Instructions for Porcel-line™ Type DVP Vacuum Circuit Breakers

READ AND UNDERSTAND THESE INSTRUCTIONS BEFORE ATTEMPTING ANY UNPACKING, ASSEMBLY, OPERATION OR MAINTENANCE OF THE CIRCUIT BREAKERS.

Westinghouse Electric Corporation

Switchgear Division, East Pittsburgh, PA 15112

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PURPOSE

This instruction book is expressly intended to cover the installation, operation and maintenance of Type DVP Vacuum Circuit Breakers.

For application information, consult your nearest Westinghouse sales office, see Westinghouse Application Data 32-262, or appropriate ANSI Standards.

SAFETY

All Safety Codes, Safety Standards and/or Regulations as they may be applied to this type of equipment must be strictly adhered to.

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westighouse Electric Corporation representative should be contacted.

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Type DVP Breakers are manufactured with several built-in interlocks and safety features to provide safe and proper operating sequences. UNDER NO CIRCUMSTANCES SHOULD THEY BE MADE INOPERATIVE.

1. Interphase Barrier is bolted to breaker at the rear so barrier can only be removed from a breaker that is out of its cell.

2. The Maintenance Handle (hand closing lever) is constructed so that it cannot be used to close the breaker when the breaker is in the housing.

3. The Levering-in Device is interlocked so that the breaker cannot be levered either in or out when the breaker contacts are closed.

4. The Breaker Mechanism is held trip-free between the Test Position and the Engaged Position to prevent accidental closing while the breaker is in an intermediate position.

5. Floor Trippers are provided to trip the breaker and discharge the closing spring when the breaker is inserted into or removed from the housing.

6. A Closed Breaker Interlock is provided to prevent releasing the closing spring if the breaker is closed.

7. Each breaker has a Coding Plate attached to the left side. This plate in conjunction with a co-operating plate in each housing acts as an interference interlock so that only suitably rated circuit breakers can be inserted.

8. A Rail Latch is provided to hold the breaker in the Test Position and to prevent damage to the levering-in screw in the housing.

9. Positive Mechanical Indicators show whether the breaker is open or closed, and whether the closing spring is charged or discharged.

WESTINGHOUSE RECOMMENDED SAFETY PRACTICES

Type DVP circuit breakers are complex high voltage electrical devices containing high speed, high energy, operating mechanisms. They are designed to operate within the current and voltage limitations on the breaker nameplate. Do not apply these breakers to systems with currents and/or voltages exceeding these limits.

1. To perform work on Type DVP circuit breakers requires personnel with training and experience in high voltage circuits and equipment. Only qualified electrical workers, familiar with the construction and operation of such equipment and the hazards involved, should be permitted to work on these circuit breakers.

2. The breakers are equipped with various interlocks. DO NOT MAKE ANY OF THE INTERLOCKS INOPERATIVE.

3. Only Qualified Persons as defined in the National Electric Safety Code should be permitted to assemble, operate or maintain these breakers.

4. For maximum safety, assemble barrier on the breaker before inserting it into an energized cell.

5. Never insert a breaker without the interphase barrier into an energized metal-clad cell beyond the test position.

6. If it is necessary to put a breaker without barrier in the test position in an energized cell, put a padlock through the hole in the levering-in crank on the levering-in shaft.

7. Never attempt to close the breaker by hand on a live circuit. The maintenance closing handle is made so that it cannot be used when the breaker is in cell. Do not remove interference bar from handle.

8. Keep fingers from top or sides of barrier when moving breaker in or out of cell. Use handle on panel to move the breaker into and out of cell.

9. When mounting barrier be sure to fasten securely all hardware; front and rear.

10. Never leave breaker in an intermediate position in a cell. Always have the breaker either in the test/disconnect or connected position.

11. Be sure breaker is open and closing spring is discharged before attempting any maintenance.

12. Do not attempt to close breaker with maintenance closing handle when closing spring is charged.

INTRODUCTION

These instructions cover the description, operation and maintenance of Westinghouse DVP Vacuum Circuit Breakers. They are the removable interrupting elements for use in horizontal drawout Porcel-line™ Metal-Clad Switchgear to provide reliable control and protection for medium voltage electrical equipment and circuits. DVP Breakers are designed for ease of handling, reliable performance and ease of maintenance.

Porcel-line™ Type DVP Vacuum Circuit Breakers are interchangeable with Porcel-line™ Type DHP Magnetic Air Circuit Breakers where the rating and application will permit. The DVP line of breakers uses the basic 150DHP500 cell as its housing.

NOTE

Type DVP breakers are protective devices. As such, they are maximum-rated devices. Therefore, they should not under any circumstances be applied outside their nameplate ratings. In addition, follow Application Data 32-262, to avoid possible problems with over-voltages on certain circuits.

Satisfactory performance of this breaker is contingent upon correct installation, adequate maintenance and servicing. Careful study of these instructions will permit the user to obtain the maximum benefits from this device.

The available DVP Breakers and their rated performance capabilities are given in Rating Table 1.

Table 1. Type DVP Breaker Ratings

Identification			Rated Values									Related Required Capabilities ③			
	Nominal Voltage Class	Nominal 3 Phase MVA Class	Voltage		Insulation Level		Current		Rated Interrupting Time	Rated Permissible Tripping Delay	Rated Max. Voltage Divided By K	Current Values		
			Rated Maximum Voltage	Rated Voltage Range Factor	Rated Withstand Test Voltage		Rated Continuous Current at 60 Hz	Rated Short Circuit Current (at rated Max. kV) ①				Maximum Sym. Interrupting Capability	3 Sec. Short-Time Current Carrying Capability	Closing and Latching Capability (Momentary)
					Low Frequency	Impulse						K Times Rated Short-Circuit Current ①		1.6 K Times Rated Short-Circuit Current
Circuit Breaker Type	kV Class	MVA Class	E	① K				I		③ Y	E/K	KI		
			kV rms		kV rms	kV rms	Amperes	kA rms	Cycles	Sec.	kV rms	kA rms	kA rms	kA rms
DVP Vacuum Circuit Breaker														
150 DVP 500		500					1200 2000	18				23	23	37
150 DVP 750	13.8	750	15	1.30	36	95	1200 2000	28	3	2	11.5	36	36	58

① For 3 phase and line to line faults, the sym. interrupting capability at a kV operating voltage

$= \frac{E}{kV}$ (Rated Short-Circuit Current)

But not to exceed KI.
Single line to ground fault capability at a kV operating voltage

$= 1.15 \frac{E}{kV}$ (Rated Short-Circuit Current)

But not to exceed KI.
The above apply on predominately inductive or resistive 3-phase circuits with normal-frequency line to line recovery voltage equal to the operating voltage.

② For Reclosing Service, the Sym. Interrupting Capability and other related capabilities are modified by the reclosing capability factor obtained from the following formula:

$$R\ (\%) = 100 - \frac{C}{6}\left[(n-2) + \frac{15-T_1}{15} + \frac{15-T_2}{15} + \ldots\right]$$

Where C = kA Sym. Interrupting Capability at the Operating Voltage but not less than 18
n = Total No. of Openings.
T_1, T_2, etc = Time interval in seconds except use 15 for time intervals longer than 15 sec.

Note: Reclosing Service with the standard duty cycle 0+15s+CO does not require breaker Capabilities modified since the reclosing capability factor R = 100%

③ Tripping may be delayed beyond the rated permissible tripping delay at lower values of current in accordance with the following formula:
T (seconds) =

$$Y\left[\frac{\text{KI (K Times Rated Short-Circuit Current)}}{\text{Short-Circuit Current Through Breaker}}\right]^2$$

The aggregate tripping delay on all operations within any 30 minute period must not exceed the time obtained from the above formula.

WESTINGHOUSE SAFETY FEATURES

Type DVP Breakers are manufactured with several built-in interlocks and safety features to provide safe and proper operating sequences. UNDER NO CIRCUMSTANCES SHOULD THEY BE MADE INOPERATIVE.

1. Interphase Barrier is bolted to breaker at the rear so barrier can only be removed from a breaker that is out of its cell.

2. The Maintenance Handle (hand closing lever) is constructed so that it cannot be used to close the breaker when the breaker is in the housing.

3. The Levering-in Device is interlocked so that the breaker cannot be levered either in or out when the breaker contacts are closed.

4. The Breaker Mechanism is held trip-free between the Test Position and the Engaged Position to prevent accidental closing while the breaker is in an intermediate position.

5. Floor Trippers are provided to trip the breaker and discharge the closing spring when the breaker is inserted into or removed from the housing.

6. A Closed Breaker Interlock is provided to prevent releasing the closing spring if the breaker is closed.

7. Each breaker has a Coding Plate attached to the left side. This plate in conjunction with a co-operating plate in each housing acts as an interference interlock so that only suitably rated circuit breakers can be inserted.

8. A Rail Latch is provided to hold the breaker in the Test Position and to prevent damage to the levering-in screw in the housing.

9. Positive Mechanical Indicators show whether the breaker is open or closed, and whether the closing spring is charged or discharged.

WESTINGHOUSE RECOMMENDED SAFETY PRACTICES

Type DVP circuit breakers are complex high voltage electrical devices containing high speed, high energy, operating mechanisms. They are designed to operate within the current and voltage limitations on the breaker nameplate. Do not apply these breakers to systems with currents and/or voltages exceeding these limits.

1. To perform work on Type DVP circuit breakers requires personnel with training and experience in high voltage circuits and equipment. Only qualified electrical workers, familiar with the construction and operation of such equipment and the hazards involved, should be permitted to work on these circuit breakers.

2. The breakers are equipped with various interlocks. DO NOT MAKE ANY OF THE INTERLOCKS INOPERATIVE.

3. Only Qualified Persons as defined in the National Electric Safety Code should be permitted to assemble, operate or maintain these breakers.

4. For maximum safety, assemble barrier on the breaker before inserting it into an energized cell.

5. Never insert a breaker without the interphase barrier into an energized metal-clad cell beyond the test position.

6. If it is necessary to put a breaker without barrier in the test position in an energized cell, put a padlock through the hole in the levering-in crank on the levering-in shaft.

7. Never attempt to close the breaker by hand on a live circuit. The maintenance closing handle is made so that it cannot be used when the breaker is in cell. Do not remove interference bar from handle.

8. Keep fingers from top or sides of barrier when moving breaker in or out of cell. Use handle on panel to move the breaker into and out of cell.

9. When mounting barrier be sure to fasten securely all hardware; front and rear.

10. Never leave breaker in an intermediate position in a cell. Always have the breaker either in the test/disconnect or connected position.

11. Be sure breaker is open and closing spring is discharged before attempting any maintenance.

12. Do not attempt to close breaker with maintenance closing handle when closing spring is charged.

13. Always remove the maintenance closing handle immediately after using it to close the breaker.

14. There are several interlocks on the breaker. They are for personnel and/or equipment protection. UNDER NO CIRCUMSTANCES SHOULD THEY BE MADE INOPERATIVE.

SAFETY NOTE

A circuit breaker should not be used by itself as the sole means of isolating a high voltage circuit; 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 should be securely grounded.

Section 1 — Receiving, Handling and Storage

Type DVP Breakers are shipped in packages designed to provide maximum protection to the equipment during shipment and storage and at the same time to provide convenient handling. The 150DVP500 and 150DVP750 breakers and barriers are shipped in separate containers.

Before placing the breaker in service see Section 3, Initial Inspection and Operation and Section 6, Maintenance.

1.1 RECEIVING

Upon receipt of the equipment, inspect the crates for any signs of damage or rough handling. Open the crates carefully to avoid any damage to the contents. A nail puller is recommended for this rather than a crow bar.

When opening the crates, be careful that any loose items or hardware are not discarded with the packing material. Check the contents of each package against the packing list.

Examine the breaker and barrier for any signs of shipping damage. File claims immediately with the carrier if damage or loss is detected and notify the nearest Westinghouse Sales Office.

1.2 HANDLING

Type DVP circuit breaker shipping containers are designed to be handled either by use of a rope sling and an overhead lifting device or by fork lift truck. If containers must be skidded for any distance, it is preferable to use roller conveyors or individual pipe rollers.

Once the breakers have been inspected for shipping damage, it is best to return them to their original shipping crates until they are ready to be installed in the Metal-Clad Switchgear.

If it is necessary to lift the breaker, attach crane hooks in the notches on the breaker chassis. Once the barrier is assembled, the hooks should be inside the barriers as shown in Figure 1. This will help to prevent damage to the barrier assembly.

The breaker may be rolled on its own wheels if the floor is reasonably smooth. In rolling it around corners, use the handling dolly. See Basic Operating Instructions.

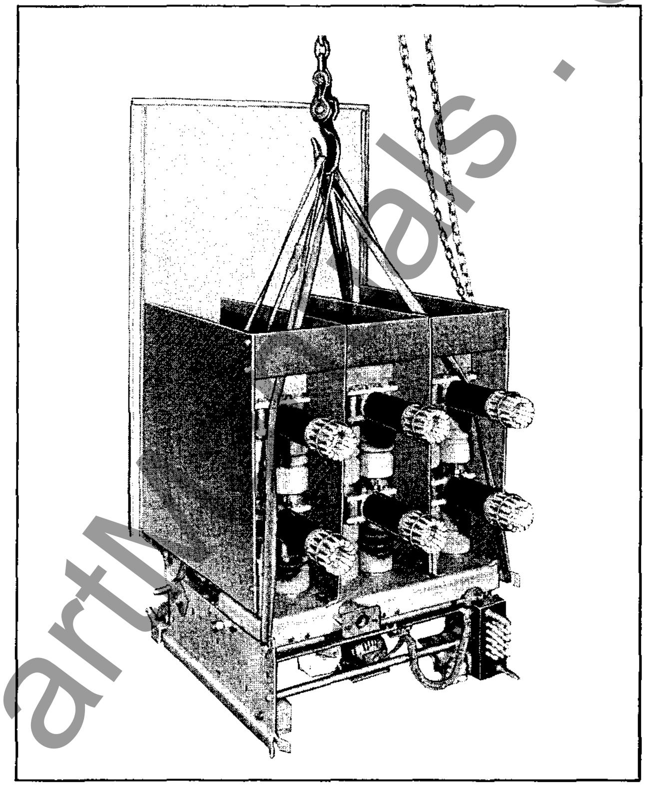


Fig. 1 *Lifting the DVP Breaker with the Barrier in Place (391414*)*

Table 2 — Approximate Weights DVP Circuit Breakers

Breaker Type	Continuous Amps	Weight in Pounds Breaker with Barrier	Shipping Weight of Barrier
150DVP500	1200	880	75
150DVP500	2000	905	75
150DVP750	1200	905	75
150DVP750	2000	930	75

Handle all parts carefully but be especially careful with the vacuum interrupters. The interrupters are encased in porcelain envelopes which are subject to breakage. Be especially careful when working near the interrupter bellows. The bellows must never be twisted as this decreases bellows' life and hence the useful life of the interrupters.

After receiving, inspect immediately before further handling for any signs of damage. If any damage is found, file a claim at once with the transportation company and notify the nearest Westinghouse Electric Corporation Sales Office.

*Photograph Number

1.3 STORING

If the circuit breakers are to be placed in storage, maximum protection can be attained by returning the breaker and barrier to their original shipping containers after checking to be sure they are free from shipping damage.

Outdoor storage except for limited intervals is not recommended. If unavoidable, the outdoor location even though used for a short time, must be well drained and a temporary shelter from sun, wind, rain, and snow must be provided. Containers should be arranged to permit free circulation of air on all sides, and temporary heaters should be used to minimize condensation. Moisture can cause rusting of metal parts and deterioration of high voltage insulation. A heat level of approximately 400 watts for each 100 cubic feet of volume is recommended with the heaters distributed uniformly throughout the structure near the floor. If the circuit breakers are stacked for storage, the stacks should be limited to two high.

Indoor storage should be in a building with sufficient heat and circulation to prevent condensation. If the building is not heated, the same general rule for heat as for outdoor storage should be applied.

When circuit breakers are stored outside their shipping containers they should be covered to protect them from dust and dirt. Again, heat and free circulation of air to prevent condensation is essential.

When convenient, completely assembled circuit breakers may be stored in their switchgear housings in the test position.

Section 2 — Description and Operation

2.1 GENERAL DESCRIPTION

Westinghouse Type DVP Circuit Breakers are horizontal drawout vacuum circuit breakers. This arrangement provides convenience of operation and safety. The current-carrying conductors are well concealed when the breaker is properly installed. The breakers are designed for use in Metal-Clad Switchgear assemblies having maximum voltages of 15.0 kV. They are equipped with spring-stored, energy-closing mechanisms. All primary insulation to ground is porcelain. All types of the DVP circuit breakers have common features, but they will vary in size and detail depending on the specific breaker type number and ratings. Fig. 11 shows a view of a 150DVP500 Breaker.

All of the controls necessary for ordinary operation of the breakers are located on the front panel and are accessible at all times. The controls referred to are shown in Figure 2, and include the following: tripping solenoids tripping trigger, closing spring release coil and spring release trigger, auxiliary switches, secondary contact controls, and the levering device. Also located on the front panel are the control relay "Y", and its associated resistor, the motor limit switch and the latch check switch.

DVP breakers are built with a spring-stored, energy mechanism which is mechanically trip-free. The mechanism is located in the chassis at the bottom of the Breaker. The vacuum interrupters are mounted on the porcelain pole unit supports which are bolted to the top of the chassis. The circuit breaker contacts are completely enclosed within the vacuum interrupter, and the arc is therefore always contained inside the interrupter. The interphase barrier assembly provides isolation between the phases and to the cell wall where necessary. A grounded metal plate on the front of the barrier assembly protects personnel from live breaker parts when the breaker is in the fully connected position.

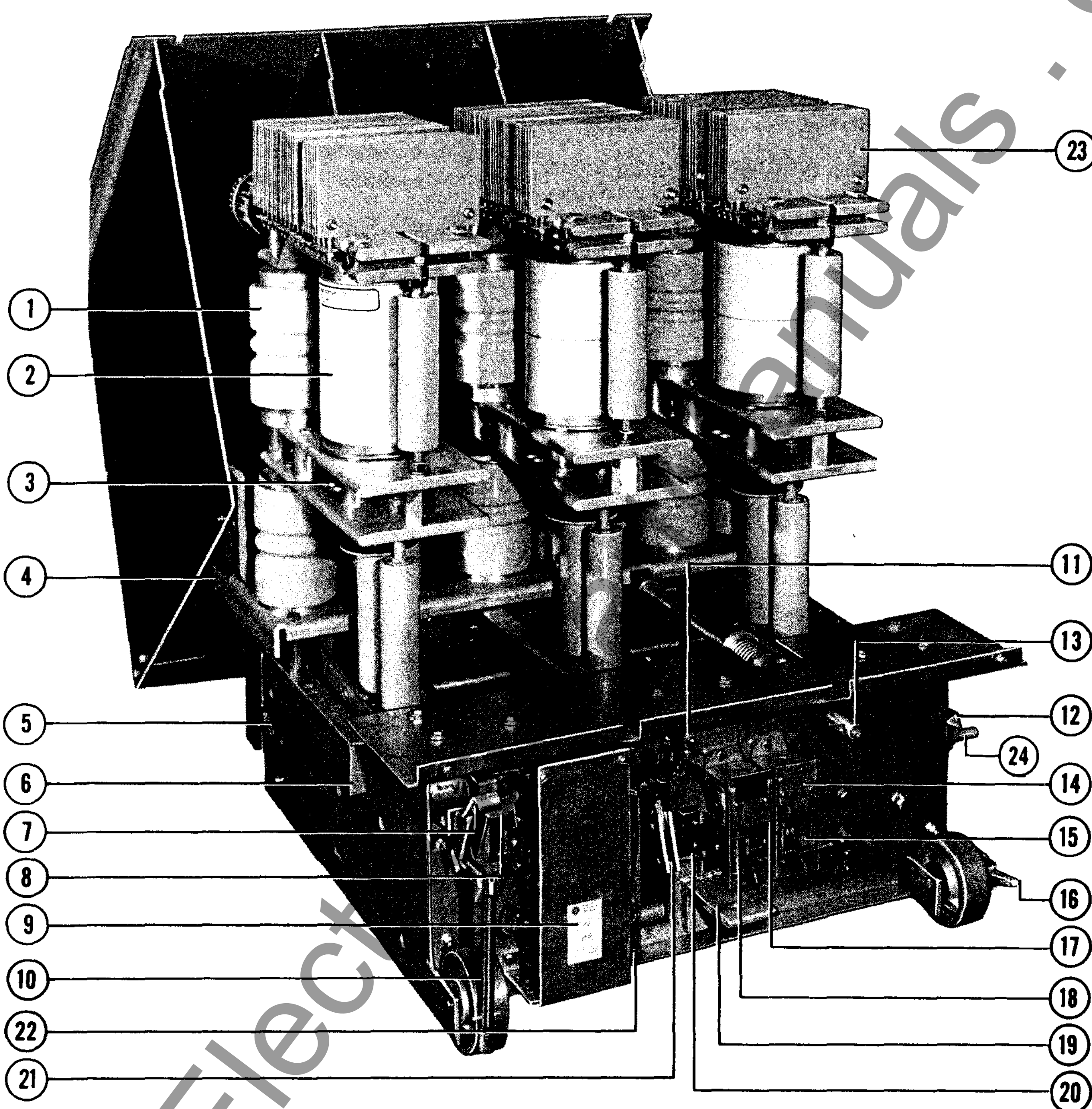
Each circuit breaker consists of a basic breaker assembly including three vacuum interrupter assemblies and a barrier assembly. Various accessories are also provided as required.

2.2 BASIC BREAKER ASSEMBLY

The basic breaker assembly includes a chassis, a control panel, an operating mechanism, the vacuum interrupter assemblies, a levering-in device, and various interlocks. This entire assembly is mounted on wheels for ease of handling.

