INSTALLATION
MAINTENANCE
RENEWAL PARTS

IB-20001A

Type PowlVac®
Vacuum Circuit Breakers

PVCB – 40.5/1200 – 31.5, 40.5kV Voltage Class, 1200A
PVCB – 40.5/2000 – 31.5, 40.5kV Voltage Class, 2000A

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WARNING

THIS EQUIPMENT MAY CONTAIN HIGH VOLTAGES AND 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 VOLTAGES ELECTRICITY. THIS DOCUMENT, AND ALL OTHER 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 AT 1-800-480-7273.

CAUTION

Before any adjustments, servicing, parts replacement, or any other act is performed requiring physical contact with the electrical working components or wiring of this equipment, the POWER SUPPLY MUST BE DISCONNECTED AND THE CIRCUIT BREAKER CLOSING SPRING MUST BE DISCHARGED.

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These instructions do not purport to cover all details or variations of the circuit breakers nor to provide for every possible contingency or hazard to be met in connection with installation, testing, operation and maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the user's purposes, the matter should be referred to Powell Electrical Manufacturing Company or call 1800-480-7273.

I. INTRODUCTION

A. PURPOSE

The purpose of this instruction book, use, and the quality of the material produced for the PowlVac® Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 series manufactured or supplied by POWELL ELECTRICAL MANUFACTURING COMPANY is to provide the operator with guideline specifications of:

1. Safety Rules.
2. A general description of the operation and maintenance of the circuit breaker.
3. Instructions for installation and putting the circuit breaker into service.
4. Instruction for replacements and a list of renewal parts with critical adjustments.
5. Illustrations, visuals, tables, and descriptions of the design and maintenance.

B. CONFLICT WITH OTHER DOCUMENTS

This instruction book is intended to assist the operator in the safety, use, installation, operation, and maintenance of the PowlVac® Vacuum Circuit Breaker Type PVCB Vacuum Circuit Breakers. This instruction book covers the design commonalities of the PowlVac® Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 series. This instruction book should be used in conjuntion with the applicable supplement pertaining to the specific model number of circuit breaker purchased. The specific model suplement for each circuit breaker model along with this instruction book must be studied and understood inorder to become fully acquanted with the Circuit Breaker. **If a conflict exists between this instruction bulletin and any other document relating to safety, use, description, installation, illustration, maintenance, renewal parts, and procedure, THIS INSTRUCTION BULLETIN SHALL TAKE PRECEDENCE. THE ONLY EXCEPTION TO THIS IS A SERVICE ADVISORY, A REVISION, OR AN ADDENDUM TO THIS DOCUMENT ISSUED BY POWELL ELECTRICAL MANUFACTURING COMPANY.**

C. OTHER ITEMS OF CAUTION

It should be noted that some illustrations contained herein may not represent the construction details of each user's particular model, but are general illustrations showing component locations.

To the extent required, the products described herein meet all applicable GB standard; but no assurance is given with respect to local codes and ordinances because they vary greatly.

Before unpacking the circuit breakers, study this manual and all other associated documentation. Follow the recommended procedure for putting into service.

D. INSTRUCTION BULLETINS ON THE WEB

Powell Electrical Manufacturing Company Instruction Bulletins are posted on the company website at www.powellservice.com. The instruction bulletins are designed to provide our customers with technical information about our product and services installation, maintenance, and renewal parts.

For more information, please contact Powell Apparatus Service Division at 1-800-480-7273, 713-944-6900, or info@powellservice.com.

II. SAFETY

Each user has the responsibility to instruct and supervise all personnel associated with the installation, operation, and maintenance of this equipment on all safety procedures that must be observed. Furthermore, each user has the responsibility of devising a complete safety program for each type or class of equipment encountered.

The circuit breakers described in this instruction book are operated by high energy, and high speed mechanisms interlocked which provides safe operating sequences. To insure the safety of personnel associated with installation, operation and maintenance of these circuit breakers, it is important that the following rules should be observed. These rules are not intended to be a complete safety program, or to take the place of the user's complete safety program. They are rather rules to cover the more important aspects of personnel safety related to PowlVac® Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 series Advanced Technology Closed Indoor PowlVac® Circuit Breakers.

A. GENERAL

1. Only supervised and qualified personnel trained in the use, installation, operation, maintenance of power equipment, power circuit breakers, and in general the particular model of equipment should be allowed to perform maintenance on these circuit breakers. It is important that all instruction books, and service advisories be studied, understood, and followed.

2. Maintenance programs must be well planned and executed consistently with both the customer's experience and the manufacturer's recommendations including service advisories and instruction books. A well-planned and executed routine maintenance is essential for the circuit breaker's reliability and safety.

   Service conditions and circuit breaker applications must be considered in the development of such programs. This includes such variables as ambient temperatures, the actual continuous current, number of operations, type of interrupting duties, and any unusual local conditions such as excessive dust, ash, corrosive atmosphere, major vermin, or insect problems.

B. SPECIFIC

1. DO NOT PERFORM ANY MAINTENANCE ON AN ENERGIZED CIRCUIT BREAKER. IF MAINTENANCE MUST BE PERFORMED ON A CIRCUIT BREAKER, REMOVE IT FROM SERVICE, DISCONNECT FROM BUS, LINE SUPPLIES, AND REMOVE IT FROM THE METAL-CLAD SWITCHGEAR ENCLOSURE.

2. DO NOT PERFORM MAINTENANCE ON A CIRCUIT BREAKER WITH THE CONTROL CIRCUIT ENERGIZED.

3. THESE CIRCUIT BREAKERS UTILIZE STORED ENERGY SPRING CHARGED MECHANISMS. ONLY SKILLED AND KNOWLEDGEABLE PERSONNEL CAPABLE OF RELEASING EACH SPRING LOAD IN A CONTROLLED MANNER MUST SERVICE THESE MECHANISMS. EXTREME CARE MUST BE EXERCISED TO KEEP ALL PERSONNEL, TOOLS, AND OTHER OBJECTS CLEAR OF MECHANISMS THAT ARE TO BE OPERATED OR RELEASED. DETAILED INFORMATION REGARDING THESE MECHANISMS CAN BE FOUND IN THIS INSTRUCTION BOOK.

4. DO NOT ATTEMPT TO CLOSE THE CIRCUIT 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 FROM THE BUS, LINE CONNECTIONS, OR SHOULD BE WITHDRAWN COMPLETELY.

6. FOR THE SAFETY OF PERSONNEL PERFORMING MAINTENANCE OPERATIONS ON THE CIRCUIT BREAKER OR CONNECTED EQUIPMENT, ALL COMPONENTS SHOULD BE DISCONNECTED BY MEANS OF A VISIBLE BREAK AND SECURELY GROUNDED.

7. INTERLOCKS ARE PROVIDED TO ENSURE 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 DEFORM THE PARTS. DO NOT FORCE THE DEVICE INTO POSITION. CONTACT THE POWELL ELECTRICAL MANUFACTURING COMPANY FOR INSTRUCTIONS.

C. X-RAYS

When voltage is applied across the contacts of a vacuum interrupter, there is the possibility of generating X-rays. The intensity of this radiation is dependent on the peak voltage and the contact gap. At the normal operating voltage of this class of equipment, the radiation levels are negligible. At the voltages specified for testing, it is recommended that the test operator be not less than three meters in front of the circuit breaker and separated from the vacuum interrupters under test by the two thickness of steel used in the construction of the circuit breaker frame, and all covers and doors secured in their normal operating conditions. The circuit breaker must be either fully open or fully closed when making high potential test. Do not test with contacts partially open.

D. SAFETY LABELS

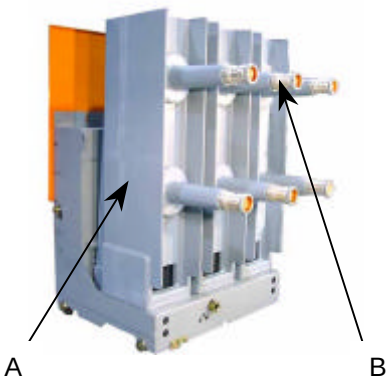
The circuit breaker has these warnings and caution labels attached at the indicated locations. Whenever the circuit breaker is handled or maintained, these warnings and caution labels must be observed.

Label Type	Description
CAUTION READ INSTRUCTIONS BEFORE ENERGIZING. THIS DEVICE MAY PRODUCE HARMFUL X-RAYS	*Attached to the outside face of the circuit breaker's front cover. The contents of this label is a printed red text on a white colored background that is placed at the circuit breaker's front cover, upper right corner.*
DANGER BE SURE CIRCUIT BREAKER CONTACTS ARE OPEN AND SPRINGS DISCHARGED BEFORE DOING ANY MAINTENANCE WORK.	*Attached to the outside face of the circuit breaker's front cover. The contents of this label is a printed red text on a white colored background that is placed at the circuit breaker's front cover, upper right corner.*
CAUTION **KEEP HANDS CLEAR**	*Attached to the circuit breaker on the inside. The contents of this label is a combined print of a black and yellow text on a combined black and yellow colored background that is placed at the connecting cross bar assembly and on the circuit breaker's bottom frame just below* connecting cross bar assembly.

III. DESCRIPTION

A. GENERAL

The PowlVac® Vacuum Circuit Breaker Type PVCB-40.5kV/1200A -31.5kA and PVCB-40.5kV/2000A -31.5kA series are designed with sealed vacuum interrupters that control the primary circuit. These vacuum interrupters are vertically assembled inside a high voltage housing that are installed on the rear of the circuit breaker's frame. Notice that there are two primary contacts per phase insulator. Figure 2 shows three high voltage housing assemblies.



A. High Voltage Housing
B. Primary Contact

Fig. 2 High Voltage Housing Insulators & Primary Contacts

The PowlVac® Circuit Breakers have their primary connections with the correspondent switchgear cell made through the six primary contacts, shown in figure 2, which are horizontally mounted to the insulators. The primary contacts are housed in an assembly known as a high voltage housing assembly. The high voltage housing assembly is composed of two primary contacts, a pushrod, a shunt, bias spring, regulators, and one vacuum interrupter, which control the voltage in the circuit breaker. Note, all personnel associated with the circuit breaker must ensure that the primary contacts do not receive rough handling and that they are never used as handles when maneuvering the circuit breaker.

