GE FKP

CONTENTS

OIL-BLAST CIRCUIT BREAKERS TYPE FKP WITH ML 14 MECHANISM

INTRODUCTION

The type FKP oil-blast breakers have been designed especially for applications on transmission lines where high speed reclosing performance is required. High speed interruption of faults is obtained by the use of contacts employing the oil-blast principle of circuit interruption. High speed reclosing is obtained by the use of a simple rugged linkage which operates on low-friction bearings, and by employing arc resistant materials for the interrupting contacts.

To facilitate installation, the breaker has skids mounted on the front and rear of the frame. The operating mechanism is installed in a weatherproof housing which is mounted on the front end of the breaker framework. The three phases are mechanically connected so as to operate simultaneously.

The FKP breaker is available in a number of current and voltage ratings. For the complete rating information of any particular breaker, refer to the breaker nameplate.

The short circuit conditions to be imposed on the breaker must not exceed its rating, nor should it be called upon to operate at voltages or currents greater than those given on the nameplate. These breakers may be used at any altitude up to 3300 feet. Use at higher altitudes requires selection of special bushings.

NOTE

Proper installation and maintenance are necessary to insure continued satisfactory operation of the breaker.

The following instructions will provide information for placing the oil-blast breaker in service and for maintaining successful operation. It should be kept in mind that the illustrations shown in this instruction book are for illustrative purposes and may not always be an actual picture of the equipment being furnished. For final information always refer to the drawings which are furnished separately with the equipment. For additional instructions concerning the operating mechanism and auxiliary equipment, refer to the individual instruction books for these devices.

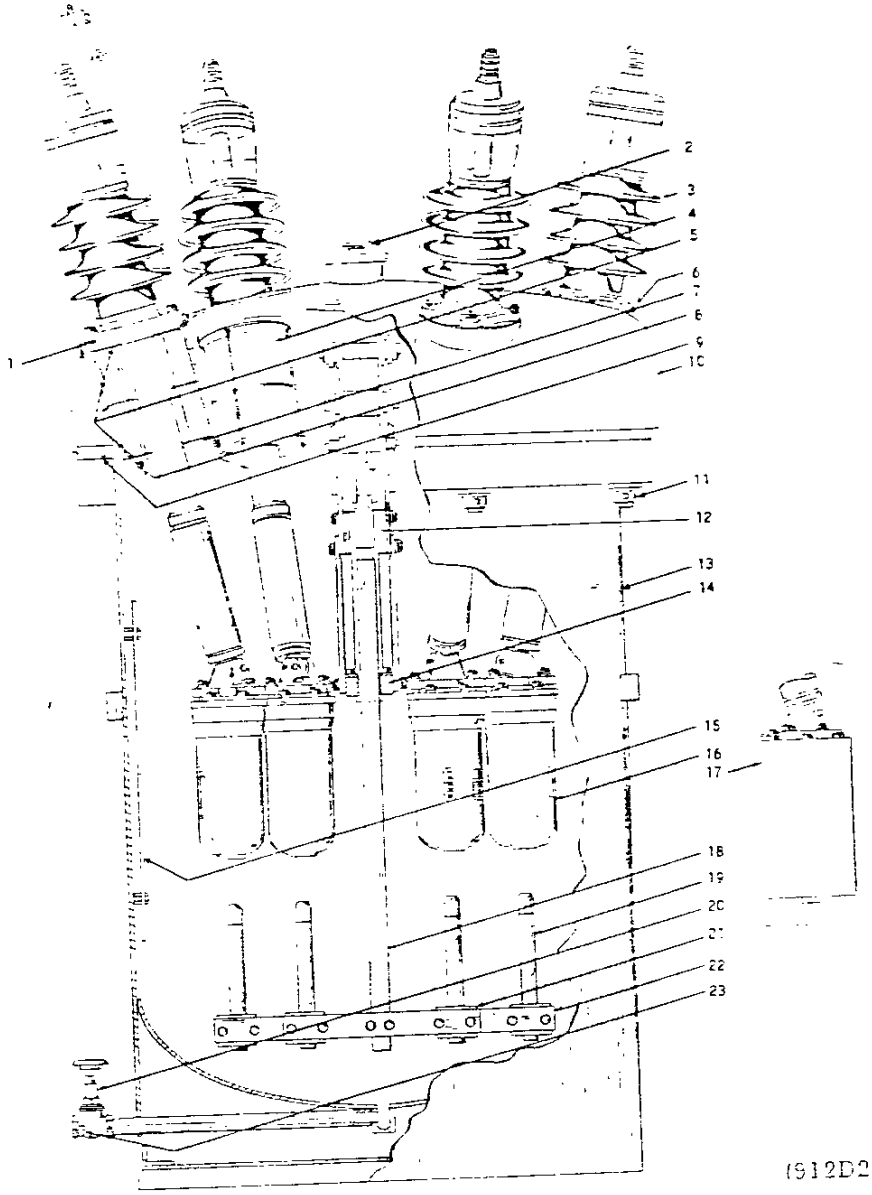
RECEIVING, HANDLING AND STORAGE

All breakers are assembled and tested at the factory. Normally, they are shipped completely assembled; that is, with the bushings, bushing current transformers, interrupters, moving contact members, and breaker linkage in place. The operating mechanism and its housing are shipped assembled on the front end of the framework.

Immediately upon receipt of this equipment examine it for any damage that might have been sustained in transit. If injury or rough handling is evident, a damage claim should be filed with the transportation company and the nearest Canadian General Electric Company Limited Apparatus Sales Office should be notified promptly.

UNPACKING AND HANDLING

Crating or boxing must be removed carefully. Use a nail puller to open the crates and do not allow either the crate or the bushing to be struck by tools while handling. The porcelains of the bushings and other parts are sometimes broken by carelessly driving a wrecking bar into the crates or boxes. If any parts made of insulating material are shipped separately, they should be protected from moisture, dirt, and damage due to rough handling. Check all parts against the packing list to make certain that no parts have been overlooked while unpacking. Always search the packing material for hardware which may have loosened in transit. All tags should be left on the



1. H.V. Bushing Gasket
2. Breather
3. Bushing
4. Current Transformer
5. Insulation Washers
6. Mounting Stud
7. Support Plate
8. Assembly Stud
9. Gasket
10. Tank Dome
11. Tank Nut
12. Shims
13. Tank
14. Lift Rod Guide
15. Liner
16. Standard Interrupter
17. Capacitor Switching Interrupter
18. Lift Rod
19. Contact Rod
20. Drain Valve
21. Contact Block
22. Crossarm Device
23. Sampling Device

FIGURE 1 FKP BREAKER - CROSS-SECTIONAL VIEW

parts until they are ready for installation. Cables used to lift the breaker should be as long as possible to prevent damage to the bushing.

STORAGE

When the breaker can be set up immediately in its permanent location and filled with oil, it is advisable to do so, even though it will not be placed in service for some time. The oil tanks should be cleaned and dried before they are filled with oil. The crating, if used, should not be taken from the bushings until after the breaker has reached its permanent location and all overhead work has been completed.

If stored outdoors, the breaker tank should be filled with oil to protect the insulating parts. The space heater in the operating mechanism housing should be energized as soon as possible in order to prevent moisture condensation inside the housing.

If the interrupters are stored separately, they should be kept in a dry room. If they must be left outdoors for a short time, they should be thoroughly covered to protect them from the weather. Under extreme conditions of humidity, or if the only storage space is damp, they should be kept in suitable containers filled with GE #10-C oil.

Replacement parts, especially lift rods, guides and other parts made of insulating material, should be stored in a dry room. It may also be advisable to hang the lift rods and guides in a vertical position to minimize the possibility of warpage, if a level storage surface is not available.

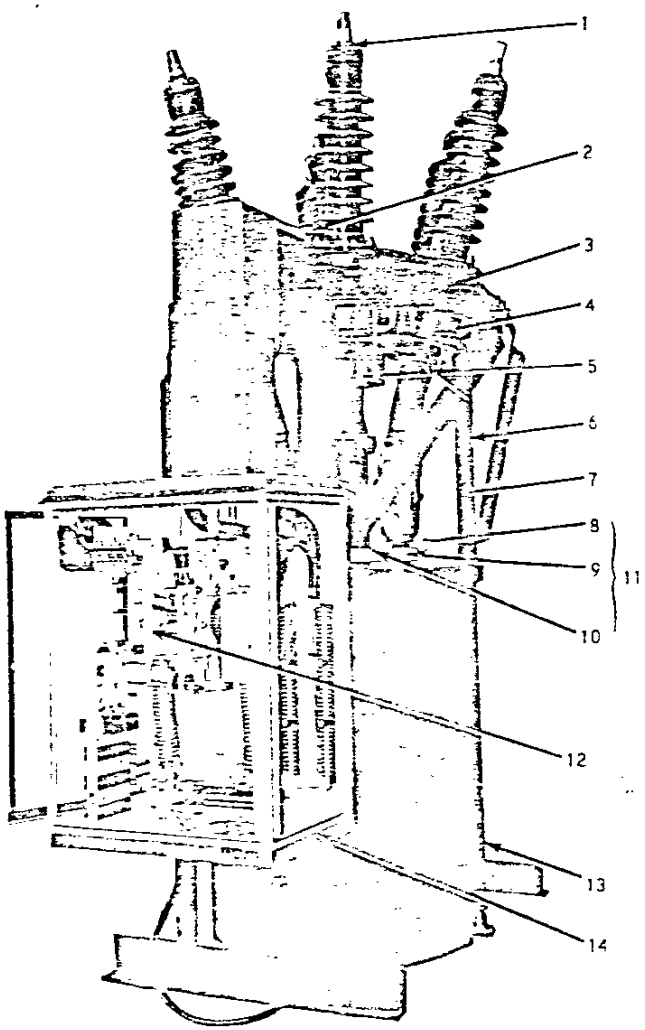
DESCRIPTION

BREAKER

Each circuit breaker is composed of an operating mechanism and a breaker assembly mounted on a common framework, as shown in figure 2. The breaker assembly consists of an oil tank, which contains the interrupters and contacts, and a top frame, which houses the breaker linkage and bushing current transformers and supports the bushings and contacts.

The breaker linkage, which is assembled in the top frame, is designed to give straight line motion to the moving contacts and to convert the motion of the operating mechanism to the proper breaker stroke. The breaker linkage is connected to the operating mechanism by an adjustable connecting rod.

A gas and oil seal is provided around the horizontal connecting rod to form a separation between the front crank box and the oil tank. An adjustable opening spring, located on the end of the operating rod, insures positive opening action and determines contact speed and parting time.



(H1178)

1. Bushing
2. Closing Buffer
3. Top Frame
4. Bushing Current Transformer
5. Opening Dashpot
6. Framework
7. Interrupter
8. Contact Rod
9. Crossarm
10. Lift Rod
11. Moving Contact Assembly
12. Mechanism
13. Ground Pad
14. Mechanism House

FIGURE 2 TYPE FKP BREAKER - MAJOR ASSEMBLY UNITS

A closing buffer and an oil filled opening dashpot are located in each phase. The closing buffer is used to prevent excessive overtravel of the moving contacts on closing and the opening dashpot is used to absorb the energy of the moving parts at the end of the opening stroke. The dashpots use the same kind of oil as used in the breaker tank. They are self-contained and will operate properly whether the oil tanks are filled or not. Since very little oil is lost during breaker operation, they will require only periodic inspection.

A 'breather' (2, figure 1) is mounted on the center phase buffer (14, figure 6) to vent any oil vapor caused by circuit interruption.

An oil gauge (25, figure 5) installed near the top of the tank, indicates the oil level directly. The correct oil level at normal temperature (20°C) is indicated on the breaker outline drawing and by a painted line on the gauge glass. The minimum oil level is the bottom of the visible portion of the gauge glass. This corresponds to the portion of the bushing which must always be immersed in oil.

The oil tank (13, figure 1) is suspended in place against the tank dome (10) by eight bolts which compress a gasket. The bolts must be tight to prevent oil leakage by the tank gasket during circuit interruption. This arrangement permits easy removal of the tanks for inspection and maintenance of the contacts and interrupters. A drain valve (20) is attached to a drain pipe at the bottom of the tank so that the tank can be completely emptied. The valve should be capped or plugged to prevent any possible leakage.

Each interrupter is mounted on the lower end of a bushing (3) by means of an adapter, which is also used to permit alignment of the interrupter.

Refer to figure 3. The interrupter consists essentially of a fiberglas tube enclosing a set of six primary contact fingers, two of which have arcing tips, and a baffle stack. The body tube has two port openings which allow the proper flow of oil across the contacts and through the baffles during interruption.

For a detailed explanation of the operation of the breaker refer to the section OPERATION. For complete information on the operating mechanism, see the mechanism instruction book PGEI 1315.

BUSHINGS

The bushings are installed in the top frame from above. Weathertight gaskets are inserted between the support flange and the top frame. Each bushing has provisions for two current transformers and the bushings can be installed and removed from the breaker without disturbing the bushing current transformer.

