 15, p	C - Oil A - Grease	Apply C - Oil to the crank arm rollers and racking crank arms. Wipe clean. Apply A - Grease to worm gear.
Main Closing Spring Guide Rod	Figure 15, o	A - Grease	
Secondary Linkage Roller	Figure 15, r	C - Oil	Remove main closing spring.
Primary Trip Prop	Figure 15, s	C - Oil	
Open-Close Flag Drive Lever Pin at Jackshaft	Figure 15, t	C - Oil	
Flag Support Pin	Figure 15, v	C - Oil	
Jackshaft Outer Bearings Support	Figure 15, w	C - Oil	
Motor Drive Shaft Coupling	Figure 15, y	A - Grease	
Wheel	Figure 14, l	A - Grease	
Motor Drive Shaft Support Bearings	Figure 15, aa	C - Oil	
Camshaft Needle Bearings	Figure 15, z	C - Oil	
Close Shaft Support Bearings	Figure 15, x	C - Oil	
Motor Cutoff Cam	Figure 15, ab	A - Grease	Apply to peripheral surface only.
Fundamental Linkage	Figure 15, u	C - Oil	Apply to penetrate where pins pass through links.

Note: For all previous lubrication requirements Powlube-104 A-Grease replaces Anderol 757 and Rheolube 368A, B-Grease replaces Mobilgrease 28 and C-Oil replaces Mobil 1 and Anderol 456. See Ch 5 Maintenance, B. Mechanism Area, 2) Lubrication for more details.

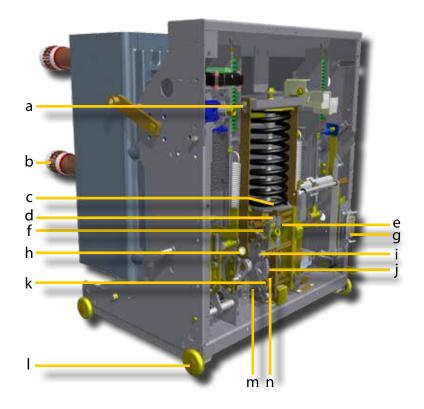








Figure 14 Lubrication









b. Primary
Disconnecting
Device



c. Primary Trip Prop Bearing



d. Trip Shaft Bearing



e. Fundamental Linkage Pin



f. Jackshaft Support



g. Secondary Disconnect Receptacle



h. Crank Pin



Pawl Support
Arm



j. Pawls



k. Ratchet Wheel



l. Wheel



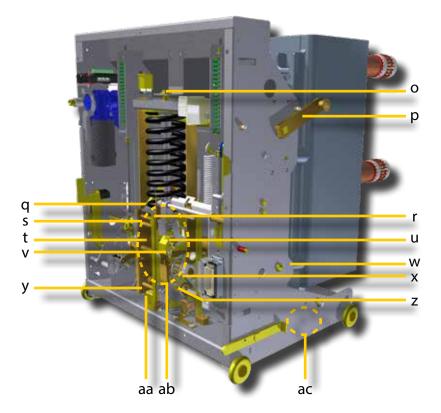
m. Motor Drive Shaft Roller Needle Bearings



n. Close Latch Shaft Face



Figure 15 Lubrication (cont)





o. Main Closing Spring Guide Rod



p. Racking Mechanism



q. Primary Trip Prop Roller



Secondary Linkage Roller



s. Primary Trip Prop



t. Open-Closed Flag Drive Lever Pin at Jackshaft



ı. Fundamental Linkage



v. Flag Support Pin



v. Jackshaft Outer Bearings Support



Close Shaft Support Bearing



Motor Drive Shaft Coupling



z. Camshaft Needle Bearings



aa. Motor Drive Shaft Support Bearings



ab. Motor Cutoff Cam



ac. Ground Connection







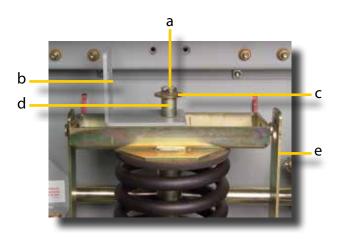


3) Closing Spring Removal

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

Although main closing spring removal is usually not necessary for lubrication, it may be necessary for performing adjustments or major overhaul tasks. Furthermore, removal of the main closing spring permits slow closing of the mechanism and the vacuum interrupter contacts. For details, see *Ch 5 Maintenance*, *B. Mechanism Area*, *4) Slow Closing of Mechanism*.