B. THE STORED ENERGY MECHANISM

Removal of eleven (11) cover attachment bolts (fig 7 [a]) enables the circuit breaker's front cover to be removed. This allows access to all components, auxiliary switch, charging motor, motor limit switch, motor relay, anti-pump relay, and latch check switch. In figure 3, the actual mechanism is removed to clearly show the auxiliary switch, open and close solenoid assemblies, latch check switch, and drive cam bearing.

The shown mechanism, figure 4 is of a stored energy type in which a charging motor is used to stretch two driving springs (fig 8 [f]). During the closing operation, the stored energy in the drive springs are used to close the vacuum interrupter contacts, compress the bias springs, charge the opening springs (fig 8 [l]), and over come frictional forces. This closing sequence can be overridden at any time due to the trip free capability of the mechanism.

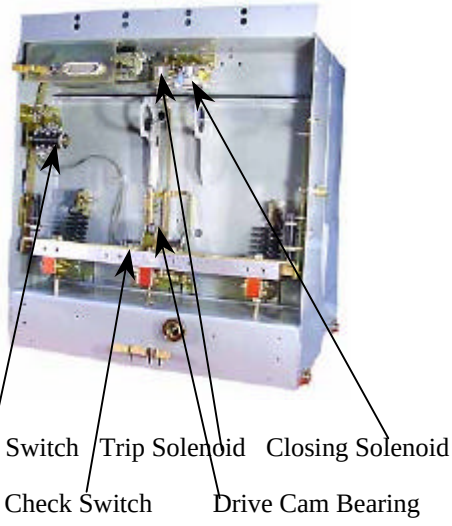


Fig. 3 Mechanism with Front Cover Removed

When the circuit breaker is tripped, the energy stored in the opening springs and bias springs will open the contacts at the correct speed. When the motor is energized, the motor eccentric will rotate and cause the driving arm assembly (fig 8 [jj]) to pivot about the drive shaft (fig 8 [dd]). The charging pawl (fig 8 [bb]) will engage with the charging gear (fig 8 [ee]) and rotate, one tooth at a time. Note, the charging gear is prevented from rotating backwards by a ratchet wheel holding pawl.

The charging motor is located in the pivoting portion of the mechanism seen in figure 4. It's output shaft is coupled to an eccentric arm that engages a ratcheting device which charges the mechanism drive springs.

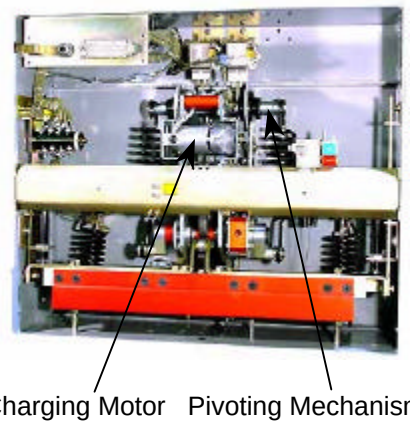


Fig. 4 Mechanism Springs Charged and Mechanism "Latched"

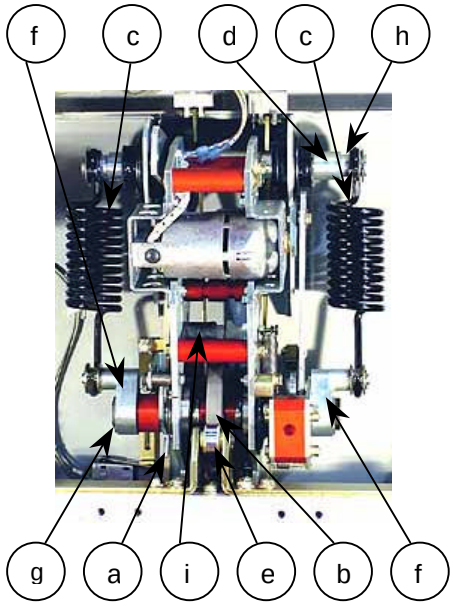
When the circuit breaker has its primary contacts open, the mechanism drive springs will discharge, and the mechanism is set in its "collapsed" position. This can be seen in figure 5.

When the control power is supplied to the circuit breaker's control circuit, the cooperating motor is energized. The motor eccentric mounted on the rotating shaft of the charging motor will then push the drive arm (fig 5 [f]) back and forth. With each stroke the charging pawl (fig 8 [bb]) engages a new tooth of the charging gear (fig 8 [ee]) and advances. Note, because the ratchet wheel holding pawl and charging gear are in partnership there is a preventive reverse rotation of the gear.

The charging gear is free to rotate on the driving shaft (fig 5 [g]) and has a pin mounted on its side. The gear and the pin, after a free rotation will engage with the pawl lift cam, which is rigidly connected with the drive shaft. Note, the resulting effect is a rotation of this shaft, which therefore charges the drive springs through a pair of drive arm.

As the rotation of the hex driving shaft progresses, the drive arms (fig 5 [f]) will pass through the lower toggle point. The drive springs (fig 8 [f]) are now fully charged and will attempt to discharge. The closing cam prevents this action. The closing cam is now engaged with the drive cam bearing (fig 8 [gg]), which is mounted on the right side of the driving cam (fig 5 [b]).

The drive springs are held in this position until a closing sequence is initiated. As soon as the crank arms are driven past the upper toggle point by the charging motor cam, a linkage assembly opens the motor limit switch and de-energizes the charging motor. At this time the ratchet arm pawl rides on the raised surface of the pawl lift cam, without engaging the next tooth of the gear, and the charging sequence ends.

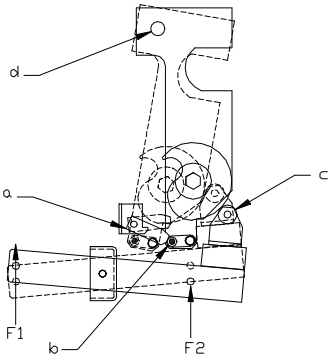


a. Indicator Cam
b. Drive Cam
c. Drive Springs
d. Pivoting Shaft
e. Drive Cam Bearing
f. Drive Arms
g. Driving Shaft
h. Mechanism Joint Shaft
i. Closing Cam Spring

Figure 5 Operating Mechanism

1. Closing Sequence

With the circuit breaker open and the drive springs fully charged, the mechanism pivots counter-clockwise, pulled by the mechanism return springs (fig 8 [o]), and reaches a configuration in which it is latched and ready to close. By energizing the closing solenoid assembly, which is located above the mechanism, or by depressing the manual close lever, the closing sequence is started. The closing cam will then disengage the closing roller of the drive cam (fig 8 [ff]), and will allow the drive arms to rotate clockwise as the drive springs discharge.



a. Opening cam
b. Mechanism opening rollers
c. Dive cam bearing
d. Mechanism pivot shaft
F1. Drive spring force
F2. Opening spring force

Fig. 6 Mechanism Fundamental Layout

While discharging, the drive springs will force the driving shaft and driving cam to rotate. The driving cam has a drive cam bearing (fig 6 [c]) riding on its surface and it is rigidly connected with the three phase linkages as shown in figure 6. Note, because the driving cam and the drive cam bearing make contact on a riding surface, as shown in (fig 6 [c]), and that they are rigidly connected in a three phase linkage, this can be seen in a sequence through a cross member. The assembly composed by the drive cam bearing, the cross member and three phase linkages, can therefore be considered as one operating link. This link pivots on three joints, one per phase, having the same axis of rotation to guarantee phase synchronization during movement.

While rotating, the driving cam shows a profile with different elevations to the drive cam bearing, thus forcing it to rotate clockwise and downward with the operating link. On the backside, the operating link is connected to the movable contacts of vacuum interrupters through a set of rotating and sliding joints, as shown in figure 9.

The resulting upward rotation of these joints pushes the movable contact to the closed position. At the same time, on the mechanism side, the rotation of the drive cam bearing extends the opening springs (fig 8 [l]). The charging motor is energized and moves the ratchet arm and its pawl back and forth. The pawl is free to engage with a tooth and starts the drive springs' charging sequence.

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

Each phase has a bias springs which are located inside the insulating pushrod shown in figure 10. Once the primary contacts are closed, the upward movement of the rotating/sliding joints continues to further compress the already pre-compressed bias springs. Because the contacts are already closed a gap will appear between the rotating/sliding joints and the heavy washer installed on the threaded shaft of the pushrod. This gap is shown in figure 10 and is referred to as "erosion indication."

