Instruction Book
Type 345SFP1500 Drawout Magnetic Puffer Circuit Breaker for 34.5 KV High Voltage Metal-Clad Switchgear

Westinghouse Electric Corporation

Switchgear Division, East Pittsburgh, Pa.

I.B. 32-352-2 Effective June, 1967

Table of Contents

List of Illustrations

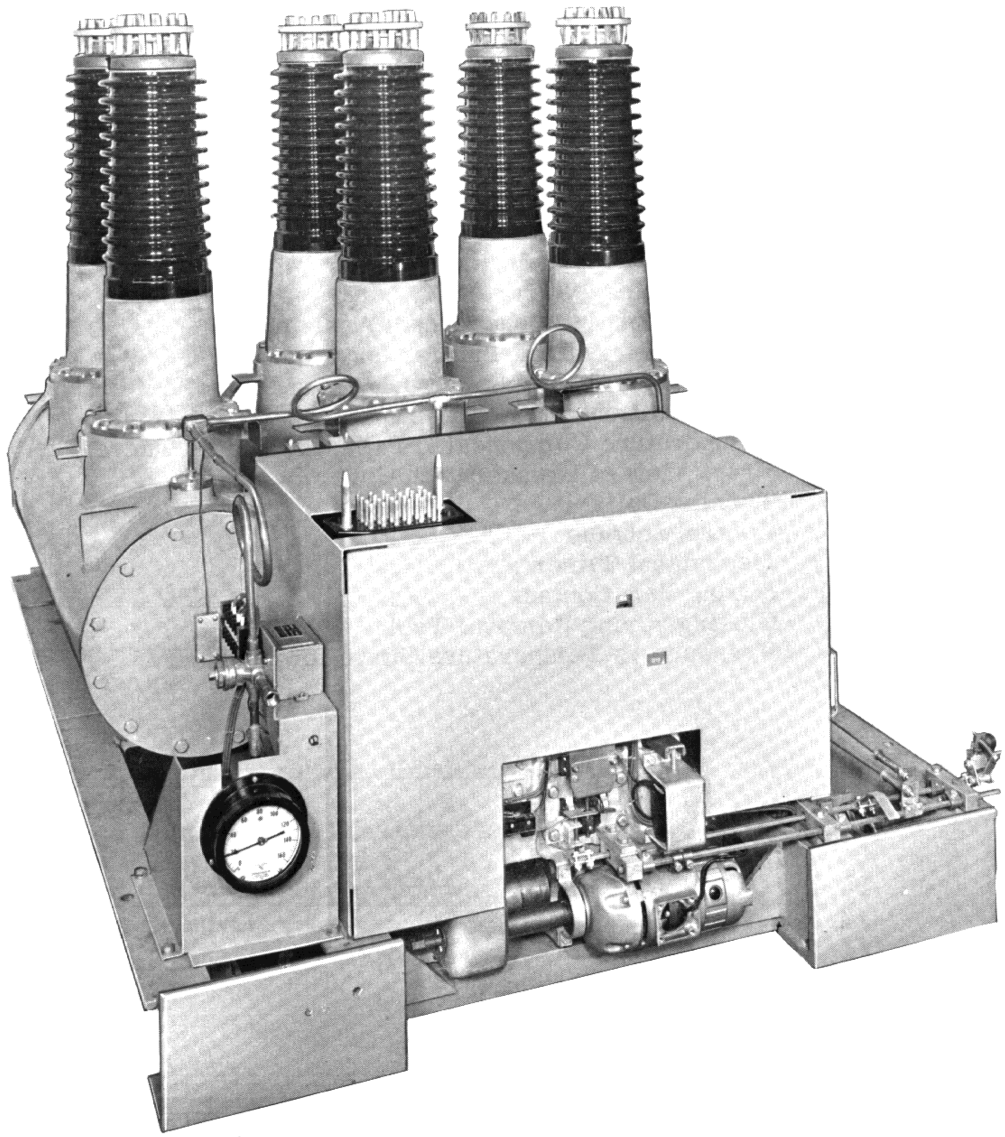


Fig. 1. Front View of Breaker

INTRODUCTION

The 345SFP1500 Magnetic Puffer Circuit Breaker is a modern high speed circuit breaker using sulfur hexafluoride (SF_6) gas as the interrupting medium. A new feature in this breaker is the magnetic assist which furnishes additional energy to drive the puffer piston against back pressure when interrupting large currents; thus permitting the extension of "single pressure" SF_6 breakers to much larger ratings than heretofore considered practical. The assist is provided by three coils (two moving and one stationary) which are inserted in series with the primary current during the opening operation. The result is a driving force tailored to the interrupting requirement. These breakers are applied by Westinghouse as part of 34.5 KV High Voltage Metal Clad Switchgear. The available ratings are listed in table at bottom of page.

Salient Features of Sulfur Hexaluoride Gas

Sulfur hexafluoride in a pure state is inert and exhibits exceptional thermal stability. More recently it has been found to have excellent arc quenching properties. These characteristics combined with its exceptionally good insulating properties make it an excellent medium for use in circuit breakers.

Sulfur hexafluoride remains a gas without condensation down to -30F at 47 psig. The density of SF_6 is about five times that of air (molecular weight equal to 146). Heat transfer by free convection is 1.6 times that of air at atmospheric pressure and 2.5 times the value of air at 30 psig.

Chemically, SF_6 is one of the most stable compounds. In the pure state it is inert, non-flammable, non-poisonous, odorless, and produces no harmful effects on personnel. However, after the gas has been exposed to an electric arc, there will be some breakdown of the gas. Activated alumina is used in the breaker to remove most of the gaseous by-products. These by-products are injurious and exposure to them should be avoided by maintenance personnel. The precautions to be followed in handling the gas are covered in detail under Maintenance.

At three atmospheres (30 psig) pressure, the dielectric strength is about 2.4 times that of air and about the same as oil.

There is some depreciation of the gas after extended periods of arcing; however, such decomposition is very slight and has a negligible effect upon dielectric strength and arc interrupting ability. Furthermore, the solid arc products formed at arc temperatures are the metallic fluorides, which are good insulators under the conditions used in the breaker.

Sulfur hexafluoride is furnished in standard industrial type cylinders, color coded green at the top end and the balance silver for easy identification. The cylinders have special size (.965" dia. -14 thds/inch Nat. Std. left hand) pressure connections supplied for absolute safety. The adapter for connection to the cylinder is a CGA #590 bullet

3 Phase Interrupting Rating MVA	Voltage Ratings				Interrupting Ratings - Amperes	
	Rated KV	Max Design KV	Min. KV For Rated Int. KV	Amperes Continuous 60	Rated Voltage	Max Amperes
1500	34.5	38	23	1200	25000	38000
1500	34.5	38	23	3000	25000	38000

shaped coupling nipple with .960 left hand, external male thread, 14 thds/inch. The breaker connection is .375 NPT (Female). The gas is stored in the cylinders at 300 pounds pressure and each cylinder contains 100 pounds of gas.

When transferring the gas from the bottles to the breaker, it is recommended that the bottles be set in a container of hot water. Due to the enormous amount of heat of vaporization required to vaporize the SF_6, it will probably be found that the water will not boil until the bottle is empty. It takes about 10 to 15 minutes to empty a bottle of gas.

The pressures developed while interrupting an arc in SF_6 gas are only a fraction of those developed in a liquid medium. The pressure from arcing in SF_6 is generated from the thermal expansion of the gas rather than from the formation of a large amount of dissociation products, such as occurs in a liquid medium. Furthermore, shock pressures are neither produced nor transmitted as in the liquid medium.

RECEIVING, HANDLING AND STORAGE

Receiving

When the circuit breaker reaches its destination, the Purchaser should check the material actually received against the shipping lists to be sure that all parts have been received. This will avoid delays in installation. If damage is found or suspected, file claims as soon as possible with the transportation company and notify the nearest representative of the Westinghouse Electric Corporation.

Handling

This circuit breaker is shipped completely assembled, with the three pole units mounted on a drawout truck. After the breaker is out of the crate, roll it on its own wheels only if the floor is smooth. To maneuver the breaker use the turning dolly. The total weight of the breaker is given on the nameplate. This information should serve as a guide to the strength of cranes or other lifting means required for handling the breakers.

When using cable slings for lifting the breaker do not allow the slings to strike the bushings, as any strain may cause the porcelain to crack or break. See Fig. 2 for location of slings under drawout truck.

Storing

If the circuit breaker is not to be installed immediately, storage facilities should be arranged to prevent any damage to it during this period. During storage, whether packed or unpacked, keep all parts in a clean dry place, warm enough and with enough clean air circulation to prevent condensation of moisture. This apparatus is insulated for high voltage and it must be protected from dirt and moisture at all times.

DESCRIPTION

General Description

The circuit breakers consist basically of three cylindrical steel tanks mounted horizontally and parallel to each other. Each tank contains sulfur hexafluoride gas (SF_6) at a pressure of 75 psig (at 70°F). A manifold system connects all three tanks. Primary bushings located vertically, near the ends of each tank, connect to an interrupter which is mounted coaxially within the tank. Each pole unit is bolted to a drawout truck which, at the front end, supports the operating mechanism. A pole unit consists of a tank, primary bushings and interrupter assembly. A stored energy mechanism closes the contacts and compresses the springs which provides the normal energy for opening the breaker.

The components briefly referred to in the preceding paragraph are described in detail under respective designations on following pages.

Tanks

The cylindrical tank has bolted end plates providing access to the inside. The tank end flange faces have annular grooves containing "0" rings, providing gas tight seals. Each tank contains a rupture disc assembly (Fig. 3) as protection against excessive pressures being developed within the vessel. It should be noted that the flat side of the carbon rupture disc is assembled inward, and if replacements are ever made it is important that this position be followed, as reversing the position affects the blowout pressure. The rupture disc is located at the center bottom of the tank to control the direction of fragments in the event of rupture and protects the disc from accidental damage. The neoprene rubber disc on the inside of the tank will probably be bubbled inward. This results from evacuating the tanks and is no cause for alarm.

Two parallel vertical flanges located near either end of the tank mount the primary bushing support. These flange faces also have annular grooves containing "0" rings, providing gas tight seals.

The manifold flange is located at the top of the tank near the small end. An "0" ring is used as a gas tight seal but it is part of the manifold assembly.

The tanks are designed and constructed in compliance with the ASME BOILER and PRESSURE VESSEL CODE FOR UNFIRED PRESSURE VESSELS, SECTION VIII.

Bushings

The bushings on these breakers are SF_6 insulated. The conductor consists of a copper tube supported at either end by the upper and lower porcelain insulators. The upper insulator is ribbed and glazed but the lower porcelain has a smooth truncated conical surface. Heavy springs keep a compressive load acting on the gasket seals located on the top and bottom of the upper insulator and also the supporting flange to provide gas-tight seals. The SF_6 gas is supplied from the breaker tank. The external surface of the lower porcelain is protected with a coating which is highly resistant to the arc products. "0" rings are used to seal the supporting flanges to the tank. See Fig. 5 for construction details.

Interrupter

The interrupter, Fig. 6 and 7, is comprised of a front main stationary and arcing contact assembly, combination front main moving, arcing, and piston assembly (including TFE Fluorocarbon interrupting chamber, piston coil, rear main moving contacts, and driver coil), rear main stationary contacts, and cylinder coil. A piston tube encloses and supports the component parts of the interrupter.

In the closed position the current path is from the left primary bushing to the front main stationary contact and into the front main moving contact. The current travels through the main moving contact tube to the rear main moving contacts and into the rear main stationary contacts. The current then travels from the rear main stationary contact mounting to the right primary bushing.

Upon opening, an arc is drawn between the front main moving contact and the front main stationary contact, also an arc is drawn between the rear main contacts at the other end of the piston assembly. The flow of SF_6 gas between the main contacts transfers the arc from the front main moving contact to the moving arcing contact which is located within the front main moving contact and projects a short distance beyond the end of the front main moving contacts. The other terminal of the arc is moved from the front main stationary contact to the stationary arcing contact which is within the front main stationary contact. The three series coils are inserted into the primary circuit when the arc is transferred to the moving arcing contact and the arc at the rear main contacts is extinguished. To trace the path of the primary current through the three series coils refer to Fig. 7.

With primary current flowing in the series coils, the piston coil is attracted to the cylinder coil and the driver coil is repelled from the cylinder coil. These additive forces (which are proportional to the square of the current) aid the mechanism in getting a high velocity flow of SF_6 gas through the orifice (center of stationary arcing contact) at high currents. The mechanism supplies the energy to compress the SF_6 gas for normal currents. The interrupting function is preformed by high velocity flow of SF_6 gas through the orifice. The moving, stationary, and arcing contacts are faced with a tungsten arc resistant material.

The sliding ball contact (Fig. 6 and 19), which is part of the cylinder coil assembly, transfers the primary current from the cylinder coil to the lower guide rod (.75 dia).

Stored Energy Mechanism

The stored energy mechanism is shown in Fig. 8. The mechanism consists of the following basic components, motor, gears, and eccentric cam for charging the springs, spring charging and spring release parts, closing cam and tripping linkage, closing springs, mechanism frame and air bumper assemblies, spring release and tripping coil assemblies, and auxiliary switch, position indicator, and operation counter assembly.

The mechanism may be in any one of the 4 normal conditions as follows:

1. Spring discharged and breaker open
2. Spring charged and breaker open
3. Spring discharged and breaker closed
4. Spring charged and breaker closed.