DVP breakers are equipped with spring-stored, energy mechanisms. Normal operation is to charge the closing spring electrically by means of the spring charging motor, and then to close the breaker electrically by energizing the spring release coil. Tripping is accomplished by energizing the trip coil. For maintenance purposes the closing spring can be charged manually; the breaker can be closed and tripped by lifting the spring release trigger and then the tripping trigger by hand.

The closing spring can be charged by hand, Fig. 4, and released by hand, Fig. 6, to close the breaker when control power is not available.



1 Post Insulator Pole Unit
2 Vacuum Interrupter
3 Roller Contact
4 Rear Lifting Tab
5 Breaker Coding Plate
6 Front Lifting Notch
7 Secondary Contact Handle
8 Operation Counter
9 Auxiliary Switch and Control Relay "Y" (Behind Cover)
10 Secondary Contact Hand Operating Rod
11 Control Relay "Y" Resistor
12 Breaker OPEN-CLOSED Indicator
13 Levering Device
14 Spring Release Solenoid "SR"
15 Closing Trigger
16 Rail Latch
17 Tripping Trigger
18 Tripping Solenoid "TC"
19 Turning Dolly Bracket
20 Latch Check Switch "LC"
21 Manual Ratchet Lever for Charging Closing Spring by Hand
22 Motor Limit Switch "LS"
23 2000 A. Cooling Fins
24 MOC Switch Operating Pin

Fig. 2 *DVP Breaker with Barrier Tilted Back: Front View Showing Mechanism Panel (391420)*

CAUTION

WHEN CONTROL POWER IS NOT AVAILABLE FOR CLOSING, IT MAY ALSO NOT BE AVAILABLE FOR TRIPPING. AN EVALUATION OF THE HAZARDS RELATED TO LACK OF TRIPPING POWER MUST BE MADE BY THE OPERATOR BEFORE CLOSING A CIRCUIT BREAKER UNDER THESE CONDITIONS. (PROTECTIVE RELAYS MAY OPERATE TO ENERGIZE THE TRIP CIRCUIT, BUT BREAKER WILL NOT TRIP DUE TO LACK OF TRIPPING POWER.)

2.3 BARRIER ASSEMBLY

The barrier assembly consists of a grounded, steel-front panel and several insulating side sheets to shield the pole units interrupters from each other. The barrier assembly is secured to the breaker chassis when mounted. It is arranged in such a way that it cannot readily be removed when breaker is in its metal-clad housing. See Fig. 3.

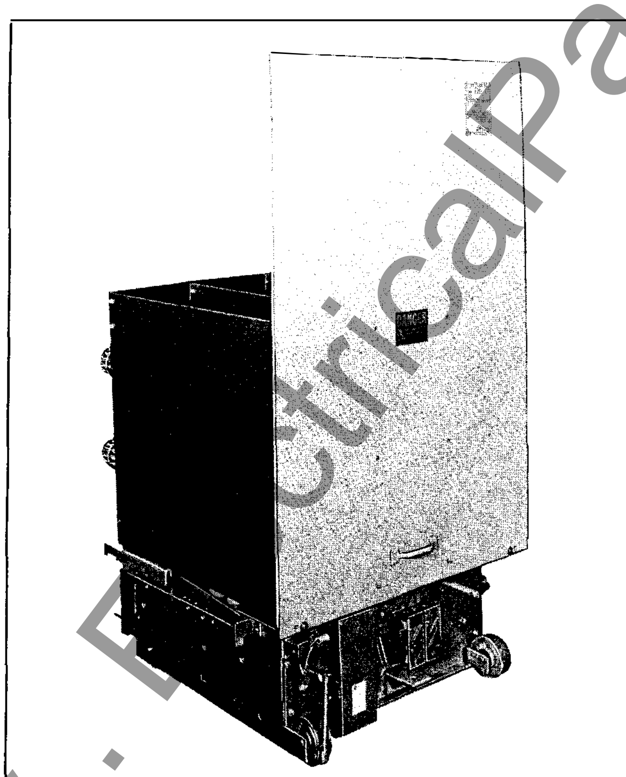


Fig. 3 *DVP Breaker with Barrier in Place (391413)*

2.4 MANUAL SPRING CHARGING

On all DVP breakers a manual ratcheting lever projects through a slot in the mechanism panel just to the left of the coil marked "Lift to Trip", Fig. 2. A maintenance handle is provided to fit into the slot in the ratchet lever. A few downward strokes charge the closing spring. When charging is complete, the closing crank goes over center with an audible "click". When the spring is fully charged, an indicator, Fig. 5, to the left of the manual ratchet lever changes position to show "SPRING CHARGED". Remove the maintenance handle after charging the closing spring.

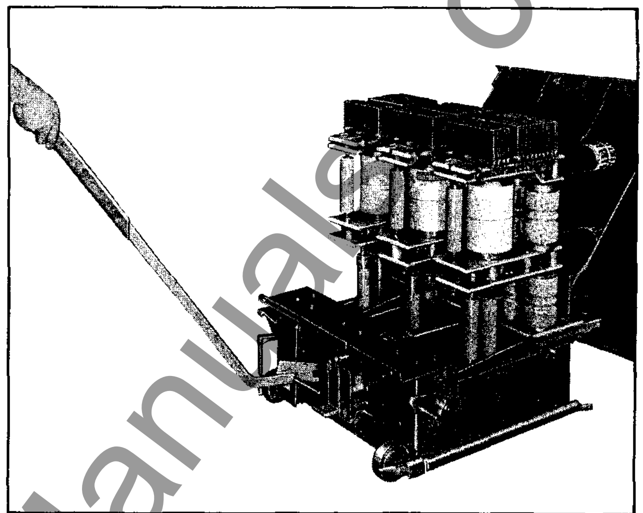


Fig. 4 *Charging the Closing Spring on DVP Breaker by Hand (391409)*

2.5 MANUAL CLOSING

After the closing spring has been charged either electrically or manually, the breaker may be closed manually by lifting the spring release plunger behind the plastic guard marked "Lift to Close". Fig. 6.

2.6 MANUAL TRIPPING

After the circuit breaker has been closed either electrically or manually, it may be tripped manually by lifting the tripping trigger plunger behind the plastic guard marked "Lift to Trip". Fig. 2.

2.7 MAINTENANCE CLOSING

CAUTION

DISCONNECT OR DE-ENERGIZE ELECTRICAL CONTROL POWER BEFORE ATTEMPTING ANY MAINTENANCE CLOSING OPERATIONS TO PREVENT ACCIDENTAL ELECTRICAL OPERATION WHILE USING MAINTENANCE CLOSING HANDLE.

DISCHARGE CLOSING SPRINGS BY MANUALLY CLOSING AND TRIPPING THE BREAKER BEFORE ATTEMPTING ANY MAINTENANCE CLOSING OPERATION. THE BREAKER CAN BE CLOSED WITH THE MAINTENANCE HANDLE ONLY WHEN THE CLOSING SPRING IS DISCHARGED. ANY ATTEMPT TO HAND CLOSE THE BREAKER WHEN THE CLOSING SPRING IS CHARGED MAY RESULT IN DAMAGE TO THE MECHANISM.

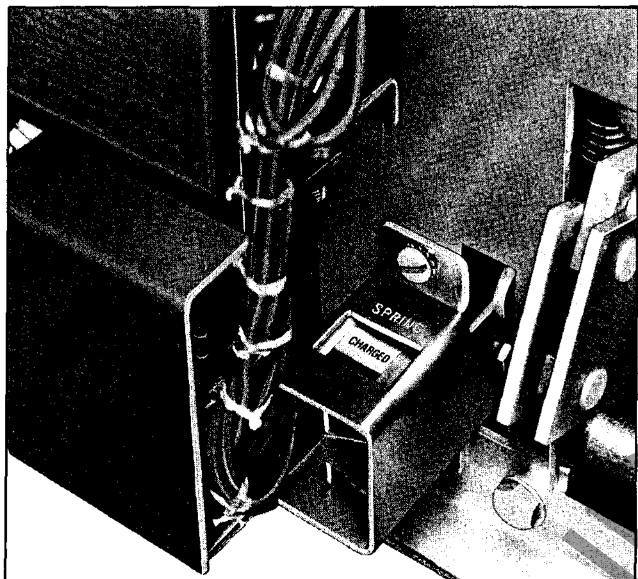


Fig. 5 *Spring Charged/Discharged Indiciator - DVP Breaker (391329)*

On DVP breakers the main shaft extends through the right hand side sheet of the breaker chassis. The maintenance handle fits on the end of the shaft for slow closing the breaker, Fig. 7. This operation is solely for the purpose of connecting and disconnecting the contacts in vacuum interrupter assemblies. The handle should be operated with a slow downward motion to bring the moving contacts up into engagement with the stationary contacts. To close the contacts, move the handle down until an audible "click" is heard indicating that the tripping trigger has fallen into position. **BE SURE THE MAINTENANCE HANDLE IS SECURELY SEATED ON THE PROJECTING MAIN SHAFT END BEFORE APPLYING CLOSING PRESSURE.**

CAUTION

REMOVE MAINTENANCE HANDLE FROM MAIN SHAFT IMMEDIATELY AFTER CLOSING THE BREAKER AND BEFORE ANY ADDITIONAL OPERATIONS ARE PERFORMED. A MOVING HANDLE COULD CAUSE BODILY INJURY AND/OR EQUIPMENT DAMAGE IF NOT REMOVED.

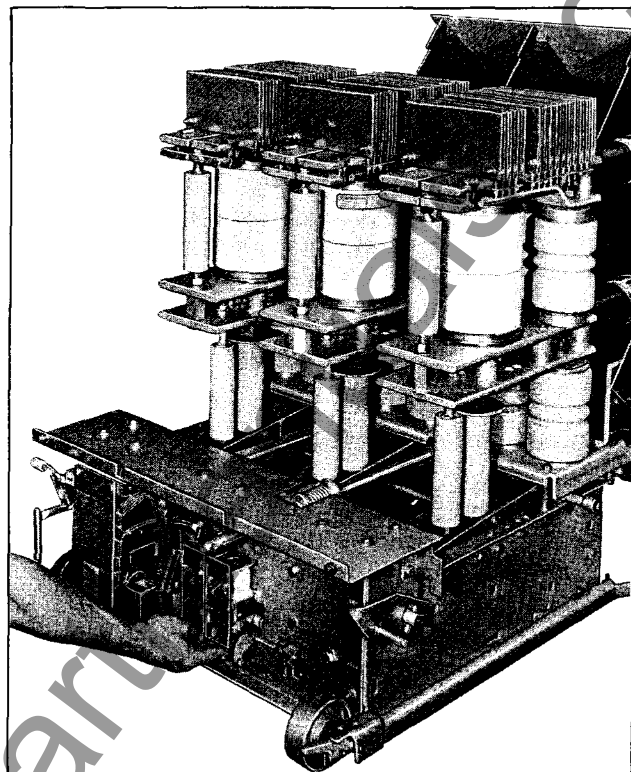


Fig. 6 *Releasing Closing Spring on DVP Breaker by Hand to Close Breaker (391418)*

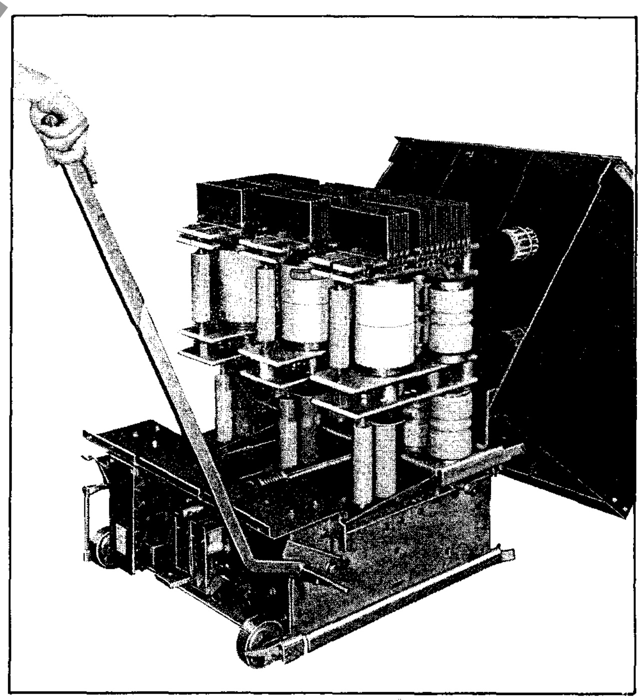


Fig. 7 *Closing DVP Breaker with Maintenance Handle (391408)*

The maintenance handle is made so that it cannot engage the main shaft of the breaker when the breaker is in the housing. This prevents any attempt to close the breaker on a live circuit by manual closing. Do not defeat this safety feature.

CAUTION

DO NOT ATTEMPT TO CLOSE THE BREAKER WITH THE MAINTENANCE HANDLE AGAINST A LIVE CIRCUIT. TO DO SO COULD CAUSE BODILY INJURY AND/OR EQUIPMENT DAMAGE. PROPER CLOSING SPEED CANNOT BE OBTAINED USING THE MAINTENANCE HANDLE.

2.8 ELECTRICAL CLOSING AND TRIPPING

DVP breaker control is so arranged that the spring charging motor will be energized as soon as control power is applied to the breaker. The motor will charge the closing spring in approximately 5 seconds. When the closing spring is fully charged, the motor will be cut off. The breaker may then be closed through the control circuitry.

Immediately following the discharging of the closing spring, the spring charging motor will be reenergized to recharge the closing spring.

After the breaker has been closed, it may be electrically tripped.

CAUTION

WITH CIRCUIT BREAKERS HAVING INDEPENDENT CLOSING AND TRIPPING CONTROL POWER CIRCUITS, THE TRIPPING POWER SHOULD ALWAYS BE ENERGIZED AND VERIFIED BEFORE THE CLOSING POWER IS APPLIED. (PROTECTIVE RELAYS MAY OPERATE TO ENERGIZE THE TRIP CIRCUIT, BUT BREAKER WILL NOT TRIP DUE TO LACK OF TRIPPING POWER.)

2.9 OPERATION OF STORED ENERGY MECHANISM

The spring stored energy mechanism performs two functions:

1. It stores closing energy by compressing, or charging, the closing spring.

2. It applies the released energy to close the breaker and simultaneously charge the opening springs.

The mechanism may rest in any one of the four positions shown in Fig. 10, as follows:

a. Breaker open, closing spring not charged.
b. Breaker open, closing spring charged.
c. Breaker closed, closing spring not charged.
d. Breaker closed, closing spring charged.

Fig. 8 shows the under side of a stored energy mechanism.

Fig. 9 shows schematic views of the spring charging parts of a stored energy mechanism.

The major component of the mechanism is a crankshaft assembly, Fig. 36, which consists of a hex shaft to which is attached the main crank, the ratchet wheel and the closing cam.

The ratchet wheel is actuated by a ratcheting mechanism driven by an electric motor. As the ratchet wheel rotates, the main crank and closing cam rotate with it.

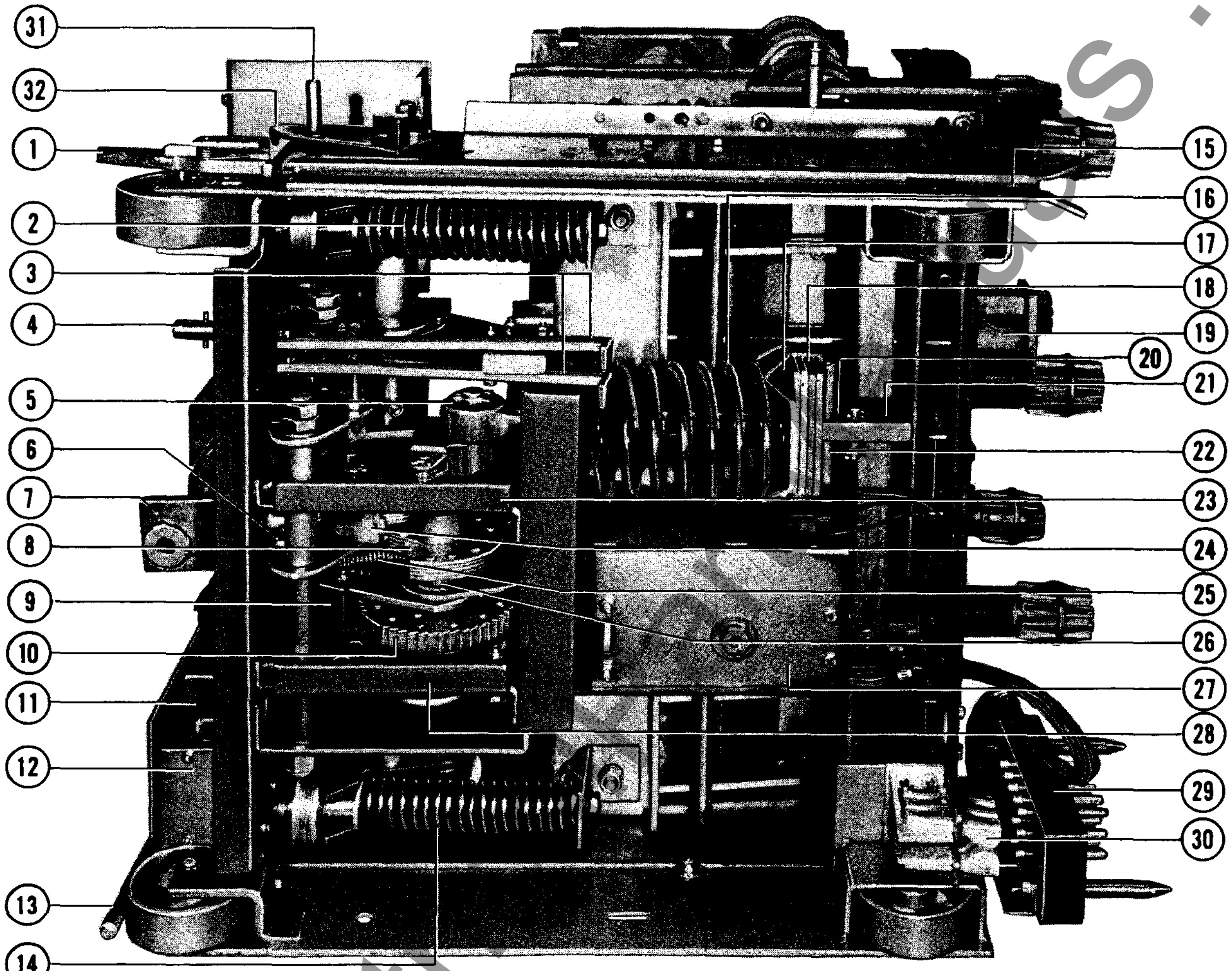
The main crank has a connecting rod connected to it which is coupled to the closing spring. As the crank is rotated, the closing spring is compressed.

Fig. 9a and 9b are schematic views of the spring charging portions of the stored energy mechanism. Fig. 9a shows the spring charged, breaker closed position. Fig. 9b shows the spring discharged, breaker open position. Rotation of the motor crank causes the driving plate and motor ratchet lever assembly to oscillate. The driving pawl, being part of the ratchet lever assembly also oscillates rotating the ratchet wheel counter-clockwise. As the ratchet wheel rotates, the main crank also rotates pulling the connecting rod with it to compress the closing spring.

When the closing spring is completely compressed, the main crank goes over center and the closing stop roller comes against the closing latch. Fig. 9a. The closing spring is now held in the compressed position. It can be released to close the breaker by raising the closing trigger either electrically or manually.

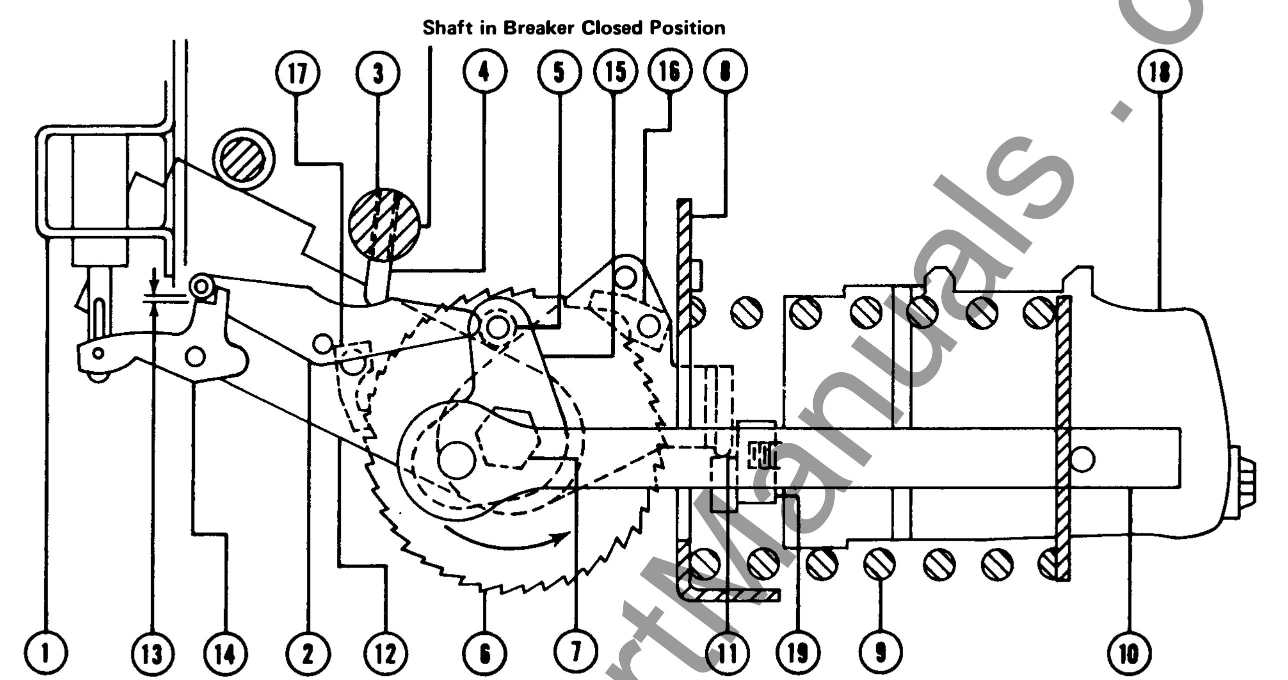
Lifting the closing trigger frees the closing latch which rotates counter-clockwise releasing the closing stop roller on the main crank. The force of the closing spring rotates the main crank and crankshaft. The closing cam, being attached to the crankshaft, also rotates causing the breaker to close.

