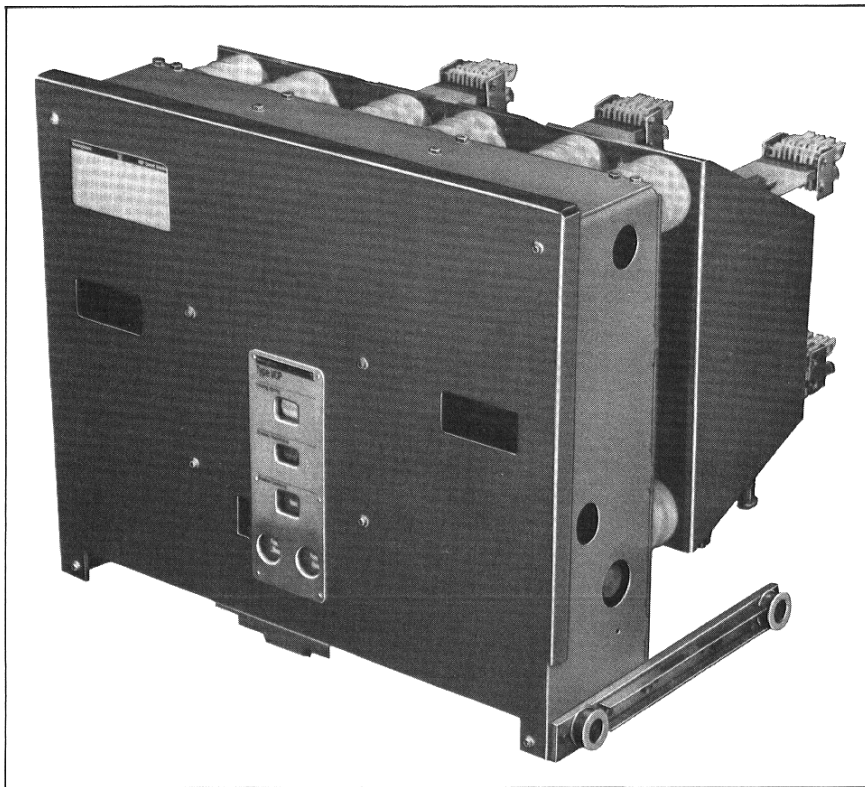


Instructions for Type VCP Vacuum Circuit Breakers



**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
I.B. 32-254-1A Effective December, 1983
Supersedes I.B. 32-254-1 dated July, 1982

CAUTION

The circuit breakers described in this book were designed and tested to operate within their nameplate ratings. Operation outside of these ratings may cause the equipment to fail, resulting in bodily injury and property damage.

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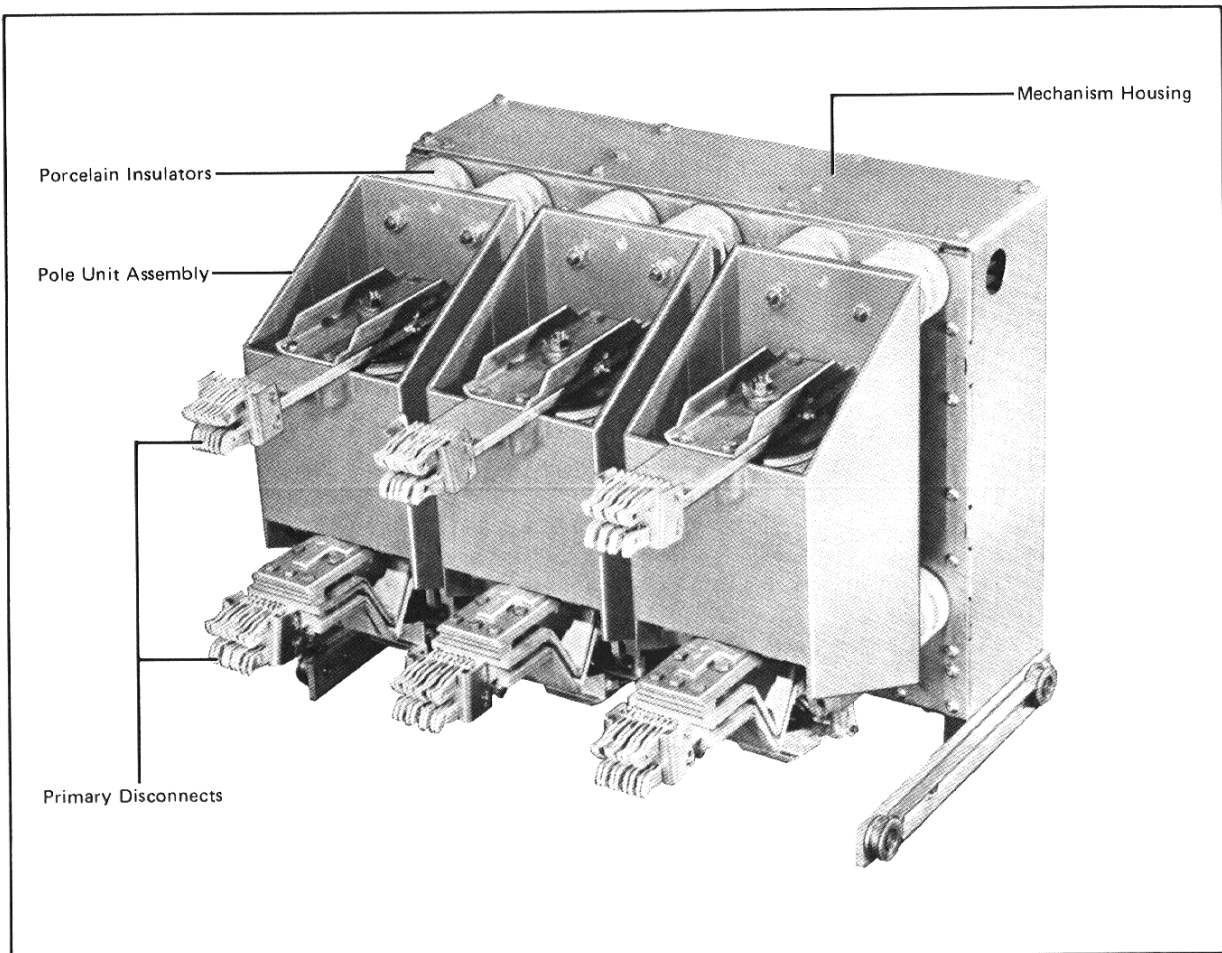
SECTION 1 – INTRODUCTION

The purpose of this book is to provide instructions on installation, operation and maintenance of Type VCP Vacuum Circuit Breakers.

Type VCP Circuit Breakers are the horizontal draw-out type interrupting elements for use in VAC-CLAD[™] Switchgear. Like ratings are interchangeable with each other. These breakers provide reliable control and protection for medium voltage electrical equipment and circuits.

These breakers meet applicable ANSI, IEEE and NEMA Standards. They are available with continuous current ratings of 1200, 2000 and 3000 amps for the nominal voltages of 4.16, 7.2 and 13.8 kV. Note that there are maximum rated devices and should be applied only in accordance with their nameplate ratings. Follow Application Data 32-264 for proper application recommendations.

Satisfactory performance of these breakers is contingent upon proper application, correct installation and adequate maintenance. The following instructions will provide information for installation and maintenance for satisfactory operation.



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 Westinghouse Electric Corporation representative should be contacted.

SECTION 2 – RECOMMENDED SAFE PRACTICES

SAFE PRACTICES

Type VCP Breakers are equipped with high speed, high energy operating mechanisms. They are designed with several built-in interlocks and safety features to provide safe and proper operating sequences. However, to ensure safety of personnel associated with installation, operation and maintenance of these breakers, the following recommendations should be considered:

- Only qualified personnel who are familiar with installation, operation and maintenance of power circuit breakers and hazards involved should be permitted to work on these breakers.
- **DO NOT** work on an energized breaker.
- **DO NOT** work on a breaker with the secondary test coupler engaged.
- **DO NOT** work on a closed breaker or a breaker with closing springs charged.
- Breakers are equipped with several safety interlocks, **DO NOT** defeat them. This may result in bodily injury or equipment damage.
- **DO NOT** attempt to close the breaker by hand on a live circuit.
- Always remove the spring charging handle from the breaker after charging the springs.
- **DO NOT USE** a circuit breaker 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 securely grounded.

SECTION 3 – RECEIVING, HANDLING AND STORAGE

3.1 RECEIVING

Each breaker is carefully inspected and shipped in a wooden crate protected by a half-slotted corrugated carton. The carton is secured to a wooden pallet by two nylon bands and several carton nails. Other accessories such as the maintenance tool, levering crank, rail clamps, etc. are shipped separately with switchgear.

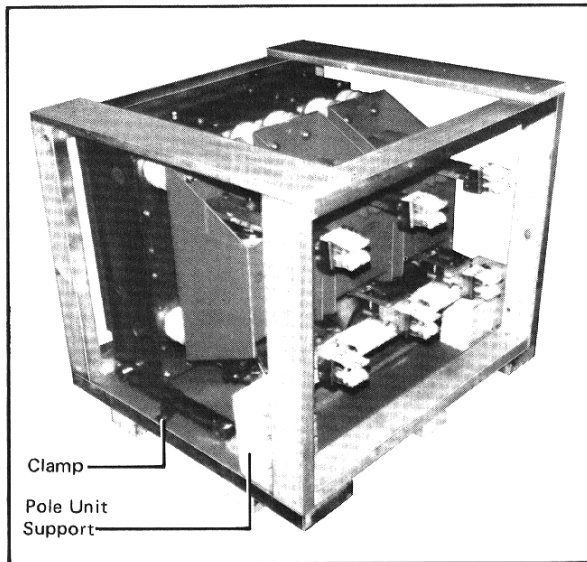


Fig. 1 1200 Amp VCP Breaker in Crate – Carton Removed

Use a nail puller to remove the nails. Shear off the nylon bands and lift up the carton. Check the contents against the packing list and examine for any damage or loss. File claims immediately with the carrier if any damage or loss is detected and notify the nearest Westinghouse sales office.

Until the breaker is ready to be delivered to the site of the switchgear for installation, **DO NOT** remove the wooden crate and pole unit support. If the breaker is to be placed in storage, maximum protection can be attained by keeping the breaker in the crate.

TOOLS AND ACCESSORIES

The following tools and accessories used with the VCP Breaker are shipped with VAC-CLAD Switchgear – one per order.

- Maintenance Tool: used primarily to charge closing springs manually and lift the shutter in breaker com-

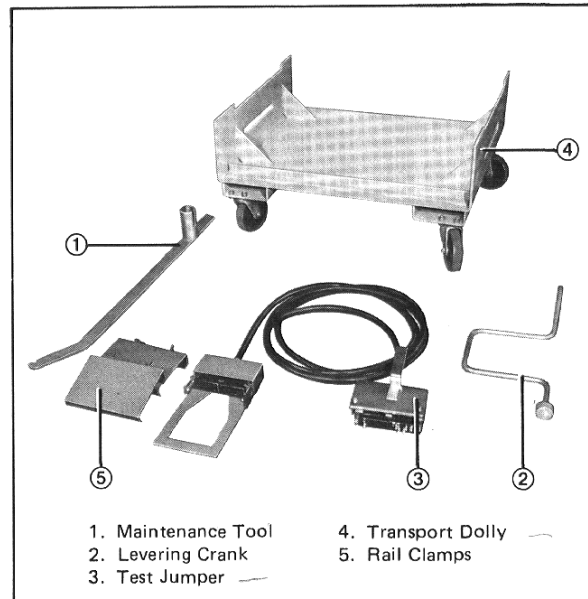


Fig. 2 VCP Breaker Tools and Accessories

partment. It may also be used to facilitate replacement of pole unit assembly.

- ✕ • Lifting Yoke: used to lift the breaker.
- Levering Crank: used to crank the breaker between test and connected position.
- ✕ • Test Jumper: used to check the operation of the breaker electrically as it rests on the extended rails outside the breaker compartment or on the transport dolly. This jumper connects the breaker secondary contacts with the compartment secondary contacts.
- ✕ • Transport Dolly: used to transport the breaker around while the breaker feet are held securely onto the dolly rails by clamps. One transport dolly with two rail clamps provided per order.

