Instructions IB-65010A

PowlVac® Type PV System 38 Vacuum Circuit Breaker

Installation

Maintenance

Renewal Parts

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I. INTRODUCTION

This instruction bulletin provides installation, operation and maintenance instructions for the PowlVac® Type PV System 38 Vacuum Circuit Breakers.

A. Safety

Each user has the responsibility to instruct all personnel associated with this equipment on all precautions which must be followed. Before uncrating the circuit breakers, all the recommended procedures included in this instruction bulletin must be carefully studied.

The following are recommendations to be considered in a user's safety program. These suggestions are not intended to supersede the user's responsibility for devising a complete safety program and shall not be considered as such. They are rather suggestions to cover the more important aspects of personnel safety related to circuit breakers. Powell neither approves nor assumes any responsibility for users practices which deviate from these recommendations. All personnel associated with installation, operation and maintenance of power circuit breakers should be thoroughly trained and supervised regarding power equipment in general as well as the particular model of equipment with which they are working.

The circuit breakers described in this instruction bulletin are operated by high energy, high speed mechanism interlocked to provide safe operating sequences. To ensure the safety of personnel associated with installation, operation and maintenance of these breakers, the following rules should be followed:

1. **DO NOT WORK ON AN ENERGIZED BREAKER. IF WORK MUST BE PERFORMED ON A BREAKER, REMOVE IT FROM THE METAL-CLAD ENCLOSURE.**
2. **DO NOT WORK ON A BREAKER WITH CONTROL CIRCUITS ENERGIZED.**
3. These breakers utilize stored-energy spring charged mechanism. These mechanisms must be serviced only by skilled and knowledgeable personnel capable of releasing each spring load in a control manner. **EXTREME CARE MUST BE EXERCISED TO KEEP ALL PERSONNEL, TOOLS, AND OTHER OBJECTS CLEAR OF MECHANISMS WHICH ARE TO BE OPERATED OR RELEASED.** Detailed information regarding these mechanisms is found in this instruction bulletin.
4. **DO NOT ATTEMPT TO CLOSE THE BREAKER BY HAND ON A LIVE CIRCUIT.**
5. **DO NOT USE AN OPEN CIRCUIT BREAKER BY ITSELF AS THE SOLE MEANS OF ISOLATING A HIGH VOLTAGE CIRCUIT.** For complete isolation, the circuit breaker should be in the disconnected position, or should be withdrawn completely.
6. For the safety of personnel performing maintenance operations on the breaker or connected equipment, all components should be disconnected by means of a visible break and securely grounded.
7. Interlocks are provided to insure proper operating sequences of the circuit breaker and for the safety of the operator. If, for any reason, an interlock does not function as described **DO NOT MAKE ANY ADJUSTMENTS, MODIFICATION OR DISFIGURE THE PARTS. DO NOT FORCE THE DEVICE INTO POSITION. CONTACT THE POWELL ELECTRICAL MANUFACTURING COMPANY FOR INSTRUCTIONS.**

B. Receiving

Upon receipt by the customer, all items should be checked against the packing list provided. Each breaker must be examined for any damage that might have occurred during shipment. The transportation company and the manufacturer should be notified immediately if there is any shortage, damage or excessive rough handling is evident.

C. Handling

Always use extra care when uncrating and handling the breaker. **NEVER USE THE PRIMARY DISCONNECT RUN-BACKS AS HANDLES! THE CIRCUIT BREAKER CAN BE ROLLED BY USING THE APPROPRIATE HANDLES LOCATED ON THE FRONT COVER, AND CAN BE LIFTED WITH A CRANE USING TWO 1/2" DIAMETER HOOKS RATED FOR 650 LBS. MINIMUM EACH.** Lifting locations are provided in the frame side members. Use a spreader wider than the breaker to prevent damage.

D. Storage

Whenever the breaker must be stored before it is put into service, the manufacturer recommends to keep it in a place that is clean, dry and free of corrosive elements and mechanical abuse.

Powell recommends that the breaker be put in its permanent location as soon as possible. If the breaker is to function in switchgear employing space heaters, install it only after the heaters are operating.

Breakers that must be stored for any length of time should be inspected regularly for rusting and overall condition. Lubrication should be restored whenever necessary.

II. INITIAL BREAKER PREPARATION

The following describes the steps that are necessary to prepare the breaker, and must be performed prior to installation into its enclosure.

Perform a complete inspection of the breaker. Particular attention should be devoted to the Cycloaliphatic insulators which provide support and electrical isolation to the primary run-backs, the vacuum interrupters assemblies. These phase insulators are located behind a metal barrier which encloses the mechanism compartment.

With a clean, dry cloth remove dirt and any moisture that may have been collected on the insulating parts.

Perform several close-open operations and make sure that the breaker operates properly.

A. Insulation

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

To check insulation integrity, the AC high potential test described below is strongly recommended. DC high potential testing is not recommended except for the Vacuum Interrupter Integrity Test.

CAUTION: IF DC HIGH POTENTIAL TESTING IS REQUIRED, THE DC HIGH POTENTIAL TEST MACHINE MUST NOT PRODUCE INSTANTANEOUS PEAK VOLTAGES EXCEEDING 50KV.

The circuit breaker insulation should be tested with the circuit breaker in the "CLOSED" position. Test each pole of the breaker separately, with the other 2 poles grounded. Perform the one minute low frequency withstand test described in ANSI Standard C37, 20.2 at the voltage level of 60kV.

This test will have checked all of the support insulators, and also the primary phase-to-phase insulation.

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

The tests described above are the only tests required to ascertain insulation integrity. Because of the design of the PV SYSTEM 38 Vacuum Circuit Breaker insulation system, no valid data can be obtained utilizing other types of high-voltage insulation tests.

B. Vacuum Integrity

Vacuum interrupters used in PV System 38 Vacuum Circuit Breakers are highly reliable interrupting elements. Satisfactory performance of these devices is primarily dependant upon the integrity of the vacuum in the chamber and internal dielectric strength. Both these parameters can be readily checked by a high potential test.