Fig. 10 shows the positions of the closing cam and tripping linkage. Note that in 10a, in which the breaker is open and the closing spring is not charged, the tripping trigger is in the tripped or unlatched position. As the closing spring is charged, the tripping trigger snaps into the



1 Rail Latch
2 Opening Spring
3 Floor Tripping Levers
4 Levering Device - Operating Shaft
5 Connecting Rod
6 Trigger Adjusting Screw
7 Turning Dolly Bracket
8 Closing Cam
9 Manual Ratchet Lever
10 Ratchet
11 Motor Limit Switch
12 Control Relay "Y"
13 Secondary Contact Hand Operating Rod
14 Opening Spring
15 Rail Guide
16 Closing Spring
17 Closing Spring Retainer Plate
18 Closing Spring Spacer
19 Levering Device Nut
20 Closing Spring Idler Link (See Fig. 34 for detail.)
21 Closing Spring Connecting Rod
22 Closing Spring Retainer Pin
23 Mechanism Frame R.H. Side Plate
24 Tripping Cam
25 Main Link Retrieving Spring
26 Crank Shaft
27 Spring Charging Motor Bracket
28 Mechanism Frame L.H. Side Plate
29 Secondary Contact Block
30 Ground Contact
31 MOC Switch Operating Pin
32 Breaker OPEN-CLOSED Indicator

Fig. 8 *Stored Energy Mechanism - DVP Breaker: Bottom View (396702)*



a. Stored Energy Mechanism: Spring Charged

1. Spring Release Solenoid
2. Closing Latch
3. Pole Unit Operating Shaft
4. Anti-Close Interlock Screw
5. Closing Stop Roller
6. Ratchet Wheel
7. Crank Shaft
8. Mechanism Frame
9. Closing Spring
10. Connecting Rod
11. Driving Plate and Motor Ratchet Lever Assembly
12. Manual Ratchet Lever and Holding Pawl Assembly
13. Clearance .010 to .030, Breaker Closed
14. Closing Trigger
15. Main Crank
16. Driving Pawl
17. Holding Pawl
18. Motor
19. Crank Assembly

b. Stored Energy Mechanism: Spring Discharged

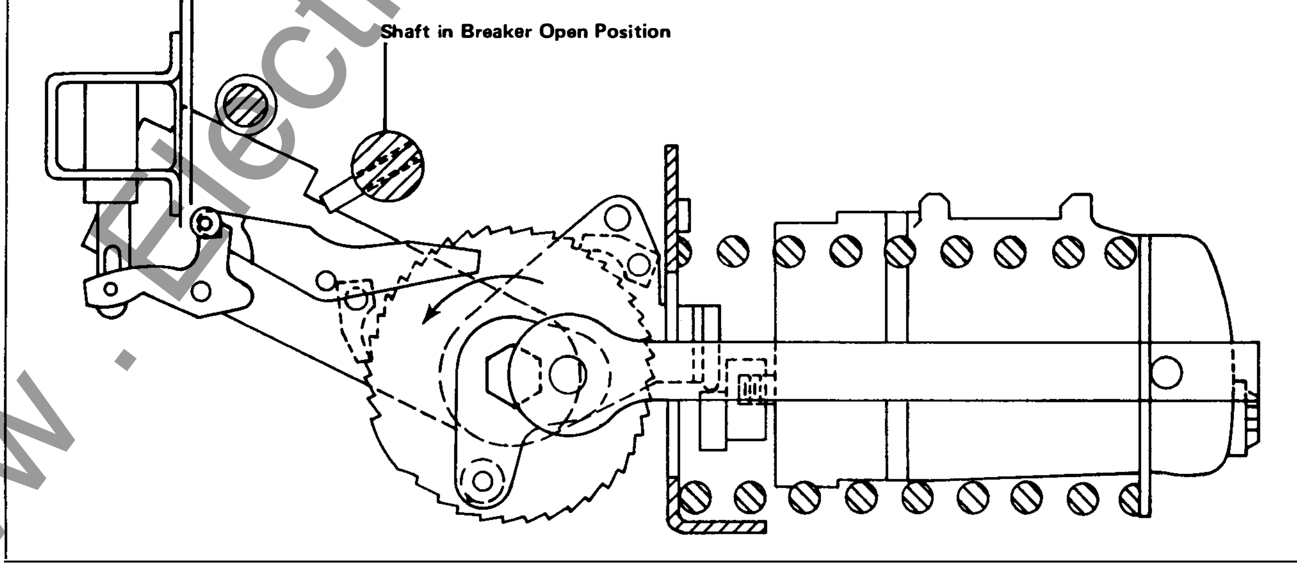
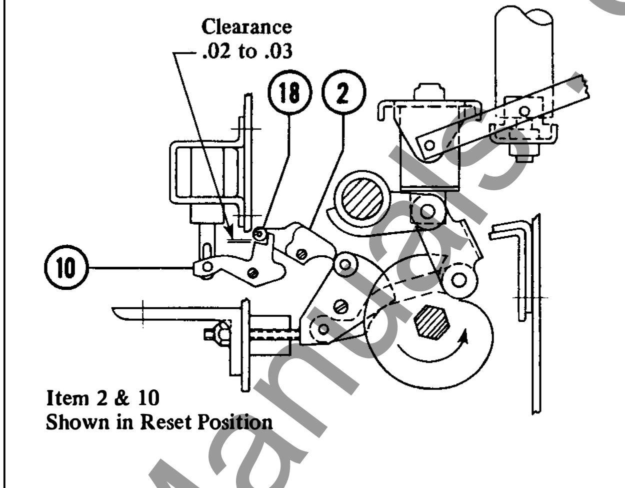


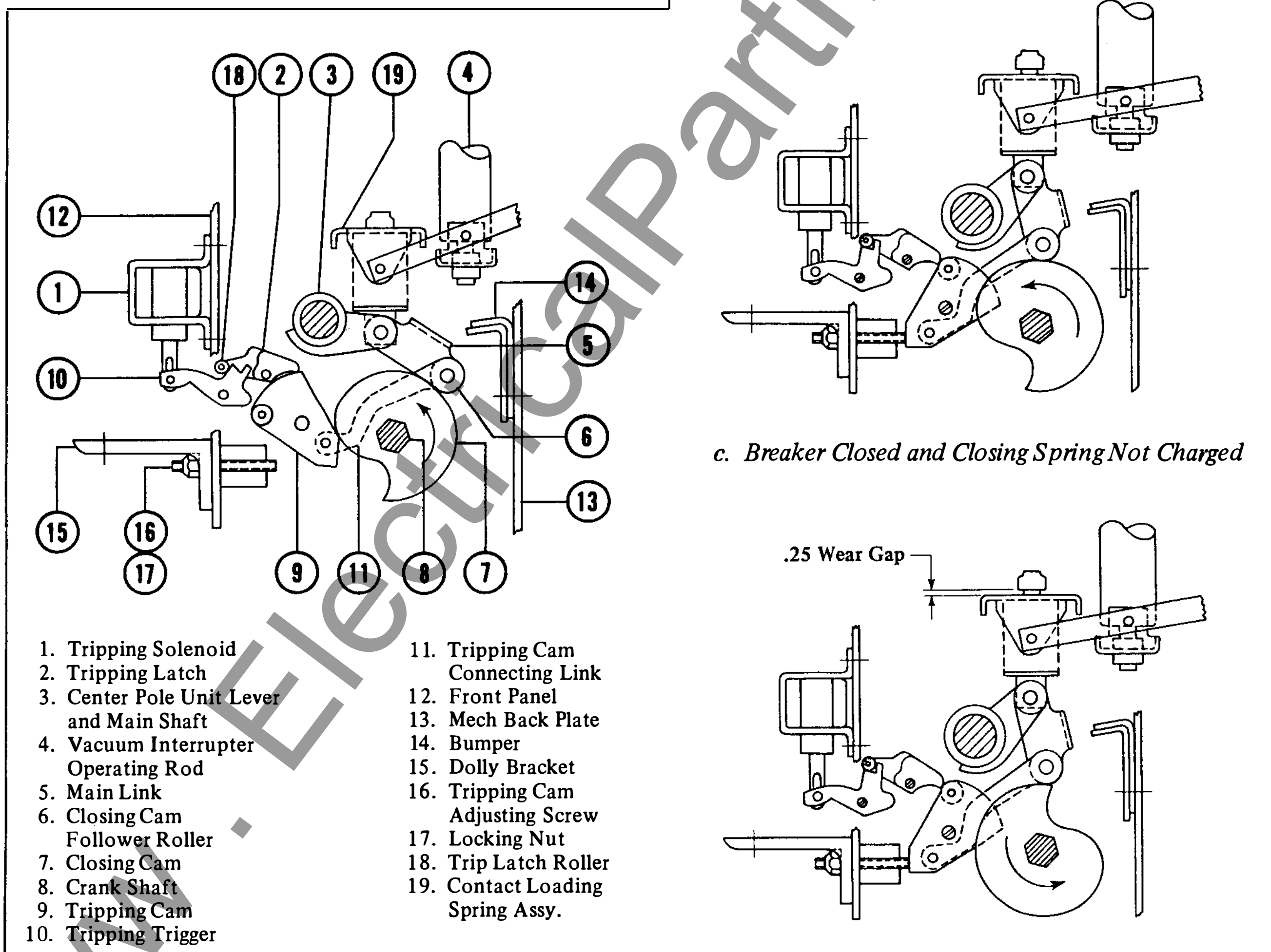
Fig. 9 *Schematic Views of Stored Energy Mechanism – DVP Breaker: Spring Charged; Spring Discharged*

fully reset or latched position as in 10b near the end of the spring charging operation.

In Fig. 10c the linkage is shown with the breaker in the closed position and before the closing spring has been recharged. Note that the closing cam has rotated about one-half turn, corresponding to the rotation of the crankshaft and ratchet wheel of Fig. 9. Rotation of the closing cam pushes the cam roller upward so as to rotate the main shaft of the breaker and close the contacts. This is possible because the restraining links between the closing cam roller and the tripping cam prevent the closing cam roller from moving off the cam to the right. The restraining links cause the tripping cam to push against the tripping latch, which pushes downward, on the left end, on top of the tripping trigger. Fig. 10d shows the breaker in the closed position after the closing spring has been recharged. Note that the closing cam has rotated about one-half turn.



b. Breaker Open and Closing Spring Charged



a. Breaker Open and Closing Spring Not Charged

c. Breaker Closed and Closing Spring Not Charged

d. Breaker Closed and Closing Spring Charged

Fig. 10 *The Four Positions of the Closing Cam and Trip Linkage – DVP Breaker*

The cam for this portion of the travel is cylindrical and causes no further movement of the closing cam follower roller. This rotation corresponds to the spring charging rotation of the ratchet wheel shown in Fig. 9.

Lifting the tripping trigger either by hand or by the tripping magnet releases the tripping latch, tripping cam and closing-cam follower roller. The linkage collapses and the breaker opens. The linkage then assumes the position shown in Fig. 10b.

2.10 MECHANISM PANEL

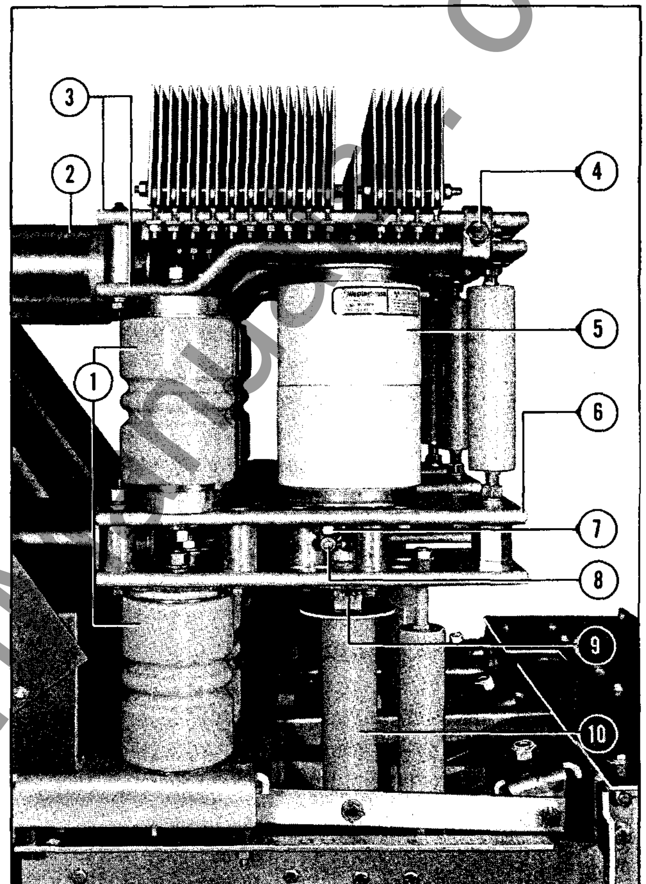
The mechanism panel, Fig. 2, is located on the front of the breaker chassis. Mounted on it are the closing spring-release magnet and the tripping magnet for closing and opening the breaker electrically. Also mounted on the mechanism panel are the auxiliary switch, operation counter, control relay, motor-cutoff switch, closing spring-charge indicator, latch check switch, breaker-position indicator, and breaker nameplate. Cams and linkages for the floor-tripper assembly are also supported on the mechanism panel. When supplied, undervoltage and transformer trip devices are also mounted on the mechanism panel.

2.11 POLE UNITS

The pole units shown in Fig. 11 include all current carrying and current interrupting parts of the vacuum breaker. The parts in Fig. 11 include the vacuum interrupter, the interrupter bottom support assembly, the clamping plates and the roller contacts which transfer current from the moving contact of the interrupter to the bottom support assembly. Three poles are mounted on the breaker as shown in Fig. 2.

2.12 VACUUM INTERRUPTER

The vacuum interrupters used for the DVP line of breakers are shown in Fig. 13 along with the other pole unit parts. These interrupters (Fig. 12) consist of two special contacts mounted on stems, a ceramic envelope with metal ends, and a bellows to allow movement of one contact while maintaining a vacuum inside the bottle. The stationary contact is rigidly fastened to the upper stem, which protrudes through the upper end plate of the interrupter and is fixed rigidly to it. The moving contact is fastened to the lower stem which is free to move through the bottom end plate. The movement of the bottom stem is limited by the bellows seal. These two contacts are used for both carrying continuous current and for interrupting fault current. The contacts are surrounded by a metal vapor shield which protects the ceramic envelope from the metal vapors formed during interruption. The interrupter is a self contained unit which is hermetically sealed to maintain the integrity of the vacuum.



1 Post Insulator	7 Mounting Nuts
2 Upper Stud	8 Roller Contacts and Lubricant
3 Upper Clamping Plates	9 Operating Rod Pin (1) and X-Washers (2)
4 Clamping Bolt	10 Operating Rod
5 Vacuum Interrupter	
6 Lower Mounting Assembly	

Fig. 11 *Type 150 DVP 500 Pole Unit in Closed Position (391416)*

NOTE

The bellows is constructed of thin material so as to be flexible. Because this material is so thin the bellows must be handled with extreme care. The bellows have been well

designed and with proper care will operate without failure over a long life. Any harsh treatment of the bellows will result in reduced life or failure. If air enters the interrupter it will not interrupt current. To prevent any abusive treatment to the bellows never pull or drive the moving stem more than the recommended 3/4 inch. In addition, under absolutely no circumstances is the moving stem to be twisted or rotated by more than one and a half degrees (1-1/2°).

During an opening operation the mechanism pulls on the porcelain operating rod and causes the moving stem of the interrupter to move downward and a gap to open between the contacts. As the contacts part an arc is drawn between them. This arc is supported by metal vapor from the contacts and continues to current zero. The absence of gas in the interrupter permits rapid recovery of dielectric strength, and causes the arc to extinguish.

2.13 INTERPHASE BARRIER

The interphase barrier is an assembly of insulating sheets, channels, and angles all mounted on a steel front plate. Figs. 1 & 3 show typical barrier assemblies.

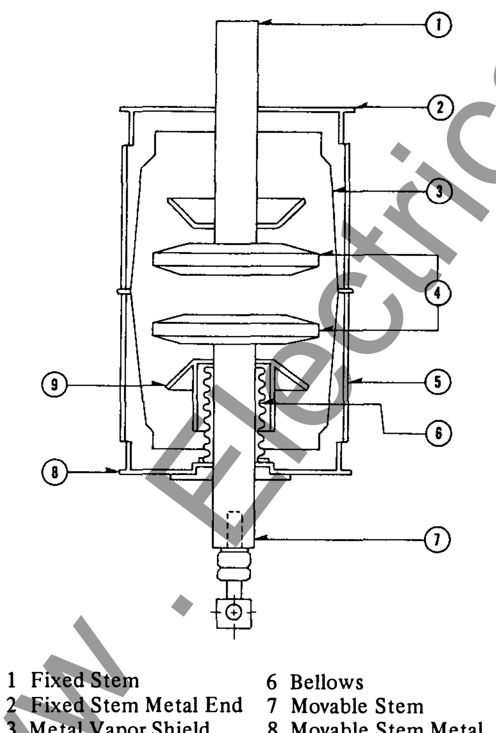


Fig. 12 *Vacuum Interrupter Sketch*

The insulating sheets, channels, and angles are so arranged that when the interphase barrier assembly is mounted on the circuit breaker, it provides phase to phase and phase to ground insulation.

The steel front plate provides a grounded metal barrier between the breaker live parts and operating personnel.

2.14 LEVERING-IN DEVICE

The purpose of the levering-in device is to move the circuit breaker between the disconnected or test position and the connected or engaged position in the cell.

Figs. 14a and 14b show the two extreme positions of the levering-in device. The main parts of the device are:

1. The levering nut.
2. The guide tube.
3. The levering-in shaft.
4. The levering-in interlock.

These components are installed as part of the breaker chassis assembly. The levering-device nut is fastened securely to the guide tube and is loosely retained in a housing fastened to the extreme rear of the chassis as shown in Fig. 15.

The operation consists of engaging the rotatable levering nut on the circuit breaker with the levering screw mounted on the rear wall of the cell. By traversing the levering nut along the levering screw, the breaker is moved between test and connected positions within the switchgear housing.

The guide tube is slotted lengthwise for a distance about equal to the travel distance of the breaker. The levering-in shaft has two rectangular hardened keys welded to it which slide in the guide tube slot. Thus, as the levering-in shaft is rotated, the guide tube and nut are also rotated.

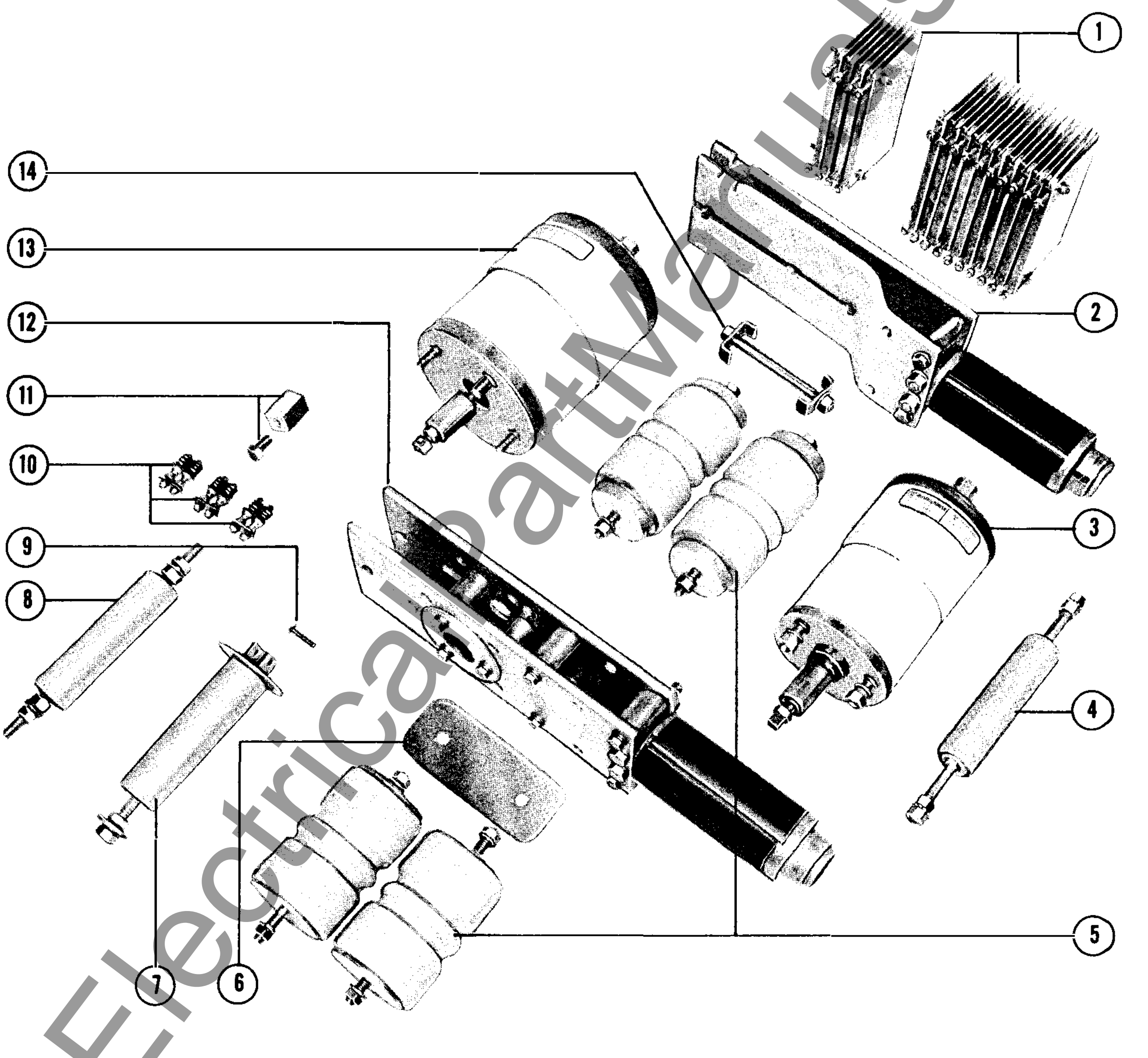
As the breaker is levered in by clockwise rotation, the keys on the levering-in shaft move toward the end of the guide tube slot. As the rear key comes out of the slot, the levering-in shaft turns freely and the breaker moves no further.