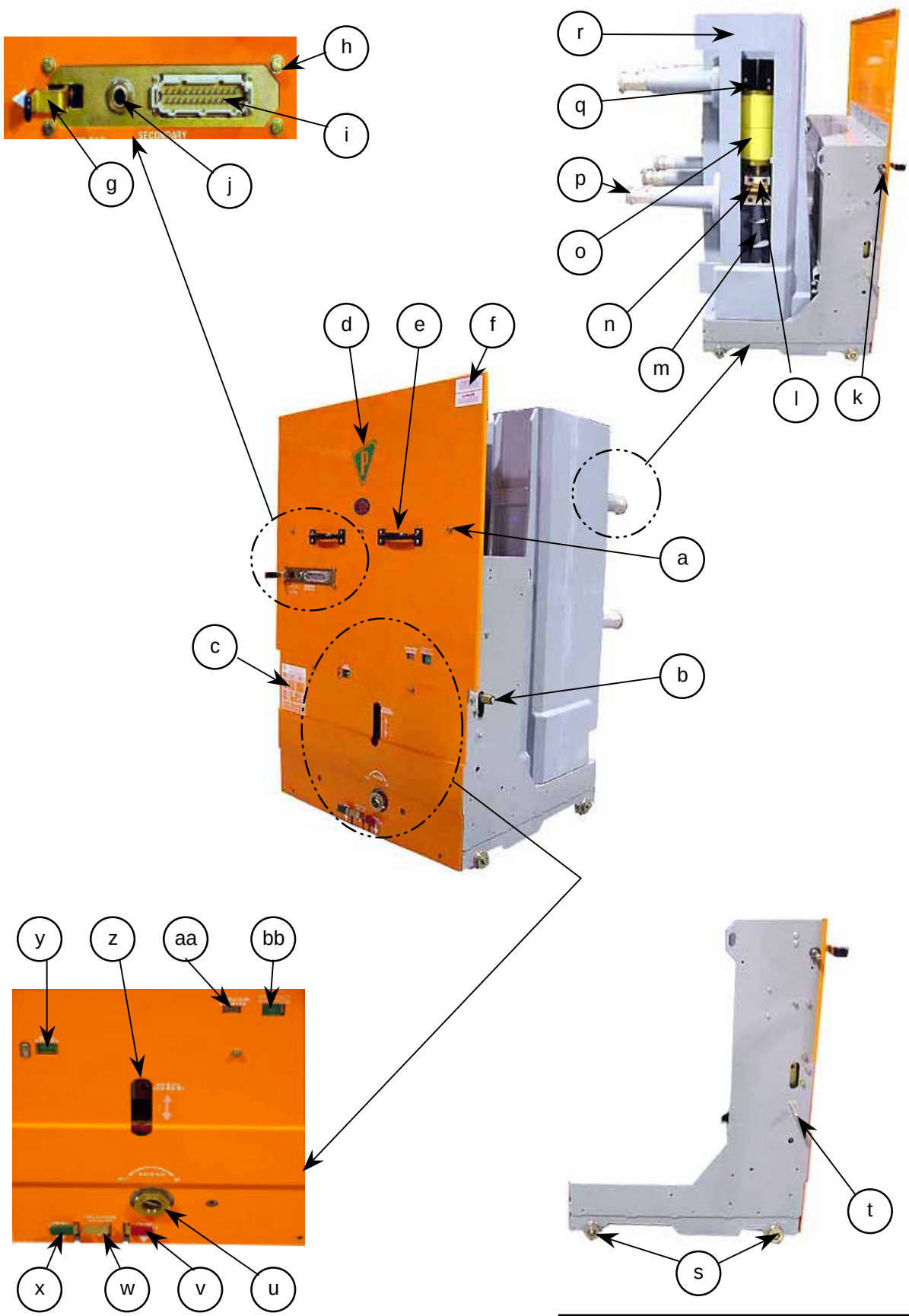
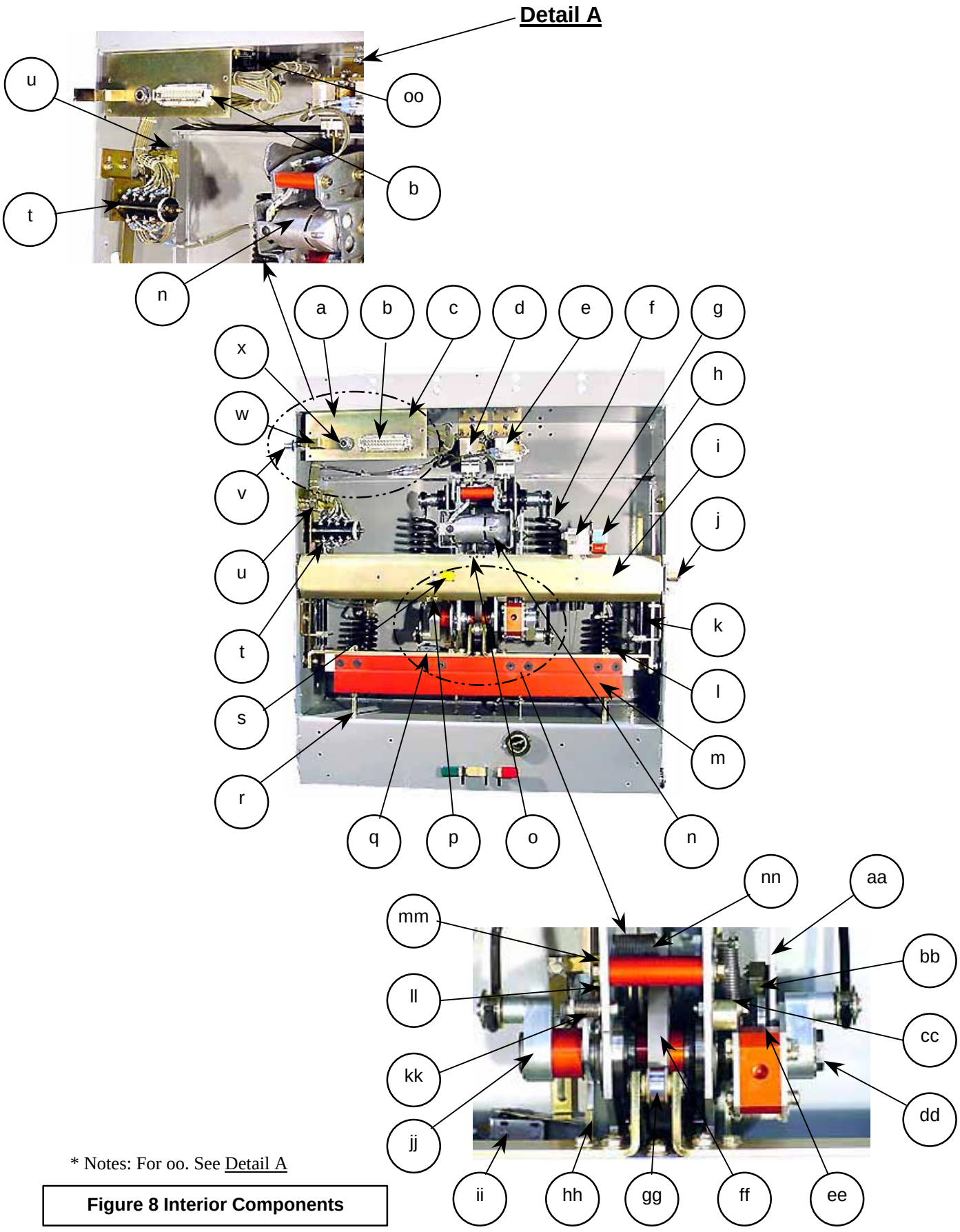


Figure 7 Exterior Components

2. Exterior Components

The exterior components in figure 7 contain figures that give the operator a visual of the parts on the exterior proportion of the PowlVac® Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 series circuit breaker product. The parts that are listed should be used as a reference guide throughout this instruction book.

a. Cover Attachment Bolts
b. MOC Operating Shaft
c. Nameplate
d. Delta “P” Powell Logo
e. Handle
f. Caution and Warning Labels
g. Secondary Disconnect Latch
h. Secondary Disconnecting Panel
i. Female Receptacle
j. Secondary Disconnect Sleeve & Panel Nut
k. Secondary Disconnect Block Pin
l. Front Terminal Clamp
m. Pushrod
n. Shunt
o. Vacuum Interrupter
p. Primary Contact with Primary Disconnecting Springs
q. Upper Primary Heat Sink (2000A)
r. High Voltage Housing
s. Roller Wheels
t. TOC Actuator
u. Hex Racking Tube
v. Manual Close Lever (Red)
w. Test Position Interlock Lever
x. Manual Trip Lever (Green)
y. Drive Spring Charge/Discharge Indicator
z. Manual Charging Mechanism
aa. Operation Counter
bb. Close /Open Position Indicator Window



* Notes: For oo. See Detail A

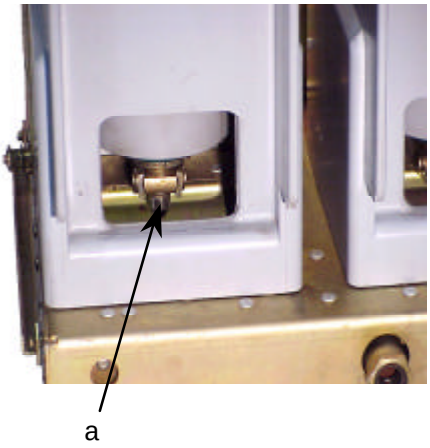
Figure 8 Interior Components

3. Interior Components

The interior components in figure 8 contain figures that give the operator a visual of the parts on the interior proportion of the PowlVac® Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 series circuit breaker product. The parts that are listed should be used as a reference guide throughout this instruction book.

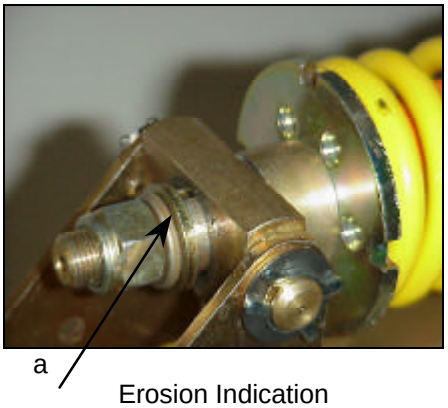
a. Motor Relay Switch (Behind Secondary Disconnect)
b. Female Receptacle (Secondary Disconnect)
c. Secondary Disconnecting Panel
d. Trip Solenoid Assembly
e. Closing Solenoid Assembly
f. Drive Spring
g. Operation Counter
h. Close/Open Position Indicator Window
i. Front Panel Assembly
j. MOC Actuator
k. Shock Absorbers
l. Opening Spring
m. Connecting Cross Bar Assembly
n. Charging Motor
o. Mechanism Return Springs
p. Motor Limit Switch
q. Latch Check Switch
r. Stop Bolts
s. Drive Spring Charge/Discharge Indicator
t. Auxiliary Switch
u. Anti Pump Relay
v. Secondary Disconnect Blocking Pin
w. Secondary Disconnect Latch
x. Secondary Disconnect Sleeve & Panel Nut

aa. Motor Arm Weldment
bb. Charging Pawl
cc. Manual Charge Return Spring
dd. Drive Shaft
ee. Charging Gear
ff. Drive Cam
gg. Drive Cam Bearing
hh. Charge/Discharge Indicator Cam
ii. Latch Check Switch
jj. Drive Arm Assembly
kk. Charge/Discharge Spring
ll. Charge/Discharge Indicator
mm. Eccentric Cam
nn. Closing Cam Spring
oo. Motor Relay Switch (Behind Secondary Disconnect Panel) (Notes: For oo. See Detail A)



a. Rotating & Sliding Joint

Fig. 9 Rotating & Sliding Joint



Erosion Indication

Fig. 10 Close-Up of Erosion Indication

4. Opening Sequence

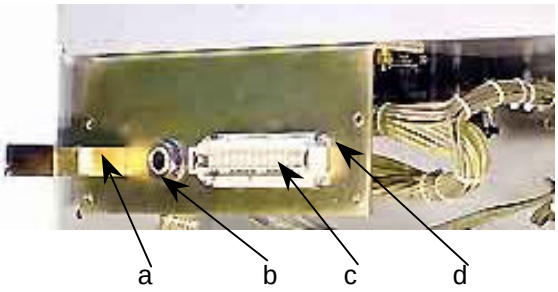
Once the circuit breaker's contacts are closed, the opening sequence can be initiated by depressing the manual tripping lever or by energizing the trip solenoid (fig 3). By either action, the opening cam (fig 6 [a]) rotates counter-clockwise disengaging from the mechanism opening rollers (fig 6 [b]).

