INSTRUCTIONS

GEK–19763D
SUPERSEDES GEK-19763C

HIGH CAPACITY OIL-BLAST CIRCUIT BREAKERS

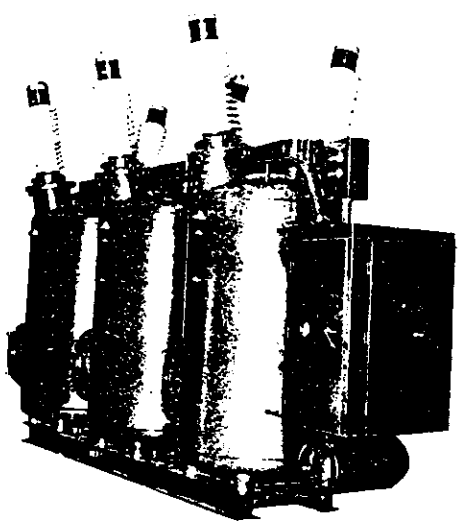
TYPES

FK-121-43000-4 and -5 121KV	43000 INTERRUPTING AMPERES	1600 CONTINUOUS AMPERES
FK-121-43000-3 and -4 121KV	43000 INTERRUPTING AMPERES	2000 CONTINUOUS AMPERES
FK-145-37000-6 and -7 145KV	37000 INTERRUPTING AMPERES	1600 CONTINUOUS AMPERES
FK-145-37000-1 and -2 145KV	37000 INTERRUPTING AMPERES	2000 CONTINUOUS AMPERES
FK-169-31000-2 and -3 169KV	31000 INTERRUPTING AMPERES	1600 CONTINUOUS AMPERES
FK-169-31000-2 and -3 169KV	31000 INTERRUPTING AMPERES	2000 CONTINUOUS AMPERES

(NOMINAL 10,000 MVA)

FK-121-65000-0	121KV	65000 INTERRUPTING AMPERES	2000 CONTINUOUS AMPERES
FK-145-55000-0	145KV	55000 INTERRUPTING AMPERES	2000 CONTINUOUS AMPERES
FK-145-55000-0	145KV	55000 INTERRUPTING AMPERES	2500 CONTINUOUS AMPERES

(NOMINAL 15,000 MVA)



POWER CIRCUIT BREAKER PRODUCTS DEPARTMENT
PHILADELPHIA, PA

GENERAL ELECTRIC

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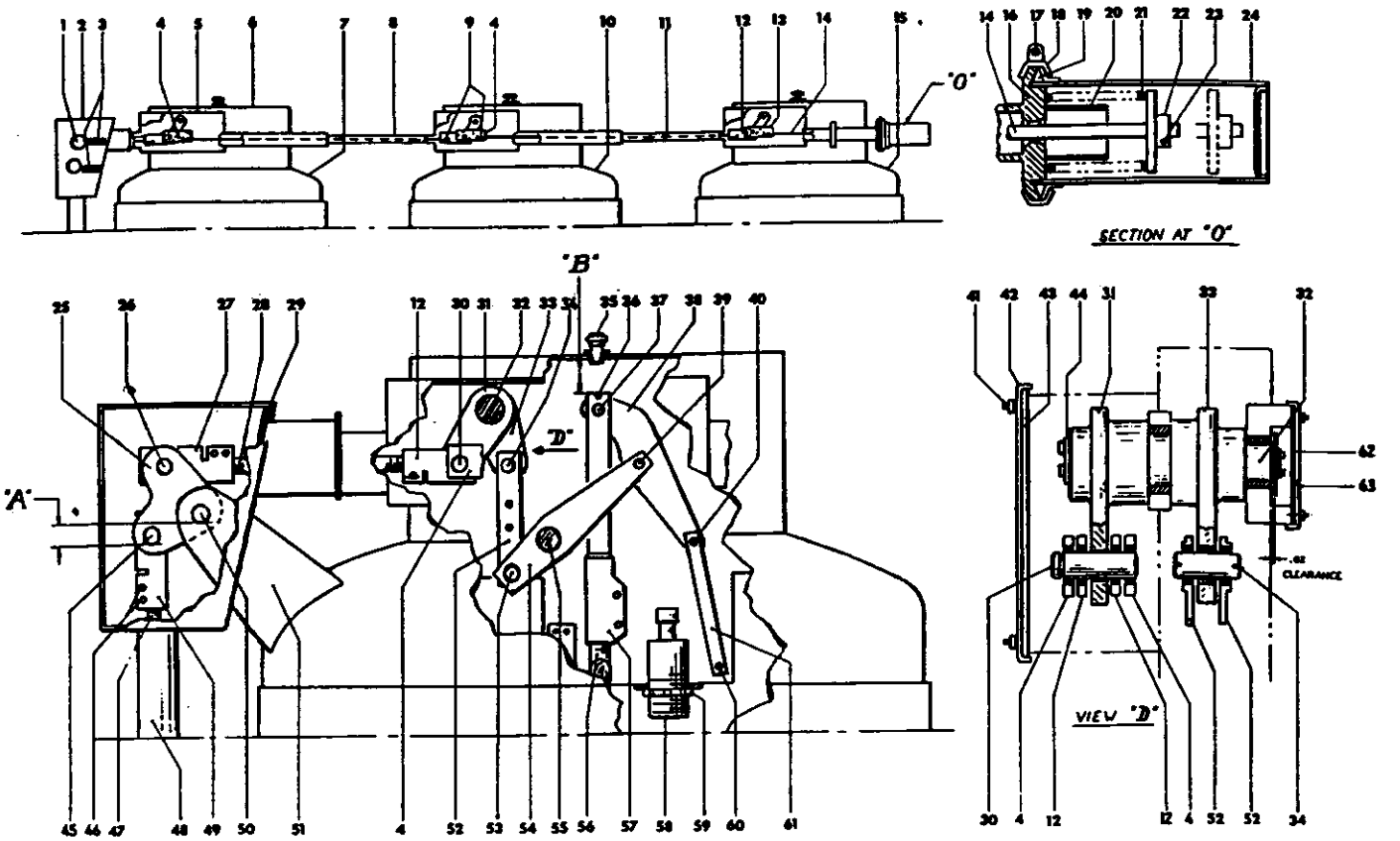

A. Front Crank Setting — 2-3/8 inches ± 1/16 inch

B. Lift Rod Setting — 1-13/16 inches ± 1/32 inch

1. Breaker Position Indicator
2. Front Crank Cover
3. Position Indicator Nameplates
4. Phase 1 and 2 Operating Rod Coupling
5. Breaker Mechanism Housing
6. Phase Unit Mechanism Housing
7. Front Phase Unit
8. Interphase Cover Pipe
9. Clamping Bolts
10. Center Phase Unit
11. Rear Interphase Operating Rod
12. Front Operating Rod Coupling of Phase Three
13. Rear Operating Rod Coupling of Phase Three
14. Opening Spring Operating Rod
15. Phase Three Unit
16. Opening Spring Support
17. Clamping Screw of Opening Spring Cover
18. Clamping Ring for Opening Spring Cover
19. Cover Gasket
20. Opening Spring Guide
21. Opening Spring
22. Opening Spring Adjusting Nut
23. Clamping Screw for Adjusting Nut
24. Opening Spring Cover
25. Front Crank
26. Front Crank to Horizontal Rod Coupling Pin
27. Front Horizontal Coupling
28. Front Horizontal Operating Rod
29. Front Cover Gasket
30. Crank Pin
31. Phase Unit Crank
32. Spline Shaft
33. Toggle Crank
34. Toggle Crank to Toggle Link Pin
35. Breather
36. Provisions for Travel Recorder (10-32 Tapped Hole)
37. Lever to Lift Rod Coupling Pin
38. Lever
39. Beam to Lever Pin
40. Lever to Guide Link Pin
41. Cover Bolts
42. Linkage Housing Cover
43. Crank Housing Cover Gasket
44. Locking Plate
45. Vertical Operating Rod Coupling Pin
46. Vertical Operating Rod Coupling Locking Bolts
47. Vertical Operating Rod
48. Vertical Operating Rod Cover Pipe
49. Vertical Coupling
50. Front Crank Pivot Pin
51. Front Crank Support
52. Toggle Link
53. Toggle Link to Beam Pin
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56. Lift Rod
57. Lift Rod Coupling
58. Opening Dashpot
59. Opening Dashpot Locking Nut
60. Guide Link Pivot Pin
61. Guide Link
62. Spline Shaft Cover Gasket
63. Spline Shaft Cover

Fig. 1. Breaker Mechanism in Closed Position

Fig. 1 (0958D0980 Rev. 1) Cover (8916483C)

HIGH CAPACITY
OIL-BLAST CIRCUIT BREAKERS

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(NOMINAL 15,000 MVA)

INTRODUCTION

The oil circuit breaker is a vital part of the modern power transmission system, being depended upon for protection, flexibility of control and efficiency of operation for stability and continuity of service.

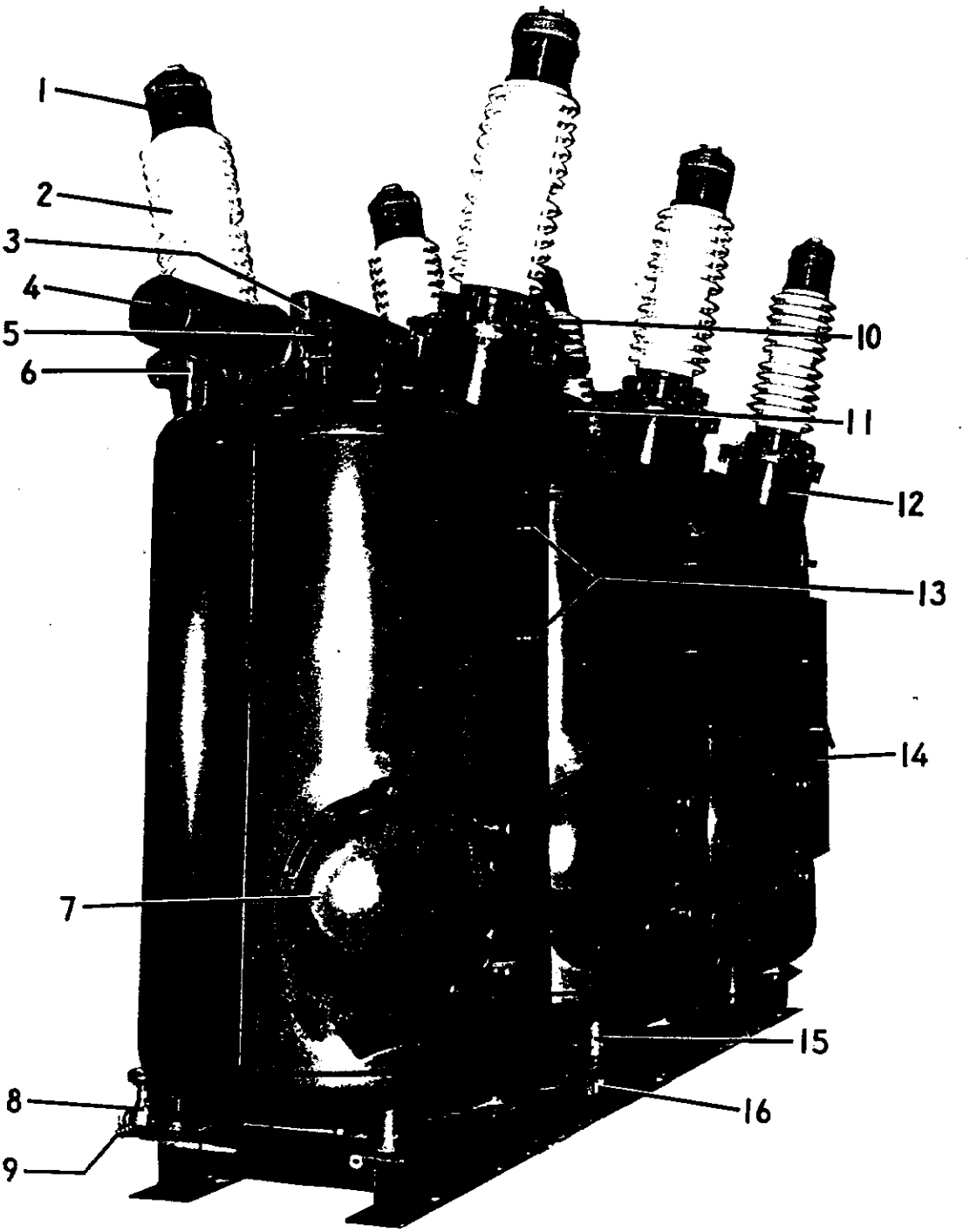
The Types FK-121, 145, and 169 high capacity oil-blast circuit breakers are designed for high speed interruption of faults and high speed reclosing on modern transmission lines of high current, voltage and short circuit rating. High speed interruption is achieved by use of contacts employing the oil-blast principle of circuit interruption. High speed reclosing is obtained by the use of a simple and rugged linkage that operates on low-friction bearings. The shorter arc durations result in decreased oil carbonization and reduced contact deterioration, and consequently less frequent maintenance. Arc resistant materials are used throughout on the interruption contacts.

To facilitate installation, the three pole units of a triple pole breaker are mounted on a unit base (13), Fig. 3. The sturdy tank supports (15), Fig. 2, facilitate inspection and painting under the tanks. The pneumatic operating mechanism (8), Fig. 3, is installed in a weatherproof housing which is fastened to the first phase. The phases are mechanically connected so as to operate simultaneously.

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 3,300 feet provided the proper bushings are selected. For the complete rating information of any particular breaker, refer to the breaker nameplate which is located inside the front door of the operating mechanism housing.

PROPER INSTALLATION AND MAINTENANCE ARE NECESSARY FOR CONTINUED SATISFACTORY OPERATION OF THE BREAKER. The following instructions will provide information for placing the 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.

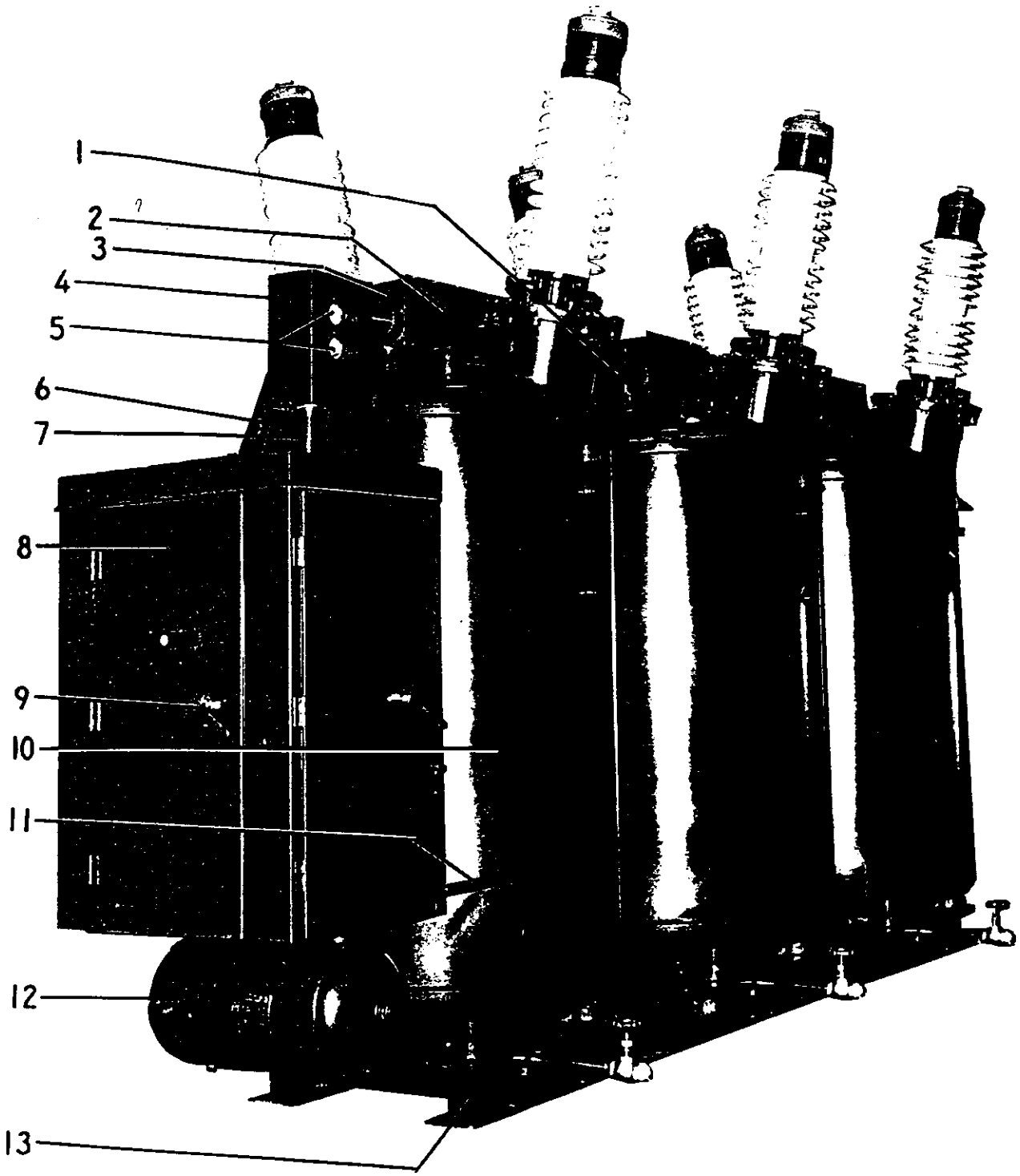
These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently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



1. Bushing Oil Level Sight Glass
2. Bushing
3. Breaker Mechanism Box
4. Opening Spring Cover
5. Bushing Current Transformer Lead Splice Box
6. Tank Oil Level Indicator
7. Manhole Door
8. Drain Valve
9. Sampling Valve
10. Capacitance Tap Outlet
11. Spline Shaft Cover
12. Bushing Current Transformer (BCT) Pocket
13. Potential Device Mounting Boss
14. Pneumatic Operator
15. Oil Tank Support Leg
16. Breaker Ground Pad

Fig. 2. Left Side View of the 10,000 mva Breaker Showing Major Assembly Components

Fig. 3 (8916483-B)



1. Interphase Operating Rod Cover Pipe
2. Coupling and Crank Box Cover - Phase 1
3. Breaker Coupling and Crank Box
4. Front Crank Cover
5. Breaker Open and Closed Indicator Windows
6. BCT Conduit
7. Vertical Operating Rod Cover Pipe
8. Operating Mechanism
9. Operating Mechanism Front Door Handle
10. Phase 1 Oil Tank
11. Mechanism House Stiffening Member
12. Operating Mechanism External Air Receiver
13. Supporting Skid

Fig. 3. Right Side View of the 10,000 mva Breaker Showing Major Assembly Components

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 an alkyd type paint as required.

All breakers are assembled and tested at the factory. They are shipped assembled in as complete units as handling and transportation facilities will permit. Where shipping clearances and handling facilities permit, the breakers will be shipped completely assembled, if the ordering information so states. Some unit base-mounted breakers have the bushings and impulse-type interrupters removed and shipped separately due to shipping difficulties or shipment to stations outside the continental United States of America. On this type of shipment the interrupters are usually mounted on brackets inside the tank as shown in Fig. 40. The bushings are separately crated as shown in Fig. 6 and are shipped directly from Pittsfield, Massachusetts.

Each phase is shipped with the bushing current transformers, breaker mechanism, and moving contact members in place. The pneumatic operating mechanism and its housing are shipped assembled on the front phase.

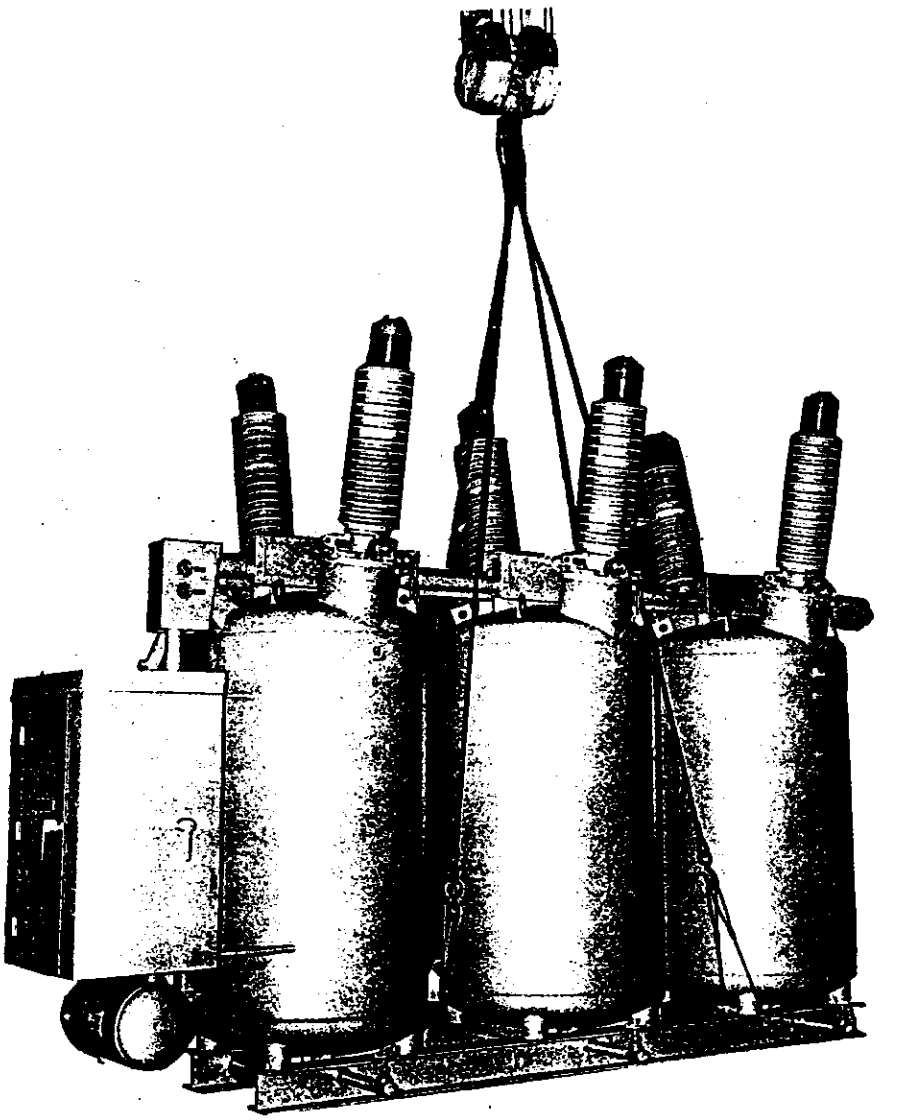


Fig. 4. Method of Slinging the Breaker For Lifting

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 immediately 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. Particular care must be taken with the bushings as the porcelain insulating sections may otherwise become chipped or damaged. 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 driving a wrecking bar into crates or boxes carelessly. For additional information concerning the care and handling of bushings see the bushing instruction book. Certain other parts of the breaker are of insulating material and must be handled so that they are protected from moisture, dirt, and damage due to rough handling.

Check all parts against the packing lis as they are unpacked and identified to b sure that no parts have been overlooke during the unpacking. This list is enclose in one of the packing cases and referenc to that packing case is made on th memorandum of shipment as containin the packing list. Always search the pac ing material for hardware which may hav loosened in transit. All tags should be le on the parts until they are ready fc installation. It is well to remember tha parts which have been removed from th breaker for shipment are identified b

Fig. 5 (8040744)

Fig. 5. Method Used to Plumb the Breaker on Its Foundation

number markings that correspond to the serial number of the breaker.

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. Clean and inspect the oil tank and remove the moisture indicator card and containers of desiccant before filling the tank with oil. Even if the breaker is to be stored for a long period of time in some location other than the permanent one, the tank should be filled with oil to protect the components made of insulating material.

During a period of short storage, six months or less, it may be advantageous to utilize the materials furnished to keep the tank dry during shipment. This material consists of a humidity indicator card fastened to the lift rod and containers of desiccant fastened to the interrupter. (See Fig. 40.) If this method of storage is chosen it is necessary to check the indicator card immediately upon receipt to be sure the tank structure has not sustained any damage in transit which would permit the entrance of moisture. IF DAMAGE IS NOTED THE CARRIER SHOULD BE NOTIFIED AS WELL AS THE NEAREST GENERAL ELECTRIC COMPANY SALES OFFICE.

After the initial inspection is completed, inspection of the indicator card should be made every 30 days to be sure no moisture leakage points have developed. If the card indicates the presence of moisture, corrective measures should be taken immediately. After the entrance point of the moisture is determined and corrected, the saturated desiccant containers should be removed and dried out by baking at 90 to 100°C for a period of four hours. They can then be mounted in tank in the same manner as received.

If it is impractical to make the 30 day inspection periods as suggested above, because of remoteness of location, the breakers should be filled with oil as a positive safeguard against moisture damage to the insulating parts.

The bushings may be stored outdoors in their crates as received, in a place where there is no danger of breakage.

ALL BREAKER COMPONENTS MADE OF INSULATING MATERIAL SHOULD BE STORED IN A DRY ROOM. These parts are all indicated by an appropriate "KEEP IN DRY PLACE" label on the outside of the case. When storing them indoors the cases should be opened to allow air to circulate freely. If the parts are packed in excelsior it

advisable to remove the excelsior completely because it tends to collect moisture which may be absorbed by the insulating materials; the moisture may also cause corrosion of metal parts. If they must be left outdoors for a week or two, they must be thoroughly covered with a tarpaulin. Sufficient heat should be applied to prevent temperature changes from causing moisture condensation on the parts. Under conditions of high humidity, or if the only indoor storage space is damp, breaker components and replacement parts should be kept in containers filled with G-E 10-C oil.

Replacement parts, especially lift rods, guides, and other parts made of insulating material, should be stored in a dry room. It is also advisable to hang the lift rods and guides in a vertical position to minimize the possibility of warpage, especially 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.

The space heater in the operating mechanism housing should be energized as soon as possible in order to prevent moisture condensation inside the housing.

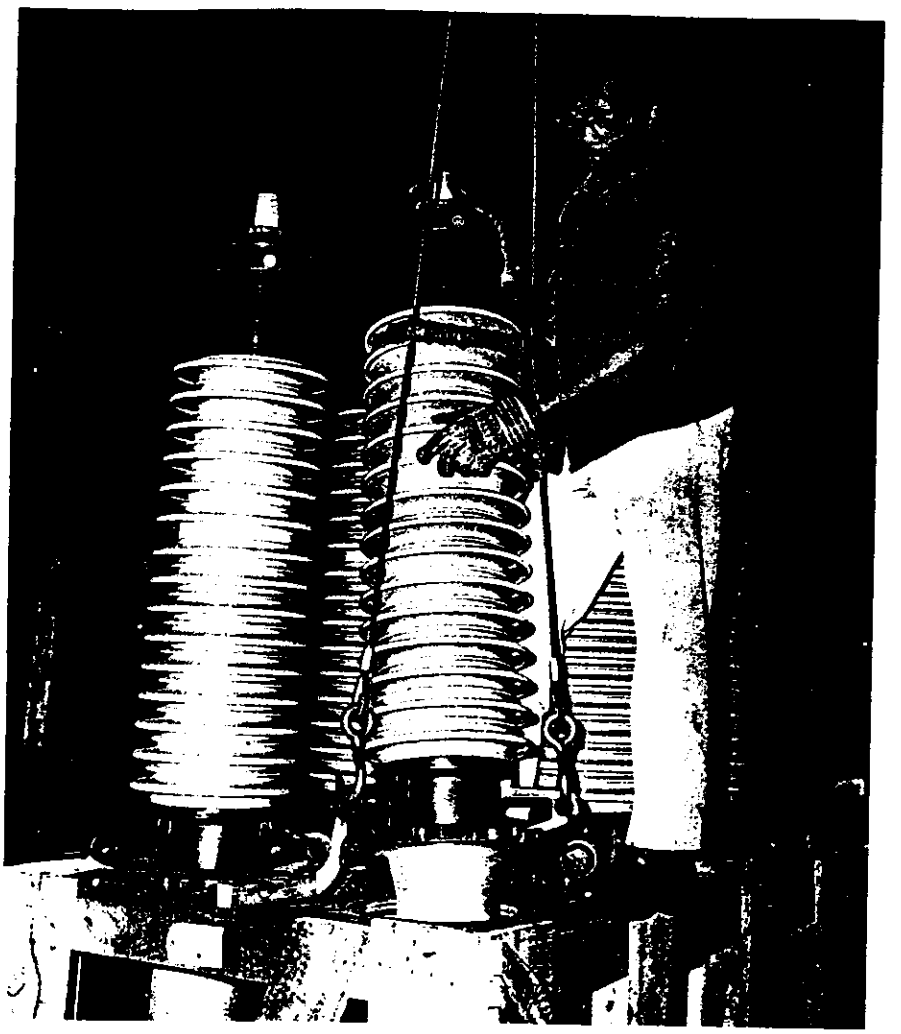


Fig. 6. Vertical Lifting of the Bushing for Removal from the Shipping Crate

DESCRIPTION

BREAKER

Each three phase breaker consists of three similar phase assemblies mounted on a common base as shown in Fig. 3. Each phase has an oil tank on which a mechanism box, interphase rod coupling box and two bushing supports are welded. These bushing supports also serve as bushing current transformer (BCT) pockets. The mechanism box houses the phase linkage that imparts the straight line motion of the horizontal operating rods to the lift rod. The breaker linkages on the three phases are connected together so that they can be operated simultaneously by the common pneumatic operating mechanism. The oil tank encloses the interrupters and insulating oil.