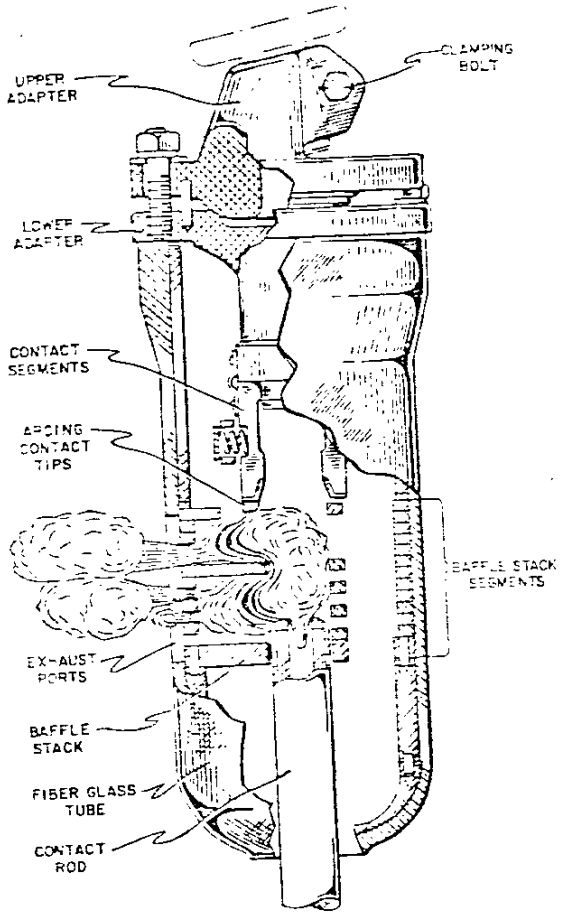


FIGURE 3 VIEW OF INTERRUPTER SHOWING ARC INTERRUPTION

BUSHING CURRENT TRANSFORMER

Bushing current transformers, Type BR are used on these breakers to provide a source of current supply for operating breaker trip coils and protective relays. Relaying transformers are of the multi-ratio type having leads which provide a wide range of ratios. Ratio and accuracy classification for standard transformers are in accordance with NEMA SG-4 specifications.

High accuracy single tap metering type current transformers can also be furnished. These have compensation applied for specified loadings and cannot be used on other loadings without affecting their accuracy. Ratio and accuracy classification for standard transformers of this type are also in accordance with NEMA SG-4 specifications.

Performance data in the form of ratio curves are available for standard transformers of standard ratios. These are supplied with the order or can be secured from the Power Delivery Department by giving the proper references.

Bushing current transformers are mounted inside the top frame. They are installed from underneath the top frame and they can be slipped over the lower end of the bushing, although the interrupters must be removed first. A supporting ring bolted to the top frame holds the transformer in place. Insulation washers above and below the transformer protect it from injury. It must be properly centered in the housing to prevent damage when the bushing is installed.

Leads from each transformer are carried on the inside of the top frame to the operating mechanism housing. These pass through a hole in the back plate of the housing and through an oil seal inside the housing.

Transformers should be connected in accordance with instruction 296 to ensure proper polarity and correct connections.

OIL

The specified high-speed performance of the modern oil-blast breaker is dependent upon the use in the breaker of oil having the proper characteristics. It is recommended that GE #10-C oil be used in these breakers since its characteristics, particularly at low temperatures, make it especially suited for use in oil-blast breakers.

Before final adjustments are made, the oil tank should be filled with GE #10-C oil. Precautions must be taken to be sure of absolute dryness and cleanliness of the apparatus before filling and to prevent the entrance of water and dirt during the transfer of oil to the apparatus. For more detailed information on equipment and procedure for filtering GE #10-C oil, obtain Bulletin GEA-4937 from the nearest Canadian General Electric Sales Office.

FILLING THE TANK

Before filling with oil, all accessories, such as the drain valve and oil gauge, must be oiltight. The threads should be filled with *Glyptal or equivalent. A plug is furnished for the outlet side of the drain valve and should be used to prevent any leakage if the valve seat becomes damaged from use.

In filling, care must be taken so that moisture will not be absorbed by the oil during the filling process. When cold drums of oil are brought into a warm place, they should be allowed to stand before opening until there is no condensation on the outside and until they are thoroughly dry. The preparation and filling should be done on a clear, dry day or adequate protection of some kind provided against moisture being absorbed. Metal or oil-proof rubber hose must be used, as oil dissolves the sulphur in ordinary rubber hose. This may cause trouble, as sulphur attacks copper.

TESTING THE OIL

All new oil should be tested before being placed in the breaker. The dielectric strength of the oil when shipped is at least 30,000 volts when tested in a standard gap with one inch disk terminals 0.1 inch apart. New oil of less than standard dielectric strength (30,000 volts) should not be placed in the breaker oil tanks until its insulating value has been brought up to the above standard (by filtering, etc.).

TANK HEATERS

Tank heaters are provided for areas of low ambient temperature. Heaters should be energized when the ambient temperature falls below 0 F.

INSTALLATION

The installation of the breaker will be facilitated by a study of those approved drawings which supplement these instructions. The approved drawings, which include an outline of the breaker and connection diagrams, provide information necessary for the proper installation of the breaker.

Before any work is done, these drawings and all related instruction books should be consulted.

LOCATION

The breaker should be located so that it will be readily accessible for cleaning and inspection. Sufficient space must be provided for operation of the tanklifter and for easy removal of the oil tank. The breaker should be mounted high enough so that it can be operated with the oil tank lowered without the moving contacts splashing in the oil. Where flood conditions exist, the mechanism housing should be above high water level.

MOUNTING

The total weight of the breaker with oil is given on the outline drawing and on the nameplate. This information will serve as a guide to the strength of the lifting means required for handling the breaker. It may be lifted by hooking into the framework. When using cable slings, do not allow the slings to strike the bushings, as any strain on these may cause them to crack or break.

As the breakers are shipped assembled on their frameworks, it is only necessary to correctly locate and fasten the frame in position on its foundation. The foundation bolts should be left loose to permit the frame to be properly plumbed and leveled by inserting shims under the feet of the frame where necessary. After this has been done, the foundation bolts should be tightened and the frame fastened securely to its foundation.

* Reg. trade-mark of General Electric Co.

CONNECTIONS

After the breaker has been located, electrical connections can be made.

WARNING

BEFORE MAKING THESE, ENSURE THAT ALL LEADS TO BE CONNECTED TO THE BREAKER ARE DE-ENERGIZED.

PRIMARY CONNECTIONS

Leads should be brought down from above if possible. Ample electrical clearance must be provided between these leads and parts of the station, such as walls, channels, and framework. Leads should be properly supported so that the breaker bushings are not subjected to unnecessary strains. The bushings should not carry cable or bus bar strains. To avoid overheating, the connecting leads must be of a current-carrying capacity at least equal to the maximum operating current of the circuit, which should not exceed the breaker rating.

Connections to the breaker are made by bolted connectors fastened to the ends of the bushings. The bolts on the terminal connectors must be securely tightened to obtain good contact. All joints must be clean, bright and free from dents or burrs.

CONTROL AND SECONDARY WIRING

All control wires should be run in conduit insofar as it is practicable. Control wires must be run separately and remote from high tension leads and must not be run in the same duct or parallel to the high tension leads unless the distance separating the two sets of wiring is sufficient to prevent possible communication between them as a result of short circuits. Control wiring of adequate size should be used so that with full operating current flowing to the operating mechanism, the voltage across the terminals of the mechanism will be within the limits specified as standard for the range of control voltage. It is recommended that all conduits entering the mechanism housing be sealed off at their entrances to the housing.

Control and bushing current transformer connections are made inside the operating mechanism housing where suitable terminal boards are provided. Connection diagrams are supplied for each breaker showing the proper connections for the operating mechanism and the bushing current transformers. Remove the shorting wires from the BCT terminal boards only after the BCT circuitry is completely wired.

GROUND CONNECTIONS

The framework of each breaker should be permanently grounded. The usual practice is to connect a heavy cable to the framework and to the ground. A grounding pad is provided on a leg of the framework to which a terminal can be attached. The grounding cable should be of sufficient size to carry 25 percent of the current rating of the breaker but not smaller than #4/0.

A good permanent low resistance ground is essential for adequate protection.

WARNING

A POOR GROUND MAY BE WORSE THAN NO GROUND AT ALL, SINCE IT GIVES A FALSE FEELING OF SAFETY TO THOSE WORKING AROUND THE EQUIPMENT AND MAY RESULT IN ULTIMATE DANGER TO BOTH EQUIPMENT AND PERSONNEL.

TANKLIFTER

The hand operated tanklifter for these breakers consists of two portable hoists of either the chain or cable type. They are hooked into slots in opposite sides of the breaker frame. The operation of the tanklifters is shown in figure 4. The hoists being light and portable are easily carried by the maintenance crew.

PRECAUTIONS

1. Before removing the tank or doing any work on the breaker, make certain that the primary circuits are open and effectively grounded.

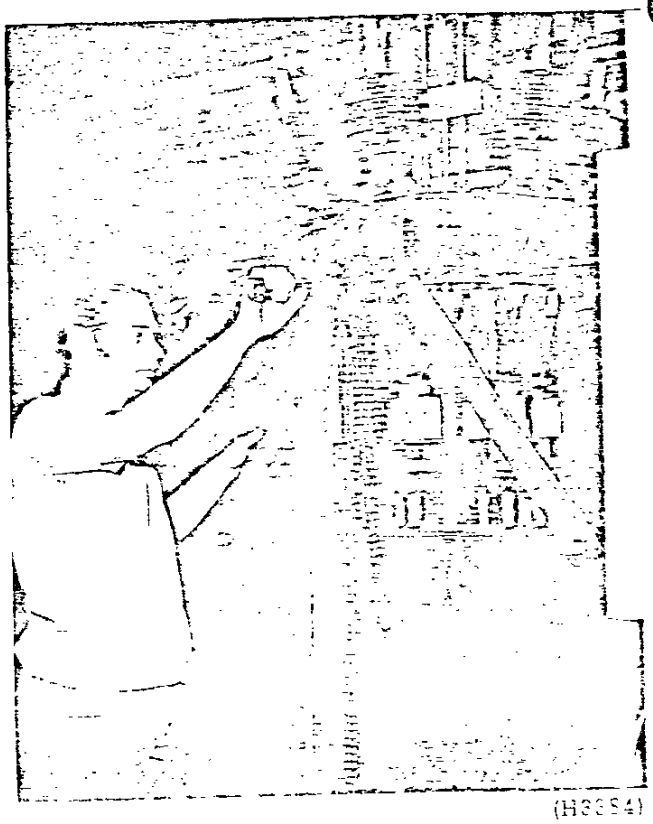


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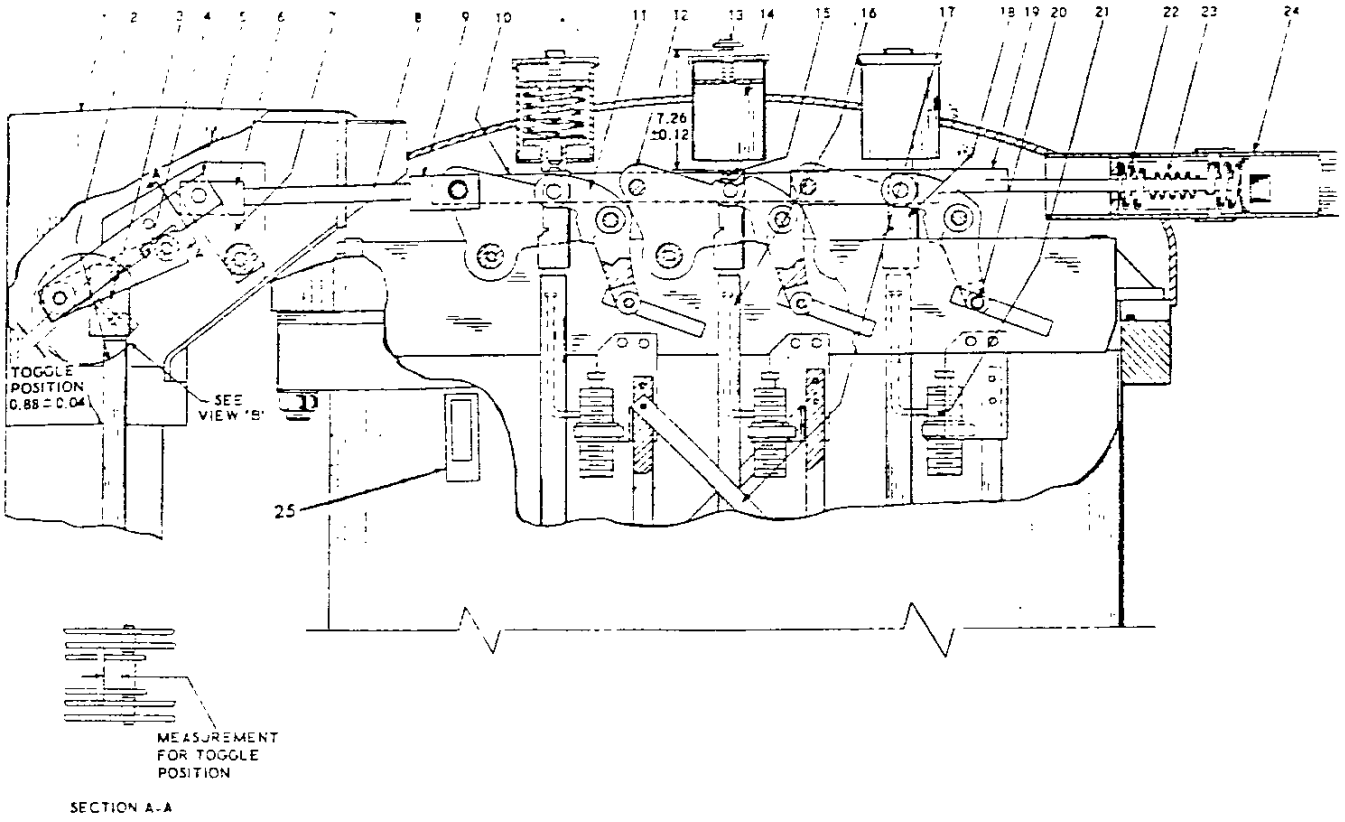
FIGURE 4 TANK LIFTER



