INSTRUCTIONS

GEK-19795C
SUPERSEDES GEK-19756E
and GEK-19795B

OIL-BLAST CIRCUIT BREAKERS

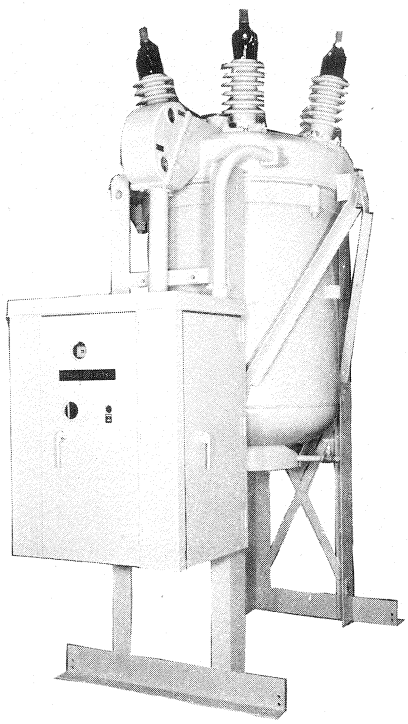
STANDARD BREAKERS

TYPES	FKA-15.5-36000-6	15.5KV,	36000	Interrupting Amperes	(Nominal 1000MVA)
	FKA-38 -22000-6	38.0KV,	22000	Interrupting Amperes	(Nominal 1500MVA)
	FKA-48.3-17000-6	48.3KV,	17000	Interrupting Amperes	(Nominal 1500MVA)
	FKA-48.3-29000-6	48.3KV,	29000	Interrupting Amperes	(Nominal 2500MVA)
	FKA-72.5-19000-3	72.5KV,	19000	Interrupting Amperes	(Nominal 2500MVA)
	FKA-72.5-27000-3	72.5KV,	27000	Interrupting Amperes	(Nominal 3500MVA)
		1200 Continuous Amperes			

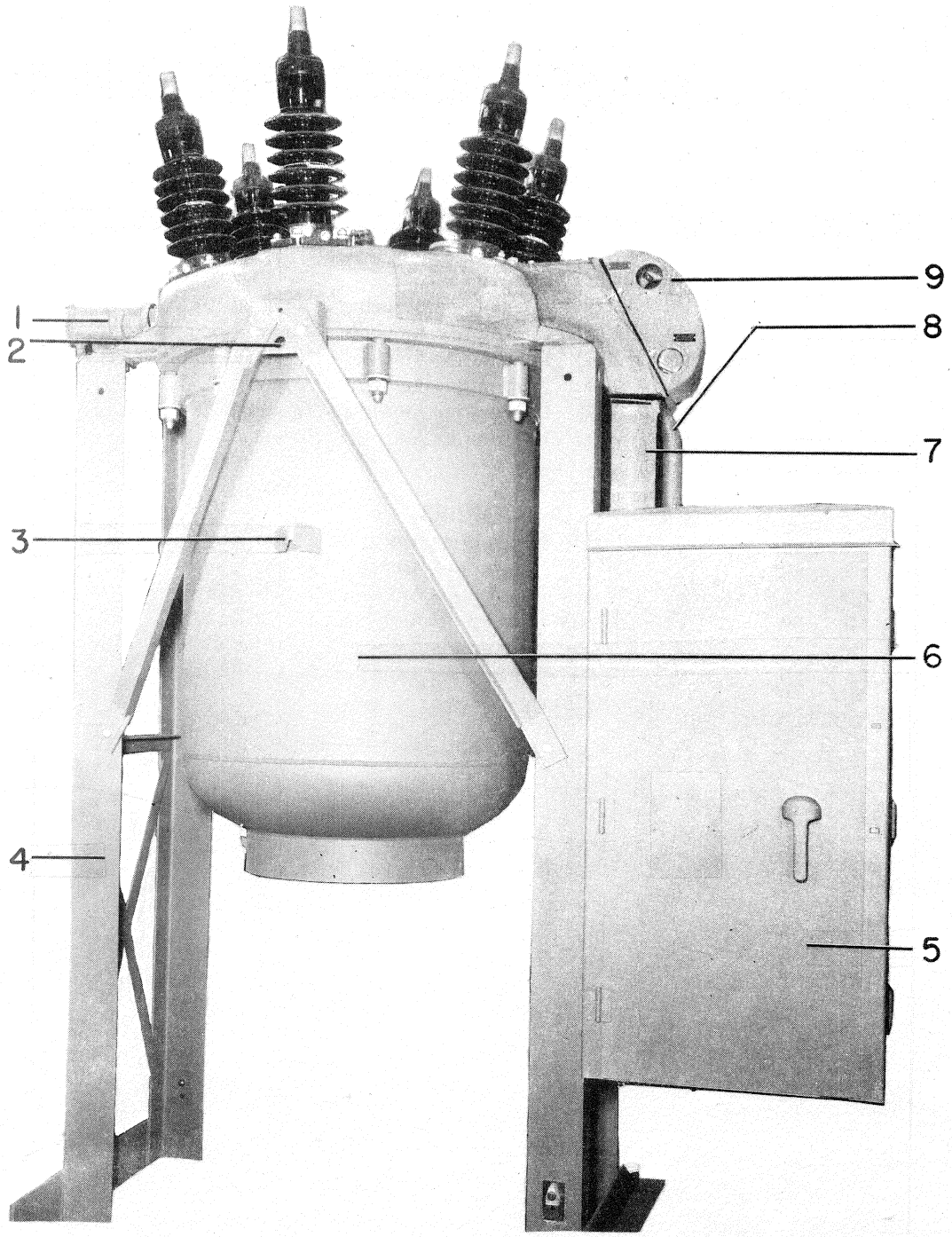
CAPACITOR SWITCHING BREAKERS

FKA-15.5-36000-6R	15.5KV,	36000	Interrupting Amperes	24000 KVAR
FKA-38 -22000-6R	38.0KV,	22000	Interrupting Amperes	30000 KVAR
FKA-48.3-17000-6R	48.3KV,	17000	Interrupting Amperes	27000 KVAR
FKA-48.3-29000-6R	48.3KV,	29000	Interrupting Amperes	27000 KVAR
FKA-72.5-19000-3R	72.5KV,	19000	Interrupting Amperes	20000 KVAR & 15000 KVAR
FKA-72.5-27000-3R	72.5KV,	27000	Interrupting Amperes	20000 KVAR & 15000 KVAR
	1200 Continuous Amperes			

CONTENTS



GENERAL ELECTRIC



1. Opening Spring Cover Pipe
2. Tank Lifter Support Bracket
3. Tank Lug
4. Breaker Framework
5. Mechanism House
6. Breaker Oil Tank
7. Vertical Operating Rod Cover Pipe
8. BCT Conduit Pipe
9. Front Crank Assembly Cover

Fig. 1 Type FKA Breaker with tank in place

OIL-BLAST CIRCUIT BREAKERS

STANDARD BREAKERS

TYPES	FKA-15.5-36000-6	15.5KV,	36000	Interrupting Amperes	(Nominal 1000MVA)
	FKA-38 -22000-6	38.0KV,	22000	Interrupting Amperes	(Nominal 1500MVA)
	FKA-48.3-17000-6	48.3KV,	17000	Interrupting Amperes	(Nominal 1500MVA)
	FKA-48.3-29000-6	48.3KV,	29000	Interrupting Amperes	(Nominal 2500MVA)
	FKA-72.5-19000-3	72.5KV,	19000	Interrupting Amperes	(Nominal 2500MVA)
	FKA-72.5-27000-3	72.5KV,	27000	Interrupting Amperes	(Nominal 3500MVA)

1200 Continuous Amperes

CAPACITOR SWITCHING BREAKERS

FKA-15.5-36000-6R	15.5KV,	36000	Interrupting Amperes	24000 KVAR
FKA-38 -22000-6R	38.0KV,	22000	Interrupting Amperes	30000 KVAR
FKA-48.3-17000-6R	48.3KV,	17000	Interrupting Amperes	27000 KVAR
FKA-48.3-29000-6R	48.3KV,	29000	Interrupting Amperes	27000 KVAR
FKA-72.5-19000-3R	72.5KV,	19000	Interrupting Amperes	20000 KVAR & 15000 KVAR
FKA-72.5-27000-3R	72.5KV,	27000	Interrupting Amperes	20000 KVAR & 15000 KVAR

1200 Continuous Amperes

INTRODUCTION

STANDARD BREAKERS

The standard type FKA 15.5-5, 38-5, 48.3-5 and 72.5-2 oil-blast circuit breakers have been designed especially for applications on transmission lines where high speed 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 and rugged linkage which operates on low friction bearings, and by employing arc resistant materials for the interrupting contacts.

The fast breaker interrupting time means less system disturbance because of a quicker clearing of the fault. The short arc lengths mean lower maintenance costs.

CAPACITOR SWITCHING BREAKERS

The capacitor switching type FKA 15.5-6R, 38-6R, 48.3-6R and 72.5-3R breakers are specially constructed type FKA oil-blast circuit breakers for capacitor switching applications. They utilize a specially designed interrupter that has a built-in wire-wound resistor so connected that during interruption it is inserted into the arcing circuit in parallel with the power arc, and upon extinguishing of the power arc the resistor is inserted in series with the main contacts. The function of this resistor is to limit the restriking voltage so that the interruption will occur at an early current zero.

Resistor equipped breakers for application on capacitor banks are not normally applied on high-speed reclosing duty.

Out-of-service reclosing operations should be made to check the mechanical operation of the breaker. If in-service high-speed reclosing is required, recommendations must be obtained from the factory.

ALL BREAKERS

To facilitate installation the three phases of the breakers are mounted in a common frame on skids mounted on the front and rear of the frame. The spring-charged mechanical 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 FKA 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 which is located inside the operating mechanism housing on one of the doors.

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.

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.

To the extent required the products described herein meet applicable ANSI, IEEE and NEMA standards; but not such assurance is given with respect to local codes and ordinances because they vary greatly.

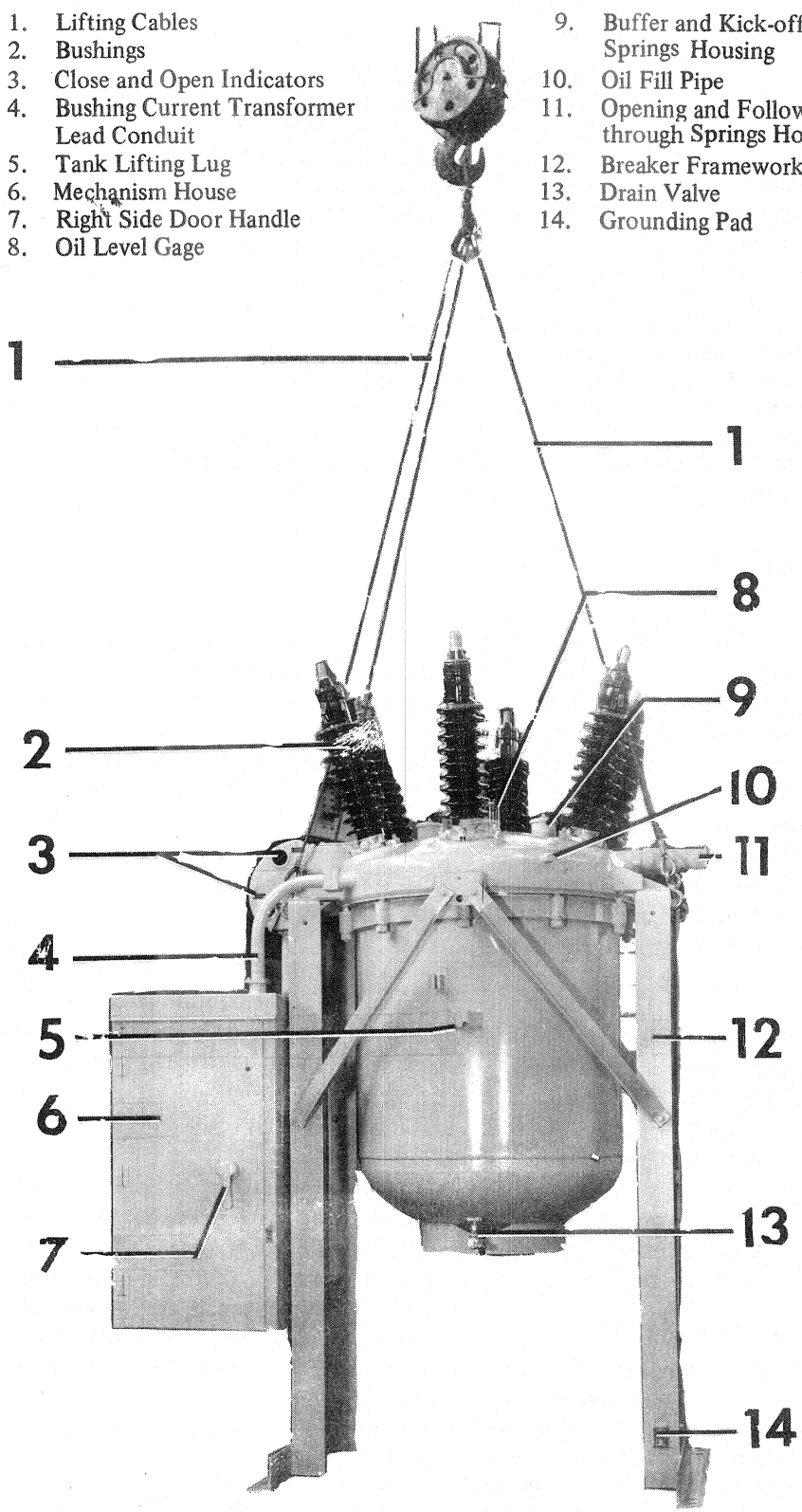


Fig. 2 View of a Type FKA Oil Circuit Breaker and the method used in lifting the breaker

Fig. 2 (8038380)

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 circuit breaker in service and for maintaining satisfactory 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.

To the extent required the products described herein meet applicable ANSI, IEEE and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

SAFETY

Each user has the responsibility to instruct all personnel associated with his equipment on all safety precautions which must be observed.

The following are recommendations to be considered in a user's safety program. These recommendations are not intended to supplant the user's responsibility for devising a complete safety program and shall not be considered as such. They are rather suggestions to cover the more important aspects of personnel safety related to circuit breakers. General Electric neither condones nor assumes any responsibility for user practices which deviate from these recommendations.

GENERAL

1. All personnel associated with installation, operation and maintenance of power circuit breakers should be thoroughly instructed and supervised regarding power equipment in general and, also, the particular model of equipment with

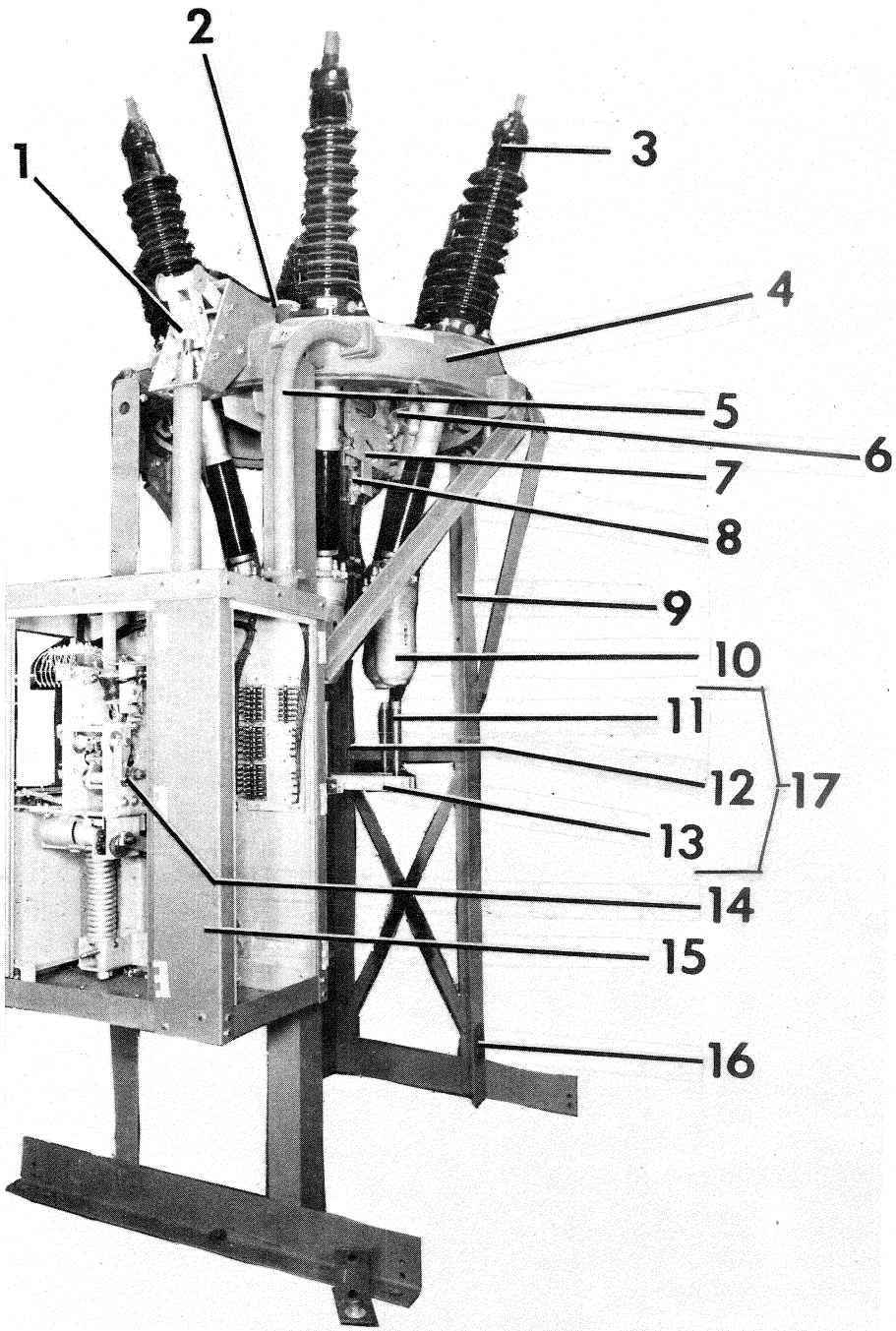


Fig. 3 (804012BA)

1. Vertical Operating Rod Coupling
2. Closing Buffer
3. Bushing
4. Breaker Dome
5. BCT Conduit Pipe
6. Bushing Current Transformer (BCT)
7. Breaker Linkage
8. Opening Dashpot
9. Framework
10. Interrupter
11. Contact Rod
12. Lift Rod
13. Crossarm
14. Mechanism
15. Mechanism House
16. Ground Pad
17. Moving Contact Assembly

Fig. 3 View of the Type FKA Oil Circuit Breaker with an ML-14-0 spring-charged operating mechanism showing major assembly units

which they are working. Instruction books and service advices should be closely studied and followed.

2. Maintenance programs must be well planned and carried out consistent with both customer experience and manufacturer's recommendations including service advices and instruction books. Good maintenance is essential to breaker reliability and safety.

Local environment and breaker application must be considered in such programs, including such variables as ambient temperatures, actual continuous current, number of operations, type of interrupting duty, and any unusual local condition such as corrosive atmosphere or major insect problems.

3. The term "breaker" includes all equipment mounted on the circuit breaker foundation.

SPECIFIC

1. DO NOT work on an energized breaker. If work has to be performed on the breaker, take it out of service, open the disconnect switches at each side of the breaker, then close the breaker and ground each phase.

2. DO NOT work on any part of the de-energized breaker until all control and heater power has been disconnected.

3. All spring-charged mechanisms related to a breaker must be serviced only by skilled and knowledgeable personnel capable of releasing each spring load in a controlled manner. Particular care must be exercised to keep personnel clear of mechanisms which are to be operated or released. Information on construction of such mechanisms is provided in the instruction book for the particular breaker.

4. If there is any evidence of or suspected deterioration of breaker dielectric capability, the yard and adjacent areas should be promptly cleared of personnel. The breaker should then be de-energized by "back-ups" and isolated by disconnect switches.

5. Operational tests and checks should be made on a breaker after maintenance, before it is returned to service, to ensure that it is capable of operating properly. The extent of such tests and checks should be consistent with the level of maintenance performed.

RECEIVING, HANDLING AND STORAGE

RECEIVING

Upon receipt of this equipment examine it for hardware which may have become loose in transit. Tighten any loose hardware and apply paint as required.

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, breaker linkage and breaker tank in place. The operating mechanism and its housing are shipped assembled on the front end of the framework.

IMPORTANT: 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 General Electric Apparatus Sales Office should be notified promptly.

UNPACKING AND HANDLING

Any 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 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. The method used in attaching these cables is shown in Fig. 2.

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 and internal parts should be cleaned and dried before the oil tanks are filled with oil. Remove the desiccant bags, and the humidity card on the lift rod. Any crating or wrapping, if used around the bushings 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 ever 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 or moisture. Under extreme conditions of humidity, or if the only storage space is damp, they should be kept in suitable containers filled with clean and dry G-E #10-C oil.

Renewal 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. Under extreme conditions of humidity, or if the only storage space is damp, they should be kept in suitable containers filled with clean and dry G-E #10-C oil.

DESCRIPTION

BREAKER

Each circuit breaker is composed of an operating mechanism (14), Fig. 3, and a breaker assembly mounted on a common framework (9) as shown in Fig. 3. The breaker assembly consists of an oil tank (6), Fig. 1, which contains the interrupters and contacts, a breaker dome (4), Fig. 3, which houses the breaker linkage, Figs. 8 and 9, and bushing current transformers (6), Fig. (3), and also support the bushings (3), Fig. 3, and interrupters (10), Fig. 3.

The breaker linkage which is assembled in the breaker dome (8), Fig. 4, is designed to give straight-line motion to the moving contact assemblies (30), Fig. 4, and to convert the motion of the operating mechanism (14), Fig. 3, to the proper breaker stroke. The breaker linkage, Fig. 8 and Fig. 9, is connected to the operating mechanism by an adjustable connecting rod (11), Fig. 14. On the front of the breaker

dome (4), Fig. 3, above the operating mechanism is the toggle linkage, Fig. 10 and Fig. 11, which is used to change the vertical operation of the operating mechanism to the horizontal operation of the breaker linkage. Contained within the breaker dome is the breaker linkage which changes the linkage horizontal movement to a straight-line vertical movement of the lift rod (18), Fig. 14. A gas and oil seal is provided around the horizontal operating rod to form a separation between the toggle linkage box (2), Fig. 10, and the interior of the breaker dome. An adjustable opening spring (25), Fig. 14 located on the back end of the opening spring coupling (23), insures positive opening action and determines contact speed and contact parting time. The follow-through spring (27), Fig. 14, is adjusted with the opening spring and insures positive opening action over the full stroke of the breaker contacts.

CLOSING BUFFER AND OPENING DASHPOT

A closing buffer (2), Fig. 3, and an oil filled opening dashpot (8) 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.

BREAKER BREATHER

A "breather" (1), Fig. 4, is mounted on the center phase closing buffer (20), Fig. 14, to vent any oil vapor caused by circuit interruption and to maintain atmospheric pressure inside the breaker dome.

OIL GAGE

A float type oil gage (2), Fig. 4, is installed in the breaker dome (8). This indicates the oil level directly through the action of a float (15), the position of which corresponds to the true oil level. The float is fastened to a pointer rod which is visible in the glass tube of the oil gage on the top of the breaker. The correct oil level at normal temperature (20°C) is indicated on the breaker outline drawing and by a painted line on the gage glass. The minimum oil level is the bottom of the visible portion of the gage glass. This corresponds to that portion of the bushing which must always be immersed in oil.

