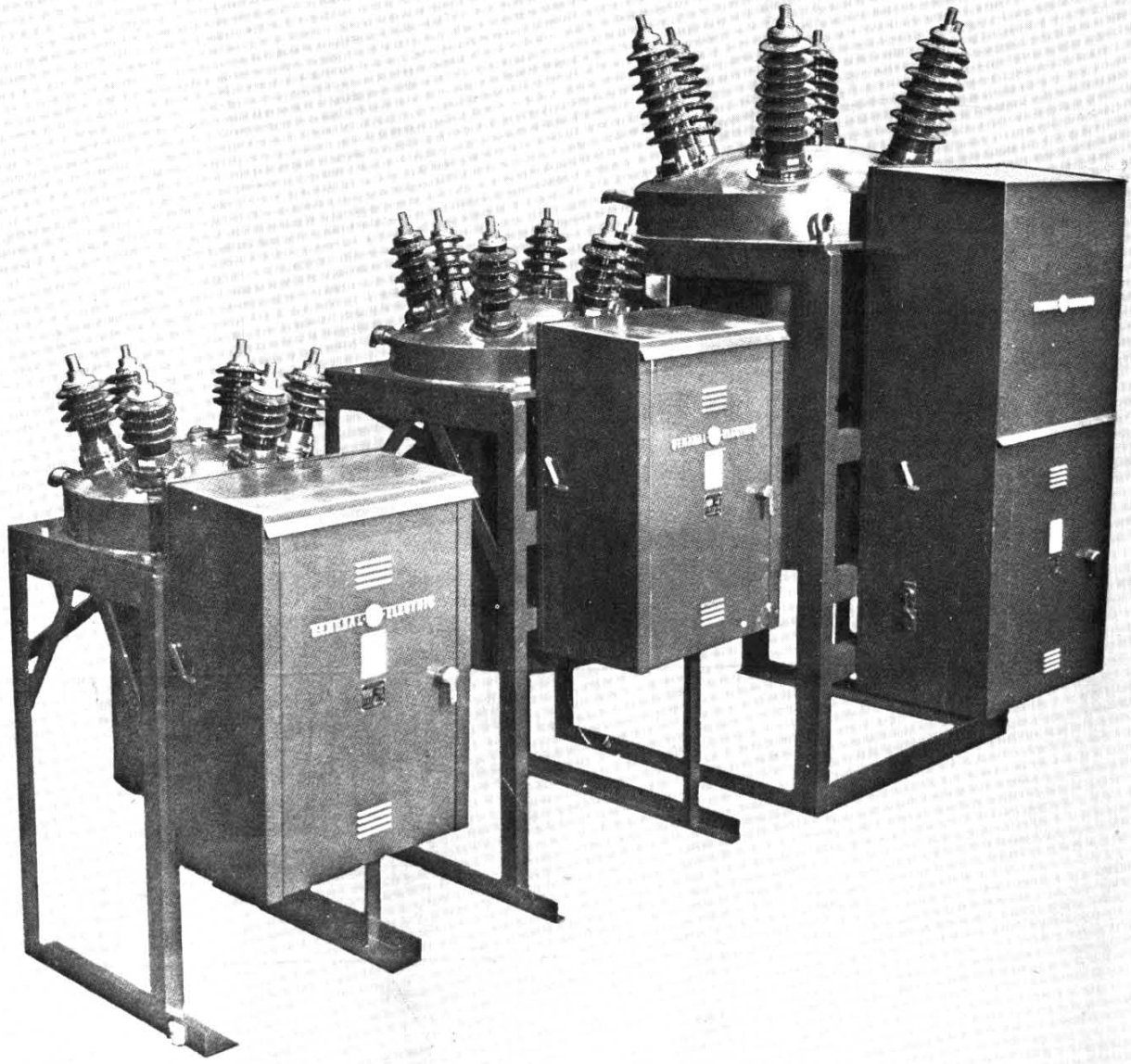
INSTRUCTIONS

1172L

OIL-BLAST CIRCUIT BREAKERS

TYPE KSO 14.4 kV TO 69 kV



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 nearest office of Canadian General Electric Company Limited.

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OIL-BLAST CIRCUIT BREAKERS

TYPE KSO 14.4 kV TO 69 kV

INTRODUCTION

These breakers are of the most modern design, incorporating the oil blast principle of arc interruption. The fast breaker interrupting time means less system disturbance because of a quicker clearing of the fault. The shorter arc length means lower maintenance because of reduced contact burning and oil deterioration.

These instructions apply to outdoor breakers rated 14,400 volts to 69,000 volts, with interrupting capacities as designated on the breaker nameplate.

The circuit breakers described may be used at any altitude up to 10,000 ft. if the proper bushings are selected. The operating mechanism is installed in a weather-tight housing attached to the circuit breaker framework, and its door provides accessability to all control parts. The breaker should not be installed in places where it will be called upon to operate at voltages or current greater than those on the nameplate. The short circuit conditions imposed should not exceed the breaker rating.

Proper installation and maintenance are necessary to insure continued satisfactory operation of the breaker. Section 19 of the Standard of the A.I.E.E., and the N.E.M.A. Switchgear Standard published by the National Electrical Manufacturers' Association, in addition to these instructions, are recommended for reference on the installation and use of the oil circuit breakers.

RECEIVING, HANDLING AND STORAGE

RECEIVING

All breakers are assembled and tested at the factory. They are shipped assembled in as completed a fashion as handling and transportation facilities will permit. Each breaker is carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment. Immediately upon receipt of a breaker, an examination should be made for any damage sustained in transit. If injury or rough handling is evident, a damage claim should be filed at once with the transportation company and notification made promptly to the nearest Canadian General Electric sales office.

HANDLING

For shipment to certain locations, it will be necessary to remove the bushings and interrupters.

When unpacking, the crating and boxing must be removed carefully. The bushing porcelains and other parts are sometimes damaged by the careless handling of uncrating tools.

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 may not be put in service for some time. The oil tanks should be cleaned and dried before they are filled with oil. The protective crating should not be taken from the bushings until the breaker has reached its permanent location and all overhead work completed.

If stored outdoors, the breaker parts which are not weather-proof should be thoroughly covered to protect them from the weather. Machined parts of the operating mechanism etc., should be slushed to prevent rusting and if the breaker is stored for any length of time it should be inspected periodically to see that rusting has not started and to insure good mechanical condition. The space heater in the mechanism housing should be energized as soon as possible in order to prevent moisture condensation inside the housing.

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

DESCRIPTION

The oil circuit breaker is composed of the solenoid mechanism and house, top frame and dome, bushings, stationary and moving contacts, and the breaker mechanism which transmits motion from the solenoid to the moving contacts.

The top frame supports the bushings, bushing current transformers, breaker mechanism and the removable tank. Figure 8 is a plan view of the dome and shows the relative position of bushing current transformers and bushing current transformer leads with respect to the mechanism. The transformer leads are brought out to the terminal blocks in the housing, making them easily accessible for connecting to meters and protective devices.

Figure 9 shows the linkage involved in transmitting the vertical travel of the solenoid to the breaker lift rod (6, Fig. 9). On a closing operation the coupling (22) is pulled down, rotates the bellcrank

and gives vertical motion to the link assembly (21). This in turn rotates the crank lever giving upward motion to the lift rods.

DASH POTS
Oil filled dash pots (Fig.10A), using the same kind of oil as in the breaker tank, absorb the energy of the moving parts at the end of the opening stroke. They are self-contained and will operate properly whether the oil tanks are filled with oil or not.

VENTING
Gases generated during circuit interruption are separated from the oil and vented to the outside by means of a pebble-filled chamber (Fig. 11) located in the top frame (1, Fig. 8).

TANK LIFTER
A pair of chain blocks serves as a tank lifter. Two men can raise the tank filled with oil quite readily. Clearance should be left to the rear of the breaker to allow for the removal of the tank for cleaning and maintenance purposes.

INTERRUPTER AND CONTACTS
The contacts consist of a stationary explosion chamber mounted on the lower end of the bushings, and moving blades and rods supported from the mechanism linkage.

Line-up of the chamber contact to the vertical position is important. The contact rod moves through the throat of the chamber and, therefore, the centre line of the chamber should coincide with the centre line of the contact rod.

The moving contacts consist of blades clamped to the lower end of the wooden operating rods and holding, by means of slotted supports, the adjustable contact rods (5, figure 9).

In mounting the adapter support and adapter, a spirit level should be used to make certain the chambers are lined up vertically. This vertical alignment can be adjusted by turning the adapter support on the centre line of the bushing or by loosening the bolts between the bushing and top frame and altering the angle of the bushing.

The moving contacts may be screwed in or out to obtain correct contact compression on all stationary contacts and to ensure that each phase is making and breaking at approximately the same time.

HEATERS
Thermostatically controlled heaters are provided in the oil tank and the operating mechanism house. The tank heaters are energized at 0°F. The house heaters are energized at 60°F. The tank heaters can be removed without draining the oil from the tank. Before draining the oil from the tank, the heaters should be de-energized.

INSTALLATION

Before installing the breaker, read these instructions and review the approved drawings which supplement these instructions. The drawings show the general arrangement, dimensions, location of foundation bolts, provision for conduit connection, electrical connections and other information necessary for the proper installation of the breaker. The approved drawings consist of a requisition summary, outline of the breaker, and the diagram of connections.

LOCATION
The breaker should be located so that it will be readily accessible for cleaning and inspection. It is important that sufficient space be provided for operation of the maintenance closing device. Where flood conditions exist, the mechanism housing should be above high water level.

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

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

Leads should be brought down from above if possible. Ample electrical clearance must be provided between leads and parts of the station, such as walls, channels, and framework. Leads should be properly supported so as not to put any unusual strain on the bushings. The bushing should not carry any cable or bus 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 end of the bushings. The bolts on the terminal connectors must be securely tightened to ensure good contact. All contacts must be clean, bright and free from dents or burrs.

CONTROL AND SECONDARY WIRING
All control wires should be run in conduit if possible. 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 them is sufficient to prevent possible communication in the event of a short circuit. Control wiring of adequate size

should be used so that with full operating current supplied to the control circuit, voltage across the mechanism terminals is within the limits specified as standard for the range of control voltage.