Once the mechanism is unlatched from the opening cam, it rotates clockwise on the mechanism pivot shaft (fig 6 [d] or (fig 5[d]). As soon as the mechanism rotates clockwise, the drive cam bearing is not biased by the driving cam but it rotates with the whole operating linkage counterclockwise, and it opens the primary contacts. The capability to perform this operating sequence at any time during the closing sequence is known as "Trip-Free" operation. All PVCB type circuit breakers have this capability.

C. SECONDARY CONTACTS

The circuit breaker's control wiring is arranged for a drawout disconnection by a 24 point male plug as shown in figure 11. It is design so that it connects to the corresponding cell mounted female receptacle. The secondary disconnect plug is mounted on a bracket on the top left side of the circuit breaker's frame. When the secondary disconnect umbilical cord from the cell is inserted into the secondary disconnect female receptacle (fig 7 [i]) of the circuit breaker, the secondary disconnect latch (fig 7 [g]) restricts the removal of the umbilical cord when the circuit breaker is in the cell.

To properly connect the secondary disconnect umbilical cord, lift the secondary disconnect latch while inserting the umbilical cord. Then release the secondary disconnect latch, which will firmly secure the umbilical cord and the secondary disconnect lock to one another. Next, fasten the secondary disconnect lock which is at the other end of the secondary disconnect.



a. Secondary Disconnect Latch
b. Secondary Disconnect Sleeve & Panel Nut
c. Female Receptacle
d. Secondary Disconnecting Panel

Fig. 11 Secondary Disconnecting Panel

D. MOC OPERATING SHAFT

The connecting cross bar assembly of the circuit breaker's operating mechanism operates the MOC operating shaft (fig 7 [b]). Movement of the connecting bar is directly related to the movement of the circuit breaker's mechanism and contacts. As the circuit breaker is inserted into the cell, the connecting cross bar engages a channel member of the Mechanism Operated Cell Switch (MOC Switch) mechanism located in the cell. Thus, the MOC actuator switch is operated by the connecting bar each time when the circuit breaker is operated, and also when the contacts of the MOC actuator switch can be correlated with circuit breaker's contact position in the same manner as the auxiliary switches mounted on the circuit breaker.

a. Drive Spring Charge/Discharge Indicator
b. Manual Trip Lever
c. Test Position Interlock Lever
d. Manual Close Lever
e. Hex Racking Tube
f. Manual Charging Mechanism
g. Operation Counter
h. Close /Open Position Indicator Window

Fig. 12 Front Cover Detail

E. INTERLOCKING

The purpose of interlocking is to prevent misoperation of the circuit breaker's mechanism. The *PowlVacÒ Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 series* circuit breaker is equipped with an interlock system that prevents the operator from manually closing a circuit breaker with the primary electrical contacts already in the closed position. This is accomplished by means of connecting the "manual close lever" to a moving assembly on the phase linkage. When the operating link is in the closed or lower position, the manual close linkage is limited in its available travel and cannot move far enough to lift the closing cam away from the closing roller on the drive cam. When the operating link is in the open or upper position, the moving assembly on the phase linkage allows the close solenoid or manual close linkage to lift the closing cam away. Do not attempt to modify or bypass this interlock, as it is necessary for the safe operation of the circuit breaker.

The Interlock provided is:

1. Circuit Breaker Cell-Coding Plates

This is a combination of a notched plate in the cell and interference bars on the circuit breaker so that only appropriately rated circuit breakers can be put into the cell.

2. Cell Interlocks

Cell interlocks operate to trip the circuit breaker and discharge the closing spring when the circuit breaker is inserted into the cell. This procedure allows the circuit breaker to be positioned in the test position or to be removed from the cell. The floor trip cam, on the cell floor manual trip levers, on the underside of the circuit breaker are used to trip the circuit breaker, and/or discharge the closing spring.

The cell interlocks also operates to hold the circuit breaker trip-free while it is traveling between the test and connected positions. This prevents accidental closing of the circuit breaker in an intermediate position. An extension of the floor trip cam mentioned above lifts the tripping lever and holds it up between the test and engaged position. The manual trip lever (fig 7 [x]) and manual close lever (fig 7 [v]) interlocks on the underside of the circuit breaker are coupled to links located in the mechanism area of the circuit breaker, which operates to engage the circuit breaker's opening and closing lever interlocks.

F. CIRCUIT BREAKER CONTACT POSITION INDICATORS

A red indicating label “Closed Position” (fig 12[d]) appears through the front cover when the primary contacts are in the closed position. A green indicating label appears through the front cover when the primary contacts are in the “Open Position.”

These indicating labels are connected to the operating linkage through a spring-loaded linkage. A depressing motion activates these levers.

G. PRIMARY CONTACTS

The PowlVac® Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 series circuit breakers have their primary connections with the correspondent cell made through the six primary contacts as shown in figure 2, which are horizontally mounted on three high voltage housing assemblies. All personnel associated with the circuit breaker must ensure that the primary contacts do not receive rough handling and that they are never used as handles when maneuvering the circuit breaker.

H. OPERATING SOLENOIDS

The closing solenoid assembly (fig 8 [e]) and secondary trip solenoid assembly (fig 8 [d]) or trip/closing coil are mounted on two separate brackets located above the mechanism as shown. The secondary trip solenoid is mounted just left side of the close solenoid as shown in figure 3.

A second shunt trip opening solenoid may be furnished as an option. If present, it will be mounted on a separate bracket that will be located a few inches on the right side of the closing solenoid.

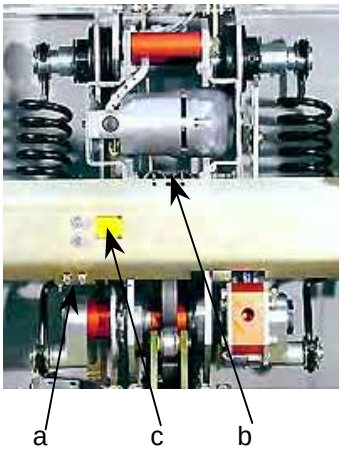
I. ANTI-PUMP RELAY & MOTOR RELAY SWITCH

The Anti-pump or Y-relay (fig 8 [u]) is located on the circuit breaker’s left side sheet of the circuit breaker’s frame. The motor relay switch (fig 8 [a]) is located behind the secondary disconnect panel. For all voltages, the anti-pump relay is a modular plug-in device. For 250 VDC applications, a dropping resistor is also needed.

J. MOTOR LIMIT SWITCH

The motor limit switch is located on a bracket attached to the front connecting panel of the circuit breaker’s frame assembly. Movement of the indicating flag displaying the condition of the circuit breaker’s mechanism drive springs actuates the motor limit switch (fig 13 [a]).
Figure 13 shows the motor limit switch installed on the front connecting panel. Notice that the front connecting panel and the drive spring charge/discharge indicating (fig 13 [c]) reads in the mechanical position charged position ”yellow,” or discharged position “green.”

If the front connecting panel needs to be removed during the course of maintenance or repair, the wires to the motor limit switch are provided with insulated plug connectors for easy connections.



a. Motor Limit Switch & Bracket
b. Front Connecting Panel
c. Drive Spring Charge/Discharge Indicator.

Fig. 13 Motor Limit Switch, Front Connecting Panel, Indicating Flag

This allows the front connecting panel to be removed and secured without hanging by two wires or forcing personnel to remove the motor limit switch from the bracket. Note the tab on the drive spring charge/discharge indicator actuating the switch.

K. LATCH CHECK SWITCH

The latch check switch (fig 14) gives recessing ability to the circuit breaker. Because it is connected in series with the closing solenoid assembly (fig. 8 [e]), the circuit breaker can only close when its contacts are closed. The opening cam movement through a link activates the latch check switch. The opening cam opens the contact of the latch check switch when the opening cam is not in contact with the mechanism opening rollers.

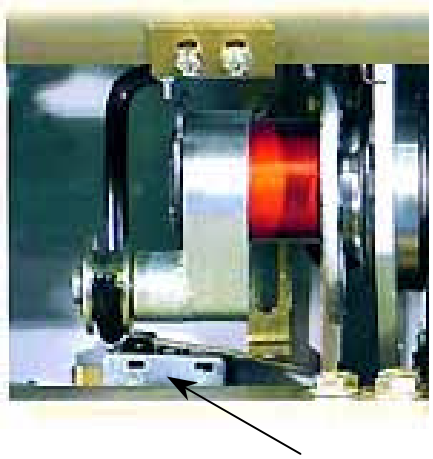
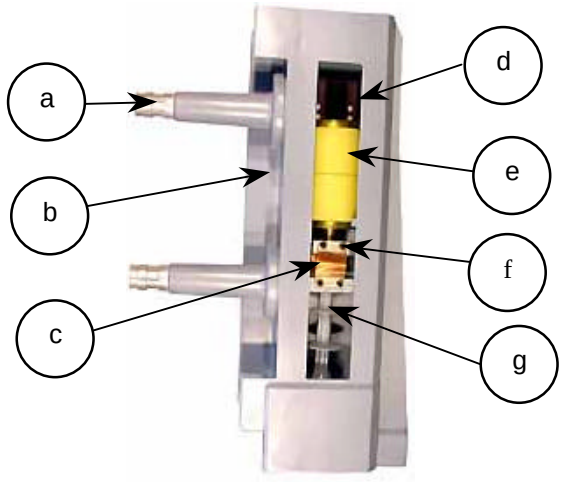


Fig. 14 Latch Check Switch

L. VACUUM INTERRUPTERS

All PVCB-40.5 type circuit breakers utilize sealed vacuum interrupters primary circuit. These vacuum interrupters (fig. 15 [e]) are vertically mounted inside the high voltage housing (fig. 15 [h]), which are installed on the back of the circuit breaker's base frame. Figure 15 shows the inside of a phase insulator seen from the top.

