INSTRUCTIONS

IB-50000

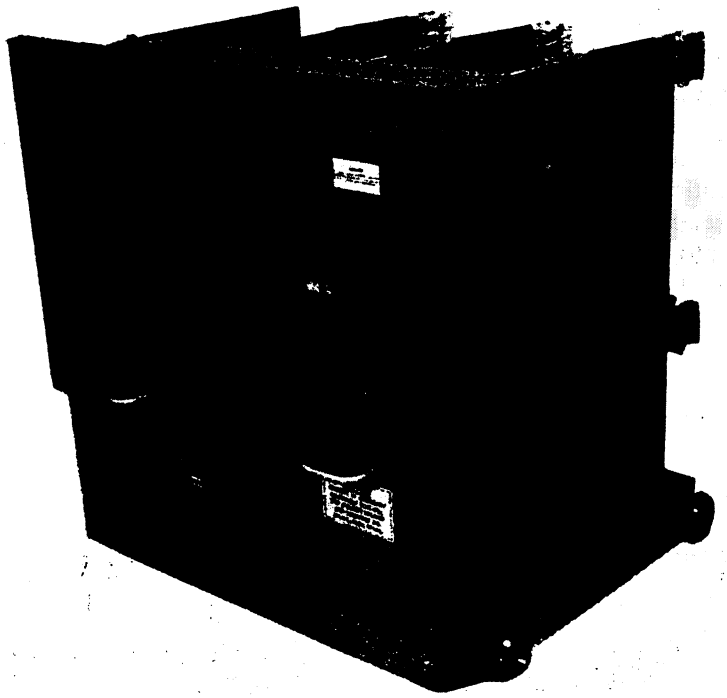
Series P-50000 POWL-VAC® VACUUM CIRCUIT BREAKERS

4.16 kV, 7.2kV and 13.8kV Voltage Classes

INSTALLATION

OPERATION

MAINTENANCE



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CONTENTS

CONTENTS, Continued

IB-50000 Insert A

D-C HIGH POTENTIAL TESTING

Many Powl-Vac circuit breakers carry a warning label reading "Do Not Subject Breaker to DC Hi-Pot" (see p. 1 of this instruction book), and the CAUTION on page 10 reads "Do not subject the breaker to high voltage direct current tests".

Many users prefer to use direct current high potential testing because of availability of test equipment. If the following conditions are met, Powl-Vac circuit breakers may be safely tested with a direct current high potential test set:

(1) Observe all the instructions about high voltage testing in the sections of this instruction book entitled "HIGH VOLTAGE INSULATION INTEGRITY" (p. 10), "VACUUM INTEGRITY" (p. 11), and "VACUUM INTERRUPTER INTEGRITY TEST" (pp. 19-20) except the prohibition against DC hi-pot testing.

(2) Test circuit breakers rated 4.16kV at 27kV DC. Test circuit breakers rated 8.25kV and 15kV at 50kV DC. The test should be for a minimum of 5 seconds and a maximum of 1 minute.

(3) 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.

(Attach this insert to the blank page opposite page 1 of IB-50000)

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.

I. INTRODUCTION

Before uncrating the breakers, study the manual and 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 and replacement of parts with critical adjustments.
5. List of renewal parts.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the Powell Electrical Manufacturing Company.

II. SAFETY

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

1. Only qualified personnel trained in the installation, operation and maintenance of power circuit breakers should be allowed to work on these breakers.
2. Do not work on an energized breaker.
3. Do not work on a breaker with the secondary test coupler connected (See Figure 17).
4. Do not work on a closed breaker.
5. Do not work on a breaker with closing springs charged.
6. Do not attempt to close the breaker by hand on a live circuit.
7. 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 disconnect position, or should be withdrawn completely.
8. 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.

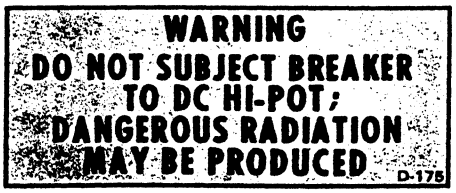
X-RAYS

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 thickness 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.

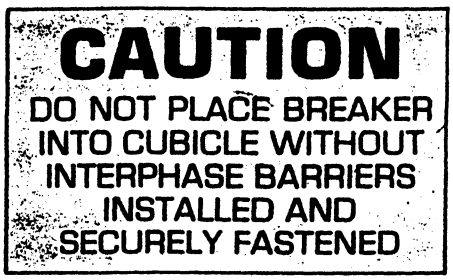
Do not subject the breaker to high voltage direct current tests — dangerous radiation may be produced.

SAFETY LABELS

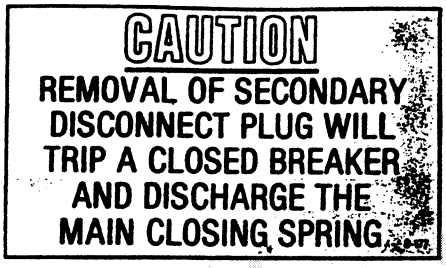
The circuit breaker has these warning and caution labels attached at the following locations. Whenever the circuit breaker is handled or maintained, these warnings and cautions must be followed.



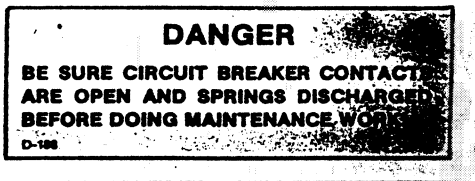
Attached to outside face of mechanism top cover plate.



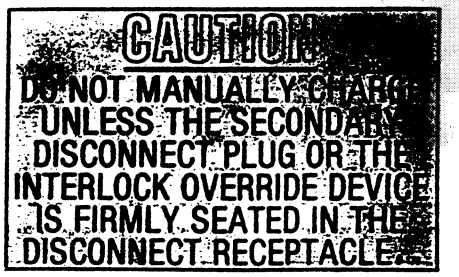
Attached to outside face of mechanism top cover plate.



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

NOTE: INSULATION

Some Powl-Vac circuit breakers have been supplied with porcelain primary connector supports and filament wound glass cycloaliphatic epoxy operating rods and primary tie bars. The following text is applicable to these breakers in addition to those with cast cycloaliphatic epoxy insulation.

A. GENERAL (Figure 1)

The Powl-Vac Vacuum 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. Cycloaliphatic epoxy resin insulators provide support for the primary bars, the vacuum interrupter assemblies and the heat dissipating fins (where used).

All the current carrying components are locasted behind a metal barrier which supports the cast cycloaliphatic epoxy 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

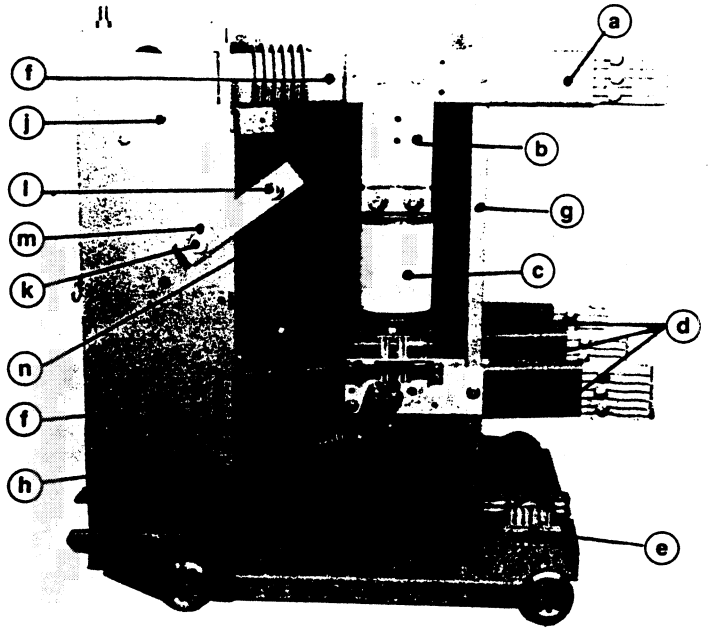


Figure 1. Side View of POWL-VAC Circuit Breaker

a. Upper Horizontal Primary Disconnect Bars
b. Vertical Connector Bars
c. Vacuum Interrupter
d. Lower Horizontal Primary Disconnect Bars
e. Ground Shoe
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

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 mid-way 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 terminal block.

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-

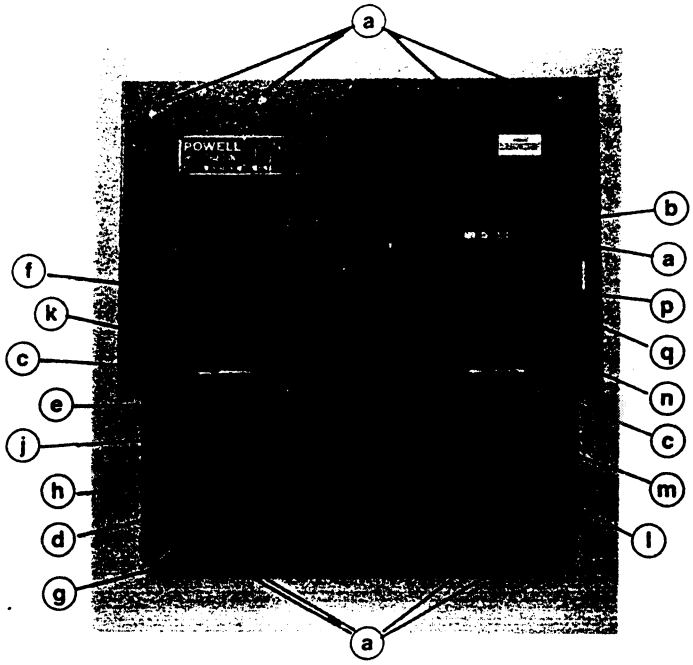


Figure 2. Front View of POW-VAC Circuit Breaker with Cover In Place

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

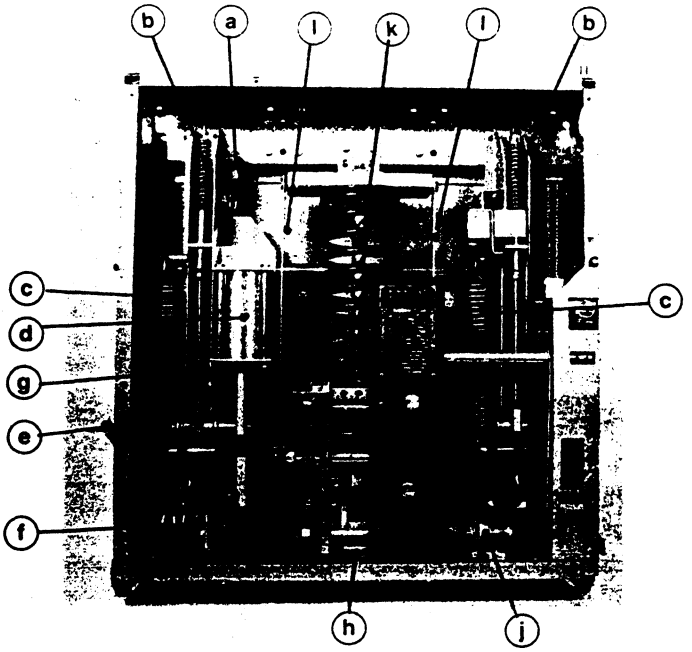


Figure 3. Front View of POWL-VAC Circuit Breaker with Cover Removed

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

in operators and interlocks, operating motor and motor cutoff switch (Figure 3).