Figures 12a and 12b are schematic views of a section of the mechanism as would be seen from the right side of the breaker. The driving pawl is actuated by an accentric cam, driven through gears by the charging motor, until charging is complete. The holding pawl holds the ratchet wheel during the back travel of driving pawl. The closing springs are held compressed by the spring release latch and in turn by the spring release trigger. It will be seen that rotation of the ratchet wheel is counter clockwise and that the connecting rod is slightly over horizontal dead center with the closing spring fully charged. It stops at that point because the cam roller bumps against the spring release latch. You can hear this at the end of the charging operation. When the spring release trigger, extending out from the mechanism frame and cover, is released by lifting the trigger either by hand or electrically, the cam roller is freed and the cranks, shaft, ratchet wheel and cam rotate rapidly counter-clockwise for about one-half turn as shown in Fig. 12b. This closes the breaker. The motor limit switch is closed by this operation and the spring is immediately charged again back to the position in Fig. 12a.

Figures 13a, -b, -c, -d, show the four conditions of the closing cam and tripping linkage. Note that in Fig. 13a, in which the breaker is open and the spring is discharged, the tripping trigger is in the tripped position. As the spring is charged, the tripping trigger snaps into the fully reset position as in Fig. 13b near the end of the spring charging operation.

In Fig. 13c the linkage is shown in the breaker closed position and before the spring has been recharged. Note that the closing cam has rotated about one-half turn, corresponding to the rotation of the cranks and ratchet wheel of Fig. 12a and 12b. Rotation of the closing cam pushes the closing roller so as to rotate the main shaft of the mechanism and close the breaker. This is possible because the restraining link between the closing roller and the tripping cam prevent the closing roller from moving to the right. The restraining links cause the tripping cam to push against the tripping latch, which pushes downward, on the left end, on top of the tripping trigger. Figure 13d shows the breaker in the closed position after the spring has been recharged. Note that the closing cam has rotated about one-half turn. The cam for this portion of the travel is cylindrical and causes no further movement of the closing roller. This rotation corresponds to the spring charging rotation of the ratchet wheel shown in Fig. 12a and 12b.

Lifting the tripping trigger either by hand or by the tripping magnet causes release of the tripping latch, tripping cam and closing roller, which opens the breaker and the linkage moves to the position shown in Fig. 13b.

The mechanism is mechanically trip free, breaker can be tripped during any part of the charging cycle. At the end of the opening motion, air bumpers (DASHPOTS) are used to absorb excess energy and act as stops for the mechanism.

Mechanical Linkage

The motion of the stored energy mechanism is transmitted through a turnbuckle to the pole units. The motion of the turnbuckle is transmitted through a lever and shaft assembly Fig. 3 to a lever on the inside of each tank. This lever is connected to the piston assembly by two rectangular insulating bars.

The shaft seal is provided by series of TFE Fluorocarbon "V" rings which are expanded against the shaft and the housing by the axial loading of a strong compression spring (Fig. 3). The shaft is supported at either end by bearings.

The accelerating spring assembly (Fig. 4) is located behind the stored energy mechanism. The springs are compressed during the closing motion of the mechanism and supplies the energy to accelerate the breaker on opening during normal switching operations. The balance of the opening force is supplied by magnetic puffer series coils acting directly on the moving contact and piston assembly in each interrupter on short circuit currents.

The turnbuckle block that connects to the mechanism has a dim. "D" stamped on it and also whether this turnbuckle link is for right, center, or left (R, C, or L) pole unit. This dimension is the measurement between the turnbuckle blocks when the breaker contacts were adjusted at the factory. The turnbuckles should not be interchanged between poles. Read Contact Adjustment in Maintenance Section of this I.B. before changing the length of any turnbuckle.

Temperature Compensated Pressure Switch

A temperature compensated pressure switch which operates on falling pressure is used to give an alarm at an intermediate pressure between normal operating pressure and a pressure at which there isn't sufficient gas pressure for a successful opening operation. Switch No. 1 is used for the alarm system and Switch No. 2 is used to prevent closing the breaker, and also cause tripping, for low pressure, if the breaker is closed. The differential between the two switches is nominally 6 psig, See Fig. 14. The temperature compensating bulb is mounted on front of the left tank.

Interlocks - Automatic Tripping

Fig. 15 shows the automatic tripping devices mounted on right side of breaker.

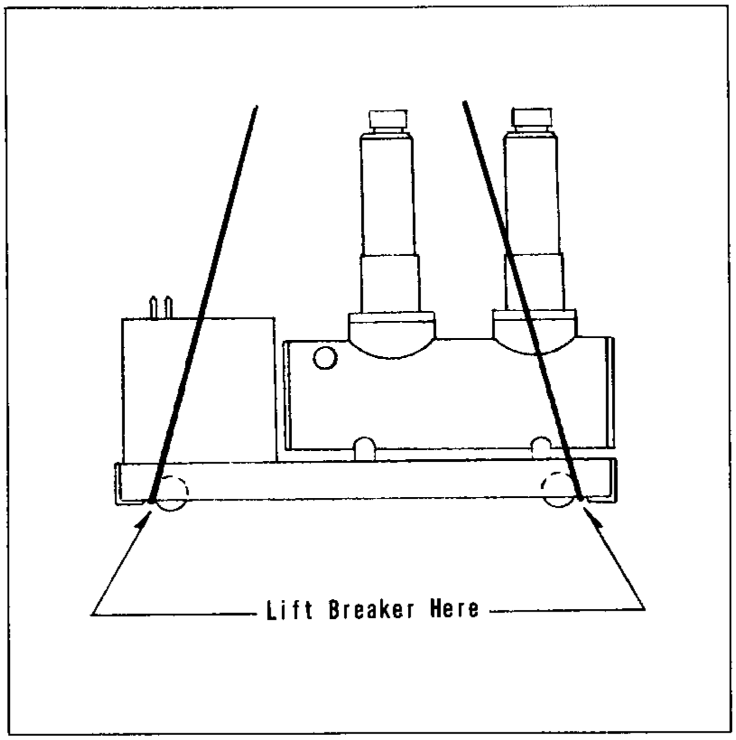


Fig. 2. Sling Location

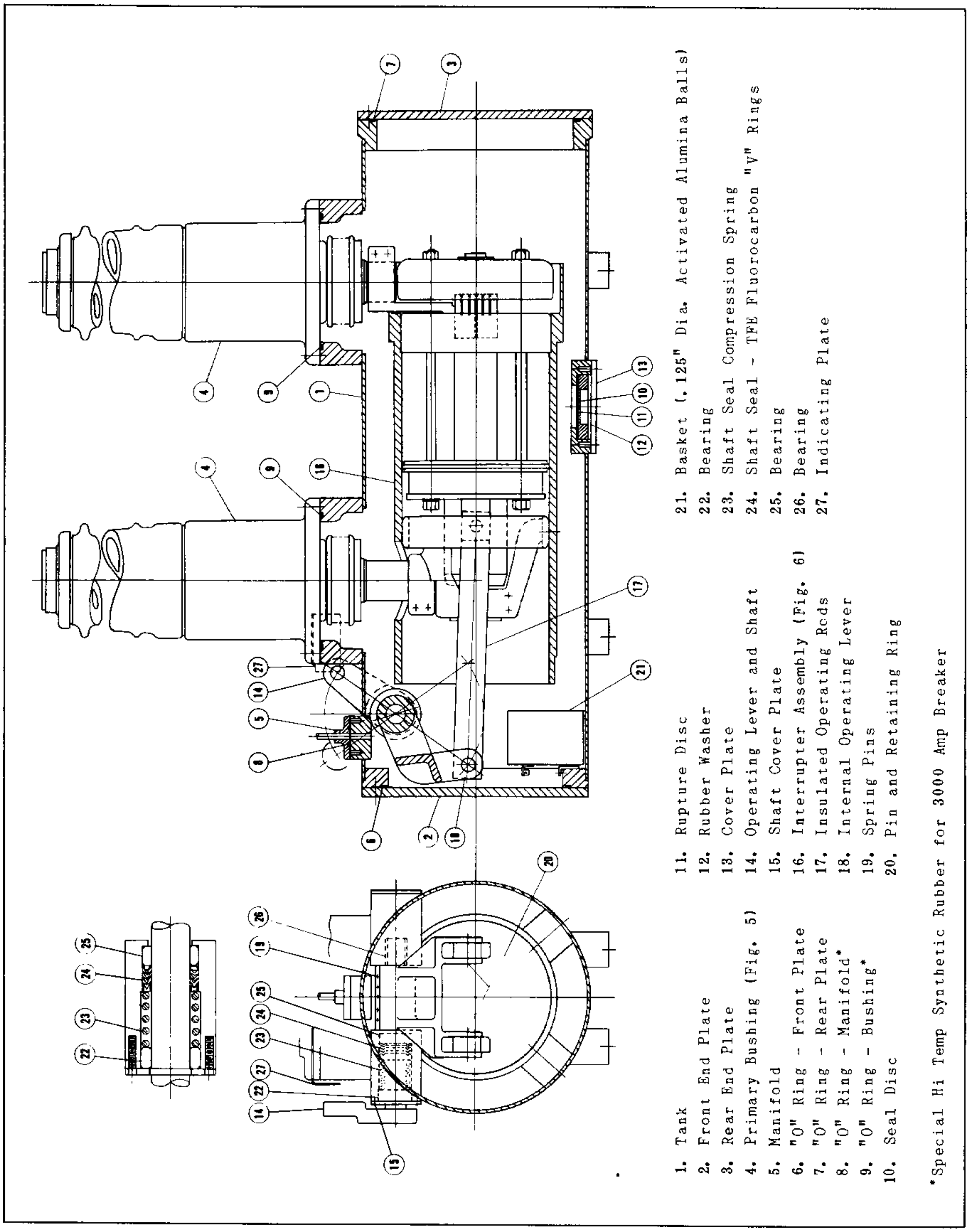


Fig. 3. Pole Unit Assembly

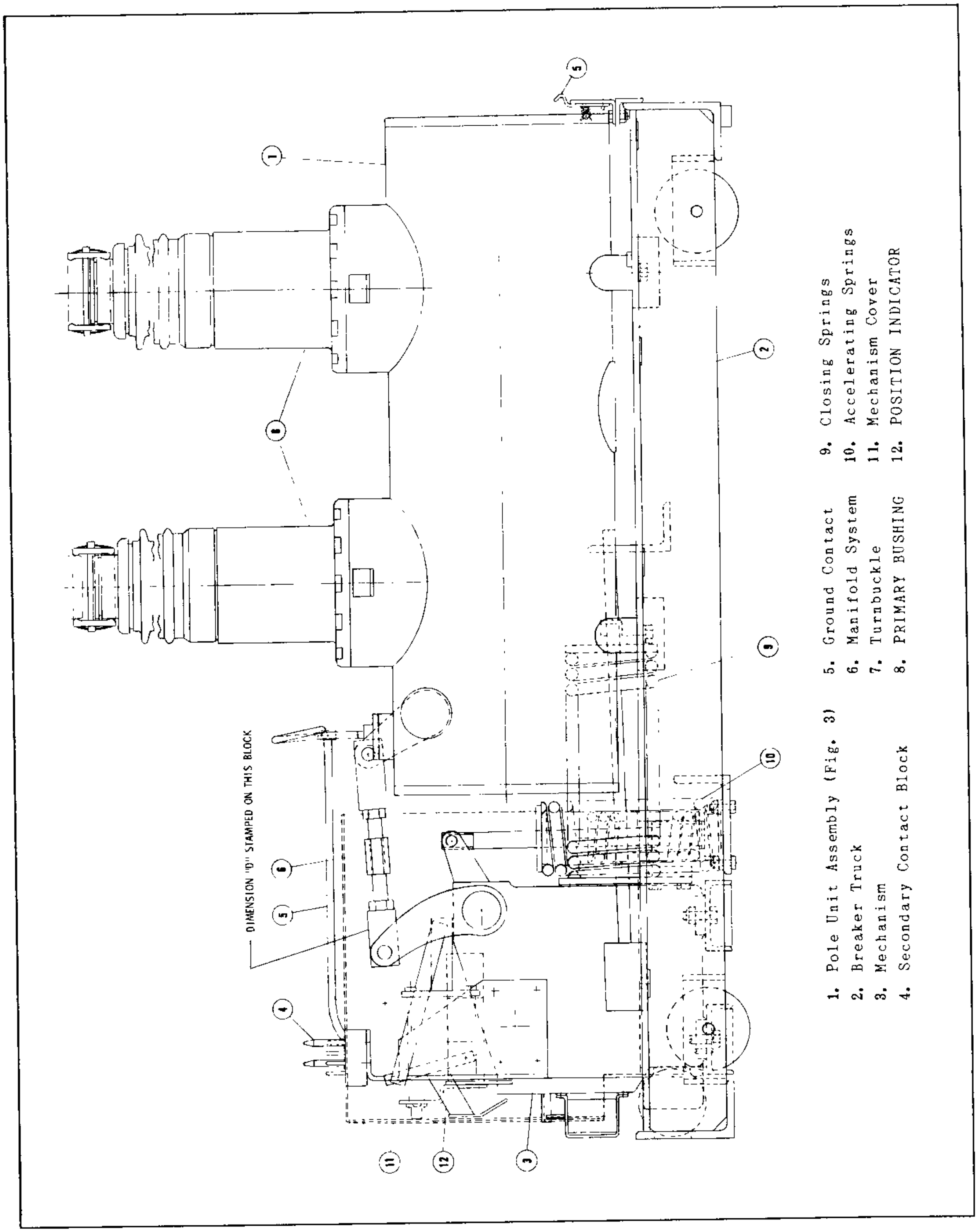
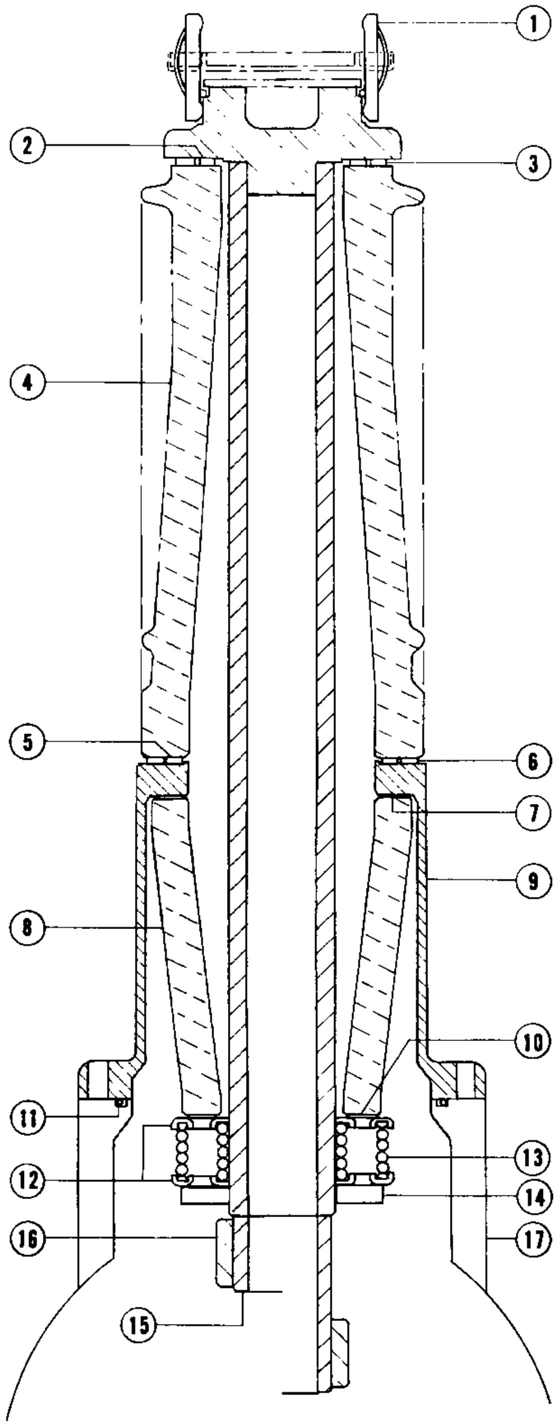