The test of the vacuum interrupter will determine its internal dielectric condition and vacuum integrity. With the breaker open and removed from the cell, apply the high potential across each interrupter separately. It is recommended that the interphase barriers be in place during this test to prevent phase-to-phase break-down. Connect the "hot" lead of the test source to the upper stud of the pole under test and the ground lead to the lower stud. If the test supply is center-point grounded, the connections may be made either way. Test voltages should not exceed 45kV ac rms 50 or 60 Hz for circuit breakers with maximum rated voltage of 27kV, and 60kV ac rms 50 or 60 Hz for circuit breakers with maximum rated voltage of 38kV and hold for one minute. If no break down occurs the interrupter is in acceptable condition. If a breakdown occurs the interrupter should be replaced.

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

After the test potential is removed, discharge any electrical charge that may be retained by grounding the conductors to which high potential has been applied, including the metallic center ring of the interrupter, if present.

C. Control Voltage Insulation Integrity

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

WARNING: When a higher than rated voltage is applied across the contacts of vacuum interrupt-ers, generation of X-rays occurs. The intensity of this radiation depends on the peak voltage and contact gap. At specified 60kV voltage value, we recommend that the operator stays at least six (6) feet away from the breaker and the vacuum interrupters under test, behind the metal barrier enclosing the mechanism. We strongly recommend to make sure that the contacts are in their FULLY open position prior to performing the hi-pot test.

1. Install the breaker into its enclosure by following all directions provided by the enclosure manufacturer.

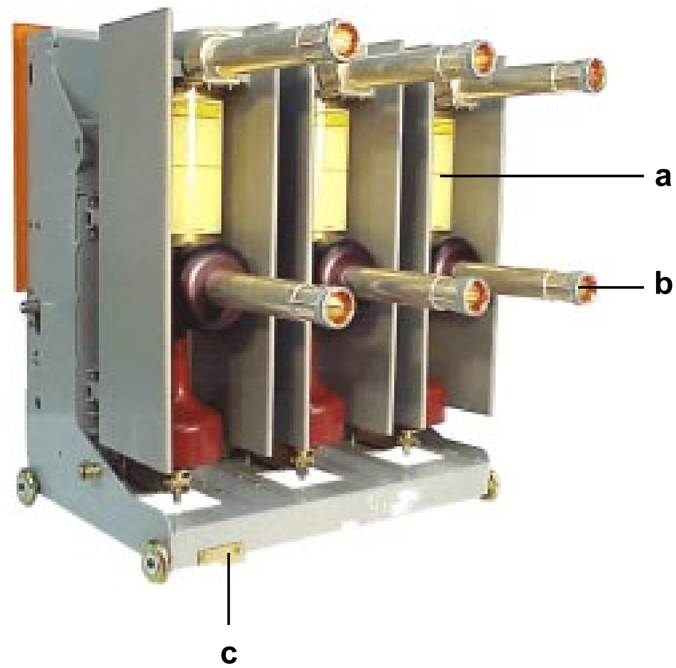
2. With the main power off, cycle the breaker several times and check for proper operation.

3. The breaker is now ready for normal service.

III. VACUUM CIRCUIT BREAKER DESCRIPTION

A. Vacuum Interrupters

To control a primary circuit, the PV System 38 Vacuum Circuit Breakers use vacuum sealed interrupters, which are vertically assembled in Cycloaliphatic epoxy insulators installed onto the back of the frame barrier. These interrupters (fig 1 [a]) consist of only a fixed and movable contact located in a sealed vacuum vessel and they are able to provide electrical isolation with a short contact gap. Driven by a very responsive mechanism, they constantly perform interruption in three cycles or less.



a. Vacuum Interrupters
b. Primary Disconnect
c. Circuit Breaker - Cell Coding Plate

Figure 1. Circuit Breaker Rear View

B. Primary Connections

The PV System 38 Vacuum Circuit Breakers have their primary connections with the correspondent switchgear made through the six primary disconnects (fig 1 [b]), which are horizontally mounted to the cycloaliphatic epoxy insulators. All personnel associated with the circuit breaker must ensure that the primary disconnects do not receive rough handling, and that they are never used as handles when maneuvering the circuit breaker.