(144C4506)

1. Front Crank Cover
2. Operating Rod
3. Front Coupling
4. Front Crank
5. Front Link
6. Connecting Rod Coupling
7. Guide Crank
8. Connecting Rod
9. Connecting Rod Coupling
10. Connecting Link
11. Lever
12. Lever
13. Breather
14. Closing Buffer
15. Analyzer Rod Connection
16. Lift Rod
17. Cross Brace
18. Lift Rod Coupling
19. Linkage Arm
20. Lever Pin
21. Opening Dashpot
22. Opening Spring
23. Follow-through Spring
24. Opening Spring Cover
25. Oil Gauge

FIGURE 5 BREAKER LINKAGE

2. Make certain that all control circuits are de-energized until electrical operation is to be performed.

3. Exercise extreme care when working on the operating mechanism. See the mechanism instruction book for additional precautions and instructions.

4. Operation of the breaker in air is not recommended, although a few air operations are permitted to check the stop clearance.

5. For manual operation refer to the mechanism instruction book.

ADJUSTMENTS

Although the breaker has been completely set up, adjusted and tested at the factory, it is recommended that all adjustments be reviewed to make certain that no change has occurred during shipment and installation. The breaker should be closed slowly by hand, using the maintenance closing device, to see that it is smooth throughout closing, that no binding occurs, and that no excessive play is noticeable between parts. Electrical operation should only be attempted after it is certain all adjustments are correct. Details of the breaker adjustments are contained in the following paragraphs.

Complete instructions for checking the operating mechanism adjustments will be found in the operating mechanism instruction book.

Using the tanklifter, as shown in figure 4, the tank can be lowered, leaving the contacts and pole unit mechanisms accessible for inspection. The trip latch of the operating mechanism is wired in place during shipment and this wire must be removed before the adjustments can be checked. All blocks and wire used to hold parts in place during shipment must be removed before the breaker is tripped open.

LINKAGE POSITION ADJUSTMENT

The position adjustment is the means of determining the correct breaker linkage position when the breaker is closed.

Using the maintenance closing device, slowly close the breaker until the prop latch of the operating mechanism just falls into place to hold the mechanism in the closed position. To prevent accidental opening, insert the blocking devices per the mechanism instruction book. Measure the lift rod setting on the center phase as shown in figure 5. This measurement is 7.26 inches plus or minus 0.12 inch.

The first and third phase lift rod settings are plus or minus 0.12 inch from the setting obtained on the center phase.

Measure the external toggle setting. This is 0.88 inch plus or minus 0.04 inch.

Measure the lift rod to the lever pin (20, figure 5) clearance with the breaker closed. This should be a minimum of 2.94 inches. It is sufficient to measure this on phase 3 only. See 'L' figure 17.

If these adjustments must be changed, the following procedure should be followed, either completely or in part, in order to obtain the settings within the specified limits.

The breaker connecting rod (8, figure 5), as well as the vertical operating rod (2), have right- and left-hand threads. Shortening of these rods will reduce these settings. Adjustment of the toggle is attained by loosening the locking bolt in the front coupling (3) and the similar locking bolt (not shown) on the mechanism end of the operating rod. Turn this rod clockwise from the top to cause shortening of the rod and closing of the toggle. Lengthening the rod would open up the toggle. This procedure will change the position setting of the breaker linkage of all three phases at the same time. Tighten the locking bolts and recheck the toggle setting and the lift rod setting.

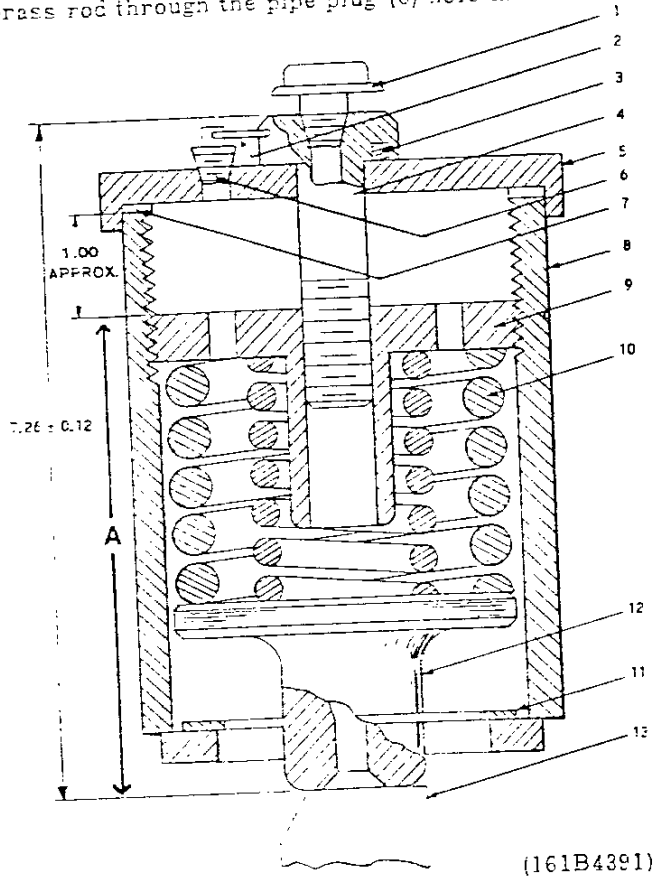
In a similar manner, the lift rod setting of the breaker linkage is adjusted by changing the length of the breaker connecting rod (8, figure 5). Altering the position setting may affect the closing buffer adjustment. Final measurement should be made after closing the breaker electrically with the breaker oil tanks in the down position and the contacts in air. Readjust as necessary to above values.

When adjustment is completed, be sure all hardware, locking bolts and plates are tight.

CLOSING BUFFER ADJUSTMENT

The closing buffer is set at the factory and should not require further adjustment. These units are set in conjunction with the lift rod setting and external toggle, and a change in either may require adjustment of the other. With reference to figure 6, and the breaker in the closed position, the adjusting disk (9) is turned down. As a starting point in making this setting, the top of the adjusting disk may be preset initially to approximately 1.00 inches below the top of the buffer housing (8).

When installing the cover bolt (4), insert a steel or brass rod through the pipe plug (6) hole in the cover



(161B4391)

1. Breather
2. Locking Wire
3. 'O' Ring
4. Cover Bolt
5. Cover
6. Plug
7. Gasket
8. Buffer Housing
9. Adjusting Disc
10. Springs
11. Shims (Used For 3 Phase Levelling)
12. Plunger
13. Lift Rod Coupling

A: 5.10 - 5.46 Factory Setting - See Inspection Sheet

FIGURE 6 CLOSING BUFFER

(5) and into one of the holes in the adjusting disk (9) to prevent the adjusting disk from turning while tightening the cover bolt. Remove the rod after the cover bolt is tight and insert the pipe plug (6) and the locking wire (2).

INTERRUPTER ADJUSTMENT

After the breaker linkage is adjusted, the contacts should be checked. Refer to figure 8. The interrupters (8) which are fastened to the lower ends of the bushings (4) must be aligned to a vertical position, with the two exhaust ports of each interrupter facing the tank as shown. Visualize a straight line through the center phase lift rod and through the center of each interrupter in turn. This line should pass exactly between the two exhaust ports of each interrupter when the ports face towards the breaker tank. The use of a spirit level will assist in aligning the interrupter. Loosening the adapter clamp (6) allows the interrupter to be moved in any direction about the vertical. Additional lateral adjustment is possible by loosening the bushing mounting bolts and changing the seating of the bushing. The contact rods move up through the throat of the chamber and, therefore, the centerline of the interrupter should coincide with the centerline of the contact rod (10). The crossbar (11 and 12) is slotted so that by loosening the locknuts the contact rods can be moved in or out to obtain alignment with the throat. The contact block can be turned end for end to obtain additional adjustment.

CONTACT WIPE ADJUSTMENT

1. With the breaker closed, measure distance 'a' (figure 7) for each interrupter.
2. Add 'a' plus 9.74* equals 'b' for each interrupter.

   * Dimension derived from glass tube length (nominal) less casting projection (nominal) and less 0.82 inch for clearance.

   i.e. 13.56 - 3.00 - 0.82 = 9.74
3. Adjust the candle length above the block or blade to 'b'.
4. Check the contact touch for all interrupters with six - lights. Screw only the candles down (max. 0.12) to bring all touches simultaneously within 0.12 of lift rod travel.

   NOTE

   The arcing tips may cause early touch and confuse the check.
5. Contact touch, as checked by lights, may be plotted as a touch line on the travel analyzer chart. The distance between this touch line and the fully closed line represents contact wipe and should be between 0.50 and 0.74 inch.

The electrical wipe of each phase of the breaker should now be recorded as an indication of the setting of the contacts. This will afford a quick check of the

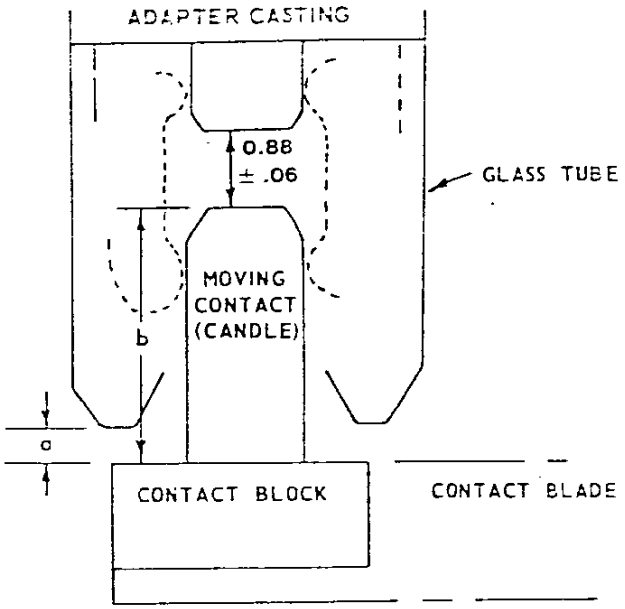


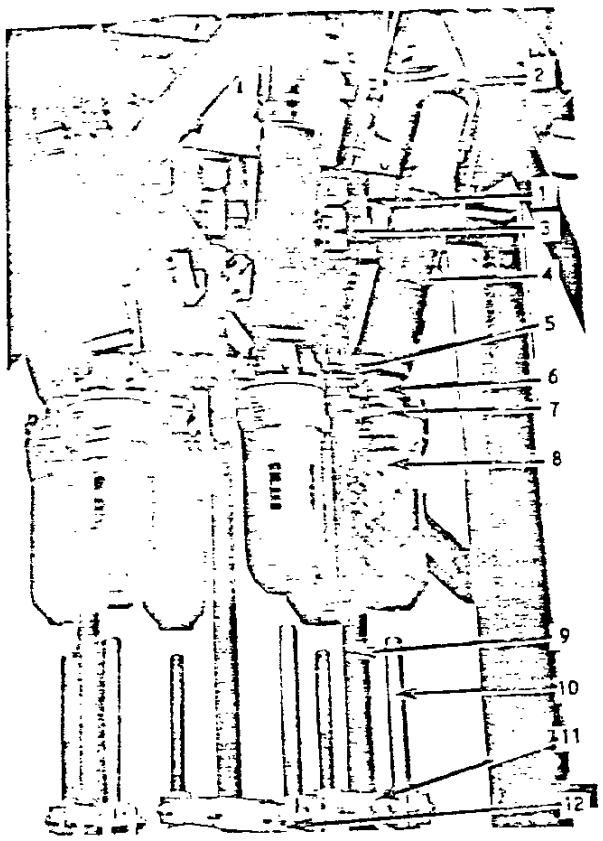
FIGURE 7 GLASS TUBE INTERRUPTER

adjustment of the contacts without the necessity of dropping the tank at a future date. The bellset wipe is not an indication of the condition of the contacts. The bellset wipe does not equal the contact rod insertion into the contact fingers due to the curved portion of the contact rod and the curved portion of the contact fingers breaking contact while the contact rod is still inserted in the finger cluster.