OIL TANK

The oil tank (18), Fig. 4, is suspended in place against the breaker dome (8) by eight breaker oil tank studs (2), Fig. 7, and nuts which compress a gasket (10), Fig. 4, located in a groove on the top of the oil tank band. The nuts must be tight to prevent oil leakage through the tank gasket area during circuit interruption and to prevent water seepage into the breaker during severe storms. This arrangement permits easy removal of the tanks for inspection and maintenance of the contacts and interrupters (20), Fig. 4. A drain valve (25) 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 accidental leakage or contamination of the oil.

BREAKER INTERRUPTERS

STANDARD INTERRUPTER

Each interrupter (20), Fig. 4 is mounted on the lower end of each bushing (3) by means of an upper and lower adapter (5 and 6), Fig. 7, which is also used for alignment of the interrupter. See Fig. 21 for the interrupter assembly. The interrupter consists essentially of a Fiberglas tube enclosing a set of eight primary contact fingers, two of which have arcing tips, insulating tubes, and a baffle stack. The body tube has two port openings which allow the proper flow of oil across the contacts and through the baffle stack during interruption as shown in Fig. 26.

CAPACITOR SWITCHING INTERRUPTER

The capacitor switching interrupter (32), Fig. 4, is somewhat different from the standard interrupter in that it contains resistor finger assemblies and is surrounded with a resistor wound on a fiber support. In addition to the contact fingers, insulating tubes and baffle stack are contained in the standard interrupter. The resistor is electrically connected across the main contacts of the breaker and is shorted out when the breaker is in the closed position. The standard interrupter does not contain the resistor or the resistor finger assembly.

For a detailed explanation of the operation of the breaker refer to the section OPERATION.

BUSHINGS

The new low-silhouette center-clamped Type U bushings which are built to the new NEMA and ANSI standards are used in these breakers. The bushings are installed in the breaker dome from above. Weathertight gaskets are inserted between the support flange and the breaker dome. Each bushing has provisions for two current transformers and the bushings can be installed and removed from the breaker without disturbing the bushing current transformers. For additional information on the construction of bushings refer to instruction book, GEH-1638.

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 ANSIC57 .13-4.1.3 and NEMA SG-4-3.10 specifications.

Single-ratio type BM high-accuracy 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. The multi-ratio type has standard tap connections. Ratio and accuracy classification for standard transformers of this type are also in accordance with ANSI C57.13-4.1.3) and NEMA SG-4-3.10 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

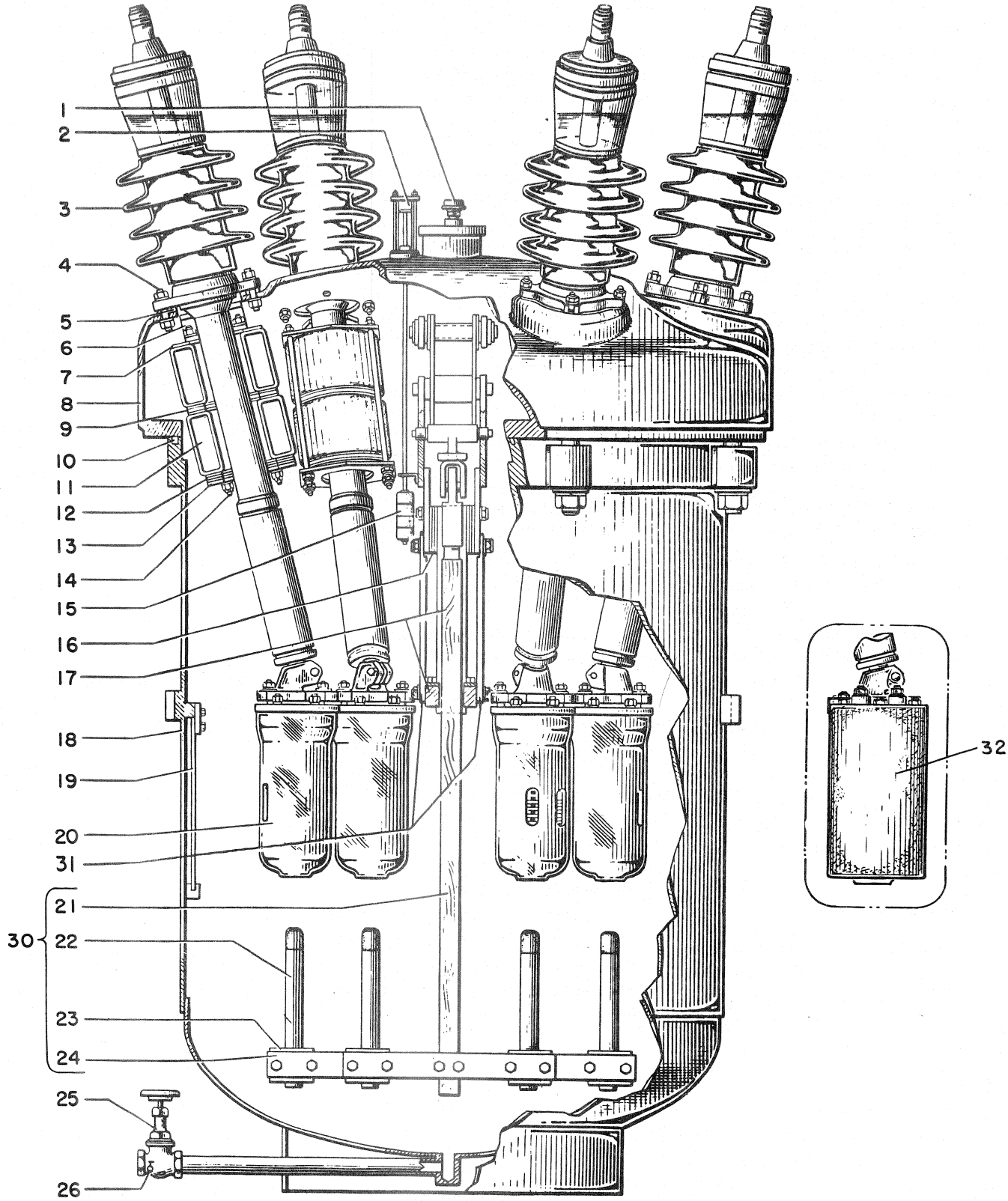


Fig. 4 (0259D0277 Rev. 2)

Fig. 4 Cross-sectional View of Breaker (One phase removed for simplicity)

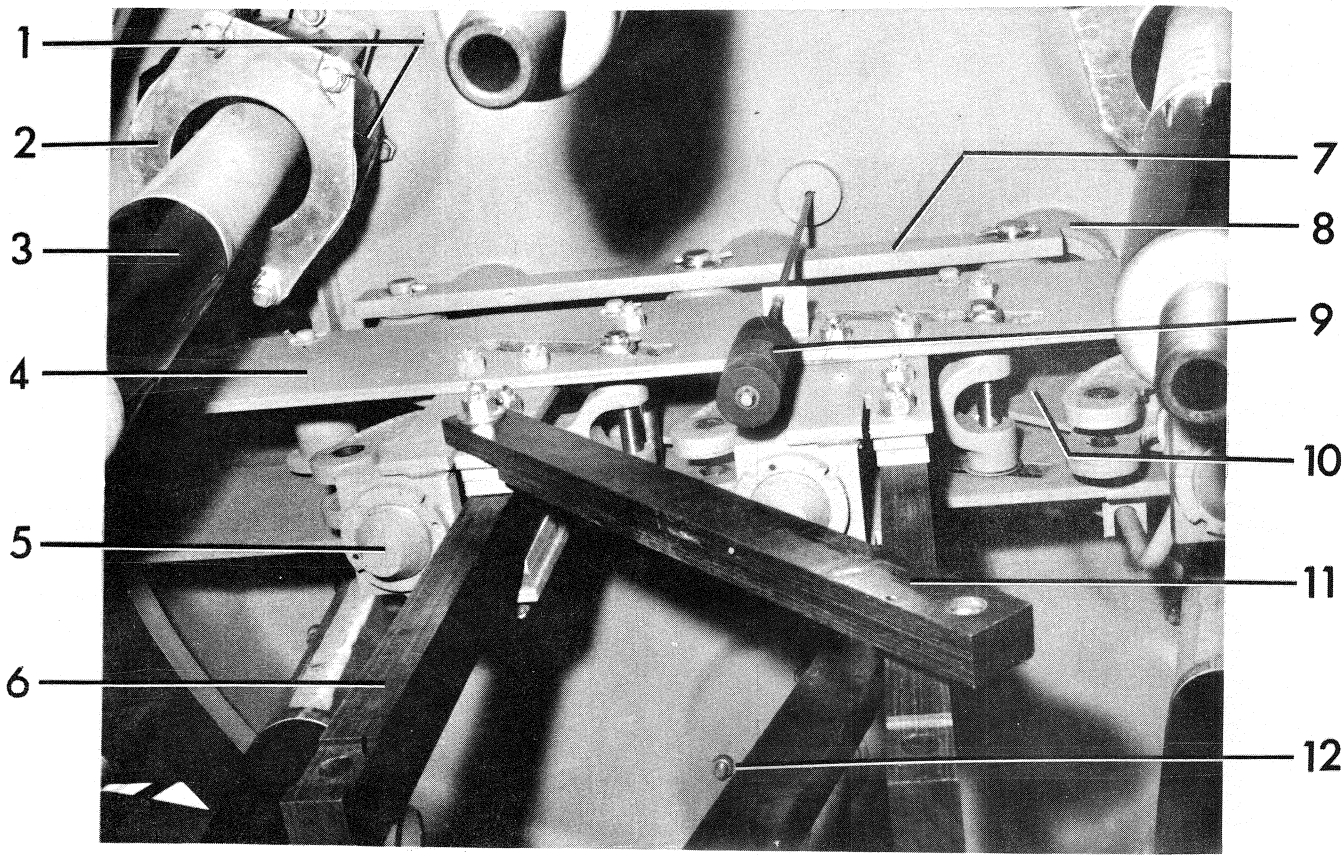


Fig 5 (8038621)

1. Bushing Current Transformer (BCT)
2. BCT Support Plate
3. Bushing
4. Linkage Support Side Plates
5. Breaker Opening Dashpots
6. Vertical Portion of the Lift Rod Guide
7. Connecting Link
8. Buffer Housing of the Rear Phase
9. Oil Level Indicator Floats
10. Beam
11. Diagonal Portion of the Lift Rod Guide
12. Bushing Mounting Studs (Underside)

Fig. 5 Right Side Vertical View of the Breaker Linkage with the interrupters, lift rods and horizontal guide plate removed.

Items for Fig. 4

1. Breather
2. Oil Gage
3. Bushing
4. Mounting Stud
5. Dome to Bushing Gasket
6. BCT Support Bracket
7. Insulation Washers
8. Breaker Dome
9. Insulation Washers
10. Tank Gasket
11. Current Transformer
12. Insulation Washers
13. Support Plate
14. Assembly Stud
15. Oil Gage Float
16. Alignment Shims
17. Lift Rod Guide
18. Oil Tank
19. Liner
20. Standard Interrupter
21. Lift Rod
22. Contact Rod
23. Contact Block
24. Crossarm
25. Drain Valve
26. Sampling Device
30. Moving Contact Assembly
31. Cross Braces
32. Capacitor Switching Interrupter

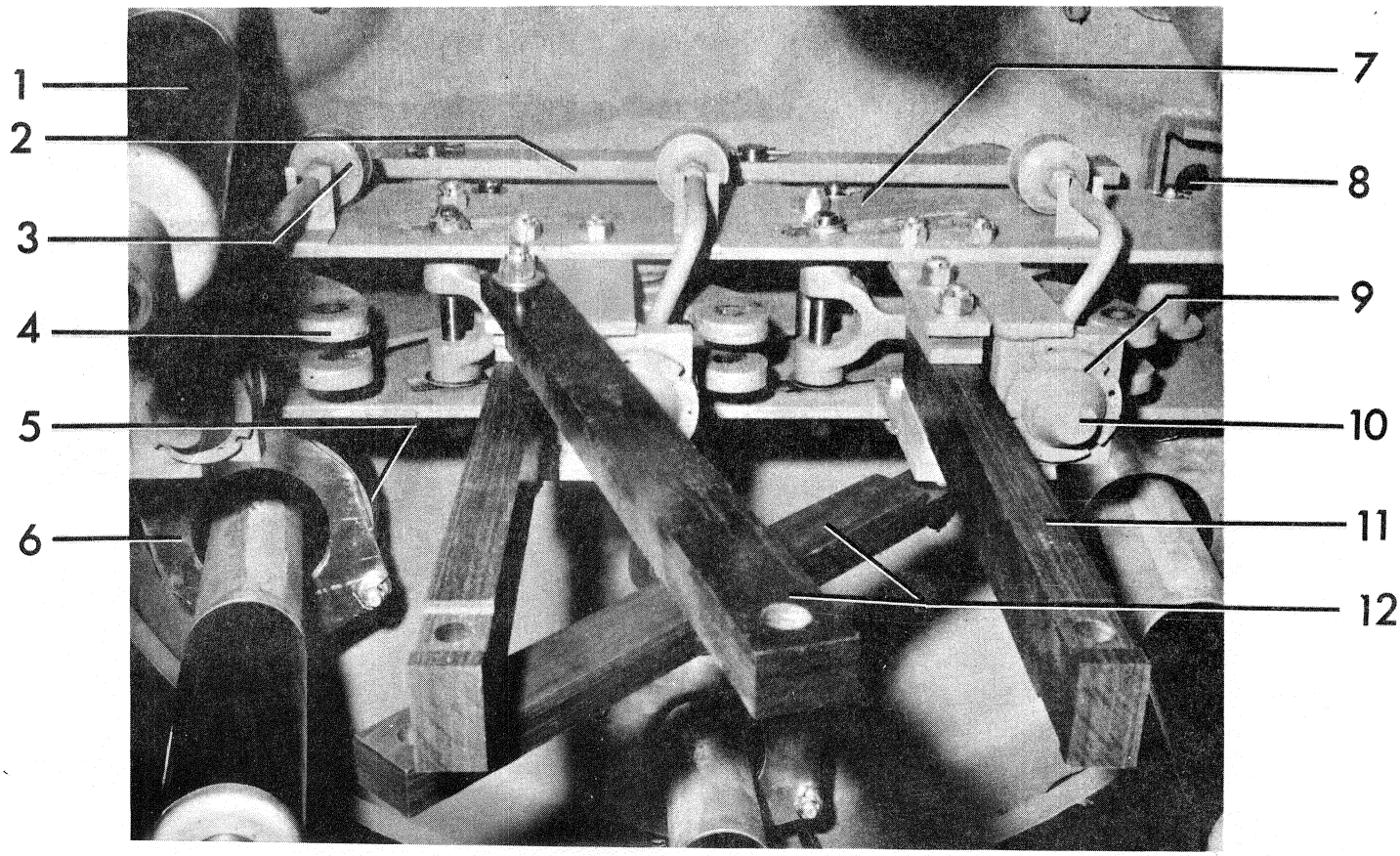


Fig. 6 (8038620)

1. Bushing
2. Connecting Link
3. Opening Dashpot Breather
4. Lever
5. Bushing Current Transformer (BCT)
6. BCT Support Plate
7. Linkage Support Side Plates
8. Horizontal Rod Adjustment Access Opening
9. Lower Opening Dashpot Adjusting Nut
10. Opening Dashpot
11. Vertical Portion of the Lift Rod Guide
12. Diagonal Portions of the Lift Rod Guide

Fig. 6 Left Side Vertical View of the Breaker Linkage with the interrupters, lift rods and horizontal guide plate removed.

Items for Fig. 7

1. Lever
2. Tank Stud
3. Bushing
4. Oil Level Float
5. Upper Interrupter Adapter
6. Lower Interrupter Adapter
7. Interrupter
8. Lift Rod
9. Contact Rod
10. Crossarm
11. Opening Dashpot Breather
12. Opening Dashpot
13. Horizontal Lift Rod Guide
14. Interrupter to Bushing Clamping Bolt
15. Breaker Rear Frame
16. Operating Mechanism - Left Door
17. Contact Block

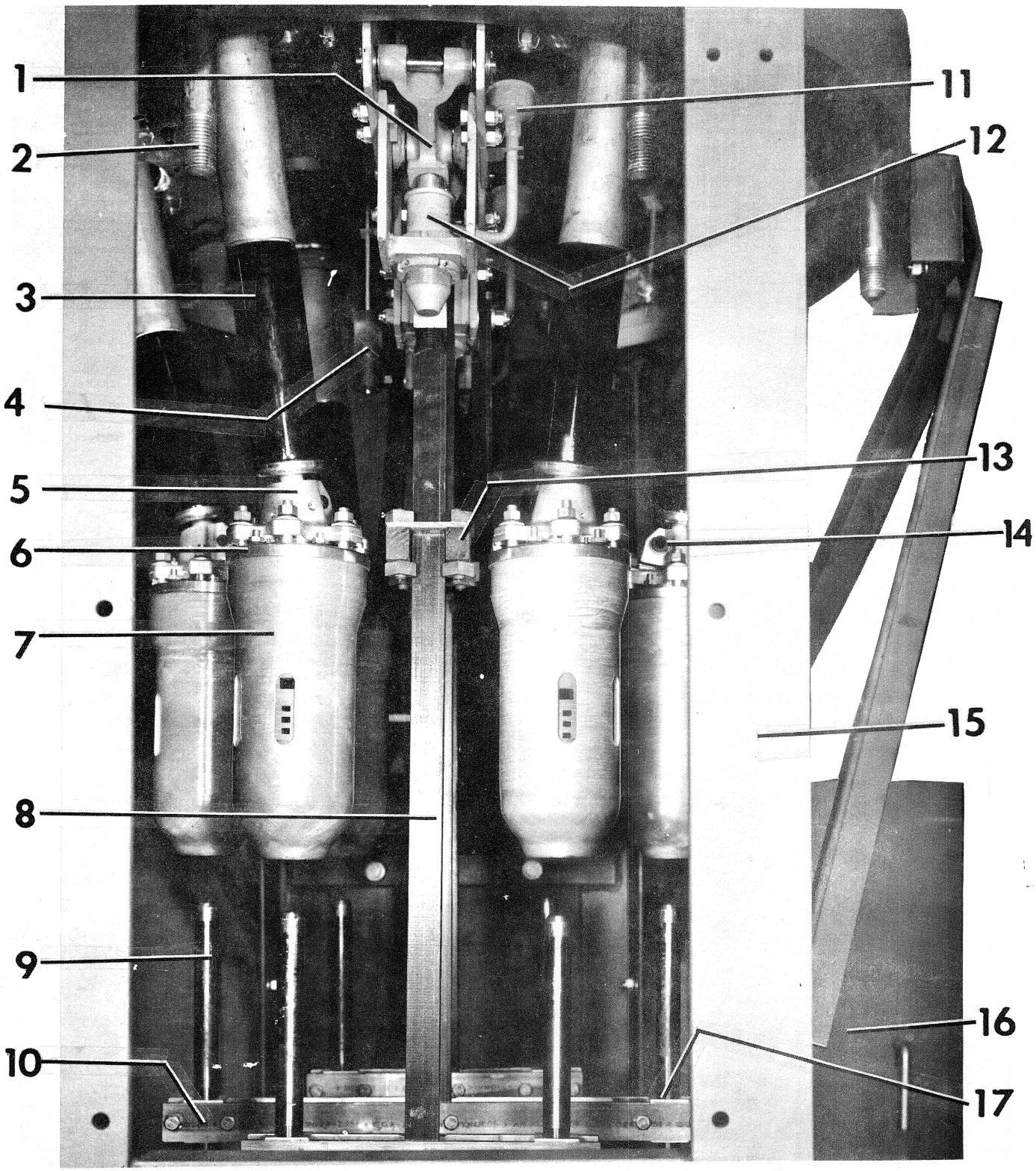


Fig. 7 Rear View of the Breaker with an ML-14-0 spring-charged operating mechanism showing the major assembly units.

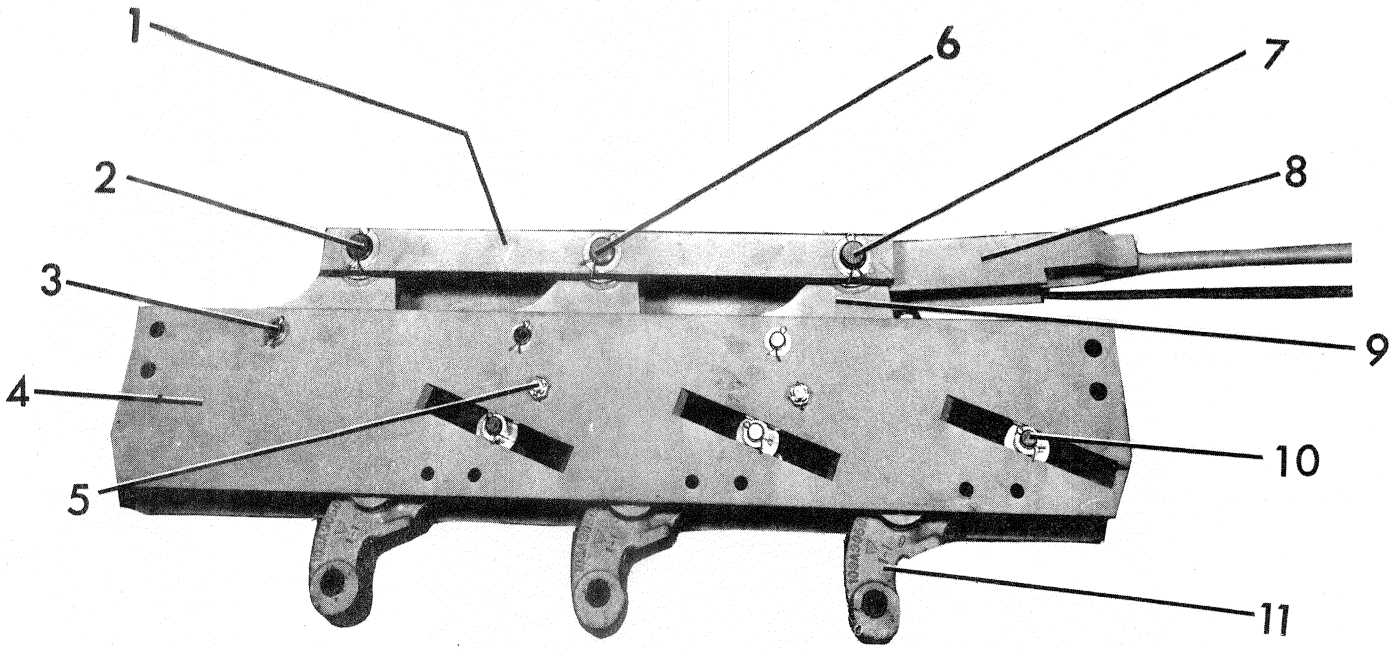


Fig. 8 (8U40123)

1. Connecting Link
2. Horizontal Operating Rod Rear Coupling Pin
3. Beam Pin
4. Linkage Support Side Plate
5. Tie Rod
6. Connecting Link Pin
7. Opening Spring Coupling Pin
8. Opening Spring Coupling
9. Beam
10. Lever Pin
11. Lever

Fig. 8 View of the Breaker Straight Line Linkage in the breaker partially-open position just prior to assembly into the breaker dome.