Figure 16 Main Closing Spring Assembly Compressed for Removal



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

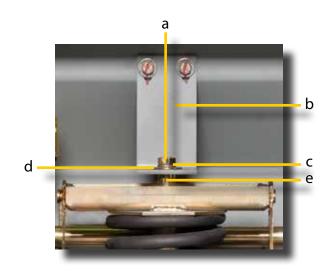
The procedure for spring removal is as follows:

 With the main closing spring discharged and the circuit breaker contacts open, remove the bolt at the top of the spring rod together with the flat washer and lock washer.

- 2. Remove the horizontal bracket at the top of the main closing spring by unfastening the two attachment bolts.
- 3. Remove the spacer from below the bracket.
- 4. Turn the bracket 90°, and replace it on the top of the spring yoke.
- 5. Place the spacer above the bracket with the flat washer above the spacer.
- 6. Insert bolt and tighten until the tension is taken off the connecting rods.
- 7. With a slight rocking motion of the main closing spring assembly, the connecting rods (Figure 16, e) can now be unhooked from the spring yoke pins and the main closing spring assembly can be removed.

Note: Care should be taken on reassembly to ensure correct location of the flat washer, lock washer and spacer (Figure 17).

Figure 17 Main Closing Spring Assembly Installed



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



4) Slow Closing of Mechanism

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

- 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.
- 2. Push the manual close operator inward and hold it in while operating the charging handle to rotate the camshaft.
- 3. When the close release latch arm has passed 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.
- 4. Continue to operate the charging handle until the crank arms point downward. The circuit breaker will now be closed and there will be a gap between the operating pushrod lock nuts and the pivot blocks.
- 5. Return the circuit breaker to the open position by depressing the manual trip operator.
- 6. To install the main closing spring assembly reverse the preceding removal procedure.

5) Mechanism Adjustments

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

A CAUTION

Do not adjust these setting unnecessarily as damage to the circuit breaker may result.

a. Adjustment of Ratchet Wheel Holding Pawl

The holding pawl support arm (Figure 6, d) is adjusted by the holding pawl adjusting eccentric (Figure 6, f).

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

To adjust the pawl perform the following steps:

- Remove the escutcheon to gain access to the head of the bolt holding the adjusting eccentric.
- 2. Loosen the bolt slightly.
- 3. Grip the eccentric with a pair of slip-joint pliers or a similar tool and rotate the stop slightly.
- 4. Tighten the holding bolt with the eccentric in the new position.







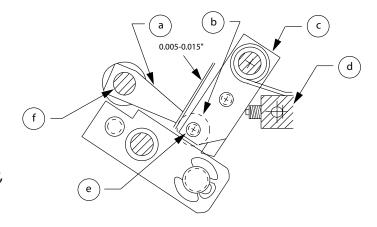


- While charging the main closing springs, using the charging motor to drive the mechanism, observe the ratcheting operation for improvement.
- 6. If the ratcheting operation has not improved, repeat the preceding sequence until the ratcheting operation is smooth. This may require several charging cycles.
- 7. When the eccentric is properly set replace the escutcheon.

