INSTRUCTIONS

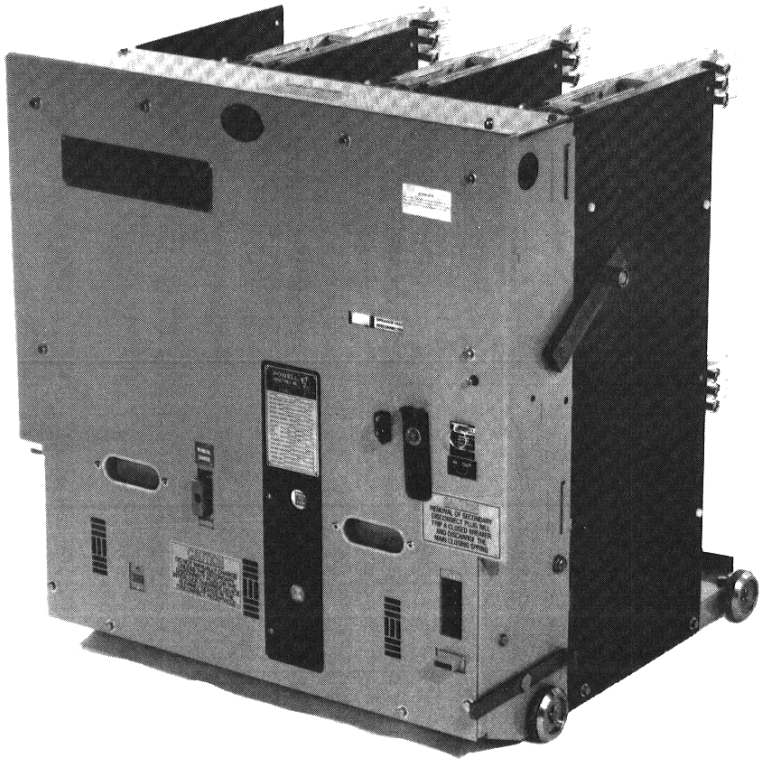
IB-60010

Series P-60000 POWL-VAC® VACUUM CIRCUIT BREAKERS

INSTALLATION

OPERATION

MAINTENANCE



POWELL INDUSTRIES, INC.

POWELL ELECTRICAL MANUFACTURING COMPANY
8550 MOSLEY DRIVE • HOUSTON, TEXAS 77075 USA
PHONE (713) 944-6900 • FAX (713) 947-4453

TABLE OF CONTENTS

ILLUSTRATIONS

TABLES

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 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.

CAUTION

Before any adjustment, 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.

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 the Powell Electrical Manufacturing Company.

I. INTRODUCTION

CAUTION: THIS INSTRUCTION BOOK IS NOT COMPLETE UNLESS USED IN CONJUNCTION WITH THE APPLICABLE SUPPLEMENT PERTAINING TO THE SPECIFIC MODEL NUMBER OF CIRCUIT BREAKER PURCHASED. THIS INSTRUCTION BOOK COVERS ONLY THE DESIGN COMMONALITIES OF THE POWL VAC CIRCUIT BREAKER PRODUCT. THE SPECIFIC SUPPLEMENT FOR EACH BREAKER MODEL ALONG WITH THIS INSTRUCTION BOOK MUST BE STUDIED AND UNDERSTOOD IN ORDER TO BECOME FULLY ACQUAINTED WITH THIS DEVICE.

It should also be noted that some of the 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 the applicable ANSI, IEEE and NEMA Standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

Before uncrating the breakers, study this document and all other associated documentation. Follow the recommended procedure for putting into service.

This manual contains:

1. Safety Rules.
2. A general description of the operation of the circuit breakers.
3. Instructions for putting into service.
4. Instructions for maintenance.

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 which 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 manual are operated by high energy, high speed mechanisms interlocked to provide safe operating sequences. To insure the safety of personnel associated with installation, operation and maintenance of these breakers, it is important the following rules 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 Powl-Vac® circuit breakers.

A. GENERAL

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

2. Maintenance programs must be well planned and executed consistent with both customer experience and manufacture's recommendations including service advisories and instruction books. Well planned and executed routine maintenance is essential to breaker reliability and safety.

   Service conditions and breaker application must be considered in the development of such programs, including such variables as ambient temperature, the actual continuous current, number of operations, type of interrupting duty and any unusual local conditions such as excessive dust or ash, corrosive atmosphere or major vermin or insect problems.

B. SPECIFIC

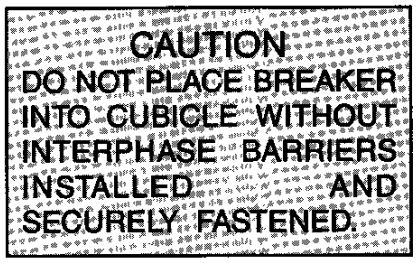
1. DO NOT WORK ON AN ENERGIZED BREAKER. IF WORK MUST BE PERFORMED ON A BREAKER, REMOVE IT FROM SERVICE AND REMOVE IT FROM THE METAL-CLAD ENCLOSURE.
2. DO NOT WORK ON A BREAKER WITH CONTROL CIRCUITS ENERGIZED.
3. These breakers utilize stored-energy spring charged mechanisms. These mechanisms must be serviced only by skilled and knowledgeable personnel capable of releasing each spring load in a controlled 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 book.
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 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 generation of 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 one meter in front of the circuit breaker and separated from the vacuum interrupters under test by the two thicknesses of steel used in the construction of the circuit breaker frame. The circuit breaker must be either fully open or fully closed when making high potential tests. Do not test with contacts partially open.

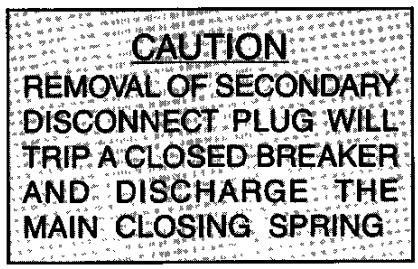
D. SAFETY LABELS

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



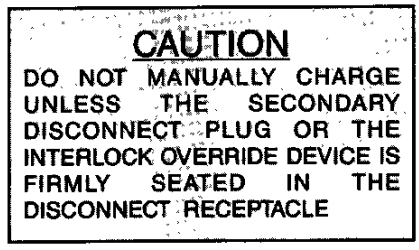
Attached to outside face of mechanism top cover plate.

Attached to outside face of mechanism top cover plate.



Attached to front cover to left of secondary disconnect aperture.

Attached to front cover at top right hand corner and also in mechanism compartment on dashpot bracket.



Attached to front cover to left of manual charging handle socket.

III. DESCRIPTION

A. GENERAL (Figure 1)

The Powl-Vac Circuit Breaker uses sealed vacuum interrupters to control the primary circuit. Primary connections to the associated metal clad switchgear are made by parallel copper busbars terminating in multiple contact fingers which are part of the busbars. Insulators provide support for the primary bars and the vacuum interrupter assemblies.

All the current carrying components are located behind a metal barrier which supports the insulators. In front of this barrier in an accessible position is the operating mechanism assembly which provides motion to each of the vacuum interrupter moving contacts through cast cycloaliphatic epoxy operating rods. In the same metal enclosed compartment as the operating mechanism is the levering-in mechanism which controls the movement of the breaker from the disconnected to the connected position. The levering-in mechanism engages with the switchgear and exerts a force on the breaker in a plane midway between the primary disconnect fingers, thus ensuring equal wipe on all primary disconnects and avoiding any tendency of the breaker to tilt under short circuit conditions. The levering-in mechanism also operates the primary disconnect shutters.

B. THE STORED ENERGY MECHANISM

The front cover (Figure 2) has cutouts and apertures giving access to various operating and levering-in mechanism indicating and operating functions and access to the secondary disconnect receptacle.

Removal of nine (9) holding screws enables the front cover to be removed, giving access to the stored energy mechanism and its interlocks, auxiliary switches, levering-in operators and interlocks, operating motor and motor cutoff switch (Figure 3).

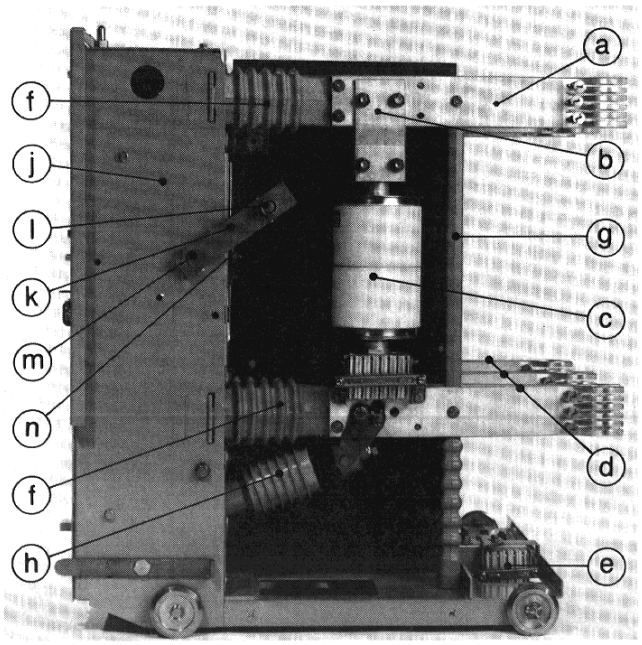


Figure 1. Side view of a typical Powl-Vac Circuit Breaker.

- *a. Upper Horizontal Primary Disconnect Bars*
- *b. Vertical Connector Bars*
- *c. Vacuum Interrupter*
- *d. Lower Horizontal Primary Disconnect Bars*
- *e. Ground Connection*
- *f. Main Insulating Supports*
- *g. Insulating Pole Support*
- *h. Main Insulating Operating Rod (Push Rod)*
- *j. Mechanism Housing*
- *k. Levering-In Crank Arm*
- *l. Crank Arm Rollers*
- *m. Levering-In Shaft*
- *n. Worm Wheel*

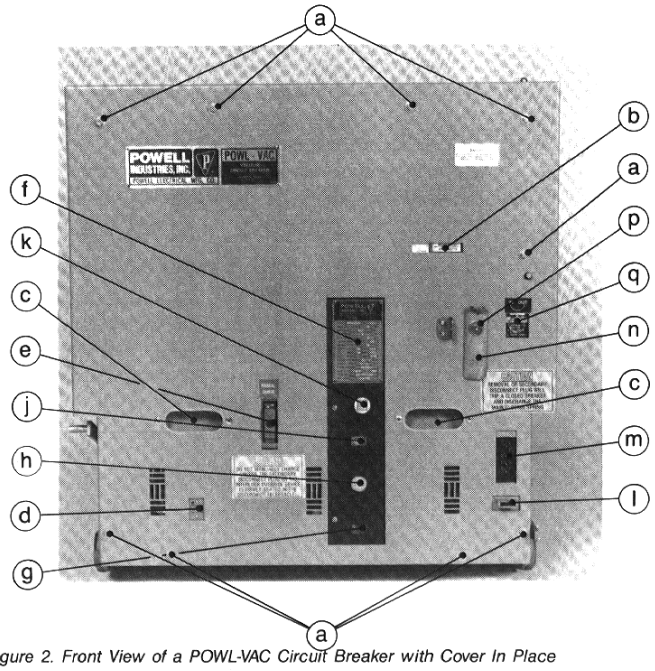


Figure 2. Front View of a POWL-VAC Circuit Breaker with Cover In Place

- *a. Cover Attachment Bolts*
- *b. Breaker Position Indicator*
- *c. Handle*
- *d. Operations Counter*
- *e. Manual Charging Crank*
- *f. Nameplate*
- *g. Spring Charge Indicator*
- *h. Manual Close Paddle*
- *j. Breaker Open/Closed Indicator*
- *k. Manual Trip Paddle*
- *l. Secondary Disconnect Guide*
- *m. Secondary Disconnect Receptacle*
- *n. Padlock Provision - Movable Arm*
- *p. Padlock Provision - Stationary Clip*
- *q. Levering-In Shaft Shutter*

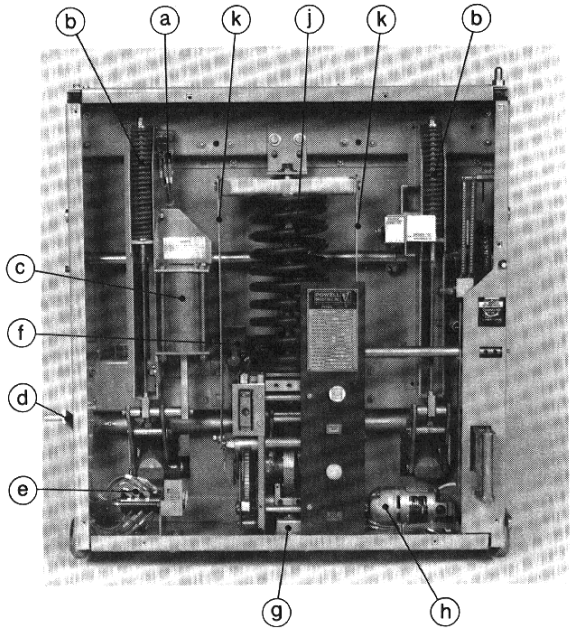


Figure 3. Front View of a POWL-VAC Circuit Breaker with Cover Removed

a. *Anti-Pump Relay*
b. *Opening Spring*
c. *Shock Absorber*
d. *MOC Operating Arm*
e. *Auxiliary Switch*
f. *Shunt Trip Coil*
g. *Closing Coil*
h. *Charging Motor*
j. *Main Closing Spring*
k. *Connecting Rods*

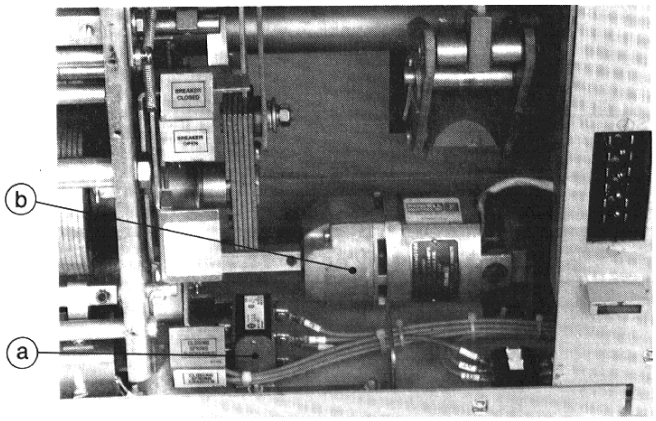


Figure 4. Charging Motor and Motor Cutoff Switch

a. *Motor Cutoff Switch Assembly*
b. *Charging Motor*

The mechanism is of the stored energy type in which a gear motor is used to compress a closing spring. During a closing operation, the energy stored in the closing spring is used to close the vacuum interrupter contacts, compress the overtravel springs, charge the opening springs and overcome friction forces. When the breaker is tripped, the energy stored in the opening and overtravel springs will open the contacts at the correct speed. The motor, located on the breaker floor pan bottom right, is supported by a bracket bolted to the floor pan (Figure 4). Its output shaft is screwed to a coupler which inserts into the eccentric drive shaft. This shaft is supported in needle bearings in the mechanism frame side sheets and transmits the motor torque from the right to the left side of the mechanism.

When the motor is energized, the eccentric shaft rotates and causes the driving arm links to pivot about the cam shaft (Figure 5). The drive pawl located on the links engages with the ratchet wheel and rotates it, one tooth at a time. The ratchet wheel is prevented from rotating backward by a holding pawl, which is supported on links which project upward from the cam shaft.

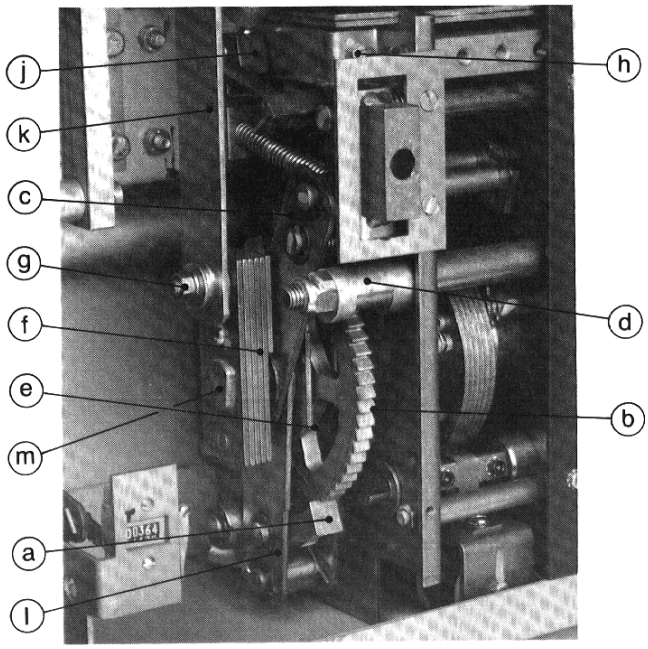


Figure 5. Main Operating Mechanism - Left Oblique View

a. *Drive Pawl*
b. *Ratchet Wheel*
c. *Holding Pawl*
d. *Holding Pawl Adjusting Eccentric*
e. *Drive Plate*
f. *Crank Arm*
g. *Crank Pin*
h. *Secondary Trip Latch Adjusting Screw*
j. *Latch Check Switch*
k. *Connecting Rod*
l. *Driving Arm Links*
m. *Cam Shaft*

To insure correct synchronization of the drive and hold pawls, the hold pawl links are located by an adjustable eccentric stop located at the left front of the mechanism. When the mechanism is operated manually, the top pawl becomes the driving pawl and the bottom pawl becomes the holding pawl.

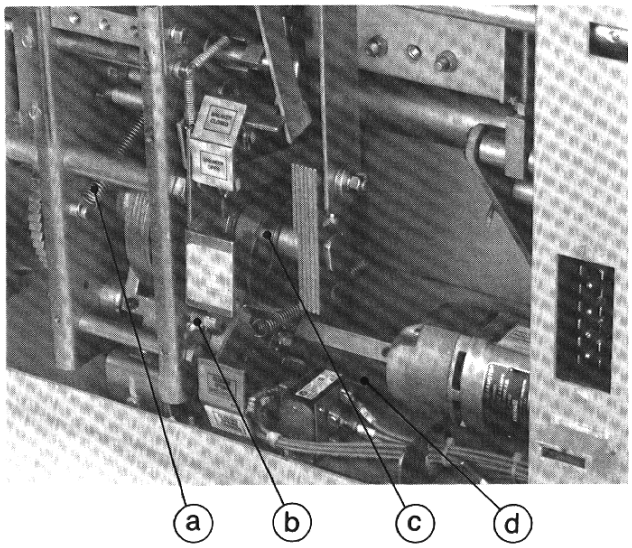


Figure 6. Main Operating Mechanism - Right Oblique View
- *a. Mechanism Reset Spring*
- *b. Close Bar Adjusting Screw*
- *c. Motor Cutoff Cam*
- *d. Motor Cutoff Switch Operating Arm*

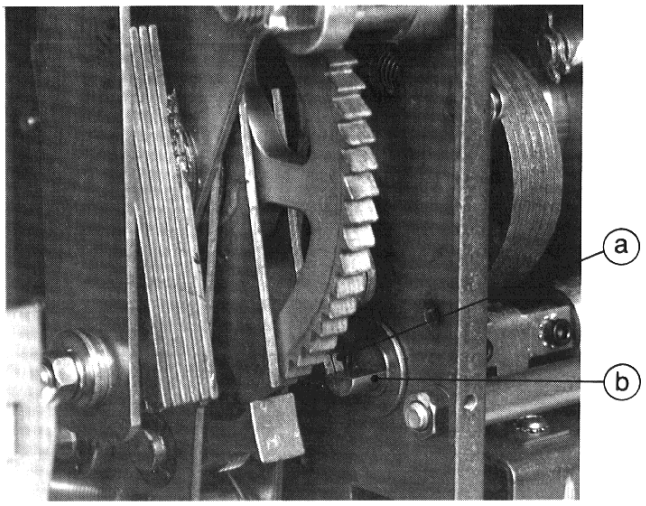
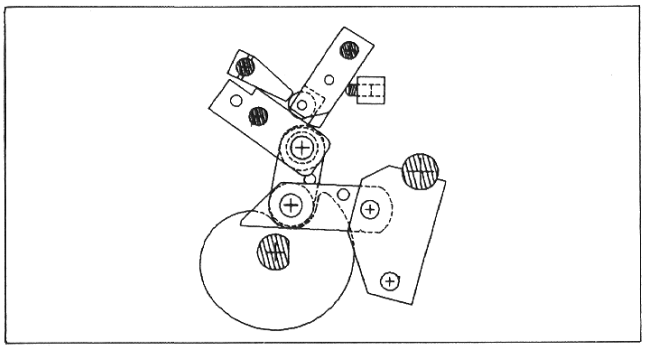
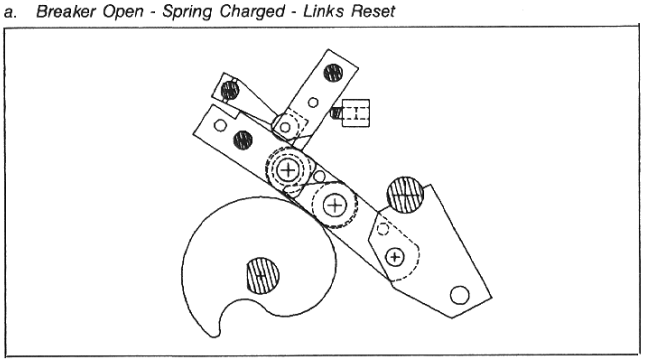


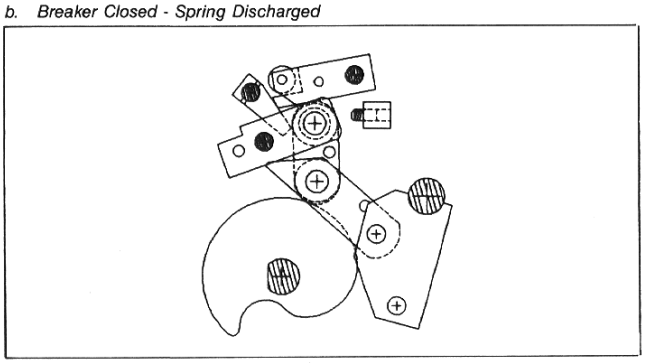
Figure 7. Close Latch Arm Engaging Close Latch Shaft
- *a. Close Latch Arm*
- *b. Close Latch Shaft*



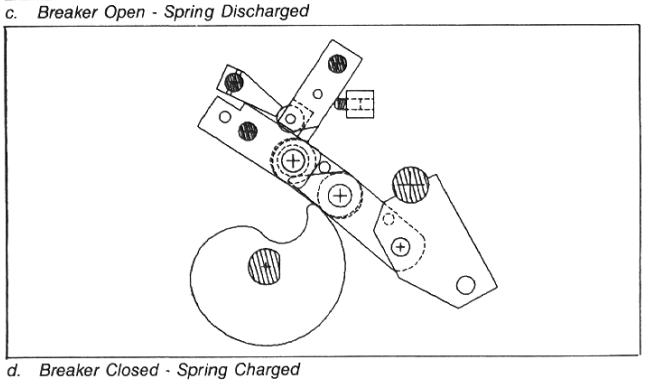
a. Breaker Open - Spring Charged - Links Reset



b. Breaker Closed - Spring Discharged



c. Breaker Open - Spring Discharged



d. Breaker Closed - Spring Charged

Figure 8. Cam and Fundamental Linkage Positions

As the ratchet wheel is rotated, projections from its side faces will engage drive plates attached to the cam shaft and the cam shaft will rotate. Attached to the ends of the cam shaft are crank arms and pointing outward from these are crank pins. These engage with the bottom ends of the connecting rods (Figure 5), the top ends of which engage pins projecting from the spring compression plate which straddles the main closing spring. As the cam shaft rotates, the connecting rods pull the spring compression plate downward, compressing the closing spring.

The ratchet wheel will drive the cam shaft so that the connecting rods go down to their lowest position and then start to move upward. At a certain point, the spring force will overcome friction and resistance and start to rotate the cam shaft. At the same time, the pawls are uncoupled from the ratchet wheel and the motor cutoff switch is operated. The motor cutoff switch located on the right of the mechanism is operated by the motor cutoff switch operating arm falling into the motor cutoff cam (Figure 6). The spring charge flag will now show that the mechanism is charged. The cam shaft would continue to rotate, except that it is restrained by the close latch arm engaging against the close latch shaft (Figure 7). The main operating cam located between the mechanism side sheets is now in a position where the main drive linkage can move to the reset position (Figure 8a).

When the close latch is released, either under the action of the closing solenoid or the manual close plate, the closing spring pulls the cam shaft around, and the main closing cam moves the main linkage into the closed position. The main linkage rotates the center lever of the drive jack shaft. The jack shaft has 3 downward-pointing pairs of levers to which are attached the operating rods. The operating rods,which are approximately horizontal, are moved towards the vacuum interrupter by the rotation of the jack shaft (Figure 9).

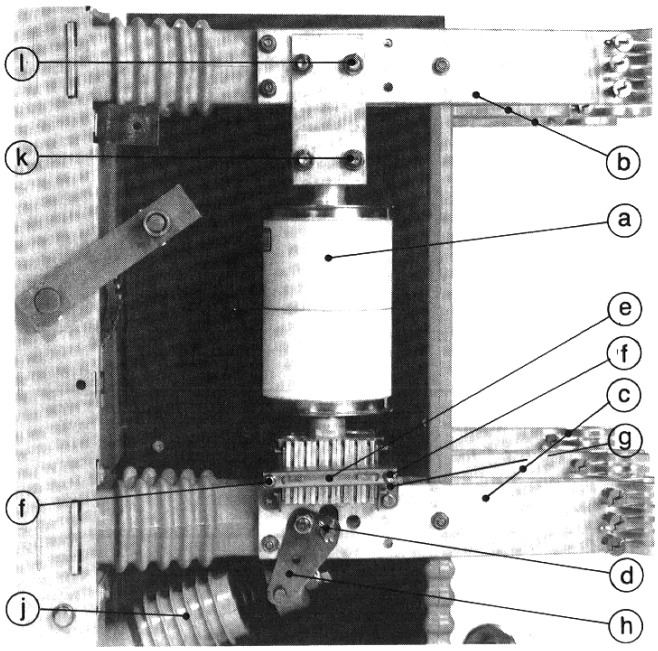


Figure 9. Typical Interrupter and Operating Rod Mechanism.

- a. *Interrupter*
- b. *Upper Main Horizontal Primary Disconnect Bars*
- c. *Lower Main Horizontal Primary Disconnect Bars*
- d. *Operating Pin*
- e. *Sliding contact Finger Assembly*
- f. *Finger Holding Screws*
- g. *Finger Assembly Mounting Clip*
- h. *Bell Crank*
- j. *Operating Rod*
- k. *Upper Contact Block Bolts*
- l. *Vertical Connector Bar Attachment Bolts*

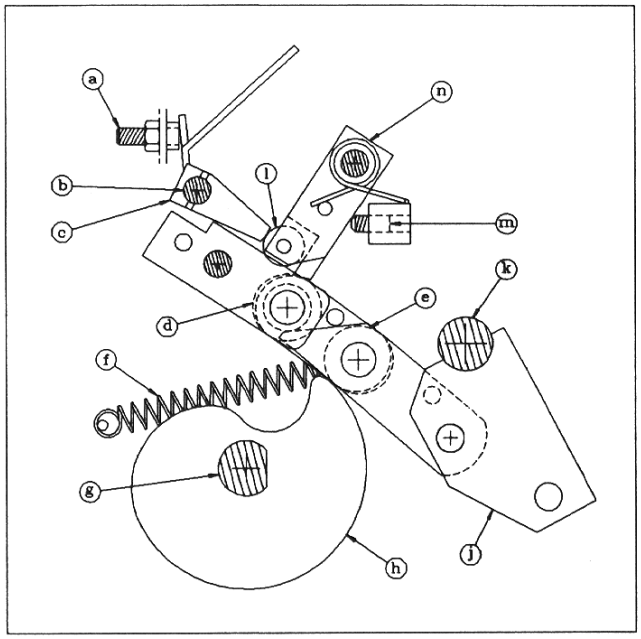


Figure 10. Mechanism and Trip Linkages

- a. *Secondary Trip Prop Adjusting Screw*
- b. *Trip Bar*
- c. *Secondary Trip Prop*
- d. *Secondary Linkage Roller*
- e. *Main Cam Roller*
- f. *Reset Spring*
- g. *Cam Shaft*
- h. *Main Drive Cam*
- j. *Center Phase Operating Lever*
- k. *Main Jack Shaft*
- l. *Primary Trip Prop Roller*
- m. *Primary Trip Prop Adjusting Screw*
- n. *Primary Trip Prop*

At the end of the operating rods remote from the jack shaft levers is a recess which encloses the contact loading springs. At the end of these springs, remote from the operating rod, is located the spring yoke which connects with the bell crank levers (Figure 24). The spring yoke is restrained by locking nuts on a stud which, passing through the contact loading spring, is

attached to the operating rod. The contact loading spring has initial compression such that as soon as the vacuum interrupter contacts touch, they are loaded by a force sufficient to resist their separation under the highest electromagnetic forces exerted by the rated short circuit current.

Further movement of the operating rods compresses the contact loading spring even more and produces a gap between the face of the spring yoke and the lock nut. This gap will reduce as the vacuum interrupter contacts erode.

The bell crank levers, which are located on the outside of the bottom primary disconnect bars, are supported on a hinge pin bridging the bars and are connected to a drive pin which, passing through a slot in the disconnect bars, bridges the bell cranks and engages an extension to the vacuum interrupter moving stem. The bell cranks give an approximate 3 to 1 multiplication of the contact loading spring force which permits reduced spring force and enables a low rate spring to be used. They also multiply the contact movement by a factor of approximately 3 so that the mechanism linkages have relatively large movements and are less critical.

In the linkage positions shown in Figures 8b and 8d, the contact loading springs and the main opening springs are both acting to compress the three (3) main mechanism links (Figure 10).

The linkage is restrained from movement by the secondary trip prop acting on the primary trip prop roller. The component of force tends to make the primary trip prop move upward, but it is restrained by the secondary trip prop face acting on the primary trip prop roller. The clearance between the primary trip prop roller and the secondary trip prop is controlled by the primary trip prop adjusting screw. When the trip shaft is rotated by the action of the manual trip plate or the electric trip solenoid, the secondary trip prop moves down and permits the primary trip prop to move upward, thus permitting the main linkage to move upward and the jack shaft to rotate, opening the breaker. The jack shaft extends from the left to the right side of the breaker frame and is supported at the main breaker frame side sheets and by the mechanism side sheets. The two outer operating rod levers on the jack shaft have connections to the breaker opening springs (Figure 3). A projection of the left lever engages a shock absorber which controls the rebound of the interrupter contacts on opening operations. An extension of the jack shaft projects through the left breaker side sheet and operates the MOC switch drive.

With the standard electrical control scheme, as soon as the closing springs are discharged on a closing operation, the motor is switched on to recharge the springs. This leaves the main closing cam in a position where the tripped linkage can reset under the action of the reset spring (Figure 10), and the primary and secondary trip props can fall into the reset position. The reset spring stretches between an extension of the main cam roller pin and a spring support pin located on the left mechanism side sheet. The trip latch check switch operated by a lever on the trip shaft will now close (Figure 5).