The following accessories are optional:

- Test Cabinet: used to provide power to check electrical operation of the breaker.
- Portable Lifter: primarily used to lift the breaker from or to the extended rails of the breaker compartment.

Breakers — Weights in Pounds (Approx.)					
Type of Breaker	Current Rating Amps	Lbs	Type of Breaker	Current Rating Amps	Lbs
50VCP250	1200	450	150VCP500	1200	450
	2000	550		2000	550
	3000	650		3000	650
50VCP350	1200	450	150VCP750	1200	450
	2000	550		2000	550
	3000	650		3000	650
75VCP500	1200	450	150VCP1000	1200	450
	2000	550		2000	550
	3000	650		3000	650

3.2 HANDLING

The breaker is secured to the crate by a clamp on each foot. When it is ready for installation, remove these clamps. A lift yoke is provided with each order. Position this lift yoke on the top of the breaker so that side lugs snap into breaker side holes and the 1-3/4-inch diameter hook hole in the yoke is facing the pole units. It is recommended that the portable lifter (optionally provided) be used to lift the breaker. The crate should be raised by using 2 x 4 or 4 x 4 blocks to permit the breaker lifting de-

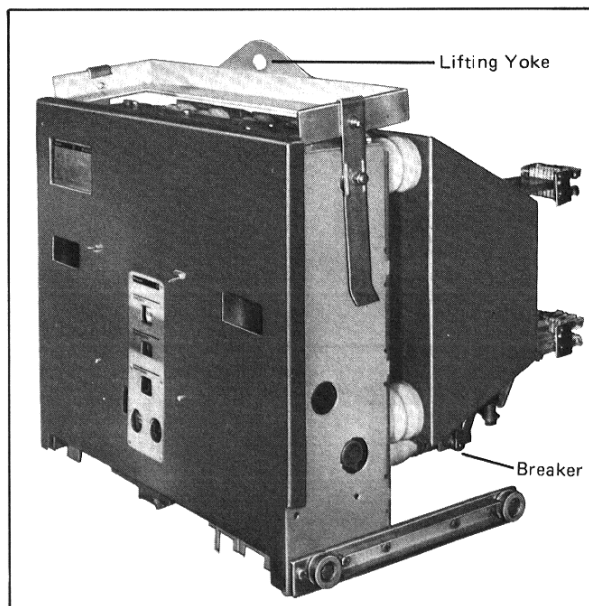


Fig. 3 Breaker Lifting Yoke in Position

vice legs run underneath the crate. However, if it is not available, any lifter may be used, provided that the hook is rated for at least 1000 lbs.

When moving the breaker around on flat level floors, place it on the transport dolly (one provided per order). Use the hand-holds to align the breaker on the transport dolly rails, **DO NOT USE** primary disconnects. Make certain that the rail clamps provided on the dolly are used to securely hold the breaker feet on the dolly rails.

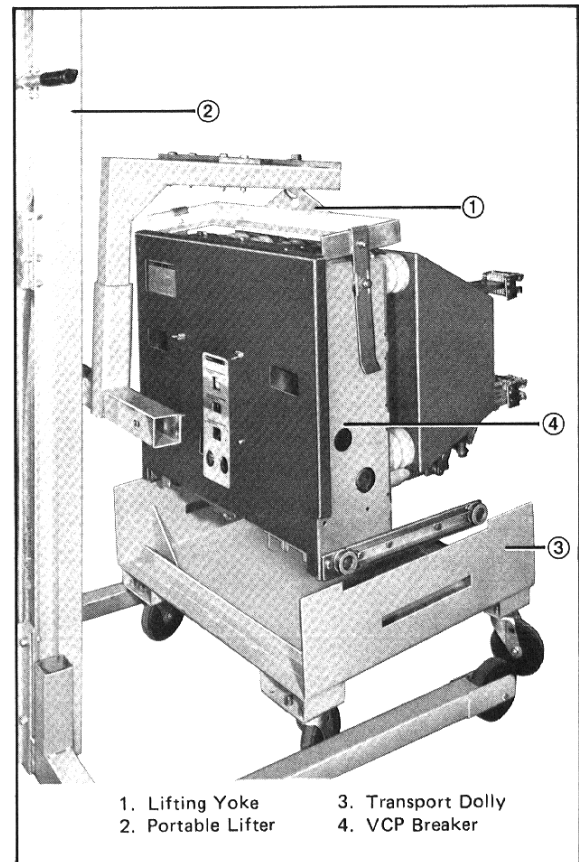


Fig. 4 VCP Breaker Being Lowered on Transport Dolly

3.3 STORAGE

If the circuit breaker is to be placed in storage, maximum protection can be attained by keeping it in the original wooden crate. Before placing it in storage, checks should be made to make sure that the breaker is free from shipping damage and in satisfactory operating condition.

The breaker is shipped with its contacts open and closing springs discharged. The indicators on the front

panel should confirm this. Insert the spring charging handle in the slot to the left of the "push-to-close" button. Charge the closing springs by pumping the handle up and down about 20 times until crisp metallic "click" is heard. This indicates that the closing springs are charged and is confirmed by the closing spring "charged" (yellow) indicator. Operate the "push-to-close" button. The breaker should close as confirmed by the breaker contacts "closed" (red) indicator. Operate the "push-to-open" button. The breaker should trip as confirmed by the breaker contacts "open" (green) indicator. After completing this initial check, leave the closing springs "discharged" and breaker contacts "open".

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, rain, snow, corrosive fumes, cement dust, etc. 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 convenient, completely assembled circuit breakers may be stored in their switchgear housings in the test position. If it is stored for any length of time, it should be periodically inspected to see that rusting has not started and it is in good mechanical condition.

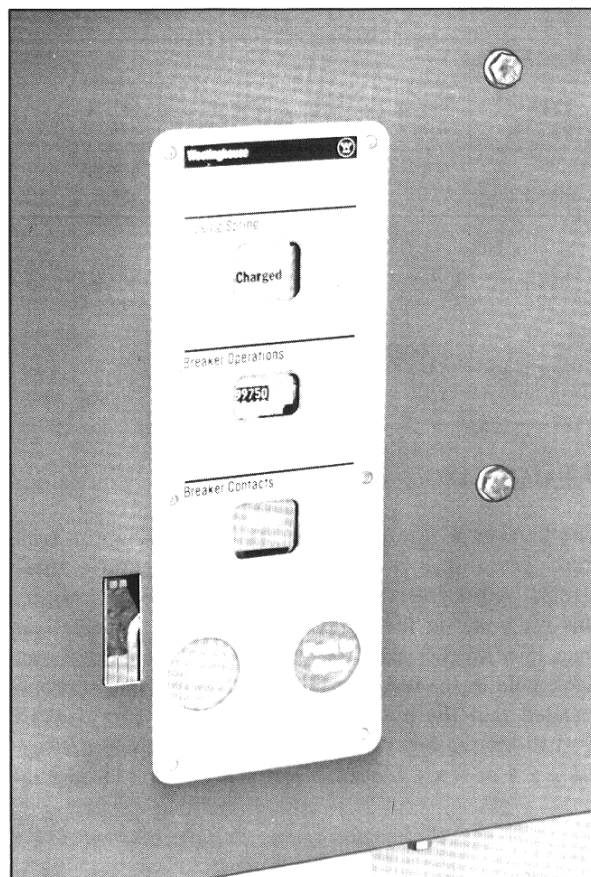


Fig. 5 VCP Breaker Escutcheon Plate

SECTION 4 – INSTALLATION

4.1 INITIAL BREAKER AND COMPARTMENT PREPARATION

Before attempting to place the breaker in service, it is important to check its compatibility with the switchgear compartment. Compare the breaker nameplate information with the compartment drawings. Make certain that the power rating of the breaker is as high or higher than switchgear rating and the control voltages are compatible. In order to assure that only breakers with adequate ratings can be inserted into the switchgear compartment, a set of code plates are provided on the breaker and in the compartment — see Fig. 6. If the breaker rating is not adequate, the mismatching code plates prevent the breaker from being inserted into test position and in turn being levered in.

Interphase barrier for type VCP breaker is part of the switchgear compartment. A safety interlock is provided that prevents the insertion of the breaker into test position unless the barrier is already in place. Barrier is shipped in the breaker compartment and held in place with string to protect it from damage during transportation. Remove this string.

Having confirmed the breaker/compartment compatibility and presence of the interphase barrier, connect the male end of the test jumper to the secondary disconnect in the compartment. The female end will be later connected to the breaker secondary disconnect. Pull the rails all the way out as indicated by dropping of the front end down a little and placing the rail in a stable horizontal position.

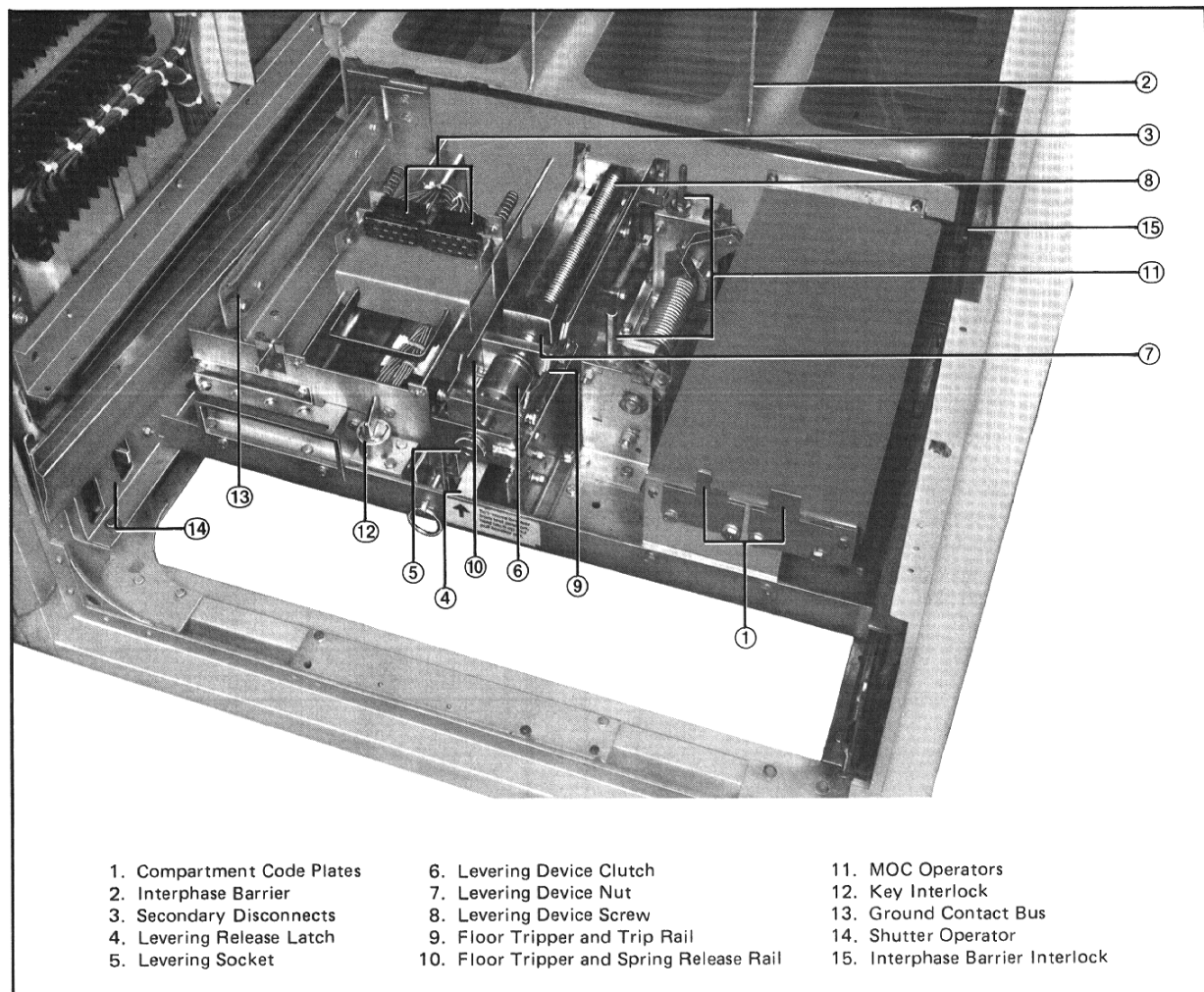


Fig. 6 VAC-CLAD Switchgear Breaker Compartment

As described in the handling section the breaker is resting on the transport dolly. It should be open and the closing springs should be discharged. Move the dolly near the switchgear. Remove the rail clamps that are holding the breaker feet to the transport dolly. Lift the breaker with the help of the portable lifter and lifting yoke. Gently and carefully lower it on the extended rails. Clamp the breaker feet on rails as shown in Fig. 9. Move the portable lifter and the lifting yoke away from the breaker.