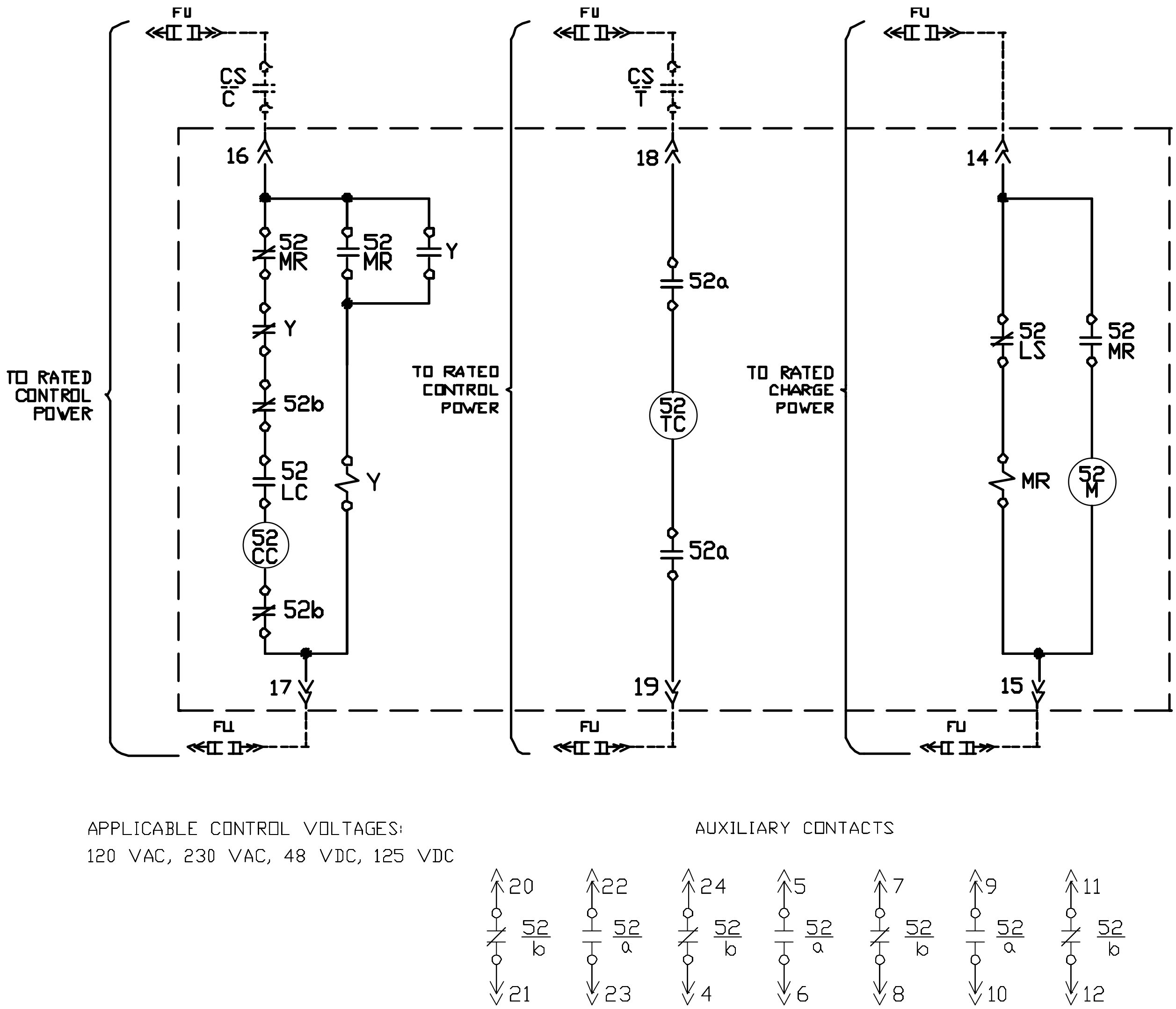
C. Operating Mechanism

The PV System 38 Vacuum Circuit Breakers employs a “Stored energy” operating mechanism. A gear motor is used to charge the drive springs. During the closing operation, the drive springs close the interrupters’ contacts, charge the bias springs which hold the contacts closed and simultaneously charge the return or opening springs. This closing sequence can be overridden at any time due to the trip-free capability of the mechanism. The mechanism is located in the front of the circuit breaker for easy accessibility in case of inspection or service.

D. Control Circuit

Figures 2 shows the schematic wiring diagram for the control circuit in the PV System 38 Vacuum Circuit Breakers. Users may select different control circuits to suit their applications. Each component and its function are described below.

Figure 2. Typical AC/DC Control Scheme



LEGEND:

- 52 LS --- SPRING CHARGE LIMIT SWITCH, SHOWN WITH BKR. CLOSING SPRINGS DISCHARGED.
- MR --- CHARGING MOTOR RELAY COIL
- 52 MR --- CHARGING MOTOR RELAY CONTACT
- 52 M --- BKR. CHARGING SPRINGS CHARGING MOTOR
- 52 CC --- BKR. CLOSING COIL
- 52 TC --- BKR. TRIP COIL
- FU --- PULL-APART FUSE BLOCK
- << --- SECONDARY DISCONNECT PIN NUMBER
- 52 a --- NORMALLY OPEN BKR. AUXILIARY SWITCH CONTACT
- 52 b --- NORMALLY CLOSED BKR. AUXILIARY SWITCH CONTACT
- 52 LC --- LATCH CHECK SWITCH
- CS C --- BREAKER CONTROL SWITCH CLOSE CONTACT
- CS T --- BREAKER CONTROL SWITCH TRIP CONTACT
- Y --- ANTI-PUMP RELAY COIL
- Y --- ANTI-PUMP RELAY CONTACT

E. Charging Motor Limit Switch

The function of the charging motor limit switch is to sense when the drive springs are discharged in which case it would energize the charging motor relay. When the drive springs reach their fully charged position, the charging motor limit switch is released thus de-energizing the motor charging relay. In the schematic wiring diagram of figure 2, the charging motor limit switch is shown in its normally closed status. As soon as the drive springs are discharged, the limit switch closes and remains closed until the drive springs are fully charged. The charging motor limit switch is shown in figure 3 [a].

a. Motor Limit Switch

Figure 3. Motor Limit Switch

F. Charging Motor Relay

As soon as the charging motor limit switch senses the drive springs discharged, the charging motor relay or MR (fig 4 [b]) is energized, thus activating the drive spring charging motor (fig 5 [c]) through a pair of normally open contacts. This simultaneously isolates the closing coil through a pair of normally closed contacts.

G. Anti-Pump Relay

The function of the anti-pump relays or Y is to avoid continuously charging or discharging the drive springs in the event of closing coil (fig 4 [c]) energized for a long time: therefore the anti-pump relay allows the closing coil to be energized only when the drive springs are in fully charged position and the charging motor relay is de-energized. The relay is shown in (fig 4 [a]).

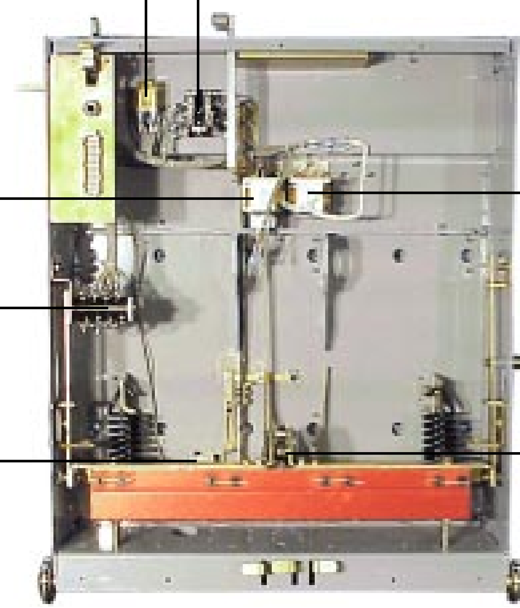
H. Auxiliary Switch

This multistage switch is used to selectively energize those parts of the control circuitry which depend upon the status of the circuit breaker primary contacts.

