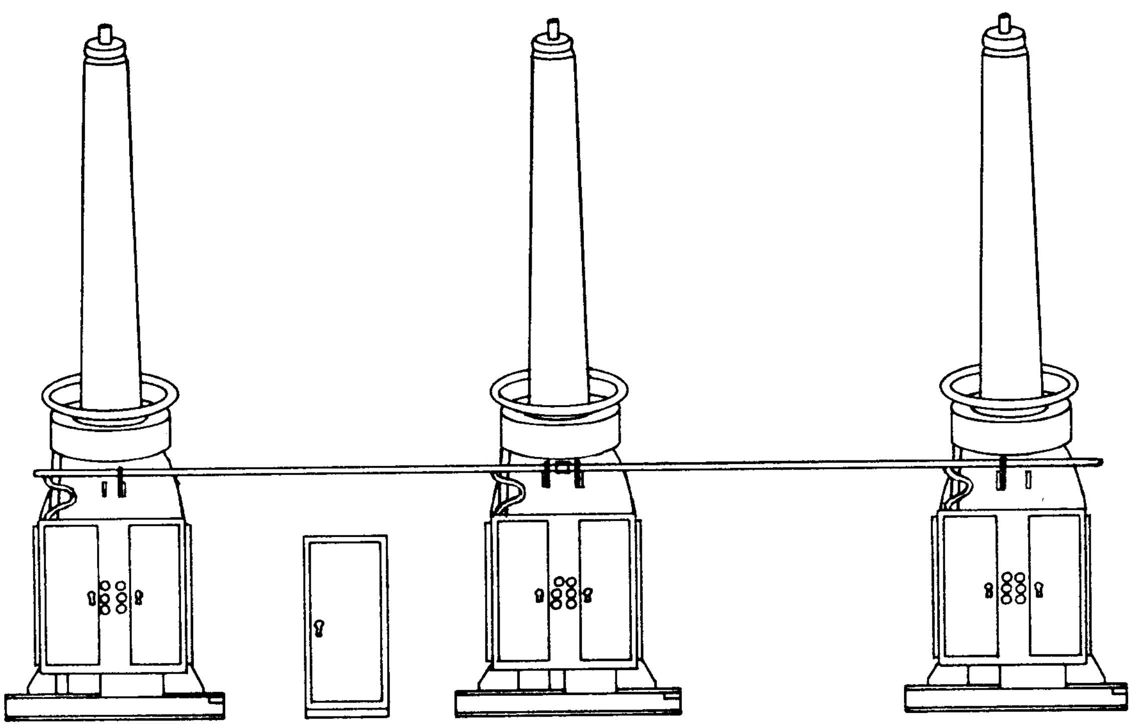
IB—9.8.3.7-17
ISSUE B

Gould I-T-E.
Instructions
Renewal Parts

550 KV GAS BREAKER MODEL C

CONTROL CABINET & THREE SINGLE POLE UNITS

(3 Mechanisms, 3 Gas Systems, 1 Air System)
(Independent Pole Operation)



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INSTRUCTIONS

1. **INTRODUCTION**

The modern, high-speed circuit breaker is an essential component of present day, high voltage transmission systems, depended upon for both routine switching operations and the critical task of high current fault protection. It should not be installed where it will be called upon to operate at voltage or currents greater than those given on the nameplate. The short circuit conditions to be imposed upon the breaker must not exceed those specified at the time the breaker was purchased.

The breaker is designed and rated in accordance with ANSI standards for high voltage circuit breakers.

Proper installation and maintenance is necessary to assure satisfactory operation of the circuit breaker.

2. **CHARACTERISTICS OF SULFUR HEXAFLUORIDE GAS, SF-6:**

Sulfur hexafluoride in a pure state exhibits exceptional thermal stability and has 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 61°F, at 265 psig. The density of SF-6 is about five times that of air (molecular weight equal to 146), and at three atmospheres (30 psig) pressure, the dielectric strength is about 2.4 times that of air and about the same as oil.

Chemically, SF-6 is one of the most stable compounds. In the pure state, it is inert, nonflammable, 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. Filters are used in the apparatus to remove the gaseous by-products and some of the gas-borne powders (See Part "D" "Precautions to be Observed When Handling Arced SF-6").

There is some deterioration of the gas after extended periods of arcing, however, it is very slight and has a negligible effect upon the dielectric strength and arc interrupting ability. Furthermore, the solid arc products formed when the gas is exposed to an electric arc are metallic fluorides which are good insulators under conditions existing within the breaker.

Sulfur hexafluoride is furnished in standard industrial type cylinders containing 115 pounds of gas. The cylinders are color-coded silver with green tops. The cylinders have special size pressure connections. The threads are National Standard left hand .965" diameter — 14 threads per inch. The adapter for connecting to the cylinder is a CGA #590 bullet-shaped coupling nipple with .960" left hand external, male thread, 14 threads per inch.

It is recommended that the gas in the cylinders be checked for moisture content, a dew point of −50°F (−46°C), or 63 ppm maximum. Refer to "Gas Handling Instruction," Part E of this book.

3. **GENERAL DESCRIPTION OF BREAKER**

The circuit breaker, Figs. 1 and 5, consists of three large vertically mounted elliptical, individually mounted, steel tanks and a separate control housing. Each tank contains sulfur hexafluoride gas SF-6 at the pressure of 45 psig at 70°F. Entrance bushings are located near the top of each tank. The interrupters are mounted on insulated support columns which serve high-pressure reservoirs within the low pressure tank.

Each pole-unit tank supports a mechanism housing containing the operating mechanism and electrical controls. The equipment for handling the SF-6 gas is also in each mechanism housing. The operating mechanisms close and open the poles through linkage and operating rods.

The current transformers are located around the outside of the entrance bushing pockets and are enclosed in a weatherproof housing. Space for three transformers per bushing is provided. Linear couplers can be provided upon demand.

Primary heaters for maintaining high-pressure gas temperature are clamped to the bottom exterior portion of the high-pressure vaporization chamber and may be removed without disturbing the gas system. This chamber is located under the mechanism housing. The heaters energize automatically. They are designed for long-life and the thermal insulation around the vaporization chamber minimizes heat loss. A secondary heater system, independent of the main system and set at a lower temperature, is provided to assist the primary heaters and maintain the system in case of primary heater failure.

3.1.1 *Tanks*

All tanks are designed and constructed to meet the ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels, Section VIII, Div. 1.

Each pole tank has a hinged manhole door. Each pole tank contains a safety valve and a rupture disc assembly as protection against excessive pressures within the vessel.

3.1.2 *Entrance Bushings*
The bushings on the breaker are SF-6 insulated. The conductor is a current-carrying tube supported at both ends by porcelain insulators. Heavy springs keep a compressive load acting on the gasket seals located on the top intermediate and bottom joints. The insulating SF-6 gas is supplied from the pole-unit tank through filtered openings at the bottom of the bushing.

3.1.3 *Interrupters (See Figs. 6 & 7)*
The interrupters operate on a two-pressure system principle. They include interrupting contacts, blast valve, high-pressure gas reservoir, passages for conducting the gas flow from the blast valve to the interrupting contacts, electrostatic shields, voltage grading capacitors and closing resistors.

In the Closed position, the current path through each interrupter unit is from the lower end of the entrance bushing into the flexible connections, adapter plates, stationary nozzle contact, moving contact, moving contact adapter into the blast valve housing. This sequence is repeated through the other interrupter units.

The contacts are designed to minimize arcing on their conducting surfaces. One arcing terminal is the top of the moving contact. It extends into the nozzle of the stationary contact when in the closed position. Upon opening, the arc is drawn first between the lower end of the stationary contact fingers and the upper end of the moving contact. It then transfers quickly from the stationary contact fingers upward to the arcing terminal inside the top adapter plate.

The interrupting function is performed by a combination cross-blast and axial flow of SF-6 gas through the center of the moving and stationary contacts. On an opening operation, the blast valve is opened mechanically. As the blast valve moves downward, it releases SF-6 gas from the high-pressure reservoir into the interrupter chamber. The moving contacts, which are mechanically connected to the blast valve, move downward with the blast valve to disengage from the stationary contact. At the end of the stroke, the blast valve seals off the flow of gas from the high-pressure reservoir.

3.1.4 *Closing Resistor (Figs. 7 & 11)*
A low ohmic resistor is provided across each break for reducing switching surge voltage. The resistor operating mechanism is driven by the blast valve simultaneously with the moving contacts. The mechanism is provided to insert the closing resistor prior to breaker contact closing. The mechanism disengages the resistor when the breaker is in the closed position so that the resistor is not in the circuit during breaker opening.

3.1.5 *Voltage Grading Capacitors (Fig. 8)*
Shunt capacitors are provided across each break for proper voltage division.

3.1.6 *Mechanical Linkage (Fig. 10)*
The motion of each pneumatic operating mechanism is transmitted through a vertical rod to a bell crank which converts the motion to a horizontal rod. The rod, in turn, is connected to a lever-bar system in the pole-unit. These drive vertical insulated rods that extend up through the center of the insulated support columns and connect to the blast valve. A compression spring at the top end of each insulating rod compensates for the variation in the linkage to provide equal contact travel and blast valve performance on all interrupters.

3.1.7 *Bell Crank and Rod Seal (See Fig. 10)*
The bell crank assembly is located just below the operating mechanism housing. It changes the vertical motion of the operating mechanism into a horizontal motion required to operate the pole units. The bell crank assembly has provision for attaching a time-travel recorder. The seal for the operating rod is between the bell crank and the pole unit and consists of a stainless steel bellows. In addition to the bellows seal, there is a back-up seal to prevent excessive loss of gas should the bellows seal fail.

3.1.8 *Accelerating Springs (See Fig. 10)*
Accelerating springs are located in each pole unit. These springs operate over the complete travel of the breaker. The springs are compressed during closing, and supply most of the energy to accelerate the breaker during opening. These same springs also exert a positive force on the blast valves to ensure positive sealing when the breaker is in the OPEN position. The balance of the opening force is supplied by the adjustable accelerating springs located in the bell crank assembly. These latter springs permit adjustment of the opening speed.

3.1.9 *Bushing Current Transformers (See Figs. 5 & 30)*
Each bushing may be equipped with any combination of up to three multi-ratio relaying or metering bushing-type current transformers. The transformers are contained within a metal housing designed to seal out moisture and are mounted externally. The secondary leads run through conduit to terminal blocks in the mechanism housing, providing a convenient location for selecting the desired ratio.

3.1.10 *Linear Coupler Transformers (See Figs. 5 & 30)*
Linear couplers are also available. Their design, mounting and wiring are similar to that of the current transformer.

4. GENERAL DESCRIPTION OF OPERATING MECHANISM (See Figs. 2, 14, 19 & 28)

The pneumatic operating mechanisms are designed to operate the circuit breaker with provisions for closing, opening, trip-free and reclosing operations.

The mechanisms are designed for electrical pneumatic operation when in service.

CAUTION: Never attempt to close a single pole with any manual closing device when the breaker is in service, as the adjacent poles will not respond.

The operating mechanisms provide a stored energy source for closing the breaker. Each mechanism is mechanically and electrically trip-free, and its speed of operation is sufficient to ensure 15-cycle reclosing when required. Each operating mechanism consists of an air system, latch mechanism, control panel and associated mechanical and electrical equipment, all enclosed in mechanism housings mounted on each tank. The mechanisms and accessories will operate at the standard ANSI and NEMA voltage ratings. DC voltage is standard for the control circuit, and AC voltage for the compressor motors and heaters. The control voltage and air pressure ranges are shown on the nameplates that are mounted on the inside of each operating mechanism housing.

4.1 AIR SYSTEM (Function of Components) (See Fig. 28)

The breaker air system consists of one air compressor and motor located in each mechanism housing. The air compressor is a two-cylinder, two-stage type with a check valve located between the compressor and the air receiver. A governor switch is piped directly into the air receiver of pole No. 1, without any valve in this piping. The lockout pressure switch and the alarm pressure switch are connected to the piping between the main air supply valve and the control valve of pole No. 1. Each mechanism housing contains an air receiver, safety valve, drain valve, control valve, pressure gauge, strainer and piping. Motors are sequenced to prevent simultaneous start-up.

The air receiver's capacity is good for at least five complete close-open operations without replenishing the air.

The control valve is a solenoid operated three-way air valve. When the solenoid is energized, the exhaust port is closed and the pressure is applied to the operating cylinder. When the solenoid is de-energized, pressure supply is cut off and the operating cylinder is connected to the exhaust. The valve is also equipped with means for manual operation for local testing.

The pneumatic system is also equipped with a throttle valve located between the main air supply valve and the control valve to control pole spread on closing.

The three air systems are connected together with common piping to insure equal pressure on each pole for closing.

4.2 GAS SYSTEM (Function of Components) (See Fig. 19)

The operation of this breaker requires a flow of gas from high-pressure to low-pressure. Auxiliary equipment is provided for reclaiming the gas used during each operation and to restore the proper pressure in the high-pressure system. The auxiliary equipment for handling the gas is located within each mechanism housing. This equipment consists of a filter system for removing the small amount of gaseous arc decomposition products in the gas, a compressor for charging the high-pressure system, a relief valve for limiting high-pressure in the high-pressure system, safety valves, hand valves, and various devices for maintaining the proper pressures.

4.2.1 *Governor Switch (63-4)*
Pressure switches responsive to pressures in each high-pressure system, control the compressors to maintain gas in the high-pressure systems at normal operating pressure. The motors driving the three gas compressors are sequenced to prevent simultaneous start-up.

4.2.2 *High-Pressure System, Low-Pressure Alarm (63-5)*
Pressure switches in each high-pressure system operate an alarm at a pressure below normal operating pressure, and above the pressure at which the low-pressure lockout switch operates.

4.2.3 *High-Pressure System, Low-Pressure Lockout (63-7)*
Pressure switches in each high-pressure system, energize a relay that opens the closing circuit to prevent closing the breaker when there is not sufficient gas pressure in any pole for a reliable opening operation. It further causes the breaker to trip before the pressure drops to a critical level.

4.2.4 *Low-Pressure System, Low-Pressure Alarm (63-6/1)*
A temperature-compensated pressure switch, for each pole, responsive to gas density in the low-pressure system, operates an alarm in the event of a loss of pressure, and before a gas

density is reached, at which the dielectric strength may be impaired.

4.2.5 *Low-Pressure System, Low-Pressure Lockout (63-6/2)*
A temperature-compensated pressure switch, for each pole, responsive to gas density in the low-pressure system, prevents the compressor from operating when the gas density in the low-pressure system is already low and further reduction would impair dielectric strength.

4.2.6 *High-Pressure System, Pressure Gauge*
A Bourdon-tube-type pressure gauge indicates the pressure in each high-pressure system.

4.2.7 *High-Pressure System, Temperature Gauge*
A Bourdon-tube-type pressure gauge indicates the temperature of each high-pressure system. The sensor at the end of the capillary tube is located in a well in the high-pressure tank.

4.2.8 *High-Pressure System, High-Temperature Alarm (23-8)*
A thermostat attached above each high-pressure gas vaporizing chamber, for each pole, closes its contacts to alert an operator that the heaters are heating the gas excessively.

4.2.9 *High-Pressure System, High-Temperature Lockouts (23-5 & 23-6)*
Thermostats attached above each high-pressure gas vaporizing chamber open their contacts to open the heater circuits if gas is being heated excessively, by either the primary or secondary heaters.

4.2.10 *Pole Disagreement Alarm (94)*
A contact on the pole diagreement relay (94) indicates a pole disagreement.

4.2.11 *Low-Pressure System, Pressure Gauge*
A Bourdon-tube-type gauge indicates the pressure in each low-pressure system.

4.2.12 *Low-Pressure System, Temperature Gauge*
A Bourdon-tube-type temperature gauge indicates the temperature of each low-pressure system. The sensor at the end of the capillary tube is located in a well in the low-pressure tanks.

4.2.13 *Relief Valve*
One relief valve is on the discharge side of the compressor to protect the compressor, oil separator, filters, and piping from excessive pressures. This valve discharges into the intake side of the compressor. Another relief valve is between the high and low-pressure systems and serves as a safety valve for the high-pressure system of the breaker. A third relief valve is located between the low-pressure side of the manifold and the low-pressure tanks of the breaker and protects the manifold piping system from excessive pressures. Each gas system is so equipped.

4.2.14 *Safety Valve*
A low-pressure system safety valve is provided to relieve excess pressure to atmosphere on each system.

4.2.15 *Gas Compressor*
The gas compressor, one for each pole, is a vertical, two-cylinder reciprocating type. The compressor is driven by an electric motor mounted directly on the compressor crankshaft, with both motor and compressor hermetically sealed within a common enclosure.

4.2.16 *Oil-Pressure Safety Control*
Special pressure controls protect the compressor against loss of oil pressure. The control is actuated by the difference in pressure between the outlet oil pressure of the oil pump, and crankcase pressure. Since the inlet pressure of the oil pump is always crankcase pressure, the net difference in the two pressures is the net lubrication oil pressure. If the oil pressure falls below safe limits, the control stops the compressor. A time-delay circuit is incorporated to delay the action of the control for a period up to two minutes to allow the compressor to establish oil pressure on start-up without nuisance tripping. The device is reset by depressing a button on the control unit.

4.2.17 *Motor Protection*
In the event the compressor fails to start, an internal thermostat opens to disconnect the motor but will reset quickly after the initial trip. If several trips occur in succession, a prolonged cooling period of perhaps 20 minutes to one hour may be required for the thermostat to reset.

4.2.18 *Filter and Dryer Units*
Molecular Sieve, Type 13X filters remove the decomposition products, water, and oil vapor from the gas during compressor operation.

4.2.19 *Oil Separator*
An oil separator returns most of the oil discharged by the compressor to the compressor crankcase, while the remainder is

trapped and held with a Molecular Sieve (Type 13X) filter.

4.3 **ELECTRICAL CONTROLS AND FUNCTION (See Fig. 45)**

Each breaker contract will vary as to the electrical components furnished, therefore, the following text will give only a general description of the major components that normally constitute the control system. For more detailed information on the control circuits for this contract, see the specific control diagrams.

4.3.1 Tripping and closing can be performed electrically by local or remote control (local control is considered to be at the control housing and not at the breaker poles). It should be kept in mind that when all control circuits are activated, that any discrepancy in the circuits of any pole will, if the breaker is closed, trip all poles. Hand tripping of a single pole will, (when the control circuits are energized) trip all poles. Manual opening or closing of a single pole may be accomplished by disconnecting the power supply to the breaker or by altering the control circuits as described elsewhere in the instruction manual.

A pole can be tripped manually by a trip lever extending outside the mechanism housing. When so tripped, closing is blocked electrically by the opening of the permissive control switch connected in series with the closing circuit. The mechanism housing doors must be opened to be able to reset the manual trip to allow closing by any means. When the manual trip is reset, the permissive control switch closes, the trip-free linkage resets and the breaker can then be closed electrically or manually.

A pushbutton on the panel in the control housing can be used for local electrical control (trip and close) provided all three poles are in the same relationship . . . (closed or open).

Remote electrical control (trip and close) can be accomplished when the "Remote Local" switch is in the "Remote" position and proper connections are made to terminal blocks.

A reclosing time-delay relay with a delay-time dial provides reclosing time adjustments from 15 cycles to at least 45 cycles. This timer must be in the circuit for all reclosing operations. Refer to diagram for connection.

4.3.2 *Air-System Controls*

A lockout pressure-relay contact is connected in the closing circuit of the breaker. It opens and prevents electrical closing of the breaker when the pressure in the air receivers drop to a predetermined air pressure too low for safe closing of the breaker.

An alarm pressure-relay contact closes on a predetermined air pressure to give an alarm indication. After the alarm indication, there is still sufficient air pressure to close the breaker.