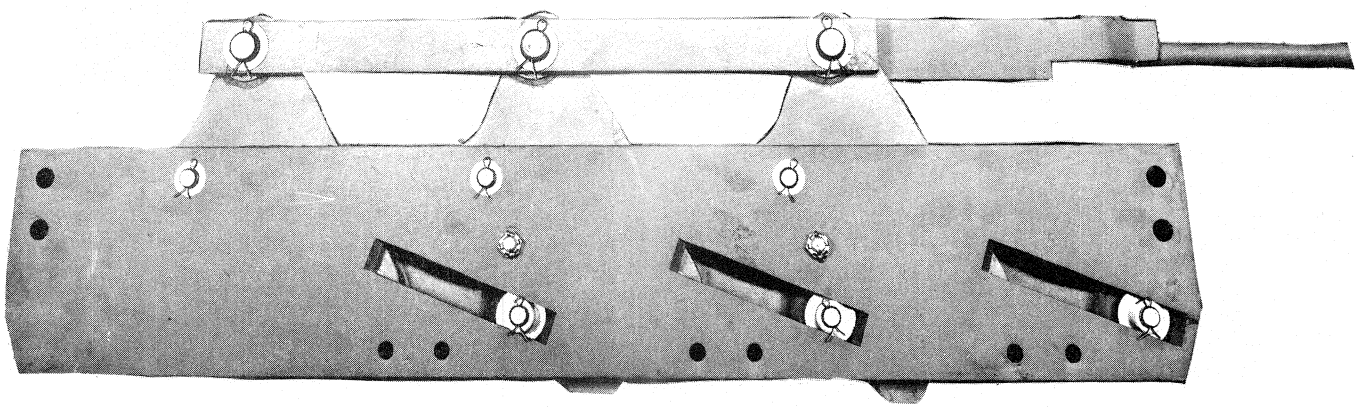


Fig. 9 (804U120)

Fig. 9 View of the Breaker Straight Line Linkage in the breaker partially-closed position just prior to assembly into the breaker dome.

the Switchgear Business Department by giving the proper references.

Bushing current transformers are mounted inside the breaker dome. They are installed from underneath the breaker dome and they can be slipped over the lower end of the bushing, although the interrupter and upper adapter must be removed first. Supporting brackets bolted to the breaker dome hold the transformers in place. Insulation spacers above and below the transformer protect it from injury. The transformer must be properly centered on the brackets to prevent its being damaged when the bushing is installed.

All transformer leads are brought out of the tanks for external connections. The leads are run in conduit through a gas and oil seal into the operating mechanism compartment where they are terminated at suitably marked terminal boards. The shorting wires should not be removed from the BCT terminal boards until the customer's permanent circuitry is installed. If it should be necessary to replace a transformer, care must be taken to see that the end of the transformer carrying the white polarity mark is placed upwards. Transformers should be connected in accordance with instructions, GEH 2020, to be sure of proper polarity and correct connections.

OIL

The high speed performance of the modern oil-blast breaker is dependent upon the use in the breaker of oil having the proper characteristics and refined under a controlled method by a reliable refinery, to fully meet the most rigid specifications. A high dielectric strength is necessary to meet insulation requirements. Efficient cooling demands low viscosity, yet not too low as to effect the flash and burning points, which must be high to minimize the fire risk. A low freezing point is required for successful operation when installed in locations subject to freezing temperatures. High resistance to carbonization minimizes the sludge and carbon deposits which reduce the dielectric strength and cooling effect of the oil. The proper oil should not readily retain moisture in suspension as the presence of one-tenth of one percent may reduce its puncturing resistance by 50 percent.

It is recommended that only uninhibited G-E #10-C oil be used in these breakers. Inhibited 10-C oil containing rust inhibiters must not be used in these breakers as the dielectric strength of this type of oil decreases rapidly after the oil is partially contaminated with minor amounts of arc products from arc interruptions.

G-E type 10-C oil is a pure mineral oil with the following characteristics:

Power Factor -	
60 cycles at 100°C - percent maximum ...	0.30
Resistivity - minimum	
ohms per centimeter at 100°C	30×10^{12}
Flash Point - degrees C	
minimum	145
Pour Point - degrees C	
maximum	-40
Acidity - mg KOH/g -	
maximum	0.02
Viscosity - Saybolt Universal	
at 37.8°C - seconds maximum ...	62
at zero °C - seconds maximum ...	320
Color	Pale amber, clear

Each lot of oil is subjected to a strict examination and is rejected unless it fully meets specifications which require, in part, that the oil shall withstand a potential of at least 26,000 volts, as measured by the standard test between 1 inch disks spaced 0.1 inch apart.

INSTALLATION

BREAKER DRAWINGS

The installation of the breaker will be facilitated by a study of the approved drawings which supplement these instructions. The approved drawings, which include an outline of the breaker, an outline of the operating mechanism and housing, 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 manual closing device and tanklifter and for 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 as shown in Fig. 2. 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.

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 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 current transformers. Remove any 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. 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.

TANK LIFTER

The manual tank lifter (13), Fig. 15, consists of two manual ratchet lever-type cable hoists. They are attached to the lifting lugs (7), welded on the outside of the tank and to the hole (3) in the support bracket attached to the dome. To lower the tank tighten up on the lifters evenly and sufficiently to support the oil tank. Remove the nuts (4) from the tank studs, then lower the tank (17).

PRECAUTIONS

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

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 permitted, but these operations should be kept to a minimum. A few air operations can be made to check the stop clearance with the breaker not energized. Operations in air normally result in higher operation speeds (3/4 to 2 feet per second faster) consequently this should be taken into account if analyzer curves are taken with the breaker contacts operating in air.

5. DO NOT USE THE MAINTENANCE CLOSING DEVICE FOR CLOSING THE BREAKER ON LOAD.

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 operated slowly by hand, using the maintenance closing device, to see that it operates

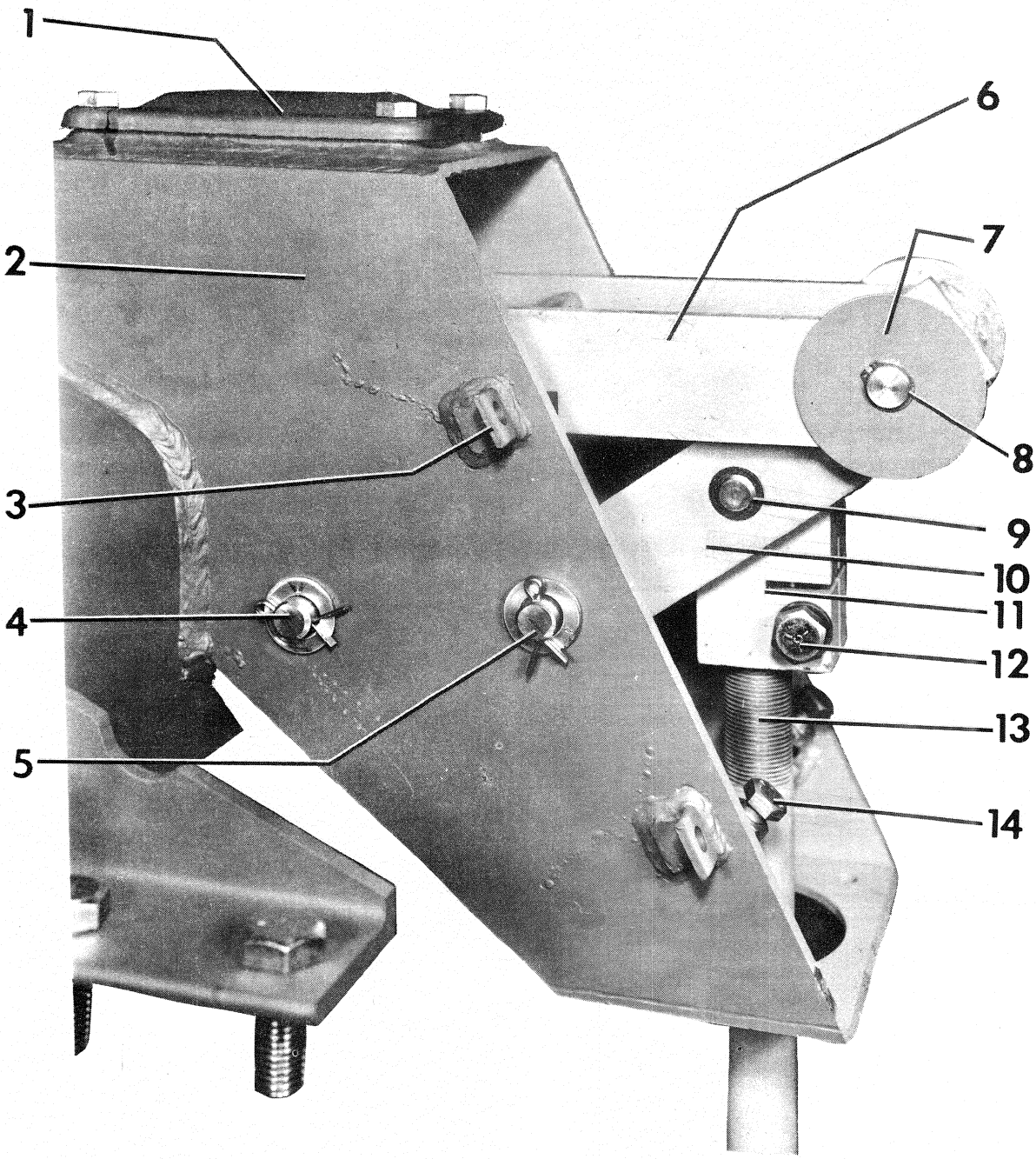


Fig. 10 (8040116)

1. Top Cover
2. Toggle Linkage Box
3. Front Cover Cleats
4. Guide Crank Pin
5. Upper Front Crank Link Pin
6. Front Link
7. Breaker Position Indicator Flag
8. Lower Front Crank Link Pin
9. Vertical Operating Rod Coupling Pin
10. Front Crank Link
11. Vertical Operating Rod Coupling
12. Vertical Operating Rod Coupling Clamping Bolt
13. Vertical Operating Rod
14. Overtravel Stop Bolt

Fig. 10 View of the Breaker Toggle Linkage in the breaker-open position.

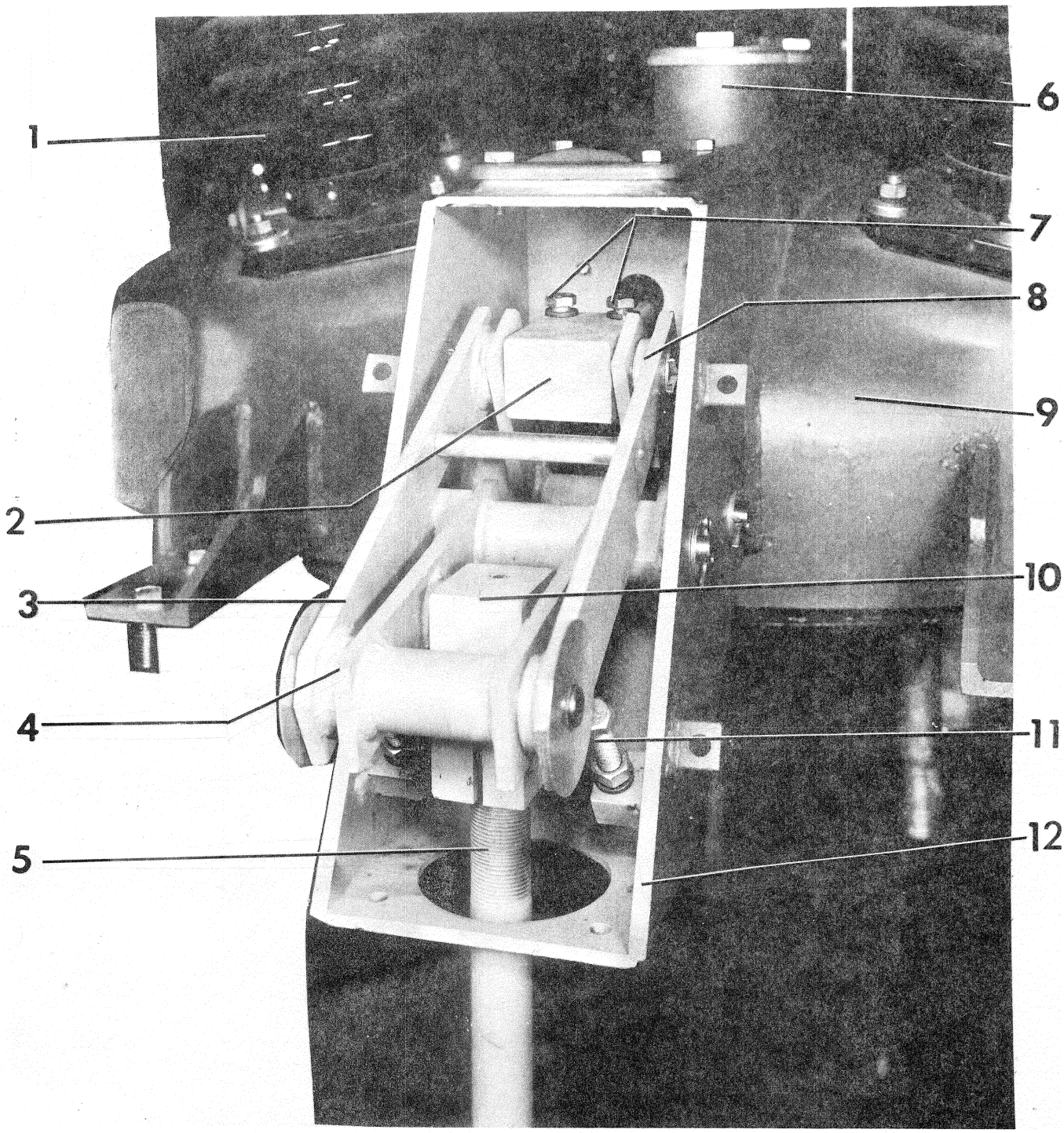


Fig. 11 (8040118A)

1. Breaker Bushing
2. Horizontal Operating Rod Front Coupling
3. Front Link
4. Front Crank Link
5. Vertical Operating Rod
6. Closing Buffer Housing
7. Horizontal Operating Rod Front Clamping Bolts
8. Guide Crank
9. Breaker Dome
10. Vertical Operating Rod Coupling
11. Overtravel Stop Bolt
12. Toggle Linkage Box

Fig. 11 View of the Breaker Toggle Linkage in the breaker-closed position.

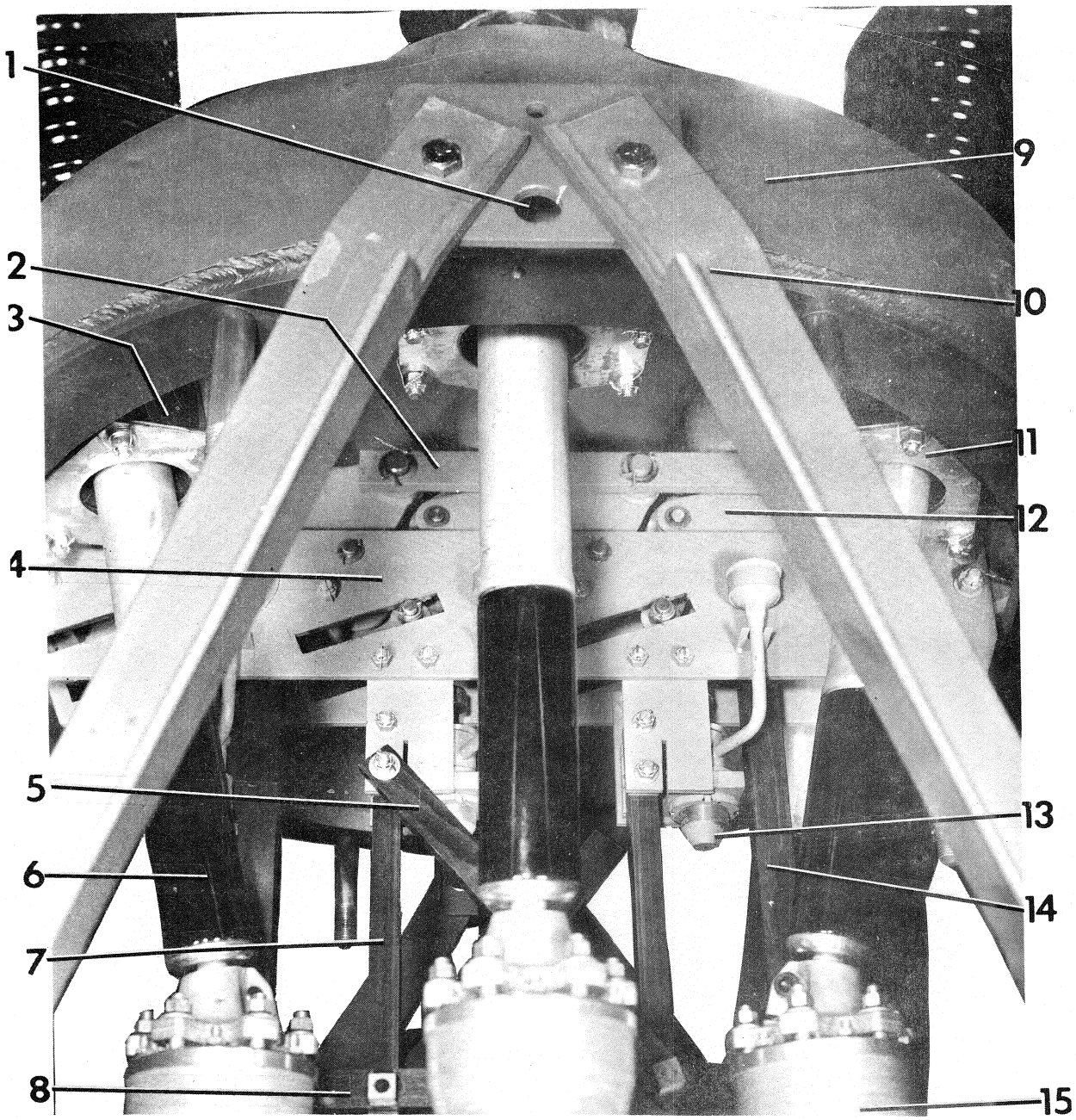
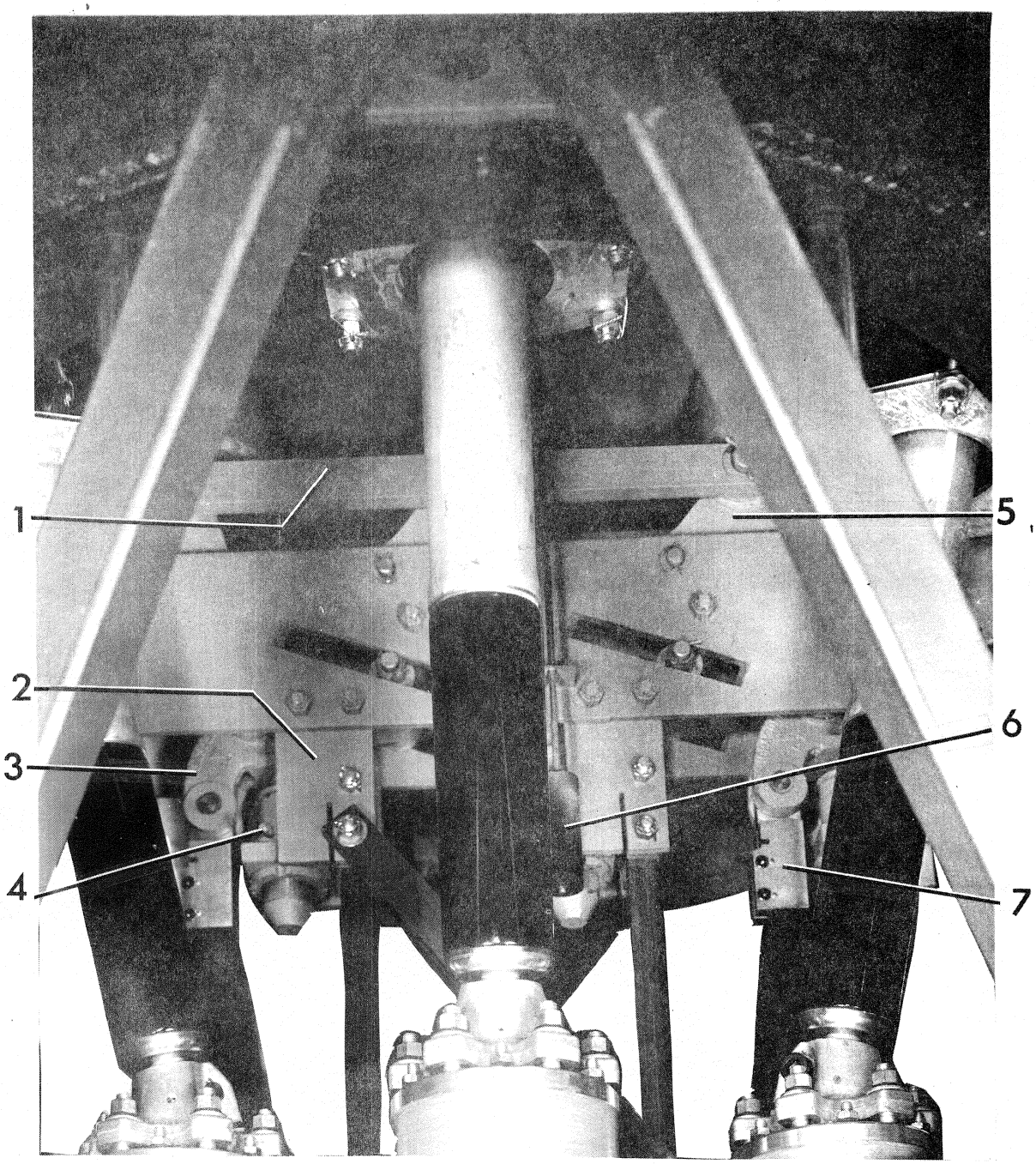


Fig. 12 (8040127)

1. Manual Tank Lifter Hook Hole
2. Connecting Link
3. Bushing Current Transformer (BCT)
4. Linkage Support Side Plate
5. Lift Rod Guide Diagonal Brace
6. Bushing
7. Lift Rod Guide Vertical Brace
8. Lift Rod Guide Horizontal Brace
9. Breaker Dome
10. Framework Diagonal Brace
11. BCT Support Plate
12. Beam
13. Opening Dashpot
14. Lift Rod
15. Interrupter

Fig. 12 Left Side View of the Linkage as installed in the 15.5 through 48.3kV breaker. The breaker is in the closed position.



1. Connecting Link
2. Lift Rod Guide and Opening Dashpot Support
3. Lever
4. Opening Dashpot Oil Level Hole
5. Beam
6. Oil Level Float
7. Lift Rod Coupling

Fig. 13 Right Side View of the Linkages installed in the 15.5 through 48.3 kV breaker with the breaker in the open position.

Fig. ... (8040125)

smoothly throughout the closing operation, that no binding occurs, and that no excessive play is noticeable between parts. The breaker cannot be opened slowly when equipped with a spring-charged mechanism, but it can be closed slowly as explained in the mechanism instruction book. 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 tank lifter, as shown in Fig. 15, the tank can be lowered, leaving the contacts and pole unit mechanisms accessible for inspection. The trip latch of the operating mechanism is wired or blocked in place during shipment and this wire or block 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 (LIFT ROD SETTING)

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

Using a maintenance closing device, slowly close the breaker until the trip 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 Fig. 14. This measurement is 7-1/4 inches ± 1/8 inch as shown in Fig. 27, item D.

The first and third phase lift rod settings are ± 1/8 inch from the setting obtained on the center phase as shown in Fig. 27, item C.

EXTERNAL TOGGLE SETTING

Measure the external toggle setting. This is 7/8 inch ± 1/32 inch with the breaker in the fully-closed position as shown in section A-A of Fig. 14 and B of Fig. 27.

LIFT ROD LEVER SETTING

Measure the lift rod (18), Fig. 14, to the lever pin (28) clearance with the breaker closed. Block the trip latch of the spring-charged mechanism to prevent accidental tripping. The lift rod lever setting is measured from the rear of the lift rod (18) to the front of the lever pin (28). This should be a minimum of 2-15/16 inches. It is sufficient to measure this on Phase Three only. See Fig. 14 and L of Fig. 27.

ADJUSTMENT CHANGES

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.

TOGGLE ADJUSTMENT

The breaker horizontal operating rod (11), Fig. 14, as well as the vertical operating rod (1) have right and left-hand threads. Shortening these rods will reduce these settings. Adjustment of the toggle is attained by loosening the locking bolt in the vertical operating rod coupling (3) and the similar locking bolt shown on the mechanism end coupling of the vertical operating rod (1). Turn this rod clockwise, as viewed 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, the lift rod setting and the lift rod lever setting.