Users should refer to figure 2 to familiarize themselves with the inner-connection between the auxiliary switch's individual stages and the breaker control circuit.

For the closing function, two "b" type auxiliary contacts are connected with the closing coil (CC): these normally closed contacts therefore, isolate the close coil when the breaker's primary contacts are closed.

For the opening function, two "a" type auxiliary contacts are connected in series with the opening coil (TC), thus isolating it when the breaker's



a. Anti-Pump Relay
b. Motor Relay
c. Closing Coil
d. Latch Check Switch
e. Auxiliary Switch
f. Opening Coil
g. Opening Cam

Figure 4. Mechanism Removed

primary contacts are open. In case of trip control voltage of 250 VDC, three “a” type auxiliary contacts are used. Figure 4 [f] shows the trip coil.

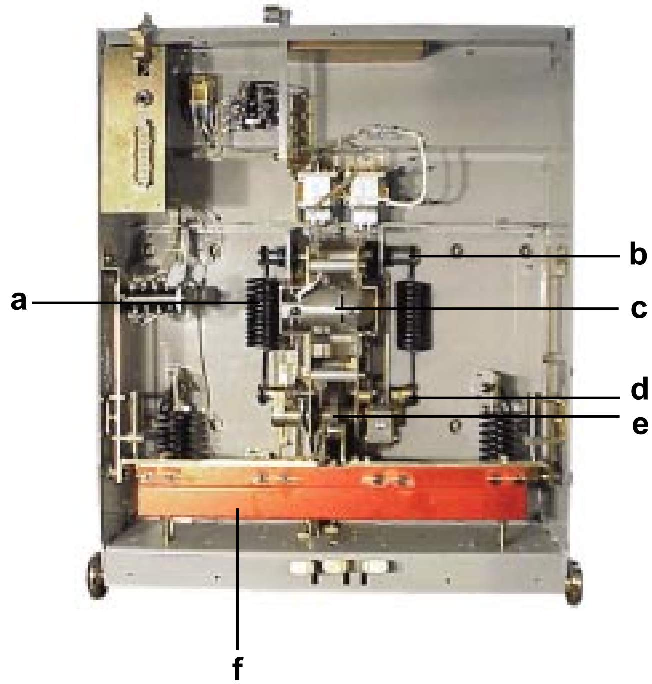
Figure 2 also show the availability of several “a” type and “b” type contacts for optional use. Figure 4 [e] shows the auxiliary switch.

I. Latch Check Switch

The latch check switch (fig 4 [d]) gives reclosing capability to the breaker. Because it is connected in series with the closing coil, the breaker can reclose only when its contacts are closed. The latch check switch, or LC, is activated by the opening cams (fig 4 [g]), (fig 10 [1]). These cams open the contacts of the switch when they are not engaged with the mechanism opening rollers (fig 10 [2]).

J. Manual Charging Feature

Manual spring charging is performed by inserting the manual charging handle, supplied with the breaker, into the manual charging arm assembly (fig 6 [c]), then by pushing down and releasing until the drive springs are fully charged, and the charged-discharged indicators displays “Charged.” When the breaker is open, after the charging of the drive springs, the mechanism pivots towards the latched position.



a. Drive Springs
b. Mechanism Pivot Shaft
c. Charging Motor
d. Crank Arm
e. Drive Cam
f. Cross Member

Figure 5. Circuit Breaker Interior View

CAUTION: IT IS VERY IMPORTANT THAT THE HANDLE IS REMOVED FROM THE MANUAL CHARGING ARM ASSEMBLY PRIOR TO CLOSING THE CIRCUIT BREAKER.

K. Indicators

Three indicators are visible through the front cover of the circuit breaker. The open-close indicator (fig 6 [b]) indicates the status of the contacts inside the vacuum interrupters, open or closed. The charge-discharge indicator (fig 6 [g]) reveals the status of the drive springs, charge or discharge. The operations counter (fig 6 [a]) advances one digit per opening operations.

L. Slow Closing Feature

For those users who require to slow close the circuit breaker, the PV System 38 Vacuum Circuit breaker operating mechanism has this capability. In order to manually slow close the circuit breaker the following steps must be accomplished:

1. Make sure that the breaker is in the open position with drive springs (fig 5 [a]) discharged and secondary circuit disconnected.

2. After removing the holding flat washers and retaining rings at both ends of the mechanism pivot shaft (fig 5 [b]) slide the top hook of the drive springs outward, disengaging them from the shaft. Remove the springs by disconnecting their bottom hooks from the crank arm roller. Figure 5 [d] shows the crank arms with the rollers.

3. Insert the manual charging handle in the manual charging arm assembly, and by pushing down releasing, advance the charging gear until it stops. In this position the drive cam (fig 5 [e]) shows a concavity, therefore allowing the mechanism to pivot toward the latched (charged) status. (The mechanism is now ready to close, only manually of course because the drive springs have been removed.) Remove the charging handle.

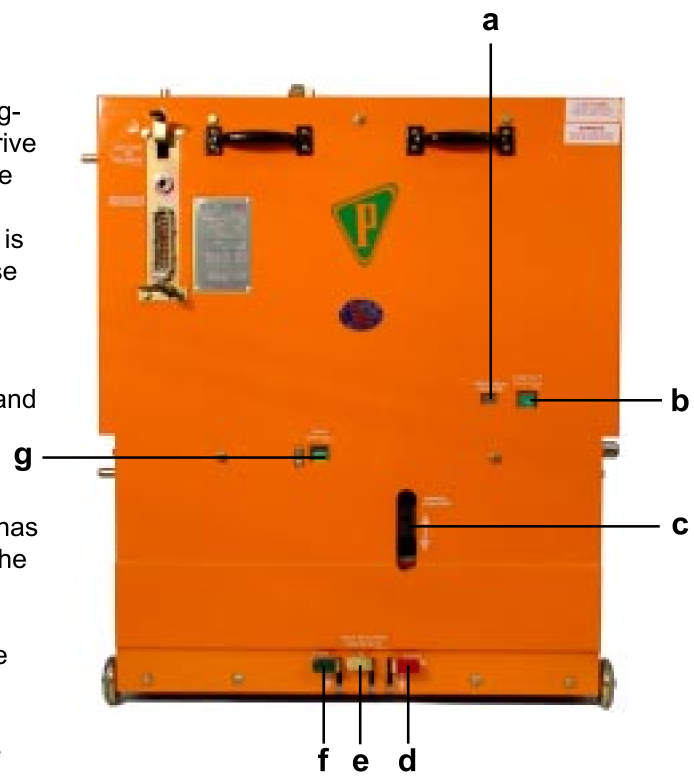
4. Depress the manual close lever (fig 6 [d]) and while keeping it depressed rotate the hexagonal shaft on its right end with a 1” open-end wrench for about 20 degrees downward; in this position the mechanism has already started the closing sequence and the drive shaft should not rotate back.