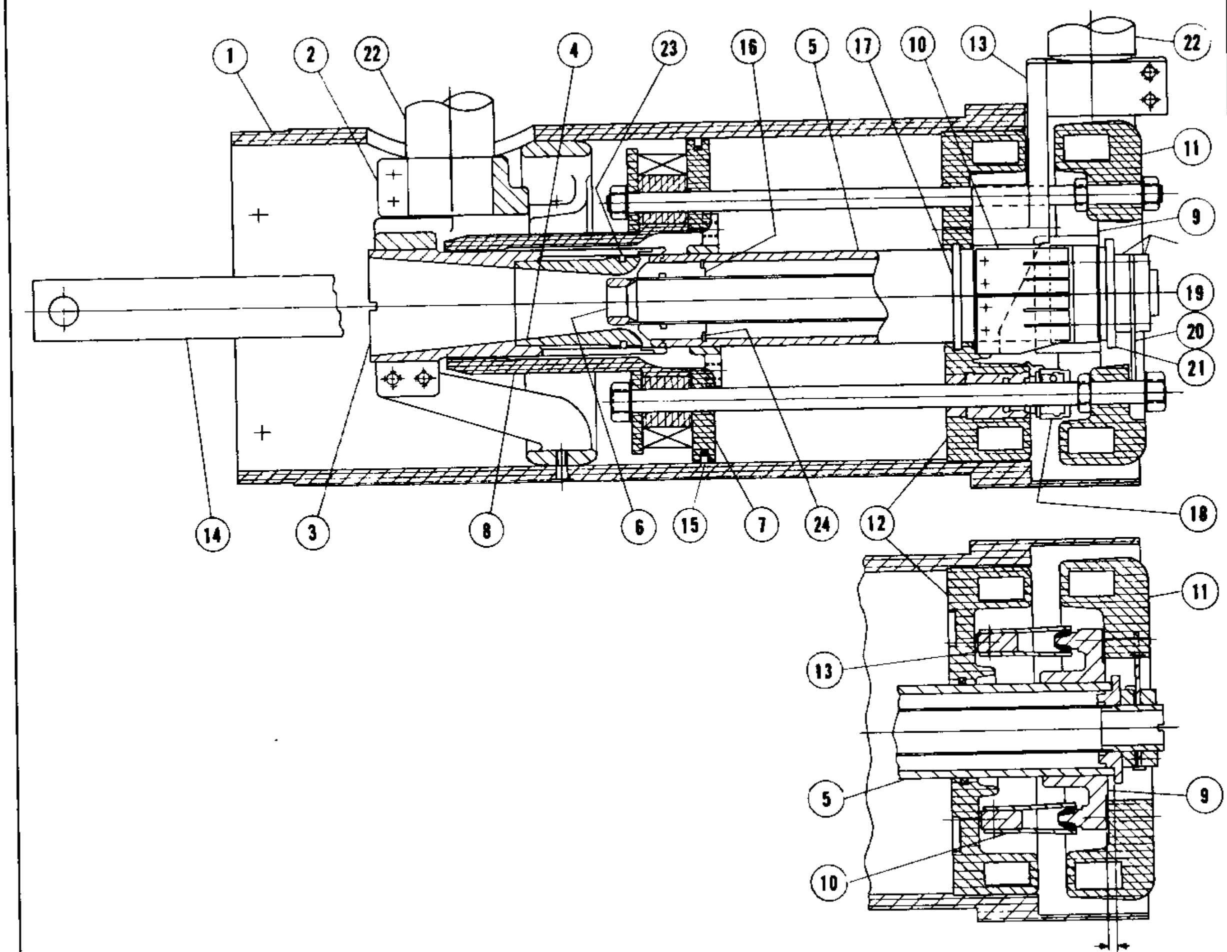
Fig. 4. Breaker Assembly



1. Primary Disconnecting Contact
2. Seal Gasket*
3. Stop Gasket
4. Insulator (Glazed Porcelain)
5. Seal Gasket*
6. Stop Gasket
7. Gasket
8. Insulator (Porcelain)
9. Supporting Flange
10. Gasket
11. "O" Ring*
12. Spring Retainer
13. Spring
14. Nut
15. Copper Tube
16. Clamp Connector
17. Tank

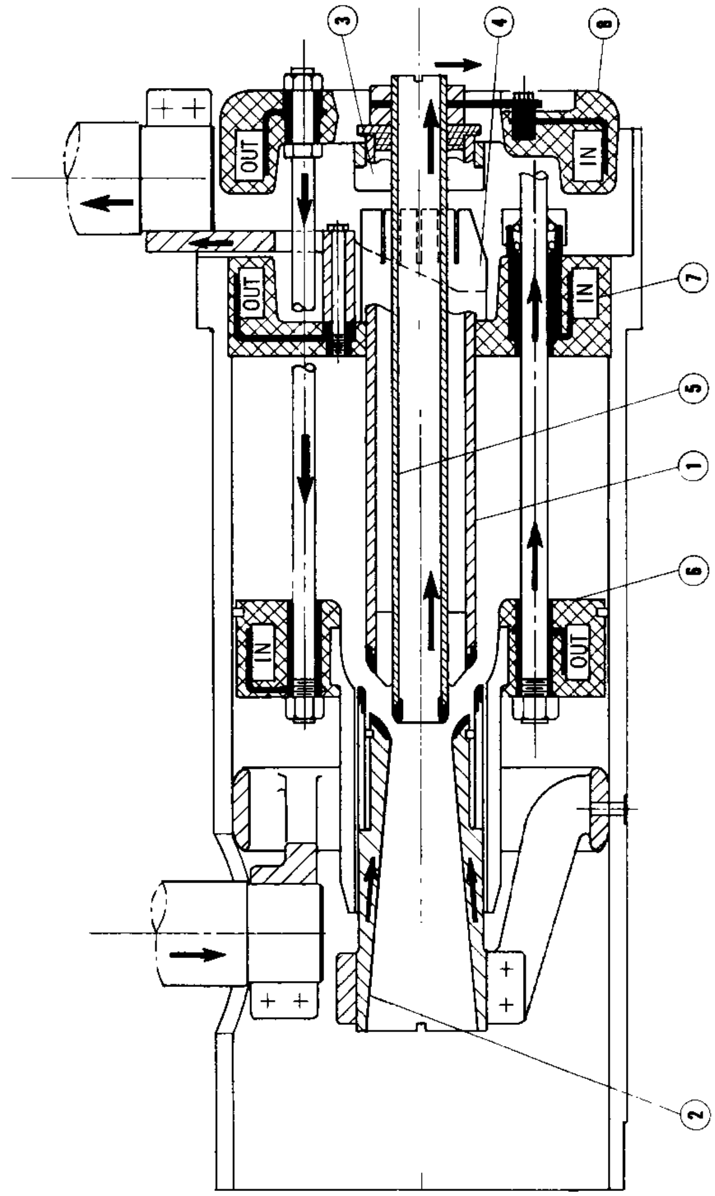
*Special Hi Temperature Synthetic Rubber for 3000 Amp Breaker.

Fig. 5. Primary Bushing



1. Piston Tube
2. Front Stationary Main Contact Mounting
3. Front Stationary Main Contact
4. Stationary Arcing Contact
5. Front Moving Main Contact
6. Moving Arcing Contact
7. Piston Coil
8. TFE - Fluorocarbon Interrupting Chamber
9. Rear Moving Main Contact
10. Rear Stationary Main Contact
11. Driver Coil (Moving)
12. Cylinder Coil (Stationary)
13. Rear Stationary Main Contact Mounting
14. Insulated Operating Rods
15. TFE - Fluorocarbon Piston Ring and Expander
16. TFE - Fluorocarbon Spacer
17. TFE - Fluorocarbon X Seal
18. Sliding Ball Contact (Fig. 16)
19. Connector Retainer Nuts
20. Connector
21. Insulating Spacer
22. Primary Bushing Tube (Fig. 5)
23. TFE - Fluorocarbon Spacer
24. Retainer Ring

Fig. 6. Interrupter - Contacts Closed



1. Front Moving Main Contacts
2. Front Stationary Main and Stationary Arcing Contacts
3. Rear Moving Main Contact
4. Rear Stationary Main Contacts
5. Moving Arcing Contact and Tube
6. Piston Coil (Moving)
7. Cylinder Coil (Stationary)
8. Driver Coil (Moving)