A compressor pressure-relay contact controls the operation of the air compressors in conjunction with a motor starter. This pressure relay is set to maintain a predetermined pressure in the air tanks. Under normal conditions, sufficient air pressure will be maintained to prevent operation of the alarm pressure-relay and the lockout pressure relay. All three pneumatic systems are interconnected to maintain equal pressure.

4.3.3 *Gas-System Controls*

The compressor-relay governor switch on each of the high-pressure gas systems controls the operation of the gas compressor in conjunction with motor starter. These pressure-relays are set to maintain a predetermined gas pressure in the high-pressure SF-6 tanks.

The alarm and lockout pressure-relays on each high-pressure gas system operate as follows: Relay contacts close on decreasing gas pressure to give an alarm signal. Other relay contacts close and energize a trip and lockout relay on continued decreasing gas pressure at a predetermined value. A set of contacts close to trip the breaker and another set of contacts open to prevent electrical closing of the breaker.

An alarm and lockout pressure relay, temperature-compensated on the low-pressure system, has two contacts. One contact closes at a predetermined value on decreasing gas pressure to give an alarm indication. On continued decreasing gas pressure, the other contact opens at a predetermined value, and in conjunction with the motor starter, shuts off the gas compressor or prevents it from operating. This prevents the compressor from lowering the gas density in the low-pressure system below the level of safe dielectric strength.

4.3.4 *Heater-Systems Controls*

Mechanism and Control Housings

The temperature inside each housing is maintained by thermostat controlled heater systems located in strategic areas. One set of heaters is continuously energized to prevent condensation.

High Pressure Tank Heaters

The high-pressure tank is heated by warm gas flowing up from the vaporizing chamber which is warmed by a primary heater bank. The bank is energized by a relay located on the control panel, which is controlled by a thermostat located inside a well in the high-pressure vaporizing chamber.

Terminal blocks are provided so that the heaters can be isolated for resistance and continuity checks with an ohmmeter.

A secondary heater system is also provided and is the exact duplicate of the main system. The thermostat of the secondary heater bank is set to provide heat only if more heat is required or the main system fails.

4.4 CONTROL PANELS

Control panels in each mechanism housing are used for mounting the necessary control devices. A separate control housing and panel is provided to operate the breaker locally, and to provide centralized termination of wires.

Located on the control panels in each pole's mechanism housing are the auxiliary switches to control the breaker. Those switches whose function require it are individually adjustable.

4.5 MIMIC DIAGRAM GAS SYSTEM (See Fig. 20)

A diagram mounted on the inside operating mechanism door shows the relationship of the valves and other gas handling components as an aid to operating personnel.

5. GENERAL DESCRIPTION OF BREAKER OPERATION (See Figs. 10 & 16)

5.0.1 *Closing Operation*

The closing operation is initiated by energizing the closing coils. This actuates the three-way control valves and admits air to the air cylinders. The piston in the cylinders moves up and this motion is transmitted to the blast valves and moving contacts through the mechanical linkage (See Fig. 10). During this operation, all accelerating springs, used for the opening operation, are charged.

As the pistons in the air cylinders near the end of their strokes, a limit-switch closes and energizes the anti-pump relay. This de-energizes the closing coils which shuts off air flow to the air cylinder. The mechanism latches hold the breaker in the closed position.

5.0.2 *Opening Operation*

The opening operation is started by energizing the trip coils. This releases each mechanism's trip free latch. The accelerating springs accelerate the blast valves and moving contacts to the open position. High-pressure gas rushes from the reservoirs to the interrupter chambers and extinguishes the arc. When the contacts are fully open, the blast valves cut off the gas flow. A dashpot in the mechanism housing cushions the end of the opening stroke. After the breaker contacts have parted, the "a" auxiliary switch contacts in the trip coil circuit de-energize the trip coil.

5.0.3 *Close-Open Operation*

The close-open operation is a combination of the closing and opening operations described above. As the breaker contacts approach their make-up position, auxiliary switch contacts on the mechanism make up the trip coil circuit. Assuming the breaker is closed on a fault, as soon as the breaker contacts close, the protective relay will energize the trip coil disengaging the trip-free mechanism which allows the breaker to reverse its motion and move to an open position. The closing piston of the mechanism, however, will continue to the fully closed position and actuate the limit switch which ultimately de-energizes the closing coil and shuts off the air flow to the cylinder. The piston and the whole latch mechanism will then return to its normal open position.

5.0.4 *Open-Close Operation*

This operation is initiated by energizing the trip coil which opens the breaker as described under "Opening Operation." The latch mechanism is ready for closing the breaker again as soon as the trip coil is de-energized and the trip latches have returned to their normal position. If a closing impulse follows immediately, the operation is referred to as "Reclosing" and is described in more detail under "Description of Electrical Operation."

5.0.5 *Manual Operation — Maintenance*

The manual or maintenance closing device consists of a hydraulic jack which is placed under the closing air cylinder assembly so that it is in line with the lower end of the piston rod. When operated, it raises or lowers the piston slowly. More detailed description will be found in Part C, Section 2.6 and Section 2.7.

NOTE: This device should never be used when the breaker is in service and should be removed from the mechanism when not needed for maintenance purposes.

5.0.6 *Pneumatic Operation — Manual*

The solenoid closing valve is equipped with means for manually operating the valve. If the air system has the required air-pressure, the pole can be closed under pneumatic power, using this means instead of the electric controls for test only (See Fig. 16).

5.0.7 *Manual Trip*
Each standard pole is equipped with a manual trip device which is operated from the outside of each mechanism housing, and when actuated will trip the pole mechanically and the other two poles electrically if the control circuits are energized.

5.0.8 *Dual Trip (Optional Equipment)*
The dual trip is a combination of two trip solenoids working independently of each other.

6. DESCRIPTION OF ELECTRICAL OPERATION (See Figs. 45, 46 & 47)

The breaker is operated from the control housing, which contains most of the common control circuitry. All customer interconnections, AC and DC power, remote control, and alarms are made in the control housing. Located in each mechanism housing are controls associated with that particular pole. Each mechanism housing is connected to the control housing by cable, in conduit, when breaker is installed.

The descriptions of operations which follow are for basic AC and DC schemes (See Figs. 45, 46 & 47). Customers should consult specific control diagrams supplied with breaker for exact operation.

6.1 DC OPERATIONS

6.1.1 *Closing*
The closing operation is essentially the same for series and parallel circuits, except for the multiple energizing paths of the closing coils in the parallel scheme.

The following preliminary conditions must exist before the breaker can be closed. All poles of the breaker must be open, the "B" contacts and latch check switches (LC) closed and the permissive control switches (69) not in a mechanically locked out position. Systems must have correct gas and air pressure so high pressure gas lockout switches (63-7) are open and air pressure lockout switch (63-2) is closed. Standard range of control voltage available at required terminals as specified on nameplate, fuses okay and control power switches closed.

Closing is initiated by a momentary operation of the close switch ($\frac{cs}{c}$) or a remote switch operation if the local remote switch (43) is in the remote position. This completes the circuit, which energizes the "X" relay. Contacts of the "X" relay operate the closing coils (cc) and seals itself in. The closing coils operate a 3-way air valve in each pole allowing high-pressure air to enter the operating cylinder which forces the piston to travel up the cylinder, closing the breaker and charging the accelerating springs. As the pistons travel upward, they activate limit switches (LS) attached to the cylinder walls. The closure of all limit switches operates the "Y" relay. The "Y" relay, through double contacts, de-energizes the "X" relay and closing coils, removing air pressure from the cylinders and venting the used air to the atmosphere. The "Y" relay remains energized through its own contact as long as the closing or reclosing circuits are energized to prevent pumping.

6.1.2 *Tripping*
Tripping is accomplished locally by a momentary operation of the trip control switch ($\frac{cs}{t}$) or automatically by operation of the gas trip relay (63-7X) or the discrepancy trip relay (94), or remotely by the customer. The circuit is completed through the double "A" contacts for each phase charging the impulse trip device (ITD), used only in 2-cycle breakers to increase tripping speed, and energize the trip coils (TC). The trip coils operate the trip solenoid that rotates the trip finger which, in turn, releases the trip lever which has been blocking the mechanism linkage. This linkage is now free to move due to the force of the breaker accelerating springs. This causes the center roller to slide off the latch and the breaker to open at full speed. The trip circuit is de-energized during the opening stroke when the double "A" contacts open. The dual trip circuit has duplicate equipment.

6.1.3 *Trip-Free Operation*
When the breaker is tripped electrically, the trip-free mechanism mechanically disconnects the closing force from the breaker linkage even if the piston rod is still held in the raised position by air pressure or by the maintenance closing device. Should the breaker close against a fault, the breaker can be tripped at full speed, even though the closing circuit is still energized.

6.1.4 *Reclosing*
The mechanisms are capable of instantaneous reclosing. The trip-free mechanism linkage returns to its normal latched position during the opening stroke. When this is accomplished, the latch check switch will close, and the mechanism is ready for reclosing both mechanically and electrically. However, an intentional delay is required for the reclosing impulse and is introduced by the reclosing time-delay relay (62) or a similar device supplied by the customer. When the reclosing circuit is energized, the reclosing time-delay relay starts its timing cycle and at the end of the preset delay time, closes its contact (62), energizing

the closing circuit. The reclosing time must not be less than 15 cycles.

6.1.5 *Trip and Lockout*

The control circuit is designed to trip the breaker and prevent it from reclosing (lockout) if the high-pressure gas system pressure drops below the point which the breaker can interrupt a fault, or if the poles become misaligned. The high-pressure gas switches (63-7) are connected so that any switch can energize the gas trip and lockout relay (63-7X) through the local-remote switch (43). With switch (43) set in the local position the poles can be closed, with no gas in the high-pressure system, for maintenance. A discrepancy circuit made up of "A" and "B" contacts sense pole misalignment and also operate the disagreement trip relay (94) to trip all open poles and reset the closing circuit by momentarily energizing the "Y" relay.

6.1.6 *Alarms*

Standard alarms provided are air system low-pressure (63-3), high-pressure gas system low-pressure (63-5), low-pressure gas system low-pressure (63-6/1), high-pressure gas system low-pressure lockout (63-7X), high temperature in high-pressure gas system (23-8) and pole disagreement indication (94).

6.2 **AC DESCRIPTION**

The AC circuitry provides power and control to compressors, heaters and service unit.

6.2.1 *Heaters*

Primary and secondary heaters are provided to keep the SF-6 gas above its liquification temperature to prevent misoperation of valves and compressors during cold weather.

Each high-pressure vaporizing chamber is heated by three primary 1000 watt strip heaters (H-10, H-11, H-12) connected in a three-phase arrangement. They are controlled by a thermostat (23-2) which operates magnetic contactor (23-2X). Over temperature protection is provided by thermostat (23-5). A secondary heating system is also provided identical to the primary system and consists of three 1000 watt strip heaters (H-13, H-14, H-15). They are controlled by a thermostat (23-3) which operates magnetic contactor (23-3X). Over temperature protection is provided by thermostat (23-6).

Mechanism and space heaters are provided as needed. The air tank valve heaters (H-1 and H-2) operate continuously. The air compressor heater (H-3) is controlled by thermostat (23-1). The gas compressor heater (H-4), the manifold and high pressure dryer heater (H-5), and the closing air valve heater (H-18) is controlled by thermostat (23-4). The control house is heated with two space heaters, (H-7) operating continuously and (H-6) controlled by thermostat (23-9).

Heater values are shown in Part E, Section 7.

6.2.2 *Gas Compressor*

The three gas compressors powered by four horsepower, three-phase, self-protecting induction motors operate independently. The magnetic contactors are operated by the compressor pressure relays (63-4) through lockout contacts of the LP gas system relays (63-6), which prevents the gas compressor from pumping the low-pressure system below its safe dielectric level, and the oil pressure safety control (OPSC) contact which will shut the compressor down on loss of oil pressure. Compressors in poles 2 and 3 are sequenced to come on after a slight delay by time-delay relays (62C and 62D) to prevent line surges.

6.2.3 *Air Compressors*

The three air compressors of the common air system are powered by one and one-half (1-1/2) horsepower, three-phase motors. Overload protection is provided in the motor starters. The air compressor pressure relays (63-1) can energize the auxiliary relay (63-1X) which will operate pole one compressor immediately and poles two and three compressors delayed sequentially through timers (62A and 62B) to prevent line surges.

PART B

RECEIVING, HANDLING AND STORING

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1.	RECEIVING	2B
2.	HANDLING	2B
3.	STORING	2B

PART B
RECEIVING, HANDLING AND STORING

1. RECEIVING

When the circuit breaker reaches its destination, the purchaser should check the material actually received against the shipping list to be sure that all parts have been received. This will avoid delays in installation. If damage is found or suspected, a claim should be filed as soon as possible with the transportation company, and the nearest representative of Gould Corporation should be notified.

2. HANDLING

The 550KV three-pole unit will be shipped as three basic tank assemblies. Bushings and the control cabinet are shipped separately. In some cases, the current transformers and linear couplers will also be shipped separately.

Refer to table below for the approximate weights of a single-pole tank assembly, bushing and current transformers.

A crane with sufficient lifting capacity will be the most efficient means for handling the breaker. Lifting lugs are provided for this purpose. The base frame of the pole unit is equipped with jacking pads and is designed for skidding and lifting with a jack where no crane is available. See Fig. 4 for lifting arrangement.

BREAKER RATING	POLE UNIT	OUTDOOR BUSHING WITH CRATE	CURRENT TRANS.
550 GA	18700 lbs.	5000 lbs.	500 lbs. max.

3. STORING

If the circuit breaker is not installed immediately, facilities *should be arranged to prevent damage* during storage. It is preferable that the circuit breaker be located on its foundation. Since the breaker will have to be opened for internal inspection to determine whether shipping damage has occurred, it will have to be sealed up again before storing.

NOTE: IF THERE ARE SHIPPING SUPPORTS INSIDE BREAKER, REMOVE PER INSTRUCTIONS IN FIG. 49, PART F.

PROCEDURE A (UP TO 3 MONTH STORAGE):

1. Evacuate breaker to .5 mm Hg. Make sure the blast valve is in the mid-way open position.
2. Back-fill the breaker with dry air (SF-6 or dry nitrogen can be used also) to 5 psig. WARNING: Do not overfill as bushing pocket shipping covers are not designed for pressures over 15 psig.
3. Energize the mechanism housing space heaters.
4. Do not energize the high-pressure vaporizer chamber primary or secondary heaters.
5. When bushings are shipped separately, they are sealed by a shipping cover and filled to about 2 psig with dry air. Shipping covers are equipped with a Schroeder valve just as used for auto tires.
   a. Do not remove shipping cover or lower insulator protective coating.
   b. If there is no pressure in a bushing, it should be refilled with dry air to 2 psig.
   c. Store bushings indoors in a dry place, or if this is not possible, they may be placed off the ground above flood level and under a good reliable cover.
6. Loose parts and spare parts should be kept sealed and stored in a dry room to minimize the possibility of damage from moisture and dust.

PROCEDURE B (3 MONTHS TO 3 YEARS STORAGE):

1. If bushings are shipped separately, install bushings per 1.10.2, Part C. If this is impractical, remove bushing pocket cover plates. Discard O-rings. Reinstall plates and covers with permanent bushing gaskets. For bushing storage, see Procedure 3.A5.
2. Place dessicant bags in low-pressure tanks per Fig. 13 and Part C, Section 4.3, Step 4.
3. Seal manhole per Part C, Section 4.3, Step 5. (using permanent manhole gasket).
4. Evacuate breaker per Part C, Section 4.3, Step 8.
5. Back-fill breaker with dry air (SF-6 or dry nitrogen can be used also), both high and low-pressure systems to 5 psig.
6. Energize continuously the mechanism housing space heaters.
7. Do not energize the high-pressure vaporizer chamber primary or secondary heaters.
8. Coat all machined parts in mechanism with rust preventive grease.
9. Same as Procedure 3.A5.
10. Same as Procedure 3.A6.
11. A routine check of the breaker condition,

heater operation, bushings and gas pressure should be made at one (1) month intervals.

12. After long term storage and before installation:
    a. Discard old desiccant bags.
    b. Discard old manhole and bushing pocket gaskets (if bushings are not installed).
    c. Wipe excess grease off machined parts in mechanism.
    d. Follow instruction book for installation procedure.

PART C

INSTALLATION

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PART C
INSTALLATION

1. **INSTALLATION**

1.1 *Location*
The breaker should be located so that it will be readily accessible for cleaning and inspection. The breaker foundation should be sufficiently high so that water will not enter the breaker mechanism housing and endanger the primary gas heaters during flood conditions.

1.2 *Equipment Furnished by Customer*
Refer to "Equipment Instruction," Part E of this book.

1.3 *Suggested Tools and Equipment for Installation and Maintenance*
Refer to "Equipment Instruction," Part E of this Book.

1.4 *Lubricant and Sealers*
A kit is available which contains the necessary lubricants, sealers and oil for installation or maintenance. Refer to "Lubricant and Seal Instruction," Torque Chart and Instructions (See Fig. 34) in Part E.

1.5 *Safety Precautions*

1. Open the primary disconnect switches on both sides of the breaker and ground their sides connected, or to be connected to the breaker.
2. De-energize all control circuits.
3. Close the main manual air supply valve in the three operating mechanisms (See Fig. 16.) Operate the three solenoid air valves manually to drain any residual air pressure.
4. **Before opening the manhole doors (Fig. 1) release the dry air from the high and low-pressure systems by removing the cap of the service connection outlet, and then opening valves A, B, C, D and E on each pole. Shown on Figs. 19 and 20.**
5. Release the shipping nuts (Fig. 21) of the gas compressor pads.
6. Before personnel start working inside the tanks, cover the insulated support tubes (Fig. 5) with clean, dry wrapping paper or cardboard to protect them from dirt and damage.
7. Only properly instructed persons should handle SF-6, N-2, F-12 and compressed dry air cylinders. Employ appropriate pressure regulating device and hose on cylinders. For details, refer to "Gas Handling Instructions," Part E.

NOTE: The pole unit tanks are considered unfired pressure vessels, and fall under the pressure vessel codes of the state or country in which the breaker is to be installed. No welding shall be performed on these tanks. If, for example, brackets to hold grounding leads are to be welded to the breaker, find a place on the frame, not on the tank wall.

8. Do not operate the gas compressor when all or part of the system is charged with air. Oil vapor from the compressor, and oxygen in the air could form an explosive mixture. Operation with nitrogen is acceptable.
9. If freon is used for leak testing as described in this part of the instruction book, be aware of the following: Freon flowing through the molecular sieve might produce excessive heat in the driers. *Do not run the compressor* while freon is applied to the system. Only after freon has been diluted with nitrogen may the compressor be turned on.
   Freon contains carbon which is not desired in the arcing zone of the SF-6 interrupter. *Freon is not to be left in the breaker permanently.*

WARNING: NEVER APPLY ANY VOLTAGE, FOR TEST PURPOSE OR OTHERWISE, WHEN BREAKER IS UNDER VACUUM CONDITION.

1.6 *Mounting and Leveling the Breaker (See Fig. 4 for Lifting & Fig. 2 for Mounting)*
The circuit breaker has practically no impact load. The foundation, therefore, only needs to support the weight of the breaker.

Mounting provision for breakers with special seismic requirements are also shown in Fig. 2. The breaker poles should be approximately level to promote proper drainage of liquid SF-6 into the vaporizing chamber. Leveling can best be done by using a spirits level on and across the interrupter support beams as shown in Fig. 15. Grout or shim as required between the breaker base structure with particular attention at the clamping or welding locations.