5. Release the manual close lever and remove the 1” wrench.

6. Operating with the manual charging handle perform a manual charging operation. The charging gear advances and the breaker will slow-close.

7. To reinstall the drive springs: make sure that the breaker mechanism is in the open status and with the two side crank arms directed upward and toward the mechanism pivot shaft. Insert the long hook of the drive springs in the roller of the crank arm and then engage the short hook back onto the mechanism pivot shaft. Reinstall the holding flat washer and retaining ring on each side of the mechanism pivot shaft.

8. Once the slow closing sequence has been completed and the drive springs installed back, the breaker secondary circuit can be connected and reenergized.



a. Operations Counter
b. Open-Close Indicator
c. Manual Charging Arm Assembly
d. Manual Close Lever
e. Test Position Interlock
f. Manual Trip Lever
g. Charge-Discharge Indicator

Figure 6. Circuit Breaker Exterior View

M. Drawout Operation

Refer to the metal-clad switchgear instruction bulletin for general information and safety rules before attempting to insert a circuit breaker into the switchgear equipment.

IV. DESCRIPTION OF THE MECHANISM'S OPERATING CAPABILITIES

What follows is a description of the operating mechanism employed in the circuit breakers Type PV System 38 Vacuum Circuit Breaker. During this description we will refer to the "Mechanism side" as the front of the breaker, the left and right sides are as if facing the mechanism, while a clockwise or counterclockwise rotation is as if we are facing the left side of the breaker.

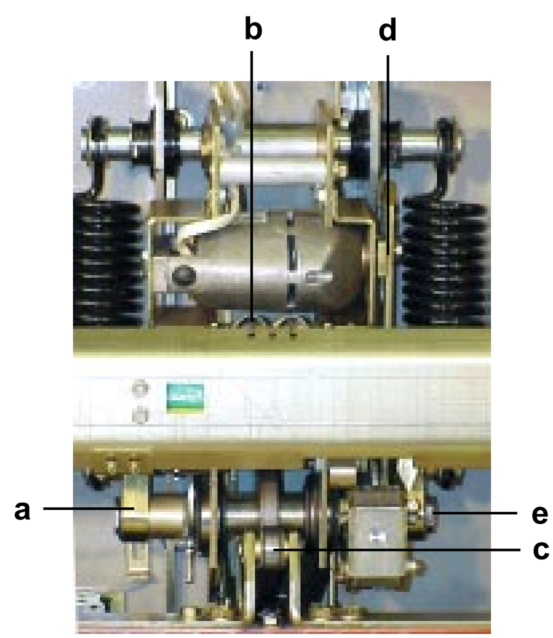
A. Drive Spring Charging

When the circuit breaker has its primary contacts open and the drive springs (fig 5 [a]) discharged, the mechanism is in its "Collapsed" position as shown in figure 7.

In this status the charging motor cam mounted on the hexagonal drive shaft (fig 8 [e]) drives a linkage assembly which closes the contacts of the motor limit switch. When the power is supplied to the breaker control circuit, the charging motor is energized.

Figure 7. Mechanism in Collapsed Position

The motor eccentric mounted on the clockwise rotating shaft of the charging motor pushes back and forward the ratchet arm (fig 8 [d]). With each stroke the ratchet arm pawl engages with a new tooth of the charging gear which consequently advances. The retrograde rotation of the gear is prevented by a holding pawl which biases the gear while the ratchet arm pawl moves back to engage another tooth. The charging gear is free to rotate on the driving shaft and has a pin mounted on its side; the gear and the pin, after a free rotation, engage with the pawl lift cam which is rigidly connected with the hexagonal driving shaft. The resulting effect is a clockwise rotation of this shaft which consequently charges the drive springs through a pair of crank arms. Figure 8 [a] shows the crank arms.



a. Crank Arm
b. Mechanism Return Springs
c. Cam Follower
d. Ratchet Arm
e. Hexagonal Drive Shaft

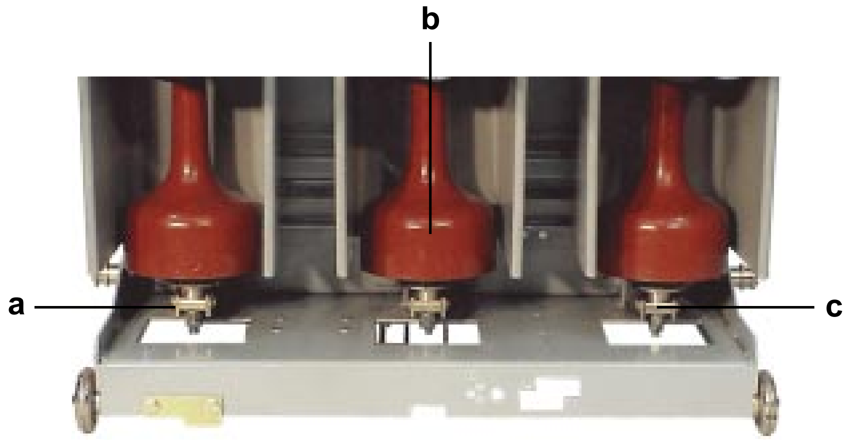
Figure 8. Mechanism View

As the rotation of the driving shaft progresses, the crank arms pass through the lower toggle point, now the driving springs are fully charged and they attempt to discharge. This action is prevented by the closing cam which is now engaged with the closing cam roller mounted on the right side of the driving cam. The driving springs are held in this position until a closing sequence is initiated.