LIFT ROD SETTING

In a similar manner, the lift rod setting of the breaker linkage is adjusted by changing the length of the breaker horizontal operating rod (11), Fig. 14. The locking bolts on both the front and rear horizontal operating rod couplings (9 and 14) will require loosening to change the length of the horizontal operating rod (11). Access to the rear locking bolts is through the two pipe plugs (1), Fig. 15. Altering the position setting may affect the closing buffer adjustment, therefore, maintain the 1/32 inch buffer dimension while adjusting the toggle and lift rod settings. Final measurements should be made after closing the breaker electrically with the breaker oil tanks in the down position and the contacts moving in air. Readjust as necessary to the proper values.

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

CLOSING BUFFER ADJUSTMENT (15.5 through 72.5 kV)

The closing buffer is set at the factory and should not require further adjustment unless the opening spring, toggle linkage or lift rod setting is adjusted. The 72.5 kV closing buffer, Fig. 17, is the same as the 15.5 through 48.3 kV closing buffer except for the addition of two 1/8 inch thick washers (14) beneath the outer kick-off spring (10). These two washers are used to increase the tripping speed and decrease the tripping time of the 72.5 kV breaker. The adjustment for the two closing buffers are identical. These units are set in conjunction with the lift rod setting, the external toggle, and the lift rod lever setting and a change in any may require adjustment of the others. With reference to Figs. 16 and 17, and the breaker in the closed position, the adjusting disk (8) is turned down until it just touches the inner buffer spring (11) then backed off a one-half turn resulting in 1/32 inch ± 1/64

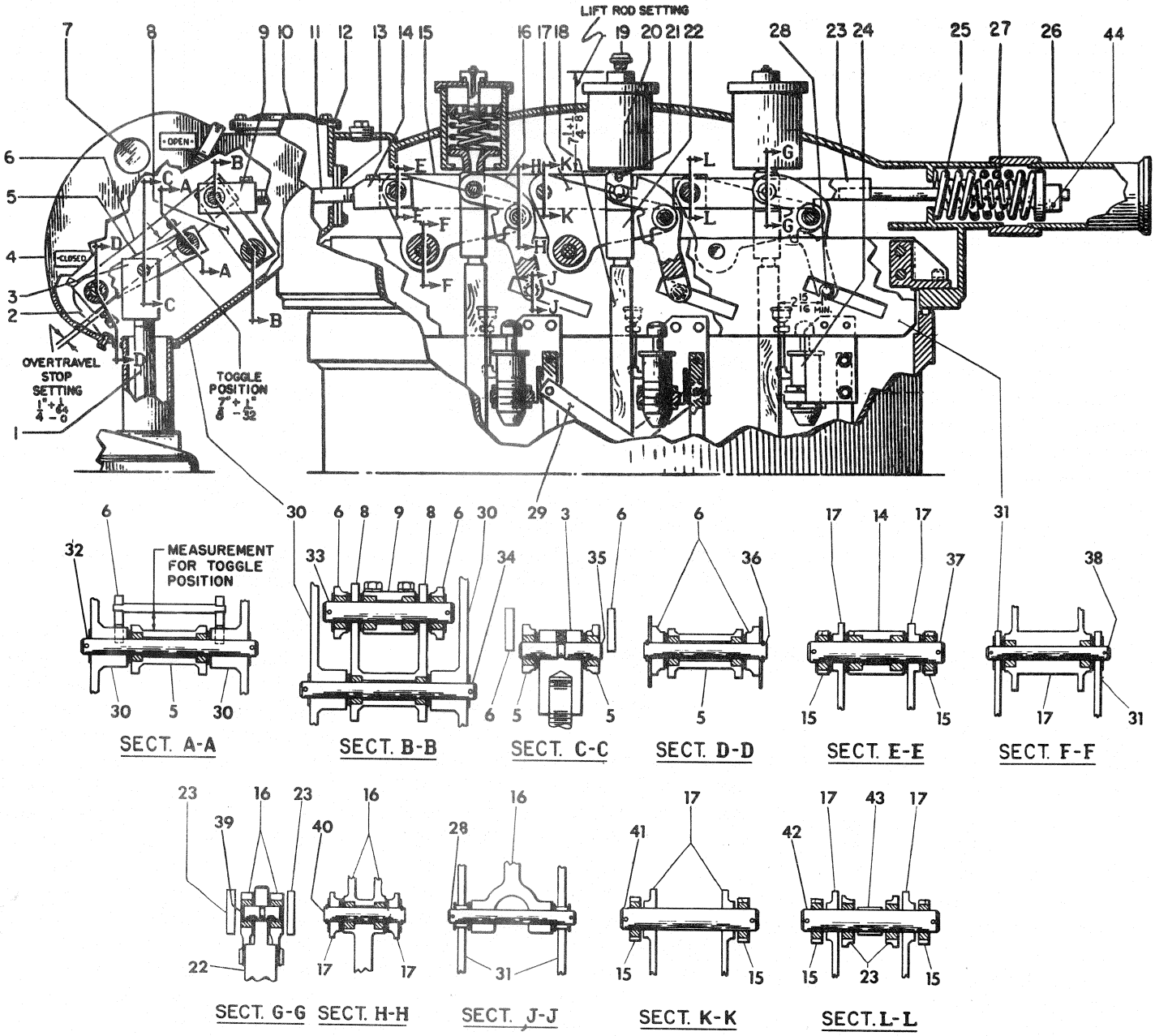


Fig. 14 Breaker Linkage

Fig. 14 (0958D0989 Rev. 0)

1. Vertical Operating Rod
2. Front Cover Gasket
3. Vertical Operating Rod Coupling
4. Front Cover
5. Front Crank Link
6. Front Link
7. Breaker Position Indicator Window
8. Guide Crank
9. Horizontal Operating Rod Front Coupling
10. Top Cover
11. Horizontal Operating Rod
12. Top Cover Gasket
13. Gas and Oil Seal
14. Horizontal Operating Rod Rear Coupling
15. Connecting Link
16. Lever
17. Beam
18. Lift Rod
19. Breather
20. Closing Buffer
21. Travel Recorder Rod Connection
22. Lift Rod Coupling
23. Opening Spring Coupling
24. Opening Dashpot
25. Opening Spring
26. Opening Spring Cover
27. Follow-through Spring
28. Lever Pin
29. Diagonal Cross Brace
30. Front Crank Assembly Support Box
31. Breaker Linkage Side Support
32. Upper Front Crank Link Pin
33. Front Link and Guide Crank Pin
34. Guide Crank Pin
35. Vertical Operating Rod Coupling Pin
36. Lower Front Crank Link Pin
37. Horizontal Operating Rod Rear Coupling Pin
38. Beam Pin
39. Lift Rod Coupling Pin
40. Lever and Beam Pin
41. Connecting Link Pin
42. Opening Spring Coupling Pin
43. Spacer
44. Opening Spring Retaining Nut and Guide

Items for Fig. 14

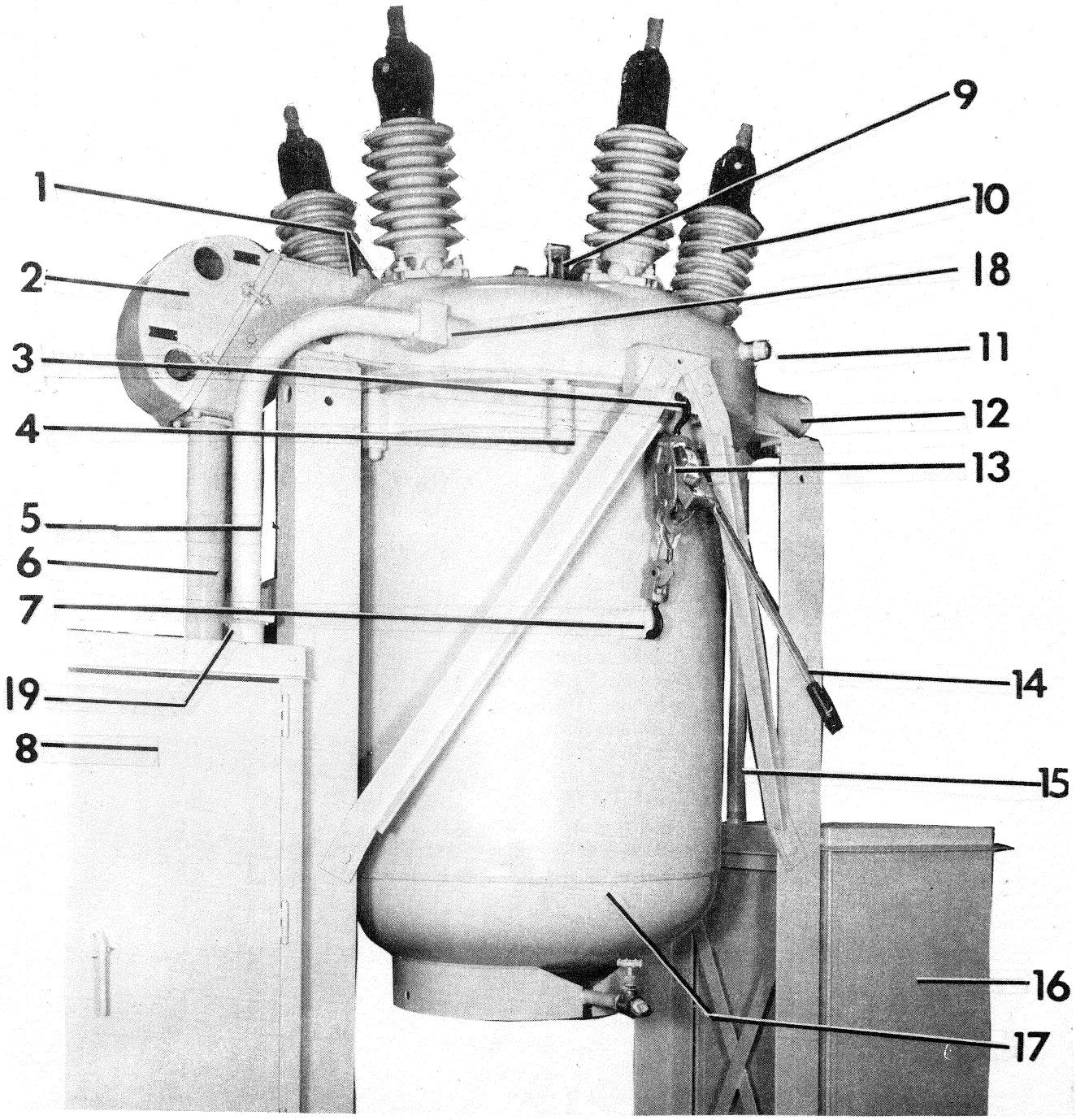
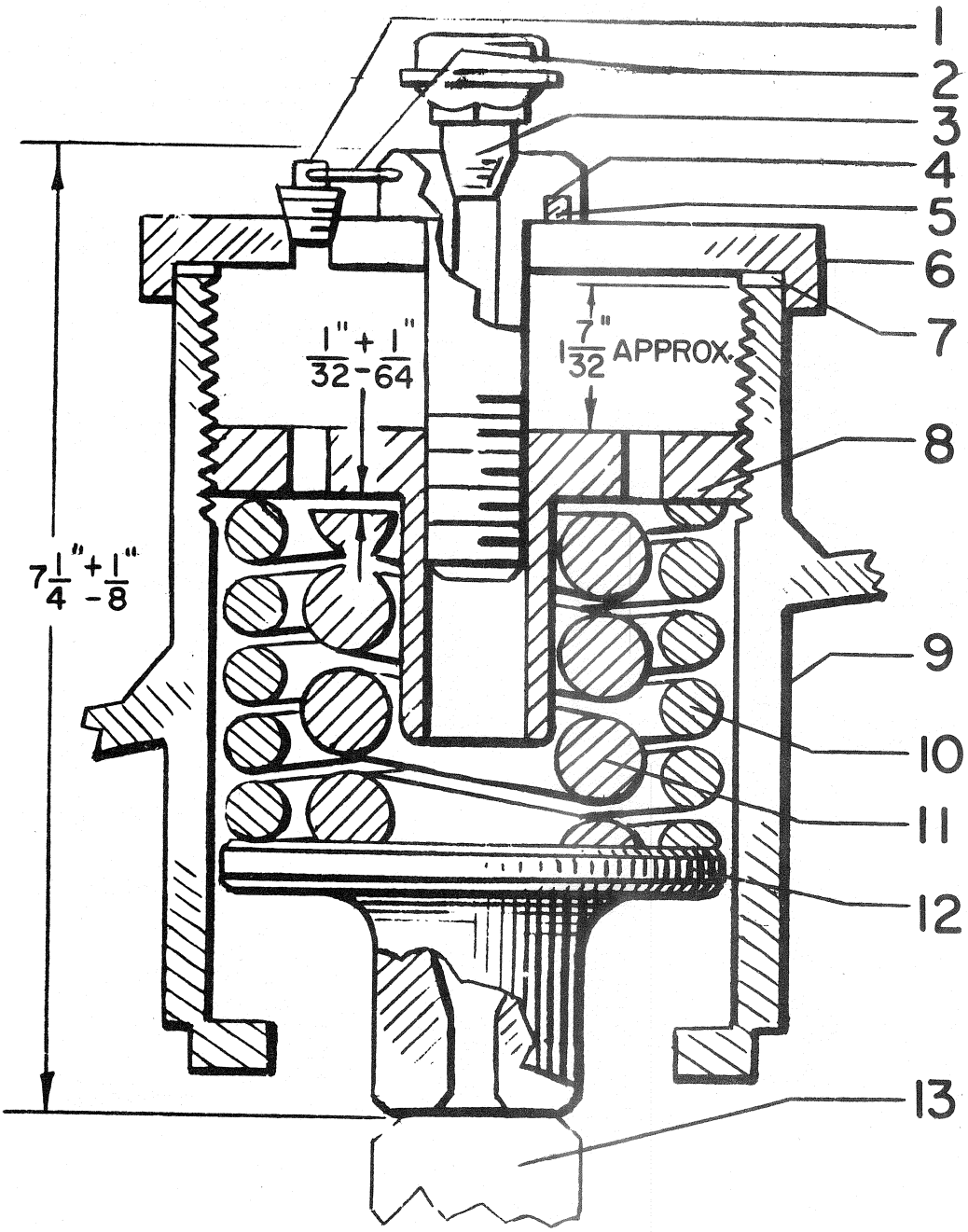


Fig. 15 (8040141A)

1. Horizontal Operating Rod Rear Coupling Bolt Access Hole Plugs
2. Front Cover
3. Tank Lifter Support Hole
4. Tank Supporting Nuts
5. BCT Conduit
6. Vertical Operating Rod Cover Pipe
7. Lifting Lug
8. Operating Mechanism
9. Oil Level Indicator
10. Bushing
11. Oil Fill Pipe
12. Opening Spring Cover
13. Manual Tank Lifter
14. Manual Tank Lifter Operating Handle
15. Relay House Conduit (Optional)
16. Relay House (Optional)
17. Oil Tank
18. Gasket
19. "O" Ring

Fig. 15 View of the Manual Tank Lifter used on the type FKA oil circuit breaker.



1. Plug
2. Locking Wire
3. Breather
4. Cover Bolt
5. "O" Ring
6. Cover
7. Gasket
8. Adjusting Disk
9. Buffer Housing
10. Outer Spring (Kick-off)
11. Inner Spring (Buffer)
12. Plunger
13. Coupling (Lift Rod)

Fig. 16 Closing Buffer for 15.5 through 48.3 kV Breakers

Fig. 16 (0809B0214 Rev. 2)

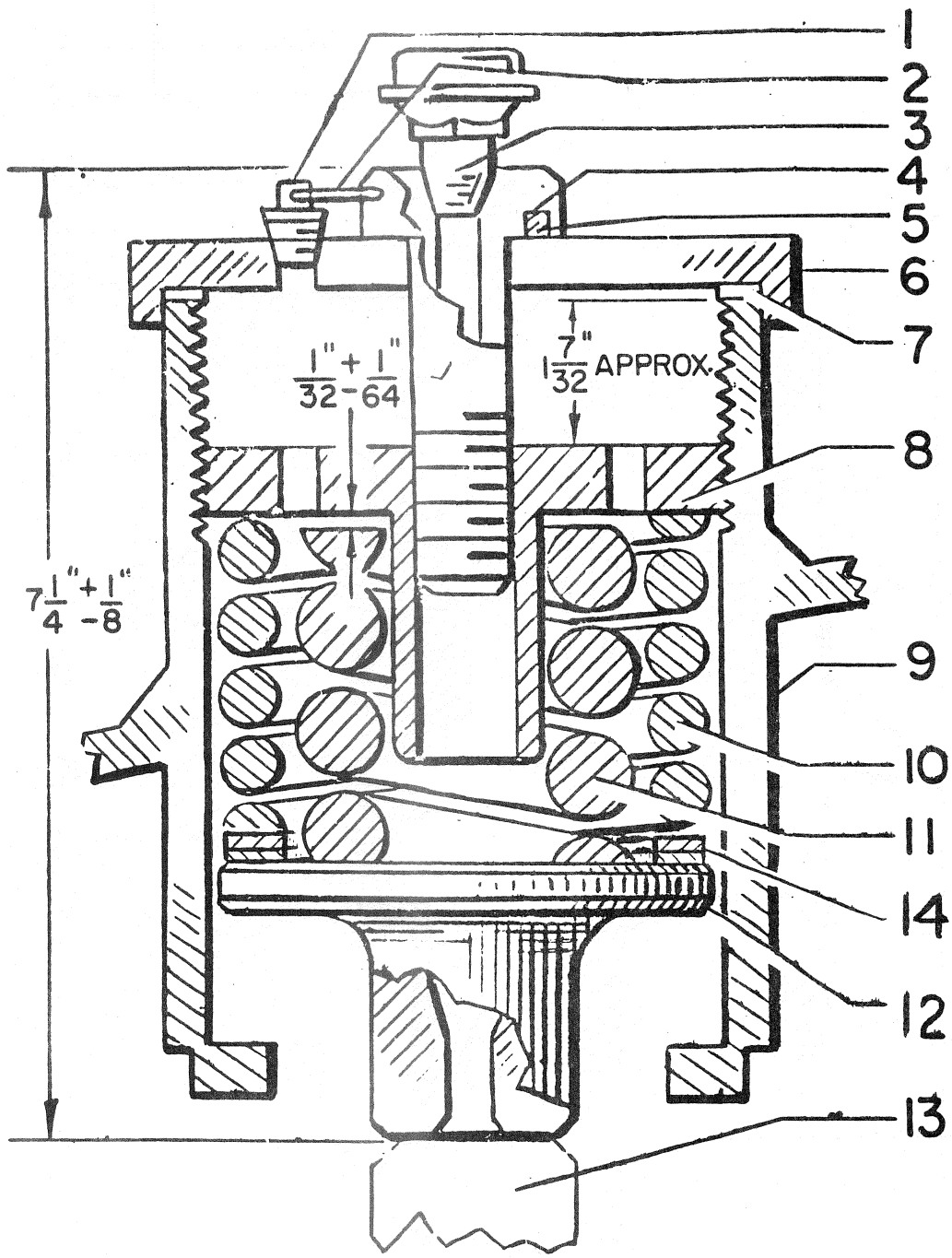
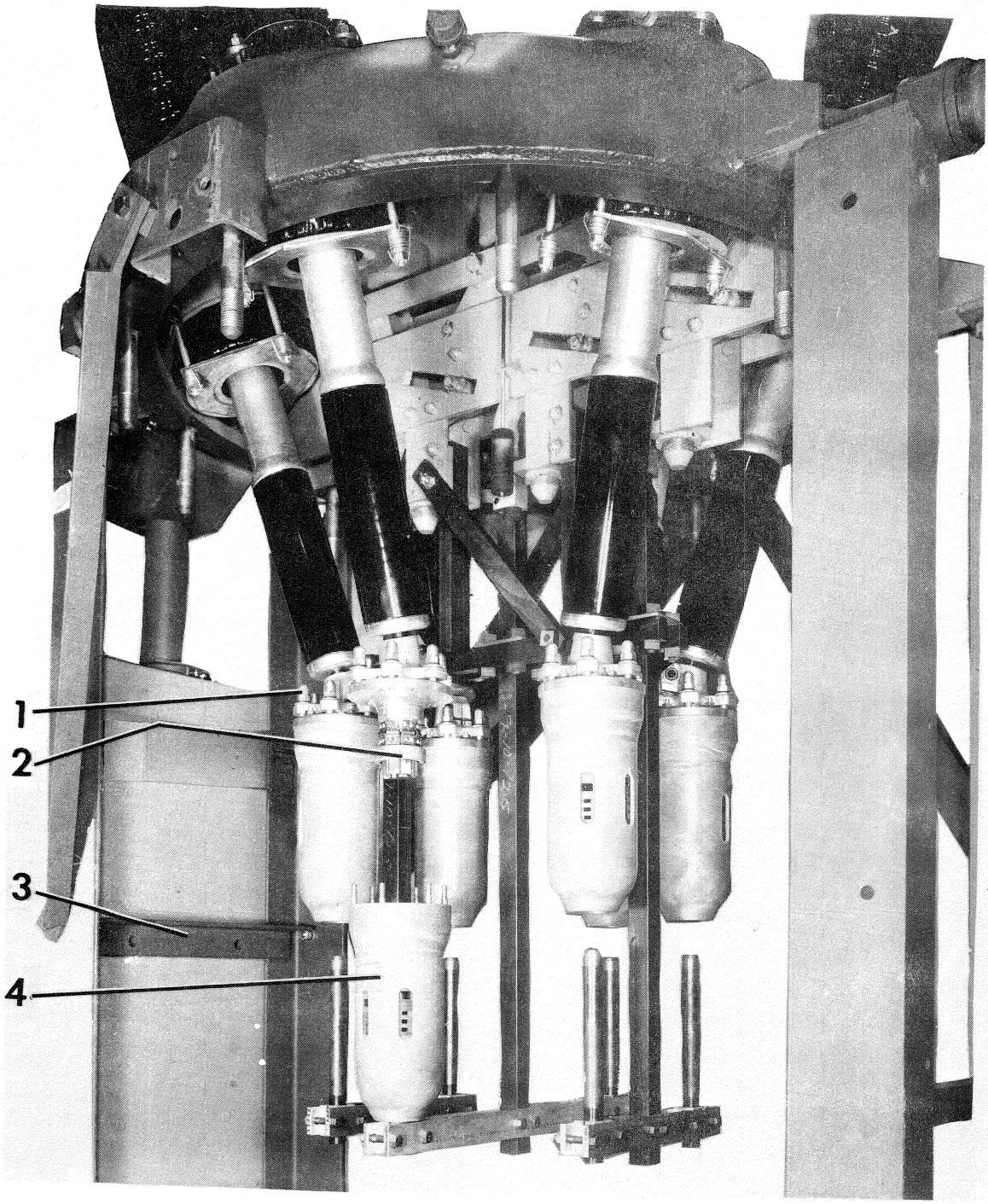


Fig. 17 (0153B5257 Rev. 1)

1. Plug
2. Locking Wire
3. Breather
4. Cover Bolt
5. "O" Ring
6. Cover
7. Gasket
8. Adjusting Disk
9. Buffer Housing
10. Outer Spring (Kick-off)
11. Inner Spring (Buffer)
12. Plunger
13. Coupling (Lift Rod)
14. Two Washers (each 1/8 inch thick)