NOTE: IF THERE ARE SHIPPING SUPPORTS INSIDE BREAKER, REMOVE PER INSTRUCTIONS ON FIG. 49, PART F.

1.7 *Connections*
Before making any electrical connections, make certain that all leads to be connected to the breaker are de-energized.

1.7.1 *Ground*
The breaker structure should be permanently

grounded. Two grounding pads are provided for convenience, one on the front and one on the rear of the structural base of each pole.

Bolted connectors are provided for attaching the grounding cable. The cable should be able to carry the maximum duration of the available fault current at breaker location. A good, permanent low-resistance ground is essential for adequate protection. A poor ground is worse than no ground at all. It gives false security to personnel working around the equipment and may result in loss of life or equipment damage.

1.7.2 *Control and Secondary*

Control devices and auxiliary equipment in the breaker and master control housing have been wired at the factory. Terminals are provided for connections of incoming control wiring. Refer to the "Connection Diagram" furnished with the breaker for making external connections, and to the mechanism nameplate for specific control voltages.

Use control wires of adequate size so that the voltage at the breaker terminals is within the standard limits.

Run control wiring separately and remotely from the current transformer leads. Conduits for external control wiring may be terminated at the removable plate located in the bottom of the mechanism housings. All conduits should be properly sealed at each housing to prevent moisture and dirt from entering.

1.8 *Moisture Precaution*

Keeping the breaker as dry as possible during storage, installation and maintenance is extremely important. When leaving the breaker overnight, close the tank manhole doors using O-ring and at least eight (8) bolts. Close valves A, B, C, D, and E (Fig. 20). If the breaker is to be left unattended for several days, it is recommended that the purging procedure under "Storing," Part B be followed.

1.9 *Current Transformer and Linear Coupler Installation*

Fig. 30 shows the current transformer or linear coupler installation. Before installing the current transformers or linear couplers, refer to the "Bushing Current Transformer Nameplate" posted inside the mechanism housing. This nameplate indicates the current transformers or linear coupler locations in the bushing pockets. Each current transformer or linear has a nameplate on its outside surface for identification.

Place eight insulated spacers (212) in the bottom of the housing equally spaced before installing the bottom current transformer or linear coupler.

Current transformers and linear couplers should be lifted with two fabric straps. Tie a rope to straps, being certain that the straps are equally spaced before lifting. The lifting angle should be aligned with the bushing angle, approximately 18°.

Once the current transformer or linear coupler is in position, insert insulation (211) in four places, straddling the center lines of the pocket (quantity at each place as required for snug fit).

Where more than one current transformer or linear coupler goes in the same pocket, place eight insulated spacers (212) equally spaced under each current transformer or linear coupler.

After current transformer or linear coupler is connected, install cover. Be sure that the insulating gasket (213) is in place and that there is a gap between cover and bushing pocket flange. Install washer (207) and nut (208) and tighten cover.

1.10 *Bushing Installation and Interrupter Connection*

Before installing the bushing and connecting interrupters "A" and "F" to the bushings, inspection of linkage and high-pressure system per Sections 1.11.1 through 2.9 is suggested.

1.10.1 *Preparation for Bushing Installation*

Remove shields above interrupters "A" and "F". Refer to Fig. 8.

1.10.2 *Bushing Installation — General (See Figs. 3 & 29)*

Make every effort to install bushings in clear weather with no rain or wind.

Remove bolts holding cover on bushing entrance pocket. Place an eye bolt in top of cover and remove cover, also remove O-Ring.

The gasket face of bushing pocket must be very clean. Wash these surfaces with mineral spirits. Do not scrape to clean because it may scratch surfaces.

Place the flat gasket (67) in recess of bushing pocket flange without grease of any kind; grease on gasket surfaces promotes leakage. The gasket may be held flat if necessary by small spots of rubber adhesive on the outside diameter of the gasket (See Fig. 29). Grease bolt threads and surfaces as shown in Fig. 29.

1.10.3 *Slinging the Bushing Using the Sling Provided by Gould Only, With Nameplate in Position Shown (See Fig. 3).*

IMPORTANT! **Outdoor bushings should be installed only after the breaker pole is secured to its foundation pad for reasons of stability.**

1.10.4 Remove the plastic protective coating on the lower insulator of the bushing. It can be stripped easily after piercing it with a fingernail or knife point. The gasket sealing surface of the bushing is cleaned in the same manner as the bushing pocket (Part 1.10.2).

Clean the lower porcelain of the bushing using a clean, dry cloth only. If further cleaning is necessary, use sandpaper and alcohol only. De-pressurize bushing and remove shipping cover (See Fig. 3).

Lower the bushing into the breaker tank, taking care not to damage the lower porcelain. Center the bushing. Place mounting bolts and washers to hold the bushing in place and tighten the screws on opposite sides, progressing around repeatedly. Now tighten them with a torque wrench. (See "Torque Value Instruction," Part E).

Outdoor bushing hold down bolts (68) and washers (69), are assembled as shown in Fig. 29.

NOTE: All bushing flanges, must never touch or be electrically connected to the transformer weather covers, after installation (See Fig. 29).

1.10.5 Tighten the hold down bolts (68) or (71) on opposite sides progressing around repeatedly using a torque wrench (See Fig. 34 for torque values).

1.10.6 *Bushing and Interrupter Electrical Connections (See Figs. 2 & 13)*
The entrance bushings have aluminum terminals at both ends. These terminals must be cleaned with 240 grit sandpaper or a wire brush. Apply Alnox Electrical Joint Compound, Gould Ed. 4.1.3318, to the bolting faces of the terminals before joining any current carrying parts to the bushing. The bus connector (73) joins the connecting conductors to the bushing (See Fig. 2).

The lower internal connections for the bushing are made as follows: (See Fig. 13)

Connect the adapter terminal (80) loosely to the flexible connectors (81) by screws (82) and washers (83, 84) and in turn have the flexible connectors loosely joined to the adapter (302) by screws (93) and washers (94, 95). Move this assembly around as required until the screws (82) washers (83, 84) line up with one of the sets of holes in the lower bushing flange. Fasten all bolts securely. See Torque Chart Fig. 34. Item (80) may be turned around to provide a greater range of adjustment.

CAUTION: Cover interrupters "A" and "F" with a cloth when wire brushing lower bushing terminal to prevent aluminum oxidized dust from contaminating the interrupters.

Install shields (111) on interrupters "A" and "F" with screws.

1.11 *Capacitors (See Figs. 7 & 8)*
The voltage grading capacitor assemblies are relatively fragile and damage may result if a unit is dropped. If damage is suspected, capacitor should be replaced.

NOTE: The location of the voltage grading capacitors and their installation can best be determined by referring to Figs. 7 & 8. It should be noted that each capacitor must be identified and located by part number and color code, both shown on the side of the cases. Only one color code may be present in any one phase. Do not mix the colors. Other phases may have a different color code.

When installing the capacitor unit, insert the top male end in the concave contact shield. Hold the capacitor unit against the shield and screw in the spherical ball screw (117), lubricated with Gould grease Ed 4.1.3321, until the ball touches the female contact at the lower end of the capacitor unit. Then screw in the spherical ball two (2) turns. Lock screw with set screw (125).

1.11.1 *Install the Common Air Supply*
Install the interphase air pipes as shown in Fig. 2. Note the bolts (87) across the flexible fitting (88) are used for sealing the connection only and the units are restrained from separating by stud (89) and bolts (90).

2. INSTALLATION INSPECTION

The breaker has been assembled, adjusted and tested at the factory and only a routine check should be required to place the unit in service.

2.1 SAFETY PRECAUTIONS

Before proceeding, the following should be kept in mind:

1. Do not work on the operating mechanism or inside the tank until:
   a. The safety pin (41) is in place to prevent accidental tripping (opening) (See Fig. 14).
   b. The manual air valve (511) is closed to prevent accidental closing (See Fig. 28).
   c. The control power is off when working on electrical components.
2. Do not work in the main breaker tanks when:
   a. The high-pressure gas system is pressurized over 100 psi.

b. If nitrogen is being used to set the blast valve or if checking inside the tank for a leak, unless breathing equipment is used with its own independent air supply.

2.2 *Linkage and Hardware Inspection (Breaker is in the CLOSED Position, safety pin in place.)*
Open all manhole doors and check that all interior nuts and bolts are tight.

NOTE: The manhole doors have been sealed with O-rings at the factory for shipping purposes. This O-ring will provide sufficient sealing during installation of the breaker. The three flat-gaskets shipped separately should be saved for final sealing of the manholes.

From this point forward, the inspection should be conducted in the following sequence when possible. Adjustments, if required, are shown on the figures indicated. Major adjustments are described in detail in Section "D".

2.3 *Resistor Switch Contact Alignment and Adjustment (Fig. 7)*
The breaker as shipped is in the closed position (main contacts made). The resistor switch contacts will be open. Check the alignment of each resistor switch contact on all poles as follows. Grasp operating rod (427) and move it upward, observing the alignment of the moving contact (428) with the resistor switch stationary contact. If adjustment is necessary, remove resistor shield (440). Loosen cap screws (450) and realign contact mounting angle (451). The contact penetration should be 3/16" ± 1/16" with the blade horizontal. Tighten cap screws (450) and replace shield (440). The moving contact at rest should be vertical within 1/2" as shown in Fig. 7 and can be adjusted by changing the length of rod (427) with breaker in open or closed position.

2.4 *Adjustment Checks, Breaker Closed* ***Manually*** *(See Figs. 13, 14 & 17) (Check Safety Devices, See 2.1)*
Check each of the following listed adjustments in the following sequence: H — J — K — AN — P — T and Y.

In the event "P" or "T" adjustments are out of their tolerance range and require resetting, complete linkage and interrupter adjustments would be required as outlined under Section D. *DO NOT* disturb these adjustments if they are in their tolerance range.

(See Figs. 12 and 13.)

The moving contact penetration settings (Dimension Y) are normally made with the shields (111) (112) and adapter (302) removed, however, this calls for considerable disassembly, so this check is best made as follows: Insert the "Y" gauge through the exhaust vent of shield (111) and (112) down into the stationary contact (374) making sure that the ears of the "Y" gauge are in the notches provided in adapter plate (303). The adjustment can not be seen. However, if the gauge is gently rocked back and forth with one's fingers, it is a simple matter to feel when the moving contact (365) engages the "Y" gauge as the contact is advanced upward. The contact is so designed that it can only be adjusted upward, and if one overshoots, the contact (365) must be lowered one turn, the breaker opened about halfway, then jacked closed. The contact rod is then advanced upward by turning the contact rod counterclockwise with a 3/16 dia. rod inserted into the hole (365A) at the lower end of the contact rod. Before an adjustment is made, lock screws (358) must be loosened. Be sure to tighten them again after the adjustment is made.

2.5 *Adjustment Checks — Breaker Open*
Open the breaker by removing the safety pin (41) and pulling on the hand trip rod (222), then reset the trip linkage by pulling on reset rod (225) as shown in Fig. 17.

Refer to Figs. 13 and 14.

Check these ajdustments in the following order AA — E — D — F — N — AB — AE and AN. These adjustments are shown or described at the figure indicated and in Part D.

2.6 *Manual Opening (See Fig. 14)*
To open the pole manually, operate the hydraulic jack (36) to force the closing cylinder rod (37) upward until the center roller (39) is lifted free of the latch (38). With a large screwdriver, push the latch back from underneath the roller. Then release the jack to allow the pole to come open. Do not operate the pole manually unless the safety pin (41) is in place to block accidental tripping.

2.7 *Manual Closing (See Fig. 14)*
The pole is closed manually by placing the hydraulic jack (36) under the rod (37) that extends from the bottom of the closing cylinder of the operating mechanism. Operate the hydraulic jack to force the closing cylinder operating rod (37) upward to close the pole through the mechanism and pole linkage. The pole is fully closed when the latch (38) falls under the center roller (39). Release the pressure of the jack to allow the roller to rest on top of the latch. (Do not close the breaker until checking resistor switch adjustments as misaligned switches can damage the switch linkages).

2.8 *Leak Inspection of the Pneumatic and High-Pressure Gas System. Breaker in the Closed Position. (See Figs. 19, 20, 26, 28, 42 & 45)*

Proceed as follows:

CHARGE PNEUMATIC AIR SYSTEM

1. Check Section 6B (1, 2 and 3) on each pole.
2. Energize air compressor motor circuits (See Wiring Diagram).
3. Check Section 6E (1, 2 and 3) on each pole, as air pressure builds up and air compressors shut off.
4. Open drain valve (512), Fig. 28, slightly on the air tank of any pole — gradually reducing the air pressure in the pneumatic system, checking 6E-1 on each pole as pressure decreases.
5. Deenergize air compressor motor circuits and check 6E (2 and 3) as pressure decreases.
6. Close drain valve and energize the air compressor motor circuits letting air pressure build up until air compressors shut off.
7. Open main air supply valve on each pole (See Fig. 16).
8. Power close each pole by operating the manual operator on the solenoid operated air valve (See Fig. 16).

PRESSURIZING THE HIGH PRESSURE GAS SYSTEM

WARNING: Do not operate gas compressors (12) Fig. 19, when air is in the breaker tanks. Check the blast valves for leaks only after a power close.

Proceed as follows for each pole:

1. Close valves A and C (See Fig. 19).
2. Open valves B, D and E (See Fig. 19).
3. Remove cap on service connection and connect to a dry air or nitrogen supply. The service connection is a 1-1/4" tube 37° JIC flare connection.

WARNING: Be sure a suitable pressure reducer and a safety valve set at not over 300 psig is connected between air or nitrogen tank and service connection (See Fig. 42).

4. Pressurize the high pressure gas system to 15 psig and in steps to 50 and 100 psig. Listen for audible leaks from blast valves at each pressure level.
5. If no leak is heard, anyone in the tank should come out as ***no one should be in the tank when the high pressure gas system exceeds 100 psig.***
6. Use two bolts opposite the hinge side to secure the manhole door slightly ajar.
7. Raise the gas pressure to 220 psig.
8. Allow the temperature and pressure to stabilize. Then close valves A and E.
9. Check blast valves leak rate. It should not exceed 2 psi per hour.

While checking the blast valves leak rate the pneumatic system can also be checked for leaks as follows: Energize the air compressor motor circuits until air pressure builds up and air compressors shut off. Check leak rate of the pneumatic system. It should not exceed 4 psi per hour.

Leaks in the pneumatic system are normally plumbing leaks. Follow instructions in Section "E" for "Pipe Thread Sealant."

The leak rate in the gas system is from the high pressure system to the low pressure system. The leak rate to the atmosphere should be "nil." If blast valve leakage is excessive see Section "D".

NOTE: Be sure service connection is capped.

2.9 *Check for Blast Valve Leaks — Breaker in the Open Position*

Remove the safety pin and hand trip the pole units. Enough pressure will remain in the high-pressure systems to check for leaks at the lower blast valve seats. A blast valve leak will be heard by the manhole door, that is ajar, but secured by two bolts opposite the hinge side. The leak rate should not exceed 2 psi per hour. If a blast valve leak is detected, see Section D.

3. PRELIMINARY TIMING TESTS

Each pole must be checked to determine if the opening speed and the opening time are within specified limits. It is best to determine these conditions before closing and filling the breaker.

3.1 *Individual Poles*

Individual poles of a circuit breaker connected in either parallel or series control schemes may be operated from the control station. The following procedure is to be followed:

1. Breaker must be tripped and Local — Remote switch in "Local" position.
2. Shut off air valves to non-operating poles.
3. Jumper around the latch check switch (LC), "B" auxiliary switch AS-1/b, and limit switch (LS) of non-operating poles in closing circuit. In the series trip scheme, the non-operating poles double "A" auxiliary switches will have to be shorted. See the wiring diagram for this contract.
4. Remove the pole disagreement relay (94) from its socket.
5. Do not manually lockout the non-operating poles.
6. Now momentary operation of the control switches will operate the desired pole only.
7. During these tests, the high-pressure gas system is to be pressurized with dry air or nitrogen at 220 psig and the pneumatic

system at maximum operating pressure. Use rated control voltage. These three conditions must be held during synchronizing tests.

3.2 *Check the Opening Speed (See Figs. 10 & 38)*
The breaker's opening speed is determined by measuring the speed of the horizontal operation rod (24) with a time travel recorder. This device also monitors the action of the opening dashpot (520). A typical installation of this equipment is shown in Fig. 10, and a typical time distance curve is shown in Fig. 38.

3.2.1 *Determining Opening Time (See Fig. 39)*
The opening time is determined with an oscillograph and this instrument is also used to determine closing time and insertion time of resistor switch contacts. Proper calibration of the galvanometer circuit will render the main and resistor contacts distinguishable on the same trace.

The closing resistors only operate on a closing operation.

The insertion time of each resistor can be determined by an oscillograph. A typical oscillogram is shown in Fig. 48. Contact bounce shows up on the oscillogram because of the low voltage on oscillograph. Line voltage of breaker would maintain circuit at initial make of the switch.

NOTE: Oscillograph control wiring can be brought out manhole which is left ajar.

3.2.2 Once the time travel recorder has been installed, check the "make" points of, and adjust, if required, the closing circuit auxiliary "b" contacts and the trip circuit auxiliary "a" contacts. The proper relationships are shown on Fig. 38. This can best be done by slowly closing the breaker with the manual closing device and monitoring the auxiliary switch contacts as the breaker closes. See Fig. 18 for instructions for contact adjustment of adjustable auxiliary switch.

3.2.3 *Obtaining Specified Speed and Opening Time (See Figs. 13 & 14)*
Establish the following conditions:

1. Manhole doors ajar two bolts holding door opposite hinges.
2. Pneumatic air pressure at rated psi.
3. Safety pin out of mechanism.
4. Pneumatic hand valve open.
5. Control circuits altered as per 3.1, energized and at rated voltage.
6. Dry air or nitrogen gas at 220 psi in the high pressure gas system.

Electrically trip the breaker and if necessary, adjust the breaker at springs C_1 and C_2 shown in Fig. 14, to obtain the specified speed and opening time as shown on Fig. 38 and 39 respectively. Compressing springs C_1 and C_2 will increase speed and decrease opening time while less compression will decrease speed and increase opening time. In case more or less spring force is required than can be obtained from springs C_1 and C_2, the main springs (91) can be adjusted at setting "S", see Fig. 13 and Part D for adjustment instructions.

3.2.4 The dashpots have been set at the factory and rarely require adjustment in the field. The following adjustments are provided (See Fig. 14).

1. The position of the breaker where dashpot action takes place is adjusted by adding or removing washers (240).
2. The level of dashpot action can be controlled by adding or removing orifice screws (See Fig. 14).

Once the opening speed and opening time of the poles have been verified, closing time adjustments can be initiated.

3.2.5 *Synchronize the Closing Time (See Figs. 28 & 39)*
All tests are to be made at the exact pressures and voltages as listed under 3.1, Step 7.

Operate each pole and determine the closing time (the time required for a pole's main contacts to make after the closing circuit has been energized). After this time has been determined for each pole, adjust the poles for synchronous closing by means of the air throttle valve (541) (See Fig. 28). When the screwdriver slot in the valve is parallel to the main piping, the valve is fully open and, when the slot is perpendicular to the line, the valve is in the maximum throttle position. If the valve is fully open on one pole, the other poles will have to be slowed up if the poles are not synchronized. The valve is designed so that the pole will close even at the maximum throttle position.

WARNING: To adjust the throttle valve, the high-pressure air must be removed from the air line. To accomplish this, close the manual air valve (511) then activate the manual operating device on the solenoid air valve (509) to discharge the trapped air. It is now safe to loosen the lock screws (92) shown on Fig. 28, turn the valve stem (97) to its new trial position, *then tighten* locking screws (92). Always

adjust the valve stems to give as little throttle action as possible in keeping with the requirements of pole spread and resistor switch insertion time. See Fig. 39 for pole spread limitations.