Fig. 7. Interrupter - Contacts Parted

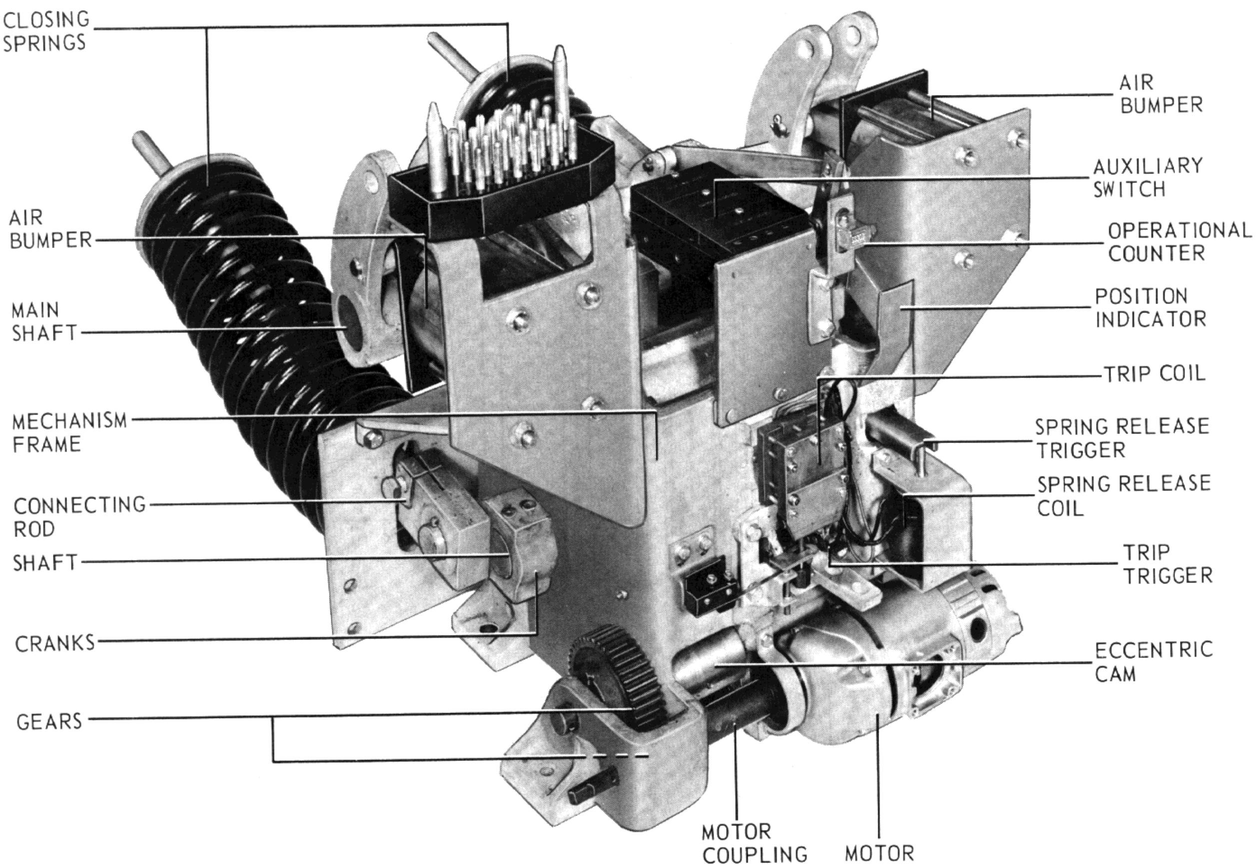
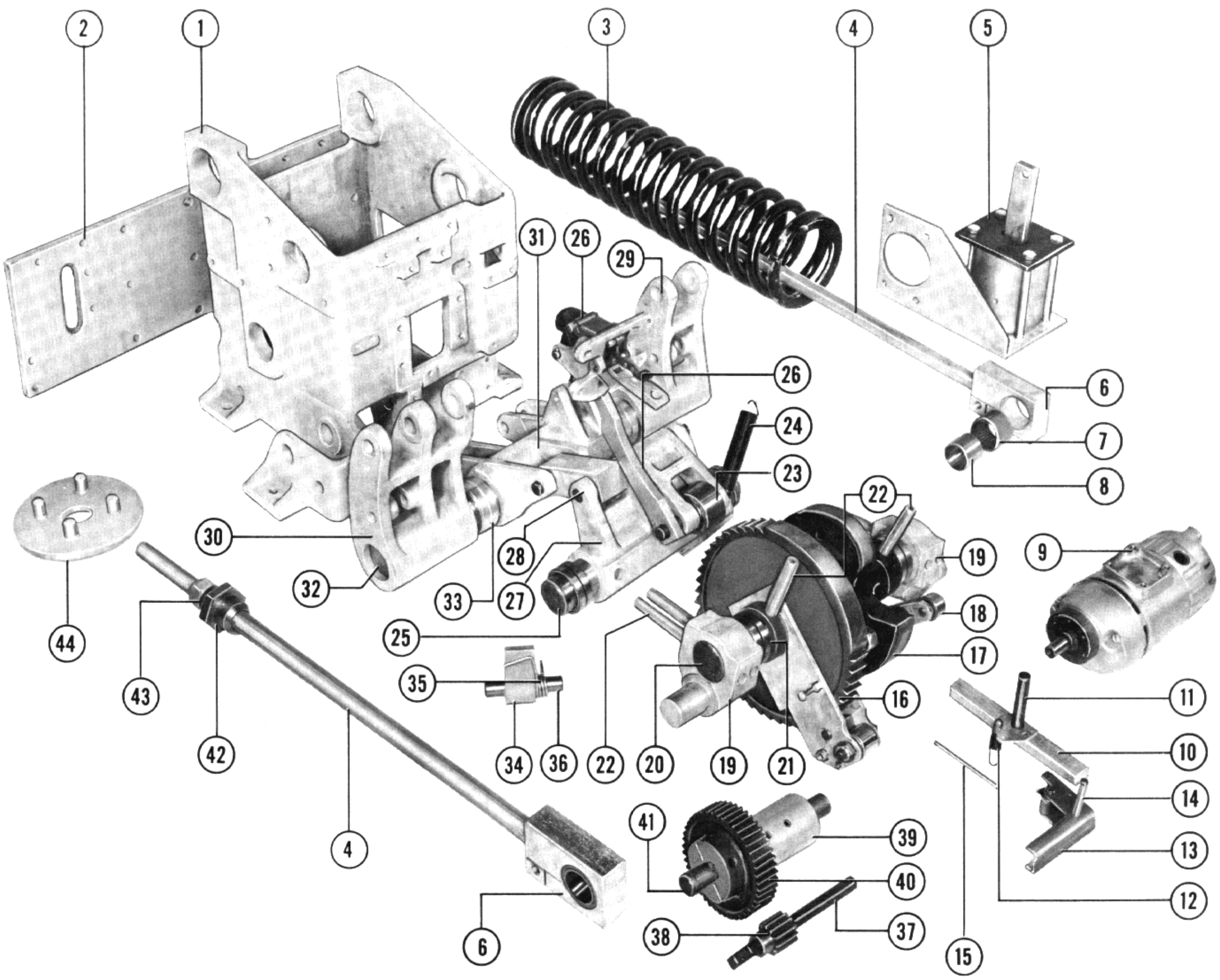


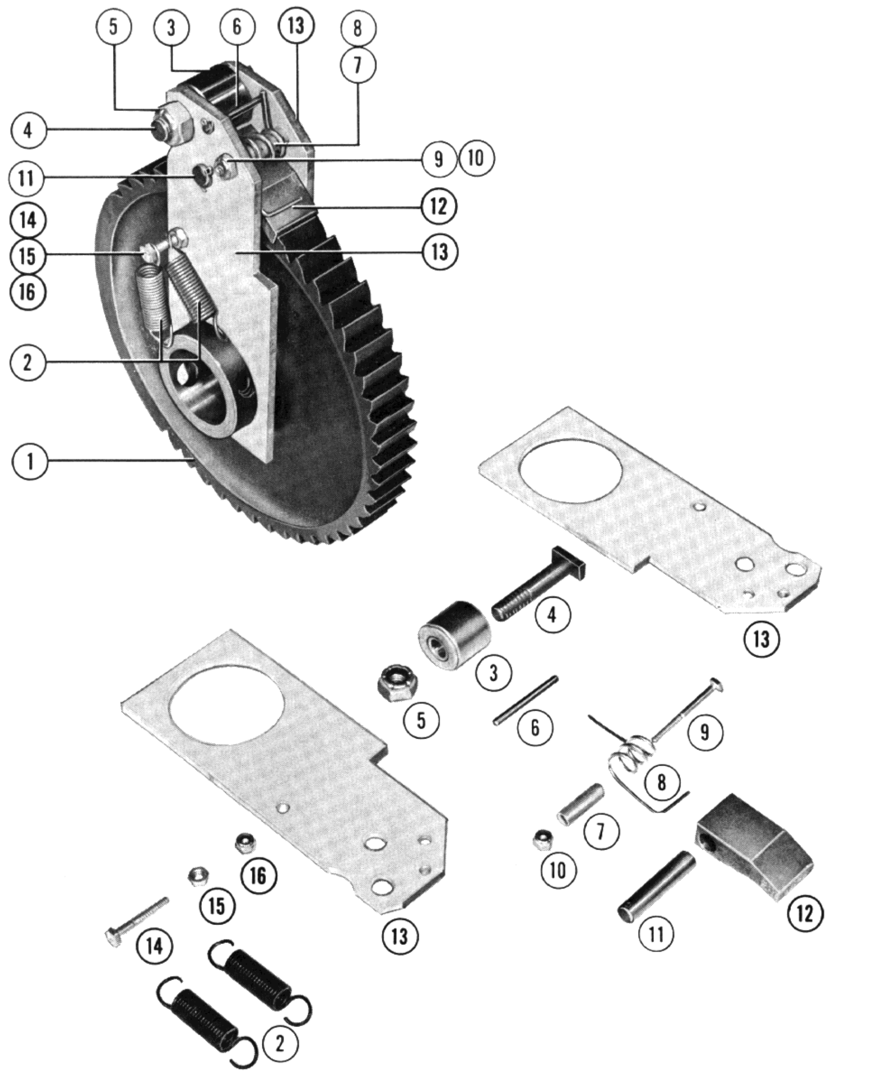
Fig. 8. Stored Energy Mechanism



1. Mechanism Frame
2. Closing Spring Retaining Plate
3. Closing Spring
4. Closing Spring Connecting Rod
5. Air Bumper Assembly
6. Connecting Rod End
7. Connecting Rod Bearing
8. Connecting Rod Bearing Inner Race
9. Spring Charge Motor
10. Spring Release Latch
11. Spring Release Latch Pin
12. Spring Release Latch Return Spring
13. Spring Release Trigger Assembly
14. Spring Release Trigger Pivot Pin
15. Spring Release Trigger Stop Pin
16. Ratchet Wheel Assembly - Fig. 11
17. Closing Cam
18. Cam Roller Assembly
19. Crank
20. Shaft
21. Bearing for Item 20
22. Spring Pin
23. Closing Roller and Pin Fig. 12
24. Closing Roller Return Spring
25. Auxiliary Shaft and Bearings
26. Trip Trigger and Linkage - Fig. 12
27. Auxiliary Shaft Lever
28. Link
29. Pole Unit Operating Lever L.H.
30. Pole Unit Operating Lever R.H.
31. Main Shaft Lever
32. Main Shaft
33. Bearings for Item 32
34. Holding Pawl
35. Holding Pawl Springs
36. Pawl Pivot Pin
37. Pinion Gear Shaft*
38. Pinion Gear
39. Eccentric
40. Spur Gear
41. Pin for Items 39 and 40
42. Closing Spring Retainer Nut
43. Closing Spring Retainer Locknut
44. Closing Spring Retainer

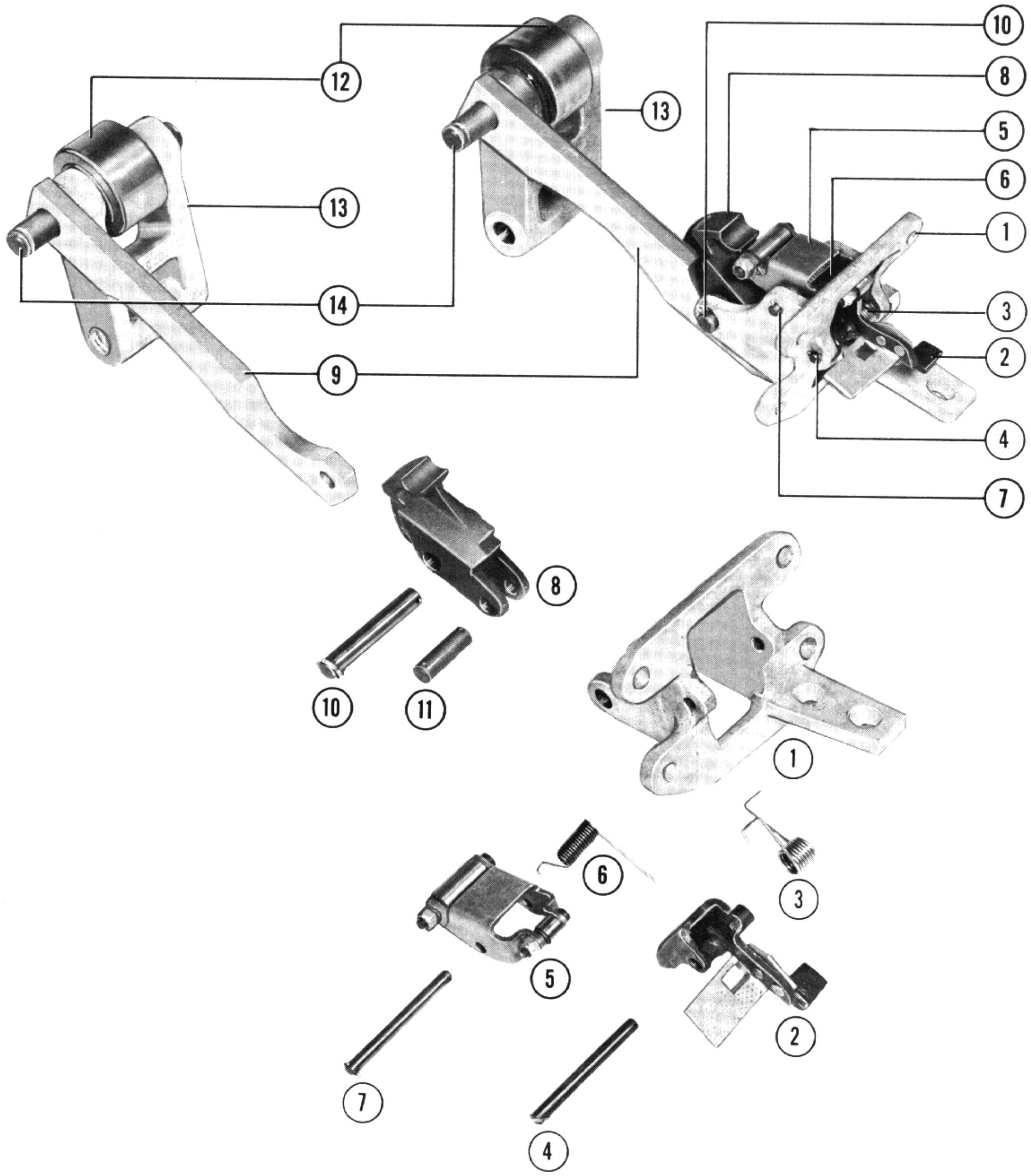
* Motor Coupling (Not Shown) (Fig. 8)