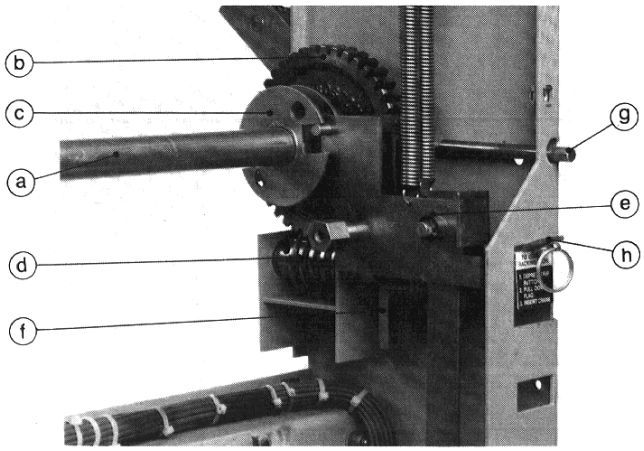


Figure 11. Levering-In Mechanism and Interlocks

a. *Levering-In Shaft.*
b. *Worm Wheel*
c. *Interlock Cam*
d. *Worm Gear*
e. *Interlock Plates*
f. *Travelling Nut Plate*
g. *Position Indicating Rod for Earlier Model Electrical Levering-In Device*
h. *Access Shutter for Levering-In Drive Shaft*

C. LEVERING-IN DEVICE

The breaker is moved between the disconnected and connected positions by the levering-in device. This consists of a shaft which is supported by the breaker frame side sheets, and which has a crank arm at each end (Figure 1). Rollers attached to the crank arms engage vertical slots in plates attached to the cell and rotation of the shaft causes the breaker to move in and out of the breaker housing. The levering-in shaft supports a worm wheel at its right end just inside the right breaker side sheet (Figure 11). The worm wheel is rotated by a worm gear on a shaft which is terminated in a hexagon drive nut attached by a shear pin. The shaft points in a direction from the front to the back of the breaker. This hexagon shaft has a threaded portion carrying a threaded plate. As the shaft is rotated, the threaded plate moves along the worm shaft until it encounters either a front or a back sleeve attached to the shaft and further rotation of the worm shaft is prevented. At this time, the position indicator on the front of the breaker will indicate that the breaker is either in the connected or disconnected position. A sockethead bolt mounted on the left side sheet serves as a backup to the threaded plate, providing a positive stop to left crank arm.

D. INTERLOCKING

The first purpose of the interlocks is to insure that a breaker cannot be moved from the disconnected to the connected position unless the main breaker contacts are open and the secondary control circuitry from the compartment to the circuit breaker is completed.

The second purpose is to insure that the control circuits cannot be broken when the breaker is in the connected position and the breaker cannot be moved from the connected position unless its main contacts are first opened.

The third purpose is to prevent the breaker from being removed from the metal-clad switchgear with the breaker closed or the closing spring charged.

This interlocking is achieved by means of a shutter over the levering-in worm shaft and an interlock bar attached to the secondary disconnect plug.

Access to the hexagon drive nut on the levering-in device is restricted by a shutter on the front panel of the breaker (Figure 11). This shutter is pivoted on the breaker frame and has a projecting pin which engages a slot on a cam on the levering-in shaft. This particular cam has two (2) slots arranged so that the shutter can only be in its upward position when the levering in cranks are in the connected, test or disconnected position. The shutter cannot be moved downward until the trip plate is pushed inward and the secondary disconnect plug is inserted. Pushing the trip plate inward moves one prop out of the way of the shutter. Insertion of the secondary plug pushes the blocking plate backward and rotates a second prop out of the way of the shutter. Then, downward movement of the shutter causes a lever operating in parallel with the shutter to move downward, and a projecting pin on this lever disengages a second cam located next to the shutter cam. Downward movement of the lever moves a bolt which locks the secondary disconnect plug in its connected position. The second cam has only one slot and the lever can only move upward when the levering-in shaft is in the disconnected position.

The downward movement of the shutter also prevents the trip plate from returning to its original position, thereby preventing mechanical or electrical closing of the breaker. The electrical closing signal is blocked by the action of the latch-check switch that is actuated by the position of the trip bar.

To summarize the action of the levering-in interlocks; the worm gear shaft shutter cannot be opened until the breaker is tripped by pushing on the trip plate and the secondary disconnect plug is inserted. Downward movement of the shutter causes its interlock pin to move out of its cam plate. It also pushes a locking bolt downward to lock the secondary disconnect plug in position. The bolt cannot return upward in any other position than disconnect because it is restrained by a cam having only one slot.

Upon removal of the secondary disconnect plug the interlock bar releases a lever that performs two functions. First, it rotates the trip bar which trips the breaker if it is closed and maintains it in the trip-free condition. Second, the lever rotates the close latch shaft to release the main closing spring if it is charged. Closing is prevented by the first action which holds the breaker tripped.

CAUTION: REMOVAL OF THE SECONDARY DISCONNECT PLUG WILL TRIP A CLOSED BREAKER AND DISCHARGE THE MAIN CLOSING SPRING.

E. SHUTTERS

In addition to moving the breaker in and out of the breaker connected position, the crank arm rollers sliding in the slots in the plates on the breaker housing operate the shutters over the primary disconnects in the switchgear cell. Downward movement of the rollers in the slots moves the shutters before there is any movement of the breaker toward the connected position.

F. BREAKER POSITION INDICATORS

The breaker position indicator is visible through an opening in the front cover. The flags indicate whether the breaker is in the connected or the disconnected position. When the "BREAKER CONNECTED" indicating flag is fully visible in the aperture, the circuit breaker is in the fully connected position. Do not attempt to turn the levering-in crank further clockwise once this point is reached. EXCESSIVE FORCE APPLIED TO THE LEVERING-IN MECHANISM MAY RESULT IN DAMAGE TO THE EQUIPMENT OR INJURY TO THE OPERATOR. When the "BREAKER TEST/DISCONNECTED" indicating flag is fully visible in the aperture, the circuit breaker is in the fully disconnected position, which is also the test position. Do not attempt to turn the levering-in crank further counter-clockwise once this point is reached. In positions other than the fully connected or disconnected, the position indicator does not give a reading (Figure 2). Refer to the section titled "Inserting Breaker into Switchgear Equipment" for more information.

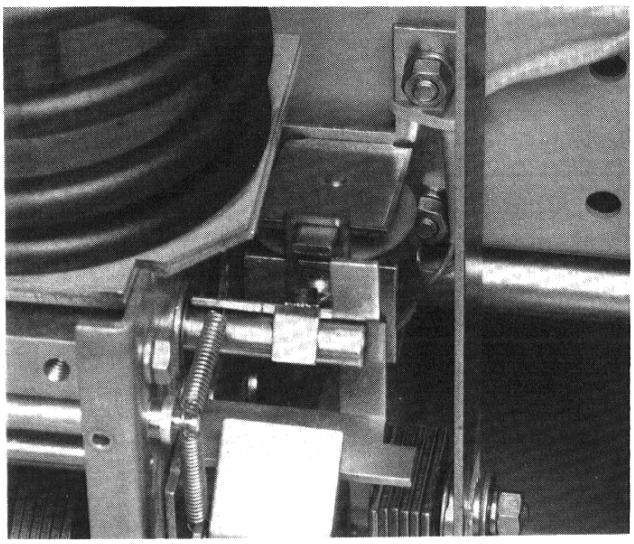


Figure 12. Shunt Trip Coil, Right

G. VACUUM INTERRUPTER CONNECTIONS

Connection to the vacuum interrupter stems is made by means of hard copper blocks. The top stem of the interrupter is threaded, and a copper block is screwed onto this stem. This block is bolted to riser plates, which are in turn bolted to the upper primary disconnect arms of the circuit breaker. Another hard copper block is clamped to the bottom or moving stem of the vacuum interrupter. Bridge contacts make contact with this block and the lower primary disconnect arms. The multiple parallel paths of the bridge contacts keep the current density low.

H. OPERATING SOLENOIDS

The closing solenoid located under the middle of the mechanism is attached to the breaker floor pan by two screws accessible from underneath the breaker (Figure 3).

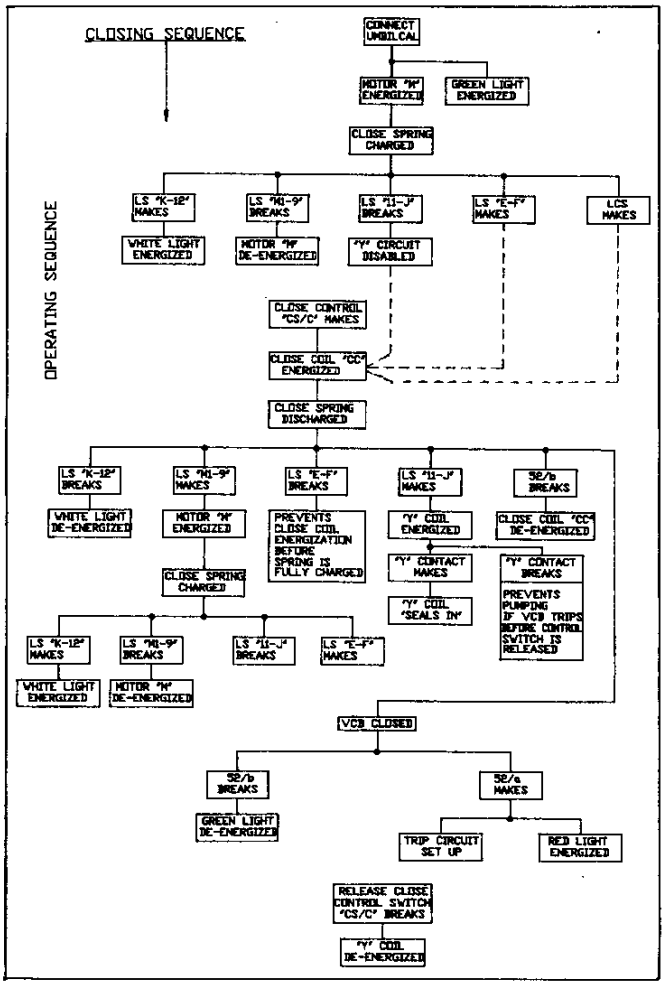


Figure 13. Control Circuit Closing Sequence

The shunt trip solenoid is to the left of the mechanism and is supported from the lower frame channel (Figure 3).

Either a second shunt trip solenoid or an undervoltage trip device may be furnished as an option. When furnished, either of these devices is to the right of the mechanism and is supported from the lower frame channel (Figure 12). Only one of these two auxiliary trip devices may be furnished on any one circuit breaker, as both types are located in the same space.

J. THE ANTI-PUMP RELAY

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

K. MOTOR CUTOFF SWITCH

The motor cutoff switch, which is located at the right of the mechanism, is attached to a bracket which is bolted to the breaker floor pan (Figure 4).

L. VACUUM INTERRUPTERS

All of the POWL-VAC family of circuit breakers utilize sealed vacuum interrupters to control the primary circuit. Because of the design variations inherent to the different types of vacuum interrupters utilized for the various ratings, specific information regarding these devices is found in the supplement provided for each different model of POWL-VAC circuit breaker.

Some vacuum interrupters appear to be identical in size and shape externally, but different models vary in rating due to differences in their internal construction. VACUUM INTERRUPTERS MUST BE REPLACED ONLY WITH NEW INTERRUPTERS OF THE SAME PART NUMBER.

M. SECONDARY DISCONNECT PLUG

Control power is transferred from the switchgear to the circuit breaker by means of the secondary disconnect plug and umbilical cord attached to the switchgear. This arrangement makes the secondary connection visible in all positions of the circuit breaker.

N. CONTROL CIRCUIT

Typical AC and DC control schemes are shown in Figure 14 and Figure 15. The control scheme of any particular circuit breaker may differ from these typical schemes, depending on the user's requirements and the auxiliary devices furnished with that circuit breaker. Check the wiring diagram supplied with the actual circuit breaker for its wiring.

The sequence of operation for all control schemes is shown in Figure 13. Circuit breaker mounted auxiliary contacts not used in the control circuit are brought out for control and indication functions. The metal-clad switchgear equipment may provide a breaker mechanism operated cell switch (MOC) for additional contacts.

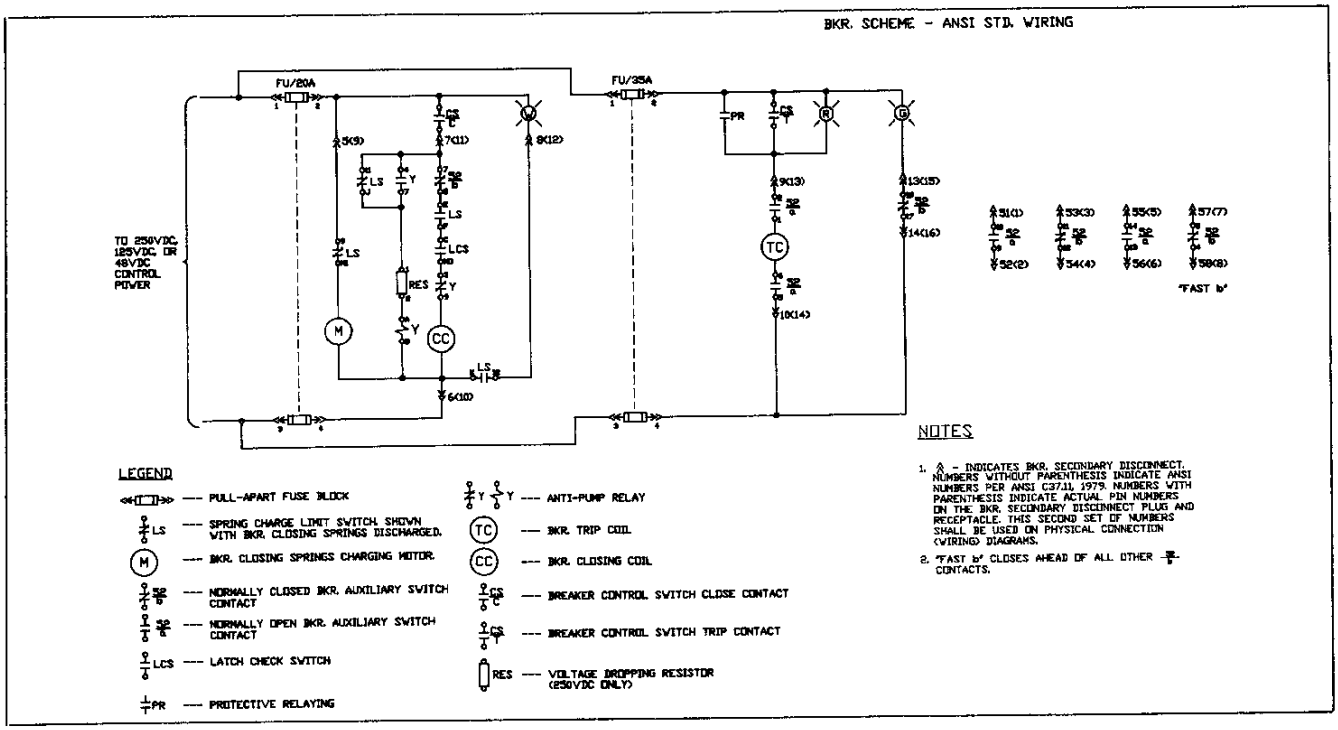


Figure 14. Typical DC Control Schematic

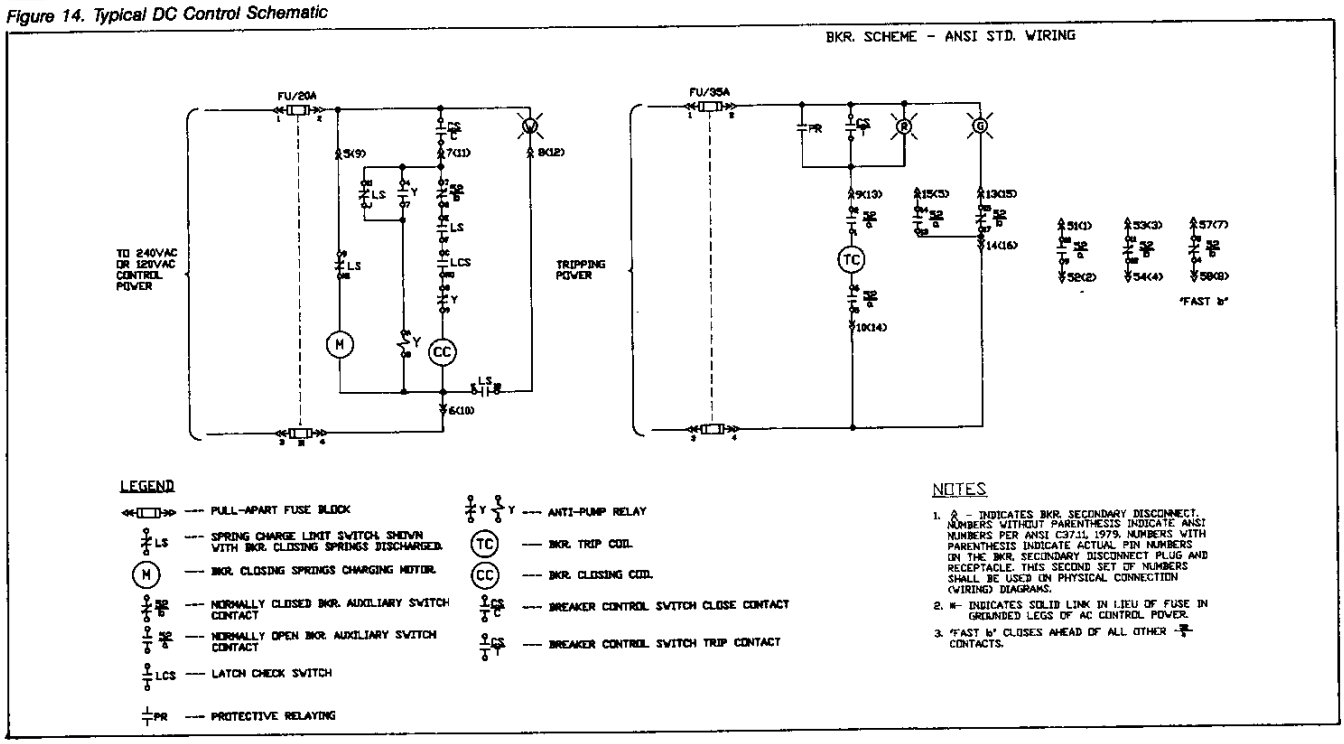


Figure 15. Typical AC control Schematic

CAUTION: IT SHOULD BE NOTED THAT THE STORED-ENERGY SPRING CHARGING MOTOR WILL BEGIN TO RUN IMMEDIATELY UPON INSERTION OF THE SECONDARY DISCONNECT PLUG IF CONTROL POWER IS AVAILABLE.

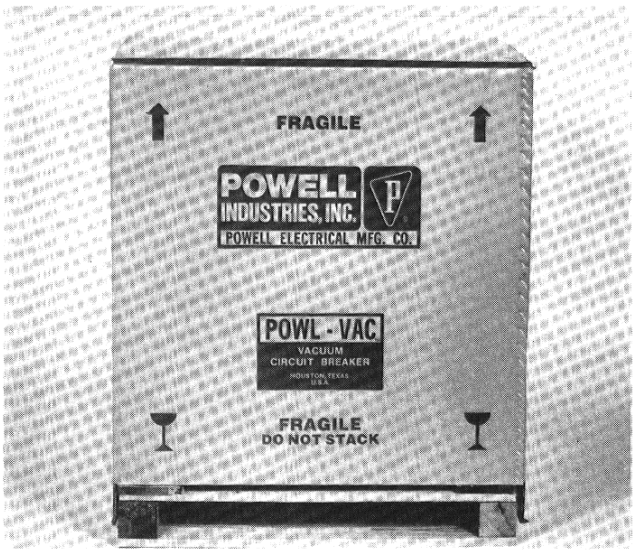


Figure 16. Circuit Breaker in Shipping Carton

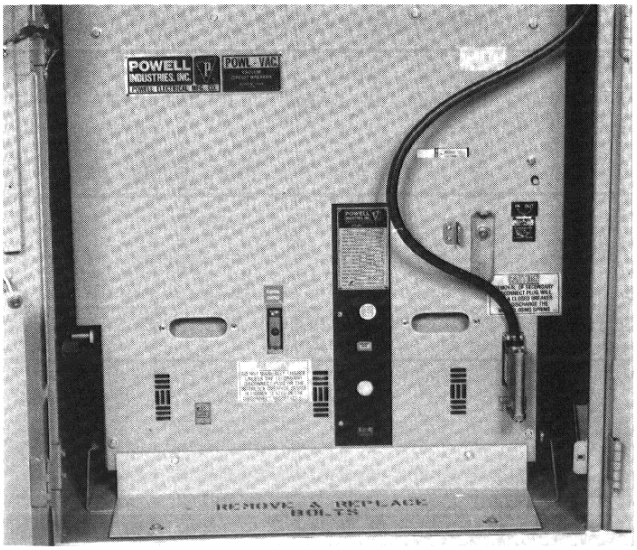
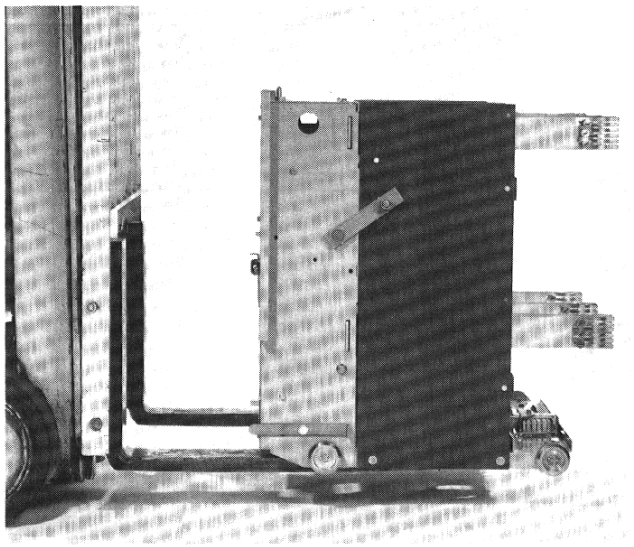


Figure 17. Circuit Breaker Bolted to Equipment Floor for Shipment



IV. INSTALLATION

A. RECEIVING

Figure 16 shows the breaker enclosed in the carton used for shipment. Check for signs of damage. If damage is found or suspected, file claims as soon as possible with the transportation company, and notify the nearest representative of Powell Electrical Manufacturing Co.

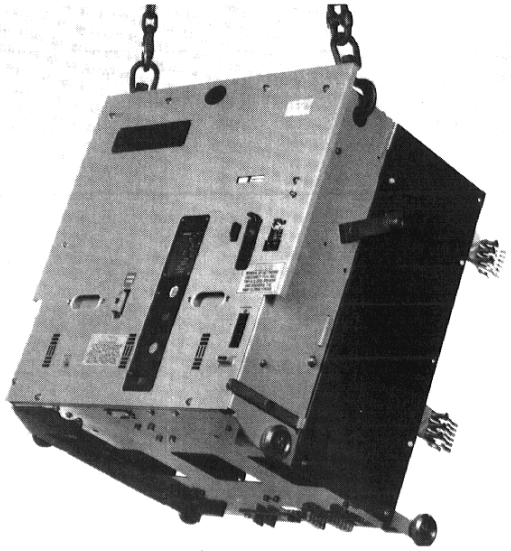


Figure 19. Circuit Breaker Being Lifted by Crane

The carton is attached to the shipping skid by two metal bands. Remove these bands and lift the carton off the circuit breaker. The breaker is attached to the skid by two more metal bands. When these are removed, the breaker may be removed from the shipping skid.

In some switchgear equipment, circuit breakers located in lower cells may be shipped in the switchgear, unpacked. The breaker will be in the disconnected position. It will be bolted to the cell floor by use of a shipping angle. The horizontal leg of this angle is bolted to the cell floor, using two cell tie-down bolts, and the vertical leg is bolted to the front of the circuit breaker using the two lower cover mounting bolts (Figure 17). Remove these four bolts, discard the shipping angle, and replace the four bolts.

B. HANDLING

After the circuit breaker has been removed from its shipping skid, it may be rolled on its own wheels on a level surface. This is the preferred way of handling the circuit breaker. When rolling the circuit breaker, it should be pushed and steered by the steel frame or the front cover. Do not handle the breaker by the primary disconnect bars.

If necessary, the breaker can be handled by a fork lift truck or an overhead crane. When using a fork lift truck, take care to avoid components located under the breaker floor pan. These components are the breaker coding plate and the ground contact. The forks on the truck should be set for a dimension over the forks of 28 inches. The forks should then ride under the wheel axles (Figure 18). The breaker can be lifted by an overhead crane using holes which have been provided for hooks at the top of the breaker frame side sheets (Figure 19).

C. STORAGE

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

(1) The breaker should be carefully protected against condensation, preferably by storing it in a warm dry room of moderate temperature, such as 40°-100°F, since dampness has an adverse effect on the insulating parts. Circuit breakers for outdoor metal-clad switchgear should be stored in the equipment only when power is available and the heaters are in operation to prevent condensation.

(2) The breaker should be stored in a clean location, free from corrosive gases or fumes. Particular care should be taken to protect the equipment from moisture and cement dust, as this combination has a very corrosive effect on many parts.

(3) Unplated surfaces of rollers, latches, etc., of the operating mechanism should be coated with grease to prevent rusting.

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

D. PUTTING INTO SERVICE

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

(1) High voltage insulation integrity.
(2) Vacuum integrity in the interrupters.
(3) Control voltage insulation integrity.
(4) Mechanical operation of the mechanism.
(5) Electrical operation of the mechanism.
(6) Levering-in device

CAUTION

High voltage across the open gaps of the interrupter can produce radiation. Personnel should stand at least 1 meter (39 inches) away from the breaker, in front of the front cover, when conducting high voltage tests. Test voltage should not exceed 36kV, 50 or 60 Hz, or 50kV dc.

(1) High Voltage Insulation Integrity

The primary circuit insulation on the breaker may be checked phase-to-phase and phase-to-ground using a 2500V megohmeter. Since definite limits cannot be given for satisfactory insulation values when testing with a megohmeter, a record should be kept of the megohmeter 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 C37.20.2-5.2.1 and -5.2.1.1, at the voltage level appropriate for the equipment, 14kV for circuit breakers rated 4.16kV or 27kV for circuit breakers rated 13.8kV.

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 POWL-VAC insulation system, no valid data can be obtained utilizing other types of high-voltage insulation tests.

(2) Vacuum Integrity

Vacuum interrupters used in Powl-Vac 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.

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 MAXMIMUM 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 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 BREAKER CONTACTS.

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 breakdown. 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 centerpoint grounded, the connections may be made either way. Apply 36kV rms 50 or 60 Hz or 50kV dc and hold for a minimum of five (5) seconds. If no breakdown occurs the interrupter is in acceptable condition. If a breakdown occurs the interrupter should be replaced.

CAUTION

WHEN TESTING WITH DC, USE A DC HIGH POTENTIAL TEST SET WITH FULL WAVE RECTIFICATION. MANY DC HIGH POTENTIAL TEST SETS USE HALF-WAVE RECTIFICATION. DO NOT USE THESE HALF-WAVE RECTIFIERS. THE CAPACITANCE OF THE VACUUM INTERRUPTER IN COMBINATION WITH THE LEAKAGE CURRENTS IN THE RECTIFIER AND ITS DC VOLTAGE MEASURING EQUIPMENT MAY RESULT IN APPLYING PEAK VOLTAGES AS MUCH AS THREE TIMES THE MEASURED VOLTAGE. THESE ABNORMALLY HIGH VOLTAGES MAY GIVE A FALSE INDICATION OF A DEFECTIVE INTERRUPTER, AND MAY PRODUCE ABNORMAL X-RADIATION.

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.

(3) 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 megohmeter or with an ac high potential tester. The ac high potential

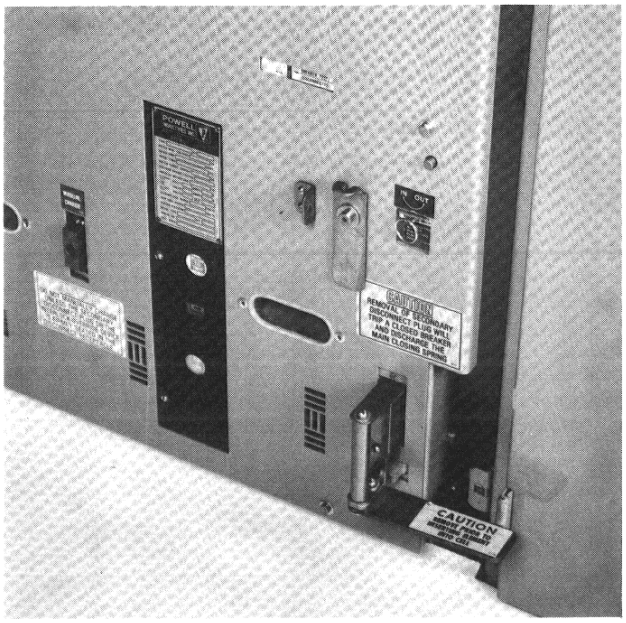


Figure 20. Circuit Breaker with Secondary Disconnect Override Device in Place

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.

(4) Mechanical Operation Check

In normal operation, the contacts of the vacuum interrupters cannot be closed unless the secondary disconnect plug is in position. To check the breaker outside of the compartment, it is necessary to simulate the connection of secondaries by inserting the secondary disconnect override device in the slot below the fixed secondary contacts (Figure 20). This device must be removed after testing and before the breaker is inserted into the cell. An interference plate will deter insertion of the circuit breaker into the cell with the override device in place. The manual charge lever should now be inserted into the manual charge crank and pushed down until a metallic click is heard. This indicates that the holding pawl has dropped into place on the ratchet wheel. Lift the lever until it is horizontal and then depress. The procedure is repeated until the spring charge flag indicates that the close spring is now charged. This requires about 60 operations of the handle. Remove the handle.

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

Push the round "PUSH TO CLOSE" operator plate and the breaker will close. The flag located above the "PUSH TO CLOSE"plate will now read "CLOSED". Push the round "PUSH TO TRIP"operator plate located at the top of the escutcheon and the breaker will open as indicated by the breaker condition flag.

(5) Electrical Operation

To check the electrical operation of the breaker, a jumper cable must be used. First, remove the control fuses in the compartment. Connect the jumper cable to the umbilical cord in the compartment and to the breaker. Insert the fuses. The motor mechanism will automatically charge the stored energy closing springs. Operation of the closing switch on the front door of the compartment will cause the breaker to close. The circuitry is arranged to cause the motor to operate again and charge the closing spring. Operating the electrical trip switch on the front door will cause the breaker to open. Alternately, the breaker may be connected to a test cabinet to perform these functions.

(6) Levering-In Device

With the breaker removed from the cell and the secondary test connector in place, the operation of the levering-in device is checked by first pushing the trip plate and moving the levering-in shutter downward to give access to the 0.75" hexagon worm shaft. It should be noted that this shutter cannot be moved downward unless the trip plate is pressed to insure an open breaker and the secondary connector or secondary disconnect override device is inserted. Insert the levering-in crank provided or a standard 3/4-inch socket onto the hex shaft. The levering-in crank arms at the side of the breaker should point in the direction of the main disconnects and the position indicator on the front cover should indicate "DISCONNECTED". Rotate the hex worm shaft in a clockwise direction. The crank arms will move downward and rotate until the position indicator reads "CONNECTED". Further rotation of the hex shaft is prevented by a threaded plate moving on a threaded portion of the hex shaft. Once the indicator reads "CONNECTED" the levering-in mechanism will have reached the end of its travel and it will be obvious by the amount of resistance that further force should not be exerted. In this position, it is possible to remove the socket from the shutter aperture and the shutter will spring back to the closed position. It will not be possible to remove the secondary disconnect override device.

Once again, push the trip plate, depress the levering-in shutter, insert the crank or socket and rotate in a counterclockwise direction until the levering-in cranks are once more in the fully withdrawn position and the indicator indicates "DISCONNECTED". With the crank arms in this position, it will be possible to remove the secondary disconnect override device.

The above procedure will have checked out the levering-in device and its associated interlocks.

E. INSERTING BREAKER INTO SWITCHGEAR EQUIPMENT

Refer to the metal-clad switchgear instruction book for general information and cautions before attempting to insert a circuit breaker into the switchgear equipment. BE SURE THAT THE LEVERING-IN CRANK ARMS AT THE SIDES OF THE BREAKER POINT IN THE DIRECTION OF THE MAIN DISCONNECTS AND THE POSITION INDICATOR READS "DISCONNECTED".

Each circuit breaker and each cell is provided with a coding plate designed to ensure that no breaker with less than the required voltage, continuous current or interrupting current rating is placed in any cell. If you attempt to insert an improperly rated breaker into a cell, these coding plates will interfere with each other and deter the insertion. The interference will occur before the breaker reaches the disconnect position. **DO NOT** ATTEMPT TO FORCE THE BREAKER PAST THIS INTERFERENCE OR REMOVE THE CODING PLATE FROM EITHER THE CELL OR THE BREAKER. Remove the incorrectly rated breaker and insert the proper breaker.

To insert a breaker into a lower compartment, first align the wheels with the housing floor pan channels. Then roll the breaker into the housing until the levering-in arms contact the levering-in cam plates in the cell. At this point, the rollout latch on the lower right side of the breaker will have engaged the stop in the cell, deterring removal of the breaker from the cell.