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

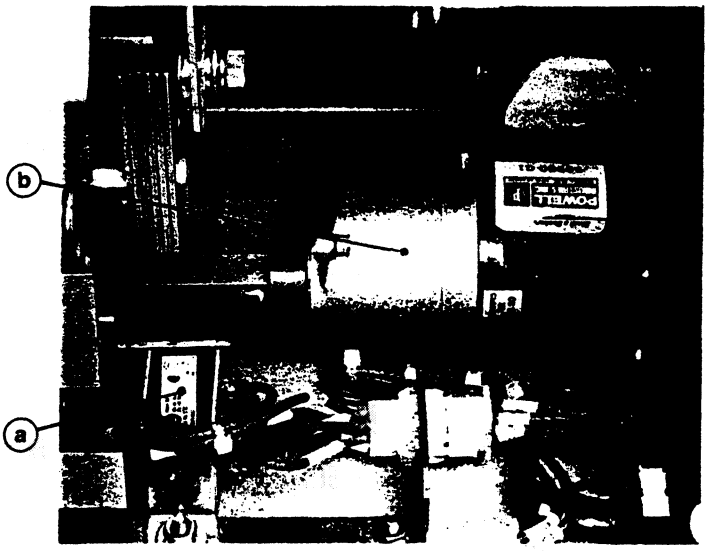


Figure 4. Charging Motor and Motor Cutoff Switch

a. Motor Cutoff Switch Assembly
b. Charging Motor

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 backwards by a holding pawl, which is supported on links which project upwards from the cam shaft.

To ensure 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.

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 outwards from these are crank pins. These engage with the bottom ends of the connecting rods (Figure 5), the top ends of which engage in pins projecting from the spring compression plate which straddles the main closing spring. As the cam

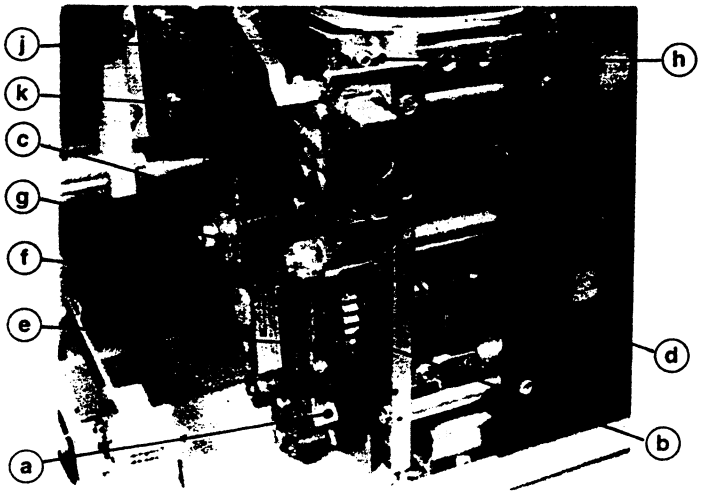


Figure 5. Main Operating Mechanism – Left Oblique View

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

shaft rotates, the connecting rods pull the spring compression plate downwards, 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 upwards. 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.

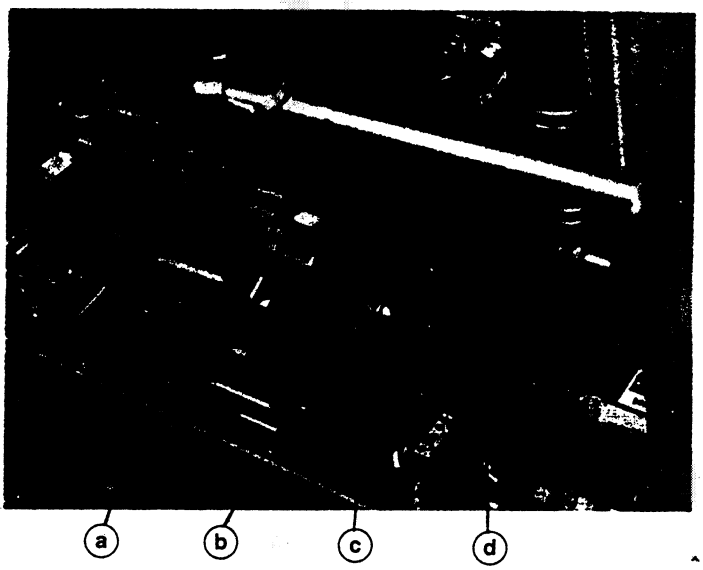


Figure 6. Main Operating Mechanism – Right Oblique View

a. Mechanism Reset Spring
b. Close Bar Adjusting Screw
c. Motor Cutoff Cam
d. Motor Cutoff Switch Operating Arm

The motor cutoff switch located on the right of the mechanism is operated by the spring charge flag falling into the spring charge 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 1).

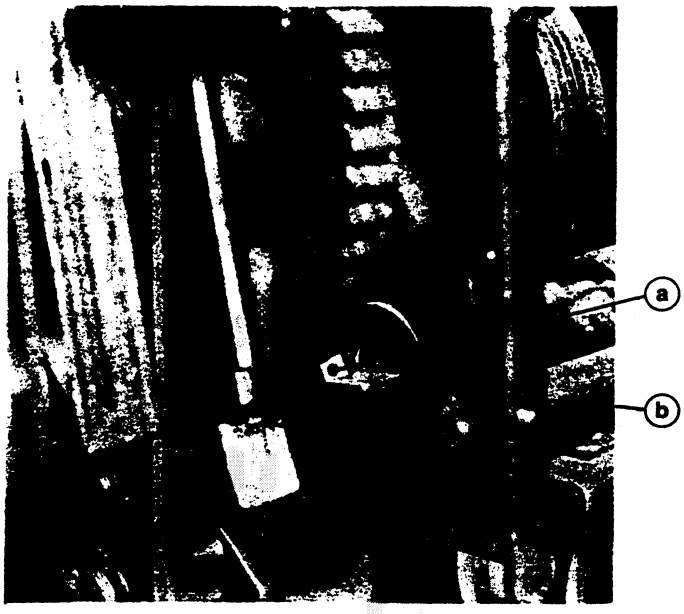
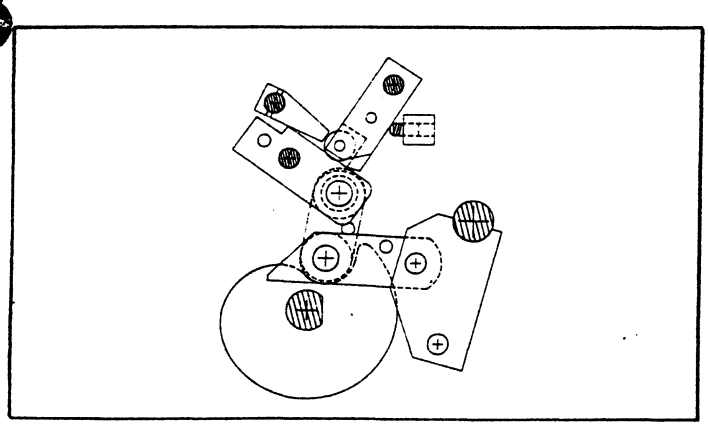


Figure 7. Close Latch Arm Engaging Close Latch Shaft
a. Close Latch Arm
b. Close Latch Shaft

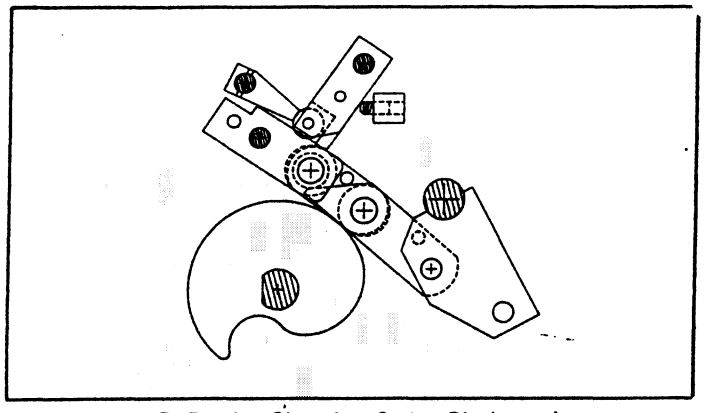
At the end of the operating rods remote from the jack shaft levers is a recess which encloses the contact loading springs. At the end of these springs, remote from the operating rod, is located the spring yoke which connects with the bell crank levers (Figure 9, Page 6). The spring yoke is restrained by a locknut 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 locknut. This gap will reduce as the vacuum interrupter contacts erode.

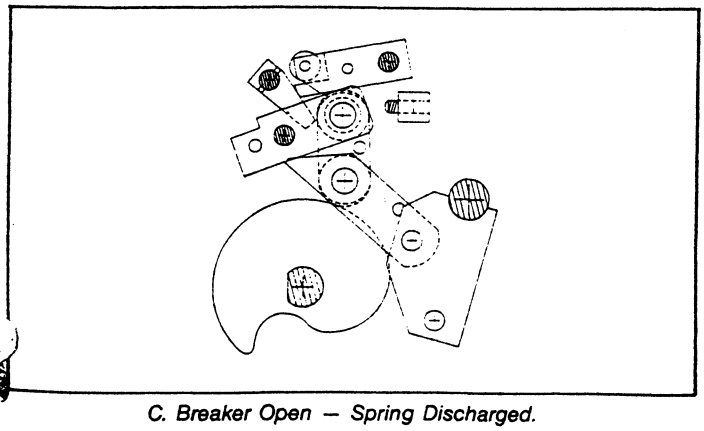
The bell crank levers, which are located on the outside of the bottom primary disconnect bars, are supported on a hinge pin bridging the bars and are connected to a drive pin which, passing through a slot in the disconnect bars, bridges the bell cranks and engages an extension to the



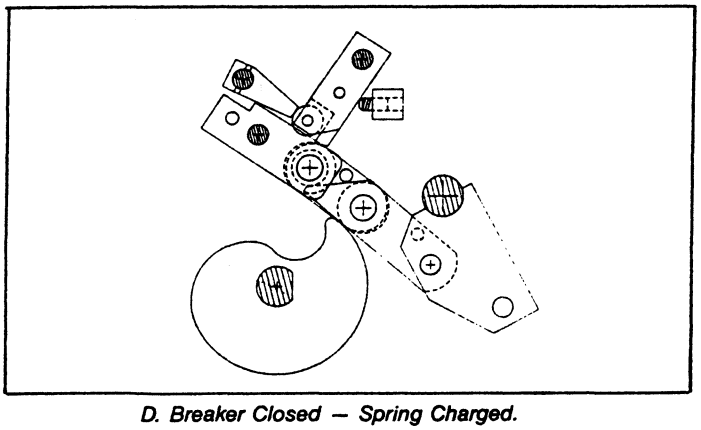
A. Breaker Open — Spring Charged — Links Reset.



