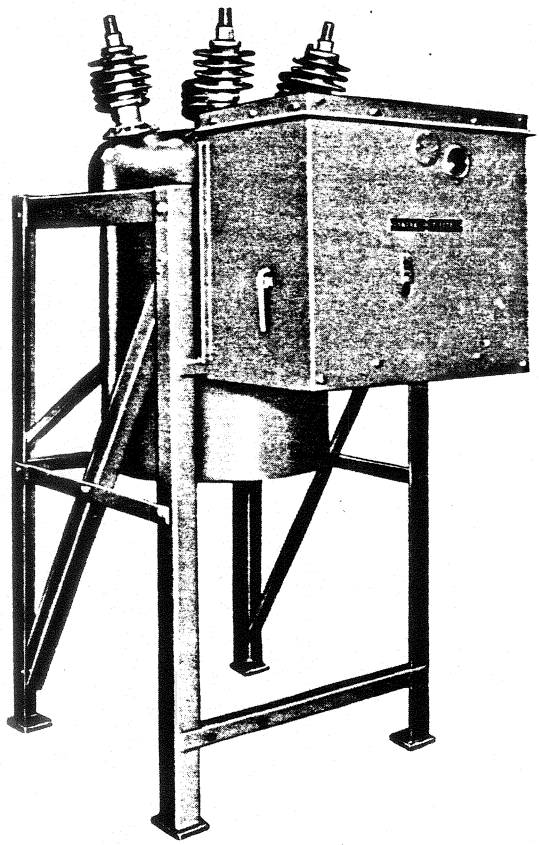
INSTRUCTIONS

GEI-57186B
SUPERSEDES GEI-57186A

OIL-BLAST CIRCUIT BREAKER

Types

FKD-23-250
FKD-23-500
and
FKD-23-250-1
FKD-23-500-1



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HIGH VOLTAGE SWITCHGEAR DEPARTMENT
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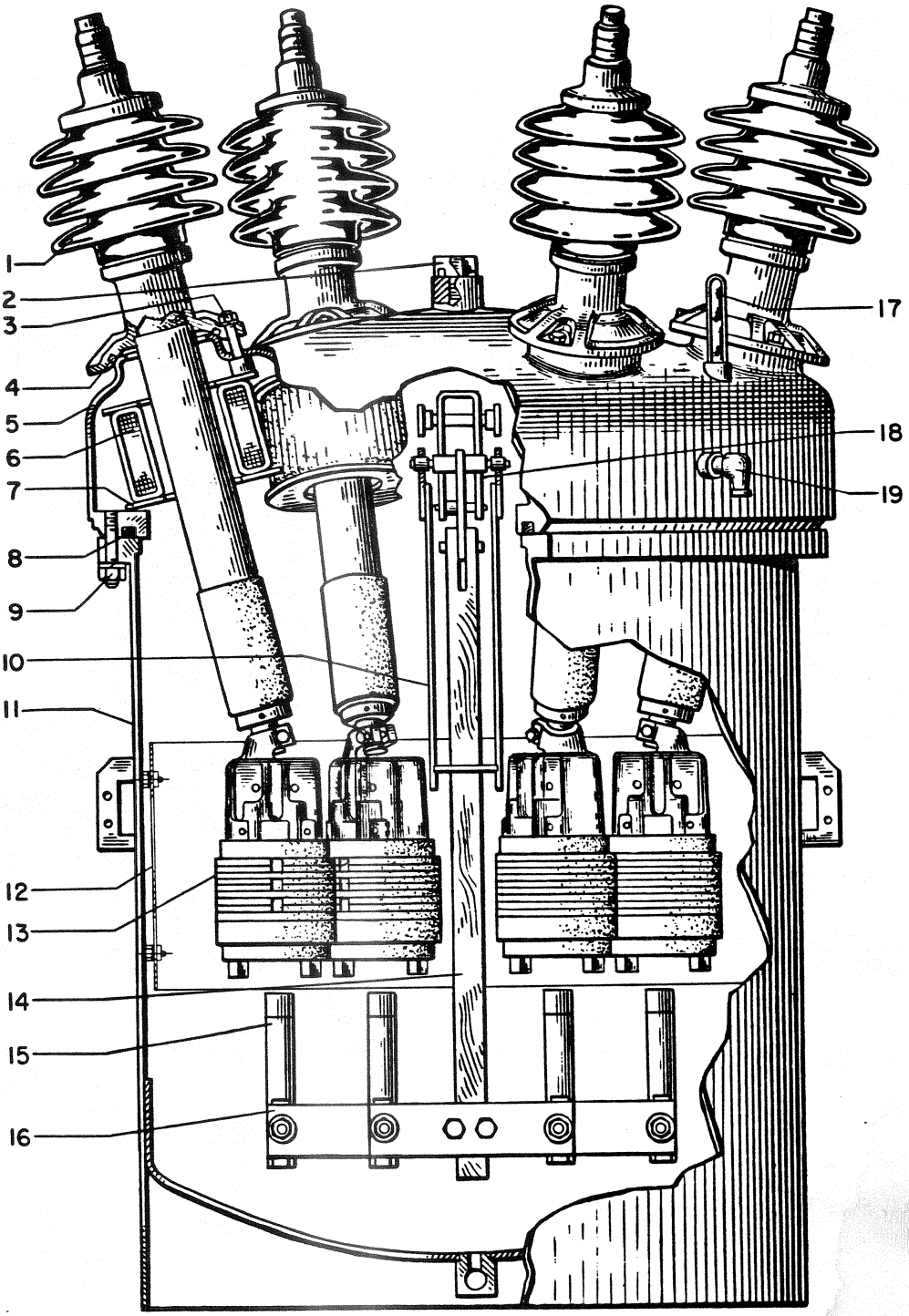

1. Bushing
2. Cap
3. Bushing Assembly Nut
4. "O" Ring Gasket
5. Dome
6. Bushing Current Transformer
7. B.C.T. Support Plate
8. Tank Gasket
9. Tank Nut
10. Lift Rod Guide
11. Tank
12. Tank Liner
13. Interrupter
14. Lift Rod
15. Contact Rod
16. Crossarm
17. Oil Gage
18. Breaker Linkage
19. Breather

Fig. 1 Breaker Unit

Cover (8026167)

Fig. 1 (0259D0175)

OIL-BLAST CIRCUIT BREAKER

TYPES

FKD-23-250 AND FKD-23-500

The Type FKD-23 Oil-blast Circuit Breaker is a triple pole outdoor breaker designed for service at a maximum circuit voltage of 23,000 volts, in current ratings of 600 or 1200 amperes and with interrupting ratings up to 500 mva as indicated on the breaker nameplate. It features the oil-blast principle of arc interruption which is designed for fast interruption. This means less system disturbance due to the shorter time required to clear the fault. Also, the short arc lengths mean lower maintenance because of reduced contact burning and oil deterioration.

An oil circuit breaker is a very important unit in the modern distribution system, being depended upon for protection and flexibility of control. It should not be installed in places where it will be called upon to operate at voltages or currents greater than those given on the nameplate. The short circuit conditions to be imposed on the breaker must not exceed the breaker rating. The oil-blast contacts are designed for the required interrupting rating at rated voltage. When used on circuits of lower than rated voltage the normal interrupting mva rating can only be retained down to the value of the circuit voltage where the amperes to be interrupted equal the maximum ampere rating of the breaker. For circuit voltages lower than this value the interrupting rating must be reduced proportionally.

RECEIVING, HANDLING AND STORAGE

All breakers are assembled and tested at the factory. They are shipped assembled as complete units. Each breaker is carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment. Immediately upon receipt of a breaker, an examination should be made for any damage sustained during shipment. If injury or rough handling is evident, a damage claim should be filed at once with the transportation company and the nearest General Electric Sales Office notified.

These breakers are shipped completely assembled on their framework. When unpacking, the crating or boxing must be removed carefully. The porcelains of the bushings and other parts are sometimes broken by driving a wrecking bar into crates or boxes carelessly.

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 tank should be cleaned and dried before it is filled with oil. The crating should not be taken from the bushings until after the breaker has reached its permanent location and all overhead work completed. If stored outdoors the tank should be filled with oil to protect the insulating parts. Although the operating mechanism housing is weatherproof, the space heater should be energized as soon as possible to prevent corrosion due to moisture condensation inside the housing.

Particular care should be taken to protect renewal parts, especially insulation parts which might absorb moisture. It is necessary that these parts be stored in a dry room.

DESCRIPTION

The FKD-23 oil-blast circuit breaker shown on the front cover consists of a three pole breaker unit and an operating mechanism. The three pole breaker unit consists of three single pole units mounted in a common dome and connected through a breaker linkage to the mechanism.

Oil-blast interrupters are mounted on the lower ends of the oil-filled bushings and contain the stationary contacts. The breaker linkage carries wood operating rods which carry the moving contacts. The contacts meet inside of the interrupting chamber. The contacts open and close (essentially) simultaneously. When the contacts open inside the interrupters, which are under oil, circuit interruption occurs.

The trip-free operating mechanism is motor charged and spring operated. The action of a closing cam driven by a torsion spring causes closing of the breaker contacts. In closing, energy is stored in compression springs. Release of this energy by operation of the mechanism trip latch causes opening of the breaker contacts.

A float type oil gage is installed in the top of the dome. This indicates the oil level indirectly through the action of a float, the position of which corresponds to the true oil level. The float is fastened to a red pointer rod which is visible in a tube on the top of the breaker. The correct oil level at normal temperature (20°C), as indicated on the breaker outline drawing, is 1-3/16" above the bottom of the visible portion of the gage glass. This corresponds to the amount of oil necessary to keep the portion of the bushing below the ground sleeve immersed in oil.