Table I. Circuit Breaker Lubrication

Location	Lubricant	Method
Electrical Parts		
Main Primary Disconnect Fingers	Mobilgrease 28	Wipe clean. Apply lubricant only to actual contact surface.
Sliding Contact Blocks	Mobilgrease 28	With breaker closed, wipe clean and apply thin smear of lube above sliding contact fingers.
Mechanical Parts		
Levering-In Device		
Worm and Wheel	Anderol 757 Grease	Feed grease between worm and wheel while rotating worm shaft between disconnected and connected positions.
Worm Shaft Bearings	Anderol A456 Oil	
Levering-In Shaft Support Bearings	Anderol A456 Oil	
Levering-In Crank Arm Rollers	Anderol A456 Oil	Tilt breaker sideways and rotate roller while lubricating.
Wheels	Anderol A456 Oil	Tilt breaker sideways and rotate wheels while lubricating.
Camshaft		
Camshaft Needle Bearings	Anderol A456 Oil	
Crank Pins	Anderol A456 Oil	
Spring Yoke Pins	Anderol A456 Oil	
Rachet Wheel	Anderol A456 Oil	
Pawls	Anderol A456 Oil	
Oscillator Arms at Camshaft	Anderol A456 Oil	
Jackshaft Lever Pins Passing Through Push Rods	Anderol A456 Oil	Avoid lubricant on push rods.
Main Spring Guide Rod	Anderol 757 Grease	
Motor Drive Shaft Support Bearing	Anderol A456 Oil	
Motor Drive Shaft Eccentric Roller Bearing	Anderol A456 Oil	
Motor Drive Shaft Coupler Recess	Anderol 757 Grease	
Secondary Trip Shaft Support Bearings	Anderol A456 Oil	
Close Shaft Support Bearings	Anderol A456 Oil	
Close Shaft Latch Face	Anderol 757 Grease	Apply light coating of grease and remove all excess.
Primary Trip Prop Shaft Support Bushings	Anderol A456 Oil	
Primary Trip Prop Shaft Roller	Anderol A456 Oil	
Primary Trip Prop Roller Bearing	Anderol A456 Oil	
Main Linkage Pins and Rollers.	Anderol A456 Oil	Apply to penetrate where pins pass through links and rollers.
Fixed Link Pin	Anderol A456 Oil	Apply to penetrate where pin passes through end link.
Jackshaft Outer Bearing Supports	Anderol A456 Oil	
Jackshaft Supports at Mechanism	Anderol A456 Oil	
Open-Closed Flag Drive Lever at Jackshaft	Anderol A456 Oil	
Motor Cutoff Switch Cam	Anderol 757 Grease	Apply to peripheral surface only.
Flag Support Pins	Anderol A456 Oil	

To insert a breaker into an upper cell, a lift truck is required. A detailed procedure for this operation is described in the instruction book for the metal-clad switchgear equipment.

To move the circuit breaker to the "CONNECTED" position, first plug the secondary disconnect device into the circuit breaker. Then push in the trip plate and move the levering-in shutter down. Insert the levering-in crank onto the hex shaft and rotate the crank clockwise. When the breaker is being inserted into the compartment, the force needed to rotate the crank will be low at the beginning of motion when movement of the crank arms is only opening the shutters; however, as the breaker moves into the compartment, the breaker main disconnect contacts will engage the fixed stabs located in the spouts and the force required to rotate the crank will increase appreciably. This is normal and as soon as the contacts are fully engaged, this force will decrease. Further rotation of the crank will cause the breaker to move further into the compartment ensuring wipe or overlap of the main disconnect contact and rotation of the crank clockwise can continue until the indicator flag reads "CONNECTED". At this point, DO NOT attempt to rotate the crank clockwise further or damage to the mechanism could occur. Once the breaker has reached the "CONNECTED" position, remove the levering-in crank and allow the levering-in shutter to return to its normal closed position. The circuit breaker is now ready for service.

The maximum force required on the levering-in crank for normal insertion of a circuit breaker will not exceed 65 lbs. EXCESSIVE FORCE APPLIED TO THE LEVERING-IN MECHANISM MAY RESULT IN DAMAGE TO THE EQUIPMENT OR INJURY TO THE OPERATOR.

To move a circuit breaker from the "CONNECTED" position to the "DISCONNECTED" position, first trip the circuit breaker. Then push in the trip plate, move the levering-in shutter down, and insert the levering-in crank. Rotate the crank counterclockwise until the indicator flag reads "TEST/DISCONNECTED". At this point, DO NOT attempt to rotate the crank further counterclockwise or damage to the mechanism could occur. The circuit breaker is now in the "TEST" position and may be operated electrically to test the operation of the breaker and/or its control circuits without completing the primary circuit.

To remove a circuit breaker from its cell, pull out the secondary disconnect plug and stow it on the clip provided in the cell. Removing this plug will cause the closing springs to discharge. If the breaker is in a lower cell, depress the rollout latch handle at the lower right side of the breaker so that the latch clears the stop on the housing floor plan channel. Then roll the breaker out onto the floor. If the breaker is in an upper cell, refer to instruction book for the metal-clad switchgear equipment for a detailed procedure for removing it.

F. POWER RACKING DEVICE

A motor-driven racking device is available as an optional accessory. Refer to the instruction bulletin provided with the device for proper operational procedures.

V. MAINTENANCE

Contact **Powell Apparatus Service Division** for assistance in performing maintenance or setting up a maintenance program.

A. GENERAL

(1) Introduction

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

A regular maintenance schedule should be established to obtain the best service and reliability from the circuit breaker. Powl-Vac circuit breakers are designed to comply with industry standards requiring maintenance every 2000 operations or once a year, whichever comes first.

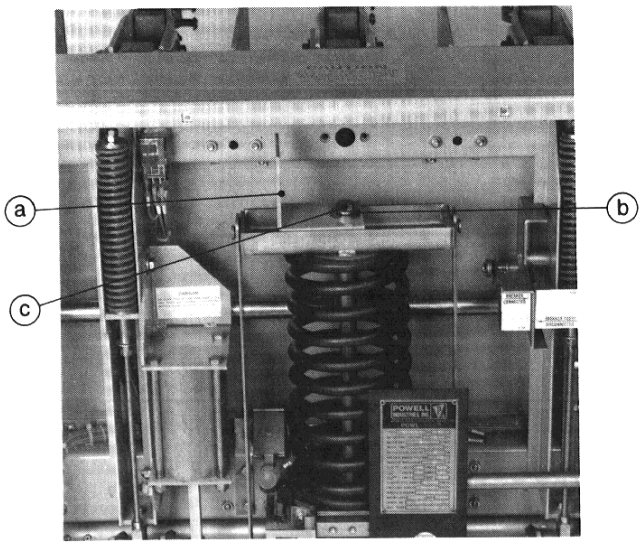


Figure 21. Main Closing Spring Assembly Compressed for Removal
- *a. Bracket*
- *b. Flat Washer*
- *c. Screw*

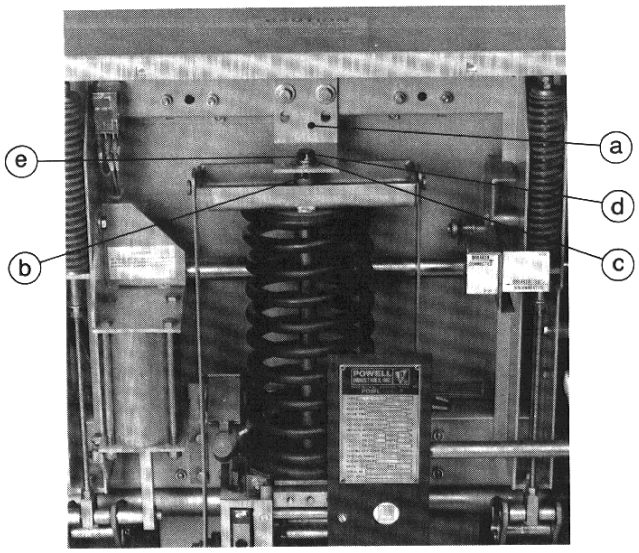


Figure 22. Main Closing Spring Assembly Installed
- *a. Bracket*
- *b. Spacer*
- *c. Flat Washer*
- *d. Screw*
- *e. Lock Washer*

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 its rating it is recommended that the breaker be inspected and necessary maintenance be 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 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 tests 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 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.

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 CHARGED SPRINGS.

(2) Inspection and Cleaning

Give the breaker a visual check for loose or damaged parts. Tighten or replace loose or missing hardware. Any part damaged so as to interfere with normal operation of the circuit breaker should be replaced. This inspection will be much easier if the front cover and interphase barrier assembly are removed.

Clean the 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 lintfree cloth or an industrial-type wiper.

Primary insulation, including the interrupter supports and the operating rods, should be cleaned also. Wipe clean with a dry lintfree cloth or an industrial type wiper. If dirt adheres and 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.

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, damaged or excessively worn parts. Operate the breaker several times manually.

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

See the sections headed "Mechanical Operation Checks" and "Levering-in Device" under the heading PUTTING INTO SERVICE for further information.

(2) Lubrication

Lubricate the mechanism and other specified parts in accordance with the lubrication chart, Table I, Page 15.

The chart shows the location of all surfaces which 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.

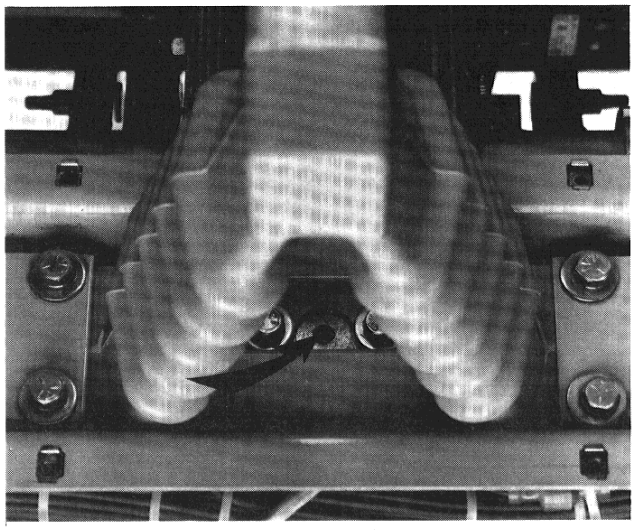


Figure 23. Primary Trip Latch Adjusting Screw

Anderol 757 Grease should be lightly applied to those bearing surfaces which are accessible and a light synthetic machine oil such as Anderol A456 should be used to penetrate through to surfaces which are inaccessible. The mechanism should be in the open, spring discharged position for lubrication. There is no necessity to disassemble the mechanism for lubrication. Tilting the breaker will facilitate the entry of the lubricant to the bearing surfaces.

(3) Closing Spring Removal and Slow Closing of Mechanism

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

With closing spring discharged and breaker contacts open, remove the screw at the top of the spring rod together with the

flat washer and lock washer. Remove the right-angle bracket by unfastening the two attachment screws. Remove the spacer from below the bracket. Turn the bracket 90° and replace it on top of the spring yoke. Place the spacer on top of the bracket with the flat washer above it. Insert screw and screw down until tension is taken off the connecting rods (Figure 21). The connecting rods can now be unhooked from the spring yoke pins and the spring assembly removed. Care should be taken on reassembly to insure correct location of the flat washer, lock washer and spacer. See Figure 22.

With the main spring assembly removed, rotate the cam shaft so that the crank arms are pointing downward. The main linkage will now move into the reset position. Push the "PUSH TO CLOSE" plate and hold in while operating the hand charge lever to rotate the cam shaft. Once the close release latch arm is past the close shaft latch plate, the "PUSH TO CLOSE" plate may be released. As the main cam engages the main linkage roller, the jackshaft will commence to rotate. Continue to operate the hand charge lever until the crank arms point upward. The breaker will now be closed and there will be a gap between the contact overtravel nuts and the contact spring yokes. See Figure 24.

(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.**

A. Adjustment of Ratchet Wheel Holding Pawl

The ratchet wheel holding pawl (c, Figure 5, Page 4) is adjusted by an eccentric cam (d, Figure 5, Page 4). If the pawl is not properly adjusted, 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 escutcheon to gain access to the head of the bolt holding the eccentric cam. Loosen the bolt slightly. While charging the spring using the charging motor to drive the mechanism, grip the eccentric cam with a pair of slip-joint pliers or a similar tool and rotate the cam slightly until 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, retighten the mounting bolt and replace the escutcheon. Be sure that the escutcheon is reinstalled on the proper circuit breaker, since the escutcheon contains the nameplate with all the breaker's rating and serial number information. The serial number of the breaker is also attached to the breaker frame near the ground shoe on a stamped metal plate. The serial number found on the nameplate must match the number affixed to the frame.

B. Adjustment of Primary and Secondary Trip Latches and Latch Check Switch

Adjust the secondary trip latch adjusting screw (h, Figure 5, Page 4) so that the overlap of the secondary trip prop on the primary trip prop roller is approximately .125 inch (Figure 10, Page 6). Adjust the primary trip latch adjusting screw (Figure 10) so that with the main linkage in the reset position the clearance between the primary trip latch roller and the secondary trip prop is 0.030 inch. The primary trip latch adjusting screw is accessible from the rear of the mechanism, between the legs of the lower center phase support insulator (Figure 23). With an 0.030 inch wire gauge between the trip bar lever and the secondary trip latch adjusting screw, the latch check switch should be open. With no gap between the lever and the screw, the latch check switch should be closed.

C. Adjustment of Close Latch

The close shaft passes through the side sheets of the mechanism frame at the front of and below the cam shaft. The left end of the shaft is shaped to make a latch face and interferes with the latch arm which is fixed to the cam shaft (Figure 7, Page 5). The other end of the close shaft is on the right side of the mechanism and a small lever attached to it is positioned by an adjusting screw (b, Figure 6, Page 5). With the main closing spring charged, turn the latch adjusting screw inward toward the rear of the breaker until the latch is released and the breaker closes. Unscrew the adjustment screw 2½ turns and lock in position with the locking nut.

(5) 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.

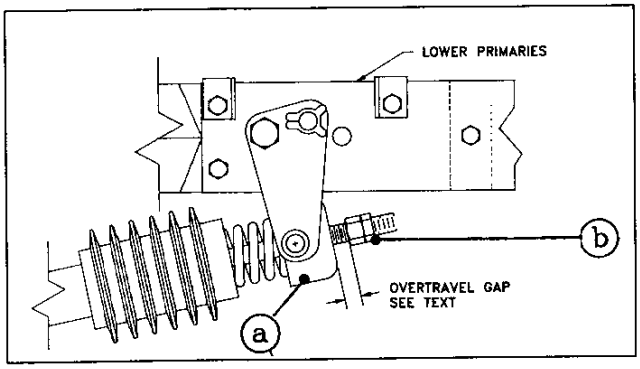


Figure 24. Operating Yoke Adjustments
a. Spring Yoke
b. Locking Nuts

C. INTERRUPTER AND CONTACT AREA

(1) Vacuum Interrupter Contact Erosion

At each inspection, the vacuum interrupters should be checked for contact erosion. The breaker must be closed for this check. Each new vacuum interrupter is set with an overtravel gap of about 7/16 to 5/8 inch between the contact loading spring yoke and the nut on the push rod stud. As the contacts erode with use, this gap will decrease. Because the factory setting of the overtravel gap varies slightly for each interrupter, a label is provided on the lower part of each interrupter. The original factory setting of the overtravel gap and the end-of-life measurement of this gap are recorded on the label. When the overtravel gap measurement reaches the end-of-life value given on this label, the interrupter should be replaced. Detailed instructions for this replacement are given in the supplementary instructions, which accompany this instruction book, for each type of vacuum interrupter.

(2) Sliding Contact Finger Wear

Remove the four sockethead screws holding the sliding contact assemblies and pivot the assemblies down. Wipe the lubricant from the surfaces of the lower contact block, the fingers and the lower main horizontal primary disconnect bars and examine these surfaces. The finger locations should present a burnished silver contact without copper appearance at more than one location. If copper is visible at more than one location per pole, or the silver is torn on the lower contact block, the interrupter should be replaced.

The sliding contact finger assemblies on the Powl-Vac circuit breaker are reversible. Since only the upper ends of the fingers experience any wiping action, the wear is normally confined to that end. If the upper ends of the fingers show noticeable wear, the finger assemblies should be reversed. Loosen the bolt holding the rear mounting clip and remove the finger assembly. Invert the assembly and replace it in the mounting clips, using the other tie rod to support the assembly. Tighten the bolt holding the rear mounting clip. If copper is visible at more than one contact location on a finger assembly, that assembly should be replaced.

Apply a light coat of Mobilgrease 28 contact lubricant to both sides of the contact blocks and to the contact areas of the lower main horizontal primary disconnect bars, then reassemble the sliding contact fingers.

(3) Mechanical Adjustment of Interrupters

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

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

(4) Vacuum Integrity

Refer to Page 10 for information on vacuum integrity and testing of interrupters.

D. OPTIONAL MAINTENANCE PROCEDURES

(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 breaker has been in storage for an extended time, especially in a damp location or other adverse environment. Both the High Voltage Insulation Integrity and Control Voltage Insulation Integrity tests should be performed. 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, except for the sliding contacts. This check should be done after interrupter replacement.

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

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

VI. RECOMMENDED RENEWAL PARTS AND REPAIR PROCEDURES

A. ORDERING INSTRUCTIONS

Refer to applicable supplementary instruction book for renewal part ordering instructions.

(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 and coils)

(3) Specify the quantity and description of the part, IB-60010, and the Supplementary Instruction Book number for the particular model and rating of circuit breaker. If the part is in the tables of recommended renewal parts found in the Supplementary Instruction Book, give its catalog number. If the part is not in the tables, the description should be accompanied by a marked illustration from this 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.

B. RECOMMENDED RENEWAL PARTS

Refer to applicable supplementary instruction book for recommended renewal part information.

It is recommended that sufficient renewal parts be carried in stock to enable the prompt replacement 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.

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

C. REPLACEMENT PROCEDURES

Due to the varied nature of the construction details found in the different ratings, detailed replacement procedures are found in the supplementary instructions supplied with each circuit breaker. Refer to those instructions for replacing the parts recommended as renewal parts. Before attempting any repair work, take note of safety practices outlined in Section II of this book.

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 CHARGED SPRINGS.

POWELL ELECTRICAL MANUFACTURING COMPANY
8550 MOSLEY DRIVE • HOUSTON, TEXAS 77075 USA
PHONE (713) 944-6900 • FAX (713) 947-4453

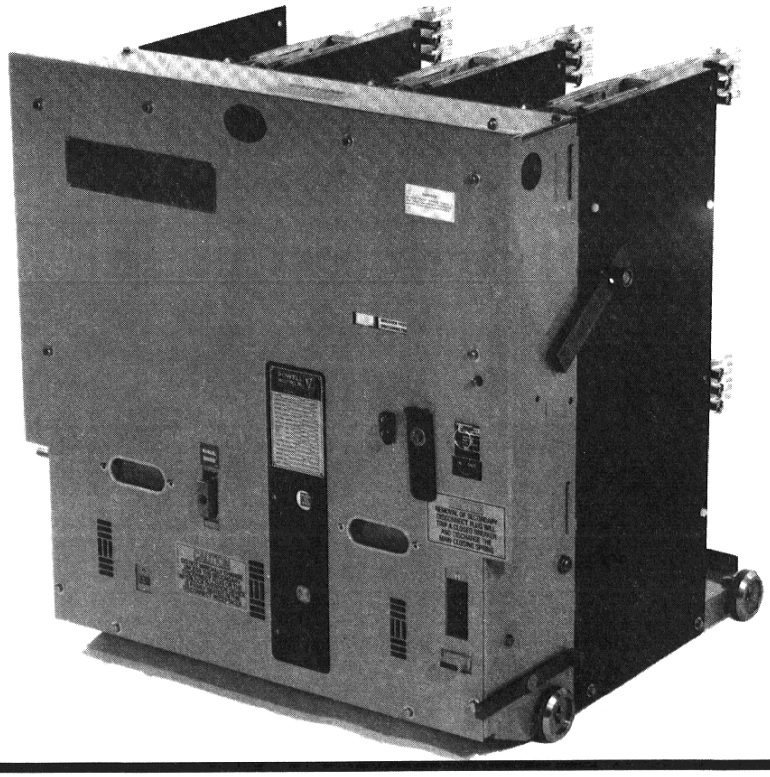
Printed in U.S.A.

Series P-60000 POWL-VAC® VACUUM CIRCUIT BREAKERS

Models 05PV0250-3 & -4, 15PV050H-3 & -4 and 15PV0500-3 & -4, 1200 A and 2000 A

CAUTION

THIS INSTRUCTION BOOK IS INCOMPLETE BY ITSELF. IT IS A SUPPLEMENT TO IB-60010 AND MUST BE USED TOGETHER WITH IB-60010. THIS INSTRUCTION BOOK CONTAINS ONLY INFORMATION THAT IS SPECIFIC TO POWL-VAC® CIRCUIT BREAKERS EQUIPPED WITH GENERAL ELECTRIC VACUUM INTERRUPTERS TYPE 50C AND 52C.



MAINTENANCE & RENEWAL PARTS

POWELL INDUSTRIES, INC.

POWELL ELECTRICAL MANUFACTURING COMPANY
8550 MOSLEY DRIVE • HOUSTON, TEXAS 77075 USA
PHONE (713) 944-6900 • FAX (713) 947-4453

TABLE OF CONTENTS

ILLUSTRATIONS

TABLES

CAUTION

Before any adjustment, 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 CIRUIT BREAKER CLOSING SPRING MUST BE DISCHARGED.

I. MAINTENANCE

(See Section V of IB-60010)

CAUTION:
These breakers utilize stored-energy spring charged mechanisms. These mechanisms must be serviced only by skilled and knowledgeable personnel capable of releasing each spring load in a controlled 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 IB-60010.

A. INTERRUPTER AND CONTACT AREA

(1) Vacuum Interrupter Contact Erosion

At each inspection, the vacuum interrupters should be checked for contact erosion. The breaker must be closed for this check. Each new vacuum interrupter is set with a gap of about 0.500 inch between the contact loading spring yoke and the nut on the pushrod. Because the factory setting of the overtravel gap varies slightly for each interrupter, a label is provided on the lower part of each interrupter. The original factory setting of the overtravel gap and the end-of-life measurement of this gap are recorded on the label. When the overtravel gap measurement reaches the end-of-life value given on this label the interrupter should be replaced. See Figure 1.

(2) Mechanical Adjustment of Interrupters

There are several factory adjustments in the interrupter area which are described below. No adjustment of these settings is required for routine maintenance. The dimensions given below are for NEW interrupters, and all of them will change during the life of the interrupter. Adjustment of these settings will be required only after interrupter replacement. **DO NOT ADJUST THESE SETTINGS UNNECESSARILY AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT.**

If major disassembly of the mechanism or the vacuum interrupters becomes necessary for any reason, all of the factory set dimensions described below must be measured and recorded prior to disassembly if interrupter replacement is not required. These dimensions must be restored to the "as-found" dimensions upon reassembly to insure proper timing and operation of the circuit breaker.

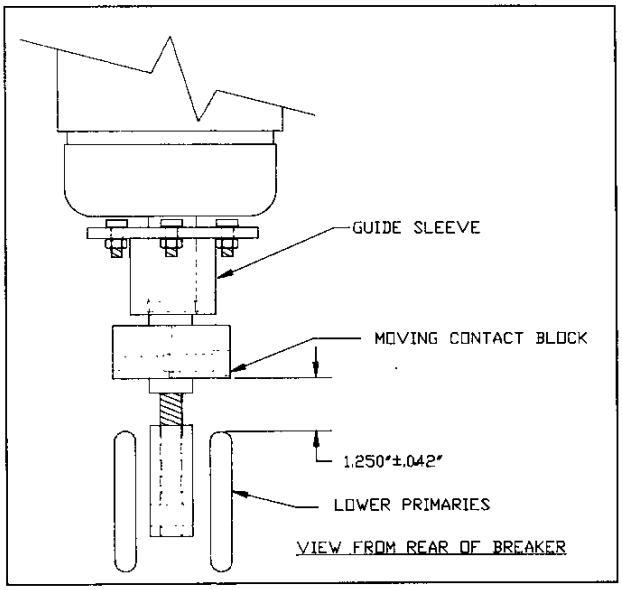


Figure 1. Moving Contact Block Measurements

NOTE: THE FOLLOWING DIMENSIONS ARE FOR NEW AND UNUSED INTERRUPTERS ONLY. THESE INITIAL SETTINGS WILL CHANGE DURING NO-LOAD BREAK-IN OPERATION OF THE INTERRUPTERS AND SUBSEQUENTLY WITH NORMAL CONTACT EROSION. NO ATTEMPT SHOULD BE MADE TO RESTORE THESE DIMENSIONS TO USED INTERRUPTERS AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT.

a. With closed contacts on a new vacuum interrupter, the bottom of the moving contact block should be 1.250" plus or minus 0.042" above the top of the lower main primary disconnect bars. See Figure 1.

b. With closed contacts on a new vacuum interrupter, the bottom of the pin which connects the bell cranks to the

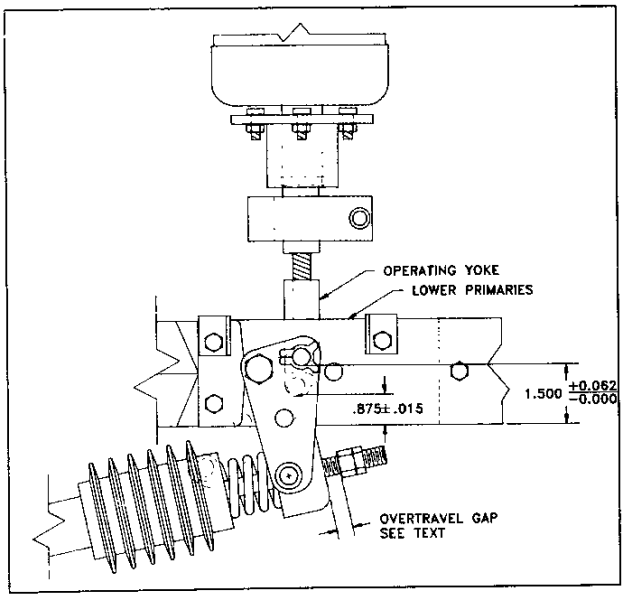


Figure 2. Operating Yoke Adjustments

operating yoke should be 1.500" + 0.06" -0.000" above the bottom of the lower main primary disconnect bars. See Figure 2.

c. With the breaker open, the dimension described in (b) should be .875"±0.015".

d. As explained in the description of the mechanism operation, when the breaker is closed a gap will exist between the contact loading spring yoke and the nut on the push rod stud, Figure 2. With a new vacuum interrupter, this gap will be about 1/2 inch. As the contacts erode, the gap will reduce to about 1/8 inch.

(3) Primary Resistance Values

Whenever maintenance procedures require that any portion of the primary current path be disassembled, the resistance of the primary current path should be checked upon reassembly. See Section V of IB-60010.

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

TYPE	RATED AMPS	RESISTANCE
05PV0250-31, -41	1200	90
05PV0250-32, -42	2000	40
15PV0500-31, -41	1200	90
15PV0500-32, -42	2000	50
15PV050H-31, -41	1200	90
15PV050H-32, -42	2000	50

II. RECOMMENDED RENEWAL PARTS AND REPAIR PROCEDURES

(See Section VI. of IB-60010)

A. ORDERING INSTRUCTIONS

(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 and coils)

(3) Specify the quantity and description of the part, and IB-60010 and IB-60011. If the part is in the tables of recommended renewal parts, give its catalog number. If the part is not in the tables, the description should be accompanied by a marked illustration from IB-60010, this bulletin, 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.

B. RECOMMENDED RENEWAL PARTS

It is recommended that sufficient renewal parts be carried in stock to enable the prompt replacement 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.

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

Table I. Interrupter and Sliding Contact Finger Assemblies

Breaker Type	Rated kV	Rated Continuous Current	Rated Momentary kA	Interrupter Assembly (3 per Bkr.)	Sliding Contact Finger Assembly (6 per Breaker)
5PV0250-3	4.76	1200A	58	60149-G1	50952-G1
5PV0250-3	4.76	2000A	58	60149-G1	50952-G1
15PV0500-3	15.0	1200A	37	60149-G2	50951-G1
15PV0500-3	15.0	2000A	37	60149-G2	50952-G1
15PV050H-3	15.0	1200A	58	60149-G2	50952-G1
15PV050H-3	15.0	2000A	58	60149-G2	50952-G1

Table II. Control Devices (1)

Control Voltage	Closing Coil	Shunt Trip Left(2)	Shunt Trip Right(3)	Under-voltage Device(4)	Charging Motor	Anti-Pump Relay
24VDC	N/A	50041-G5	50042-G6	50028-G4	N/A	N/A
48VDC	50026-G1	50041-G1	50042-G1	50028-G3	50960-G6	PVKUP11D55-48
125VDC	50026-G3	50041-G2	50042-G3	50028-G1	50960-G4	PVKUP11D55-110
250VDC	50026-G4	50041-G3	50042-G4	50028-G2	50960-G5	PVKUP11D55-110(5)
120VAC	50026-G1	50041-G1	50042-G1	N/A	50960-G4	PVKUP11A55-120
240VAC	50026-G2	50041-G6	50042-G2	N/A	50960-G5	PVKUP11A55-240
Capacitor Trip (6)	N/A	50041-G4	50042-G5	N/A	N/A	N/A

NOTES FOR TABLE II

1. One each required per breaker if breaker was originally equipped with this item. All breakers have closing coil, left shunt trip, charging motor, and anti-pump relay. Right shunt trip and undervoltage device are optional. See notes 2-4.
2. Standard shunt trip.
3. Secondary shunt trip, where furnished. Cannot be present with undervoltage device.
4. Where furnished. Cannot be present with right-hand shunt trip.
5. For 250VDC applications, a dropping resistor, 50747-G2, is required in series with this relay's coil.
6. For use with capacitor trip units with 240VAC input. Consult factory for other ratings.

Table III. Miscellaneous Parts

Qty/Bkr	Description	Catalog No.
18	Primary Contact Spring Assembly	50740-G1
1	Latch Check Switch	PVBA-2RV2-A2
1	Motor Cutoff Switch Assembly	50756-G1
	Ground Shoe Finger Assembly	
2	5PV0250-3, 1200A & 2000A	50952-G3
2	15PV0500-3, 1200A & 2000A	50951-G2
2	15PV050H-3, 1200A & 2000A	50952-G3
1	Auxiliary Switch Assembly	102108LN

C. REPLACEMENT PROCEDURES

This section includes instructions for replacing all the parts recommended as renewal parts. Before attempting any repair work, take note of safety practices outlined in Section II of IB-60010.

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 CHARGED SPRINGS.

(1) Vacuum Interrupter

a. Open circuit breaker and discharge closing spring.
b. Remove the front cover of the circuit breaker.
c. Remove interphase barrier assembly.
d. Measure and record the height of the opening springs (b, Figure 3, IB-60010).
e. Relieve the tension on the opening springs by removing the locknuts and hex nuts found on top of the opening springs. During this operation, hold the breaker open by inserting a large screwdriver or similar tool under the pin connecting the opening spring rod to the jack shaft levers and over the spacer that contacts the open-position stop bolt, then applying pressure upward. The jack shaft will rotate to the interrupter "contact touch" position when the tension is relieved from the opening springs and the pressure on the tool holding the breaker open is relaxed, due to the vacuum present in the interrupters.
f. Loosen the set screw holding the operating yoke to the operating pin. Remove X-washer from one end of the vacuum interrupter operating pin and pull the pin (d, Figure 9, IB-60010). The X-washer can be opened by squeezing the two projecting tabs with pliers.
g. Remove the four socket-head screws, two on each side (f, Figure 9, IB-60010), holding the sliding contact assemblies, and pivot the sliding contact assemblies down.
h. Unscrew and remove the operating yoke at the lower end of the vacuum interrupter (Figure 2).
i. Loosen, but do not remove, the two bolts through the upper contact block (k, Figure 9, IB-60010).
j. Loosen, but do not remove, the four bolts connecting the vertical bars above the vacuum interrupter to the upper main horizontal primary disconnect bars.
k. While supporting the vacuum interrupter, remove the two bolts connecting the upper contact block to the vertical bars.
l. Remove the vacuum interrupter.
m. Unscrew the upper contact block from the vacuum interrupter.
n. Check the contents of the replacement vacuum interrupter kit. It should contain the following:
   1. A vacuum interrupter of the proper rating, with the lower contact block attached. **DO NOT DISTURB THE ATTACHMENT OF THE CONTACT BLOCK TO THE INTERRUPTER.** This critical assembly has

been made at the factory. Attempting to modify it may result in damage to the vacuum interrupter stem, making the interrupter unusable.