The end of the guide tube is shaped like a steep-pitch one-turn screw thread so that when the levering shaft is rotated COUNTERCLOCKWISE the rear key will catch, enter the slot, rotate the guide tube and nut, and the breaker will be withdrawn.

At the end of the travel, the nut will disengage from the screw and spin free. The levering-in interlock is described in the Interlock Section of this book.

2.15 SHUTTER OPERATING ROLLER

The shutter operating roller is located on the right side of the breaker chassis. Fig. 15. Its function is to engage the



1 2000 A. Cooling Fin Assembly
2 Clamping Plates
3 500 MVA Vacuum Interrupter
4 Upper Porcelain Insulating Strut
5 Porcelain Post Insulators
6 Insulator Spacer
7 Porcelain Operating Rod Assembly
8 Lower Porcelain Insulating Strut
9 Operating Rod Pin
10 Roller Contact Assembly
11 Lower Mounting Plate Spacer and Hardware
12 Lower Mounting Plate
13 750 MVA Vacuum Interrupter
14 Clamping Plate Hardware

Fig. 13 *DVP Breaker Pole Unit Details (391630)*

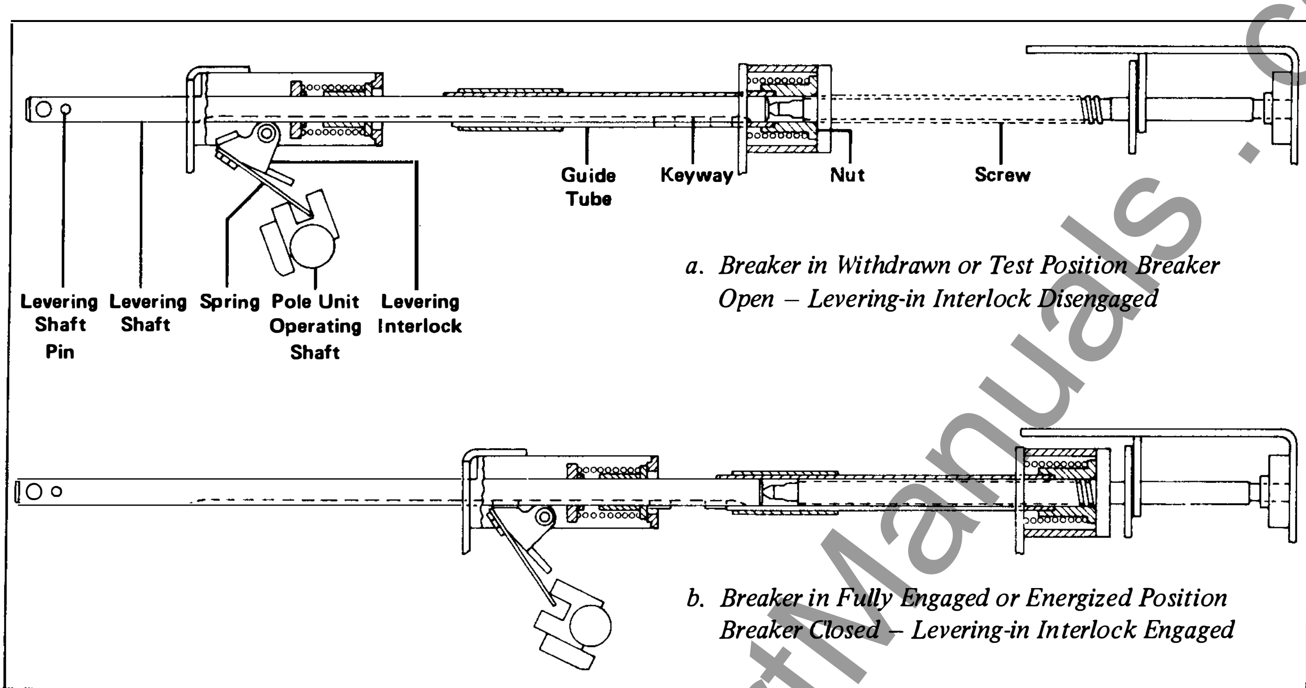


Fig. 14 *Schematic of DVP Breaker Levering-in Device and Interlock*

shutter operating cam in the cell to raise the shutter over the stationary disconnecting contacts as the breaker is levered from the test position to the engaged position in the cell.

2.16 GUIDE CHANNEL AND RAIL LATCH

The guide channel is an inverted U-shaped channel welded along the bottom edge of the right hand chassis side sheet. The guide channel cooperates with the guide rail welded to the floor of the metal-clad cell. The two pieces acting together position the breaker laterally in the cell. Fig. 16.

The rail latch is located directly in front of the guide channel. Its purpose is two fold.

1. The rail latch stops the breaker in the cell just before the levering screw and nut engage.

2. The rail latch holds the breaker in the disconnected or test position.

The rail latch has two catching dogs, one on each side of the pivot, which engage notches in the cell guide rail. A spring normally holds the front dog down against the rail so that as the breaker is pushed into the cell, the front dog will drop into the rear notch and prevent further movement. If an attempt is made to override the latch by pressing down on it as the breaker is rolled in, the rear dog will catch in the front notch and impede further movement. This latch prevents damage to the levering-in nut and screw.

When it is desired to lever the breaker into the engaged position from the test position, the rail latch is pressed down (it can conveniently be done with the foot, see Fig. 17) and the breaker is pushed into the cell approximately 1/4 inch so that the levering-device nut and screw can be engaged.

When the breaker is levered out of the cell and the levering nut and screw have become disengaged, the breaker should be pulled out of the cell approximately 1/4 inch more to engage the rail latch, thus locking the breaker in the test position.

The rail latch must be released to withdraw the breaker from the test position in the cell.

2.17 SECONDARY CONTACTS

The breaker control wiring is arranged for drawout disconnecting by means of a 15 point male plug arranged to connect to a female receptacle mounted in the rear of the cell. See Fig. 18. The secondary contact plug is mounted on a moveable bracket on the left side of the breaker chassis. This permits it to be extended to the rear while the breaker is in the test position to make contact with the stationary receptacle in the cell so that the control circuits are completed.

Normally the secondary contacts are held stationary relative to the breaker chassis. This is accomplished by a notch in the bar connecting the secondary contact hand operating rod to the secondary contact mounting bracket which acts on the edge of the mechanism panel to hold the assembly in position.

To engage the secondary contacts while the breaker is in the test position, lift the secondary contact hand operating rod, Figs. 2 and 19a, enough to release it from the mechanism panel. Push to the rear until the cross-pin in the hand operating rod goes into the slots in the secondary contact engaging handle as shown in Fig. 19b. The handle is then pressed down to make final engagement of the secondary contacts.

2.18 GROUND CONTACT

The ground contact is an assembly of spring-loaded fingers to provide a disconnectable means for grounding the breaker chassis after it has been inserted into a switchgear cell. The ground contact is located on the underside of the chassis next to the left hand rear wheel of the breaker. An extension of the switchgear ground bus is secured to the cell floor in such a position to engage the ground contact when the breaker is pushed into the test position and to remain engaged in all positions of the circuit breaker from the test position to and including the engaged position. See Fig. 20.

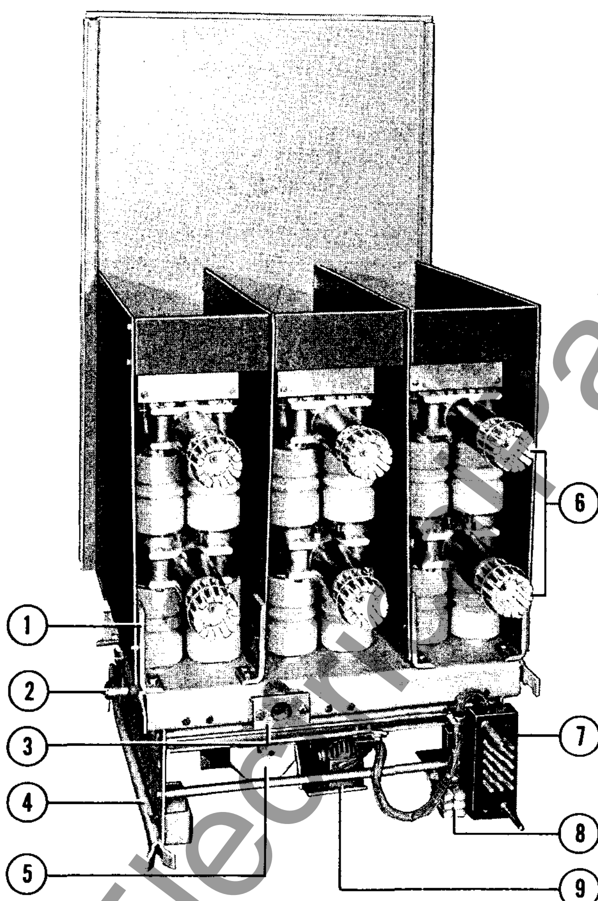


Fig. 15 *Rear View of DVP Breaker and Levering Device (391410)*

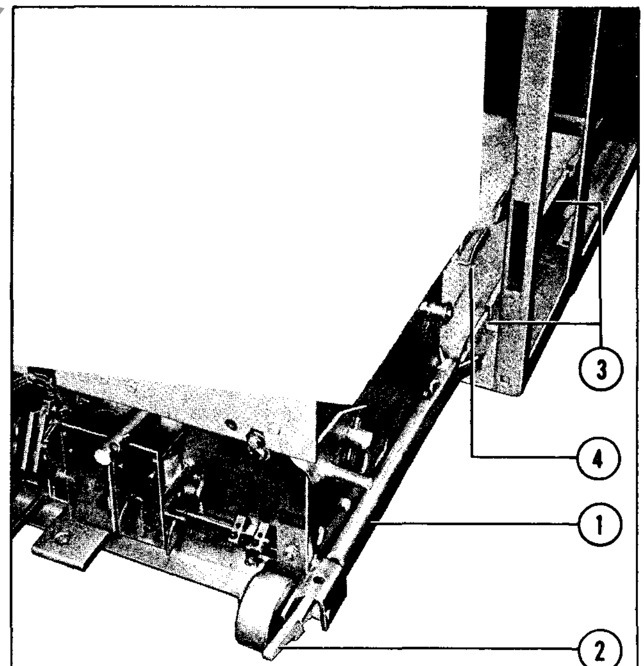


Fig. 16 *Breaker Guide Channel and Rail Latch (393301)*

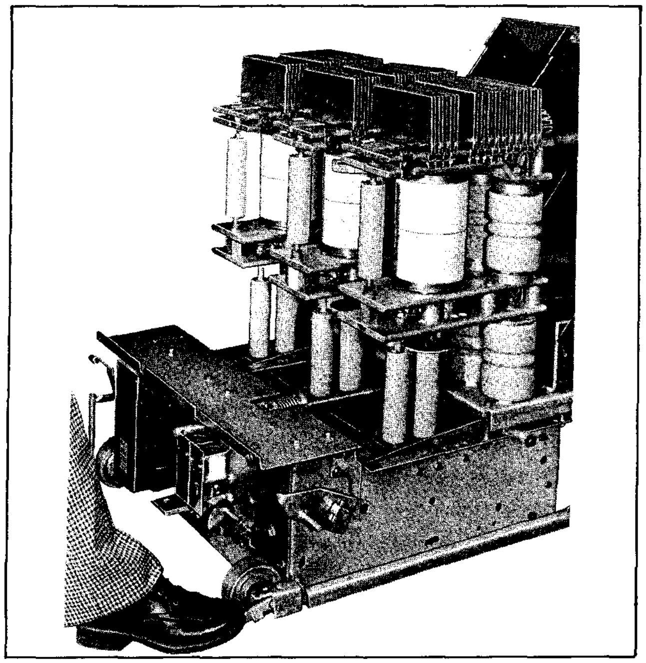


Fig. 17 *Releasing Rail Latch – DVP Breaker (391417)*

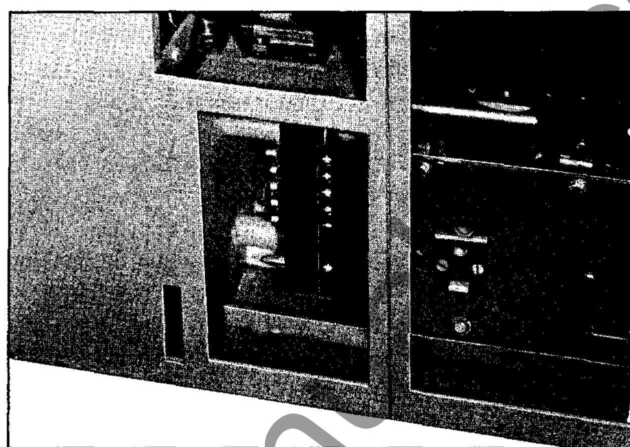


Fig. 18 *Breaker in Cell – Secondary Contacts Engaged (393314)*

2.19 BREAKER OPEN-CLOSED INDICATOR AND MOC SWITCH OPERATING PIN

The breaker OPEN-CLOSED position indicator is a lever assembly secured to the main shaft of the breaker operating mechanism where it projects through the right hand side sheet of the breaker chassis. Movement of this lever is directly related to movement of the breaker mechanism and contacts. OPEN and CLOSED nameplates on the right side of the mechanism panel are located to indicate respective positions of the breaker contacts in relation to the position of this lever. Figs. 2 and 21.

A heavy pin welded to the breaker position indicator lever projects to the right of the breaker chassis. Fig. 21. As the breaker is inserted into the cell this pin engages a channel member of the Mechanism Operated Cell Switch (MOC Switch) mechanism located in the switchgear cell. Thus the MOC switch is operated by the pin each time that the breaker is operated and the contacts of the MOC Switch can be correlated with breaker contact position in the same manner as the auxiliary switches mounted on the breaker. (Note that the MOC Switch operating pin is furnished on all breakers. MOC switches are provided in the cell only when specified on the switchgear order.)

2.20 INTERLOCKS

All DVP breakers are equipped with several interlocks. These interlocks permit proper breaker operation and prevent improper breaker operation.

CAUTION

CONDITIONS HAZARDOUS TO PERSONNEL, EQUIPMENT, AND PROPERTY CAN BE CREATED SHOULD ANY OF THE INTERLOCKS BE BY-PASSED OR MADE INOPERATIVE.

2.20.1. Breaker-Cell Coding Plates – This is a combination of a notched plate in the cell and interference bars on the breaker so that only appropriately rated breakers can be put into the cell. Figs. 2 and 22.

2.20.2. Levering-in Interlock –The levering-in interlock is designed to prevent moving the breaker into or out of the energized position if the breaker contacts are closed. It consists of a movable key, mounted securely on the rear of the mechanism panel, which can enter an elongated keyway in the front part of the levering-in shaft. The key is spring-operated by the closing and opening movement of the breaker main shaft. When the breaker is CLOSED, a force is applied through a flat spring to the key causing it to enter the keyway on the levering-in shaft. The levering-in shaft may be left in any position so that the keyway may not line up with the key. However, since the key is pressing against the shaft, it will snap into the keyway on the first rotation of the shaft as the keyway comes into line with the key. This prevents further rotation of the levering-in shaft thus blocking the levering of the breaker. Opening the breaker removes the key from the levering-in shaft keyway. Fig. 14.

If excessive force is applied to the levering-in shaft while the interlock key is engaged, the levering-in shaft pin, Fig. 14, located where the levering-in crank is attached, will break allowing the crank to turn free. The strength of this pin has been purposely selected to protect unaccessible internal parts of the interlock assembly from

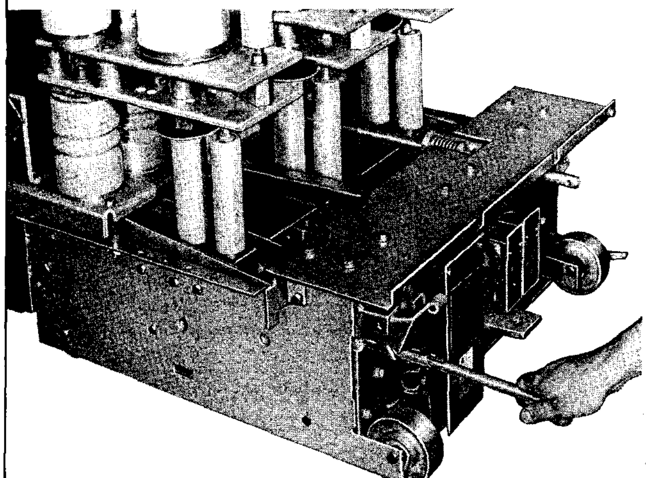


Fig. 19a *(391411)*

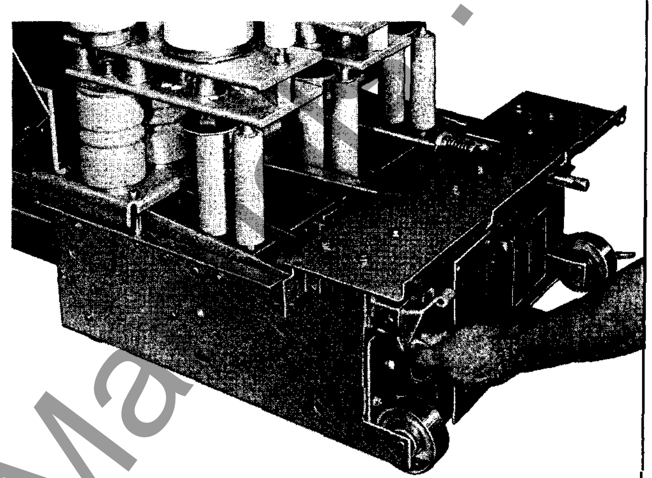


Fig. 19b *(391421)*

Fig. 19 *Operation of Secondary Contacts in Test Position – DVP Breaker*

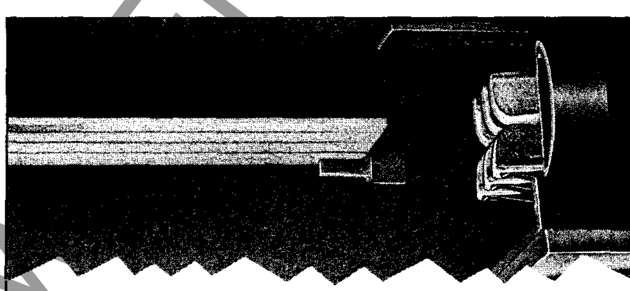
mechanical damage. If the pin is broken it is an indication that the breaker should be opened before further levering is attempted.

CAUTION

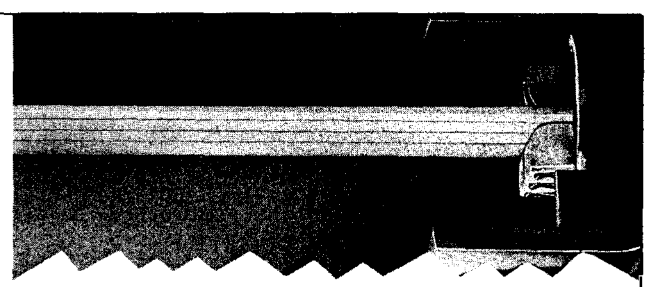
THE INTERLOCK COULD BE DAMAGED IF LEVERING-IN PINS STRONGER THAN THOSE SUPPLIED ON ORIGINAL EQUIPMENT ARE USED, USE ONLY PIN STYLE NO. 103A133H07.

2.20.3. Anti-Close Interlock – The anti-close interlock is provided to prevent releasing the closing spring to close the breaker when the breaker is already closed. As shown in Fig. 9 the anti-close interlock presses down on the spring release latch while the breaker is closed. Under this condition there should be a clearance of .010 to .030 inches between the front spring-release, latch roller and the top of the spring-release trigger. If the spring-release trigger is lifted while the breaker is closed, it will simply rotate past the front spring release latch roller without releasing the main latch to discharge the closing spring. The trigger will reset when released.