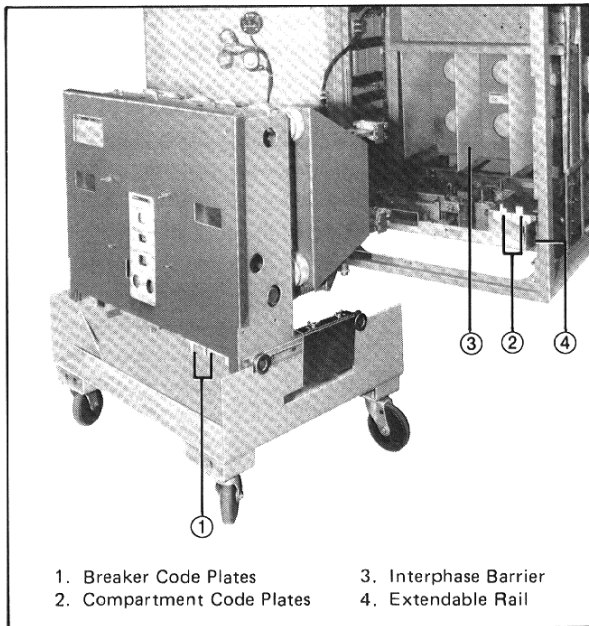


Fig. 7 VCP Breaker in the Process of Installation

4.2 MANUAL BREAKER OPERATION

The breaker is now in maintenance position on the extended rails. Manually charge the closing springs. Place the bent slotted end of the maintenance tool into the slot on the left hand side of escutcheon plate. Charge springs with about 20 downward strokes of the handle until a crisp metallic click is heard and closing springs charged/discharged indicator shows "charged". Remove the handle.

Depress the "push to close" button. The breaker should close as indicated by breaker contacts "closed" indicator. The closing springs indicator will show "discharged".

Note the operation counter reading. Depress the "push to open" button. The breaker will open as indicated by breaker contacts "open". The counter readings will advance by one.

Alternatively, manual breaker operation may be checked while breaker is resting securely on the transport dolly as shown in Fig. 7.

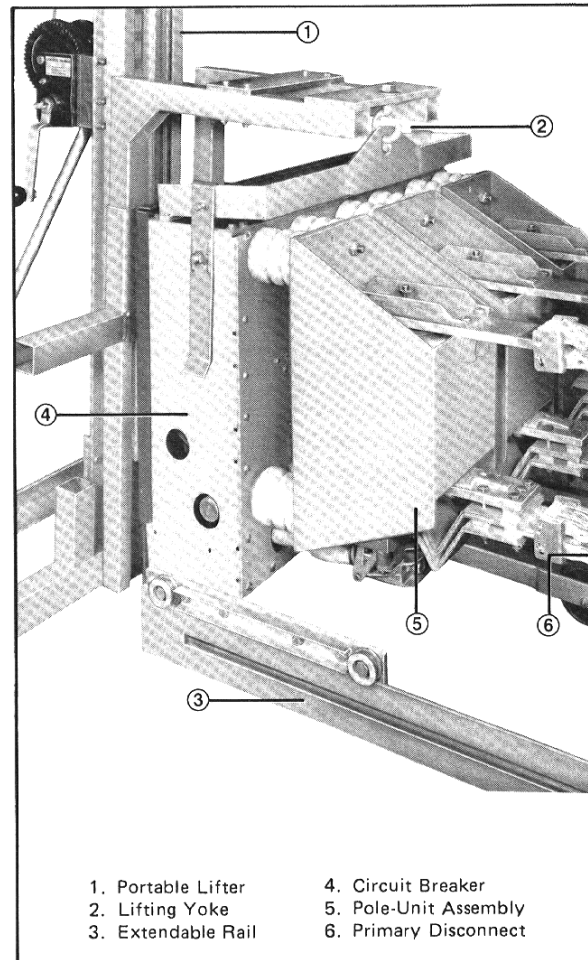


Fig. 8 VCP Breaker Being Lowered on Extended Rails

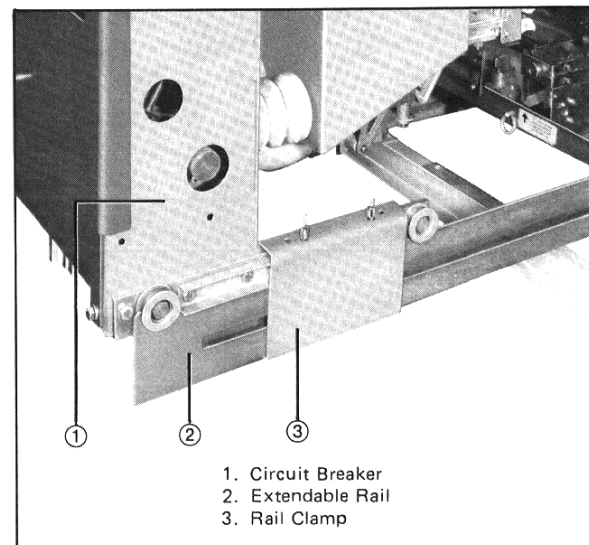


Fig. 9 VCP Breaker in Maintenance Position on Extended Rails

4.3 VACUUM INTERRUPTER INTEGRITY CHECK

Using a dry lint-free cloth or a paper towel, clean all the insulating surfaces of the pole units. Conduct a vacuum interrupter integrity check as described in the maintenance Section 6.2.

4.4 CONTACT WEAR GAP CHECK

Manually charge the closings springs and close the breaker. Check the contact wear gaps for each pole. The wear gaps should be .56 to .62 inches. Record the wear gap for comparison with future values in order to determine contact erosion.

4.5 PRIMARY CIRCUIT RESISTANCE CHECK

Check the primary circuit resistance as described in the maintenance Section 6.6. The resistance should not exceed the values specified in maintenance section.

Trip the breaker.

4.6 ELECTRICAL OPERATION CHECK

As described at the end of Section 4.1, one end of the test jumper is already connected to the breaker compartment disconnects. Now connect the other end of the test jumper to the breaker secondary disconnect plugs. If the secondary control circuit is energized, the spring charging motor will immediately start charging the closing springs as soon as the secondary contacts are engaged. As soon as the closing springs are completely charged, the motor will automatically turn off. Using the control switch on the door, close the breaker. As soon as the breaker closes, the motor will immediately recharge the closing springs.

Trip the breaker using control switch on the door. Turn off the control power manually close and trip the breaker. Disconnect the test jumper from the breaker and the compartment disconnects and remove it. If available, a breaker electrical check may be conducted with the test cabinet.

Alternatively, electrical operation check may be made with the breaker securely resting on transport dolly as shown in Fig. 10.

4.7 BREAKER/COMPARTMENT INTERFACE CHECK

Remove the rail clamps. Using the hand-holds push the breaker into the compartment. Test position is reached when levering latch under the breaker engages the levering device nut in the compartment as indicated by a crisp metallic sound. Push the rails into storage position.

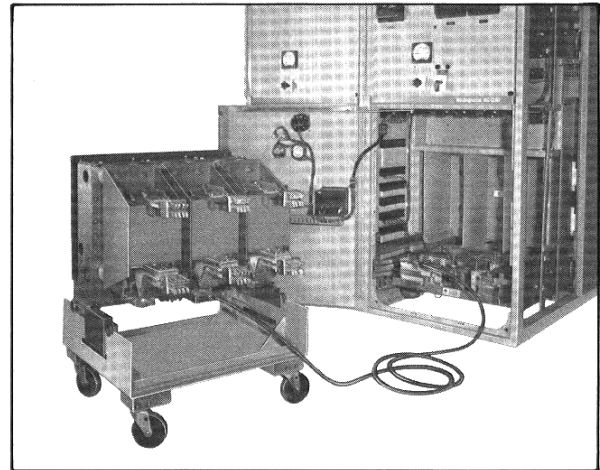


Fig. 10 VCP Breaker - Electrical Operation Check on Transport Dolly

Pull the secondary disconnects in the compartment forward as far as possible. The secondaries are now engaged and latched. If the control circuit is energized, the motor will automatically start charging the closing springs. Motor will stop as soon as the charging is completed.

Electrically open and close the breaker several times. With the breaker closed and springs charged, hold the close control switch made. With the trip control switch, trip the breaker. Even though close control switch is made, the breaker will not close because of the anti-pump characteristic of the control scheme. Engage the levering crank in the levering socket. Engagement requires pushing the crank forward as far as possible.

Turn the crank clockwise to move the breaker towards the connected position. Some increase in turning effort will be experienced when the primary disconnects initially engage the stabs. The connected position is reached when the crank begins to turn "spin free". Addi-

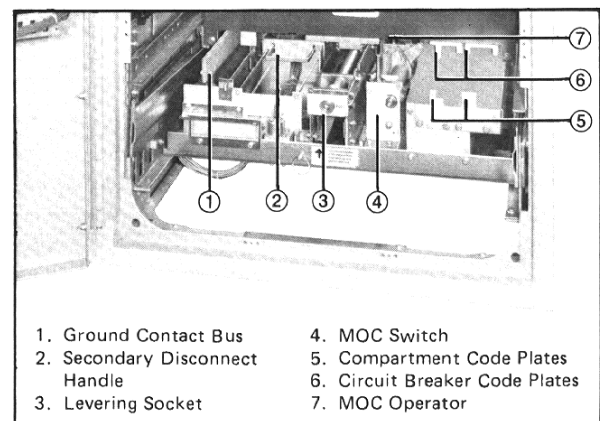


Fig. 11 VCP Breaker in Connected Position

tional turning will not result into any forward movement of the breaker. Again even though the close control switch is made, the breaker will not close. Remove the crank.

Turn off the close control switch once and turn it on again. The breaker will close. Operate the breaker several times to check its operation in the connected position. With the breaker closed and springs charged, attempt to engage the levering crank. The crank cannot be engaged fully unless the breaker is tripped. Trip the breaker. Engage the levering crank and turn it counterclockwise to bring the breaker to the test/disconnect position. This

position is indicated by "spin free" turning of the crank. Additional turning will not result into any motion of the breaker. Remove the crank. Make certain that the crank is turned counterclockwise until it is "spin free".

Pull the secondary disconnects forward as far as possible. Close the breaker. As before, the motor will start and charge the closing springs. Holding the levering latch release up, pull the breaker forward with the hand holds. The breaker will automatically trip, close and trip. Thus as the breaker is pulled out to maintenance position it is always open with the closing springs discharged. Push the breaker back into the test/disconnect position.

SECTION 5 – DESCRIPTION AND OPERATION

GENERAL

Westinghouse type VCP Breakers are horizontal draw out type vacuum circuit breakers. They are designed for use in VAC-CLAD type Metal-Clad switchgear compartments having maximum voltage rating of 15.0 KV. Most ratings can be stacked two high in a vertical section which results in considerable savings in floor space. They use sealed vacuum interrupters to establish and interrupt a primary circuit. The mechanism is front mounted spring-stored energy type which not only aids personnel safety but also provides ease of inspection and accessibility for servicing. The same basic mechanism is used for all ratings which require minimum investment in spare parts. All primary insulation to ground is porcelain which can be easily cleaned. Due to the inherent long life characteristics of the vacuum interrupters, highly reliable spring-stored energy type mechanism and primary porcelain insulation, type VCP circuit breakers provide long trouble free service with minimum maintenance.