B. Breaker Closed — Spring Discharged.



C. Breaker Open — Spring Discharged.



D. Breaker Closed — Spring Charged.

Figure 8. Cam and Fundamental Linkage Positions

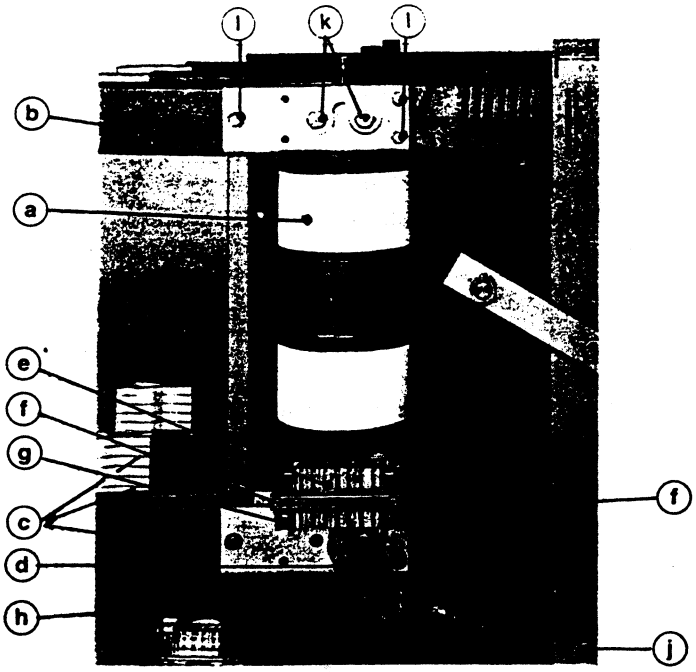


Figure 9. Interrupter and Operating Rod Mechanism

- *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. Upper Horizontal Primary Disconnect Bar Mounting Bolts*

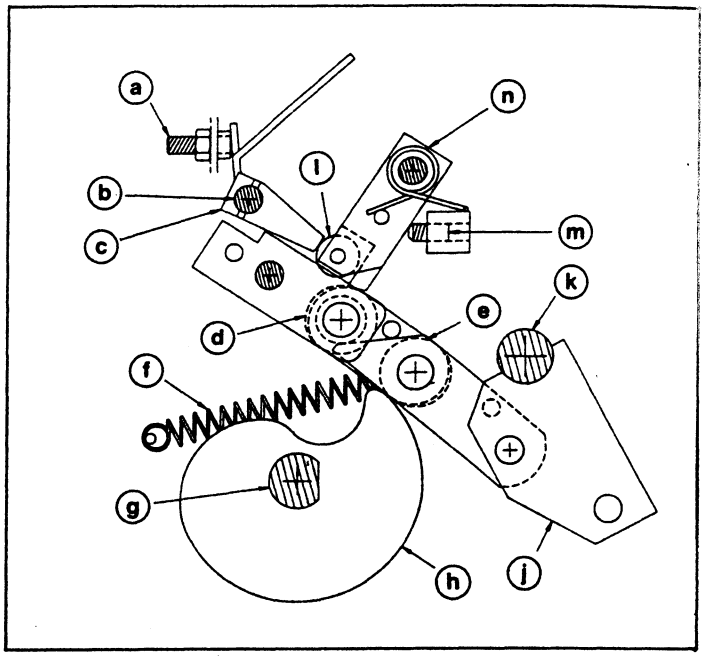


Figure 10. Mechanism and Trip Linkages

- *a. Secondary Trip Prop Adjusting Screw*
- *b. Trip Bar*
- *c. Secondary Trip Latch*
- *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*

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 of approximately 12 mm by a factor of 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 upwards, 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 upwards, thus permitting the main linkage to move upwards 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 where it is clamped by hook plates. The two outer operating rod levers on the jack shaft have connections to the breaker opening springs (Figure 3, Page 3). These are two large diameter, low rate tension springs which move the contacts to their fully open position, and two high rate kickoff springs, which assist the contact loading springs in providing the initial high speed contact separation. A projection of the left lever engages a shock absorber which controls 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 8D), 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, Page 4).

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, Page 2). 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 should indicate that the breaker is either in the connected or disconnected position. A socket-head bolt mounted on the left side sheet serves as a backup to the threaded plate, providing a positive stop to left crank arm.

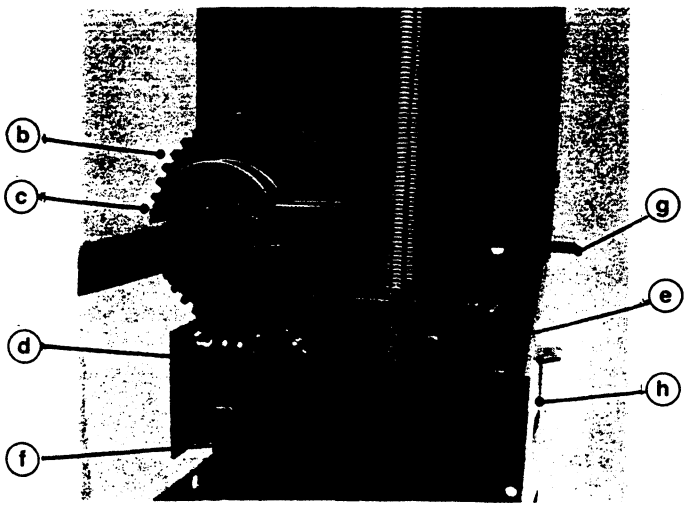


Figure 11. Levering-In Mechanism and Interlocks

a. Levering-In Shaft (not shown)
b. Worm Wheel
c. Interlock Cam
d. Worm Gear
e. Interlock Plates
f. Travelling Nut Plate
g. Position Indicating Rod for Electrical Levering-In Device
h. Access Shutter for Levering-In Drive Shaft

D. INTERLOCKING

The first purpose of the interlocks is to ensure 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 ensure 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.

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 upwards position when the levering in cranks are in the connected, test or disconnected position. The shutter cannot be moved downwards until the trip plate is pushed inwards and the secondary disconnect plug is inserted. Pushing the trip plate inwards moves one prop out of the way of the shutter. Insertion of the secondary plug pushes the blocking plate backwards and rotates a second prop out of the way of the shutter. Then, downwards movement of the shutter causes a lever operating in parallel with the shutter to move downwards, 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 upwards when the levering-in shaft is in the disconnect position. To summarize the action of the levering-in interlocks; the worm gear shaft shutter

cannot be depressed 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 downwards to lock the secondary disconnect plug in position. The bolt cannot return upwards in any other position than disconnect because it is restrained by a cam having only one slot.

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 move the shutter before there is any movement of the breaker toward the connected position.

F. BREAKER POSITION INDICATORS

The breaker position indicator is on the front cover. The flags indicate whether the breaker in connected or disconnected. When the arrow on the particular indicator points exactly to the center mark, the breaker will have moved to the indicated position. When the "BREAKER CONNECTED" indicating arrow is opposite the center mark, 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. When the "BREAKER TEST/DISCONNECTED" indicating arrow is opposite the center mark, 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, Page 3).

G. VACUUM INTERRUPTER CONNECTIONS

Connection to the vacuum interrupter stems is made by means of hard copper blocks which are screwed on to the threaded stems of the vacuum interrupters. The top stems of the vacuum interrupters are securely clamped in a block between the top primary disconnect arms. The bottom or moving stem of the vacuum interrupter is attached to another threaded hard copper block and bridge contacts make contact with this block and the bottom 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, Page 3).

The shunt trip solenoid is to the left of the mechanism and is supported from the bottom frame channel (Figure 3, Page 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 bottom 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.

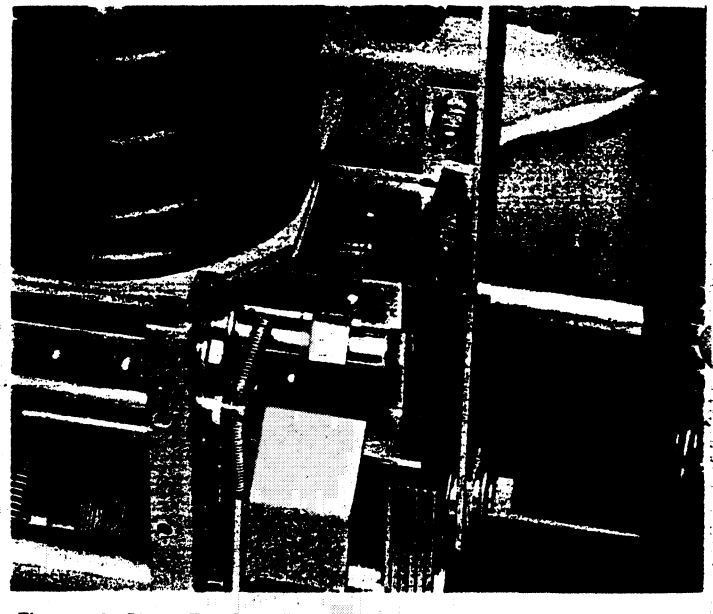


Figure 12. Shunt Trip Coil, Right

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, Page 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, Page 3).

L. VACUUM INTERRUPTERS

The vacuum interrupters differ in size and have different constructions depending on their ratings. The vacuum interrupters shown in Figure 1, Page 2 are the smallest and need connecting plates to bridge the gap between the vacuum interrupter top stem and the top primary disconnect arms. The higher current vacuum interrupters used

for the highest ratings are longer and do not need connecting plates.

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 breaker.

IV. INSTALLATION

A. RECEIVING

Figure 13 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.