2.20.4. Floor Tripping and Closing Spring Release Interlocks – The floor tripping and closing spring-release interlocks operate to trip the breaker and discharge the closing spring when the breaker is inserted into the cell to the test



a. Ground Contacts – Disengaged (393344-3A)



b. Ground Contacts – Engaged (393344-2A)

Fig. 20 *Breaker in Cell Showing Ground Contacts*

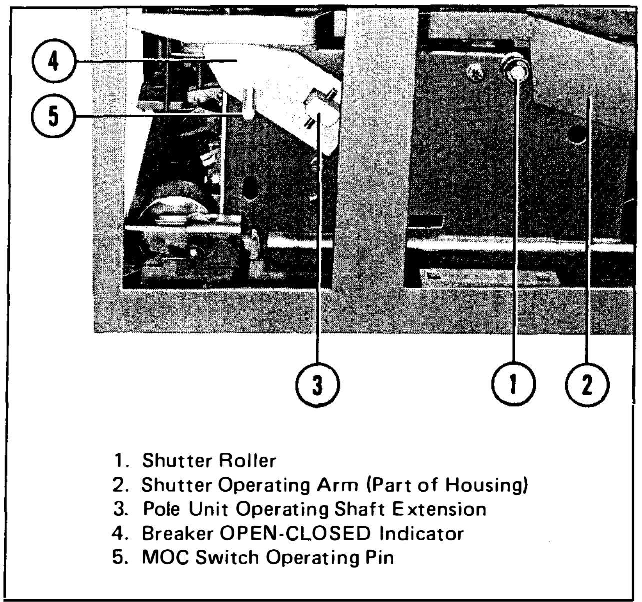


Fig. 21 *Breaker in Housing: Side View (393303)*

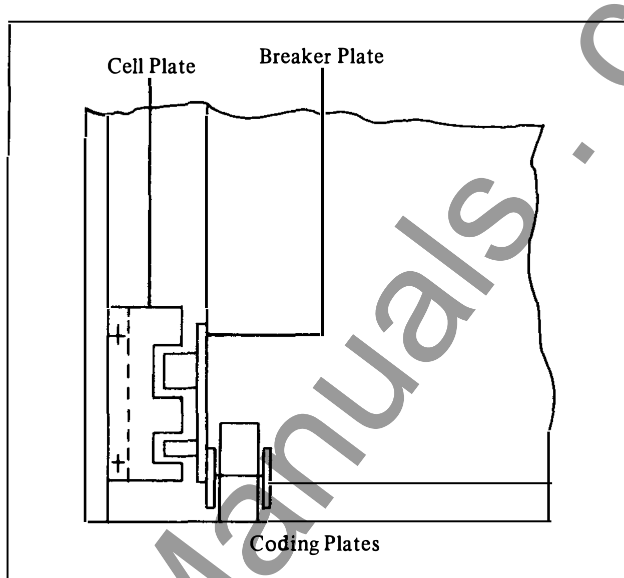


Fig. 22 *Breaker and Cell Coding Plates*

position or removed from the cell. Cam plates on the cell floor, Fig. 16, lift trip levers on the underside of the breaker, Fig. 31, to trip the breaker and/or discharge the closing spring.

The floor tripping interlock also operates to hold the breaker trip-free while it is travelling between the test and connected positions. This is to prevent accidental closing of the breaker in an intermediate position. An extension of the cam plate mentioned above lifts the tripping lever and holds it up between the test and engaged position. The floor tripping and closing spring release interlock levers on the underside of the breaker are coupled to cams located on the front panel of the breaker which operate to engage the breaker tripping and close release triggers as described under *Manual Closing* and *Manual Tripping*.

2.20.5. Rail Latch – The main function of the rail latch, Fig. 17, is to prevent damage to the levering-in screw and nut. It also functions to latch the breaker in the test position. Operation of the rail latch has previously been described under Description and Operation.

2.20.6. Barrier – The interphase barriers on all DVP breakers are constructed so that if they are properly installed they cannot readily be removed when the breaker is in the cell.

2.20.7. Maintenance Handle – The maintenance handle Figs. 4 and 7 has an interference bar welded to it to prevent using the handle when the breaker is in the cell. **DO NOT REMOVE THIS INTERFERENCE BAR.**

2.21 CONTROL SCHEMES

Basically all DVP stored-energy operated breakers operate the same. There may be different control voltages and there may be one or more tripping elements to open the breaker but the principal mode of operation for all DVP breakers is as follows:

As soon as the secondary contacts make up, the spring charging motor will start to charge the closing spring provided control power is available. When the spring is completely charged, the motor cut-off switch will turn the motor off. The breaker can be closed by closing the control switch to energize the spring-release solenoid on the breaker mechanism panel. This releases the closing spring to close the breaker. When the breaker closes, the motor will immediately start recharging the closing spring.

The breaker can be tripped open by energizing the tripping solenoid by means of the control switch or by the action of protective relays. This releases the trip latch allowing the opening springs to cause the circuit breaker to open. Figs. 23a and 23b are typical d-c control schemes. Fig. 24 is a typical a-c control scheme.

2.22 UNDERVOLTAGE TRIP ATTACHMENT

The undervoltage trip shown in Fig. 25 is an electromechanical device that trips the circuit breaker when the voltage on its coil falls to between 30 and 60 per cent of normal.

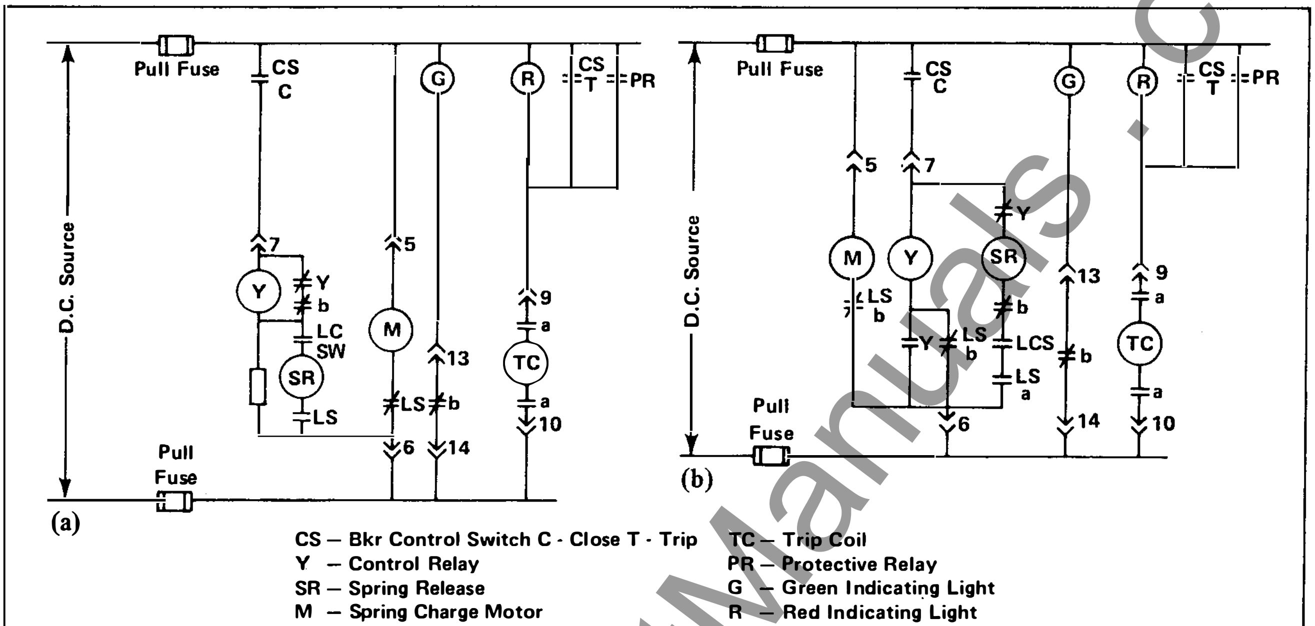


Fig. 23 *D-C Control Schemes – Typical*

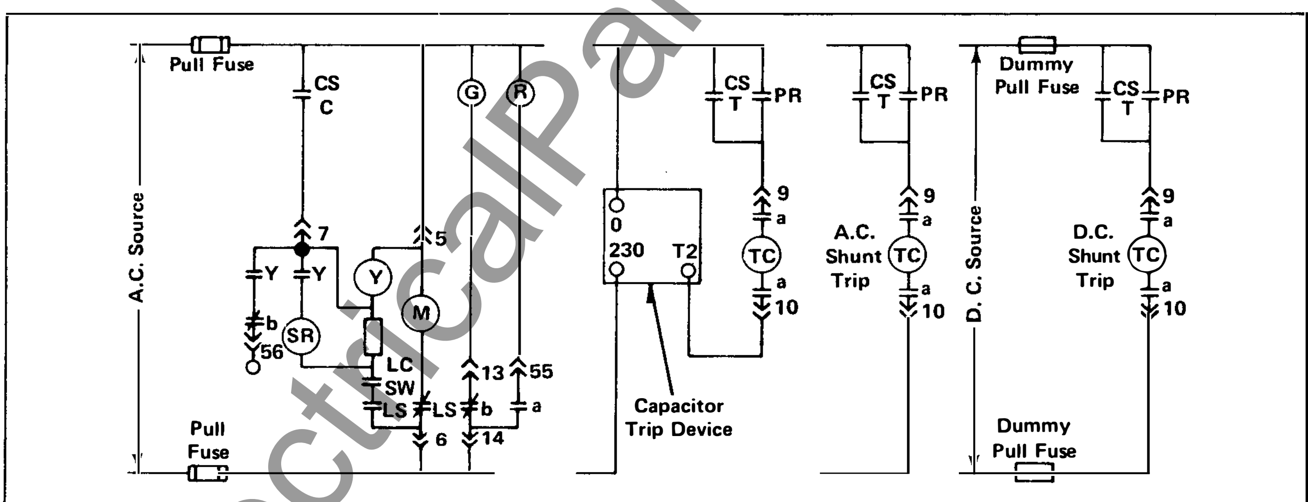


Fig. 24 *A-C Control Schemes – Typical*

In operation, the moving core is held magnetically against the stationary core and a spring. The moving core is linked to a roller lever which restrains the tripping lever of this assembly.

When the coil voltage is reduced sufficiently, the roller lever spring overcomes the magnetic attraction between the two cores. The moving core travels downward and rotates the roller lever counterclockwise so that the roller moves to release the tripping lever. A torsion spring around the pivot pin of the tripping lever then rotates it counterclockwise causing a linkage on the under side of this lever to trip the breaker.

As the breaker opens, a pin on the center pole reset lever strikes the undervoltage reset lever and rotates it counterclockwise against the tripping lever and roller lever. The roller lever and tripping lever are rotated clockwise and the moving core re-engages the stationary core.

As the breaker closes, the center pole reset lever moves away from the undervoltage reset lever. The tripping lever acted upon by its torsion spring moves counterclockwise against the roller on the roller lever.

The undervoltage is now completely reset and in position to trip the breaker if the undervoltage coil voltage drops 30 to 60 percent of normal.

NOTE

Special care should be taken when working on a breaker with an undervoltage attachment. The breaker will trip as soon as the control source is de-energized. With the undervoltage de-energized, the breaker may be closed with the maintenance handle to check the contacts but the breaker cannot be latched closed.

2.23 ACCESSORIES

Several maintenance items are supplied with each order of metal-clad switchgear. They are shipped with the switchgear order, not with the breakers. Those directly associated with the breaker are:

2.23.1. Maintenance Handle – Used to close the breaker contacts during maintenance only. Also used to manually charge the breaker closing spring.

CAUTION

DO NOT ATTEMPT TO CLOSE THE BREAKER WITH THE MAINTENANCE HANDLE WHEN THE BREAKER IS IN THE HOUSING. TO DO SO COULD CAUSE BODILY INJURY AND/OR EQUIPMENT DAMAGE.

2.23.2. Turning Dolly – Used to maneuver the breaker when out of the cell and to assist in lining the breaker up before putting it into the cell.

[redacted]

DO NOT USE THE TURNING DOLLY TO MOVE THE BREAKER IN OR OUT OF THE CELL. TO DO SO COULD CAUSE DAMAGE TO EQUIPMENT.

2.23.3. Levering-in Crank – Used to move the breaker between the Test Position and the Connected Position.

Table 3. DVP Breaker Stored Energy Mechanism Control Power Requirements

Rated Control Voltage	Spring Charge Motor Run Amperes 15 Kv	Time Sec.	Close or Trip Amperes	Voltage Range Close	Voltage Range Trip	Ind. Light Amperes
48 V Dc	13.0	5	10	40-50	28-60	.035
125 V Dc	5.0	5	5	90-130	70-140	.035
250 V Dc	2.6	5	2	180-260	140-280	.035
115 V Ac	6.0	5	17	95-125	95-125	.035
230 V Ac	3.0	5	7	190-250	190-250	.035

Control Power Transformers • Disconnect Type • 1 Phase • 60 Hertz

Primary Volts ① Taps +7½%	Primary Volts ① Rated	Primary Volts ① Taps −7½%	Secondary Volts	Kva	Kv Class
2580	2400	2220	240/120	5, 10, 15	5
4470	4160	3850	240/120	5, 10, 15	5
5160	4800	4400	240/120	5, 10, 15	5
7740	7200	6680	240/120	5, 10, 15	15
12900	12000	11100	240/120	5, 10, 15	15
14300	13300	12300	240/120	5, 10, 15	15

① If connected line to ground, system neutral must be solidly grounded.

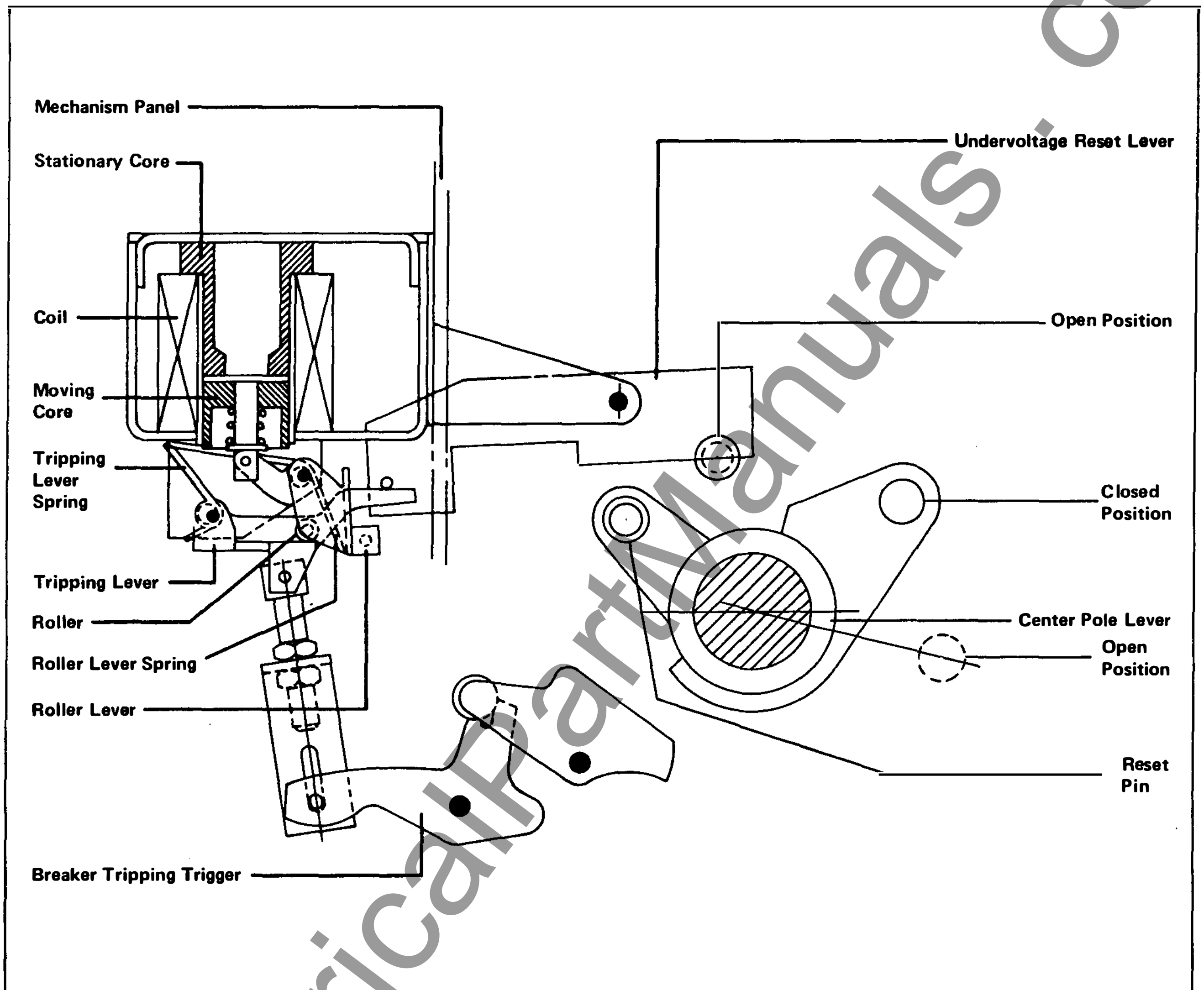


Fig. 25 *Undervoltage Trip Attachment*

Section 3 — Initial Inspection and Operation

3.1 INSPECTION AND OPERATION

Before attempting to put the breaker in service it should carefully be checked and operated manually. The breakers were adjusted, inspected and tested at the factory before they were shipped and should require no readjusting before they are put in service. Do not change any adjustments, assemblies or parts unless they are obviously damaged or incorrectly adjusted. However, handling and transportation conditions could cause some damage or loss of adjustment. If some part is obviously out of adjustment, refer to the Adjustment section of this instruction book for the correct settings.

The following sequence for inspection and operation should be followed:

1. Examine breaker for loose or obviously damaged parts.

2. Operate breaker manually.

NOTE

Before trying to close the breaker with the maintenance closing handle, make sure that the closing spring is discharged. It can not be closed this way with the spring charged. If it is tried, the tripping linkage may be damaged. Breaker should be open and spring discharged as it is received.

a) Manually charge closing spring — Place the end of the maintenance closing handle in the slot in the manual ratchet lever. This lever projects through a slot in the front of the mechanism panel just to the left of the "Lift Plunger to Open" magnet. See Fig. 33. Charge spring with several downward movements of the lever until the lever suddenly turns freely and a positive metallic "click" is heard. See Fig. 4. **DO NOT ATTEMPT TO RATCHET ANY FURTHER. REMOVE MAINTENANCE HANDLE.**

b) Release closing spring to close breaker manually — Place finger under spring-release solenoid plunger marked "Lift Plunger to Close" and lift. See Fig. 6. This releases the closing latch and closes the breaker.

c) Trip breaker manually — Place finger under trip solenoid plunger marked "Lift Plunger to Open" and lift. See Figs. 2 & 33. This releases the tripping latch and the breaker opens.

3. Operate breaker electrically.

After going through the above steps, the breaker may now be operated electrically.

A test cabinet or a test jumper is the preferred method for electrically operating the breaker out of the cell for inspection and maintenance.

a) Connect the female plug from the test cabinet or test jumper to the secondary contact plug on the rear of the breaker.

b) If the test jumper is used, plug the male end of the jumper into an energized secondary contact block in a convenient cell.

c) The spring-charging motor will immediately start to charge the closing spring as soon as the secondary contacts are engaged. As soon as the closing spring is completely charged, the motor will automatically be turned off.

d) Close the breaker — If a test cabinet is being used, the control switch or pushbutton switch is used to close the breaker. If the test cable is used, the control switch on the cell door is used to close the breaker.

e) As soon as the breaker closes the motor will immediately recharge the closing spring.

f) Trip breaker using control switch or pushbutton switch.

g) Disconnect secondary contacts from test cabinet or test cable.

h) Close and trip the breaker manually by lifting the "Lift Plunger to Close" and "Lift Plunger to Trip" solenoid plungers in that order. All springs are now completely discharged.

3.2 CHECKING THE INTERRUPTER FOR VACUUM

Checking the vacuum integrity of the interrupters requires a high potential test. Before conducting test the following caution should be observed.

CAUTION

APPLYING A HIGH VOLTAGE ACROSS AN OPEN GAP IN A VACUUM MAKES X-RAY EMISSION POSSIBLE. THE LEVEL OF X-RAY EMISSION FROM A VACUUM BREAKER WITH PROPER CONTACT SPACING AND WITH 36 KV ACROSS THE OPEN CONTACTS IS EXTREMELY SMALL AND WELL BELOW THE MAXIMUM LEVEL PERMITTED BY STANDARDS. HOWEVER, THERE IS ALWAYS THE POSSIBILITY THAT THE CONTACTS ARE OUT OF ADJUSTMENT AND THEREFORE CLOSER THAN THEY SHOULD BE, OR THAT THE VOLTAGE ACROSS THE CONTACTS IS GREATER THAN 36 KV. THEREFORE, IT IS ADVISABLE THAT ALL OPERATING PERSONNEL STAND BEHIND THE STEEL FRONT BARRIER AND REMAIN AT LEAST ONE METER AWAY FROM THE BREAKER.

The vacuum interrupters have been carefully inspected at the factory before being shipped to the customer. The integrity of the vacuum can be checked by opening the breaker and Hi Potting the open contacts of each phase, with 36 KV A.C. for one minute. Experience has indicated that, if the interrupter has lost vacuum, the open contacts quickly flash over in a positive manner well before the high potential tester can reach 36 KV. If the interrupter does not flash over during the one minute interval, it indicates adequate vacuum. (This voltage is higher than the value stated in standards for field testing 15 KV switchgear, but is necessary to check for vacuum.)

CAUTION

DURING THE HIGH POTENTIAL TEST THE VAPOR SHIELD INSIDE THE VACUUM INTERRUPTER CAN ACQUIRE AN ELECTROSTATIC CHARGE. THIS CHARGE SHOULD BE BLED OFF IMMEDIATELY AFTER THE TEST BY GROUNDING THE METAL RING WHICH CIRCLES THE CENTER OF THE CERAMIC ENVELOPE. ACCIDENTAL CONTACT WITH CHARGE COULD CAUSE INJURY OR DEATH.

3.3 CHECKING CONTACT WEAR GAPS

The contact stroke and wear gaps are factory set at approximately .25" but should be checked every 2000 operations to see that they are not less than .06", and they should be reset only in the event that a vacuum interrupter assembly is replaced. To check the wear gap the breaker must be outside the cell with the barriers tilted back and the breaker contacts closed. Figure 26 shows the gap being checked. The initial wear gap should be between .22" to .28". Fig. 27 shows breaker with barrier tilted back exposing interrupters.