GROUNDING

The framework of each breaker should be permanently grounded. The usual practice is to connect a heavy cable from framework to ground, a bolted connector being supplied for this purpose. The cable should be able to carry 25% of rated current of the breaker but should not be smaller than #4/0.

WARNING

A GOOD PERMANENT LOW-RESISTANCE GROUND IS ESSENTIAL FOR ADEQUATE PROTECTION. A POOR GROUND GIVES A FALSE FEELING OF SAFETY TO THOSE WORKING AROUND THE BREAKER AND MAY RESULT IN ULTIMATE LOSS OF LIFE OR DAMAGE TO THE EQUIPMENT.

PRELIMINARY CHECKS

Before making any changes or adjustments to the breaker, read carefully the factory electrical and mechanical inspection sheets pertaining by serial number to the breaker in question.

Although the breaker has been completely set up, adjusted and tested at the factory, it is suggested that all adjustments be reviewed to see that no change has occurred during shipment and installation. Manual operation should be used for all preliminary inspections. The breaker should be operated by hand to see that it is smooth throughout the closing and opening strokes, that no binding occurs and that no excessive play is noticeable between parts. Electrical operation should only be attempted after it is certain that all adjustment have been made correctly.

The adjustments of the operating mechanism are not included in this book. The instruction book for the particular operating mechanism used should be referred to for details.

With the tank-lifter, the tank can be lowered, leaving the contacts and breaker mechanism accessible for inspection.

CAUTION

The trip latch of the operating mechanism is wired in place during shipment. This wire must be removed before inspection. All wire and blocks used to hold parts in place during shipment must be removed before the breaker is tripped open.

OIL

The specific high speed performance of the modern oil blast breaker is dependent upon the use of oil having the proper characteristics, refined under a controlled method by a reliable refiner to meet fully the rigid specifications of Canadian General Electric Company. A high dielectric strength is necessary to meet insulation requirements. A low freezing point is required for successful operation when installed locations subject to freezing temperatures. High resistance to carbonization minimizes the sludge and carbon deposits which reduce the dielectric strength and cooling effect of the oil. It is very important that the oil be free of all moisture as the presence of one tenth of one percent may reduce its puncturing resistance by fifty percent.

Before final adjustments are made, the oil tank should be filled with GE #10C oil. Precautions must be taken to insure absolute dryness and cleanliness of the apparatus before filling and to prevent the entrance of water and dirt during transfer of oil to the tank. Customers desiring detailed information on equipment and procedure for filtering G.E. #10C oil should obtain Bulletin GEA-4937 from the nearest CGE sales office. Before filling with oil, all accessories such as valves and gauges must be oil tight. The threads should be covered with glyptal or equivalent. Plugs are furnished for the outlet side of the drain valves and should be used to prevent any leakage should the valve seats become damaged from use. The normal oil level is indicated by the oil gauge and may vary from minimum to maximum, but should never drop below the visible portion of the glass.

While the oil is shipped in sealed containers, careless handling during shipment or storage may result in absorption of moisture by the oil. All new oil should be tested before being placed in the oil circuit breaker. The dielectric strength of the oil when shipped is at least 30,000 volts when tested in a standard gap with 1" disc terminals 0.1" apart. New oil of less than standard dielectric strength (30,000 volts) should not be put in the breaker tank until its insulating value has been brought up to standard (by filtering or other methods).

In filling, care must be taken so that moisture will not be absorbed by the oil. When cold drums are brought into a warm place they must be left standing until condensation has disappeared and drums are thoroughly dry. If the installation is outdoors, the preparation and filling must be done on a clear dry day or adequate protection of some kind provided against moisture being absorbed.

Metal or oil proof rubber hose must be used because oil dissolves the sulphur in ordinary rubber hose, this condition being undesirable as the sulphur attacks the copper in contacts, etc.

BREAKER ANALYSER CHARTS

When all breaker adjustments have been made, the

bearing surfaces of the mechanism properly lubricated, and the tank filled with oil, the breaker may be operated.

A travel analyser may be attached to the breaker to obtain an accurate travel record of breaker performance. The removable operating rod of the analyser screws into the top of the breaker crosshead, access through the dome being obtained with a removable pipe plug inserted for this purpose. A #10-24 hole is drilled in the cross head to receive the analyser rod.

Representative travel curves of opening, closing and trip free operations are illustrated in Fig. 6. It should not be necessary to make any adjustment to come within the limits shown. Any variation from the limits given in Table I should be reported to the nearest Canadian General Electric sales office.

FINAL INSTALLATION INSPECTION

(See Table 2)

After the oil circuit breaker has been installed with all mechanical and electrical connections completed, the following tests and inspections should be made. Reference should be made to the electrical and mechanical inspection sheets supplied with each breaker.

1. See that the breaker is properly set up and levelled on its foundation.

2. Close the breaker by hand and check the following points:
   (a) Interrupter port alignment (see figure 7).
   (b) Contact alignment.
   (c) Minimum clearance between blade and bottom of interrupter.
   (d) Stroke (see Table 2).
   (e) Clearance for all moving parts, connecting pipes, etc.
   (f) Distance between top plate and crosshead (see factory mechanical inspection sheet, and MAINTENANCE section.

3. Check that all nuts, bolts, washers, cotter pins, and terminal connections are in place and tightened.

4. Inspect and test all insulated wiring to see that no damage, possible grounds or short circuits have occurred during installation.

5. See that all bearing surfaces of the breaker operating mechanism have been properly lubricated.

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

7. Operate breaker electrically and check (refer to Fig. 6 and Table 2):
   (a) Operating times-
      1. Closing time from closing impulse till contacts touch.
      2. Opening time from tripping impulse till contacts part.
      3. Trip free time from contacts touch till contacts part on trip free operation.
   (b) Rebound (1/8 inch max.)

8. See that current carrying parts connected to the bushings are correctly installed according to standard practice and that all joints, whether made with bar or cable, are made correctly.

9. See that all covers and bolted connections are securely tightened and that all pipe plugs for inspection openings are tightened and glyptalled so as to prevent the entrance of moisture.

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

MAINTENANCE

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

1. At regular inspections:

   (a) The current carrying capacity of high pressure line or point contacts is practically independent of the condition of the contact surface. With sufficient contact pressure the area of contact is not important. Therefore, with these contacts, where arcing and current carrying functions are performed by the same contact, it is not necessary to maintain the surface of the contacts. As the contacts are burnt away by arcing, it may be necessary to readjust the contact compression and, when burned sufficiently, to replace the contacts.

   (b) The oil should be checked. Oil in service should be tested at approximately three month intervals. If the dielectric strength of the oil tests less than 16,500 volts, it should be filtered. When sampling oil, the sample container should be a wide mouthed glass bottle, cork stoppered, with at least one pint capacity. The bottle should be cleaned and dried and free from moisture before it is used.

Test samples should be taken only after the oil has settled for some time. Samples should be taken from the valve at the bottom of the tank and sufficient oil drawn off to make certain that the sample represents oil from the tank proper and not oil that is stored in the drain pipe. A glass receptacle is preferable 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.

(c) All insulation parts should be thoroughly cleaned to remove any trace of carbon which may remain when the oil is drained from the tank. It is recommended that the oil be removed and the tank cleaned, since the carbon which adheres to the side of the tank is not removed by filtering.

(d) The operating and breaker mechanism should be thoroughly checked and all bearing surfaces lubricated, using Imp. Oil Beacon 325.

(e) Dashpots should be checked and the pistons examined to that they work freely and function properly.

(f) All bolts, nuts, washers, cotter pins and terminal connections should be in place and properly tightened. The gland nuts, small valves and oil gauge should be checked to see that they are sufficiently tight to prevent leakage. In tightening gland nuts and gauge connections, care must be taken not to damage packing nor put undue strains on the gauge glass.

(g) Operate the breaker slowly by hand and then electrically; check the points listed under FINAL INSTALLATION INSPECTION in each case.

2. Be sure the breaker and its mechanism are disconnected from all sources of electric power before inspecting or repairing. After the breaker has been disconnected from the power lines, grounding leads should be properly attached before coming in contact with breaker parts.

3. Be sure the breaker framework is well grounded.

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

5. Clean the bushings at regular intervals. This is very important where abnormal conditions exist, such as salt deposits, cement dust or acid fumes, to avoid flashover as a result of accumulation of foreign substances on their surfaces.

6. See that the oil is kept at the proper level in the breaker tank.

7. The maintenance closing device is to be used in making adjustments only and should never be used to close the breaker on load. Care should be taken also to see that the breaker is never operated electrically with the maintenance jack in position.

8. The apparatus should always be operated by hand after any adjustments are made to make certain all parts are in order.

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

PREPARATION OF GASKETS AND GASKET SURFACES

These procedures apply for cork, neoprene, vellumoid, rubber and similar material.

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

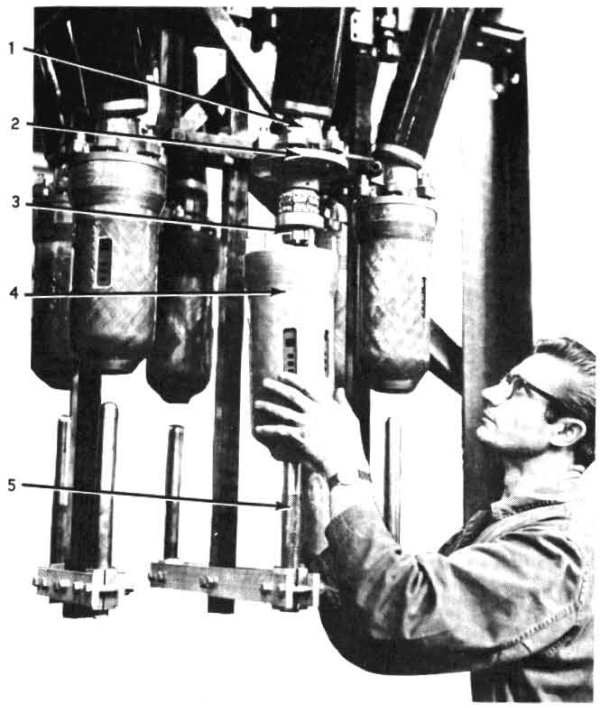
All surfaces, where gaskets (except rubber gaskets) are to be permanently assembled, should be given a full unbroken coat of "1201" compound. All gaskets (except rubber gaskets) for such joints should be given a similar coat. This should be done at such a time in the assembly cycle that the compound can be allowed to dry at least one half hour, and not more than twenty four hours, before assembly. In making up permanent joints, both the gasket and gasket surfaces should again be coated with Glyptal and the parts bolted up before the Glyptal sets.