Each tank is held against the top frame by eight studs which secure the tank against a rubber gasket located in a groove on the underside of the top frame. The bolts must be tight to prevent oil leakage around the tank gasket during circuit interruption. This arrangement permits easy removal of the tank for maintenance of the contacts. A drain valve is attached to the drain pipe at the bottom of the tank so that all the oil may be drained. The valve should be plugged when not in use to prevent any possible leakage.

BUSHINGS

The bushings are of the oil-filled, center clamped design. The bushing is made with *Herkolite insulation around the bushing core. The ground sleeve and flange are pressed on. The bushings are completely sealed with gaskets under pressure of a spring washer at the top of the porcelain. This construction lends itself to easy assembly and disassembly. The porcelain at the top of the bushing is under an axial compressive load which is sufficient to allow some cantilever loading of the bushing. The construction of the bushing flange provides a swivel joint to aid in alignment. A rubber "O" ring seal is provided between the bushing flange and the dome.

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

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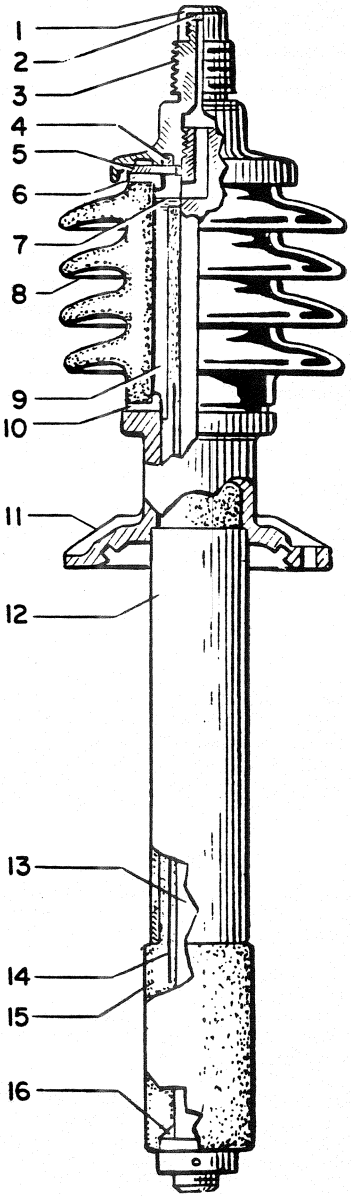
BUSHING CURRENT TRANSFORMERS

Bushing current transformers, Type BR-B, 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 five leads which provide a wide range of ratios. Ratio and accuracy classification for standard transformers are in accordance with ASA C-57-13.017(C) and NEMA SG-6-250 specifications.



1. Cap
2. Gasket
3. Terminal
4. Gasket
5. Belleville Washer
6. Gasket
7. Oil Level
8. Porcelain
9. Oil
10. Gasket
11. Support
12. Ground Sleeve
13. Stud
14. Equalizer
15. Herkolite Insulation
16. Gasket

Fig. 2 Oil Filled Bushing

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 ASA C-57-13.017 (C) and NEMA SG-6-250 specifications.

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

Bushing current transformers are mounted inside of 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. The seal assembly consists of a flexible compound seal held between two rigid compound plates. The gasket is installed between the inner plate and the housing. Bolts are screwed into tapped holes in the housing and compress the seal around the leads to prevent communications between the breaker top frame and the inside of the housing.

TANKLIFTER

The hand operated tanklifter for these breakers consists of a removable drive assembly and pulleys. The drive unit, which is bolted in place, employs worm gears to drive two drums which straddle the tank. Flexible cable is wound on these drums and passes over the removable pulleys and down to the tank. Operation of the tanklifter is shown in Fig. 3. The tanklifter is normally stored indoors.

SPECIAL TOOLS

Each breaker is provided with a maintenance closing bolt which may be inserted in the front of the mechanism coupling through the small access hole in the front sheet of the mechanism housing. This bolt is stored on the right hand side of the front sheet. For the use of this bolt see the section on ADJUSTMENTS.

Each breaker is provided with a "T" wrench which may be used to manually wind the main spring. Use of this wrench is given in the section on ADJUSTMENTS.

INSTALLATION

INSTALLATION

The installation of the breaker will be facilitated by a study of these instructions and a review of the approved drawings which supplement these instructions. The drawings show the general arrangement, dimensions, location of foundation bolts, provisions for conduit connections, electrical connections and other information necessary for the proper installation of the breaker. The approved drawings consist of the requisition summary, outline of the breaker with its operating mechanism and housing, and the connection diagrams.

The breakers are shipped in the closed position with a 3/4" steel bolt in place of the maintenance bolt. This steel bolt should be removed and discarded. In addition the manual trip linkage and the manual closing release handle are wired to prevent operation. These wires should be removed and discarded.

This mechanism is designed only for electrical operation. Mechanical interlocks prevent closing the breaker with too little spring or inserting the maintenance bolt without tripping the latch as in the previous model. HOWEVER, NEVER ATTEMPT TO CLOSE THE BREAKER UNDER LOAD WITH THE MAINTENANCE CLOSING BOLT. UNDER EMERGENCY CONDITIONS THE BREAKER MAY BE CLOSED AGAINST LOAD BY MANUALLY OPERATING THE CLOSING RELEASE DEVICE. NO ATTEMPT SHOULD BE MADE TO CLOSE THE BREAKER UNLESS THE BREAKER IS IN THE OPEN POSITION.

LOCATION

The breaker should be located so that it will be readily accessible for cleaning and inspection. Sufficient space must be provided for the operation of the maintenance closing device and tanklifter and for easy removal of the oil tank. 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 four holes in the horizontal section of the angles which are part of the dome or by hooking into the framework. Do not allow cable slugs to strike the bushings as any strain 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. 3/4" bolts are recommended for foundation bolts. 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.

CONNECTIONS

After the breaker has been located, electrical connections can be made. Before making these, every precaution must be taken to see that all leads to be connected to the breaker are dead.

Fig. 2 (0809801145)

RIMARY 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 entrance 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. All bushing current transformer terminal boards are shipped shorted and grounded. These connections should be changed upon setting the bushing current transformer ratio.

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 bolted connector is provided on a leg of the framework to which this cable can be attached. The cable should be able to carry 25% of the current rating of the breaker but should not be smaller than #4/0.

A good, permanent, low resistance ground is essential for adequate protection. 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 loss of life or damage to the apparatus.

ADJUSTMENTS

BREAKER

Although the breaker has been set up, adjusted and tested at the factory, it is advisable to review all adjustments to see that no change has occurred during shipment and installation. Manual operation should be used for all preliminary inspections. The breaker should be slowly operated by hand to see that it is smooth throughout the closing and opening of the breaker, that no binding occurs, and that no excessive play is noticeable between parts. The opening dashpot in the mechanism is self-contained so that the breaker may be operated electrically in air. Electrical operation should only be attempted after it is certain that all adjustments are made correctly. Details of these adjustments are given in the following paragraphs.

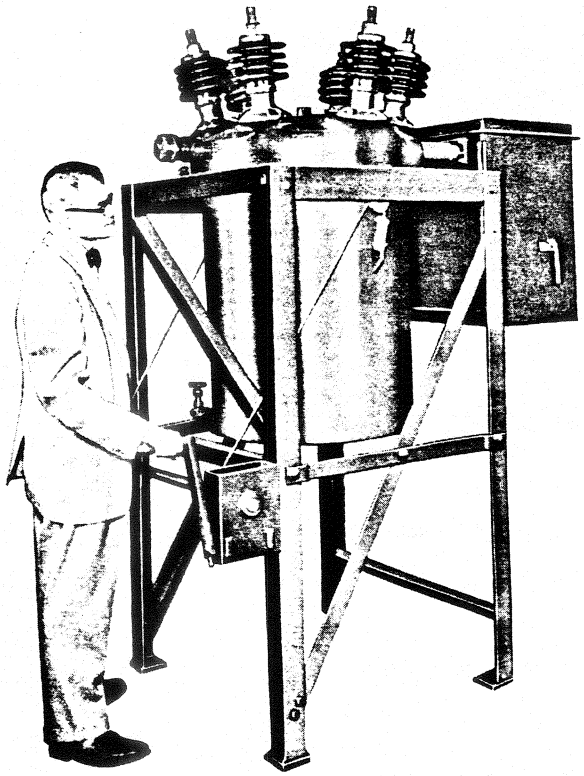


Fig. 3 (8026276)

Fig. 3 Left Rear View of Circuit Breaker Showing Tanklifter

The breaker is shipped in the closed position with the main spring discharged. The closed position is maintained by a 3/4-10 steel bolt screwed into the front of the coupling (3) Fig. 4. This bolt is for shipping purposes only and should be removed and discarded. Any maintenance closing may be done with the maintenance closing bolt which is described below.

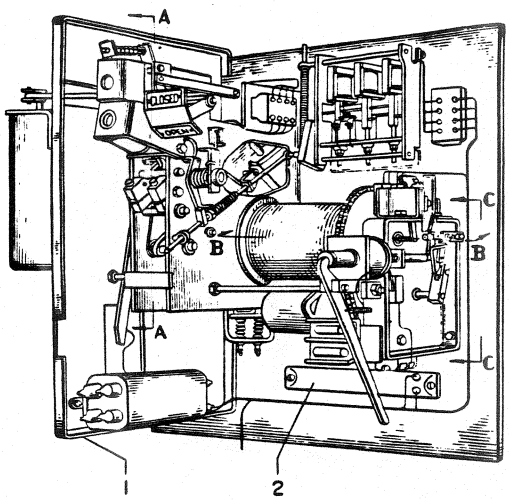
The breaker may be closed slowly by means of the maintenance device. This is a jacking bolt which screws into the front of the breaker operating rod coupling (3) Fig. 4 and pulls the operating rod forward toward the closed position. Since the bolt pulls directly on the operating rod the trip latch is ineffective to trip the breaker.