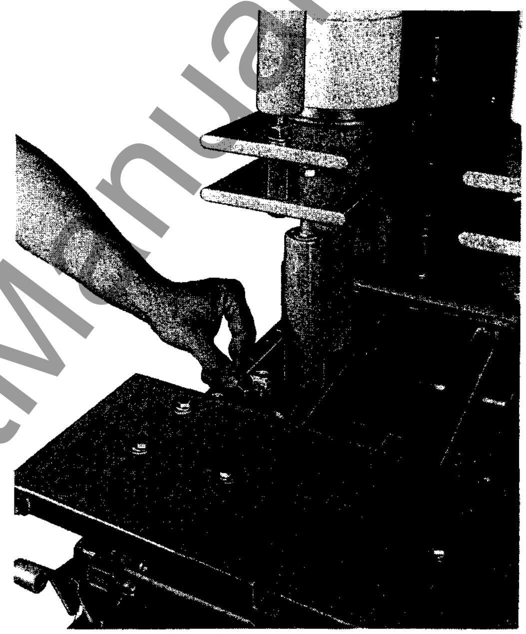


Fig. 26 *Measuring Contact Wear Gap – DVP Breaker (391415)*

It is safe to operate this breaker with less than .25" wear gap. As the contacts in the vacuum interrupter erode, the wear gap will diminish. WHEN THE WEAR GAP IS DOWN TO .06" THE VACUUM INTERRUPTER ASSEMBLY MUST BE REPLACED and the wear gaps set to .25" again. Under normal duty the vacuum interrupters should last for many years. NEVER ALLOW THE GAP TO DISAPPEAR since there will be no force holding the contacts closed and no hammer action to open the contacts. On the other hand an excessively larger wear gap puts unwarranted stress on the mechanism. THE WEAR GAPS SHOULD NOT BE RESET after the breaker has been put in service. If this is done there will be no record or valid indication of contact life. When an interrupter is replaced and the gaps are set to .25", the contact travel will automatically be .53" to .59". As the gaps diminish due to contact wear, the travel will increase.

Section 4 — Installation

4.1 POSITION BREAKER

Move breaker and barrier to a convenient location as close to the metal-clad cell it is to be used in as is convenient and remove from shipping crates if this has not already been done. See section on Handling.

NOTE

Be sure breaker is open and closing spring is discharged before starting to mount the barrier.

4.2 MOUNT BARRIER

Barrier assemblies for **DVP** breakers are the same for all sizes and ratings. The following procedure is applicable to all ratings.

a. Remove the bolts that are provided on the four L-shaped polyester brackets on the rear mounting pan.

b. Place the barrier assembly on breaker. The insulating side sheets of the barrier assembly must be placed on the outside of the two outer brackets. Set the inside insulating sheets beside the upright portion of the two inner L-shaped brackets. See Fig. 1.

Be sure that the barrier is seated as far down and as far back on the breaker chassis as possible. The steel panel should be in front of the lip on the barrier mounting pan, Fig. 3. The front part of the insulating subassembly should rest on top of the front barrier mounting pan.

c. Line up holes on sheets with those on brackets. Insert bolts into the holes in sheet and brackets with the bolt heads in the two outer brackets on the outside of insulating sheets.

Insert bolts into holes of two inner brackets with the bolt heads on the outside of insulating sheets. Bolt lock nuts will face toward the breaker sides. Tighten bolts to fasten the sheets to brackets.

d. Loosen the two bolts provided on the front mounting pan. Set the square slots at bottom edge of steel panel on the bolts. These slots permit some shifting of the barrier on the breaker side-to-side to center. Tighten bolts to fasten the steel panel to the barrier mounting pan.

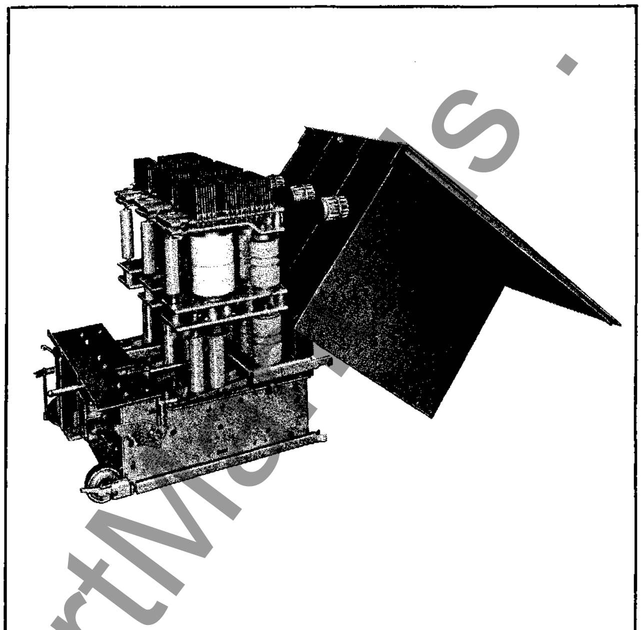


Fig. 27 *DVP Breaker with Barrier Tilted Back (391412)*

e. The installation of a barrier is not a precise operation. However, reasonable care is required to insure that the barrier is centered on the circuit breaker and aligned side-to-side, front-to-back and vertically. Once the barrier is aligned, all the bolts should be tightened to maintain the alignment. A final adjustment to line up the barrier with the cell opening may be necessary just prior to inserting the breaker into the cell.

4.3 POSITION BREAKER IN FRONT OF CELL

For general movements of breaker where corners must be turned and for positioning in front of the cell, use the turning dolly. Place vertical pin of dolly in hole in handling bracket at bottom and center of mechanism panel by tilting dolly handle sharply toward breaker. Push dolly handle down until front wheels of breaker lift off floor. Breaker can now be steered by horizontal movement of dolly handle. See Fig. 28.

CAUTION

USE HANDLE ON FRONT STEEL PANEL ON BARRIER ASSEMBLY TO PULL OR PUSH BREAKER STRAIGHT FORWARD OR BACKWARD ONLY. KEEP HANDS OFF EDGES OF FRONT BARRIER IN MOVING BREAKER TO AVOID BODILY INJURY.

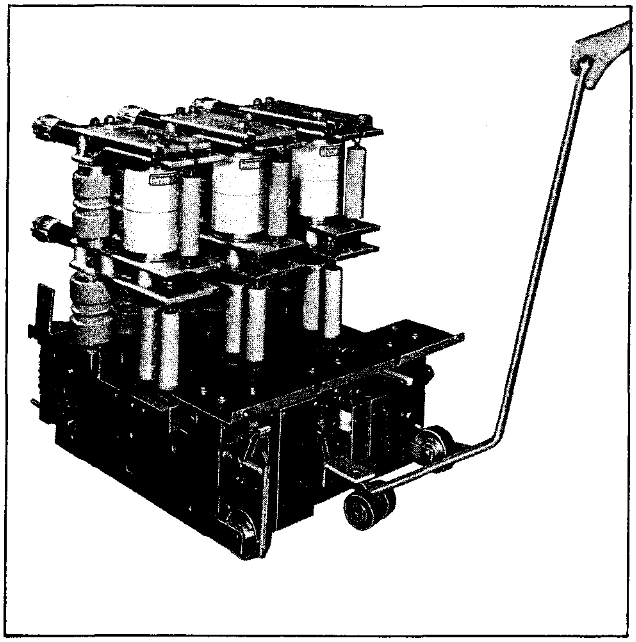


Fig. 28 *Using Turning Dolly (396701)*

a. Examine disconnecting finger clusters for any signs of damage. See that they are properly positioned and that the retaining bolts are in place in the end of the breaker studs. Clean off any dirt, paper, etc. **DO NOT APPLY GREASE TO FINGER CLUSTERS.**

b. Check secondary contacts to see that none are bent out of alignment.

c. Make sure that the cell is clean and clear of anything that might interfere with breaker travel.

d. Levering screw in cell should be clean and free from dirt or grit. See that there is sufficient grease packed in the levering-in nut on the breaker to lubricate the screw.

4.4 PUSH BREAKER INTO TEST POSITION IN CELL

a. Line up guide channel on right hand side of breaker near floor with guide rail on right hand side of cell floor. See Fig. 16.

b. Remove handling dolly once breaker is aligned with guide on cell floor.

CAUTION

DO NOT START BREAKER INTO CELL WITH TURNING DOLLY. THIS COULD CAUSE FAILURE OF MOC SWITCH PIN TO ENGAGE PANTOGRAPH IN CELL AND DAMAGE LEVERING-IN SCREW.

c. Push breaker into cell until rail latch at front of guide channel catches in notch in guide rail and stops further movement of breaker toward rear of cell.

d. The breaker is now in the TEST POSITION.

CAUTION

KEEP HANDS OFF EDGES OF FRONT STEEL BARRIER WHEN PUSHING BREAKER INTO CELL TO AVOID BODILY INJURY.

NOTE

The breaker may open and its closing spring may be discharged while it is pushed into the cell, depending on whether the breaker was left closed or open, or whether the closing spring was left charged or discharged while the breaker was standing outside the housing.

4.5 ENGAGE SECONDARY CONTACTS

a. Lift the handle on left hand side at front of chassis to a horizontal position. Lift further to disengage notch in rod from top edge of panel and push toward rear of breaker. The small horizontal pin in the handle will engage the two slots in the lever which is pivoted immediately above the handle. See Figs. 2 and 19.

b. Push down on the curved end of the lever as far as it will go to complete engagement of secondary contacts with female receptacle on the wall of cell.

NOTE

As soon as the secondary contacts make up the motor will charge the closing spring if the control circuit is energized.

4.6 OPERATE BREAKER IN TEST POSITION

a. The breaker may now be electrically closed and tripped by using the control switch on the cell door.

b. The control of the breaker is arranged so that the closing spring will recharge immediately after each closing operation.

4.7 LEVER BREAKER INTO CELL

a. Trip Breaker Open

CAUTION

THE POLE UNIT PARTS ARE ALIVE AT FULL CIRCUIT VOLTAGE WHEN THE BREAKER IS IN THE FULLY ENGAGED POSITION. BEFORE MOVING THE BREAKER INTO THAT POSITION, MAKE SURE THAT MAIN BARRIER ASSEMBLY HAS BEEN PROPERLY FASTENED IN PLACE. FAILURE TO DO THIS MAY CAUSE SERIOUS DAMAGE OR INJURY.

NOTE

Mechanical interlock prevents levering breaker into or out of the cell if breaker is closed. If excessive force is applied to the levering-in mechanism while the breaker is closed, the 3/16 pin that the levering-in crank engages will shear.

b. Press down on rail latch on right side of breaker. See Fig. 17. Push breaker toward rear of cell as far as it will go, about 1/4 inch.

c. Be sure breaker is pushed in until it stops. This should require only a few pounds of push. It brings the levering nut on the breaker up to the screw in the cell.

d. Engage crank on levering shaft, push moderately toward rear of cell and turn crank clockwise. Breaker will move slowly toward rear of cell. After breaker starts to move it is not necessary to push. See Fig. 29.

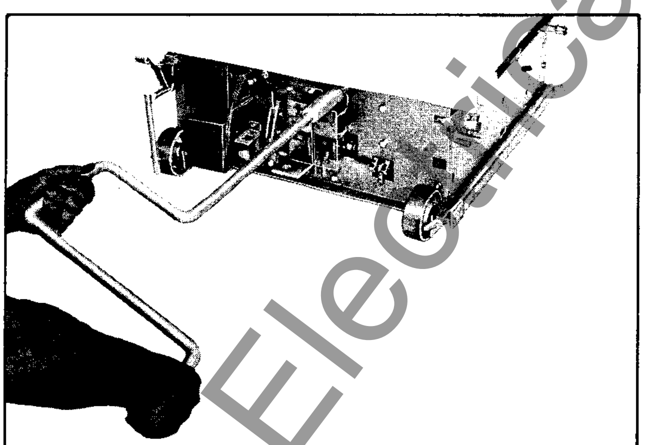


Fig. 29 *Using Levering-in Crank (388826)*

e. Continue cranking until crank turns freely and breaker stops moving. When breaker is fully engaged, front steel barrier should be 1/4 inch or less from cell frame angles.

f. This is the OPERATE or ENGAGED POSITION.

g. Breaker may now be closed and tripped electrically using the control switch on the cell door.

4.8 REMOVE BREAKER FROM OPERATE POSITION

a. Trip Breaker Open

NOTE

Mechanical interlock prevents levering breaker into or out of the cell if breaker is closed.

b. Engage crank on levering device shaft and turn counterclockwise until crank rotates freely.

c. Pull breaker toward front of cell until rail latch engages slot in rail. Breaker is then secured in TEST POSITION.

4.9 REMOVE BREAKER FROM CELL

a. Press down on rail latch to free breaker from rail.

b. Pull breaker out of cell using handle on front of barrier.

NOTE

The breaker may open and its closing spring may be discharged as it is withdrawn from the cell depending on whether breaker was left closed or open, or whether spring was left charged or discharged while standing in the test position.

Section 5 — Adjustments

DVP Breakers are adjusted, inspected and tested at the factory and should give many years of troublefree service. However, with the time and operations some wear will naturally occur and some readjustment to components may be necessary from time to time.

The following paragraphs give the proper settings and the method of adjusting to attain them.

5.1 TRIPPING LATCH CLEARANCE

If the barrier occasionally fails to close or operate trip free, it may be due to failure of the mechanism to reset as soon as the closing spring is fully charged. This may be caused by inadequate clearance between the tripping trigger and trip latch roller, Fig. 10b. Check the clearance and adjust if necessary as outlined below.

With the breaker out of the cell remove the transparent plastic cover (Lift Plunger to Trip) from in front of the tripping trigger and proceed to adjust clearance as follows:

1. Charge the closing spring.

2. Loosen locking nut, Item 17, Fig. 10a.

3. Turn the tripping cam adjusting screw, Item 16, Fig. 10a clockwise until the trip latch roller, Item 18, Fig. 10a positively touches the latch surface of the tripping trigger, Item 10, Fig. 10a. Do not overtighten. A nominal pressure is all that is required.

4. Raise the tripping trigger approximately one inch and release it. It will remain up approximately as shown in Fig. 10a.

5. Back the trip cam adjusting screw "OUT" VERY SLOWLY until the trip latch roller and tripping latch just reset. Then back the adjusting screw out an additional one quarter turn. There will be a small but noticeable clearance between the roller and the latch surface (.02 to .03 inch clearance). See Fig. 10b.

6. Tighten the locking nut.

5.2 HOLDING PAWL ADJUSTMENT

If the motor runs but the closing spring does not charge, the holding pawl can be repositioned relative to the ratchet wheel by loosening the set screw that holds the pawl adjusting collar and moving it left or right so that the manual ratchet lever and holding pawl assembly stops on a

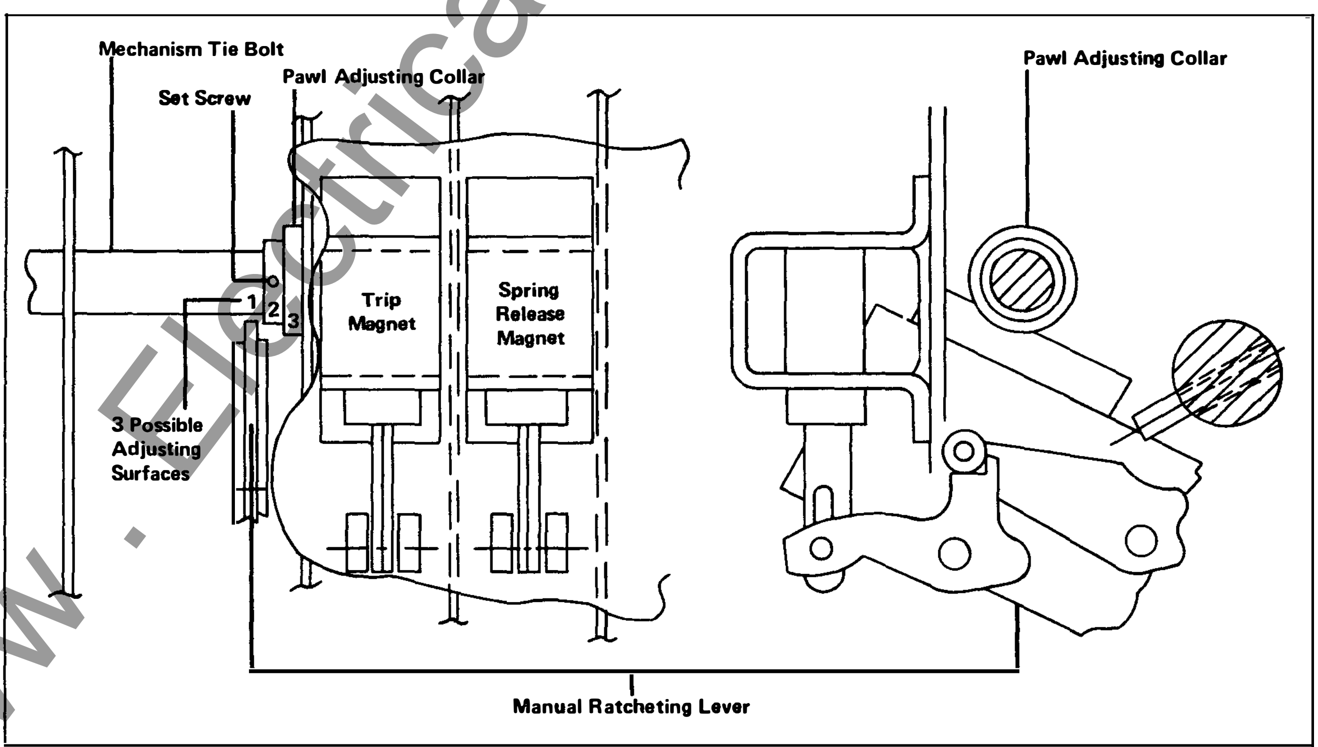


Fig. 30 *Holding Pawl Adjustment*

different surface, Fig. 30. Three possible adjustment surfaces are provided.

5.3 ANTI-CLOSE INTERLOCK ADJUSTMENT

If the closing spring can be discharged on a closed breaker by lifting the "Lift-to-Close" plunger, the anti-close interlock is not in proper adjustment. With the breaker closed and the spring charged, there should be a clearance of 0.010 to 0.030-inch between the closing trigger and the closing latch roller. Follow this procedure for readjustment.

CAUTION

THIS PROCEDURE REQUIRES WORK ON A CLOSED, SPRING CHARGED BREAKER. EXTREME CAUTION MUST BE EXERCISED TO AVOID ACCIDENTAL OPERATION OF THE CLOSING AND TRIPPING TRIGGERS. UNEXPECTED OPERATION OF CIRCUIT BREAKER COULD CAUSE BODILY INJURY.

1. Remove breaker from cell.

2. Tilt barrier back after removing front panel screws.

3. Remove barrier mounting pan, Fig. 33.

4. With propane torch apply heat to pole unit operating shaft, Item 3, Fig. 9a, and anti-close interlock screw to soften anerobic adhesive holding screw in place.

5. Remove screw and clean.

6. Charge spring, close breaker, recharge spring.

7. Apply fresh anerobic adhesive to screw and put back in shaft.

8. Run screw down till it bears on the closing latch.

9. Slowly run screw down farther to obtain the required 0.010 to 0.030 inches clearance between the roller and closing trigger. See Item 13, Fig. 9a.

10. Trip breaker, close breaker, trip breaker.

11. Reassemble breaker.

5.4 LATCH CHECK SWITCH ADJUSTMENT

If the spring release coil circuit cannot be completed even though the mechanism is reset, or if the circuit can be completed even though the mechanism is not reset, the latch check switch may be out of adjustment.

Refer to Item 20, Fig. 2. The latch check switch is a snap action switch which makes contact when the tripping trigger is in the fully reset position ready for the breaker to close. Where the tripping trigger is not reset, the latch check switch is open. As used in the control scheme, the latch check switch will not allow the spring release coil circuit to be completed until the tripping trigger has reset.

The switch operating arm is of tough steel and is subject to only very light forces. It is set at the factory and should remain in adjustment unless tampered with. It is adjustable by bending the arm slightly. Correct adjustment is for the switch to make contact when the tripping trigger is 1/8 to 3/16 from its completely reset position measured at the center of the trip plunger stem.

5.5 FLOOR TRIPPER ADJUSTMENT

If the breaker with closing spring charged does not automatically discharge the spring as it is either being inserted into or withdrawn from the TEST position, the spring release lever is out of adjustment.

If the closed breaker does not automatically trip as it is either being inserted into or withdrawn from the **TEST** position, the tripping lever is out of adjustment.

The floor trippers Fig. 31, are set at the factory and unless the breaker is rolled over an obstruction on the floor that bends the actuators, they should not require adjusting.

If, either should require readjusting, a checking tool similar to that shown in Fig. 32 should be made and the following procedure followed.

1. Set the breaker on a smooth flat surface preferably off the floor at a convenient height. Remove barrier before the breaker is lifted off the floor.

2. Manually charge the closing spring.

3. Slide adjusting tool under spring release lever, Fig. 31 and slowly push forward until lever end is resting on 1/2 inch high surface. Breaker should not close.

4. Continue sliding tool forward until lever end is resting on 5/8 inch high surface. Breaker should close.

5. If breaker closes on 1/2 inch high surface or does not close on 5/8 inch high surface, reposition spring-release, trigger cam, Item 3, Fig. 33, by loosening the set screw, Item 5, Fig. 33, and moving the cam up or down as required.

6. Be sure to tighten set screw after adjusting.

7. Slide tool under breaker tripping lever, Fig. 31 and proceed as in 3, 4, 5, and 6 above to reset the breaker tripping lever.