To change the contact insertion, loosen the locknuts and rotate the contact rod (10, figure 8) in the appropriate direction. At the same time there should be at least 0.5 inch clearance between the bottom of the interrupter and the crossarm (11 or 12) with the breaker closed, so that overtravel will not damage the interrupter or contacts. Tighten the locknuts and recheck all the contact adjustments and alignment. With the breaker properly adjusted, the contacts of the three phases should make and break at approximately the same time, or within 0.26 inch of each other.

If ductor readings are to be made on the breaker, they should be checked before oil is placed in the tanks. A 100 ampere ductor should be used to measure the resistance of the contacts. Checking this way will eliminate the necessity of draining the oil should a high reading be found. A complete pole unit (bushing terminal to bushing terminal) should measure 400 microhms or less when new. The reading should not exceed 700 microhms after the breaker has been in service.

It is a good practice to check the bushing current transformers before placing oil in the tanks. If any damage has occurred in transit or installation it can be corrected with a minimum of lost time. This procedure also insures the removal of any grounding



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1. Opening Dashpot
2. Bushing Current Transformer Support Plate
3. Lift Rod Coupling
4. Bushing
5. Lift Rod Guide
6. Upper Adapter and Clamp
7. Lower Adapter
8. Interrupter
9. Lift Rod
10. Contact Rod
11. Crossbar
12. Crosstar

FIGURE 8 BREAKER UNIT

or shorting connections which may have been left on the BCT leads after the completion of factory tests and installation of the customer's permanent BCT circuitry.

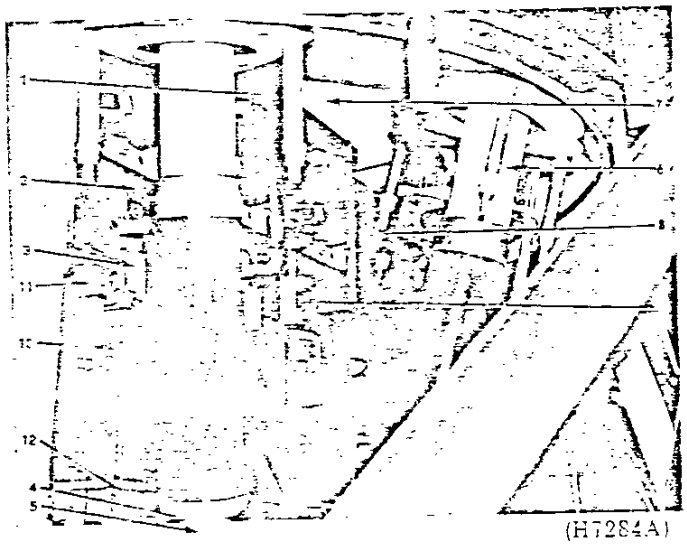
STROKE

After the closed position adjustments of the breaker have been completed, it will be necessary to check the breaker in the open position.

The opening dashpots (11, figure 9) should be checked for proper oil level, and filled with GE #10-C oil if necessary. This check should be made with the piston up; that is, with the breaker in the partially closed position so that the lever (2) is not touching the piston. A small pipe plug is located at the oil level line. If the oil level is even with the bottom of this hole, the oil level is satisfactory and the breaker can be opened.

The stroke of the breaker, which is the total movement of the lift rod (10) from the fully closed to the fully open position, should measure 12 inches plus or minus 0.26 inches as specified on the outline drawing. The minimum stroke of the lift rod from the fully closed position during a reclose operation must not be less than 10 inches with the breaker contacts in GE #10-C oil. The dashpot should be the final stop of the breaker in the open position. The dashpots are threaded to permit adjustment for this purpose. Raising the dashpots shortens the stroke and lowering them lengthens it. When making adjustments, all dashpots should be made to operate at approximately the same time.

The normal oil level at 20 C is indicated on the outline drawing. A float type oil gauge is supplied. The range between minimum and maximum is represented by the visible portion of the gauge glass and covers a temperature range from plus 40 C to minus 30 C. The oil level at any intermediate temperature is represented by a proportionate part of the gauge range. It is important that the oil level never falls below the minimum level. This is selected so that the lower porcelain of the bushing will always be immersed and prevent corona discharge from the ground sleeve.



(H7284A)

1. Connecting Link
2. Lever
3. Lift Rod Coupling
4. Upper Adapter and Clamp
5. Interrupter
6. Ground Sleeve of Bushing
7. Closing Buffer
8. Beam
9. Support for Opening Dashpot & Lift Rod Guide
10. Lift Rod
11. Opening Dashpot
12. Lift Rod Guide

FIGURE 9 BREAKER LINKAGE

The breaker should not be energized for at least twelve hours after filling to permit air bubbles to escape from the oil due to the possibility of decreasing the dielectric strength of the oil.

OPERATING MECHANISM CHECK

Visual inspection of the mechanism should be made to see that all cotter pins are in place, all nuts and terminal connections tight, no binding present, and that the mechanism is properly lubricated in accordance with the mechanism instruction book.

SPEED ADJUSTMENT

After completing the preceding installation adjustments and inspection, and after filling the tank with oil, the breaker may be operated electrically to check the speed adjustment.

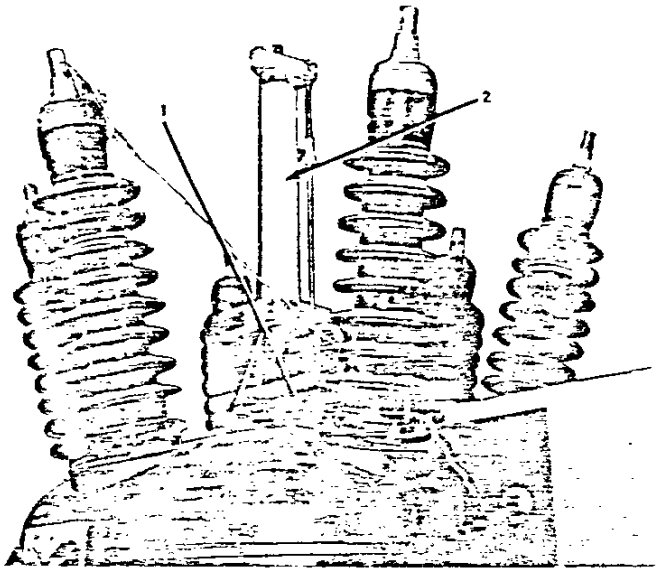
A travel analyzer should be attached to the breaker to obtain an accurate travel record of breaker performance. A #10-24 tapped hole is located in the top of the lift rod coupling, as indicated in figure 5, to accommodate the rod used with the travel analyzer. Access to this tapped hole is by removal of the breather (13, figure 5) which is screwed into the closing buffer assembly. The travel analyzer (2, figure 10) is readily mounted on brackets.

The opening speed is determined by drawing a straight line through two points on the travel curve (see figures 11 and 12). One point is to be located on the opening curve 1.12 inches from the fully closed position. This is the point at which the contacts part. The second point is to be located on the opening curve 6.12 inches (measured vertically) from the fully closed position. The slope of this line is an indication of the opening speed.

If it is found necessary to readjust the opening speed of the breaker, change the setting on the opening spring (22, figure 5). By setting this spring to have less compression in the closed position, the opening speed will be reduced. It also follows that by setting the spring to have more compression in the closed position, the opening speed will be increased. Any adjustment of the opening spring will change the adjustment of the contact stop clearance. After adjusting the opening spring, check the contact clearance. Readjust as necessary.

The average closing speed can be determined in a similar manner by drawing a straight line through two points located 1.12 inches and 2.12 inches from the fully closed position. The closing speed is controlled by the operating mechanism. There is no adjustment for the closing speed. For additional information, consult the mechanism instruction book paying particular attention to the section on INSTALLATION ADJUSTMENTS.

The overtravel of the lift rod must not exceed 0.26 inches. The best way to accurately measure this is to place some putty about 0.50 inches above the pencil head on the analyzer, with the breaker in the closed position. Trip and close the breaker. If the pencil head does not touch the putty, move the putty down, and repeat this operation until the pencil head just touches the putty during the closing operation. If the overtravel is found to exceed 0.26 inches, check the buffer setting.



(H4475)

1. Analyzer Support Brackets
2. Straight Line Travel Analyzer

FIGURE 10 INSTALLATION OF TRAVEL ANALYZER

When opening in oil, the breaker should open the full stroke. The travel curve will be acceptable if the indicated rebound is less than 0.62 inches. A slight variation between the three phases within the above tolerance is permissible.

SUMMARY OF ADJUSTMENTS AND CHECKS

Refer to figure 18 for physical location.

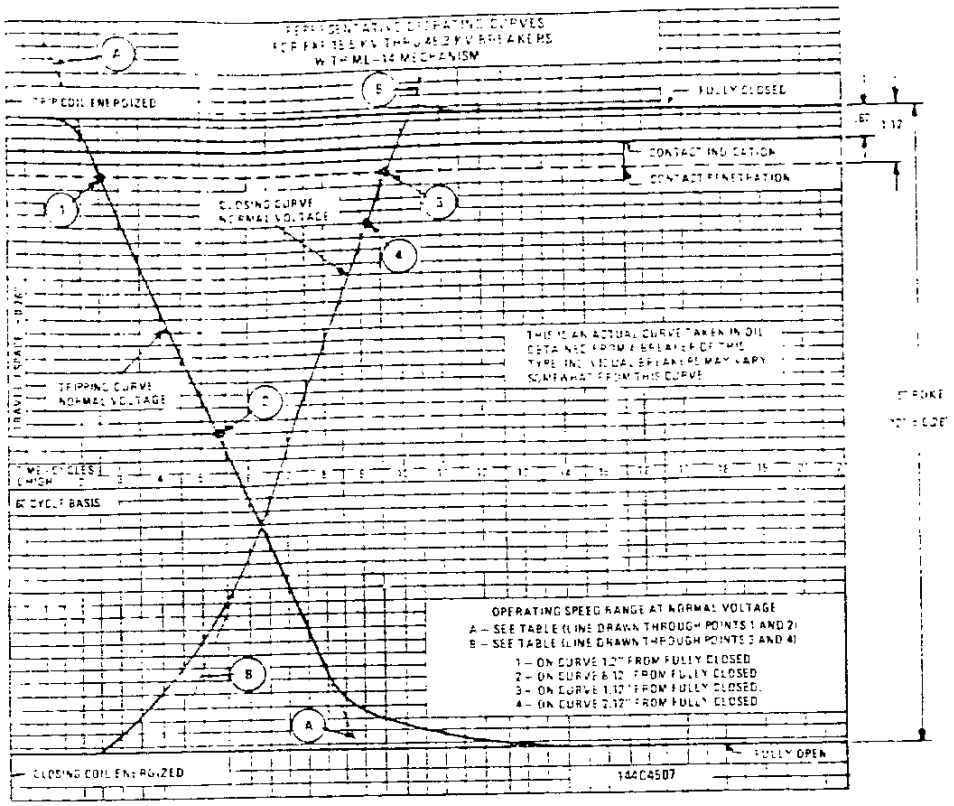
With the tank off:

A. The overtravel stop setting, which is used as an indication of the internal lift rod setting, should be 0.26 inches plus 0.015 inches minus 0 with the breaker in the closed position.

B. The toggle position, which is an indication of the toggle linkage, should be 0.88 inches plus or minus 0.04 inches in the breaker closed position.

C. Phase 1 and phase 3 lift rod settings are compared with the lift rod setting of phase 2 and must be within plus or minus 0.12 inches of the phase 2 lift rod setting in the breaker closed position.