2. Two X-washers.
3. Two containers of lubricant, one tacky high pressure grease Anderol 757, and one contact grease Mobilgrease 28.

p. Screw the upper contact block onto the upper stem of the vacuum interrupter so that 3 to 5 threads of the interrupter stem protrude from the top of the contact block. This adjustment is not critical at this point, as it will be gauged later.

q. Install the new interrupter in the breaker by reversing steps m through f above.

r. Set the height of the interrupter in the breaker by rotating the interrupter. Be careful to turn the interrupter by its ceramic body. Do not attempt to turn it by the lower contact block or the movable stem, as this might result in damage to the interrupter's bellows and loss of vacuum. Rotate the interrupter until the lower surface of the lower contact block is 1.125" above the upper edge of the lower primaries. See Figure 1. Then rotate the interrupter downward as necessary to position the long edges of the block parallel and in line with the lower primaries. Recheck the dimension between the lower surface of the contact block and the upper surface of the lower primaries. This dimension should be 1.125" plus or minus 0.042".

s. Remove the nut from the bell crank mounting bolt and remove the bell cranks.

t. Insert the pin through the operating yoke and the lower primaries.

u. Set the height of the operating yoke so that the bottom of the pin is 1.438" + 0.062" – 0.000" above the bottom edge of the lower primaries. See Figure 1.

v. Remove the pin and reassemble the bell cranks.

w. Lubricate the pin with a liberal coat of the tacky high pressure grease, Anderol 757, insert the pin through both bell cranks and the operating yoke, and place a new X-washer in the groove of the pin. Tighten the X-washer by squeezing the two open ends together with pliers. Tighten the set screw in the bottom of the operating yoke.

x. Tighten all bolts in the upper contact structure to 45 lb-feet.

y. Apply a light coat of Mobilgrease 28 contact lubricant to the left and right sides of the lower contact block and reassemble the sliding contact fingers.

z. Fully open the breaker by reversing step e. Reset the opening springs to the dimension recorded in step d.

aa. Close and open the circuit breaker about 50 times to properly seat the vacuum interrupter contact surface.

bb. Measure the stroke of the vacuum interrupter contacts. This can be accomplished by measuring the distance from the top of the moving contact block to the lower flange of the interrupter with the breaker open and again with the breaker closed. The difference of these two measurements is the stroke of the interrupter contacts. The stroke for these ratings is 0.562" to 0.625". If the stroke is found to be outside these limits, it will be necessary to adjust the operating yoke by turning it upward or downward. Turning it downward decreases the stroke, while turning it upwards increases the stroke. Each half-turn of the operating yoke will change the stroke by 0.050".

CAUTION: IF ADJUSTMENT OF THE OPERATING YOKE IS REQUIRED, MAKE CERTAIN THE BREAKER IS OPEN AND THE MAIN SPRING IS DISCHARGED PRIOR TO ADJUSTING THE OPERATING YOKE.

This adjustment can be accomplished by the following procedure:

1. Loosen the set screw in the operating yoke.
2. Remove the "X" washer from one side of the pin.
3. While applying a downward force to the moving contact block just sufficient to overcome the force of the vacuum, slid the pin out of one bellcrank and the operating yoke.

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

4. Rotate the operating yoke as required.
5. Install the pin through the operating yoke and bell crank. Install the "X" washer and tighten the set screw in the operating yoke.
6. Repeat the above steps as required to obtain the specified stroke.

cc. With the breaker closed, measure the gap between the contact loading spring yoke and the nut on the pushrod stud. Record this value in the space of the label on the vacuum interrupter marked "new". Deduct .38" from this dimension and record the result in the space marked "end-of-life".

dd. Replace interphase barrier assembly.

(2) Sliding Contact Finger Assembly

Instructions are given in the maintenance section of IB-60010 for removing and inverting the sliding contact finger assembly. Follow these instructions, but install the new finger assembly instead of re-installing the old one.

(3) Closing Coil Assembly

The closing coil is located in the lower front center of the circuit breaker. See Figure 3, Page 4 of IB-60010. To replace it:

a. Remove front cover of the breaker.
b. Elevate the breaker so that there is at least 6 inches of clear space below the bottom pan of the breaker.

c. Unplug the closing coil from the wire harness.
d. Remove two bolts holding closing coil assembly to base pan and drop the closing coil out of the bottom of the breaker.
e. Insert new closing coil assembly into the breaker from below, bolt it in place and plug it into the wiring harness. No adjustment is required.
f. Close breaker several times electrically to insure that coil is functioning properly.
g. Replace front cover.

(4) Shunt Trip Coil Assembly, Left

This assembly is located in the center part of the mechanism area, just to the left of the main closing spring. See Figure 3, Page 4 of IB60010. To replace it:

a. Remove front cover of breaker.
b. Unplug the trip coil from the wiring harness.
c. Remove the two bolts holding the trip coil assembly to the breaker frame and remove the assembly.
d. Bolt new assembly in place and plug it into the wiring harness.
e. Trip the breaker electrically several times at nominal control voltage to insure that coil is functioning properly.
f. Check the time interval from energization of the trip coil (at nominal control voltage) to the parting of the main contacts of the circuit breaker. This time must be within 40 to 55 milliseconds. If necessary, bend the trip lever slightly to achieve this setting. See Figure 3.
g. Trip the breaker electrically at minimum control voltage.
h. Replace front cover.

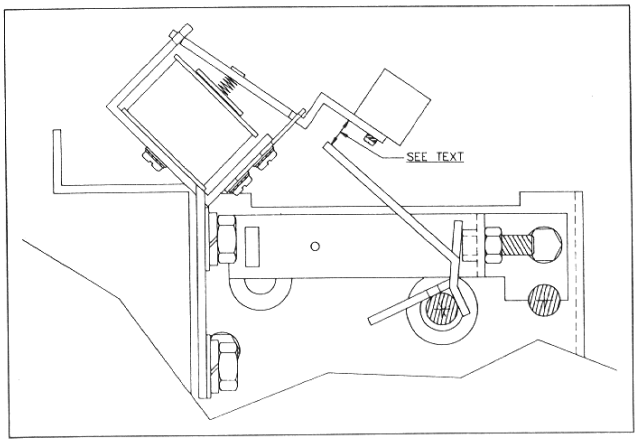


Figure 3. Trip Lever Gap Adjustment

(5) Shunt Trip Coil Assembly, Right

This assembly is located in the center part of the mechanism area, just to the right of the main closing spring. See Figure 12, Page 8 of IB60010. To replace it:

a. Remove front cover of breaker.
b. Unplug the trip coil from the wiring harness.
c. Remove the two bolts holding the trip coil assembly to the breaker frame and remove the assembly.

NOTE: It will be easier to remove the trip coil assembly if the right hand main operating spring connecting rod is removed. See section headed "Closing Spring Removal and Slow Closing of Mechanism" under Maintenance in IB-60010 for procedures for removing this connecting rod.

d. Bolt new assembly in place and plug it into the wiring harness. No adjustment is required.
e. Re-assemble spring connecting rod and main spring, if previously removed.
f. Trip the breaker electrically several times to insure that the coil is functioning properly.
g. Replace front cover.

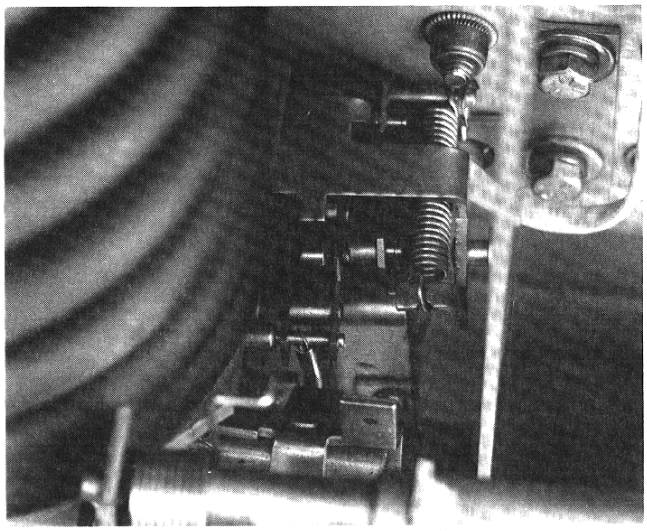


Figure 4. Undervoltage Device Mounted on Circuit Breaker

(6) Undervoltage Device Assembly

This assembly is located in the center part of the mechanism area, just to the right of the main closing spring. See Figure 4. To replace it:

a. Remove front cover of breaker.
b. Remove right hand main operating spring connecting rod. See section headed "Closing Spring Removal and Slow Closing of Mechanism" under Maintenance in IB60010 for procedures for removing this rod.
c. Unplug the undervoltage device from the wiring harness.
d. Remove the two bolts holding the undervoltage device assembly to the breaker frame and remove the assembly.
e. Bolt new assembly in place.
f. Re-assemble the main operating spring connecting rod.

g. While the undervoltage device has been tested at the factory, it is necessary to check and possibly adjust its settings once it has been assembled to the circuit breaker. This will require a variable voltage DC source capable of output of from 40% to 100% of the DC rating of the undervoltage device. Connect this source to the terminals of the undervoltage device coil.

Apply a DC voltage of 80% of the undervoltage coil rating. The undervoltage device should pick up and allow the breaker to close. Close and trip the breaker several times, using manual or shunt trip, to be sure that the vibration of breaker operation does not cause the undervoltage device to drop out improperly. If the device does drop out during this test, rotate the screw at the bottom of the device to the right in 1/8 turn steps until the proper operation is obtained. This adjustment may be fine tuned by bending the tab at the base of the beam spring up in 1/16 inch steps. See Figure 5.

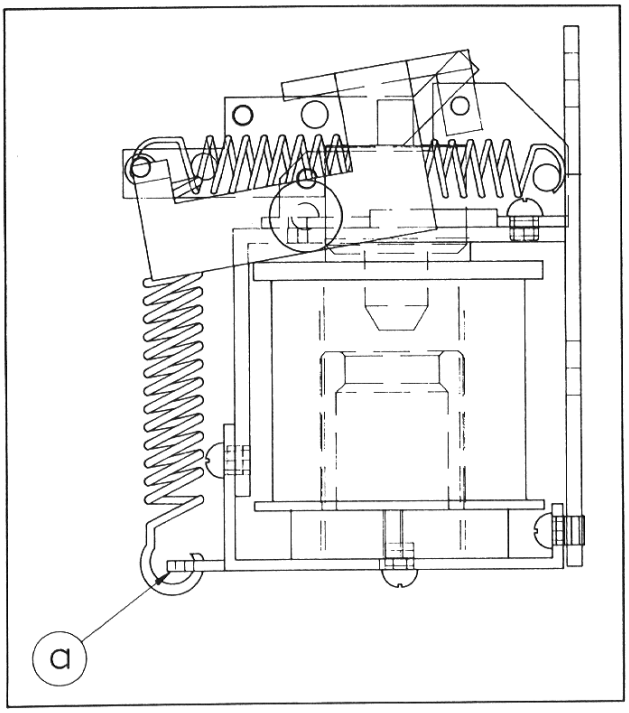


Figure 5. Undervoltage Device
a. Beam Spring Tab

Check dropout of undervoltage device by reducing test voltage to 52-56%. The undervoltage device should drop out and cause the breaker to trip in this voltage range. If dropout voltage is too low, bend the tab at the base of the beam spring down slightly to raise the voltage.

h. Disconnect the test source and plug the undervoltage device into the wiring harness.
i. Replace front cover.

(7) Charging Motor Assembly

The charging motor assembly is located at the lower right-hand side of the mechanism (See Figure 4, Page 4 of IB-60010). To replace it:

a. Remove front cover of the breaker.
b. Unplug the motor from the wiring harness.
c. Remove the two bolts holding the motor mounting bracket to the base pan and slide the motor to the right, disconnecting the motor shaft from the mechanism, and lift the motor out.
d. Lubricate the end of the shaft of the new motor liberally with Anderol 757 grease.
e. Position the new motor assembly in the circuit breaker, being sure that the pin on the end of the drive shaft engages the slot in the mechanism shaft.
f. Bolt the motor to the base pan and plug it into the wiring harness.
g. Operate the circuit breaker several times to insure that the motor operates smoothly.
h. Replace front cover.

(8) Anti-Pump Relay

This relay is located near the top of the mechanism, to the left of the main operating spring. See Figure 6. To replace it:

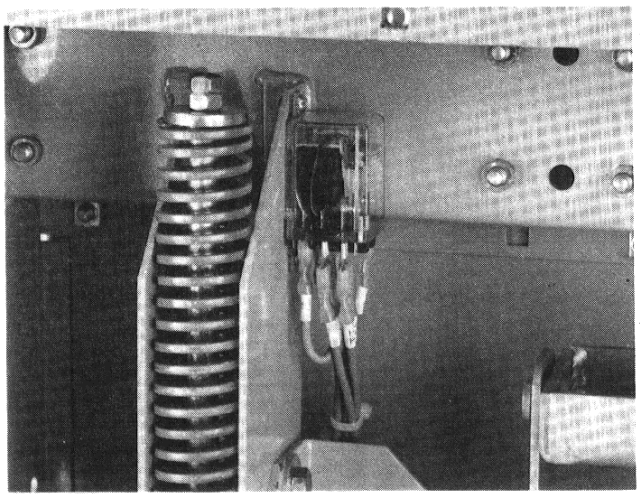


Figure 6. Anti-Pump Relay

a. Remove front cover of breaker.
b. Disconnect leads from anti-pump relay, being careful to note which wires go to which terminal.
c. Loosen lower mounting screw of relay.
d. Remove upper mounting screw and lift relay off lower screw.
e. Place new relay over lower screw, reinstall upper screw, and tighten both screws.

f. Reconnect all wires to the proper terminals of the relay.
g. Relays in 250VDC closing circuits are provided with dropping resistors to apply the proper voltage to the relay coil. The resistor is mounted adjacent to the relay. It may be replaced by unplugging it from the relay and unscrewing the mounting feet from the breaker frame, replacing the resistor and reassembling.
h. Operate the breaker several times to insure that the relay functions properly.
i. Replace front cover.

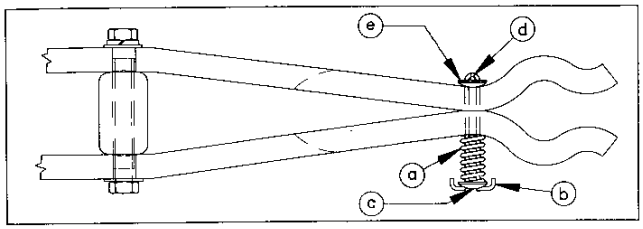


Figure 7. Primary Disconnect Finger Spring Assembly
a. Spring
b. Support
c. Cap
d. Keeper
e. Secondary Cap (1200A Models Only)

(9) Primary Contact Spring Assembly

These springs are located at the outer end of the primary contact bars. See Figure 7. To replace them:

a. Depress spring support sufficiently to allow keeper to be removed. For 1200 ampere breakers, remove the secondary cap.
b. Remove cap, spring support and spring.
c. Slide new spring onto spring support and place spring support in slot between fingers.
d. Depress head of spring support and install secondary cap (if required) and keeper in slot in end of spring support.
e. Release spring slowly, allowing keeper to seat properly.

NOTE: Springs are to be installed in every other slot in fingers; top, center and bottom. The second and fourth slots are empty.

(10) Latch Check Switch

The latch check switch is located on the left-hand side of the main mechanism frame, near the bottom of the main closing spring. See Figure 5, Page 4 of IB-60010. To replace it:

a. Remove the front cover of breaker.
b. Remove two screws holding switch to mechanism. Do not lose nut plate into which these screws are threaded.
c. Disconnect wires from switch.
d. Connect wires to new switch and fasten switch in place with screws and nut plate previously removed.
e. Adjust switch per instructions in section headed "Adjustment of Primary and Secondary Trip Latches and Latch Check Switch" under MAINTENANCE in IB-60010.
f. Operate breaker electrically several times to insure that it is working.
g. Replace front cover.

(11) Motor Cutoff Switch Assembly

The motor cutoff switch assembly is located on the floor pan of the mechanism area, just to the right of the main mechanism. See Figure 4, Page 4 of IB-60010. To replace it:

a. Remove the front cover of breaker.
b. Disconnect wires from switch, being careful to identify each wire by the terminal number from which it was removed.
c. Remove the two bolts holding the assembly to the breaker floor pan and remove the assembly.
d. Install new cutoff switch assembly, bolt it to the floor pan. Reconnect the wiring. No adjustment is needed.
e. Operate breaker electrically several times to insure that it is working.
f. Replace front cover.

(12) Ground Shoe Finger Assembly

The ground shoe assembly is located at the rear edge of the breaker floor pan between the center and right poles of the breaker. See Figure 8. To replace it:

a. Elevate the breaker so that there is at least 6 inches of clear space below the bottom pan of the breaker.
b. Remove the bolt holding the retaining clip to the ground shoe mounting bracket, and remove the retaining clip.
c. Slide the finger assembly slightly forward, so that the ends of the mounting rods on each side of the assembly are clear of the holes in the ground shoe mounting bracket. Press down on finger assembly and remove it from bottom of breaker.
d. Remove from socket-head screws holding two side finger assemblies to two red spacer tubes.
e. Assemble new side finger assemblies to red spacer tubes.
f. Wipe old lubricant off the ground shoe mounting bracket on breaker and apply a thin coat of contact lubricant Mobilgrease 28 to mounting bracket.
g. Insert new finger assembly from below the breaker floor pan and press up and slide back until the mounting rods can be inserted into the holes in the ground shoe mounting bracket.
h. Reinstall the retaining clip.

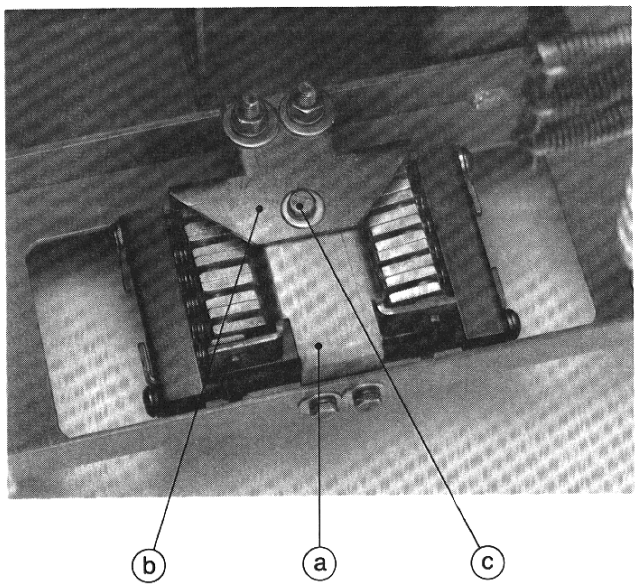


Figure 8. Ground Shoe
- *a. Mounting Bracket*
- *b. Retaining Clip*
- *c. Holding Bolt*

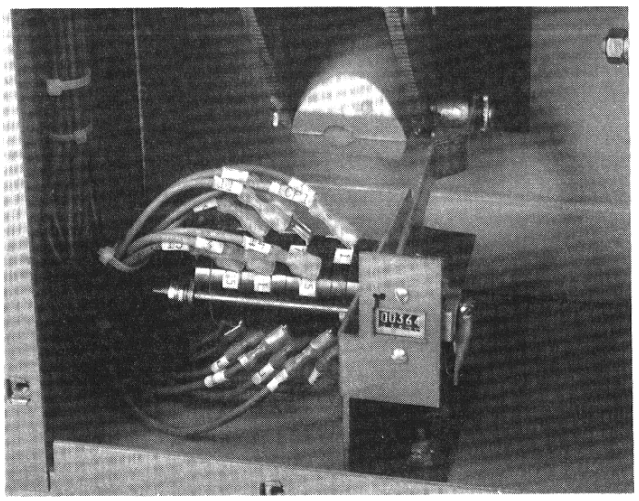


Figure 9. Auxiliary Switch

(13) Auxiliary Switch

The auxiliary switch is located in the lower left front of the mechanism area. See Figure 9. To replace an auxiliary switch:

a. Remove the front cover of breaker.
b. Disconnect wires from switch, being careful to identify each wire by the terminal number from which it was removed.
c. Remove the "E" ring securing the switch operating arm to the operations counter 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. Make sure the terminal marked "15" on the deck farthest from the operating shaft is facing the front of the breaker.
f. Insert the operating arm of the switch into the hole in the end of the operations counter linkage and secure with the "E" ring removed in step c.
g. Reconnect the wiring. Be sure wires are connected to the same terminals from which they were removed.
h. Operate breaker electrically several times to insure that it is working.
i. Replace front cover.

POWELL ELECTRICAL MANUFACTURING COMPANY
8550 MOSLEY DRIVE • HOUSTON, TEXAS 77075 USA
PHONE (713) 944-6900 • FAX (713) 947-4453

Printed in U.S.A.

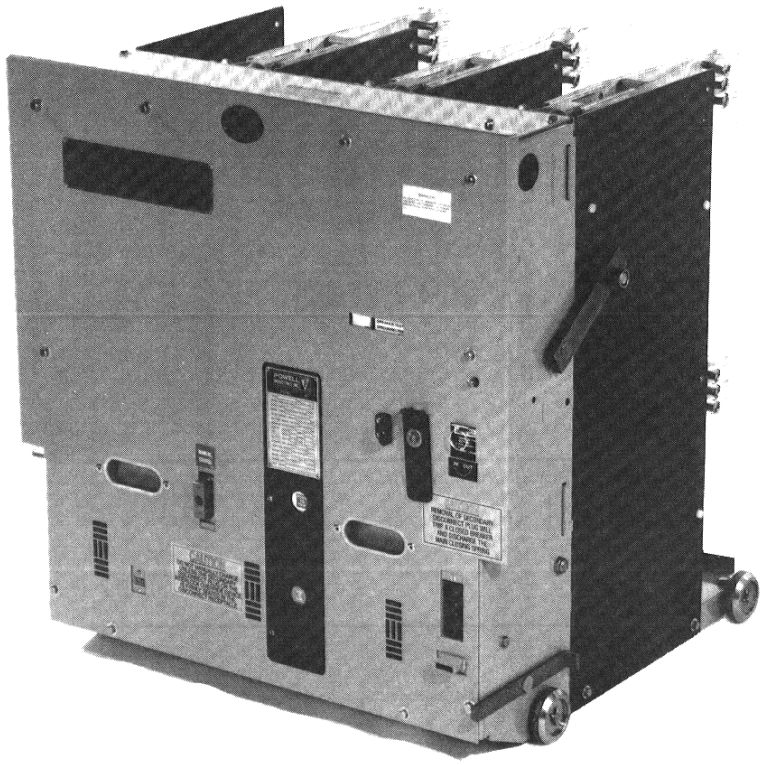
Series P-60000 POWL-VAC® VACUUM CIRCUIT BREAKERS

Models 15PV0750-6 & -7 and 15PV075H-6 & -7

1200 A and 2000 A

CAUTION

THIS INSTRUCTION BOOK IS INCOMPLETE BY ITSELF. IT IS A SUPPLEMENT TO IB-60010 AND MUST BE USED TOGETHER WITH IB-60010. THIS INSTRUCTION BOOK CONTAINS ONLY INFORMATION THAT IS SPECIFIC TO POWL-VAC® CIRCUIT BREAKERS EQUIPPED WITH WESTINGHOUSE VACUUM INTERRUPTERS TYPE 35296.



MAINTENANCE &

RENEWAL PARTS

POWELL INDUSTRIES, INC.

POWELL ELECTRICAL MANUFACTURING COMPANY
8550 MOSLEY DRIVE • HOUSTON, TEXAS 77075 USA
PHONE (713) 944-6900 • FAX (713) 947-4453

TABLE OF CONTENTS

ILLUSTRATIONS

TABLES

CAUTION

Before any adjustment, 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 CIRUIT BREAKER CLOSING SPRING MUST BE DISCHARGED.

I. MAINTENANCE

(See Section V of IB-60010)

CAUTION:

These breakers utilize stored-energy spring charged mechanisms. These mechanisms must be serviced only by [illegible] and knowledgeable personnel capable of releasing each spring load in a controlled manner. EXTREME CARE MUST BE EXERCISED TO KEEP ALL PERSONNEL, [illegible] OTHER OBJECTS CLEAR OF MECHANISMS [illegible] TO BE ACTIVATED OR RELEASED. Detailed [illegible] these mechanisms is found in [illegible]

A. INTERRUPTER AND CONTACT AREA

(1) Vacuum Interrupter Contact Erosion

At each inspection, the vacuum interrupters should be checked for contact erosion. The breaker must be closed for this check. Each new vacuum interrupter is set with a gap of 0.500 inch to 0.625 inch between the contact loading spring yoke and the nut on the pushrod. Because the factory setting of the overtravel gap varies slightly for each interrupter, a label is provided on the lower part of each interrupter. The original factory setting of the overtravel gap and the end-of-life measurement of this gap are recorded on the label. When the overtravel gap measurement reaches the end-of-life value given on this label the interrupter should be replaced. See Figure 2.

(2) Mechanical Adjustment of Interrupters

There are several factory adjustments in the interrupter area which are described below. No adjustment of these settings is required for routine maintenance. The dimensions given below are for NEW interrupters, and all of them will change during the life of the interrupter. Adjustment of these settings will be required only after interrupter replacement. **DO NOT ADJUST THESE SETTINGS UNNECESSARILY AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT.**

If major disassembly of the mechanism or the vacuum interrupters becomes necessary for any reason, all of the factory set dimensions described below must be measured and recorded

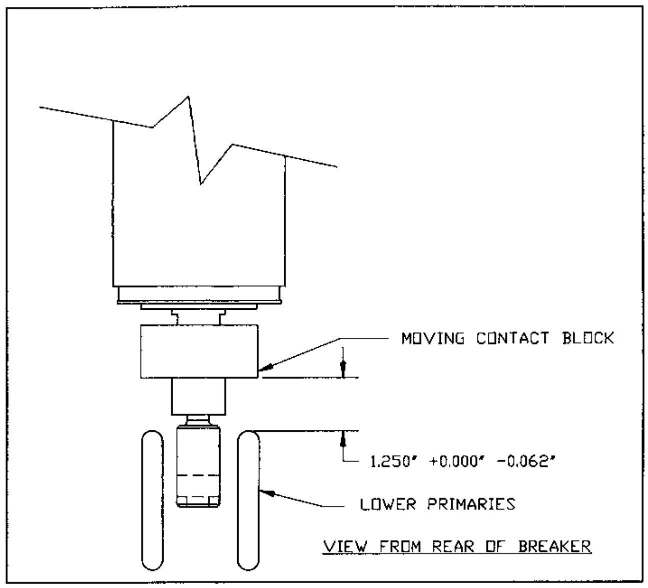


Figure 1. Moving Contact Block Measurements

prior to disassembly if interrupter replacement is not required. These dimensions must be restored to the "as-found" dimensions upon reassembly to insure proper timing and operation of the circuit breaker.

NOTE: THE FOLLOWING DIMENSIONS ARE FOR NEW AND UNUSED INTERRUPTERS ONLY. THESE INITIAL SETTINGS WILL CHANGE DURING NO-LOAD BREAK-IN OPERATION OF THE INTERRUPTERS AND SUBSEQUENTLY WITH NORMAL CONTACT EROSION. NO ATTEMPT SHOULD BE MADE TO RESTORE THESE DIMENSIONS TO USED INTERRUPTERS AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT.

a. With closed contacts on a new vacuum interrupter, the bottom of the moving contact block should be 1.250" + 0.00" -0.062" above the top of the lower main primary disconnect bars. See Figure 1.

b. With closed contacts on a new vacuum interrupter, the bottom of the pin which connects the bell cranks to the

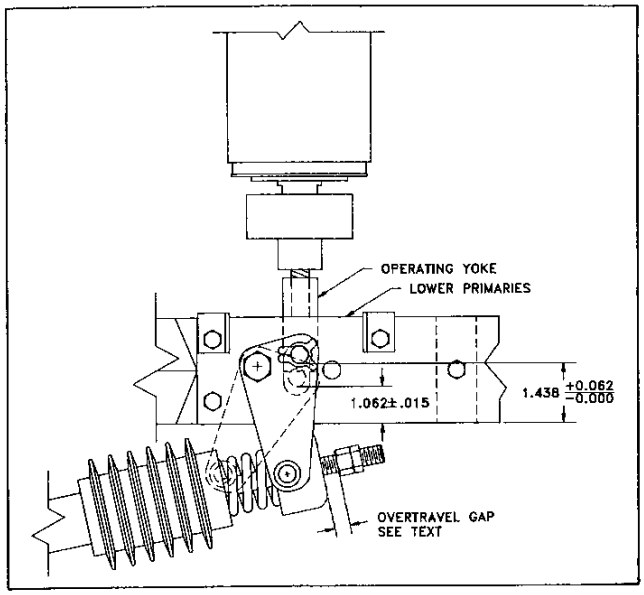


Figure 2. Operating Yoke Adjustments

operating yoke should be 1.438"+0.062" -0.000" above the bottom of the lower main primary disconnect bars. See Figure 2.

c. With the breaker open, the dimension described in (b) should be 1.062"±0.015".

d. As explained in the description of the mechanism operation, when the breaker is closed a gap will exist between the contact loading spring yoke and the nut on the push rod stud, Figure 2. With a new vacuum interrupter, this gap will be between 1/2 inch and 5/8 inch. As the contacts erode, the gap will reduce to about 3/16 inch.

(3) Primary Resistance Values

Whenever maintenance procedures require that any portion of the primary current path be disassembled, the resistance of the primary current path should be checked upon reassembly. See Section V of IB-60010.

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

TYPE RATED	AMPS	RESISTANCE
15PV0750-61	1200	60
15PV0750-62	2000	50
15PV075H-61	1200	60
15PV075H-62	2000	50
15PV0750-71	1200	60
15PV0750-72	2000	50
15PV075H-71	1200	60
15PV075H-72	2000	50

II. RECOMMENDED RENEWAL PARTS AND REPAIR PROCEDURES

(See Section VI. of IB-60010)

A. ORDERING INSTRUCTIONS

(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 and coils)

(3) Specify the quantity and description of the part, and IB-60010 and IB-60012. If the part is in the tables of recommended renewal parts, give its catalog number. If the part is not in the tables, the description should be accompanied by a marked illustration from IB-60010, this bulletin, 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.

B. RECOMMENDED RENEWAL PARTS

It is recommended that sufficient renewal parts be carried in stock to enable the prompt replacement 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.

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

Table I. Interrupter and Sliding Contact Finger Assemblies

Breaker Type	Rated kV	Rated Continuous Current	Rated Momentary kA	Interrupter Assembly (3 per Bkr.)	Sliding Contact Finger Assembly (6 per Breaker)
15PV0750-6	15.0	1200, 2000	58	60500G05	50952-G1
15PV0750-7	15.0	1200, 2000	58	60500G05	50952-G1
15PV075H-6	15.0	1200, 2000	77	60500G06	50956-G1
15PV075H-7	15.0	1200, 2000	77	60500G06	50956-G1

Table II. Control Devices (1)

Control Voltage	Closing Coil	Shunt Trip Left(2)	Shunt Trip Right(3)	Under-voltage Device(4)	Charging Motor	Anti-Pump Relay
24VDC	N/A	50041-G5	50042-G6	50028-G4	N/A	N/A
48VDC	50026-G1	50041-G1	50042-G1	50028-G3	50960-G6	PVKUP11D55-48
125VDC	50026-G3	50041-G2	50042-G3	50028-G1	50960-G4	PVKUP11D55-110
250VDC	50026-G4	50041-G3	50042-G4	50028-G2	50960-G5	PVKUP11D55-110(5)
120VAC	50026-G1	50041-G1	50042-G1	N/A	50960-G4	PVKUP11A55-120
240VAC	50026-G2	50041-G6	50042-G2	N/A	50960-G5	PVKUP11A55-240
Capacitor Trip (6)	N/A	50041-G4	50042-G5	N/A	N/A	N/A

NOTES FOR TABLE II

1. One each required per breaker if breaker was originally equipped with this item. All breakers have closing coil, left shunt trip, charging motor, and anti-pump relay. Right shunt trip and undervoltage device are optional. See notes 2-4.
2. Standard shunt trip.
3. Secondary shunt trip, where furnished. Cannot be present with undervoltage device.
4. Where furnished. Cannot be present with right-hand shunt trip.
5. For 250VDC applications, a dropping resistor, 50747-G2, is required in series with this relay's coil.
6. For use with capacitor trip units with 240VAC input. Consult factory for other ratings.