8. Breaker should neither close nor trip when 1/2 inch high surface is under the lever ends.

9. Breaker must close or trip when 5/8 inch high surface is under the bar.

10. Be sure closing spring is discharged and breaker is tripped open after completing adjustments.

11. Set breaker back on floor and remount barriers.

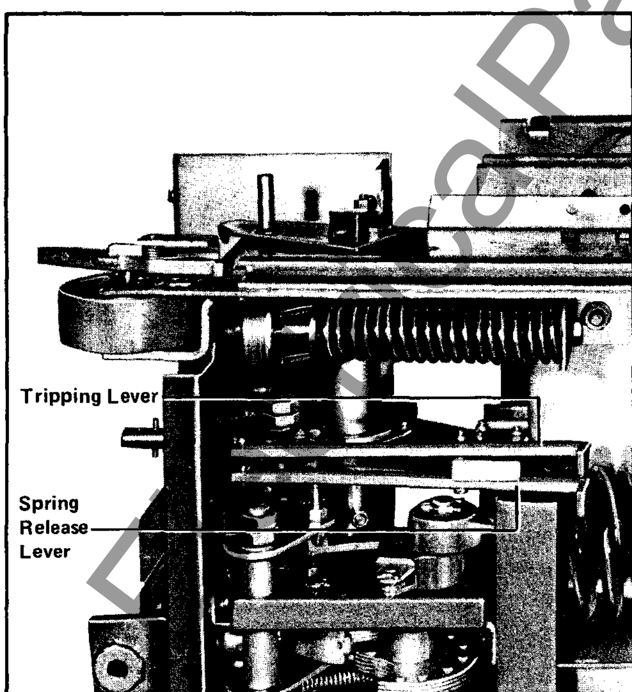


Fig. 31 *Floor Tripping and Closing Spring Release Levers (Floor Trippers) – DVP Breaker Bottom View (396702)*

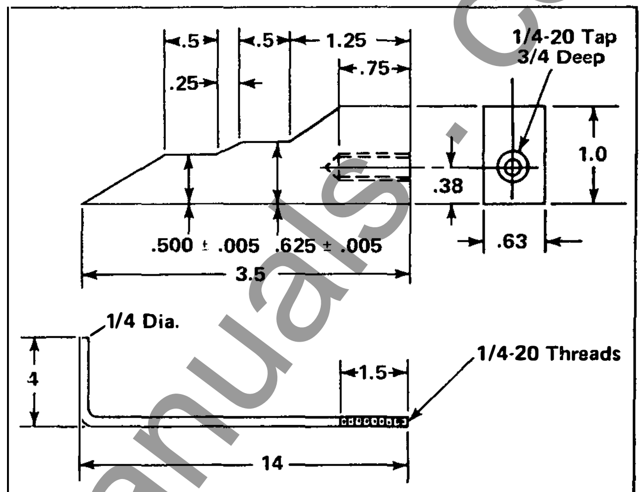
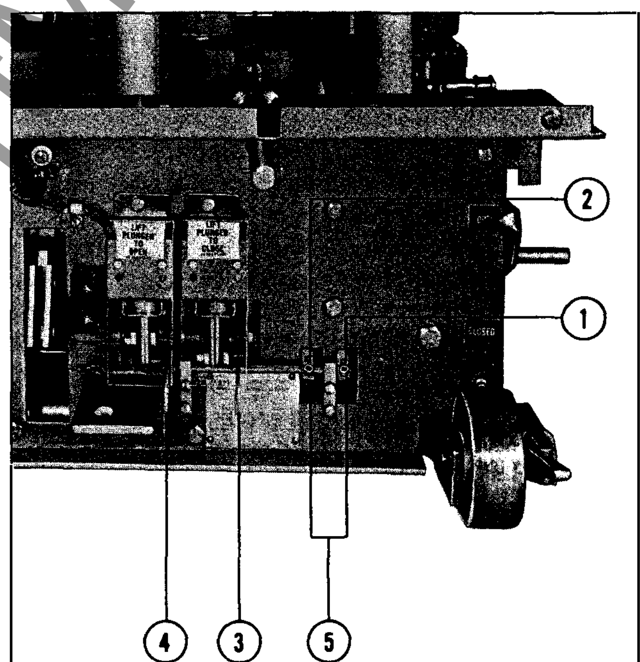


Fig. 32 *Floor Tripper Adjusting Tool*



1. Tripping Leakage
2. Closing Linkage
3. Spring Release Trigger Cam
4. Tripping Trigger Cam
5. Set Screws

Fig. 33 *Floor Tripper Adjustments – DVP Breaker (396703)*

Section 6 — Maintenance

This class of power circuit breaker is a protective device to prevent damage to more expensive apparatus and to maintain continuity of electric power service. To maintain greatest reliability the breaker should be inspected and given all indicated maintenance on a regular schedule. The Type DVP circuit breakers are designed to comply with standards performing switching operations based on maximum of 2000 operations or once a year whichever comes first.

Actual inspection and maintenance will depend upon individual application conditions. Some atmospheric conditions such as extremes of dust and moisture or corrosive gases might indicate inspection and maintenance at more frequent intervals than 2000 operations. Very clean and dry conditions combined with low switching duty will justify longer times between inspection and maintenance operations. With experience, each user can set an inspection and maintenance schedule which is most economical for the particular case.

These breakers are adjusted, inspected and tested at the factory in line with high standards of quality control and reliability. They should not require readjustments before placing in service. Do not change any adjustments, assemblies or parts unless there has been an obvious damage or incorrect adjustment. For instance, handling and transportation conditions could cause loss of adjustment or damage.

Therefore, some inspection should be done on the breaker immediately after receiving the breaker.

6.1 INSPECTION/MAINTENANCE PROGRAMS

In order to obtain the most effective use of this type of maintenance instructions, it is important for the user to establish an inspection program that will permit him to routinely examine each circuit breaker after regularly scheduled intervals of operation as well as at discrete times when conditions requiring particular maintenance procedures may be observed. Various suggestions are noted below to be used in setting up suitable inspection/maintenance programs.

6.2 INSPECTION/MAINTENANCE RECORDS

As a part of an ongoing inspection/maintenance program some form of recordkeeping is suggested. Records may consist of a simple diary whose primary purpose is to document that an established inspection/maintenance schedule is actually being followed. However, more completely detailed records will facilitate evaluation of a breaker's condition or its changing condition. Such records may include formal check lists, detailed descriptions of conditions found, notes on operating duty, tests performed, maintenance procedures undertaken, etc. Whether simple records or more complete records are kept is for the user to decide. Records can be very helpful in determining both the types and extent of maintenance which may be required and in determining whether inspections should be scheduled more or less frequently.

6.3 INSPECTION SCHEDULES

The schedule for routinely inspecting circuit breakers will depend on three inter-related factors.

1. Time since the last inspection.
2. Number of load switching operations since the last inspection.
3. Number of short circuit switching operations since the last inspection.

Whichever of these three factors comes up first is the factor which determines when an inspection should be made.

The routine inspection interval should be based either on Time or on the Number of Anticipated Load Current Switching Operations whichever comes first. Superimposed on this routine inspection schedule is the requirement that the breaker must be inspected after an accumulation of a number of short current switching operations if this occurs before the Time or Load Switching Operations interval is completed.

6.3.1 Routine Inspection Interval Based on Time

An initial inspection at the end of the first year in service is suggested because it provides an opportunity to evaluate conditions at an early point in the life of a circuit breaker. Based on conditions found, realistic decisions can be made concerning the length of time for succeeding inspection intervals. **However, the interval must not exceed one year.**

6.3.2 Routine Inspection Interval Based on Load Switching

The maximum number of load switching operations between scheduled inspections should not exceed the "Maximum Number of Operations Between Servicing" as shown in Table 4.

Table 4. Operations – Continuous Current Rating Basis

Circuit Breaker Type	Continuous Current Rating Amperes	Number of Operations: Max. No. Operations Between Servicing	No Load Mechanical Duty	Fault Operation: Full Load	Fault Operation: Inrush	Nonfault Duty: Full Load	Nonfault Duty: Inrush
All DVP Vacuum Breakers	1200	2000	10,000	1000	750	5000	3000
	2000	2000	10,000	1000	750	3000	2000

The table lists recommended numbers of load switching operations. The different columns apply depending on whether the load switching duty includes inrush currents or not and whether it includes fault current switching or not.

6.3.3 Inspection Interval Based on Short Circuit Switching

Since the short circuit switching requirements for circuit breakers may vary widely from one installation to another, both in the number of short circuits which are switched and in the magnitude of the short circuit current to be interrupted, it is necessary to establish practical guidelines on which to determine how frequently a circuit breaker requires inspection to be certain that necessary maintenance is performed to keep the breaker in good operating condition.

Circuit breakers described in this instruction book have been required to demonstrate that each rating can endure an accumulation of short circuit interruptions totaling at least 400% of its respective maximum rated short circuit interrupting capability without maintenance being performed. By relating the actual short circuit interruptions performed by a circuit breaker in the field to the capability demonstrated in design tests, a practical basis for scheduling inspections and maintenance can be established. A key term which will be used here is the "most likely" short circuit which can occur. While recognizing that a circuit breaker is applied on the basis that it has the capability of interrupting the largest short circuit which can occur at its location in an electrical system, experience indicates that the probability is quite small that the largest possible fault will occur during the operating life of any given circuit breaker. Experience also shows that many circuit breakers are applied where lower level short circuits will probably occur during the life of the circuit breaker with some degree of regularity or predictability. By selecting inspection/maintenance intervals which are related to the possible occurrence of "most likely" short circuits and allowing for the contingency that a maximum system short circuit can occur at any time during the interval, a practical inspection/maintenance guide can be established.

The following chart lists the level of the "most likely" fault as a percentage "P" of the maximum short circuit interrupting rating of the breaker. Each percentage "P" is coupled with an interval number "N" which is a suggested number of "most likely" short circuit interruptions which the circuit breaker may be permitted to accumulate within an established maintenance interval before it is removed from service for inspection and possible maintenance.

Table 5. Suggested Inspection/Maintenance Interval

"Most Likely" Short Circuit (P)	Accumulated Short Circuit Interruptions (N)
Greater than 50%*	1*
50%	2
40%	3
35%	4
28.5%	6
24.5%	8
20% and less	12

NOTE:* **For a short circuit interruption at P greater than 50%, it is strongly recommended that inspection of the circuit breaker always be made immediately after a single interruption.

During the inspection following the accumulation of "N" interruptions, attention should be directed to the measurement of contact wear gaps. See Item 3.3. Insulating members as well as general physical and mechanical condition should also be checked. (Refer to appropriate maintenance instructions in this instruction book for guidance.) Several operations using control power are also advisable for checking mechanism operation. Whether maintenance is required or not, or whether maintenance procedures can be delayed until the next scheduled routine inspection/maintenance date, is a decision which must be made in each case on the basis of the conditions found and operating experience.

When a circuit breaker has accumulated 'a total of "N" ' short circuit interruptions or less at percentage "**P**" in any inspection interval, and after the circuit breaker has been inspected and maintained when necessary, the circuit breaker may be returned to service to begin a new inspection interval and a new accumulation of "N" "most likely" short circuit interruptions. Care should be exercised to keep the selected "**P**" and "N" characteristic for each circuit breaker up-to-date with system growth.

The maintenance interval chart is a suggested guide which has been developed on the basis of the demonstrated endurance capability of the circuit breakers. The number of operations given in the chart was conservatively chosen to reduce the level of periodic maintenance and to give a longer life before major maintenance is required.

6.3.4 Service Conditions

The time or number of operations indicated above are based on the usual service conditions of ambient temperatures in the range from plus 40°C to minus 30°C, altitudes below 3300 feet (1000 meters), and relatively clean and dry conditions.

Unusual service conditions such as exposure to damaging fumes and vapors, excessive or abrasive dust, explosive mixtures of dust or gases, steam, salt spray, and excessive moisture will usually reduce the time or number of switching operations between scheduled inspections. When unusual conditions prevail, this information may be referred to the nearest Westinghouse Sales Office for special inspection/maintenance recommendations.

The foregoing three inspection schedules cannot be discretely applied. Depending on the particular application, one of the three operating conditions will predominate. Whichever cycle is completed first, time in service, number of load current switching operations, or short circuit switching operations, will determine the completion of an inspection/maintenance interval. It will be necessary to remove the breaker from service for inspection and necessary maintenance as soon as practical.

6.3.5 Total Breaker Life

While operating duties are important considerations in establishing an inspection/maintenance program, it is equally important to consider factors which relate to the total life of a circuit breaker. Although it is usual to think in terms of years in service, breaker life in terms of total accumulated operations is a more definitive parameter. A breaker which has passed the mid-point of its operational life may reasonably require more frequent inspection and different levels of maintenance than a newer breaker.

As illustrated by the chart "Operations – Continuous Current Rating Basis", a breaker will have a longer mechanical life span than an electrical life span. Time allowed for maintenance may have to be extended to permit part replacements and more extensive maintenance procedures during later life. An inspection/maintenance program will take these life factors into account. Where the selection of an initial inspection interval is often arbitrarily and conservatively established primarily due to a lack of operating experience, later life inspection/maintenance scheduling can be more realistically determined based on the experience which has accumulated. It is at this point where the advantages of well kept inspection/maintenance records will become manifest.

6.3.6 Changing Duty Considerations

A further consideration in an on-going inspection/maintenance program can be generally categorized as "changing duty". For some applications changes may occur to increase breaker load current. For other applications changes may include more frequent switching or exposure to more short circuit switching operations. Dirt and dust may accumulate faster or may change in content. Damaging fumes or vapors may become more significant in their effects on breaker condition. The effect of these and other similar types of changes can be detected in an on-going inspection program and inspection/maintenance schedules originally developed may have to be modified from time to time as a result.

6.4 INSPECTION/MAINTENANCE PROGRAM REVIEWS

In order to keep an ongoing inspection/maintenance program up to date so that it reflects the experience accumulated, it is suggested that such programs be reviewed on a periodic basis through the life of the circuit breaker. The first review should be made following the initial inspection after a breaker is placed in service. Subsequent reviews will depend on the type of application. For breakers which accumulate operations slowly (100 or less per year), subsequent reviews are suggested at seven to ten year intervals. For breakers which accumulate operations more rapidly, reviews are suggested after approximately 25%, 50%, 75% and 100% of the number of operations shown in the chart "Operations – Continuous Current Rating Basis" under "No Load Mechanical Duty", have been accumulated.

6.5 ROUTINE INSPECTION

The maximum time between routine inspections as dictated by either time in service, load current switching operations, or short circuit switching should not be exceeded. Maintenance should include removal of the circuit breaker from its switchgear housing, an inspection to determine the condition of the circuit breaker, and cleaning to remove dust, dirt or other contaminants. Servicing may also include exercising operations of the circuit breaker, testing, adjusting, lubrication, tightening and other maintenance procedures as recommended in this instruction book.

6.5.1 Checking Contact Wear Gap

Check wear gap in accordance with procedure outlined in Item 3.3.

6.5.2 Mechanical Operation

Mechanically the circuit breaker should be quick, snappy and positive in operation. There should be no signs of sluggishness or hesitation. Should there be sluggishness indicated during an inspection, remove the barrier, and operate the circuit breaker slowly with the maintenance operating handle in order to identify the source of difficulty. Refer to the section on Maintenance Procedures for corrective actions to be taken. After maintenance has been performed, a few exercising operations using control power are advisable. Any excess lubricant should be wiped off to prevent the accumulation of dust and dirt on and near moving parts.

6.6 MAINTENANCE PROCEDURES

Following are recommendations for the maintenance of particular breaker components. These include vacuum interrupter assemblies, mechanisms, insulation and lubrication.

6.6.1 Vacuum Interrupter Assembly Inspection and Maintenance

Check the vacuum integrity of the interrupters every year, or more frequently when dictated by the accumulated switching frequencies shown in Table 5.

The procedure outlined in Item 3.2 should be used to check the vacuum integrity. It is unlikely to find that the vacuum integrity has been impaired. However, if it is impaired, the vacuum interrupter assembly should be replaced according to procedure in Item 6.7.1.

Check the wear gap according to procedure in Item 3.3. If the wear gap is less than .06", the vacuum interrupter must be replaced.

6.6.2 Mechanical Timing

The mechanical operating speed of the breaker should be satisfactory as received. The breakers are checked at the factory for contact speed and contact bounce. These values do not change appreciably during the mechanical life of the breaker and are not considered as part of the regular inspection and maintenance program.

The timing for contact part and close may be checked by monitoring control circuit current, and using no more than 6 volts DC and one ampere through the vacuum interrupter contacts to indicate closed or open condition.

Typical time ranges for nominal control voltages are:

a) Trip coil signal initiation to contact part: 24-34 milliseconds.

b) Close coil signal initiation to contact close: 40-65 milliseconds.

The speed of the vacuum interrupter contacts can be checked by using a potentiometer and an oscilloscope. The potentiometer must have 2 inches of linear travel. It is fastened between the frame of the breaker and the operating rod. The speed is then checked with an oscilloscope. The speeds should be in the following range: 2.5 ft/sec. to 3.5 ft/sec. closing, 5.0 ft/sec. to 7.5 ft/sec. opening.

6.6.3 Mechanism

Close the breaker by spring power and open by normal tripping action. Try charging the closing spring electrically and also by hand. In either case, at the completion of the charging operation there should be an audible "click" as the crank arm goes over center. With electrical charging, the motor should automatically cut off at the sound of the click. With hand charging, the handle will tend to run free as the click is heard.

In these operations, closing and opening should be snappy, without hesitation or sluggishness.

In addition to the above operational check, the following points should be checked:

1. With the breaker open and the closing spring charged, check for clearance between the tripping trigger and tripping latch roller. Refer to Fig. 10b. The trigger should not touch the roller. If adjustment is necessary see section on Adjustments.

2. With breaker closed and closing spring charged, check for clearance between the closing trigger and the closing latch roller. Refer to Fig. 9a. If adjustment is necessary see section on Adjustments.

3. Lubricate the mechanism sparingly as described under Lubrication.

6.6.4 Insulation

Insulation maintenance consists primarily of keeping the insulating surfaces clean. This can be done by wiping off the insulation each time the breaker is removed from the cell.

In case there is any tightly adhering dirt that will not come off by wiping, it can be removed with a mild solvent or water. Be sure to dry the insulation completely after this type of cleaning.

6.6.4.1 Cleaning Procedure for Porcelain Insulation

If the porcelain insulation or the ceramic surface of the vacuum interrupter requires cleaning, it is suggested that the surface to be cleaned be wiped with a dry lint free cloth or a dry paper towel. This surface can be washed with distilled water but be sure that the surface is completely dry before placing the breaker in service. If a solvent is required to cut the dirt, use Stoddards solvent Westinghouse 55812CA or commercial equivalent. Be sure the surface is completely dry before placing the breaker in service. Do not use any type of detergent to wash the surface of a porcelain insulator as detergents leave an electrical conducting residue as they dry.

6.6.5 LUBRICATION

6.6.5.1 Mechanism

The most reliable performance on the stored energy mechanism can be obtained by lubrication. All parts which require it are lubricated with a molybdenum disulphide grease, Westinghouse M. No. 53701 QB, when assembled. Some items should be lubricated at regular maintenance intervals. Other parts normally should require lubrication only after long periods of time. Otherwise, it should be done at any time the breaker is slow or sluggish in opening or closing or where bearings may be clogged with dirt.

After each interval of 2000 Operations, the following items should be lubricated with light machine oil applied sparingly:

1. Front and rear tripping latch rollers and pivot pin.
2. Tripping trigger pivot pin.
3. Spring release latch roller and pivot pin.
4. Spring release trigger and pivot pin.
5. Tripping cam pivot pin and restraining link pin.

6.6.5.2 Roller Bearings

On the stored energy mechanisms there are roller bearings on the main shaft, crank shaft, connecting rod, and closing cam follower.

These bearings are packed at the factory with a top grade slow oxidizing grease which normally should be effective for many years. They should not be disturbed unless there is definite evidence of sluggishness or dirt, or unless the parts are dismantled for some reason.

If it is necessary to disassemble the mechanism, the bearings and related parts should be thoroughly cleaned of old grease in a good grease solvent. **DO NOT USE CARBON TETRACHLORIDE.** They should then be washed in light machine oil until the cleaner is removed. After the oil has drained off they should be packed with grease, Westinghouse No. 53701QB.

6.6.5.3 Secondary Contacts

Use only a very light coating of petrolatum.

6.6.5.4 Drawout Disconnect Contact Fingers

Use only a very light coating of petrolatum.

6.7 REPAIR AND REPLACEMENT

6.7.1 Vacuum Interrupter Assembly Replacement

The following procedure should be used to replace a vacuum bottle and set the wear gaps. See Figs. 11 and 26.

1. Take breaker out of the cell.

2. Tilt back the barrier.

3. Remove "X" washers from operating rod pin at the top of operating rod.

4. Using maintenance handle, slowly close breaker until the wear gap starts to appear. At the point just before the gap starts to appear, the pin should be easily removed from the operating rod.

5. Remove the two nuts holding the bottom conductors to the insulators. Remove the upper nut on the front insulator stud.

6. Lift off the interrupter assembly.

7. Mount the new interrupter assembly by following the replacement procedure in reverse order.

At this point wear gaps may be set if necessary as follows:

8. Loosen the bottom nut on the bottom of the operating rod. After the nut is loose, turn the nut down an additional 1/2 inch.

9. Attach the operating rod to the vacuum interrupter with the pin and new "X" washers. The breaker can be partially closed with the maintenance handle so that the operating rod will reach the vacuum bottle to allow the pin to be inserted.

10. Slowly close the breaker with the maintenance handle while watching the wear gap. If the gap gets larger than .38″ before the breaker latches close, do not continue closing with the handle, but reopen breaker and spin the upper nut on the end of the operating rod upward thereby shortening the operating rod. If no gap appears at all when the breaker is closed, the operating rods are too short and the upper nut should be turned down. Again slowly close the breaker with the maintenance handle until a gap of .31″ appears when the breaker is closed. Then tighten the lower nut on the bottom of the operating rod. (See Fig. 13.) This results in a wear gap of about .25″ when the locking washers are compressed. The lower nut should be very tight. The upper nut is not tightened.

6.7.2 Removal and Installation of Spring Charging Motor

The spring charging motor can be expected to last under normal conditions for the life of the breaker without requiring removal or replacement. However, if it does become necessary to remove the spring charging motor proceed as follows:

1. Discharge all springs.

2. Tilt back barrier and remove its support pan.

3. Place breaker on bench at convenient working height.

4. Disconnect motor leads.

5. Remove four nuts holding motor assembly to mechanism. **DO NOT REMOVE THE BOLTS FROM THE MECHANISM BACK PLATE.**

6. Remove motor assembly.

7. Remove motor crank, Fig. 39, by striking sharp blow with soft mallet. Threads are right hand.

8. Remove motor from mounting bracket.

9. Install new motor in reverse order. **BE SURE MOTOR CRANK ROLLER IS UNDER DRIVING PLATE,** Item 11, Fig. 9a.

6.7.3 Removal and Installation of Closing Spring

Under normal conditions it should not be necessary to change the closing spring during the useful life of the mechanism. If the spring does have to be changed, a Closing Spring Removal Tool 592C864G01 is available from Westinghouse.