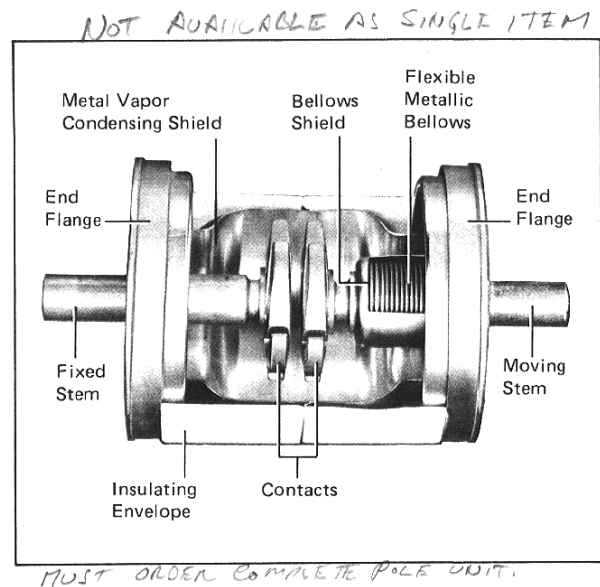
5.1 INTERRUPTER ASSEMBLY

Vacuum interrupters are mounted vertically in a molded pole base and supported from the fixed stem clamped on to the top conductor. Current transfer from the moving stem at the bottom is accomplished through a unique Westinghouse patented clamped joint. This design not only eliminates any need for lubrication and maintenance required in typical sliding joints but also assures reliable low resistance joint. Multiple sliding finger type primary disconnect at the end of the top and bottom conductors provide means for connecting and disconnecting the breaker to the primary stabs in the switchgear compartment.

Vacuum interrupter wear indicator is located at the end of the operating rod under the bottom of the pole unit assembly. It is clearly visible when breaker is withdrawn and magnified nearly 250%.

5.1.1 Vacuum Interrupter

The Type VCP breaker for VAC-CLAD Metal-Clad utilizes vacuum interrupters for interruption and switching functions. Vacuum interruption was chosen for VAC-CLAD due to the characteristics of vacuum interrupters — enclosed interrupter, small size and weight interrupting time (high speed), long life, reduced maintenance, and



environmental compatibility (low noise, no arc by-products, and minimum mechanical shock).

Arc interruption is simple and fast. The vacuum interrupter is shown. In the closed position — normal current flows thru the interrupter. When a fault occurs and interruption is required, the contacts are quickly separated. An arc is drawn between the contact surfaces and is rapidly moved around the slotted electrode surface by self-induced magnetic effects, which prevents gross electrode erosion and the formation of hot spots on the surface. The arc burns in an ionized metal vapor, which continually leaves the contact area and condenses on the surrounding metal shield.

At current zero, the arc extinguishes, vapor production ceases; and very rapid dispersion, cooling, recombination, and deionization of the metal vapor plasma together with the fast condensation of metal vapor products cause the vacuum condition to be quickly restored — hence the separated contacts withstand the transient recovery voltage.

5.1.2 Contact Wear Gap Indication

The purpose of the Wear Gap Indication is to determine the erosion of the contacts. When erosion reaches .12 inches, the interrupter should be replaced. In order to facilitate erosion measurement in VCP interrupters, linkage is set up to magnify the erosion by nearly 250% at the Wear Gap Indicator.

The mechanism, thru pole shaft provides limited amount of motion to the operating rod. Initial motion of the operating rod goes towards raising the moving stem up to make the contacts. Once the contacts are made, remainder of the motion shows up as gap between the wear gap nut and spring yoke. Due to erosion gap between moving and fixed stem contacts increase. This requires more motion to make the contacts and less is available for wear gap. Thus as the contacts erode, the wear gap goes down, the difference being proportional to erosion.

The wear gap is set to be .56 to .62 inches at the factory. When it goes down to .31 inches it approximates nearly .12 inches of erosion. There is a step on the spring yoke surface. When the front edge of the nut approximately lines up with this step, the gap is nearly .31 and it is time to replace the vacuum interrupter. It is very unlikely that the interrupter will have to be replaced due to erosion of contacts. However, wear gaps should be recorded at the time of installation to make determination of the need for replacement.

Note that the wear gap nut is not an adjustment nut and must not be tampered.

5.2 MECHANISM

Spring-stored energy type operating mechanism is mounted in the front in the rectangular box. It includes all the basic elements of storing the energy, closing and tripping functions of the breaker, manual and electrical controls and interlocks. Manual controls are all in the front and most readily accessible. Porcelain insulators in the rear are used to mount the vacuum interrupter assemblies. Mechanism motion to close and open the interrupter contacts is provided thru porcelain operating rods connecting mechanism pole shaft to the bell cranks of the interrupter assemblies.

The mechanism is mechanically trip free type. Closing springs may be charged manually with the help of the maintenance tool or electrically thru the charging motor. Closing of the interrupter contacts is accomplished by releasing the energy stored in the closing springs either manually or electrically. The energy released by the closing springs closes the contacts, charges the contact loading springs, charges the reset spring and overcomes the frictional forces encountered during the closing operation. The breaker may be opened manually or electrically with the energy provided by the contact loading springs and reset springs.

5.2.1 Operation of Stored Energy Mechanism

The spring-stored energy essentially stores the closing energy by charging the closing springs and applies the released energy to close the breaker, charge the contact loading springs and reset spring. The mechanism may rest in any one of the four positions shown in Fig. 14 as follows:

- a. Breaker open, closing springs discharged
- b. Breaker open, closing springs charged
- c. Breaker closed, closing springs discharged
- d. Breaker closed, closing springs charged

Fig. 12 shows the front view of the stored energy mechanism.

Closing Springs Charging

Fig. 13 shows the schematic views of the spring charging parts of the stored energy mechanism.

The major component of the mechanism is a cam shaft assembly which consists of a hex shaft to which are attached the spring cranks (one on each end), 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 spring cranks and closing cam rotate with it.

The spring cranks have spring ends connected to them which are in turn coupled to the closing springs. As the cranks rotate, the closing springs get charged.

Fig. 13a and 13b are schematic views of the spring charging portions of the stored energy mechanism. Fig. 13a shows the springs charged, breaker closed position. Fig. 13b shows the springs discharged, breaker open position. Rotation of the motor crank causes the driving plate and motor ratchet lever to oscillate. The drive pawl, being part of the ratchet lever assembly also oscillates rotating the ratchet wheel counterclockwise. As the ratchet wheel rotates, the spring cranks also rotate pulling the spring ends with them to charge the closing springs (one extension spring on each end of the cam shaft).

Closing Operation

When the closing springs are completely charged, the spring cranks go over the center and the closing stop roller

comes against the spring release latch Fig. 14b. The closing springs are now held in charged position. They can be released to close the breaker by moving the spring release latch out of the way. This may be done manually or electrically by depressing the spring release lever which turns the spring release "D" shaft thru the spring release wire. The force of the closing springs rotates the cam shaft thru springs cranks. The closing cam being attached to the cam shaft also rotates causing the breaker to close.

Fig. 14 shows the positions of the closing cam and tripping linkage. Note that in 14a in which the breaker is open and the closing springs discharged, the trip "D"

shaft and the latch are in unlatched position. As the closing springs are charged, the trip latch snaps into the fully reset or latched position as in 14b near the end of spring charging operation.

In Fig. 14c the linkage is shown with the breaker in the closed position and before the closing springs have been recharged. Note that the closing cam has rotated about one-half turn corresponding to the rotation of the cam shaft and the ratchet wheel of Fig. 13. Rotation of the closing cam pushes the main link roller downward so as to rotate the pole shaft of the breaker and close the contacts. This is possible because the restraining links between the