ONLY QUAILIFIED PERSONNEL MUST REPLACE VACUUM INTERRUPTERS ONLY WITH NEW INTERRUPTERS OF THE SAME PART NUMBER. Note, the operator should refer to section Safety ll before making any adjustments. For a listing of the vacuum interrupters used in PowlVac® Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 *series* circuit breakers, see Table I. Each vacuum interrupter bears a label that indicates its part number, and caution label. Refer to the circuit breaker's instructions for the applicable vacuum interrupter description and maintenance procedures.



a. Primary Contact
b. High Voltage Housing
c. Shunt
d. Upper Primary Heat Sink (2000A)
e. Vacuum Interrupter
f. Front Terminal Clamp
g. Pushrod

Fig. 15 Vacuum Interrupter Assembly

M. CONTROL CIRCUIT

A typical AC/DC control scheme is shown in figure 16. On PowlVac® Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 series circuit breakers, all motor circuits are wired separately from the closing circuit and tripping circuits. The control scheme for a specific circuit breaker may differ from this example due to specific customer requirements or auxiliary devices furnished with the circuit breaker.

Table I. Vacuum Interrupters

Circuit Beaker Type	Rated kV	Rated Continuous Current	Rated Short Circuit Current kA	Interrupter Assembly (3 per Bkr.)
PVCB-40.5/1200A	40.5	1200A	31.5	WL35890P
PVCB-40.5/2000A	40.5	2000A	31.5	WL35890P

CAUTION

IT SHOULD BE NOTED THAT THE STORED ENERGY SPRING CHARGING MOTOR WILL BEGIN TO RUN IMMEDIATELY UPON ENERGIZATION OF CONTROL POWER.

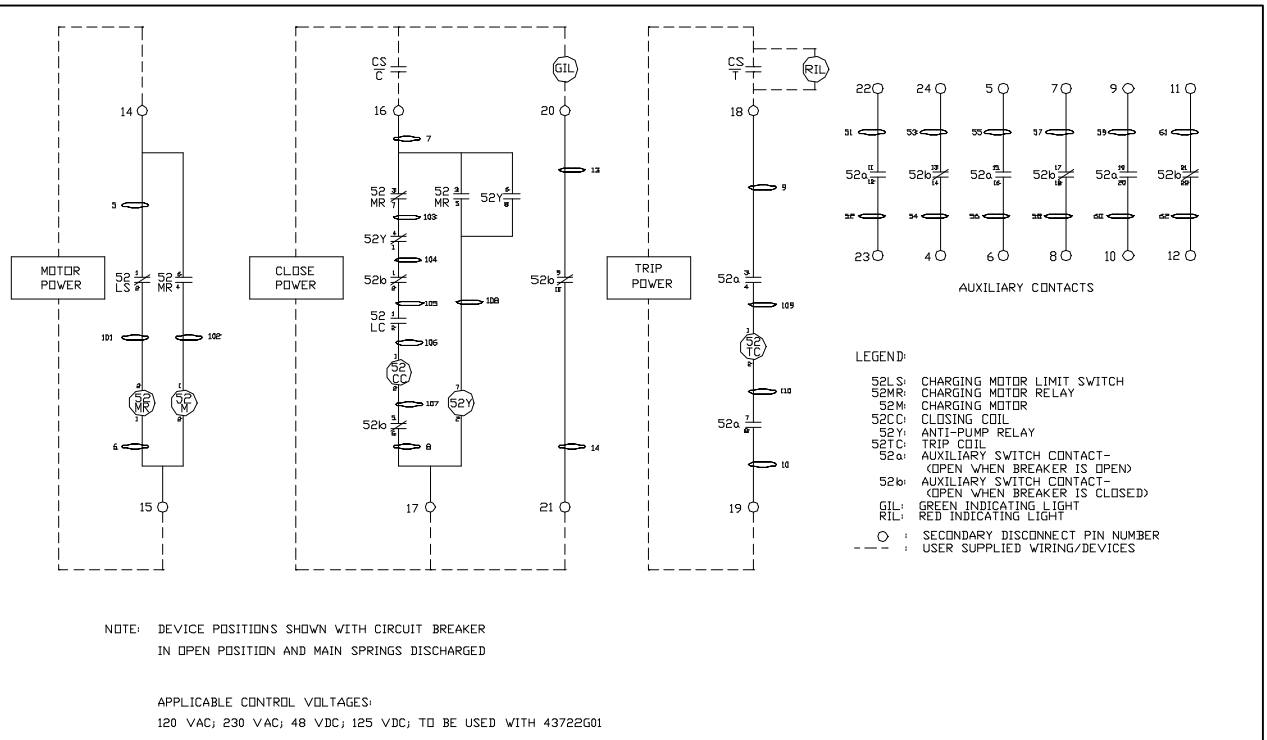


Fig. 16 – Typical Control Scheme for AC/DC Operation, Excluding 250V DC Operation

N. GROUND CONNECTIONS

The ground shoe assembly is an assembly bracket that provides a means of grounding the circuit breaker's frame after it has been inserted into the cell. The ground shoe is spring loaded to assure that the appropriate ground connection is correspondent to the ground bar located in the cell. The ground shoe assembly is located on the bottom side of the back end frame just below the hex racking tube (fig 7 [u]), which is to the left-hand rear wheel on the circuit breaker.

An extension of cell's ground bus is secured on the cell floor and engages the ground contact when the circuit breaker is pushed into the test position. It also remains engaged in all positions of the circuit breaker from the test position to the fully engaged position.

The shutter roller (fig 7 [h]) is located on the both sides of the circuit breaker's frame. Its function engages the shutter operating cam in the cell that raises the shutter over the stationary primary disconnects as the circuit breaker is racked into the cell.

III. INSTALLATION

A. RECEIVING

The front page shows the circuit breaker assembly fully assembled and ready for service. Depending on how the unit was shipped will determine the amount of re-assembly in the field as needed. For most shipping conditions, the unit will be fully assembled and ready for service. Check for signs of damage as soon as possible. If damage is found or suspected, file claims with the transportation company and notify the nearest representative of Powell Electrical Manufacturing Company as soon as possible.

B. HANDLING

Always use extra care when uncrating and handling the circuit breaker. "NEVER USE THE PRIMARY CONTACTS 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 ½" diameter hooks rated for 800 lbs. minimum each. Lifting locations are provided on the frame side members. Use a spreader wider than the circuit breaker to prevent damage. "Use extra care when lifting the PowlVac® Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 series circuit breakers because they are unevenly balanced in reference to the lifting locations!"

C. STORAGE

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

1. The unit must be protected against condensation, preferably in a clean, dry room of moderate temperature, such as 40°F to 100°F, since dampness has an adverse effect on the insulating parts.

2. The storage location should be free of corrosive gases or fumes. Particular care should be taken to protect the equipment from moisture and dust of any kind, as this combination has a very corrosive effect on many parts.

3. If the circuit breaker is stored for any length of time, it should be inspected regularly to see that corrosion has not started and to insure that the circuit breaker is in good mechanical condition.

4. If the circuit breaker is stored under unfavorable conditions, it should be thoroughly cleaned and dried out before putting into service.

5. Lubrication should be restored whenever necessary. If the circuit breaker is stored for any length of time, it should be inspected periodically to see that rusting has not started and to insure that the circuit breaker is in good mechanical condition. Should the circuit breaker be stored under unfavorable atmospheric conditions, it should be cleaned and dried out before being placed into service.

D. PUTTING INTO SERVICE

Before shipment from the factory, all circuit breaker functions will have been thoroughly checked. If the user wishes to recheck the operations, we recommend that the checks be performed in the sequence listed below:

1. **High voltage insulation integrity**
2. **Mechanical operation of the mechanism**
3. **Electrical operation of the mechanism**

CAUTION

HIGH VOLTAGE 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 VOLTAGE SHOULD NOT EXCEED 95kV 50/60Hz FOR 15.5kV, 40.5kV CLASS CIRCUIT BREAKERS.

CAUTION

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

CAUTION

If DC high potential testing is required, the DC high potential test machine must not produce instantaneous peak voltages exceeding 50kV.

CAUTION

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

X-RADIATION PRODUCED DURING THIS TEST WITH RECOMMENDED VOLTAGE AND NORMAL CONTACT SPACING IS EXTREMELY LOW AND WELL BELOW MAXIMUM PERMITTED BY STANDARDS. HOWEVER, AS A PRECAUTIONARY MEASURE AGAINST POSSIBILITY OF APPLICATION OF HIGHER THAN RECOMMENDED VOLTAGE AND/OR BELOW NORMAL CONTACT SPACING, IT IS RECOMMENDED THAT ALL OPERATING PERSONNEL STAND AT LEAST ONE METER AWAY FROM THE UNIT WHILE TESTING.

DO NOT APPLY VOLTAGE THAT IS HIGHER THAN THE RECOMMENDED VALUE. DO NOT USE CONTACT SPACING LESS THAN THE NORMAL OPEN POSITION SEPARATION OF THE CIRCUIT BREAKER CONTACTS.

1. High Voltage Insulation Integrity

The circuit breaker's high voltage insulation system, which consists of the pushrods (fig 15 [g]) and primary conductor assemblies, should be hipot tested prior to initially placing the circuit breaker in service or following the interruption of a fault. The primary circuit insulation on the circuit breaker may be checked phase-to-phase and phase-to-ground using a 2500V insulation resistance tester. Since definite limits cannot be given for satisfactory insulation values when testing with an insulation resistance tester, a record should be kept of the insulation resistance tester readings as well as the temperature and humidity readings. This record should be used to detect any weakening of the insulation system from one check period to the next.