To change the closing spring, refer to Figs. 34 and 35 and proceed as follows:

1. Close and trip breaker manually to be sure all springs are discharged.

2. Remove barrier.

3. Assemble nut, thrust bearing, thrust washer, collar and tube on stud. Items 9, 8, 7, 6, 5 and 10, Fig. 35.

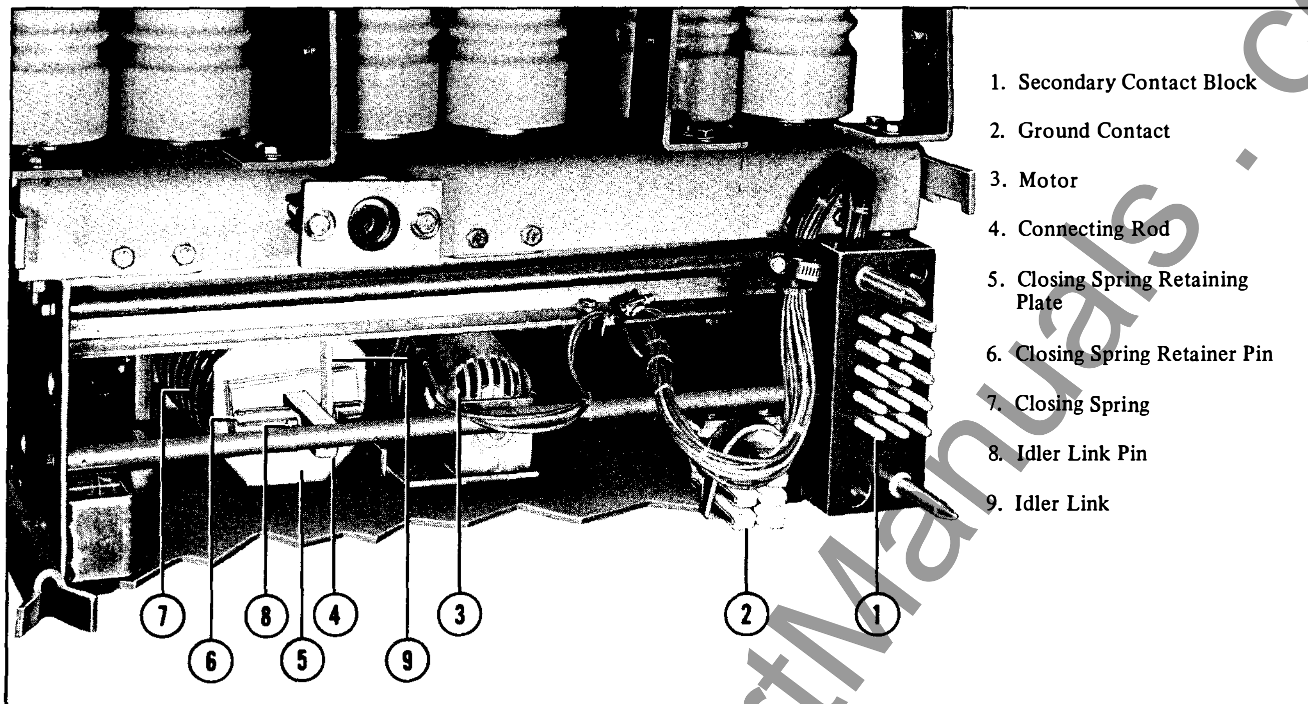


Fig. 34 *DVP Breaker Chassis: Rear View (396668)*

4. Screw stud, Item 10, into end of connecting rod, Item 1, as far as it will go, Fig. 35.

5. Hold stud firmly and remove idler link and pin. Items 8 and 9, Fig. 34.

NOTE: **SPRING WILL MOVE EITHER UP OR DOWN WHEN IDLER LINK IS REMOVED.**

6. Position the tube, Item 5, so that the slots straddle pin 4 thru the connecting rod 1, Fig. 35.

7. Tighten nut 9 so that spring retainer 2 is moved away from pin 4, Fig. 35.

8. Drive pin 4 out of hole in connecting rod 1, Fig. 35.

9. Hold end of stud 10 with a wrench to keep it from turning and unscrew nut 9 until closing spring 3 is completely free of tension, Fig. 35. Travel will be from 5 to 6.5 inches depending on breaker rating.

10. Remove tool and spring.

11. Reassemble in reverse order.

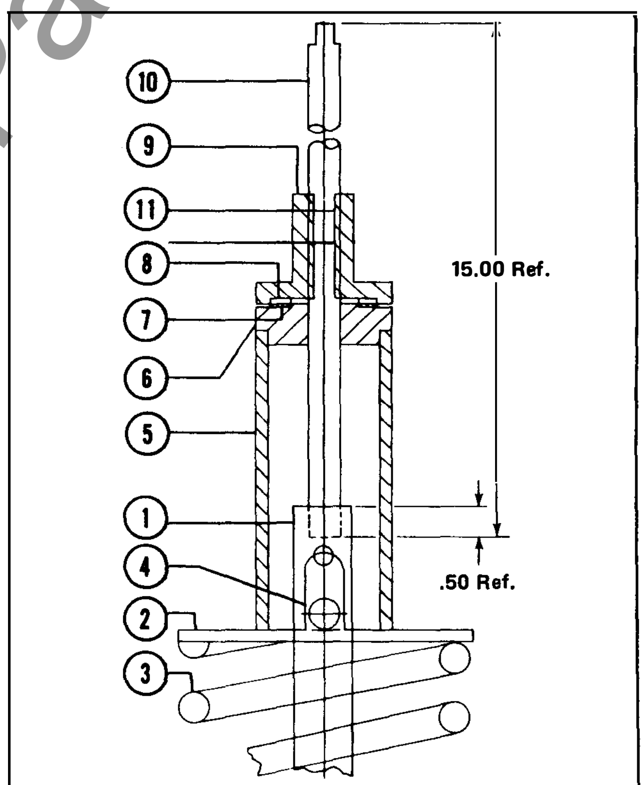


Fig. 35 *Closing Spring Removal Tool*

Section 7 — Renewal Parts

7.1 PARTS IDENTIFICATION

Individual parts and subassemblies for the circuit breakers are marked in the various figures. Refer to list of illustrations for a figure that may show a part in question for a particular type or rating of circuit breaker.

Renewal Parts Data, listing by name and style number the recommended renewal parts to be kept in stock, are supplied separate from this book. When ordering parts, always specify the part name and style number, if known, from the Renewal Parts Data. If the style number is not known, refer to the Figure number, name and item number as shown in this book, along with the breaker type and shop order number or style number as shown on the nameplate on the front cover of the circuit breaker.

Some of the detail parts shown in the figures in this book will be available only as part of a sub-assembly. The detail parts in the figures are illustrated to show their function and location in the assembly; but certain parts, due to installation procedures, are recommended and furnished as part of a sub-assembly. The renewal parts data indicates which parts are available as individual items or in a sub-assembly. When inquiring about or ordering parts, refer to the figures in this book and the renewal parts data for identification of the part or sub-assembly in question.

7.2 RECOMMENDED SPARE PARTS LISTS

An adequate stock of spare parts will help minimize emergency situations and can substantially reduce production down time.

The amount of investment to be made in spare parts stock can be dependent on a number of individual factors. The items recommended and the quantities specified on page 40 are intended as a guide.

NOTE

For one to five circuit breakers, order parts identified #.

For six to ten circuit breakers, order double quantity identified #, plus required number of all other parts recommended.

7.3 ORDERING INFORMATION

1. Name item and give its style number. Specify quantity desired.

2. State method of shipment desired.

3. Send all orders or correspondence to nearest Westinghouse Sales Office.

Spare Parts for Pole Units	#Number Required	Reference Figure
1. 150 DVP 500-1200A	1	11
2. 150 DVP 500-2000A	1	11
3. 150 DVP 750-1200A	1	11
4. 150 DVP 750-2000A	1	11
5. Primary Disconnect - 1200A	2	15
6. Primary Disconnect - 2000A	2	15

Breaker Chassis Parts	#Number Required	Reference Figure
1. Auxiliary switch, upper	1	2
2. Auxiliary switch, lower	1	2
3. Latch check switch	1	2
4. Motor cut-off switch	1	2
5. Control relay, "Y" (specify voltage)	1	2
6. Trip coil 48 v.d.c. 125 v.d.c. 250 v.d.c. Capacitor	1	2
7. Spring release coil 48 v.d.c. 125 v.d.c. 250 v.d.c. 115 v.a.c., 60 Hz 230 v.a.c., 60 Hz	1	2
8. Spring charging motor 48 v.d.c. 125 v.a.c. or d.c. 230 v.a.c. or d.c.	1	8
9. Ground contact cluster	1	8
10. Resistor assembly Specify "Y" relay voltage	1	2
11. Fastener Kit	1	Style 8065A 19GO1

Section 7 — Renewal Parts

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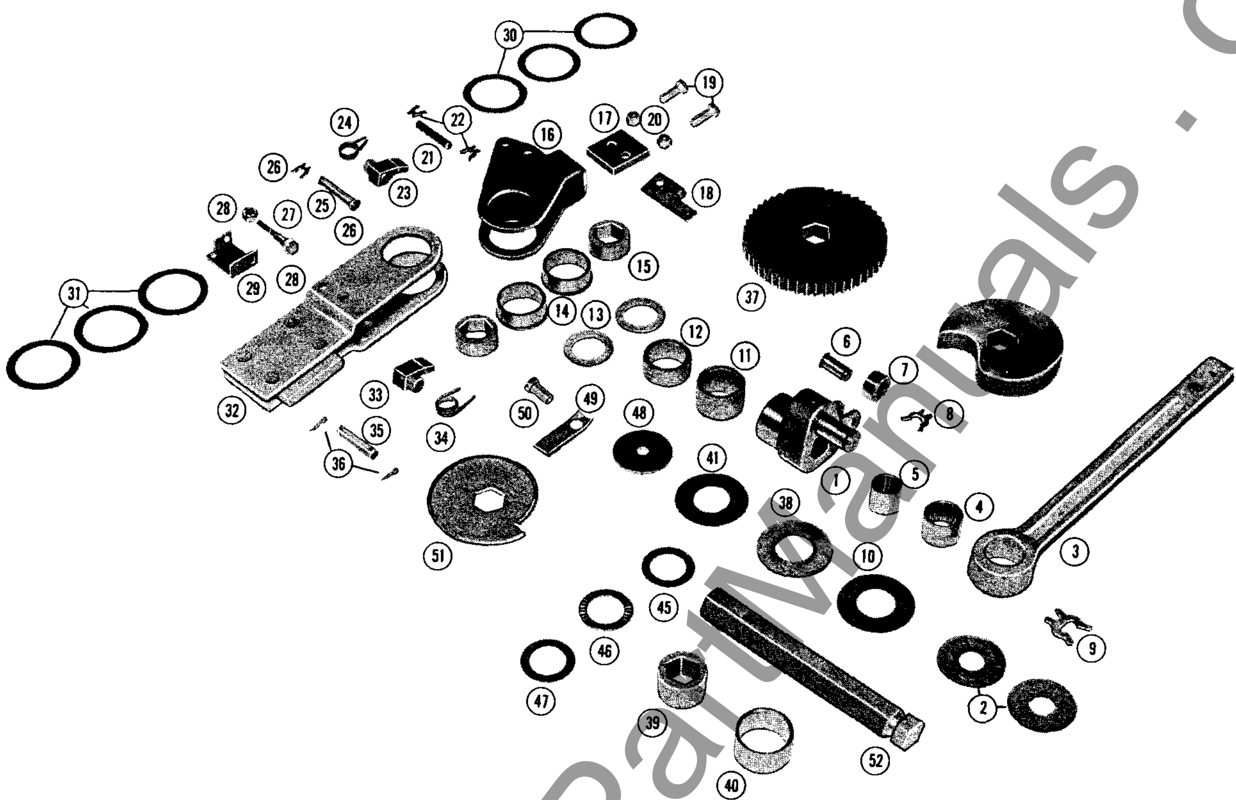
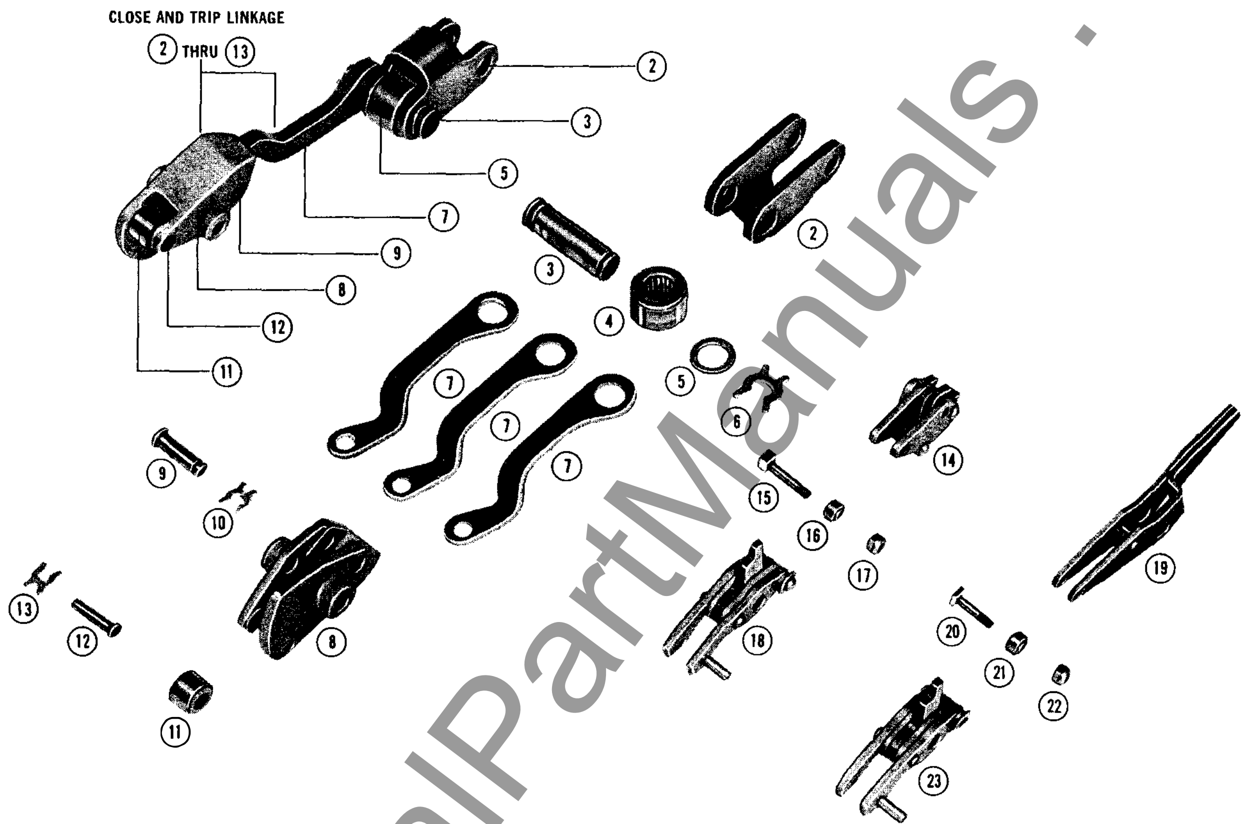


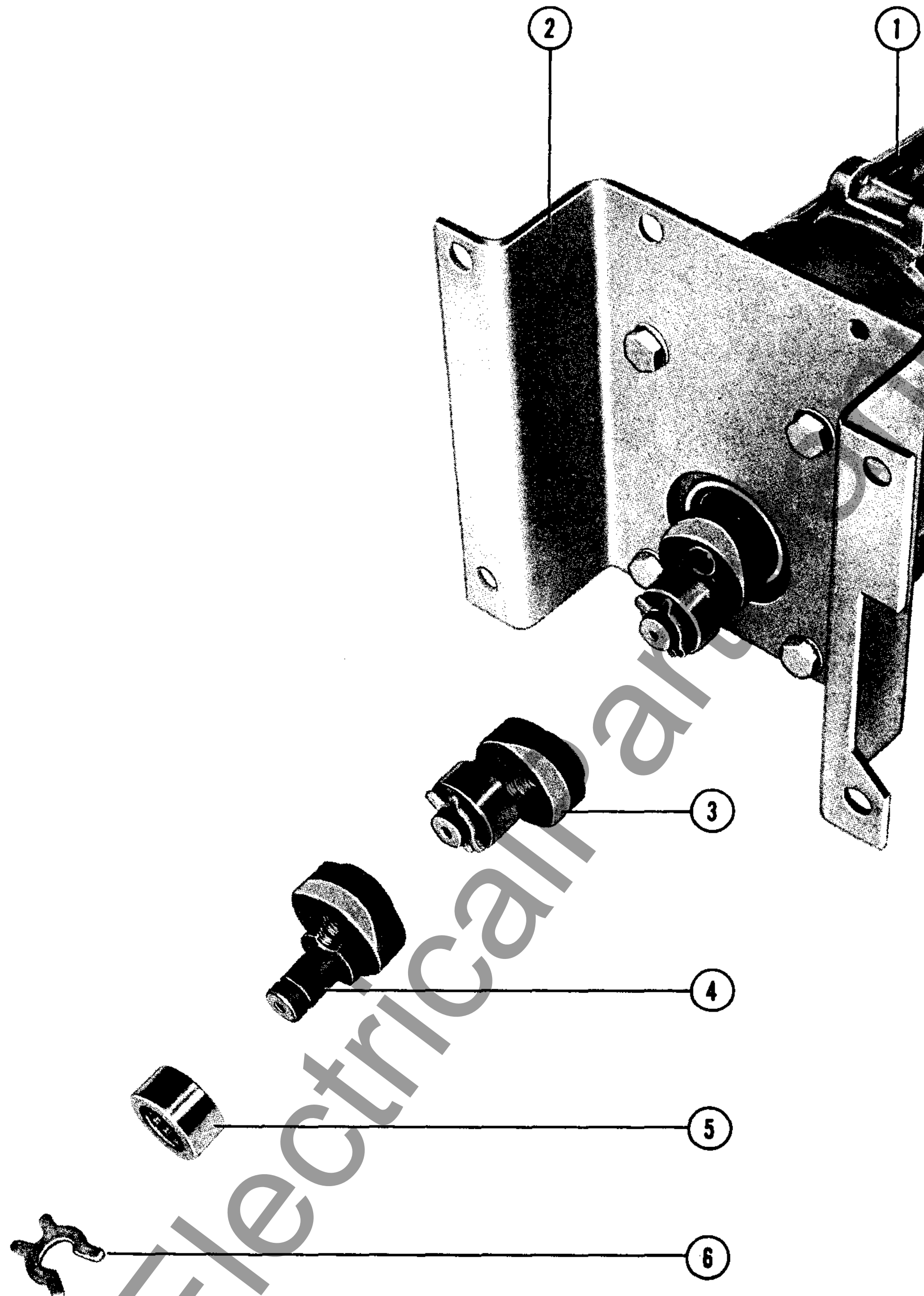
1. Main Crank
2. Wide Washer for Item 1
3. Connecting Rod
4. Connecting Rod Bearing
5. Connecting Rod Bearing Inner Race
6. Closing Stop Roller Pin
7. Closing Stop Roller
8. X-Washer for Item 6
9. X-Washer for Item 1
10. Hardened Washer
11. Spacer
12. Closing Cam
13. Spacer Washers
14. Ratchet Lever Bearings
15. Ratchet Lever Bearing Insert
16. Motor Ratchet Lever
17. Driver Plate
19. Driver Plate Mounting Bolts
20. Nuts for Item 19
21. Driving Pawl Stop Pin
22. X-Washers for Item 21
23. Driving Pawl
24. Driving Pawl Spring
25. Driving Pawl Pivot Pin with Head
26. X-Washers for Item 25
27. Holding Pawl Stop Pin
28. Elastic Stop Nut
29. Manual Ratchet Lever Spring Retainer
30. Spacer Washers
31. Spacer Washers
32. Manual Ratchet Lever
33. Holding Pawl
34. Holding Pawl Spring
35. Holding Pawl Pivot Pin
36. Cotter Pins
37. Ratchet Wheel
38. Washer
39. Crank Shaft Bearing Insert
40. Crank Shaft Bearing Inner Race
41. Hardened Washer
45. Thrust Bearing Race - 13.8 KV
46. Thrust Bearing - 13.8 KV
47. Thrust Bearing - 13.8 KV
48. End Washer
49. Locking Clip
50. Limit Switch Cam Retainer Bolt
51. Limit Switch Cam
52. Crank Shaft

Fig. 36c. *Stored Energy Mechanism – DVP Breaker: Parts for Crankshaft Subassembly (381962)*



1 Close and Trip Linkage Subassembly
2 Main Closing Link
3 Closing Cam Follower Roller Pin
4 Closing Cam Follower Roller
5 Spacer Washer for Item 3
6 X-Washer for Item 3
7 Tripping Cam Connecting Link
8 Tripping Cam
9 Connecting Link Pin
10 X-Washer for Item 9
11 Tripping Cam Roller
12 Tripping Cam Roller Pin
13 X-Washer for Item 12
14 Tripping Latch
15 Tripping Latch Roller Pin
16 Tripping Latch Roller
17 Nut for Item 15
18 Tripping Trigger
19 Closing Latch
20 Closing Latch Roller Pin
21 Closing Latch Roller
22 Nut for Item 20
23 Closing Trigger

Fig. 37 *Stored Energy Mechanism – DVP Breaker: Parts for Close and Trip Linkage Subassembly (381961)*



1 Motor
2 Motor Mounting Bracket
3 Crank Assembly Complete
4 Crank
5 Roller
6 X-Washer

Fig. 39 *Spring Charging Motor Assembly – DVP Breaker (393903)*

Memorandum

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