In jacking from the to open to the closed position the cam follower roller (14), Fig. 4 must pass around the nose to the top of the cam. Normally this action is blocked by the trip latch. However, introduction of the maintenance bolt with the breaker open causes rotation of the trip latch during most of the closing stroke. Near the closed position the trip latch is released by the interlock, but held by the mechanism linkage until the closed position is reached. The breaker may be left in the closed position and the maintenance bolt withdrawn and conversely, the maintenance bolt may be inserted with the breaker in the closed position without tripping the breaker.

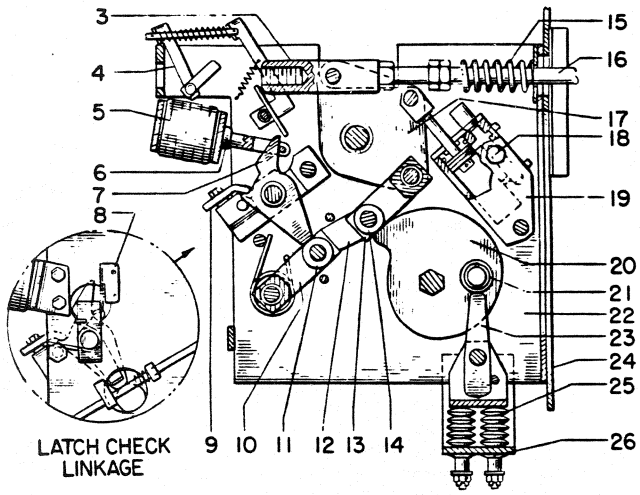
The closed position is established by proceeding forward until the trip latch drops in place and then backing-off until the load of the interrupters is taken by the mechanism linkage. The maintenance bolt has a 3/4-10 thread. The torque required to raise the contacts to the point of meeting is small and is about hand tight. The torque required to complete closing is about 50 ft. - lbs.

The breaker may be checked for correct adjustment by first establishing that the linkage is in the correct relation to the other parts. The linkage reference dimension, breaker closed, is 3-5/16" ± 1/8" measured from the top of the coupling in the center phase to the top of the lip of the boss in the center of the dome. This measurement is not a critical dimension.

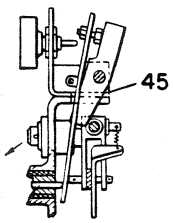
The stroke of the breaker contacts is 5" ± 1/8" no load. The open position is determined by equalling the weight of the contacts and the force of the slightly compressed opening springs with a relatively high gradient balancing spring (15) Fig. 4 located around the breaker operating rod in the mechanism. In the open position the



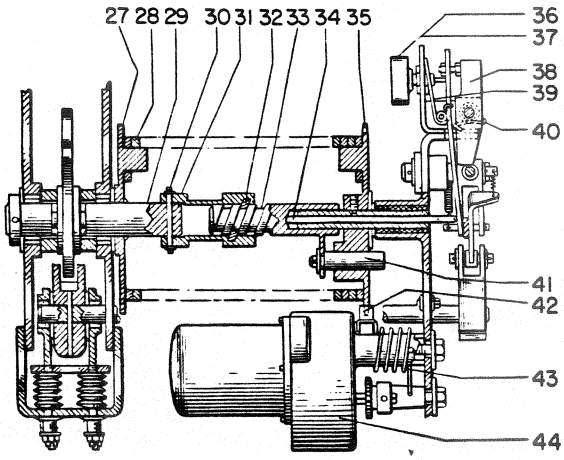
FRONT OBLIQUE VIEW



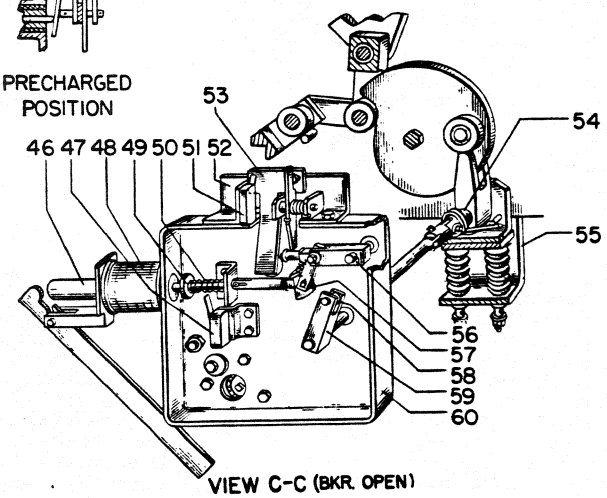
SECTION A-A (BKR. CLOSED)



PRECHARGED POSITION



SECTION B-B



VIEW C-C (BKR. OPEN)

1. Control Panel
2. Heater
3. Coupling
4. Maintenance Bolt Interlock
5. Trip Coil
6. Trip Coil Armature
7. Trip Latch
8. Latch Checking Switch
9. Latch Stop Plate
10. Trip-free Link
11. Trip Latch Roller
12. Intermediate Link
13. Toggle Link
14. Cam Follower Roller
15. Balancing Spring
16. Breaker Operating Rod
17. Output Crank
18. Dashpot Fill Plug
19. Dashpot
20. Cam
21. Cam Prop Roller
22. Mechanism Frame
23. Cam Prop
24. Back Plate
25. Spring Washers
26. Belleville Washers
27. Spring Plate
28. Spring
29. Shaft
30. Pin
31. Coupling
32. Key
33. Jack Screw
34. Control Plunger
35. Sprocket Wheel
36. Spring Cut-out Switch-Front
37. Motor Governor Switch-Rear
38. Latch
39. Paddle Spring
40. Latch Spring
41. Stop Pin
42. Ratchet Pawl
43. Ratchet Spring
44. Motor
45. Manual Spring Cut-out Interlock
46. Closing Release Coil Armature
47. CCX Switch
48. Closing Release Coil
49. Closing Release Coil Plunger
50. Return Spring
51. Alarm Switch
52. Switch Bracket
53. Paddle
54. Cam Prop Return Spring
55. Buffer
56. Lever
57. Closing Release Pawl
58. Roller
59. Cam Prop Lever
60. Motor Support Bracket

Fig. 4 (0122F445)

Fig. 4 Type ML-10-1 Mechanism

balancing spring is compressed approximately 1/4" and the opening springs are compressed to 5-1/4". This corresponds to 1-1/8" from the outside of the spring washer to the end of the housing. Adjustment of either the balancing spring or the opening spring will affect the stroke and the other spring, the balancing spring moving about 1/3 of the change of the opening spring.

The alignment of the interrupters and contact rods is adjusted by rocking the bushings and interrupter about the ball joint under the bushing flange. The contact rod should enter the interrupter centrally and should not bind throughout its stroke. Be sure that the bushing flange nuts are equally tight after adjustment has been made.

The wipe of the contacts is 3/8" + 0", - 1/16". This may be adjusted by raising or lowering the contact rods with respect to the crossarm. The lower part of the contact rod and the inner surface of the end of the crossarm is serrated horizontally. The contact rod is slotted. This allows vertical adjustment in 1/16" steps.

The six contact rods may be adjusted to produce the same contact wipe. In addition to this they should touch the contact fingers at the same time. Practically, some differences will exist between phases but it should be possible to adjust them within 1/8" of each other.

MECHANISM

The cam prop (23) Fig. 4 is supported by a spring buffer. The buffer consists of 40 spring washers inside the "U" bracket and 16 Belleville washers outside of the "U" bracket. The 40 washers are arranged in four stacks. Each stack contains five series sets of two washers in parallel. The individual washer is saddle shaped and when it is properly paired to obtain minimum height, the distance between the inner surfaces at the hole is 3/32". The normal stack height under compression is 15/16".

The Belleville washers outside of the "U" bracket are stacked as saucers are stacked and thus are in parallel. The castellated nuts are adjusted so that the cam prop roller (21) Fig. 4 bears on the cam prop (23) with central bearing (front view) and with a wipe on the centerline of the prop of ± 1/16" (side view). A small hole in the side mechanism frame permits a view of the prop wipe. The castellated nuts are wired in pairs to prevent loosening during operation. The buffer adjustment is made at the factory and normally need not be changed.

The wipe of the trip latch (7) Fig. 4 is adjustable with the position of the latch plate (9). The wipe should be 1/4"± 1/16".

The trip latch clearance should be .008" to .020" in the open position. This is adjustable by a change in the shims which hold the yoke which in turn holds the trip latch.

There should be about 1/16" clearance between the trip latch plunger extension pin and the face of the latch arm with the trip coil deenergized.

The latch checking switch should operate when the latch resets in order to indicate latch position. The latch checking switch should have 1/16" to 1/8" wipe when the latch is reset.

The 69 Switch is located behind the control panel. This should operate to open its circuit when the manual trip device is operated. It is reset by means of a reset knob extending through to the front of the panel. Slotted holes in the mounting bracket provide adjustment for this switch.

CHARGING AND DISCHARGING THE SPRING

Each breaker is furnished with a "T" wrench which may be used to charge and discharge the spring.

This wrench is stored on the right hand side of the mechanism front sheet along with the maintenance closing bolt. The sprocket wheel (35) Fig. 4 holds one end of the main spring (28) and also acts as a ratchet wheel through the action of its ratchet. The "T" wrench fits the square end of the motor shaft which is accessible through a hole in the motor support bracket (60). Clockwise rotation of the wrench charges the spring. Overwinding of the spring is prevented by a stop pin (41) which extends out through the sprocket wheel and engages a bolt extension of the motor support bracket. This stop pin is driven by the differential indicator device which acts as a jacking screw to extend the stop pin out a distance proportional to the number of turns of the spring. With the spring slightly past the fully wound position, the stop pin should interfere axially approximately 1/4" with the stop bolt. The fully wound position is indicated by a stop clearance of 3/4" ± 1/4" manually. Electrically, the motor drift will close the stop clearance to about 1/2" ± 1/4".