For joints which have to be opened, the surface of the removable gasket should not be coated nor the part installed until the compound on the gasket is perfectly dry. The side of the gasket to be assembled against the uncoated surfaces should be greased to prevent sticking.

Rubber gaskets, due to their composition, do not require coating with compound or greasing as outlined above for gaskets of other material.

DASH POTS

Since very little oil is lost during breaker operation, the dash pots will require only periodic maintenance. The oil level can be checked by removing the cap on the outer end of the fill pipe leading to the inside of the dash pot cylinder. The fill pipe is located at the correct oil level. Oil can be added to the cylinder through this fitting.



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

Figure 1 Lowering the Interrupter for Inspection

VENT CHAMBER

There are no adjustments and no maintenance required unless the pebbles should be removed and cleaned. The elbow (4, figure 8) is removable for this purpose.

INTERRUPTER AND CONTACTS

With the oil tank removed, and the breaker in the open position, the interrupters can be lowered for inspection or repair by removing the six assembly nuts (6, figure 5) on the studs which pass through the lower adapter into the interrupter tube.

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

Before contact fingers can be changed, the spring retaining ring (6, figure 2), which is mounted around them, must be removed. This ring can be pried loose with a screwdriver after removing the cotter pins. To change the arcing fingers and the current transfer fingers, special tools are used to compress all the contact springs at the same time. See figure 2 and proceed as follows using tool 216A7445G1.

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

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

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

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

5. Turn the entire assembly upside down and press the entire length of the cylinder downward, as shown in figure 2.

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

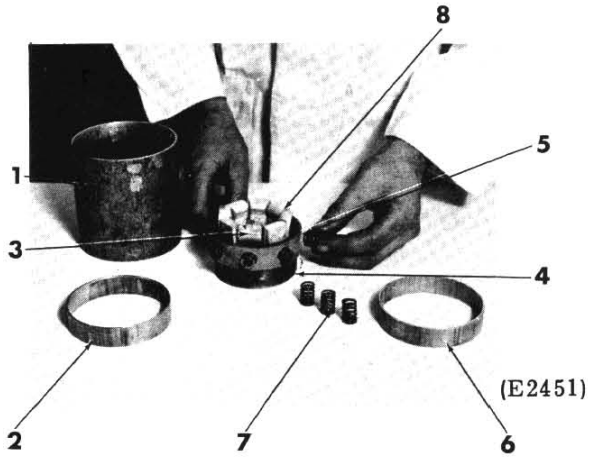
7. The assembly is now drilled and fastened with three cotter pins, spaced midway between fingers on the horizontal centerline of the retaining ring.

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

If this tool is not available, a large hose clamp which utilizes the screw or worm type of tightener can be used to compress the spring a sufficient amount to force the spring (14, figure 5) into the spring retainer (13) by using a small screwdriver as a lever. The spring retainer must be clamped by the hose clamp at the same time as the springs are clamped by having the edge of the spring retainer just against the springs.

If further disassembly of the interrupter is required, the upper spacer (10), the baffle stack (20) and lower spacer (22) can be lifted out. When reassembling, make certain that the exhaust slots in the baffles (20) face the exhaust ports (18) of the body tube.

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



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

Step 1

(E2450)

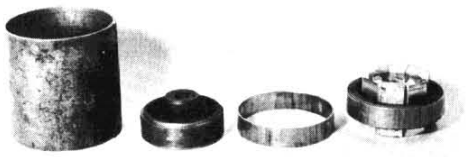
Step 2

(E2449)

Step 3

(E2448)

Step 4



(E2452)

Step 5

Figure 2 Assembling Contact Fingers

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

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

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

BUSHINGS

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

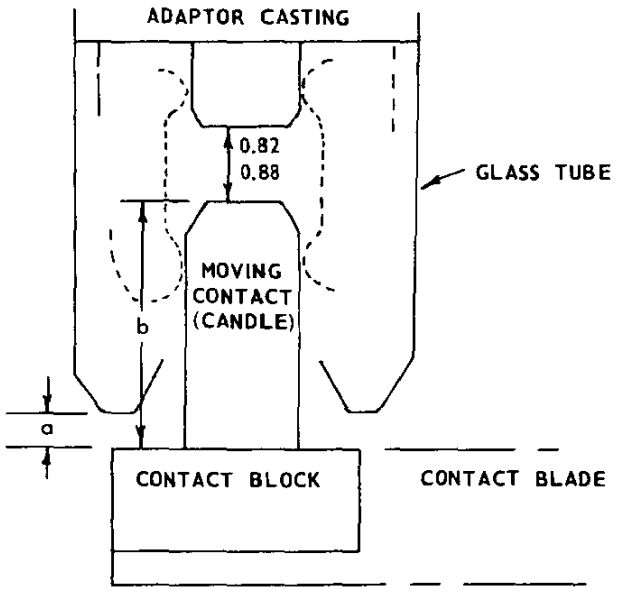
If removal of a bushing is required, it will first be necessary to remove the interrupter. The bushing can be removed and installed from the top of the breaker. When reinstalling the bushing, make certain that the gasket between the top frame and the mounting flange of the bushing is in good condition.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

BUSHING CURRENT TRANSFORMERS

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

Bushing current transformers are mounted in the top frame, as shown in figure 7. To remove the bushing current transformer, first disconnect the transformer lead wires. Loosen the adapter clamp (6, figure 13) and remove the interrupter unit. Remove the three assembly nuts (8, figure 6) permitting the supporting plate (7) and the current transformer (4) to be lowered.

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



Glass Tube Interrupter - See figure 14A

Figure 3

CONTACT WIPE ADJUSTMENT

34.5 KV, 1500 MVA,
46 KV, 1500 MVA,
69 KV, 5000 MVA.

1. Set the top dimension as shown on the assembly drawing (dimension is given from the crosshead bottom edge to the top of the top plate).

2. With the breaker closed, measure distance 'a' for each interrupter.

3. Add 'a' +
   9.06 *(1500 No Resis) = 'b' for each } Pre-1970
   9.74 *(1500 With Resis) interrupter } breakers
   9.74*(5000 No Resis)

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

   i.e. $\frac{69\text{-}5000}{13.56\text{-}3.00\text{-}0.82 = 9.74}$ (All)

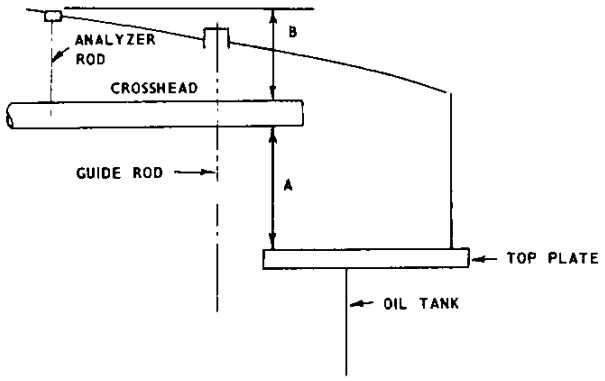
   $\frac{34.5/46\text{-}1500 \text{ No Resis}}{13.56\text{-}3.68\text{-}0.82 = 9.06}$ } Pre-1970 breakers

   $\frac{34.5/46\text{-}1500 \text{ With Resis}}{14.24\text{-}3.68\text{-}0.82 = 9.74}$ } Pre-1970 breakers

   $\frac{34.5/46\text{-}1500}{13.56\text{-}3.00\text{-}0.82 = 9.74}$ } All from 1969 SN 61348-46KV 61169-34.5KV

4. Adjust the candle length above the block to 'b'.

5. Check the contact touch for all interrupters with 6 - lights. Screw only the candles down (max. 1/8) to bring all touches simultaneously within 1/8 of lift rod travel.



Refer to figure 10, Breaker Mechanism

Figure 4

NOTE
The arcing tips may cause early touch and confuse the check.

6. Contact touch, as checked by lights, may be plotted as a touch line on the travel analyzer chart. The distance between this touch line and the fully closed line represents contact wipe and should be between 0.62 and 0.74 inch.

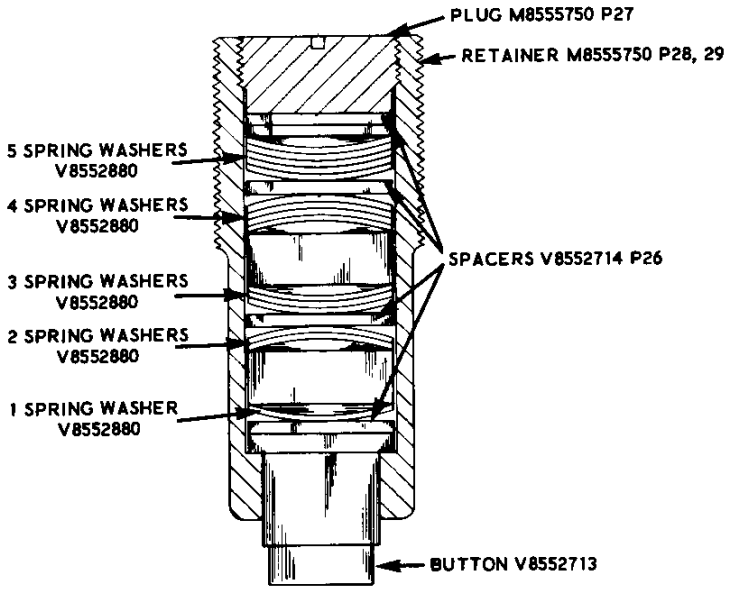
7. The opening springs for these breakers are enclosed in a housing in the dome. The housings have a gasketed top cap, and the springs are accessible from above by removing this top cap. At initial assembly, some shims may be included to increase the spring compression and thus increase opening speed. It should not be necessary to change the shimming during the life of the breaker.

CAUTION

Use caution at all times when removing the top cap. The cap may be against a loaded spring. NEVER REMOVE THE TOP CAP WHILE THE BREAKER IS CLOSED.