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

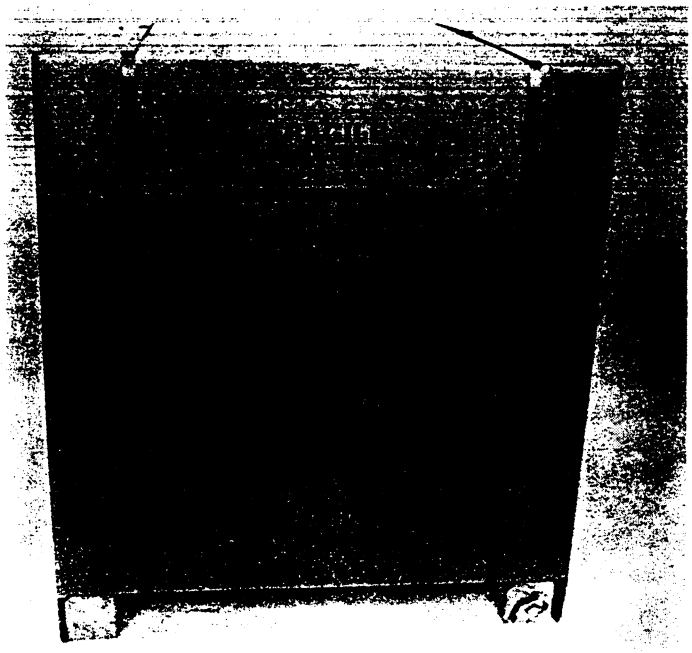


Figure 13. Circuit Breaker in Shipping Carton

more metal bands. When these are removed, the breaker may be removed from the shipping skid (See B. Handling).

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 (See Figure 14). Remove these four bolts, discard the shipping angle, and replace the four bolts.

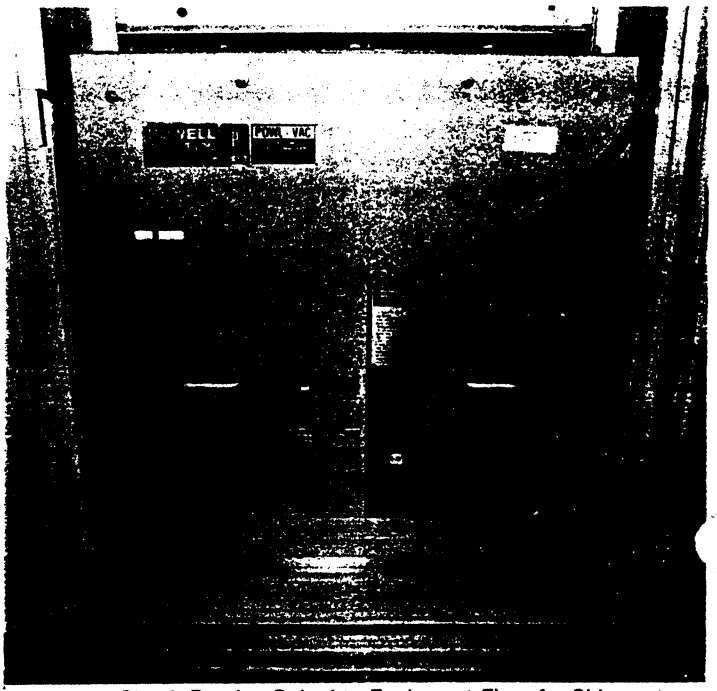


Figure 14. Circuit Breaker Bolted to Equipment Floor for Shipment

B. HANDLING

The breaker can be handled by a fork lift truck if care is taken 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". The forks should then ride under the wheel axles (Figure 15). The breaker can be lifted by overhead crane using holes which have been provided at the top of the breaker frame side sheets for hooks (Figure 16).

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

Figure 15. Circuit Breaker Being Listed by Fork Lift

Figure 16. Circuit Breaker Being Lifted on Crane

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

It should be noted that the center shield of the vacuum interrupter can acquire an electrical charge during testing and a grounding stick should always be used to discharge the shield as well as the other metal conducting parts immediately after testing. In addition, high voltage across the open gaps of the interrupter can produce radiation. Personnel should stand away from the breaker in front of the front cover, and test voltages should not exceed 27 KV, 60 Hertz. DO NOT SUBJECT THE BREAKER TO HIGH VOLTAGE DIRECT CURRENT TESTS — DANGEROUS RADIATION MAY BE PRODUCED.

(1) HIGH VOLTAGE INSULATION INTEGRITY

Check the breaker condition flags (Figure 2, Page 3). They should read "BREAKER OPEN, MECHANISM DISCHARGED." Wire the 3 top pole conductors of the breaker, and ground the 3 bottom pole conductors. Perform the one minute high voltage test prescribed in ANSI Standard C37.20-1974, 5.5 and 4.2.5, at the voltage level appropriate for the equipment.

Repeat with the voltage applied to the bottom conductors and the top conductors grounded.

This test will have checked the top, bottom and rear support insulators. It has also checked the vacuum integrity as far as **complete** loss of vacuum is concerned.

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

(2) VACUUM INTEGRITY

If the user wishes to check for partial reduction of vacuum that might reduce the performance of the vacuum interrupter, we recommend the use of the portable vacuum checker device. Instructions on its use are included with the device.

For further information, see Section headed "VACUUM INTERRUPTER INTEGRITY TEST" under the Maintenance heading in this instruction book.

(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 insulation tester or with an AC high potential tester. The AC high potential test should be made at 1125 volt, 60 hertz, 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, 60 hertz. 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 test connector in the slot below the fixed secondary contacts. (Figure 17). This 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 test connector 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 30 operations of the handle. Remove the handle. Push the round blue "push to close" plate and the breaker will close. The flag located above the "push to close" plate will now read "closed." Push the round red trip plate located at the top of the escutcheon and the breaker will open as indicated by the breaker condition flag.

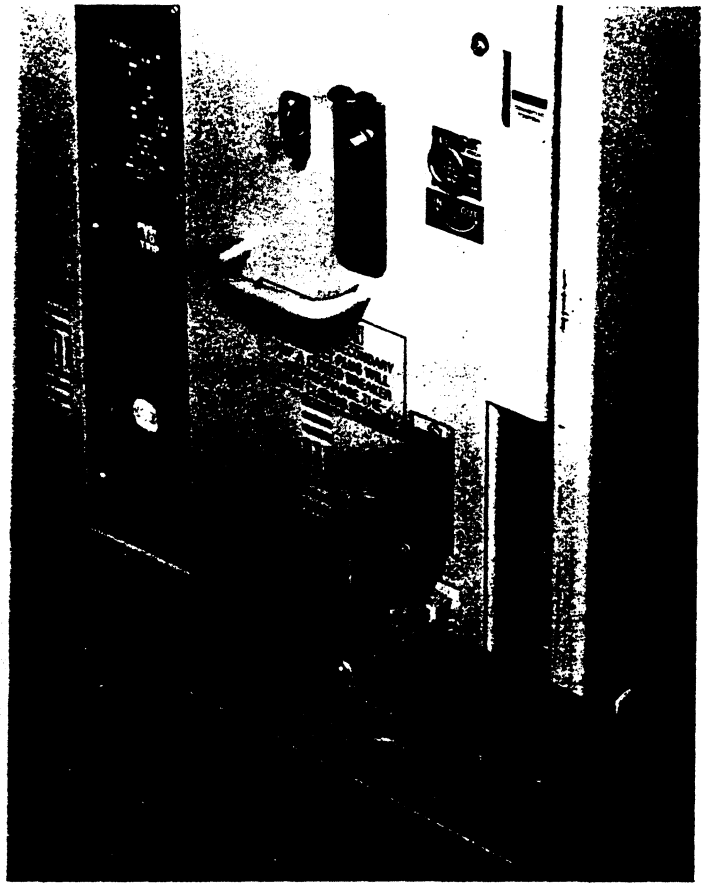


Figure 17. Circuit Breaker with Secondary Test Connector in Place

(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 connector test bar in place, the operation of the levering-in device is checked by first pushing the trip plate and moving the levering-in shutter downwards to give access to the 0.75" hexagon worm shaft. It should be

noted that this shutter cannot be moved downwards unless the trip plate is pressed to ensure an open breaker and the secondary connector or secondary connector test bar is inserted. Insert the levering-in crank provided or a standard ¾ 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 indicators on the left side of the front cover should indicate "DISCONNECTED." Rotate the hex worm shaft in a clockwise direction. The crank arms will move downwards 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" and the indicating arrow is opposite to the central indication mark, 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 test bar.

Once again, push the trip plate, depress the levering-in shutter, insert the crank or socket and rotate in a counter-clockwise 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 connector test bar.

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.

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, IB-51000.

To move the circuit breaker to the "CONNECTED" position, first plug in 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 may damage the circuit breaker or the switchgear equipment.

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 counter-clockwise until the indicator flag reads "TEST/DISCONNECTED." At this point, **do not** attempt to rotate the crank further counter-clockwise 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 IB-51000 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 (Figure 18). When furnished, it is used as follows:

To connect the breaker

Ensure that breaker is fully inserted into cell and that levering-in crank arms are in correct position relative to hook plates. Remove ¼-20 cover bolt from right side of front cover (See Figure 2, Page 3). Open levering-in access

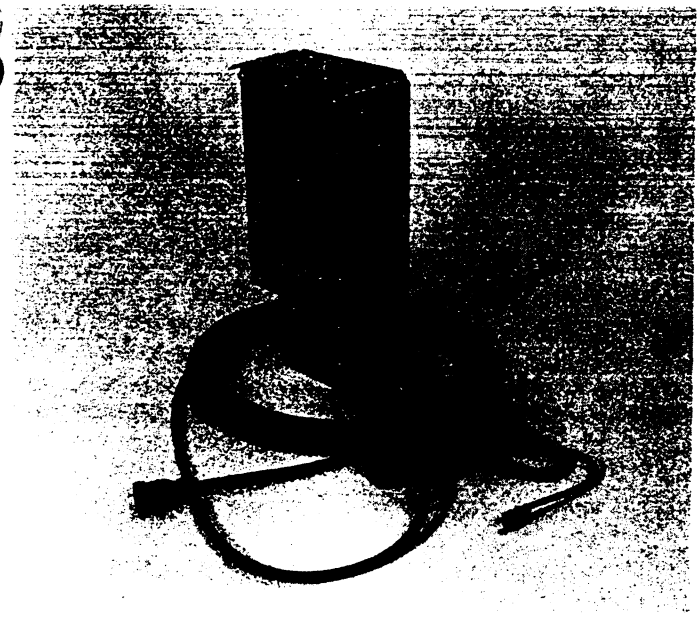


Figure 18. Power Racking Device

shutter by first pushing breaker trip plate and then moving shutter downwards. Insert power racking adaptor sleeve (See Figure 19) onto hexagonal racking shaft. Grasp the power racking device by the top lifting rod and place over the right portion of the front cover top flange so that the hook portion of the racking device matches the cutout at the back of the flange (See Figure 20). The racking device can now swing downwards and the locking screw can be inserted into the hole from where the front cover holding screw was previously removed. Finger