3.2.6 *Resistor Switch Timing (Figs. 7 & 39)*

The resistor switch insertion time (the time the resistor switch makes before the breaker poles main contacts make) is shown on Fig. 39. The main adjustment for this timing is made with the throttle valve described in Section 3.2.5. Small timing adjustments of approximately one millisecond can be made with turnbuckle (452) shown in Fig. 7. However, do not adjust this rod where the moving contact blade (428) is over 1/2" as measured at the nose end from its true vertical position as shown in Fig. 7.

3.2.7 *Pole Resistance*

Measure and record the pole resistance bushing terminal to terminal. Resistance limitations are shown in Part E.

It is also good practice at this time to slowly close the breaker with the manual closing device until all resistor switches are engaged, stopping before the main contacts touch and again record the pole resistance. The resistance measurement bushing to bushing will be the total resistance of the resistors (See Part E).

3.3 FINAL CHECK BEFORE SEALING THE BREAKER POLES.

Refer to check list at the end of this section. All checks with the exception of (I1 to I5 AND J2, 3 and 4) now should be complete. If not, complete them and prepare to close the breaker.

3.3.1 *Leak Inspection to Atmosphere (Low-Pressure System)*

The manhole doors have been sealed with O-rings at the factory for shipping purposes. The O-ring will provide sufficient sealing during leak inspection of the breaker.

If a Halogen Leak Detector is to be used, add Freon-12 to the system by connecting the Freon-12 cylinder to the sampling valve (Fig. 20).

Close manifold valves C, D and E and open manifold valves A and B (Fig. 20). Open the sampling valve and the Freon cylinder valve. Let Freon-12 flow into the low-pressure tanks until the low-pressure gauge reads one (1) psig. Close all the valves. *If liquid leak detector is to be used, omit the operation described above. Pressurize the system as described below.*

Connect a nitrogen or dry air cylinder to the service connection, open all valves and bring pressure to equalized pressure (See Fig. 26).

NOTE: During the filling and draining of the low-pressure system for leak inspection, it is desirable to check and adjust the low-pressure temperature compensated relay and its contacts 63-6/1 and 63-6/2, as at this time it is easy to lower the pressure of the system to alarm and lockout pressure. After the breaker is filled with gas, these pressures can only be obtained by removing the SF-6 gas.

Check for leaks with a Halogen or liquid leak detector (for more details, refer to "Leak Detector and Moisture Analyzer," Part E), in all the places listed below:

In the pole mechanism housings:

1. All plugs and connections.
2. All hose connections, fittings and pipe caps, including the ones on the service connection and the sampling valve connection.
3. The plug on the gas compressor oil filling nipple.
4. The safety valve

On the pole unit:

5. The seal on the rupture disc.
6. The seal of the bushing flange.
7. The vacuum valve.
8. The bellows. Remove the tube cap (145) Fig. 10 and check for leaks from the bellows (25). See Part D Section 10.4.

If a leak has been detected, refer to instructions in Section 10.4, "Corrective Action," Part D of this book.

If possible, let the pole unit stand pressurized overnight, record the temperature and the pressure. A check the next morning would give added assurance that the unit is leak free if again the temperature and pressure are checked. A change of each 5°F will correspondingly change the pressure 0 .75 psi.

4. FILLING THE BREAKER WITH GAS

After the mechanical inspection and adjustments have been completed, the breaker is ready to be sealed, evacuated, dried out and filled with gas.

4.1 *Evacuation and Dry-Out*

WARNING: Never apply any voltage, for test purposes or otherwise, when breaker is under vacuum condition.

General Description of Process

Moisture in the air trapped inside the breaker after closing the manholes may condense on the surface of the internal parts during a drop in ambient temperature.

The evacuation has a dual purpose; to remove the air from the breaker and to draw out moisture. It should always follow soon after closing the manholes.

Both high-pressure and low-pressure temperature gauges must be above 0°F during the evacuation period. Contact the factory, if this is not the case.

Vacuum Pump

A 150 CFM size vacuum pump is recommended, but if only a smaller size is available, the pump-down time to 0.5 mm Hg will be longer. The vacuum pump should be checked for capability of pulling a 0.01 mm Hg vacuum or better.

CAUTION: The vacuum pump must have provision to prevent oil from being drawn into the breaker when the pump is turned off. If this provision is not inherent to the pump, a valve must be installed between the pump and the point where the vacuum gauge is connected. When taking vacuum readings on the breaker this valve must be closed.

Vacuum Hose

Use the shortest and largest diameter hose practical (e.g., 10 feet or less by 2 inches i.d.). This will allow a more effective pull-down from the breaker.

Vacuum Gauge

An accurate vacuum gauge must be used. Stokes electrical gauges, Model TB-3, 4 or 5 or equivalent, are suitable. Locate gauge on or near gas manifold.

4.2 *Preparation for Sealing and Evacuating the Breaker*

Make sure that all tools and extraneous material have been removed and that the tanks are clean. Wipe all support columns, shields, capacitors, resistors and interruptors, using a clean, dry, lint-free cloth only. If it is necessary to clean some surfaces, use alcohol only (except Ethyl Alcohol). Certain surfaces have a special coating which is not compatible with Ethyl Alcohol or certain cleaning solvents. Remove all extraneous material at the bottom of the tanks with a vacuum cleaner and in winter, be sure that no snow or ice is left behind. Clean manhole flange with industrial solvent. Remove any grease, rust or corrosion, using steel wool if necessary. Be careful not to scratch surface. Dry surface thoroughly.

4.3 *Sealing and Evacuating the Breaker*

Proceed step by step as follows:

1. Start out by reading the manufacturer's instruction for the vacuum pump. Connect the vacuum pump hose to the valve on a low-pressure tank (See Fig. 32). Be sure service connection cap is installed on the manifold (See Fig. 20). Open valves A, B, C, D and E of the manifold. "DO NOT START THE VACUUM PUMP AT THIS POINT."
2. Record Keeping
   A concise record of the results during evacuation and filling and moisture measurements is of utmost importance. A suggested sheet for record keeping is shown at the end of Part C. When the sheet is completed, forward a copy to the Gould Power Systems Division for record purposes.
3. During evacuation all blast valves should be between their upper and lower seats to allow free evacuation through the interruptor. To accomplish this, close the pole with the maintenance closing device (hydraulic jack) to the point where the latch (38) is about to fall under the center current roller (39) (See Fig. 14). Then open the pole slowly until dimension "B" is about 1/2 to 3/4 inches. Repeat on other two poles.
4. Installation of desiccant bags in each pole unit tank. Use two bags per pole and install in tanks per Fig. 13. Remove the protective envelope, cut off the tie cords and discard them, then lay the bags quickly in the tank bottom to reduce the time during which the desiccant bags are exposed to atmospheric moisture. Proceed with next step promptly. See Section 7 for added information regarding these bags.
5. Install manhole flat gasket. Do not apply grease or any other substance on the gasket or groove surface to hold gasket in place. This would promote leakage. Instead, use the gasket assembly clips (539) furnished to hold the gasket as shown in Fig. 33.

   Apply a thin film of grease (See Fig. 35) to bolt threads and to flange surface between O.D. of gasket and outside edge of flange, moving clips as necessary. See that no grease is applied to the gasket surface by wiping thoroughly with a dry cloth. Close cover. Install a bolt and nut in the hole opposite the hinges. As manhole door is pulled closed, remove each clip in turn as the door starts to engage the clip.

WARNING: CHECK THAT CLIPS ARE REMOVED FROM THE DOOR.

Place four bolts 90° apart and tighten snugly. START VACUUM PUMP as soon as the manhole is sealed. Install the remaining bolts and start tightening them, first on diametrically opposite sides, progressing around the door. Then tighten bolts around the door once more to check for the correct torque (refer to "Torque Value Instructions," Part E). The use of an impact wrench is suggested to reduce the time required for initial tightening of the bolts.

6. Fill the two filter-dryers with desiccant. The filter-dryer columns are located on the right side of the mechanism housing. Any "old" Molecular Sieve which had been applied to the filter-dryers at the factory must now be removed since it will have absorbed excessive moisture during installation. To isolate the filter-dryer columns from the system during evacuation, proceed as follows. (For system pressurized with SF-6, refer to Part D.)
   a. Close valves A, B, C, D and E (See Fig. 20). Remove the service connection cap and open valves A and E. Air will rush in through the service connection until the piping, filters and compressor are at atmospheric pressure.
   b. Drain the Molecular Sieve by removing the top plugs (14) on the filter-dryer's columns and the bottom plugs (14) located underneath the housing (See Fig. 25).
   c. Check the bottom plugs and clean the threads carefully. Replace them using sealant per Part E of this book.
   d. The filling of the desiccant should be performed quickly to reduce the time during which the Molecular Sieve and the interior of the filter-dryer columns are exposed to atmospheric moisture. Before filling the columns with desiccant, check the top plugs and clean the threads carefully. Have the threads sealant material on hand before proceeding with filling. Pour the desiccant (Molecular Sieve, type 13X) from the shipping container directly into the dryers, using a funnel for this operation. Fill the dryer until the desiccant level reaches about 1" below the filling holes (See Fig. 24). Install the top plugs with sealant as described under step 6c.
7. Install the service connection cap on the manifold and open valves B, C and D, valves A and E remain open. The piping, filters, etc. are now again connected to the pole unit tank on which a vacuum is being drawn.
8. *Evacuation and Drying Process*
   As soon as the vacuum has come down to 0.5 mm Hg, start the hour count. (The time it takes to get to 0.5 mm Hg will depend on the capacity of the pump, length of hoses, ambient temperature, etc.) The vacuum dry-out will be completed and the breaker is considered dry when a vacuum of 0.5 mm Hg (500 microns) or less is drawn and held for 24 hours at 0.5 mm Hg or less. Readings shall be taken only when the vacuum pump is turned off.

   When evacuation is completed, close the vacuum valve (Fig. 32), also close valves A, B, C, D and E of the manifold (Fig. 20).

   The manual closing device can be removed. Charge the breaker with SF-6 gas per paragraph 4.3.1.

4.3.1 *Charging the Breaker with SF-6 Gas*

The properties of the gas used in the breaker must meet the specification for Sulfur Hexafluoride according to ASTM-D2472-71, except for the water content, which should correspond to a maximum dew point of −46°C (−50°F) or 63PPM$_V$.

CAUTION: DO NOT APPLY LIQUID SF-6 TO THE BREAKER.

An in-line dryer-filter must be used when filling the breaker with gas to bring the moisture content of the gas down to the level specified for the breaker.

Gould can provide such a dryer-filter. For application and operation of this portable dryer, read special instructions supplied with the unit.

Start out by reading the instructions for the gas service unit. Connect the flexible hose of the gas service unit with the in-line dryer to the breaker service connection on the manifold (See Fig. 20) or the vacuum valve (See Fig. 32) and start the vacuum pump to remove the air from hose and dryer. When vacuum gauge reads 0.5 mm Hg, open valves A, B, C, D and E on the manifold or the vacuum valve on the tank if the service unit is connected to this valve.

NOTE: If the breaker is to be charged with gas using the vacuum valve on the tank, install the service connection cap on the manifold (See Fig. 20) and open valves A, B, C, D and E of the manifold.

1. Determine the correct amount of gas to fill the breaker pole as follows:
   a. Read L.P. system temperature from the gauge in the mechanism housing.
   b. Refer to Fig. 26. Read from the curves labeled, "Equalized Systems at Rated Pressure," the pressure in psig corresponding to the low-pressure system temperature noted in Step 1. This is the charging pressure.
2. With valves A, B, C, D and E open on the manifold, let gas flow into both high and low-pressure systems, and charge until the pressure gauge reads the psig determined in step 1b. When the proper charge is reached, stop the gas supply and close valves A and E or the vacuum valve on the tank if the service unit is connected to this valve. This condition should be maintained for at least one hour to make sure that the

gas has reached a stable temperature in all parts of the breaker and bushings. Add or remove gas if necessary, to maintain proper charging pressure.

3. Close valve C and energize the gas compressor motor circuit. The high-pressure system gauge will now indicate a build-up toward the 265 psig high-pressure value as a result of the compressor operation while the low-pressure side goes down toward 45 psig.

   The compressor pressure switch is set to stop the compressor when the pressure has reached 265 psig. The charts show the equivalent ratio for the normal low-pressure system charge. Check the pressure and temperature readings and determine if the correct amount of gas is in the breaker. Add or take out gas if necessary. Remove the supply hose following instructions of the service unit.
4. At this time, it is a good practice to recheck pressure switch settings as shown under Section 6, Paragraph J.
5. The breaker is now filled with gas and should be checked for moisture content in the gas.

4.3.2 *Operation of Moisture Analyzer (See also 1.1 Part D)*

Reliable moisture measurements require attention to cleanliness and prescribed procedures, particularly as it applies to excluding moisture contamination from the analyzer instrument and its connection. The tubing used to connect the instrument to the manifold sampling valve must be *stainless steel,* and should be capped immediately after use to keep out moisture. It is important that the recommendations of the instrument supplier be followed carefully.

Moisture content of SF-6, N2 or dry air can be analyzed with a Meeco Electrolytic Analyzer, Beckman Instrument Moisture Analyzer or equivalent. For more detail, refer to "Equipment Instruction," Part E.

The maximum moisture content to be expected from gas cylinders are:

SF-6:

Dew Point of $-46°C$ ($-50°F$) or 63 PPM_V

N2:

Dew Point of $-55°C$ ($-68°F$) or 20 PPM_V

Dry Air:

Dew Point of $-55°C$ ($-68°F$) or 20 PPM_V

For gas sampling from the breaker poles, there are two connection points, one at the sampling valve (Fig. 20) located on the top right side of the gas manifold, and one at the vacuum valve Fig. 32. It is recommended that the moisture be measured at both locations at this time. If the gas filling hose is still connected to the vacuum valve, remove the hose and re-install the 2-inch pipe plug in the valve using sealant as per Part E. The 1/8" pipe plug in the 2-inch plug is to be removed. Install a 1/8" 37° flare JIC connector or any fitting which will fit the analyzer sampling line. The connection at the manifold sampling valve has a flare connection as mentioned above. On both locations, first connect the moisture analyzer connecting tube, then connect the moisture analyzer electrically. (About 30 minutes warm-up time is generally required). When the instrument is ready, open the sampling valve of the manifold or vacuum valve to admit gas to the instrument. The moisture indication is likely to be extremely high at first because the instrument and the connecting line are still "wet." Follow analyzer instructions for flushing the system with gas and taking readings.

4.3.3 *Gas Moisture Control*

If the moisture readings are 40 PPM_V or lower, the gas is dry enough and no further drying is necessary.

If the moisture level is slightly higher than 40 PPM_V but not more than about 100 PPM_V and the readings were taken right after filling the breaker with gas, another reading should be taken about 4 hours later. The desiccant bags in the pole unit tanks will have had time to absorb moisture and the level will most likely be below 40 PPM_V.

If the moisture content is substantially higher than 100 PPM_V but not more than 200 PPM_V or if the drying process is to be speeded up, circulation of the gas through the dryers in the mechanism will help to get faster results. Proceed as follows:

1. Make certain that valves B and D are open, and A, C and E are closed. The pole unit should be in the OPEN position.
2. Start the gas compressor, and when the high-pressure system reaches its rated pressure, use the manual closing device (hydraulic jack) to close the pole just enough to open the blast valves. Gas will now circulate from the high-pressure system to the low-pressure system through all blast valves in the pole unit. When the high-pressure system has dropped to equalized pressure, release the jack to close the blast valves in the pole. Let the high-pressure build up to 265 psig again, and repeat "circulation" of gas. Continue these circulating cycles which forces the gas to flow through the filter-dryer units of the breaker gas system.

3. Take moisture readings after every five circulations to establish the drying trend.
4. The gas drying process is accomplished when the moisture content has been brought down to 40 PPM_V regardless of ambient temperature.

NOTE: **Excessive Moisture**
If the moisture content of the gas is very high, like 200 PPM_V or more after filling the breaker, the drying process must have been carried out improperly. In this case, it will be best to draw the gas out of the breaker through an external dryer and repeat the drying process.

CAUTION: **When taking the moisture reading at the maniifold sampling valve in the mechanism, the best time to actually read the meter is while the gas compressor is running. As soon as the compressor stops, high-pressure gas in the oil separator and dryer is automatically bled off to the low-pressure side. This bleeding off process can be heard for about ten (10) minutes after the compressor stops. A reading taken during this time is likely to be lower than if taken during compressor operation because the piping which feeds the sampling connection is full of dry gas from the high-pressure side.**

5. **TIMING TEST**

Timing test, with normal SF-6 pressure in the low and high-pressure systems, should be made at this point. Follow the procedure as per Section 3 except tests are now conducted with SF-6 gas in the unit, and the tests should now be conducted on the complete (3 pole) breaker to insure that all poles operate within the timing limits set by Figs. 38 and 39.

6. **INSTALLATION CHECK LIST**

A. Check Control Wiring Connections
   1. Open circuit or loose connections.
   2. Current transformer connections.
   3. High-pressure vaporizing chamber heaters.
   4. Thermostat settings for vaporizing chamber heaters, primary and secondary (See Fig. 26 and Part E, Section 6).

B. Compressors and Dashpot
   1. Gas compressor. Release shipping clamps — check oil level (Figs. 21 and 22). (Oil level should be between ½ and ¾ on sight glass.)
   2. Air compressors. Check oil level — drive belt tension.
   3. Dashpots (note special oil, see "Lubrication Chart") oil level (See Fig. 14).

C. Breaker Adjustments
   1. Blast valves, closed position. Check for leaks.
   2. Blast valves, open position. Check for leaks.
   3. Closing resistor. Visual inspection (Fig. 7).

D. Pneumatic Operating Mechanism (Fig. 17)
   1. Trip lever centered.
   2. Gap "F" between trip lever and roller.
   3. Gap "K" between roller and stop screw.
   4. Gap "E" between trip lever and armature striker.

E. Pressure Switch Settings (Air): See mechanism nameplates.
   1. Governor switch (63-1) opens ____ psig, closes ____ psig.
   2. Low-pressure alarm switch (63-3) opens ____ psig, closes ____ psig.
   3. Low pressure interlock (63-2) opens ____ psig, closes ____ psig.
   4. Leak rate of system, 4 psig/hr., maximum.

F. Timing Tests (Part D)
   Air system pressure as shown on nameplate: gas systems filled with SF-6 gas at rated pressure with the low-pressure system pressure corresponding to the prevailing gas temperature.
   1. Trip coil energized until contact part (cycles). ————
   2. Opening Speed (feet per second). ————
   3. Closing time (cycles). ————
   4. Rundown Test. Air and gas pressure before and after each operation.
   5. Resistor switch insertion time (time between resistor contact make and main contact make).
      a. At rates air pressure (milliseconds). ————
      b. At lockout air pressure (milliseconds). ————

G. Resistance (Section 4.0.1, Part E)
   1. Contact resistance and main current path terminal to terminal (micro-ohms). ————
   2. Closing resistance, resistance per pole (6 resistors in series) (ohms). ————

A Phase	B Phase	C Phase

H. Final Visual Check for Loose Hardware Before Closing Tanks

I. Closing Tanks and Final Checks
1. Clean manhole flanges and install desiccant bags in each tank.
2. Clean and grease manhole flanges per Fig. 33. Install gaskets and torque bolts (See Torque Valve Instruction, Part E).
3. Filter and dryer units. Fill with new desiccant (Section 4.3, Part C).
4. Leak check of all gasketed and pipe joints.
5. Moisture check of gas (Part C). PPM_V low-pressure system.