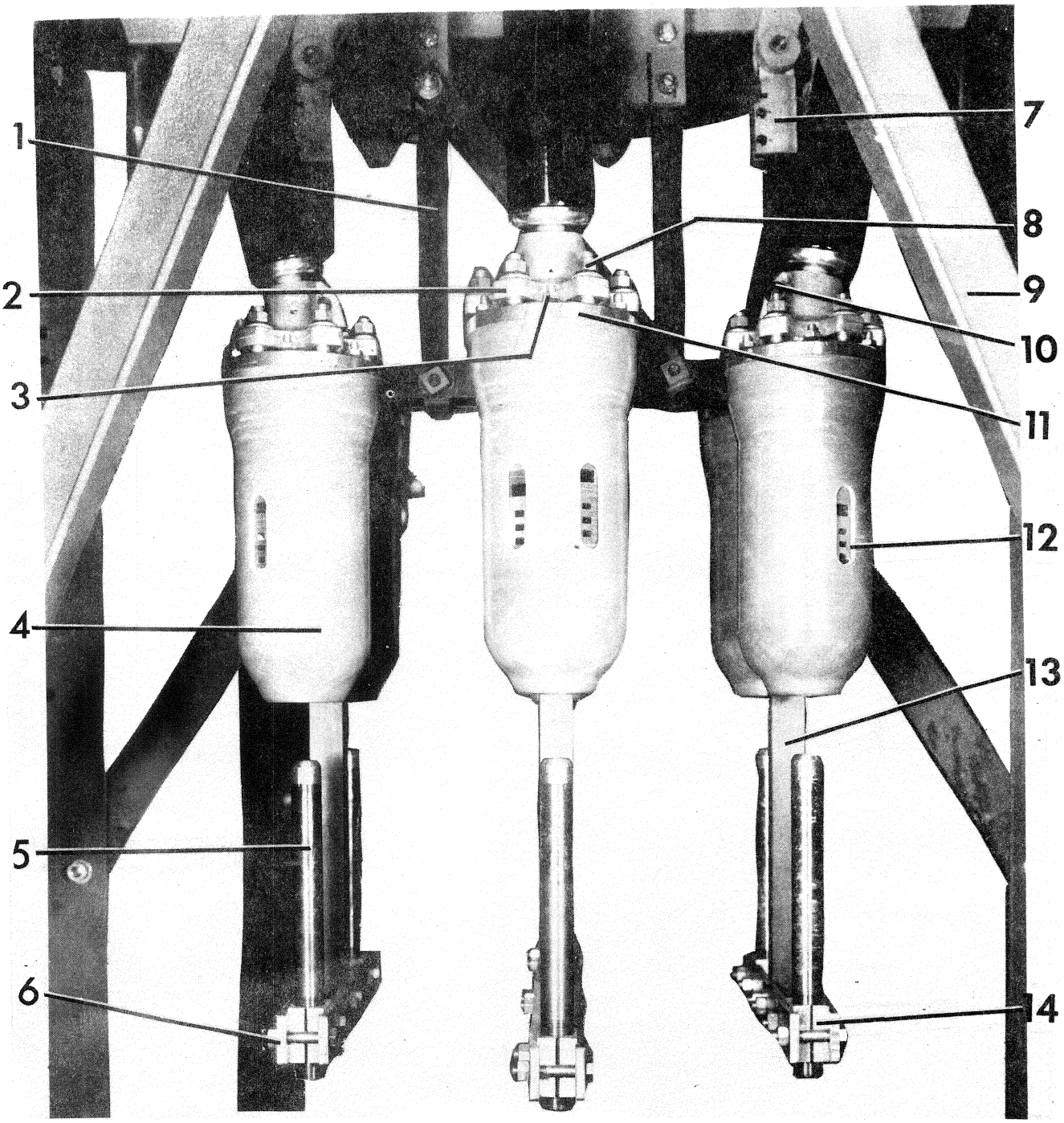
Fig. 17 Closing Buffer for 72.5 kV Breakers

Fig. 18 (8040147A)



1. Corona Nut used on 72.5 kV Breakers only
2. Finger Cluster Assembly
3. Upper Mechanism Supporting Member
4. Interrupter Tube and Associated Parts lowered for inspection of finger cluster

Fig. 18 Left Side View of the Interrupters and Associated Parts of the 72.5 kV Breaker with one interrupter tube dropped for inspection contacts



1. Vertical Member of Lift Rod Guide
2. Upper Adapter
3. Maintenance Nut
4. Interrupter
5. Contact Rod
6. Crossarm
7. Lift Rod Coupling
8. Interrupter Adjusting Nut
9. Diagonal Side Brace of Framework
10. Adapter Clamping Bolt
11. Lower Adapter
12. Exhaust Port
13. Lift Rod
14. Contact Block

Fig. 19 Right Side View of the Interrupters and Associated Parts of the 15.5 through 48.3 kV Breaker

Fig. 19 (8040124 A)

Fig. 20 (0202A6041 Rev. 1)

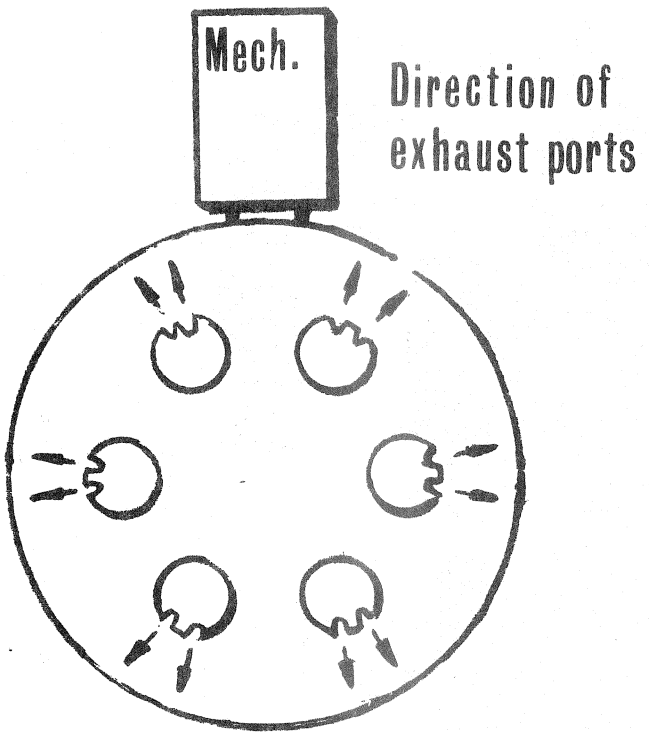


Fig. 20 View Showing the Direction in which the interrupter exhaust ports point

inch clearance with the breaker closed and lift rod and front toggle set to the proper amount as shown in F, Fig. 27. As a starting point in making this setting the top of the adjusting disk (8), Figs. 16 and 17, may be preset initially to approximately 1-7/32 inches below the top of the buffer housing (9).

When installing the cover bolt (4) insert a screwdriver or a steel or brass rod through the pipe plug (1) hole in the cover (6) and into one of the holes in the adjusting disk (8) to prevent the adjusting disk from turning while tightening the cover bolt (4). Remove the rod after the cover bolt is tight and insert the pipe plug (1) and the locking wire (2). Use Permatex #2 or similar to seal the pipe threads of the pipe plug (1). Do not use a sealer which is electrically conductive.

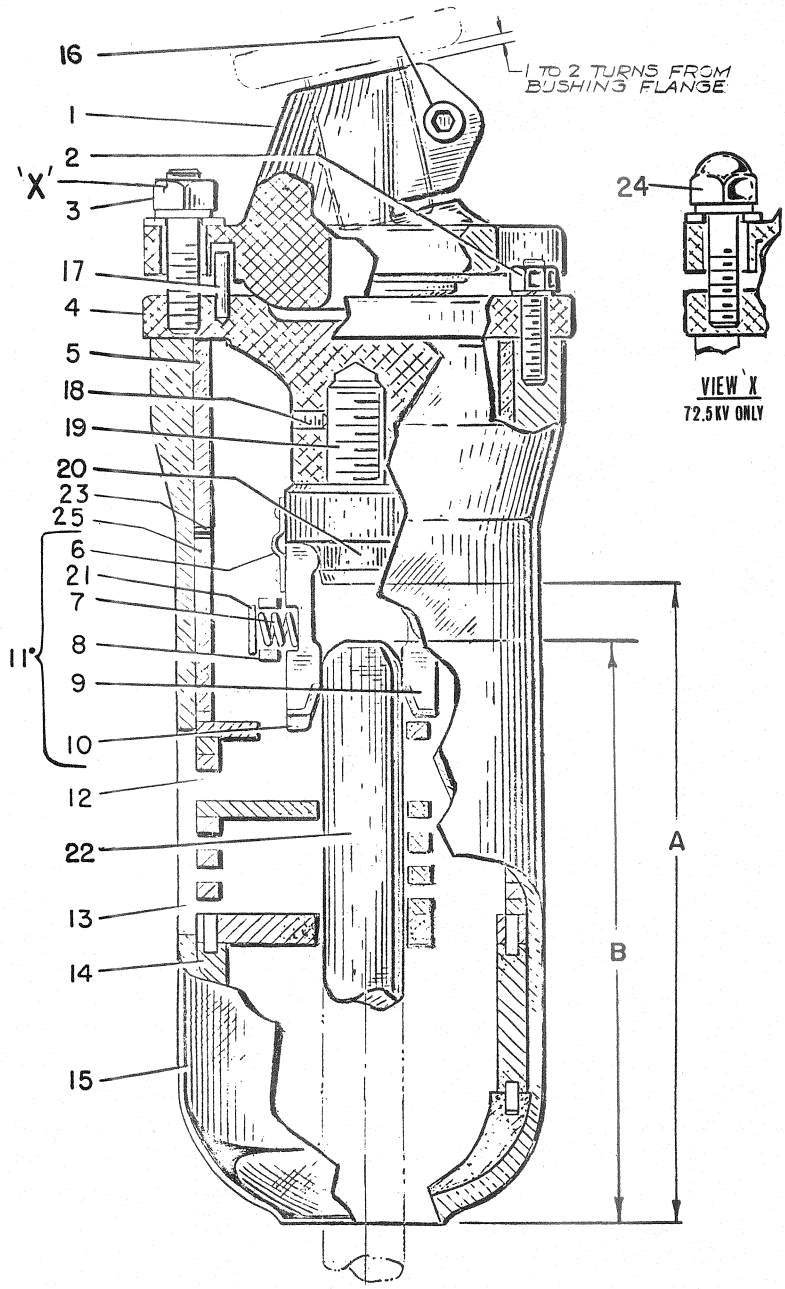
INTERRUPTER ADJUSTMENT

After the breaker linkage is adjusted, the contacts should be checked. Refer to Fig. 19. The interrupters (4) which are fastened to the lower ends of the bushings must be aligned to a vertical position, with the two exhaust ports of each interrupter facing the tank as shown in Fig. 20. The use of a spirit level will assist in aligning the interrupter. Make the upper adapter (2), Fig. 19, plumb first by using a spirit level on the underside machined surface. The adapter must be plumb when the bushing mounting nuts on top of the breaker dome are tight. The lower adapter (11) also must be removed. Loosening the adapter clamping bolt (10) allows the adapter to be moved in any direction about the vertical. After the upper adapter is plumb and the clamping bolt is tight install the lower adapter (11) which is assembled to the interrupter (4). Plumb the interrupter using a spirit level on the interrupter tube at three positions approximately 120 degrees apart. After the interrupter is plumb, slowly close the breaker to make certain the contact rod engages the contact finger cluster assembly (2), Fig. 18, properly. 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 (5), Fig. 19. The contact block (14) is slotted so that by loosening the locknuts the contact rods can be moved in or out to obtain alignment with the throat. Additional lateral adjustment, if required, is possible by loosening the bushing mounting nuts and changing the seating of the bushing. The contact block can also be turned end for end to obtain additional adjustment.

CONTACT ADJUSTMENT OF THE STANDARD INTERRUPTER (Fig. 21)

1. The contact stop clearance is 7/8 inch ± 1/16 inch; item "H", Fig. 27 This is the most important measurement in the interrupter. When this is correct the insertion, penetration and electrical wipe are correct.

   a. Use a depth gage to measure the distance from the bottom of the interrupter to the contact stop



1. Upper Adapter
2. Assembly Nut
3. Locking Nut
4. Lower Adapter
5. Upper Insulating Spacer
6. Flexible Connector
7. Contact Spring
8. Spring Cage
9. Contact Finger
10. Arcing Tip Finger
11. Contact Finger Assembly (Finger Cluster)
12. Baffle Stack
13. Exhaust Port Opening
14. Lower Insulating Spacer
15. Interrupter Tube
16. Adapter Locking Bolt
17. Locking Pin
18. Set Screw
19. Contact Assembly Support
20. Contact Stop
21. Spring Retainer
22. Contact Rod
23. Insulating Shims
24. Corona Nut - 72.5kV only
25. Intermediate Insulating Spacer

Items for Fig. 22

Fig. 21 (0842C0619 Rev. 6)

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

Fig. 21 Cross-sectional View of the Standard Interrupter.

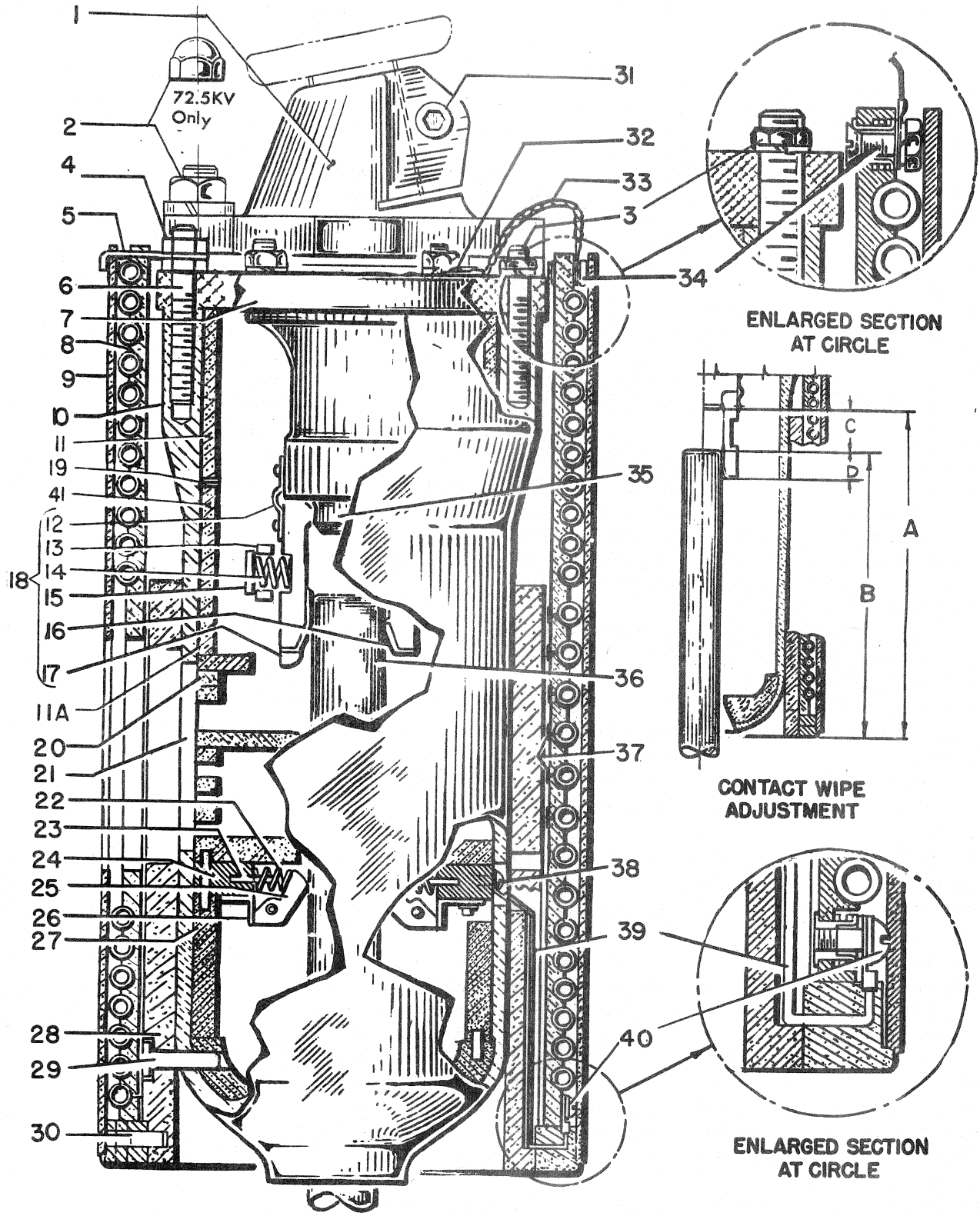


Fig. 22 Cross-section View of the Capacitor Switching Interrupter.

(20), Fig. 21, inside the interrupter.

b. Measure the insertion of the contact rod into the interrupter as a reference.

c. Item (a) minus Item (b) must be 7/8 inch ± 1/16 inch.

2. After checking and adjusting (if necessary) the contact stop clearance, check the contact rod penetration into the finger cluster assembly. This should be 1-1/8 inches ± 1/16 inch and should not require any adjustment. See "G" of Fig. 27.

The contact stop clearance of the interrupters of any one phase must be within 1/32 inch of each other so that burning of the two sets of contacts in the phase is approximately equal. 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 adjustment of the contacts without the necessity of dropping the tank at a future date. The bellset wipe should be 1/2 inch to 7/8 inch. 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. The length of the bellset wipe dimension is due to the curved portion of the contact rod (22), Fig. 21, and the curved portion of the contact fingers (9) breaking contact. At this time the contact rod is still inserted in the finger cluster.

To change the contact insertion, loosen the locknuts and rotate the contact rod (5), Fig. 19, in the appropriate direction. At the same time there should be at least 1/2 inch clearance between the bottom of the interrupter (4) and the crossarm (6) with the breaker closed, so that overtravel will not damage the interrupter or contacts (Item J), Fig. 27. 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 mechanically at approximately the same time, or within 1/4 inch of each other between phases and within 1/32 inch of each other in a phase.

BREAKER	KV	RATED CAPACITOR SWITCHING, SINGLE BANK ONLY. (Capacitor bank nameplate rating) KVAR @ KV INDICATED	
		GROUNDED BANK	UNGROUNDED BANK
FKA-15.5-36000-6R	15.5	24000	24000
FKA-38 -22000-6R	38.0	30000	30000
FKA-48.3-17000-6R	48.3	27000	27000
FKA-48.3-29000-6R	48.3	27000	27000
FKA-72.5-19000-3R	72.5	20000	15000
FKA-72.5-27000-3R	72.5	20000	15000

CONTACT ADJUSTMENT OF THE CAPACITOR SWITCHING INTERRUPTER (Fig. 22)

The contact adjustment of the capacitor switching interrupter is made in the same manner as the contact adjustment of the standard interrupter, Fig. 21. Reference should be made to the capacitor switching interrupter, Fig. 22 for the proper item numbers.

CONTACT ROD CLEARANCE (J), Fig. 27.

The contact rod crossarm assembly must have a minimum of 1/2 inch clearance to the underside of the interrupter tube, Item J of Fig. 27. The nominal clearance is 15/16-inch.

INSPECTION

STANDARD INTERRUPTER (Fig. 21)

The standard interrupter consists essentially of a laminated glass filament tube enclosing a baffle stack and a set of eight primary contact fingers, two of which have an arcing tip. The body tube has two port openings which permit the proper flow of oil across the contacts and through the baffles during interruption as shown in Fig. 26.

CAPACITOR SWITCHING INTERRUPTER (Fig. 22)

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

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

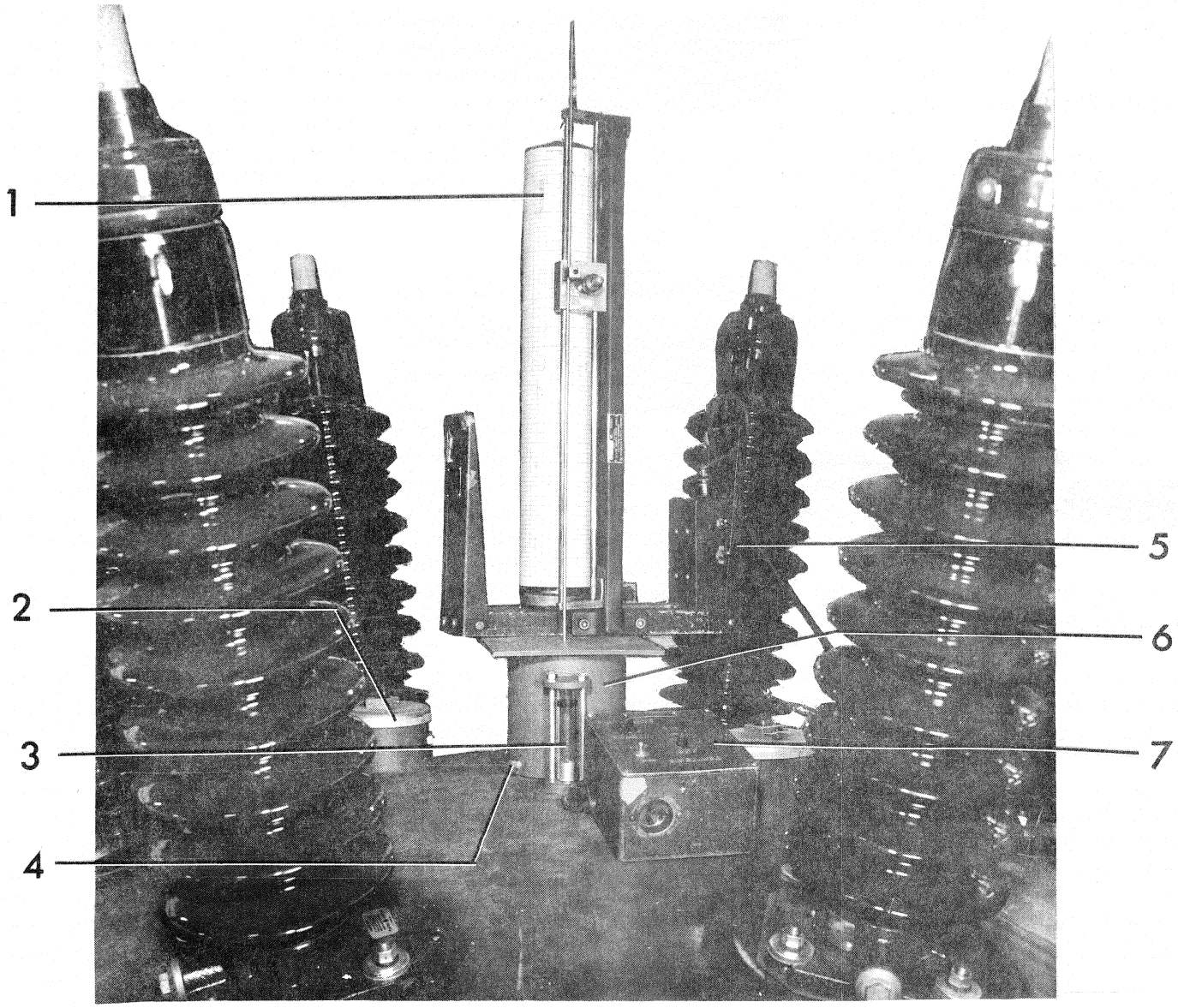
With the breaker in the partially open position the resistance of the grading resistors must be checked. This can be done by adjusting the stroke of the breaker so that the contact rod (36), Fig. 22, is making contact with the resistor contact finger (25) but not making contact with the finger cluster (18). Measure from the contact rod to the bushing adapter (1) for the resistance value.

The resistance of the resistor (8) which surrounds the Fiberglas interrupter tube (10) is given in the following tabulation.

BREAKER	RESISTANCE PER INTERRUPTER IN OHMS
FKA-15.5-36000-6R	15
FKA-38 -22000-6R	83
FKA-48.3-17000-6R	150
FKA-48.3-29000-6R	150
FKA-72.5-19000-3R	526
FKA-72.5-27000-3R	526

The resistance must be plus five percent minus ten percent of the stated value per interrupter but must be within ± 5% of

Fig. 23 (8038411)



1. Straight Line Travel Analyzer
2. Closing Buffer and Kickoff Spring Housing
3. Oil Gage
4. Bracket Tightening Screws
5. Analyzer Control Box
6. Analyzer Support Bracket
7. Breaker Control Box

Fig. 23 Installation of Travel Analyzer

each other in any one phase. The contact adjustment, contact rod clearance, and the remainder of the checks are identical with the adjustments and checks of the standard interrupter.