To check insulation integrity, the “AC High Potential Test” described below is strongly recommended. “DC High Potential Test” is not recommended except for the “Vacuum Interrupter Integrity Test.”

The circuit breaker insulation should be tested with the circuit breaker in the "Closed Position." Test each pole of the circuit breaker separately, with the other two poles grounded. Perform the one minute low frequency withstand test at the voltage level appropriate for the equipment, 95kV for circuit breakers rated 40.5 kV. This test will have checked all of the support insulators, and also the primary phase-to-phase insulation. The tests described above are the only tests required that ascertain insulation integrity. Because of the design of the PowlVac® Advanced Technology indoor circuit breaker insulation system, no valid data can be obtained utilizing other types of high-voltage insulation tests.

Note, field maintenance insulation resistance testing can be conducted with either AC or DC hipot test sets. DC testing is very common due to the availability of the equipment. Consistent and historical readings are more important than predetermined values. A clean dry circuit breaker will help yield accurate and consistent readings.

Recommended maintenance test voltages for PVCB circuit breakers are:

- 40.5kV circuit breakers @ 95kVAC or 37kVDC for one minute.

Contact the Powell Apparatus Service Division for more information at the website www.powellservice.com, or call 1-800-480-7273.

The test of the vacuum interrupter will determine its internal dielectric condition and vacuum integrity. With the circuit breaker open and removed from the cell, apply the high potential across each interrupter separately. Connect the "Hot" lead of the test source to the upper primary disconnect of the pole under test and the ground lead to the lower primary disconnect. If the test supply is center-point grounded, the connections may be made either way. Apply a minimum of 40kV rms, 60Hz or hold for a minimum of (5) seconds. If no breakdown occurs the interrupter is in acceptable condition. If a breakdown occurs the interrupter should be replaced.

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 variable results, which are often misinterpreted as a vacuum interrupter failure. Due to this misinterpretation of leakage readings, we do not recommend DC testing. Several testing companies and customers insist on the use of DC testing. Contact the Powell Apparatus Service Division for more information at the website www.powellservice.com, or call 1-800-480-7273.

2. Mechanical Operation Check

In normal operation, the contacts of the vacuum interrupters are closed electrically. For this test, it should be closed by manually charging the mechanism. The manual charging handle should be inserted into the manual charge opening on the front cover and pushed down until it stops. Note that this indicates that the ratchet wheel holding pawl has dropped into place on the charging gear (fig 8 [ee]). Next, raise the lever and repeat the pushing stroke, and notice that the drive spring charge/discharge indicator window (fig 13 [c]) on the circuit breaker will read "charged” showing a yellow flag through the drive spring charge/discharge indicator window (fig 12 [a]) on the front cover.

Now remove the handle, and press the red lever that is located at the bottom of the front cover to manually "push to close" the circuit breaker. The drive springs will then react and press the green lever that is located at the bottom of the circuit breaker labeled "push to trip" to manually trip the circuit breaker and the "open/closed position indicator window" will change from a red "closed" indicator to a green "open" indicator.

3. Electrical Operation Check

To check the electrical operation of the circuit breaker, the umbilical cord must be fastened securely to the secondary disconnect and the control power must be energized. As soon as the control power is present, the circuit breaker mechanism will start to charge the drive springs (fig 8 [f]).

IV. MAINTENANCE

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

A. GENERAL

1. Introduction

A regular maintenance schedule should be schedule to obtain the best service and reliability from the circuit breaker. PowlVac® Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 series circuit breakers are designed to comply with industry standards requiring maintenance every 2000 operations or once a year, whichever comes first.

An actual inspection and maintenance schedule 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 should be inspected and have the necessary maintenance performed as soon as is practical. Some atmospheric conditions such as extremes of dust and moisture or corrosive gases might indicate inspection and maintenance at more frequent intervals than 2000 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 that is best suited for a particular use.

A permanent record of all maintenance work should be kept; the degree of detail depends 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 tests made, the condition of circuit breakers and repairs and adjustments that were made. This record should begin with any checks done at the time of installation.

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

Before attempting any maintenance work, take note of safety practices outlines in Section II of this book.

CAUTION

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

2. Inspection and Cleaning

Perform a visual inspection check for any loose or damaged parts on the circuit breaker. Tighten and/or replace loose and/or missing hardware. Any parts damaged so as to interfere with normal operation of the circuit breaker should be replaced. This inspection should be performed with the front cover removed.

Clean the circuit breaker, removing loose dust and dirt. Do not use an air hose to blow the circuit 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 clean dry lint-free cloth or an industrial-type wiper.

Other inspections and cleaning of parts include the high voltage housing, primary contacts, and the pushrods. Do not use any type of detergent to wash the surface of high voltage housing, as detergent may leave an electrical conducting residue on the surface as it dries.

B. MECHANISM AREA

1. Mechanical Operation

Remove the circuit breaker front cover, exposing the mechanism. Make a careful visual inspection of the mechanism for loose or excessively worn parts. Operate the circuit breaker several times manually. See the section headed "Mechanical Operation Check" under the heading “Putting into Service” for further information.

2. Drive Springs Removal

Disassembly of the drive springs removal mechanism is not required for routine lubrication. However, for major overhaul, removal of the drive springs or opening springs is necessary. For further assistance, contact a qualified Powell Technician, or the Powell Apparatus Service Division for assistance in performing maintenance, or setting up a maintenance program. For maintenance from Powell Apparatus Service Division (PASD), the website is located at powellservice.com, or call 1-800-480-7273.

3. Electrical Operation

After any necessary mechanical maintenance and lubrication are done, operate the circuit breaker electrically several times to ensure that the electrical control system works properly. See section headed "Electrical Operation” under the "Putting into Service" heading in this instruction book.

4. Mechanism Adjustments

Several factory adjustments in the mechanism are described below. No adjustment of these settings is required for routine maintenance, but they may need to be adjusted after major overhaul or removal of the mechanism. “Do not adjust these settings unnecessarily, as mechanical damage may occur.”

a. Adjustment of Ratchet Wheel Holding Pawl

The ratchet wheel holding pawl is adjusted by an eccentric cam. If the pawl needs adjusting, there will be a "knocking" noise when the ratcheting mechanism is operating, or the mechanism will not ratchet at all. To adjust the pawl, remove the front cover to gain access to the head of the bolt holding the eccentric cam. Loosen the bolt slightly. To adjust by griping the eccentric cam with a pair of slip-joint pliers or a similar tool and rotate the cam slightly until electrically the ratcheting operation is smooth. This may require several charging cycles, as each charging cycle lasts only a few seconds. When the eccentric cam is properly set, re-tighten the mounting bolt and replace the front cover. Be sure that the front cover is reinstalled on the proper circuit breaker, since the front cover contains the nameplate with all the circuit breaker's rating and serial number information.

5. Lubrication

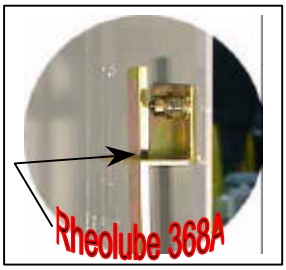
Lubricate the mechanism and other specified parts in accordance with the lubrication chart, Table II.

Powell offers a complete lubrication kit (Powlube-102) which contains all the lubricants required for maintaining 6-10 circuit breakers. The table shows the location of all surfaces that should be lubricated together with the type of lubricant and method of application. The guiding rule in lubrication should be to lubricate regularly, use lubricant sparingly and remove all excess lubricant.

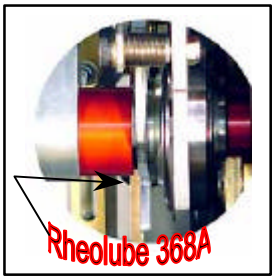
Rheolube-368A is interchangeable with Anderol 757 Grease and should be lightly applied to those bearing surfaces that are accessible, and a light synthetic machine oil such as Anderol 456 should be used to penetrate through to surfaces which are inaccessible. The mechanism should be in the open springs discharged position for lubrication. There is no necessity to disassemble the mechanism for lubrication.

Table II. Circuit Breaker Lubrication

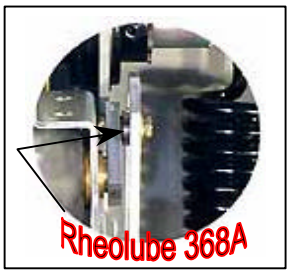
Location	Reference Figure	Lubricant	Method
Mechanical Parts			
Charge/Discharge Indicator Cam	A	Rheolube 368A Grease	On contact surface of cam.
Charging Bearing	B	Rheolube 368A Grease	
Charging Gear	C	Rheolube 368A Grease	Grease on teeth.
Secondary Disconnect Latch	D	Rheolube 368A Grease	Apply grease behind the secondary bracket on the secondary disconnect latch on the fork location.
Shock Absorber	E	Rheolube 368A Grease	Where the shock pin interfaces with the connecting bar.
MOC Link	F	Rheolube 368A Grease	Where MOC link interfaces with the MOC link support bracket.
Auxiliary Switch	G	Rheolube 368A Grease	Where auxiliary switch link interfaces with the auxiliary switch actuator.
MOC Link	H	Rheolube 368A Grease	Where MOC link interfaces with the MOC link support bracket.