Table III. Miscellaneous Parts

Qty/Bkr	Description	Catalog No.
18	Primary Contact Spring Assembly, 2000A	50740-G1
18	Primary Contact Spring Assembly, 1200A	50740-G2
1	Latch Check Switch	PVBA-2RV2-A2
1	Motor Cutoff Switch Assembly	50756-G1
	Ground Shoe Finger Assembly	
2	15PV0750-6, 1200A & 2000A	50952-G3
2	15PV0750-7, 1200A & 2000A	50952-G3
2	15PV075H-6, 1200A & 2000A	50952-G3
2	15PV075H-7, 1200A & 2000A	50952-G3
1	Auxiliary Switch Assembly	102108LN

C. REPLACEMENT PROCEDURES

This section includes instructions for replacing all the parts recommended as renewal parts. Before attempting any repair work, take note of safety practices outlined in Section II of IB-60010.

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 CHARGED SPRINGS.

(1) Vacuum Interrupter

a. Open circuit breaker and discharge closing spring.
b. Remove the front cover of the circuit breaker.
c. Remove interphase barrier assembly.
d. Measure and record the height of the opening springs (b, Figure 3, IB-60010).
e. Relieve the tension on the opening springs by removing the locknuts and hex nuts found on top of the opening springs. During this operation, hold the breaker open by inserting a large screwdriver or similar tool under the pin connecting the opening spring rod to the jack shaft levers and over the spacer that contacts the open-position stop bolt, then applying pressure upward. The jack shaft will rotate to the interrupter "contact touch" position when the tension is relieved from the opening springs and the pressure on the tool holding the breaker open is relaxed, due to the vacuum present in the interrupters.
f. Loosen the set screw holding the operating yoke to the operating pin. Remove X-washer from one end of the vacuum interrupter operating pin and pull the pin (d, Figure 9, IB-60010). The X-washer can be opened by squeezing the two projecting tabs with pliers.
g. Remove the four socket-head screws, two on each side (f, Figure 9, IB-60010), holding the sliding contact assemblies, and pivot the sliding contact assemblies down.
h. Unscrew and remove the operating yoke at the lower end of the vacuum interrupter (Figure 2).
i. Loosen, but do not remove, the two bolts through the upper contact block (k, Figure 9, IB-60010).
j. Loosen, but do not remove, the four bolts connecting the vertical bars above the vacuum interrupter to the upper main horizontal primary disconnect bars.
k. While supporting the vacuum interrupter, remove the two bolts connecting the upper contact block to the vertical bars.
l. Remove the vacuum interrupter.
m. Unscrew the upper contact block from the vacuum interrupter.
n. Check the contents of the replacement vacuum interrupter kit. It should contain the following:
   1. A vacuum interrupter of the proper rating, with the lower contact block attached. **DO NOT DISTURB THE ATTACHMENT OF THE CONTACT BLOCK TO THE INTERRUPTER.** This critical assembly has

been made at the factory. Attempting to modify it may result in damage to the vacuum interrupter stem, making the interrupter unusable.
2. Two X-washers.
3. Two containers of lubricant, one tacky high pressure grease Anderol 757, and one contact grease Mobilgrease 28.

p. Screw the upper contact block onto the upper stem of the vacuum interrupter so that 3 to 5 threads of the interrupter stem protrude from the top of the contact block. This adjustment is not critical at this point, as it will be gauged later.
q. Install the new interrupter in the breaker by reversing steps m through f above.
r. Set the height of the interrupter in the breaker by rotating the interrupter. Be careful to turn the interrupter by its ceramic body. Do not attempt to turn it by the lower contact block or the movable stem, as this might result in damage to the interrupter's bellows and loss of vacuum. Rotate the interrupter until the lower surface of the lower contact block is 1.250" above the upper edge of the lower primaries. See Figure 1. Then rotate the interrupter downward as necessary to position the long edges of the block parallel and in line with the lower primaries. Recheck the dimension between the lower surface of the contact block and the upper surface of the lower primaries. This dimension should be 1.250" + 0.000 -0.062".
s. Remove the nut from the bell crank mounting bolt and remove the bell cranks.
t. Insert the pin through the operating yoke and the lower primaries.
u. Set the height of the operating yoke so that the bottom of the pin is 1.438" + 0.062" – 0.000" above the bottom edge of the lower primaries. See Figure 1.
v. Remove the pin and reassemble the bell cranks.
w. Lubricate the pin with a liberal coat of the tacky high pressure grease, Anderol 757, insert the pin through both bell cranks and the operating yoke, and place a new X-washer in the groove of the pin. Tighten the X-washer by squeezing the two open ends together with pliers. Tighten the set screw in the bottom of the operating yoke.
x. Tighten all bolts in the upper contact structure to 45 lb-feet.
y. Apply a light coat of Mobilgrease 28 contact lubricant to the left and right sides of the lower contact block and reassemble the sliding contact fingers.
z. Fully open the breaker by reversing step e. Reset the opening springs to the dimension recorded in step d.
aa. Close and open the circuit breaker about 50 times to properly seat the vacuum interrupter contact surface.
bb. Measure the stroke of the vacuum interrupter contacts. This can be accomplished by measuring the distance from the top of the moving contact block to the lower flange of the interrupter with the breaker open and again with the breaker closed. The difference of these two measurements is the stroke of the interrupter contacts. The stroke for these ratings is 0.375" to 0.469". If the stroke is found to be outside these limits, it will be necessary to adjust the operating yoke by turning it upward or downward. Turning it downward decreases the stroke, while turning it upwards increases the stroke. Each half-turn of the operating yoke will change the stroke by 0.077".

CAUTION: IF ADJUSTMENT OF THE OPERATING YOKE IS REQUIRED, MAKE CERTAIN THE BREAKER IS OPEN AND THE MAIN SPRING IS DISCHARGED PRIOR TO ADJUSTING THE OPERATING YOKE.

This adjustment can be accomplished by the following procedure:
1. Loosen the set screw in the operating yoke.
2. Remove the "X" washer from one side of the pin.
3. While applying a downward force to the moving contact block just sufficient to overcome the force of the vacuum, slid the pin out of one bellcrank and the operating yoke.

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

4. Rotate the operating yoke as required.
5. Install the pin through the operating yoke and bell crank. Install the "X" washer and tighten the set screw in the operating yoke.
6. Repeat the above steps as required to obtain the specified stroke.

cc. With the breaker closed, measure the gap between the contact loading spring yoke and the nut on the pushrod stud. Record this value in the space of the label on the vacuum interrupter marked "new". Deduct .38" from this dimension and record the result in the space marked "end-of-life".
dd. Replace interphase barrier assembly.

(2) Sliding Contact Finger Assembly

Instructions are given in the maintenance section of IB-60010 for removing and inverting the sliding contact finger assembly. Follow these instructions, but install the new finger assembly instead of re-installing the old one.

(3) Closing Coil Assembly

The closing coil is located in the lower front center of the circuit breaker. See Figure 3, Page 4 of IB-60010. To replace it:

a. Remove front cover of the breaker.
b. Elevate the breaker so that there is at least 6 inches of clear space below the bottom pan of the breaker.

c. Unplug the closing coil from the wire harness.
d. Remove two bolts holding closing coil assembly to base pan and drop the closing coil out of the bottom of the breaker.
e. Insert new closing coil assembly into the breaker from below, bolt it in place and plug it into the wiring harness. No adjustment is required.
f. Close breaker several times electrically to insure that coil is functioning properly.
g. Replace front cover.

(4) Shunt Trip Coil Assembly, Left

This assembly is located in the center part of the mechanism area, just to the left of the main closing spring. See Figure 3, Page 4 of IB60010. To replace it:

a. Remove front cover of breaker.
b. Unplug the trip coil from the wiring harness.
c. Remove the two bolts holding the trip coil assembly to the breaker frame and remove the assembly.
d. Bolt new assembly in place and plug it into the wiring harness.
e. Trip the breaker electrically several times at nominal control voltage to insure that coil is functioning properly.
f. Check the time interval from energization of the trip coil (at nominal control voltage) to the parting of the main contacts of the circuit breaker. This time must be within 40 to 55 milliseconds. If necessary, bend the trip lever slightly to achieve this setting. See Figure 3.
g. Trip the breaker electrically at minimum control voltage.
h. Replace front cover.

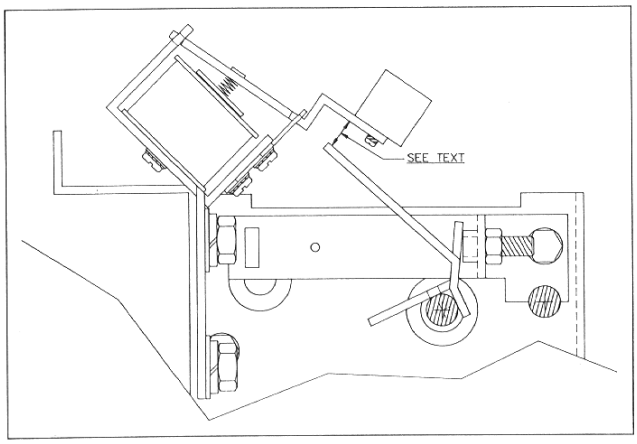


Figure 3. Trip Lever Gap Adjustment

(5) Shunt Trip Coil Assembly, Right

This assembly is located in the center part of the mechanism area, just to the right of the main closing spring. See Figure 12, Page 8 of IB60010. To replace it:

a. Remove front cover of breaker.
b. Unplug the trip coil from the wiring harness.
c. Remove the two bolts holding the trip coil assembly to the breaker frame and remove the assembly.

NOTE: It will be easier to remove the trip coil assembly if the right hand main operating spring connecting rod is removed. See section headed "Closing Spring Removal and Slow Closing of Mechanism" under Maintenance in IB-60010 for procedures for removing this connecting rod.

d. Bolt new assembly in place and plug it into the wiring harness. No adjustment is required.
e. Re-assemble spring connecting rod and main spring, if previously removed.
f. Trip the breaker electrically several times to insure that the coil is functioning properly.
g. Replace front cover.

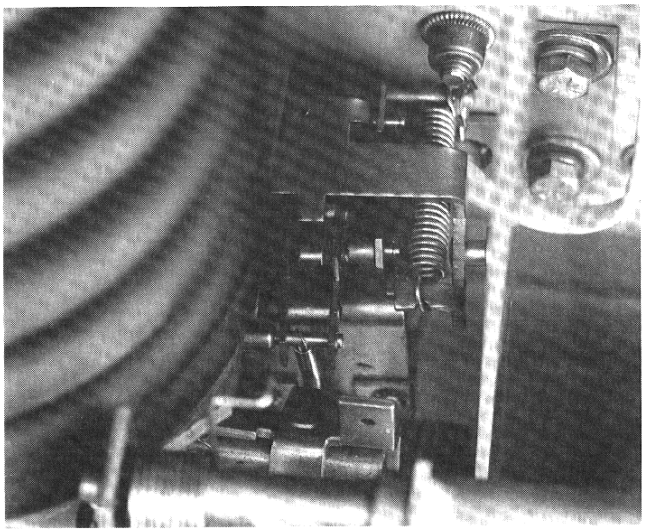


Figure 4. Undervoltage Device Mounted on Circuit Breaker

(6) Undervoltage Device Assembly

This assembly is located in the center part of the mechanism area, just to the right of the main closing spring. See Figure 4. To replace it:

a. Remove front cover of breaker.
b. Remove right hand main operating spring connecting rod. See section headed "Closing Spring Removal and Slow Closing of Mechanism" under Maintenance in IB60010 for procedures for removing this rod.
c. Unplug the undervoltage device from the wiring harness.
d. Remove the two bolts holding the undervoltage device assembly to the breaker frame and remove the assembly.
e. Bolt new assembly in place.
f. Re-assemble the main operating spring connecting rod.

g. While the undervoltage device has been tested at the factory, it is necessary to check and possibly adjust its settings once it has been assembled to the circuit breaker. This will require a variable voltage DC source capable of output of from 40% to 100% of the DC rating of the undervoltage device. Connect this source to the terminals of the undervoltage device coil.

Apply a DC voltage of 80% of the undervoltage coil rating. The undervoltage device should pick up and allow the breaker to close. Close and trip the breaker several times, using manual or shunt trip, to be sure that the vibration of breaker operation does not cause the undervoltage device to drop out improperly. If the device does drop out during this test, rotate the screw at the bottom of the device to the right in 1/8 turn steps until the proper operation is obtained. This adjustment may be fine tuned by bending the tab at the base of the beam spring up in 1/16 inch steps. See Figure 5.

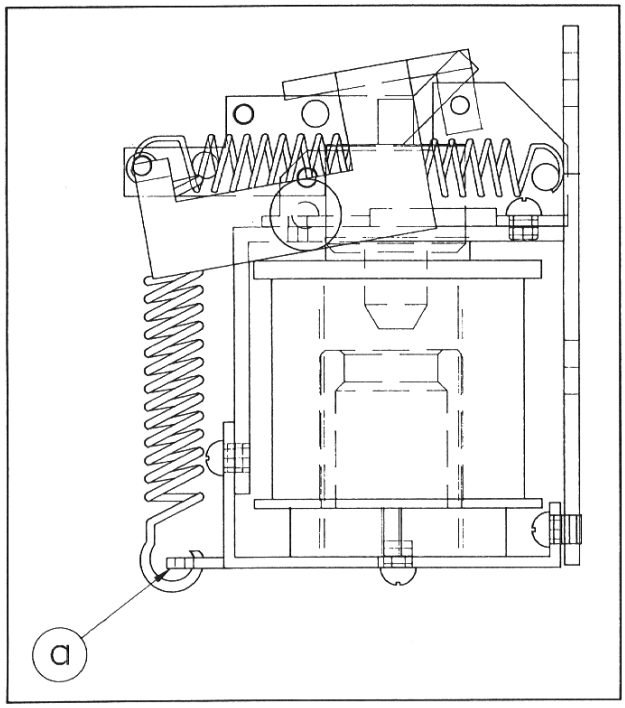


Figure 5. Undervoltage Device
a. Beam Spring Tab

Check dropout of undervoltage device by reducing test voltage to 52-56%. The undervoltage device should drop out and cause the breaker to trip in this voltage range. If dropout voltage is too low, bend the tab at the base of the beam spring down slightly to raise the voltage.

h. Disconnect the test source and plug the undervoltage device into the wiring harness.
i. Replace front cover.

(7) Charging Motor Assembly

The charging motor assembly is located at the lower right-hand side of the mechanism (See Figure 4, Page 4 of IB-60010). To replace it:

a. Remove front cover of the breaker.
b. Unplug the motor from the wiring harness.
c. Remove the two bolts holding the motor mounting bracket to the base pan and slide the motor to the right, disconnecting the motor shaft from the mechanism, and lift the motor out.
d. Lubricate the end of the shaft of the new motor liberally with Anderol 757 grease.
e. Position the new motor assembly in the circuit breaker, being sure that the pin on the end of the drive shaft engages the slot in the mechanism shaft.
f. Bolt the motor to the base pan and plug it into the wiring harness.
g. Operate the circuit breaker several times to insure that the motor operates smoothly.
h. Replace front cover.

(8) Anti-Pump Relay

This relay is located near the top of the mechanism, to the left of the main operating spring. See Figure 6. To replace it:

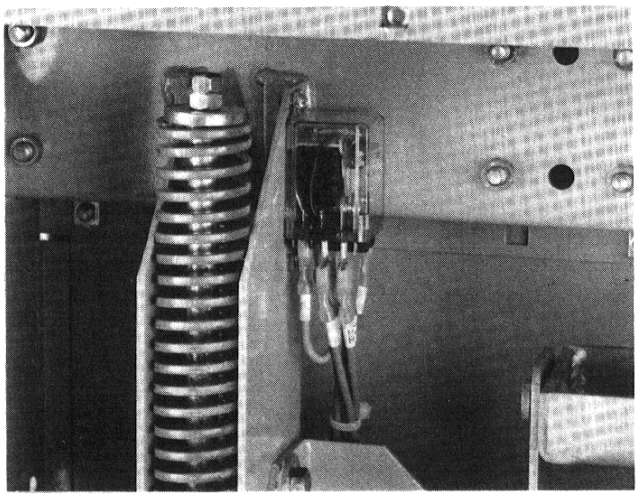


Figure 6. Anti-Pump Relay

a. Remove front cover of breaker.
b. Disconnect leads from anti-pump relay, being careful to note which wires go to which terminal.
c. Loosen lower mounting screw of relay.
d. Remove upper mounting screw and lift relay off lower screw.
e. Place new relay over lower screw, reinstall upper screw, and tighten both screws.

f. Reconnect all wires to the proper terminals of the relay.
g. Relays in 250VDC closing circuits are provided with dropping resistors to apply the proper voltage to the relay coil. The resistor is mounted adjacent to the relay. It may be replaced by unplugging it from the relay and unscrewing the mounting feet from the breaker frame, replacing the resistor and reassembling.
h. Operate the breaker several times to insure that the relay functions properly.
i. Replace front cover.

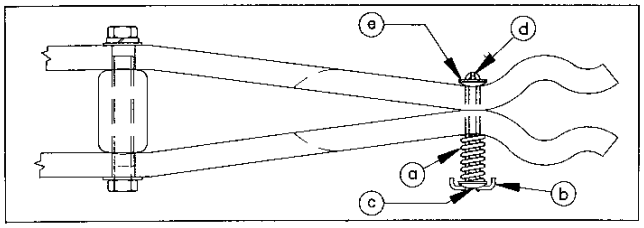


Figure 7. Primary Disconnect Finger Spring Assembly
a. Spring
b. Support
c. Cap
d. Keeper
e. Secondary Cap (1200A Models Only)

(9) Primary Contact Spring Assembly

These springs are located at the outer end of the primary contact bars. See Figure 7. To replace them:

a. Depress spring support sufficiently to allow keeper to be removed. For 1200 ampere breakers, remove the secondary cap.
b. Remove cap, spring support and spring.
c. Slide new spring onto spring support and place spring support in slot between fingers.
d. Depress head of spring support and install secondary cap (if required) and keeper in slot in end of spring support.
e. Release spring slowly, allowing keeper to seat properly.

NOTE: Springs are to be installed in every other slot in fingers; top, center and bottom. The second and fourth slots are empty.

(10) Latch Check Switch

The latch check switch is located on the left-hand side of the main mechanism frame, near the bottom of the main closing spring. See Figure 5, Page 4 of IB-60010. To replace it:

a. Remove the front cover of breaker.
b. Remove two screws holding switch to mechanism. Do not lose nut plate into which these screws are threaded.
c. Disconnect wires from switch.
d. Connect wires to new switch and fasten switch in place with screws and nut plate previously removed.
e. Adjust switch per instructions in section headed "Adjustment of Primary and Secondary Trip Latches and Latch Check Switch" under MAINTENANCE in IB-60010.
f. Operate breaker electrically several times to insure that it is working.
g. Replace front cover.

(11) Motor Cutoff Switch Assembly

The motor cutoff switch assembly is located on the floor pan of the mechanism area, just to the right of the main mechanism. See Figure 4, Page 4 of IB-60010. To replace it:

a. Remove the front cover of breaker.
b. Disconnect wires from switch, being careful to identify each wire by the terminal number from which it was removed.
c. Remove the two bolts holding the assembly to the breaker floor pan and remove the assembly.
d. Install new cutoff switch assembly, bolt it to the floor pan. Reconnect the wiring. No adjustment is needed.
e. Operate breaker electrically several times to insure that it is working.
f. Replace front cover.

(12) Ground Shoe Finger Assembly

The ground shoe assembly is located at the rear edge of the breaker floor pan between the center and right poles of the breaker. See Figure 8. To replace it:

a. Elevate the breaker so that there is at least 6 inches of clear space below the bottom pan of the breaker.
b. Remove the bolt holding the retaining clip to the ground shoe mounting bracket, and remove the retaining clip.
c. Slide the finger assembly slightly forward, so that the ends of the mounting rods on each side of the assembly are clear of the holes in the ground shoe mounting bracket. Press down on finger assembly and remove it from bottom of breaker.
d. Remove from socket-head screws holding two side finger assemblies to two red spacer tubes.
e. Assemble new side finger assemblies to red spacer tubes.
f. Wipe old lubricant off the ground shoe mounting bracket on breaker and apply a thin coat of contact lubricant Mobilgrease 28 to mounting bracket.
g. Insert new finger assembly from below the breaker floor pan and press up and slide back until the mounting rods can be inserted into the holes in the ground shoe mounting bracket.
h. Reinstall the retaining clip.

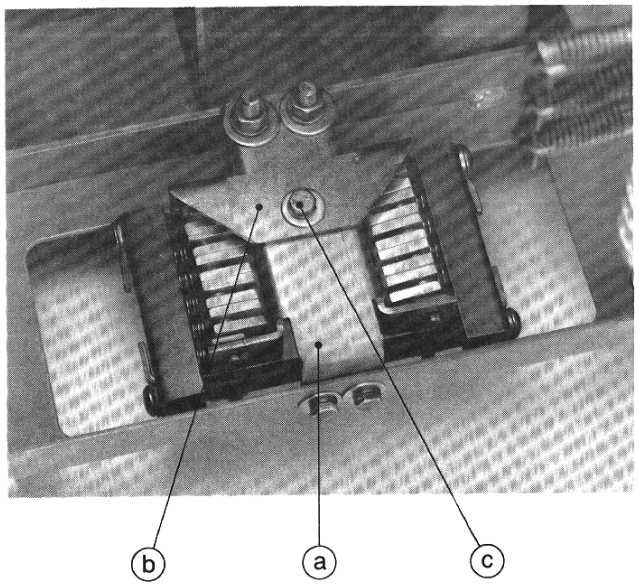


Figure 8. Ground Shoe
- *a. Mounting Bracket*
- *b. Retaining Clip*
- *c. Holding Bolt*

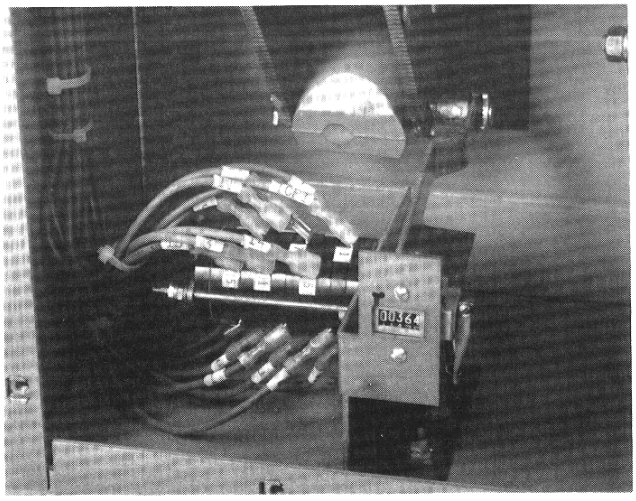


Figure 9. Auxiliary Switch

(13) Auxiliary Switch

The auxiliary switch is located in the lower left front of the mechanism area. See Figure 9. To replace an auxiliary switch:

a. Remove the front cover of breaker.
b. Disconnect wires from switch, being careful to identify each wire by the terminal number from which it was removed.
c. Remove the "E" ring securing the switch operating arm to the operations counter 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. Make sure the terminal marked "15" on the deck farthest from the operating shaft is facing the front of the breaker.
f. Insert the operating arm of the switch into the hole in the end of the operations counter linkage and secure with the "E" ring removed in step c.
g. Reconnect the wiring. Be sure wires are connected to the same terminals from which they were removed.
h. Operate breaker electrically several times to insure that it is working.
i. Replace front cover.

POWELL ELECTRICAL MANUFACTURING COMPANY
8550 MOSLEY DRIVE • HOUSTON, TEXAS 77075 USA
PHONE (713) 944-6900 • FAX (713) 947-4453

Printed in U.S.A.

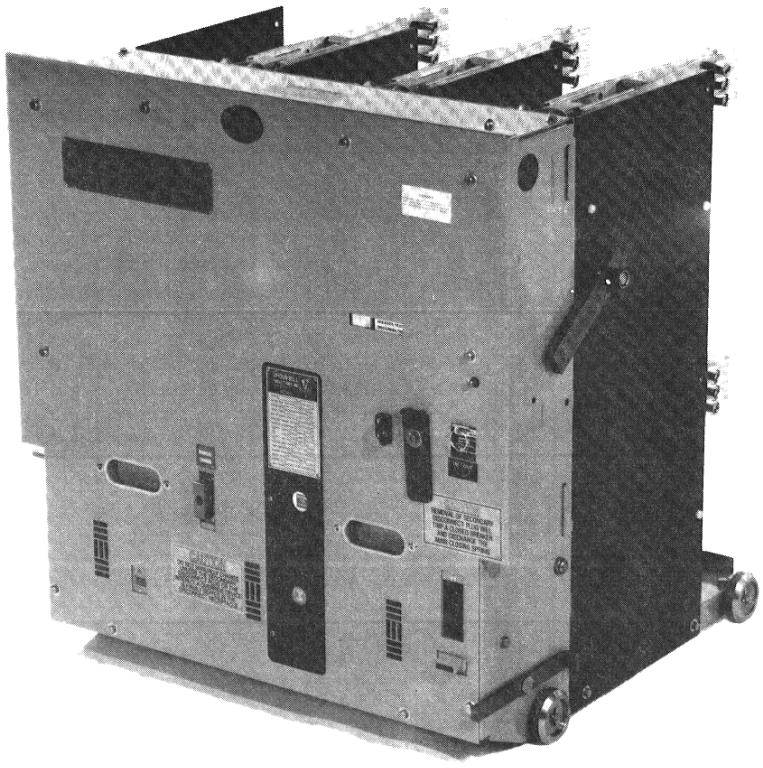
Series P-60000 POWL-VAC® VACUUM CIRCUIT BREAKERS

Models 15PV1000-6 & -7, 05PV0350-6 & -7 and 75PV0500-6 & -7, 1200A, 2000A and 3000A

05PV025H-6 & 7, 15PV050H-6 & 7, 15PV075H-6 & 7 3000A

CAUTION

THIS INSTRUCTION BOOK IS INCOMPLETE BY ITSELF. IT IS A SUPPLEMENT TO IB-60010 AND MUST BE USED TOGETHER WITH IB-60010. THIS INSTRUCTION BOOK CONTAINS ONLY INFORMATION THAT IS SPECIFIC TO POWL-VAC® CIRCUIT BREAKERS EQUIPPED WITH WESTINGHOUSE VACUUM INTERRUPTERS TYPE 35297.



MAINTENANCE & RENEWAL PARTS

POWELL INDUSTRIES, INC.

POWELL ELECTRICAL MANUFACTURING COMPANY
8550 MOSLEY DRIVE • HOUSTON, TEXAS 77075 USA
PHONE (713) 944-6900 • FAX (713) 947-4453

TABLE OF CONTENTS

ILLUSTRATIONS

TABLES

CAUTION

Before any adjustment, 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 CIRUIT BREAKER CLOSING SPRING MUST BE DISCHARGED.

I. MAINTENANCE

(See Section V of IB-60010)

CAUTION:
These breakers utilize stored-energy spring charged mechanisms. These mechanisms must be serviced only by skilled and knowledgeable personnel capable of releasing each spring load in a controlled 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 IB-60010.

A. INTERRUPTER AND CONTACT AREA

(1) Vacuum Interrupter Contact Erosion

At each inspection, the vacuum interrupters should be checked for contact erosion. The breaker must be closed for this check. Each new vacuum interrupter is set with a gap of about 0.500 inch between the contact loading spring yoke and the nut on the pushrod. Because the factory setting of the overtravel gap varies slightly for each interrupter, a label is provided on the lower part of each interrupter. The original factory setting of the overtravel gap and the end-of-life measurement of this gap are recorded on the label. When the overtravel gap measurement reaches the end-of-life value given on this label the interrupter should be replaced. See Figure 1.

(2) Mechanical Adjustment of Interrupters

There are several factory adjustments in the interrupter area which are described below. No adjustment of these settings is required for routine maintenance. The dimensions given below are for NEW interrupters, and all of them will change during the life of the interrupter. Adjustment of these settings will be required only after interrupter replacement. **DO NOT ADJUST THESE SETTINGS UNNECESSARILY AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT.**

If major disassembly of the mechanism or the vacuum interrupters becomes necessary for any reason, all of the factory set dimensions described below must be measured and recorded prior to disassembly if interrupter replacement is not required. These dimensions must be restored to the "as-found" dimensions upon reassembly to insure proper timing and operation of the circuit breaker.

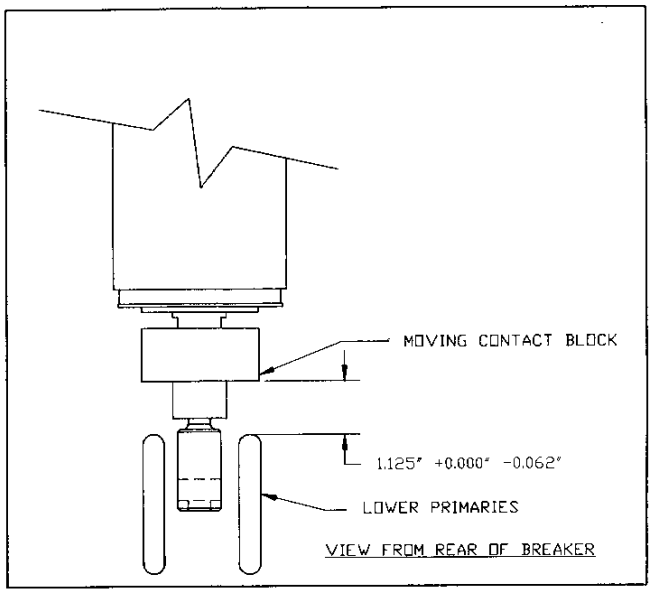


Figure 1. Moving Contact Block Measurements

NOTE: THE FOLLOWING DIMENSIONS ARE FOR NEW AND UNUSED INTERRUPTERS ONLY. THESE INITIAL SETTINGS WILL CHANGE DURING NO-LOAD BREAK-IN OPERATION OF THE INTERRUPTERS AND SUBSEQUENTLY WITH NORMAL CONTACT EROSION. NO ATTEMPT SHOULD BE MADE TO RESTORE THESE DIMENSIONS TO USED INTERRUPTERS AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT.

a. With closed contacts on a new vacuum interrupter, the bottom of the moving contact block should be 1.125" + 0.00" -0.062" above the top of the lower main primary disconnect bars. See Figure 1.

b. With closed contacts on a new vacuum interrupter, the bottom of the pin which connects the bell cranks to the

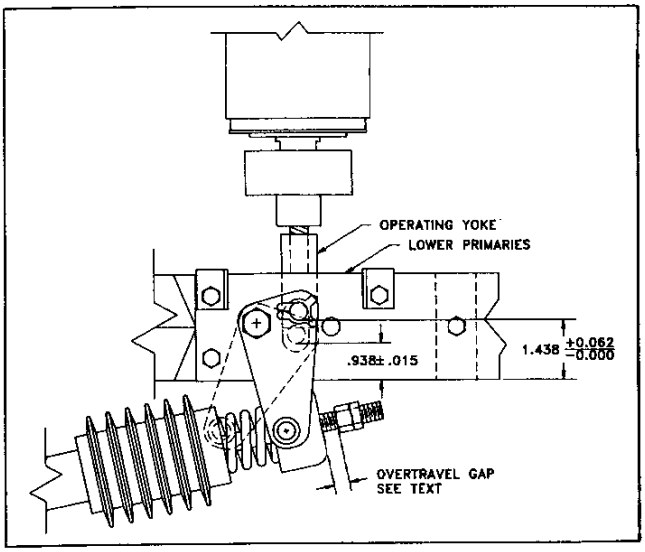


Figure 2. Operating Yoke Adjustments

operating yoke should be 1.438"+0.062" -0.000" above the bottom of the lower main primary disconnect bars. See Figure 2.

c. With the breaker open, the dimension described in (b) should be .938"±0.015".

d. As explained in the description of the mechanism operation, when the breaker is closed a gap will exist between the contact loading spring yoke and the nut on the push rod stud, Figure 2. With a new vacuum interrupter, this gap will be about 1/2 inch. As the contacts erode, the gap will reduce to about 1/8 inch.