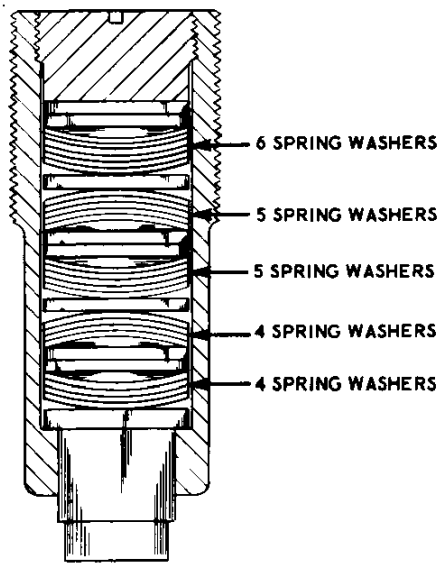
SETTING TOP DIMENSION - BREAKER CLOSED
34.5 KV, 1500 MVA,
46 KV, 1500 MVA,
69 KV, 5000 MVA,

ADJUSTMENT
Screw the front operating rod into or out of the clevis (left hand thread).



14.4 kV 500-1500 MVA
34.5 kV 500-1000 MVA
46 kV 500-1000 MVA

A



OTHERWISE SAME AS A
PART NUMBERS SAME AS A

34.5 kV 1500 MVA
46 kV 1500 MVA
69 kV 1000-5000 MVA

B

Figure 5 Buffer Assembly

SETTINGS

34.5 KV, 1500 MVA 46 KV, 1500	'A' should be 9.61
69 KV, 5000 MVA	'A' should be 10.94

NOTES

1. B. is a check dimension for the crosshead position which can be made from outside the tank, through the analyzer rod hole in the dome. This is now recorded for each individual breaker on its mechanical inspection report.

2. Note that the breaker closed position of the crosshead determines the amount of compression imparted to the opening springs which are in the dome. The higher the crosshead, the greater the compression, and the higher the opening speed. A crosshead set too high may result in springs going solid and severe shock to the structure.

BUFFER ASSEMBLY

The internal parts of the assembly must be completely free of grit, chips, burrs, etc. Slush the assembly of washers and spacers with light machine oil before inserting in the retainer. Do not apply excessive torque to the plug. While the plug is being assembled rap the button sharply several times to align the internal parts and relieve binding(see figure 5).

RENEWAL PARTS

It is recommended that sufficient renewal parts be carried in stock to enable the prompt replacement of any worn, broken or damaged part. It will be readily appreciated that a stock of such parts minimizes service interruptions caused by breakdowns and saves time and expense.

Table 1 is a list of parts which are most subject to wear or breakage and which are recommended for stocking. The number stocked will vary depending on severity of service and the time required to secure replacements, but a study of the following table will indicate a basis for ordering spares.

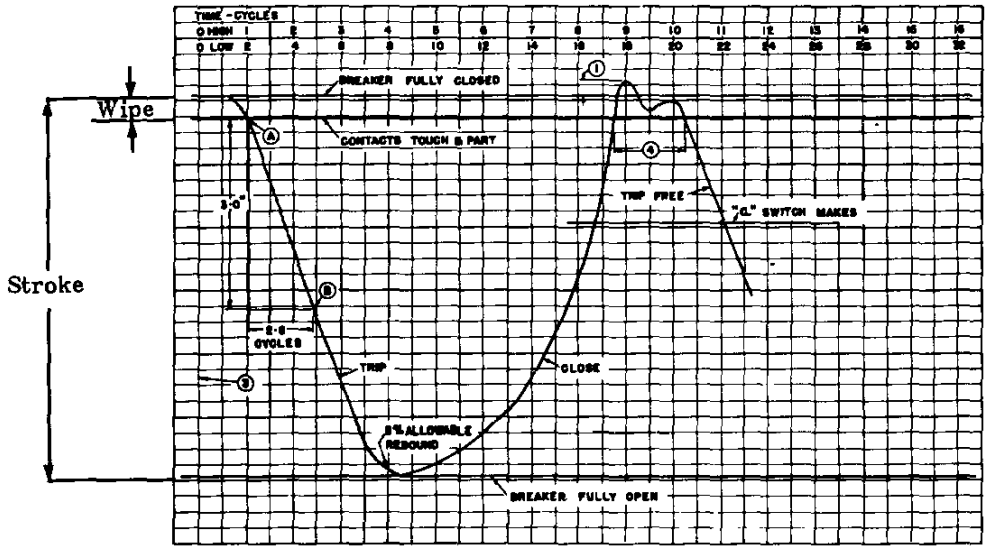
Type of Breaker	No. per Breaker							Recommended Stock														
								1 Breaker							5 Breakers							
	Bushing	Contact Finger	Contact Rod	*Contact Blade	Lift Rod	Lift Rod Guide	Oil Gauge Glass	Bushing	Contact Finger	Contact Rod	*Contact Blade	Lift Rod	Lift Rod Guide	Oil Gauge Glass	Bushing	Contact Finger	Contact Rod	*Contact Blade	Lift Rod	Lift Rod Guide	Oil Gauge Glass
KSO-14.4 KV 250/500/1000 MVA 600/1200/2000 Amps and 1500 MVA 1200/4000 Amps	6	36	6	3	3	1	1	1	36	6	0	1	0	1	3	72	12	2	3	1	2
KSO-14.4 KV 1000 MVA 3000 Amps	6	54	6	3	3	1	1	1	54	6	0	1	0	1	3	108	12	2	3	1	2
KSO-23KV 250/500 MVA 600/1200 Amps	6	36	6	3	3	1	1	1	36	6	0	1	0	1	3	72	12	2	3	1	2
KSO-34.5 KV 500/1000 MVA 800/1200/2000 Amps	6	24	6	3	3	1	1	1	24	6	0	1	0	1	3	48	12	2	3	1	2
KSO-34.5 KV 1500 MVA 1200/2000 Amps	6	48	6	6	3	1	1	1	48	6	0	1	0	1	3	96	12	2	3	1	2
KSO-46KV 500/1000 MVA 800/1200/2000 Amps	6	24	6	3	3	1	1	1	24	6	0	1	0	1	3	48	12	2	3	1	2
KSO-46KV 1500 MVA 1200/2000 Amps	6	48	6	6	3	1	1	1	48	6	0	1	0	1	3	96	12	2	3	1	2
KSO-69KV 1000/1500 MVA 800/1200 Amps	6	12	6	6	3	1	1	1	12	6	0	1	0	1	3	24	12	2	3	1	2
KSO-69KV 2500/3500 MVA 1200/2000 Amps	6	30	6	3	3	1	1	1	30	6	0	1	0	1	3	60	12	2	3	1	2

*The contact blade has two lengths, the longer blade for use on the centre phase. Recommended 1 long blade, 1 short blade.

Table 1 Renewal Parts Stocking

TYPICAL ANALYSER CHART AS TAKEN ON TYPE KSO 14.4–500 1200 AMPERE—OIL CIRCUIT BREAKER

(REFER TO TABLE 2 FOR VALUES ON BREAKERS OF OTHER RATINGS)



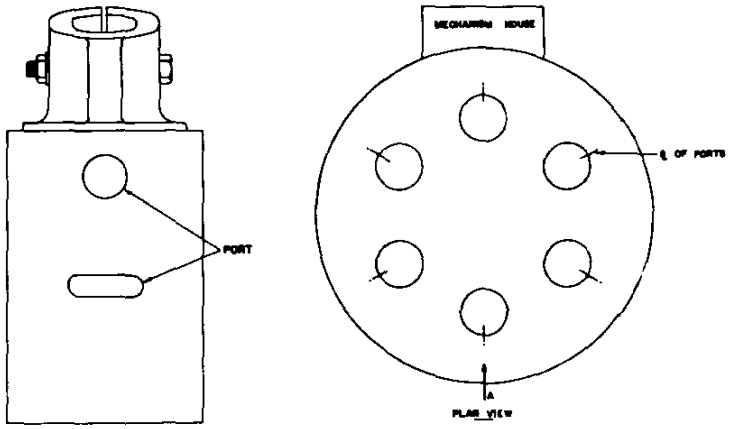
1. OVERTRAVEL ¼", MAX. ½"
2. AVERAGE OPENING SPEED FROM 'A' TO 'B'
   $\frac{60}{2.8} \times \frac{3}{12}$ = 5.4 FT./SEC. RANGE-5 TO 6 FT./SEC.
3. CLOSE & TRIP COIL ENERGIZED ON ZERO LINE
4. TRIP FREE TIME-CONTACTS TOUCH TO CONTACTS OPEN..3.0 CYCLES

A. CONTACTS PART
B. 3" FROM CONTACT TOUCH POSITION

(309C735)