In order to discharge the spring from any wound position it is necessary to gradually relieve the force of the spring. Turn the "T" wrench slightly clockwise and raise the ratchet (42) by depressing the small handle. Allow spring to unwind gradually until its force is completely relieved.

PRECAUTIONS:

1. BE SURE THAT THE MOTOR IS DISCONNECTED FROM POWER SOURCE BEFORE ATTEMPTING MANUAL WINDING.
2. DO NOT ALLOW THE SPRING TO REVERSE WIND WITHOUT RESTRAINING ITS MOTION WITH THE "T" WRENCH SINCE DAMAGE TO THE DIFFERENTIAL INDICATOR MAY RESULT.

The motor governor switch (37), the spring cut-out switch (36), the alarm switch (51) and the latch for the manual spring cut-out switch (38) are attached to a bracket mounted on the motor support bracket (60). They are all actuated by the differential indicator parts (31) and (33) through the plunger and paddle. The motion of the plunger is parallel and equal to that of the stop pin advancing to the right with rising spring pressure.

The motor governor switch which is normally closed and the spring cut-out switch which is normally open are individually adjustable by means of the small jam nuts holding them in place. The motor governor switch should be adjusted to open its contacts on rising spring pressure when the main torsion spring is wound 2-1/6 turns or 780°.

This position as given above is indicated by a stop clearance of 3/4" ± 1/4" manually. For convenience the line painted on the spring is parallel to the axis of the spring when the spring is fully wound to its 2-1/6 turns.

The spring cut-out switch is set to close its contacts on rising spring pressure at approximately two turns. There are 54 teeth on the sprocket wheel so for convenience the SCO switch is set eight teeth from the fully wound position. The manual SCO interlock is set so that it latches 12 teeth from the fully wound position or four teeth before the electrical circuit in the SCO is made. The latch clearance of the manual spring interlock should be .002" to .015". This is adjusted by shimming the switch bracket and normally need not be changed.

The alarm switch is set to close its contacts on falling spring pressure from one plus to two turns from the fully wound position. This may be adjusted from the slotted hole mounting, but it should not be set so close as to limit the return stroke of the paddle, i.e. exceed 1/8" wipe on the alarm switch.

The closing release coil auxiliary contact switch (CCX) is located on the motor support bracket. This switch should be set to break its contacts when the gap between the closing release coil armature and its pole piece is 1/16" to 1/8".

The auxiliary switch mounted on the mechanism panel provides non-overlapping "a" and "b" switches which break the trip coil current. (Refer to the wiring diagram furnished with the instruction book.) For electrical trip-free operation these switches should make before the main breaker contacts make and are set to close their contacts approximately 1" before the fully closed position.

The opening dashpot located in the rear of the mechanism house is filled with D50H27 oil (Univis #J-43). The fill plug is located in the right side of the dashpot, being exposed by a hole in the right side of the mechanism frame when facing the mechanism. The oil level is even with the bottom of the fill hole with the breaker in the closed position.

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 G.E. #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 G.E. #10-C oil. Precautions must be taken to insure 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. Customers desiring detailed information on equipment and procedure for filtering G.E. #10-C oil should obtain Bulletin GEH-1180A from the nearest General Electric Sales Office.

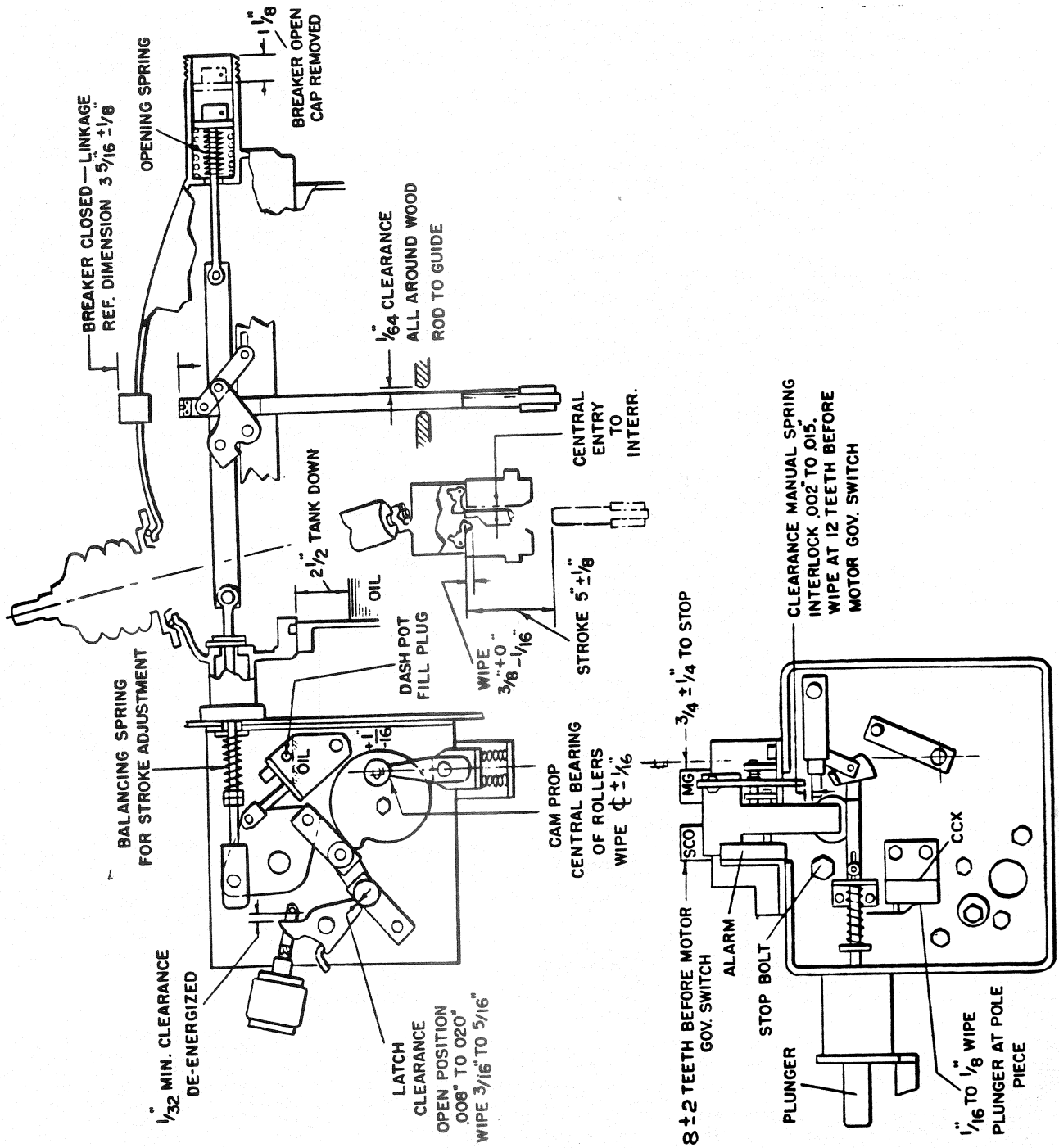


Fig. 5 Adjustments for Type FKD-23-250/5[illegible] Oil-blast Circuit Breaker, 600 and 1200 Amperes

Fig. 5 (0842C0407)

FILLING THE TANK

Before filling with oil, all accessories such as the drain valve and oil gage must be oil-tight. 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.

The normal oil level at 20°C is 1-3/16" above the lowest portion of the oil gage glass. The range between minimum and maximum is represented by the visible portion of the gage glass and covers a temperature range of 70°C or from + 40°C to -30°C. The oil level at any intermediate temperature is represented by a proportionate part of the gage range. It is important that the oil level never falls below the minimum level. This is selected so that the lower end of the bushing is always immersed in oil above the end of the ground sleeve.

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 because oil dissolves the sulphur in ordinary rubber hose. This may cause trouble, as sulphur attacks copper.

TESTING THE OIL

While the oil is shipped in sealed containers, careless handling during shipment or storage may result in absorption of moisture by 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 26,000 volts when tested in a standard gap, with 1" disc terminals 0.1" apart. New oil of less than standard dielectric strength (26,000 volts) should not be placed in the breaker oil tanks until its insulating value has been brought up to the above standard (by filtering or otherwise).

SUMMARY OF ADJUSTMENTS

The following summary of adjustments is listed against breaker position and spring position as an aid to checking. Refer to Fig. 5.

Breaker Open — Spring any position, no control power.

- **BKR. -** Mark the breaker open position.
- **MECH. -** The trip latch clearance should be .008" to .020". The trip latch wipe should be 3/16" to 5/16".
- **MECH. -** The latch checking switch should have 1/16" to 1/8" wipe with latch reset.

Breaker Closing — (Using maintenance closing bolt) Spring any position, no control power.

- **BKR. -** The breaker should operate smoothly throughout its stroke.
- **BKR. -** Mark the contact make point.
- **BKR. -** The lift rods should hang in a vertical position with approximately 1/64" clearance between the guide and the rod all around.
- **BKR. -** The contacts should be centrally aligned with the interrupter.
- **MECH. -** The trip circuit "a" auxiliary switch contacts should make approximately 1" from fully closed position.

Breaker Closed, Spring any position, no control power.

- **BKR. -** The linkage reference dimension should be 3-5/16" ± 1/8".
- **BKR. -** Mark the closed position. From above the stroke should be 5" ± 1/8" and the wipe should be 3/8" + 0", -1/16". (Note that the latch is holding the force of the breaker parts, not the maintenance bolt.)
- **MECH. -** The dashpot oil level should be even with the bottom of the fill hole.