Fig. 9. Stored Energy Parts



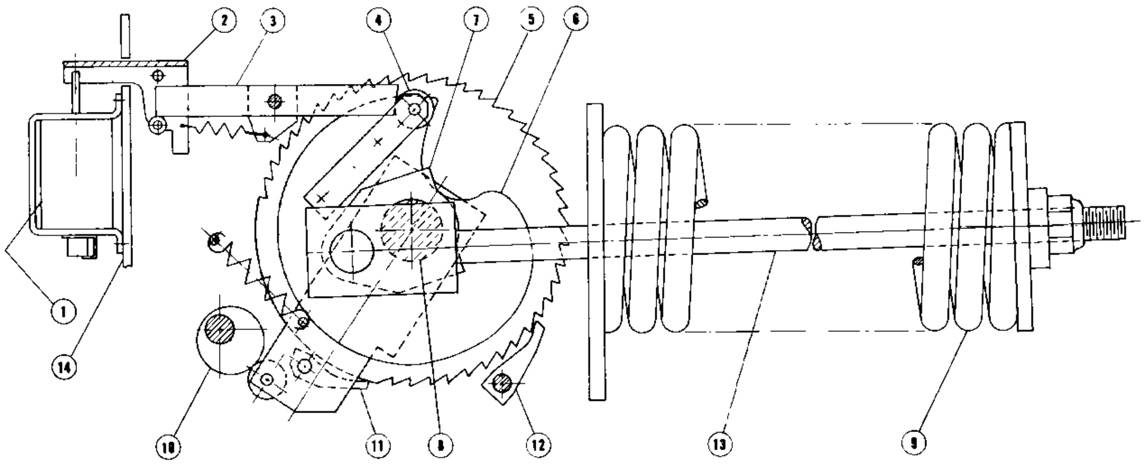
1. Ratchet Wheel
2. Retrieving Springs
3. Eccentric Roller
4. Eccentric Roller Pin
5. Nut for Item 4
6. Stop Pin for Driving Pawl Spring
7. Driving Pawl Spring Spacer (Tube)
8. Driving Pawl Spring
9. Bolt for Driving Pawl and Spring
10. Nut for Item 9
11. Driving Pawl Pivot Pin
12. Driving Pawl
13. Driving Pawl Mounting Plates
14. Spring Anchor Bolt
15. Spring Anchor Nut
16. Spring Anchor Lock Nut

Fig. 10. Stored Energy Ratchet Wheel Assembly



1. Tripping Mounting Bracket	8. Tripping Cam
2. Tripping Trigger Assembly	9. Restraining Link
3. Tripping Trigger Spring	10. Tripping Cam Pivot Pin
4. Tripping Trigger Pin	11. Pin for Items 8 and 9
5. Tripping Latch Assembly	12. Closing Roller
6. Tripping Latch Spring	13. Closing Roller Lever
7. Tripping Latch Pivot Pin	14. Closing Roller Pin

Fig. 11. Stored Energy Trip Trigger and Linkage



1. Spring Release Magnet and Coil, "SR"
2. Spring Release Trigger
3. Spring Release Latch
4. Cam Roller
5. Ratchet Wheel
6. Cam
7. Crank
8. Shaft
9. Closing Spring
10. Eccentric
11. Driving Pawl
12. Holding Pawl
13. Connecting Rod
14. Mechanism Frame

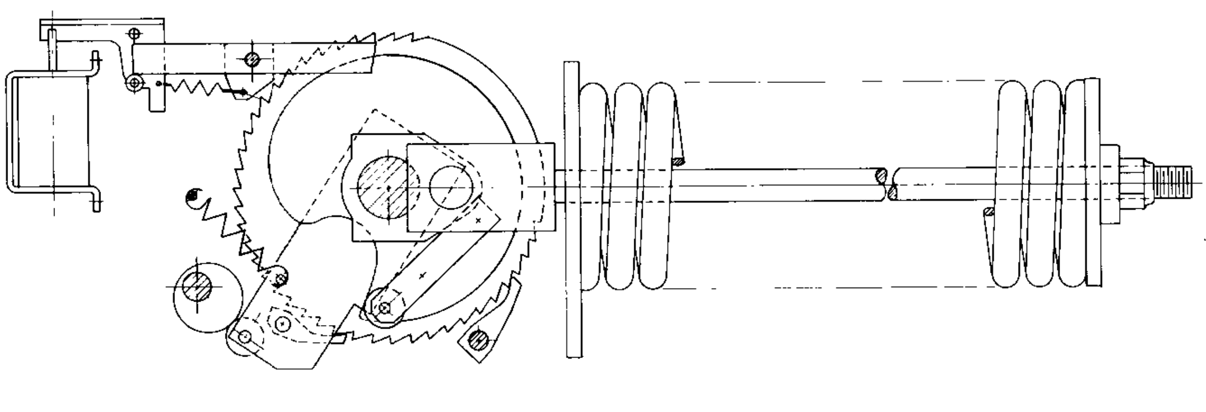


Fig. 12. Schematic Views of Spring Charging Parts

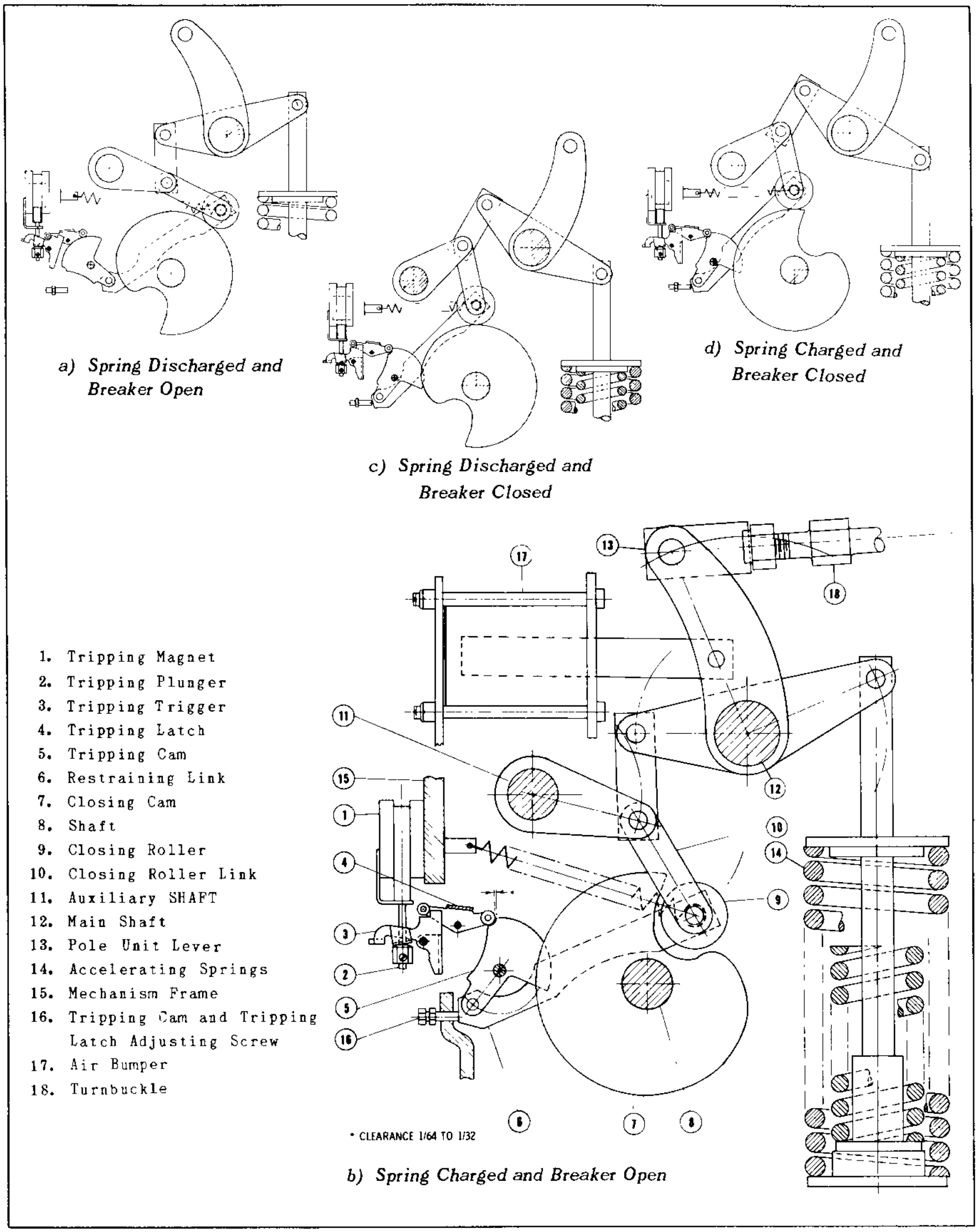
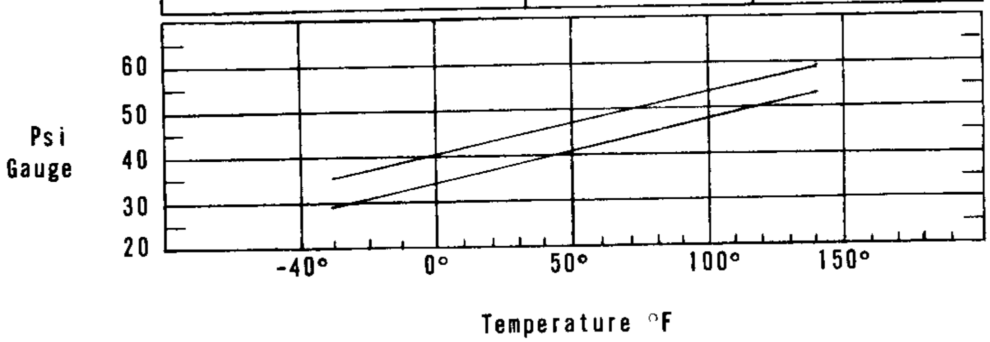


Fig. 13. Four Positions of Closing Linkage

Type M27B Model 7200		
Temperature Compensated Pressure Switch		
	-30°F	140°F
*Switch No. 1	35 Psi	59 Psi
Switch No. 2	29 Psi	53 Psi

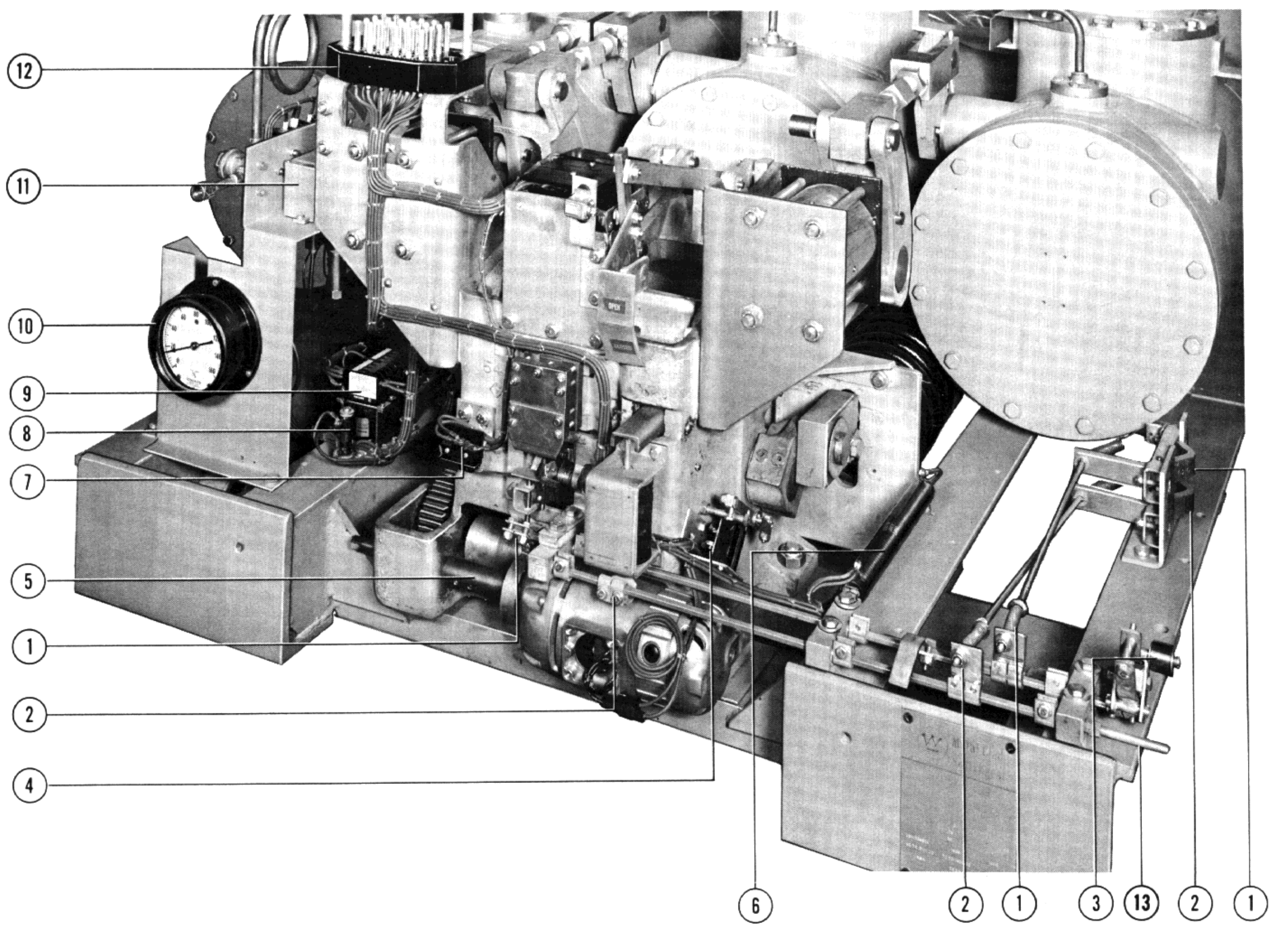


*Spread between Switch No. 1 and Switch No. 2 must be within ± 2.0 Psi of specified spread per curves.