D. Phase 2 lift rod setting should be 7.26 inches



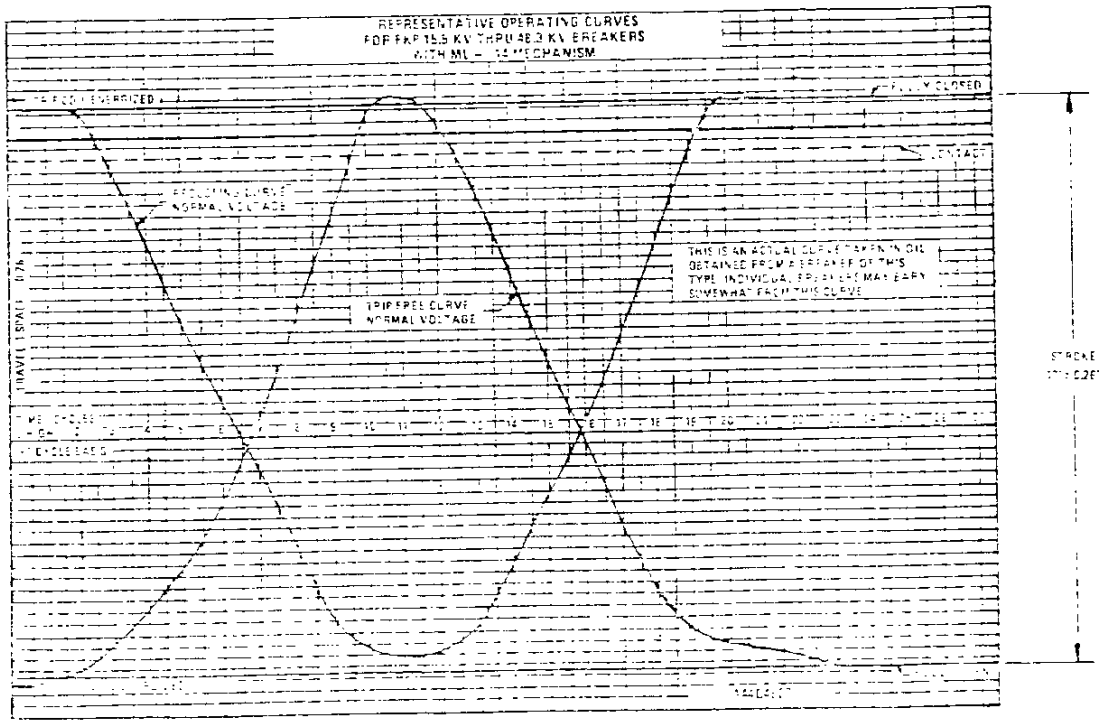
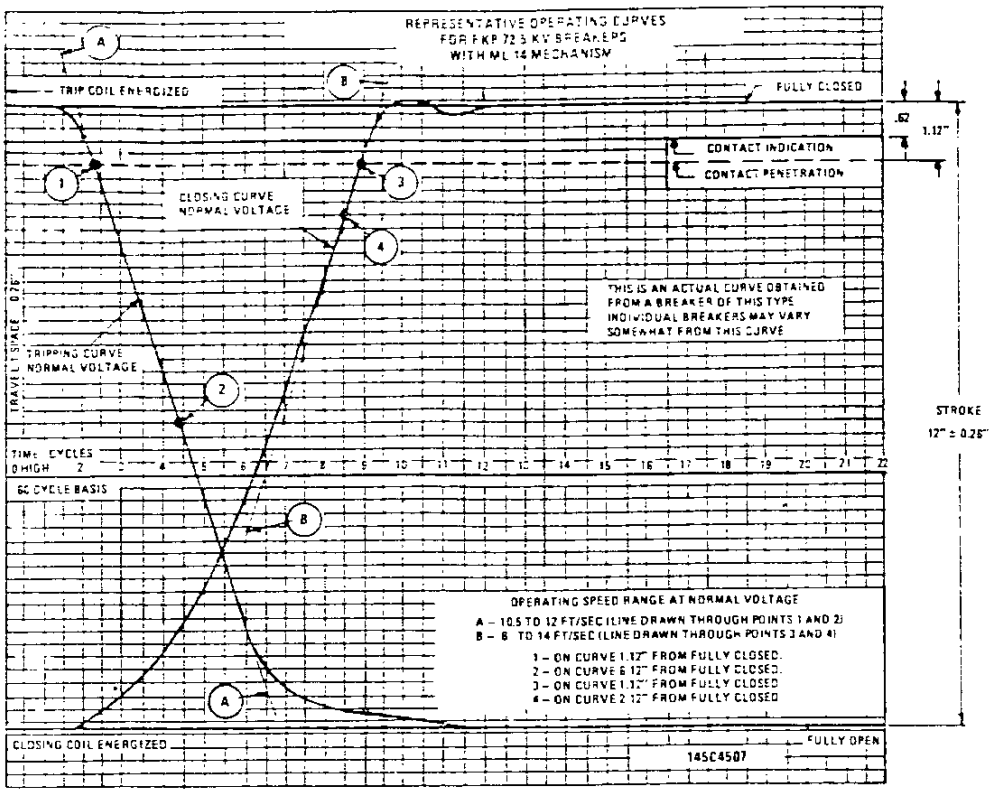


FIGURE 11 REPRESENTATIVE OPERATING CURVES WITH AN ML-14 OPERATING MECHANISM FOR FKP 15.5 kV THRU 48.3 kV BREAKERS. CURVES TAKEN IN OIL



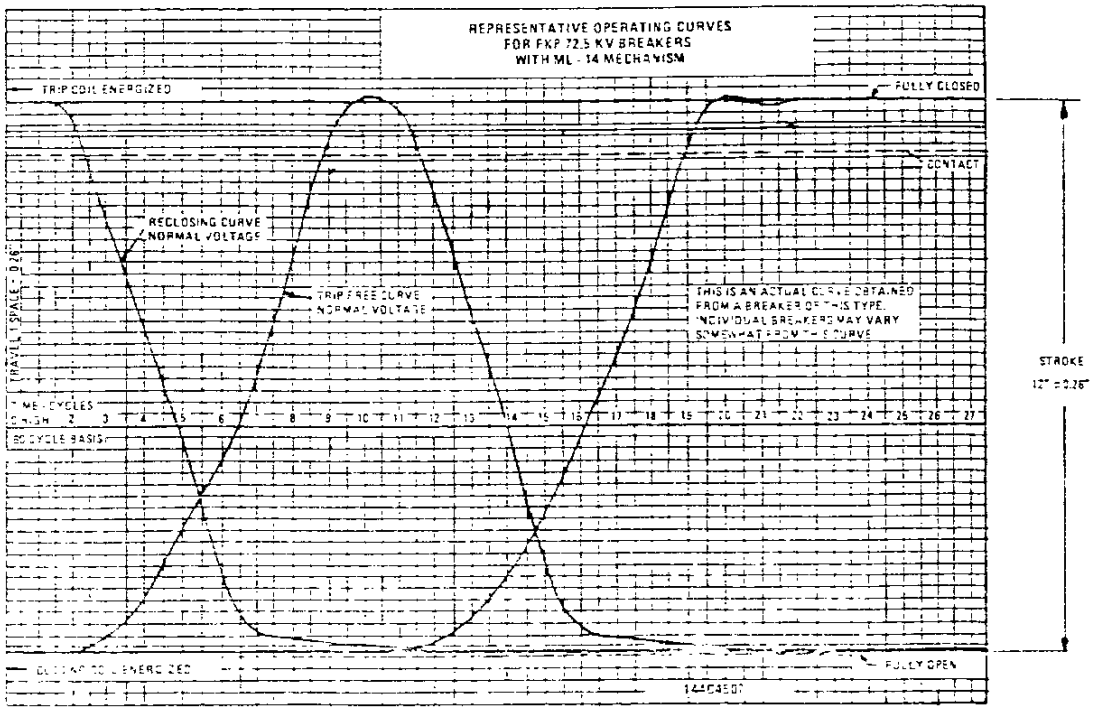


FIGURE 12 REPRESENTATIVE OPERATING CURVES WITH AN ML-14 OPERATING MECHANISM FOR FKP 72.5 KV SPEAKERS, CURVES TAKEN IN OIL

TABLE OF ADJUSTMENTS

For future reference, the initial adjustments and checks of the breaker at the time of installation should be written in the appropriate columns of the chart below.

		Phase 1	Phase 2	Phase 3
External Overtravel Stop Setting	0.20 inches + 0.015 inches -0			
Breaker Stroke	12 inches ± 0.26 inches			
Lift Rod Setting (Phase 2)	7.26 inches ± 0.12 inches			
Lift Rod Setting (Phase 1 and 3)	Phase 2 setting dimension ± 0.12 inches			
Lift Rod to Lever Pin Clearance (Minimum)	2.94 inches			
External Toggle Setting	0.88 inches ± 0.04 inches			
Preliminary Closing Buffer Setting	1.00 inches			
Contact Wipe (Electrical)	0.62 inches ± 0.12 inches			
Contact Stop Clearance	0.88 inches ± 0.06 inches			
Contact Resistance - (Using 100 Ampere Ductor) (All parts cold - 20°C)				
New Contacts - Microhms	250			
Used Contacts - Microhms (Maximum)	450			
Part Contacts in Any One Phase	Within 0.04 inch of each other			
Part Contacts Between Phases	Within 0.26 inch of each other			
Crossbar to Interrupter Minimum Clearance	0.5 inches			
Crossbar to Interrupter Nominal Clearance	0.94 inches			
Opening Spring Compressed Length - Not Less Than	6.62 inches			
Opening Spring Nominal Compressed Length	7.50 inches			
Tripping Time (Maximum Normal Voltage)	3.0 cycles			

TABLE OF ADJUSTMENTS (Continued)

		Phase 1	Phase 2	Phase 3
Opening Speed from fully closed (1-1/8 inches to 6-1/8 inches) (14.4 through 46 KV Breakers)	10.5 to 12.0 feet per second			
38kV - 3000 Amp	8.5 to 10 ft per second			
Opening Speed from fully closed (1-1/8 inches to 6-1/8 inches) (69 KV Breakers)	10.5 to 12.0 feet per second			
Closing Speed from fully closed (1-1/8 inches to 2-1/8 inches) (14.4 through 69 KV Breakers)	8 to 14 feet per second			
Overtravel (Maximum) On Closing	0.26 inches			
Rebound (Maximum) On Opening	0.62 inches			
Rebound (Maximum) On Closing	0.38 inches			
Closing Time (Maximum)	20 cycles			
Closing Time (Nominal)	10 to 15 cycles			
Reclosing Time (Maximum)	20 cycles			
Minimum Dropout on Reclosing (in Oil)	10 inches			
Nominal Dropout on Reclosing (in Oil)	11 inches			
Lift Rod Clearance in guide block	0.015 inches			

Note: The opening spring cover (24, figure 5) must be in place before operating the breaker.

plus or minus 0.12 inches, in the breaker closed position.

E. The nominal opening spring compression is 1 inch for 14.4 through 34.5 KV breakers and 1.5 inches for 46 and 69 KV breakers. The compressed length of the opening spring should not be less than 6.62 inches.

F. The contact wipe, which is the insertion of the contact rod into the contact segments, is 0.62 inches plus or minus 0.12 inches.

G. The contact stop clearance should measure 0.88 inches plus or minus 0.06 inches.

H. The minimum clearance between the crossbar and the interrupter is 0.5 inches. The nominal clearance is 0.94 inches. This is measured in the breaker closed position.

J. The breaker stroke should be 12 inches plus or minus 0.26 inches.

K. The lift rod should hang in an approximately vertical position with a clearance of approximately 0.015 inches minimum between the guide block and the side of the rod in both directions.

L. The lift rod to lever pin clearance should be a minimum of 2.94 inches with the breaker closed. Measure on phase 3 only.

With the tank in place and filled with oil:

A. Contact opening speed, - refer to Table of Adjustments.

B. Overtravel, 0.26 inches maximum.

C. Rebound, not more than 0.62 inches.

D. Contact closing speed, 8 to 14 feet per second for 14.4 through 69 KV breakers.

FINAL INSPECTION

1. See that the breaker is properly set up and leveled on its foundation within a 1/4 inch over the frame height.

2. See that all nuts, washers, bolts, cotter pins, lock rings, and terminal connections are in place and tightened. The gland nuts on all valves and oil gauges should be checked to see that they are sufficiently tight to prevent leakage. In tightening gland nuts, precautions should be taken to prevent damaging the packing through excessive pressure.

3. Inspect all insulated wiring to see that no damage has resulted during installation, and test for possible grounds or short circuits.

4. See that all bearing surfaces of the operating mechanism and breaker linkage have been lubricated.

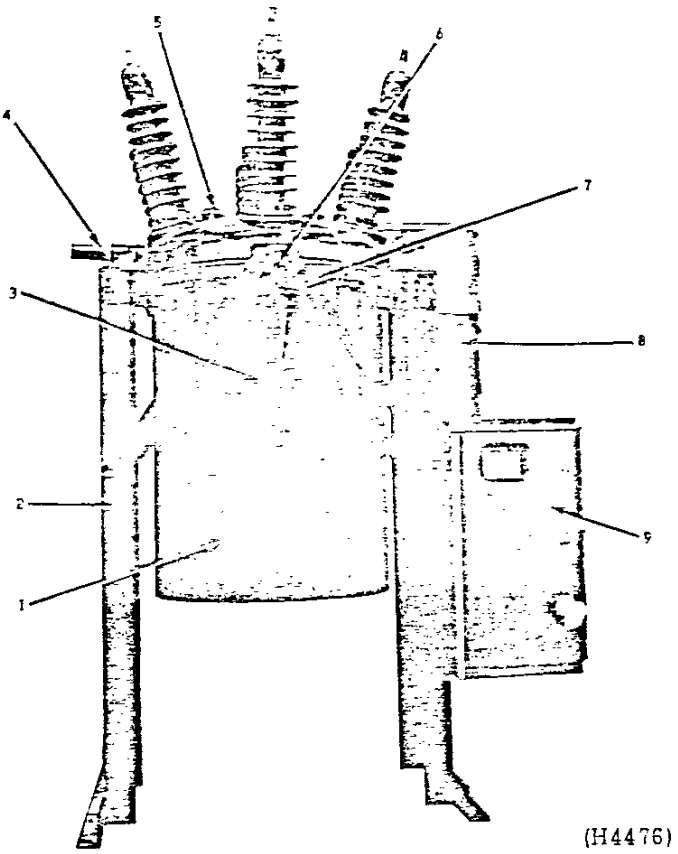
5. Make certain that the dashpots are filled to the proper level.