J. Gas System

	A Phase	B Phase	C Phase
1. Pressure switch settings high-pressure systems (Section 1.2.2, Part D). See breaker nameplates and Fig. 26.			
Governor switch (63-4) opens (psig).			
Governor switch (63-4) closes (psig).			
Low-pressure alarm switch (63-5) closes (psig).			
Low-pressure lockout switch (63-7) closes (psig).			
2. Pressure switch settings, low-pressure systems (Section 1.2.2, Part D)			
Low-pressure alarm (63-4/1) closes (psig).			
Low-pressure lockout (63-4/2) opens (psig).			
3. Leak rate high-pressure system, 3 psig per hour maximum (psig per hour).			
4. Final gas filling (Section 4.3.1, Part C). Low-pressure system			
Pressure (psig)			
Temperature (°F)			
High-pressure system			
Pressure (psig)			
Temperature (°F)			
Equalized systems			
Pressure (psig)			
Temperature (°F)			

K. Current Transformers and Linear Coupler Transformers
1. All cover gaskets in place.
2. All covers in place and hardware tightened.

7. **PREPARATION OF DESICCANT BAG FOR INSTALLATION IN BREAKER**

The actual desiccant bag is shipped in a protective bag, which is hermetically sealed to keep atmospheric moisture out. This bag shows the date of manufacture. It is recommended that *bags should not be stored for more than two years* before using.

1. Carefully rip the protective bag open on one end as shown in Fig. 23. Do not use scissors as they might damage the inner bag.

NOTE: Once the protective bag is open, the desiccant starts absorbing moisture. Proceed promptly.

2. Pull the desiccant bag out and also the *small indicator bag.* The contents of *the indicator should be blue* as seen through the bag. If it is not blue, the outer bag must have been damaged and the desiccant bag is useless and must be discarded.
3. Install the desiccant bag in the breaker promptly, keeping the time of exposure to atmosphere to a minimum. Cut tie cords from the bags and *discard.*

NOTE: The protective outer bag is sealed under vacuum and the "tight fit" usually indicates this. However, in very warm ambient temperatures, the molecular sieve gives off some of the air it had absorbed. This might cause the outer bag to expand and look like a pillow. This does not necessarily indicate that the desiccant is ineffective.

8. **RECORD OF DRYING BREAKER POLES BY VACUUM METHOD**

BREAKER TYPE: ______________________ BREAKER SER. NO. ______________________

DATE	POLE	TIME	HOURS FROM START	GAS CART OR VACUUM PUMP GAUGE MM HG	AMBIENT °F	L.P. GAUGE °F	REMARKS
	A						
	A						
	A						
	A						
	A						
	A						
	A						
	A						
	A						
	B						
	B						
	B						
	B						
	B						
	B						
	B						
	B						
	B						
	C						
	C						
	C						
	C						
	C						
	C						
	C						
	C						
	C						

BEFORE ENERGIZING BREAKER	POLE	A	B	C
POLE FILLED WITH SF-6 GAS	(DATE)			
MOISTURE CONTENT AT MANIFOLD	(PPM_V)			
MOISTURE CONTENT AT TANK VALVE	(PPM_V)			
MOISTURE CONTENT, HIGH PRESSURE SYSTEM	(PPM_V)			

PART D

MAINTENANCE

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PART D
MAINTENANCE

1. GENERAL MAINTENANCE PROCEDURE

It is recognized that the inspection and maintenance program will vary with users. It is important that a system of regular inspections be established, the frequency being determined by operating experience. By compiling operating data on individual breakers, the programming of maintenance can be established.

Even after many electrical interruptions, the decomposition of the SF-6 gas will be so slight as to have a negligible effect on the dielectric strength and interrupting ability of the breaker. Therefore, it will be found that SF-6 breakers can be operated over long periods of time with minimum maintenance. However, it is recommended that the breaker be inspected at the end of the first year of service. Subsequent inspection and maintenance should occur every 250 operations (250 opening, plus 250 closing) or every three years, whichever occurs first. In installations where a combination of fault duty and repetitive operation is encountered, an inspection is recommended after every severe fault operation.

1.0.1 *Maintenance and Breaker Interrupting Duty*

The "ANSI Standard Application Guide for AC High Voltage Circuit Breakers C37.010" will provide helpful information for users who have not established their own maintenance policies.

Following are some of the factors to be considered in determining whether internal inspection and maintenance of the breaker is needed in less than 3 to 5 year intervals after the first year inspection.

Number of Switching Operations. If the breaker has operated under full-load and no-load conditions only without any fault interruptions, an internal inspection will not be necessary unless the external checks and inspections should indicate the need for one.

Number of Overload and Fault Operations. Integrated fault duty shall be the determining factor.

Severity of Fault Operations. Close-Open and Reclosing operations under maximum fault current conditions are more severe in respect to contact wear than normal "Open" fault interruptions. This fact should be considered especially for breakers which have automatic reclosing duty to perform.

Excessive Contact Resistance. If resistance between bushing terminals is excessive, it is likely due to erosion of the contacts. (See Section 4.0.1, Part E, for "Resistance of Contact and Main Current Path").

1.0.2 *Frequency of Gas Compressor Operation*

The running time meter of the gas compressor and the pole units operation counter should be read periodically (e.g., once a week) and the results recorded. If the running time, after subtracting the fixed allowance for breaker operations, should show a noticeable increase in compressor operation, the leakage rate from high to low-pressure systems should be investigated. The oil level in the gas compressor crankcase should be checked periodically (e.g., once a week).

1.0.3 *Leakage Rate to Atmosphere*

In any gas system, a slow gradual leakage may be expected, but gas loss should remain within acceptable limits. In the low-pressure system of these breakers, the leakage should not exceed 5 psig per year.

It is realized that most operators would prefer not to wait for a low-pressure alarm in the low-pressure system before adding gas to the breaker. On the other hand, it is desirable to avoid unnecessary fillings as a small drop in pressure may be due to the system being temporarily out of equilibrium at the time of observation. A reasonable compromise is to wait until the pressure in the low-pressure system, as measured under stable conditions, drops to 5 psig above the alarm pressure before adding gas.

1.0.4 *Excessive Moisture in Gas*

If the breaker has been purged properly and the gas was dry at the initial filling, the moisture content can change in service for only two reasons:

1. In spite of careful purging, some moisture might still have been left behind, especially if the initial start-up was done at a low ambient temperature. Internal surfaces, paint, or other substances may have retained moisture, only to give it up later at a higher temperature.
2. Moisture entering the system through leakage paths.

Therefore, moisture content should be checked no later than two months after initial filling of the breaker. After that, if the first check did not indicate anything unusual, subsequent checks should be made at regular intervals, not to exceed four months.

The maximum moisture content for the initial filling was given as 40 PPM_V. (See Section 4.3.2, "Gas Moisture Control," Part D). However, in actual service, the following maximum levels can be applied depending on the expected lowest ambient temperatures. When filling the breaker, the 40 PPM_V level must not be exceeded no matter what the expected low temperature might be.

Expected Min. Low Temp.	Moisture in PPM_V	
Temp. °F	At Initial Filling	Maximum Safe Level
– 22	40 or below	70
– 10	40 or below	100
0	40 or below	150
+ 10 & above	40 or below	220

CAUTION: If a moisture level of 220 PPM_V is reached, steps must be taken to bring the level down no matter what the expected temperature might be. There are several ways in which this can be accomplished depending on available equipment and on whether a maintenance outage is feasible.

a. Circulate the gas per Section 4.3.3, Steps 1 to 4, Part C, after replacing the desiccant per Section 4.2, Part D.

b. Drain the gas from the breaker through an external dryer and go through the drying process as described under installation (See Section 4, Part C). Also install new desiccant bags in all pole units. This requires a complete breaker outage.

NOTE: When taking moisture readings, also record ambient temperature, temperature of high-pressure and low-pressure gas, and weather conditions such as bright sunlight, rain or strong wind. Moisture content, especially when approaching marginal levels, varies somewhat with temperature due to absorbed moisture which is driven off the walls of the breaker at high temperatures and reabsorbed at lower temperatures. If, for example, the sun heats up some areas of the tank surface while wind is cooling other surfaces, the temperature gauge reading alone does not give an accurate indication.

1.1 PROCEDURE FOR MOISTURE CHECKS (See Figs. 32 & 42)

Reliable moisture measurements require attention to cleanliness and prescribed procedures, particularly as it applies to excluding moisture contamination from the analyzer instruments and its connections. The tubing used to connect the instrument to the manifold sampling valve (Fig. 42) or the vacuum valve on the rear of the tank (Fig. 32) must be stainless steel and should be capped immediately after use to keep out moisture. It is important that the recommendations of the instrument supplier be followed carefully. Moisture content of SF-6 can by analyzed with a Meeco Electrolytic Analyzer, Beckman Instrument Moisture Analyzer or equivalent. For more detail, refer to "Equipment Instruction," Part E of this book.

To sample gas from the breaker, connect the moisture analyzer connecting tube to the sampling valve connection located on the top right side of the gas manifold or the vacuum valve on the tank. The moisture analyzer should be connected at these points as follows:

READING FROM THE MANIFOLD SAMPLING VALVE.

1. Be certain that the sampling valve is closed.
2. The valve has a 1/8" 37° Flare 41C connector and cap. Take off the cap on the flare connector, and connect the analyzer to it.
3. Prepare and calibrate the analyzer, following instructions given in the instrument manual.
4. When the instrument is ready, open the sampling valve. Proceed with step 5 that follows. Read also the information given under "CAUTION" in Section 4.3.3, Part C.

READING FROM THE VACUUM VALVE ON THE TANK.

1. Be certain that the vacuum valve is closed.
2. Take off the 1/8" pipe plug, install a 1/8" 37° flare 41C connector and connect the analyzer to it.
3. Prepare and calibrate the analyzer following instructions given in the instrument manual.
4. When the instrument is ready, open the vacuum valve.
5. The moisture indication is likely to be extremely high at first, because the instrument and the connecting line are still "wet." Follow analyzer instructions for flushing the system with gas and taking the actual reading.
6. Record the moisture reading, as well as temperature gauge readings, for high and low-pressure systems, ambient temperature, and a statement of weather conditions.

7. Close the vacuum valve, disconnect the instrument, and replace the cap on the connector.

1.2 ROUTINE CHECKS (Gas in the Breaker)

1.2.1 *Operation*

1. Check closing and tripping operations, using all usual relays and circuits involved in the operation of the breaker. Be sure all connections are tight. Check breaker timing with time travel recorder and oscillograph (See Figs. 38 and 39 and Section 3.2 through 3.2.6, Part C).
2. Check closing and tripping at minimum operating voltage.
3. Check the strip heaters in the mechanisms and the high-pressure gas vaporizing chamber heater circuits (See Fig. 27 and Section 7, Part E).
4. Check the oil level in the gas compressors and air compressors (Fig. 22).

1.2.2 *Gas Pressure Switch Settings (See Fig. 26)*

1. Open valve C a little, so that gas slowly bleeds from the high-pressure system. Then, by observing the high-pressure system pressure gauge, note the pressure at which the governor switch starts the gas compressor. Let the compressor build up pressure in the high pressure system. Check if the compressor cut-off is as specified on nameplate in the front mechanism housing.
2. Deenergize the gas compressor motor circuit. Continue to bleed the pressure from the high-pressure to the low-pressure side, observing the pressure at which the alarm switch contacts operate. Note also the pressure at which the high-pressure lockout switch operates. Check these valves against the figures on the nameplate.
3. Close valve C and energize the gas compressor motor circuit. As the gas compressor restores the pressure in the high-pressure system, observe the point where the lockout switch, alarm switch, and the governor switch operate. Check these valves against the figures on the nameplate.
4. If a gas service unit is available, connect the flexible hose to the service connection. Close valve D and open valve A. Start the compressor on the service unit and pump down the low-pressure system, observing the pressure and temperature at which the low-pressure alarm and low-pressure lockout switches operate. Stop the compressor and energize the tank heaters on the service unit. Open the breaker refill valve on the service unit and return the gas to the low-pressure system in the breaker, observing the pressure and temperature at which the lockout and alarm switch contacts operate. Compare the results with the applicable Gas Pressure Chart, Fig. 26, considering the temperature which prevails in the low-pressure system. Shut off the flow of gas to the breaker when the pressure gauge on the low-pressure system indicates a return to normal pressure. Close valve A, open valve D, then disconnect the gas service unit.

1.2.3 *Air Pressure Switch Settings*

To check the pressure switches in the air system, vary the pressure by opening the drain valve on the air receivers to lower the pressure and run the air compressors, to raise the pressure. Compare the settings with the data given on the nameplate.

1.3 PERIODIC INSPECTION

1.3.1 PRECAUTIONS:

Prior to performing any inspection or maintenance, the following precautions should be taken:

1. **Check that all control circuits are deenergized, including the compressor motor circuits.**
2. **Check that all primary disconnects are open and grounded.**
3. **Check that the breaker structure is properly grounded. A good safety practice is to verify that grounding leads are in place and connected, prior to coming in contact with any of the breaker parts.**
4. **Do not work on the pole or mechanism while it is in the closed position unless the safety pin has been inserted in the trip latch to prevent accidental tripping (See Fig. 14, Item 41).**
5. **Use the maintenance closing device while performing maintenance inspections or making adjustments. Do not use the maintenance closing device to operate the pole when the pole is energized.**
6. **The main air-supply valve should be closed and the piping bled before any work is performed on the operating mechanism or the pole. Close the main air-supply valve with the pole open. Manually operate each solenoid closing valve by depressing the button located on top of the solenoid to bleed off the pressurized air in the piping (see Fig. 16).**
7. **Do not operate the pressure relief valve manually. Relief valves are emergency devices and are not designed for manual operation. If emergency manual operation is required, the valve must be retested and reset to the pressure value stamped on the valve body.**

1.3.2 *External Inspection*

1. Check all fasteners to see that they are in place and properly tightened. Check all gland nuts on all valves, gauges and switches to see that they are sufficiently tight to prevent leakage.
2. Check latch, roller and other machined surfaces for wear and oxidation of the lubricants. Operate each of the latch mechanisms with the maintenance operating device. If the operating mechanism seems to be difficult or sluggish in operation, check bearing surfaces of shafts, pins, bushings and sliding parts for hardened grease and other substances that might interfere with their operation. Disassemble to clean and lubricate as described in Section 1.4, "Periodic Cleaning and Lubrication," which follows this Section.
3. Check that the heaters and thermostats are functioning properly. The ON and OFF setting of thermostats should be checked. This is not possible with non-adjustable thermostats. For these circuits, momentarily bypass the thermostats to check the operation of the heaters.
4. Check the air compressors, motors and belt drive. (Refer to the "Compressor Instruction Book"). Observe the time for the compressors to pump from zero to normal operating pressure. This should not exceed 60 minutes.
5. The condensate should be blown from each air receiver at one-week intervals until such time as the operator's maintenance experience indicates longer intervals. To blow the condensate from each air receiver, slowly open the drain valve and allow the pressure to drop 20 to 30 psig. Close the drain valve and wait until the compressors stop. Repeat until all moisture is expelled.
6. Check for leaks in the air system and repair, if necessary. A liquid leak detector solution may be used but should be completely removed after checking. If piping joints leak, or if they have been opened for any reason, clean and assemble as per Fig. 37.
7. Check relays, contactors, switches and fuses for clean contacts and for proper operation.
8. Check the oil level in the air compressor.
9. Check the oil level in the maintenance closing device. With this device in an upright position and the ram fully lowered, the oil should be level with the filler hole.

1.4 PERIODIC CLEANING AND LUBRICATION

The mechanisms have been properly lubricated during assembly at the factory. However, oils and greases oxidize with age and must be renewed. Oxidation is evidenced by hardening of the lubricant. If the operations are frequent, the lubricants are gradually squeezed out.

The maintenance period for lubrication depends to a great extent upon local conditions. Until a suitable time schedule has been determined, it is recommended that a periodic lubrication of parts be made as shown on the "Lubrication Chart," Fig. 35.

Wherever cleaning is required, as indicated in the Lubrication Chart, the following procedure is recommended:

NOTE: Do not use carbon tetrachloride for cleaning purposes.

1. Remove the pneumatic system strainer (Fig. 16). Blow the foreign particles out with air and wash the screen in a nonflammable cleaning solvent. Dry thoroughly and replace. Repeat in the other two mechanisms.
2. Sleeve Bearings. The pins should be removed and all old grease removed by immersion in clean petroleum solvent or similar cleaner. Wipe the pins and bearings clean and apply a small amount of grease to the entire surface of both parts just before reassembling.
3. Open ball bearing, roller bearing and needle bearings. Remove the bearings from the mechanism and place them in a clean petroleum solvent or a similar cleaner. By agitating the bearings in the cleaning solution and by using a stiff brush to remove the hardened grease, the bearings can be satisfactorily cleaned. After the bearings have been thoroughly cleaned, spin them in clean, new, light machine oil until the cleaner is entirely removed. Drain off this oil and repack immediately with grease, and make sure all metal parts are greased (See Lubrication Chart).

IMPORTANT: Use only the grease specified on the lubrication chart on roller, ball, or needle bearings.

4. Sealed bearings. Under ordinary circumstances, the life of the special grease in these bearings should be at least ten years. If oxidation of the lubricant has made them sluggish, they must be replaced (See Lubrication Chart).

2. TEST FOR LEAKS TO ATMOSPHERE (GAS SYSTEM)

If there are indications of excessive leaks to atmosphere, the following steps should be taken:

2.0.1 *With the Gas Still in the System*

Take the breaker out of service and check for leaks with a liquid or sonic leak detector in the following locations:

A. In the Mechanism Housing:
   1. All plugs and connections on filter-dryer assemblies.
   2. All hose connections, fittings and pipe caps, including the ones on service connection, and sampling valves.
   3. The plug on the gas compressor oil filling fitting.
   4. The plugs and fittings on the high-pressure reservoir.
   5. The fittings on the vaporizing chamber. Make certain that the heaters are turned off before removing the covers.

B. On the Pole-Unit Tanks:
   1. All manholes.
   2. The safety valves.
   3. The seal on the rupture discs.
   4. The top, bottom and intermediate joint seals of the porcelain bushings and the bushing flanges.
   5. The vacuum valves.
   6. The bellows. See Section 3.3.1, Step 8, Part C.

2.0.2 *Without SF-6 Gas in the Systems*

If the breaker must be checked for leaks to the atmosphere when there is no gas in the systems, proceed as follows:

1. Seal the manholes.
2. If a Halogen Leak Detector is to be used, add Freon-12 to the systems by connecting the Freon-12 cylinder to the service connection.

   Open valves A and B and the cylinder valve. Let Freon flow until the low-pressure gauge reads 1 psig. If liquid leak detector is to be used, omit this operation. Pressurize the system as follows.
3. Connect nitrogen or dry air cylinder to the service connection, and open all valves of the manifold and bring the pressure to 60 psig.
4. Check for leaks with a sonic or liquid leak detector in all the places listed in Section 2.0.1.

2.1 *Corrective Action*

When a leak has been detected and located, the following action is recommended after removing the gas from the breaker.

2.1.1 *For Tube Connection*

Disassemble the connection, clean and seal per Fig. 37.

2.1.2 *For Gasket Seals (Except for Bushings, which can only be disassembled at factory)*

Remove old gasket, clean and check groove and flange. Reassemble with a new gasket.

2.1.3 *Replacement of Bellows*

The gasket seals or the sliding rod seal of the bellows assembly requires expert attention. A Gould serviceman should perform this work.

3. EVACUATING THE SF-6 GAS FROM THE BREAKER

3.0.1 *Preparatory Steps*

Before an internal inspection can be made on the breaker, it is necessary to evacuate the SF-6 gas and store in a storage tank. It is not economical to exhaust this gas to the atmosphere. A gas service unit should be made available for this purpose.