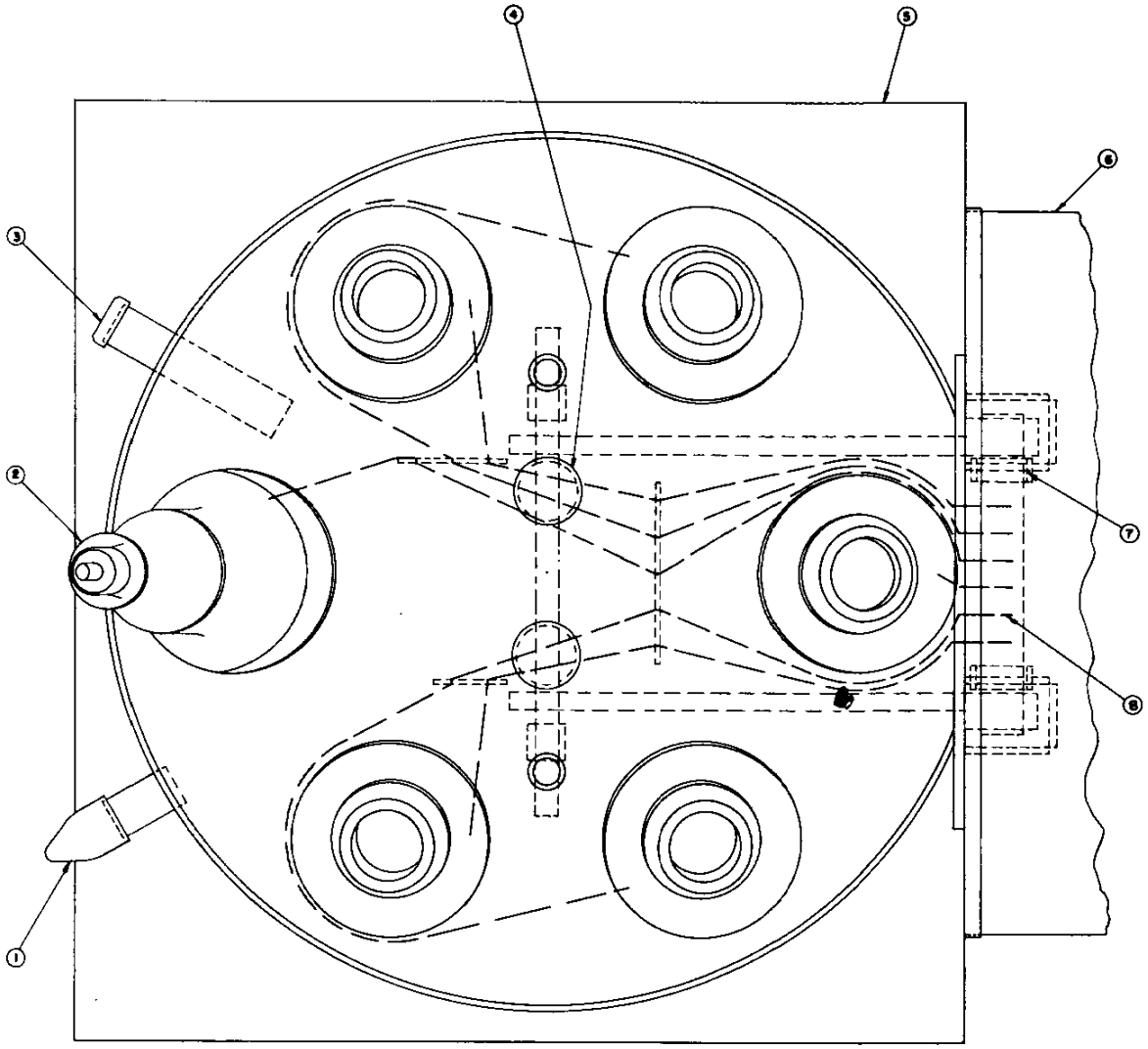
Figure 6

VIEW OF INTERRUPTER FROM ARROW "A" SHOWING PORT



(309C734)

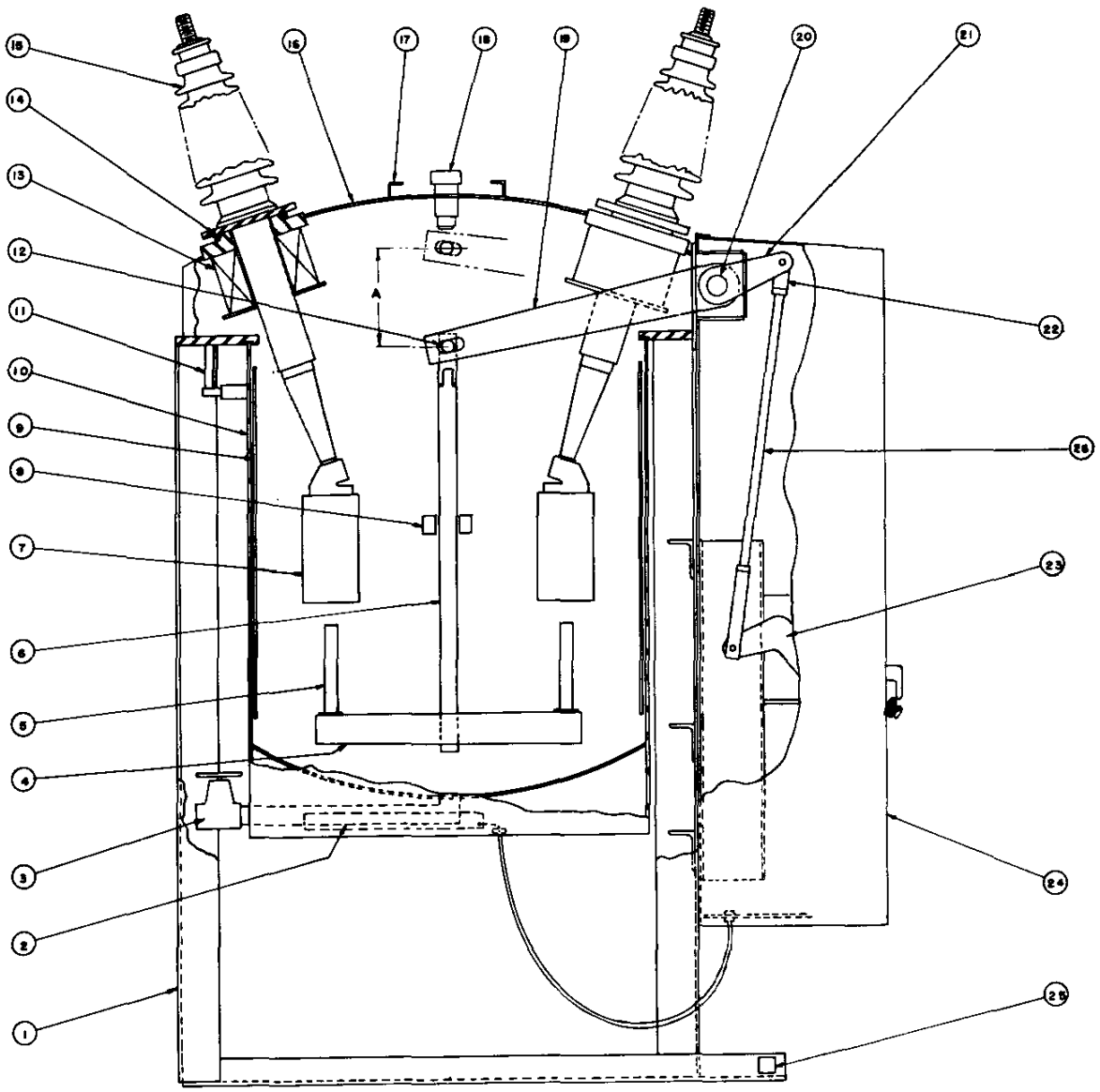
Figure 7



(498C800)

1. Separating Vent
2. High Voltage Bushing
3. Fill Valve
4. Buffer
5. Top Frame
6. Mechanism House
7. Shaft Bushing
8. Bushing Current Transformer Lead

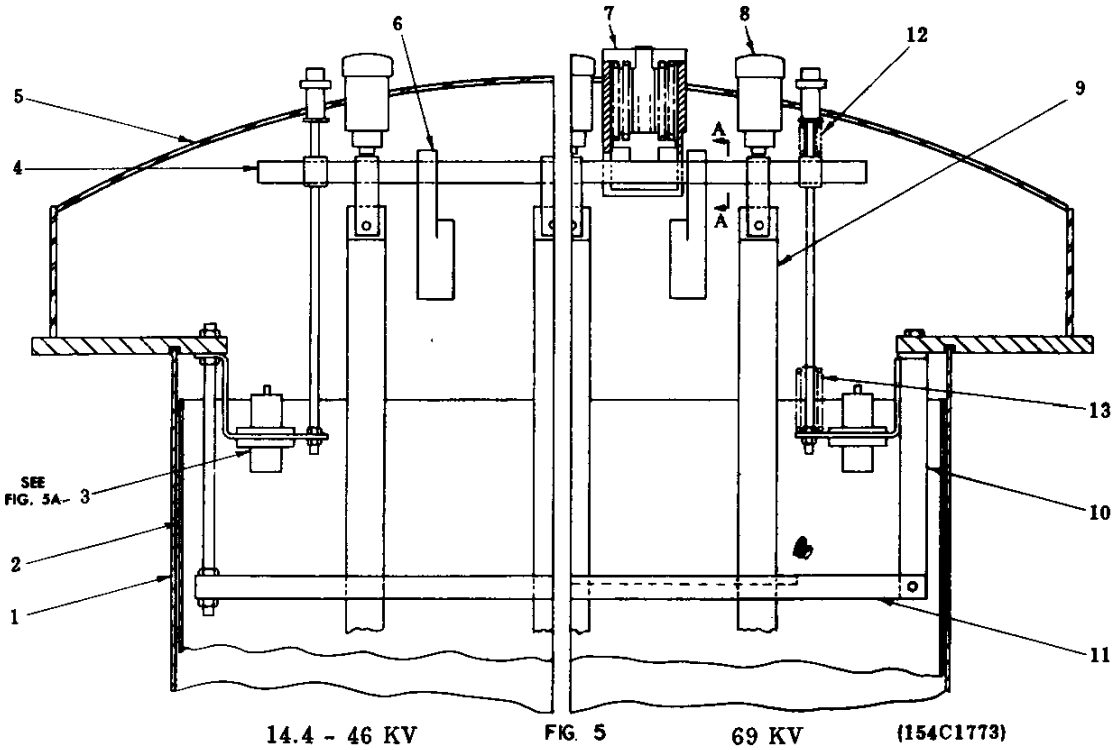
Figure 8 Plan View



(498C943)

1. Framework
2. Tank Heaters
3. Drain Valve
4. Contact Blade
5. Contact Rod
6. Lift Rod
7. Explosion Chamber
8. Guide
9. Tank Lining
10. Oil Tank
11. Oil Gauge
12. Crosshead
13. Bushing Current Trans.
14. Bushing Gasket
15. Bushing
16. Top Frame
17. Analyzer Support
18. Buffer
19. Crank
20. Spline Shaft
21. Lever
22. Adjustable Coupling
23. Solenoid Crank
24. Mechanism House
25. Grounding Terminal
26. Operating Rod