The breaker mechanism, located in the breaker mechanism housing (5), Fig. 1, atop each phase transmits the motion of the operating mechanism to the movable contact assembly producing a straight line motion of the movable contacts. The breaker mechanism is so designed that the operating rods (11) are always in tension on both closing and opening operations due to the spring load of the interrupters (13), Fig. 9, and the opening spring (21), Fig. 1. Oil dashpots (58) decelerate the opening speed prior to the fully-open position, allowing the movable contacts to come to rest with little or no rebound. An adjustable opening spring (21), Fig. 1, located at the end of the horizontal operating rod on the third phase unit (15) insure positive opening action of a predetermined speed and contact parting time.

The tanks are equipped with entrance manholes (17), Fig. 9, to permit easy access to the interior of the phases for inspection and maintenance. Each tank

has a drain valve (53) and either a pipeplug screwed into the valve or a sampling valve (54) that is attached to the drain valve. Each phase is also equipped with a float-type oil level indicator (42) that indicates the proper level of the oil in the tank.

Fig. 7 (8040718)

INTERRUPTER

The interrupter (13), Fig. 9, consists of a tube made from an insulating epoxy-glass material enclosing the upper and lower finger-cluster-type stationary contacts, a movable contact assembly having two contact rods, and a baffle assembly for arc control. The stationary contacts and contact rods form two interrupting breaks, each with its own baffle assembly. The interrupter tube has two back pressure valves, one for each contact break, to permit gas and arc products to be ejected from the interrupter tube. Two impulse pumps (34), Fig. 20, force oil into the interrupter when the breaker opens always maintaining a positive oil pressure.

Contact pressure is obtained by individual springs on each of the contact fingers of the cluster assemblies. Opening of the contacts is achieved by springs in the interrupter that force the rods out of contact with the stationary contacts. The interrupter is closed by the crossarm (20), Fig. 9, which is fastened to the lift rod (51), Fig. 9, of the breaker. The crossarm has a set of contact fingers on each end directly under each interrupter so that all moving contact points are of the sliding type rather than the butt type.

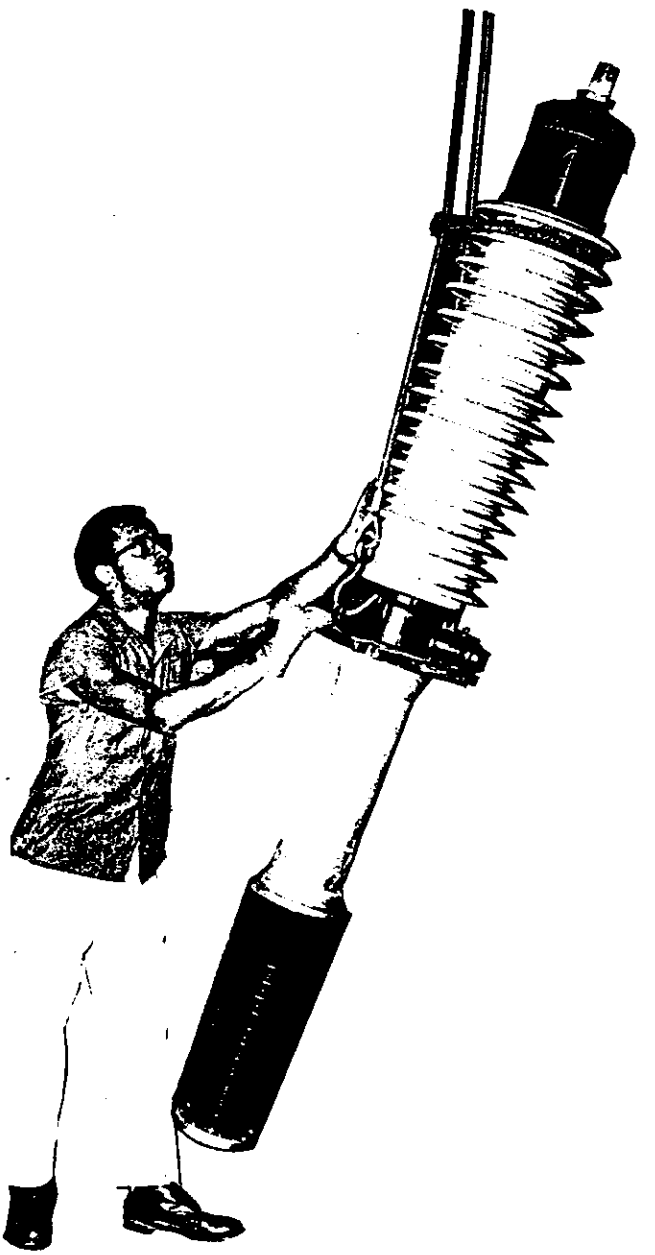


Fig. 7. Slinging Arrangement for Installation of the Bushing in the Breaker

Each interrupter assembly is shunted by a resistor which serves to divide the voltage between interrupters of a phase during interruption and also limits the overvoltage developed across the breaker after interruption. This resistor (50), Fig. 20, consists of an insulating board around which is wound a continuous length of helix wound wire as shown. The wire winding is covered by an inner and outer insulating cover.

Overtravel on closing is limited by means of the buffer springs in the pneumatic operating mechanism, the opening spring of the breaker (21), Fig. 1, and the four buffer springs (66), Fig. 18, in the interrupter. The interrupter is stopped from moving in a closing direction by the shoulder on the buffer guide rod (61), Fig. 18, striking the lower adapter plate (24), Fig. 18. This, of course, limits breaker overtravel.

The opening energy of the interrupter is absorbed upon completion of the opening stroke by the spring type washers (13), Fig. 19, located in the lower housing.

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

OPERATING MECHANISM

The operating means for closing and opening the breaker is a mechanism (8), Fig. 3, of the pneumatic type located in a weatherproof housing on the front phase. Instructions for the mechanism are contained in a separate instruction book, a copy of which is in the complete breaker instruction book located in the instruction book pocket which is fastened to the front door of the pneumatic operating mechanism house.

BUSHINGS

The oil-filled bushings (2), Fig. 2, on these breakers are of a hermetically-sealed construction. Type U bushings built to the new ANSI standards are used in these breakers. The 2000 and 2500 continuous ampere bushings are not interchangeable with transformer bushings. They are equipped with a capacitance tap (10), Fig. 2, for making power factor tests and when used with a separate potential device, provide a voltage supply for operating relays and instruments.

The bushings are installed in the bushing current transformer pockets from above. An adapter plate (25), Fig. 9, with weathertight gaskets (24) is inserted between the support flange of the bushing and the bushing current transformer pockets to facilitate alignment. Each bushing has provision for two bushing current transformers and the bushings can be installed or removed from the breaker without disturbing the transformers. The bushings are normally installed properly aligned in the breaker.

The external connection to the bushing must be sufficiently slack or flexible to avoid putting a mechanical strain on the bushing parts.

For additional information on the construction of bushings refer to instruction book, GEH 1627.

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 ANSI C37-13.017 (C) and NEMA SG-6-250 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 C37.13.017 (C) and NEMA SG-6-250 specifications.

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

Bushing current transformers are mounted inside the breaker dome. They are installed from above the breaker dome. BCT support plates (9), Fig. 9, bolted to the BCT pocket (5) 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 the transformer from being damaged when the bushing is installed.

If necessary the BCT's can be slipped over the lower end of the bushing, although the complete interrupter (13), Fig. 9, including the upper adapter (41), Fig. 20, and (3), Fig. 18, must be removed first. This is a more difficult method of installing the BCT and should

Fig. 8. Method Used to Measure Front Crank Setting

necessary control connections. Where flood conditions exist, the breaker foundation should be sufficiently high so that the mechanism housing is above high water level. It is also important that the breaker foundation be perfectly level, as this will assure maximum smoothness of operation.

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 wrapping cables around the oil tank support legs (15), Fig. 2, of Phases 1 and 3 as shown in Fig. 4.

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 which then will require replacement and repair of the bushings which were damaged.

FOUNDATION REQUIREMENTS

Until recently, the notation on our outline drawings relative to the foundation loading on oil circuit breakers performing normal rated duty said:

Downward Force: Three times the dead weight including oil.

Upward Force: One times the dead weight including oil.

Our notation on outline drawings now say: "Foundation Recommendations for Breakers Performing Normal Rated Duty":

Bearing Load each leg: 60,000 pounds - Short time loading - 20 milliseconds

Tensile Load each bolt - 30,000 pounds - Short time loading - 20 milliseconds

Minimum weight of concrete foundation - 30,000 pounds

We expect that for 95 percent of the cases this more realistic explanation would make a better job at a reduced cost for the following reasons:

Most oil circuit breakers of the "Bulk oil" design employ interrupters which arc, make pressure and interrupt. This principal has been used for many years and has resulted in reliable designs which to this day are unequaled in reliability.

The consequence of interrupter pressure is tank pressure. It is this tank pressure which makes the mechanical loadings. For instance a 100 psi peak pressure on a 2000 square inch area of a tank bottom makes 100 tons of force. Fortunately this is only for a short time; i.e., 1/50 part of second.

By pointing out that the legs should withstand 60,000 pounds bearing stress, the contractor knows that he needs a reasonable bearing area underneath the legs so that he either installs a bearing plate or grouts the H beam at that point.

By pointing out that the 1 1/4 inch bolts will have a 30,000 pound load we avoid the use of thin hold-down clips, shallow bolts or thin anchor plates.

Hold-down clips can be used if they can hold down 30,000 pounds, two inches from the web of the H beam. It will turn out that the bolt to hold down the hold-down clip will have to take much more than 30,000 pounds.

The weight of the foundation, 30,000 pounds, is based on 7-1/2 cubic yards of concrete. The total load of the breaker plus the foundation at 138kV is about 66,000 pounds. Since the weight of a three-phase 138kV, 10 GVA breaker is 36,000 pounds, the weight of the foundation plus breaker is not increased by the short-time bearing load on each breaker leg, consequently there is very little effect on the supporting soil. This sets the bearing load required under the foundation. This should result in savings in foundation costs where soil bearing is low relative to 138,000 pounds (30,000 pounds base and three times 36,000 pounds for breaker) as previously used with the three-times-weight formula.

Trouble is anticipated for those b
ers which are mounted on thin fo
tions, railroad ties or other temp
foundations. With a heavy fault c
tion, these breakers will bounce off
foundations, possibly rip open the
bottoms and leak. In other words,
will not perform at their full mva ra
and if they cannot, the loss of perf
ance means a reduced load.

The high mechanical forces w
occur during interruption are more
an order of magnitude greater than t
seen during an earthquake and as an e
benefit you get in an oil circuit bre
design, equipment which can withs
an earthquake with no difficulty.

BREAKER INSTALLATION

Installation of the breaker is gre
simplified as the tanks are aligned
mounted on a unit base with the ir
phase connecting rods and cover pipe
place.

Sling the three-phase breaker as
tured in Fig. 4 and move it into loca
with a crane. To level the breaker, dr
plumb line outside the center tank f
the plumb mark on the bushing pote
device mounting boss (13), Fig. 2, wel
to the side of the tank to the co
sponding plumb mark on the oil d
line. Check the other two tanks to m
certain they also line up properly
necessary, shim the unit base until
plumb bob is within 1/4 inch of
mark. Refer to Fig. 5 for the meth
used to plumb the breaker.

The foundation bolts should be
loose to permit the breaker to be pr
erly plumbed and leveled by insert
shims under the supporting skid (13), F
3, where necessary. After this has be
done, grouting should be applied betwe
the breaker skid and the foundation:
foundation bolts should be tightened a
the supporting skid fastened securely
its foundation.

The remaining sections on CONNE
TIONS, MECHANICAL ADJUSTMEN
and so forth should be followed throu

to be sure no shifting of parts has been sustained in shipment. Before proceeding with the checking of the breaker all shipping braces on the bushing, inside the tank and in the mechanism house, should be removed.

The degree of readjustments required in fully assembled breakers is purely a function of the handling received in transit. Every effort has been made at the factory to insure the rigidity of all members which may shift out of adjustment. Even with these precautions, it is sometimes necessary to realign and readjust some components on the breaker.

PNEUMATIC CLOSING WITHOUT OIL

All adjustments listed in SUMMARY OF ADJUSTMENTS, a tabulation contained in this book, should be checked and any discrepancies between the book and the breaker should be corrected. The checks pertaining to the lift rod setting, interrupter setting, front crank setting and opening spring should be measured after the breaker is closed pneumatically. This breaker can be closed pneumatically without oil in the tanks provided certain precautions are taken. These are as follows:

The power lines to the breaker must not be energized.

There must not be anyone inside the breaker tanks, or leaning into the tanks.

The breaker must be operated at its minimum air pressure per the nameplate inside the front door of the mechanism house.

The breaker must be closed manually slowly to check for any malfunction before closing it pneumatically.

After the various checks are made the breaker can be tripped out, again without oil in the tanks, without damage to the breaker.

Note: While checks are being made on the breaker the air to the main control valve should be shut off or drained. The trip latch of the operating mechanism must be blocked as explained in the mechanism instruction book to prevent accidental tripping while the various checks are being made.

If loosened for any reason while the breaker was in the open position, all locking bolts on couplings must be tightened to 90 foot-pounds torque before the breaker is closed either manually or electrically as damage to the threads can result if the rods pull out of the couplings.

LIFT ROD

On fully assembled breakers it is permissible to adjust the lift rod (51), Fig. 9, as much as 1/2-inch off vertical as measured at the bottom of the rod. This adjustment may be required to obtain proper alignment between the external probe (72), Figs. 18 and 20, of the interrupter and the guide socket (71), of the crossarm. If more than 1/2-inch of adjustment is required, the guide should be adjusted to allow the rod to hang vertically and the necessary alignment adjustments should be made on the bushing (2), Fig. 9, and the interrupter (13).

When the various clearances are checked out the procedures listed after MECHANICAL ADJUSTMENTS should be followed.

If the various clearances do not check out to the previously mentioned tolerances it will be necessary to realign and readjust the bushings, lift rod and interrupter as outlined in the following paragraphs.

MOVING CONTACT MEMBERS

The lift rods and crossarms of all three phases are in place as the breaker tanks are received. Check to see that the lift rods (51), Fig. 9, are hanging in a vertical position and have clearance of 1/64-inch in the guide blocks (49) in both directions. It is not necessary that the lift rod have clearance to the guide block on all four sides, but should be checked on both centerlines of the tank to be sure no binding exists between the guide block and the rod. Like the fully assembled breakers, the lift rod may hang as much as 1/2-inch out of plumb over its entire length, but any dimension in excess of this should be corrected by realignment of either the lift rod, interrupters or bushings or all three.

The vertical positioning of the lift rod (51), Fig. 9, should be checked with the top of the external break finger cluster (19), Fig. 9, on the crossarm (20) jacked to a position of approximately 17-3/4 inches from the bottom of the tank. This position is measured from the top of the guide socket (71), Figs. 18 and 20, but at the center of the tank. The rods are properly located and aligned by adding or removing the necessary shims (45), Fig. 9, at the top of the lift rod guide (48).

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 bushing current transformers (BCT). Remove any shorting wires from the BCT terminal boards only after the BCT circuitry is completely wired.

GROUND CONNECTIONS

The tanks and support skid of each breaker should be permanently grounded. The usual practice is to connect a heavy cable to the support skid of the breaker and to the ground. A grounding pad (16), Fig. 2, is provided on both sides of the support skid of each breaker 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.

PRECAUTIONS

1. Before moving the breaker, opening the tank doors, 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 using minimum operating pressure per the breaker nameplate. Do not operate the breaker without oil in the tanks at normal air pressure as damage to the breaker can result. A few air operations can be made to check the interrupter setting, the wipe, front crank setting and the lift rod setting with the breaker not energized. Operations in air normally result in higher operation speeds (3/4 to 2 feet-per-second faster on opening and 2 to 6 feet-per-second faster on closing), 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 DEVICES 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 trip latch of the mechanism should be blocked before manually operating the breaker to prevent any possibility of the breaker tripping out erroneously. The breaker should be operated slowly by hand, using the maintenance closing device, to see that it operates smoothly throughout the closing operation, that no binding occurs, and that no excessive play is noticeable between parts. The breaker can be opened or closed slowly manually. The load of the breaker should first be taken up by the maintenance closing device and then the holding prop of the operating mechanism pushed aside so that the maintenance closing device can be slowly backed off to permit the breaker to open. 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.

The trip latch of the operating mechanism is blocked in place during shipment and this 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.

Any air lines in the pneumatic mechanism that were disconnected for shipment should be reconnected before attempting to operate the breaker pneumatically.

INTERRUPTER (INITIAL MANUAL CLOSING)

Using the maintenance closing device on the operating mechanism, close the breaker slowly, checking that the external finger cluster assemblies (19), Fig. 9, of both interrupters in a phase contact the external probe (72), Figs. 18 and 20, at the same time. Continue closing the breaker and at the same time check for any binding until the props fall under the rollers in the mechanism. At this time the interrupter setting will be approximately 1/8 inch too large but will be approximately the same on all six interrupters. This is due to not having the same force, momentum and acceleration as when the breaker is closed pneumatically. Do not readjust until after the breaker is closed

electrically. At that time adjustment will probably not be required. Check to make certain that the interrupters hang within 1/8-inch of plumb over their lengths and their contacts are in line with those on the crossarm.

LIFT ROD SETTING (INITIAL MANUAL CLOSING)

While the breaker is closed also check the lift rod setting. It also will be approximately 1/8 inch too large on all three phases for the same reason the interrupter setting was too large.

FRONT CRANK SETTING (INITIAL MANUAL CLOSING)

The front crank setting should be slightly different when the breaker is closed manually than the front crank setting when the breaker is closed electrically but less than 1/16 inch from the proper setting.

CLOSING BREAKER WITHOUT OIL

After the above items are checked manually and are found to be within the specified tolerance they can be checked more accurately by closing the breaker pneumatically without oil in the tanks by observing a few precautions. Set air pressure to the minimum value as specified on the breaker nameplate and make certain no one is in the breaker tanks or near any moving member of the breaker.

LINKAGE ADJUSTMENT (ELECTRICAL CLOSING)

Close the breaker electrically and measure the interrupter setting. It should measure 4-5/16 inches ± 1/32 inch or an aggregate of 8-5/8 inches ± 1/16 inch with the two interrupters of any one phase within 3/32 inch of each other. If this is incorrect it must be readjusted, but not until the front bell crank and lift rod settings have been checked and found to be correct.

LIFT ROD SETTING (ELECTRICAL CLOSING)

The lift rod setting should measure 1-13/16 inches ± 1/32 inch when the breaker is closed electrically as shown in Fig. 1 and Fig. 10. If any of the three phases measures beyond this dimension readjustment to the proper dimension is required. This can be accomplished by turning the horizontal operating rods (11, and/or 29), Fig. 1, in the appropriate direction.

Fig. 10. Method Used to Measure the Lift Rod Setting

FRONT BELL CRANK SETTING (ELECTRICAL CLOSING)

The front bell crank setting should be 2-3/8 inch ± 1/16 inch as shown in Fig. 1 and Fig. 8 with the breaker fully closed. If it is not, adjustment is necessary.

LINKAGE ADJUSTMENT

If the front bell crank setting, Fig. 1 and Fig. 8 is incorrect it must be reset and the cause (for it being incorrect) found. The resetting can be done by turning the vertical operating rod (47), Fig. 1, the proper amount. Check to make certain the bolts in the coupling (49) and the bolts in the coupling on the lower end of the vertical operating rod (47) are tight. If not, tighten them to 80 to 90 foot-pounds of torque with the breaker open. If a torque wrench is not available tighten the bolts so that, with the breaker in the open position, a 12-inch pipe wrench applied with moderate force cannot turn the operating rod. When this is done the bolts are properly tightened. Adjusting the front bell crank will affect the adjustment of both the lift rod settings and the interrupter settings of all three phases.

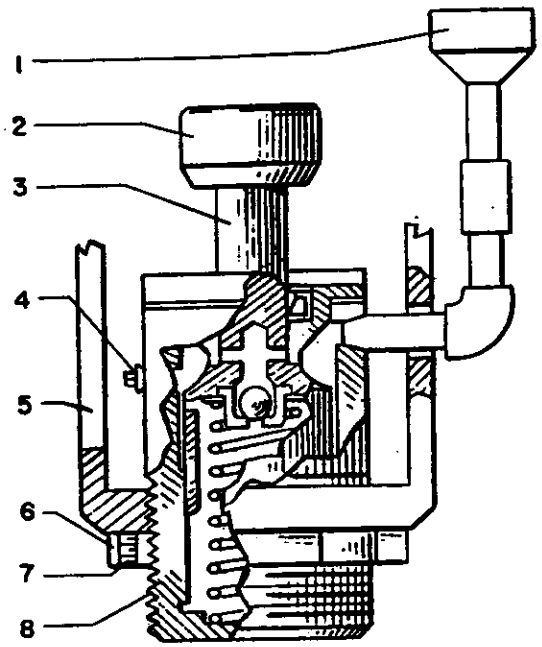
The lift rod settings, Fig. 1 and Fig. 10, can be adjusted by turning the horizontal operating rod (29), Fig. 1, of Phase

First, make certain no one is in the tanks. Second, set the air pressure at the minimum operating level (low pressure lockout switch setting on the breaker nameplate). Third, close the breaker then drain the air and block the trip latch to prevent accidental tripping while checking the various settings. Fourth, check the bellcrank setting, the three lift rod settings and each interrupter setting. In all probability the lift rod setting is 1/16 inch to 3/16 inch less than the 1-13/16 inches ± 1/32 inch dimension which was set manually due to the overtravel of the linkage when closed electrically. The lift rod settings can be adjusted back to their proper settings by turning the horizontal operating rods or the vertical operating rod in the proper direction after the breaker is tripped out. Do not loosen the clamping bolts on the rod couplings unless the breaker is in the open position. In the open position the spring load is removed. This is to prevent possible stripping of the threads on the operating rod or in the coupling. One complete turn of the operating rod will result in approximately 1/2-inch change in the lift rod setting since the rods have right- and left-hand threads and there is a three-to-one ratio between the breaker lift rod stroke and the mechanism output crank stroke. Tighten the hardware of the couplings to 90 foot-pounds of torque.

Continue adjusting the rods until the desired lift rod setting is obtained. Again close the breaker electrically as outlined above. Check the interrupter setting. It should be correct because it was adjusted manually when the lift rod setting was adjusted. If any readjustment is necessary, remove from or add shims between the external contact probe and the interrupter contact support plate.

GRADING RESISTOR

The value of the grading resistor (50), Fig. 18, should also be checked. An interrupter assembly for the 121, 145 and 169kV breakers should bridge at 1350 ohms plus 5 percent minus 10 percent over the complete breaker but must be within ± 5 percent of 1350 ohms in any one phase. An interrupter assembly for the 169kV breakers until recently bridged at 1620 ohms plus 5 percent minus 10 percent over the complete breaker but had to be within ± 5 percent of 1620 ohms in any one phase.



1. Breather
2. Cap
3. Piston
4. Pipe Plug
5. Mounting Frame
6. Locknut
7. Set Screw
8. Body

Fig. 11. Cutaway View of Breaker Opening Dashpot Assembly

When the breaker is adjusted properly install the corona (static) shields. Lock the corona shield bolts to the corona shield by use of the safety wire. The wire must go through the bolt head and the ¼ inch hole in the boss inside the shield. Do not permit the wire to be outside the cutout in the shield as this adversely affects the dielectric strength of the shield. Fill the breaker with oil, finish the checks in the mechanism, check out the operation of the breaker using a straight line type analyzer and, 12 hours after putting in the oil, energize the breaker.

ADJUSTMENT OF STROKE

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

Check the opening oil dashpots (58), Fig. 1, on each unit for oil level and fill with G-E 10-C oil if necessary. Make this check with the stem up, that is, with the breaker in the partially-closed position so that the striking boss on the lever (38) is not contacting the dashpot stem. Remove the pipe plug (4), Fig. 11, and check to see if oil is just below the level of the hole. If the level is not correct replace the plug and remove the breather (1). Add G-E 10-C oil until the breather standpipe is full. Replace the breather cap and actuate the piston plunger several times to release any trapped air bubbles. Remove the pipe plug to allow excess oil to drain off.