6. Make certain that the tank is filled to the proper level.

7. Make certain that the installation adjustments and operating adjustments have been thoroughly checked.

8. See that all covers and bolted connections are securely tightened and that all pipe plugs for inspection openings are properly installed and tightened to prevent the entrance of moisture.

9. See that any point where the surface of the paint has been damaged during installation is repainted immediately.



1. Breaker Oil Tank
2. Breaker Framework
3. Tank Lug
4. Opening Spring Cover
5. Closing Buffer
6. Tank Lifter Support Bracket
7. Tank Lifter
8. Vertical Operating Rod and BCT Lead Cover Box
9. Operating Mechanism House

FIGURE 13 TYPE FKP BREAKER - TANK IN PLACE

OPERATION

The mechanical operating mechanism provides the energy for all operations of the breaker. Control voltage and pressure ranges where applicable for proper operation are given on the operating mechanism nameplate.

These mechanisms are designed for rapid closing, opening, and trip-free operations and (when requested) reclosing operation. During the closing operation, the operating mechanism moves the vertical operating rod (2, figure 5) in a downward direction. This motion is transmitted through the breaker linkage to the vertical lift rods (16), closing the breaker.

The opening operation is the reverse of the closing operation.

When the breaker opens under load, the contacts part, drawing arcs between the tips of the contact rods and the arcing tips of the stationary contacts. The pressure generated by the arcs forces fresh oil past the arcing area, at the same time forcing the arcs between the baffles in the direction of the port openings, as shown in figure 3, carrying the arc products away from the contacts and out of the interrupter. Thus, rapidly lengthening and cooling the arc, its resistance is increased and at an early current zero the arc cannot re-establish itself, and interruption occurs.

MAINTENANCE

To maintain dependable service and safety of power equipment, it is recommended that a definite schedule be set up and followed, as serious shutdowns can be avoided by locating potential sources of trouble in an early stage. A periodic lubrication of parts subject to wear is also vitally important for the successful operation of the breaker and operating mechanism.

WARNING

BEFORE ANY MAINTENANCE WORK IS PERFORMED, MAKE CERTAIN THAT ALL CONTROL CIRCUITS ARE DE-ENERGIZED AND THAT THE BREAKER PRIMARY CIRCUITS ARE OPEN AND EFFECTIVELY GROUNDED. DO NOT WORK ON THE BREAKER OR MECHANISM WHILE IN THE CLOSED POSITION UNLESS THE PROP AND TRIP LATCH HAVE BEEN SECURELY WIRED OR BLOCKED TO PREVENT ACCIDENTAL TRIPPING.

PRECAUTIONS

1. Be sure the breaker is disconnected from all electric power, both high voltage and operating, before inspecting or repairing.

2. After the breaker has been disconnected from the power lines, grounding leads should be properly attached before coming in contact with any of the breaker parts.

3. Be sure the breaker tanks and frame are well grounded.

4. Use the maintenance closing device to assist in making adjustments. This is the primary purpose of the device because it permits slow closing.

5. After making any adjustments, operate the apparatus manually before attempting electrical operation.

6. Disconnect all electrical leads to the oil tank before lowering the tank.

PERIODIC INSPECTION

The frequency of periodic inspection should be determined by each operating company on the basis of the number of operations (including switching), the magnitude of currents interrupted, and any unusual operations which occasionally occur. Operating experience will soon establish a maintenance schedule which will give assurance of proper breaker condition. On installations where a combination of fault duty and repetitive operation is encountered, an inspection is recommended after any severe fault operation.

The contacts and baffles must be replaced after the breaker has interrupted a total of five times the rated interrupting current of the breaker. This is known as "integrated amperes" and is the sum of all currents, normal switching current as well as full rated fault current, interrupted by the breaker contacts.

1. The condition of the contacts should be checked. See that they are aligned, and that the contact surfaces bear with firm, uniform pressure.

2. The quality of the oil should be checked. Oil in service should be tested at frequent intervals three month periods are recommended.

   If the dielectric strength of the oil tests less than 22,000 volts, it should be filtered.

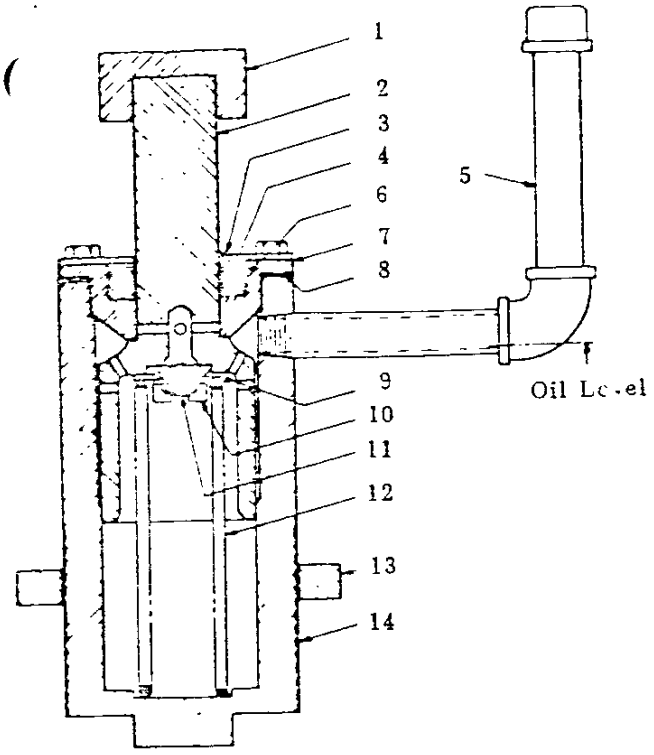
   When sampling oil, the sample container should be a large-mouthed glass bottle. The bottle should be cleaned and dried with benzine and free from moisture before it is used. A dry cork stopper should be used. The sample of the oil should be at least one pint. Test samples should be taken only after the oil has settled for some time.

   Samples should be taken from the valve at the bottom of the tank and sufficient oil should first be drawn off to make sure the sample represents oil from the tank proper and not that stored in the drain pipe. A glass receptacle is desirable so that if water is present it may be readily observed. If water is found, an investigation of the cause should be made and a remedy applied. Excessive water is indicative of leakage somewhere in the breaker structure.

3. All insulation parts should be thoroughly cleaned to remove all traces of carbon which may remain after the oil has been drained from the tank. It is recommended that the oil be removed and the tank cleaned at regular intervals because filtering the oil alone does not remove the carbon which adheres to the inside of the tank.

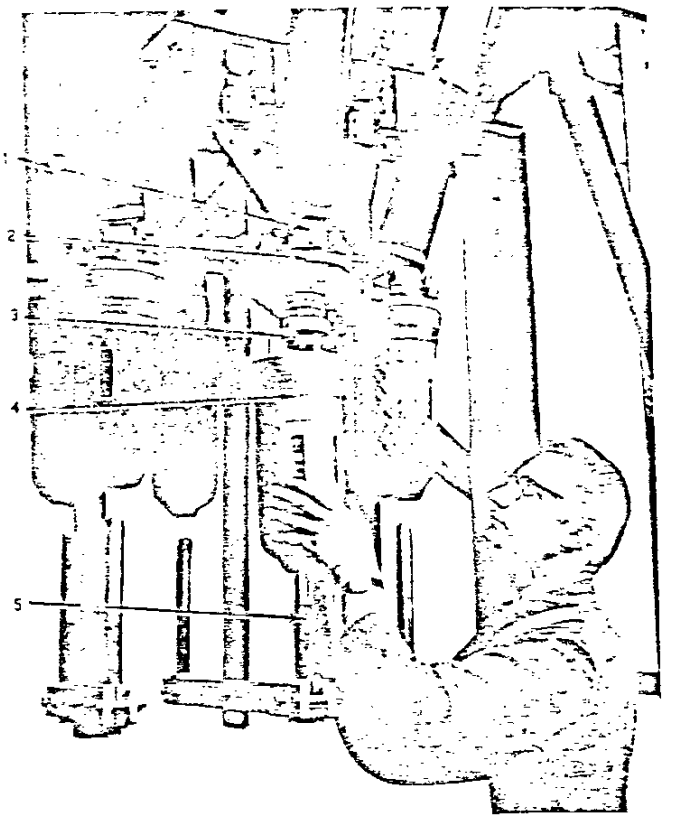
4. The breaker linkage lubrication should be thoroughly checked. All bearing surfaces should be lubricated with BEACON 325 and 2-3 drops of No. 20 Lubricating Oil every 2 years.

5. The opening dashpot oil level should be checked. See figure 14. With the dashpot plunger in the up position, oil may be added at this point. The dashpots use GE #10-C breaker oil. The dashpots should be examined to see that the piston works freely and that there is no sludge present.



1. Cap
2. Piston
3. Cover
4. Washers
5. Fill Pipe
6. Oil Seal
7. Cover
8. Gasket
9. Washer
10. Cup
11. Ball
12. Spring
13. Locking Plate
14. Cylinder

FIGURE 14 OPENING DASH POT ASSEMBLY



1. Upper Adapter and Clamp
2. Lower Adapter
3. Stationary Contact Fingers
4. Interrupter Unit
5. Contact Rod

FIGURE 15 LOWERING THE INTERRUPTER FOR INSPECTION

6. All bolts, nuts, washers, cotter pins, lock rings, and terminal connections should be in place and properly tightened. The gland nuts on the valve should be checked to see that they are sufficiently tight to prevent leakage. In tightening a gland nut, precautions should be taken to prevent damaging the packing through excessive pressure.

7. Inspect the bushing supports, as the vibration due to the operation of the breaker may cause the bushings to move slightly and result in misalignment of the contacts.

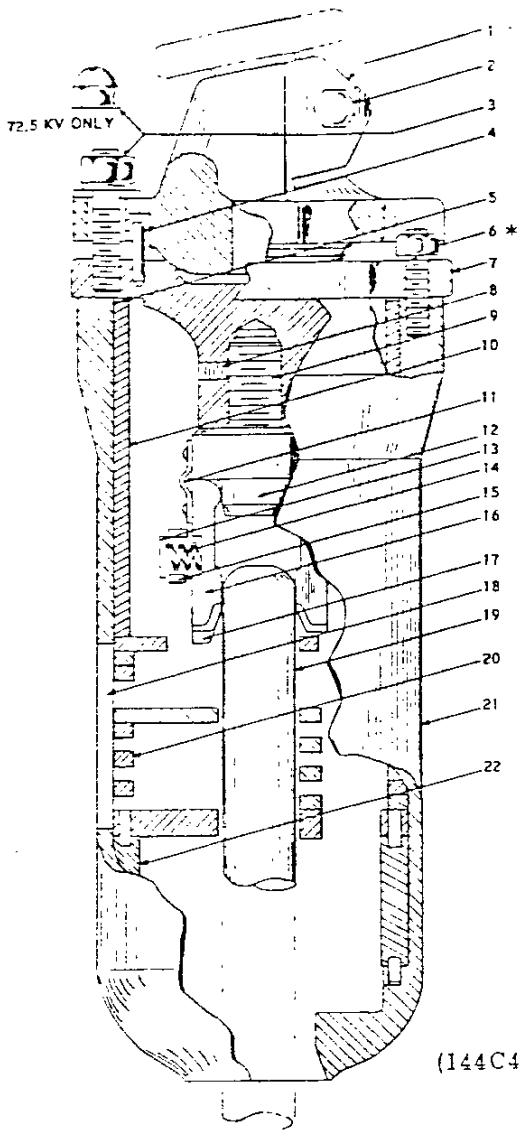
8. Clean the bushing porcelains at regular intervals, especially where abnormal conditions prevail, such as salt deposits, cement dust, or acid fumes, to avoid flashover as a result of accumulation of foreign substances on their surfaces.

   If a water solution under pressure is used to clean the bushing porcelains, care must be taken that the stream of solution is not directed at the breather (1, figure 6) located on top of the buffer housing. An excessive stream of solution directed up at the breather might permit some of the solution to enter the breather and damage the insulation. The breather may be removed and a pipe plug installed properly during a washing operation of this type. Make certain the breather is installed properly after the washing operation.