WIRE COLOR CODE

	Switch No. 1	Switch No. 2
Common	White	Yellow
Norm. Open	Blue	Orange
Norm. Closed	Black	Red

Fig. 14. Temperature Compensated Pressure Switch Curve



1. Tripping Trigger Interlock Linkage
2. Spring Release Trigger Interlock Linkage
3. Tripping Trigger Roller Lever Assembly
4. Spring Charge Motor Limit Switch "LS"
5. Spring Charge Motor Coupling
6. Tripping Coil Resistor
7. Latch Check Switch - "L. C. Sw."
8. Spring Release Resistor
9. Auxiliary Relay "63X" & "Y"
10. Pressure Gage
11. Temperature Compensated Pressure Switch "63"
12. Secondary Contact Block
13. Breaker Position Switch Actuating Arm

Fig. 15. Front View of Breaker with Cover Removed

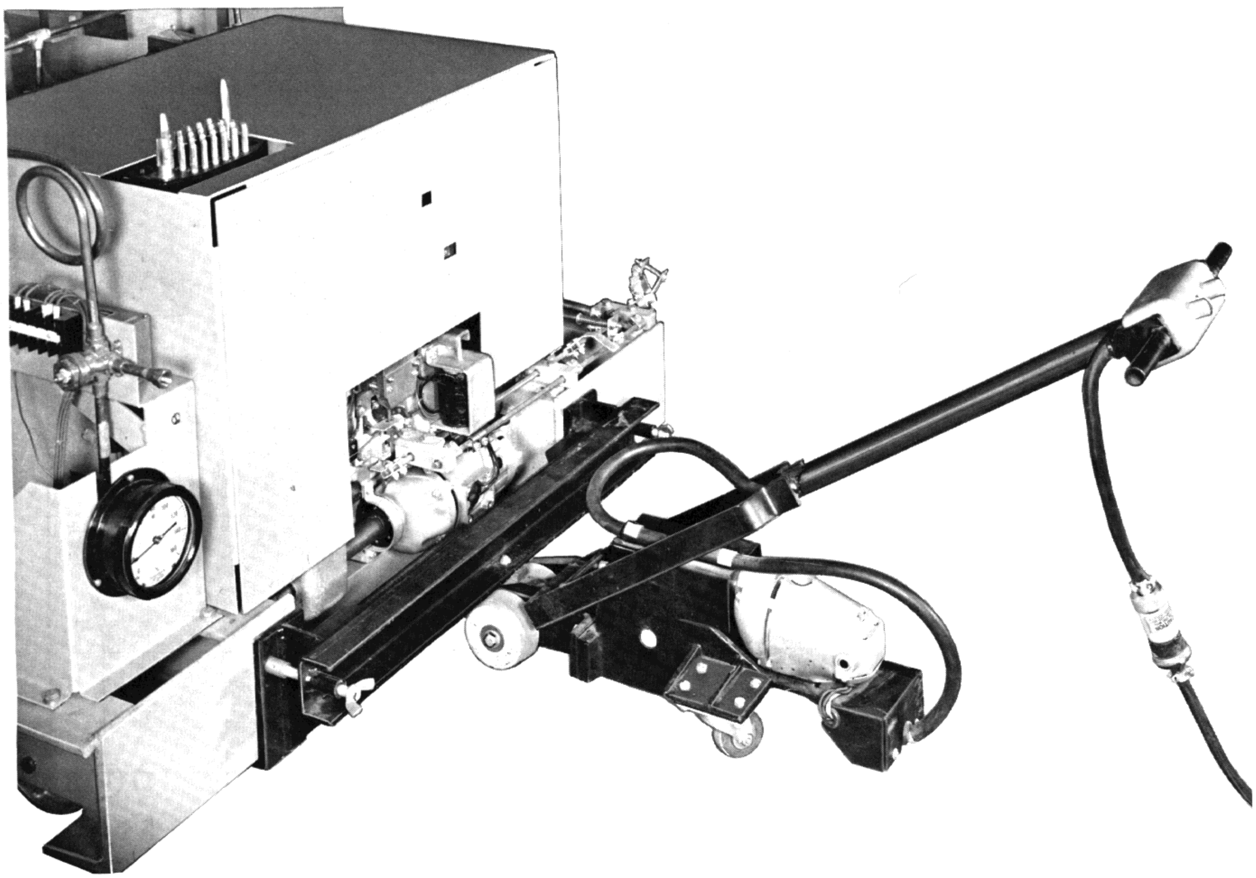
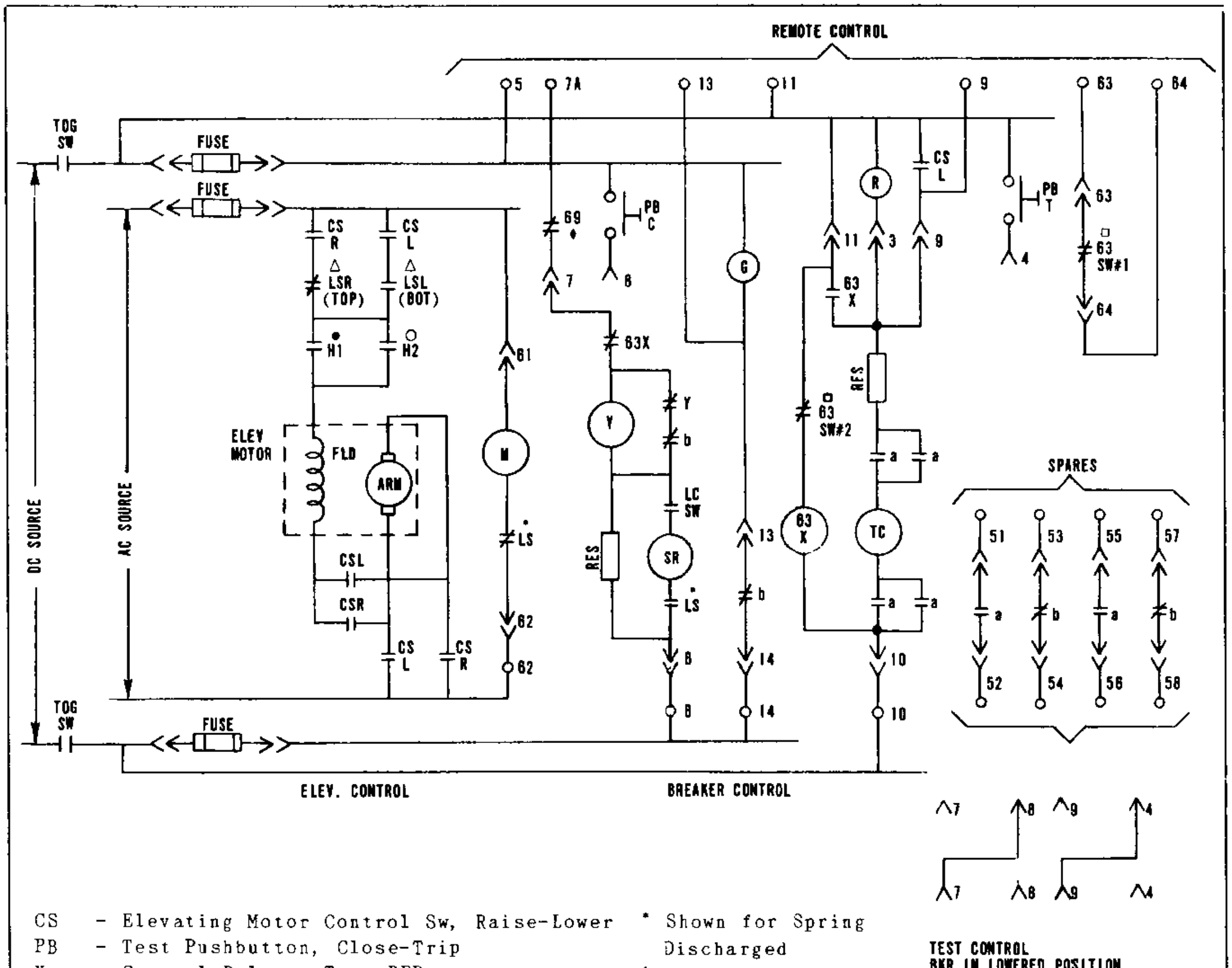


Fig. 16. Turning Dolly



CS - Elevating Motor Control Sw, Raise-Lower
PB - Test Pushbutton, Close-Trip
Y - Control Relay - Type BFD
SR - Spring Release Coil
M - Spring Charging Motor
TC - Trip Coil
63 - Temp Compensated Gas Pressure Sw
63X - Aux. Relay to Dev 63 - Type BFD
H1 - Bkr Position Sw
H2 - Over-Ride Sw for Device H1
LSR - Elevating Mech Limit Sw - Raise
LSL - Elevating Mech Limit Sw - Lower
69 - Manual Trip & Lockout Device (Optional)
LCSW - Latch Check Sw
a&b - Breaker Aux Sw
LS - Spring Charging Motor Limit Sw

• Shown for Spring Discharged
△ Shown for Elev Mech in Lowered Position
● Shown for Bkr Improperly Positioned
○ Closes Before "H1" Breaks when Elevating Bkr & Opens After "H1" Makes when Lowering Bkr
♦ Shown in Reset Position
□ Shown with No Gas Pressure

Fig. 17. Breaker Control Scheme

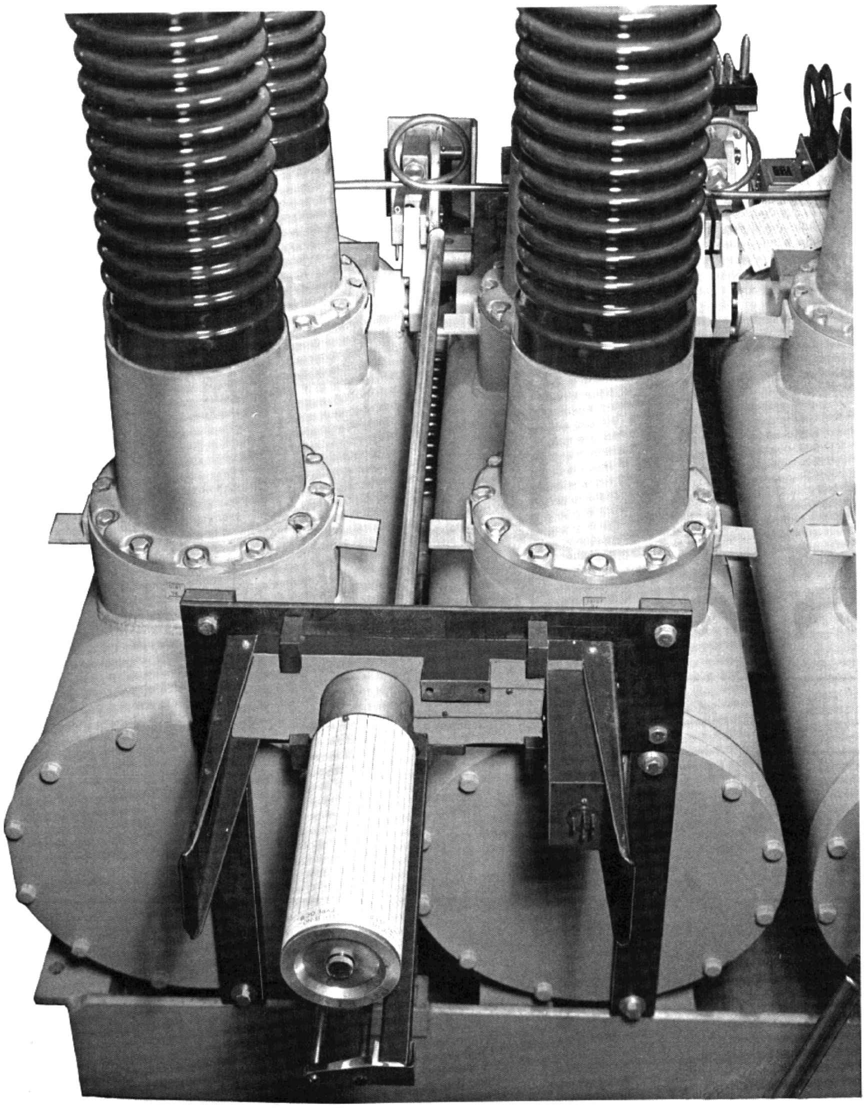
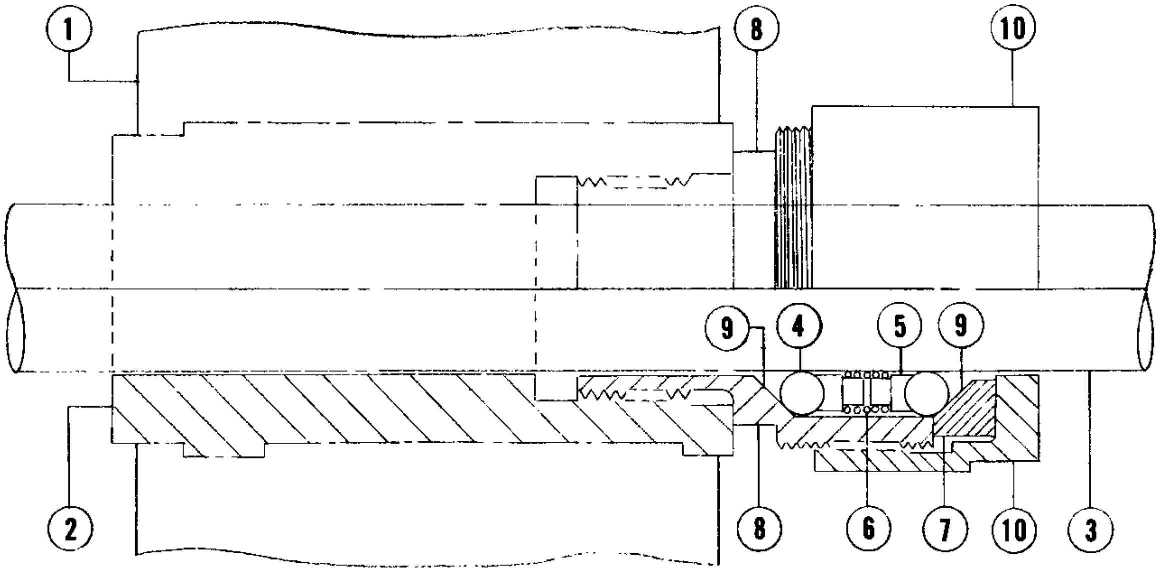
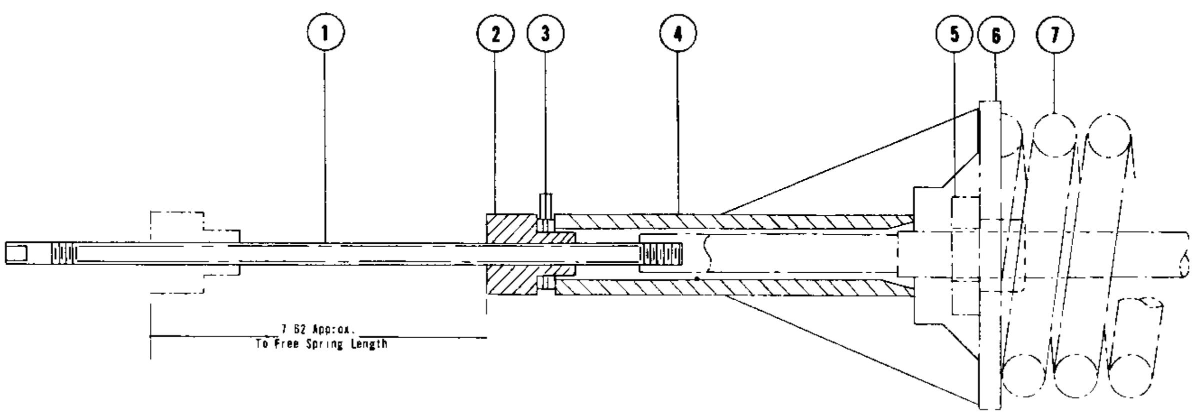