The dashpots should be the final stop of the breaker in the open position. Check to see that the breaker mechanism linkage comes to rest on the dashpot caps in all pole units at approximately the same time. The proper stroke of the breakers is 15 inches ± 1/2 inch. The dashpots are threaded and can be adjusted up or down to obtain the desired stroke after releasing the set screw (7

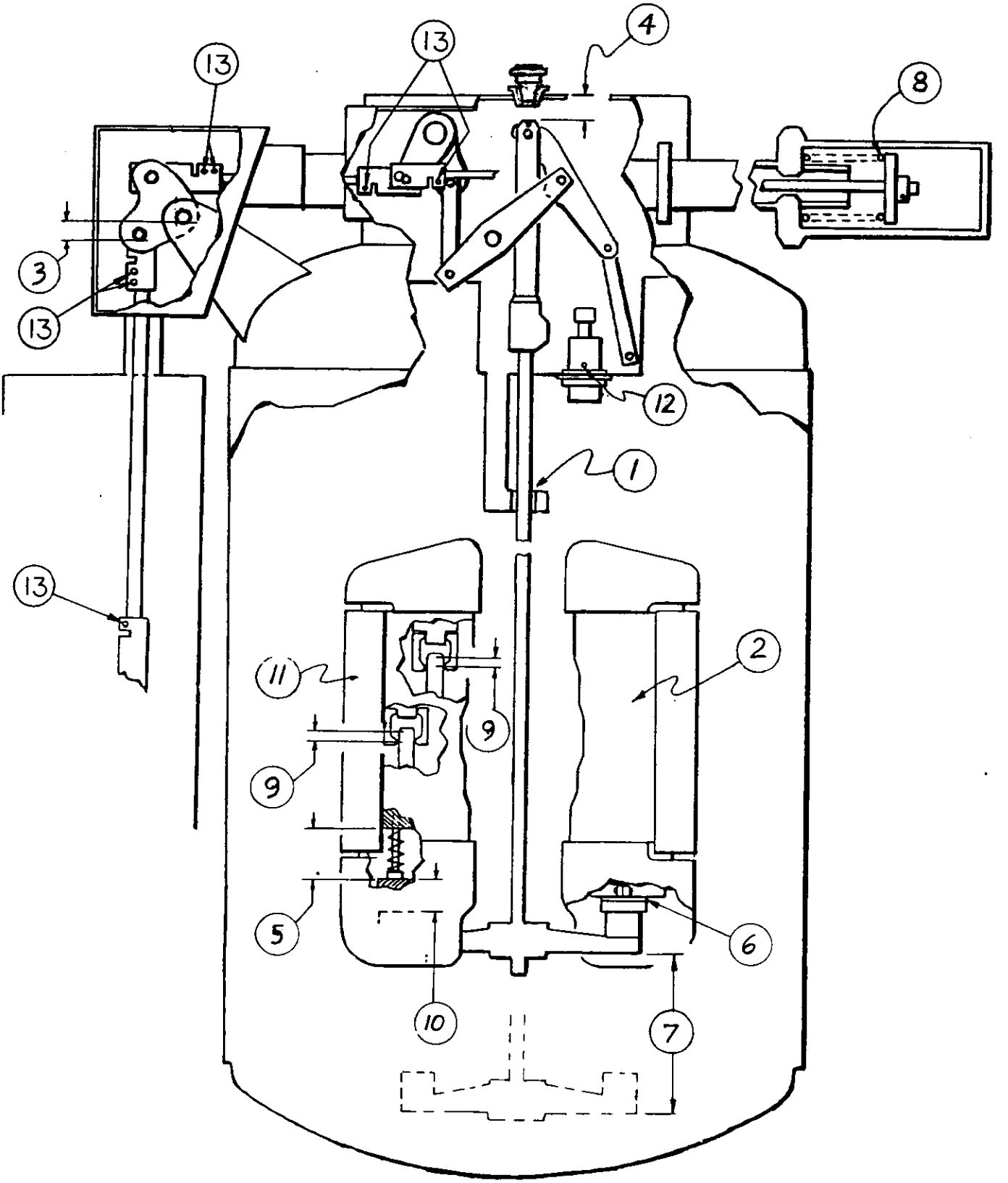


Fig. 12. Physical Location of Breaker Adjustments and Check Points

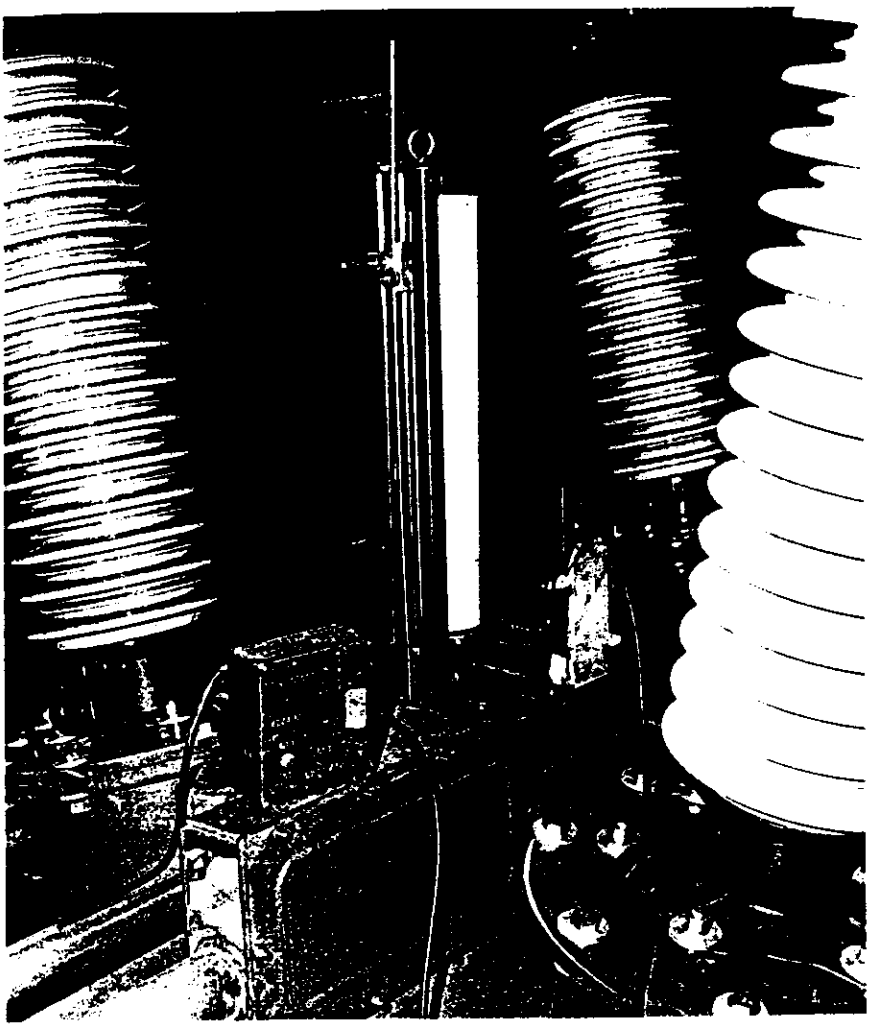


Fig. 13 (8040719)

Fig. 13. Installation of Travel Analyzer

The normal oil level at 20°C is indicated on the outline drawing. A marker on the float-type oil gage (42), Fig. 9, is set to this reference point. The range between minimum and maximum is represented by the visible portion of the gage glass and covers a temperature range of 70°C, or from plus 40°C to minus 30°C. The oil level at any intermediate temperature is represented by a proportionate part of the gage range. With this type of gage, the oil level is indicated directly by the action of the float which assumes the true oil level. It is important that the oil level never falls below the minimum level. This is selected so that the lower porcelain of the bushing will always be immersed and prevent corona discharge from the ground sleeve.

OPERATING ADJUSTMENTS

Pneumatic Operator Check

Make a visual inspection of the mechanism to see that all cotter pins are in place, that all nuts and terminal connections are tight, that no binding is present, and that all points are properly lubricated in accordance with the mechanism instruction book.

While the tanks are being filled with oil, the checks can be made on the operating mechanism. Check the compressor oil level and charge the air receiver up to the operating pressure. The settings of all pressure and cutoff switches must be checked. Make reference to the mechanism instruction book for these adjustments and to the breaker nameplate for the proper pressure switch settings.

Opening Spring

The nominal opening spring (21), Fig. 1, compressed length is 10 inches when the breaker is in the fully-closed position. This corresponds to a nominal compression of 3-9/16 inches for the 10,000 mva breaker and 4-1/2 inches for the 15,000 mva breaker. This spring should not be compressed to a length less than 9-1/2 inches. The free length of the 10,000 mva spring is 13-9/16 inches ± 3/8 inch. The free length of the 15,000 mva spring is 14-1/2 inches ± 1/2 inch. When the breaker is fully open there is no compression on the 10,000 mva spring whereas there could be 3/4 inch compression on the 15,000 mva spring which corresponds to approximately a 300-pound load. Therefore care must be taken when removing the opening spring from the 15,000 mva breaker.

Speed Adjustment

After completing the preceding installation adjustments and inspection, and after filling the tanks with oil and the operating mechanism with air, the breaker may then be operated electrically to obtain the proper operating speed.

Close the breaker electrically at normal pressure and check the lift rod setting (B), Fig. 1. It will be necessary to remove the breather (35) and reducer in order to insert the gage to make this measurement. Some variation will probably be found between the settings obtained with power and with manual operation. Readjust the breaker if necessary to the recorded settings which were obtained when the breaker was checked out by closing it without oil in the tanks. If these settings are not held, difficulty may be encountered in closing properly at the minimum of the pressure range. A minus dimension beyond the tolerance will compress the interrupter overtravel springs (66), Fig.

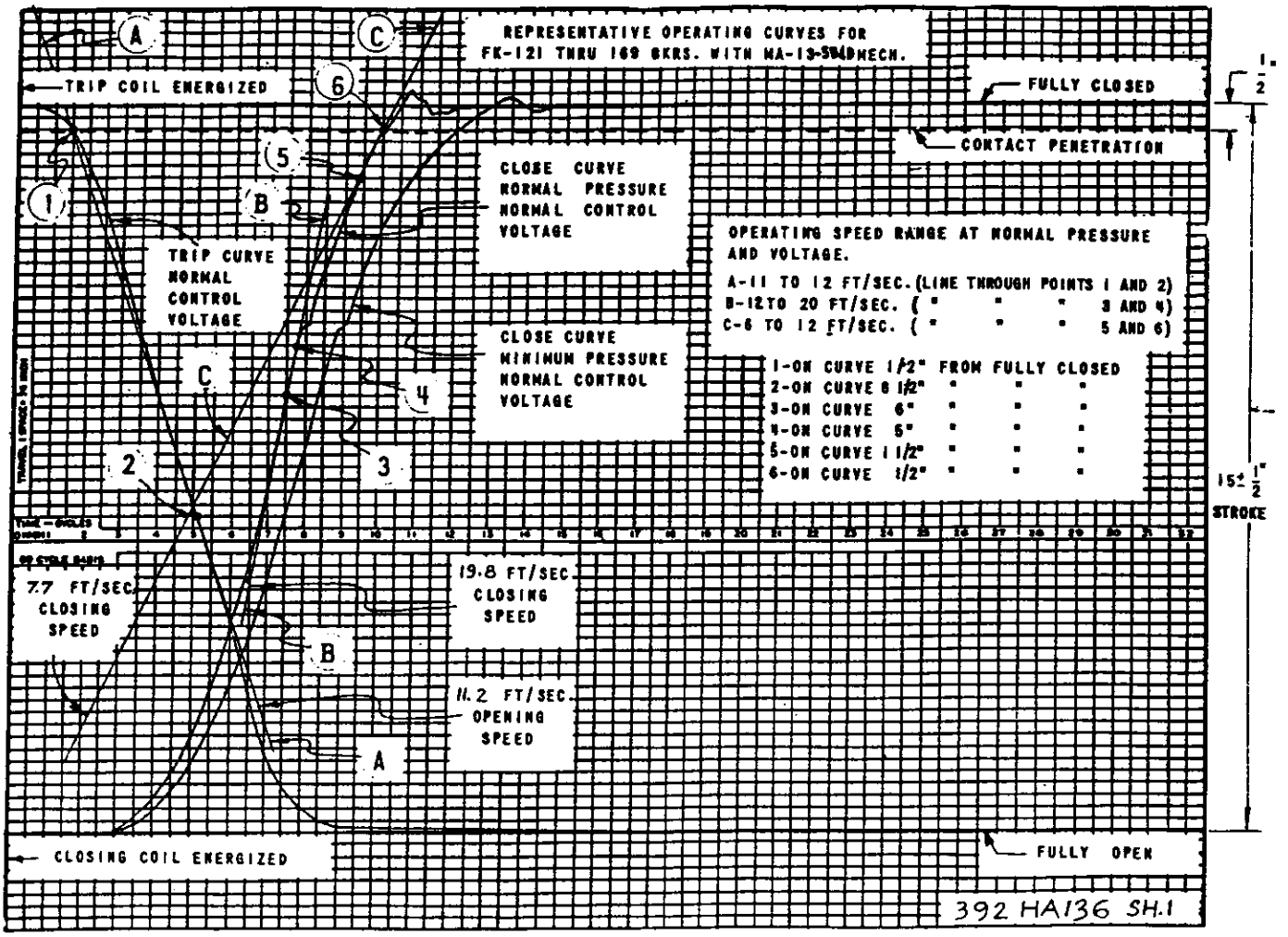


Fig. 14. Representative No-load Travel Curves of Opening and Closing Operations with an MA13-5B or MA13-5D Pneumatic Operating Mechanism on the Breaker and with the Breaker Contacts Immersed in No 10-C Oil

18, increasing the spring load on the pneumatic operator. As in the case of manual adjustments, the clamping bolts on the coupling and straddle links must be retightened before the breaker is again closed.

In the case of breakers shipped completely assembled reference should be made to the instruction book. The front crank setting should be held to its normal ± 1/16 inch tolerance.

At this point attach a travel analyzer with the bracket furnished (see Fig. 13) to the breaker to obtain an accurate travel record of breaker performance. Typical curves are obtained on the center pole as this phase gives an average of the three phases. A 10-32 tapped hole is located in the top of the lift rod coupling (57), Fig. 1, of each pole unit to accommodate the rod used with the travel analyzer. Access to this hole is gained by the removal of the breather (35). Owing to the high speeds encountered, a straight-line type of travel analyzer is recommended.

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 (Figs. 14 and 15) 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. When no-load trip-free operations are taken on the breaker the trip portion of the curve should be initiated through the breaker main contacts as this more closely simulates an actual trip-free breaker operation where the breaker is closed against a fault.

Opening Speed

The opening speed is determined by

Fig. 15 (392HA136 Sh. 2 Rev. 1)

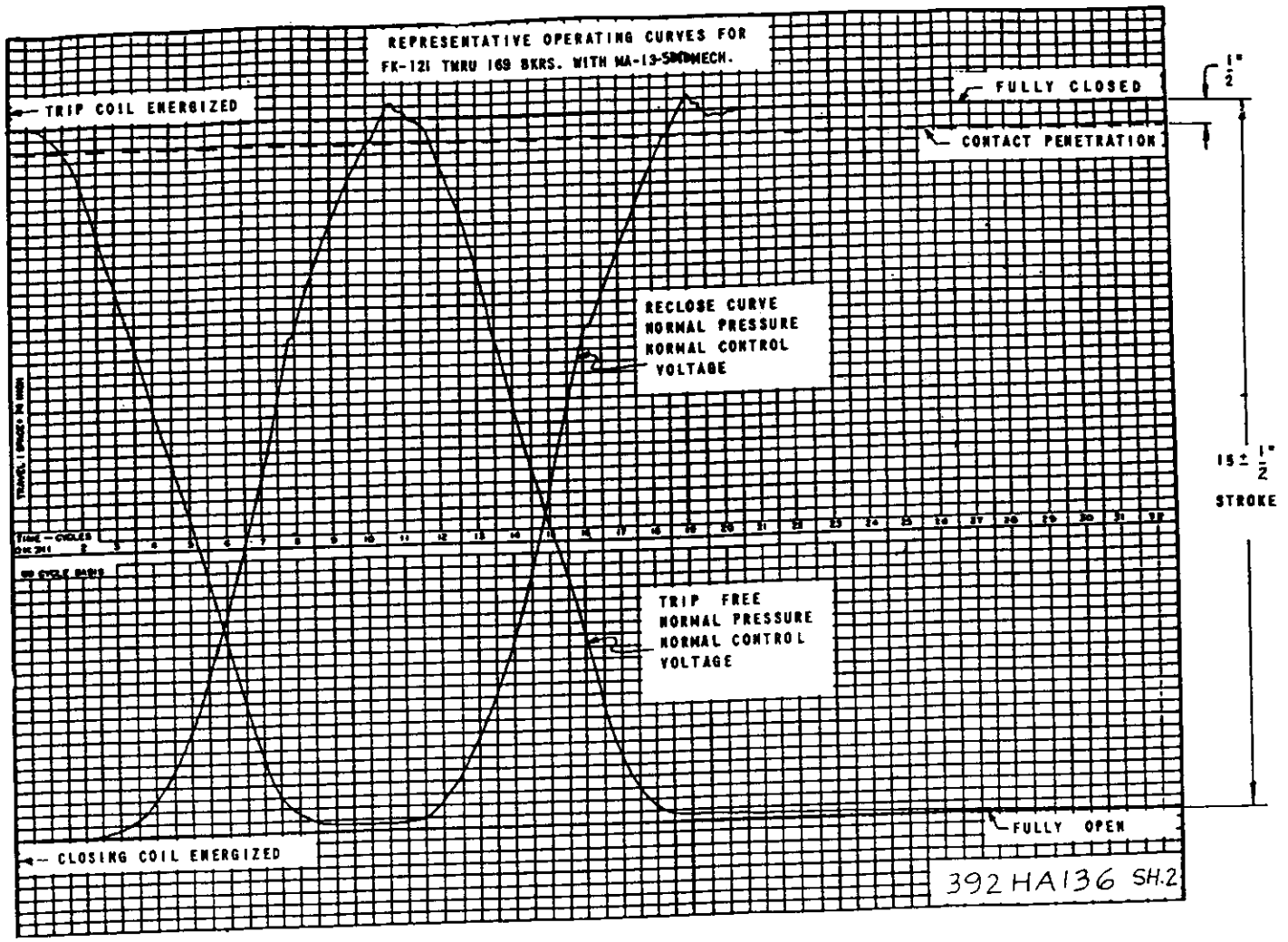


Fig. 15. Representative No-load Travel Curves for Reclosing and Trip-free Operations with an MA13-5B or MA13-5D Pneumatic Operating Mechanism on the Breaker and with the Breaker Contacts Immersed in No. 10-C Oil

drawing a straight line through two points on the travel curve. Refer to Fig. 14. One point is to be located on the opening curve 1/2 inch from the fully-closed position. This is the point at which the contacts part. The second point is to be located on the opening curve 8-1/2 inches (measured vertically) from the fully-closed position. The slope of this line is an indication of the opening speed which should be 11-1/2 ± 1/2 feet-per-second with the breaker contacts in oil. 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.

3) Draw a straight line between the proper points as shown on the representative travel curves, Figs. 14 and 15, which is the slope of the curve.

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 settings on the opening spring (21), Fig. 1. 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 lift rod setting. Readjust as necessary.

Closing Speed

The average closing speed can be determined in a similar manner. From a point

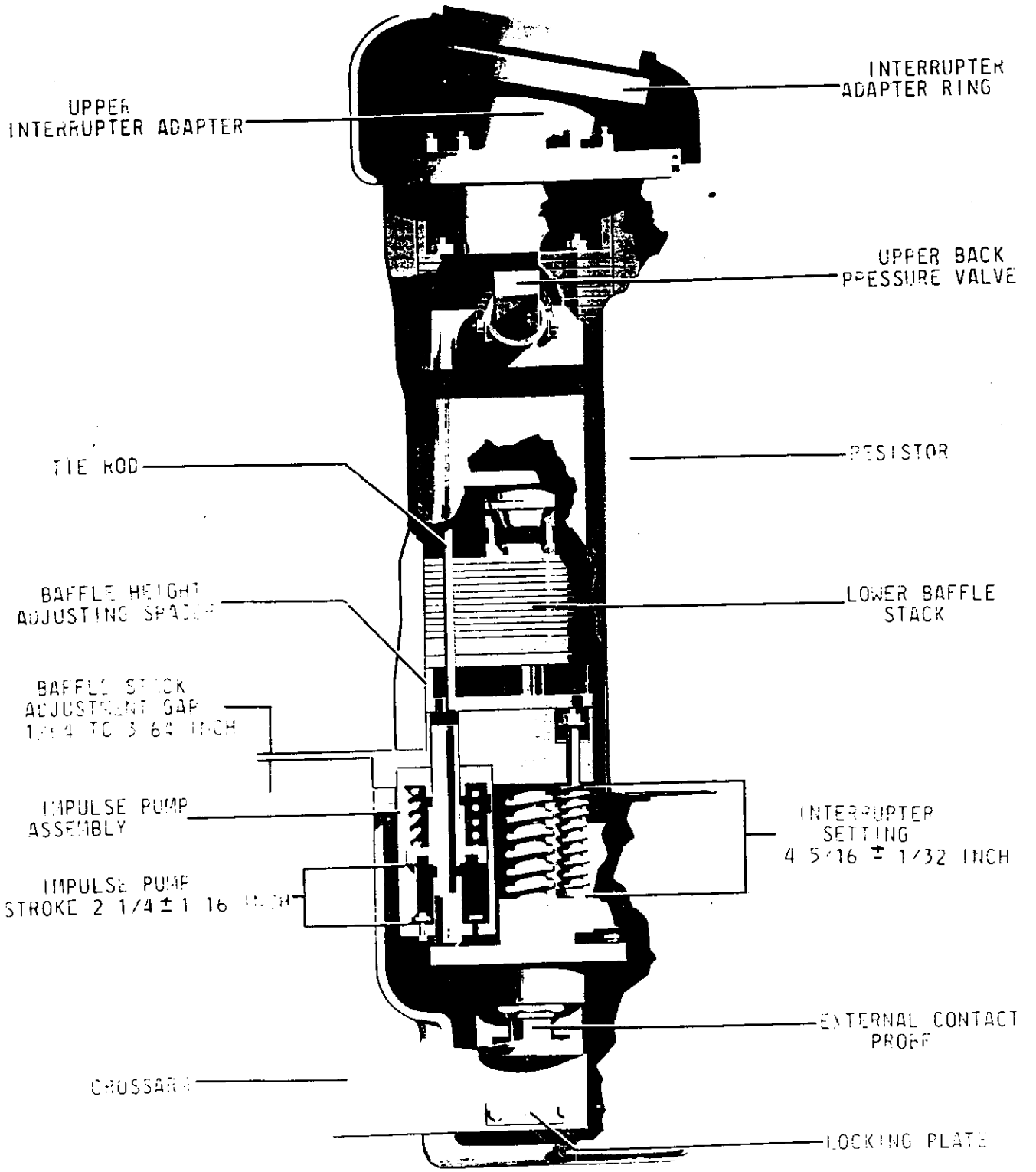


Fig. 16. Cutaway Front View of the Interrupter of a Nominal 10,000 mva Breaker

Fig. 17 (8040079 Rev. 1)

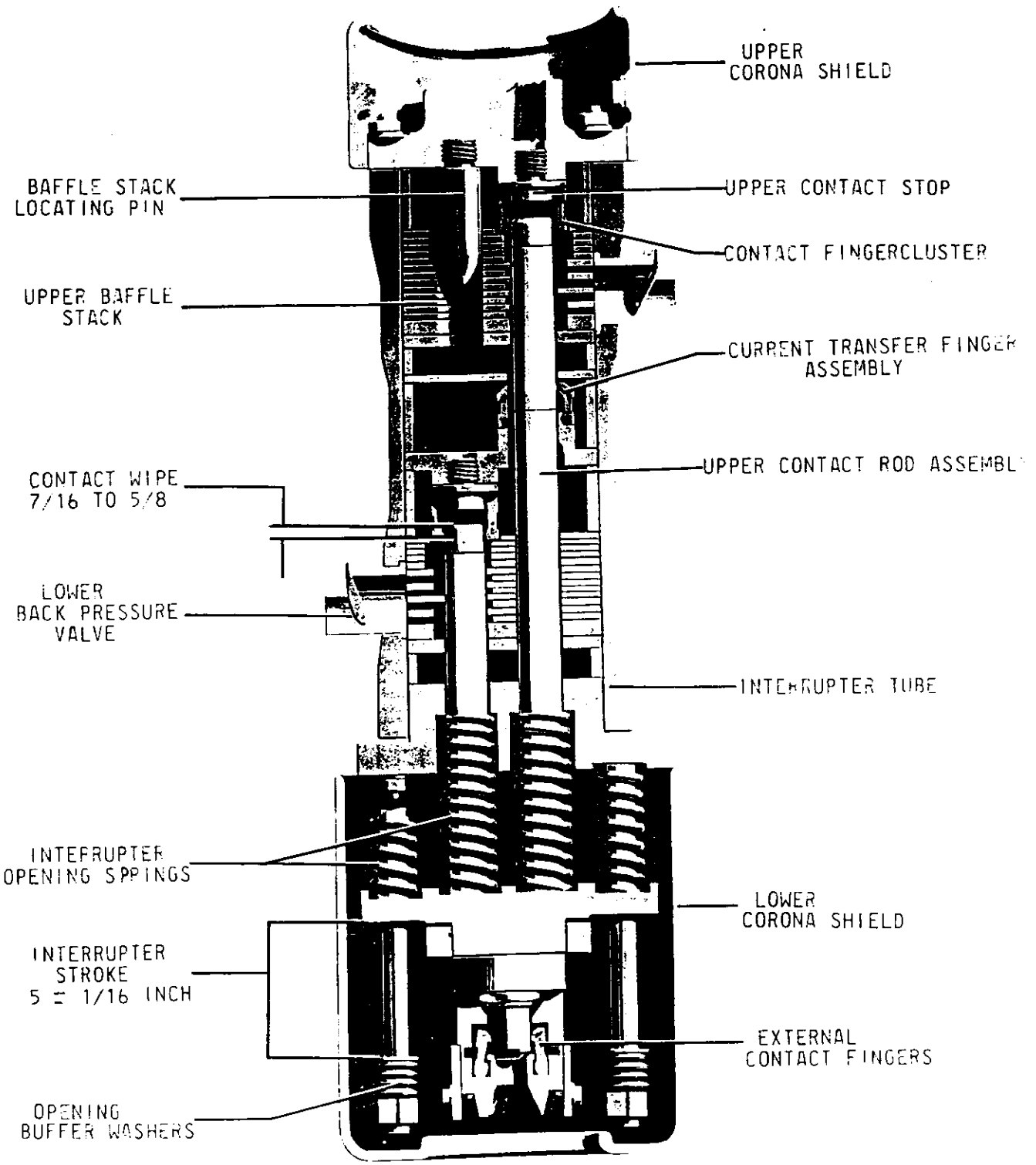


Fig. 17. Cutaway Side View of the Interrupter of a Nominal 10,000 mva Breaker

5-1/4 inches from fully closed to a point 4-1/4 inches from closed, the average speed should be between 6 and 20 feet-per-second. From a point 1-1/2 inches from fully closed to a point 1/2 inch from fully closed, the average speed should be from 6 to 12 feet-per-second. The closing speed is mainly controlled by the pneumatic operating mechanism and to some minor extent by the opening spring of the breaker. All three phases of the breaker must close and open within 180 degrees of each other and within 60 degrees in any one phase. The orifice nut on the piston rod of the closing cylinder of the operating mechanism has the largest effect on the closing speed which is not adjustable. A somewhat smaller but adjustable effect on the closing speed and closing time is the orifice adjusting screw as described in the operating mechanism instruction book. Screwing this orifice adjusting screw in all the way will slow the breaker closing speed and time. The orifice adjusting screw is effective for approximately ½ inch from the seated position and can vary the closing time approximately 1-½ cycles. For additional information, consult the instruction book for the operating mechanism paying particular attention to the section on INSTALLATION ADJUSTMENTS.

Lift Rod Overtravel

The overtravel of the lift rod must not exceed 1/2 inch when closing the breaker. The analyzer pencil always indicates more overtravel than there actually is due to clearances of the pencil support. The best way to accurately measure this is to place some putty about 5/8 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 1/2 inch, check the trip speed. If the trip speed is on the low side of the allowable range tighten the opening spring (21), Fig. 1, which will raise the opening speed, lower the closing speed and lower the overtravel. The interrupters also have a built-in stop which is

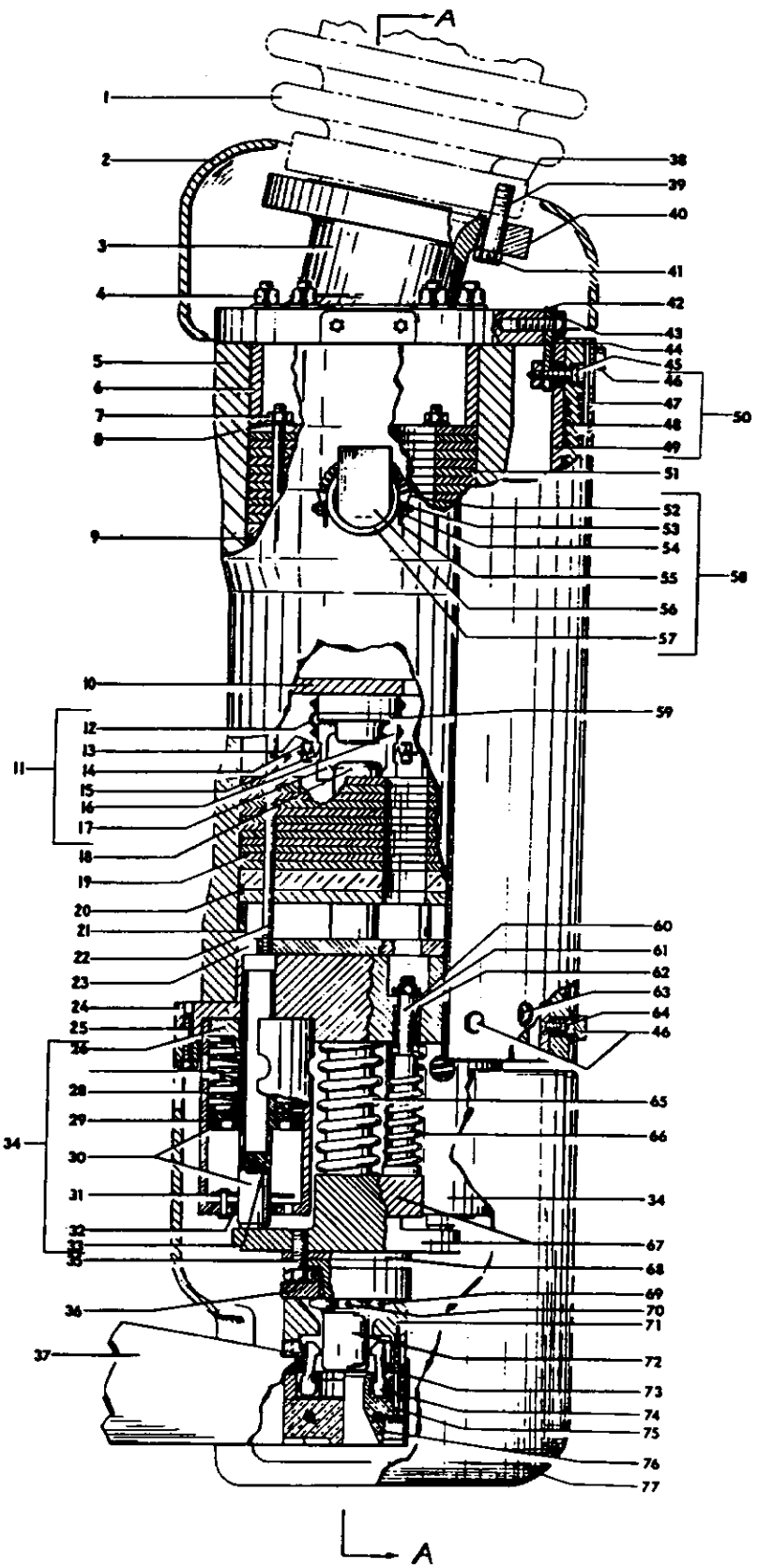


Fig. 18 Rear View of Interrupter – FK 121/145/169 Nominal 10,000 mva

the shoulder of the buffer guide rod (61), Figs. 18 and 20. This will also limit the overtravel.