9. Check all adjustments of the breaker linkage and contacts as explained in the section INSTALLATION ADJUSTMENTS.

10. Consult the operating mechanism instruction book for maintenance recommendations on the operating mechanism.

11. See that the oil is at the proper level in the tank.



1. Upper Adapter
2. Adapter Locking Bolt
3. Locking Nut
4. Locating Pin
5. Insulating Shim
6. Assembly Nut
7. Lower Adapter
8. Set Screw
9. Contact Assembly Support
10. Upper Insulating Spacer
11. Flexible Connector
12. Contact Stop
13. Spring Retainer
14. Contact Spring
15. Spring Cage
16. Contact Finger
17. Arcing Tip
18. Exhaust Port Opening
19. Contact Rod
20. Baffle Stack
21. Interrupter Tube
22. Lower Insulating Spacer

* Torque to 200 to 250 in.-lb.

FIGURE 16 STANDARD INTERRUPTER - CROSS SECTION VIEW

12. Check the electrical operation and speed adjustments as explained under INSTALLATION ADJUSTMENTS.

REPAIR AND REPLACEMENT

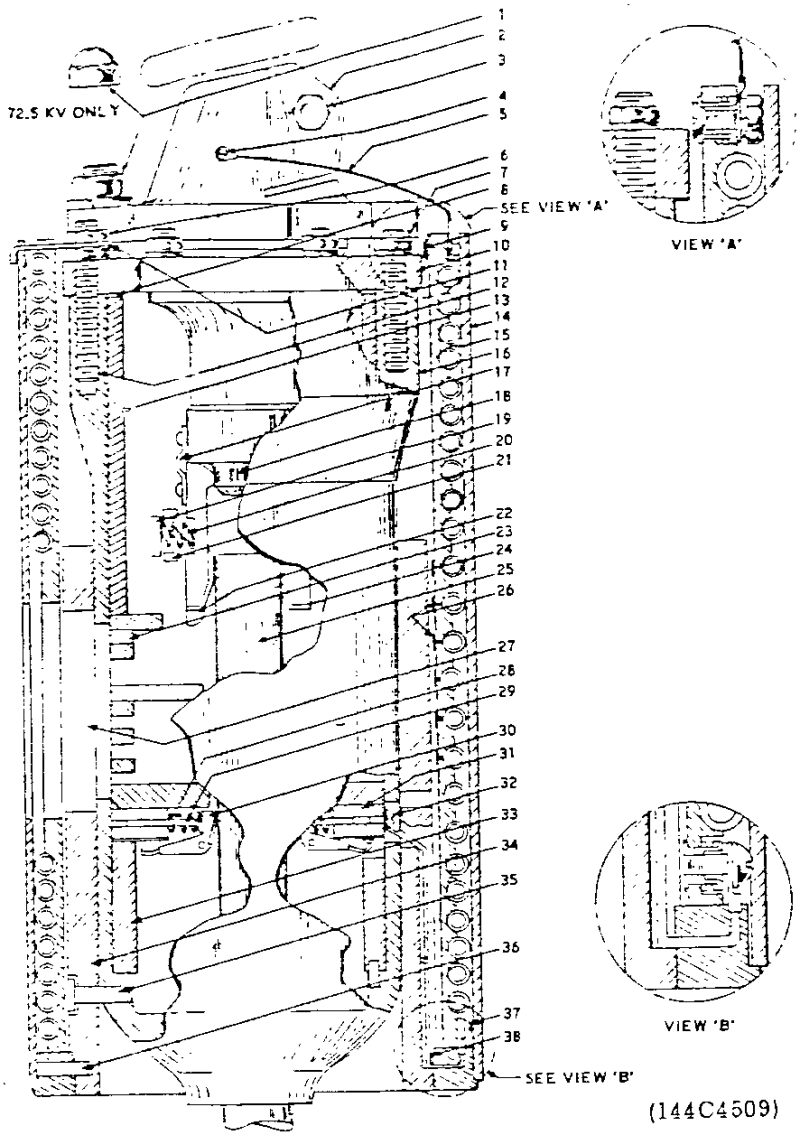
INTERRUPTER AND CONTACTS

With the oil tank removed, and the breaker in the open position, the interrupters can be lowered for inspection or repair by removing the six assembly nuts (6, figure 16) on the studs which pass through the lower adapter into the interrupter tube.

The contact finger assembly is now accessible and can be examined for excessive burning, pitting or wear. Since the adapter (7) has not been disturbed, the reassembly will not require a realignment of the interrupter. If it is necessary to change any contact fingers (16), first mark the position of the finger containing the extended arcing tip (17) on the contact stop (12). Remove the flexible connectors (11) from the fingers. This permits removal of the contact finger assembly.

Before contact fingers can be changed, the spring retaining ring (6, figure 19), which is mounted around them, must be removed. This ring can be pried loose with a screwdriver after removing the cotter pins. To change the arcing fingers and the current transfer fingers, special tools are used to compress all the contact springs at the same time. See figure 19 and proceed as follows using tool 216A7445G1.

1. Set the contact fingers (3 and 8) in the alignment block (4) with the contact ends down. The arcing contact fingers (3), having the Elkonite extension will fit into the slot of the alignment block.
2. Place the spring guide (5) in position and insert



1. Adjusting Nut
2. Upper Adapter
3. Clamping Bolt
4. Resistor Lead Screw
5. Resistor Lead
6. Locking Nut
7. Assembly Nut
8. Insulating Shim
9. Resistor Terminal Screw
10. Lower Adapter
11. Locating Clip
12. Interrupter Stud
13. Upper Insulating Spacer
14. Resistor Cover
15. Resistor Support
16. Interrupter Tube
17. Flexible Connector
18. Contact Stop
19. Spring Retainer
20. Contact Spring
21. Contact Spring Cage
22. Arcing Tip
23. Baffle Stack
24. Contact Finger
25. Contact Rod
26. Cotter Pins
27. Exhaust Port Opening
28. Pin
29. Contact Finger Spring
30. Contact Finger
31. Resistor Finger Support
32. Resistor Lead Screw
33. Lower Insulating Spacer
34. Resistor Support Spacer
35. Spacer Pin
36. Resistor Support Pin
37. Resistor Terminal Screw
38. Resistor Lead

FIGURE 17 CAPACITOR SWITCHING INTERRUPTER

the springs (7) through the holes in the guide into the retaining holes in the contact fingers.

3. Place the brass retaining rings (2 and 6) into the untapered end of the cylinder (1). These are identical rings, one being used as a spacer tool and the other as a part of the contact finger assembly.

4. Place the cylinder, tapered end down, over the clustered fingers.

5. Turn the entire assembly upside down and press the entire length of the cylinder downward, as shown in figure 19.

6. Remove the cylinder, alignment block, and one retaining ring.

7. The assembly is now drilled and fastened with three cotter pins, spaced midway between fingers on the horizontal centerline of the retaining ring.

The contact assembly is now ready for installation in the interrupter. Using the alignment block (4) to insure equal pressure on all fingers, push the finger cluster onto the end of the mounting stud in the interrupter being certain the location of the arcing contact finger lines up with the mark which was put on the adapter.

If this tool is not available, a large hose clamp which utilizes the screw or worm type of tightener can be used to compress the spring a sufficient amount to force the spring (14, figure 16) into the spring retainer (13) by using a small screwdriver as a lever. The spring retainer must be clamped by the hose clamp at the same time as the springs are clamped by having the edge of the spring retainer just against the springs.

If further disassembly of the interrupter is required, the upper spacer (12), the baffle stack (20) and lower spacer (22) can be lifted out. When reassembling, make certain that the exhaust slots in the baffles (20) face the exhaust ports (18) of the body tube.

When reassembling the interrupter, care must be taken that locating pins in the insulating spacers and baffles are properly installed in their respective locating holes. This will insure that the exhaust port of the baffle stack is located at the exhaust port opening of the interrupter tube.

The upper insulating spacer (10) should extend 0.015 inches to 0.06 inches above the interrupter tube (21). This protrusion makes certain that the baffle stack (20) and spacers (10 and 22) are held in place tightly when the interrupter is completely assembled. The 0.015 inch to 0.06 inch dimension is adjusted by the insulating shims (5). When the items which go into the interrupter tube are installed, put the interrupter in place on the lower adapter (7), making certain the arcing tip (17) lines up with the slot in the baffle.

After assembly, check to see if the baffle stack exhaust ports can be seen while looking into the interrupter through the exhaust port opening in the interrupter. If it can not be seen the interrupter is incorrectly assembled.

When remounting the interrupter and adapter to the bushing, a spirit level should be used to insure vertical alignment. Furthermore, upon completion of maintenance work it will be necessary to review all contact adjustments as explained in the section on INSTALLATION ADJUSTMENTS.

CAPACITOR SWITCHING INTERRUPTER (FIG. 17)

The capacitor switching breaker is somewhat different from the standard breaker in that the capacitor switching breaker has interrupters which contain resistors and resistor finger assemblies whereas the interrupters in the standard breaker do not.

The capacitor switching ability of the capacitor switching breakers is given in the tabulation below. At different voltages within the 'K' factor range the capacitor switching ability is reduced.

The resistance of the resistor which surrounds the fibre glass interrupter tube (16) is also given in the table.

The resistance must be plus 5% minus 10% of the stated value per interrupter but must be within ± 5% of each other in any one phase. The contact adjustment and checks are identical with those of the standard interrupter

BUSHINGS

Little or no maintenance is required of the bushings other than a periodic cleaning of the porcelains. In locations where abnormal conditions prevail, such as salt deposits, cement dust, etc., it should be recognized that a special hazard exists and the bushings should be cleaned regularly to avoid accumulations on the external surfaces that might cause a flashover.

If removal of a bushing is required, it will first be necessary to remove the interrupter. The bushing can be removed and installed from the top of the breaker. When reinstalling the bushing, make certain that the gasket between the top frame and the mounting flange of the bushing is in good condition. The mounting bolts should be tightened gradually and evenly, and all interrupter adjustments should be checked.

BUSHING REPLACEMENT

If several or all six bushings are being replaced it is recommended that the bushing positioning be established by using the locating template. This template 266A5173 can be readily made from a 30.0 inch blank of 1/4 inch hardboard, or fibreboard.

The template is threaded on to the lift rods from below and clamped as illustrated so that the upper interrupter adapter casting boss just enters each hole.

The position of each bushing can be adjusted by using shims at each mounting stud - shims such as 216A7278 P51.2. Shim only three studs (not the four). One shim will be the principal adjuster and the other two of half thickness as gap fillers. To ensure gasket compression for weather sealing, no more than 3/16 of shims to be used. Weathersealing after tightening can be assured by using a caulking compound.

Each bushing adapter boss should be concentric in the

Breaker kV-AMPS	kV	Resistance per Interrupter in ohms	Rated Capacitor Switching (Single Bank) Capacitor bank nameplate rating kVAR at kV indicated	
			Grounded Bank	Ungrounded Bank
FKP-15.5-36000	15.5	15	24000	24000
FKP-38-22000	38.0	83	30000	30000
FKP-48.3-17000	48.3	150	29000	20000
FKP-48.3-29000	48.3	150	29000	30000
FKP-72.5-19000	72.5	526	20000	17500
FKP-72.5-27000	72.5	526	20000	17500