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

b. Adjustment of Primary & Secondary Trip Prop

Figure 18 Primary & Secondary Trip Prop Adjustment



- a. Secondary Trip Prop
- b. Primary Trip Prop Roller
- c. Primary Trip Prop
- d. Primary Trip Prop Adjusting Screw
- e. Rivet
- f. Trip Bar

Perform the following procedures to adjust the primary trip prop:

- Remove the main closing spring.
 Refer to Ch 5 Maintenance,
 B. Mechanism Area, 3) Closing Spring Removal.
- 2. Adjust the primary trip prop adjusting screw (Figure 18, d) so that with the fundamental linkage in the reset position, the clearance between the primary trip prop roller and the secondary trip prop is 0.005" to 0.015". The primary trip prop adjusting screw is accessible from the rear of the stored energy mechanism and is located inside the hole beside the lower middle insulator supporting the live part assembly.
- 3. Replace the main closing spring.



c. Tripping System Adjustment

A WARNING

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

To adjust the PowlVac 38™ ARM Series 4 Tripping System perform the following steps:

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

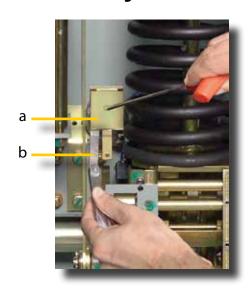
A CAUTION

Do NOT allow the secondary trip propadjusting screw to turn while loosening the locking nut. Failure to observe this caution will severely damage the mechanism.

- 4. Manually charge the circuit breaker main spring.
- 5. Manually CLOSE the circuit breaker.
- 6. Slowly turn the secondary trip prop adjusting screw (Figure 6, b) clockwise in 1/8 turn (45°) increments until the breaker trips OPEN. Carefully note the rotational position of the tool used to turn the adjusting screw at the moment the

- breaker operates. Do NOT turn the screw any further clockwise after the breaker operates.
- 7. Turn the secondary trip prop adjusting screw (Figure 6, b) counter-clockwise 1½ full turns from the position noted in step 6.
- 8. While holding the secondary trip prop adjusting screw from turning, securely tighten the secondary trip prop adjusting screw locking nut.
- 9. Manually charge the main closing spring using the manual charge handle per *Ch 4 Installation*, *D. Placing the Circuit Breaker Into Service*, *4) Mechanical Operation Check*.
- 10. Manually CLOSE the circuit breaker.
- 11. Using leaf type feeler gauges with a total of 0.090" thickness selected, position the feeler gauge as shown in *Figure 19*.

Figure 19 Feeler Gauge



- a. Trip Coil Armature
- b. Feeler Gauge









12. Slowly depress the trip coil armature (Figure 19, a) using the manual charge handle or screwdriver and position the tool as shown in Figure 19. Depress the handle until the armature contacts the feeler gauges. The circuit breaker should not trip.

Note: Do NOT tilt the armature. Tilting the armature by applying a load to the right of the feeler gauges will produce incorrect results.

- 13. Choose one of the following steps according to the TRIP status:
 - i. If the circuit breaker TRIPPED during the test performed in step 12, increase the gap between the trip coil armature and the latch check operator by bending the latch check operator downwards slightly using channel lock pliers or a small crescent wrench. Repeat steps 9 through 12.

Note: Bend the latch check operator in very small increments. This process may take several attempts.

- ii. If the circuit breaker did NOT TRIP during the test performed in *step 12*, proceed to *step 14*.
- 14. Reset the feeler gauges with 0.030" selected and position the feeler gauge as shown in *Figure 19*.
- 15. Slowly depress the trip coil armature using the manual charge handle. Position the handle as shown in *Figure 19*. Depress the handle until the armature contacts the feeler gauges. The circuit breaker should trip.

Note: Do NOT tilt the armature. Tilting the armature by applying a load to the right of the feeler gauges will produce incorrect results.

16. If the circuit breaker did not TRIP during the test performed in step 15, remove the feeler gauges and trip the breaker. Decrease the gap between the trip coil armature and the latch check operator by bending the latch check operator upwards slightly using channel lock pliers or a small crescent wrench.

Note: Bend the latch check operator in very small increments. This process may take several attempts.