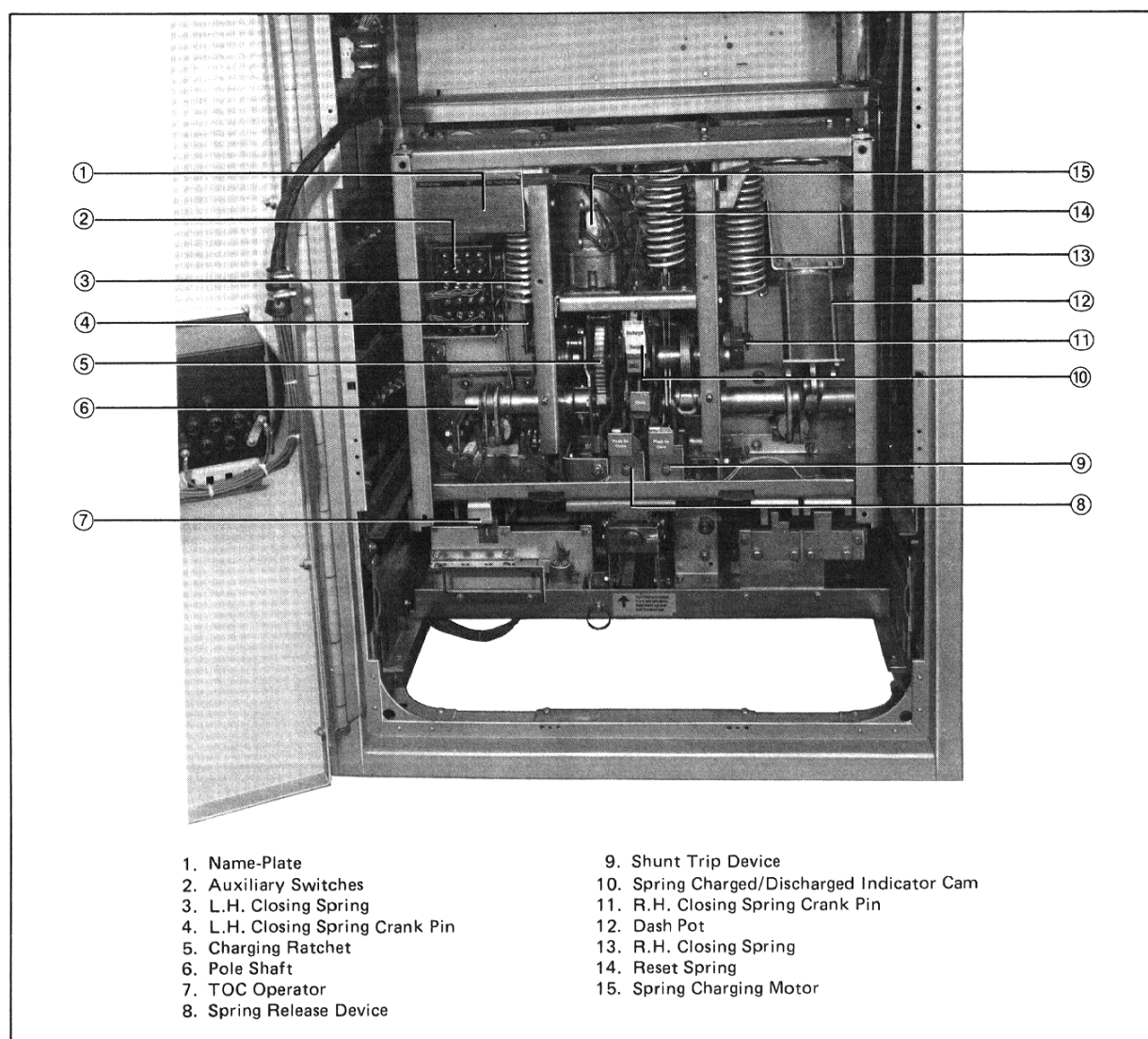


Fig. 12 VCP Breaker in Test/Disconnect Position - Front Panel Removed

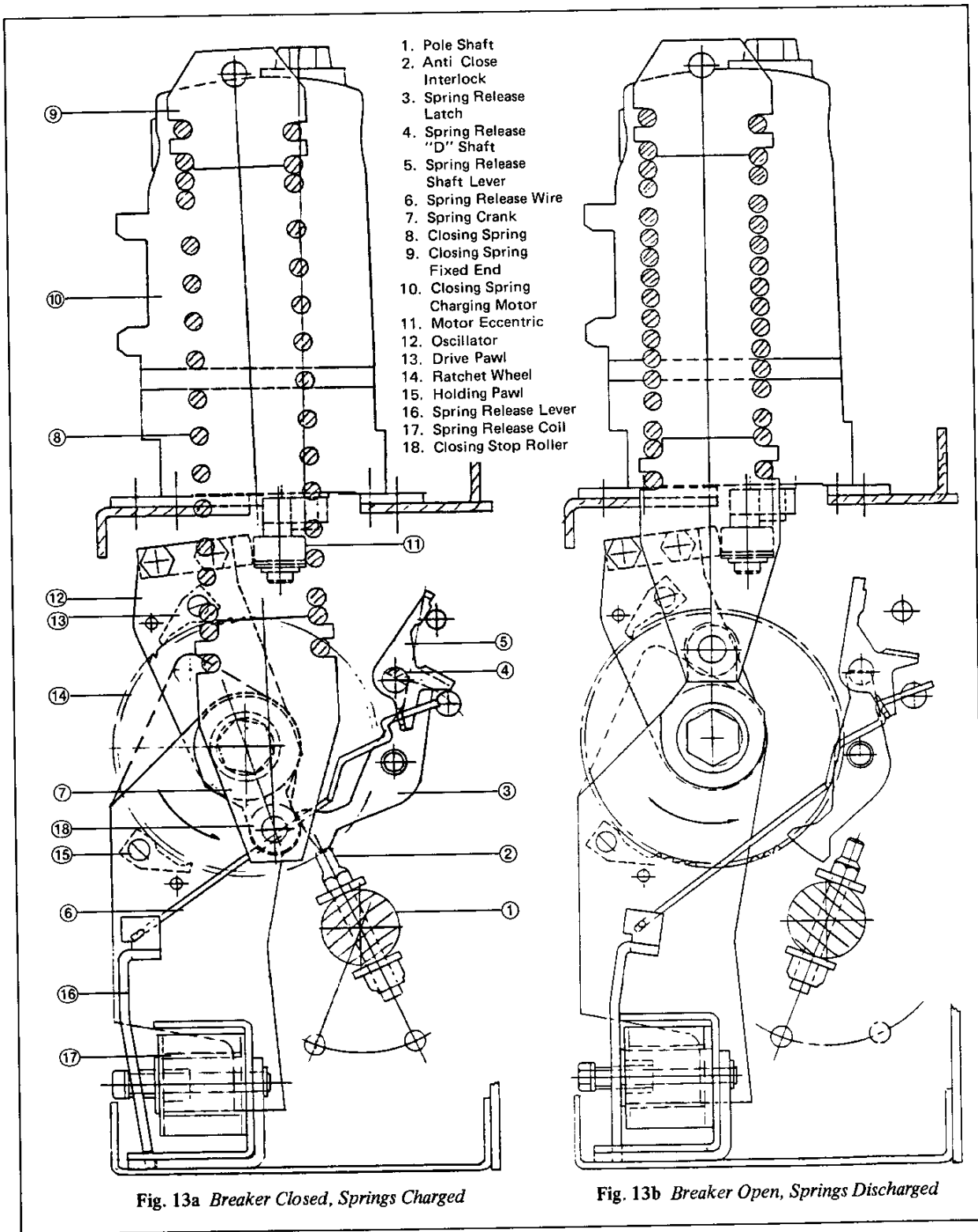


Fig. 13 *Stored Energy Mechanism*

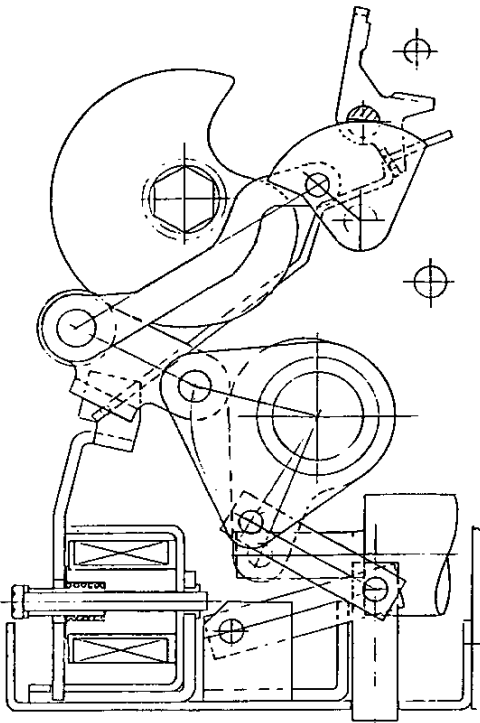


Fig. 14a Breaker Open & Closing Spring Not Charged

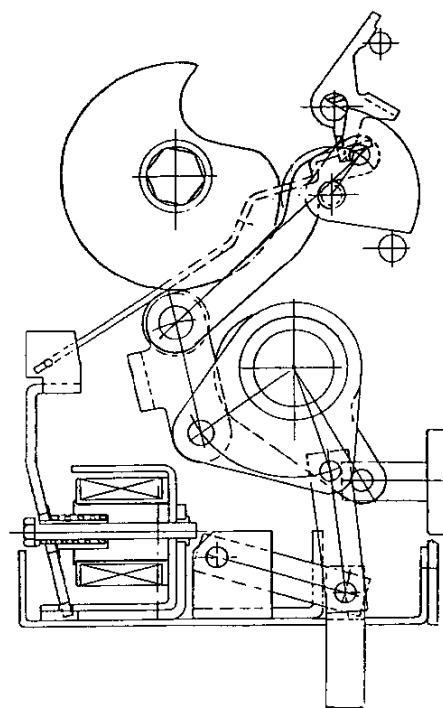


Fig. 14c Breaker Closed & Closing Spring Not Charged

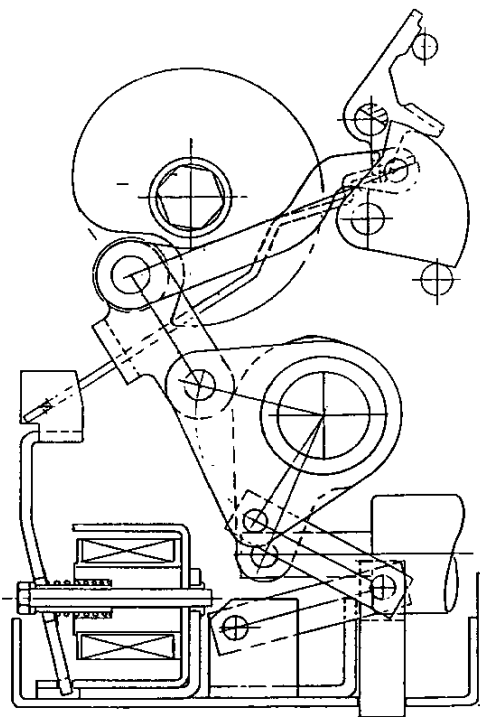


Fig. 14b Breaker Open & Closing Spring Charged

1. Pole Shaft
2. Main Link
3. Restraining Links
4. Trip Latch
5. Trip "D" Shaft
6. Trip Shaft Lever
7. Trip Wire
8. Shunt Trip Lever
9. Shunt Trip Coil
10. MOC Operator
11. Cam Shaft
12. Closing Cam
13. Operating Rod

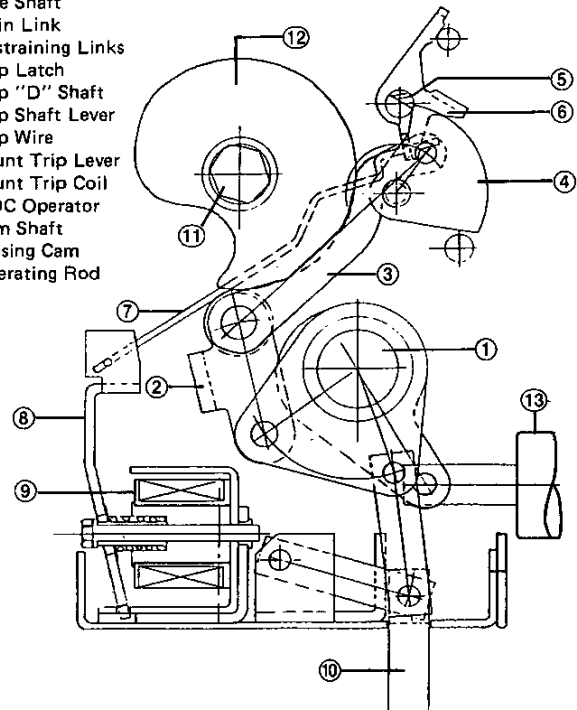


Fig. 14d Breaker Closed & Closing Spring Charged

Fig. 14 Four Positions of Closing Cam and Trip Linkage

main link roller and the trip latch prevent the main link roller from moving off the cam to the left. The restraining links cause the trip latch to push against the trip "D" shaft. Fig. 14d 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.

The cam for this portion of the travel is cylindrical and causes no further movement of the main link roller. This rotation corresponds to the spring charging rotation of the ratchet wheel shown in Fig. 13.

Opening Operation

Depressing the shunt trip lever either by hand or by the shunt trip coil turns the trip "D" shaft thru the trip wire and permits the trip latch to turn counterclockwise under the influence of contact loading springs via main link and restraining link. This permits the linkage to collapse and open the breaker. The linkage then assumes the position shown in Fig. 14b.

5.2.2 Interlocks

All VCP breakers are provided with several safety interlocks. They are intended to prevent injury to the personnel and/or damage to the equipment by permitting proper operation. Following are the interlocks.

5.2.2.1 Breaker - Compartment Code Plates

A set of two plates on the breaker and a set in the compartment forms this interlock. It is intended to prevent insertion of lower rated breaker into higher rated compartment (except for 3000 amp breaker and 3000 amp compartment which require matched breaker and compartment). The ratings are based on continuous current, interrupting current, close and latch current and maximum voltage. Breaker with the same or higher rating in all of the above categories can be inserted into the compartment of equal or lower rating. If the ratings do not agree as required, the breaker is prevented from insertion into test position. This prevents levering all together. See Fig. 11.

5.2.2.2 Anti-Close Interlock

This is an interlock that prevents discharge of closing springs electrically or manually when the breaker is already closed - see Fig. 13a. Regardless of how the spring release "D" shaft may be upset, spring release latch is prevented from getting out of the way of roller by the anti-close interlock screw head.

5.2.2.3 Floor Tripping and Spring Release Interlocks

These interlocks are operated by the interaction between the floor tripper rollers (Fig. 15) on the bottom of the breaker and levering device rails or interlock operator surfaces (Fig. 6). They perform several functions:

1. Hold the breaker in the trip free mode by holding the trip "D" shaft upset between test/disconnect and connected positions. Latch check switch is also held open thus preventing any electrical close signal.
2. Permits the breaker to be withdrawn in safe mode (breaker open, springs discharged) when moved from test/disconnect to withdrawn position or vice versa. Note that there is never a free discharge of the closing springs that unduely impose heavy stresses on the mechanism parts.
3. Trip the breaker (if closed) before being levered from test/disconnect position. The above functions are accomplished by pushing up the tripper rollers which in turn upset trip or spring release "D" shafts.

5.2.2.4 Levering Interlock

The purpose of this interlock is to prevent the engagement of the levering crank with the breaker in connected position if it is closed. A tab on the right hand side of the levering slide cage interferes with the breaker moc operator preventing the slide from moving far enough to permit engagement of the levering crank.

5.2.2.5 Interphase Barrier Interlock

This interlock is entirely part of the switchgear compartment but it is mentioned here since it prevents insertion of the breaker in the compartment if the barrier is not already in place. The barrier pushes the lever on the right hand side which would otherwise interfere with breaker right foot - see Fig. 6.

5.2.3 Control Schemes

Basically there are two control schemes for type VCP breakers - one for d-c control and one for a-c control see Fig. 16. There may be different control voltages or more than one tripping elements, but the principal mode of operation is as follows:

As soon as the secondary disconnects make up, the spring charging motor automatically start charging the closing springs provided the control power is available.