Start out by reading the instructions in the instruction manual for the service unit. Make certain that the unit is purged of air, or if unit contains gas, that it is of good quality. Check the supply voltage before plugging in the service unit. Connect the flexible hose of the unit to the service connection of the manifold under the mechanism housing. Be sure to check the direction of rotation of the vacuum pump.

3.0.2 *Draining the Gas (See Fig. 20)*

After evacuating the hose, proceed as follows:

1. Make sure that manifold valves B and D are completely open, then open valve E slowly and let the high-pressure gas flow to the in line dryer-filter and service unit.
2. When the high-pressure gauge on the breaker indicates that the pressure is equalized between the breaker and the service unit, open manifold valves A and C.
3. Start the compressor in the service unit and follow instructions step-by-step until a vacuum of **about 2 mm Hg** is reached. Then close all valves on the service unit.

3.0.3 *Precautions to be Observed when Handling Arced SF-6 Gas*

WARNING: Although sulfur hexaflouride gas in the pure state is colorless, odorless, tasteless and non-toxic, serious oxygen deficiency can result if a large volume of pure gas is breathed. Also, toxic decomposition products are formed when arcing occurs in the gas. Therefore, precautions should be taken against breathing gas containing these toxic products, especially right after the manholes are opened. Allow time for the decomposition products to become safely diluted with air.

Molecular Sieve Type 13X 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 the evacuation and back filling operation is allowed to escape to the atmosphere upon opening the breaker. As a result, operating personnel are not likely to be exposed to a significant amount of gas when the breaker is opened.

Used desiccant should be discarded. Regeneration for the purpose of re-using the desiccant, although possible, is not recommended.

CAUTION: The Molecular Sieve, having absorbed arc products, could be harmful if swallowed by humans or animals. Discard safely.

If for some reason, a significant amount of arced gas is present, there will be certain warning indications. A pungent and unpleasant odor and/or irritation of the upper respiratory tract and eyes, will give an early warning, within seconds, to personnel in the vicinity before a significant toxic reaction should occur. The absence of any odor or irritation should indicate no toxic by-products.

3.0.4 *Opening the Pole-Units (Manholes)*

After the vacuum is broken, it is recommended that the pole-units be opened immediately. When opening the manholes, caution should be observed to prevent the inhalation of the gray fluoride dust usually present in the tanks after the breaker has been in service. A mask with air supply approved for breathing and gloves and clothing to cover all parts of the body **must** be worn when performing the following work:

1. Using a vacuum cleaner to remove as much gray powder as possible.
2. Removing the desiccant bags (Fig. 13). Care should be exercised in handling bags upon removal from the circuit breaker as they may contain SF-6 arc products.
3. Use a fan to dilute any remaining SF-6.

4. REPLACING DESICCANTS IN FILTER-DRYERS AND POLE UNITS

It is recommended that all desiccant be replaced every time the breaker is drained of gas and opened for inspection. Although it is not likely that the dryers will become saturated in the time period between normal maintenance inspections, replacement will be more costly if later it should become necessary to take the breaker out of service for the sole purpose of desiccant replacement.

NOTE: The desiccant bags in each pole unit must be replaced. The new bags are to be installed before sealing and evacuation of the breaker (See Part C Section 4.3, Step 4, and Fig. 13 for instructions).

4.1 *Replacing Desiccant in the Filter-Dryers (Without Gas in Breaker)*

The old desiccant should be removed after the maintenance inspection is completed, but during evacuation of breaker.

4.2 *Replacing Desiccant in the Filter-Dryers (While Gas Remains in Breaker) (See Figs. 20, 25 & 37)*

Should it become necessary to replace desiccant while the breaker is still charged with SF-6 gas, proceed as follows:

1. Close manifold valves A, B, C, D and E. Connect the flexible hose of the gas service unit to the service connection.
2. Next, go through the preparatory steps previously described in Section 3, "Evacuating the SF-6 Gas From the Breaker," Part D. After evacuating the hose, open valves A and E, but leave B, C and D closed. The gas trapped in the filters, oil separator, compressor, and piping can now flow to the service unit. The gas in the breaker will not be affected.
3. Start refrigeration and compressor of the service unit and follow instructions step-by-step until a vacuum of about 2 mm Hg is reached. Then close all valves on the service unit.
4. Break the vacuum by loosening the service hose connection. Apply the new desiccant as follows:
   a. Drain the Molecular Sieve by removing the top plugs on the filter-dryer and the bottom plugs located underneath the housing.
   b. Check the bottom plugs and clean the threads carefully. Replace them using sealant (See Figs. 25 & 37).
   c. The filling of the desiccant should be performed quickly to reduce the time during which the Molecular Sieve and the interior of the filter-dryer columns are exposed to atmospheric moisture. Before filling the columns with desiccant, check the top plugs and clean threads carefully. Have the thread sealant material on hand before proceeding with filling.

      Pour the desiccant (Molecular Sieve, Type 13X) from shipping container directly into the dryers using a funnel for this operation. Fill the dryer until the desiccant level reaches about 1" below the filling holes (See Fig. 24). Install the top plugs with sealant as described in step 4b.

5. Tighten the service hose connection again, and start evacuating the air from the system following instructions for the service unit. When the vacuum gauge indicates 0.5 mm Hg or less, evacuation is complete. Close all valves in the service unit.
6. Establishing the proper amount of gas in the breaker pole unit.
   a. Open valve B to establish pressure in filter, compressor and dryer units.
   b. Close valve A and open valve D.
   c. If required, run the gas compressor to establish proper high-pressure as per nameplate in the mechanism housing (it may be necessary to temporarily open valve C to start compressor. Close valve C).
   d. Close valve E.
   e. Establish low-pressure system per Chart, Fig. 26. To add or remove gas of the low-pressure system, open valve A. Charge or remove gas as required by opening the valves on the gas service unit. Close valve A when proper pressure is established.
   f. Disconnect the service unit and place the cap on the service connection.

5. ADDING OIL TO GAS COMPRESSOR (Fig. 22)

CAUTION: Do not remove any plug or cap on the gas compressor without first making certain that the high and low-pressure sides are discharged. The crankcase is under gas pressure in normal breaker operation and oil cannot be added while the compressor is in service. Remove air bleed screw from center of fill plug before removing plug.

The best time to replenish the oil is during regular maintenance of the breaker when the gas is already removed. In this case, the adding of oil per step 5 that follows, can immediately follow the desiccant change, outlined in step 4 of Section 4.2.

It may become necessary to add oil while the breaker is still charged with SF-6 gas. In this case, the preparatory steps will be the same as for "Replacing Desiccant," described in Section 4.2.

1. Connect gas servicing unit per Section 4.2, Step 1.
2. Proceed per Section 4.2, Step 2.
3. Drain gas per Section 4.2, Step 3.
4. Break vacuum per Section 4.2, Step 4.
5. Add oil until the level comes up to the 1/2 mark of the sight glass. (The oil to be used in this compressor should be in accordance with "Lubrication Chart," Fig. 35 of this book.)
6. Clean and seal the fill cap per "Pipe Thread Sealant," Fig. 37.
7. Start evacuating the system per Section 4.2, Step 5.
8. Establish proper amount of gas per Section 4.2, Step 6.

6. GENERAL MAINTENANCE OF GAS COMPRESSOR

This compressor is hermetically sealed, motor and all, and should not need any further maintenance other than adding oil.

7. INTERRUPTER MAINTENANCE AND ADJUSTMENT

Wipe any traces of powder from the interrupter and insulating surfaces. This powder in the absence of moisture has a high dielectric strength but is hygroscopic, and when exposed to atmosphere will materially reduce the insulation level of the breaker.

Wipe all supports, shields, capacitors, resistors and interrupters using a clean, dry, lint-free cloth only. If it becomes necessary to clean some surfaces, use Alcohol only (except Ethyl Alcohol).

7.0.1 *Preparation for Inspection of Main Contact and Interrupter (See Figs. 7, 8 & 12)*

To expose the stationary and moving contacts for detailed inspection, it is necessary to remove the grading capacitors across each interrupter, the shields, jumpers, and resistor switch rods.

Proceed as follows:

1. On interrupters A, B, C, D, E and F, loosen set screws, (125), then ball screws, (117), holding each capacitor, until free to remove (Fig. 7).
2. Unscrew screws (113) and remove shields (112) on interrupters B and C, D and E, and shields (111) on interrupters A and F (See Fig. 12).

NOTE: Prior to removing shields (111 and 112), identify shields on all interrupters in each pole to facilitate reassembly.

3. On interrupters A and F, remove screws and washers (93, 94 and 95) to separate jumper (81) from adapter (302). Remove screws and washers (82, 83 and 84) to separate and remove jumpers (81) and adapters (80). On interrupters B, C, D and E, remove screws and washers (94, 95 and 96) to remove jumpers (106).
4. Remove resistor switch rod (427) by the removal of bolts (457) at each end of rod.
5. Remove screws (366) to remove the stationary contact assembly consisting of interrupter tube (370), the stationary contact (374), adapters (301) and (302), and deflector assembly (528).

7.0.2 *Main Contact and Interrupter Inspection*

If the engaging surfaces of contacts are free from pitting and erosion, they can be returned to service. When main contacts replacement is required, follow the instructions given in Section 7.1.

For minor finishing of the stationary contacts, and moving contact surfaces, use a fine file or emery paper. All minor finish of contacts should be done outside the breaker to prevent metallic dust from falling inside the valve housing or contaminating insulated surfaces inside the breaker.

Inspect the deflectors (item 371, Fig. 12) for pitting and erosion.

If the main contacts and interrupter inspection is satisfactory, reassemble the interrupter components.

7.1 *Replacing Main Contacts (Fig. 12)*

Replace stationary contact as follows:

1. Remove screws (305, 373 and 375) to disassemble the stationary contact assembly and replace stationary contact (374). Reassemble making sure plate hole patterns are located as shown in Fig. 9.

Replace moving contact as follows:

1. Close breaker with maintenance closing device. Release lock screws (358) and unscrew moving contact assembly and adapter (364) out of bearing block (357). Lift the entire assembly out of the blast valve housing (340).
2. Before installing the new moving contact assemblies, make certain the cylindrical portion of adapter (364) where the contact fingers will slide, is clean. Any grease or dust must be carefully removed and a thin film of grease *sparingly* applied on the contact engaging surfaces (see Lubrication Chart, Fig. 35).
3. To install the new moving contact assembly (365), slide the contact rod through the cylindrical portion of adapter (364), and screw the contact rod into bearing block (357) by rotating the contact and adapter until the bottom of rod is flush with the bottom of bearing block.

7.2 *Interrupter Installation (Fig. 12)*

After the moving contact is installed, assemble the interrupter to the point where the stationary contact is in place. Proceed as follows:

1. Clean gas blast housing (340) and coat surface per instructions in Fig. 12.

NOTE: Care must be taken to keep inside of blast valve housing clean.

2. Install stationary contact assembly on all interrupters with screws (366) being sure location of hole patterns are correct (See Fig. 9).
3. The contact penetration can now be set unless the blast valve adjustment has been altered. In this case, adjust the blast valves per Section 8 through 8.3 before proceeding.

7.3 *Main Contact Penetration (See Figs. 9, 12 & 13)*

With the breaker fully open and the upper seal assemblies (343 through 351) in place, jack the breaker fully closed and release the manual closing device. Set the contact "Y" gauge in notch for dimension "Y" (See Figs. 9 & 13). Then insert a 1/4" rod into contact rod hole (365A) and unscrew rod counterclockwise until the top of the moving contact lightly bears on the contact "Y" gauge. If during the adjustment the contact overshoots, screw the rod down, then tap on the top end of the moving contact with a soft driver (wood hammer handle) to remove the free play, then readjust contact upward to dimension "Y". *The contact can only be adjusted upward.*

After all contact penetrations are adjusted, tighten lock screws (358) in each bearing block (357) (Fig. 12). With the breaker still in the closed position, loosen all screws (375) to allow stationary contact (374) to center itself with moving contact (365). Retighten all screws (375). Restore the interrupter for service as follows and as shown in Fig. 12.

1. On interrupters A and F assemble adapters (80) and jumpers (81) to bushing and adapter (302) with screws and washers (82, 83, 84, 93, 94 and 95). On interrupters B, C, D and E assemble jumper (106) to adapter (302) with screws and washers (94, 95 and 96).
2. Install resistor switch rods (427), with upper and lower bolts (457). Replace these rods at their original location to avoid readjusting each for length. Be sure rod ends do not bind.
3. Install shields, outboard (111), and inboard (112) with screws (113).
4. Reinstall grading capacitors per Figs. 7 and 8. See Part C, Section 1.11.
5. Visually check the operation of the resistor switch. See Part C, Section 2.3.

8. BREAKER LINKAGE/BLAST VALVE ADJUSTMENT

8.1 *Breaker Linkage (Fig. 10)*

During extensive maintenance or parts replacement, it may be necessary to disassemble the breaker linkage or interrupter blast valves. If such is the case, reassembly should be checked in sequence, as follows:

CAUTION: Insert the safety pin (41), Fig. 14, to prevent accidental tripping of the pole unit. Lock screws on turn-

buckles, and rod ends connecting the breaker's pull rods should be unscrewed with the breaker in the OPEN position only. Do not close the pole unit without tightening lock screws on all turnbuckles and rod ends.

See Fig. 10 for information as to which rods have right and left-hand threads at opposite ends. Adjustments are made by turning the rods or turn-buckles as described below:

See Figs. 13 & 14.

With the manual closing device, close the pole unit, noting all the while that the "P" dimension is not falling below the given value and that "S" and "T" dimensions are not exceeded.

Adjustment "P" is made by rotating vertical rod (20) in rod ends (21) and (22). Open the breaker then lock with screws (26 and 27) when adjustment is complete.

CAUTION: **Rod end (23) is screwed onto the rod (24) all the way, and the two lock screws prevent adjustment at this point. Do not change this thread engagement, otherwise the bellows (25) will be destroyed.**

Use "TUV" gauge to check dimension "T" from the bottom surface of the insulated support column to the upper surface of the gauge pin (See Fig. 13 DET. TU and V) on each pole unit. Adjust by rotating the turn-buckle (147) if "T" is not within tolerance. At the same time, also check dimension "S." This dimension is measured between the face lock clamp (459) on rod (24) and the face of flange (460). "S" is adjusted by loosening screws (461) and turning the hexagon spacer (462). "T" dimension will not change.

CAUTION: **When making the above adjustments, be sure that all the threaded rods are still engaged in their rod ends to a length of at least 1-1/2 of their diameters.**

8.2 *Blast Valve Adjustments in Open Position*

To adjust the blast valve in the OPEN position, proceed as follows:

See Figs. 7 & 12.

1. First, partially close the pole unit to raise the moving contacts near their closed position, then uncouple moving contacts (365), by removing the external lock nuts (354) and pins (355).
2. Then remove the upper seal support plate (347), held by screws (348). Also remove lock ring (351), shims (349 and 350) and seal plate assembly (343, 344, 345) held in place by screws (346). Remove lock screws (337). Rotate rod (314) clockwise with a screwdriver in slot, until blast valve hub is about 3/4" from the end of rod (314).

NOTE: **Rod (314) cannot be turned with the pole full open, so jack the pole unit in slightly to take the tension off the rod. Rotate the rod as indicated.**

3. Close the pole unit with the maintenance closing device to the point where the latch (38) is about to fall under center roller (39) (See Fig. 14). Then open the pole unit slowly to the "U" dimension. Dimension "U" is measured on the "TUV" gauge from the bottom surface of the insulated support column (101) to the top surface of gauge pin as shown in Fig. 13. Close valves A, B, and C of the manifold (See Fig. 20), connect dry air to the service connection. Bleed enough air into the high-pressure system through valves "E" and "D" so that leaks can be heard at the blast valve. Rotate rod (314, Fig. 12) counterclockwise until the leak stops.
4. When all valves are leak-free, check to make sure that the blast valves are all the way down. This can be verified by observing that the blast valve (328) is in contact with the top of slip ring (331) as shown in Fig. 6. If the slip ring is not in contact with the blast valve stop, rotate rod (314) counterclockwise with a screwdriver in slot until it is engaged. See Fig. 6 where it states "No Gap When Breaker Open."
5. When all blast valves are leak-free, run all lock nuts (336) down until they bear on blast valve hub, then raise the nut about two turns, install lock screws (337) and tighten. This locks blast valve. Recouple moving contacts (365) by inserting pins (355) and secure with external lock nut (354).

The possible sources of blast valve leaks are:

Sliding seals (329 and 333)
Lower end seal gasket (320)
O-ring (335)

The usual cause for blast valve leaks is misadjustment of the blast valve against the end seal gasket (320). This type of leak can usually be heard by bleeding air into the high pressure system at moderate pressure.

Inspect for leaks with a sonic leak detector. Do not use any type of liquid leak detector inside breaker tank. Use a narrow probe leak detector and pinpoint the leak. If leak is along the face of the end seal gasket (320), it can, in most cases, be stopped by adjusting the blast valve (328). However, leaks originating from other seal components must be stopped by replacing any defective seal.

NOTE: **A sonic leak detector will always disclose minor leakage from the Teflon U seals (329) and (333), and this is normal. This condition should not be considered serious unless the leak rate from the high pressure system to the low pressure system exceeds 2 psig**

per hour at 220 psi with air in the system.

8.3 *Blast Valve Adjustment and Leak Detection in CLOSED Position (Figs. 12 & 13)*

After the blast valves are adjusted in OPEN position, as per Section 8.2, the blast valves must be adjusted in the closed position. Proceed as follows:

1. With the upper seal assemblies (343, 344, 345) removed, slowly close the pole unit until dimension "V" is obtained. Use the "TUV" gauge to measure between the bottom surface of the support column and the top of gauge pin. See Fig. 13.
2. With the pole unit in the "V" position, replace the upper seal assemblies (343, 344, 345, 346) Fig. 12. Then, add shims (349, 350) to fill the space completely up to the lower surface of the lock ring groove. Then insert lock ring (351) and upper seal plate (347). Lock these rings with screws (348). Make sure that the *top* shim is always .032" thick. A shim, .015" thick, will slide into the snap ring groove and foul the adjustment.
3. Open the pole, then close pneumatically (power close) at rated air pressure. With valves A, B and C of the manifold (See Fig. 19) closed and valves E and D open, pressurize the high pressure system with dry air through the service connection in steps 10 psi, 25 psi to 50 psig and check for audible leaks at each level. Assuming that there were no leaks in the open position, the only source of blast valve leaks in the closed position would be sealing face (343) (more likely) or Teflon U seal (329), (not likely). Check for leaks only after a power (pneumatic) close.
4. Check around the blast valve (328) seal for leaks. Do not use any type of liquid inside the tank for leak detection. Leaking gas usually gives an audible hissing sound.
5. If a leak at the end seal (343) is noted, depressurize the high-pressure system by opening valve C.
6. Open the pole unit only to a point where the valve (328) is lowered about 1/4", then remove the upper-seal support plate (347) and lock ring (351). Add a shim (349) 0.015" thick under the top shim (350) 0.032" thick, over the leaking valve. Install the lock ring (351), the upper seal plate (347) and screws (348). Pneumatically close the breaker and again check for leaks. Repeat as required to seal the valve, only after making sure that there is no other reason for the leakage, such as a damaged valve (328) or seal (343). For the final leak check, raise the pressure to 220 psi and note that the leak rate does not exceed 2 psi per hour.

NOTE: Safety Regulations — No one in the breaker tank when the pressure in the high pressure system exceeds 100 psi.

7. When leak inspection is completed, disconnect the dry air from the service connection and open valves D and E.

CAUTION: Adding more than two shims 0.015 inches thick beyond the "V" dimension will reduce the total travel of the blast valve and moving contacts. Before adding a third shim, investigate for other causes and make necessary corrections.