Rising spring pressure, spring partially discharged, no control power.

- **MECH. -** The manual spring interlock latch should engage 12 teeth before the motor governor switch opens. Latch clearance .002" to .015".
- **MECH. -** The spring cut-out switch should make its contact eight teeth before the motor governor switch opens.
- **MECH. -** The motor governor switch should open its contacts when the stop clearance is 3/4" ± 1/4" between the stop pin and the manual stop located on the motor support brackets.

Additional adjustments not dependent on breaker or spring position.

- **MECH. -** The CCX Switch should have 1/16" to 1/8" wipe with the closing release coil armature against the pole piece.
- **MECH. -** The 69 Switch should open its contacts when the manual trip linkage is operated.
- **MECH. -** The maintenance bolt interlock should clear the trip latch in its normal position.
- **MECH. -** The trip coil plunger should clear the trip latch by 1/32" minimum with the latch reset.
- **MECH. -** The cam prop rollers should have central bearing and rest on the centerline of the cam prop with ± 1/16" tolerance.

Operation Adjustments (Discussed under Operation.)

a. The tripping speed should be 6 ft. to 8 ft. per second.
b. The closing time should be a maximum of 15 cycles.
c. The reclosing time should be approximately 16 to 20 cycles.
d. The contact parting time should be less than 2.5 cycles except where current tripping devices are used. In this case, the contact parting time will be delayed by the time required for operation of the current tripping device.

BUSHINGS

The bushings are installed from above the top frame. The gasket is installed between the support flange and the top frame. The interrupters are aligned by adjustment of the bushing on a spherical seat. After this adjustment has been made be sure that the bushing nuts are tightened evenly.

A bushing can be removed without disturbing the bushing current transformer. To remove the bushing first remove the four bolts holding the wood rod guide, and drop the guide down on top of the crossarm. The interrupter can now be removed by loosening the clamping bolt and unscrewing it from the bushing. Remove the three bushing nuts and the bushing will be free to be removed.

BUSHING CURRENT TRANSFORMERS

The bushing current transformers are mounted on the inside of the top frame and are installed from underneath the top frame. The bushing current transformer leads are brought through an oil seal into the mechanism house. In order to remove a bushing current transformer it is necessary to remove the interrupter from the bushing. With the leads disconnected and the interrupter removed, the bushing current transformer support plate can be removed and the transformer slipped down over the lower end of the bushing.

FINAL INSPECTION

After the breaker has been installed with all mechanical and electrical connections completed, the following inspections and tests should be made:

1. See that the breaker is properly set up and leveled on its foundation.
2. See that all nuts, washers, bolts, cotter pins and terminal connections are in place and tightened up. The gland nuts on all valves and oil gages should be checked to see that they are sufficiently tight to prevent leakage. In tightening the gland nuts, precautions should be taken to prevent damaging the packing through excessive pressure.

* Reg. Trade-Mark of General Electric Company

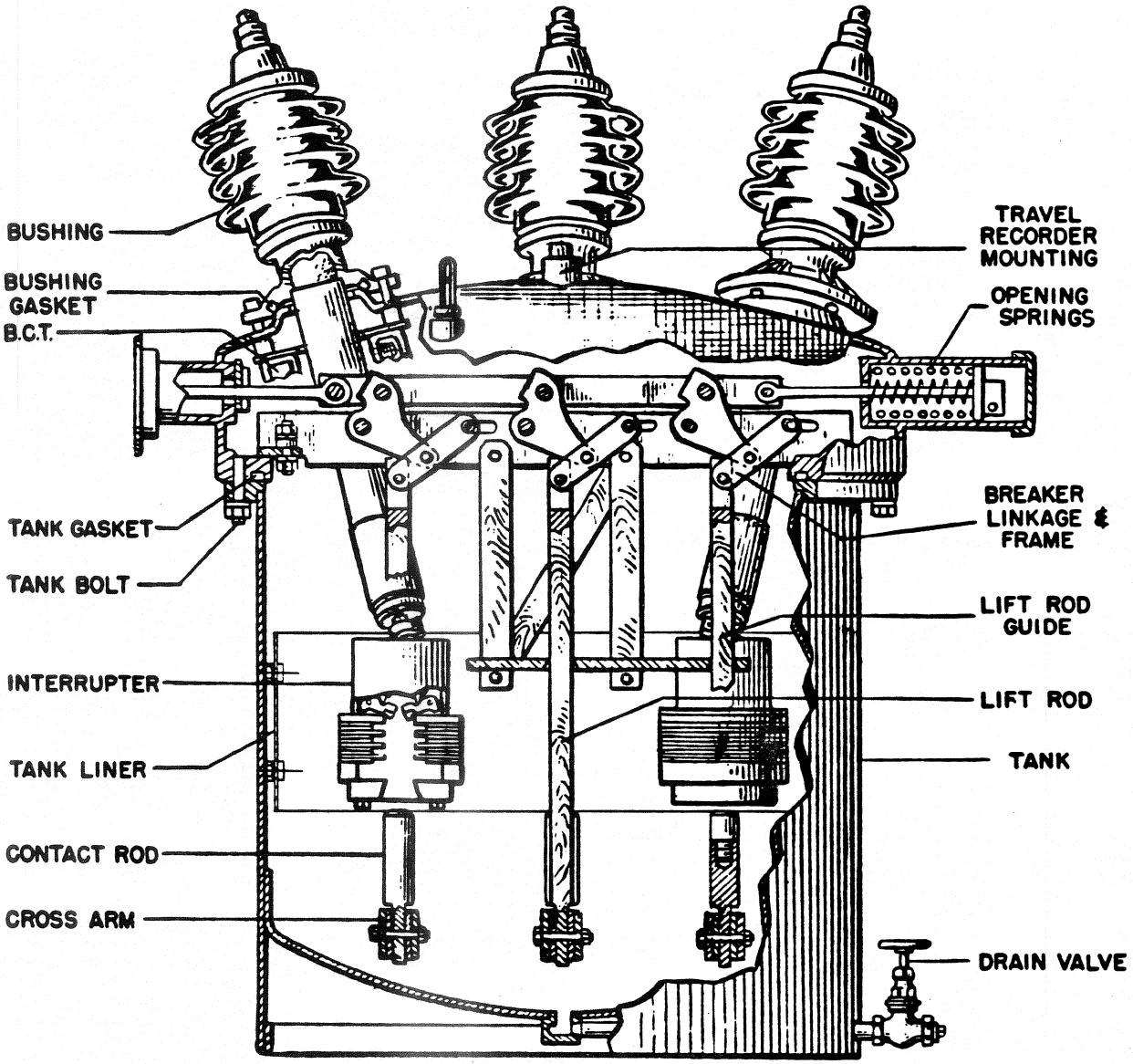


Fig. 6 (0842C429)

Fig. 6 Linkage and Contacts

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

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

5. See that the tank is filled with oil to the proper level.

6. Make certain that the dashpot 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 are properly installed and tightened to prevent the entrance of moisture.

9. See that all points where the surface of the paint has been damaged during installation are repainted immediately.

OPERATION

SPRING OPERATED MECHANISM

CLOSING

Consider the mechanism with the main spring fully wound and the control power available. See Fig. 4.

When the closing release coil (48) is energized through the closing control switch, the closing release armature and plunger (46) and (49) push the closing release pawl (57) against a roller extension on the cam prop lever (59). The pawl escapes beyond the cam prop lever after giving it a small angular displacement.

The main torsion spring (28) is retained at the right end by the sprocket wheel (35) and at the left end by the spring plate (27). The spring plate is coupled directly to the cam (20) so that the force of the spring is taken by the cam prop rollers on the cam prop. The cam prop is supported by a spring buffer (55).

The cam prop lever is coupled to the cam prop (23) through a universal type coupling. As the cam prop lever (59), and hence the cam prop, receives the

momentary angular displacement, the cam prop rollers (21) escape from the cam prop (23) under force of the torsion spring (28), rotate with the cam (20) and return to their normal position on top of the cam prop, which has returned to its normal vertical position through the action of the cam prop return spring. The rotation of the main cam is 360°. During this rotation the cam follower roller is lifted away from the cam center and forces the bottom of the output crank (17) backward, since the trip latch roller (11) is held in position by the trip latch (7). When the bottom of the output crank is forced backward it pulls forward on the coupling which attaches to the breaker operating rod. This motion is transmitted through the breaker linkage to close the contacts inside of the interrupters. The pin attaching the output crank (17) to the coupling (3) carries the levers to operate the SB-1 auxiliary switch, the position indicator, and the operation counter.

The closed position of the breaker is reached when the cam prop rollers rest on top of the cam prop. The additional energy supplied by the spring over and above that required by the breaker is absorbed by the spring buffer. No overtravel of the breaker contacts is required by the mechanism to close since the cam in the closed position serves as a prop.

RECHARGING THE SPRING

Inside the spring (28) is a differential indicating device which relates the angular relation of the main torsion spring. The spring is wound 2-1/6 turns or 780° when fully wound. In closing, the spring discharges 360° down to 420° or 1-1/6 turns. This is the precharged position. The action of the differential indicator device and the motor governor switch is to restore the spring to its fully wound position. In this fully wound position the mechanical stop (41) projects through the sprocket wheel (35) and prevents overwinding of the main torsion spring.