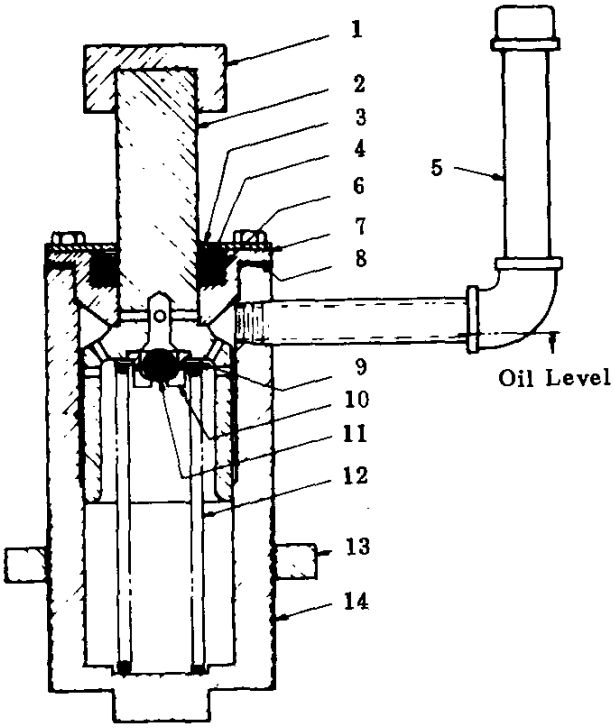
Figure 9 Sectional View Through Centre Phase



1. Tank
2. Tank Lining
3. Oil Dashpot
4. Crosshead
5. Top Frame
6. Crank
7. Opening Spring Assembly
+ 8. Buffer
9. Lift Rod
10. Guide Support
11. Guide
* 12. Opening Springs
* 13. Balancing Springs

\# 69 KV - 5000 MVA Only
\+ Not on 14.4 or 23 KV 28"
* 69 KV Only

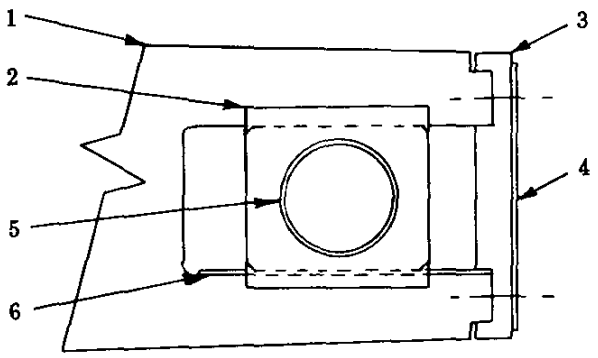
Figure 10 Breaker Mechanism



(P8591563)

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

Figure 10A Opening Dash Pot Assembly

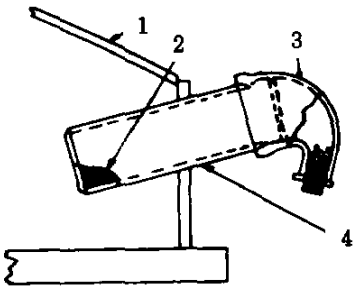


View A-A

(154C1773)

1. Side Crank
2. Side Crank Slider
3. Slide Retainer
4. Lock Plate
5. Bushing
6. Bearing Plate

Figure 10B Side Crank Bearing
69 KV 5000 MVA Only

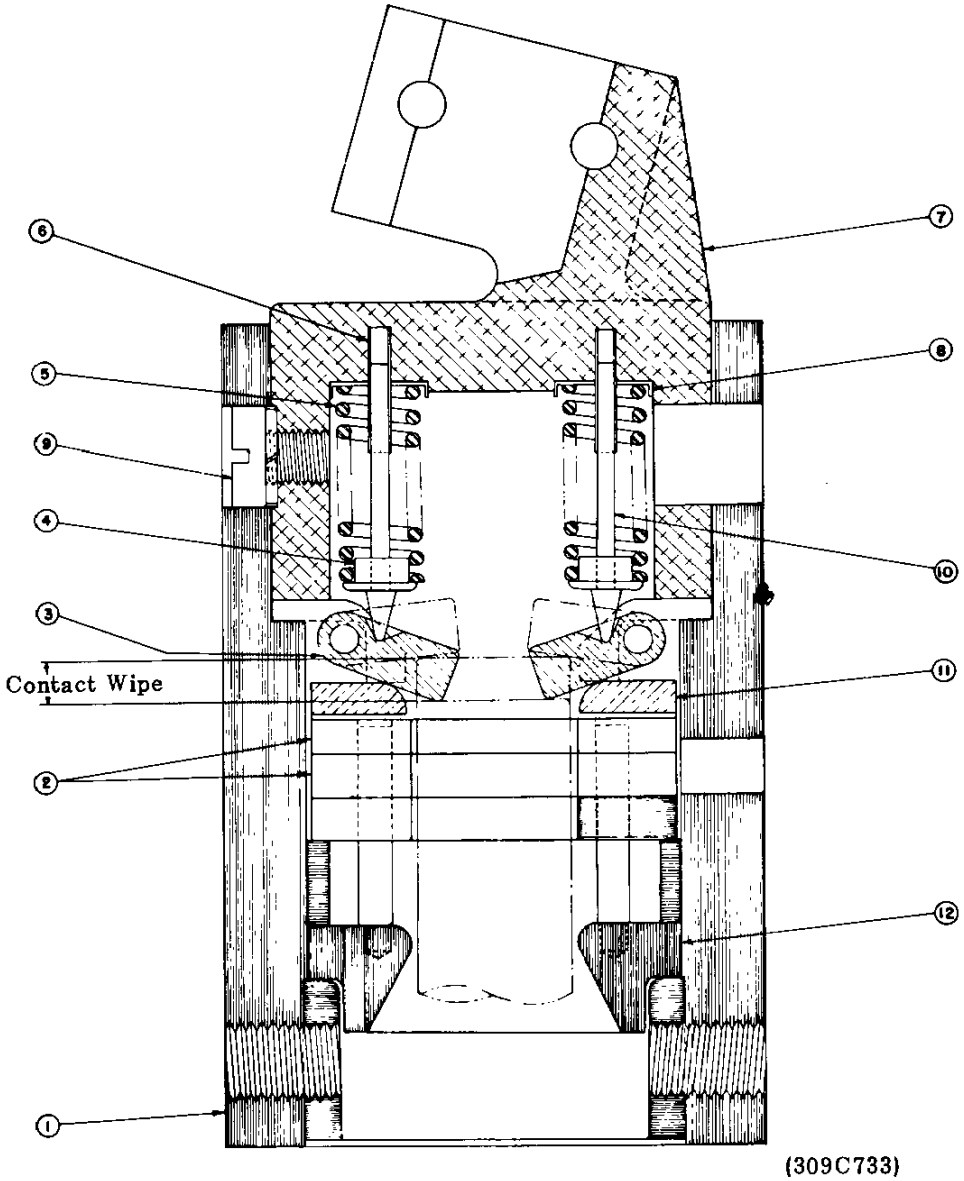


(498C944)

1. Top Frame
2. Pebbles
3. Street Elbow
4. Chamber

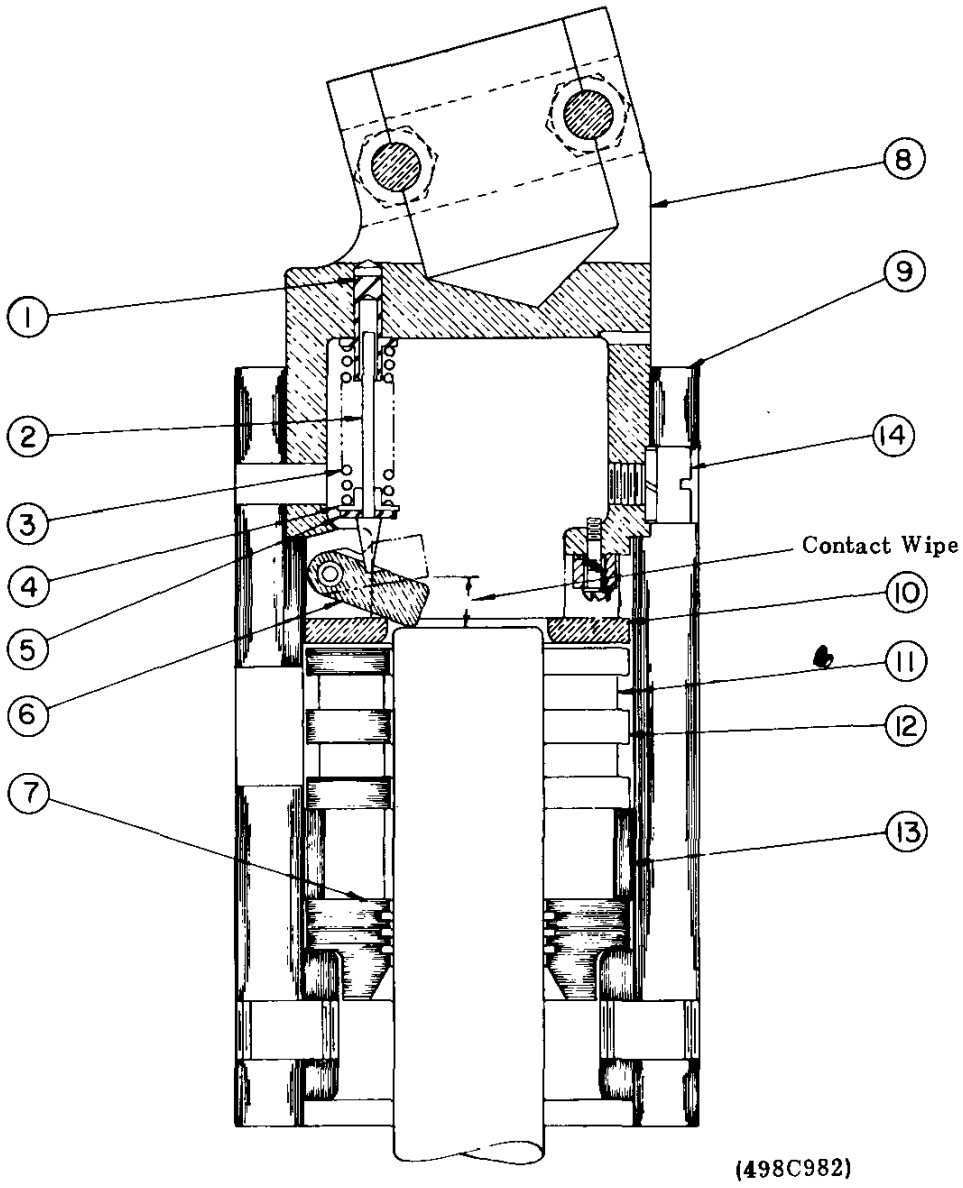
ROTATE ELBOW TO UPRIGHT POSITION FOR FILLING WITH PEBBLES FIT PIPE PLUG & RETURN TO DOWN POSITION.