Fig. 18. Mechanical Timer



1. Cylinder Coil
2. Coil Terminal
3. .75" Dia. Guide Rod
4. .188" Dia. Bronze Ball
5. TFE Fluorocarbon Ball Seat
6. Spring
7. Sliding Ball Cap
8. Sliding Ball Housing
9. Hi Temperature Grease
10. Sliding Ball Retaining Cap

Fig. 19. Sliding Ball Contact



1. Stud
2. Special Hex Nut
3. Thrust Bearing
4. Triangular Spacer
5. Retainer Nut
6. Retainer Disc
7. Closing Spring

Fig. 20. Closing Spring Removal Tool

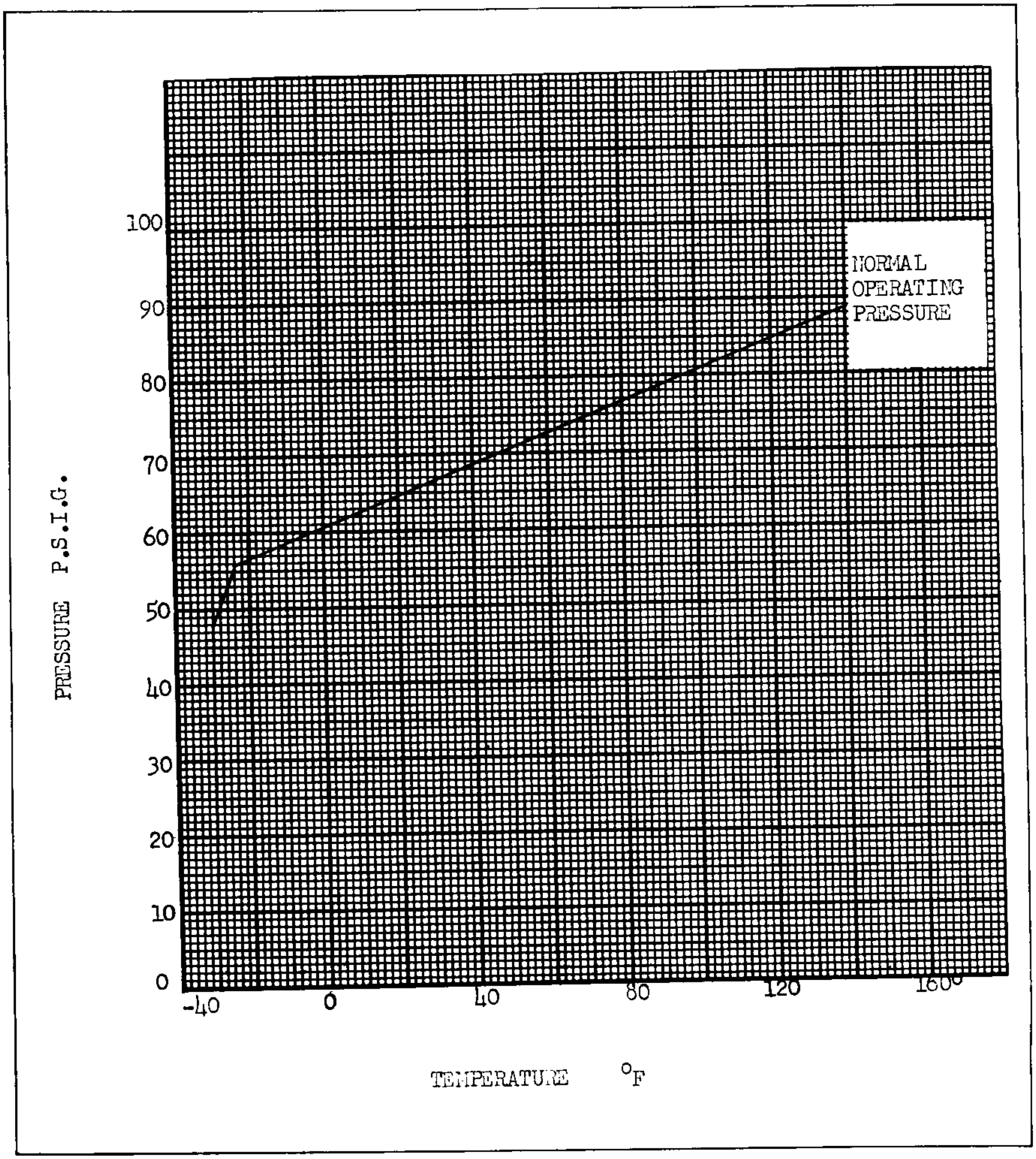


Fig. 21. Pressure vs Temperature Curve for SF_6 Gas

These devices assures that the breaker is open and that the closing springs are discharged when a breaker is first moved into or removed from the cell. The top linkage system on right hand side of breaker is connected to the tripping trigger and the bottom linkage to the spring release trigger. Pushing in approx. .5 inches on either lever actuates a linkage system. Three vertical bars are welded to the right hand lifting channel and are used to actuate the top and bottom levers. The upper 2 bars trip the breaker open and the lower bar closes the breaker. The lower bar is located between the two upper bars to insure that the breaker is open and the closing spring is discharged when the breaker is rolled into or out of the cell.

Vertical Lift Interlock

To insure that the contacts are open when the breaker is raised to the operating position, a roller lever on right front of the breaker drawout truck rides on an interlock bar (mounted on right side of cell) to hold the breaker trip free until the primary contacts are engaged. The roller lever is part of the tripping linkage.

To prevent lowering the breaker with the contacts closed, this same roller interlock trips the breaker open before the primary contacts part. This roller lever should trip the breaker in approx. .5 inch downward travel. The roller lever, in the operating position, should have clearance between the roller and the interlock bar, in other words the linkage system should not touch the tripping trigger in the operating position.

Turning Dolly

The turning dolly is an electrically driven dolly used to assist in the alignment of the breaker to the housing, see Fig. 16. The dolly adapter plate mounts on front of the drawout truck with two captive winged bolts. The dolly should not be used to insert or remove the breaker from the housing. The adapter plate must be removed before the cell doors can be closed.

Control Scheme

The breaker control scheme is shown in Fig. 17 and is self-explanatory except for the action of latch check switch and the low pressure cutout switch.

The latch check switch (LC SW) is mounted on left front of mechanism frame, which makes contact when the tripping trigger is in the fully reset position ready for the breaker to close, Fig. 15. When the tripping trigger is not reset, the latch check switch is open. When properly connected in the control circuit it will not allow the closing circuit (spring release coil) to be energized until the mechanical resetting of the tripping trigger is complete.

The control scheme will become inoperative if the gas pressure drops below 42 psig (70°F) due to the action of switch #2 of the temperature compensated pressure switch (Device 63) and its associated relay 63X.

INSTALLATION

Filling with SF_6 Gas

The 345SFP1500 breaker is shipped completely assembled and with approximately 15 psig of SF_6 gas in the breaker. The approximate weight of SF_6 gas required to fill a breaker is 30 pounds. One bottle of SF_6 gas will fill three breakers with gas to spare. Immersing the bottle in hot water will facilitate getting out as much gas as possible. The breaker connection is .375 NPT (Female). The filling valve has a TFE Fluorocarbon seat and should not be closed with excessive force, 60 to 75 inch-pounds is sufficient.

Breakers should be filled with SF_6 gas to 75 psig (at 70°F), see Pressure-Temperature Curve Fig. 21 to determine filling pressure at other temperatures.

Operation

With breaker in the operating position in the cell (secondary contacts engaged), motor normally charges closing springs as soon as control voltage is applied to the control circuit. Spring is also charged immediately after each closing operation.

Breaker is closed electrically by applying voltage to the spring release coil. Breaker is tripped electrically by applying voltage to the trip coil. Auxiliary switches, "a" contacts in tripping circuit and "b" contact in spring release circuit, are used to interrupt the coil currents, see control scheme Fig. 17.

Capacitor Switching Caution:

WHEN A CAPACITOR BANK IS DISCONNECTED FROM THE BUS IT IS LEFT WITH A TRAPPED CHARGE EQUAL TO OR GREATER THAN THE CREST OF LINE TO GROUND VOLTAGE. IT IS THEREFORE RECOMMENDED THAT WHEN A CAPACITOR BANK IS DE-ENERGIZED, IT SHOULD NOT BE RE-ENERGIZED FOR AT LEAST FIVE MINUTES TO ALLOW THE CAPACITORS TO DISCHARGE.

ADJUSTMENT AND MAINTENANCE

General

This class of power circuit breaker is a protective device to prevent damage to more expensive apparatus and to maintain continuity of electric power service. To maintain greatest reliability they should be inspected and given maintenance on a regular schedule. With experience, each user can set an inspection and maintenance schedule which is most economical for the particular case.

These breakers are adjusted, inspected and tested at the factory in line with high standards of quality control and reliability. They should not require readjustments before placing in service. Do not change any adjustments, assemblies or parts unless there has been obvious damage or incorrect adjustment. However, handling and transportation conditions could cause loss of adjustment or damage.

The slight decomposition of SF_6 gas after many arc interruptions has a negligible effect on the dielectric strength and arc interrupting ability of the breaker. By taking advantage of the extended life designed into the contacts, it will be found that SF_6 breakers can be operated over long periods of time without the necessity for general maintenance. Unless the breaker has experienced an exceeding high number of heavy interrupting faults, it will probably not be found necessary to inspect the internal parts of the breaker more frequently than three to five years. The main reasons calling for internal inspection of the SF_6 type breaker more often than this would be excessive loss of gas, high contact drop, or radical change in operating speed.

Gas Leakage

All leaks are eliminated prior to shipment. If during the life of the breaker some pressure drop is noted due to imperceptible leaks, it would not be necessary nor economical to try to locate and repair them unless the pressure drop exceeds approximately 5 Psi over a years time.

It is realized that most operators would prefer not to wait for a low pressure alarm in the system before adding gas to the breaker. On the other hand, it is desirable to avoid unnecessary fillings for a small drop in pressure. A reasonable compromise is to wait until the pressure drops to 55 psig (at 70°F), which is 5 Psi above the alarm pressure, before refilling to 75 psig (at 70°F).

Precautions to be Observed When Handling Arced SF_6

WARNING

SULFUR-HEXAFLUORIDE GAS IN THE PURE STATE IS COLORLESS, ODORLESS, TASTELESS, AND IS NON-TOXIC. BEWARE OF OXYGEN DEFICIENCY IF LARGE VOLUMES OF GAS ARE BREATHED. TOXIC DECOMPOSITION PRODUCTS ARE FORMED IN THE GAS WHEN ARCING OCCURS IN IT. DO NOT BREATHE GAS CONTAINING THESE TOXIC PRODUCTS, ESPECIALLY WITHIN A FEW MINUTES AFTER THE TANKS ARE OPENED AND UNTIL THE DECOMPOSITION PRODUCTS ARE SAFELY DILUTED WITH AIR.

ACTIVATED ALUMINA IS INCORPORATED IN ALL SF_6 BREAKERS. THIS MATERIAL HAS BEEN FOUND TO BE QUITE EFFICIENT IN REMOVING THE CHEMICALLY ACTIVE PRODUCTS FORMED DURING ARCING. A SUFFICIENT AMOUNT OF THIS MATERIAL IS USED TO REMOVE THE TOXIC ARC PRODUCTS EXPECTED TO BE PRODUCED BETWEEN MAINTENANCE OPERATIONS ON THE BREAKER. THE SMALL PERCENTAGE OF GAS WHICH REMAINS AFTER OPENING THE BREAKER SHOULD BE ALLOWED TO ESCAPE TO THE ATMOSPHERE. AS A RESULT, OPERATING PERSONNEL SHOULD NOT BE EXPOSED TO A SIGNIFICANT AMOUNT OF GAS WHEN THE BREAKER IS OPENED.