CONTACT RESISTANCE CHECK

If contact resistance checks (ductor readings) are to be made on the breaker they should be checked before oil is placed in the tanks and with the breaker in the fully-closed position. A 100-ampere ductor with 100 amperes flowing in the circuit 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 250 microhms or less when new. The reading should not exceed 450 microhms after the breaker has been in service. If the resistance is higher than the allowable microhms, operate the breaker several times electrically. This will break down any silver oxides formed on the contact surfaces. Check the resistance again. If still high clean the contact tips and the threads of the contact rod and check the terminals on top of the bushings for any loose hardware or bad connections. Continue checking through the circuit until the problem is solved and the resistance is within the proper values.

BUSHING CURRENT TRANSFORMER CHECKS

It is a good practice to check the bushing current transformer 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 or shorting connections which may have been left on the BCT leads after the completion of the factory tests and installation of the customer's permanent BCT circuitry.

BREAKER 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 (13), Fig. 12, should be checked for proper oil level, and filled with G-E #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 (3), Fig. 13, is not touching the piston. A small pipe plug in the oil level hole (4) is located at the oil level line. If the oil level is even with the bottom of this hole the oil level is satisfactory. Replace the pipe plug then open the breaker.

The stroke of the breaker, which is the total movement of the lift rod (18), Fig. 14, from the fully closed to the fully open position, should measure 12 inches plus or minus 1/4 inch 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 G-E #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.

FILLING THE TANKS

Before the final operation adjustments are made, the tank must be filled with G-E #10-C oil. First however, make certain that all cotter pins, washers, bolts, lock rings, etc. are in place and properly tightened, and that all fittings and accessories have been made oil tight. Use G-E #1201 compound (Glyptal*), Permatex #2 or similar to seal the joints if necessary. Do not use an electrically conductive sealer as it might contaminate the oil. 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.

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 per ANSI standards, with 1 inch diameter disk terminals 0.1 inch apart. New oil of less than standard dielectric strength should not be placed in the breaker oil tanks until its insulating value has been brought up to the above standard. If further details are desired on the characteristics and maintenance of G-E #10-C oil, obtain Bulletin GEA-4937 from the nearest Apparatus Sales Office of the Company.

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

The normal oil level at 20°C is indicated on the outline drawing. A float-type oil gage is supplied. The range between minimum and maximum is represented by the visible portion of the gage glass and covers a temperature range of 70°C which is 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 will always be immersed and prevent corona discharge from the ground sleeve. 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 air bubbles decreasing the dielectric strength of the oil.

OPERATING MECHANISM CHECK

A 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 checked and lubricated in accordance with the mechanism instruction book. When the spring-

*Registered trademark of the General Electric Company

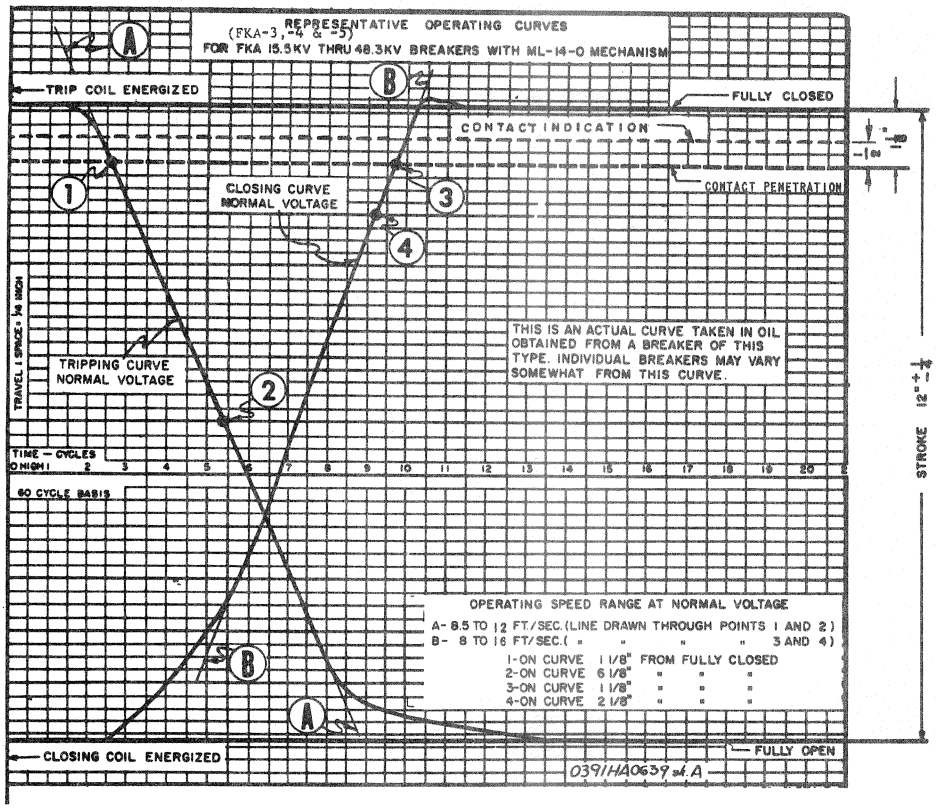


Fig. 24 (0391HA0639 Sh. A and B Rev. 3)

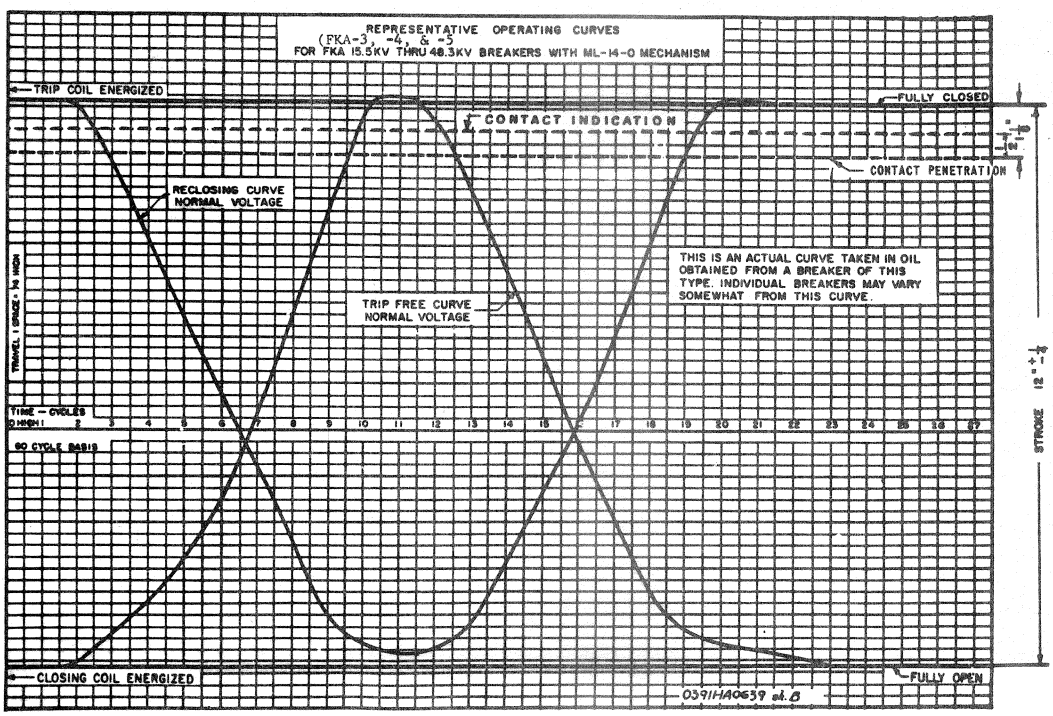


Fig. 24 Representative Travel Curves with an ML-14-0 spring-charged operating mechanism FKA-15.5 through 48.3 kV breakers, curves taken in oil.

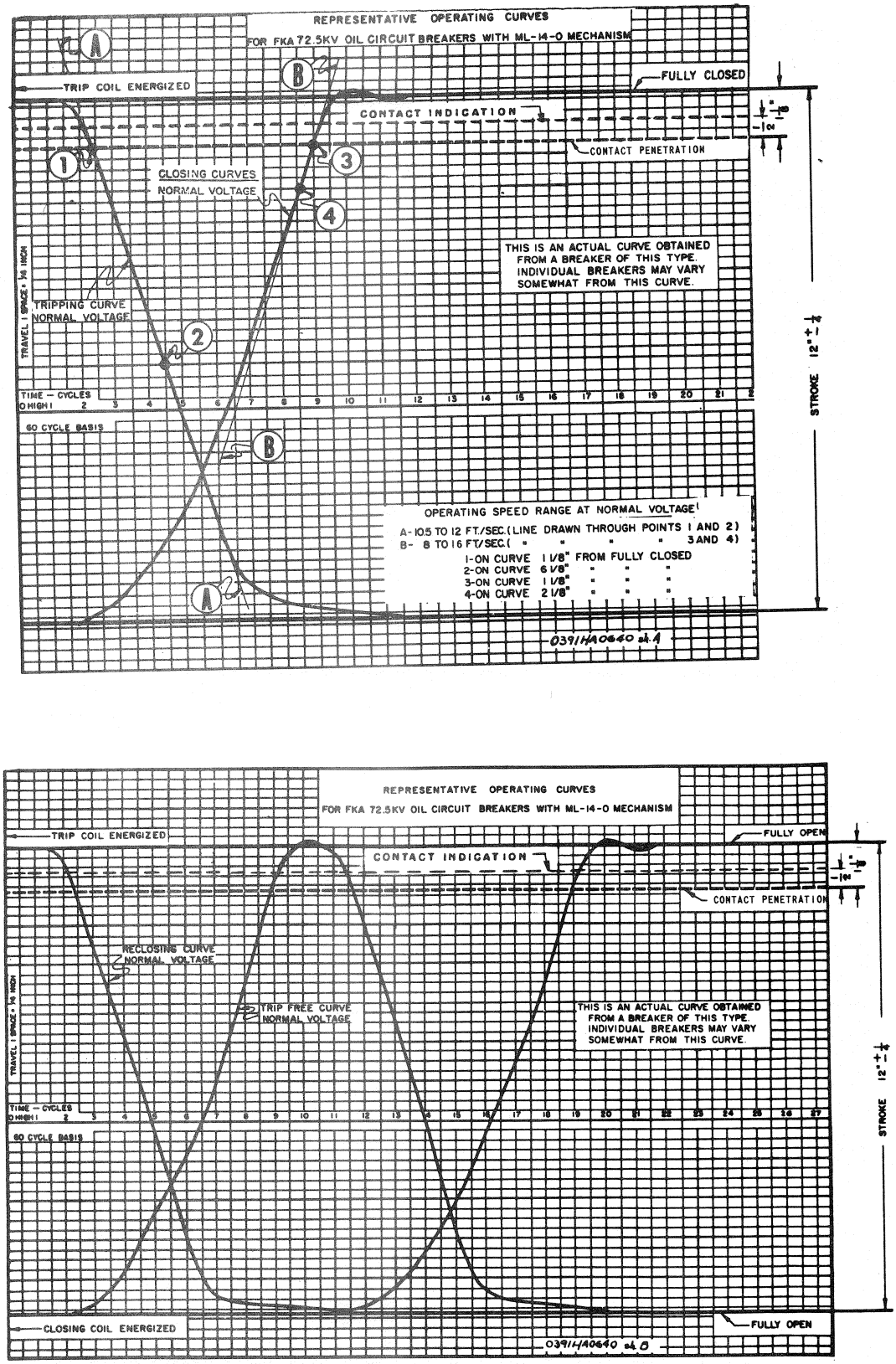


Fig. 25 (0391HA0640 Sh. A and B Rev. 3)

Fig. 25 Representative Travel Curves with an ML-14-0 spring-charged operating mechanism FKA-72.5 breaker, curves taken in oil.

charged mechanism is used, slowly close the mechanism as described in the mechanism instruction book. The spring-charged mechanism cannot be opened slowly. If any binding occurs the cause of the binding should be located and corrected or explained before operating the breaker.

While the tank is being filled with oil, the checks can be made on the operating mechanism.

The driving and latching pawls, ratchet wheel clearance, etc., should be checked.

Reference should be made to the spring-charged mechanism instruction book for the adjustments and checks.

OPENING SPRING

15.5 THROUGH 48.3 KV BREAKERS

The opening spring (25), Fig. 14, used on the 15.5 through 48.3 kV breakers which utilize an ML-14-0 or ML-14-0Y1 has the following settings.

The nominal compressed length is 7-3/8 inches when the breaker is in the fully-closed position.

This corresponds to a nominal spring compression of 7/8 inch. This spring should not be compressed to a length less than 6-5/8 inch and when compressed to this length the spring must not go solid on overtravel when closing.

The free length of this spring is 8-1/4 inches ± 1/4 inch.

72.5 KV BREAKERS

The opening spring (25), Fig. 14, used on the 72.5 kV breakers which utilize an ML-14-0, or ML-14-0Y1 as an operator has the following settings.

The nominal compressed length is 7-1/2 inches when the breaker is in the fully-closed position.

This corresponds to a nominal spring compression of 1-1/2 inches. This spring should not be compressed to a length less than 7-1/4 inch, and, when compressed to this length, the spring must not go solid on overtravel when closing.

The free length of this spring is 9 inches ± 1/8 inch.

The springs which have a free length of 9 inches ± 1/8 inch are identical.

FOLLOW-THROUGH SPRING

The nominal follow-through spring (27), Fig. 14, compressed length is the same as the compressed length of the opening spring (25). However, the compression of the follow-through spring is different because the free length is different. The nominal compression of the follow-through spring is 5-13/32 inches for the 15.5 through 48.3 kV breakers with the ML-14 or ML-14-0Y1 operating mechanisms and 6-1/32 inches for the 72.5 kV breaker. This spring is compressed somewhat at all times in both the breaker-open and the breaker-closed positions. This spring should not be compressed to a length less than 6-1/2 inches as it will possibly take a permanent set if compressed beyond this figure. The free length of this spring is 12 inches ± 1/4 inch.

Care must be taken when removing the opening spring retaining nut and guide (44), Fig. 14, from the opening spring coupling rod (23) since there is approximately 1/2 inch of compression on the follow-through spring in the breaker fully-open position. This amounts to approximately a 20-pound spring force.

The follow-through spring is not adjustable by itself since it is adjusted at the same time the opening spring is adjusted.

It follows that the opening operation is the reverse of the closing operation.

When the breaker opens under load the contacts separate, drawing arcs between the tips of the contact rods and the arcing tips of the staionary 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 Fig. 26, 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 reestablish itself, and interruption occurs.

SPEED ADJUSTMENT

After completing the preceding installation adjustments and inspection, and after filling the tank with oil, the breaker may then 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 #10-32 tapped hole is located in the top of the lift rod coupling, as indicated in the travel recorder rod connection (21), Fig. 14, to accommodate the rod used with the travel

analyzer. Access to this tapped hole is by removal of the breather (19) which is screwed into the closing buffer assembly. The travel analyzer (1), Fig. 23, is readily mounted by attaching the bracket (6) to the center phase buffer housing after unscrewing the breather (19), Fig. 14.

Normally it is only necessary to take analyzer curves on the center phase of the breaker. This curve will be the accumulated result of the speeds and times of the three phases since the exact operating characteristics of the three phases are different. The operating curves (Fig. 24 and Fig. 25) and breaker speeds of these breakers were obtained from the center phase of an actual breaker. If the curves are not satisfactory and difficulties arise, analyzer curves of the other two phases will help determine where and what the problem is.

OPENING SPEED

The opening speed is determined by drawing a straight line through two points on the travel curve. See Fig. 24 and Fig. 25. One point is to be located on the opening curve 1-1/8 inches from the fully-closed position. This is the point at which the contact rod penetration into the finger cluster begins when closing the breaker. This point is not where bellset wipe would occur. The second point is to be located on the opening curve 6-1/8 inches (measured vertically) from the fully-closed position. The slope of this line is an indication of the opening speed, which should be 8.5 to 12.0 feet per second with the breaker contacts in oil for the 15.5 through 48.3 kV breakers and 10.5 through 12 feet per second for the 72.5 kV breakers. One method of determining the speed of the breaker using a Cincinnati straight line analyzer and standard analyzer paper is to do the following:

1) Set the analyzer speed to high.
2) Obtain the curves.

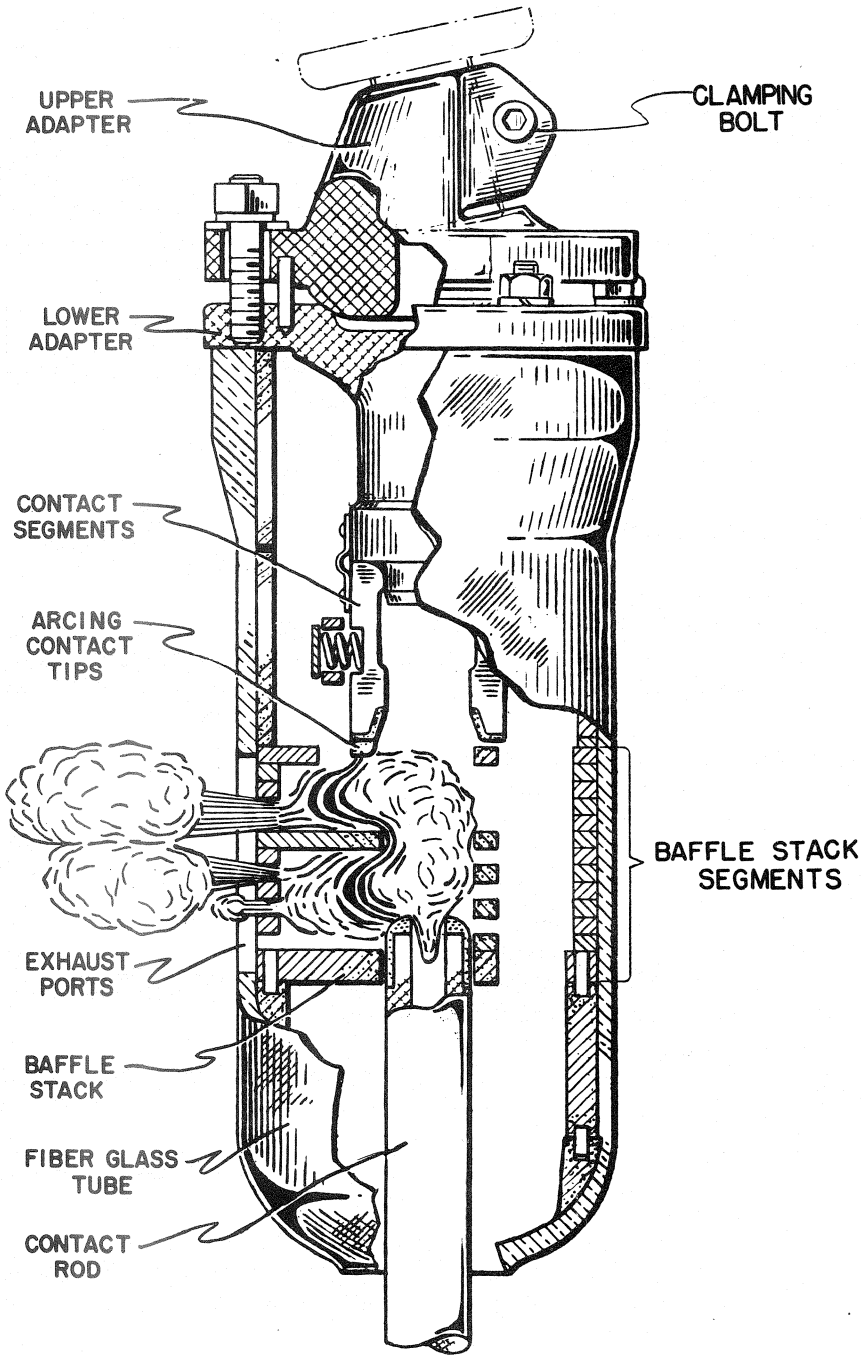


Fig. 26 (0124C3280 Rev. 2)

Fig. 26 Cutaway View of Interrupter showing arc interruption

3) Draw a straight line between the proper points as shown on the representative travel curves, Fig. 24 and 25.

4) Count off five cycles in the horizontal direction from a convenient point on the straight line and mark this point.

5) Measure vertically the distance from the point obtained in Step 4 to the straight line drawn in Step 3. This dimension in inches is equal to the speed of the breaker in feet-per-second.

If it is found necessary to readjust the opening speed of the breaker, change the setting on the opening spring (25), Fig. 14. 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 and the buffer clearance. After adjusting the opening spring check the contact stop clearance (H), Fig. 27 and the buffer setting (F). Readjust as necessary.

CLOSING SPEED

The average closing speed of the breaker can be determined in a similar manner by drawing a straight line through two points located 1-1/8 inches and 2-1/8 inches from the breaker fully-closed position. The closing speed is controlled by the operating mechanism and the opening spring. If changes are required the opening spring compression can be changed, but this will change the opening speed, consequently, the opening speed will require checking if the closing speed is adjusted. There is no other adjustment for the closing speed. For additional information, consult the mechanism instruction book paying particular attention to the section on INSTALLATION ADJUSTMENTS.

LIFT ROD OVERTRAVEL

The overtravel of the lift rod must not exceed 1/4 inch when closing the breaker. The best way to accurately measure this is to place some putty about 1/2 inch above the pencil head on the analyzer, with the breaker in the closed position. Then 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 1/4 inch, check the buffer setting. The 72.5 kV breaker has two 1/8 inch thick washers (14), Fig. 17, under the outer spring (10). If the overtravel is excessive check that these washers are in place and that the buffer clearance is correct.

When opening in oil, the breaker should open the full stroke. The travel curve will be acceptable if the indicated rebound at the fully-open position is less than 5/8 inch. A slight variation between the three phases within the above tolerance is permissible.

LIFT ROD OVERTRAVEL

The lift rod overtravel should be checked when the opening and closing speeds are checked. This should not exceed 1/4 inch when closing the breaker. For a more detailed explanation see OPERATION.

SUMMARY OF ADJUSTMENTS AND CHECKS

Refer to Fig. 27 for the physical location of the following items. With the tank down and the breaker interrupters exposed:

A) Check the overtravel stop setting, which is used as an indication of the internal lift rod setting. It should be 1/4 inch + 1/64 inch -0 with the breaker in the breaker fully-closed position.

B) Check the toggle position, which is an indication of the setting of the toggle linkage. It should be 7/8 inch ± 1/32 inch in the breaker fully-closed position.

C) Phase One and Phase Three lift rod settings are compared with the lift rod setting of Phase Two and must be within ± 1/8 inch of the Phase Two lift rod setting in the breaker-closed position.

D) Phase Two lift rod setting should be 7-1/4 inches ± 1/8 inch, in the breaker fully-closed position.

E) The nominal opening spring compression is one inch for the 15.5 through 48.3 kV breakers and 1-1/2 inches for the 72.5 kV breakers. The compressed length of the opening spring for the 15.5 through 48.3 kV breakers should not be less than 6-5/8 inches and for the 72.5 kV breakers not less than 7-1/4 inches. The follow-through spring should be compressed at all positions for all breakers.

F) The inner spring of the closing buffer must have 1/32 inch ± 1/64 inch clearance when the breaker is closed. A preliminary adjustment can be checked. This is the measurement from the top of the adjusting disk inside the buffer housing to the top of the buffer housing. This measurement is approximately 1-7/32 inch. There are two 1/8 inch thick washers beneath the outer spring in the buffer housing of the 72.5 kV breakers only.

G) The contact penetration, which is the insertion of the contact rod into the contact segments, is 1-1/8 inches ± 1/16 inch. This will give an electrical wipe of approximately 1/2 to 7/8 inch.

H) The contact stop clearance should measure 7/8 inch ± 1/16 inch. The contacts in any one phase should part within 1/32 inch of each other. The contacts in any phase should part within 1/4 inch of the contacts of any other phase.