(3) Primary Resistance Values

Whenever maintenance procedures require that any portion of the primary current path be disassembled, the resistance of the primary current path should be checked upon reassembly. See Section V of IB-60010.

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

TYPE	RATED AMPS	RESISTANCE
15PV1000-61, -71	1200	60
15PV1000-62, -72	2000	44
15PV1000-63, -73	3000	44
15PV050H-63, -73	3000	44
15PV075H-63, -73	3000	44
75PV0500-61, -71	1200	60
75PV0500-62, -72	2000	44
75PV0500-63, -73	3000	44
05PV0350-61, -71	1200	60
05PV0350-62, -72	2000	44
05PV0350-63, -73	3000	44
05PV025H-63, -73	3000	44

II. RECOMMENDED RENEWAL PARTS AND REPAIR PROCEDURES

(See Section VI. of IB-60010)

A. ORDERING INSTRUCTIONS

(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 and coils)

(3) Specify the quantity and description of the part, and IB-60010 and IB-60013. If the part is in the tables of recommended renewal parts, give its catalog number. If the part is not in the tables, the description should be accompanied by a marked illustration from IB-60010, this bulletin, 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.

B. RECOMMENDED RENEWAL PARTS

It is recommended that sufficient renewal parts be carried in stock to enable the prompt replacement 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.

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

Table I. Interrupter and Sliding Contact Finger Assemblies

Breaker Type	Rated kV	Rated Continuous Current	Rated Momentary kA	Interrupter Assembly (3 per Bkr.)	Sliding Contact Finger Assembly (6 per Breaker)
15PV1000-6, -7	15.0	1200, 2000	77	60500G07	50956-G1
15PV1000-6, -7	15.0	3000	77	60500G07	50956-G2
75PV0500-6,-7	8.25	1200, 2000	66	60500G07	50956-G1
75PV0500-6,-7	8.25	3000	66	60500G07	50956-G2
05PV0350-6, -7	4.76	1200, 2000	78	60500G07	50956-G1
05PV0350-6, -7	4.76	3000	78	60500G07	50956-G2
05PV025H-6, -7	4.76	3000	78	60500G07	50956-G2
15PV050H-6, -7	15.0	3000	58	60500G07	50956-G2
15PV075H-6, -7	15.0	3000	77	60500G07	50956-G2

Table II. Control Devices (1)

Control Voltage	Closing Coil	Shunt Trip Left(2)	Shunt Trip Right(3)	Under-voltage Device(4)	Charging Motor	Anti-Pump Relay
24VDC	N/A	50041-G5	50042-G6	50028-G4	N/A	N/A
48VDC	50026-G1	50041-G1	50042-G1	50028-G3	50960-G6	PVKUP11D55-48
125VDC	50026-G3	50041-G2	50042-G3	50028-G1	50960-G4	PVKUP11D55-110
250VDC	50026-G4	50041-G3	50042-G4	50028-G2	50960-G5	PVKUP11D55-110(5)
120VAC	50026-G1	50041-G1	50042-G1	N/A	50960-G4	PVKUP11A55-120
240VAC	50026-G2	50041-G6	50042-G2	N/A	50960-G5	PVKUP11A55-240
Capacitor Trip (6)	N/A	50041-G4	50042-G5	N/A	N/A	N/A

NOTES FOR TABLE II

1. One each required per breaker if breaker was originally equipped with this item. All breakers have closing coil, left shunt trip, charging motor, and anti-pump relay. Right shunt trip and undervoltage device are optional. See notes 2-4.
2. Standard shunt trip.
3. Secondary shunt trip, where furnished. Cannot be present with undervoltage device.
4. Where furnished. Cannot be present with right-hand shunt trip.
5. For 250VDC applications, a dropping resistor, 50747-G2, is required in series with this relay's coil.
6. For use with capacitor trip units with 240VAC input. Consult factory for other ratings.

Table III. Miscellaneous Parts

Qty/Bkr	Description	Catalog No.
18	Primary Contact Spring Assembly, 2000, 3000A	50740-G1
18	Primary Contact Spring Assembly, 1200A	50740-G2
1	Latch Check Switch	PVBA-2RV2-A2
1	Motor Cutoff Switch Assembly	50756-G1
2	Ground Shoe Finger Assembly 15PV1000-6, -7 05PV0350-6, -7 1200, 2000, 3000A	50952-G2
2	05PV025H-6, -7 15PV050H-6, -7 15PV075H-6, -7 3000A	50952-G2
1	Auxiliary Switch Assembly	102108LN

C. REPLACEMENT PROCEDURES

This section includes instructions for replacing all the parts recommended as renewal parts. Before attempting any repair work, take note of safety practices outlined in Section II of IB-60010.

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 CHARGED SPRINGS.

(1) Vacuum Interrupter

a. Open circuit breaker and discharge closing spring.
b. Remove the front cover of the circuit breaker.
c. Remove interphase barrier assembly.
d. Measure and record the height of the opening springs (b, Figure 3, IB-60010).
e. Relieve the tension on the opening springs by removing the locknuts and hex nuts found on top of the opening springs. During this operation, hold the breaker open by inserting a large screwdriver or similar tool under the pin connecting the opening spring rod to the jack shaft levers and over the spacer that contacts the open-position stop bolt, then applying pressure upward. The jack shaft will rotate to the interrupter "contact touch" position when the tension is relieved from the opening springs and the pressure on the tool holding the breaker open is relaxed, due to the vacuum present in the interrupters.
f. Loosen the set screw holding the operating yoke to the operating pin. Remove X-washer from one end of the vacuum interrupter operating pin and pull the pin (d, Figure 9, IB-60010). The X-washer can be opened by squeezing the two projecting tabs with pliers.
g. Remove the four socket-head screws, two on each side (f, Figure 9, IB-60010), holding the sliding contact assemblies, and pivot the sliding contact assemblies down.
h. Unscrew and remove the operating yoke at the lower end of the vacuum interrupter (Figure 2).
i. Loosen, but do not remove, the two bolts through the upper contact block (k, Figure 9, IB-60010).
j. Loosen, but do not remove, the four bolts connecting the vertical bars above the vacuum interrupter to the upper main horizontal primary disconnect bars.
k. While supporting the vacuum interrupter, remove the two bolts connecting the upper contact block to the vertical bars.
l. Remove the vacuum interrupter.
m. Unscrew the upper contact block from the vacuum interrupter.
n. Check the contents of the replacement vacuum interrupter kit. It should contain the following:
   1. A vacuum interrupter of the proper rating, with the lower contact block attached. **DO NOT DISTURB THE ATTACHMENT OF THE CONTACT BLOCK TO THE INTERRUPTER.** This critical assembly has

been made at the factory. Attempting to modify it may result in damage to the vacuum interrupter stem, making the interrupter unusable.

2. Two X-washers.
3. Two containers of lubricant, one tacky high pressure grease Anderol 757, and one contact grease Mobilgrease 28.

p. Screw the upper contact block onto the upper stem of the vacuum interrupter so that 3 to 5 threads of the interrupter stem protrude from the top of the contact block. This adjustment is not critical at this point, as it will be gauged later.

q. Install the new interrupter in the breaker by reversing steps m through f above.

r. Set the height of the interrupter in the breaker by rotating the interrupter. Be careful to turn the interrupter by its ceramic body. Do not attempt to turn it by the lower contact block or the movable stem, as this might result in damage to the interrupter's bellows and loss of vacuum. Rotate the interrupter until the lower surface of the lower contact block is 1.125" above the upper edge of the lower primaries. See Figure 1. Then rotate the interrupter downward as necessary to position the long edges of the block parallel and in line with the lower primaries. Recheck the dimension between the lower surface of the contact block and the upper surface of the lower primaries. This dimension should be 1.125" + 0.000 -0.062".

s. Remove the nut from the bell crank mounting bolt and remove the bell cranks.

t. Insert the pin through the operating yoke and the lower primaries.

u. Set the height of the operating yoke so that the bottom of the pin is 1.438" + 0.062" – 0.000" above the bottom edge of the lower primaries. See Figure 1.

v. Remove the pin and reassemble the bell cranks.

w. Lubricate the pin with a liberal coat of the tacky high pressure grease, Anderol 757, insert the pin through both bell cranks and the operating yoke, and place a new X-washer in the groove of the pin. Tighten the X-washer by squeezing the two open ends together with pliers. Tighten the set screw in the bottom of the operating yoke.

x. Tighten all bolts in the upper contact structure to 45 lb-feet.

y. Apply a light coat of Mobilgrease 28 contact lubricant to the left and right sides of the lower contact block and reassemble the sliding contact fingers.

z. Fully open the breaker by reversing step e. Reset the opening springs to the dimension recorded in step d.

aa. Close and open the circuit breaker about 50 times to properly seat the vacuum interrupter contact surface.

bb. Measure the stroke of the vacuum interrupter contacts. This can be accomplished by measuring the distance from the top of the moving contact block to the lower flange of the interrupter with the breaker open and again with the breaker closed. The difference of these two measurements is the stroke of the interrupter contacts. The stroke for these ratings is 0.438" to 0.500". If the stroke is found to be outside these limits, it will be necessary to adjust the operating yoke by turning it upward or downward. Turning it downward decreases the stroke, while turning it upwards increases the stroke. Each half-turn of the operating yoke will change the stroke by 0.077".

CAUTION: IF ADJUSTMENT OF THE OPERATING YOKE IS REQUIRED, MAKE CERTAIN THE BREAKER IS OPEN AND THE MAIN SPRING IS DISCHARGED PRIOR TO ADJUSTING THE OPERATING YOKE.

This adjustment can be accomplished by the following procedure:

1. Loosen the set screw in the operating yoke.
2. Remove the "X" washer from one side of the pin.
3. While applying a downward force to the moving contact block just sufficient to overcome the force of the vacuum, slid the pin out of one bellcrank and the operating yoke.

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

4. Rotate the operating yoke as required.
5. Install the pin through the operating yoke and bell crank. Install the "X" washer and tighten the set screw in the operating yoke.
6. Repeat the above steps as required to obtain the specified stroke.

cc. With the breaker closed, measure the gap between the contact loading spring yoke and the nut on the pushrod stud. Record this value in the space of the label on the vacuum interrupter marked "new". Deduct .38" from this dimension and record the result in the space marked "end-of-life".

dd. Replace interphase barrier assembly.

(2) Sliding Contact Finger Assembly

Instructions are given in the maintenance section of IB-60010 for removing and inverting the sliding contact finger assembly. Follow these instructions, but install the new finger assembly instead of re-installing the old one.

(3) Closing Coil Assembly

The closing coil is located in the lower front center of the circuit breaker. See Figure 3, Page 4 of IB-60010. To replace it:

a. Remove front cover of the breaker.
b. Elevate the breaker so that there is at least 6 inches of clear space below the bottom pan of the breaker.

c. Unplug the closing coil from the wire harness.
d. Remove two bolts holding closing coil assembly to base pan and drop the closing coil out of the bottom of the breaker.
e. Insert new closing coil assembly into the breaker from below, bolt it in place and plug it into the wiring harness. No adjustment is required.
f. Close breaker several times electrically to insure that coil is functioning properly.
g. Replace front cover.

(4) Shunt Trip Coil Assembly, Left

This assembly is located in the center part of the mechanism area, just to the left of the main closing spring. See Figure 3, Page 4 of IB60010. To replace it:

a. Remove front cover of breaker.
b. Unplug the trip coil from the wiring harness.
c. Remove the two bolts holding the trip coil assembly to the breaker frame and remove the assembly.
d. Bolt new assembly in place and plug it into the wiring harness.
e. Trip the breaker electrically several times at nominal control voltage to insure that coil is functioning properly.
f. Check the time interval from energization of the trip coil (at nominal control voltage) to the parting of the main contacts of the circuit breaker. This time must be within 40 to 55 milliseconds. If necessary, bend the trip lever slightly to achieve this setting. See Figure 3.
g. Trip the breaker electrically at minimum control voltage.
h. Replace front cover.

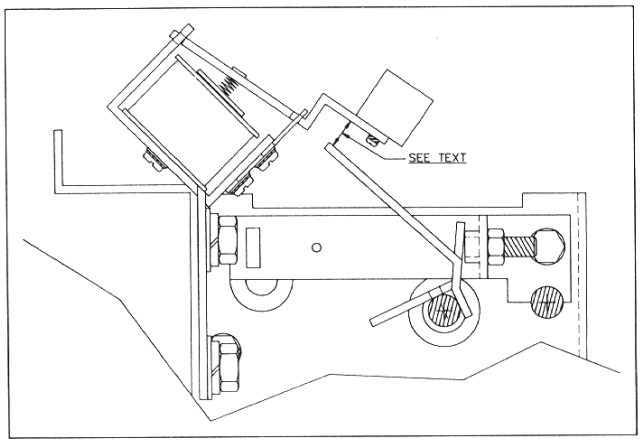


Figure 3. Trip Lever Gap Adjustment

(5) Shunt Trip Coil Assembly, Right

This assembly is located in the center part of the mechanism area, just to the right of the main closing spring. See Figure 12, Page 8 of IB60010. To replace it:

a. Remove front cover of breaker.
b. Unplug the trip coil from the wiring harness.
c. Remove the two bolts holding the trip coil assembly to the breaker frame and remove the assembly.

NOTE: It will be easier to remove the trip coil assembly if the right hand main operating spring connecting rod is removed. See section headed "Closing Spring Removal and Slow Closing of Mechanism" under Maintenance in IB-60010 for procedures for removing this connecting rod.

d. Bolt new assembly in place and plug it into the wiring harness. No adjustment is required.
e. Re-assemble spring connecting rod and main spring, if previously removed.
f. Trip the breaker electrically several times to insure that the coil is functioning properly.
g. Replace front cover.

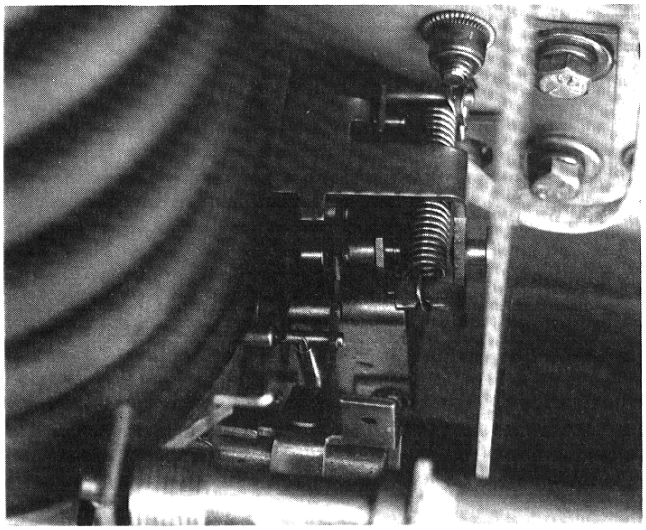


Figure 4. Undervoltage Device Mounted on Circuit Breaker

(6) Undervoltage Device Assembly

This assembly is located in the center part of the mechanism area, just to the right of the main closing spring. See Figure 4. To replace it:

a. Remove front cover of breaker.
b. Remove right hand main operating spring connecting rod. See section headed "Closing Spring Removal and Slow Closing of Mechanism" under Maintenance in IB60010 for procedures for removing this rod.
c. Unplug the undervoltage device from the wiring harness.
d. Remove the two bolts holding the undervoltage device assembly to the breaker frame and remove the assembly.
e. Bolt new assembly in place.
f. Re-assemble the main operating spring connecting rod.

g. While the undervoltage device has been tested at the factory, it is necessary to check and possibly adjust its settings once it has been assembled to the circuit breaker. This will require a variable voltage DC source capable of output of from 40% to 100% of the DC rating of the undervoltage device. Connect this source to the terminals of the undervoltage device coil.

Apply a DC voltage of 80% of the undervoltage coil rating. The undervoltage device should pick up and allow the breaker to close. Close and trip the breaker several times, using manual or shunt trip, to be sure that the vibration of breaker operation does not cause the undervoltage device to drop out improperly. If the device does drop out during this test, rotate the screw at the bottom of the device to the right in 1/8 turn steps until the proper operation is obtained. This adjustment may be fine tuned by bending the tab at the base of the beam spring up in 1/16 inch steps. See Figure 5.

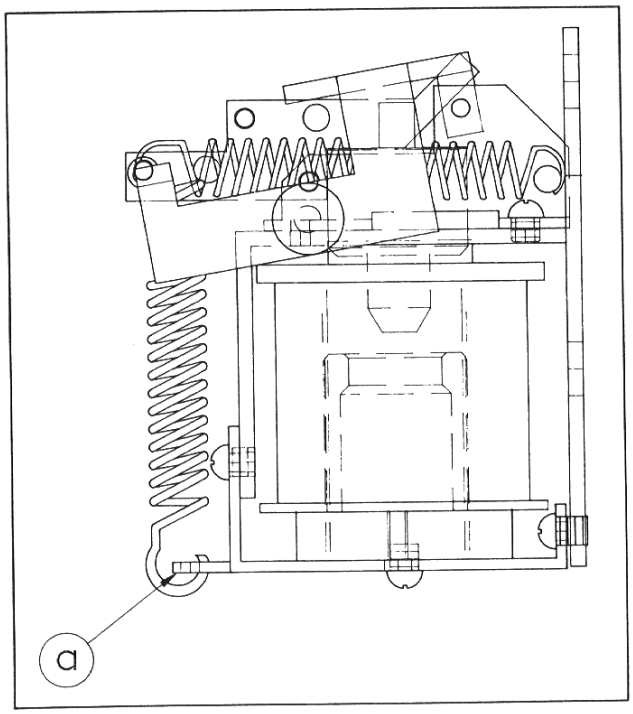


Figure 5. Undervoltage Device
a. Beam Spring Tab

Check dropout of undervoltage device by reducing test voltage to 52-56%. The undervoltage device should drop out and cause the breaker to trip in this voltage range. If dropout voltage is too low, bend the tab at the base of the beam spring down slightly to raise the voltage.

h. Disconnect the test source and plug the undervoltage device into the wiring harness.
i. Replace front cover.

(7) Charging Motor Assembly

The charging motor assembly is located at the lower right-hand side of the mechanism (See Figure 4, Page 4 of IB-60010). To replace it:

a. Remove front cover of the breaker.
b. Unplug the motor from the wiring harness.
c. Remove the two bolts holding the motor mounting bracket to the base pan and slide the motor to the right, disconnecting the motor shaft from the mechanism, and lift the motor out.
d. Lubricate the end of the shaft of the new motor liberally with Anderol 757 grease.
e. Position the new motor assembly in the circuit breaker, being sure that the pin on the end of the drive shaft engages the slot in the mechanism shaft.
f. Bolt the motor to the base pan and plug it into the wiring harness.
g. Operate the circuit breaker several times to insure that the motor operates smoothly.
h. Replace front cover.

(8) Anti-Pump Relay

This relay is located near the top of the mechanism, to the left of the main operating spring. See Figure 6. To replace it:

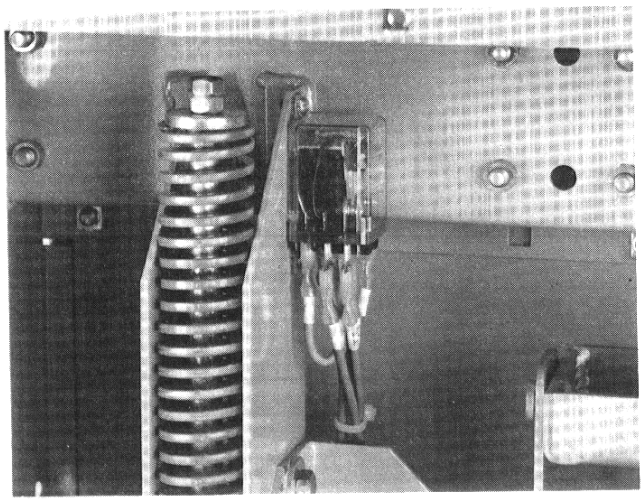


Figure 6. Anti-Pump Relay

a. Remove front cover of breaker.
b. Disconnect leads from anti-pump relay, being careful to note which wires go to which terminal.
c. Loosen lower mounting screw of relay.
d. Remove upper mounting screw and lift relay off lower screw.
e. Place new relay over lower screw, reinstall upper screw, and tighten both screws.

f. Reconnect all wires to the proper terminals of the relay.
g. Relays in 250VDC closing circuits are provided with dropping resistors to apply the proper voltage to the relay coil. The resistor is mounted adjacent to the relay. It may be replaced by unplugging it from the relay and unscrewing the mounting feet from the breaker frame, replacing the resistor and reassembling.
h. Operate the breaker several times to insure that the relay functions properly.
i. Replace front cover.

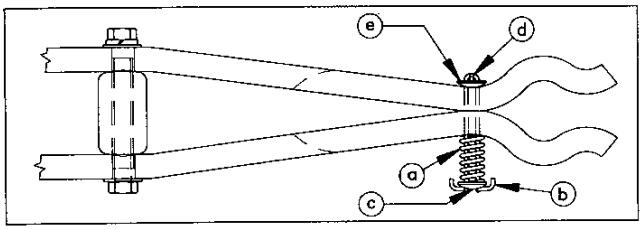


Figure 7. Primary Disconnect Finger Spring Assembly
a. Spring
b. Support
c. Cap
d. Keeper
e. Secondary Cap (1200A Models Only)

(9) Primary Contact Spring Assembly

These springs are located at the outer end of the primary contact bars. See Figure 7. To replace them:

a. Depress spring support sufficiently to allow keeper to be removed. For 1200 ampere breakers, remove the secondary cap.
b. Remove cap, spring support and spring.
c. Slide new spring onto spring support and place spring support in slot between fingers.
d. Depress head of spring support and install secondary cap (if required) and keeper in slot in end of spring support.
e. Release spring slowly, allowing keeper to seat properly.

NOTE: Springs are to be installed in every other slot in fingers; top, center and bottom. The second and fourth slots are empty.

(10) Latch Check Switch

The latch check switch is located on the left-hand side of the main mechanism frame, near the bottom of the main closing spring. See Figure 5, Page 4 of IB-60010. To replace it:

a. Remove the front cover of breaker.
b. Remove two screws holding switch to mechanism. Do not lose nut plate into which these screws are threaded.
c. Disconnect wires from switch.
d. Connect wires to new switch and fasten switch in place with screws and nut plate previously removed.
e. Adjust switch per instructions in section headed "Adjustment of Primary and Secondary Trip Latches and Latch Check Switch" under MAINTENANCE in IB-60010.
f. Operate breaker electrically several times to insure that it is working.
g. Replace front cover.

(11) Motor Cutoff Switch Assembly

The motor cutoff switch assembly is located on the floor pan of the mechanism area, just to the right of the main mechanism. See Figure 4, Page 4 of IB-60010. To replace it:

a. Remove the front cover of breaker.
b. Disconnect wires from switch, being careful to identify each wire by the terminal number from which it was removed.
c. Remove the two bolts holding the assembly to the breaker floor pan and remove the assembly.
d. Install new cutoff switch assembly, bolt it to the floor pan. Reconnect the wiring. No adjustment is needed.
e. Operate breaker electrically several times to insure that it is working.
f. Replace front cover.

(12) Ground Shoe Finger Assembly

The ground shoe assembly is located at the rear edge of the breaker floor pan between the center and right poles of the breaker. See Figure 8. To replace it:

a. Elevate the breaker so that there is at least 6 inches of clear space below the bottom pan of the breaker.
b. Remove the bolt holding the retaining clip to the ground shoe mounting bracket, and remove the retaining clip.
c. Slide the finger assembly slightly forward, so that the ends of the mounting rods on each side of the assembly are clear of the holes in the ground shoe mounting bracket. Press down on finger assembly and remove it from bottom of breaker.
d. Remove from socket-head screws holding two side finger assemblies to two red spacer tubes.
e. Assemble new side finger assemblies to red spacer tubes.
f. Wipe old lubricant off the ground shoe mounting bracket on breaker and apply a thin coat of contact lubricant Mobilgrease 28 to mounting bracket.
g. Insert new finger assembly from below the breaker floor pan and press up and slide back until the mounting rods can be inserted into the holes in the ground shoe mounting bracket.
h. Reinstall the retaining clip.

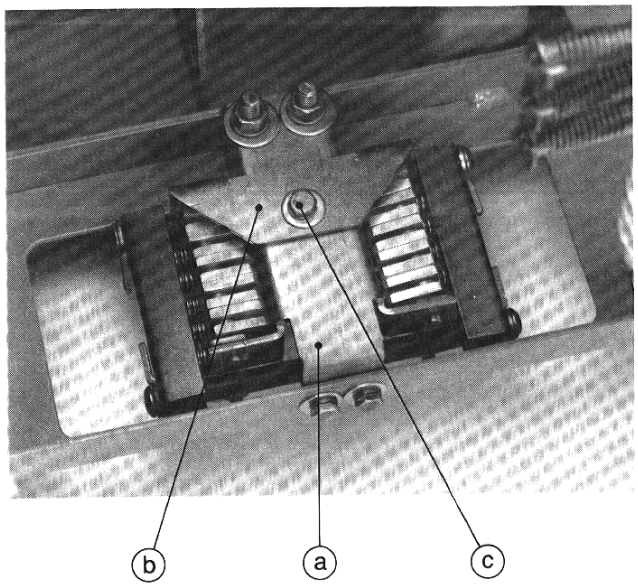


Figure 8. Ground Shoe
- *a. Mounting Bracket*
- *b. Retaining Clip*
- *c. Holding Bolt*

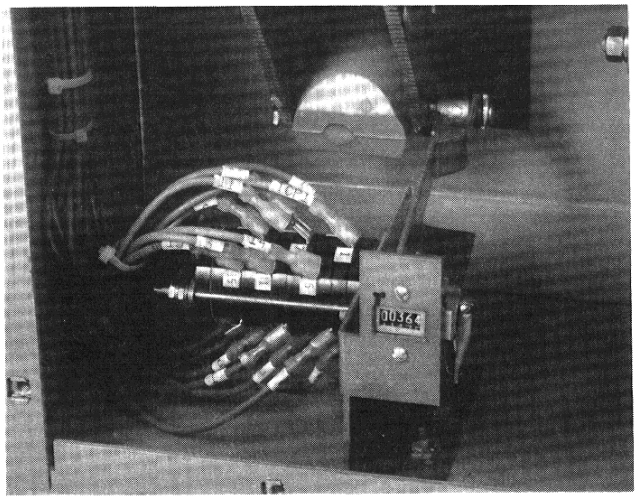


Figure 9. Auxiliary Switch

(13) Auxiliary Switch

The auxiliary switch is located in the lower left front of the mechanism area. See Figure 9. To replace an auxiliary switch:

a. Remove the front cover of breaker.
b. Disconnect wires from switch, being careful to identify each wire by the terminal number from which it was removed.
c. Remove the "E" ring securing the switch operating arm to the operations counter 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. Make sure the terminal marked "15" on the deck farthest from the operating shaft is facing the front of the breaker.
f. Insert the operating arm of the switch into the hole in the end of the operations counter linkage and secure with the "E" ring removed in step c.
g. Reconnect the wiring. Be sure wires are connected to the same terminals from which they were removed.
h. Operate breaker electrically several times to insure that it is working.
i. Replace front cover.

POWELL ELECTRICAL MANUFACTURING COMPANY
8550 MOSLEY DRIVE • HOUSTON, TEXAS 77075 USA
PHONE (713) 944-6900 • FAX (713) 947-4453

Printed in U.S.A.

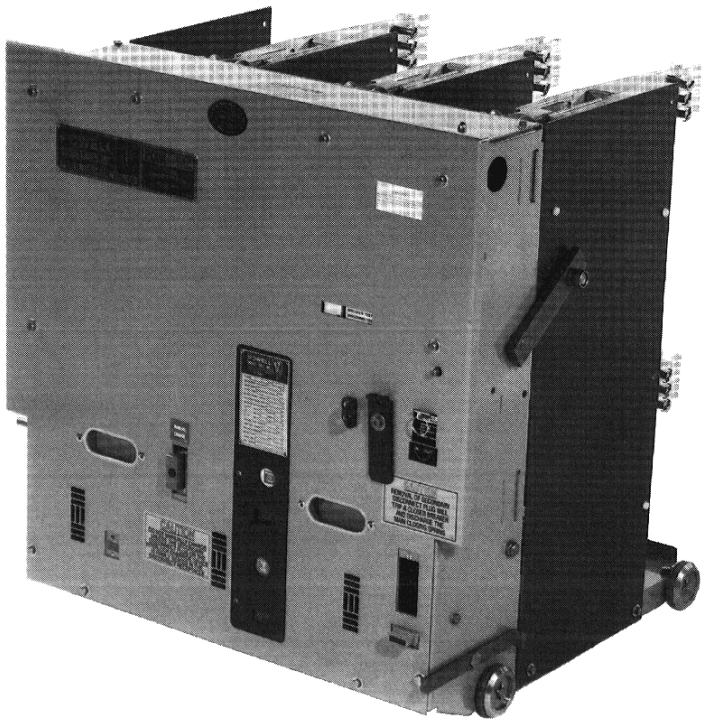
SUPPLEMENTARY INSTRUCTIONS IB-60015

Series P-60000 POWL-VAC® VACUUM CIRCUIT BREAKERS

Models 15PV0750 and 15PV075H
1200 A and 2000 A

CAUTION

This instruction book is incomplete by itself. It is a supplement to IB-60010 and must be used together with IB-60010. This instruction book contains only information that is specific to POWL-VAC® circuit breakers equipped with Westinghouse vacuum interrupters type 34999.



MAINTENANCE &

RENEWAL PARTS

Powell Electrical Manufacturing Company
8550 Mosley Drive • Houston, Texas 77075 USA
Phone (713) 944-6900 • Fax (713) 947-4453

TABLE OF CONTENTS

ILLUSTRATIONS

TABLES

CAUTION

Before any adjustment, 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.

I. MAINTENANCE

(See Section V of IB-60010)

CAUTION

These breakers utilize stored-energy spring charged mechanisms. These mechanisms must be serviced only by skilled and knowledgeable personnel capable of releasing each spring load in a controlled manner. EXTREME CAUTION 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 IB-60010.

A. INTERRUPTER AND CONTACT AREA

(1) Vacuum Interrupter Contact Erosion

At each inspection, the vacuum interrupters should be checked for contact erosion. The breaker must be closed for this check. Each new vacuum interrupter is set with a gap of 0.500 inch to 0.625 inch between the contact loading spring yoke and the nut on the pushrod. Because the factory setting of the overtravel gap varies slightly for each interrupter, a label is provided on the lower part of each interrupter. The original factory setting of the overtravel gap and the end-of-life measurement of this gap are recorded on the label. When the overtravel gap measurement reaches the end-of-life value given on this label the interrupter should be replaced. See Figure 2.

(2) Mechanical Adjustment of Interrupters

There are several factory adjustments in the interrupter area which are described below. No adjustment of these settings is required for routine maintenance. The dimensions given below are for NEW interrupters, and all of them will change during the life of the interrupter. Adjustment of these settings will be required only after interrupter replacement. **DO NOT ADJUST THESE SETTINGS UNNECESSARILY AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT.**

If major disassembly of the mechanism or the vacuum interrupters becomes necessary for any reason, all of the factory set dimensions described below must be measured and recorded prior to disassembly if interrupter replacement is not required. These dimensions must be restored to the "as-found" dimensions upon reassembly to insure proper timing and operation of the circuit breaker.

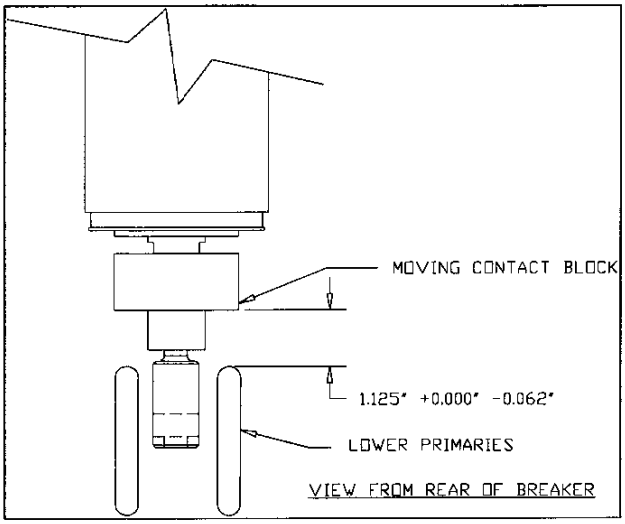


Figure 1. Moving Contact Block Measurements

NOTE: THE FOLLOWING DIMENSIONS ARE FOR NEW AND UNUSED INTERRUPTERS ONLY. THESE INITIAL SETTINGS WILL CHANGE DURING NO-LOAD BREAK-IN OPERATION OF THE INTERRUPTERS AND SUBSEQUENTLY WITH NORMAL CONTACT EROSION. NO ATTEMPT SHOULD BE MADE TO RESTORE THESE DIMENSIONS TO USED INTERRUPTERS AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT.

a. With closed contacts on a new vacuum interrupter, the bottom of the moving contact block should be 1.125" +0.00" -0.062" above the top of the lower main primary disconnect bars. See Figure 1.
b. With closed contacts on a new vacuum interrupter, the bottom of the pin which connects the bell cranks to the operating yoke should be 1.438" +0.062" -0.000" above the bottom of the lower main primary disconnect bars.