In parallel with the stop pin (41), the control plunger (34) extends through the sprocket shaft and actuates the motor governor switch (37) and the spring cut-out switch (36). When the main cam rotates to close the breaker, the coupling (31) turns with it withdrawing the jack screw (33) which withdraws the stop pin and allows the control plunger to be withdrawn through the action of the intermediate lever return spring. When the control plunger (34) is withdrawn, the motor switch contacts close and the motor winds the sprocket (and spring) in the same direction in which the cam turned. As the sprocket turns, the coupling is held and the jack screw extends itself until the control plunger actuates the motor governor switch at which point the spring is again fully wound.

This control feature allows the spring to be fully wound from its completely discharged position by applying the proper motor voltage.

TRIPPING

The energy stored in the contact finger springs and the opening springs during each closing operation is used to accelerate the parts on opening. When the trip coil is energized through a protective device, the trip latch rotates counterclockwise and allows the linkage to collapse. The cam follower roller slips around the front of the cam and the holding force on the breaker operating rod is released. This allows movement toward the open position and tripping is accomplished.

TRIP-FREE OPERATION

The spring charged mechanism linkage is both mechanically and electrically trip-free.

RECLOSING

A breaker is normally operated in the closed position. From this position one high speed reclosing operation is possible since the spring contains sufficient energy for one closing operation. Subsequent reclosing operations depend upon the spring winding time which is 3 to 5 seconds, depending upon the available control voltage at the time. Following tripping, the latch checking switch indicates that the linkage is recoupled and thus controls the release of the closing mechanism. Normal high speed reclosing time is 15 to 20 cycles.

ANTI-PUMP

This mechanism is provided with anti-pump protection by the use of a seal-in resistor. The seal-in resistor is inserted by the operation of the closing release coil switch (CCX) which will remain in the operative position as long as an operator holds the control switch. Under this condition the closing release coil cannot be deenergized and, therefore, cannot be re-energized to cause pumping.

BREAKER LINKAGE AND INTERRUPTERS

CLOSING

The breaker contacts consist of a set of stationary fingers and a moving contact. The breaker linkage raises and lowers the moving contacts in a straight line. The moving contacts are raised to the closed position by the operating mechanism and held there by the prop and latches in the mechanism. When the latch is released in the mechanism the contact finger springs accelerate the moving contact downward toward the open position. The amount of travel, 5" ± 1/8", is known as the stroke.

The motion of the parts is as follows:

Refer to Fig. 6. To close the breaker the operating rod is pulled to the left. This rotates the lever counterclockwise and raises the beam. The beam is attached to the vertical wood insulating rod. The wood rod carries the crossarm which carries the moving contact rods. The moving contacts enter the interrupter chamber (the chamber is oriented with the vertical centerline of the breaker and the contacts are adjusted for central entry) and raise the contact fingers 3/8", stopping in this position which is referred to as the closed position. In raising the contact fingers the 3/8" (wipe) the contact finger springs are compressed. These springs decelerate the moving contacts at the end of the closing stroke.

TRIPPING

When the breaker opens under load, the contacts part drawing arcs between the tip of the contact fingers and the moving contact. The pressure generated by the arc forces oil through the port openings in the baffle stack. The flow of oil established, coupled with the configuration of the baffle stack, produces interruption. The opening dashpot in the operating mechanism limits the opening speed of the breaker contacts and absorbs the energy at the end of the breaker stroke.

The opening dashpot is so designed that additional opening distance is available to decelerate the higher speeds associated with interrupting high currents. This travel will be in excess of the 5" set dimension but the final open position should be 5". No-load operation will not produce more than 1/4" overtravel on opening.

CURRENT TRIP ATTACHMENT

The Type ML-10 operating mechanism may be equipped with a current trip attachment in addition to or in place of the potential trip. Refer to Instruction Book GEI-9340 on Impact Trip Mechanism.

SPEED MEASUREMENT

After completing the preceding installation, adjustments and inspection and after filling the tanks with oil, the breaker may be operated electrically to check the no-load performance. A travel analyzer may be used to obtain this information. A #10-32 tapped hole is located in the center of the block on top of the lift rod for phase #2. Access to the tapped hole is through the hole in the center of the dome.

The opening speed is determined by drawing a straight line through two points on the travel curve. See Fig. 8. One point is located on the opening curve 3/8" from fully closed. This is the point at which the contacts part. The second point is located on the opening curve 2-3/8" from the fully open position (measured vertically). The slope of the line is an indication of the opening speed which should be 6 to 8 ft./sec.

If it is found that the opening speed is not within the specified limits, recheck the contact wipe. The contact finger springs accelerate the contact rods on opening and a variation in the amount of wipe would affect the no-load speed.

The closing speed is determined by the mechanism and is not adjustable.

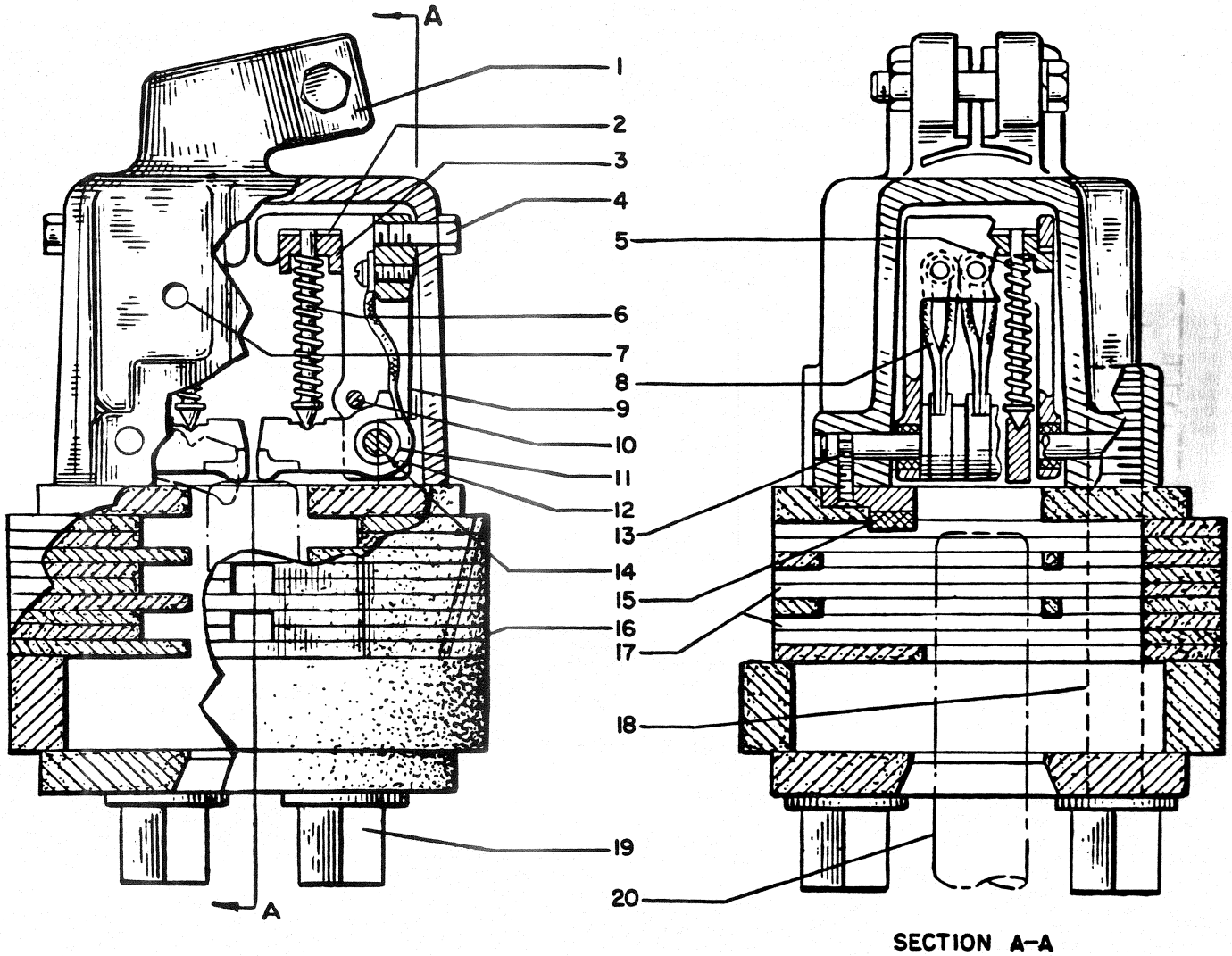
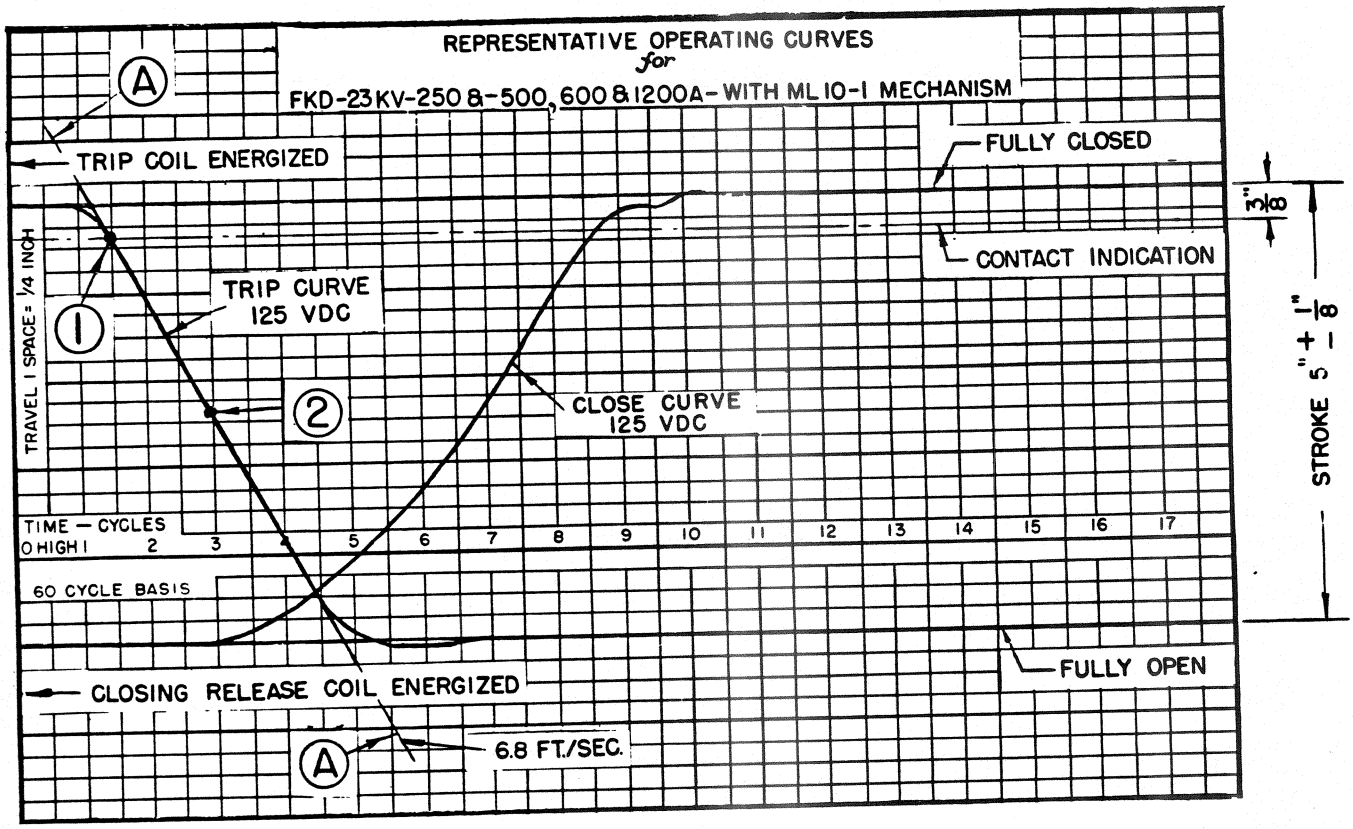