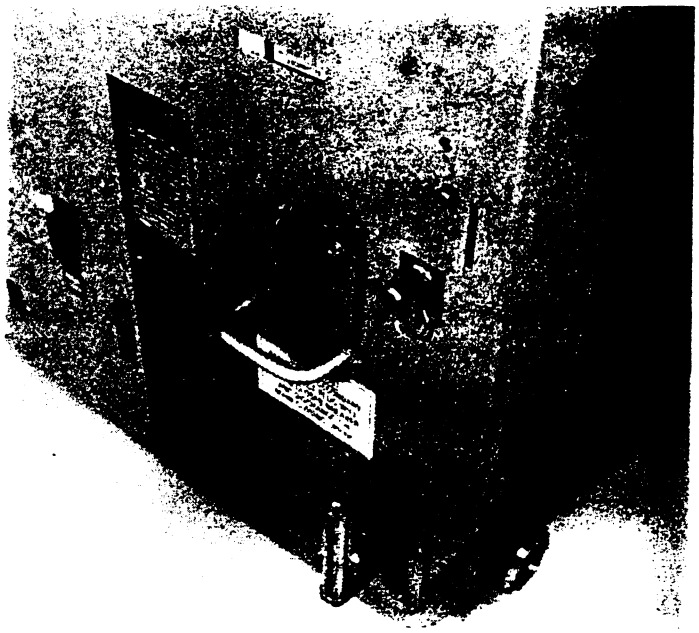


Figure 19. Power Racking Device Adapter on Levering-In Shaft

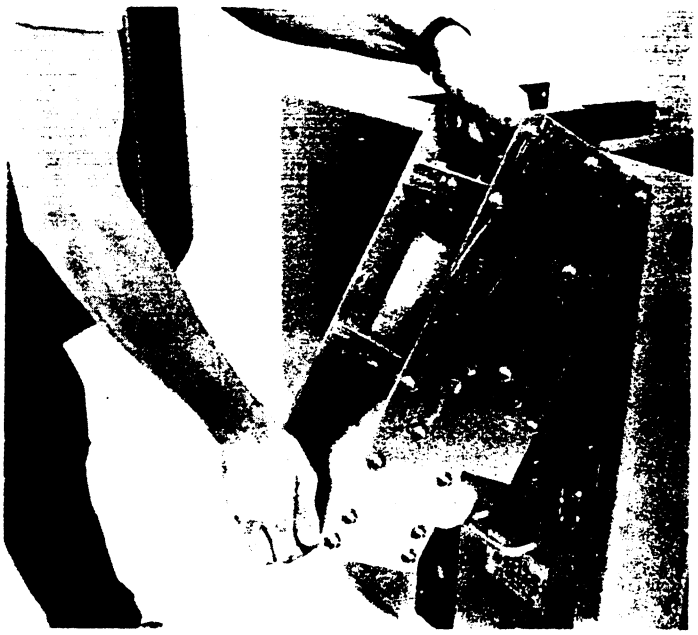


Figure 20. Placing Power Racking Device on Circuit Breaker

tighten the screw so that the racking device is flush with the breaker front cover (See Figure 21). The extension cable of the racking device can now be extended so that the control box is in the required operating location. A 25-ft. length of cable is supplied as standard. The control box needs a 120VAC supply to operate the racking device. To insert the breaker, switch the two position control switch to the "in" position and push the switch downwards. The breaker will commence its movement into the breaker con-

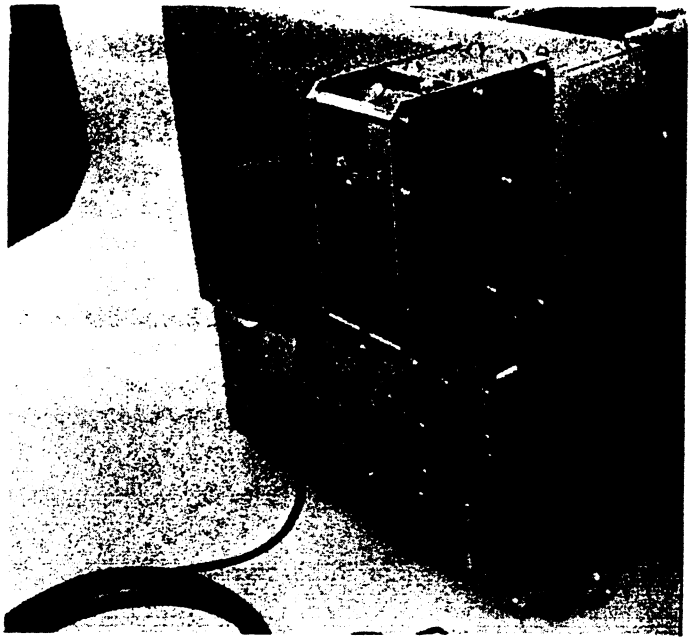


Figure 21. Power Racking Device in Place on Circuit Breaker

nected position and the movement will automatically cease when the breaker is fully connected. To remove the power racking device, first remove the power supply to the control box and then unscrew the locking screw on the front of the power racking device. The device can then be lifted off the breaker front cover by swinging the bottom end away from the cover and lifting the device over the flange of the breaker cover.

To operate the breaker, the power racking adaptor sleeve must be removed to permit the shutter to move upwards thus removing the trip safety feature from the mechanism. Replace the adaptor sleeve in its mounting clip on the side of the power racking device and replace the cover screw. The breaker is now ready for normal operation.

To remove the breaker

Use the same procedure as for connecting the breaker, except the power racking remote control switch should be switched to the "out" position before pushing the switch downwards. The motor will automatically stop when the breaker is fully withdrawn.

CAUTION: If the control switch is not held down until the breaker is either fully connected or fully withdrawn and the power racking device is removed, operation of the breaker will not be possible because the levering-in shutter will not return to its "up" position releasing the trip safety interlock.

V. MAINTENANCE

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

A. GENERAL

1. Introduction

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 (1000 for 3000A breakers) or once a year, whichever comes first.

Actual inspection and maintenance will depend upon individual application conditions such as number of operations, magnitude of currents switched, desired overall system reliability and operating environment. Any time the breaker is known to have interrupted a fault current at or near 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 1000 to 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.

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.

Before attempting any maintenance 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** WORK ON A CLOSED BREAKER OR A BREAKER WITH THE CLOSING SPRINGS CHARGED.

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 lint-free 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 lint-free 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 connector test bar into the secondary disconnect receptacle to perform this operation (See Figure 17, Page 11).

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 17).

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.

Anderol 757 Grease should be lightly applied to those bearing surfaces which are accessible and a light synthetic machine oil such as Mobil 1 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 entr 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 connecting rods (See Figure 22). The connecting rods can now be unhooked from the spring yoke pins and the spring assembly removed. Care should be taken on reassembly to ensure correct location of the flat washer, lock washer and spacer. See Figure 23.

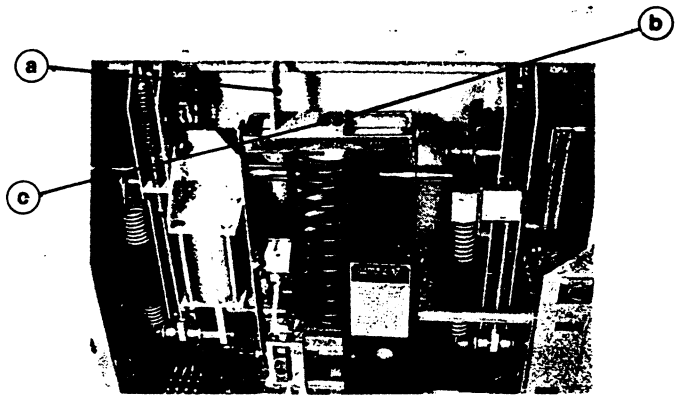


Figure 22. Main Closing Spring Assembly Compressed for Removal

a. Bracket
b. Flat Washer
c. Screw

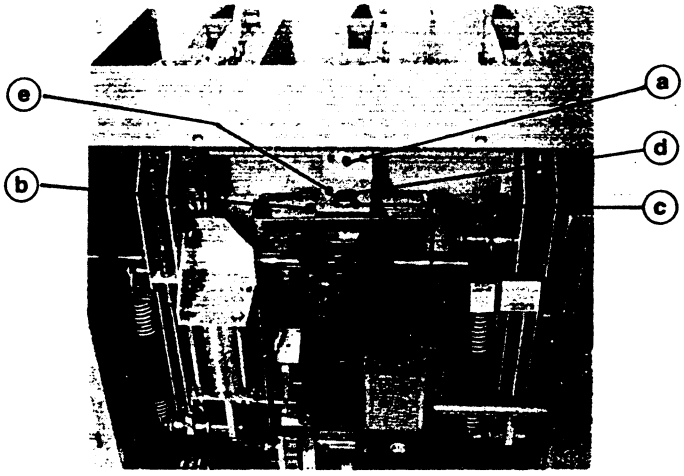


Figure 23. Main Closing Spring Assembly Installed

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

With the main spring assembly removed, rotate the cam shaft so that the crank arms are pointing downwards. 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 face, the "push to close" 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 upwards. The breaker will now be closed and there will be a gap between the contact overtravel nuts and the contact spring yokes. See Figure 25, Page 19.

4. **Mechanism Adjustments**

There are several factory adjustments in the mechanism which 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, re-tighten the mounting bolt and replace the escutcheon. Be sure that the escutcheon is reinstalled on the circuit breaker, since the escutcheon contains the nameplate with all the breaker's rating and serial number information.

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 inches (Figure 10, Page 6). Adjust the primary trip latch adjusting screw, Figure 10, so that the main linkage in the reset position the clearance between the primary trip latch roller and the secondary trip prop is 0.030 inches. 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 26, Page 20). With 0.030 inch wire gauge between the trip bar lever, and the secondary trip latch adjusting screw, the latch

Table 1

Location	Lubricant	Method
Electrical Parts		
Main Primary Disconnect Fingers	Mobilgrease 28	Wipe Clean. Apply lube 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	Feed grease between worm and wheel while rotating worm shaft between disconnected and connected positions.
Worm Shaft Bearings	Mobil 1 Machine Oil	
Levering-in Shaft Support Bearings	Mobil 1 Machine Oil	
Levering-in Crank Arm Rollers	Mobil 1 Machine Oil	Tilt Breaker sideways and rotate roller while lubricating.
Wheels	Mobil 1 Machine Oil	Tilt Breaker sideways and rotate wheels while lubricating.
Camshaft		
Camshaft Needle Bearing	Mobil 1 Machine Oil	
Crank Pins	Mobil 1 Machine Oil	
Spring Yoke Pins	Mobil 1 Machine Oil	
Ratchet Wheel	Mobil 1 Machine Oil	
Pawls	Mobil 1 Machine Oil	
Oscillator Arms at Camshaft	Mobil 1 Machine Oil	
Main Spring Guide Rod	Mobil 1 Machine Oil	
Motor Drive Shaft Support Bearing	Mobil 1 Machine Oil	
Motor Drive Shaft Roller Needle Bearings	Mobil 1 Machine Oil	
Motor Drive Shaft Coupler Recess	Mobil 1 Machine Oil	
Trip Shaft Support Bearings	Mobil 1 Machine Oil	
Close Shaft Support Bearings	Mobil 1 Machine Oil	
Close Shaft Latch Face	Anderol 757 Grease	Apply light coating of grease and remove all excess.
Primary Trip Prop Shaft Support Bearings	Mobil 1 Machine Oil	
Primary Trip Prop Shaft Roller	Mobil 1 Machine Oil	
Main Linkage	Mobil 1 Machine Oil	Apply to penetrate where pins pass through links.
Fixed Link Pin	Mobil 1 Machine Oil	Apply to penetrate where pin passes through end link.
Jackshaft Outer Bearing Supports	Mobil 1 Machine Oil	
Jackshaft Supports at Mechanism	Mobil 1 Machine Oil	
Open-Closed Flag Drive Lever at Jackshaft	Mobil 1 Machine Oil	
Motor Cutoff Switch Cam	Anderol 757 Grease	Apply to peripheral surface only.
Flag Support Pins	Mobil 1 Machine Oil	
Jackshaft Lever Pins Passing Through Push Rods	Mobile 1 Machine Oil	Avoid lubricant on push rods

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 4). With the main closing spring charged, turn the latch adjusting screw inwards towards 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.