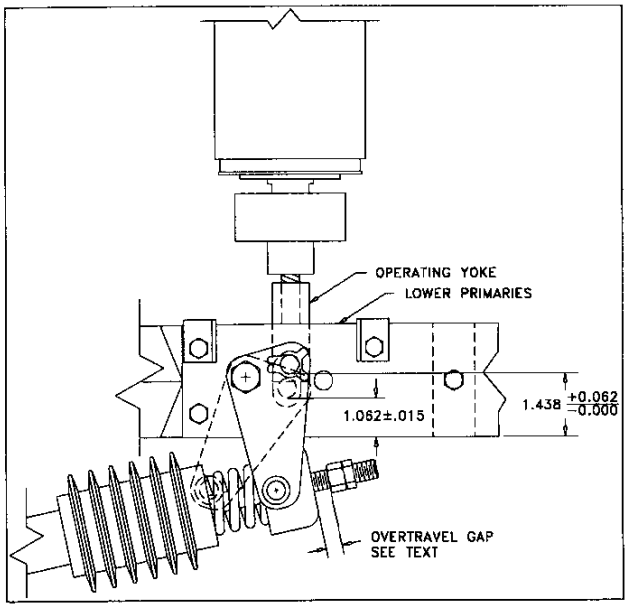


Figure 2. Operating Yoke Adjustments

See Figure 2.

c. With the breaker open, the dimension described in (b) should be 1.062" ± 0.015".
d. As explained in the description of the mechanism operation, when the breaker is closed a gap will exist between the contact loading spring yoke and the nut on the pushrod stud, Figure 2. With a new vacuum interrupter, this gap will be between 1/2 inch and 5/8 inch. As the contacts erode, the gap will reduce to about 3/16 inch.

(3) Primary Resistance Values

Whenever maintenance procedures require that any portion of the primary current path be disassembled, the resistance of the primary current path should be checked upon reassembly. See Section V of IB-60010.

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

TYPE	RATED AMPS	RESISTANCE
15PV0750	1200	60
15PV0750	2000	50

II. RECOMMENDED RENEWAL PARTS AND REPAIR PROCEDURES

(See Section VI. of IB-60010)

A. ORDERING INSTRUCTIONS

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 and coils)

3) Specify the quantity and description of the part, and IB-60010 and IB-60015. If the part is in the tables of recommended renewal parts, give its catalog number. If the part is not in the tables, the description should be accompanied by a marked illustration from IB-60010, this bulletin, 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.

B. RECOMMENDED RENEWAL PARTS

It is recommended that sufficient renewal parts be carried in stock to enable the prompt replacement 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.

Spare or replacement parts which are furnished may not be identical to the original parts, since improvements are made from time to time. The parts which are furnished, however, will be interchangeable. Tables I, II and III list the recommended spare parts to be carried in stock by the user. The

recommended quantity is not specified. This must be determined by the user based on the application. As a minimum, it is recommended that one set of parts be stocked per ten breakers or fraction thereof.

Table I. Interrupter and Sliding Contact Finger Assemblies

Breaker Type	Rated kV	Rated Continuous Current	Rated Momentary kA	Interrupter Assembly (3 per Bkr.)	Sliding Contact Finger Assembly (6 per Breaker)
15PV0750	15.0	1200, 2000	58	60500G10	50952-G1
15PV0750	15.0	1200, 2000	58	60500G10	50952-G1
15PV075H	15.0	1200, 2000	77	60500G11	50956-G1
15PV075H	15.0	1200, 2000	77	60500G11	50956-G1

Table II. Control Devices (1)

Control Voltage	Closing Coil	Shunt Trip Left(2)	Shunt Trip Right(3)	Under-voltage Device(4)	Charging Motor	Anti-Pump Relay
24VDC	N/A	50041-G8	50042-G8	N/A	N/A	N/A
48VDC	50026-G1	50041-G1	50042-G1	50028-G7	50960-G6	RR2BA-US-DC48V
125VDC	50026-G3	50041-G2	50042-G3	50028-G5	50960-G4	RR2BA-US-DC110V
250VDC	50026-G4	50041-G3	50042-G4	50028-G6	50960-G5	RR2BA-US-DC110V(5)
325VDC	N/A	N/A	N/A	50028-G9 W/TIME DELAY	N/A	N/A
120VAC	50026-G1	50041-G5	50042-G1	N/A	50960-G4	RR2BA-US-AC120V
240VAC	50026-G2	50041-G6	50042-G2	N/A	50960-G5	RR2BA-US-AC240V
Capacitor Trip (6)	N/A	50041-G4	50042-G5	N/A	N/A	N/A

NOTES FOR TABLE II

1. One each required per breaker if breaker was originally equipped with this item. All breakers have closing coil, left shunt trip, charging motor, and anti-pump relay. Right shunt trip and undervoltage device are optional. See notes 2-4.
2. Standard shunt trip.
3. Secondary shunt trip, where furnished. Cannot be present with undervoltage device.
4. Where furnished. Cannot be present with right-hand shunt trip.
5. For 250VDC applications, a dropping resistor, 50747-G2, is required in series with this relay's coil.
6. For use with capacitor trip units with 240VAC input. Consult factory for other ratings.

Table III. Miscellaneous Parts

Qty/Bkr	Description	Catalog No.
18	Primary Contact Spring Assembly, 2000A	50740-G1
18	Primary Contact Spring Assembly, 1200A	50740-G2
1	Latch Check Switch	PVBA-2RV2-A2
1	Motor Cutoff Switch Assembly	50756-G1
1	Ground Shoe Finger Assembly Auxiliary Switch Assembly	102108LN

C. REPLACEMENT PROCEDURES

This section includes instructions for replacing all the parts recommended as renewal parts. Before attempting any repair work, take note of safety practices outlined in Section II of IB-60010.

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 CHARGED SPRINGS.

(1) Vacuum Interrupter

a. Open circuit breaker and discharge closing spring.
b. Remove the front cover of the circuit breaker.
c. Remove interphase barrier assembly.
d. Measure and record the height of the opening springs (b, Figure 3, IB-60010).
e. Relieve the tension on the opening springs by removing the locknuts and hex nuts found on top of the opening springs. During this operation, hold the breaker open by inserting a large screwdriver or similar tool under the pin connecting the opening spring rod to the jack shaft levers and over the spacer that contacts the open-position stop bolt, then applying pressure upward. The jack shaft will rotate to the interrupter "contact touch" position when the tension is relieved from the opening springs and the pressure on the tool holding the breaker open is relaxed, due to the vacuum present in the interrupters.
f. Loosen the set screw holding the operating yoke to the operating pin. Remove X-washer from one end of the vacuum interrupter operating pin and pull the pin (d, Figure 9, IB-60010). The X-washer can be opened by squeezing the two projecting tabs with pliers.
g. Remove the four socket-head screws, two on each side (f, Figure 9, IB-60010), holding the sliding contact assemblies, and pivot the sliding contact assemblies down.
h. Unscrew and remove the operating yoke at the lower end of the vacuum interrupter (Figure 2).
i. Loosen, but do not remove, the four bolts connecting the vertical bars above the vacuum interrupter to the upper main horizontal primary disconnect bars.
j While supporting the vacuum interrupter, remove the two bolts connecting the upper contact block to the vertical bars using a 19mm socket.

k Remove the vacuum interrupter.

l Check the contents of the replacement vacuum interrupter kit. It should contain the following:
1. A vacuum interrupter of the proper rating, with the lower contact block attached. DO NOT DISTURB THE ATTACHMENT OF THE CONTACT BLOCK TO THE INTERRUPTER. This critical assembly has been made at the factory. Attempting to modify it may result in damage to the vacuum interrupter stem, making the interrupter unusable.
2. Two X-washers.
3. Two containers of lubricant, one tacky high pressure grease Anderol 757, and one contact grease Mobilgrease 28.

m. Install the new interrupter in the breaker by reversing steps m through f above.

n. Remove the nut from the bell crank mounting bolt and remove the bell cranks.

o. Insert the pin through the operating yoke and the lower primaries.

p. Set the height of the operating yoke so that the bottom of the pin is 1.438" + 0.062" - 0.000" above the bottom edge of the lower primaries. See Figure 1.

q. Remove the pin and reassemble the bell cranks.

r. Lubricate the pin with a liberal coat of the tacky high pressure grease, Anderol 757, insert the pin through both bell cranks and the operating yoke, and place a new X-washer in the groove of the pin. Tighten the X-washer by squeezing the two open ends together with pliers. Tighten the set screw in the bottom of the operating yoke.

s. Tighten all bolts in the upper contact structure to 45 lb-feet.

t. Apply a light coat of Mobilgrease 28 contact lubricant to the left and right sides of the lower contact block and reassemble the sliding contact fingers.

u. Fully open the breaker by reversing step e. Reset the opening springs to the dimension recorded in step d.

v. Close and open the circuit breaker about 50 times to properly seat the vacuum interrupter contact surface.

x. Measure the stroke of the vacuum interrupter contacts. This can be accomplished by measuring the distance from the top of the moving contact block to the lower flange of the interrupter with the breaker open and again with the breaker closed. The difference of these two measurements is the stroke of the interrupter contacts. The stroke for these ratings is 0.375" to 0.469". If the stroke is found to be outside these limits, it will be necessary to adjust the operating yoke by turning it upward or downward. Turning it downward decreases the stroke, while turning it upwards increases the stroke. Each half-turn of the operating yoke will change the stroke by 0.055".

CAUTION: IF ADJUSTMENT OF THE OPERATING YOKE IS REQUIRED, MAKE CERTAIN THE BREAKER IS OPEN AND THE MAIN SPRING IS DISCHARGED PRIOR TO ADJUSTING THE OPERATING YOKE.

This adjustment can be accomplished by the following procedure:
1. Loosen the set screw in the operating yoke.
2. Remove the "X" washer from one side of the pin.
3. While applying a downward force to the moving contact block just sufficient to overcome the force of the vacuum, slide the pin out of one bellcrank and the operating yoke.

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

4. Rotate the operating yoke as required.
5. Install the pin through the operating yoke and bell crank. Install the "X" washer and tighten the set screw in the operating yoke.
6. Repeat the above steps as required to obtain the specified stroke.

x. With the breaker closed, measure the gap between the contact loading spring yoke and the nut on the pushrod stud. Record this value in the space of the label on the vacuum interrupter marked "new". Deduct .38" from this dimension and record the result in the space marked "end-of-life".

y. Replace interphase barrier assembly.

(2) Sliding Contact Finger Assembly

Instructions are given in the maintenance section of IB-60010 for removing and inverting the sliding contact finger assembly. Follow these instructions, but install the new finger assembly instead of re-installing the old one.

(3) Closing Coil Assembly

The closing coil is located in the lower front center of the circuit breaker. See Figure 3, Page 4 of IB-60010. To replace it:

a. Remove front cover of the breaker.

b. Elevate the breaker so that there is at least 6 inches of clear space below the bottom pan of the breaker.

c. Unplug the dosing coil from the wire harness.

e. Remove two bolts holding closing coil assembly to

Insert new closing coil assembly into the breaker from below, bolt it in place and plug it into the wiring harness. No adjustment is required.

f. Close breaker several times electrically to insure that base pan and drop the closing coil out of the bottom of the breaker.
g. coil is functioning properly.
h. Replace front cover.

(4) Shunt Trip Coil Assembly, Left

This assembly is located in the center part of the mechanism area, just to the left of the main closing spring. See Figure 3, Page 4 of IB-60010. To replace it:

a. Remove front cover of breaker.
b. Unplug the trip coil from the wiring harness.
c. Remove the two bolts holding the trip coil assembly to the breaker frame and remove the assembly.
d. Bolt new assembly in place and plug it into the wiring harness.
e. Trip the breaker electrically several times at nominal control voltage to insure that coil is functioning properly.
f. Check the time interval from energization of the trip coil (at nominal control voltage) to the parting of the main contacts of the circuit breaker. This time must be within 40 to 55 milliseconds. If necessary, bend the trip lever slightly to achieve this setting. See Figure 3.
g. Trip the breaker electrically at minimum control voltage.
i. Replace front cover.

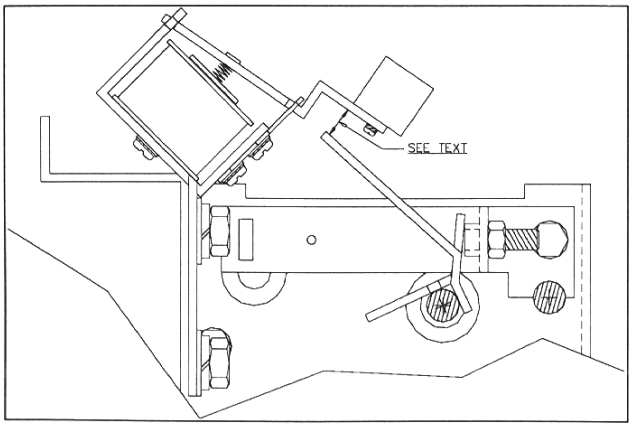


Figure 3. Trip Lever Gap Adjustment

(5) Shunt Trip Coil Assembly, Right

This assembly is located in the center part of the mechanism area, just to the right of the main closing spring. See Figure 12, Page 8 of IB-600I0. To replace it:

a. Remove front cover of breaker.
b. Unplug the trip coil from the wiring harness.
c. Remove the two bolts holding the trip coil assembly to the breaker frame and remove the assembly.

NOTE: It will be easier to remove the trip coil assembly if the right hand main operating spring connecting rod is removed. See section headed "Closing Spring removal and Slow Closing of Mechanism" under Maintenance in IB-60010 for procedures for removing this connecting rod.

d. Bolt new assembly in place and plug it into the wiring harness. No adjustment is required.
e. Re-assemble spring connecting rod and main spring, if previously removed.
f. Trip the breaker electrically several times to insure that the coil is functioning properly.
g. Replace front cover.

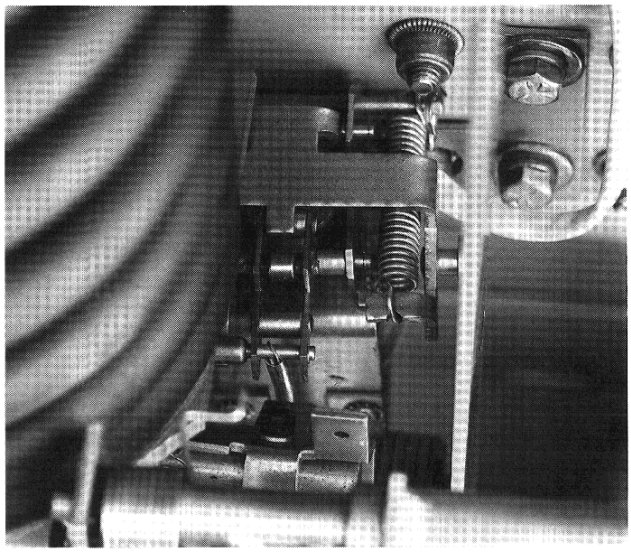


Figure 4. Undervoltage Device Mounted on Circuit Breaker

(6) Undervoltage Device Assembly

This assembly is located in the center part of the mechanism area, just to the right of the main closing spring. See Figure 4. To replace it:

a. Remove front cover of breaker.
b. Remove right hand main operating spring connecting rod. See section headed "Closing Spring Removal and Slow Closing of Mechanism" under Maintenance in IB-60010 for procedures for removing this rod.
c. Unplug the undervoltage device from the wiring harness.

d. Remove the two bolts holding the undervoltage device assembly to the breaker frame and remove the assembly.
e. Bolt new assembly in place.
f. Re-assemble the main operating spring connecting rod.
g. While the undervoltage device has been tested at the factory, it is necessary to check and possibly adjust its settings once it has been assembled to the circuit breaker. This will require a variable voltage DC source capable of output of from 40% to 100% of the DC rating of the undervoltage device. Connect this source to the terminals of the undervoltage device coil.

Apply a DC voltage of 80% of the undervoltage coil rating. The undervoltage device should pick up and allow the breaker to close. Close and trip the breaker several times, using manual or shunt trip, to be sure that the vibration of breaker operation does not cause the undervoltage device to drop out improperly. If the device does drop out during this test, rotate the screw at the bottom of the device to the right in 1/8 turn steps until the proper operation is obtained. This adjustment may be fine tuned by bending the tab at the base of the beam spring up in 1/16 inch steps. See Figure 5. Check dropout of undervoltage device by reducing test voltage to 52 - 56%. The undervoltage device should drop out and cause the breaker to trip in this voltage range. If dropout voltage is too low, bend the tab at the base of the beam spring down slightly to raise the voltage.

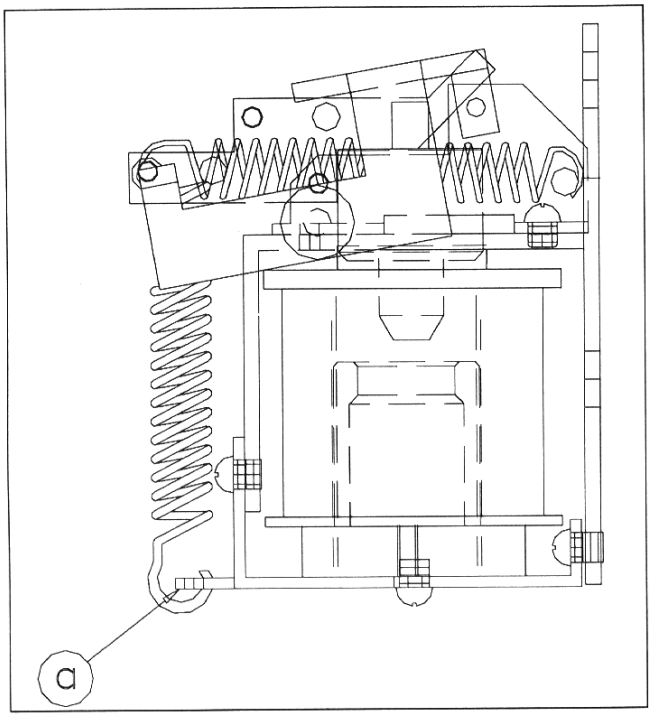


Figure 5. Undervoltage Device
a. Beam Spring Tab

h. Disconnect the test source and plug the undervoltage
i. device into the wiring harness.
j. Replace front cover.

(7) Charging Motor Assembly

The charging motor assembly is located at the lower right-hand side of the mechanism (See Figure 4, Page 4 of IB-60010). To replace it:

a. Remove front cover of the breaker.
b. Unplug the motor from the wiring harness.
c. Remove the two bolts holding the motor mounting bracket to the base pan and slide the motor to the right, disconnecting the motor shaft from the mechanism, and lift the motor out.
d. Lubricate the end of the shaft of the new motor liberally with Anderol 757 grease.
e. Position the new motor assembly in the circuit breaker, being sure that the pin on the end of the drive shaft engages the slot in the mechanism shaft.
f. Bolt the motor to the base pan and plug it into the wiring harness.
g. Operate the circuit breaker several times to insure that the motor operates smoothly.
h. Replace front cover.

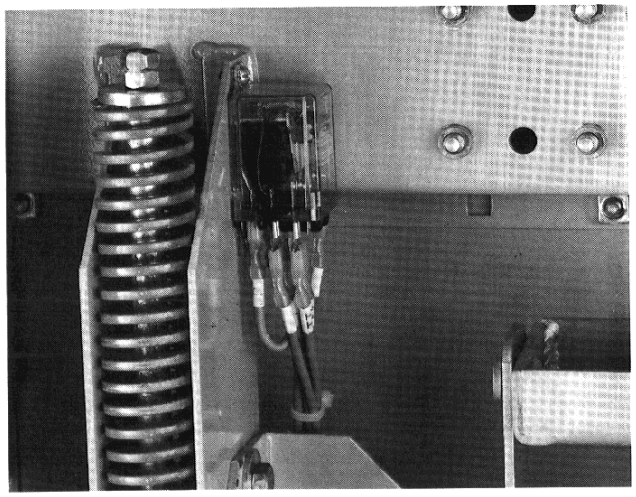


Figure 6. Anti-Pump relay

(8) Anti-Pump Relay

This relay is located near the top of the mechanism, to the left of the main operating spring. See Figure 6. To replace it:

a. Remove front cover of breaker.
b. Disconnect leads from anti-pump relay, being careful to note which wires go to which terminal.
c. Loosen lower mounting screw of relay.
d. Remove upper mounting screw and lift relay off lower screw.
e. Place new relay over lower screw, reinstall upper screw, and tighten both screws.
f. Reconnect all wires to the proper terminals of the relay.
g. Relays in 250VDC closing circuits are provided with dropping resistors to apply the proper voltage to the relay coil. The resistor is mounted adjacent to the relay. It may be replaced by unplugging it from the relay and unscrewing the mounting feet from the breaker frame, replacing the resistor and reassembling.
h. Operate the breaker several times to insure that the relay functions properly.
i. Replace front cover.

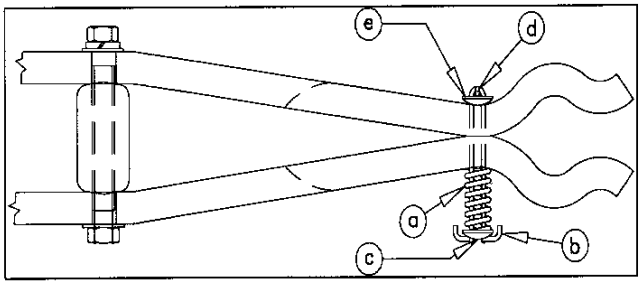


Figure 7. Primary Disconnect Finger Spring Assembly
a. Spring
b. Support
c. Cap
d. Keeper
e. Secondary Cap (1200A Models only)

(9) Primary Contact Spring Assembly

These springs are located at the outer end of the primary contact bars. See Figure 7. To replace them:

a. Depress spring support sufficiently to allow keeper to be removed. For 1200 ampere breakers, remove the secondary cap.
b. Remove cap, spring support and spring.
c. Slide new spring onto spring support and place spring support in slot between fingers.
d. Depress head of spring support and install secondary cap (if required) and keeper in slot in end of spring support.
e. Release spring slowly, allowing keeper to seat properly.

NOTE: Springs are to be installed in every other slot in fingers; top, center and bottom. The second and fourth slots are empty.

(10) Latch Check Switch

The latch check switch is located on the left-hand side of the main mechanism frame, near the bottom of the main closing spring. See Figure 5, Page 4 of IB-60010. To replace it:

a. Remove the front cover of breaker.
b. Remove two screws holding switch to mechanism. Do not lose nut plate into which these screws are threaded.
c. Disconnect wires from switch.
d. Connect wires to new switch and fasten switch in place with screws and nut plate previously removed.
e. Adjust switch per instructions in section headed "Adjustment of Primary and Secondary Trip Latches and Latch Check Switch" under MAINTENANCE in IB-60010.
f. Operate breaker electrically several times to insure that it is working.
g. Replace front cover.

(11) Motor Cutoff Switch Assembly

The motor cutoff switch assembly is located on the floor pan of the mechanism area, just to the right of the main mechanism. See Figure 4, Page 4 of IB-60010. To replace it:

a. Remove the front cover of breaker.
b. Disconnect wires from switch, being careful to identify each wire by the terminal number from which it was removed.
c. Remove the two bolts holding the assembly to the breaker floor pan and remove the assembly.
d. Install new cutoff switch assembly, bolt it to the floor pan. Reconnect the wiring. No adjustment is needed.
e. Operate breaker electrically several times to insure that it is working.
f. Replace front cover.

(12) Ground Shoe Finger Assembly

The ground shoe assembly is located at the rear edge of the breaker floor pan between the center and right poles of the breaker. See Figure 8. To replace it:

a. Elevate the breaker so that there is at least 6 inches of

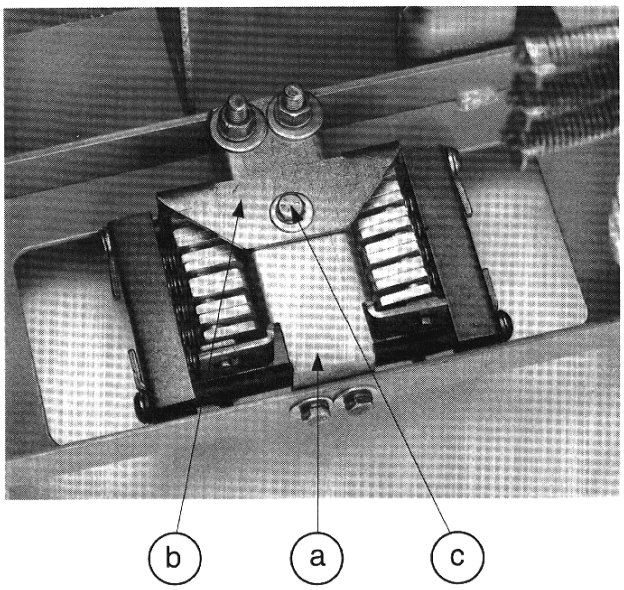


Figure 8. Ground shoe
a. Mounting Bracket
b. Retaining clip
c. Holding Bolt

clear space below the bottom pan of the breaker.

b. Remove the bolt holding the retaining clip to the ground shoe mounting bracket, and remove the retaining clip.
c. Slide the finger assembly slightly forward, so that the ends of the mounting rods on each side of the assembly are clear of the holes in the ground shoe mounting bracket. Press down on finger assembly and remove it from bottom of breaker.
d. Remove four socket-head screws holding two side finger assemblies to two red spacer tubes.
e. Assemble new side finger assemblies to red spacer tubes.
f. Wipe old lubricant off the ground shoe mounting bracket on breaker and apply a thin coat of contact lubricant Mobilgrease 28 to mounting bracket.
g. Insert new finger assembly from below the breaker floor pan and press up and slide back until the mounting rods can be inserted into the holes in the ground shoe mounting bracket.
i. Reinstall the retaining clip.

(13) Auxiliary Switch

The auxiliary switch is located in the lower left front of the mechanism area. See Figure 9. To replace an auxiliary switch:

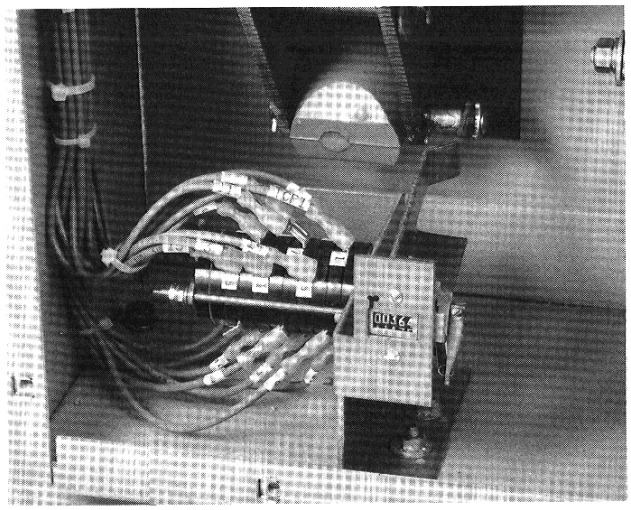


Figure 9. Auxiliary Switch

a. Remove the front cover of breaker.
b. Disconnect wires from switch, being careful to identify each wire by the terminal number from which it was removed.
c. Remove the "E" ring securing the switch operating arm to the operations counter 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. Make sure the terminal marked "15" on the deck farthest from the operating shaft is facing the front of the breaker.
f. Insert the operating arm of the switch into the hole in the end of the operations counter linkage and secure with the "E" ring removed in step c.
g. Reconnect the wiring. Be sure wires are connected to the same terminals from which they were removed.
h. Operate breaker electrically several times to insure that it is working.
i. Replace front cover.

POWELL ELECTRICAL MANUFACTURING COMPANY
8550 MOSLEY DRIVE • HOUSTON, TEXAS 77075 USA
PHONE (713) 944-6900 • FAX (713) 947-4453

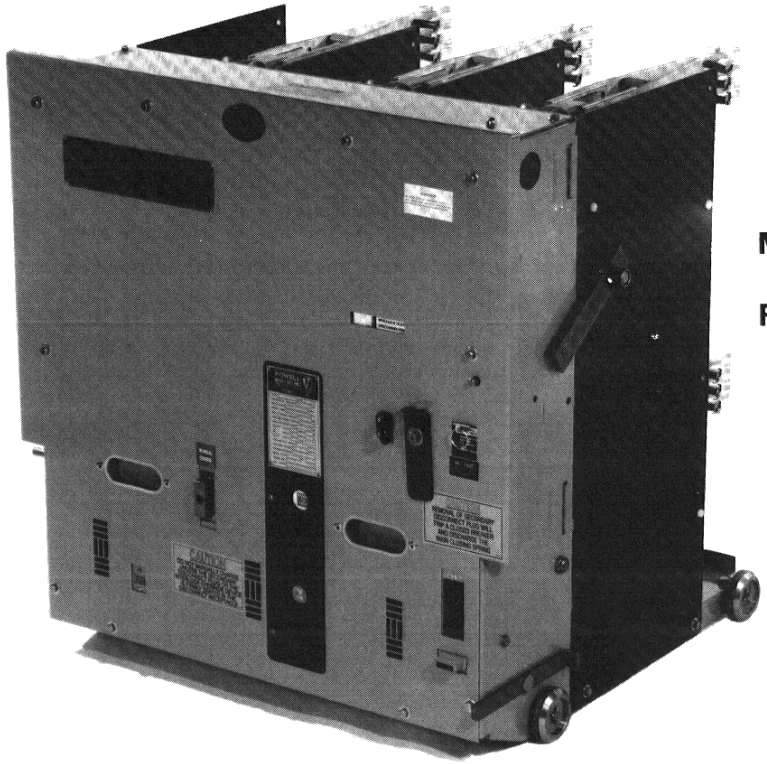
Printed in U.S.A.

Series P-60000 POWL-VAC® VACUUM CIRCUIT BREAKERS

Models 15PV1000-6 & -7, 05PV0350-6 & -7 and 75PV0500-6 & -7
1200 A, 2000 A and 3000 A
Models 05PV025H-6 & -7, 15PV050H-6 & -7 and 15PV075H-6 & -7
3000 A

CAUTION

This instruction book is incomplete by itself. It is a supplement to IB-60010 and must be used together with IB-60010. This instruction book contains only information that is specific to POWL-VAC® circuit breakers equipped with Mitsubishi vacuum interrupters type 10B30C.



MAINTENANCE &

RENEWAL PARTS

POWELL INDUSTRIES, INC.

Powell Electrical Manufacturing Company
8550 Mosley Drive • Houston, Texas 77075 USA
Phone (713) 944-6900 • Fax (713) 947-4453

TABLE OF CONTENTS

ILLUSTRATIONS

TABLES

CAUTION

Before any adjustment, 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.

I. MAINTENANCE

(See Section V of IB-60010)

CAUTION

These breakers utilize stored-energy spring charged mechanisms. These mechanisms must be serviced only by skilled and knowledgeable personnel capable of releasing each spring load in a controlled manner. EXTREME CAUTION 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 IB-60010.

A. INTERRUPTER AND CONTACT AREA

(1) Vacuum Interrupter Contact Erosion

At each inspection, the vacuum interrupters should be checked for amount of contact erosion. The breaker must be closed for this check. Each vacuum interrupter hexagonal moving stem has a red mark painted on one of the hexagon faces. On a new vacuum interrupter, the upper edge of this red mark is approximately 0.1" from the white plastic stem guide plate, which is fastened to the bottom of the interrupter. As the contacts erode with use, the 0.1 " gap between the red mark and the guide plate decreases. When the upper edge of the red mark reaches the guide plate, the vacuum interrupter should be replaced. A small mirror is helpful for this inspection.