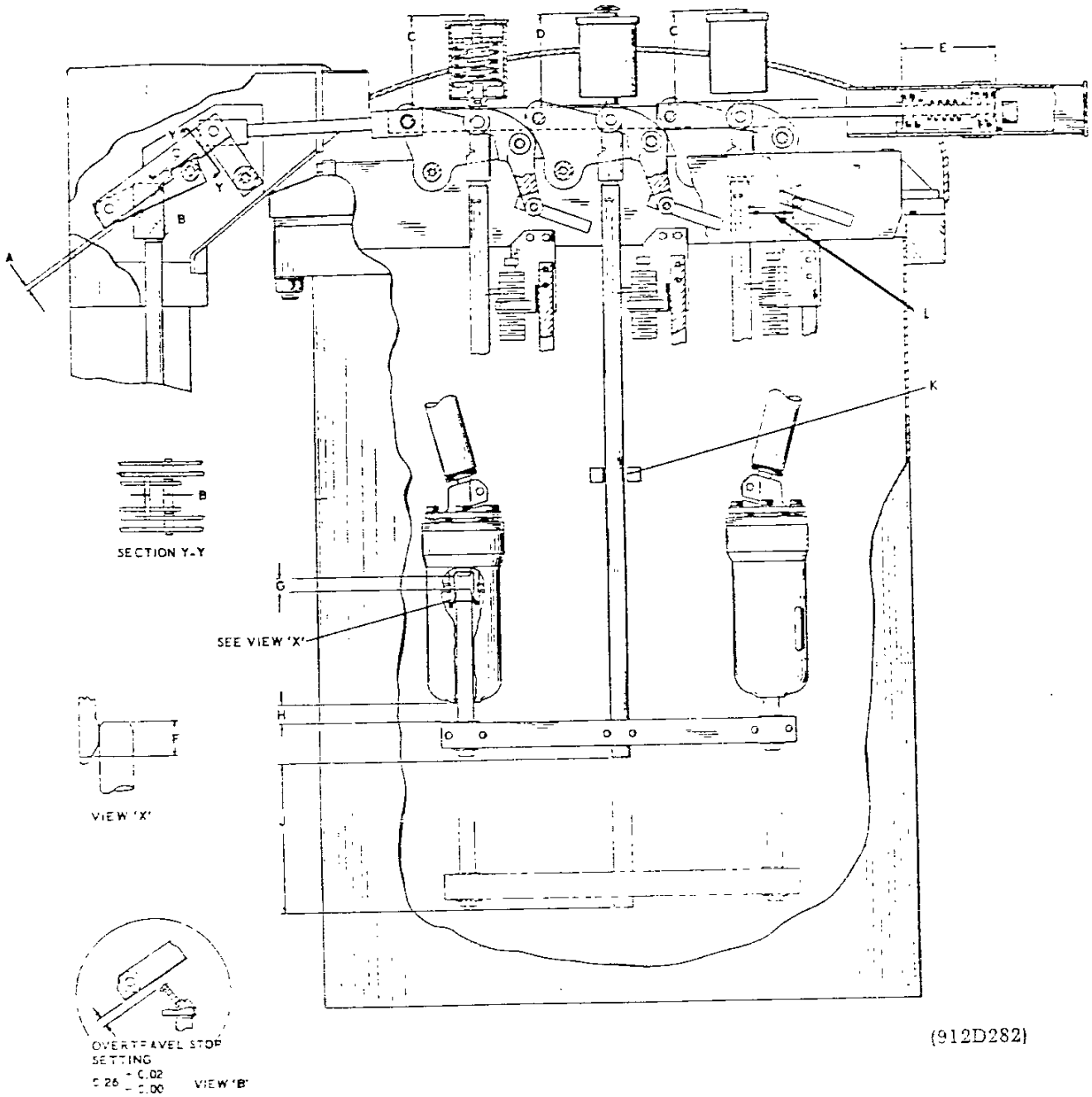
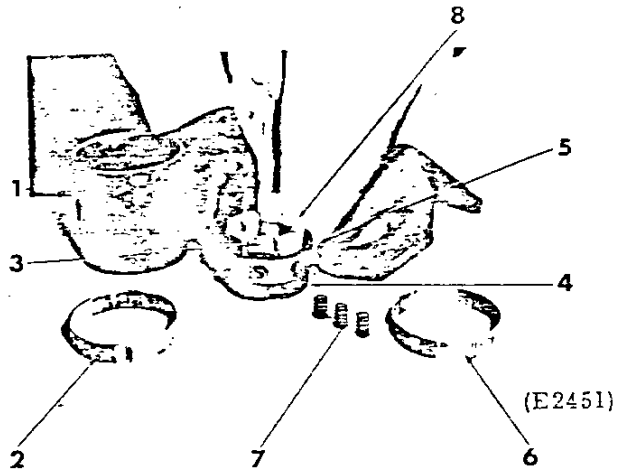
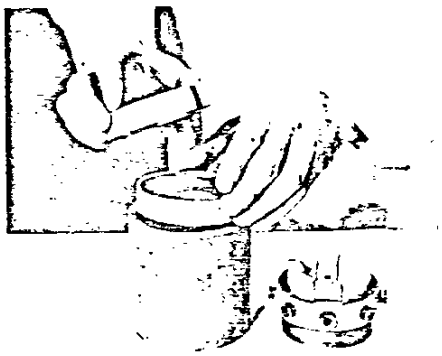


FIGURE 18 BREAKER ADJUSTMENTS AND CHECK POINTS



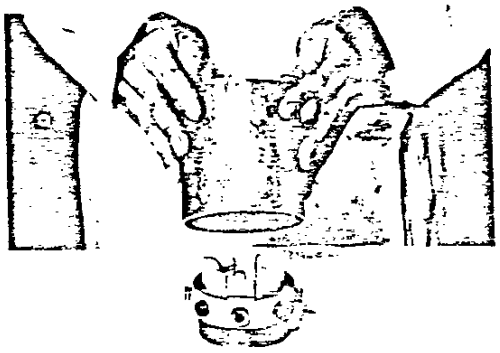
1. Tapered Cylinder
2. Retaining Ring
3. Arcing Contact Finger
4. Contact Alignment Block
5. Spring Guide
6. Retaining Ring
7. Contact Springs
8. Main Contact Fingers

Step 1



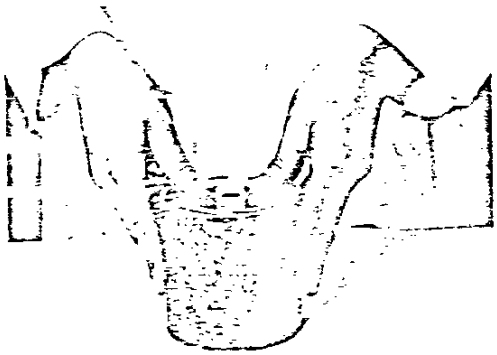
(E2450)

Step 2



(E2449)

Step 3



(E2448)

Step 4

(E2452)

Step 5

FIGURE 19 ASSEMBLING CONTACT FINGERS

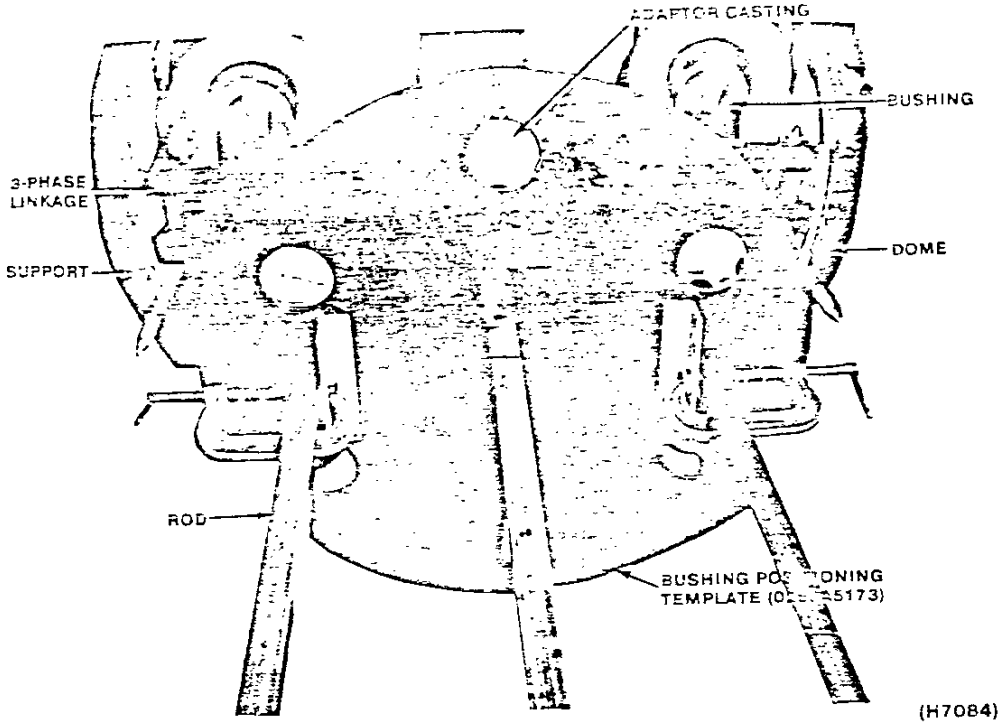


FIGURE 20 ASSEMBLY OF BUSHINGS

template hole , within .060.

lignment of moving contacts to the interrupters will be aight forward after proper positioning of the bushings.

BUSHING CURRENT TRANSFORMERS

Transformers should be connected in accordance with instructions 296 to be sure of proper polarity and correct connections. If it should be necessary to replace a transformer, care must be taken to see that the end of the transformer carrying a white mark is placed upwards.

Bushing current transformers are mounted in the top frame, as shown in figure 2. To remove the bushing current transformer, first disconnect the transformer lead wires. Loosen the adapter clamp (6, figure 8) and remove the interrupter unit. Remove the three assembly nuts (8, figure 1) permitting the supporting plate (7) and the current transformer (4) to be lowered.

Bushing current transformers may be installed either before or after the bushings are in place. Insulation washers above and below the transformer protect it from injury. It must be properly centered to prevent it from becoming damaged when the bushing is installed.

SUGGESTED MAINTENANCE SCHEDULE

WARNING

BEFORE ANY BREAKER WORK, COMPLETE ALL SAFETY PROCEDURES INCLUDING: OPEN AND ISOLATE THE BREAKER AND GROUND THE LINES, FRAME AND TANK.

Minor Service - every 6 to 12 months

1. Take an oil sample and test for: colour, water and dielectric strength.
2. If the test indicates that the oil is in poor condition, drain the tank and refill with good oil. Check oil level.
2. Repair any points of water entry if the oil contains much water. Inspect bushings for breakage and contamination.
3. Check that heaters are working.
4. Clean housing and paint housing and tank if needed. Check housing for main leaks - seal if needed with caulking or new gaskets.
5. Operate breaker, under observation, from local and remote control.

If a breaker has been out of service for several weeks, this Minor Service should be alone before it is re-energized.

Major Service - annual to 5 years.

Criteria for this inspection and overhaul period are:
- experience and service history
- fault interruptions
- heavy switching
- signs of distress such as heavy smoke or oil throwing

Table 6 of A.N.S.I. C37.06 can be used as a guide to setting the schedule, e.g.

a) 5 full fault close-open operations
b) 10 50% fault close-open operations
c) c) 20 25% fault close-open operations
d) 1 full fault and 100 load switchings
e) 125 load switchings

1. a) Take an oil sample and test for: colour, water and dielectric strength.
   b) If the test indicates that the oil is in poor condition, drain the tank and refill with good 30kV minimum oil. If the oil was black and dirty, clean the tank and bushings. Use clean oil for wipe downs not solvent cleaners. Disconnect the tank heaters b fore lowering or draining.
2. a) Inspect the interrupters - interrupter contacts f damage, burning. Replace the contacts if the ti are burned 50% or more.
   b) Clean the interrupters, baffle stacks, etc.
   c) Check verticals of frame, interrupters, guides, l rods, moving contacts. Check horizontals of cro arms (blades).
   d) Check the tank gasket, bushing tightness and das pot motion by hand pressure. Check the dashp oil level.
   e) Clean breather - separating vent. Remove pebbl (if of this type) clean them and reassemble.
   f) Slowly close and open the breaker if possible ar check for smooth non binding motion, for cente ing of moving contacts in interrupters, for eve touching of buffers and dashpots.
   g) Check for 3 phase contact touch using lamps (SE CONTACT WIPE ADJUSTMENT).
   h) Close the breaker and take Ductor Readings main path resistance at say 10 amps dc. If th reading is high then recheck with 100 amps. record of readings will establish what is normal the list at the end of this schedule is based upo the factory limit for new breakers plus 100%.

      High readings should be investigated by localizir the high spots, by point to point measuremen Surface cleaning and tightening should lower th reading. Measure the interrupter resistor ohms (the breaker is so equipped).
   j) Check mechanism for cleanliness. Lubricate e.g lubricate journal bearings with two or three drop of no. 10 or 20 lubricating oil. Petroleum base o will mix with the Beacon 325 grease used assembly.
   k) Check for mechanism settings e.g.:
      latch wipe and clearance
      props wipe and clearance
      latch motion smooth and non binding.
   l) Raise tank, check for gasket seal all around an refill with oil. Check all hardware for tightness.
   m) Operate breaker and analyze the close and ope motions using a travel analyzer. Check the OPE and CLOSED indicators. Check auxiliary switch for proper make and break.

The above is intended as a basic guide only and is not fully comprehensive instruction. It is recommended th a check-off sheet be written including everything to

inspected, for the guidance of personnel and for reporting by the service man.

The resistances are given for guidance only. Unfortunately readings equal to or better than these do not guarantee that the breaker is good. However readings which are worse should be investigated and corrective action taken.

A record of the resistance of a number of breakers in service should be used as the basis for judgement of a specific breakers condition.

DUCTOR READINGS (TYPICAL MAX.)			ohms
KSO	14.4 kV	600/1200/2000A/3000A	200
	23 kV	600/1200A	260
	34.5 kV	800/1200/2000/2500A	300
	46 kV	800/1200/2000/2500A	300
	69 kV	800/1200/2000/ 1500 MVA	500
		1200A 2500/5000 MVA	600
		2000A 2500/5000 MVA	260
FKP	15.5 to 25.8 kV		300
	15.5 to 48.3 kV	1200A/2000A	300
		3000A	150
	72.5 kV	1200A	500
		1600A/2000A	400

RENEWAL PARTS

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

Renewal parts may not always be identical to the original parts, since improvements are made from time to time. The parts which are furnished, however, will be interchangeable.

When ordering renewal parts, address the nearest Sales Office of Canadian General Electric Company Limited giving the complete data shown on the breaker nameplate, such as the serial number type and rating of the breaker. The breaker nameplate is mounted on the outside of the front door of the operating mechanism compartment. Also furnish a complete description of each part, the quantity required, and, if possible, the number of the requisition on which the breaker was originally furnished.