As soon as the crank arms pass the lower toggle point, the linkage limit switch de-energizes the charging motor. At this time the ratchet arm pawl rides on the raised surface of the pawl lift cam without engaging with next tooth of the gear. The drive springs' charging sequence smoothly ends.

B. Closing Sequence

With the breaker open, once the drive springs are charged, the mechanism pivots counterclockwise pulled by the mechanism return spring (fig 8 [b]), and reaches a configuration in which is latched and ready to close. By energizing the closing coil, which is located above the mechanism to the right, or by depressing the manual close lever, the closing sequence is initiated. The closing cam disengages with the closing roller of the driving cam, and the crank arms are free to rotate clockwise pulled by the drive springs.



a. Phase Linkages (3)
b. Pushrod (3)
c. Rotating and Sliding Joints (3)

Figure 9. Vacuum Interrupters and Phase Linkages

While discharging, the drive springs force the driving shaft and the driving cam to rotate. The driving cam has a cam follower (fig 8 [c]) riding on its surface and rigidly connected with the three phase linkages (fig 9 [a]), through a cross member (fig 5 [f]). The assembly composed by the cam follower, the cross member and the three phase linkages, all rigidly connected, can, therefore, be considered as one operating link. This link pivots on three joints, one per phase, having the same axle of rotation, shown in figure 9 [a], to guarantee phase synchronization during movement.

While rotating, the driving cam shows a profile with different elevations to the cam follower, thus forcing it to rotate clockwise and downward with the operating link. On the back side, the operating link is connected to the movable contacts of the vacuum interrupters through a set of rotating and sliding joints (fig 9 [c]). The resulting clockwise, upward, rotation of these joints pushes the movable contacts to the closed position. At the same time, on the mechanism side, the clockwise rotation of the operating link further extends the opening springs. The clockwise rotation of the driving shaft rotates the lift cam out of engagement with the charging gear pin, without affecting the position of the gear. The charging motor cam and its link assembly close the motor limit switch, the charging motor is energized and moves the ratchet arm and its pawl back and forward; the pawl is free to engage with a tooth and starts the drive springs' charging sequence.

At the same time the cam follower rides on the circular portion of the driving cam maintaining the closed status of the primary contacts.

Between the movable contacts and the rotating/sliding joint the circuit breaker has a set of spring elements, called bias springs. Each phase has a bias spring, which is located inside the insulating pushrod (fig 9 [b]). Once the primary contacts are closed, the clockwise and upward rotation of the rotating/sliding joints continues, causing a further compression of these already pre-compressed bias springs. Because the contacts are closed they are stationary: therefore, a gap will appear between the rotating/sliding joints and the heavy washer installed on the threaded shafts of the pushrods through a 1/2"-20 hex nut and washer. This gap "E" is shown in the diagrammatical figure 11, and is later referred to as "Erosion indication."

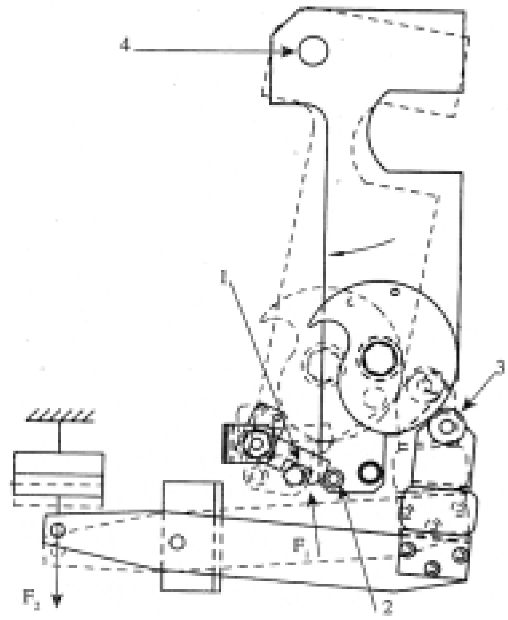
C. Opening Sequence

Once the circuit breaker's contacts are closed, the opening sequence can be initiated by depressing the open manual lever or by energizing the opening coil. By doing so the opening cams (fig 10 [1]) will rotate counterclockwise disengaging themselves from the mechanism opening rollers (fig 10 [2]).

Once the mechanism is not latched and biased by the opening cams, it rotates clockwise on the mechanism pivot shaft (fig 10 [4]).

This rotation is caused by the cam roller (fig 10 [3]) pushed by the opening spring forces F1 and bias spring forces F2. As soon as the mechanism rotates clockwise, the driving cam roller is not biased by the driving cam anymore, therefore it rotates with the whole operating linkage counterclockwise, opening the primary contacts.

The capability to perform this opening sequence at any time during the closing operation is called trip-free. All PV System 38 Vacuum Circuit Breakers have this capability.



1. Opening Cam
2. Opening Rollers
3. Cam Roller
4. Mechanism Pivot Shaft
F1. Opening Spring Force
F2. Bias Spring Force

Figure 10. Mechanism Fundamental Layout

V. MAINTENANCE

A. Introduction

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

A regular maintenance schedule should be established to obtain the best service and reliability from the circuit breaker. PV System 38 Vacuum Circuit Breakers are designed to comply with industry standards requiring maintenance every 500 operations or once a year, which ever comes first.

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 breaker is known to have interrupted a fault current at or near it's rating it is recommended that the breaker be inspected and necessary maintenance be performed as soon as practical. Some atmospheric conditions such as extremes of dust and moisture or corrosive gases might indicate inspection and maintenance at more frequent intervals than 500 operations. 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 which is best suited for the particular use. If maintenance is performed at longer time intervals than one year, the vacuum interrupter test should be performed each time the breaker is removed from the metal-clad switchgear for reasons other than scheduled breaker maintenance if it has been more than one year since the last vacuum interrupter integrity test.