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.

After satisfactory curves have been obtained, lock the final adjustments in position. Assemble all gaskets, covers and fittings and tighten properly.

Summary of Adjustments and Checks

Refer to Fig. 12 for the physical location.

1. The lift rods 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.

2. The interrupters should be within 1/8 inch of plumb over their length and their contacts in line with those on the crossarm.

3. With the breaker closed the front crank setting should be 2-3/8 inches, plus or minus 1/16 inch.

4. The lift rod setting should be 1-13/16 inches plus or minus 1/32 inch for preliminary manual adjustment as initially set up. Settings by power should be held to within plus 1/32 inch, minus 0 of the manual adjustment.

5. With the breaker fully closed check the interrupter setting. This should be 4-5/16 inches ± 1/32 inch or an aggregate of 8-5/8 inches ± 1/16 inch with the two interrupters in any phase within 3/32 inch of each other with 1-13/16 inches lift rod setting.

The buffer springs (66), Figs. 18 and 20, for the 10000 MVA breaker are nominally not compressed with the interrupter fully closed but are compressed to approximately 3/4 inch for the 15000 MVA breaker.

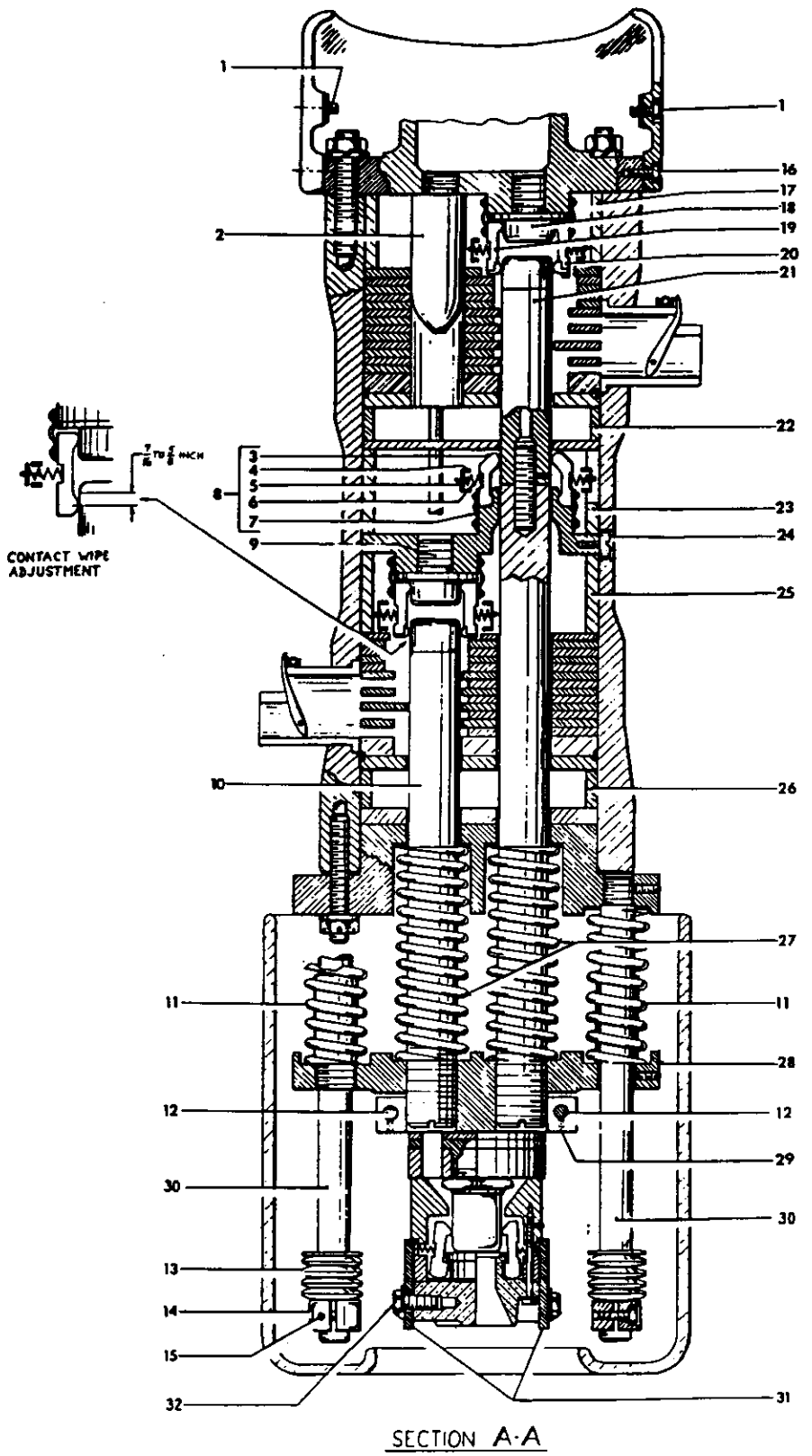
6. The amount of shims under the external probe of the interrupter should be a minimum of 0.030 inch to a maximum of 0.500 inch.

7. The lift rod stroke should be 15 inches, plus or minus 1/2 inch.

8. The nominal opening spring compressed length is 10 inches for both the 10,000 mva and the 15,000 mva opening spring. The minimum compressed length of the opening spring is 9-1/2 inches.

1. Bushing
2. Upper Corona Shield
3. Upper Adapter
4. Interrupter Nut
5. Interrupter Tube
6. Top Spacer
7. Baffle Stack Nut
8. Baffle Stack Washer
9. Upper Baffle Seal
10. Finger Support Plate
11. Contact Finger Assembly - Complete (Finger Cluster)
12. Flexible Connector-Current Carrying
13. Contact Spring Cage
14. Contact Spring Retainer
15. Contact Spring
16. Contact Finger
17. Arcing Tip Contact Finger
18. Lower Contact Rod
19. Lower Baffle Stack
20. Lower Baffle Seal
21. Lower Height Adjusting Spacer
22. Baffle Stack Tie Rod
23. Baffle Stack Lower Plate
24. Lower Adapter Plate
25. Lower Corona Shield Screw
26. Impulse Pump Top Plate with Bushing
27. Impulse Pump Springs (3)
28. Impulse Pump Cylinder
29. Impulse Pump Piston Ring
30. Impulse Pump Piston Rod and Piston
31. Impulse Pump Check Valve
32. Impulse Pump Cylinder Bushing
33. Impulse Pump Oil Port
34. Impulse Pump
35. External Probe Mounting Bolt
36. External Probe Buffer Plate
37. Crossarm
38. Bushing Adapter Ring
39. Adapter Ring Mounting Bolt
40. Interrupter Adapter Ring
41. Safety Wire
42. Resistor Support Locking Plate
43. Resistor Support Plate Mounting Bolt
44. Resistor Support Plate
45. Upper Resistor Contact Bolt
46. Insulated Resistor Nut
47. Resistor Cover
48. Resistor Board and Resistor
49. Resistor Back Board
50. Resistor Complete
51. Upper Baffle Stack
52. Back Pressure Valve Flipper Spring
53. Back Pressure Valve Flipper Pivot Stud
54. Back Pressure Valve Flipper Pivot Nut
55. Back Pressure Valve Flipper Crank
56. Back Pressure Valve Flipper
57. Back Pressure Valve Exhaust Tube
58. Back Pressure Valve Complete
59. Lower Contact Stop
60. Buffer Stop Washer
61. Buffer Guide Rod
62. Buffer Guide Rod Bushing
63. Lower Resistor Contact Bolt
64. Resistor Tie Bolt
65. Interrupter Opening Spring
66. Buffer Spring
67. Contact Mounting Plate
68. Adjustment Shims
69. Buffer Plate Support Nut
70. Buffer Plate Support Nut Set Screw
71. Guide Socket For External Probe
72. External Probe
73. Contact Spring
74. External Contact Finger
75. External Contact Assembly Clamping Bolt
76. External Contact Lower Housing
77. Lower Corona Shield

Items for Fig. 18



1. Upper Corona Shield Clamp
2. Baffle Stack Locating Pin
3. Transfer Finger
4. Transfer Finger Spring Cage
5. Transfer Finger Spring Retainer
6. Transfer Finger Spring
7. Flexible Connector
8. Transfer Finger Assembly Complete
9. Lower Contact Stop
10. Lower Contact Rod
11. Guide Opening Spring
12. Contact Rod Clamping Bolt
13. Shock Absorbing Spring Washers
14. Spring Washer Retainer Nut
15. Set Screw
16. Upper Corona Shield Mounting Bolt
17. Baffle Stack Clamping Spacer
18. Upper Contact Stop
19. Contact Finger
20. Arcing Tip Contact Finger
21. Upper Contact Rod
22. Upper Baffle Stack Spacer
23. Intermediate Baffle Stack Spacer
24. Baffle Stack Retaining Screw
25. Lower Baffle Stack Spacer
26. Lower Baffle Stack Adjusting Spacer
27. Opening Springs
28. Contact Rod Mounting Plate
29. Contact Rod Set Screw
30. Contact Rod Mounting Plate Guide Rod
31. Crossarm
32. Crossarm Contact Clamping Bolts

Fig. 19. Side View of Interrupter – FK 121/145/169 – Nominal 10,000 mva

Compressing the spring to a value less than 9-1/2 inches might permit the spring to go solid on overtravel possibly damaging the breaker.

The free length of the 10,000 mva spring is 13-9/16 inches ± 3/8 inch. The free length of the 15,000 mva spring is 14-1/2 inches ± 1/2 inch.

9. The contact wipe of the upper and lower contact break is 7/16 inch to 5/8 inch.

10. The interrupter stroke is 5 inches ± 0.040 inch. This is adjusted by the use of the spring washers (13), Figs. 19 and 21, and shims. The spring washer retaining nut (14), Figs. 19 and 21, must be up against the shoulder on the contact rod mounting plate guide rod (30), Figs. 19 and 21.

11. With the interrupters open, check the resistance of the grading resistors. These should check to 1350 ohms, plus or minus 5 percent per interrupter in any one phase but can be 1350 ohms, plus 5 percent minus 10 percent for the 121, 145 and 169kV breakers. The resistance of the 169kV breaker resistors until recently checked to 1620 ± 5 percent per interrupter in any one phase but could have been 1620 +5 percent −10 percent for the entire 169kV breaker.

12. 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.

13. Check the tightness of the clamping bolt(s) of the couplings to 80/90 foot-pounds torque. If a torque wrench is not available, tighten the bolt(s) so that with the breaker in the open position, a twelve-inch pipe wrench applied with moderate force cannot turn the operating rod. When this is done the clamping bolts are properly tightened.

Operations with the Tanks Filled with Oil

Operate the breaker electrically and check the following points:

a. Operating times - closing, opening, reclosing, and trip-free.

b. Contact opening speed - 11-1/2 plus or minus 1/2 feet-per-second measured at 1/2 inch to 8-1/2 inches from the breaker fully-closed position.

c. Contact closing speed - 12 to 18 feet-per-second measured at 5 to 6 inches from the breaker fully-closed position and 6 to 12 feet-per-second measured at 1/2 to 1-1/2 inches from the breaker fully-closed position.

d. The breaker opens completely on reclosing operations.

e. Lift rod overtravel on closing is 1/2 inch.

f. Rebound on closing is not more than 1/4 inch.

g. Rebound on opening is not ore than 5/8 inch.

FINAL INSPECTION

1. See that the breaker is properly set up and leveled on its foundation and that the foundation 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 should be checked to see that they are sufficiently tight to prevent leakage. In tightening the gland nuts, precautions should be taken to prevent damaging the packing through excessive pressure.

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 have been lubricated.

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

6. Make certain that the oil tanks are filled to the proper level.

7. Make certain that the installation adjustments and operating adjustments have been thoroughly checked and recorded in the space provided under the TABLE OF ADJUSTMENTS.

8. See that all covers and bolted connections are securely tightened and that all pipe plugs for inspection openings are properly installed, tightened and sealed 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 alkyd base paint with a suitable primer if necessary.

TABLE OF ADJUSTMENTS

For further 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
Breaker stroke	15 ± 1/2 inch			
Lift rod setting (Power)	1-13/16 + 1/32 - 0 inch			
Lift rod setting (Manual - Initial Setup)*	1-13/16 ± 1/32 inch			

TABLE OF ADJUSTMENTS (Continued)

For further 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
Front crank setting	2-3/8 ± 1/16 inch			
Contact wipe	7/16 to 5/8 inch			
Contact wipe setting (Manual – initial setup)**	9/16 to 5/8 inch			
Interrupter setting	4-5/16 ± 1/32 inch			
Interrupter setting (Manual – initial setup)**	4-5/16 ± 1/64 inch			
Part Contacts in any one phase of each other	1/16 inch maximum			
Part Contacts between phases	1/2 inch maximum			
Buffer guide rod over or under travel (10,000 mva breaker)	1/32 ± 1/32 inch			
Buffer guide rod over travel (15,000 mva breaker)	3/4 ± 1/32 inch			
Interrupter travel	5 ± 1/16 inch			
Interrupter travel (Manual – initial setup)**	5 ± 1/32 inch			
Reassembled baffle stack height (Lower exhaust port to baffle stack top) (See INTERRUPTER ASSEMBLY)	13-5/8 ± 1/16 inch			
Opening spring nominal compressed length	10 inches			
Opening spring minimum compressed length	9½ inches			
Opening spring free length (10,000 mva)	13-9/16 ± 3/8 inch			
Opening spring free length (15,000 mva)	14-½ ± 1/2 inch			
Interrupter shunting resistor (121, 145 and 169kV)	1,350 ohms ± 5 percent			
Interrupter shunting resistor (169kV older breakers)	1,620 ohms ± 5 percent			
Contact Resistance (using a 100-ampere ductor with 100 amperes flowing)				
New contacts - microhms	350			
Used contacts - microhms	525			
Opening speed (Feet-per-second) Stroke measured at 1/2 inch to 8½ inches from breaker fully-closed position	11 to 12			
Closing speed (Feet-per-second) Stroke measured at 5 to 6 inches from breaker fully-closed position	12 to 20			

TABLE OF ADJUSTMENTS (Continued)

For further 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
Closing Speed (Feet-per-second)				
Stroke measured at 1/2 to 1½ inches from breaker fully-closed position	6 to 12			
Reclosing time (Maximum)	20 cycles			
Trip to contact part time (Maximum-T_1 only)	1.7 cycles			
Trip to contact part time (Maximum-T_2 only)	2.0 cycles			
Closing time (Nominal)	14 cycles			
Interrupting time (Maximum-normal voltage)	3 cycles			
Overtravel (Maximum on closing)	1/2 inch			
Rebound (Maximum on closing)	1/4 inch			
Rebound (Maximum on opening)	5/8 inch			
Orifice size used in main control valve of mechanism				
10,000 mva breaker	1-3/8 inch			
15,000 mva breaker	None or 1-3/8 inches			
**Initial setup of the breaker after bushing installation, replacement or factory assembly.				

OPERATION

To close the breaker, the pneumatic operating mechanism moves the vertical operating rod (47), Fig. 1, in the mechanism house in a downward direction. This motion is transferred through the front crank (25), located in the crank housing on the front of the Phase One tank, to the horizontal connecting rods (29 and 11) and to the opening spring operating rod (14). This action operates the linkage on all three pole units which, in turn, transfers the motion of the vertical lift rods (56) in each of the breaker tanks.

On opening, the lift rods and the crossarms are gradually decelerated by the dashpots (58) which the striking boss of each lever contacts a few inches before the fully-open position. This action eliminates the possibility of a large rebound at the end of the opening stroke.

When opening the breaker slowly with the jack, the opening spring (21), Fig. 1, supplies sufficient force to release the finger cluster assembly (19), Fig. 9, on the crossarm from the external probe (72), Figs. 18 and 20, on the interrupter.

On a fault operation the contacts part drawing two simultaneous arcs each within its own baffle assembly. Pressure generated by the arc causes oil to flow into the arc and through the pathways formed by the baffle assembly to the back pressure valves in the interrupter tube. Gas and arc products are thus ejected from the interrupter tube and clean oil is forced into the arc. The dielectric strength between contacts is thus built up more rapidly than the recovery voltage so that the arc is unable to restrike after passing through current zero, and the fault is cleared.

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 in an early stage. A periodic lubrication of parts subject to wear is also vitally important for the successful operation of the breaker and operating mechanism.

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.

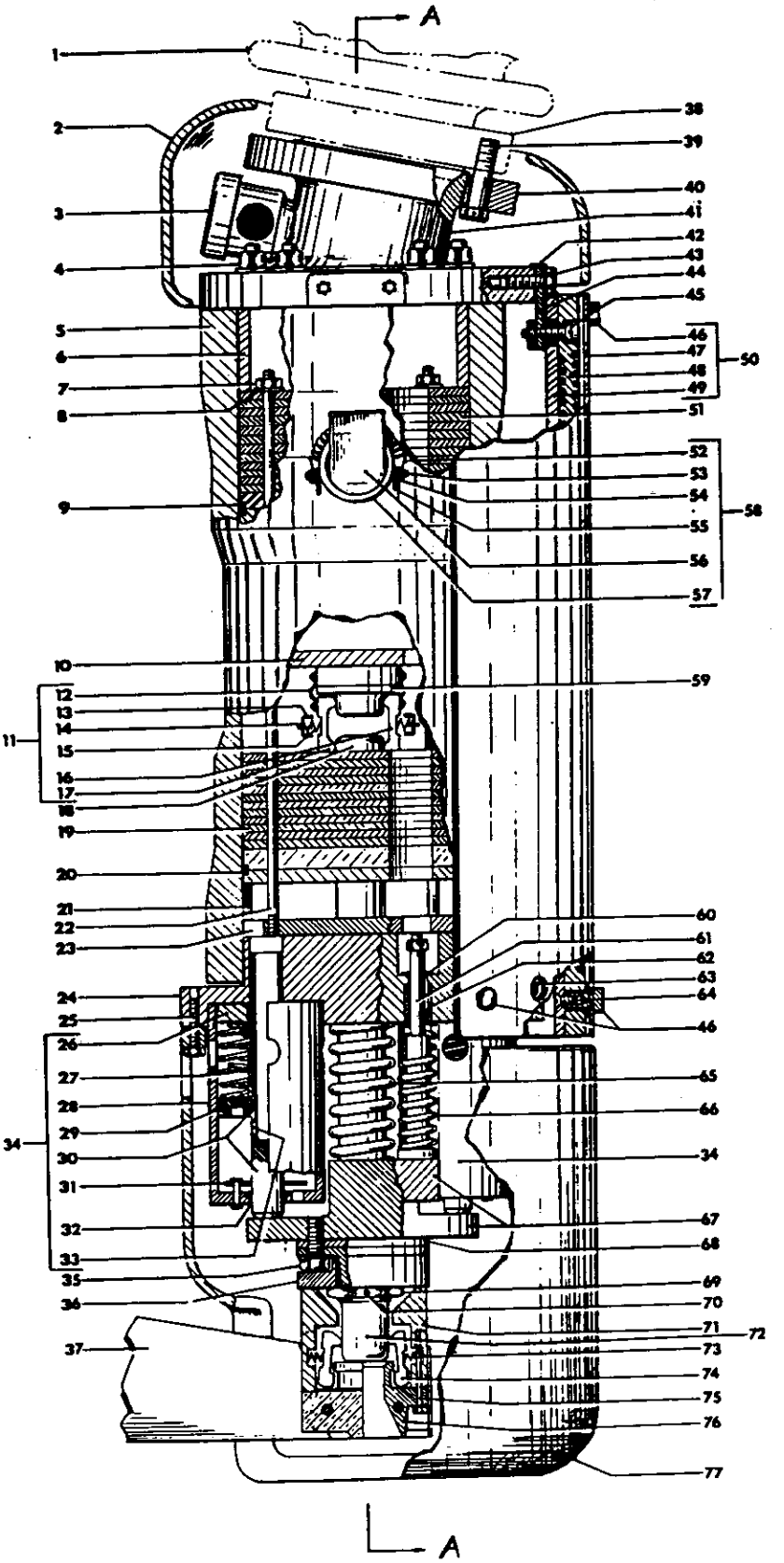


Fig. 20. Rear View of Interrupter FK-121/145 Nominal 15,000 mva

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 not 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 and frame tanks are well grounded.

4. Use the maintenance closing device on pneumatic mechanisms to assist in making adjustments. This is the primary purpose of the device because it permits slow closing and opening. IT SHOULD NOT BE USED FOR CLOSING THE BREAKER ON LOAD.

5. It is advisable to drain the air receiver before working on the pneumatic operator or the breaker.

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

7. Use only an alkyd paint for the exterior of the breakers and mechanism house for touch up or repainting.

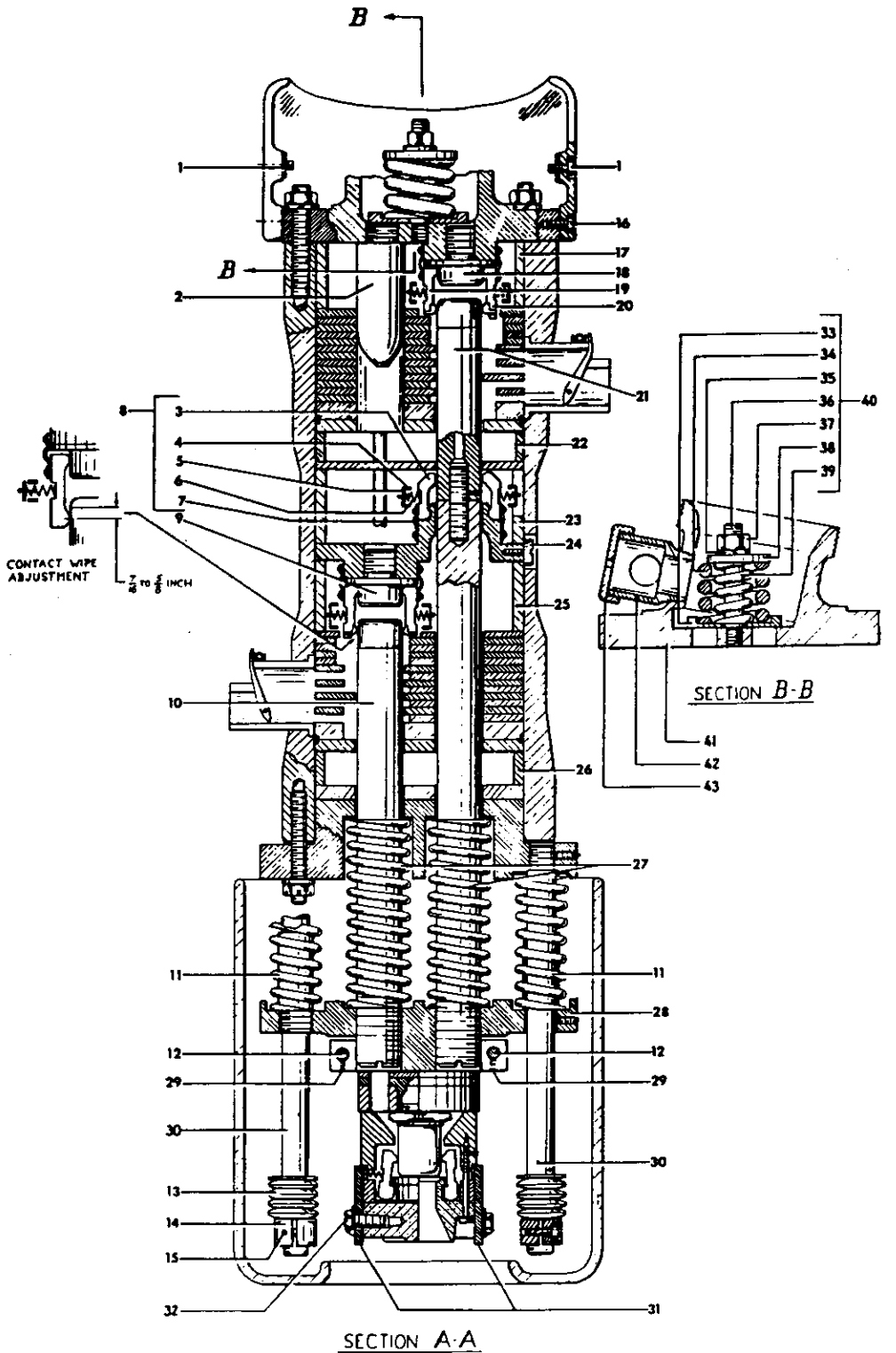
PERIODIC INSPECTION

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

1. Bushing
2. Upper Corona Shield
3. Safety Relief Valve Exhaust Chamber
4. Interrupter Nut
5. Interrupter Tube
6. Top Spacer
7. Baffle Stack Nut
8. Baffle Stack Washer
9. Upper Baffle Seal
10. Finger Support Plate
11. Contact Finger Assembly Complete (Finger Cluster)
12. Flexible Connector-Current Carrying
13. Contact Spring Cage
14. Contact Spring Retainer
15. Contact Spring
16. Contact Finger
17. Arcing Tip Contact Finger
18. Lower Contact Rod
19. Lower Baffle Stack
20. Lower Baffle Seal
21. Lower Height Adjusting Spacer
22. Baffle Stack Tie Rod
23. Baffle Stack Lower Plate
24. Lower Adapter Plate
25. Lower Corona Shield Screw
26. Impulse Pump Top Plate With Bushing
27. Impulse Pump Springs (3)
28. Impulse Cylinder
29. Impulse Piston Ring
30. Impulse Pump Piston Rod and Piston
31. Impulse Pump Check Valve
32. Impulse Pump Cylinder Bushing
33. Impulse Pump Oil Port
34. Impulse Pump
35. External Probe Mounting Bolt
36. External Probe Buffer Plate
37. Crossarm
38. Bushing Adapter Ring
39. Adapter Ring Mounting Bolt
40. Interrupter Adapter Ring
41. Upper Adapter
42. Resistor Support Locking Plate
43. Resistor Support Plate Mounting Bolt
44. Resistor Support Plate
45. Upper Resistor Contact Bolt
46. Insulated Resistor Nut
47. Resistor Cover
48. Resistor Board and Resistor
49. Resistor Back Board
50. Resistor Complete
51. Upper Baffle Stack
52. Back Pressure Valve Flipper Spring
53. Back Pressure Valve Flipper Pivot Stud
54. Back Pressure Valve Flipper Pivot Nut
55. Back Pressure Valve Flipper Crank
56. Back Pressure Valve Flipper
57. Back Pressure Valve Exhaust Tube
58. Back Pressure Valve Complete
59. Lower Contact Stop
60. Buffer Stop Washer
61. Buffer Guide Rod
62. Buffer Guide Rod Bushing
63. Lower Resistor Contact Bolt
64. Resistor Tie Bolt
65. Interrupter Opening Spring
66. Buffer Spring
67. Contact Mounting Plate
68. Adjustment Shims
69. Buffer Plate Support Nut
70. Buffer Plate Support Nut Set Screw
71. Guide Socket For External Probe
72. External Probe
73. Contact Spring
74. External Contact Finger
75. External Contact Assembly Clamping Bolt
76. External Contact Lower Housing
77. Lower Corona Shield

Items for Fig. 20



1. Upper Corona Shield Clamp
2. Baffle Stack Locating Pin
3. Transfer Finger
4. Transfer Finger Spring Cage
5. Transfer Finger Spring Retainer
6. Transfer Finger Spring
7. Flexible Connector
8. Transfer Finger Assembly Complete
9. Lower Contact Stop
10. Lower Contact Rod
11. Guide Opening Spring
12. Contact Rod Clamping Bolt
13. Shock Absorbing Spring Washers
14. Spring Washer Retainer Nut
15. Set Screw
16. Upper Corona Shield Mounting Bolt
17. Baffle Stack Clamping Spacer
18. Upper Contact Stop
19. Contact Finger
20. Arcing Tip Contact Finger
21. Upper Contact Rod
22. Upper Baffle Stack Spacer
23. Intermediate Baffle Stack Spacer
24. Baffle Stack Retaining Screw
25. Lower Baffle Stack Spacer
26. Lower Baffle Stack Adjusting Spacer
27. Opening Springs
28. Contact Rod Mounting Plate
29. Contact Rod Set Screw
30. Contact Rod Mounting Plate Guide Rod
31. Crossarm
32. Crossarm Contact Clamping Bolts
33. Safety Spring Lower Retaining Plate
34. Outer Spring
35. Washer
36. Stud
37. Lock Nut
38. Safety Spring Upper Retaining Plate
39. Inner Spring
40. Safety Relief Valve Complete
41. Upper Interrupter Adapter
42. Safety Relief Valve Exhaust Cylinder
43. Safety Relief Valve Exhaust Cap

Fig. 21. Side View of Interrupter FK-121/145 Nominal 15,000 mva

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.