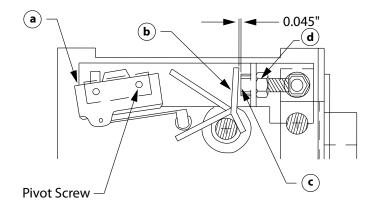
- 17. Repeat steps 9 through 16 until the breaker does not trip with the 0.090" gauge inserted in the trip coil armature gap and does trip with the 0.030" gauge inserted into the trip coil armature gap.
- 18. Manually charge the main closing spring using the manual charge handle per *Ch 4 Installation*, *D. Placing the Circuit Breaker Into Service*, *4) Mechanical Operation Check*.
- 19. Replace circuit breaker front cover.

d. Latch Check Switch Adjustment

The latch check switch adjustment (Figure 20) described is not required for routine maintenance; however, the latch check switch may need to be adjusted after major overhaul, removal of the mechanism, or tripping system adjustment.



Figure 20 Latch Check Switch Adjustment



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

To adjust the latch check switch perform the following steps:

- Remove the main closing spring.
 Refer to Ch 5 Maintenance,
 Mechanism Area, 3) Closing Spring Removal.
- 2. Rotate the crank arms until the spring charge indicator displays, CLOSING SPRING CHARGED.
- 3. Loosen the two screws which secure the latch check switch and rotate the latch check switch about the pivot screw downward to the lowest position allowed. The latch switch contacts are now OPEN.
- 4. Insert a 0.045" gauge between the secondary trip prop adjusting screw (Figure 20, c) 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.

- 5. To confirm that the latch check switch is properly set, slowly depress and release the manual trip operator to verify that the latch check switch OPENS and CLOSES properly. (An audible click of the contacts will be heard). The latch check switch contacts will OPEN as the latch check operator is moved by the manual trip operator away from the secondary trip prop adjusting screw. Slowly withdraw the manual trip operator and the latch check switch contacts should close when the latch check operator is between 0.045" to 0.015" away from the secondary trip prop adjusting screw.
- 6. Depress the manual close operator and rotate the crank arm until resistance is felt.
- 7. Depress and hold the manual trip operator inward and rotate the crank arms until the spring charge indicator displays, CLOSING SPRING DISCHARGED.
- 8. Reinstall the circuit breaker main closing spring.

e. Adjustment of Close Latch Shaft

The close latch shaft (Figure 6, I) passes through the side sheets of the stored energy mechanism frame at the front of and below the cam shaft. One end of the shaft is shaped to make a latch face and interferes with the close latch arm (Figure 6, k), which is fixed to the cam shaft. The other end of the close latch shaft is attached to a lever positioned by a close bar adjusting screw (Figure 6, r).









To adjust the close latch shaft perform the following procedures:

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

6) Electrical Operation

After performing any necessary mechanical and lubrication maintenance, operate the circuit breaker electrically several times to ensure that the electrical control system works properly. See Ch 4 Installation, D. Placing the Circuit Breaker Into Service, 5) Electrical Operation Check.

C. VACUUM INTERRUPTER AND CONTACT AREA

1) Vacuum Interrupter and Contact Erosion

At each inspection the vacuum interrupters should be checked for contact erosion. The circuit breaker must be closed for this check. Each new vacuum interrupter is set with a gap of about 0.150" to 0.188" between the high voltage pivot block and the flat washer 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 top of the front terminal clamp in both open and closed positions and the vacuum interrupter. Refer to Ch 6 Recommended Renewal Parts and Repair Procedures, C. Replacement Procedures, 1) Vacuum Interrupter Assembly.

2) Vacuum Integrity

Refer to *Ch 4 Installation, D. Placing the Circuit Breaker Into Service,*2) Vacuum Integrity for information on vacuum integrity and testing of vacuum interrupters.

3) 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.



A CAUTION

Adjustments of these settings is only necessary when repair requires the removal or replacement of the vacuum interrupter. Do not adjust these settings unnecessarily as damage to the circuit breaker may result.