Figure 11 Separating Vent



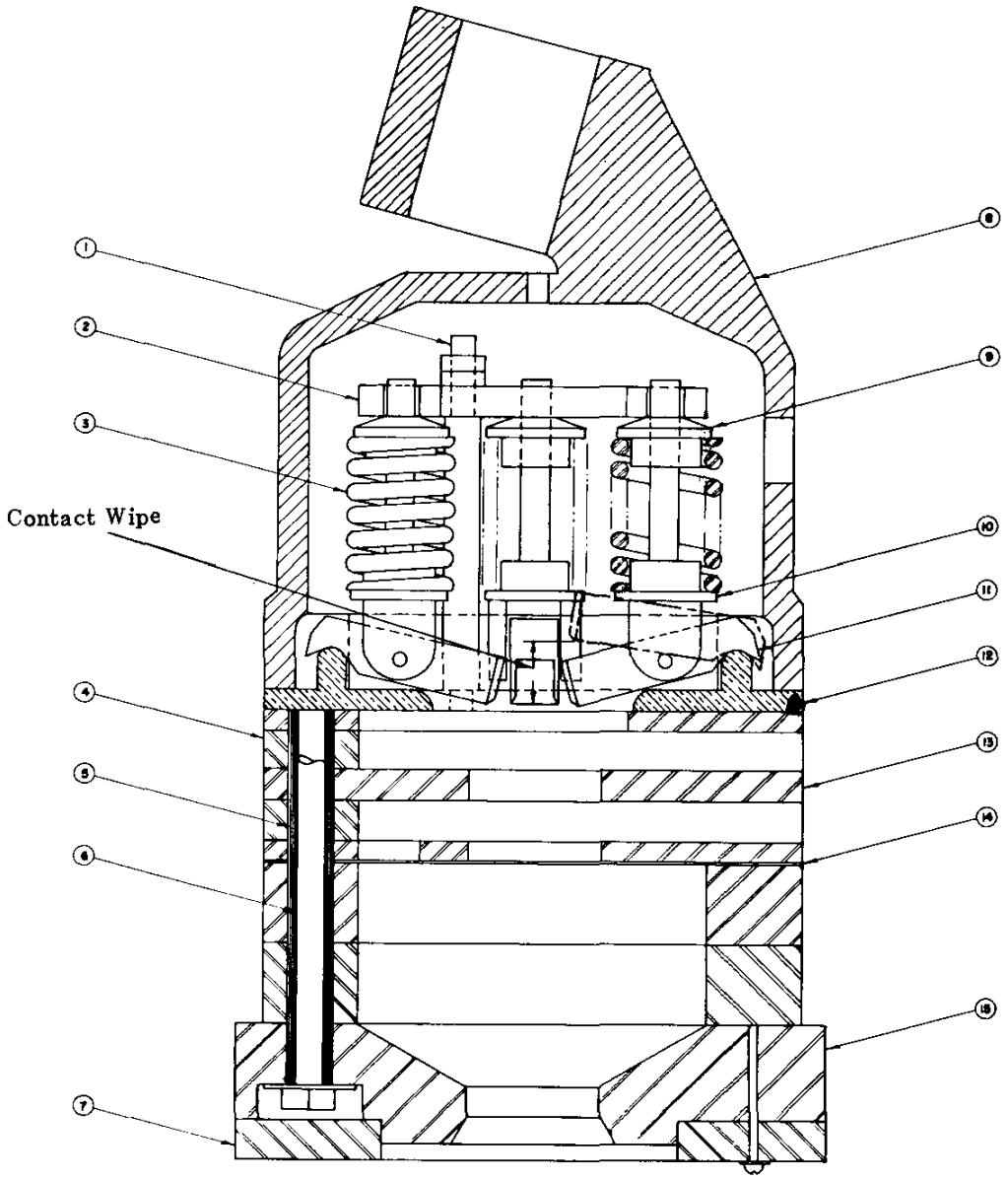
1. Explosion Pot Body
2. Jet Plates
3. Contact Finger
4. Spring Bushing
5. Spring
6. Guide
7. Adapter
8. Insulating Cap
9. Dowel Screw
10. Spring Stem
11. Stop Plate
12. Throat

Figure 12 Explosion Chamber (6 Fingers)
14.4 and 23 kV - 600, 1200 and 2000 Amperes



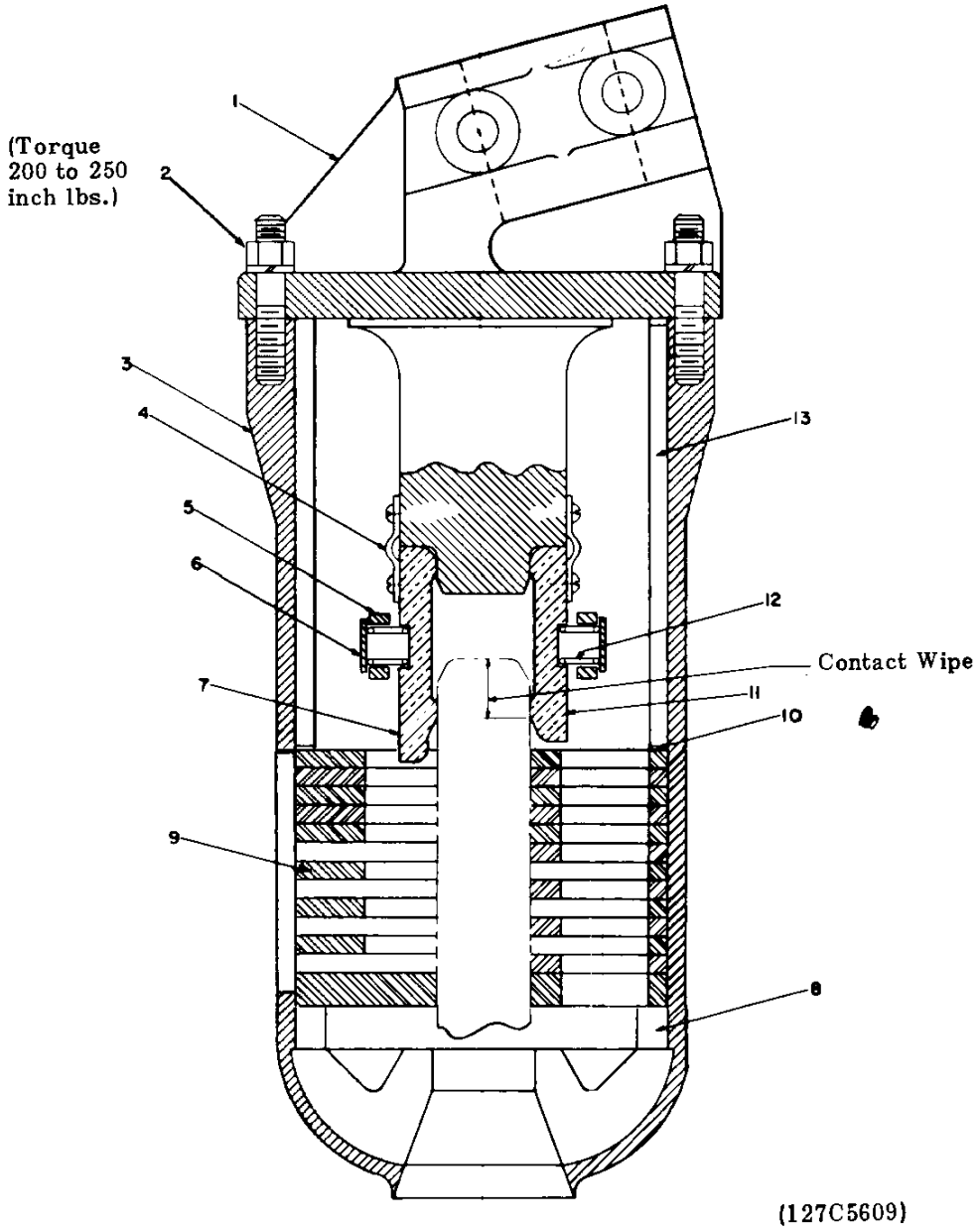
1. Guide
2. Stem
3. Spring
4. Bushing
5. Washer
6. Contact Finger
7. Throat Plate
8. Adapter
9. Body
10. Stop Plate
11. Jet Plate
12. Baffle
13. Spacer
14. Dowel Screw