8. If it is necessary to add a third 0.015 shim after the first setting to stop leakage, the moving contact penetration must be checked and adjusted as per section 7.3.
9. The adjustment of the blast valve in the "open" and "closed" position should result in a blast valve stroke of 2-1/2" ± 3/64". This can be checked by measuring the location of the pin (354) in relation to the top of the lower seal plate (319) in both the open and closed positions and then taking the difference. If the blast valve (measured at the pin) travels out of the tolerance range, an error has been made and the valves should be reset. Synchronous closing of the contacts in all three poles demands uniform contact travel (See Fig. 12).

9. CAPACITORS

Installation and care of the grading capacitors is covered in Part C.

10. MISCELLANEOUS COMPONENTS OF BREAKER

10.1 *Insulated Rod Assembly (Fig. 11)*

The insulated rod (309) should not require maintenance. However, removal of the rod is required to replace seal (138). If replacement of this seal is necessary, care must be taken to assemble the seal, facing as shown. If an insulated rod must be removed or replaced, the following precautions should be taken:

1. Rod (309) must be free from dirt and fingermarks.
2. Retainer (316) including rod (314) Fig. 12, is staked and pinned and should not be taken apart. It should be replaced by a new assembly if its condition is questionable. The rod (314) should be free to rotate in the compression spring assembly, but should not have an axial play of more than 0.015 inches.

10.2 *Removing an Insulated Rod and Insulated Support Column (See Figs. 11 & 12)*

If it becomes necessary to remove or replace an insulated rod (309), seal (138) or an insulated support column (101), proceed as follows:

NOTE: First, with the maintenance closing device (hydraulic jack) close the pole unit to the "U" dimension. Dimension "U" is measured with a "TUV" gauge as shown in Fig. 13.

1. Remove grading capacitors, shields, top shield assembly and *jumpers* per instruction given under Part C. See Fig. 7.
2. Remove the shields (466) at screws (467). Uncouple moving contacts (365) by removing the external locknut (464) and pins (465). Lift off the valve housing assembly with a jack handle hoist shown in Fig. 11, or by hand with two men. With the pole unit at about one-half closed, remove locknut (336) by removing lock screws (337) and rotate rod (314) clockwise with a screwdriver in slot until valve (328) can be lifted out.

CAUTION: Use care in handling the blast valve, to avoid damage to seats and sliding seal surfaces.

3. Remove the lower valve seat assembly (319) from the top of the support tube (101) by first removing screws (468). This allows the shield (469) to be lowered to gain access to screws (470). When these screws are removed, the lower valve seat assembly can be lifted out of the support tube. Protect the 0-ring (326) from damage.
4. To remove the insulated support tube (Fig. 11), remove screws (468) to allow lifting shield (469) to expose screws (470). When these screws are removed it allows the support tube to be lifted free of the support plate (471). Lift the tube just high enough to loosen the lower screw (78). The lift rod assembly (309) can now be removed by unscrewing from rod (76). The tube can now be removed. Protect 0-ring (326).

NOTE: PLACE A RAG INTO THE GAS PASSAGE HOLE TO KEEP IT CLEAN.

5. Removal and Replacement of the Bushing Guides (74) and Rod Seal (138).

   These parts are all contained within plate (471). Remove the screws (472 and 473) to lift the plate (471) free of the support beams, taking care not to damage rod (76) when the plate lifts clear of the rod. The bushing guides (74) and seal (138) are difficult to remove without damage, and any of these parts removed should be discarded and replaced with new parts. Before replacing the guides and seal, be sure the cavities are clean. NOTE THE DIRECTION THAT SEAL IS INSTALLED. BE SURE THAT THE UPPER RETAINING RING (474) IS IN PLACE.
6. Seals, Lower Blast Valve Seat Assembly (See Fig. 12)

   The seals (321 and 320) can be changed by removing screws (324) and hold down clamp (323). When replacing seal (321), be sure it is pointed down as shown. The lower blast valve seal (320) must be installed by forcing its outer edge into the beveled groove all around and then the hold down clamp plate (323) along with screws (324) are used to force the gasket seal (320) into the groove. NOTE TWO HOLES IN THE CLAMP PLATE (323) ARE TAPPED TO FACILITATE ITS REMOVAL BY USING SCREWS (324) IN THESE HOLES AS JACK SCREWS.

10.3 *Installing an Insulating Rod and Support Column (See Figs. 11 & 15)*

1. Install the support plate (471).

   Install O-rings (475) into a clean groove. Lower the plate over a lubricated rod (76), then install screws (470) and (472). The "gas passage hole" must be free from dirt or other foreign objects.
2. Installation of the support tube (101) and insulated operating rod (76) (Fig. 11).

   First wipe the insulated support column and insulated rod, using a clean dry, lint-free cloth. If it becomes necessary to clean some surfaces, use alcohol (except Ethyl Alcohol). Wipe clean the support plate (471), *remove the rag that was inserted in the gas flow hole to prevent foreign material from falling in.* Clean O-ring groove in support plate (471) with a clean, dry, lint-free cloth. If the condition of the O-ring is questionable, replace and lubricate per Lubrication Chart Fig. 35.

   Place the support tube (101) over the lower end plate (471) and block or hang it about ten inches high over the plate then install the operating rod (309). Protect the rod from dirt and finger marks. Handle the end metal fittings only. Screw rod end (476) on to rod (76) until it bottoms on the rod shoulder, then lubricate screws (78) per Fig. 34 and tighten. IMPORTANT: Be sure to tighten to a torque value of 30 to 35 foot lbs. After tightening screws, attempt to unscrew the rod by hand to insure that it is tight. When satisfied that this joint is tight, lower the tube (101) onto the end plate (471) noting that the O-ring (326) is in place.
3. Assemble the lower support clamp assembly, consisting of split rings (477), hoop ring (478), shield (469), screws (470) and (468). Note the location of the split of the ring, Fig. 15. Assemble the split ring (477), hoop ring (478) and the lubricated screws (470). Tighten screws lightly from side to side so as not to cock the split rings (477). Finish tightening the screws to the torque value shown in Fig. 34. Split ring ends should be even. Install shield (469) and screws (468).

4. Install the lower Blast Valve Seat and Clamp Down Assemblies. Clean lower seat assembly (319) with a clean, dry, lint-free cloth. Replace O-ring (326). Before inserting the lower seat assembly (319), lubricate rod (314) ("Lubricate Chart"). Place shield (469) and hoop ring (478) in that order over the support tube, then lower the assembly over the rod. Check the mounting holes pattern location (See Fig. 15). Place screws (342), as shown and use a straight edge or string to line up with the corresponding screws of the other seat assemblies. Be sure location of notches in lower seat assembly (319) is as shown in Fig. 15 for correct resistor hole alignment.
5. Assemble the Upper Clamp Down Assembly. Install split rings (477), hoop ring (478) and lubricated screws (470). Screws (470) should be tightened lightly first from side to side with care taken that the split rings are level and not cocked. Note the location of the split in the rings Fig. 15, typical top and bottom. The hoop ring must be in place before any tightening of the screws (470) is attempted. The threads and head bearing areas of screws should be lubricated then all screws tightened as above to a torque value shown on Fig. 34. Assemble shield (469) with screws (468).
6. Installation of Blast Valve and Interrupter (See Figs. 11 & 12)

   Clean the valve with a dry, lint-free cloth, and apply a very thin film of grease sparingly (see "Lubrication Chart,") to the sliding surfaces of the blast valve body (328), slip ring (331), and O-ring (335). Wipe off any excess. Pull the seal ring assembly (items 332, 333, 334 and 335) carefully up toward the ears on the blast valve to get it ready for installation.

   With the pole unit on the "U" dimension as shown in Fig. 13, insert blast valve assembly (525) and rotate rod (314) counterclockwise with a screwdriver in slot, until blast valve hub is 3/4" from end of rod (314). Slide the seal ring assembly (332, 333, 334, and 335) down and carefully press it into the seal recess in lower seat assembly (319) by hand. DO NOT USE A HAMMER. Assemble interrupter components per Fig. 12 and adjust blast valve in open and closed position per Section 8.2 and 8.3, Part D.
7. Replacing the Upper Blast Valve Seal (Fig. 12)

   Remove the upper seal support plate (347) held in place by screws (348), locking ring (351), shims (349 and 350), and lift seal assembly (343, 344, 345, and 346), by inserting two (2) screws (348) into plate (345) for use as lifting handles. Remove screws (346) so that the two plates holding the seal (343) come apart and the latter can be replaced. See Part D, Section 8.3 for installation.
8. Check the moving contacts penetration, see Part 7.3, Section D.

10.4 *Testing the Bellows and Auxiliary Rod Seal (Fig. 10)*

The bellows (25) used to seal operating rod (24) as it enters each pole unit will not require any maintenance. Should any bellows start to leak, a backup sliding seal assembly consisting of plates (137 and 139), seal (136 and 140), is provided as a back-up device to prevent a rapid loss of gas. This will allow the user to keep the equipment in service until it is convenient to make repairs.

To test the integrity of the bellows, remove the tube cap (145) which extends from the bellows assembly to the inside front of each mechanism housing. While the gas is still in the breaker, use a leak detector to check for the presence of gas in the tube. If a leak is detected at this point, it indicates a ruptured bellows.

If it is necessary to replace a bellows assembly, a Gould serviceman must perform the work.

10.5 *Bushing Maintenance*

Little or no maintenance of the bushings is required. Finger marks and grease may be removed from the lower porcelain with a clean, dry, lint-free cloth. If further cleaning is necessary, use alcohol (except Ethyl Alcohol) and sandpaper only.

10.6 *Replacing Bushing (Figs. 8 & 29)*

Disconnect the electrical connection between the bottom terminal of the bushing and the interrupter. To remove the bushings sling the bushings as shown in Fig. 3. The bushing angle will be correct when the lifting fixture is used. For bushing installation, see Part C, Section 1.10.

10.7 *Replacing Bushing Filters (Fig. 10)*

Filter (479) which is part of the bushing assembly, prevents powder formed by fault interruption from entering the bushing. These filters should be replaced only after considerable fault duty, when the interrupters are undergoing major overhaul.

10.8 *Replacing Current Transformers or Linear Couplers (Fig. 30) (See Part C, Section 1.9)*

CAUTION: Reduce low-pressure system to atmospheric pressure prior to removing or installing new current transformers or linear couplers.

10.9 *Replacement of Rupture Disc (See Fig. 31)*

10.10 *Resistor and Resistor Switch (See Fig. 7)*
This assembly should not need maintenance except when maintaining interrupters.

1. The closing resistor exterior and rod (427) must be clean. Use a dry cloth, or if necessary, alcohol (except Ethyl Alcohol).
2. The opening in lever assembly (482) at pin (417) should be lubricated per Lubrication Chart.
3. The resistor switch stationary contacts should be lubricated per lubrication chart.

11. OPERATING MECHANISM ADJUSTMENTS (Fig. 17)

11.1 *Open Position (Fig. 17)*

1. Center the trip finger (214) on roller (215) by inserting a 0.006" shim between finger (214) and stop screw (221), then extend the stop screw (221) until finger (214) jams against the safety pin (41). Lock stop screw (221) in place then remove shim.
2. Check gap "F" between roller (215) and trip finger (214). Adjust if required, by means of stop screw (218). Lock with screws (219).
3. Check dimension "E", the clearance between the trip finger (214) and the trip armature (220). Adjustment is made by adding or removing shims (483). This allows the solenoid assembly to be moved toward or away from the trip finger (214), as required. Tighten nut (484).
4. Check dimension "D", the clearance between the pin (485) of the manual trip and the trip finger (214). Adjustment is made by adjusting the nut (486).
5. Check the operation of the hand trip device.
   a. Check that the linkage locks out as the plunger of lockout device (225) falls behind collar (226) (See dimension "AE"). Adjust by relocating rod (222) into block (228). Tighten nut (239).
   b. Check that the contacts of permissive control switch (224) are open when the linkage is locked out. If not proceed as follows: With the trip linkage in position shown, thread rod (248) through plunger (225) until switch (224) contacts make a "click." Then screw rod (248) one more turn, and lock with jam nut.
   c. Check that the trip finger (214) has been disengaged from roller (215) when the hand trip linkage is locked out.

11.2 *Closed Position (Fig. 17)*

NOTE: Install safety pin (41) to prevent accidental tripping.

1. Check dimension "K". Adjust as required, by stop screw (229). Lock stop screw by means of lock screws (230).
2. Check dimension "J". Adjust as required, by adding shim washers (231) only. The latch check switch (232) must remain clamped tight to its mounting plate (233).

11.3 *Dashpot (Fig. 14)*
The dashpot is pre-adjusted at the factory and will not require any attention other than a periodic check of the oil level. (Refer to Lubrication Chart.) For adjustment, see Part C, Section 3.2.4.

11.4 *Strainer (Fig. 16)*
Remove the pneumatic system screen strainer (508). Blow the dust out with air and wash the screen in cleaning solvent. Dry and replace.

12. OPERATION TIMING TEST (Figs. 38 & 39)

A detailed instruction is covered in Part C, Section 3.

13. HEATER INSPECTION AND REPLACEMENT

Schematic diagram (Fig. 45) shows typical electrical connections of the heaters. The rating of each heater is given in Part E of this book under "Heater Ratings."

High Pressure Gas Vaporizing Chamber Heaters (See Fig. 27)
A routine visual inspection and occasional check with an ohmmeter will suffice to check the condition of the heaters. If replacement of a unit is necessary, install the new unit in the same position with the same mounting hardware.

Each heater unit consists of three elements, star connected. The primary heater and the secondary heater units are connected in parallel with separate controls.

The resistance of series/parallel circuits and the individual resistance of the heaters is given in Part E under "Heater Rating." Terminals are provided in the mechanism housing so that each heater can be isolated for a resistance check with an ohmmeter. For safety reasons, it is recommended that the heater circuits be de-energized before heater leads are disconnected.

To remove a heater, first disconnect the wiring at the heater terminal screws. The heater may then be slipped out between the spring loaded retainer bars and the heat exchanger.

When replacing a heater, the spring loaded retainer bars should be temporarily held down so the heater can be slipped into place.

PART E

EQUIPMENT INSTRUCTION

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PART E
EQUIPMENT INSTRUCTION

1. **EQUIPMENT FURNISHED BY CUSTOMER**

1.1 *Vacuum Pump and Gauge*
A 150 CFM vacuum pump is recommended, but if a smaller size only is available, it is satisfactory. However, the pumpdown time will take longer. An accurate vacuum gauge must be used. Stokes electrical gauge, Model TB-4, or equivalent, is suitable.

1.2 *Hose Assembly*
It is recommended that a short and large diameter hose (e.g., 10 feet or less by 2 inches O.D.) be connected between the vacuum valve of the breaker and the vacuum pump, or between the service connection and the service unit.

1.3 *Portable Filter Assembly*
The breaker can then be filled with gas, through the service connection at the mechanism as described in 4.3.1, Section C (See Fig. 41).

An in-line portable filter ***must*** be used each time the breaker is being filled with gas, or when removing the gas. The filter removes arc products and moisture from the gas, which in turn protects the compressor and vacuum pump from damage. Place filter in the line between the breaker service connection and the SF-6 service unit or gas bottles. A filter, as shown in Fig. 41 or of similar design, utilizing 13X Molecular Sieve can be used. The filter is to be positioned vertically when in use, so that gas is forced to flow through the desiccant and cannot find a short path over its surface. Care must be taken to insure that the liquid SF-6 will not enter the portable filter or breaker. Moisture readings must be taken after filling has been completed. The moisture readings should be taken from the sampling valve in the operating mechanism housing as described in 4.3.2, Section C.

The 13X Molecular Sieve must be replaced after passing approximately 3500 pounds of gas through the filter.

Filling instructions: Stand unit upright and remove pipe plug at bottom end of unit, letting old desiccant out and discard it. Check the plug and clean the threads thoroughly. Apply the Teflon Tape and Rectorseal #2 (refer to "Pipe Thread Sealant" See Fig. 37) to pipe plug and replace the plug.

Optional:

Hose Assemblies (Airoquip Mfg.)

ITEM	QTY.	PART NO.	DESCRIPTION
*	1	042L017-76	Hose, 6 ft. Airoquip #1503-20-72
*	1	042L017-77	Hose, 10 ft. Airoquip #1503-20-120

NOTE: *Airoquip Hose has #411-20 J.I.C. swivel (Female 1-1/4" 37° Flare) at both ends.

Filling the unit with desiccant should be performed quickly to reduce the time which the Molecular Sieve and the interior of the column are exposed to the atmosphere. (Perform indoors if possible.) Pour the desiccant from the shipping container directly into the filter using a funnel. Fill the unit to about 1" from the top as shown in Fig. 24. Install the top pipe plug as soon as filled. If hoses are not connected to unit, always have the flared cap in place to protect threads and seal from the atmosphere.

1.4 *Service unit which includes:*
1. Vacuum Pump
2. Gas Compressor
3. Vacuum Gauge
4. Storage Tank
5. Refrigeration Unit

Reference:
(1) Cosmodyne Corporation
2920 Columbia Street
Torrance, California 90509

(2) Limco
Long Island Metal, Inc.
Garvies Point Rd.
Glen Cove, N.Y. 11542

1.5 *Gases*
One 38 pound cylinder of F-12 Freon (cylinder size "C"). Forty-five to seventy cylinders of dry air or nitrogen (cylinder size "A").

1.6 *Gas Cylinder Regulator and Valve*
AIR (Cylinder size "A")
Air Products and Chemical, Inc., single stage regulator, delivery pressure range 0-500 (psig). Code E11-F-N115G.
N_2 (Cylinder size "A")
Same as above.

SF-6 (Cylinder size "A")
Air Products and Chemical, Inc., single stage regulator, delivery pressure range 1-180 (psig). Code Number E11-4-N515F. Connection 1/4" NPT.

F-12 (Cylinder size "C")
Air Products and Chemical manual control valve, without gauge, with 1/4" FNPT outlet. Four foot hose with compatible fittings.

1.7 *Leak Detector and Moisture Analyzer*

Instrument Leak Detector

REFERENCE: Halogen Leaktector, Code 23-7023
Bacharach Instrument Company
625 Alpha Drive
Pittsburgh, Pennsylvania 15238

Ultrasonic Translater-Delcon #4918A
Delcon Div. of Hewlett-Packard Company
Mountain View, California 94042

Moisture Analyzer

REFERENCE: Electrolytic Moisture Analyzer (MEECO)
Manufacturing Engineering and Equipment Corp.
250 Titus Avenue
Warrington, Pennsylvania

Trace Moisture Analyzer
Beckman Bulletin #4101
Beckman Process Instruments Division
Fullerton, California 92634

Liquid Leak Detector

REFERENCE: Leak-Tec
American Gas & Chemical, Inc.

Gas Leak Detector

REFERENCE: Calgon Corporation
Pittsburgh, Pennsylvania 15730

1.8 *Timing Devices*

1. Mechanical Time-Travel Recorder
2. Oscillograph for resistor timing

1.9 *Tools and Equipment for Installation and Maintenance*

The intent of this list is to inform the purchaser of a suggested set of tools and equipment to have available when installing or maintaining the breaker. Most of the tools listed are normally carried by a mechanic, and most of those shown can be substituted by any tool which will perform the same function. The suggested quantities are for a three/four man crew.