J) The minimum allowable clearance between the crossarm contact block and the interrupter is 1/2 inch. The nominal clearance is 15/16 inch. This is measured in the breaker fully-closed position.

K) The breaker stroke should be 12 inches ± 1/4 inch.

L) The lift rod to lever pin clearance should be a minimum of 2-15/16 inches with the breaker in the fully-closed position. Measure on Phase Three only. It is not necessary to make this measurement on the other two phases. This measurement is an indication of the external toggle setting and the lift rod setting.

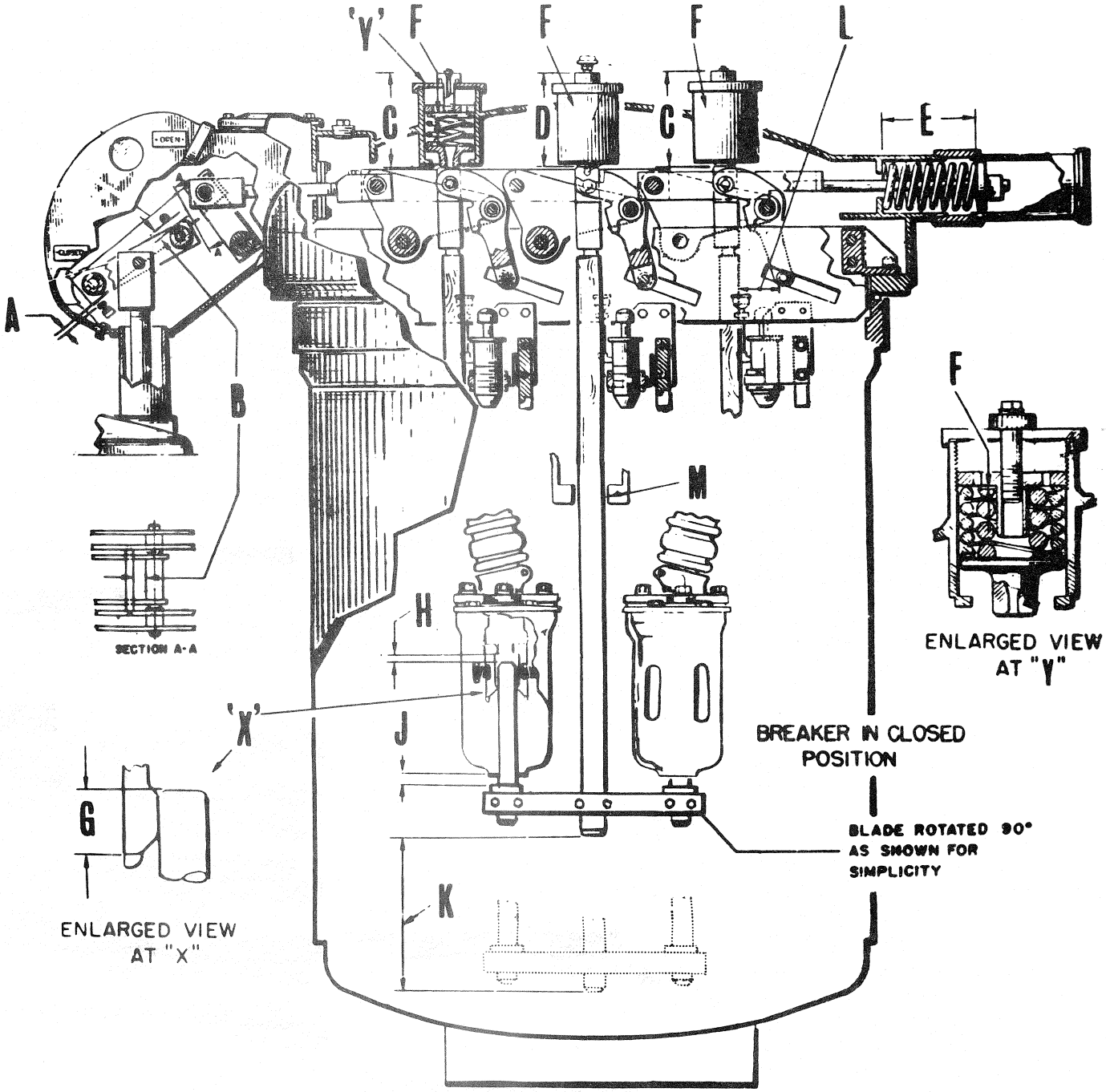


Fig. 27 (0104C8095 Rev. 2)

Fig. 27 Physical Location of Breaker Adjustments and Check Points

M) The lift rod should hang in an approximately vertical position with a clearance of approximately 1/64 inch minimum between the guide block and the side of the rod in both directions.

With the tank in place and filled with oil:

A) The contact opening speed is 8-1/2 to 12 feet per second for the 15.5 through 48.3 kV breakers and 10-1/2 to 12 feet per second for the 72.5 kV breakers.

B) Overtravel on closing is 1/4 inch maximum.

C) Rebound on opening is not more than 5/8 inch.

D) Rebound on closing is not more than 3/8 inch.

E) Contact closing speed is 8 to 16 feet per second for 15.5 through 72.5 kV breakers.

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 (Breaker Closed)	1/4 inch + 1/64 inch -0			
Breaker Stroke	12 inches ± 1/4 inch			
Lift Rod Setting (Phase 2)	7-1/4 inches ± 1/8 inch			
Lift Rod Setting (Phases 1 and 3)	Phase 2 setting dimension ± 1/8 inch			
Lift Rod to Lever Pin Clearance (Minimum)	2-15/16 inches			
External Toggle Setting	7/8 inch ± 1/32 inch			
Preliminary Closing Buffer Setting	1-7/32 inches ± 1/32 inch			
Closing Buffer Clearance Plus Free Travel	1/32 inch ± 1/64 inch			
Contact Penetration	1-1/8 inches ± 1/16 inch			
Contact Wipe (Electrical Bellset)	1/2 inch to 7/8 inch			
Contact Stop Clearance	7/8 inch ± 1/16 inch			
Overtravel Stop Clearance	1/4 inch + 1/64 inch -0			
Contact Resistance - (Using 100-ampere ductor with 100 amperes flowing)				
New Contacts - Microhms	250			
Used Contacts - Microhms (Maximum)	450			
Part or Make Contacts in Any One Phase (Not electrical measurement)	Within 1/32 inch of each other			
Part Contacts Between Phases	Within 1/4 inch of each other			
Crossbar to Interrupter Minimum Clearance	1/2 inch			
Crossbar to Interrupter Nominal Clearance	15/16 inch			
Opening Spring Compressed Length				
Not less than				
(15.5 through 48.3 kV Breakers)	6 5/8 inches			
(72.5 kV Breakers)	7 1/4 inches			
Opening Spring Nominal Compressed Length				
(15.5 through 48.3 kV Breakers)	7 3/8 inches			
(72.5 kV Breakers)	7 1/2 inches			
Tripping Time (Maximum-Normal Voltage)	3.0 cycles			

TABLE OF ADJUSTMENTS (Continued)

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
Opening Speed (1-1/8 inches to 6-1/8 inches) from fully closed (15.5 through 48.3 kV breakers)	8-1/2 to 12 feet per second			
Opening Speed (1-1/8 inches to 6-1/8 inches) from fully closed (72.5 kV breakers)	10-1/2 to 12 feet per second			
Closing Speed (1-1/8 inches to 2-1/8 inches) from fully closed (15.5 through 72.5 kV Breakers)	8 to 16 feet per second			
Overtravel (Maximum) On Closing	1/4 inch			
Rebound (Maximum) On Opening	5/8 inch			
Rebound (Maximum) On Closing	3/8 inch			
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			
Lift Rod Clearance	1/64 inch			

Note: The opening spring housing (26), Fig. 14, must be in place before operating the breaker.

FINAL INSPECTION

1. See that the breaker is properly set up and leveled on its foundation and that the foundation bolts or nuts are tight.

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 gages 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 oil 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 using an alkyd base paint.

OPERATION

The spring-charged 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.

The mechanism is 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 (1), Fig. 14, in a downward direction. This motion is transmitted through the breaker linkage to the vertical lift rods (18), closing the breaker.

MAINTENANCE

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

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. ALSO, 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. THE CLOSING SPRINGS OF THE SPRING-CHARGED OPERATING MECHANISM SHOULD BE GAGGED BEFORE WORKING ON THE BREAKER.

See the mechanism instruction book for the proper method used to block the latches, props and springs.

PRECAUTIONS

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

   Circuit breakers are <u>not</u> to be considered as an isolating means for providing safety to personnel when working on lines or other electrically connected equipment.

   Visible-break isolating means with suitable grounding provisions must be used to provide visible isolation from the power lines.

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, frame and tank 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. The spring-charged mechanism uses a standard 1/2 inch drive ratchet wrench with a 5/8 inch socket to slowly close the breaker. This mechanism <u>cannot</u> be opened slowly. See the mechanism instruction book pertaining to the proper method of blocking the closing springs before attempting to close the breaker manually. THE BREAKER MUST NOT BE CLOSED SLOWLY ON LOAD.

   NOTE: When the ML-14 spring-charged mechanism is used as the operator, it is advisable to wire or block the front trip latch in the latched position to prevent an accidental tripping when operating the mechanism with the manual device. This is because the ML-14 operating mechanism is mechanially trip-free. Before placing the breaker in service or operating it electrically make certain the blocking device is removed.

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

   NOTE: The crossarm (13), Fig. 3, is normally approximately two inches below the surface of the oil when the breaker is open and the tank is down; consequently, care must be taken when operating the breaker manually with the tank down to prevent splashing of the oil. Either raise the tank so the oil level is above the contact rods or drain some of the oil out of 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, 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. The baffle stack will deteriorate due to arcing at approximately the same rate as the 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 first be taken from the valve at the bottom of the tank and sufficient oil should 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 and wiped down using a clean lint-free cloth saturated with clean #10-C oil 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 or to the insulating members.

4. The breaker linkage lubrication should be thoroughly checked. All bearing surfaces should be lubricated with G-E Lubricant D50H15.

5. The opening dashpot oil level should be checked. The opening dashpot level is correct when the oil will just run out of the hole left by removing the small pipe plug in the side of the cylinder. With the dashpot plunger in the up position oil may be added at this point. The dashpots use G-E #10-C breaker oil. The dashpots should be examined to see that the piston works freely and that there is no sludge present.

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. If the bushing mounting nuts are not sufficiently secure tighten with approximately 40 to 50 foot pounds of torque.

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 (3), Figs. 16 and 17, 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 and bushings.

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

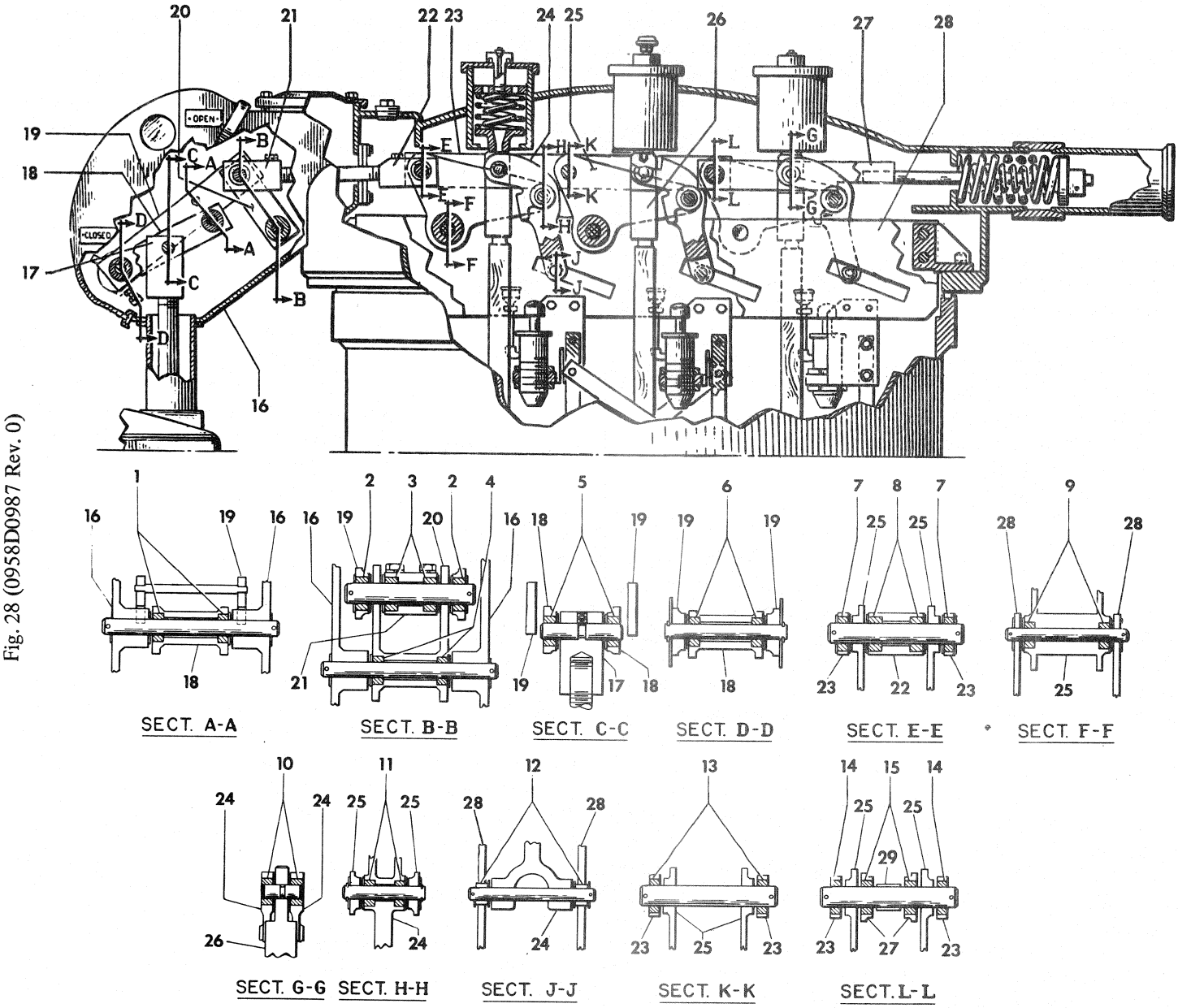
REPAIR AND REPLACEMENT

STANDARD INTERRUPTER ASSEMBLY

With the oil tanks removed and the breaker in the open position, the interrupters (10), Fig. 3 can be lowered for inspection or repair by simply removing the six assembly nuts (2), Fig. 21, on the studs which pass through the lower adapter (4) and fasten into the interrupter tube (15) as shown in Fig. 21. The contact assembly (11) is now accessible and can be examined for excessive burning, pitting or wear. Since the studs fastening the upper (1) and lower (4) adapters have not been disturbed the assembly will probably not require a realignment of the interrupter. If it is necessary to change any contact fingers (9) and (10), first mark the position of the fingers containing the extended arcing tip (10) on the contact stop (20) above the flexible connector (6). Remove the flexible connectors (6) from the fingers. This permits removal of the entire contact finger assembly (11). If further disassembly of the interrupter is required the upper spacer (5) and intermediate spacers (25), insulating shims (23), the baffle stack (12) and the lower spacer (14) can be lifted out.

When reassembling the interrupter, the spacers and baffle stack are put back in the reverse order from the way in which they were taken out. 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 (12) is located in the exhaust slot opening (13) of the interrupter tube.

Fig. 28 (0958D0987 Rev. 0)



1. Top Front Crank Link Bushing
2. Front Link Bushing
3. Horizontal Operating Rod Front Coupling Bushing
4. Guide Crank Bushing
5. Center Front Crank Link Bushing
6. Bottom Front Crank Link Bushing
7. Front Connecting Link Bushing
8. Horizontal Operating Rod Rear Coupling Bushing
9. Beam Bushing
10. Lever Bushing (Top)
11. Lever Bushing (Center)
12. Breaker Linkage Side Support Roller
13. Center Connecting Link Bushing
14. Rear Connecting Link Bushing
15. Opening Spring Coupling Bushing
16. Front Crank Assembly Support Box
17. Vertical Operating Rod Coupling
18. Front Crank Link
19. Front Link
20. Guide Crank
21. Horizontal Operating Rod Front Coupling
22. Horizontal Operating Rod Rear Coupling
23. Front Connecting Link
24. Lever
25. Beam
26. Lift Rod Coupling
27. Opening Spring Coupling
28. Breaker Linkage Side Support
29. Spacer

Fig. 28. View of the Breaker showing bearing locations

The upper insulating spacer (5) should extend 1/64 inch to 1/32 inch above the top edge of the interrupter tube with the two 1/8 inch wide slots on the top side. This protrusion makes certain that the baffle stack (12) and spacers (5, 25 and 14) are tightly held in place when the interrupter is completely assembled. The 1/64 to 1/32 inch dimension is adjusted by the use of the insulating shims (23). The intermediate insulating spacer (25) is installed in the interrupter tube (15) with the two 1/8 inch slots on the bottom side. This assures that the insulating shims (23) are completely and firmly compressed. When the items which go into the interrupter tube are installed, put the interrupter in place on the lower adapter (4) making certain the arcing tips of the arcing t p finger (10) line up with the slots in the top plate of the baffle stack (12).

When tightening the 3/8-16 nuts (2), which fasten the interrupter tube to the adapter a torque of 200 to 250 inch-pounds should be used.

After assembly make certain that the exhaust ports of the baffle can be seen while looking into the interrupter through the exhaust port opening (13) of the interrupter tube. If the exhaust ports cannot be seen, the interrupter is incorrectly assembled and must be corrected by disassembly and rotation of the baffle to the proper location. Check for missing or crushed baffle locating pins.

If either the upper (1) or lower (4) adapter has, for some reason been disturbed, in relation to each other and the bushing, a spirit level should be used to insure vertical alignment. The upper adapter can be swivelled around the bushing lower mounting stud by loosening the clamping bolt (16) and the bushing can be slid around somewhat on the breaker dome to obtain additional adjustment. When tightening the 1/2-13 locking nuts (3) which fasten the upper and lower adapters together the torque value should be between 350 and 500 inch-pounds and care must be taken that the interrupter alignment is not disturbed. Recheck the interrupter alignment after tightening all hardware.

CAPACITOR SWITCHING INTERRUPTER

With the oil tanks removed, and the breaker in the open position, the capacitor switching interrupters can be lowered for inspection or repair by simply removing the six assembly nuts, (3), Fig. 22, the locating clip (5) and the resistor lead (33). The contact fingers (16) and (17) are now accessible and can be examined for excessive burning, pitting or wear. Since the upper adapter (1) has not been disturbed the reassembly will not require a realignment of the interrupter. If it is necessary to change any contact fingers, first mark the position of the arcing tip (17) on the contact stop (35) above the flexible connector (12) then remove the flexible connectors (12) from the fingers (16) and (17) permitting the removal of the contact segment assembly (18).

If further disassembly of the interrupter is required simply lift out the upper insulating spacer (11), the insulating shims (19), the intermediate insulating spacer (41), and the baffle stack (20). The resistor terminal screw (40) must be disconnected before removal of the resistor finger support (24). Gently raise the resistor until the resistor terminal screw (40) is exposed. Next remove the screw by using a screwdriver through the hole in the resistor support spacer (28). The remaining lower insulating spacer (27) can now be removed.

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 (20) is located at the exhaust port opening (21) of the interrupter tube (10).

The upper insulating spacer (11), Fig. 22, should extend 1/64 inch to 1/32 inch above the top edge of the interrupter tube (10). This protrusion makes certain that the baffle stacks (20) and spacers (11, 41, and 27) are held in place tightly when the interrupter is completely assembled. The 1/64 inch to 1/32 inch dimension is adjusted by the insulating shims (19). The intermediate insulating spacer (41) is installed in the interrupter tube (10) with the two 1/8 inch slots on the bottom side. This assures that the insulating shims (19) are completely and firmly compressed. When the items which go into the interrupter tube (10) are installed or the interrupters are equipped with resistors, attach the lower resistor lead (39) to the resistor finger support. Attach the interrupter tube to the lower adapter (7) and install the locating clips (5) in the slots provided on the resistor and resistor cover. Make certain

the exhaust openings in the resistor and cover line up with the exhaust port opening in the interrupter tube. Attach the upper lead (33) to the adapter with the lead screw (32). After the assembly is complete check the resistance of the resistors with the contact rod (36) out of the finger cluster (18), but with the contact rod still making contact with the resistor fingers (25). Check to see if the exhaust ports in the baffle stacks (20) can be seen while looking into the interrupter through the exhaust slot opening (21) in the interrupter. If it cannot be seen the interrupter is incorrectly assembled and must be disassembled and properly reassembled.

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 the "O" ring between the top frame and the mounting flange of the bushing is replaced with a new "O" ring. The mounting bolts should be tightened gradually and evenly to approximately 50 foot-pounds of torque, and all interrupter adjustments should be checked.

BUSHING CURRENT TRANSFORMERS

Transformers should be connected in accordance with the instruction book, GEH-2020, 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 surface of the transformer carrying a white mark is placed upwards.

Bushing current transformers are mounted in the top frame as shown in Figs. 6, 18 and 29. To remove the bushing current transformer, first remove the interrupter unit and disconnect the transformer lead wires from the terminal boards which are located in the mechanism control cabinet. Cut off the terminal on the end of the BCT lead and then pull the lead through the BCT seal located at the top of the BCT conduit pipe (5), Fig. 3. Pull approximately six inches of each wire at a time through the BCT seal from the BCT side of the seal. Pry the seal out of its seat. Loosen the nut and bolt in the center of the seal. This permits easy removal of the necessary wires from the seal.

Loosen the adapter clamp bolt (10), Fig. 19, and remove the interrupter unit. Then remove the four assembly nuts (14), Fig. 4 permitting the supporting plate (13) and the current transformer (11) 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.

LUBRICATION

In order to maintain reliable operation, it is important that all circuit breakers and their mechanisms be properly lubricated at all times. During assembly at the factory all bearing surfaces, machined surfaces, and all other parts of the breaker subject to wear have been properly lubricated using the best lubricants available. However, even the finest oils and greases oxidize to some extent with age, as evidenced by hardening and darkening in color. Consequently, all lubricants should be renewed periodically.

Frequent operation of a breaker causes the lubricant to be forced out from between the bearing surfaces. A simple lubrication will sometimes clear up symptoms of distress which might be mistaken for more serious trouble. It is also recommended that all breakers be operated at regular intervals to insure the user that the equipment has not become sluggish.

The correct period between maintenance lubrication depends to a great extent upon local conditions. Until a definite schedule has been worked out, the breaker should be lubricated annually and also whenever it is overhauled, as outlined in the LUBRICATION CHART. Breakers in very highly repetitive service should be checked more often.