Fig. 7 (0842C0420)

1. Adapter
2. Insulation
3. Guide Block
4. Screw
5. Spring
6. Spring Guide
7. Vent Hole
8. Contact Finger Braid
9. Yoke
10. Stop Pin
11. Sleeve
12. Contact Finger
13. Set Screw
14. Hinge Pin
15. Arcing Plate
16. Baffle Stack
17. Port Baffles
18. Insulated Stud
19. Insulated Nut
20. Contact Rod

Fig. 7 Oil-Blast Interrupter



OPERATING SPEED RANGE
A - 6 TO 8 FT./SEC. (LINE DRAWN THROUGH POINTS 1 AND 2)
1 - ON CURVE 3/8" FROM FULLY CLOSED
2 - ON CURVE 2 3/8" " " "

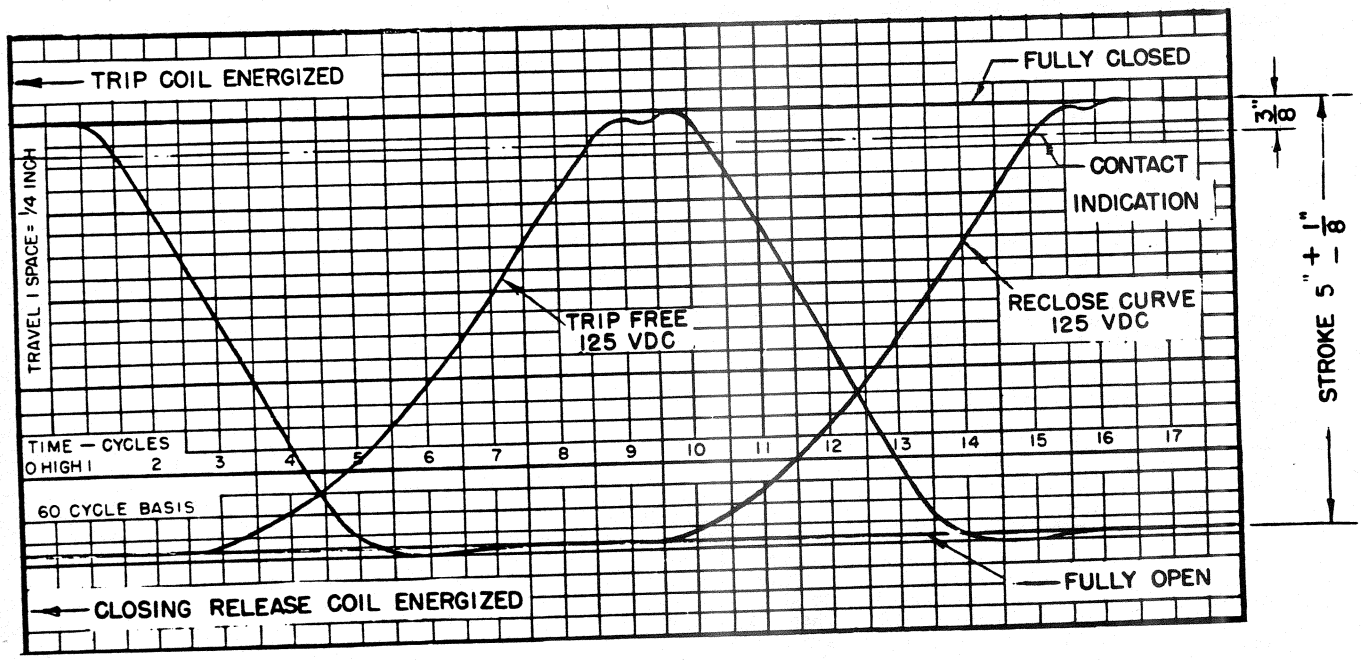


Fig. 8 (112HA862)

Fig. 8 Representative Travel Curves

MAINTENANCE

The safety and successful functioning of connected apparatus depend upon proper and reliable operation of the oil circuit breaker. To obtain this, the oil circuit breaker must have regular systematic inspections during which every part is looked over carefully. The frequency of the inspections should be determined by each operating company on the basis of the number of operations (including switching), the magnitude of the current interrupted and any unusual operations which occasionally occur. Operating experience will soon establish a maintenance schedule which will give an assurance of proper breaker condition. The following paragraphs list the main points to be included in an inspection and a number of general recommendations.

PRECAUTIONS

1. Be sure the breaker and its mechanism are disconnected from all electric power, both high voltage and operating, before inspecting or repairing. After the breaker has been disconnected from power lines, grounding leads should be properly attached before coming in contact with any of the breaker parts.
2. Be sure the breaker framework is well grounded.
3. Use the maintenance closing device to assist in making adjustments. This is the primary purpose of the device because it permits slow closing and opening. It should not be used for closing the breaker on load.

PERIODIC INSPECTION

1. The contacts should be checked. See that they are aligned and that contact surfaces bear with firm uniform pressure. Replace badly pitted or burned contacts before they are burned away sufficiently to cause damage to other parts of the apparatus. If contact surfaces are only roughened they may be smoothed down with a fine file.
2. 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 16,500 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. The sample of 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 valves at the bottom of the tank and sufficient oil 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 insulating 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 of the oil does not remove the carbon which adheres to the sides of the tank.
4. The operating and breaker mechanisms should be thoroughly checked. All bearing surfaces should be lubricated.
5. The dashpot piston should be examined to see that it works freely so that the dashpot functions properly.
6. All bolts, nuts, washers, cotter pins and terminal connections should be in place and properly tightened. The gland nuts on all valves and oil gages should be checked to see that they are sufficiently tight to prevent leakage. In tightening the gland nuts, precautions should be taken to prevent damaging the packing through excessive pressure.
7. Operate the breaker slowly by hand, and check the points listed under SUMMARY OF ADJUSTMENTS.
8. Operate the breaker electrically and check the points listed under SUMMARY OF ADJUSTMENTS.
9. Inspect the bushing supports as the vibration due to the operation of the breaker may cause the bushing to move slightly and result in misalignment of contacts.
10. Clean the bushings at regular intervals 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.
11. See that the oil is at the proper level in the tank.
12. After making any adjustments operate apparatus by hand before attempting electrical operation.
13. Installation and maintenance will generally result in damage to the surface of the paint and corrosion will result at these points. All such places should be repainted immediately.

REPAIR AND REPLACEMENT

If it should be necessary to replace a bushing current transformer, care must be taken to see that the end of the transformer carrying a white polarity mark is placed upwards. Performance data in the form of excitation and ratio curves are available for all transformers on the standard ratios. These are supplied with the order or can be secured from the Switchgear Department by giving the proper references. For more detailed information refer to Instruction Book GEH-2020.

INTERRUPTERS

The surfaces of the moving contacts are plainly visible with the breaker open and the tank lowered. The condition of the moving contacts is a good indication of the condition of the contact fingers. Refer to Fig. 7. By removing the four insulated bolts and lowering the baffle stack, the contact fingers may be seen. Each baffle stack is marked by a "V" so that proper relation of the baffles may be maintained during assembly.

If it is found by inspection that the fingers are badly eroded, they should be replaced.

To disassemble the fingers:

1. Remove the baffle stack.
2. Remove the two 3/8" bolts in the ends of the adapter.
3. Remove one #8 set screw from below each hinge pin.
4. Remove hinge pin. The finger assembly is free to be removed.