(2) Mechanical Adjustment of Interrupters

There are several factory adjustments in the interrupter area which are described below. No adjustment of these settings is required for routine maintenance. The dimensions given below are for NEW interrupters, and all of them will change during the life of the interrupter. Adjustment of these settings will be required only after interrupter replacement. **DO NOT ADJUST THESE SETTINGS UNNECESSARILY AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT.**

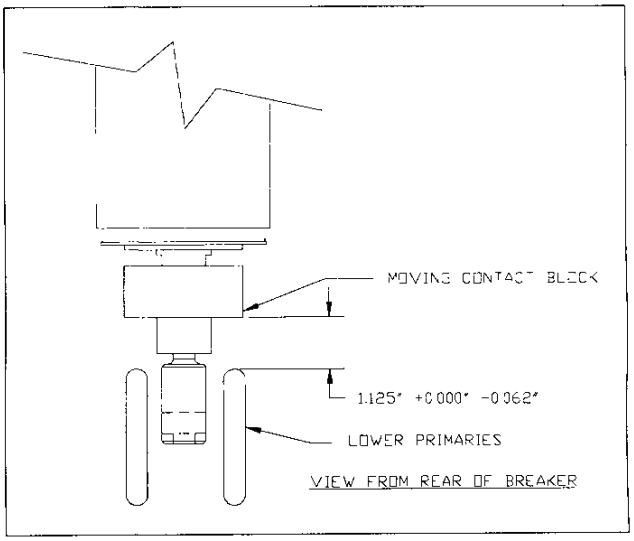


Figure 1. Moving Contact Block Measurements

If major disassembly of the mechanism or the vacuum interrupters becomes necessary for any reason, all of the factory set dimensions described below must be measured and recorded prior to disassembly if interrupter replacement is not required. These dimensions must be restored to the "as-found" dimensions upon reassembly to insure proper timing and operation of the circuit breaker.

NOTE: THE FOLLOWING DIMENSIONS ARE FOR NEW AND UNUSED INTERRUPTERS ONLY. THESE INITIAL SETTINGS WILL CHANGE DURING NO-LOAD BREAK-IN OPERATION OF THE INTERRUPTERS AND SUBSEQUENTLY WITH NORMAL CONTACT EROSION. NO ATTEMPT SHOULD BE MADE TO RESTORE THESE DIMENSIONS TO USED INTERRUPTERS AS DAMAGE TO THE CIRCUIT BREAKER MAY RESULT.

a. With closed contacts on a new vacuum interrupter, the bottom of the moving contact block should be 1.125" +0.00" -0.062" above the top of the lower main primary disconnect bars. See Figure 1.
b. With closed contacts on a new vacuum interrupter, the bottom of the pin which connects the bell cranks to the operating yoke should be 1.438" +0.062" -0.000" above

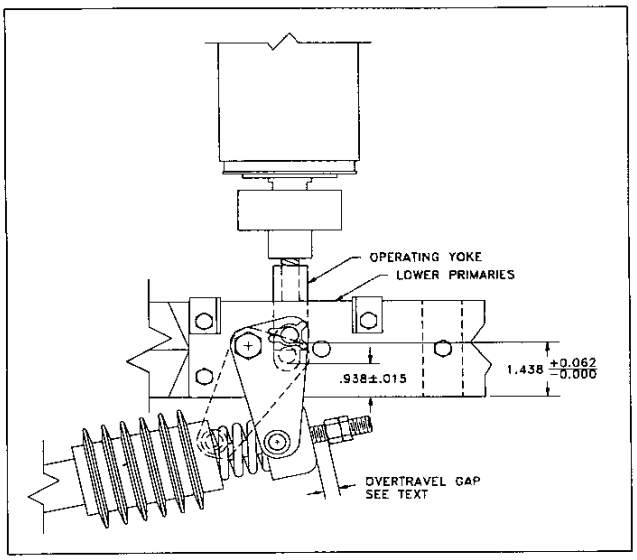


Figure 2. Operating Yoke Adjustments

the bottom of the lower main primary disconnect bars. See Figure 2.

c. With the breaker open, the dimension described in (b) should be .938" ± 0.015".

d. As explained in the description of the mechanism operation, when the breaker is closed a gap will exist between the contact loading spring yoke and the nut on the pushrod stud, Figure 2. With a new vacuum interrupter, this gap will be between 1/2 inch and 5/8 inch. As the contacts erode, the gap will reduce to about 3/16 inch.

(3) Primary Resistance Values

Whenever maintenance procedures require that any portion of the primary current path be disassembled, the resistance of the primary current path should be checked upon reassembly. See Section V of IB-60010.

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

TYPE	RATED AMPS	RESISTANCE
15PV1000-61, -71	1200	44
15PV1000-62, -72	2000	44
15PV1000-63, -73	3000	44
15PV050H-63, -73	3000	44
15PV075H-63, -73	3000	44
75PV0500-61, -71	1200	44
75PV0500-62, -72	2000	44
75PV0500-63, -73	3000	44
05PV0350-61, -71	1200	44
05PV0350-62, -72	2000	44
05PV0350-63, -73	3000	44
05PV025H-63, -73	3000	44

II. RECOMMENDED RENEWAL PARTS AND REPAIR PROCEDURES

(See Section VI. of IB-60010)

A. ORDERING INSTRUCTIONS

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 and coils)

3) Specify the quantity and description of the part, and IB-60010 and IB-60016. If the part is in the tables of recommended renewal parts, give its catalog number. If the part is not in the tables, the description should be accompanied by a marked illustration from IB-60010, this bulletin, 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.

B. RECOMMENDED RENEWAL PARTS

It is recommended that sufficient renewal parts be carried in stock to enable the prompt replacement 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.

Spare or replacement parts which are furnished may not be identical to the original parts, since improvements are made from time to time. The parts which are furnished, however, will be interchangeable. Tables I, II and III list the recommended spare parts to be carried in stock by the user. The

recommended quantity is not specified. This must be determined by the user based on the application. As a minimum, it is recommended that one set of parts be stocked per ten breakers or fraction thereof.

Table I. Interrupter and Sliding Contact Finger Assemblies

Breaker Type	Rated KV	Rated Continuous Current	Rated Momentary Current	Interrupter Assembly (3 per Bkr.)	Sliding Contact Finger Assembly (6 per Breaker)
15PV1000-6, -7	15.0	1200, 2000	77	50955-G2	50956-G1
15PV1000-6,-7	15.0	3000	77	50955-G4	50956-G2
75PV0500-6,-7	8.25	1200, 2000	66	50955-G2	50956-G1
75PV0500-6,-7	8.25	3000	66	50955-G4	50956-G2
05PV0350-6,-7	4.76	1200, 2000	78	50955-G2	50956-G1
05PV0350-6,-7	4.76	3000	78	50955-G4	50956-G2
05PV025H-6,-7	4.76	3000	78	50955-G4	50956-G2
15PV050H-6, -7	15.0	3000	58	50955-G4	50956-G2
15PV075H-6,-7	15.0	3000	77	50955-G4	50956-G2

Table II. Control Devices (1)

Control Voltage	Closing Coil	Shunt Trip Left (2)	Shunt Trip Right (3)	Under-voltage Device (4)	Charging Motor	Anti-Pump Relay
24VDC	N/A	50041-G8	50042-G8	N/A	N/A	N/A
48VDC	50026-G1	50041-G1	50042-G1	50028-G7	50960-G6	RR2BA-US-DC48V
125VDC	50026-G3	50041-G2	50042-G3	50028-G5	50960-G4	RR2BA-US-DC110V
250VDC	50026-G4	50041-G3	50042-G4	50028-G8	50960-G5	RR2BA-US-DC110V(5)
325VDC	N/A	N/A	N/A	50028-G9 w/Time Delay	N/A	N/A
120VAC	50026-G1	50041-G5	50042-G1	N/A	50960-G4	RR2BA-US-AC120V
240VAC	50026-G2	50041-G6	50042-G2	N/A	50960-G5	RR2BA-US-AC240V
Capaci-tor Trip (6)	N/A	50041-G4	40042-G5	N/A	N/A	N/A

NOTES FOR TABLE II

1. One each required per breaker if breaker was originally equipped with this item. All breakers have closing coil, left shunt trip, charging motor, and anti-pump relay. Right shunt trip and undervoltage device are optional. See notes 2-4.
2. Standard shunt trip.
3. Secondary shunt trip, where furnished. Cannot be present with undervoltage device.
4. Where furnished. Cannot be present with right-hand shunt trip.
5. For 250VDC applications, a dropping resistor, 50747-G2, is required in series with this relay's coil.
6. For use with capacitor trip units with 240VAC input. Consult factory for other ratings.

Table III. Miscellaneous Parts

Qty / Bkr	Description	Catalog No.
18	Primary Contact Spring Assembly 1200, 2000, 3000A	50740-G1
1	Latch Check Switch	PVBA-2RV-A2
1	Motor Cutoff Switch assembly	50756-G1
2	Ground Shoe Finger Assembly 15PV1000-6, -7 05PV0350-6, -7 1200, 2000, 3000A	50952-G2
2	05PV025H-6, -7 15PV050H-6, -7 15PV075H-6, -7 3000A	50952-G2
1	Auxiliary Switch Assembly	102108LN

C. REPLACEMENT PROCEDURES

This section includes instructions for replacing all the parts recommended as renewal parts. Before attempting any repair work, take note of safety practices outlined in Section II of IB-60010.

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 CHARGED SPRINGS.

(1) Vacuum Interrupter

a. Open circuit breaker and discharge closing spring.
b. Remove the front cover of the circuit breaker.
c. Remove interphase barrier assembly.
d. Measure and record the height of the opening springs (b, Figure 3, IB-60010).
e. Relieve the tension on the opening springs by removing the locknuts and hex nuts found on top of the opening springs. During this operation, hold the breaker open by inserting a large screwdriver or similar tool under the pin connecting the opening spring rod to the jack shaft levers and over the spacer that contacts the open-pcsition stop bolt, then applying pressure upward. The jack shaft will rotate to the interrupter "contact touch" position when the tension is relieved from the opening springs and the pressure on the tool holding the breaker open is relaxed, due to the vacuum present in the interrupters.
f. Remove X-washer from one end of the vacuum interrupter operating pin and pull the pin (d, Figure 9, IB-60010). The X-washer can be opened by squeezing the two projecting tabs with pliers.
g. Remove the four socket-head screws, two on each side (f, Figure 9, IB-60010), holding the sliding contact assemblies, and pivot the sliding contact assemblies down.
h. Unscrew and remove the operating yoke at the lower end of the vacuum interrupter (Figure 2).
i. Loosen, but do not remove, the two bolts through the upper contact block (k, Figure 9, IB-60010).
j. Remove the primary contact springs at the outer end of the horizontal primary disconnect bars (Figure 7).
k. Remove the nuts from the three bolts holding the upper horizontal primary disconnect bars to the insulating supports.
l. While supporting the vacuum interrupter, remove the two

bolts connecting the upper contact block to the main horizontal primary disconnect bars.

m. Remove one of the upper horizontal primary disconnect bars.
n. Remove the vacuum interrupter.
o. Unscrew the upper contact block from the vacuum interrupter.
p. Check the contents of the replacement vacuum interrupter kit. It should contain the following:
   1. A vacuum interrupter of the proper rating with the lower contact block attached. Do not disturb the attachment of the contact block to the interrupter. This critical assembly has been made at the factory. Attempting to modify it may result in damage to the vacuum interrupter stem, making the interrupter unusable.
   2. Two X-washers.
   3. Two assembly gauges, one marked 100B774 and the other marked 100B775.
   4. Two containers of lubricant, one tacky high pressure grease Anderol 757 and one contact grease Mobilgrease 28.
q. Screw the upper contact block onto the upper stem of the vacuum interrupter so that 3 to 5 threads of the interrupter stem protrude from the top of the contact block. This adjustment is not critical at this point, as it will be gauged later.
r. Install the new interrupter into the breaker by reversing steps j, h and g above. All hardware should be snug but not tightened. The operating yoke should be threaded onto the operating rod of the vacuum interrupter so that 3 or 4 threads show at the top of the yoke. This adjustment is not critical at this point, as it will be gauged later.
s. Set the height of the interrupter in the circuit breaker by rotating the interrupter. Use gauge 100B775. With this gauge sitting on the upper surfaces of the lower main horizontal primary disconnect bars, the lower surface of the lower contact block should touch the step of the gauge. Rotate the interrupter in ½-turn increments until a snug fit is achieved. The interrupter must be positioned so that the set screw in the lower contact block points to either the front or the back of the circuit breaker. The two smooth sides of the contact block must be on the left and the right sides where the sliding contacts are located, and these surfaces must be parallel to the main horizontal primary disconnect bars. See Figure 1.
t. Occasionally the high temperatures used in the manufacturing of vacuum interrupters causes the two stems of the interrupter to be slightly out of line. Examine the interrupter to see if it appears to be straight up and down. If not, lower it by ½-turn to see if the alignment is improved. If it is, leave it at the new position. If not, return it to the previous position.
u. Remove the nut from the bell crank mounting bolt and remove one bell crank.
v. Insert the pin through the operating yoke but not through the bell cranks.
w. Set the height of the operating yoke using gauge 100B774. With the long arm of the gauge against the lower surface of the main horizontal primary disconnect bars, the lower surface of the pin should touch the step of the gauge. Adjust the height of the operating yoke in ½-turn increments until a snug fit is achieved. See Figure 2.
x. Remove the pin and reassemble the bell crank.
y. Lubricate the pin with a liberal coat of the tacky high pressure grease, Anderol 757, insert the pin through both bell cranks and the operating yoke, and place a new X-washer in the groove of the pin. Tighten the X-washer by squeezing the two open ends together with pliers.
z. Tighten all bolts in the upper contact structure. The ½" bolts in the upper contact block and the vertical connecting bars should be tightened to 45 lb-feet, and the 5/16" bolts in the upper main horizontal primary disconnect mountings should be tightened to 12 - 18 lb-feet.
aa. Apply a light coat of Mobilgrease 28 contact lubricant to the left and right sides of the lower contact block and reassemble the sliding contact fingers.
bb. Fully open the breaker by reversing step e. Reset the opening springs to the dimension recorded in step d.
cc. Close and open the circuit breaker about 50 times to properly seat the vacuum interrupter contact surface.
dd. Measure the stroke of the vacuum interrupter contacts. This can be accomplished by measuring the distance from the top of the moving contact block to the lower flange of the interrupter with the breaker open and again with the breaker closed. The difference of these two measurements is the stroke of the interrupter contacts. The stroke for these ratings is 0.472" to 0.512". If the stroke is found to be outside these limits, it will be necessary to adjust the operating yoke by turning it upward or downward. Turning it downward decreases the stroke, while turning it upwards increases the stroke. Each half-turn of the operating yoke will change the stroke by .040".

CAUTION: IF ADJUSTMENT OF THE OPERATING YOKE IS REQUIRED, MAKE CERTAIN THE BREAKER IS OPEN AND THE MAIN SPRING IS DISCHARGED PRIOR TO ADJUSTING THE OPERATING YOKE.

This adjustment can be accomplished by the following procedure:

1. Loosen the set screw in the operating yoke.
2. Remove the "X" washer from one side of the pin.
3. While applying a downward force to the moving contact block just sufficient to overcome the force of the vacuum, slide the pin out of one bellcrank and the operating yoke.

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

4. Rotate the operating yoke as required.
5. Install the pin through the operating yoke and bell crank. Install the "X" washer and tighten the set screw in the operating yoke.
6. Repeat the above steps as required to obtain the specified stroke.

ee. Replace interphase barrier assembly.
ff. Replace the front cover.

(2) Sliding Contact Finger Assembly

Instructions are given in the maintenance section of IB-60010 for removing and inverting the sliding contact finger assembly. Follow these instructions, but install the new finger assembly instead of re-installing the old one.

(3) Closing Coil Assembly

The closing coil is located in the lower front center of the circuit breaker. See Figure 3, Page 4 of IB-60010. To replace it:

a. Remove front cover of the breaker.
b. Elevate the breaker so that there is at least 6 inches of clear space below the bottom pan of the breaker.
c. Unplug the closing coil from the wire harness.
d. Remove two bolts holding closing coil assembly to base pan and drop the closing coil out of the bottom of the breaker.
e. Insert new closing coil assembly into the breaker from below, bolt it in place and plug it into the wiring harness. No adjustment is required.
f. Close breaker several times electrically to insure that coil is functioning properly.
g. Replace front cover.

(4) Shunt Trip Coil Assembly, Left

This assembly is located in the center part of the mechanism area, just to the left of the main closing spring. See Figure 3, Page 4 of IB-60010. To replace it:

a. Remove front cover of breaker.
b. Unplug the trip coil from the wiring harness.
c. Remove the two bolts holding the trip coil assembly to the breaker frame and remove the assembly.
d. Bolt new assembly in place and plug it into the wiring harness.
e. Trip the breaker electrically several times at nominal control voltage to insure that coil is functioning properly.
f. Check the time interval from energization of the trip coil (at nominal control voltage) to the parting of the main contacts of the circuit breaker. This time must be within 40 to 55 milliseconds. If necessary, bend the trip lever slightly to achieve this setting. See Figure 3.
g. Trip the breaker electrically at minimum control voltage.
h. Replace front cover.

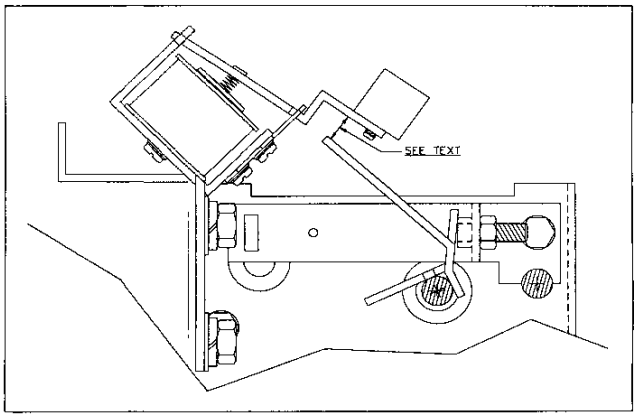


Figure 3. Trip Lever Gap Adjustment

(5) Shunt Trip Coil Assembly, Right

This assembly is located in the center part of the mechanism area, just to the right of the main closing spring. See Figure 12, Page 8 of IB-60010. To replace it:

a. Remove front cover of breaker.
b. Unplug the trip coil from the wiring harness.
c. Remove the two bolts holding the trip coil assembly to the breaker frame and remove the assembly.

NOTE: It will be easier to remove the trip coil assembly if the right hand main operating spring connecting rod is removed. See section headed "Closing Spring removal and Slow closing of Mechanism" under Maintenance in IB-60010 for procedures for removing this connecting rod.

d. Bolt new assembly in place and plug it into the wiring harness. No adjustment is required.
e. Re-assemble spring connecting rod and main spring, if previously removed.
f. Trip the breaker electrically several times to insure that the coil is functioning properly.
g. Replace front cover.

(6) Undervoltage Device Assembly

This assembly is located in the center part of the mechanism area, just to the right of the main closing spring. See Figure 4. To replace it:

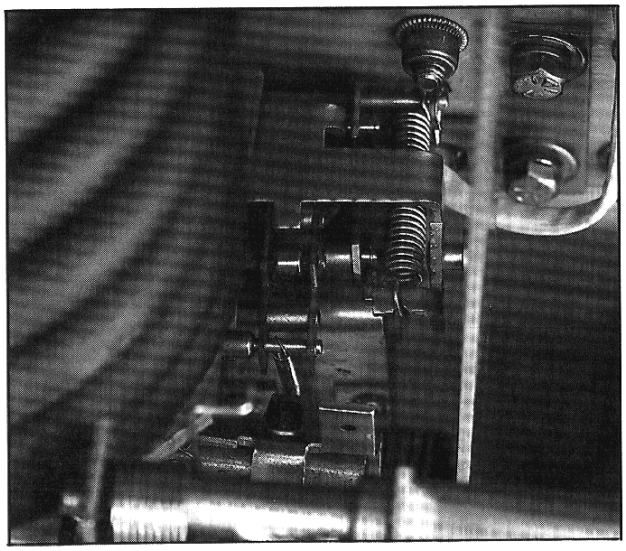


Figure 4. Undervoltage Device Mounted on Circuit Breaker

a. Remove front cover of breaker.
b. Remove right hand main operating spring connecting rod. See section headed "Closing Spring Removal and Slow Closing of Mechanism" under Maintenance in IB-60010 for procedures for removing this rod.
c. Unplug the undervoltage device from the wiring harness.
d Remove the two bolts holding the undervoltage device assembly to the breaker frame and remove the assembly.
e. Bolt new assembly in place.
f. Re-assemble the main operating spring connecting rod.
g. While the undervoltage device has been tested at the factory, it is necessary to check and possibly adjust its settings once it has been assembled to the circuit breaker. This will require a variable voltage DC source capable of output of from 40% to 100% of the DC rating of the undervoltage device. Connect this source to the terminals of the undervoltage device coil.

Apply a DC voltage of 80% of the undervoltage coil rating. The undervoltage device should pick up and allow the breaker to close. Close and trip the breaker several times, using manual or shunt trip, to be sure that the vibration of breaker operation does not cause the undervoltage device to drop out improperly. If the device does drop out during this test, rotate the screw at the bottom of the device to the right in 1/8 turn steps until the proper operation is obtained. This adjustment may be fine tuned by bending the tab at the base of the beam spring up in 1/16 inch steps. See Figure 5.

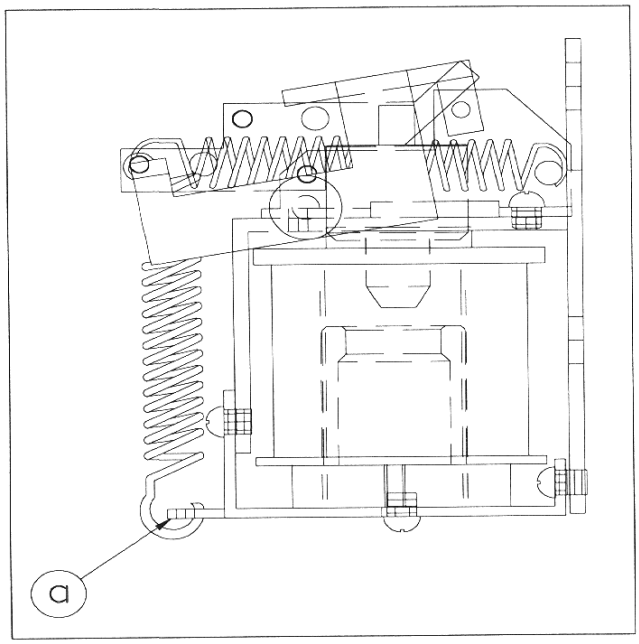


Figure 5. Undervoltage Device
a. Beam Spring Tab

Check dropout of undervoltage device by reducing test voltage to 52 - 56%. The undervoltage device should drop out and cause the breaker to trip in this voltage range. If dropout voltage is too low, bend the tab at the base of the beam spring down slightly to raise the voltage.
h. Disconnect the test source and plug the undervoltage
i. device into the wiring harness.
j. Replace front cover.

(7) Charging Motor Assembly

The charging motor assembly is located at the lower right-hand side of the mechanism (See Figure 4, Page 4 of IB-60010). To replace it:

a. Remove front cover of the breaker.
b. Unplug the motor from the wiring harness.
c. Remove the two bolts holding the motor mounting bracket to the base pan and slide the motor to the right, disconnecting the motor shaft from the mechanism, and

lift the motor out.

d. Lubricate the end of the shaft of the new motor liberally with Anderol 757 grease.
e. Position the new motor assembly in the circuit breaker, being sure that the pin on the end of the drive shaft engages the slot in the mechanism shaft.
f. Bolt the motor to the base pan and plug it into the wiring harness.
g. Operate the circuit breaker several times to insure that the motor operates smoothly.
h. Replace front cover.

(8) Anti-Pump Relay

This relay is located near the top of the mechanism, to the left of the main operating spring. See Figure 6. To replace it:

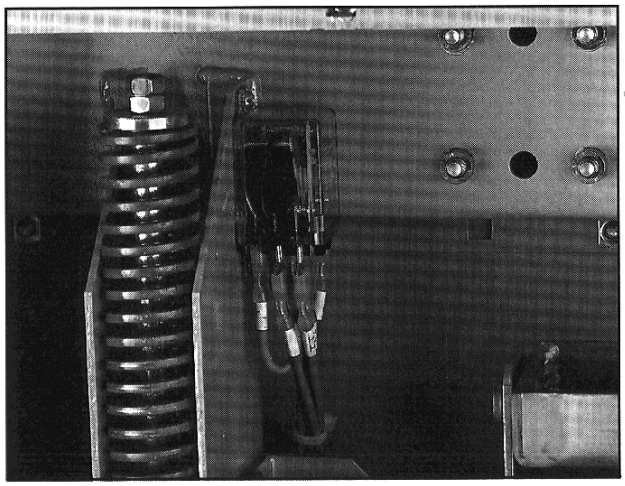


Figure 6. Anti-Pump relay

a. Remove front cover of breaker.
b. Disconnect leads from anti-pump relay, being careful to note which wires go to which terminal.
c. Loosen lower mounting screw of relay.
d. Remove upper mounting screw and lift relay off lower screw.
e. Place new relay over lower screw, reinstall upper screw, and tighten both screws.
f. Reconnect all wires to the proper terminals of the relay.
g. Relays in 250VDC closing circuits are provided with dropping resistors to apply the proper voltage to the relay coil. The resistor is mounted adjacent to the relay. It may be replaced by unplugging it from the relay and unscrewing the mounting feet from the breaker frame, replacing the resistor and reassembling.
h. Operate the breaker several times to insure that the relay functions properly.
i. Replace front cover.

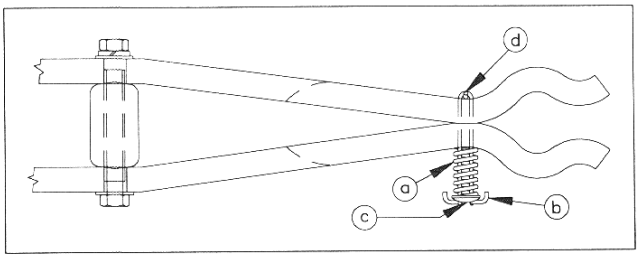


Figure 7. Primary Disconnect Finger Spring Assembly
a. Spring
b. Support
c. Cap
d. Keeper

(9) Primary Contact Spring Assembly

These springs are located at the outer end of the primary contact bars. See Figure 7. To replace them:

a. Depress spring support sufficiently to allow keeper to be removed.
b. Remove cap, spring support and spring.
c. Slide new spring onto spring support and place spring support in slot between fingers.
d. Depress head of spring support and install keeper in slot in end of spring support.
e. Release spring slowly, allowing keeper to seat properly.

NOTE: Springs are to be installed in every other slot in fingers; top, center and bottom. The second and fourth slots are empty.

(10) Latch Check Switch

The latch check switch is located on the left-hand side of the main mechanism frame, near the bottom of the main closing spring. See Figure 5, Page 4 of IB-60010. To replace it:

a. Remove the front cover of breaker.
b. Remove two screws holding switch to mechanism. Do not lose nut plate into which these screws are threaded.
c. Disconnect wires from switch.
d. Connect wires to new switch and fasten switch in place with screws and nut plate previously removed.
e. Adjust switch per instructions in section headed "Adjustment of Primary and Secondary Trip Latches and Latch Check Switch" under MAINTENANCE in IB-60010.
f. Operate breaker electrically several times to insure that

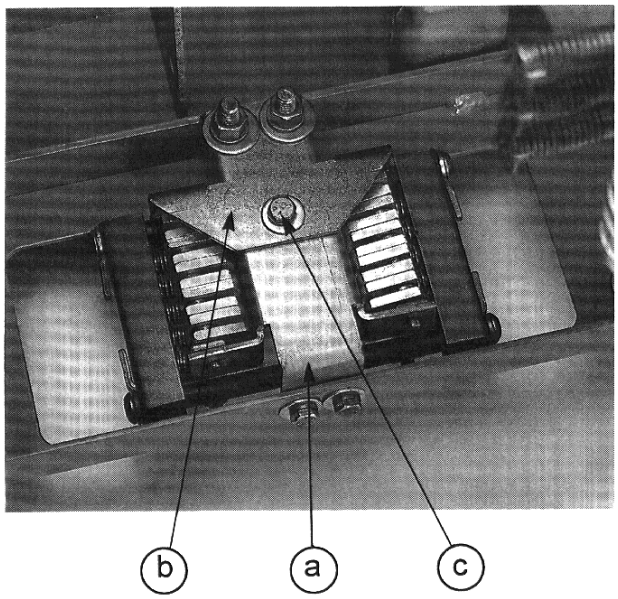


Figure 8. Ground shoe
a. Mounting Bracket
b. Retaining clip
c. Holding Bolt

it is working.

g. Replace front cover.

(11) Motor Cutoff Switch Assembly

The motor cutoff switch assembly is located on the floor pan of the mechanism area, just to the right of the main mechanism. See Figure 4, Page 4 of IB-60010. To replace it:

a. Remove the front cover of breaker.
b. Disconnect wires from switch, being careful to identify each wire by the terminal number from which it was removed.
c. Remove the two bolts holding the assembly to the breaker floor pan and remove the assembly.
d. Install new cutoff switch assembly, bolt it to the floor pan. Reconnect the wiring. No adjustment is needed.
e. Operate breaker electrically several times to insure that it is working.
f. Replace front cover.

(12) Ground Shoe Finger Assembly

The ground shoe assembly is located at the rear edge of the breaker floor pan between the center and right poles of the breaker. See Figure 8. To replace it:

a. Elevate the breaker so that there is at least 6 inches of clear space below the bottom pan of the breaker.
b. Remove the bolt holding the retaining clip to the ground shoe mounting bracket, and remove the retaining clip.
c. Slide the finger assembly slightly forward, so that the ends of the mounting rods on each side of the assembly are clear of the holes in the ground shoe mounting bracket. Press down on finger assembly and remove it from bottom of breaker.
d. Remove four socket-head screws holding two side finger assemblies to two red spacer tubes.
e. Assemble new side finger assemblies to red spacer tubes.
f. Wipe old lubricant off the ground shoe mounting bracket on breaker and apply a thin coat of contact lubricant Mobilgrease 28 to mounting bracket.
g. Insert new finger assembly from below the breaker floor pan and press up and slide back until the mounting rods can be inserted into the holes in the ground shoe mounting bracket.
h. Reinstall the retaining clip.

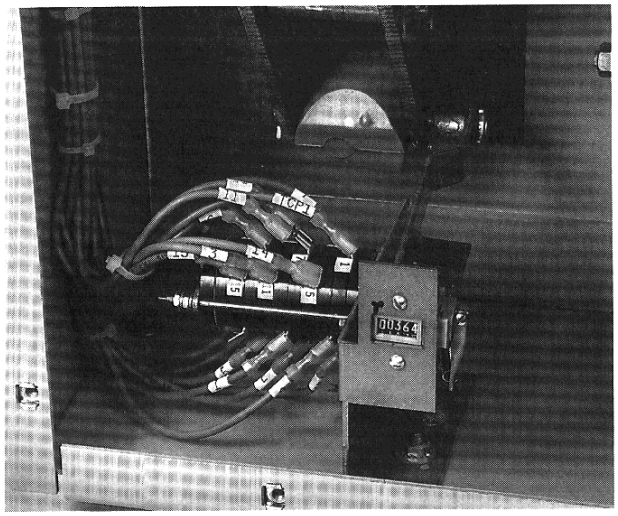


Figure 9. Auxiliary Switch

(13) Auxiliary Switch

The auxiliary switch is located in the lower left front of the mechanism area. See Figure 9. To replace an auxiliary switch:

a. Remove the front cover of breaker.
b. Disconnect wires from switch, being careful to identify each wire by the terminal number from which it was

removed.

c. Remove the "E" ring securing the switch operating arm to the operations counter 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. Make sure the terminal marked "15" on the deck farthest from the operating shaft is facing the front of the breaker.
f. Insert the operating arm of the switch into the hole in the end of the operations counter linkage and secure with the "E" ring removed in step c.
g. Reconnect the wiring. Be sure wires are connected to the same terminals from which they were removed.
h. Operate breaker electrically several times to insure that it is working.
i. Replace front cover.

POWELL ELECTRICAL MANUFACTURING COMPANY
8550 MOSLEY DRIVE • HOUSTON, TEXAS 77075 USA
PHONE (713) 944-6900 • FAX (713) 947-4453

Printed in U.S.A.