A permanent record of all maintenance work should be kept, the degree of detail depending on the operating conditions. In any event, it will be a valuable reference for subsequent maintenance work and for station operation. It is recommended that the record include reports of test made, the condition of breakers and repairs and adjustments that were made. This record should begin with any checks done at the time of installation and energization.

Because of extensive quality control checks made at the factory, the operation counter on a new circuit breaker will normally register over 250 operations. The actual reading of the operations counter should be recorded when the circuit breaker is put into service and whenever any maintenance is performed.

MAKE CERTAIN THAT THE CONTROL CIRCUITS ARE DE-ENERGIZED AND THE BREAKER IS RESTING SECURELY OUTSIDE THE SWITCHGEAR HOUSING. DO NOT START TO WORK ON A CLOSED BREAKER OR A BREAKER WITH THE CLOSING SPRINGS CHARGED.

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

B. Vacuum Interrupter

It is suggested to perform the following tasks to assure the highest reliability:

1. Monitoring of the Erosion Indication: Figure 11 diagrammatically shows a partial side view of the high voltage module. The erosion gap indication is shown as “E”. The value of this gap is set at 0.150”-0.188” by the manufacturer. The difference between the actual value and the original value determines the erosion of the contacts. The value of this erosion cannot be greater than 0.100”; therefore, the value of the erosion indication, gap “E”, cannot be smaller than 0.080”. Vacuum interrupters that reach this point must be replaced.

2. Vacuum Integrity: Perform a high-pot test follow the directions as described in Section II., paragraph B.

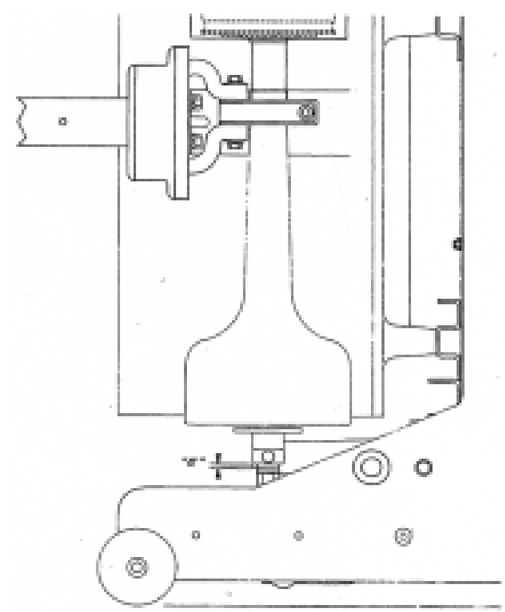


Figure 11. Monitoring of the Erosion Indication

C. Insulating Surfaces

Clean the breaker, removing loose dust and dirt.
Do not use an air hose to blow the breaker out; this may result in loose dirt or grit being blown into bearings or other critical parts and causing excessive wear. Either use a vacuum cleaner or wipe with a dry lint-free cloth or an industrial-type wiper.

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

D. Mechanism

Inspect the entire operating mechanism and all linkages looking for any loose hardware and any broken or excessively worn parts. All wiring and wiring insulations should be inspected for damages or loose connections. Cams, riding surfaces and bearings should be inspected for damage or excessive wear.

E. Lubrication

The manufacturer suggest that the users do not apply any additional lubrication on any part or component of the circuit breaker for the entire life of the breaker. This type of circuit breaker was tested for more than 1,500 operations without requiring any additional lubrication or maintenance.

F. Electrical

Inspect all electrical connections making sure that they are tight and clean.

VI. RENEWAL OF PARTS

It is recommended that sufficient renewal parts be carried in stock to enable the proper placement of any worn, broken or damaged part. A stock of such parts minimizes service interruptions caused by breakdowns and saves time and expense. When continuous operation is a primary consideration, more renewal parts should be carried, the amount depending on the severity of the service and the time required to secure replacements, identical to the original parts, since improvements are made from time to time. The parts which are furnished, however, will be interchangeable. Tables found in the supplementary instruction 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 10 breakers or fraction thereof.

A. Replacement Procedures

This section includes instructions for replacing close coil, open coil, motor relay, anti-pump relay and spring charging motor parts. **BEFORE ATTEMPTING THESE REPLACEMENT PROCEDURES, CAREFULLY READ AND APPLY ALL OF THE SAFETY PRACTICES OUTLINED IN SECTION I. OF THIS INSTRUCTION BULLETIN.**

1. Closing Coil Assembly

The closing coil assembly is located at the top center of the circuit breaker, right of the opening coil assembly. See figure 4 [c]. To replace this assembly:

a. Open and discharge the drive spring.
b. Remove front cover of the circuit breaker.
c. Unplug the closing coil assembly from the wire harness.
d. Remove the hardware from the coil linkage of the bottom of the closing coil assembly, paying close attention to the order of the hardware.
e. Remove the hardware from the press studs, which are connected to the top back panel of the circuit breaker, replace the closing coil assembly.
f. Insert the new closing coil assembly by connecting it back to the coil linkage with the hardware, and bolt it to the top back panel, and connect the wiring harness. No further adjustments are required of the closing coil assembly.
g. Operate the circuit breaker several times electrically to insure that the closing coil assembly is functioning properly.
h. Replace the circuit breaker’s front cover.

2. Opening Coil Assembly

The opening coil assembly is located at the top center of the circuit breaker, left of the closing coil assembly. See figure 4 [f]. To replace this assembly:

a. Open and discharge the drive springs.
b. Remove front cover of the circuit breaker.
c. Unplug the opening coil assembly from the wire harness.
d. Remove the hardware from the coil linkage of the bottom of the opening coil assembly, paying close attention to the order of the hardware.
e. Remove the hardware from the press studs, which are connected to the top back panel of the circuit breaker, replace the opening coil assembly.
f. Insert the new opening coil assembly by connecting it back to the coil linkage with the hardware, and bolt it to the top back panel, and connect the wiring harness. No further adjustments are required of the opening coil assembly.
g. Operate the circuit breaker several times electrically to insure that the opening coil assembly is functioning properly.
h. Replace the circuit breaker's front cover.