Fig. 22 (8040832)

Fig. 23 (8040829)

The baffle stack must be replaced when the contact hole through the baffle plate just above the top exhaust port in the baffle stack is 1/4 inch in diameter larger than the diameter of the contact rod as measured 90 degrees from the center of the arcing tip on the finger. See Fig. 32A. This baffle stack plate hole is 1-5/8 inch ± 1/64 inch in diameter when the baffle stack is new.

The *Elkonite tip of the contact rods can be machined to remove the eroded portion of the tip but the contact rod after machining must meet the following conditions. If either of these conditions is not met the contact rod must be discarded.

A. The contact fingers must not rest on the copper portion of the contact rod when the breaker is closed; they must be safely on the *Elkonite portion of the rod.

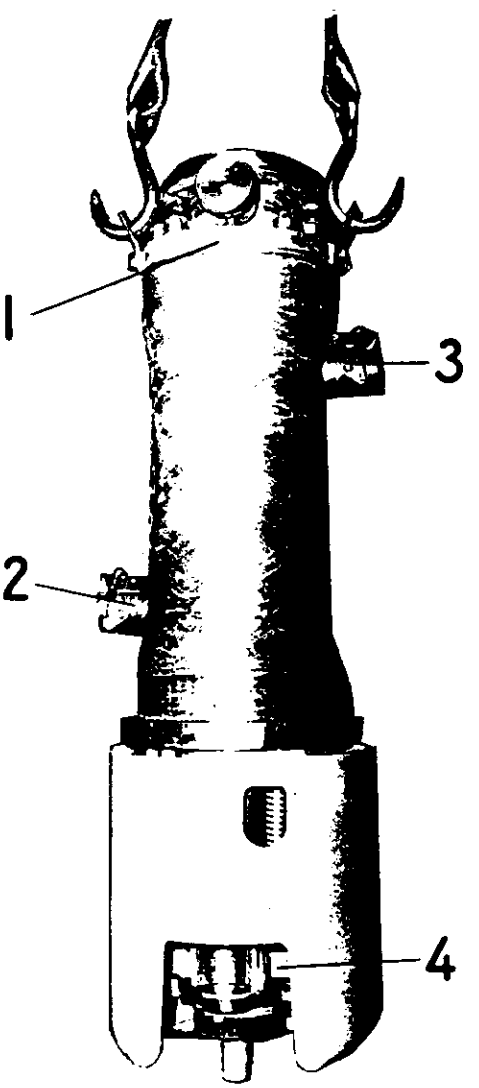
B. The lower end of the threaded portion of the contact rod must be below the clamping bolt (12), Figs. 19 and 21, on the contact rod mounting plate (28), Figs. 19 and 21.

The arcing tip finger must be replaced when the 1/4 inch long (new) arcing tip has eroded until it is 1/8 inch long.

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

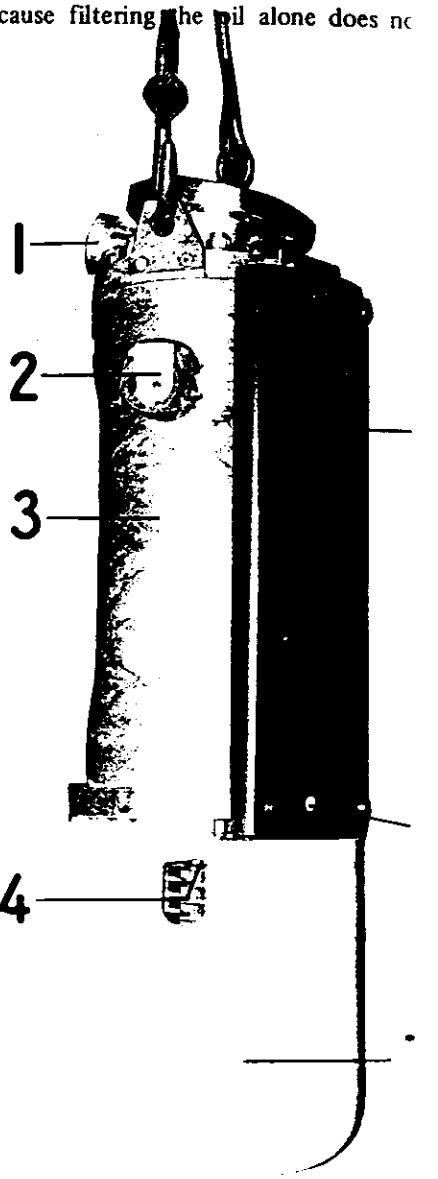
2. The quality of the oil should be checked. Oil in service should be tested at frequent intervals; three month periods are recommended.
If the dielectric strength of the oil tests less than 22,000 volts, it should be filtered. When sampling oil, the sample container should be a large-mouthed glass bottle. 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 G-E 10-C oil to remove all traces of carbon which may remain after the c has been drained from the tank. It recommended that the oil be remove and the tank cleaned at regular interva because filtering the oil alone does nc



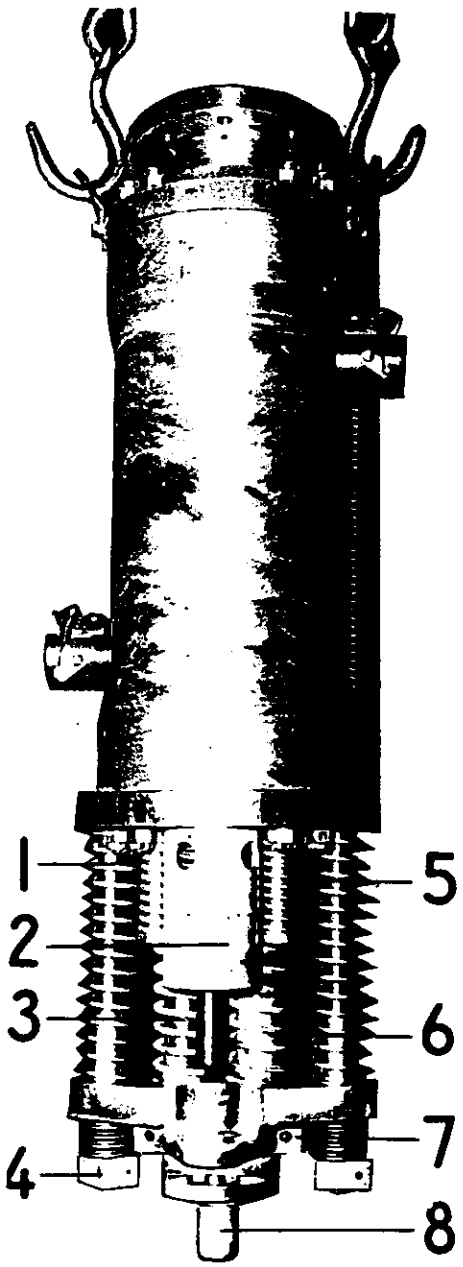
1. Upper Adapter
2. Lower Back Pressure Valve
3. Upper Back Pressure Valve
4. Contact Rod Mounting Plate

Fig. 22. Left View
of the Nominal 15,000 mva Interrupter with the Upper Corona Shield Removed



1. Safety Relief Valve Exhaust Chambe
2. Back Pressure Valve
3. Interrupter Tube
4. Lower Corona Shield Mounting Bolt
5. Resistor
6. Front Lower Resistor Mounting Screw
7. Lower Corona Shield

Fig. 23. Rear View
of the Nominal 15,000 mva Interrupter with the Upper Corona Shield Removed



1. Contact Rod Mounting Plate Guide Rod
2. Impulse Pump
3. Lower Contact Rod
4. Spring Washer Retaining Nut Clamping Bolt
5. Buffer Spring
6. Upper Contact Rod
7. Contact Rod Clamping Bolt
8. External Contact Probe

Fig. 24. Left View of the Nominal 10,000 mva Interrupter without the Corona Shields

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. Add a sufficient amount of clean G-E 10-C breaker oil, working the piston up and down approximately 1/4 inch to relieve air pockets, to bring the oil level even with the opening. Then remove the pipe plug, draining the oil to the correct level. An alternate method is to remove the breather and fill through the vertical pipe. Examine the dashpot pistons to see that they work freely so that the dashpots function properly and that there is no sludge present.

6. Check the alignment of the movable contacts on the crossarm with the interrupter external contacts. Vibration due to the operation of the breaker may cause the bushings to move slightly, resulting in misalignment of the contacts. Minor misalignment of the contacts is not detrimental to the operation of the breaker.

7. 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.

8. 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.

9. 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 (36), Fig. 9, 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.

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

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

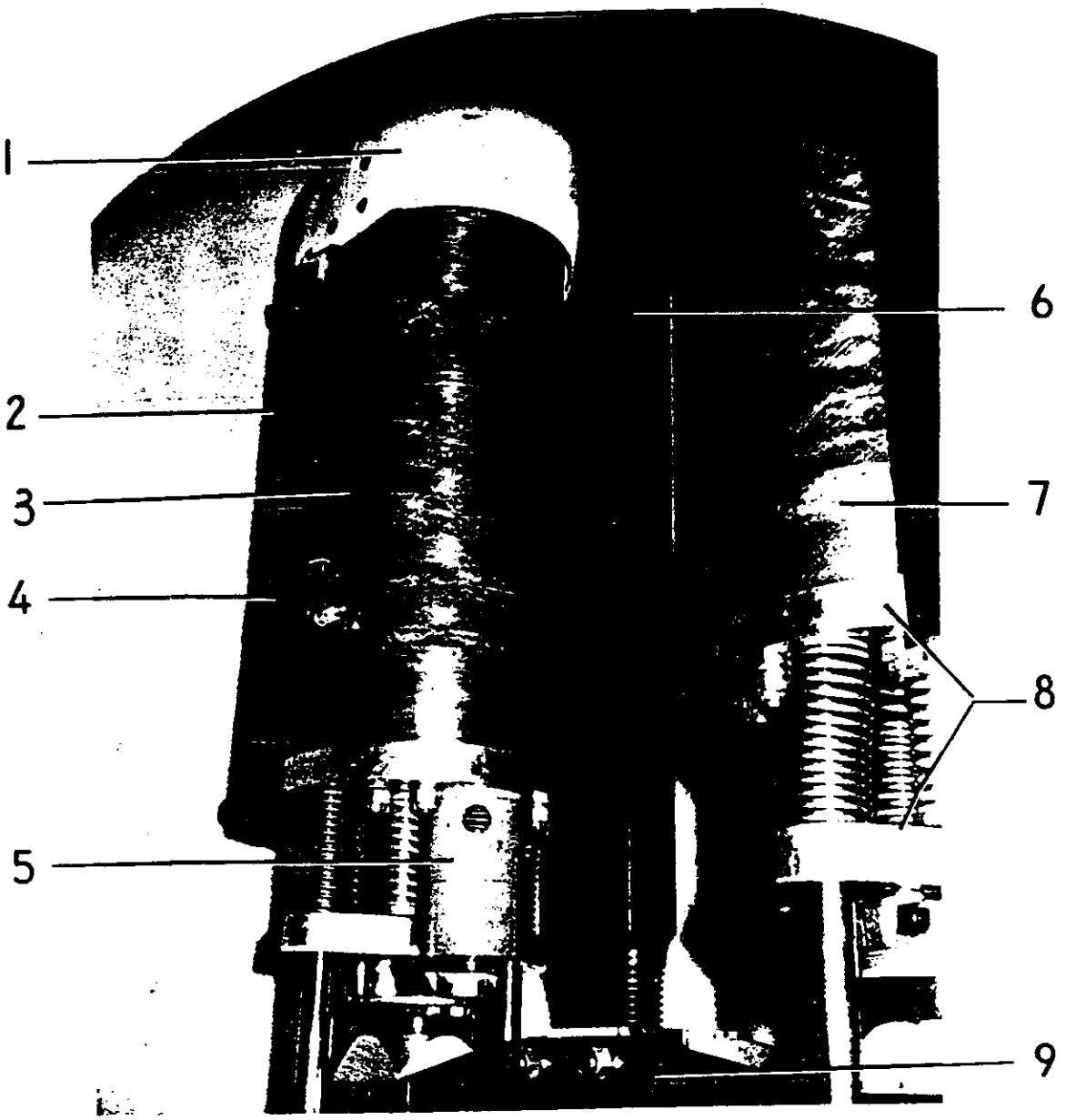
12. See that the oil is at the proper level in the tank and bushings.

13. Check the drain valve of the three oil tanks making certain they are closed and that the pipe plug is tight to prevent leakage of the G-E 10-C insulating oil.

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

Fig. 24 (8040831)

Fig. 25 (8040854)



1. Upper Corona Shield
2. Resistor
3. Baffle Stack Retaining Screw
4. Lower Back Pressure Valve
5. Impulse Pump
6. Lift Rod
7. Interrupter Tube
8. Lower Housing
9. Crossarm

Fig. 25. View Looking into the Breaker Manhole Showing the Nominal 10,000 mva Interrupter with the Lower Corona Shield Removed and the Breaker in the Fully-closed Position

REPAIR AND REPLACEMENT

The following precautions should be observed when any disassembly work is done on the interrupters or the breaker:

1. Be sure all locking set screws are removed before attempting to remove any bolts or nuts. Several locations have two locking set screws.

2. Spot all threaded pieces with the proper size drill before reassembling locking set screws.

3. Grease all types of clamping bolts before assembly to insure good clamping action.

4. Renew all cotter pins, snap rings, safety wire, and locking plates removed for maintenance or inspection for ease of assembly.

BREAKERS

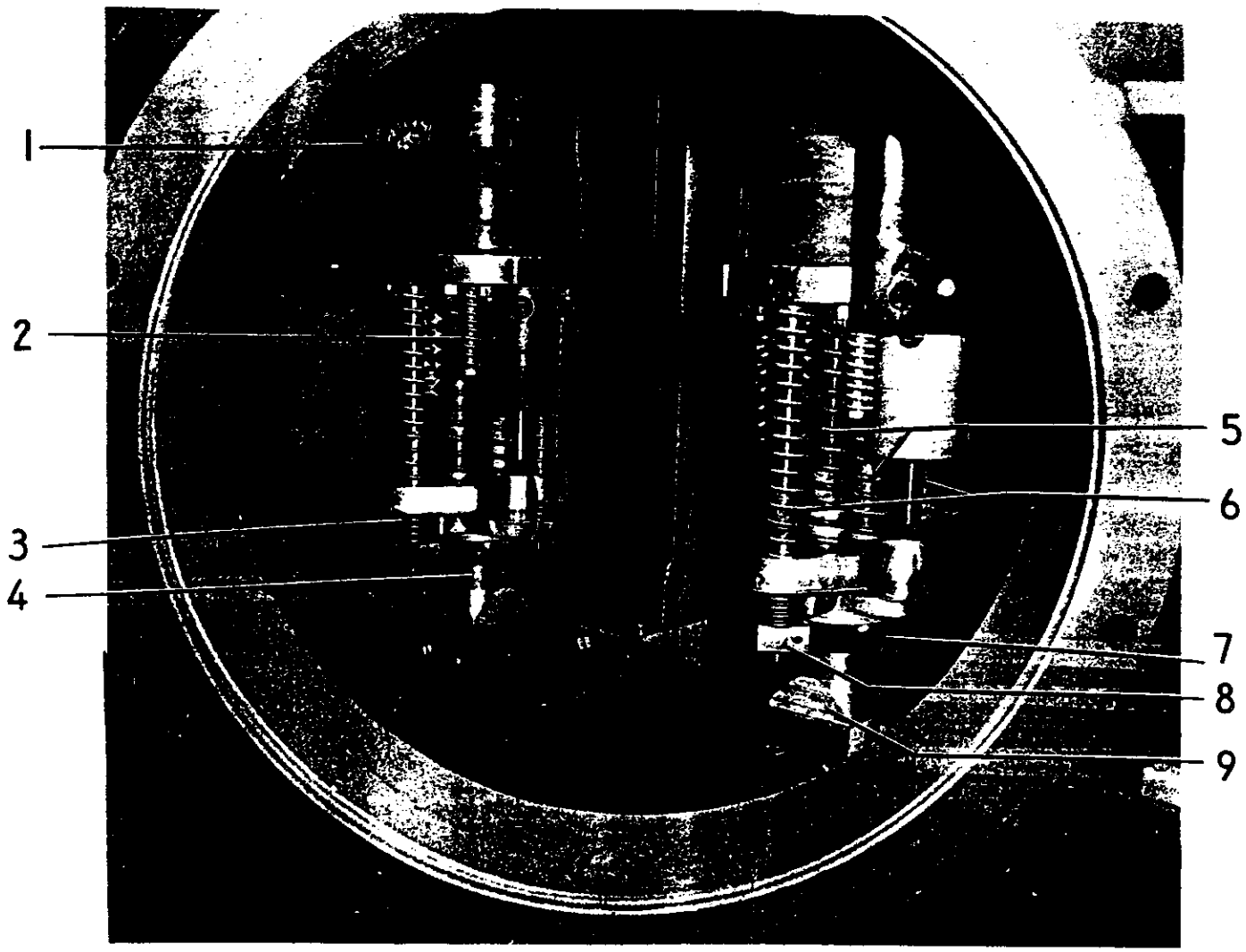
The difference between the FK-121-43000-4 and -5, the FK-121-43000-3 and -4, the FK-145-37000-6 and -7, the FK-169-31000-2 and -3 and the FK-145-37000-1 and -2 is basically just the supporting skid (13), Fig. 3. The earlier dash number breakers had a lighter skid which was sufficient for the 10,000 mva rating but insufficient for the 15,000 mva rating. The later dash numbe breakers have a 10,000 mva rating ski which at a later date can be modified b welding in some one inch thick gussett beneath the oil tanks if uprating th breaker to 15,000 mva is desired by th customer. The earlier dash numbe breakers cannot be uprated to 15,00 mva without replacing the entire support ing skid.

INTERRUPTERS

The following list shows the differences between the 10,000 mva interrupter and the 15,000 mva interrupter. Items which are not mentioned are identical.

Item	10,000 mva Interrupter	15,000 mva Interrupter
Contact Finger Assembly Complete (11), Figs. 18 and 20	Eight Contact Fingers 13/16 inch wide form ring of 1-½ inch diameter	Twelve Contact Fingers ½ inch wide form ring of 1-½ inch diameter
Upper Adapter (3), Fig. 18 and (41), Fig. 20	No opening to upper chamber; tapped for 8 contact fingers	Opening to upper chamber through safety relief valve (40), Fig. 21, contains exhaust opening, tapped for 12 contact fingers
Contact Rod (10 and 21), Figs. 19 and 21	Diameter - 1-½ inch; Wall thickness - ¼ inch	Diameter - 1-½ inch; Wall thickness - ½ inch
Transfer Finger Assembly Complete (8), Fig. 19 and 21	Fingers - 13/16 inch wide; two tapped holes for flexible lead; 1-½ inch diameter	Fingers - 11/16 inch wide; one tapped hole for flexible lead; 1-½ inch diameter
Finger Support Plate (10), Figs. 18 and 20	Tapped for 8 contact fingers	Tapped for 12 contact fingers
Safety Relief Valve and Exhaust (40 and 42), Fig. 21	None	One each per interrupter
Buffer Spring (66), Figs. 18 and 20	Higher spring gradient 4-¼ inches long (free length)	Lower spring gradient 4-11/16 inches long (free length)

Fig. 26 (8040727)



1. Lower Back Pressure Valve
2. Buffer Spring
3. Opening Shock Absorber Spring Washers
4. Interrupter External Contact Probe
5. Interrupter Opening Springs
6. Interrupter Guide Opening Springs
7. Buffer Plate
8. Spring Washer Retaining Nut
9. External Probe Contact Rod Guide Socket

Fig. 26. View Looking into the Breaker Manhole of the Nominal 10,000 mva Interrupters with the Breaker Partially Closed and the Lower Corona Shields Removed

Item	10,000 mva Interrupter	15,000 mva Interrupter
Buffer Guide Rod (61), Figs. 18 and 20	Overall Length - 6-½ inches	Overall length - 7-¼ inches
Breaker Skid (Earlier dash numbers)	No one-inch thick gussets under tanks	Two one-inch thick gussets under each tank.
(Later dash numbers)	No one-inch thick gussets under tanks but 1/2-inch thick gussets on inner side of each "I"-beam web (uprateable only).	Two one-inch thick gussets under each tank and 1/2-inch thick gussets on inner side of each "I"-beam web
Buffer Spring (See Note)	Nominally not compressed with interrupter fully closed	Nominally compressed 3/4 inch with interrupter fully closed
Bushing Adapter Ring (38), Figs. 18 and 20	Holes tapped through for bolts (39), Fig. 18	Holes not tapped through for bolts (39), Fig. 20
NOTE: The interrupter setting is 4 5/16 inches ± 1/32 inch for both the 10,000 mva interrupter and the 15,000 mva interrupter.		

Throughout the construction of the interrupter, many parts are spotted and locked by half-dog point set screws. Frequently cup point set screws are inserted, in addition, to lock these set screws. During disassembly of the interrupter make sure that both set screws are removed in these cases.

CONTACT ROD REMOVAL

The contact rods (10 and 21), Figs. 19 and 21, can be removed for inspection without removing the interrupter from the bushing and without disturbing the shunting resistor assembly. The lower shield (77), Figs. 18 and 20, is removed by disassembling the three screws (25), Figs. 18 and 20, visible through the openings in the shield. The contact rod mounting plate (28), Figs. 19 and 21, and the contact rods can be removed as an assembly, see Fig. 28, by removal of the spring washer retaining nut (14), Figs. 19 and 21, and the set screw (15), Figs. 19 and 21.

CAUTION: Care must be taken when removing the contact rod mounting plate so that the shock absorbing spring washers (13), Figs. 19 and 21, and the various spacing washers are not lost or mixed up. The contact rod mounting plate must be reassembled on the guide rods (30), Figs. 19 and 21, in the same manner as they were originally. The same parts must be reinstalled on the parts from which they were removed. This will make certain that the contact rod mounting plate rides up and down the guide rods without binding. Identifying the various parts before disassembly will make it easier and simpler to reassemble properly. Slide the contact mounting plate off the guide rods being careful not to loosen the various washers. The contact rods can now be examined for replacement if necessary.

CONTACT ROD REPLACEMENT

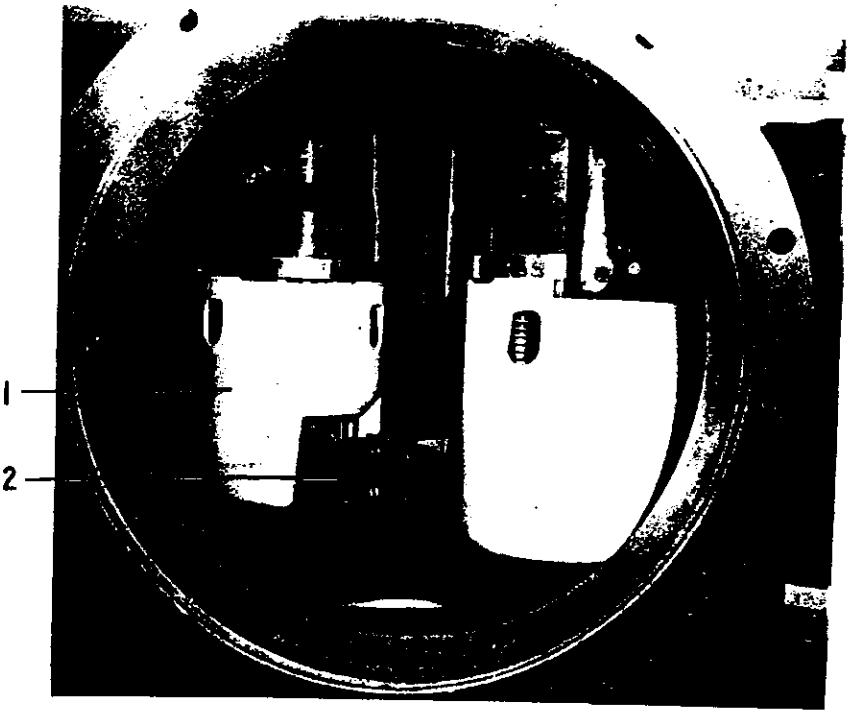
When replacing contacts, it will be necessary to adjust the contact rods in order to obtain the correct contact wipe. The baffle stack assembly, Figs. 31 and 32, and the lower adapter plate (10), Fig. 28, and impulse pump assembly (8), must be in place in the interrupter. Remove the opening springs (27), Figs. 19 and 21, and the guide opening springs (11), Figs. 19 and 21, from the contact rods and push this contact rod assembly up into the interrupter. By means of one wire of a continuity checker or an indicating light on the screw (24), Figs. 19 and 21, in the finger support plate (10), Figs. 18 and 20, and the other wire on the adapter (3), Fig. 18 and (41), Fig. 20, or on the contact rod mounting plate (67), Fig. 18, the upper or lower contact wipe may be determined.

A. The 10,000 mva interrupter is fully closed when the top of the contact rod mounting plate just touches the bottom of the buffer guide rod (61), Fig. 18.

B. The 15,000 mva interrupter is fully closed when the top of the contact rod mounting plate (67), Fig. 20, compresses the buffer spring (66), Fig. 20, 3/4 inch. In either the 10,000 mva interrupter or in the 15,000 mva interrupter the interrupter setting in "A" or "B" above is still the 4-5/16 inches ± 1/16 inch. When setting the wipe by turning the threaded rods in or out of the contact mounting plate it is advisable to hold 4-5/16 inch ± 1/64 inch and set the wipe at 9/16 to 5/8 inch. This will eliminate the possibility of having less than the 7/16 inch wipe after test operations.

Replace the opening springs (27), Figs. 19 and 21, and the guide opening springs (11). Replace the shock absorbing spring washers (13) and shims. Set the buffer dimension to 5 inches ± 0.040 inch. Complete the assembly of the interrupter.

Fig. 27 (8040725)



1. Lower Corona Shield
2. Crossarm

Fig. 27. View Looking into the Breaker Manhole of the Interrupters with the Breaker Closed

Tighten the clamping bolts (12), Figs. 19 and 21, in the contact rod mounting plate (28) to a torque of 50 foot-pounds.