C. INTERRUPTER AND CONTACT AREA

1. **Vacuum Interrupter Contact Erosion**

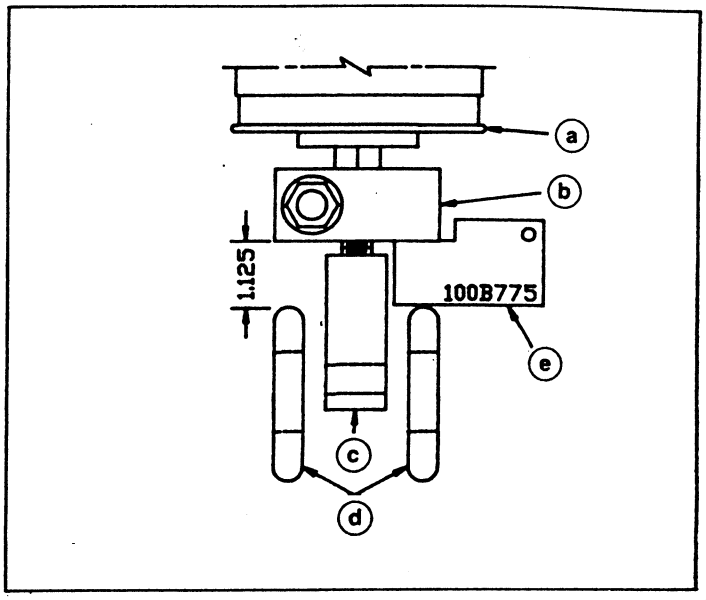
At each inspection, the vacuum interrupters should be checked for amount of contact erosion. The breaker must be closed for this check. Each vacuum interrupter hexagonal moving stem has a red mark painted on one of the hexagon faces. On a new vacuum interrupter, the upper edge of this red mark is approximately 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. **Sliding Contact Finger Wear**

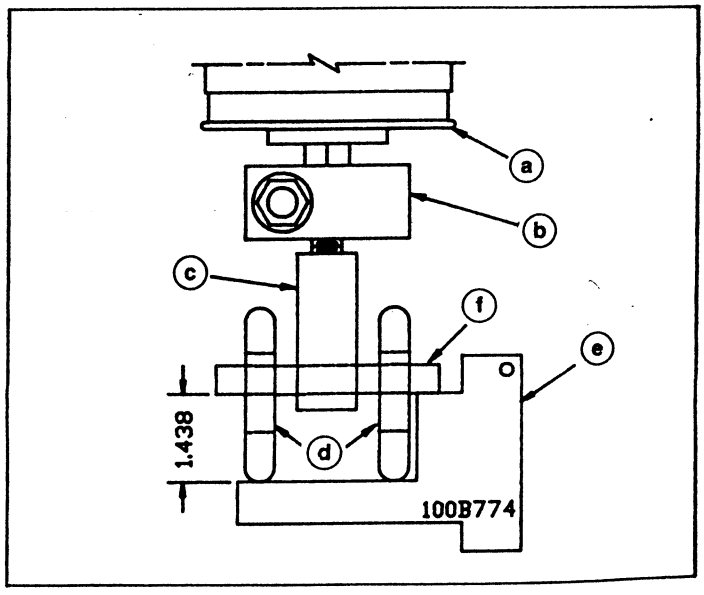
Remove the four socket-head screws (f, Figure 9, Page 6) holding the sliding contact assemblies and pivot the assemblies down. Wipe the lubricant from the surfaces of the lower contact block, the fingers and the lower main horizontal primary disconnect bars and examine these surfaces. The finger locations 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 (g, Figure 9, Page 6) 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.



A: Interrupter Height Gauging



B: Operating Yoke Adjustment

Figure 24. Gauging New Interrupter

- *a. Vacuum Interrupter*
- *b. Lower Contact Block*
- *c. Operating Yoke*
- *d. Lower Main Horizontal Primary Disconnect Bars*
- *e. Gauge*
- *f. Vacuum Interrupter Operator Pin*

3. **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 after interrupter replacement or any major overhaul of the breaker which involves interrupter or mechanism removal. **DO NOT ADJUST THESE SETTINGS UNUNNECESSARILY.**

a. With closed contacts on a new vacuum interrupter, the bottom of the sliding contact block should be 1.125″ ±.060″ above the top of the main horizontal primary disconnect bars. See Figure 24A. Use gauge 100B775.

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″ ±.080″ above the bottom of the main horizontal primary disconnect bars. See Figure 24B. Use gauge 100B774.

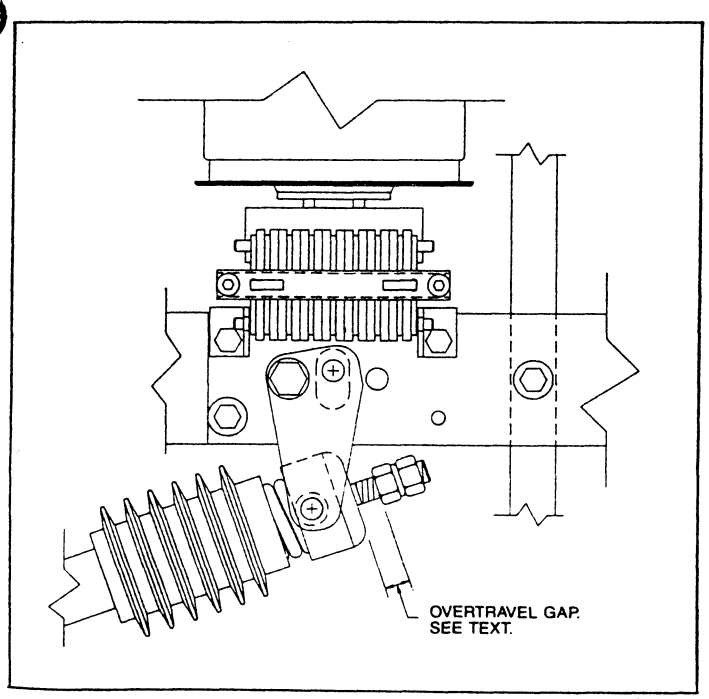


Figure 25. Operating Rod Nut Gap Adjustment

c. With the breaker open, the dimension described in (b) should be 0.937″ ±.080″.

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 25. With a new vacuum interrupter, this gap will be between ½″ and ⅝″. As the contacts erode, the gap will reduce to about ⅛″.

If it is necessary to adjust any of these dimensions after major maintenance, refer to the instructions for replacing a vacuum interrupter in the REPAIR PROCEDURES section of this instruction book. Gauges 100B774 and 100B775, used in these adjustments, are included with replacement interrupters furished by Powell. If you need these gauges and are not replacing an interrupter, contact Powell Apparatus Service Division (PASD).

4. **Vacuum Interrupter Integrity Test**

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 one minute 20kV AC RMS high potential test. During this test, the following caution must be observed:

CAUTION

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

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

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.

It is recommended that this test be done using the Type V-1 Vacuum Interrupter Test Set. Instructions for its use are included with this test set. If

this test set is not available, any suitably rated AC high potential test set may be used. To avoid any ambiguity in the AC high potential test due to leakage or displacement (capacitive) current, the test set should have sufficient volt-ampere capacity; it is recommended that the equipment be capable of delivering 25 mA of current at the test voltage for one minute.

Any interrupter found to be defective in this test should be replaced immediately.

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. This resistance should not exceed 55 micro-ohms for 1200A and 2000A breakers rated 15kV, 500 MVA Class, and it should not exceed 40 micro-ohms for any other circuit breaker.

   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″ thick by 3″ or 4″ wide by 4″ 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

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-50000. 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 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.

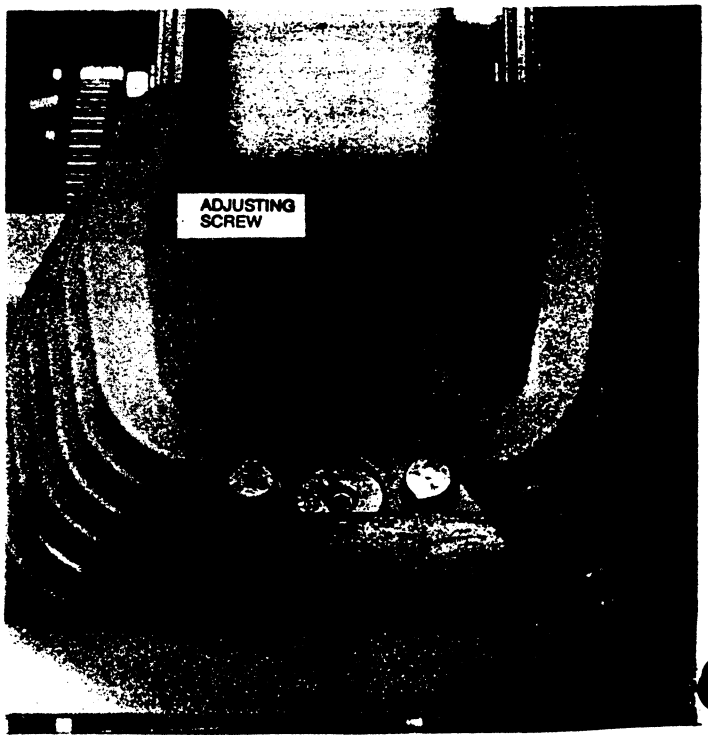


Figure 26. Primary Trip Latch Adjusting Screw

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.