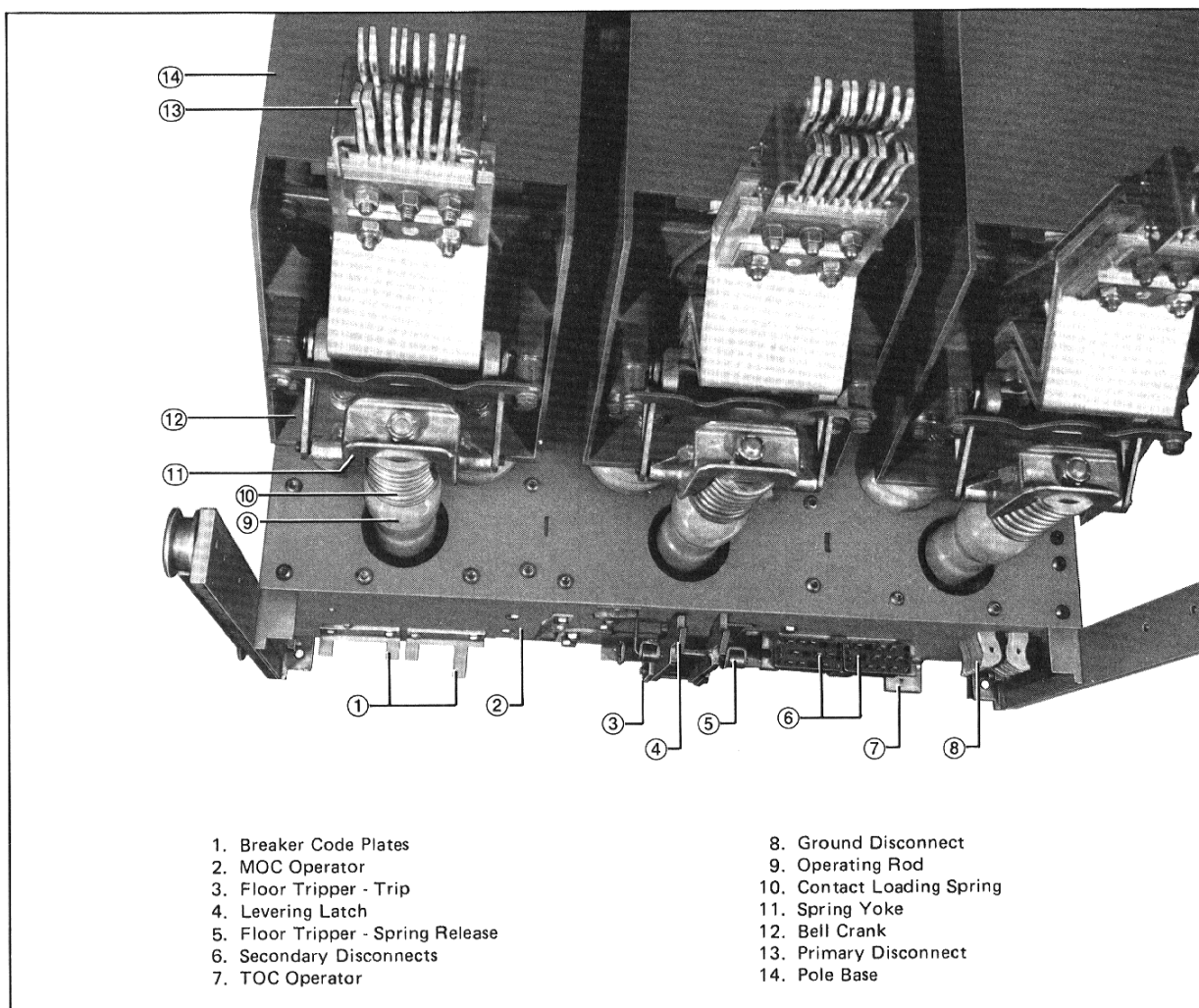


Fig. 15 VCP Breaker Rear Bottom View

When the springs are charged, the motor cut off switch turns the motor off. The breaker may be closed by making up control switch close ($\frac{CS}{C}$) contact. Automatically upon closing of the breaker, the motor starts charging the closing springs. The breaker may be tripped any time by making up control switch trip ($\frac{CS}{T}$) contacts. Note the position switch contact in spring release circuit in the d-c scheme. This contact makes before the secondary disconnects make and break after they make. This feature prevents the breaker from closing automatically even though control switch close contact may have been made while the breaker is levered to connected position.

5.2.4 Undervoltage Trip Device

The Undervoltage Trip Device shown in Fig. 17 is an electromechanical device that trips the circuit breaker when the voltage on its coil falls to between 60. to 30 percent or lower of nominal.

In operation with nominal voltage on coil, the moving core is held to the stationary core by magnetic force against the roller lever torsion spring. The moving core is linked to the roller lever which restrains the trip lever.

When the coil voltage is reduced sufficiently, the roller lever spring overcomes the magnetic force between two

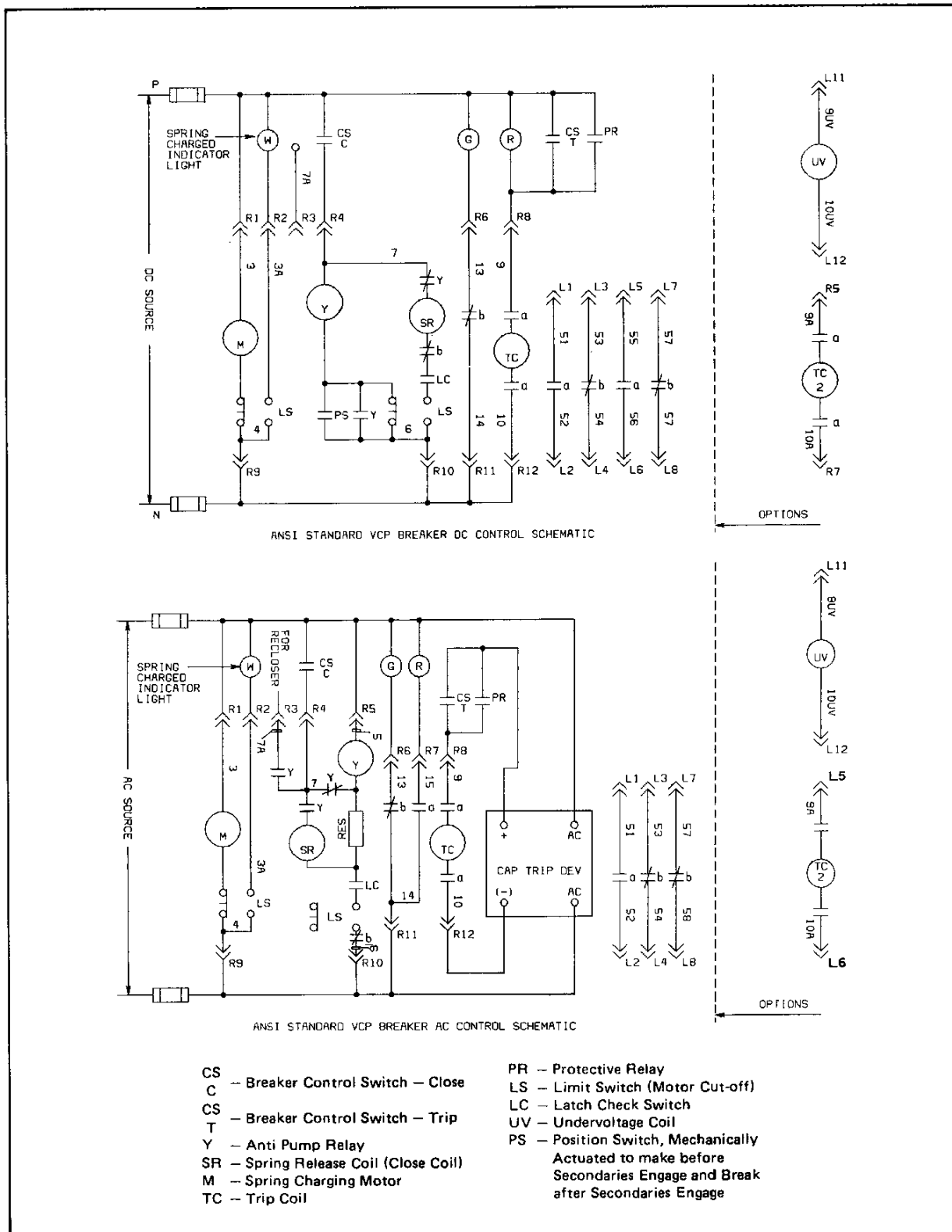


Fig. 16 Typical 'AC' and 'DC' Control Schemes

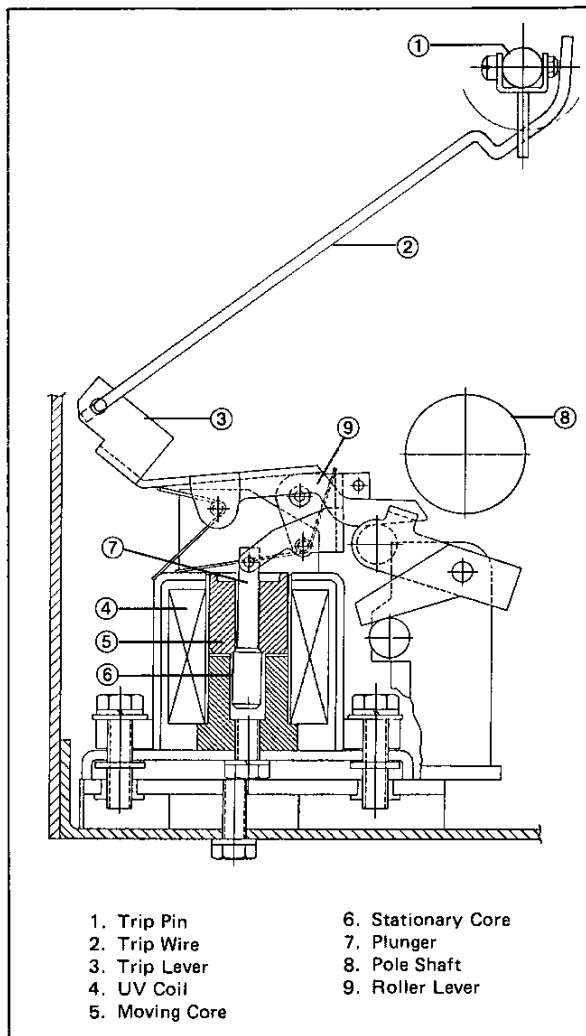


Fig. 17 Undervoltage Trip Device

cores. The moving core moves up and rotates the roller lever clockwise so that the roller moves out of the way of the trip lever. A torsion spring around the pivot pin of the trip lever then rotates it clockwise causing the trip wire to turn the trip "D" shaft and trip the breaker. As the breaker opens, a pin on the right pole reset lever operates the undervoltage trip device reset linkage which lifts up the right hand end of the trip lever turning the roller lever counterclockwise and resetting the moving core. As long as breaker is open, this position is maintained. If the trip device coil has at least 85% of nominal voltage, the breaker may be closed. Otherwise upon attempting to close, it will automatically trip out.

Note that with undervoltage trip device, the breaker cannot be closed unless proper voltage to the coil is applied. These devices are available for d-c control voltages only.

5.2.6 Secondary Disconnect

The breaker control wiring is arranged for drawout disconnects by means of a set of two 12 point (total 24 points) male plugs arranged to connect a corresponding set of female plugs mounted in the switchgear compartment. The breaker plugs are mounted on the left side under the bottom pan of the mechanism and they are held fixed in that position. The female plugs in the compartment are mounted on a movable carriage. See Figures 15 and 6.

To engage the disconnects while the breaker is in test position, simply pull the carriage all the way towards the front. This will latch the disconnects. Normally the disconnect will engage automatically as the breaker is levered into connected position.

5.2.7 Ground Disconnect

The Ground Disconnect is an assembly of spring loaded fingers similar to 1200/2000 amp primary disconnect to provide a disconnectable means for grounding the breaker chassis after it has been inserted into the switchgear compartment. The ground contact is located on the left hand side of the breaker under the mechanism bottom pan. An extension of the switchgear ground bus is secured to compartment floor in such a position to engage the ground disconnect 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 connected position - see Figures 15 and 6.

5.2.8 MOC and TOC Operators

As shown in Fig. 14, MOC (Mechanism Operated Control) Operator is coupled to the pole shaft. In the test and connected positions of the breaker, this operator aligns directly above the MOC switch plungers in the compartment. As the breaker closes, this operator moves down and pushes the switch plunger to change the MOC contact positions. Thus MOC switch contact positions can be correlated with the breaker contact position in the same manner as the Auxiliary switches mounted in the breaker. (Note that the MOC switch operator is provided on all breakers but MOC switches in the compartment are provided only when specified on the switchgear order).

As shown in Figure 14, TOC (Truck Operated Control) Operator is mounted in the front of the mechanism in the center left position. It operates the TOC switch as it moves to the connect position in the switchgear compartment.