If the burning of the rod tips is not excessive, further inspection of the stationary contacts is not necessary. If, however, the contact rods require replacement, it is then desirable to inspect the interrupter more fully.

CONTACT FINGER AND BAFFLE STACK

To disassemble the lower stationary contact finger cluster (11), Figs. 18 and 20, the current transfer finger assembly (8), Figs. 19 and 21, and baffle stacks (19 and 51), Figs. 18 and 20, remove the lower housing which contains the lower adapter plate (24), the impulse pump (34), the interrupter opening springs, etc. First remove the lower corona shield (77) by removing the safety wire from the three corona shield mounting bolts and then the screws (25). Next, remove the two resistor mounting bolts (63) and the eight nuts which support the lower housing, Fig. 28. Remove the lower housing.

Remove the baffle stack retaining screw (24), Figs. 19 and 21, which will permit the complete baffle stack assembly, Fig. 31, to drop out. This assembly weighs approximately 40 pounds; consequently, care must be exercised while removing it.

Further disassembly of the baffles and contacts is effected by removing the nuts (1), Fig. 31, at the top of the three tie rods (2), Fig. 32, that hold the assembly together. It is then a simple matter to replace the baffle stacks if required. The nuts have been fastened to the rods with G-E *Glyptal adhesive; consequently, care must be exercised while removing the nut; otherwise breakage of the tie rod will result. Upon reassembly, the baffle stack, Fig. 31, must have a height of 13-5/8 inches ± 1/16 inch as measured from the top of the baffle stack at the baffle stack nuts (1), to the top of the large lower exhaust slot in the exhaust port of the lower baffle (6). This is adjusted by the use of different lower baffle stacks (6), until the proper height of 13-5/8 inches ± 1/16 inch is obtained.

The baffle stack must be replaced when the contact hole through the baffle plate just above the top exhaust port in the baffle stack is 1/4 inch in diameter larger than the diameter of the contact rod as measured 90 degrees from the center of the arcing tip on the finger. See Fig. 32A. This baffle stack plate hole is 1-5/8 inch ± 1/64 inch in diameter when the baffle stack is new.

The *Elkonite tip of the contact rods can be machined to remove the eroded portion of the tip but the contact rod after machining must meet the following conditions. If either of these conditions is not met the contact rod must be discarded.

A. The contact fingers must not rest on the copper portion of the contact rod when the breaker is closed; they must be safely on the *Elkonite portion of the rod.

B. The lower end of the threaded portion of the contact rod must be below the clamping bolt (12), Figs. 19 and 21, on the contact rod mounting plate (28), Figs. 19 and 21.

The arcing tip finger must be replaced when the 1/4 inch long (new) arcing tip has eroded until it is 1/8 inch long.

To inspect the upper set of contact fingers fastened to the upper adapter (3), Fig. 18 and (41), Fig. 20, it is only necessary to look up through the interrupter tube (5), Figs. 18 and 20. To replace fingers (19 and 20), Figs. 18 and 20, in this upper cluster, it is necessary to first remove the upper corona shield (2), Figs. 18 and 20, then remove the resistor (50) by removing bolts (45 and 63) and castle nuts (4) which permits lowering of the interrupter tube (5). The upper fingers (19 and 20), Figs. 19 and 21, are now accessible and, since the adapter (3 and 41), Figs. 18 and 20, respectively have not been disturbed, the reassembly

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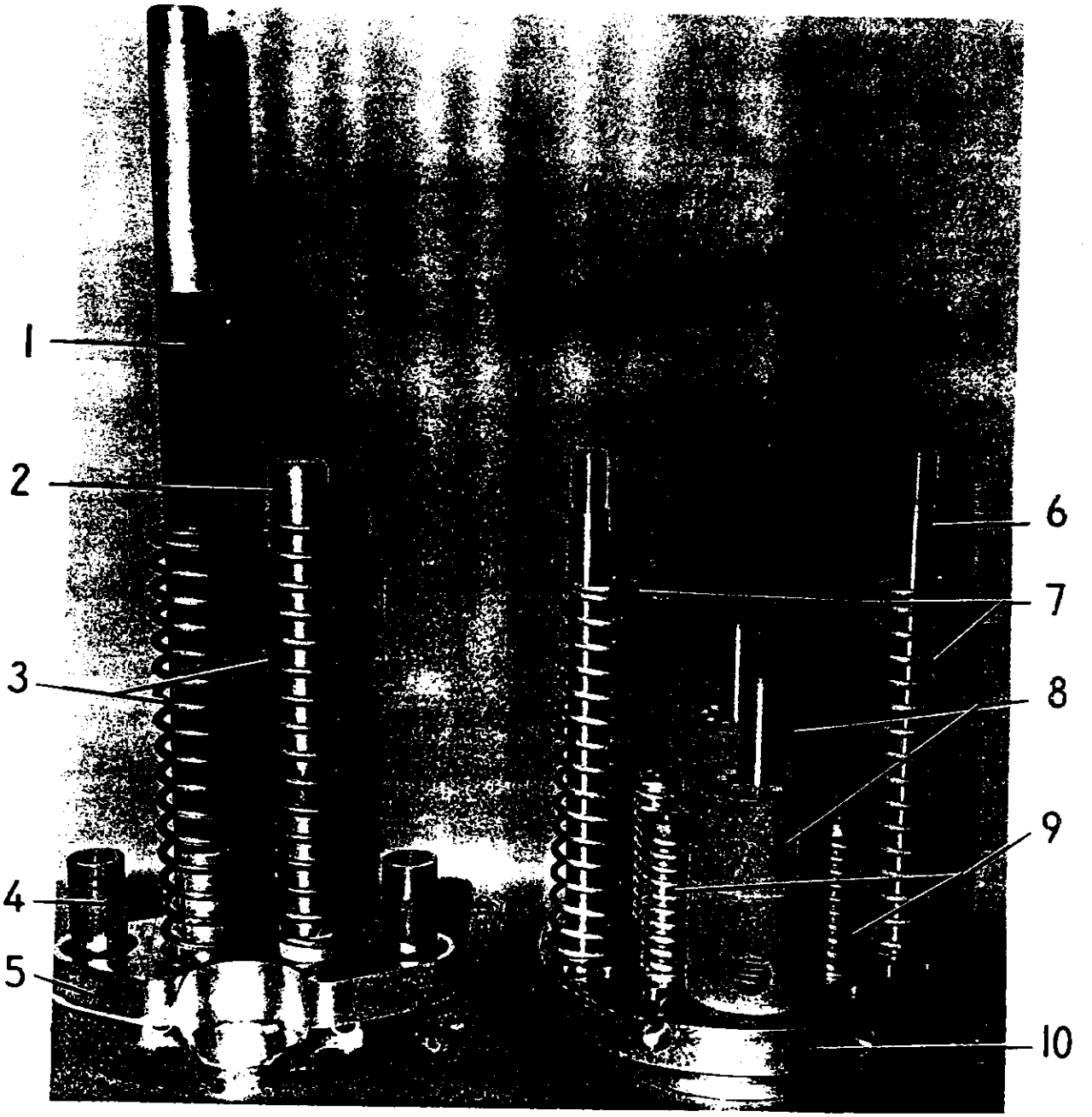


1. Upper Contact Rod
2. Lower Contact Rod
3. Interrupter Opening Springs
4. Guide Rod Bushings
5. Contact Rod Mounting Plate
6. Guide Rod
7. Guide Rod Opening Springs
8. Impulse Pump
9. Buffer Springs
10. Lower Adapter Plate

Fig. 28. Lower Interrupter Housing Disassembled

of the interrupter will not require a realignment of the interrupter.

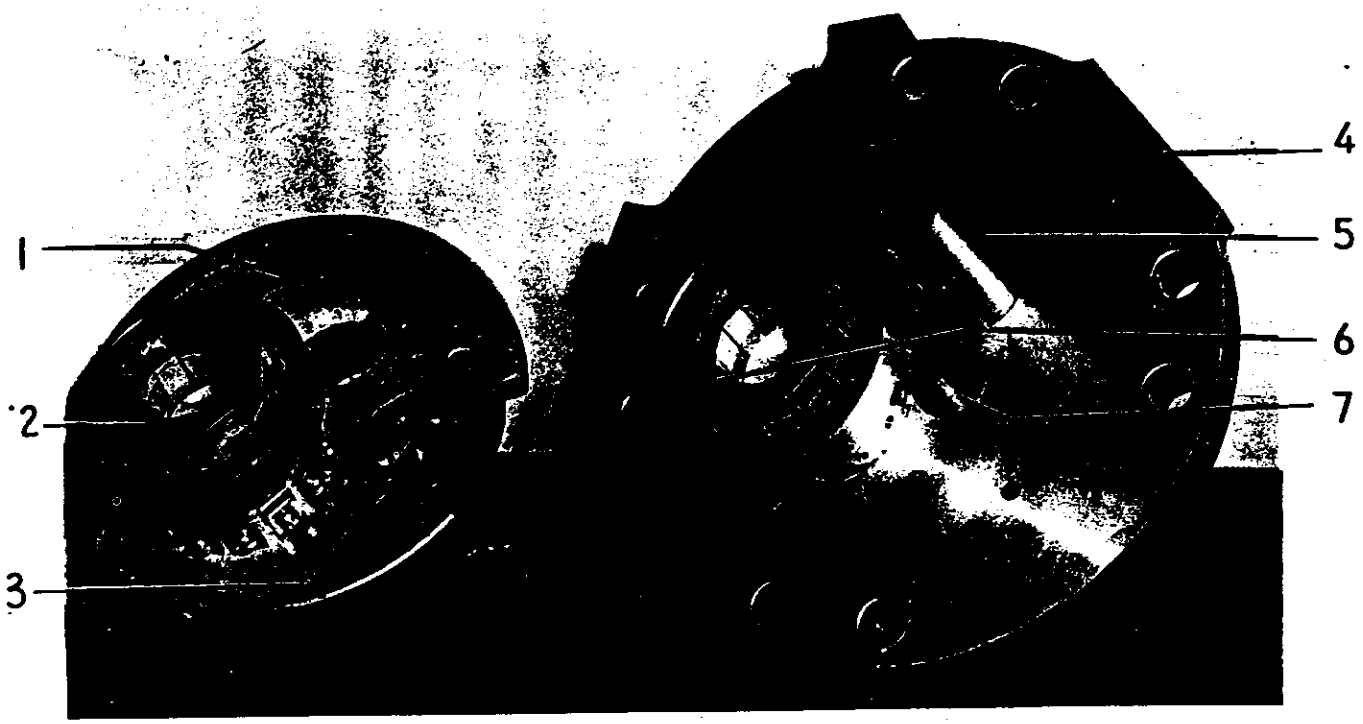
CONTACT FINGER ASSEMBLY

When replacing the upper or lower contact fingers it is advisable to mark the location of the arcing contact finger on the mounting adapter of both assemblies. This will facilitate reassembly of the finger cluster when new fingers are used. The lead tips on the arcing fingers must be properly positioned as they fit into a recess in the top of the upper and lower baffle stacks.

To change the arcing fingers and the current transfer fingers, special tools which are furnished with the interrupter are used to compress all the contact springs at the same time. See Fig. 38 and proceed as follows:

1. Set the contact fingers (3 and 8) in the alignment block (4) with the contact ends down. This block has slots for proper positioning of the

Fig. 29 (8040830)



1. Lower Contact Finger Support Plate
2. Arcing Finger (Lower Cluster)
3. Transfer Finger Assembly
4. Upper Adapter
5. Baffle Stack Locating Pin
6. Arcing Finger (Upper Cluster)
7. Safety Relief Valve Port

Fig. 29. Upper and Lower Contact Finger Assemblies of the Nominal 15,000 mva Interrupter

arcing contact fingers (3), those having the Elkonite extension.

2. Place the spring guide (5) in position and insert the springs (7) through the holes in the guide into the retaining holes in the contact fingers.

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

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

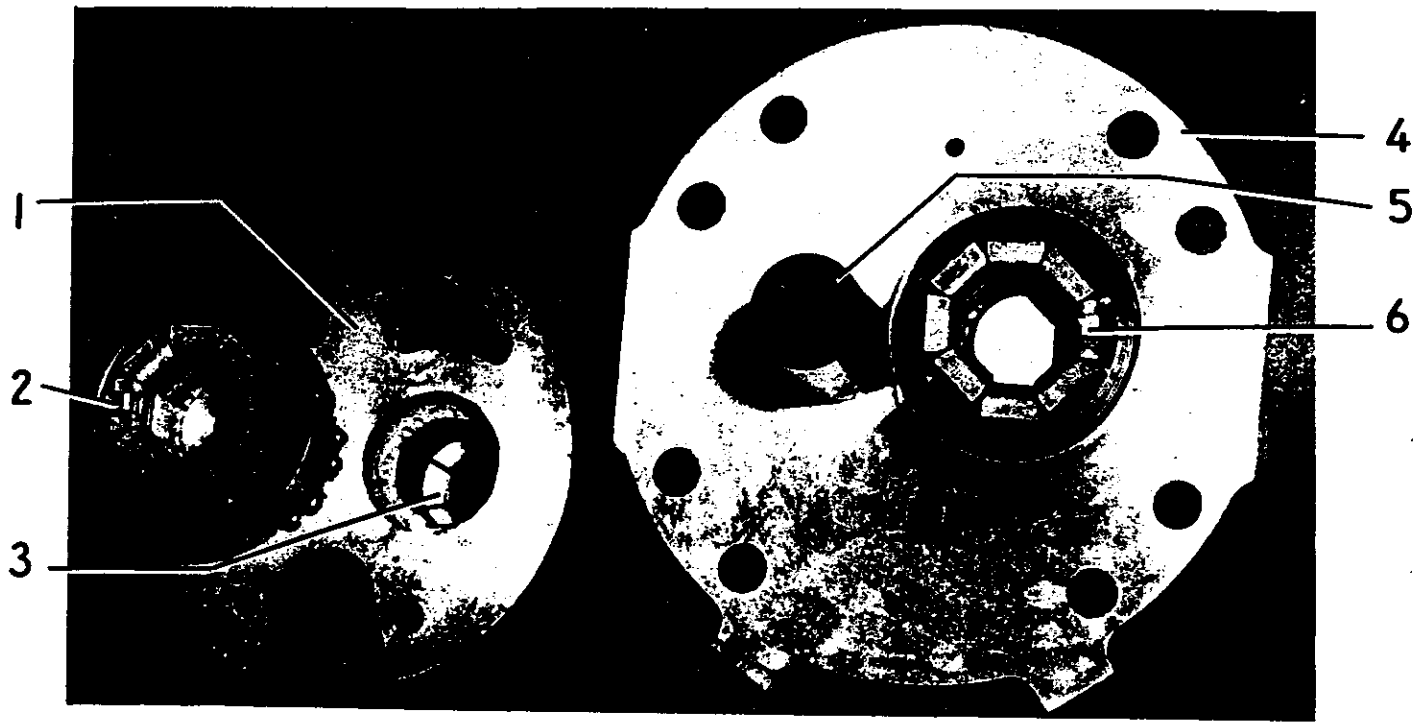
5. Turn the entire assembly upside down and press downward the full length of the cylinder.

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

Drill the assembly and fasten with three cotter pins spaced on the horizontal centerline of the retaining ring, midway between fingers.

If this tool is not available, a large hose clamp which utilizes the screw or worm type of tightener can be used to compress the spring a sufficient amount to force the spring (7) into the spring retainer ring (6) by using a small screwdriver as a lever. The spring retainer must be clamped by the hose clamp at the same time as the springs are clamped by having the edge of the spring retainer just against the springs. Care must be taken that the spring is properly seated and that it does not spring out and cause injury. Placing the entire assembly in a clean burlap bag and assembling it helps prevent escape of the springs while permitting a sufficient view of what is being done.

The contact assembly is now ready for installation in the interrupter. Using the alignment block (4) or a flat block of wood, to insure equal pressure on all



1. Lower Contact Finger Support Plate
2. Arcing Finger (Lower Cluster)
3. Transfer Finger Assembly
4. Upper Adapter
5. Baffle Stack Locating Pin
6. Arcing Finger (Upper Cluster)

Fig. 30. Upper and Lower Contact Finger Assemblies of the Nominal 10,000 mva Interrupter

fingers, push the finger cluster onto the end of the mounting stud in the interrupter being certain that the location of the arcing contact finger lines up with the mark which was put on the adapter.

The current transfer finger cluster (11), Figs. 18 and 20, is assembled in a similar manner except that a larger fixture which is supplied with the interrupters is used. Otherwise, follow the same procedure that is used for changing the contact fingers as explained previously.

RESISTOR

The shunting resistor is disassembled by first removing the contact bolts (45 and 63), Figs. 18 and 20, then removing the flat head screws and insulating nuts. The disassembled parts are shown in Fig. 33. Difficulty will be encountered in reassembly of the resistor; consequently, it should not be taken apart. Checking the ohmic value of the resistor is usually sufficient.

INTERRUPTER REASSEMBLY

When reassembling the interrupter tube (5), Figs. 18 and 20, to either the upper adapter (3), Fig. 18, and (41), Fig. 20, or the lower plate (24), Figs. 18 and 20, there must be a gap of 1/64 to 1/16 inch between the interrupter tube and either the upper adapter or the lower housing when the castle nuts (4), Figs. 18 and 20, on the eight studs are snug. This insures that the baffle stack is tight when the castle nuts are tightened to 40 to 50 foot-pounds torque. Insert the cotter pin through the nut and stud to maintain the baffle stack tightness. If there is insufficient or too much gap adjustment is required. This can be adjusted with the use of different lower height adjusting spacers (7), Fig. 31, until the proper gap is obtained.

Before reassembly of the contact rod mounting plate (5), Fig. 28, identify the springs (3 and 7), Fig. 28, and remove them from the guide rods and contact rods (1, 2 and 6), Fig. 28. Install the contact rod mounting plate on the appropriate guide rods and check to make certain the plate rides freely up and down the guides. If the plate sticks or binds it has probably been assembled improperly. Remove the plate, turn it 180 degrees and reinstall. It should now move freely.

If the adapter (3), Fig. 18, and (41), Fig. 20, is removed from the bushing adapter ring (38), Figs. 18 and 20, the

Fig. 31 (8040745)

entire interrupter will require realignment as explained under the section INTERRUPTER INSTALLATION and INTERRUPTER ADJUSTMENT found in the INSTALLATION portion of this instruction book. The adapter ring bolts (39), Fig. 18, and (41), Fig. 20, should be tightened uniformly to a torque of 20 to 25 foot-pounds.

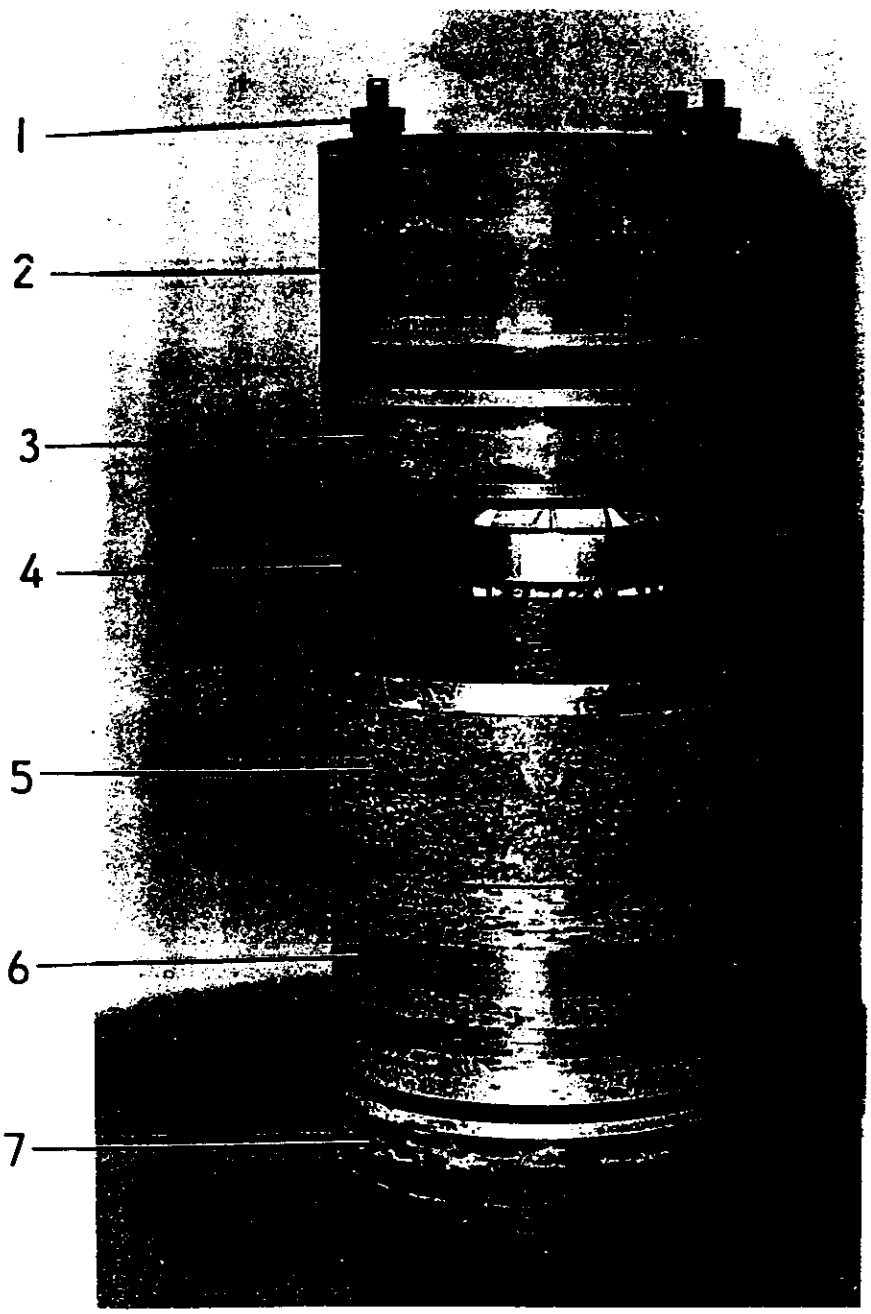
After the entire interrupter has been reassembled, it is advisable to check the fully-closed position of the interrupter as explained in INTERRUPTER INSTALLATION.

LOWER INTERRUPTER HOUSING

Except in rare instances, it should not be necessary to replace or adjust any part of the lower housing, Fig. 28, except the contact rods (1 and 2). If it should be necessary, the lower housing may be disassembled as follows:

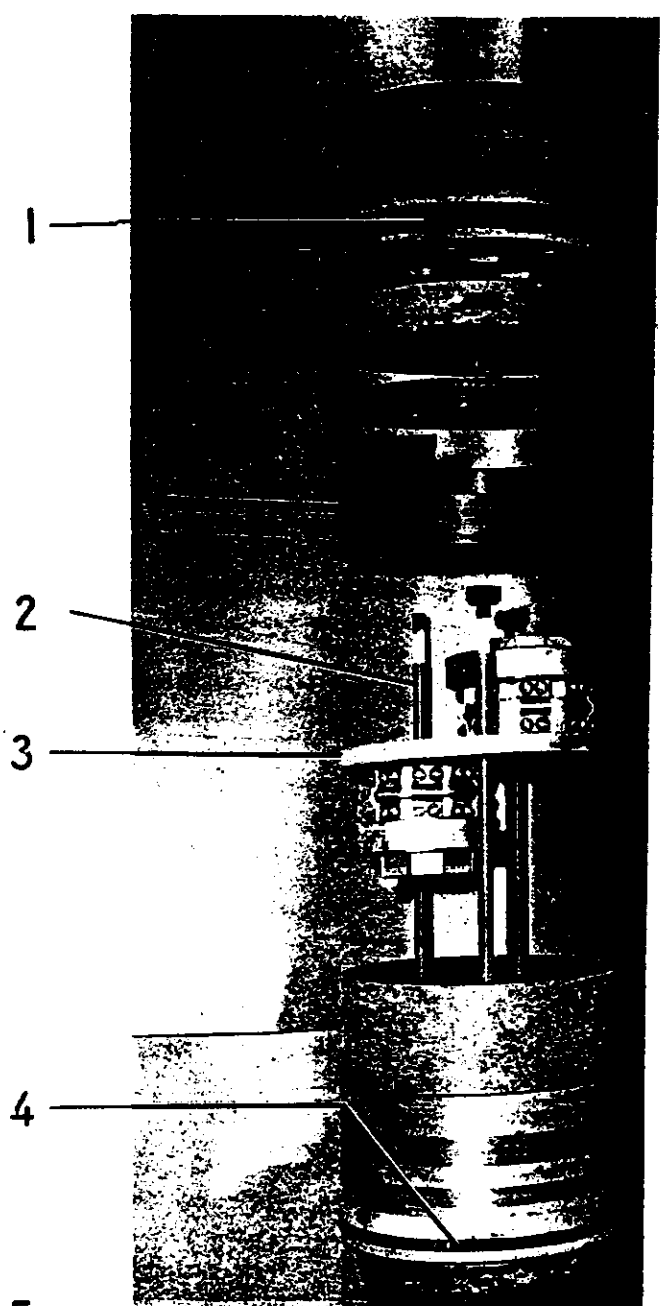
Remove the contact rod mounting plate (5), Fig. 28, and the lower adapter plate as a complete assembly from the interrupter tube as explained previously. The baffle stack and contact assembly, Fig. 31, may remain in the interrupter, held in place by the single screw (24), Figs. 19 and 21, through the side of the tube (5), Figs. 18 and 20.

Remove the set screw from the spring washer retaining nuts (8), Fig. 26, loosen the clamping bolt (4), Fig. 24, and then remove the spring washer retaining nuts being careful to keep the spring washers (3), Fig. 26, and shims identified as to the particular guide rod (6), Fig. 28, from which they were removed. Since there is some precompression on the interrupter opening springs (3), Fig. 28 (approximately 20 pounds), care must be used when removing the retaining nuts. Before further disassembly identify the guide rod bushings (4), Fig. 28, with their respective guide rods (6), Fig. 28. This will assure proper operation upon reassembly since these parts are manufactured and built to very close tolerances. Removal of the buffer springs (9), Fig. 28, will require



1. Baffle Stack Nut
2. Upper Baffle Stack
3. Upper Baffle Stack Spacer
4. Intermediate Baffle Stack Spacer
5. Lower Baffle Stack Spacer
6. Lower Baffle Stack
7. Lower Height Adjusting Spacer

Fig. 31. Interrupter Baffle Stack Assembly (Nominal 10,000 mva)



1. Upper Baffle Stack Seal Ring
2. Tie Rod
3. Finger Support Plate
4. Lower Baffle Stack Seal Ring
5. Impulse Oil Passage

Fig. 32. Interrupter Baffle Stack Disassembled (Nominal 10,000 mva)

an arbor press or similar as th springs are prestressed considera (approximately 200 pounds for 10,000 mva breakers and 100 pour for the 15,000 mva breakers). Up removal of the buffer springs and t buffer guide rod (61), Figs. 18 and 2 the buffer guide rod bushings (6 Figs. 18 and 20, can be inspected a replaced as necessary. The contact r bushings in the lower adapter pla (10), Fig. 28, are pressed into positio If these need replacing new bushin must be pressed or tapped into po tion with an arbor press or by the u of a plate and hammer.

If necessary the impulse pumps (8 Fig. 28, can be removed as a unit b removal of the bolts which fasten t impulse pump to the lower adapter pla (10). Do not disassemble the impul pump until the section under IMPULS PUMP is understood as there are appro mately 200 pounds of pre-tension on t springs inside the pump. To reassemb the lower interrupter housing simply r verse the procedure as outlined abov keeping in mind that the guide ro bushings, the proper stack of spring was ers and the shims must be assembled t their respective guide rods to prevent an possibility of binding.