IF, FOR SOME REASON, A SIGNIFICANT AMOUNT OF ARCED GAS IS PRESENT, CERTAIN WARNING INDICATIONS SUCH AS A PUNGENT AND UNPLEASANT ODOR, AND/OR IRRITATION OF THE UPPER RESPIRATORY TRACT AND EYES WILL GIVE AN EARLY AND SUFFICIENT WARNING WITHIN SECONDS TO PERSONNEL IN THE VICINITY BEFORE A SIGNIFICANT TOXIC REACTION SHOULD OCCUR. THE ABSENCE OF ANY ODOR OR IRRITATION SHOULD INDICATE SAFE WORKING CONDITIONS.

Annual Inspection

It is recommended that the breaker be given an annual inspection consisting of the following:

1. Check the electrical and mechanical operation (interlocks, etc.) of the breaker.

2. Check the contact resistance across the primary bushings. This should not be over 90 micro-ohms and should not include resistance of the primary disconnecting contacts.

3. Measure contact engagement by closing breaker and connecting a continuity checker across the primary bushings of one pole unit.

CAUTION

TIE TRIPPING TRIGGER SO IT CANNOT BE INADVERTENTLY TRIPPED.

Remove pin from turnbuckle link nearest mechanism and use a taper pin (approx. .5 dia.) as a lever in the pin hole to slowly pry the turnbuckle link toward the open position. Measure distance from closed position to contact parting. This minimum dimension for a new breaker is .200 inches. Record contact engagement for each pole so a log of contact engagements can be kept for the life of the breaker.

4. Check the pressure gage and the ambient temperature. Check the pressure for the ambient temperature observed by consulting Curve, Fig. 21.

5. Check for loose bolts, missing cotter pins, etc., in mechanism and pole units.

6. Check control wiring for loose connections.

7. Check operational timing. The mechanical operating speed of the breaker should be satisfactory as received. Some users include timing as part of inspection and maintenance. Timing tests should be made after the breaker has been filled to 75 psig (70°F) with SF_6 gas. Fig. 18 shows the Cincinnati Timer instrument mounted on the rear of the tanks. Minimum opening speed 5 feet/second at approximate middle of opening travel. Minimum closing speed 4 feet/second at point where contacts touch. Assume travel of contacts approximately 6.9 inches. The most important operation relative to breaker performance is the opening operation.

Inspection and Adjustment of Contacts

Before an internal inspection can be made on the breaker, it is first necessary to exhaust the SF_6 gas to the atmosphere, remove the manifold assembly, and disconnect the turnbuckles. The center pole unit should be removed leaving the outer pole units on the drawout truck. The end plates from all three tanks should be removed. After the tanks are opened, the interior should be flushed with dry nitrogen. This will dilute any remaining SF_6 and also blow the small amount of arc product powders from the tanks. These powders should also be flushed from the interrupters. Caution should be observed to prevent the inhalation of the fine metallic fluoride dust. A dust mask should be worn while doing this work, and it is also advisable to avoid skin irritation by wearing gloves and keeping other parts of the body covered, especially if perspiring. These powders, while sealed in the tanks in the absence of moisture, have a high dielectric strength, but are hygroscopic and when exposed to the atmosphere can reduce the insulation level of the breaker. Remove the activated alumina baskets. Unclamp and unscrew the front main stationary and arcing contact assembly for inspection. Before removing the front main stationary contact assembly mark it so it can be replaced in the same position. Inspection of the front main moving contact can be made with the contact in the tank. Remove the driver coil, see Fig. 6, by removing the .75 and .625 diameter nuts, four mounting bolts, and connection strap. Inspection of rear main contacts is now possible. The rear main stationary contact assembly can be removed if desired but the primary bushing assembly would have to be removed first. Unclamp the rear main stationary contact assembly from the bushing copper tube and the bushing can be lifted out after removing the twelve mounting bolts. Mark bushing so it can be replaced in the same location. Removing the four mounting bolts frees the rear main stationary contact assembly from the cylinder coil. Very little pitting or erosion should be found on the contacts. Any slight roughness due to erosion or pitting can be smoothed up with a fine file.

Reassemble contacts and check contact engagement as per paragraph 3 of Annual Inspection. If contact engagement is approximately .150 to .175 inches or slightly less the turnbuckle locking clips should be opened up and the distance between the turnbuckle blocks increased approximately .050 inches. The turnbuckle dimension between blocks can be increased a total of .100 inches and after the contact engagement is again reduced to approximately .150 the contacts should be replaced. Turnbuckle block dimension "D", see Fig. 4, should be marked with a + .050 (or the corrected amount) each time the contacts are adjusted. Recheck contact engagement and reassemble pole unit. Reassemble breaker and evacuate the breaker with a vacuum pump capable of pulling a vacuum below .5mm Hg or below 500 microns. Evacuate the breaker to 500 microns and fill the breaker to 75 psig (70°F) with SF_6 gas.

Replacement of Moving Contacts

To replace the main moving contacts (front and rear) it is necessary to remove the interrupter assembly from the tank. Both bushings have to be removed. The interrupter assembly can now be removed from the tank after disconnecting the insulating rods (Part of Piston Assembly) from the internal operating lever and the four .75 diameter mounting bolts. Remove driver coil, rear main stationary contact assembly, and the inner .75 and .625 diameter nuts. Remove sliding ball retaining cap, Fig. 19, and all loose parts of this contact. Remove the front main stationary contact mounting by removing the three mounting bolts around the periphery of the piston tube and pulling it out of the piston tube. With a long extension remove the four .5 diameter hex head bolts (spaced 90° apart) that hold the front main moving contact to the piston assembly. The piston assembly is now free to be pulled from the piston tube. Remove the two Allen Head Set Screws that lock the rear main moving contact to the main moving contact tube and unscrew the rear main moving contact. The front main moving contact is now free to be pulled through the large hole in the cylinder coil. A TFE Fluorocarbon X seal is in this large hole and should be replaced before a new front main moving contact is installed. Shim copper is put around the threaded end of the moving main contact tube when it is passed through the large hole of the cylinder coil to protect the X seal from damage. Remove shim after the front main moving contact is installed in cylinder coil. Mount new front main moving contact on piston assembly and temporarily insert assembly into piston tube to see if assembly moves freely. If assembly does not move freely check to see if new contact is parallel and equidistant to guide rods. Reinsert piston assembly to check for free movement. The TFE Fluorocarbon piston ring and expander can be assembled after the piston assembly has been put into the piston tube by forcing ring and expander into piston groove through hole in top of piston tube. Mark threaded end (inside) of front main moving contact at .75 diameter guide rod side. Remove the four bolts holding front main moving contact and partially remove piston assembly; holding front main moving contact in the full open position. Screw the rear main moving contact on to the front main moving contact until the threaded end of main moving contact tube is $.188\ ^{+.000}_{-.040}$ from machined part of rear main moving contact, see Fig. 6. Replace the four bolts that hold the front main moving contact with thread locking compound on threads, check to see that the front main moving contact mark is to the .75 diameter guide rod. Assemble rear main stationary contact assembly to the driver coil. Engage rear main contacts fully and tighten the two set screws in the rear main moving contact, plastic plugs are used between set screw points and threads to prevent damage to threads. Assemble moving arcing contact into the main moving contact tube. Assemble front main stationary contact mounting into piston tube and screw front main stationary and arcing contact assemble into it. Adjust the front main stationary contact so that it overlaps .5 to .563 inches from fully closed (rear main contact almost jammed) to contacts just part (moving in the opening direction). Tighten clamping bolts on front main stationary contact mounting. Assemble sliding ball contact on .75 diameter guide rod and tighten cap after applying thread locking compound sparingly to internal threads. Assemble driver coil temporarily on rear main moving contact and move inner nuts until they are snug against the driver coil, use thread locking compound to lock nuts in this position. Move rear main contacts to the fully closed position and check for clearance between driver coil and rear main stationary contact mounting, minimum clearance .016 inches. Use thread locking compound on outer .75 and .625 diameter outer nuts. Reassemble interrupter into tank and primary bushings on tank. Engage insulating operating rods with inside lever. Reactivate the activated alumina baskets by heating to approximately 400°F for four hours and reassemble into tanks. Tighten bushing clamp connections and reassemble tank end plates. Mount tanks on drawout truck and connect turnbuckles to mechanism.

Set dimension between turnbuckle blocks to 6.125 inches (preliminary adjustment) (unlock locking clips first). Close breaker and tie tripping trigger so it cannot be inadvertently tripped. Turn turnbuckle until contacts just part in opening direction (use continuity checker for indicator). Measure distance between turnbuckle blocks. Adjust turnbuckle so that dimension between blocks is .200 to .225 inches more than the measurement at the time contacts part. This is the closed position of the pole unit. Tighten turnbuckle lock nuts and set locking clips. Dimension between turnbuckle blocks at closed position should be stamped on block nearest the mechanism for reference. Finish reassembly of breaker, evacuate, and fill with SF_6 gas.

Inspection and Adjustment of Mechanism

CAUTION

BEFORE ATTEMPTING ANY WORK ON BREAKER OR MECHANISM MAKE SURE BREAKER IS OPEN AND CHARGING SPRING IS DISCHARGED.

The closing and opening operations should be snappy, without hesitation. Under normal circumstances, that is if there are no signs of shipping damage or of anything interfering with mechanical movement, this is a satisfactory check for closing and opening of a breaker before placing it in service.

With the breaker open and spring charged, as in Fig. 13b, there is an important point where there must be enough clearance for satisfactory operation.

Referring to Fig. 13b, the clearance between the rear roller of the tripping latch and the vertical surface of the tripping cam should be 1/64 to 1/32 inch. If there is no clearance at all, the tripping latch roller cannot drop into place and the tripping trigger cannot reset. Therefore, the breaker will not close. This clearance can be adjusted by the screw on front of the frame under the tripping trigger. In order to see this clearance it is necessary to look from the top with the mechanism cover removed. First loosen the locknut. Turn the screw clockwise to decrease clearance, counterclockwise to increase clearance, hold and retighten the locknut.

For motor limit switch adjustment refer to Fig. 15. The motor limit switch stops the motor of the stored energy mechanism after charging is complete. It is a single pole double throw switch, operated by a lever on the right side of the mechanism frame. Adjustment is by turning the hexagonal bolt located head-down at front end of the operating lever. With closing spring discharged, screw the bolt until the lower contacts make. Continue turning downward to get a good 1/16 overtravel on the switch. When the closing spring is charged, the minimum clearance between the bolt head and switch operating rod should be 1/32 inch.

For latch check switch adjustment refer to Fig. 15. The latch check switch makes contact when the tripping trigger is in the fully reset position. The switch operating arm is of tough steel and is subject to only very light forces. It is set at the factory and should remain in adjustment unless tampered with. It is adjustable by bending the arm slightly. Correct adjustment is for the switch to make contact when the tripping trigger is 1/8 to 3/16 from its completely reset position, measured where the operating arm touches the tripping trigger.

The mechanism travel is set at the factory and should never need adjustment. This travel measured at a point on the turnbuckle link should be between 5.4 and 5.6 inches.

For high speed trip adjustment refer to Fig. 15. The high speed trip plunger lifts the tripping trigger in response to an electrical impulse. The lower end of the plunger (extending through the tripping trigger) is threaded for a conical nut. When the tripping trigger is fully reset, the conical nut should be 2-1/2 to 3 turns from touching the tripping trigger. Tighten set screw in conical nut to lock in this position.

Closing Spring Removal

Sometime it might be necessary to remove the closing springs to replace a part in the mechanism. To remove these springs it is necessary to remove the mechanism assembly from the drawout truck, Fig. 8. A special tool as shown in Fig. 20 is also needed to safely remove these springs. The stud and special hex nut are made of heat treated steel. This tool can be purchased from Westinghouse. Remove ESNA nut (locking nut) from ends of connecting rods and screw stud into one connecting rod.

CAUTION

HOLD STUD WITH WRENCH ON FLATS (AT END OF STUD) TO PREVENT THE STUD FROM UNSCREWING WHILE REMOVING CLOSING SPRING.

Unscrew retainer nut until it touches triangular spacer and then back off the special nut on the stud until the retainer disc touches the retainer nut. Repeat until retainer nut is free and then back off special nut until spring is free. Remove stud and proceed to remove other spring. To assemble closing spring reverse above procedure.

LUBRICATION

The roller bearings in the stored energy mechanism are packed at the factory with a top grade slow oxidizing grease which normally should be effective for some years. They should not be disturbed unless there is definite evidence of sluggishness, dirt or unless the parts are dismantled for some other reason. If it does appear advisable, the bearings and related parts should be thoroughly cleaned of old grease in a good grease solvent such as kerosene or household dry cleaner. They should then be washed in light machine oil until the cleaner is removed. After the oil has drained off they should be packed with grease, Westinghouse M. No. 9921-4. This grease is available in 4 oz. tubes identified as S#1802395.

The tripping latch assembly (Fig. 11) should be repacked with a "Molly" (molybdenum polysulphide) grease, Westinghouse M. No. 8577-3.

The sliding ball contact (Fig. 19) and the shaft seal "V" rings (Fig. 3) should be repacked with a special grease, Westinghouse S#512A196H03 (1 oz. tube), if they are ever dismantled.

Some pins (example, turnbuckle pins) are designed to operate dry but a very thin film of grease can be used on these pins if the customer desires.

RENEWAL PARTS

When ordering renewal parts, always specify the part name and style number, if known, from the Renewal Parts Data, not included in this book. If the style number is not known, use the Figure number, name, and item number if given, together with the instruction book number. Also always supply the complete information from the nameplate on the front of the breaker drawout truck.