5.3 INTERPHASE BARRIER

Unlike in most breaker designs, interphase barrier in type VCP breaker is part of the switchgear compartment. Interlock is provided so that the breaker can be inserted only if the barrier is installed in the compartment. When the breaker is in connected position, the barrier is in place to provide the interphase insulation. However when the breaker is withdrawn, the barrier remains in the compartment. This design readily permits unobstructed inspection of the breaker in withdrawn position. As shown in Fig. 7 it is a single piece design molded from high quality glass polyester.

5.4 LEVERING DEVICE

The purpose of the Levering Device is to move the circuit breaker between Test/Disconnect and Connected positions while providing safety interlocks. For VCP breakers, the device is power screw and drive nut type with a clutch. Although the device is mounted in the switchgear compartment, a brief description here will help understanding the operation Fig. 18 and Fig. 6.

The device primarily consists of a power screw, a drive nut, a clutch, two side rails and a sliding cage. In the Test/Disconnect position, the nut is all the way in the front. As the breaker is pushed in, the levering latch snaps on the nut. Turning the crank clockwise while pushing forward advances the breaker towards Connected position. During this travel, the floor tripper "Trip" roller is lifted up holding the breaker trip free. When the breaker reaches connected position, the crank turns "Spin Free" providing no further breaker movement.

If the breaker is closed in this position, levering crank cannot be engaged. After tripping the breaker, the levering crank may be engaged and breaker withdrawn to Test/Disconnect position by turning the crank counterclockwise. Again this position is indicated by "Spin Free" turning of the crank.

The breaker levering latch may be disengaged by lifting the latch release. As the breaker is withdrawn from test position, it comes out with contacts open and springs discharged (safe mode) on account of the safety interlock.

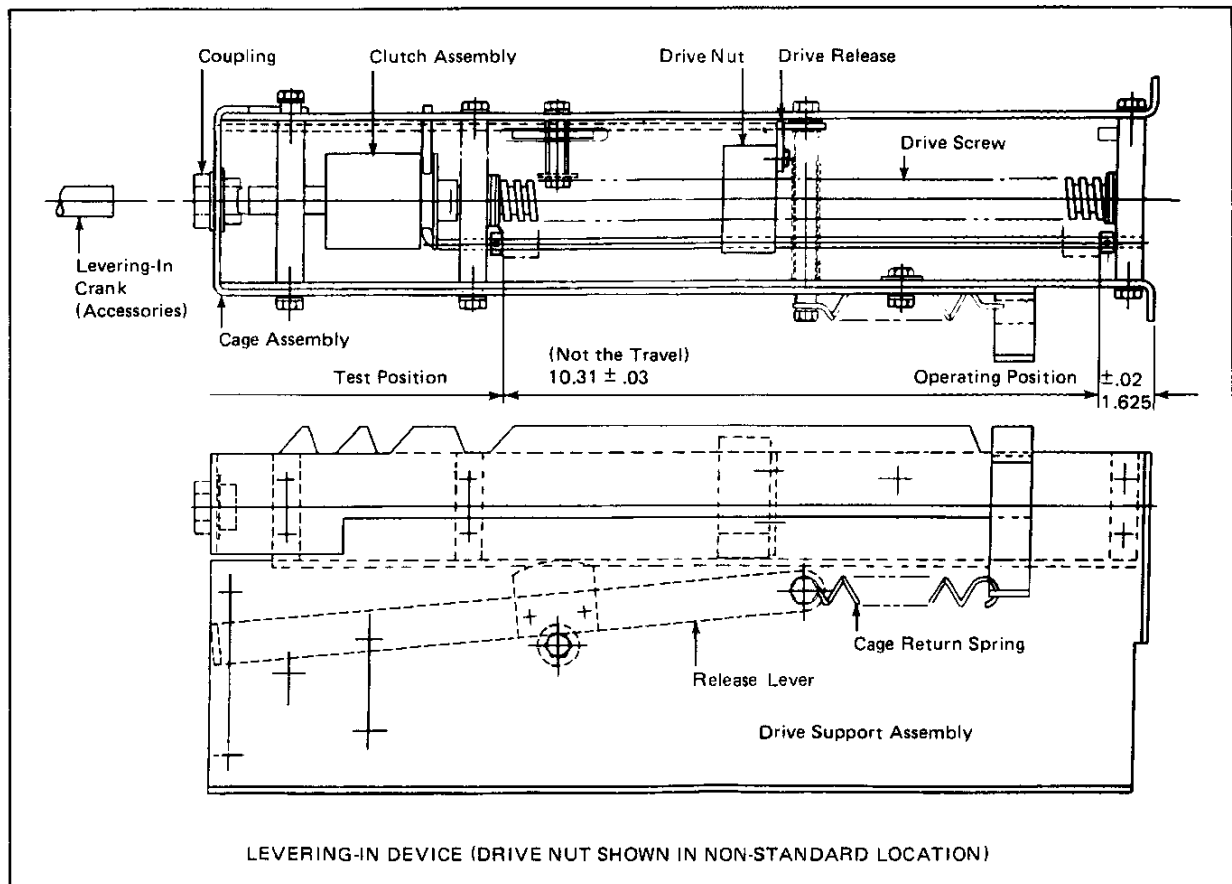


Fig. 18 Levering Device Assembly

SECTION 6 – MAINTENANCE

6.1 GENERAL

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. Type VCP circuit breakers are designed to comply with standards requiring maintenance at least every 1000 to 2000 operations (depending upon rating) or once a year, whichever comes first.

Actual inspection and maintenance will depend upon individual application conditions such as number of operations, magnitude of currents switched, desired overall system reliability and operating environment. Any time the breaker is known to have an interrupted fault current at or near its rating, it is recommended that the breaker be inspected and necessary maintenance be performed as soon as is practical. Some atmospheric conditions such as extremes of dust and moisture or corrosive gases might indicate inspection and maintenance at more frequent intervals than 1000 to 2000 operations. Very clean and dry conditions combined with low switching duty will justify longer times between inspection and maintenance operations. With experience, each user can set an inspection and maintenance schedule which is most economical for the particular use.

Before attempting any maintenance work, take note of safety practices outlined earlier in this book:

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

The following should be inspected and maintained every 2000 operations (1000 operations for 3000A breaker) or once a year, whichever comes first, until the schedule is determined based on operating experience of the user.

6.2 VACUUM INTERRUPTER INTEGRITY TEST

Vacuum interrupters used in type VCP circuit breakers are highly reliable interrupting elements. Satisfactory performance of these devices is primarily dependent upon the integrity of the vacuum in the chamber and internal di-

electric strength. Both these parameters can be readily checked by a one minute 36 KV A-C RMS high potential test. During this test, the following caution must be observed:

CAUTION

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

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

With the breaker open and securely resting either on the extended rails or the transport dolly, connect all top primary studs (bars) together and to the high potential machine lead. Connect all bottom studs together and ground them along with the breaker frame and secondary contacts. Start the machine at zero potential, increase to 36 KV A-C RMS, 60 Hz and maintain for one minute (for all voltage ratings up to 15 KV max.). Successful withstand indicates that all interrupters are satisfactory. If there is a breakdown, the defective interrupter or interrupters should be identified by an individual test and replaced before placing the breaker in service. During individual tests, it is recommended that the interphase barrier be used in order to prevent phase to phase breakdown — approximately 1/8 thick glass polyester barrier will be satisfactory.

After the high potential is removed, discharge any electrical charge that may be retained.

High-Pot Testing

To avoid any ambiguity in the a-c high potential test due to leakage or displacement (capacitive) current, the test unit should have sufficient volt-ampere capacity; it is recommended that the equipment be capable of delivering 25 mA of current for one minute.

Although an a-c high potential test is recommended, a d-c test may be performed if only a d-c test unit is available. In this case, 40 kV d-c should be applied for one minute, and the test equipment should be capable of delivering 5mA of current for one minute to avoid ambiguity due to field emission or leakage currents.

The proposed current delivery capability of 25 mA a-c and 5 mA d-c apply when all three VI's are tested in parallel. If individual VI's are tested, current capability may be one third of these values.

Note that the indicated high-potential test voltages of 36 kV rms a-c and 40 kV d-c apply irrespective of whether the breaker voltage rating is 5 kV, 7.5 kV, or 15 kV.

CAUTION

Some d-c high potential units, operating as unfiltered halfwave rectifiers, are not suitable for use to test vacuum interrupters, because the peak voltage appearing across the interrupters can be substantially greater than the value read of the meter.

It is recommended that only a-c high potential test be used to determine vacuum integrity. D-C testers may provide a pulse lot higher than what is read on the meter, thus subjecting the interrupter to higher than recommended voltage. In turn this may give an erroneous indication of a defective interrupter when it may really be satisfactory. In addition, it may also increase the level of x-radiation.

6.3 CONTACT EROSION

Since the contacts are contained inside the interrupter, they remain clean and require no maintenance. However, during high current interruptions there may be a minimal amount of erosion from the contact surfaces. Maximum permitted erosion is .12 inch. To determine contact erosion, close the breaker and measure the wear gap as shown in Fig. 19, the change in the wear gap between the time of installation and now divided by 2.5 gives the amount of erosion. However, a simple indication of .12 inch contact erosion is given by the wear gap measuring nearly .31 inches — this corresponds to the leading edge of the wear gap nut lining up with the step on spring yoke.

It is extremely unlikely that the contact erosion will reach .12 inch during normal lifetime of the breaker. However, in such a case, the vacuum interrupter assembly should be replaced.

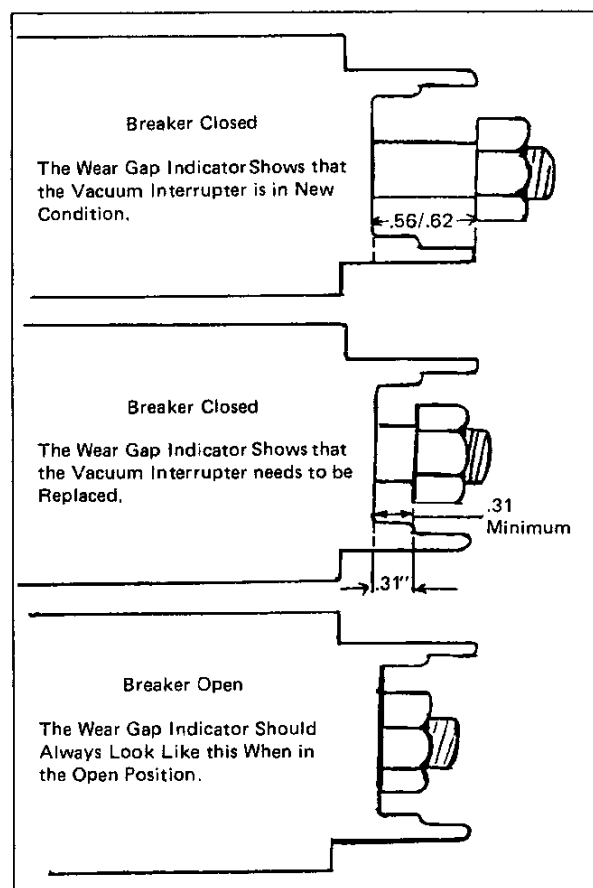


Fig. 19

6.4 INSULATION

In VCP breakers, all primary insulation to ground is porcelain and thus requires minimal maintenance. Insulation maintenance primarily consists of keeping the insulating surfaces clean. This can be done by wiping off all insulating surfaces with a dry lint-free cloth or dry paper towel. In case there is any tightly adhering dirt that will not come off by wiping, it can be removed with a mild solvent or distilled water. But be sure that the surfaces are dry before placing the breaker in service. If a solvent is required to cut dirt, use Stoddard's Solvent Westinghouse 55812CA or commercial equivalent. Do not use any type of detergent to wash the surface of a porcelain insulator, as detergent leaves an electrical conducting residue as it dries.

Secondary control wiring requires inspection for tightness of all connections and damage to insulation.