IMPULSE PUMP

When the impulse pump (8), Fig. 28 of the interrupter requires disassembl for any reason care must be taken be cause the pump springs have approxi mately 200 pounds preload on then when the breaker is in the open position and are approximately 11 inches lon when free. The pump can be disassemble by using an arbor press to compress th springs (27), Figs. 18 and 20, and push the top end of the piston rod (30) out th top of the screwed-on top plate (26) There is a 3/16-inch through hole 1/ inch from the end of the hollow pisto rod (30). When this rod extends throug the cap sufficiently insert a pin through the hole and release the arbor press. Thi pin captures the springs and permits removal of the cap. The three springs, th cap and the piston rod will be remove

Fig. 32A (0269A9515 Rev. 0)

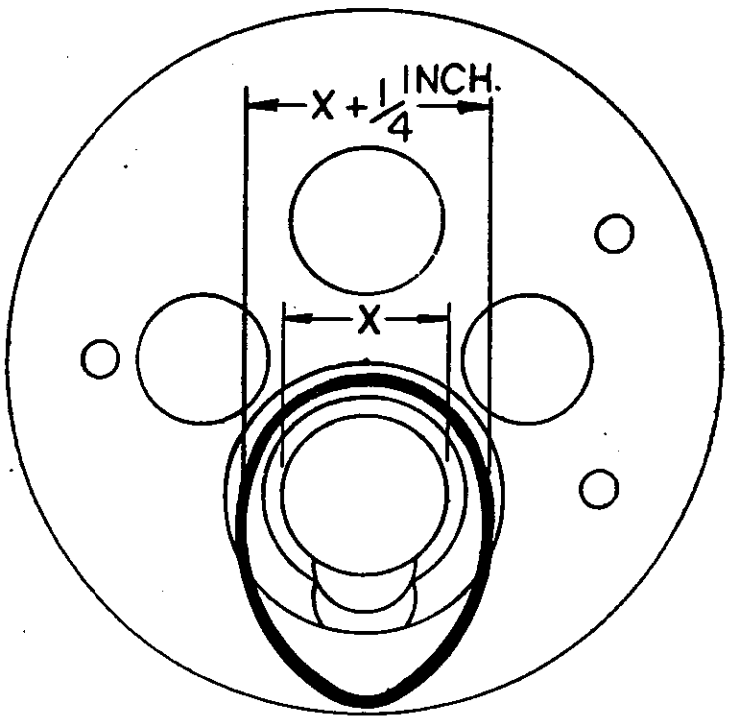


Fig. 32A. Allowable Baffle Stack Erosion (Measured on Plate above Top Exhaust Slot)

from the impulse pump cylinder (28) as an assembly. If further disassembly is required the pin will require removal and the springs must be kept from escaping from around the piston rod. Keep in mind that the free length of the three springs is approximately 11 inches and that there is approximately 200 pounds of preload on the spring when the piston is extended out the bottom of the cylinder.

After the entire interrupter has been reassembled it is advisable to check the contact wipe of the interrupters as explained in INTERRUPTER INSTALLATION and adjust the lift rod setting, the interrupter stroke and the interrupter setting as explained under INTERRUPTER ADJUSTMENT.

MOVING CONTACT MEMBERS

The three moving contact members each consists of a two-piece crossarm, threaded and bolted onto the lower end of a lift rod, supporting the current-carrying finger clusters for the interrupters. The finger cluster assembly is held to the crossarm by two bolts as shown in Fig. 26. In normal operation this assembly should seldom have to be removed but should be checked for wear and/or misalignment.

The moving contacts are guided by a lift rod guide which is attached to the top frame. The guide must be properly located and aligned so that the moving contact member hangs freely in the open position. The guide also controls the direction of the contacts on closing so that the cluster finger assemblies engage the external contact probe of the interrupter centrally. There should be approximately 1/64-inch clearance between the sides of the lift rod and guide to prevent binding, which would interfere with the operation of the moving contacts. (See INSTALLATION ADJUSTMENTS.)

BUSHINGS

Little or no maintenance is required of the bushings other than a periodic cleaning of the porcelains. Instruction book GEK 2020 shows the construction of the bushings. 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.

Bushing Alignment

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. Proper alignment of the bushing is obtained using the bushing aligning tool supplied with the breaker tools. The interrupter has to be removed. Mount the aligning tool on the bottom of the bushing using the two bolt holes which are toward the lift rod from the center line of the bushing. Attach the aligning bracket with the arrow pointing toward the low side of the bushing (away from the lift rod) so the stamping on the aligning bracket can be seen. This will put the plumb bob string hole one inch toward the lift rod from the center line of the bushing. Line up the plumb bob with the center of the tool which fits in the cross arm cup. The breaker and lift rod guides have been previously plumbed. The plumb bob point should be within 1/8 inch of the center of the crossarm cup. 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 (BCT) are mounted in housings with the sides forming a part of the top frame. See Fig. 35 for the method used in the 121 and 145 kV breakers. The bottom consists of removable sections which support the bushing current transformers. The bushing current transformers may be installed in the housings either before or after the bushings are in place. Insulation washers above and below the transformer protect it from injury. The BCT's must be properly centered in the housing to prevent damaging the BCT's when the bushing is installed.

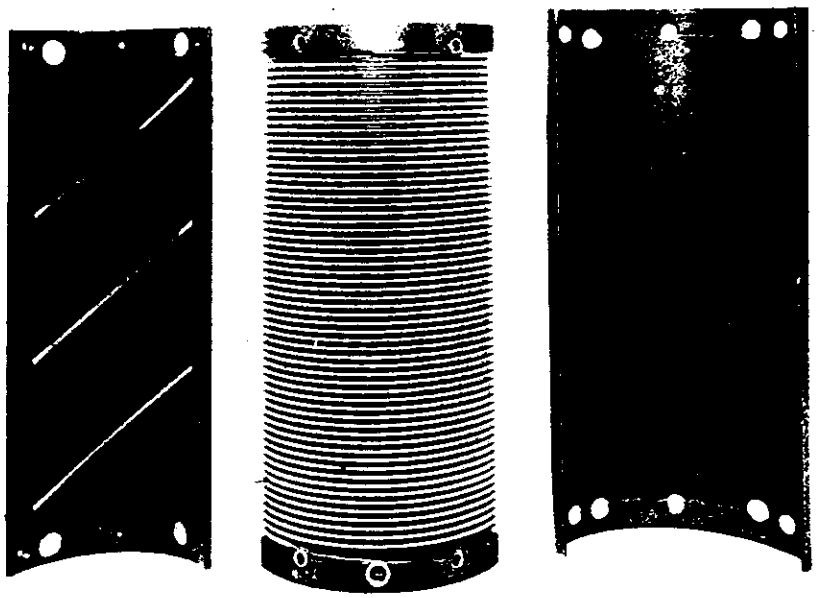


Fig. 33. Shunting Resistor Assembly

The mounting method used in the 169 kV breaker is somewhat different. See Fig. 36. The BCT's are mounted in a separate cage consisting of three long studs, top and bottom plates with insulation washers above and below the transformer to prevent it from injury. This cage is installed from above. It cannot be installed from below. The three studs fit into three bosses welded to the inside of the BCT pocket (12), Fig. 2. Clips (15), Fig. 36, and spring washers (16), are used to prevent the cage from shifting during shipment.

To remove the BCT first remove the interrupter unit and disconnect the transformer lead wires from each other in the BCT conduit box (32), Fig. 9. Identify each lead as it is disconnected for ease in reassembly.

The BCT leads are brought out through a hole at the center of the housing inside the top frame and carried through a metal conduit to a vertical outlet pipe. At the top of the pipe is a sealing gasket through which the leads are threaded into a BCT conduit box (32), Fig. 9, where the leads are spliced to leads which are connected to the terminal boards inside the operating mechanism house. The gasket is then compressed so that it seals around the leads and against the pipe. The BCT conduit box is attached to the outlet pipe on each pole unit. There are conduit connections between these boxes and the mechanism housing to protect the BCT wires.

The bushing of the 169 kV breaker must be removed to remove the BCT's. The cage can then be removed and the BCT removed from the BCT support cage. See Fig. 36.

To remove the BCT's from the 121 and 145 kV breakers, remove the two bottom plates (14), Fig. 35, carefully while supporting the BCT's then slide the BCT's down the bushing and remove from the breaker. The BCT's can also be removed by removing the bushing and lifting the BCT's up and out of the BCT pocket.

When reconnecting the BCT's care must be taken that the white mark is placed upwards.

GASKETS

The following instructions cover the preparation of gaskets and gasket surfaces whenever it becomes necessary to replace them. Clean all gasket surfaces thoroughly to remove all oil, grease or foreign material which will prevent proper adhesion of the gaskets or sealing of the joints. Allow them to become thoroughly dry before proceeding with treatment. Give all surfaces where gaskets (except rubber gaskets) are to be permanently assembled a full, thin, unbroken coat of G-E 1201 *Glyptal cement to prevent the gaskets from soaking up water. Make certain the edges of the gaskets are completely coated. Also give the gaskets (except rubber gaskets) for such joints as these a similar coat. Do this at such a time in the assembly cycle that the compound will have dried at least one-half hour before final assembly. A longer time, up to 24 hours, is not detrimental. In making up the permanent joints, coat both the gasket and gasket surfaces with G-E 1203 compound and bolt the parts before the compound sets.

Rubber gaskets can be adequatel

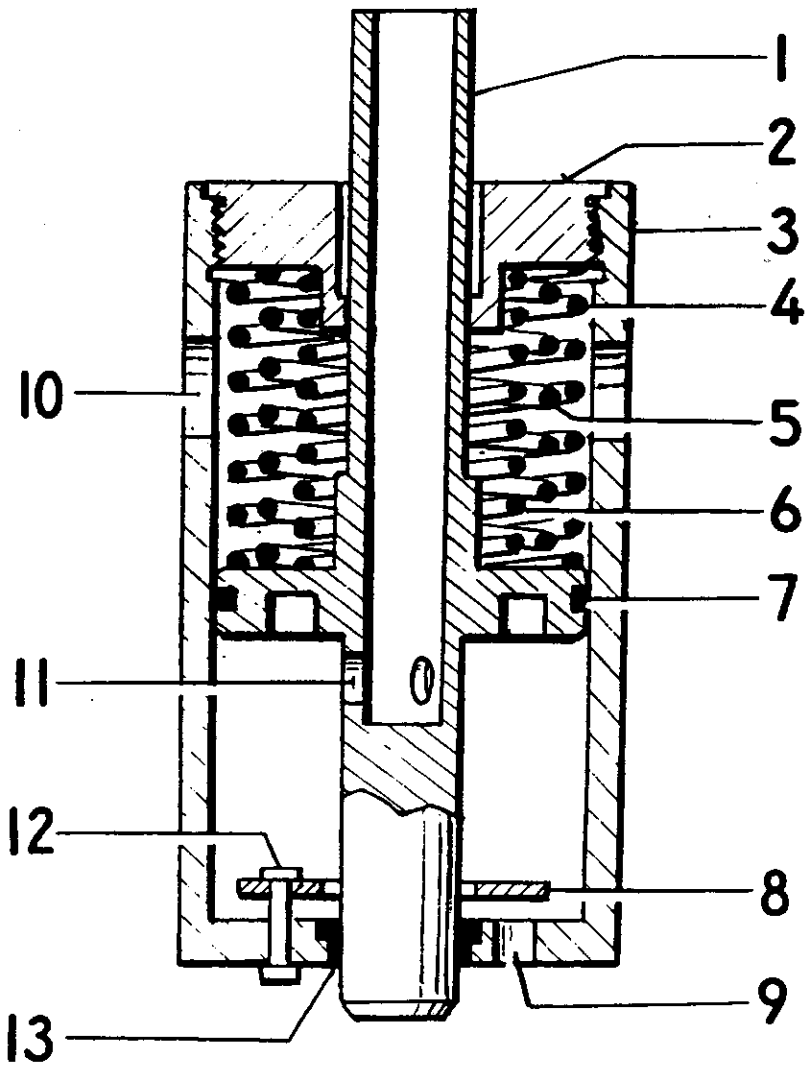


Fig. 34 (0203A1758 Rev. 0)

1. Piston
2. Cap
3. Cylinder
4. Outer Spring
5. Center Spring
6. Inner Spring
7. Piston Ring
8. Check Valve
9. Oil Fill Holes
10. Oil Escape Holes
11. Oil Passage Holes from Pump
12. Check Valve Retaining Rivet
13. Spun-over Bronze Bushing

Fig. 34. Impulse Pump Assembly

cleaned if washed in warm water using a bath soap or any other non-detergent soap. Rinse thoroughly with clear water and let air dry before using. Apply a thin coating of D50H15 grease or similar before using where the joint will be opened periodically.

For joints such as covers, manholes, or places where the joint has to be opened, do not coat the surfaces that separate with compound but instead apply a coating of grease to prevent sticking.

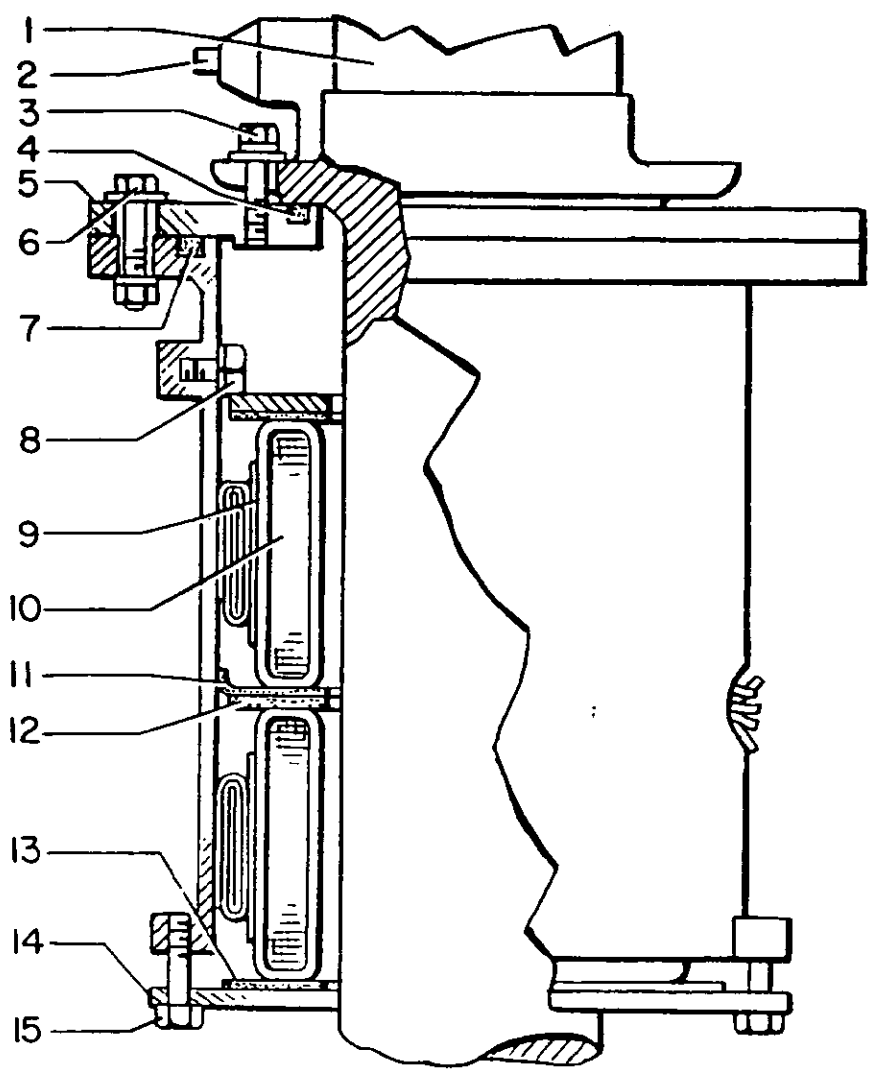
Where rubber gasket material is shipped in strips to be cut to prescribed lengths, the gaskets should be scarfed together. This may be done by cutting the two ends to be joined at 45-degree mating angles. The gasket should then be cemented together with a suitable adhesive. With gaskets thus prepared, a good waterproof joint will be obtained. If the gasket is to be assembled in a place other than the horizontal, the scarfed joint should be placed at the lowest elevation point to further reduce the possibility of leakage.

Rubber gaskets, due to their composition, do not require coating with compound as outlined above for gaskets of other material. Use a good grade of rubber cement, if necessary, to hold in place during assembly.

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.

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 - *Textolite and Bronze)	Very light application of light machine oil, SAE20 or 30.	Clean per instructions. Apply D50H15 liberally.
Opening Dashpot	With piston in the up position, fill even with fill hole using clean G-E 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.		



1. High Voltage Bushing
2. Capacitance Tap Outlet
3. Bushing Mounting Bolt
4. Bushing Gasket
5. Adapter Plate
6. Adapter Mounting Bolt
7. Adapter Gasket
8. Bolt
9. Spacer
10. Bushing Current Transformer
11. Insulating Washer
12. Steel Washer
13. Spacer
14. Bottom Plate
15. Clamping Bolt

Fig. 35 (0809B0167 Rev. 1)

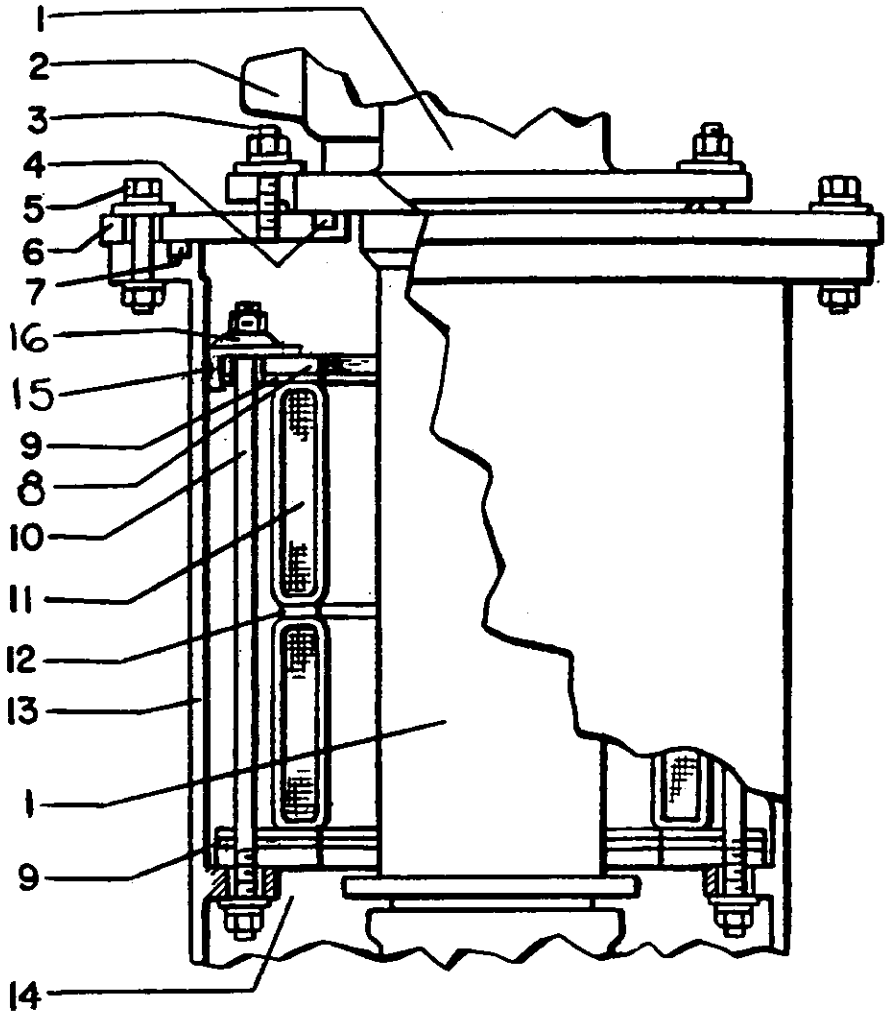
Fig. 35. View of Transformer Housing and Bushing Mounting Used in FK-121 and 145 kV Breakers Only

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 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.

Fig. 36 (0109B1815 Rev. 2)



1. Bushing
2. Capacitance Outlet
3. Bushing Mounting Bolt
4. Gasket
5. Adapter Bolt
6. Adapter
7. Gasket
8. Top Flange
9. Gasket
10. Stud
11. Bushing Current Transformer
12. Washer
13. Transformer Housing
14. Bottom Flange
15. Positioning Clip
16. Spring Washer

Fig. 36. View of Transformer Housing Cage and Bushing Mounting Used in FK-169 kV Breakers Only

CLEANING

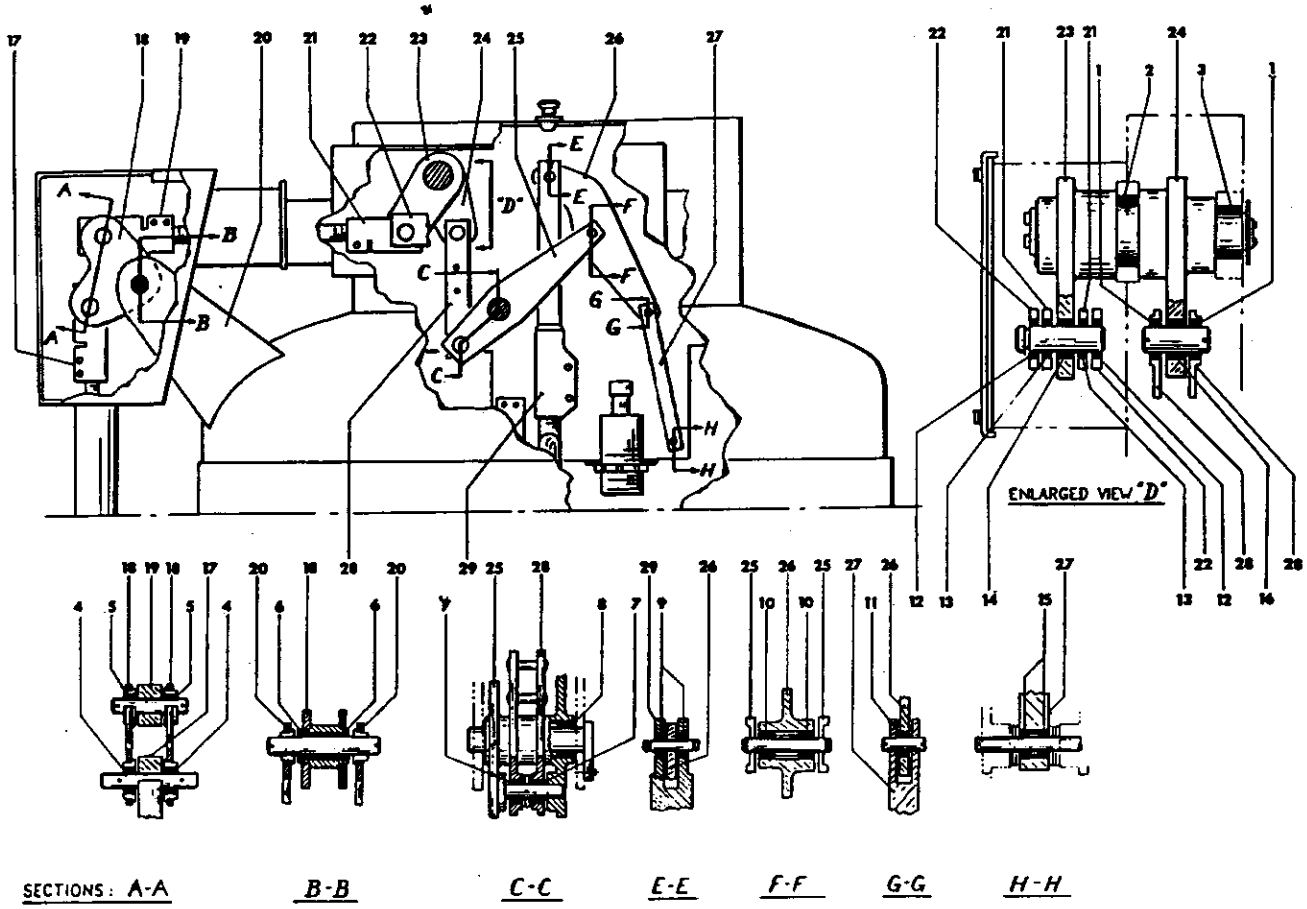
Wherever cleaning is required, as indicated in the LUBRICATION CHART, the following procedures are recommended:

SLEEVE BEARINGS

The pins should be removed and all old oxidized grease removed by immersion in clean petroleum solvent or other similar cleaner. Do not use Chlorothene unless the metallic bearings and pins are dipped into a container of light clean oil to protect the surfaces immediately after cleaning with Chlorothene.

Do not use Chlorothene on *Textolite bearings as it will adversely affect the *Textolite.

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

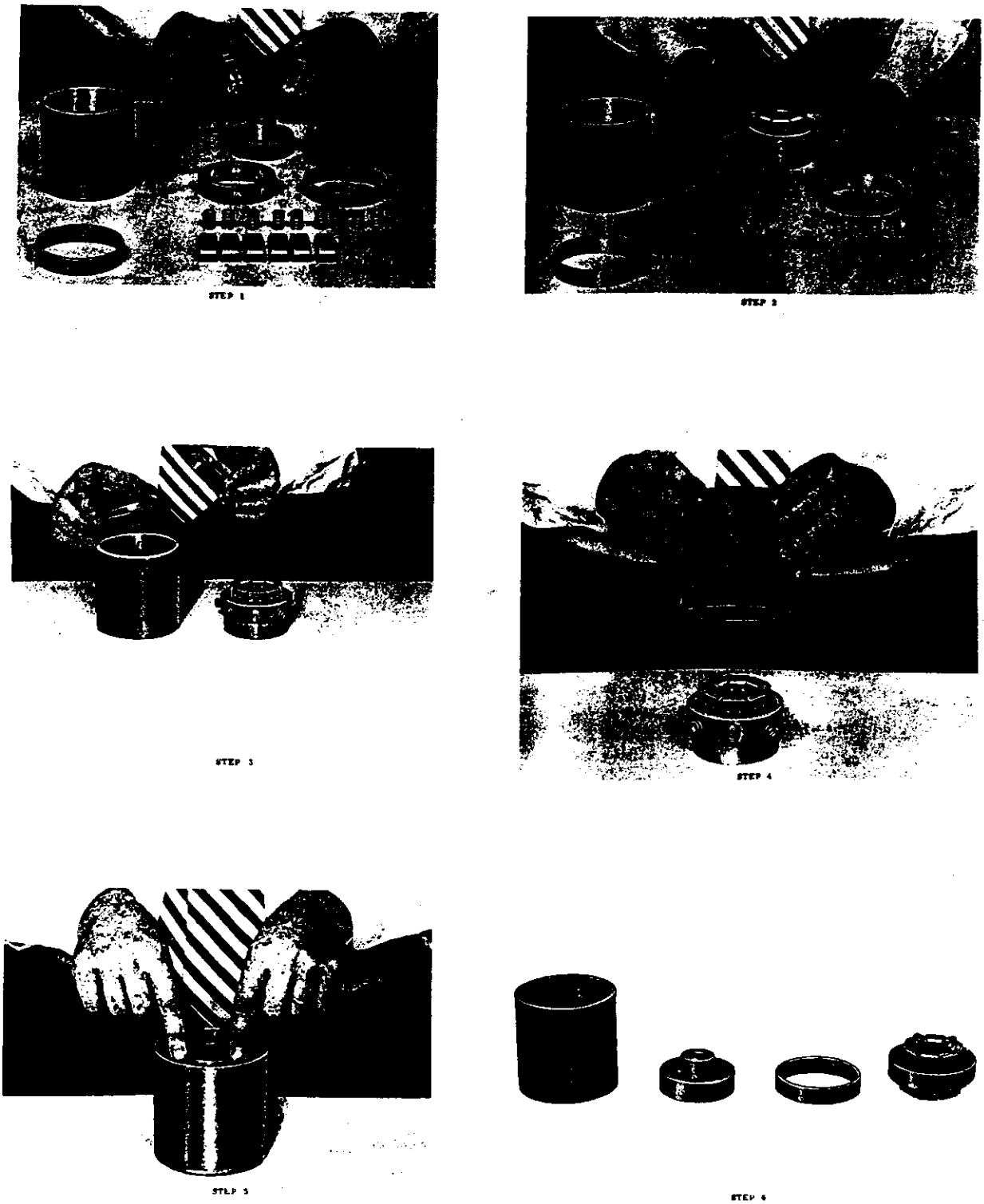


1. Toggle Link Upper Bushings
2. Spline Shaft Bushing (Large)
3. Spline Shaft Bushing (Small)
4. Front Crank Lower Bushings
5. Front Crank Upper Bushings
6. Front Crank Pivot Bushings
7. Toggle Link Lower Bushings
8. Beam Bushings
9. Lift Rod Coupling Bushings
10. Lever-Upper Bushings
11. Lever-Lower Bushings
12. Phase Rod Coupling Bushings - Rear
13. Phase Rod Coupling Bushings - Front
14. Side Crank Bushing
15. Guide Link Bushings
16. Toggle Crank Bushing
17. Vertical Coupling
18. Front Crank
19. Breaker Front Horizontal Rod Coupling
20. Front Crank Support
21. Phase Horizontal Operating Rod Coupling - Front
22. Phase Horizontal Operating Rod Coupling - Rear
23. Side Crank
24. Toggle Crank
25. Beam
26. Lever
27. Guide Link
28. Toggle Link
29. Lift Rod Coupling

Note: Ream bronze bushings (14) and (16) from 1.497 to 1.500 inches after pressing into side crank and toggle crank. Textolite* bushings do not require reaming.