Table 2.
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)
5PV250	4.76	1200, 2000	58	50954-G2	50952-G1
5PV250H	4.76	1200, 2000	78	50954-G4	50956-G1
5PV250H	4.76	3000	78	50955-G4	50956-G2
5PV350	4.76	1200, 2000	78	50955-G2	50956-G1
5PV350	4.76	3000	78	50955-G4	50956-G2
7.5PV500	8.25	1200, 2000	66	50955-G2	50956-G1
7.5PV500	8.25	3000	66	50955-G4	50956-G2
15PV500	15	1200	37	50953-G2	50951-G1
15PV500	15	2000	37	50953-G4	50951-G1
15PV500H	15	1200, 2000	58	50954-G2	50952-G1
15PV500H	15	3000	58	50955-G4	50956-G2
15PV750	15	1200, 2000	58	50954-G2	50952-G1
15PV750H	15	1200, 2000	77	50954-G4	50956-G1
15PV750H	15	3000	77	50955-G4	50956-G2
15PV1000	15	1200, 2000	77	50955-G2	50956-G1
15PV1000	15	3000	77	50955-G4	50956-G2

Table 3.
Control Devices (1)

Control Voltage	Closing Coil	Shunt Trip Left (2)	Shunt Trip Right (3)	Undervoltage Device (4)	Charging Motor	Anti-Pump Relay
24VDC	N/A	50746-G5	50731-G6	50719-G4	N/A	N/A
48VDC	50730-G1	50746-G1	50731-G1	50719-G3	50960-G2	PVKUP11D55-48
125VDC	50730-G3	50746-G2	50731-G3	50719-G1	50960-G1	PVKUP11D55-110
250VDC	50730-G4	50746-G3	50731-G4	50719-G2	50960-G3	PVKUP11D55-110(5)
120VAC	50730-G1	50746-G1	50731-G1	N/A	50960-G1	PVKUP11A55-120
240VAC	50730-G2	50746-G6	50731-G2	N/A	50960-G3	PVKUP11A55-240
Capacitor Trip(6)	N/A	50746-G4	50731-G5	N/A	N/A	N/A

NOTES FOR TABLE 3

1. One each required per breaker if breaker was originally equipped with this item. All breakers have closing coil, charging motor and anti-pump relay. Some breakers have a shunt trip coil on the left, some on the right, and some in both locations. Undervoltage device is optional. See notes 2, 3, and 4.
2. Standard shunt trip for all -0 breakers and for all breakers shipped January, 1986 or later.
3. Standard shunt trip for all -1 breakers shipped 1985 or earlier. Secondary shunt trip (where furnished) for all other breakers. 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 4, 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 –	
	6-point disconnect	50987-G1
	9-point disconnect	50756-G1
2	Ground Shoe Finger Assembly	50952-G2
1	Auxiliary Switch Assembly (1)	50933-G1
	or Auxiliary Switch (2)	0285A8860G1

NOTES FOR TABLE 4

1. For breakers shipped prior to August, 1985, which used Type SBM auxiliary switches.
2. For breakers shipped August, 1985, or later.

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 2, 3 and 4 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

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 this book.

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

1. **Vacuum Interrupter**
   a. Open circuit breaker and discharge closing spring.
   b. Remove front cover of circuit breaker.
   c. Disconnect upper ends of the two opening springs from the studs on which they are connected. (See Figure 3, Page 3).
   d. Remove interphase barrier assembly.
   e. Remove X-washer from one end of the vacuum interrupter operating pin and pull the pin (d, Figure 9, Page 6). The X-washer can be opened by squeezing the two projecting tabs with pliers.
   f. Remove the four socket-head screws, two on each side, (f, Figure 9, Page 6) holding the sliding contact assemblies, and pivot the sliding contact assemblies down.

g. Unscrew and remove operating yoke at lower end of the vacuum interrupter (c, Figure 24, Page 18).
h. Loosen, but do not remove, the two bolts through the upper contact block (k, Figure 9, Page 6).

The next step varies depending on the rating of the interrupter being replaced.

ja. For circuit breakers equipped with 10B12S or 10B20H interrupters, which have the vertical copper connecting bars between the upper contact block and the upper main horizontal primary disconnect bars (See Figure 1, Page 2):
1. Loosen but do not remove the four bolts connecting the vertical bars to the horizontal primary disconnect bars.
2. While supporting the vacuum interrupter, remove the two bolts connecting the upper contact block to the vertical bars.
3. Remove the vacuum interrupter.

OR

jb. For circuit breakers equipped with 10B30C interrupters, which have the upper contact block directly between the main horizontal primary disconnect bars (See Figure 9, Page 6):
1. Remove the primary contact springs at the outer end of the horizontal primary disconnect bars (Figure 27).
2. Remove the nuts from the three bolts holding the upper horizontal primary disconnect bars to the insulating supports (l, Figure 9, Page 6).
3. While supporting the vacuum interrupter, remove the two bolts connecting the upper contact block to the main horizontal primary disconnect bars.
4. Remove one of the upper horizontal primary disconnect bars.
5. Remove the vacuum interrupter.

k. Unscrew the upper contact block from 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 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.

m. 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.

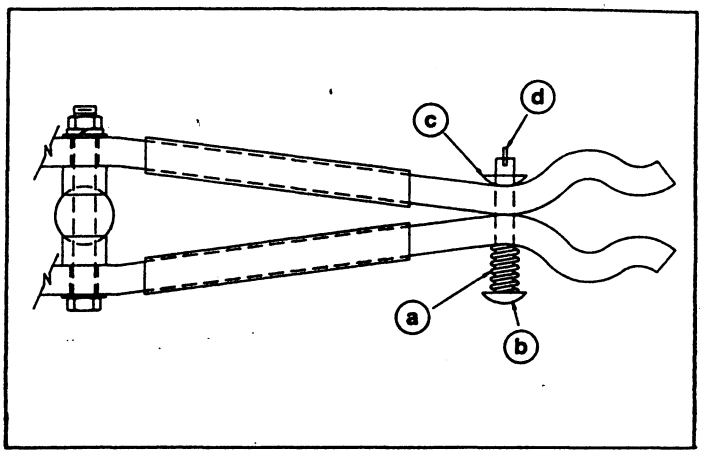


Figure 27. Primary Disconnect Finger Spring Assembly
a. Spring
b. Support
c. Cap
d. Keeper

n. 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.
p. 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 snut 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 24A, Page 18.

q. 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.

r. Remove the nut from the bell crank mounting bolt and remove one bell crank.

s. Insert the pin through the operating yoke but not through the bell cranks.

t. 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 24B, Page 18.

u. Remove the pin and reassemble the bell crank.

v. 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.

w. 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 ⅝" bolts in the upper main horizontal primary disconnect mountings should be tightened to 12-18 lb-feet.

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

y. Reconnect the opening springs.

z. With the circuit breaker in the open position, check the dimension from the bottom surface of the lower main primary disconnect bars to the lower surface of the operating pin. This dimension should be .937". The dimension may be adjusted by turning the nut on the end of the push rod assembly.

aa. Close the circuit breaker and check the gap between the end of the nut on the operating rod shaft and the surface of the cap on the operating rod spring. This gap should be between ½" and ⅝". (See Figure 25, Page 19). If the gap does not fall within this range, recheck all adjustments above.

bb. Reassemble front cover and interphase barriers.

2. **Sliding Contact Finger Assembly**

Instructions are given in the maintenance section of this manual for removing and inverting the sliding contact finger assembly. Follow these instructions, but install the new finger assembly instead of reinstalling the old one.

3. **Closing Coil Assembly**

The closing coil is located in the lower front center of the circuit breaker (See Figure 3). To replace it:

a. Remove front cover of the breaker.

b. Elevate the breaker so that there is at least 6" 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 3). 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. With the breaker mechanism in the reset position, check the gap between the trip coil armature and the trip lever extending from the trip shaft. This gap should be between ¼" and ⅝". If necessary, bend the trip lever slightly to achieve this setting. See Figure 28.

f. Trip the breaker electrically several times to insure that coil is functioning properly.

g. Replace front cover.

5. **Shunt Trip Coil Assembly, Right**

This assembly is locted in the center part of the

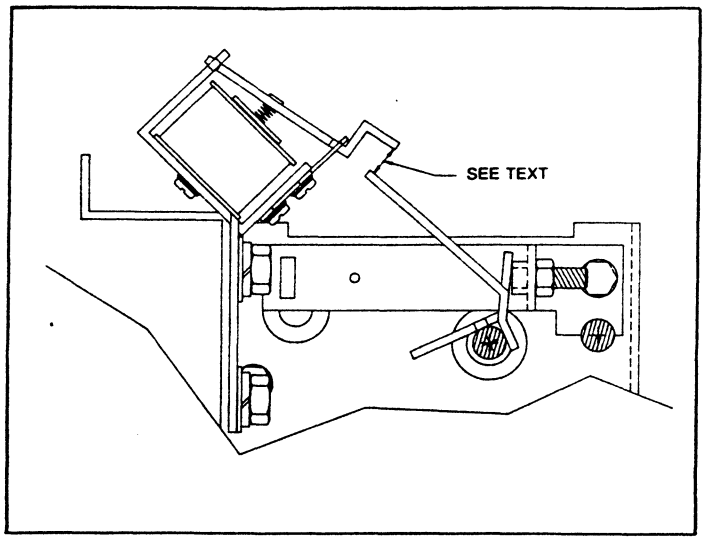


Figure 28. Trip Lever Gap Adjustment

mechanism area, just to the right of the main closing spring (See Figure 12, Page 8). 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 this instruction book 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. Reassemble 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 29). 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 this instruction book 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. Reassemble 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 under-

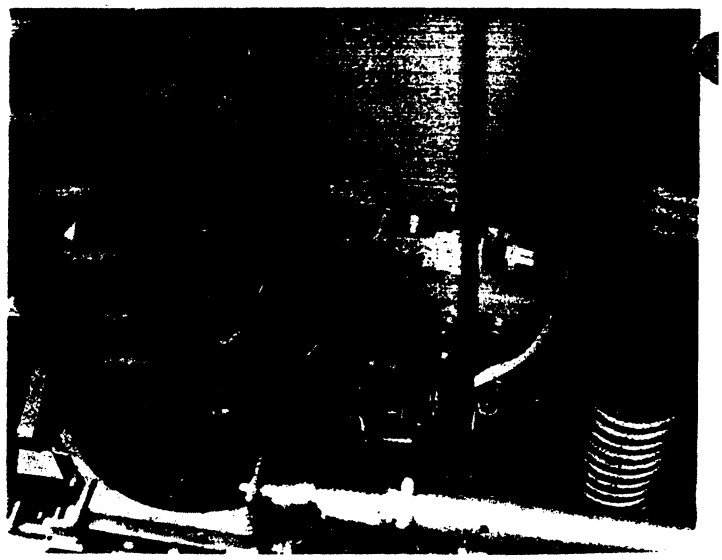


Figure 29. Undervoltage Device Mounted on Circuit Breaker

voltage 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 knob at the bottom of the device to the right in ⅛ 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 (See Figure 30) up in 1/16" steps.