Figure 13 Explosion Chamber (9 Fingers)
14.4 kV - 3000 Amperes



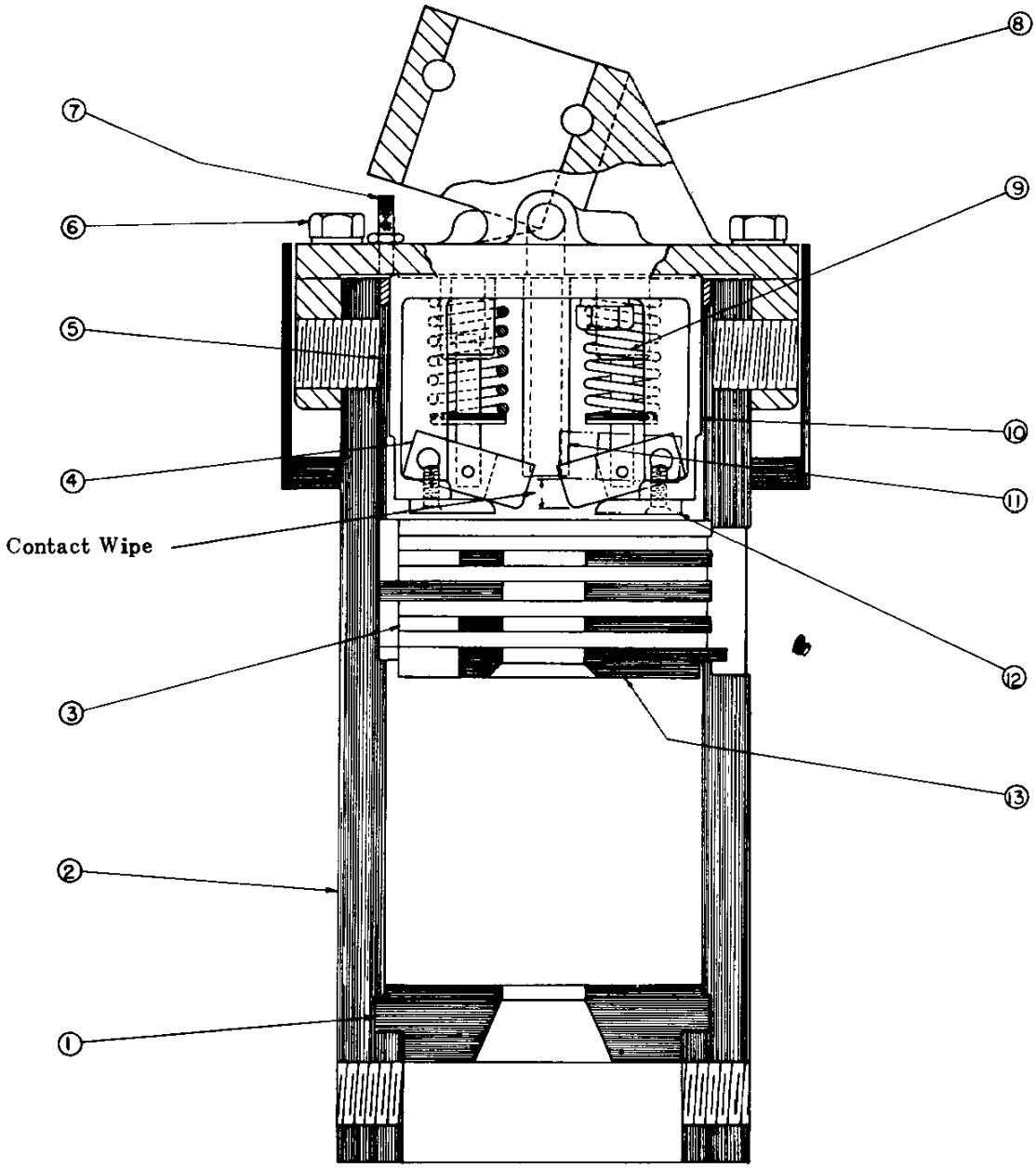
1. Stud
2. Guide Plate
3. Spring
4. Spacer
5. Tube
6. Dowel Screw
7. Insulating Plate
8. Adapter
9. Spring Seat
10. Spring Collar
11. Contact Finger
12. Base Plate
13. Baffle
14. Gasket
15. Throat

Figure 14 Explosion Chamber (4 Fingers)
34.5 and 46 kV - 600, 1200 and 2000 Amperes



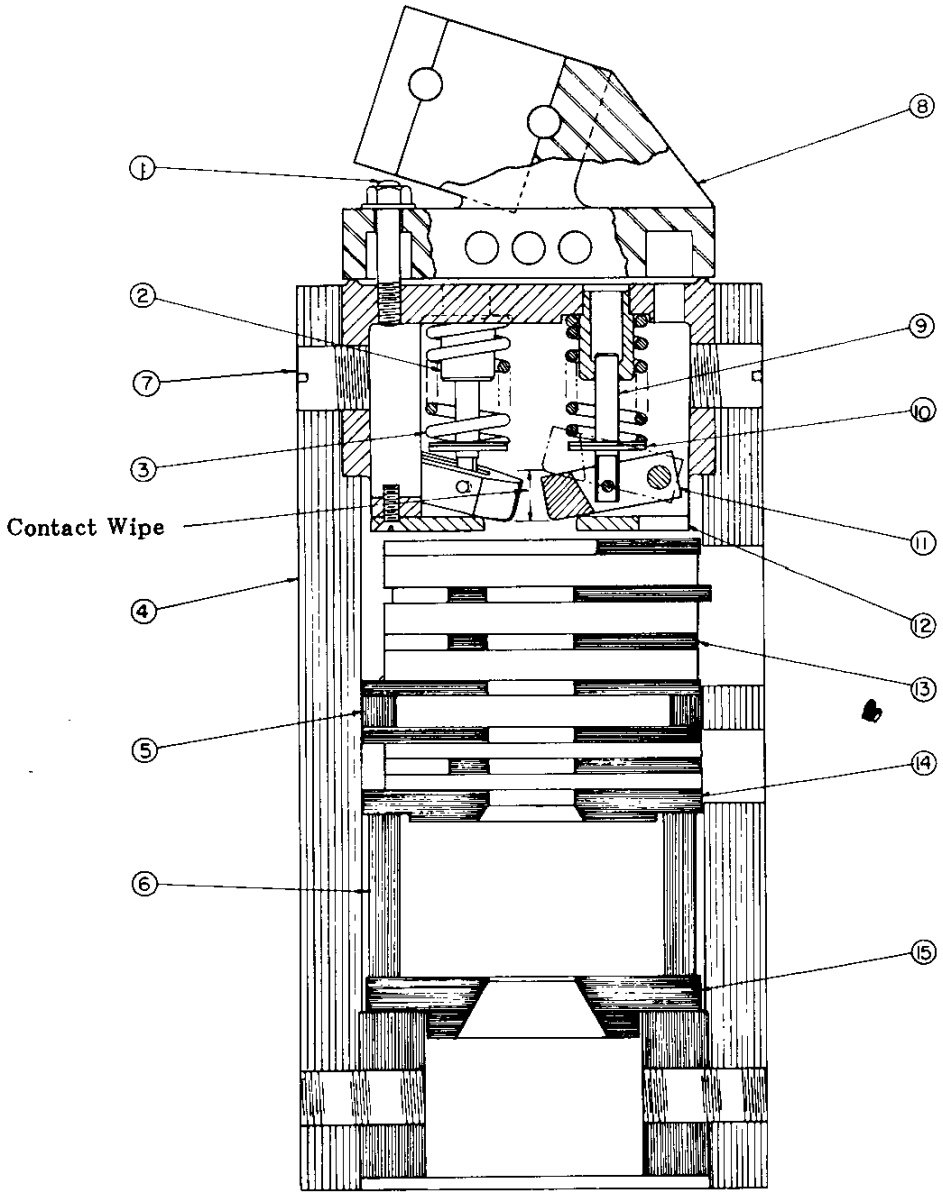
1. Adapter
2. Nut
3. Tube
4. Flexible Lead
5. Spring Cable
6. Spring Retainer
7. Lead Finger
8. Lower Spacer
9. Baffle Stack
10. Shims
11. Finger
12. Spring
13. Upper Spacer

Figure 14A Radial Cross Blast Interrupter (8 Fingers)
34.5 and 46 kV - 1500 MVA
69 kV - 5000 MVA



1. Throat
2. Chamber Body
3. Baffle Assembly
4. Contact
5. Spacer
6. Dowel Screw
7. Jack Screw
8. Adapter
9. Spring
10. Contact Base
11. Vent Tube
12. Arcing Plate
13. Inner Throat

Figure 15 Explosion Chamber (2 Fingers)
69 kV - 1000 and 1500 MVA



1. Stud
2. Guide Bush
3. Spring
4. Body
5. Spacer
6. Tube
7. Dowel Screw
8. Adapter
9. Spring Guide
10. Spring Collar
11. Contact Finger
12. Arcing Plate
13. Baffle Plate
14. Inner Throat
15. Outer Throat

Figure 16 Explosion Chamber (5 Fingers)
69 kV - 2500 and 3500 MVA

Type	KV	MVA Ratings	Current Ratings	Tank Size (Inches)	Mechanism Type	Stroke (Inches)	Contact Wipe (Inches)	Maximum Overtravel (Inches)①	Opening Speed (Ft/Sec)①	Maximum Rebound (Inches)①	Distance for Calculation of Opening Speed (Inches)①	Maximum Trip Time (Cycles)①	Maximum Trip-Free Time (Cycles)①	Maximum Closing Time (Cycles)①
KSO	14.4	500, 1000	600, 1200	28	SD-18	$6.00 \pm .25 / 0$	$.38 \pm .06 / 0$	.50	5.0-6.0	.25	3.00	3.5	4.5	23
KSO		500, 1000	2000							.32				26
KSO		1000	600, 1200	36		$8.50 \pm .25 / 0$				.25	5.00			30
KSO		1000	3000		SD-19	$10.00 \pm .25 / 0$	$.50 \pm 0 / .06$	.44		.38				35
KSO	23②	250, 500	600, 1200	28	SD-18	$6.00 \pm .25 / 0$	$0.38 \pm .06 / 0$	.50	5.0-6.0	.25	3.00	3.5	4.5	23
KSO	34.5	1000	800, 1200, 2000	36	SD-18	$10.00 \pm .25 / 0$	$0.75 \pm .06 / 0$	.50	6.0-7.0	.62	5.00	3.5	4.5	26††
KSO		1500	1200, 2000 2500		SD-19	$12.00 \pm .25 / 0$	$.62 \pm .12$		8.5-9.5	.50		3.5	4.5	30
KSO	46	1000, 1500	800, 1200, 2000	36	SD-18	$10.00 \pm .25 / 0$	$.75 \pm .06 / 0$	.50	6.0-7.0	.62	5.00	3.5†	4.5‡	26††
KSO		1500	1200, 2000 2500		SD-19	$12.00 \pm .25 / 0$	$.62 \pm .12$		8.5-9.5	.50		3.5†	4.5‡	30
KSO	69	1000, 1500	800, 1200	54	SD-18	$13.00 \pm .25 / 0$	$.62 \pm .06 / 0$	.38	6.5-7.5	.50	5.00	3.5†	4.5‡	35*
KSO		2500, 3500	800, 1200, 2000		SD-19				7.0-8.0					
		5000	1200, 2000				$.62 \pm .12$	.44	10.0-12.0	.38		3.0	4.0	

† 2.5 Cycles when pneumatic mechanism is used.
‡ 3.5 Cycles when pneumatic mechanism is used.
†† 12 Cycles when pneumatic mechanism is used.
* 18 Cycles when pneumatic mechanism is used.
① See Typical Analyser Chart Fig. 1 (Page 9) for reference.
② See PGEI-3421 for Modernized KSO 23KV

Table 2 Installation Inspection Data

POWER DELIVERY
DEPARTMENT
PETERBOROUGH, ONTARIO

CANADIAN GENERAL ELECTRIC

TPP-1-77