Check the insulation integrity as follows:

6.5 INSULATION INTEGRITY CHECK

Primary Circuit:

The integrity of primary insulation may be checked by the a-c high potential test. The test voltage depends upon the maximum rated voltage of the breaker. For the breakers rated 4.76 KV, 8.25 KV, and 15 KV, the test voltages are 15 KV, 27 KV and 27 KV RMS, 60 Hz respectively. Conduct the test as follows:

Close the breaker. Connect the high potential lead of the test machine to one of the poles of the breaker. Connect the remaining poles and breaker frame to ground. Start the machine with output potential at zero and increase to the test voltage. Maintain the test voltage for one minute. Repeat the procedure for the remaining poles. Successful withstand indicates satisfactory insulation strength of the primary circuit.

If the d-c high potential machine is used, make certain that the peak voltage does not exceed the peak of the corresponding a-c RMS test voltage.

Secondary Circuit:

Remove the motor leads. Connect all points of the secondary disconnect pins with a shooting wire. Connect this wire to the high potential lead of the test machine. Ground the breaker frame. Starting with zero, increase the voltage to 1125 RMS, 60 Hz. Maintain the voltage for one minute. Successful withstand indicates satisfactory insulation strength of the secondary control circuit. Remove the shooting wire and reconnect the motor leads.

6.6 PRIMARY CIRCUIT RESISTANCE CHECK

Since the main contacts are inside the vacuum chamber they remain clean and require no maintenance at any time. Unlike most typical circuit breaker designs, VCP breakers do not have sliding contacts at the moving stem either. Instead they use a highly reliable and unique flexible clamp design that eliminates the need for lubrication and inspection for wear.

If desired, the d-c resistance of the primary circuit may be measured as follows: close the breaker, pass at least 100 amps d-c current through the breaker. With the low resistance instrument, measure resistance across the studs on the breaker side of the disconnects for each pole. The resistance should not exceed $60 \mu\Omega$, $40 \mu\Omega$ and $20 \mu\Omega$ for 1200 amp, 2000 amp and 3000 amp breakers respectively.

6.7 MECHANISM

Make a careful visual inspection of the mechanism for any loose parts such as bolts, nuts, pins, rings, etc. Check for excessive wear or damage to the breaker components. Operate the breaker several times manually and electrically to make certain the operation is crisp and without any sluggishness.

6.8 LUBRICATION

All parts that require lubrication have been lubricated during the assembly with molybdenum disulphide grease, Westinghouse M No. 53701QB. Over the period of time, this lubricant may be pushed out of the way or degrade. So, proper lubrication at regular intervals is essential for maintaining the reliable performance of the mechanism. Once a year or every 2000 operations (1000 operations for 3000 amp breaker) whichever comes first, the following areas should be lubricated with light machine oil such as mobil 1 applied sparingly:

1. Wire links ends.
2. Spring charged/discharged indicator cam surface.
3. Trip latch surface/trip pin mating surfaces.
4. Spring release latch/spring release pin mating surfaces.
5. Closing and opening springs crank pins.
6. Bell crank pins in pole unit area.

After lubrication operate the breaker several times making sure that opening and closing operations are crisp and snappy.

Roller bearings are used on the pole shaft, the cam shaft, the main link and the motor eccentric. 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 becomes necessary to disassemble the mechanism, their bearings and related parts should be thoroughly cleaned off 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 been drawn off, the bearings should be packed with Westinghouse Grease 53701QB or equivalent.

SECTION 7 — RENEWAL PARTS

GENERAL

In order to minimize production downtime, it is recommended that an adequate quantity of spare parts be carried in stock. The quantity will vary from customer to customer, depending upon the service severity and continuity requirements. Each customer should develop his own stock level based on operating experience.

The following items in the quantity specified may be used as guide:

7.1 RECOMMENDED RENEWAL PARTS FOR VCP CIRCUIT BREAKER

Description	Qty.
Interrupter Assemblies:	
50VCP250-1200A — 58 kA	3
50VCP250H-1200A — 78 kA	3
50VCP250-2000A — 58 kA	3
50VCP250H-2000A — 78 kA	3
50VCP250-3000A — 58 kA	3
50VCP250H-3000A — 78 kA	3
50VCP350-1200A — 78 kA	3
50VCP350-2000A — 78 kA	3
50VCP350-3000A — 78 kA	3
75VCP500-1200A — 66 kA	3
75VCP500H-1200A — 78 kA	3
75VCP500-2000A — 66 kA	3
75VCP500H-2000A — 78 kA	3
75VCP500-3000A — 66 kA	3
75VCP500H-3000A — 78 kA	3
150VCP500-1200A — 37 kA	3
150VCP500H-1200A — 58 kA	3
150VCP500-2000A — 37 kA	3
150VCP500H-2000A — 58 kA	3
150VCP500-3000A — 37 kA	3
150VCP500H-3000A — 58 kA	3
150VCP750-1200A — 58 kA	3
150VCP750H-1200A — 77 kA	3
150VCP750-2000A — 58 kA	3
150VCP750H-2000A — 77 kA	3
150VCP750-3000A — 58 kA	3
150VCP750H-3000A — 77 kA	3
150VCP1000-1200A — 77 kA	3
150VCP1000-2000A — 77 kA	3
150VCP1000-3000A — 77 kA	3

Description	Qty.
1200 Amp. Primary Disconnect	6
2000 Amp. Primary Disconnect	6
3000 Amp. Primary Disconnect	6
Operating Rods	3
Spring Charging Motor	
48V DC	1
125 DC/120 AC	1
250 DC/240 AC	1
Spring Release (Close) Coil	
48V DC	1
125V DC	1
250V DC	1
120V AC	1
240V AC	1
Shunt Trip Coil	
48V DC	1
125V DC	1
250V DC	1
Anti-Pump Y Relay	
48V DC	1
125V DC	1
250V DC	1
120V AC	1
240V AC	1
Motor Cut-Off Switch	1
Position Switch (DC Relay)	1
Resistor (AC Relay)	1
Latch Check Switch	1
Auxiliary Switch (Standard Breaker)	2
Auxiliary Switch (Breaker with Trip No. 2)	3
Fastener Kit	1

7.2 ORDERING INSTRUCTIONS

- Always specify breaker rating information and shop order number.
- Describe the item, give style number and specify the quantity desired.
- For electrical components, specify voltage.
- State method of shipment desired.
- Send all orders or correspondence to the nearest Westinghouse sales office.

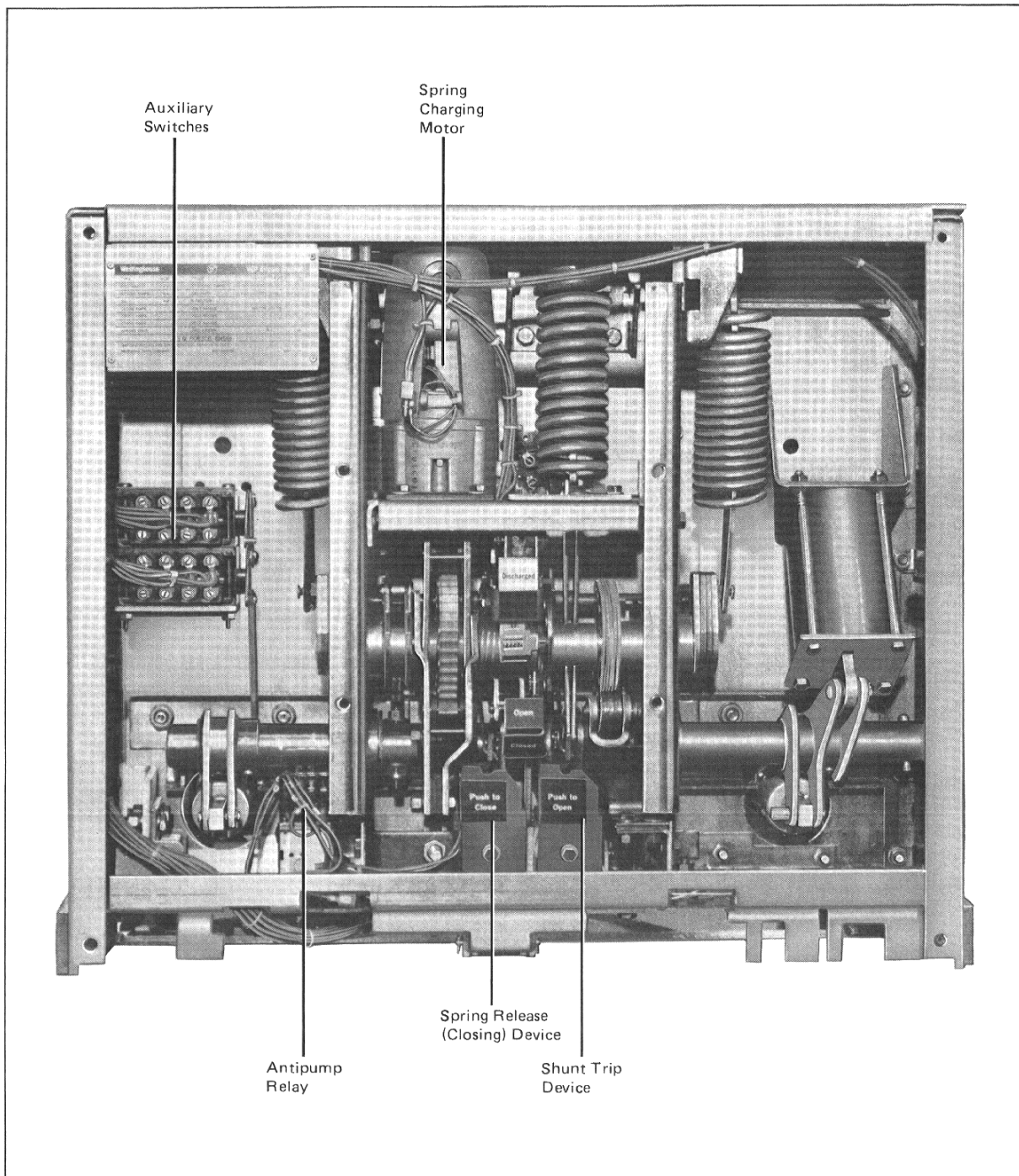


Fig. 20

Table 1: Application: Available Breaker Types Rated on Symmetrical Current Rating Basis

Identification			Rated Values						Related Required Capabilities③								
Circuit Breaker Type	Nominal Voltage Class	Nominal 3-Phase MVA Class	Voltage Rated Maximum Voltage	Rated Voltage Range Factor	Insulation Level Rated Withstand Test Voltage		Current Rated Continuous Current at 60 Hz	Rated Short Circuit Current (at rated Max. Kv) ②	Rated Interrupting Time	Rated Permissible Tripping Delay	Rated Max. Voltage Divided By K	Current Values					
	Kv Class	MVA Class	E Kv rms	K	Low Fre- quency	Impulse	Amperes	KA rms	Cycles	Sec.	E/K Kv rms	K Times Rated Short-Circuit Current② KI		1.6 K Times Rated Short-Circuit Current			
												KA rms	KA rms	KA rms			
VCP Vacuum Circuit Breaker																	
50 VCP 250	4.16	250	4.76	1.24	19	60	1200 2000 3000	29	5	2	3.85	36	36	58			
H 50 VCP 250①							1200 2000 3000							78①			
50 VCP 350		350		1.19			1200 2000 3000	41						4.0	49	49	78
75 VCP 500	7.2	500	8.25	1.26	36	95	1200 2000 3000	33	5	2	6.6	41	41	66			
150 VCP 500	13.8	500	15	1.30	36	95	1200 2000 3000		5	2	11.5	23	23	37			
H 150 VCP 500①							1200 2000 3000	18						58①			
150 VCP 750		750						1200 2000 3000						28	36	36	58
H 150 VCP 750①								1200 2000 3000									77①
150 VCP 1000		1000						1200 2000 3000						37		48	48

① Non-Standard Breaker with High Momentary Rating available for Special Applications.

② For 3 phase and line to line faults, the sym interrupting capability at a Kv operating voltage

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

But not to exceed KI.

Single line to ground fault capability at a Kv operating voltage

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

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.

③ For Reclosing Service, the Sym. Interrupting Capability and other related capabilities are modified by the reclosing capability factor obtained from the following formula:

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

Where C = KA Sym. Interrupting Capability at the Operating Voltage but not less than 18.

n = Total No. of Openings.

T₁, T₂, 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%.

④ Tripping may be delayed beyond the rated permissible tripping delay at lower values of current in accordance with the following formula:

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

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