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.

j. Replace front cover.

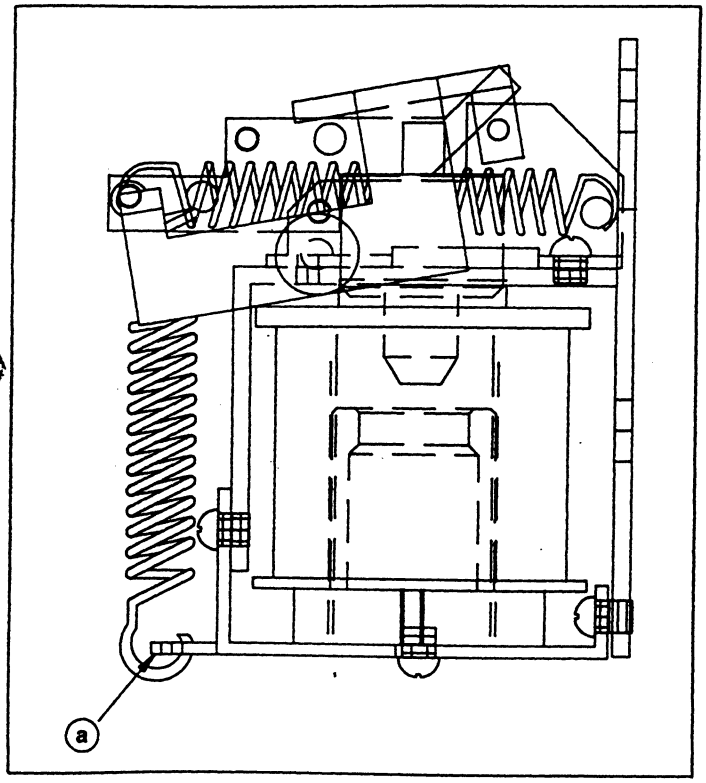


Figure 30. Undervoltage Device

a. Beam Spring Tab

7. **Charging Motor Assembly**

The charging motor is located at the lower right-hand side of the mechanism (See Figure 4, Page 3). To replace it:

a. Remove front cover of 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 springs (See Figure 31). 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 terminals.

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. This 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.

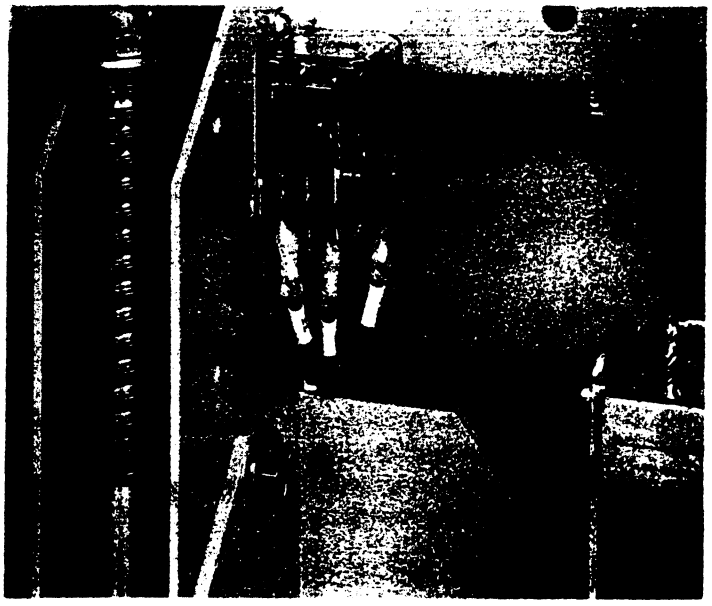


Figure 31. Anti-Pump Relay

h. Some breakers with 48VDC and 240VAC closing circuits were originally provided with dropping resistors in the coil circuit. The replacement relay will have a full voltage coil, so the resistor is no longer needed. It should be removed and the two terminals of the relay to which the resistor was connected should be connected with a wire jumper.
i. Operate the breaker several times to insure that the relay functions properly.
j. Replace front cover.

9. **Primary Contact Spring Assembly**

These springs are located at the outer end of the primary contact bars (See Figure 27, Page 22). 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. Place cap over spring support on other side of fingers from spring.
e. Depress head of spring support and install keeper in slot in end of spring support.
f. 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). To replace it:

a. Remove 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 & Secondary Trip Latches & Latch Check Switch" under MAINTENANCE in this instruction book.
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 3). To replace it:

a. Remove front cover of breaker.
b. Unplug the wiring harness from the motor cutoff switch assembly.
c. Remove the two bolts holding the assembly to the breaker floor pan and remove the assembly.
d. Install new motor cutoff switch assembly, bolt to floor pan, and plug wiring harness into plug on new assembly. No adjustment is needed.

NOTE: Some circuit breakers have motor cutoff switch assemblies with 6-point plugs and some with 9-point plugs. Be sure the assembly is replaced with a similar one, or the circuits will not work properly.

e. Operate breaker several times electrically to insure that it is operating properly.
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 32). To replace it:

Figure 32. Ground Shoe

a. Mounting Brackets
b. Holding Bolts

a. Elevate the breaker so that there is at least 6" of clear space below the bottom pan of the breaker.
b. Remove bolts holding two ground shoe mounting brackets to ground bar, and remove the two brackets.
c. 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 ground bars on breaker and apply a thin coat of contact lubricant Mobilgrease 28 to ground bars.
g. Insert new finger assembly from below the breaker floor pan and press up until the upper lobe of the fingers snaps into place on the ground bus.
h. Reinstall the two mounting brackets.

13. **Auxiliary Switch**

The auxiliary switch is located in the lower left front of the mechanism area. Two types of auxiliary switch have been used in Powl-Vac circuit breakers. Breakers shipped in August, 1985 or later have type SB-12 auxiliary switches (See Figure 3, Page 3) while those shipped before then have type SBM auxiliary switches (See Figure 33). The procedures for replacing the two types differ somewhat, as listed below. To replace an auxiliary switch:

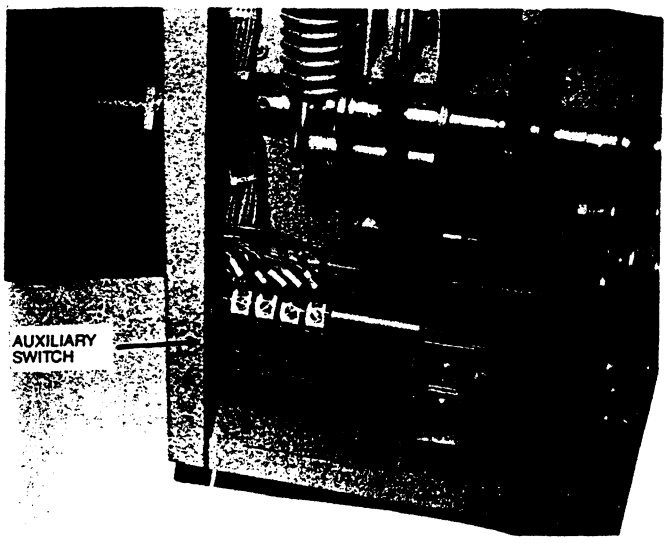


Figure 33. Type SBM Auxiliary Switch in Circuit Breaker

a. Remove front cover of circuit breaker.
b. Disconnect the wiring from the auxiliary switch, being careful to identify each wire by the switch terminal number from which it was removed. Pull the wiring harness up and away from the switch.

If the circuit breaker has a type SB-12 auxiliary switch, follow steps c. through h. and q. through s. If the breaker has a type SBM auxiliary switch, skip to step j. and proceed from there. For type SB-12 auxiliary switch:

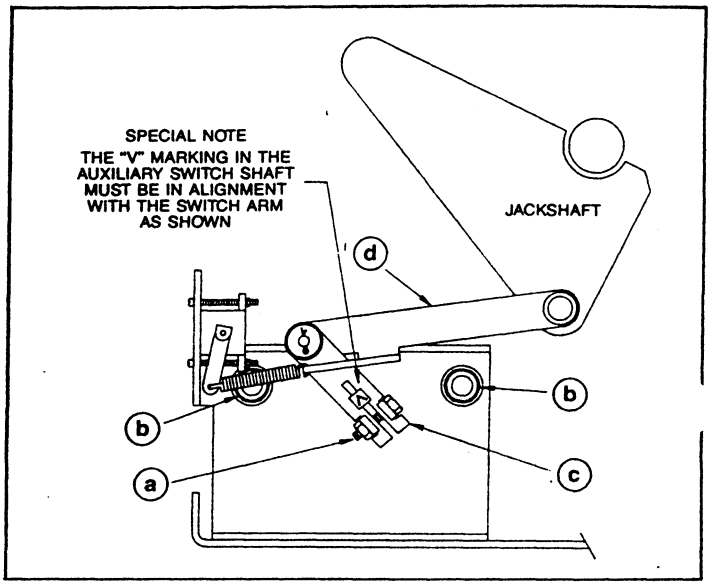


Figure 34. Auxiliary Switch Assembly with SB-12 Auxiliary Switch
a. Operating Arm Clamping Bolt
b. Auxiliary Switch Mounting Bolts
c. Operating Arm
d. Operating Link

c. Loosen the bolt clamping the operating arm to the switch shaft (a, Figure 34).
d. Remove the two bolts holding the switch to the switch mounting bracket (b, Figure 34) and remove the switch by pulling it to the left.
e. Insert the new switch and bolt it to the mounting bracket.
f. Slide the operating arm onto the switch shaft, being sure that the arrow stamped on the end of the switch shaft is positioned as shown in Figure 34.
g. Align the operating arms so that the link going back to the jackshaft is at right angles to the switch shaft and tighten the clamping bolt.
h. Go to step q.

For type SBM auxiliary switch:

j. The replacement assembly furnished will in-

clude a type SB-12 auxiliary switch, and the entire assembly will be changed.

k. Remove X-washer from end of pin at jackshaft end of the auxiliary switch operating link, and slide end of link off the pin.

l. Unbolt the auxiliary switch mounting bracket from the breaker floor pan and remove the entire auxiliary switch assembly.

m. Bolt the new assembly to the breaker floor pan.

n. Place the operating link on the pin at the jackshaft and replace X-washer. Be sure the operating link is at right angles to both the pin and the switch shaft. The switch assembly can be rotated slightly about its mounting bolts to assure this alignment.

p. Replacing the auxiliary switch assembly has replaced the operations counter. Record readings of both old and new counters. From this point on, total operations on the breaker will be the sum of the operations recorded on the two counters.

q. Connect wiring harness to new switch. Be sure wires are connected to the same terminals they were removed from.

r. Operate circuit breaker electrically several times to insure that both switch and counter are working properly.

s. Replace front cover.

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