3. Spring Charging Motor

The drive spring charging motor is located at the top center of the mechanism and is shown in figure 5 [c]. To replace it:

a. Remove the front cover of the circuit breaker.
b. Unplug the charging motor from the wiring harness, and remove the tie wrap that supports the motor's lead wire.
c. Remove the nut, washer, and bearing from the motor eccentric, paying close attention to the order of hardware.
d. Remove the motor eccentric from the charging motor.
e. Detach the charging motor from the rear motor bracket by removing the two small screws and lock washers.
f. Loosen the hardware from the front motor bracket, while detaching the rear motor bracket from the left-hand mechanism side sheets completely.
g. Pull the charging motor from the mechanism and remove the motor shaft spacer and flange, and insert both the spacer and flange back onto the new motor.
h. Lubricate the motor shaft spacer & flange lightly with Rheolube 368A grease.
i. Apply Loctite 243 to hardware.
j. Replace items in "c."
k. Replace the circuit breaker's front cover.

4. Motor Relay

The motor relay is located near the left top of the mechanism compartment. Figure 4 [b] shows the motor relay. To replace it:

a. Remove the front cover.
b. Disconnect leads from the motor relay, being careful to note which wire goes to which terminal.
c. Remove the two 8-32 holding screws and the locknuts located on the other side of the front steel panel with a 3/8" open end wrench. Remove the motor relay.
d. Install the new relay using the 8-32 screws and new locknuts.
e. Connect all wires to the proper terminals of the new motor relay.
f. Place back the front cover.

5. Anti-Pump Relay

The anti-pump relay is located near the left top of the mechanism compartment. Figure 4 [a] shows the motor relay. To replace it:

a. Remove front cover of circuit breaker.
b. Disconnect the leads front anti-pump relay, being careful to note which wires go to which terminal.
c. Loosen the lower mounting screw of the relay.
d. Remove the upper screw and grommets.
e. Remove the washer, lock washer, nut, and lift the relay off the lower screw.
f. Place the new relay over the lower screw, and reinstall the lower hardware and tighten both the screws.
g. Reconnect all wires to the proper terminals of the relay.
h. Operate the circuit breaker several times to insure that the relay functions properly.
i. Replace the circuit breaker's front cover.

B. Ordering Instructions

When ordering parts, users should adhere to the following procedures:

1. Order Renewal Parts from **Powell Apparatus Service Division (PASD)**.

2. Always specify complete nameplate information, including:

    a. Type
    b. Serial Number
    c. Rated Voltage
    d. Rated Amps
    e. Impulse Withstand
    f. Control Voltage (for control devices coils)

3. Specify the quantity and description of the part, particular model and rating of the circuit breaker. If the part is in the tables of recommended renewal parts, give it's catalog number. If the part is not in the tables, the description should be accompanied by a marked illustration from this instruction bulletin or the supplementary instructions and a photo or a sketch showing the part needed.

4. Standard hardware, such as screws, bolts, nuts, washers, etc., should be purchased locally. Hardware used in bolted joints of conductors must be SAE Grade 5 or better in order to insure proper clamping torque and prevent overheating of the joints. Hardware should be plated to deter corrosion.

Table I. Recommended Renewal Parts

Description	Qty. per Brk.	Catalog No.
Vacuum Interrupter Assembly		
27kV 25kA, 1200A	3	42408G01P
27kV 25kA, 2000A	3	42859G01P
38kV 40kA, 1200A	3	43649G02P
38kV 40kA, 2000A	3	43650G02P
Opening Solenoid Assembly 48VDC	1	43285G09P
Opening Solenoid Assembly 125VDC	1	43285G08P
Opening Solenoid Assembly 250VDC	1	43285G05P
Opening Solenoid Assembly 120VAC	1	43285G12P
Opening Solenoid Assembly 240VAC	1	43285G11P
Closing Solenoid Assembly 48VDC	1	43285G03P
Closing Solenoid Assembly 125VDC	1	43285G02P
Closing Solenoid Assembly 250VDC	1	43285G10P
Closing Solenoid Assembly 120VAC	1	43285G07P
Closing Solenoid Assembly 240VAC	1	43285G06P
Charging Motor Assembly 48VDC	1	43716G02P
Charging Motor Assembly 125VDC	1	43716G01P
Charging Motor Assembly 250VDC	1	43716G05P
Charging Motor Assembly 120VAC	1	43716G03P
Charging Motor Assembly 240VAC	1	43716G04P
Motor Limit Switch Assembly	1	42256G01P
Auxiliary Switch	1	GS180
Anti-Pump Relay 48VDC	1	RR2BA-US-DC48V
Anti-Pump Relay 125VDC	1	RR2BA-US-DC110V
Anti-Pump Relay 250VDC	1	RR2BA-US-DC110V
Anti-Pump Relay 120VAC	1	RR2BA-US-AC120V
Anti-Pump Relay 240VAC	1	RR2BA-US-AC230V
Motor Relay 48VDC	1	GS186
Motor Relay 125VDC	1	GS187
Motor Relay 250VDC	1	GS188
Motor Relay 120VAC	1	GS189
Motor Relay 240VAC	1	GS190

Notes:

1. For 250VDC applications, a dropping resistor, 43723G01P, is required in series with this relay's coil.

WARNING

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

IT IS DESIGNED FOR USE, INSTALLATION AND MAINTENANCE BY SOPHISTICATED USERS OF SUCH EQUIPMENT HAVING EXPERIENCE AND TRAINING IN THE FIELD OF HIGH VOLTAGE ELECTRICITY. THIS DOCUMENT, AND ALL OTHER ASSOCIATED DOCUMENTATION, SHOULD BE FULLY READ AND UNDERSTOOD AND ALL WARNINGS AND CAUTIONS ABIDED BY. IF THERE ARE ANY DISCREPANCIES OR QUESTIONS, THE USER SHOULD CONTACT POWELL ELECTRICAL MANUFACTURING COMPANY IMMEDIATELY.

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