H.MOC Link

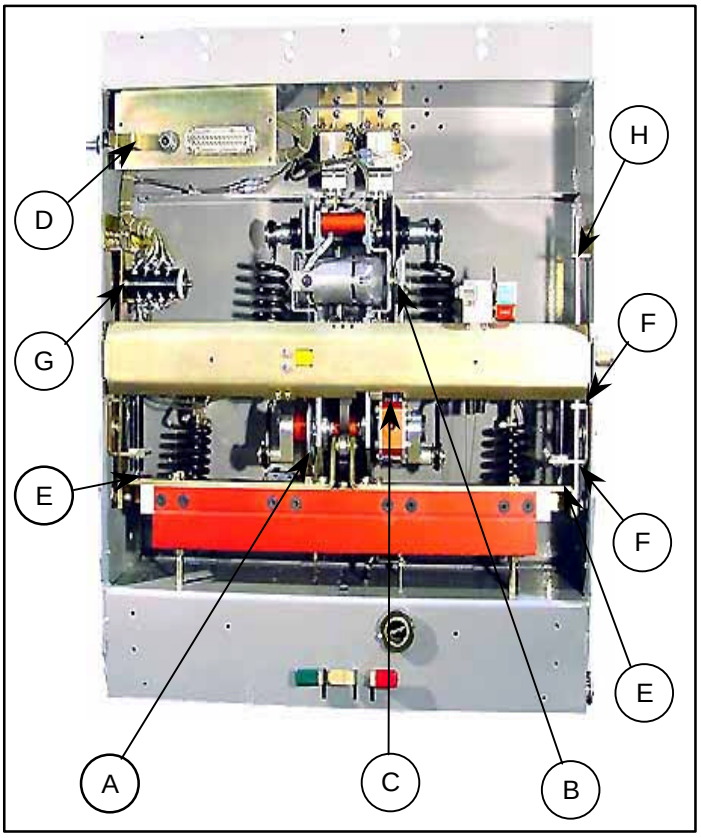


A.Charge/Discharge Indicator Cam

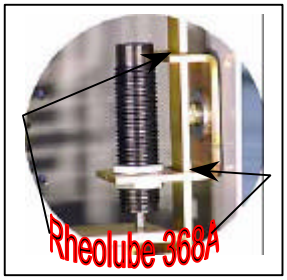


B.Charging Bearing

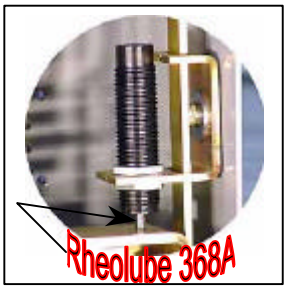
G. Auxiliary Switch



C. Charging Gear



F.MOC Link



E. Shock Absorber

D. Secondary Disconnect Pin

Fig. 17 Lubrication Areas

Caution

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

X-RADIATION PRODUCED DURNING THIS TEST WITH RECOMMENDED VOLTAGE AND NORMAL CONTACT SPACING IS EXTREMELY LOW AND WELL BELOW MAXIMUM PERMITTED BY STANDARDS. HOWEVER, AS A PRECAUTIONARY MEASURE AGAINST POSSIBILITY OF APPLICATION OF HIGHER THAN RECOMMENDED VOLTAGE AND/OR BELOW NORMAL CONTACT SPACING, IT IS RECOMMENDED THAT ALL OPERATING PERSONNEL STAND AT LEAST ONE METER AWAY IN FRONT OF THE CIRCUIT BREAKER.

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.

C. INTERRUPTER AND CONTACT AREA

1. Vacuum Interrupter 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 an overtravel gap about 0.173 to 0.189 inch between the high voltage joint and the ½" washer at the bottom on the end on the pushrod stud. As the contacts erode with use, this gap will decrease. Because the factory setting of the overtravel gap varies slightly for each vacuum interrupter, a label is provided on the on the high voltage housing, centered between the upper and lower primary conductors. The original factory setting of the overtravel gap and the end-of-life measurement of this gap are recorded on this label. When the overtravel gap measurement reaches the end-of-life value given on this label, the vacuum interrupter should be replaced.

2. Vacuum Integrity

Refer to the section for information on high voltage insulation integrity.

Vacuum interrupters used in the PowlVac® Vacuum Circuit Breaker Type PVCB-40.5/1200 -31.5 and PVCB-40.5/2000 -31.5 series circuit breakers are highly reliable interrupting elements. Satisfactory performance of these devices is primarily dependent 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 circuit breaker open and removed from the cell, apply the high potential across each vacuum interrupter separately. It is recommended that interrupter inter-phase barriers be in place during this test to prevent a phase-to-phase breakdown. Connect the "hot' lead of the test source to the upper stud of the pole under test and ground the lead to the lower stud. If the test supply is counterpoint grounded, the connections may be either way. Apply a minimum of 40kV rms., 60Hz or hold for a minimum of (5) seconds. If no breakdown occurs the vacuum interrupter is in acceptable condition. If a breakdown occurs the vacuum interrupter should be replaced.

No attempt should be made to try neither 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.

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 vacuum interrupter, if present.

There are several factory adjustments in the vacuum interrupter area, which are described in the instructions for each particular rating of circuit breaker. No adjustment of these settings is required for routine maintenance. The dimensions given in this instruction book are for new vacuum interrupters, and all of them will change during the life of the vacuum interrupter. Adjustment of these settings will be required only after vacuum interrupter replacement. "**DO NOT ADJUST THESE SETTINGS UNNECESSARILY AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT."**

If disassembly of the mechanism or the vacuum interrupters becomes necessary for any reason, all of the dimensions found in the directions must be measured and recorded prior to disassembly if vacuum interrupter replacement is not required. These dimensions must be restored to the "As-Found" condition upon reassemble, which insures the proper timing and operation of the circuit breaker.

D. OPTIONAL MAINTENANCE PRODECURES

1. High Potential Tests

These tests are not ordinarily required for routine maintenance, but should be performed after a heavy fault interruption or after the circuit breaker has been in storage for an extended time, especially in a damp location or other adverse environment. See the section of this instruction bulletin headed "Putting into Service" for details of these procedures.

2. Primary Resistance Check

This check is not required for routine maintenance, but it is suggested after any major maintenance that requires disassembly of any part of the primary circuit. This check should be done after any vacuum interrupter replacement. To check the resistance, pass a minimum of 100A DC through the circuit breaker pole with the circuit breaker closed. Measure the voltage drop across the primary contacts and calculate the resistance. This resistance should not exceed 50 micro-ohms for Model PVCB – 40.5/1200 A – 31.5, 40.5kV Voltage Class, 1200A or 60 micro-ohms for Models PVCB – 40.5/2000 A – 31.5, 40.5kV Voltage Class, 2000A.

VI. RECOMMENDED RENEWAL PARTS AND REPAIR PROCEDURES

A. ORDERING INSTRUCTIONS

Order Renewal Parts from Powell Apparatus Service Division (PASD). The website is located at www.powellservice.com, or call 1-800-480-7273.

1. 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 and solenoids)

2. Specify the quantity and description of the part and the instruction bulletin. If the part is in the tables of recommended miscellaneous parts, or renewal parts, give its part number. If the part is not in the tables, the description should be accompanied by a marked illustration from this instruction book, or a photo or a sketch showing the part needed.

3. 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.

B. RECOMMENDED RENEWAL PARTS

It is recommended that a sufficient amount of renewal parts be carried in stock to enable the prompt replacement of any worn broken or damaged parts. A stock of such parts minimizes service interruptions caused by breakdowns and saves time and expense. When continuous operation is a primary consideration, proper renewal parts should be stocked and correlated with the operation depending on the severity of the service and the time required securing the replacements.

Spare or replacement parts that are furnished may not be identical to the original parts, since improvements are made from time to time. The parts, which are furnished, however, will be interchangeable. The recommended spare parts are to be carried in stock by the user. The recommended quantity is not specified. This must be determined by the user based on the application. As a minimum, it is recommended that one set of parts be stocked per ten circuit breakers or fraction thereof.

Table lll. Control Devices

Control Voltage	Closing Solenoid Assembly	Trip Solenoid Assembly	Shunt Trip Solenoid Assembly	Charging Motor	Motor Relay	Anti-Pump Relay
48VDC	43285G03P	43285G09P	43285G09P	RY048	GS186	RR2BA-US-DC48V
125VDC	43285G02P	43285G08P	43285G08P	RY120	GS187	RR2BA-US-DC110V
250VDC	43285G10P	43285G05P	43285G05P	RY240	GS188	RR2BA-US-DC110V
120VAC	43285G07P	43285G12P	43285G12P	RY120	GS189	RR2BA-US-AC12OV
240VAC	43285G06P	43285G11P	43285G11P	RY240	GS190	RR2BA-US-AC24OV

NOTES FOR TABLE lll

1. All circuit breakers are manufactured with a closing solenoid, trip solenoid, charging motor, motor limit switch, and anti-pump relay. A shunt trip solenoid assembly is optional.
2. For 250VDC applications, a dropping resistor, 43723G01P, is required in series with this relay's coil.

Table IV. Miscellaneous Parts

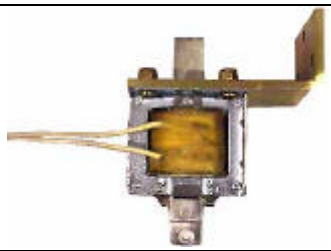
Index No.	Circuit Breaker Type	Description	Part No.	Qty.	Illustration
1	40.5 kV 1200 A 40.5 kV 2000 A	Auxiliary Switch Assembly	GS180 GS180	1 1	
2	40.5 kV 1200 A 40.5 kV 2000 A	Closing Solenoid Assembly (Specify closing voltage) (Specify closing voltage)	See P. 26 See P. 26	1 1	
3	40.5 kV 1200 A 40.5 kV 2000 A	Drive Springs	40743P01 40743P01	2 2	
4	40.5 kV 1200 A 40.5 kV 2000 A	Ground Shoe	69433G01 69433G01	1 1	
5	40.5 kV 1200 A 40.5 kV 2000 A	Hand Charge Lever	50235P01 50235P01	1 1	
6	40.5 kV 1200 A 40.5 kV 2000 A	High Voltage Housing	43221P02 43221P02	3 3	

Table IV. Miscellaneous Parts (Continued)

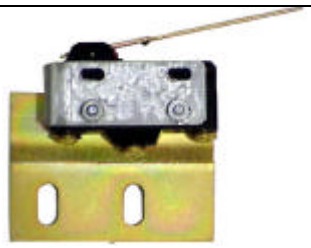
Index No.	Circuit Breaker Type	Description	Part No.	Qty.	Illustration
7	40.5 kV 1200 A 40.5 kV 2000 A	Latch Check Switch Assembly	42255G02 42255G02	1 1	
8	40.5 kV 1200 A 40.5 kV 2000 A	Motor Limit Switch Assembly	42256G01 42256G01	1 1	
9	40.5 kV 1200 A 40.5 kV 2000 A	Motor Relay Switch (Specify closing voltage) (Specify closing voltage)	See P. 26 See P. 26	1 1	
10	40.5 kV 1200 A 40.5 kV 2000 A	Opening Spring	40742P01 40742P01	2 2	
11	40.5 kV 1200 A 40.5 kV 2000 A	PowlVac® Lubrication Kit	Powlube-102 Powlube-102	1 1	
12	40.5 kV 1200 A 40.5 kV 2000 A	Primary Contact (2 per phase) (2 per phase)	43240G01 43240G01	6 6	