When it is necessary to remove or replace the vacuum interrupter, refer to Ch 6 Recommended Renewal Parts and Replacement Procedures, C. Replacement Procedures, 1) Vacuum Interrupter Assembly or contact the Powell Service Division.

D. OPTIONAL MAINTENANCE PROCEDURES

1) High Potential Tests

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

Ch 4 Installation, D. Placing the Circuit

Breaker Into Service.

2) Timing

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

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

Table C Timing				
Cycles	Cycles Closing Time (ms)			
3	≤ 80	< 35		
5	≤ 80	< 55		

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









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

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

Table D Primary Resistance						
Breaker Type	Rated (kV)	Continuous Current (Amperes)	Resistance (Micro-ohms)			
38PV40ARMX-4	38	1200	46			
38PV40ARMX-4	38	2000	36			
38PV40ARMM-4	38	1200	46			
38PV40ARMM-4	38	2000	36			
38PV40ARMS-4	38	1200	46			
38PV40ARMS-4	38	2000	36			



Ch 6 Recommended Renewal Parts and Replacement Procedures

A. ORDERING INSTRUCTIONS

- 1. Order Renewal Parts from Powell at *powellind.com* or call 1.800.480.7273.
- 2. Always specify the complete nameplate information including:
 - Breaker Type
 - Serial Number
 - Rated Voltage
 - Rated Amps
 - Impulse Withstand
 - Control Voltage (for control devices and coils)
- 3. Specify the quantity and description of the part and the instruction bulletin number. If the part is in any of the recommended renewal parts tables, specify the catalog number. If the part is not in any of the tables, a description should be accompanied by a marked illustration from this instruction bulletin, 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 larger quantity of renewal parts should be stocked depending on the severity of the service and the time required to secure replacement parts.

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

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

C. REPLACEMENT PROCEDURES

This section includes instructions for replacing the parts recommended as renewal parts. Before attempting any maintenance repair work, take note of the safety practices outlined in *Ch 2 Safety* of this instruction bulletin.

A CAUTION

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











All service manuals can be found on powellind.com.

1) Vacuum Interrupter Assembly

CAUTION

The vacuum interrupter should only be replaced by a qualified person or a Powell Service technician. Contact Powell for further assistance at 1.800.480.7273.

2) Closing Coil Assembly

Refer to service manual 01.4SM.1300 Closing Coil Assembly for replacement and installation procedures.

3) Primary Shunt Trip Coil Assembly

Refer to service manual 01.4SM.1600 Primary Shunt Trip Coil Assembly for replacement and installation procedures.

4) Secondary Shunt Trip Coil Assembly

Refer to service manual 01.45M.1700 Secondary Shunt Trip Coil Assembly for replacement and installation procedures.

5) Undervoltage Device Assembly (UV)

Refer to service manual 01.4SM.1800B Undervoltage Assembly for replacement and installation procedures.

6) Charging Motor Assembly

Refer to service manual 01.4SM.1200 Charging Motor Assembly for replacement and installation procedures. 7) Anti-Pump Relay Assembly

Refer to service manual 01.4SM.1000 Anti-Pump Relay Assembly for replacement and installation procedures.

8) Latch Check Switch

Refer to service manual 01.4SM.1400 Latch Check Switch Assembly & Tripping System Mechanism Adjustment for replacement and installation procedures.

9) Motor Cutoff Switch Assembly

Refer to service manual 01.4SM.1500 Motor Cutoff Switch Assembly for replacement and installation procedures.

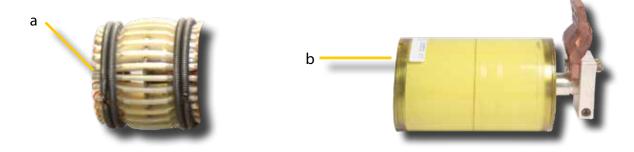
10) Auxiliary Switch

Refer to service manual 01.4SM.1100 Auxiliary Switch Assembly for replacement and installation procedures.