Fig. 37. View of the Breaker Showing Bearing Location

Fig. 38 (8041931)



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

Fig. 38. Method of Assembling Typical Contact Fingers

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.

BUSHING REPLACEMENT

If it is necessary to replace bushings in the linkage the bronze bushings will require reaming after they are pressed into place. Bronze bushings (14 and 16), Fig. 37, should be reamed to 1.497 to 1.500 inch after being pressed into place. Textolite bushings do not require reaming.

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 and Chlorothene 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.

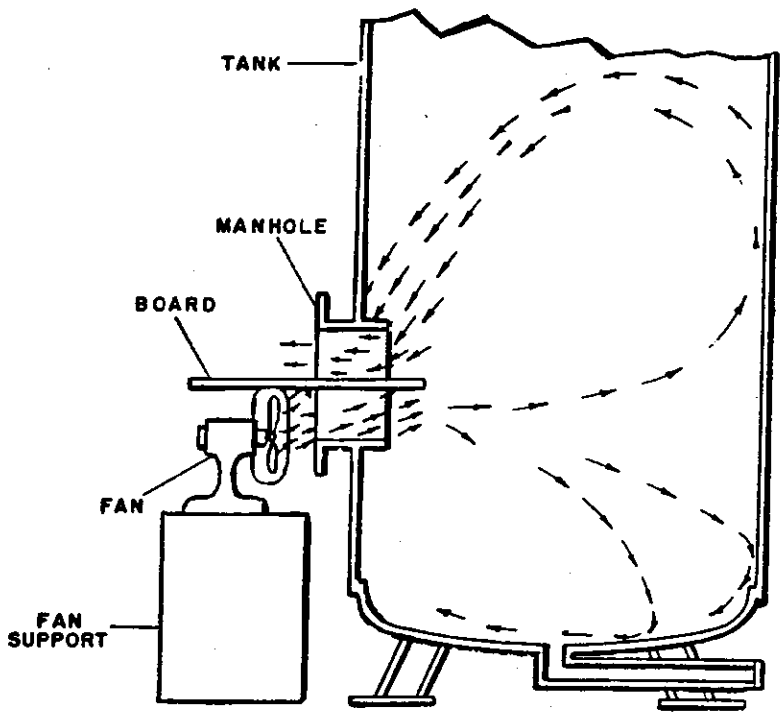


Fig. 39 (6558498 Rev. 1)

Fig. 39. Air Circulation in Tank to Remove Fumes

REPLACEMENT PARTS

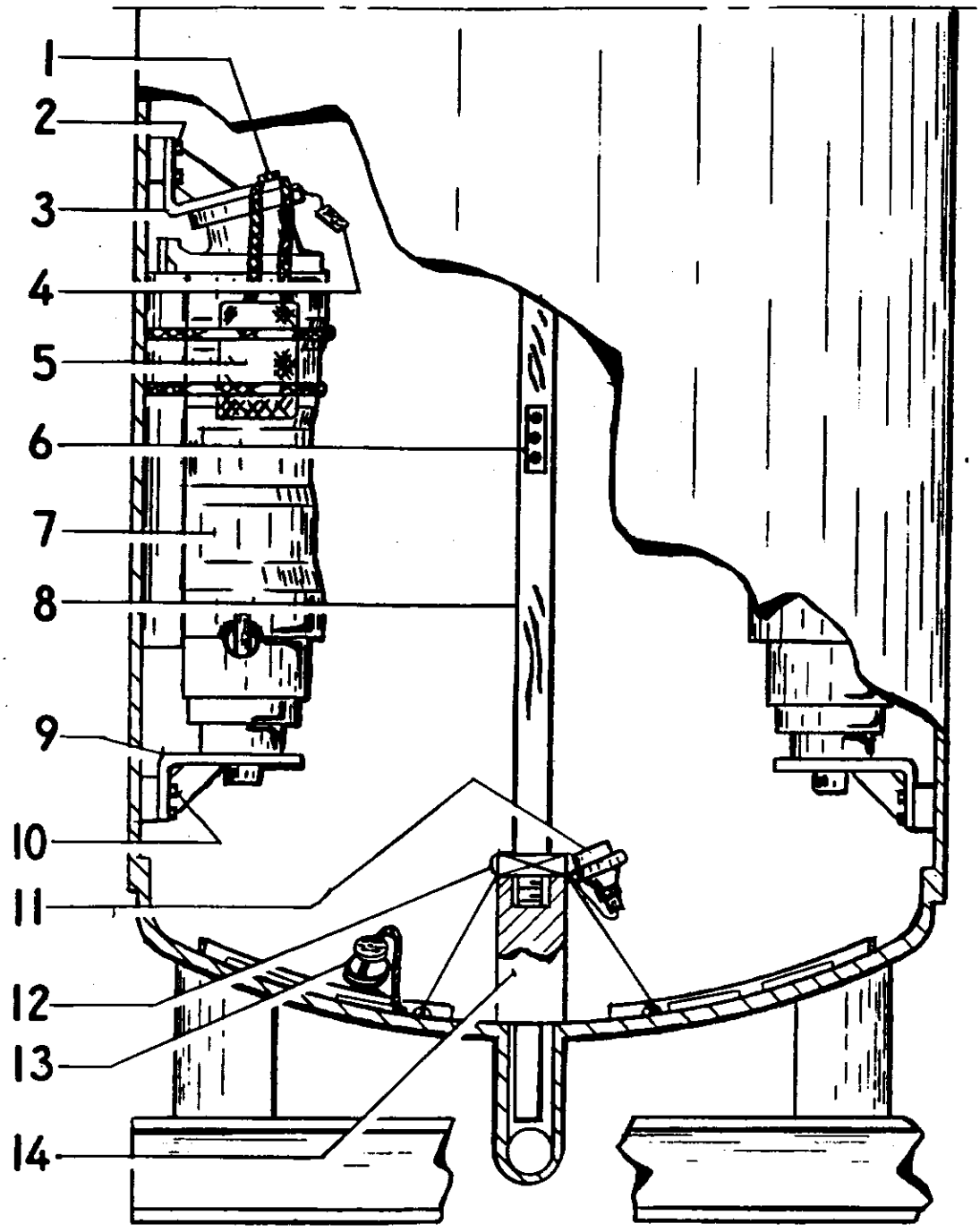
It is recommended that sufficient replacement parts be carried in stock to enable prompt replacement of worn, broken, or damaged parts. A stock of such parts minimizes service interruptions caused by breakdowns and saves time and expense. When continuous operation is a primary consideration, more renewal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

The following is a list of replacement parts. 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 improvements are made from time to time. The parts which are furnished, however, will be interchangeable.

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 the front door 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. 40 (0203A1732 Rev. 1)



1. Interrupter Mounting Bolts
2. Upper Bracket Mounting Bolts
3. Upper Mounting Bracket
4. Instruction Card
5. Desiccant
6. Moisture Indicator Card
7. Interrupter
8. Lift Rod
9. Lower Mounting Bracket
10. Lower Bracket Mounting Bolts
11. Breaker Tank Breather
12. Crossarm
13. Shims and Safety Wire
14. Lift Rod Shipping Support

Fig. 40. Interrupters as Mounted inside Breaker Tanks for Shipment when Bushings Are Shipped Separately

FIG. NO.	REF. NO.	QUANTITY PER BREAKER									CATALOG NO.	DESCRIPTION
		FK-121-4300C-4 and -5 1600 AMP	FK-121-43000-3 and -4 2000 AMP	FK-145-37000-6 and -7 1600 AMP	FK-145-37000-1 and -2 2000 AMP	FK-169-31000-2 and -3 1600 AMP	FK-169-31000-2 and -3 2000 AMP	FK-121-65000-0 2000 AMP	FK-145-55000-0 2000 AMP	FK-145-55000-0 2500 AMP		
1	#	3	3	3	3	3	3	3	3	3	006440310P001	Lock Nut for Opening Dashpot
1	+*	4	4	4	4	4	4	4	4	4	0183V0711P001	Gasket for Glass Breaker Position Indicator Window
1	1	4	4	4	4	4	4	4	4	4	0178V0727P001	Glass for Breaker Position Indicator Window
1	*19	1	1	1	1	1	1	1	1	1	0438A0609P001	Gasket - Opening Spring Cover
1	+*28	1	1	1	1	1	1	1	1	1	0178L0786G001	Gasket - Front Bellcrank Housing Upper, Lower and Sides
1	58	3	3	3	3	3	3	3	3	3	0178L0792G003	Opening Dashpot
9	+*	1	1	1	1	1	1	1	1	1	0454A506P002	"O" Ring - BCT Conduit at Mechanism House Roof
9	#*	6	6	6	6	6	6	6	6	6	006440357P001	Gasket Upper and Lower Oil Gage
9	#	–	–	3	3	–	–	–	3	3	0153B6709G001	Crossarm and Lift Rod Assembly Complete Including the Paddle
9	#	3	3	–	–	–	–	3	–	–	0153B6709G002	Crossarm and Lift Rod Assembly Complete Including the Paddle
9	#	–	–	–	–	3	3	–	–	–	0153B6709G003	Crossarm and Lift Rod Assembly Complete Including the Paddle
9	2	6	–	–	–	–	–	–	–	–	11B546	Bushing-High Creep - One Piece External Porcelain
9	2	6	–	–	–	–	–	–	–	–	11B401	Bushing
9	2	–	6	–	–	–	–	–	–	–	11B568	Bushing (Non TBI)
9	2	–	–	6	–	–	–	–	–	–	11B411	Bushing
9	2	–	–	–	6	–	–	–	–	–	11B660	Bushing (Non TBI)
9	2	–	–	–	–	6	–	–	–	–	11B421	Bushing
9	2	–	–	–	–	–	6	–	–	–	11B651	Bushing (Non TBI)
9	2	–	–	–	–	–	–	6	–	–	11B403	Bushing
9	2	–	–	–	–	–	–	–	6	–	11B413	Bushing (Non TBI)
9	2	–	–	–	–	–	–	–	–	6	11B415	Bushing (Non TBI)
9	13	–	–	–	–	–	–	6	6	6	0214X0867G008	Interrupter Complete
9	+*15	3	3	3	3	3	3	3	3	3	0173A9024P001	Gasket - Manhole
9	*19	6	6	6	6	6	6	6	6	6	0153B6710G001	External Probe Contact Finger Assembly Complete
9	+*24	6	6	6	6	–	–	6	6	6	0182V0937P005	Gasket - Breaker Frame to Bushing Adapter
9	+*24	–	–	–	–	6	6	–	–	–	0182V0937P004	Gasket - Breaker Frame to Bushing Adapter
9	+*27	6	6	–	–	–	–	6	–	–	0182V0937P001	Gasket - Bushing to Bushing Adapter

*Recommended replacement parts
#Not identified
+Limited shelf life
† Only one of these spacers used per interrupter

FIG. NO.	REF. NO.	QUANTITY PER BREAKER									CATALOG NO.	DESCRIPTION
		FK-121-43000-4 and -5 1600 AMP	FK-121-43000-3 and -4 2000 AMP	FK-145-37000-6 and -7 1600 AMP	FK-145-37000-1 and -2 2000 AMP	FK-169-31000-2 and -3 1600 AMP	FK-169-31000-2 and -3 2000 AMP	FK-121-65000-0 2000 AMP	FK-145-55000-0 2000 AMP	FK-145-55000-0 2500 AMP		
9	+*27	–	–	6	6	–	–	–	6	6	0182V0937P002	Gasket - Bushing to Bushing Adapter
9	+*27	–	–	–	–	6	6	–	–	–	0182V0937P003	Gasket - Bushing to Bushing Adapter
9	+*31	3	3	3	3	3	3	3	3	3	0183V0396P001	Gasket - Conduit Box Cover
9	+*33	1	1	1	1	1	1	1	1	1	0454A0506P002	"O" Ring - Conduit Box Front (Phase 1)
9	+*34	5	5	5	5	5	5	5	5	5	0454A0506P001	"O" Ring - Conduit Box Other Places
9	36	3	3	3	3	3	3	3	3	3	0182V0804P001	Oil Tank Breather
9	+*38	3	3	3	3	3	3	3	3	3	0158A8216P001	Gasket - Phase Crank Housing Side Cover
9	+*41	3	3	3	3	3	3	3	3	3	006315854P002	Gasket - Spline Shaft Cover
9	42	3	3	3	3	–	–	3	3	3	0809B0181G005	Oil Gage Assembly Complete
9	42	–	–	–	–	3	3	–	–	–	0809B0181G004	Oil Gage Assembly Complete
9	*43	3	3	3	3	3	3	3	3	3	006370470P019	Glass Tube - Oil Gage
9	48	3	3	3	3	3	3	3	3	3	0153B9249G001	Lift Rod Guide Assembly Complete Including the Paddle
9	49	3	3	3	3	3	3	3	3	3	0384A0378P002	Lift Rod Guide Paddle
9	51	3	3	–	–	–	–	3	–	–	0153B6734P003	Lift Rod
9	51	–	–	3	3	3	3	–	3	3	0153B6734P001	Lift Rod
9	53	3	3	3	3	3	3	3	3	3	0368A0827P003	Drain Valve - 2 Inch
9	54	3	3	3	3	3	3	3	3	3	0183V0933P001	Sampling Valve - 3/8 Inch
18	#	6	6	6	6	–	–	–	–	–	0214X0867G004	Interrupter Complete
18	#	–	–	–	–	6	6	–	–	–	0214X0867G006	Interrupter Complete
18	5	6	6	6	6	6	6	–	–	–	0153B9247G001	Interrupter Tube Complete with Studs and Back-pressure Valves
18	6	6	6	6	6	6	6	–	–	–	0175V0433P003	Top Spacer

*Recommended replacement parts
#Not identified
+Limited shelf life
†Only one of these spacers used per interrupter

FIG. NO.	REF. NO.	QUANTITY PER BREAKER									CATALOG NO.	DESCRIPTION
		FK-121-43000-4 and -5 1600 AMP	FK-121-43000-3 and -4 2000 AMP	FK-145-37000-6 and -7 1600 AMP	FK-145-37000-1 and -2 2000 AMP	FK-169-31000-2 and -3 1600 AMP	FK-169-31000-2 and -3 2000 AMP	FK-121-65000-0 2000 AMP	FK-145-55000-0 2000 AMP	FK-145-55000-0 2500 AMP		
18	*7	18	18	18	18	18	18	–	–	–	006300991P005	Baffle Stack Tie Rod Nut
18	*8	18	18	18	18	18	18	–	–	–	0175V0482P001	Baffle Stack Tie Rod Washer
18	*9	12	12	12	12	12	12	–	–	–	0132A1222P009	Upper Baffle Stack Seal
18	*11	12	12	12	12	12	12	–	–	–	0203A1776G001	Current Contact Finger Assembly Complete (Upper and Lower)
18	*12	144	144	144	144	144	144	–	–	–	0153B5228P001	Flexible Leads for Primary Arcing and Transfer Fingers
18	16	84	84	84	84	84	84	–	–	–	0397A0902P004	Contact Fingers - Upper and Lower Break
18	17	12	12	12	12	12	12	–	–	–	0153B5260P003	Arcing Tip Contact Fingers - Upp and Lower Break
18	*19	6	6	6	6	6	6	–	–	–	0129C1057G002	Lower Baffle Stack
18	*20	12	12	12	12	12	12	–	–	–	0132A1222P009	Lower Baffle Stack Seal
18	*22	18	18	18	18	18	18	–	–	–	0202A5574P003	Baffle Stack Tie Rod
18	29	12	12	12	12	12	12	–	–	–	0132A1222P008	Impulse Pump Piston Ring
18	34	12	12	12	12	12	12	–	–	–	0153B9248G001	Impulse Pump Assembly Complet
18	36	6	6	6	6	6	6	–	–	–	0124C3241P004	External Probe Buffer
18	47	6	6	6	6	6	6	–	–	–	6420489P003	Resistor Cover
18	50	6	6	6	6	–	–	–	–	–	06477780G011	Interrupter Resistor Complete - Less Mounting Hardware - 1350 Ohms
18	*51	6	6	6	6	6	6	–	–	–	0129C1057G001	Upper Baffle Stack
18	58	12	12	12	12	12	12	–	–	–	0153B9231G001	Back Pressure Valve Complete - Disassembled (With Adhesive)
18	*59	6	6	6	6	6	6	–	–	–	0153B5296P001	Lower Contact Stop
18	60	24	24	24	24	24	24	–	–	–	0177V0468P008	Buffer Rod Washer
18	62	24	24	24	24	24	24	–	–	–	0202A6365P001	Buffer Guide Rod Bushing (Textolite)
18	68	12	12	12	12	12	12	–	–	–	0202A6359P001	Shim for External Probe (0.020 I
18	68	6	6	6	6	6	6	–	–	–	0202A6359P002	Shim for External Probe (0.031 I
18	68	18	18	18	18	18	18	–	–	–	0202A6359P003	Shim for External Probe (0.062 I
18	*72	6	6	6	6	6	6	–	–	–	0124C3211P002	External Probe Contact
18	74	72	72	72	72	72	72	–	–	–	0124C3244P003	External Contact Finger
18	*#	6	6	6	6	6	6	–	–	–	0153B6710G001	External Contact Finger Assemb Complete

* Recommended replacement parts
#Not identified
+Limited shelf life
† Only one of these spacers used per interrupter

FIG. NO.	REF. NO.	QUANTITY PER BREAKER									CATALOG NO.	DESCRIPTION
		FK-121-43000-4 and -5 1600 AMP	FK-121-43000-3 and -4 2000 AMP	FK-145-37000-6 and -7 1600 AMP	FK-145-37000-1 and -2 2000 AMP	FK-169-31000-2 and -3 1600 AMP	FK-169-31000-2 and -3 2000 AMP	FK-121-65000-0 2000 AMP	FK-145-55000-0 2000 AMP	FK-145-55000-0 2500 AMP		
19	#	12	12	12	12	12	12	–	–	–	06477400P008	Interrupter Stroke Adjusting Washer
19	#	12	12	12	12	12	12	–	–	–	006370569P095	Contact Rod Guide Bushing (Textolite)
19	3	48	48	48	48	48	48	–	–	–	0179V0402P001	Transfer Fingers
19	*8	6	6	6	6	6	6	–	–	–	0203A1775G001	Transfer Finger Assembly Complete
19	*9	6	6	6	6	6	6	–	–	–	0153B5296P001	Lower Contact Stop
19	*10	6	6	6	6	6	6	–	–	–	0104D5822G002	Short Contact Rod (Lower)
19	13	96	96	96	96	96	96	–	–	–	0202A6363P001	Shock Absorbing Spring Washer
19	*18	6	6	6	6	6	6	–	–	–	0153B5296P001	Upper Contact Stop
19	*21	6	6	6	6	6	6	–	–	–	0159C2847G003	Long Contact Rod (Upper)
20	#	–	–	–	–	–	–	6	6	6	0214X0867G008	Interrupter Complete
20	5	–	–	–	–	–	–	6	6	6	0153B9247G001	Interrupter Tube Complete with Studs and Back-pressure Valves
20	6	–	–	–	–	–	–	6	6	6	0175V0433P003	Top Spacer
20	*7	–	–	–	–	–	–	18	18	18	006300991P005	Baffle Stack Tie Rod Nut
20	*8	–	–	–	–	–	–	18	18	18	0175V0482P001	Baffle Stack Tie Rod Washer
20	*9	–	–	–	–	–	–	12	12	12	0132A1222P009	Upper Baffle Stack Seal
20	*11	–	–	–	–	–	–	12	12	12	0203A1776G003	Current Contact Finger Assembly Complete - (Upper or Lower) -
20	*12	–	–	–	–	–	–	216	216	216	0153B5228P002	Flexible Leads for Primary, Arcing and Transfer Fingers.
20	16	–	–	–	–	–	–	132	132	132	0153B9229G002	Primary Fingers - Upper and Lower Break
20	17	–	–	–	–	–	–	12	12	12	0153B9229G001	Arcing Fingers - Upper and Lower Break
20	19	–	–	–	–	–	–	6	6	6	0129C1057G002	Lower Baffle Stack
20	*20	–	–	–	–	–	–	12	12	12	0132A1222P009	Lower Baffle Stack Seal
20	*22	–	–	–	–	–	–	18	18	18	0202A5574P003	Baffle Stack Tie Rod
20	29	–	–	–	–	–	–	12	12	12	0132A1222P008	Impulse Pump Piston Ring
20	34	–	–	–	–	–	–	12	12	12	0153B9248G001	Impulse Pump Assembly Complete
20	36	–	–	–	–	–	–	6	6	6	0124C3241P004	External Probe Buffer
20	47	–	–	–	–	–	–	6	6	6	6420489P003	Resistor Cover
20	50	–	–	–	–	–	–	6	6	6	06477780G011	Interrupter Resistor Complete - Less Mounting Hardware - 1350 Ohms

*Recommended replacement parts
#Not identified
+Limited shelf life
† Only one of these spacers used per interrupter

FIG. NO.	REF. NO.	QUANTITY PER BREAKER									CATALOG NO.	DESCRIPTION
		FK-121-43000-4 and -5 1600 AMP	FK-121-43000-3 and -4 2000 AMP	FK-145-37000-6 and -7 1600 AMP	FK-145-37000-1 and -2 2000 AMP	FK-169-31000-2 and -3 1600 AMP	FK-169-31000-2 and -3 2000 AMP	FK-121-65000-0 2000 AMP	FK-145-55000-0 2000 AMP	FK-145-55000-0 2500 AMP		
20	51	–	–	–	–	–	–	6	6	6	0129C1057G001	Upper Baffle Stack
20	58	–	–	–	–	–	–	12	12	12	0153B9231G001	Back Pressure Valve Complete - Disassembled (With Adhesive)
20	*59	–	–	–	–	–	–	6	6	6	0153B5296P001	Lower Contact Stop
20	60	–	–	–	–	–	–	24	24	24	0177V0468P008	Buffer Rod Washer
20	62	–	–	–	–	–	–	24	24	24	0202A6365P001	Buffer Guide Rob Bushing (Textolite)
20	68	–	–	–	–	–	–	12	12	12	0202A6359P001	Shim for External Probe (0.020 Inch
20	68	–	–	–	–	–	–	6	6	6	0202A6359P002	Shim for External Probe (0.031 Inch
20	68	–	–	–	–	–	–	18	18	18	0202A6359P003	Shim for External Probe (0.062 Inch
20	*72	–	–	–	–	–	–	6	6	6	0124C3211P002	External Probe Contact
20	74	–	–	–	–	–	–	72	72	72	0124C3244P003	External Contact Finger
20	*#	–	–	–	–	–	–	6	6	6	0153B6710G001	External Contact Finger Assembly Complete
21	#	–	–	–	–	–	–	12	12	12	06477400P008	Interrupter Stroke Adjusting Washer
21	#	–	–	–	–	–	–	12	12	12	006370569P095	Contact Rod Guide Bushing (Textolite)
21	3	–	–	–	–	–	–	72	72	72	0153B5291P001	Transfer Fingers
21	8	–	–	–	–	–	–	6	6	6	0203A1775G003	Transfer Finger Assembly Complete
21	*9	–	–	–	–	–	–	6	6	6	0153B5296P001	Lower Contact Stop
21	*10	–	–	–	–	–	–	6	6	6	0104D5801G002	Short Contact Rod (Lower)
21	13	–	–	–	–	–	–	96	96	96	0202A6363P001	Shock Absorbing Spring Washers
21	*18	–	–	–	–	–	–	6	6	6	0153B5296P001	Upper Contact Stop
21	*21	–	–	–	–	–	–	6	6	6	0104D5801G007	Long Contact Rod (Upper)
31	3	6	6	6	6	6	6	6	6	6	0174V0123P003	Upper Baffle Stack Spacer
31	4	6	6	6	6	6	6	6	6	6	0175V0435P001	Intermediate Baffle Stack Spacer
31	5	6	6	6	6	6	6	6	6	6	0175V0433P003	Lower Baffle Stack Spacer
31	†7	6	6	6	6	6	6	6	6	6	0174V0123P003	Lower Height Adjusting Spacer 1-1/16 Inch High
31	†7	6	6	6	6	6	6	6	6	6	0174V0123P005	Lower Height Adjusting Spacer 1-3/32 Inch High

*Recommended replacement parts
#Not identified
+Limited shelf life
† Only one of these spacers used per interrupter

FIG. NO.	REF. NO.	QUANTITY PER BREAKER									CATALOG NO.	DESCRIPTION
		FK-121-43000-4 and -5 1600 AMP	FK-121-43000-3 and -4 2000 AMP	FK-145-37000-6 and -7 1600 AMP	FK-145-37000-1 and -2 2000 AMP	FK-169-31000-2 and -3 1600 AMP	FK-169-31000-2 and -3 2000 AMP	FK-121-65000-0 2000 AMP	FK-145-55000-0 2000 AMP	FK-145-55000-0 2500 AMP		
31	†7	6	6	6	6	6	6	6	6	6	0174V0123P006	Lower Height Adjusting Spacer 1-1/8 Inch High
31	†7	6	6	6	6	6	6	6	6	6	0174V0123P007	Lower Height Adjusting Spacer 1-5/32 Inch High
31	†7	6	6	6	6	6	6	6	6	6	0174V0123P004	Lower Height Adjusting Spacer 1-3/16 Inch High
37	*1	6	6	6	6	6	6	6	6	6	006370569P102	Toggle Link Upper Bushing (Textolite)
37	*2	3	3	3	3	3	3	3	3	3	006370570P002	Spline Shaft Bushing - Large (Textolite)
37	*3	3	3	3	3	3	3	3	3	3	006370569P001	Spline Shaft Bushing - Small (Textolite)
37	*4	2	2	2	2	2	2	2	2	2	006370568P055	Front Crank Lower Bushing (Textolite)
37	*5	2	2	2	2	2	2	2	2	2	006370568P055	Front Crank Upper Bushing (Textolite)
37	*6	2	2	2	2	2	2	2	2	2	006370569P009	Front Crank Pivot Bushing (Textolite)
37	*7	6	6	6	6	6	6	6	6	6	006448580P007	Toggle Link Lower Bushing (Textolite)
37	*8	6	6	6	6	6	6	6	6	6	006370569P009	Beam Bushing (Textolite)
37	*9	6	6	6	6	6	6	6	6	6	006370567P008	Lift Rod Coupling Bushing (Textolite)
37	*10	6	6	6	6	6	6	6	6	6	006370567P059	Lever Upper Bushing (Textolite)
37	*11	3	3	3	3	3	3	3	3	3	006370566P059	Lever Lower Bushing (Textolite)
37	*12	6	6	6	6	6	6	6	6	6	006370569P098	Rear Phase Rod Coupling Bushing (Textolite)
37	*13	6	6	6	6	6	6	6	6	6	006370569P001	Front Phase Rod Coupling Bushing (Textolite)
37	*14	3	3	3	3	3	3	3	3	3	0387A0313P004	Pole Unit Crank Bushing (Bronze)
37	*15	6	6	6	6	6	6	6	6	6	006370566P055	Guide Link Bushing (Textolite)
37	*16	3	3	3	3	3	3	3	3	3	0202A6370P001	Toggle Crank Bushing (Bronze)

*Recommended replacement parts
#Not identified
+Limited shelf life
† Only one of these spacers used per interrupter