To remove the fingers from the finger assembly:

5. Compress the fingers slightly in a vise and remove 3/16" diameter stop pin.
6. Release the vise.
7. Snap out the springs and sprin guide from the fingers.
8. Remove the sleeve. Note that the 1/8" washers are between the fingers and the 3/32" washers are beside the fingers.
9. Unscrew the fingers and replace. Be sure the braid is pulled down so that the screw is in the center of the eye.
10. Reassemble in the reverse order. Make sure the fingers work freely.
11. The stud end with 1-1/2" of thread screws into the adapter 1-1/2" or flush with the top of the boss.
12. A torque of from 8 to 12 ft-lbs. should be applied to the insulating nuts to prevent cracking at assembly.
13. In replacing the two 3/8" bolts tighten slightly more than snug.

In addition to the fingers, each interrupter employs an arcing plate which aids in transferring the arc to the port opening. These arcing plates may be used until the arc resistant material is eroded about 75%. When replacing the arcing plate be sure to prick punch the material at the slot of the countersunk screw to prevent loosening.

The contact tip of the moving contact assembly (600 amp. only) may be replaced. The replacement contact tip should be screwed in tight and then locked by upsettir

ome of the material from the contact rod to the notches in the contact tip.

GASKETS

Prepare gaskets and gasket surfaces (for cork, vellumoid and similar material) as follows:

All gasket surfaces shall be thoroughly cleaned to remove all oil, grease, or foreign material which will prevent proper adhesion of the gaskets, or sealing of the joints. They shall be allowed to become thoroughly dry before proceeding with treatment.

All gasket surfaces where gaskets are to be permanently assembled shall be given a full unbroken coat of G.E. #1201 compound. All gaskets (except rubber gaskets) for such joints shall be given a similar coat. This shall be done at such time in the assembly cycle that the compound will be allowed to dry at least one half hour before final assembly. A longer time up to 24 hours is not detrimental. In making up permanent joints both the gaskets and gasket surfaces are again coated with G.E. #1201 compound and the parts bolted up before the compound sets.

For joints such as covers, manholes, or places where the joint has to be opened do not coat the gasket surface of the removable part or install this part until the compound on the gasket is perfectly dry. The side of the gasket to be assembled against the uncoated surfaces can be greased to prevent sticking.

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 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 the General Electric Company 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 inside 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.

A recommended list of renewal parts is printed below and on Page 16.

FIG. NO.	REF. NO.	CATALOG NO. FOR MODEL FKD-23	CATALOG NO. FOR MODEL FKD-23-1	QUAN. PER BKR.	DESCRIPTION
1*	2	397A963 P-16	397A963 P-16	1	Gasket For Stop Bolt
1*	4	182V292	182V292	6	Gasket For Bushing Support
1	6	#	#	#	Bushing Current Transformer
1*	8	182V835 P-5	182V835 P-5	1	Tank Gasket
*			0809B0301 G-2	1	Tank Liner Complete
1	10	268B648 G-1	268B648 G-2	1	Lift Rod Guide Assembly
1*	13	0103A3959 P-1	0103A3959 P-3	3	Lift Rod
1	13A	0808B0661 G-2		2	Moving Contact Assembly - End Phase 600A.
1	13A	0808B0661 G-4		2	Moving Contact Assembly - End Phase 1200A.
1	13A	0808B0661 G-1		1	Moving Contact Assembly - Middle Phase 600A.
1	13A	0808B0661 G-3		1	Moving Contact Assembly - Middle Phase 1200A.
1	13A		0809B0327 G-2	2	Moving Contact Assembly - End Phase 600 & 1200A.
1	13A		0809B0327 G-1	1	Moving Contact Assembly - Middle Phase 600 & 1200A.
1	14	397A500 P-2		6	Contact Rod 600A.
1*	14	397A501 G-1		6	Contact Tip 600A.
1	14	0103A3850 G-2		6	Contact Rod & Tip 1200A.
1	14		0103A3850 G-2	6	Contact Rod & Tip 600 & 1200A.
1	16	0809B0174 G-1	0809B0174 G-1	1	Oil Gage Compete
1	16A		0103A6161 P-1	1	Glass For Oil Gage - Glass Top
1	16B	181V558	181V558	1	Glass For Oil Gage - Steel Top
+1	19	178V727	178V727	1	Glass For Indicator (Mech. Hse.)
+1	20	103A1847 P-2	103A1847 P-2	1	Gasket For Maint. Device Cover (Mech. Hse.)
+1	21	6001070 P-1	6001070 P-1	1	Drain Valve
2*		0267C0987 G-1	0267C0987 G-1	6	Bushing Complete
2	2	179V508	179V508	6	Gasket For Bushing Cap
2	4	6477428 P-84	6477428 P-84	6	"O" Ring For Bushing Terminal
2	6	178V103	178V103	12	Gasket For Porcelain
2	8	268B696 P-3	268B696 P-3	6	Porcelain
4*	2	0103A2049 P-2	0103A2049 P-2	1	Heater 115V. AC
4*	2	0103A2049 P-1	0103A2049 P-1	1	Heater 230V. AC
4*	5	See Table 1, Next Page		1	Potential Trip Coil
4*	8	179V585 P-1	179V585 P-1	1	Latch Checking Switch (LC)
4*	11	183V714	183V714	1	Trip Latch Roller
4	14	183V714	183V714	1	Cam Follower Roller
4*	18A	6477428 P-1	6477428 P-1	1	Gasket For Dashpot Piston Rod
4*	18B	6477428 P-10	6477428 P-10	1	Gasket For Dashpot Cylinder
4	20	286B416 G-2	286B416 G-2	1	Cam
4	20A	0178L0789 G-1	0178L0789 G-1	1	Cam - Incl. Rollers (Ref. 21)
4	28	454A196	454A196	1	Spring

\# Give Complete B.C.T. Nameplate Date

* Not Illustrated

* Recommended for Normal Maintenance

FIG. NO.	REF. NO.	CATALOG NO. FOR MODEL FKD-23	CATALOG NO. FOR MODEL FKD-23-1	QUAN. PER BKR.	DESCRIPTION
4	31	0178L0789 G-2	0178L0789 G-2	1	Coupling Incl. Ref. 32
4	33	428A866 G-1	428A866 G-1	1	Jack Screw
4	35	428A908 G-1	428A908 G-1	1	Sprocket Wheel
4*	36	421A957 G-1	421A957 G-1	1	Spring Cut-out Switch (SCO)
4*	37	421A957 G-2	421A957 G-2	1	Motor Governor Switch (44)
4	44	See Table 4 below		1	Motor
4	47	179V585 P-1	179V585 P-1	1	CCX Switch (Same as Ref. 8)
4*	48	See Table 2 below		1	Closing Release Coil
4	61	See Table 3 below		1	Seal-In Resistor For Clos. Rel. Coil
4	51	179V585 P-1	179V585 P-1	1	Alarm Switch (SA) (Same as Ref. 8)
4	55	286B816 G-2	286B816 G-2	1	Buffer & Prop Asm. Comp. Incl. Refs. 23, 25, 26, 59
4*	‡62	6174599 G-2	6174599 G-2	3	Current Trip Coil - 3 Amps. (As Required)
4*	‡62	22D3G226	22D3G226	3	Current Trip Coil - 5 Amps. (As Required)
4*	‡62	6174599 G-6	6174599 G-6	1	Capacitor Trip Coil
4	‡63	6203764 P-18	6203764 P-18	2	Fuse For Motor 230, 250, 115, 125V. (3A.)
4	‡63	6203764 P-3	6203764 P-3	2	Fuse For Motor 48V. (6A.)
1-7	12	615C420 G-5	0842C0487 G-9	6	Interrupter Complete 600A.
1-7	12	615C420 G-6	0842C0487 G-10	6	Interrupter Complete 1200A.
7	2	0103A3852 P-1	0103A3852 P-1	12	Insulation
7	3	0103A3853 P-1	0103A3853 P-1	12	Guide Block
7	5	454A589	454A589	36	Spring
7	6	183V314	183V314	36	Spring Guide
7	9	0808B0678 P-1	0808B0678 P-1	12	Yoke 600A
7	9	0808B0678 P-2	0808B0678 P-2	12	Yoke 1200A
7	10	183V318	183V318	12	Stop Pin
7	11	183V313	183V313	12	Sleeve
7*	12	296B387 G-1	296B387 G-1	36	Contact Finger
7	14	0103A3855 P-1	0103A3855 P-1	12	Hinge Pin
7*	15	428A926 G-1	428A926 G-1	6	Arcing Plate
7	16	615C420 G-9	0842C0487 G-9	6	Baffle Stack (Incl. Refs. 18 & 19)
7	18	0103A4927 P-1	0103A4927 P-1	24	Insulated Stud
7	19	0103A4927 P-2	0103A4927 P-2	24	Insulated Nut
7*	21	615C420 G-10	0842C0487 G-10	12	Yoke & Contacts - Including Refs. 2, 3, 5, 6, 9, 10, 11, 12 600A
7*	21	615C420 G-11	0842C0487 G-11	12	Yoke & Contacts - Including Refs. 2, 3, 5, 6, 9, 10, 11, 12 1200A

‡ Not Illustrated

* Recommended for Normal Maintenance

Voltage Rating	Table #1 Potential Trip Coil Ref. #5	Table #2 Closing Release Coil Ref. #48	Table #3 Seal in Resistor Ref. #61	Table #4 Motor Ref. #44
24 DC	6174582 G-27	6174582 G-27	235L434 G-12	-----
48 DC	6174582 G-32	6174582 G-32	235L434 G-11	268B673 P-3
125 DC	6174582 G-22	6174582 G-22	235L434 G-15	268B673 P-2
250 DC	6174582 G-2	6174582 G-2	235L434 G-10	268B673 P-1
115 AC	6174582 G-27	366A764 G-1	0103A5114 P-2	268B673 P-2
230 AC	6174582 G-32	6174582 G-10	0103A5114 P-1	268B673 P-1