The LUBRICATION CHART shown gives complete information for lubricating the breakers. One column shows the recommended ANNUAL LUBRICATION which requires no disassembly. The other

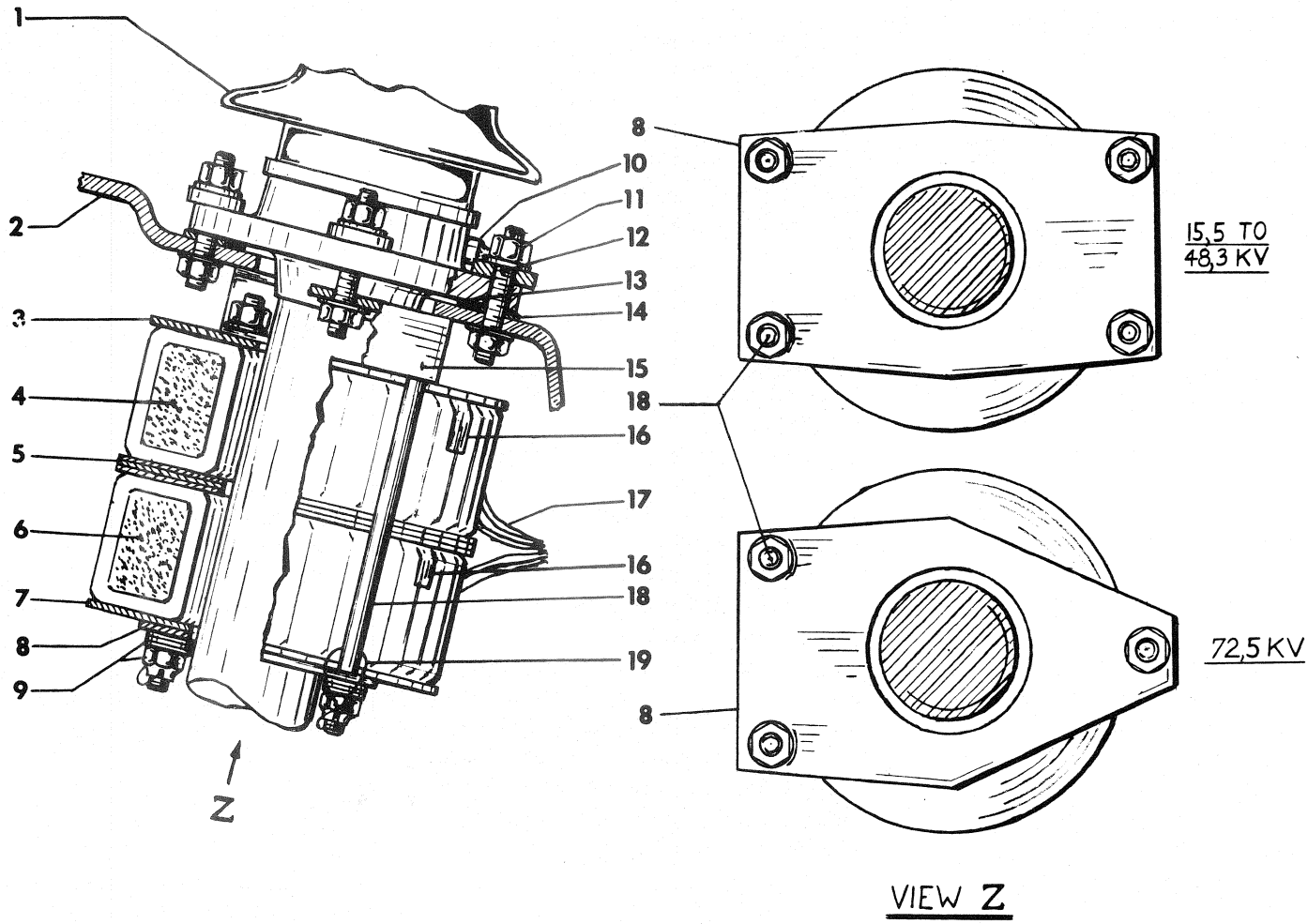


Fig. 29 (0129C0554 Rev. 0)

1. Bushing
2. Breaker Dome
3. Insulation Washer
4. Upper BCT (Position Y)
5. Insulation Washers
6. Lower BCT (Position X)
7. Insulation Washer
8. BCT Support Plate
9. Spacer Washers
10. Bushing Capacitance Tap
11. Bushing Mounting Nut
12. Bushing Mounting Stud
13. Bushing to Dome Gasket
14. Bushing to Dome Gasket Retainer
15. BCT Mounting Plate
16. White Polarity Strips
17. BCT Leads
18. BCT Mounting Stud
19. Safety Wire

Fig. 29 Bushing Current Transformer and Bushing Mounting

LUBRICATION CHART		
PART	LUBRICATION AT ANNUAL MAINTENANCE PERIOD	ALTERNATIVE LUBRICATION (REQUIRES DISASSEMBLY)
Ground Surfaces (Rollers, etc.)	Wipe clean and apply D50H15. Use very thin film on magnet faces.	Same as maintenance lubrication.
Sleeve Bearings (Breaker Linkage)	Very light application of light machine oil SAE20 or 30.	Clean per following instructions. Apply D50H15 liberally.
Opening Dashpot	With piston in the up position, fill even with fill hole using clean #10-C oil	Clean thoroughly and refill. Same instructions as maintenance lubrication.
Note: General Electric Lubricant D50H15 is available only in cartons containing twelve collapsible tubes of grease. This is a total of three pounds of grease to the carton. It is so packaged to insure cleanliness and to prevent oxidation.		

column, ALTERNATIVE LUBRICATION, outlines a procedure similar to that performed on the mechanism at the factory, but should be used only in case of a general overhaul or disassembly for other reasons, or if the operation of the breaker becomes sluggish. The alternative method of lubrication, however, should be undertaken after five years of service.

CLEANING

Wherever cleaning is required, as indicated in the LUBRICATION CHART, the following procedures are recommended:

SLEEVE BEARINGS

The pins should be removed and all old oxidized grease removed by immersion in clean petroleum solvent or similar cleaner. DO NOT USE CHLOROTHANE AS IT WILL ADVERSELY AFFECT THE TEXTOLITE BUSHINGS.

If the grease in the bearings has become badly oxidized it may be necessary to use alcohol (the type used for thinning shellac) to remove it. Ordinarily, by agitating the bearings in the cleaning solution, and using a stiff brush to remove the solid particles, the bearings can be satisfactorily cleaned. Do not handle the bearings or pins with bare hands as deposits from the skin onto the bearings and pins are inducive to corrosion. If the bearings or pins are touched, the contamination can be removed by washing in alcohol. After the bearings or pins have been thoroughly cleaned, dip in clean, new, light machine oil until the cleaner or solvent is entirely removed.

Wipe the pin and bearing clean, then apply a small amount of G-E Lubricant D50H15 to the entire surface of both just before reassembling.

NOTE: If it becomes necessary to clean the bearings in alcohol (shellac thinner), be sure the alcohol is perfectly clean, and do not allow the bearings to remain in the alcohol more than a few hours. If it is desirable to leave the bearings in the alcohol for a longer time, an inhibited alcohol such as is used for antifreeze should be used. Even then the bearings should be removed from the alcohol within twenty-four hours. Esso Anti-Freeze and Du Pont Zerone are satisfactory for this purpose. Precautions against the toxic effects of the alcohol must be exercised by wearing rubber gloves and by using the alcohol in a well ventilated room; excessive exposure to the fumes can be unpleasant to personnel. Washing the bearings in the light oil and draining should follow immediately, then apply the lubricant.

REPLACEMENT PARTS

It is recommended that sufficient renewal parts be carried in stock to enable prompt replacement of worn, broken, or damaged 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.

A list of replacement parts follows. This list includes both recommended renewal parts as designated by the asterisk (*) as well as a listing of parts ordered most frequently. The actual drawing number as well as the figure and part numbers in this book are given. Where parts are required that do not appear on this list, and hence no drawing number is available, the instruction book number as well as the figure and part number should be given on the purchase order.

Replacement parts may not always be identical to the original parts since im-

provements are made from time to time. The parts which are furnished, however, will be interchangeable. All "O" rings have a limited shelf life of three years.

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

Fig. No.	Ref. No.	Quantity per Oil-Blast Circuit Breaker												Catalog No.	Description
		FKA 15.5 36000		FKA 38 22000		FKA 48.3 17000		FKA 48.3 29000		FKA 72.5 19000		FKA 72.5 27000			
		-6	-6R	-6	-6R	-6	-6R	-6	-6R	-3	-3R	-3	-3R		
4	*2	1	1	1	1	1	1	1	1	1	1	1	1	006370470 P020	Oil Gage Glass Tube
4	*2	2	2	2	2	2	2	2	2	2	2	2	2	006440357 P001	Gasket - Oil Gage Upper and Lower
4	*3	6	6	—	—	—	—	—	—	—	—	—	—	7B522	Bushing (TBI)
4	*3	—	—	6	6	—	—	—	—	—	—	—	—	7B955	Bushing (Non TBI)
4	*3	—	—	—	—	6	6	6	6	—	—	—	—	7B956	Bushing (Non TBI)
4	*3	—	—	—	—	—	—	—	—	6	6	6	6	7B597	Bushing (Non TBI)
4	*10	1	1	1	1	1	1	1	1	—	—	—	—	0173A9024 P004	Gasket-Tank
4	*10	—	—	—	—	—	—	—	—	1	1	1	1	0173A9024 P005	Gasket-Tank
4	19	1	1	1	1	1	1	1	1	—	—	—	—	0153B5271 G001	Tank Liner
4	19	—	—	—	—	—	—	—	—	1	1	1	1	0809B0203 G001	Tank Liner
4	21	3	3	3	3	—	—	—	—	—	—	—	—	0188B9285 P001	Lift Rod
4	21	—	—	—	—	3	3	3	3	—	—	—	—	0188B9285 P002	Lift Rod
4	21	—	—	—	—	—	—	—	—	3	3	3	3	0188B9285 P003	Lift Rod
4	*22	6	—	6	—	6	—	6	—	6	—	6	—	0158A8776 P002	Contact Rod
4	*22	—	6	—	6	—	6	—	6	—	6	—	6	0103A6272 P011	Contact Rod
4	25	1	1	1	1	1	1	1	1	1	1	1	1	0123B2600 G001	Drain Valve (1 Inch Globe)
4	30	—	—	—	—	—	—	—	—	2	—	2	—	0123B1903 G021	Blade and Rod Assembly Complete - Phase 1 and 3
4	30	—	—	—	—	—	—	—	—	1	—	1	—	0123B1903 G022	Blade and Rod Assembly Complete - Phase 2
4	30	—	—	—	—	2	—	2	—	—	—	—	—	0123B1903 G011	Blade and Rod Assembly Complete - Phase 1 and 3
4	30	—	—	—	—	1	—	1	—	—	—	—	—	0123B1903 G012	Blade and Rod Assembly Complete - Phase 2
4	30	—	—	—	—	—	—	—	—	—	2	—	2	0123B1903 G023	Blade and Rod Assembly Complete - Phase 1 and 3
4	30	—	—	—	—	—	—	—	—	—	1	—	1	0123B1903 G024	Blade and Rod Assembly Complete - Phase 2
4	30	—	—	—	—	—	2	—	2	—	—	—	—	0123B1903 G015	Blade and Rod Assembly Complete - Phase 1 and 3
4	30	—	—	—	—	—	1	—	1	—	—	—	—	0123B1903 G016	Blade and Rod Assembly Complete - Phase 2
4	30	2	—	2	—	—	—	—	—	—	—	—	—	0123B1903 G017	Blade and Rod Assembly Complete - Phase 1 and 3
4	30	1	—	1	—	—	—	—	—	—	—	—	—	0123B1903 G018	Blade and Rod Assembly Complete - Phase 2
4	30	—	2	—	2	—	—	—	—	—	—	—	—	0123B1903 G019	Blade and Rod Assembly Complete - Phase 1 and 3
4	30	—	1	—	1	—	—	—	—	—	—	—	—	0123B1903 G020	Blade and Rod Assembly Complete - Phase 2
6	9	6	6	6	6	6	6	6	6	6	6	6	6	0181V0744 P001	Opening Dashpot Adjusting Nuts
6	10	3	3	3	3	3	3	3	3	3	3	3	3	0178L0271 G001	Opening Dashpot
12	5	2	2	2	2	2	2	2	2	2	2	2	2	0269A2175 P001	Lift Rod Guide Diagonal Brace
12	7	2	2	2	2	2	2	2	2	—	—	—	—	0269A2176 P003	Lift Rod Guide Vertical Support
12	7	—	—	—	—	—	—	—	—	2	2	2	2	0269A2176 P002	Lift Rod Guide Vertical Support
12	8	2	2	2	2	2	2	2	2	2	2	2	2	0269A2176 P001	Lift Rod Guide Horizontal Support
12	ø	1	1	1	1	1	1	1	1	—	—	—	—	010405847 G004	Lift Rod Guide Support Assembly Complete
12	ø	—	—	—	—	—	—	—	—	1	1	1	1	0104D5847 G003	Lift Rod Guide Support Assembly Complete
14	*2	1	1	1	1	1	1	1	1	1	1	1	1	0399A0298 P001	Gasket - Front Cover
14	*7	4	4	4	4	4	4	4	4	4	4	4	4	0178V0727 P001	Indicator Window - Glass (Open and Closed)
14	*0	4	4	4	4	4	4	4	4	4	4	4	4	0183V0711 P001	Indicator Window - Gasket
14	*12	1	1	1	1	1	1	1	1	1	1	1	1	0399A0298 P002	Gasket - Top Cover

Fig. No.	Ref. No.	Quantity per Oil-Blast Circuit Breaker												Catalog No.	Description
		FKA 15.5 36000		FKA 38 22000		FKA 48.3 17000		FKA 48.3 29000		FKA 72.5 19000		FKA 72.5 27000			
		-6	-6R	-6	-6R	-6	-6R	-6	-6R	-3	-3R	-3	-3R		
14	28	3	3	3	3	3	3	3	3	3	3	3	3	006076406 P567	Lever Pin (Steel)
14	32	1	1	1	1	1	1	1	1	1	1	1	1	183V0713 P002	Upper Crank Link Pin (Steel)
14	33	1	1	1	1	1	1	1	1	1	1	1	1	183V0713 P001	Front Link and Guide Crank Pin (Steel)
14	34	1	1	1	1	1	1	1	1	1	1	1	1	183V0713 P002	Guide Crank Pin (Steel)
14	35	1	1	1	1	1	1	1	1	1	1	1	1	183V0710 P001	Vertical Operating Rod Coupling Pin (Steel)
14	36	1	1	1	1	1	1	1	1	1	1	1	1	103A2124 P018	Lower Front Crank Link Pin (Steel)
14	37	1	1	1	1	1	1	1	1	1	1	1	1	183V0713 P004	Horizontal Operating Rod Rear Coupling Pin (Steel)
14	38	3	3	3	3	3	3	3	3	3	3	3	3	183V0713 P003	Beam Pin (Steel)
14	39	3	3	3	3	3	3	3	3	3	3	3	3	183V0740 P001	Lift Rod Coupling Pin (Steel)
14	40	3	3	3	3	3	3	3	3	3	3	3	3	103A2123 P021	Lever and Beam Pin (Steel)
14	41	1	1	1	1	1	1	1	1	1	1	1	1	183V0713 P004	Connecting Link Pin (Steel)
14	42	1	1	1	1	1	1	1	1	1	1	1	1	183V0713 P004	Opening Spring Coupling Pin (Steel)
15	18	1	1	1	1	1	1	1	1	1	1	1	1	0269A2086 P001	Gasket - Upper Portion of BCT Conduit
15	19	2	2	2	2	2	2	2	2	2	2	2	2	0161A6080 P009	"O" Ring - Lower Portion of BCT Conduit
16 & 17	5	3	3	3	3	3	3	3	3	3	3	3	3	0397A0963 P009	"O" Ring - Buffer Cover Bolt
16 & 17	7	3	3	3	3	3	3	3	3	3	3	3	3	0181V0113 P001	Gasket - Buffer Cover
16 & 17	10	1	1	1	1	1	1	1	1	1	1	1	1	0397A0851 P001	Outer Spring (Kick-off)
16 & 17	11	1	1	1	1	1	1	1	1	1	1	1	1	0103A6590 P001	Inner Spring (Buffer)
17	14	–	–	–	–	–	–	–	–	6	6	6	6	0181V0112 P002	Washer - 1/8 Inch Thick
21	All	6	–	6	–	–	–	–	–	–	–	–	–	0214X0286 G003	Interrupter Complete
21	All	–	–	–	–	6	–	6	–	–	–	–	–	0214X0286 G031	Interrupter Complete
21	All	–	–	–	–	–	–	–	–	6	–	6	–	0214X0286 G033	Interrupter Complete
21	1	6	–	6	–	–	–	–	–	–	–	–	–	0124C3208 P002	Upper Adapter
21	1	–	–	–	–	6	–	6	–	–	–	–	–	0991C0271 P002	Upper Adapter
21	1	–	–	–	–	–	–	–	–	6	–	6	–	0991C0271 P004	Upper Adapter
21	5	6	–	6	–	6	–	6	–	6	–	6	–	0103A6957 P007	Upper Insulating Spacer
21	6	48	–	48	–	48	–	48	–	48	–	48	–	0153B5228 P001	Flexible Connectors
21	7	48	–	48	–	48	–	48	–	48	–	48	–	006076150 P001	Contact Finger Spring
21	8	6	–	6	–	6	–	6	–	6	–	6	–	0176V0880 P004	Spring Cage
21	*11	6	–	6	–	6	–	6	–	6	–	6	–	0195X0154 G001	Contact Segment Assembly Complete
21	*12	6	–	6	–	6	–	6	–	6	–	6	–	0267C0907 G002	Baffle Stack
21	*20	6	–	6	–	6	–	6	–	6	–	6	–	0158A9646 P001	Contact Stop
21	21	6	–	6	–	6	–	6	–	6	–	6	–	0382A0163 P003	Spring Retainer
21	23	12	12	12	12	12	12	12	12	12	12	12	12	0103A6964P002	Insulating Shim - 0.031 Inch Thick
21	25	6	–	6	–	6	–	6	–	6	–	6	–	0103A6957 P007	Intermediate Insulating Spacer
21	9	6	–	6	–	6	–	6	–	6	–	6	–	0123B1983 G005	Interrupter Tube and Studs Assembled
22	All	–	6	–	–	–	–	–	–	–	–	–	–	0214X0286 G013	Interrupter Complete
22	All	–	–	–	6	–	–	–	–	–	–	–	–	0214X0286 G030	Interrupter Complete
22	All	–	–	–	–	–	6	–	6	–	–	–	–	0214X0286 G032	Interrupter Complete
22	All	–	–	–	–	–	–	–	–	–	6	–	6	0214X0286 G034	Interrupter Complete
22	1	–	6	–	6	–	–	–	–	–	–	–	–	0124C3208 P002	Upper Adapter
22	1	–	–	–	–	–	6	–	6	–	–	–	–	0991C0271 P002	Upper Adapter
22	1	–	–	–	–	–	–	–	–	–	6	–	6	0991C0271 P004	Upper Adapter
22	8	–	6	–	–	–	–	–	–	–	–	–	–	0153B5200 G004	Resistor and Resistor Wire Support (15 Ohms)
22	8	–	–	–	6	–	–	–	–	–	–	–	–	0153B5200 G003	Resistor and Resistor Wire Support (83 Ohms)
22	8	–	–	–	–	–	6	–	6	–	–	–	–	0153B5200 G002	Resistor and Resistor Wire Support (150 Ohms)
22	8	–	–	–	–	–	–	–	–	–	6	–	6	0153B5200 G001	Resistor and Resistor Wire Support (526 Ohms)
22	9	–	6	–	6	–	6	–	6	–	6	–	6	0143B7630 P001	Resistor Cover
22	12	–	48	–	48	–	48	–	48	–	48	–	48	0153B5228 P001	Flexible Connectors
22	13	–	6	–	6	–	6	–	6	–	6	–	6	0176V0880 P004	Spring Cage
22	14	–	48	–	48	–	48	–	48	–	48	–	48	006076150 P001	Contact Finger Spring
22	15	–	6	–	6	–	6	–	6	–	6	–	6	0382A0163 P003	Spring Retainer

Fig. No.	Ref. No.	Quantity per Oil-Blast Circuit Breaker												Catalog No.	Description
		FKA 15.5 36000		FKA 38 22000		FKA 48.3 17000		FKA 48.3 29000		FKA 72.5 19000		FKA 72.5 27000			
		-6	-6R	-6	-6R	-6	-6R	-6	-6R	-3	-3R	-3	-3R		
22	*18	–	6	–	6	–	6	–	6	–	6	–	6	0195X0154 G001	Contact Segment Assembly Complete
22	19	12	12	12	12	12	12	12	12	12	12	12	12	0103A6964P002	Insulating Shim - 0.031 Inch Thick
22	*20	–	6	–	6	–	6	–	6	–	6	–	6	0267C0907 G002	Baffle Stack
22	22	–	18	–	18	–	18	–	18	–	18	–	18	006551729 P001	Resistor Contact Finger Spring
22	23	–	18	–	18	–	18	–	18	–	18	–	18	006477415 P009	Resistor Finger Pin
22	*25	–	18	–	18	–	18	–	18	–	18	–	18	009924682 P002	Resistor Contact Finger
22	*35	–	6	–	6	–	6	–	6	–	6	–	6	0158A9646 P001	Contact Stop
22	Ø	–	6	–	6	–	6	–	6	–	6	–	6	0123B1983 G006	Interrupter Tube and Studs Assembled
22	Ø	–	6	–	–	–	–	–	–	–	–	–	–	0214X0873 G001	Resistor Complete (With Resistor, Cover, Wire-wound Tube, Hardware and Upper and Lower Leads)
22	Ø	–	–	–	6	–	–	–	–	–	–	–	–	0214X0873 G002	Resistor Complete (With Resistor, Cover, Wire-wound Tube, Hardware and Upper and Lower Leads)
22	Ø	–	–	–	–	–	6	–	6	–	–	–	–	0214X0873 G003	Resistor Complete (With Resistor, Cover, Wire-wound Tube, Hardware and Upper and Lower Leads)
22	Ø	–	–	–	–	–	–	–	–	–	6	–	6	0214X0873 G004	Resistor Complete (With Resistor, Cover, Wire-wound Tube, Hardware and Upper and Lower Leads)
28	1	2	2	2	2	2	2	2	2	2	2	2	2	006370567 P009	Top Front Crank Link Bushing (Textolite)
28	2	2	2	2	2	2	2	2	2	2	2	2	2	006370567 P067	Front Link Bushing (Textolite)
28	3	2	2	2	2	2	2	2	2	2	2	2	2	006370567 P063	Horizontal Operating Rod Front Coupling Bushing (Textolite)
28	4	2	2	2	2	2	2	2	2	2	2	2	2	006370567 P009	Guide Crank Bushing (Textolite)
28	5	2	2	2	2	2	2	2	2	2	2	2	2	006370567 P015	Center Front Crank Link Bushing (Textolite)
28	6	2	2	2	2	2	2	2	2	2	2	2	2	006370567 P009	Bottom Front Crank Link Bushing (Textolite)
28	7	2	2	2	2	2	2	2	2	2	2	2	2	006370567 P063	Front Connecting Link Bushing (Textolite)
28	8	2	2	2	2	2	2	2	2	2	2	2	2	006370567 P063	Horizontal Operating Rod Coupling Bushing (Textolite)
28	9	6	6	6	6	6	6	6	6	6	6	6	6	006370566 P059	Beam Bushing (Textolite)
28	10	6	6	6	6	6	6	6	6	6	6	6	6	006370566 P061	Lever Bushing (Top) (Textolite)
28	11	6	6	6	6	6	6	6	6	6	6	6	6	006370566 P061	Lever Bushing (Center) (Textolite)
28	12	6	6	6	6	6	6	6	6	6	6	6	6	182V0294 P001	Lever Roller (Steel)
28	13	2	2	2	2	2	2	2	2	2	2	2	2	006370567 P063	Center Connecting Link Bushing (Textolite)
28	14	2	2	2	2	2	2	2	2	2	2	2	2	006370567 P063	Rear Connecting Link Bushing (Textolite)
28	15	2	2	2	2	2	2	2	2	2	2	2	2	006370567 P063	Spring Coupling Bushing (Textolite)
30	13	6	6	6	6	6	6	6	6	–	–	–	–	0138A7102 P004	Gasket - Bushing to Breaker Dome
30	13	–	–	–	–	–	–	–	–	6	6	6	6	0138A7102 P005	Gasket - Bushing to Breaker Dome
30	14	6	6	6	6	6	6	6	6	–	–	–	–	0399A0231P001	Gasket Retainer
30	14	–	–	–	–	–	–	–	–	6	6	6	6	0399A0231 P002	Gasket Retainer

Ø Not Numbered
* Recommended Renewal Part

GENERAL ELECTRIC COMPANY
SWITCHGEAR BUSINESS DEPARTMENT
PHILADELPHIA, PA 19142

GENERAL ELECTRIC

PRINTED IN U.S.A.