Table E Primary Current Path						
Breaker Type	Rated (kV)	Rated Continuous Current (Amps)	Vacuum Interrupter Assembly	Primary Disconnecting Cluster		
38PV40ARMX-4	38	1200	43642G08	43606G01		
38PV40ARMX-4	38	2000	43642G09	43606G06		
38PV40ARMM-4	38	1200	43642G08	43606G01		
38PV40ARMM-4	38	2000	43642G09	43606G06		
38PV40ARMS-4	38	1200	43642G08	43606G01		
38PV40ARMS-4	38	2000	43642G09	43606G06		

Figure 21 **Primary Current Path**



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









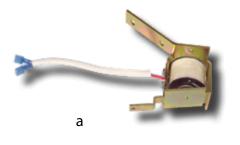
Table F Control Devices								
Control	Primary Shunt Trip Coil Assembly (2)		Shunt Trip	Undervoltage Device	Charging Motor	Anti-Pump	Closing Coil	Racking
Voltage	3-Cycle	5-Cycle	Coil Assembly (3)	Assembly (4)	Assembly	Relay (5)	Assembly	Motor
24VDC	50027G05	50041G08	50042G06	n/a	n/a	n/a	n/a	509140 (8)
48VDC	50027G01	50041G01	50042G01	50028G11	50960G06	RR2BA-US- DC48V	43684G05	509140 (8)
125VDC	50027G02	50041G10	50042G03	50028G10	50960G04	RR2BA-US- DC110V	43684G03	509140 (8)
250VDC	50027G03	50041G03	50042G04	n/a	50960G05	RR2BA-US- DC110V	43684G04	509140 (8)
120VAC	50027G01	50041G05	50042G01	n/a	50960G04	RR2BA-US- AC120V	43684G01	509140 (8)
240VAC	50027G06	50041G06	50042G02	n/a	50960G05	RR2BA-US- AC240V	43684G02	509140 (8)
Capacitor Trip (6)	50027G04	50041G04	50042G05	n/a	n/a	n/a	n/a	509140 (8)

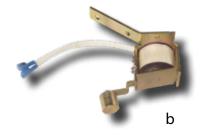
Notes:

- 1) One required per circuit breaker if the circuit breaker was originally equipped with this item. All circuit breakers have a closing coil, primary shunt trip coil, charging motor, and an anti-pump relay assembly. Secondary shunt trip coils and undervoltage device assemblies are optional (see notes 2-7).
- 2) Primary shunt trip coil is available as a 3 cycle and 5 cycle control device. Trip coil assemblies must only be replaced with the same type as originally supplied.
- 3) Secondary shunt trip coil cannot be furnished with an undervoltage device assembly.
- 4) Where furnished, cannot be present with secondary shunt trip coil assembly.
- 5) For 250VDC applications, a dropping resistor 50747G02 is required in series with the anti-pump relay assembly.
- 6) For use with capacitor trip units with 240VAC input. Consult factory for other circuit breaker ratings.
- 7) All control devices are available with push-on terminals. Consult factory for control devices with screw terminals.
- 8) Racking motor is available with isolated power supply.

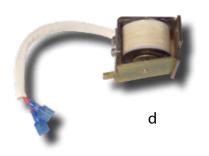


Figure 22 Control Devices















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









Table G Miscellaneous Parts						
Description	Catalog Number	Illustration				
Auxiliary Switch	102112PB					
Ground Connection	40767G01					
Latch Check Switch	BA-2RV2-A2					
Motor Cutoff Switch Assembly	50756G03					
PowlVac® Lubrication Kit	Powlube-104	POWELL BEAUTION IN CONTROL CONTROL				
Operating Pushrod	43645P01					









01.4IB.65121 PowlVac 38™ ARM Series 4 **Vacuum Circuit Breaker**

38kV, 1200A & 2000A

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