Table IV. Miscellaneous Parts (Continued)

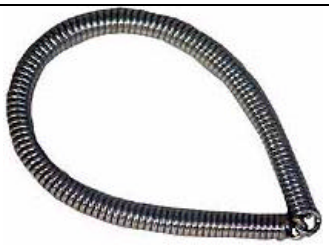
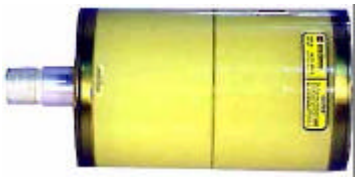
Index No.	Circuit Breaker Type	Description	Part No.	Qty.	Illustration
13	40.5 kV 1200 A 40.5 kV 2000 A	Primary Disconnect Spring (4 per phase) (4 per phase)	2226 2226	12 12	
14	40.5 kV 1200 A 40.5 kV 2000 A	Pushrod Assembly (1 per phase) (1 per phase)	43222P01 43222P01	3 3	
15	40.5 kV 1200 A 40.5 kV 2000 A	Racking Handle	67775H01 67775H01	1 1	
16	40.5 kV 1200 A 40.5 kV 2000 A	Shock Absorber	40202P01 40202P01	2 2	
17	40.5 kV 1200 A 40.5 kV 2000 A	Shunt (2 per phase) (2 per phase)	43226P01 43226P01	6 6	
18	40.5 kV 2000 A	Upper Primary Heat Sink (4 per phase) (4 per phase)	43305P01	12	

Table IV. Miscellaneous Parts (Continued)

Index No.	Circuit Breaker Type	Description	Part No.	Qty.	Illustration
19	40.5 kV 1200 A 40.5 kV 2000 A	Vacuum Interrupter (1 per phase) (1 per phase)	WL35890P WL35890P	3 3	
20	40.5 kV 1200 A 40.5 kV 2000 A	Wheel	43311P01 43311P01	4 4	
21	40.5 kV 1200 A 40.5 kV 2000 A	Rail Wheel	43311P02 43311P02	4 4	

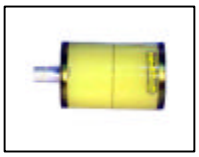
C. REPLACEMENT PROCEDURES

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

Note: Make certain that the control circuits are de-energized and the circuit breaker is resting securely outside the switchgear. Do not start to perform maintenance on a closed circuit breaker or a circuit breaker with the drive 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 charged springs.

1. Vacuum Interrupter

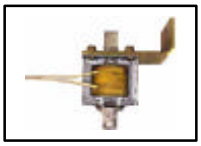
The vacuum interrupter is located in the high voltage housing.
See figure 15 [e] to replace it:



a. Open primary contacts with the drive springs discharged.
b. Remove the primary contacts.
c. Remove the hardware from the pushrod that connects to the linkage assembly located at the bottom of the circuit breaker frame, paying close attention to the order of assembly.
d. Remove the high voltage housing from the circuit breaker's frame.
e. Remove the pushrod from the lower bus connector by hand.
f. Remove the hardware that connects the lower bus connector, shunt, and high voltage housing.
g. Remove the hardware which connects the vacuum interrupter, upper bus connector, and high voltage housing.
h. Disassemble the heat sinks from the upper bus connector. (2000A only)
i. Remove the vacuum interrupter from the high voltage housing.
j. Disassemble the front terminal clamp, shunt and vacuum interrupter, and replace the parts as needed.
k. Firmly hand tighten the vacuum interrupter with the front terminal clamp until the threads bottom out. Then rotate the front terminal clamp back off the threads a ½ turn to allow the counterbore hole of the front terminal clamp to face up. The caution label and counterbore hole should be aligned.
l. Insert the head cap screw and lock washer into the counterbore hole of the front terminal clamp and tighten to 25 ft./lbs.
m. Assemble the shunt onto the front terminal clamp.
n. Assemble the upper heat sink to the upper bus connector. (2000A only)
o. Insert the vacuum interrupter assembly and upper bus connector with the heat sinks attached back into the high voltage housing. Note, the caution label on the vacuum interrupter should be facing the threaded end of the bus connector.
p. Assemble the hardware to the new vacuum interrupter which connects the upper bus connector, and tighten to 50 ft./lbs.
q. Assemble the upper bus connector to the high voltage housing.
r. Assemble and insert the lower bus connector to the shunt.
s. Assemble the lower bus connector to the high voltage housing.
t. Assemble the pushrod to the vacuum interrupter. (Hand tighten)
u. Assemble the high voltage housing back on the circuit breaker frame.
v. Assemble the hardware that connects the pushrod with the linkage assembly located near the bottom of the circuit breaker frame.
w. Assemble the primary contacts to the upper bus connector and lower bus connector, and tighten to 70 ft./lbs.

2. Closing Solenoid Assembly

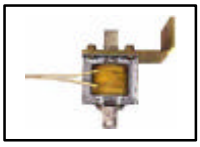
The closing solenoid is located at the top front center of the circuit breaker right of the trip solenoid assembly, which is connected to the top back panel. The trip solenoid assembly can be replaced by using the same method of the closing solenoid assembly. See (fig 8 [e]) to replace it:



a. Open and discharge the drive spring.
b. Remove front cover of the circuit breaker.
c. Unplug the closing solenoid assembly from the wire harness.
d. Remove the hardware from the solenoid linkage from the bottom of the closing solenoid 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 solenoid assembly.
f. Insert the new closing solenoid assembly by connecting it back to the solenoid 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 solenoid assembly.
g. Close the circuit breaker several times electrically to insure that the closing solenoid assembly is functioning properly.
h. Replace the circuit breaker's front cover.

3. Trip Solenoid Assembly

The trip solenoid assembly is located at the top right center of the circuit breaker right of the closing solenoid assembly, which is connected to the top back panel. The secondary trip solenoid assembly can be replace by using the same method of the closing solenoid assembly. See (fig 8 [d]) to replace it:



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

4. Ground Shoe Assembly

The ground shoe assembly is located on the bottom side of the back end frame just below the hex racking shaft (fig 6[e]), which is located next to the left-hand rear wheel of the circuit breaker.

a. Remove the hardware located on the front and back location of the ground shoe assembly.
b. Replace with a new ground shoe assembly making sure that the fingers are facing in the direction of the rear of the circuit breaker.
c. Lightly lubricate the surface contact of the fingers with mobilgrease 28.

5. Charging Motor Assembly

The charging motor assembly is located at the top center of the mechanism.
See (fig 8 [n]) to replace it:

a. Remove the front cover of the circuit breaker.
b. Unplug the 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 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 anderol 757 grease.
i. Apply Loctite 243 to hardware.
j. Replace items in "c.".
k. Replace the circuit breaker's front cover.

6. Anti-Pump Relay

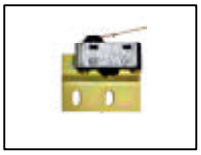
This relay is located near the left top of the mechanism, on the left side sheet.
See (fig 8 [u]) to replace it:

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

NOTE: FOR 250VDC APPLICATIONS, A DROPPING RESISTOR, 43723G01P, IS REQUIRED IN SERIES WITH THIS RELAY'S COIL. TO ASSEMBLE THE DROPPING RESISTOR TO THE ANTI-PUMP RELAY REFER TO FIGURE 18.

Fig. 18 Anti-Pump Relay and Dropping Resistor Assembly

7. Latch Check Switch Assembly



The latch check switch is located on the inside of the circuit breaker, behind the connecting bar assembly, at the bottom left side of the mechanism. See figure 14 to replace it:

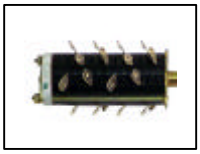
a. Remove the front cover of circuit breaker.
b. Remove the two nuts, and washers holding the switch to the back of the circuit breaker.
c. Disconnect the wires from switch.
d. Reconnect the wires to the new switch assembly and fasten it back in place with the nuts, and washers to the location previously removed making sure that the two grommets are still in place behind the latch check switch bracket.
e. To adjust the switch see the instructions in section headed "Adjustment of Primary and Secondary Trip Latches and Latch Check Switch" under MAINTENANCE in this instruction book.
f. Operate circuit breaker electrically several times to insure that it is working.
g. Replace the circuit breaker's front cover.

8. Motor Limit Switch Assembly

The motor limit switch assembly is located on the backside of the connecting panel of the mechanism area, just to the left if the main mechanism.
See figure 8 [p] to replace it:

a. Remove front cover of the circuit breaker.
b. Remove the two screws, washer, and lock washer from the face of the connecting panel located just to the left if the main mechanism, paying close attention to the order of the hardware.
c. Disconnect the wires from switch, being careful to identify each wire by the terminal number from which it was removed.
d. Install the new motor limit switch assembly, reconnect the wiring, and assemble it back onto the connecting panel. The switch must be closed with the mechanism discharged.
e. Operate the circuit breaker electrically several times to insure that it is working.
f. Replace the circuit breaker's front cover.

9. Auxiliary Switch



The auxiliary switch is located on the inside of the left side sheet of the circuit breaker. See figure 8 [t] to replace the auxiliary switch:

a. Remove front cover of circuit breaker.
b. Disconnect wires from switch, being careful to identify each wire by the terminal number from which it was removed.
c. Remove the fastener, securing the switch operating arm to auxiliary switch linkage.
d. Remove the two screws holding the auxiliary switch to its mounting bracket, and remove the switch.
e. Insert the new switch and attach it to the mounting bracket with the two screws removed in step d.
f. Insert the operating arm of the switch in to the hole in the end of the operations counter linkage and secure with the fastener removed in step c.
g. Reconnect the wiring. Be sure wires are connected to the same terminals from which they were removed.
h. Operate circuit breaker electrically several times to insure that it is working.
i. Replace the circuit breaker's front cover.

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