Item	Qty.	
1	1	Impact Wrench — 1/2" drive
2	1 ea.	Impact Sockets — 1/2" drive, 9/16" hex, 1-5/8" hex
3	1	Impact Adapter — 1/2" sq. drive to 3/4" sq. drive
4	1	Torque Wrench — 1/2" sq. drive, 10 to 150 ft. lbs.
5	1	Torque Wrench — 3/4" drive, 10 to 600 ft. lbs.
6	3 sets	Box-end Wrenches: (3/8, 7/16, 1/2, 9/16, 5/8, 11/16, 3/4, 15/16, 1-1/16, 1-1/4, 1-5/8, 1-7/16)
7	3 ea.	Socket Ratchet Wrench — 1/2" drive, 3/8" drive and 3/4" drive
8	3 ea.	Sockets — 3/8" sq. drive (3/8, 7/16, 1/2, 9/16, 5/8)
9	3 ea.	Sockets — 1/2" sq. drive (1/2, 9/16, 5/8, 11/16, 3/4, 15/16, 1-1/16, 1-1/4) Sockets — 3/4" sq. drive (1-5/8 and 1-7/16)
10	3 ea.	Sockets, Allen — 3/8" drive (1/8, 5/32, 9/64, 3/16, 1/4, 5/16, 3/8) Allen (Proto 4990)
11	3 ea.	Socket, Allen — 1/2" drive, 1/2" Allen
13	3 ea.	Extension 3/8" and 1/2" sq. drive X 6" and 12" Proto 4765
14	1	Adjustable Wrench, 12" (Rigid No. E-110)
16	3 ea.	Truarc Pliers, external type 102 and 90° type 102

Item	Qty.	
17	3 sets	Screwdrivers
18	2	AC Electric Extension Cords w/junction box to handle 3-4 plugs (115 VAC)
19	3	AC Lamps with cords (115 VAC)
20	2	Fans, all purpose type to force fresh air through the manholes after leak inspection
21	1	Portable vacuum cleaner

2. GAS HANDLING INSTRUCTION

Only properly instructed personnel should handle SF-6, N2, and F-12 gas. Employ appropriate pressure regulating devices and hoses on cylinders.

Provide an all-purpose fan to force fresh air through the manhole before entering the breaker when using N2 for leak test or breathing equipment with its own independent air supply.

Check moisture content of dry air, N2 and SF-6 in cylinders. The maximum moisture content should be as shown in Part C, Section 4.3.2.

2.1 *Cylinder Fittings*

Air: (Cylinder size "A", 3 X 55)
Standard industrial type cylinders which are color-coded cream for easy identification. Cylinder pressure connection is .945" in diameter, 14 threads/inch, National Standard left hand. Cylinder adapter for connections is a CGA590 or CGA fitting compatible with vendor cylinders.

F-12: (Cylinder size "C", 8 X 22)
Standard service type cylinders which are color-coded blue for easy identification. Cylinder pressure connection is for easy identification. Cylinder pressure connection is 1.030" in diameter, 14 threads/inch, National Standard right hand. Cylinder adapter for connection is a cylinder valve outlet CGA620 nipple and nut.

N2: (Cylinder size "A", 9 X 55)
Standard industrial type cylinders which are color-coded olive for easy identification. Cylinder pressure connection is .965" in diameter, 14 threads/inch, National Standard right hand. Cylinder adapter for connection is a CGA580 nipple and hexagon nut.

SF-6: (Cylinder size "A", 9 X 55)
Standard industrial type cylinders which are color-coded silver with green top for easy identification. Cylinder pressure connection is .945" in diameter, 14 threads/inch, National Standard left hand. Cylinder adapter for connection is a CGA590 nipple and hexagon nut.

2.2 *Heating Cylinders*

SF-6 cylinders only have to be heated to expedite the transfer of gas from the cylinders to the service unit or to the breaker. This can be achieved using the following methods:

Use a portable electric heater, or use two sets of band heaters. Clamp the band heaters on the SF-6 cylinder, such that one band is near the bottom and the other at 12 to 15 inches from the bottom of the cylinder. Energize the heaters only when transferring the gas from the cylinder. Another means of heating the cylinder is a drum with 20 gallons of water and a portable gas heater. (Do not heat over 200°F.)

2.3 *Procedure to Transfer SF-6 From Service Unit to an Empty Cylinder*

EQUIPMENT (See Fig. 43):
1. Service Unit
2. Empty SF-6 Cylinder
3. Scale 0-300 lbs.
4. Nylon Tube and Pipe Fittings

PROCEDURE:
Follow this procedure only when pressure in the service unit is at least 300 psig. This is an indication that liquid SF-6 is in the tank of the service unit.
1. Connect an empty gas cylinder to the tank on the service unit as shown in Fig. 43. Place cylinder on the scale.
2. Open Valves 2 and 3.
3. Start evacuating air until 0.5 mm vacuum is reached.
4. Note cylinder weight. It should be about 125 lbs.
5. Close Valve 2. Open Valve 1, and let liquid SF-6 flow to the cylinder. This flow will be visible through the nylon tube. Weight of the cylinder will start increasing.
6. Watch weight of cylinder and flow of SF-6 liquid. Increase in cylinder weight should not be above 100 lbs. (Maximum total weight should be 220-230 lbs.)

7. As soon as 100 lbs. of weight increase is reached, close Valves 1 and 3. Go to step 12.
8. If liquid SF-6 stops flowing before above weight increase of 100 lbs. is reached, close Valve 1, open Valve 2, and evacuate SF-6 from the cylinder, the same as if it were the breaker.
9. Within a few minutes, ice will start forming on the cylinder surface. Watch compressor suction pressure gauge on the service unit panel. When it shows pressure below 0 psig, close Valve 2 and stop gas removing process.
10. Open Valve 1, and let liquid SF-6 flow to the cylinder.
11. When increase in cylinder weight reaches 100 lbs., close Valves 1 and 3.
12. Open Valve 2, remove SF-6 from pipes by operating the service unit.
13. Cylinder is now filled; it can be disconnected and stored.
14. Start from Step 1 above with a new cylinder.

If all pipe connections are ready, it takes approximately 15 minutes to fill the cylinder by following this procedure.

3. LUBRICANT AND SEALER INSTRUCTION

3.1 Periodic Cleaning and Lubrication requirements are detailed in Fig. 35.

NOTE: For lubricant, sealer and oil kits, see Fig. 35.

3.2 *Air Compressor Lubrication Requirement*

Maintenance Schedule:
Semi-annually, apply "Gould Compressor Upper Treatment" (2 oz. plastic bottle #301A003) to the air intake by saturating the filter pad or removing the muffler cover and adding the upper treatment directly to the air intake with the compressor running.

Additional Checks:
Check the crankcase oil level. If necessary, add "Gould Compressor Oil #109A003, Type 10." Drain and replace each year.

Acceptable Lubricants:
Only "Gould Compressor Upper Treatment #301A033" and "Gould Compressor Oil #109A003, Type 10" for crankcase are acceptable.

This oil is a special formulation designed for intermittent duty air compressors.

3.3 *Hydraulic Sealant for Flare Fittings*

MATERIAL: Loctite Hydraulic Sealant (Gould Ed 4.1.3037) Fig. 37.

PURPOSE: To seal pneumatic, hydraulic, or gas lines against leakage and to lock connector threads.

APPLICATION: Use on flared joints and locking nuts of J.I.C. 37° flared fittings. Temperature Range: −65° to 300°F.

PROCEDURE: First thoroughly clean fitting. Locquic Primer Grade T (Gould Ed 4.1.3036) should be used for general degreasing purposes and also to activate the surfaces of zinc, cadmium plated or anodized aluminum parts. Allow it to dry at least three minutes and then, using applicator nozzle, apply Loctite Hydraulic Sealant (Gould Ed 4.1.3037) in limited amounts to flared portion of fittings. Assemble parts and allow one hour for hardening at 70°F (longer time if colder). Heat speeds hardening.

For Hydraulic Sealant Kit, see Bulletin IB—9.5.0-18 in this manual.

3.4 *Pipe Thread Sealant*

TO SEAL PIPE THREADS AGAINST SF-6 GAS:

PROCESS: **NOTE: Follow each step exactly (Fig. 37).**

1. Clean male and female threads to bare metal (tap or die if required). Wash both threads clean with a good industrial solvent (Chlorothene-NU). Check threads with DRYSEAL (NPTF) gauges before proceeding.
2. Wrap the male threads (including the first thread) to their full width with the proper width of Teflon tape (up to 1" wide tape for large threads). Do not lap the tape to obtain proper width. The tape must be applied clockwise facing the threads. See the following chart for the number of turns of tape required.
3. Apply Rectorseal #2 over the Teflon tape. Do not apply to the first two threads.

PIPE SIZE	NO. TAPE TURNS
2" to 1-1/2" IPS	4
1-1/4 to 1	3
3/4 to 1/2	2
3/8 to 1/8	1-1/2

4. RESISTANCE VALUES

4.0.1 *Resistance of Bushings, Contacts and Main Current Path*

CURRENT PATH	MAX. MICRO-OHMS
Main Current Path (Bushing Top Cap to Bushing Top Cap)	260
Contacts (Bushing Bottom Cap to Bushing Bottom Cap)	150
Bushing (Top Cap to Bottom Cap)	55

4.0.2 *Resistance of Closing Resistors*
To measure, close breaker with maintenance closing device until resistor switches make

Individual Resistors .... 71 to 79 ohms
Total Resistance —
6 in Series Measured
Bushing to Bushing ..... 450 ohms nominal

5. RELIEF VALVE, SAFETY VALVE AND RUPTURE DISC RATINGS

DESCRIPTION	RATING	FUNCTION
Item 10, Fig. 20	250 psig	Relief Valve on the Discharge Side of the Compressor to the Low-Pressure System.
Item 10, Fig. 20	250 psig	Relief Valve between High and Low-Pressure System.
Item 10A, Fig. 20	125 psig	Relief Valve between Low-Pressure of Manifold and Low-Pressure of Breaker.
Item 8, Fig. 16	70 psig	Low-Pressure Safety Valve.
Fig. 31	130 psig ± 5%	Rupture Disc

6. THERMOSTAT SETTING INSTRUCTION

DESCRIPTION	CONTACT CLOSES	CONTACT OPENS	ADJUSTABLE	FUNCTION
23-1	55°F	70°F	No	Thermostat for air compressor heaters.
23-2	72°F	75°F	Yes	Thermostat for primary high-pressure vaporizing chamber heaters.
23-3	66°F	69°F	Yes	Thermostat for secondary high-pressure vaporizing chamber heaters.
23-4	55°F	70°F	No	Thermostat for gas compressor heater, the manifold,, the high-pressure dryer and the air valve heater.
23-5, 23-6	150°F	210°F	No	Thermostat for high-pressure system high-temperature lockouts.primary heaters same except secondary heaters.'
23-8	260°F	220°F	No	Thermostat for high-pressure system high-temperature alarm.
23-9	55°F	70°F	No	Thermostat for control housing space heater.

7. **HEATER RATINGS (1/2 Voltage Application)**

DESIGNATION	OPERATING WATTS	LOCATION
H-1	75	Next to Air Tank Drain Valve
H-2	75	Next to Air Tank Drain Valve
H-3	150	Under Air Compressor
H-4	150	Under Gas Compressor
H-5	150	Next to Manifold and High-Pressure Dryer
H-6 & H-7	150 Each	In Control House
H-18	250	On the Closing Valve

HIGH PRESSURE TANK VAPORIZING CHAMBER (Operated at Full Voltage)

STAR CONNECTED HEATER ELEMENTS	TOTAL WATTS		FUNCTION
	RATED	OPERATING	
H-10 through H-12	3,000	3,000	Primary Heaters
H-13 through H-15	3,000	3,000	Secondary Heaters

OHMIC RESISTANCE OF HEATERS H-10 THROUGH H-15

OPERATING VOLTAGE	RESISTANCE ACROSS EACH LEG
208	42 ohms to 44 ohms
230	51 ohms to 54 ohms
460	205 ohms to 215 ohms

8. **RENEWAL PARTS**

Sufficient renewal parts should be carried in stock to enable prompt replacement of worn or damaged parts. Careful planning for a stock of such parts will minimize service interruptions caused by equipment breakdown and will ultimately save time and expense.

The number of renewal parts which should be maintained is dependent upon conditions of operation and past experience. When continuous operation is of primary importance, more renewal parts should be stocked, the amount being dependent upon the severity of the service and the time required to secure replacements. It is recommended that subassemblies be stocked for use as spares.

Renewal parts may not always be identical to the original parts, since revisions are being made constantly in an effort to improve our products. The parts which are furnished, however, will be interchangeable.

Standard hardware items may not be listed and it is suggested that these items be purchased locally to save time and expense. Where the hardware is of a special nature or where standard hardware is specifically requested by the customer, it will be provided by the factory. Parts orders of low monetary value will be invoiced at the minimum billing rate in effect at the time of shipment.

When ordering renewal parts, or for information concerning service or repair of your equipment, address the nearest sales office of Gould. It is important that the following information is taken from the breaker nameplate and renewal parts list to properly identify the parts:

1. Serial Number
2. Type
3. Rating (ampere and voltage)
4. Item Number
5. Description
6. Number Required

All parts are shipped F.O.B. point of shipment, freight not allowed. The company will establish the method and routing of the shipment of parts. Our standard carriers are either rail or truck.

The customer may specify method and route of shipment, but in so doing obligates himself for the additional expense incurred. Shipment may also be sent by parcel post or by air.

8.0.1 OPERATING MECHANISM PARTS:

DESCRIPTION	INSTRUCTION BOOK		QTY. PER BREAKER	RECOMMENDED QUANTITY
	ITEM NO.	FIGURE NO.		
Gas Compressor	12	19, 25	3	1
Gasket, Gas Compressor Seal (Inlet & Outlet)	12A	19, 25	6	2
Switch, Oil Pressure	13	25	3	1
Temperature Gauge, L.P. System	9	19	3	1
Temperature Gauge, H.P. System	5	19	3	1
Pressure Gauge, L.P. System	8	19	3	1
Pressure Gauge, H.P. System	4	19	3	1
Pressure Switch				
Alarm & Interlock	2,2A	19, 20	6	2
Compressor	1	19, 20	3	1
L.P. System, Temperature Compensated Pressure Switch	3	19, 20	3	1
Oil Separator Seal Kit (see instructions for installation & maintenance for Oil Separator).	15A	25	—	3 kits
Motor	504	16, 28	3	1
Belt	515	16	3	1
Pressure Gauge, Air	503	16, 28	3	1
Pressure Switch, Alarm, Lockout	500,502	16, 28	2	1
Pressure Switch, Motor	501	16, 28	1	1
Switch, Micro	224, 232	17	3	1
	516	17	3	1
Trip Solenoid	517	17	6	2
Meter Totalizer	518	16	3	1
Close Valve (Less Coil)	509	16, 28	3	1
Close Valve Repair Kit	509A	16	—	3
Close Valve Coil	519	16	3	1
Dashpot	520	10, 14	3	1
Desiccant Material (Filter-Dryer)	521	24	50 lbs.	50 lbs.
Heater Strip (75W) H-1, H-2	—	45	6	2
Heater Strip, (150W) H-3 to H-7	—	45	11	5
Heater, (250W) H-18	—	45	3	1
Valve, Safety Air	507	28	3	1
Valve, Check Air	506	28	3	1
Valve, Safety Gas	11	16, 19	3	1
Valve, Relief Gas	10	19, 20	6	1
Valve, Relief Gas	10A	19, 20	3	1

8.0.2 BREAKER PARTS

DESCRIPTION	INSTRUCTION BOOK		QTY. PER BREAKER	RECOMMENDED QUANTITY
	ITEM NO.	FIGURE NO.		
Bushing (2000A/3000A)	—	1	6	2
Gasket, Bushing	67	29	6	2
Blast Valve Assembly	525	12	9	3
Stationary Contact	374	12, 13	18	6
Moving Contact Ass'y	365	12, 13	18	6
Capacitor, Grading Kit	230 A030-06	8	3 kits	1 kit
Thermostat, High Lockout, Gas	7, 7A	27	6	2
Thermostat, High Alarm, Gas	6	27	3	1
Insulated Rod Assembly	309	11, 12	9	3
Lower Seat Valve Seal Kit	526	12	—	9 kits
Washer Mold Seat (1)	320	11, 12	9	—
Seal Poly-Pck (1)	321	12	9	—
Bushing, Guide (1)	322	12	9	—
Upper Valve Seat Kit	527	12	—	3 kits
Washer Seat (1)	343	12	9	—
Shim (4)	349	12	36	—
Shim (4)	350	12	36	—
Interrupter Tube	370	12	18	6
Deflector Assembly	528	12	18	6
Bushing, Guide	529	12	18	6
O-ring	326	11	9	3
Ring, Retaining (Internal)	351	12	9	3
Bushing, Guide	530	12	9	3
O-ring	475	11	9	3
Pull Rod Seal Kit	531	11	—	9 kits
Sliding Seal (1)	138	11	9	—
Bushing, Guide (2)	74	11	18	—
Retaining Ring	474	11	9	—
Bellows Seal Kit	532	10	—	1 kit
Sliding Seal (1)	136	10	1	—
O-ring (1)	533	10	1	—
O-ring (1)	534	10	1	—
O-ring (1)	140	10	1	—
O-ring (1)	535	10	1	—
Rupture Disc	536	19, 31	3	1
Manhole Gasket Kit	537	33	—	1 kit
Gasket (3)	538	33	3	—
Gasket Clip (8)	539	33	—	—
Desiccant Bags	—	13	6	6
O-ring	488	27	3	1
O-ring	490	27	3	1
Heater Strip H-10 to H-15	540, 540A	27	18	9
Resistor	—	7	18	2
Resistor Contact, Moving	428	7	18	2
Resistor Contact, Stationary	428A	7	18	2
Resistor Switch Oper. Rod	427	7, 13	18	2
Filter, Bushing	479	10	6	2

PART F

ILLUSTRATIONS

FIGURE	DESCRIPTION
1	Breaker Outline
2	Field Erection
3	Lifting Bushing
4	Lifting Breaker
5	Single Pole Cross Section
6	Interrupter Nomenclature
7	Resistor and Grading Capacitor Installation
8	Capacitor Arrangement, One Pole
9	Interrupter Tube Assembly
10	Mechanical Linkage, Oper. Mech. to Main Contacts
11	Support Column and Insulated Rod Assembly
12	Interrupter Cross Section
13	Breaker Linkage Adjustment
14	Operating Mechanism with Hydraulic Jack
15	Mounting Insulated Support Column
16	Operating Mechanism
17	Operating Mechanism Adjustments
18	Instructions for Cont. Assem. of Adj. Aux. Sw.
19	Gas Control System
20	Mimic Diagram and Gas Manifold
21	Gas Compressor Mounting
22	Gas Compressor
23	Dessicant Bag
24	Filling Filter-Dryers
25	Compressor & Filter-Drier Unit
26	Gas Pressure Chart
27	Vaporizing Chamber, Heater Arrangement & Gaskets
28	Pneumatic Operating System
29	Bushing Installation
30	Current Transformers and Linear Couplers
31	Rupture Disc
32	Vacuum Valve in Tank
33	Manhole Gasket Installation
34	Torque Values, Key Bolts and Screws and Locking Information
35	Lubrication Chart
36	Special Tools
37	Hydraulic Sealant for Flare Fittings and Pipe Threads
38	Typical Travel Curves
39	Oscillograph Trace, Sample
40	Hose to Portable Filter to SF_6 Service Unit
41	Hose to Portable Filter to Breaker Pole
42	Pressure Regulator and Safety Valve in Gas Supply Line
43	Transferring SF_6 From Service Unit to Empty Cylinder
44	Schematic Diagram Descriptive Chart
45	Basic Schematic AC Diagram
46	Basic DC Series Connected Diagram
47	Basic DC Parallel Connected Diagram
48	Typical Oscillogram Showing Insertion Time of Each Closing Resistor
49	Removing Temporary Shipping Supports

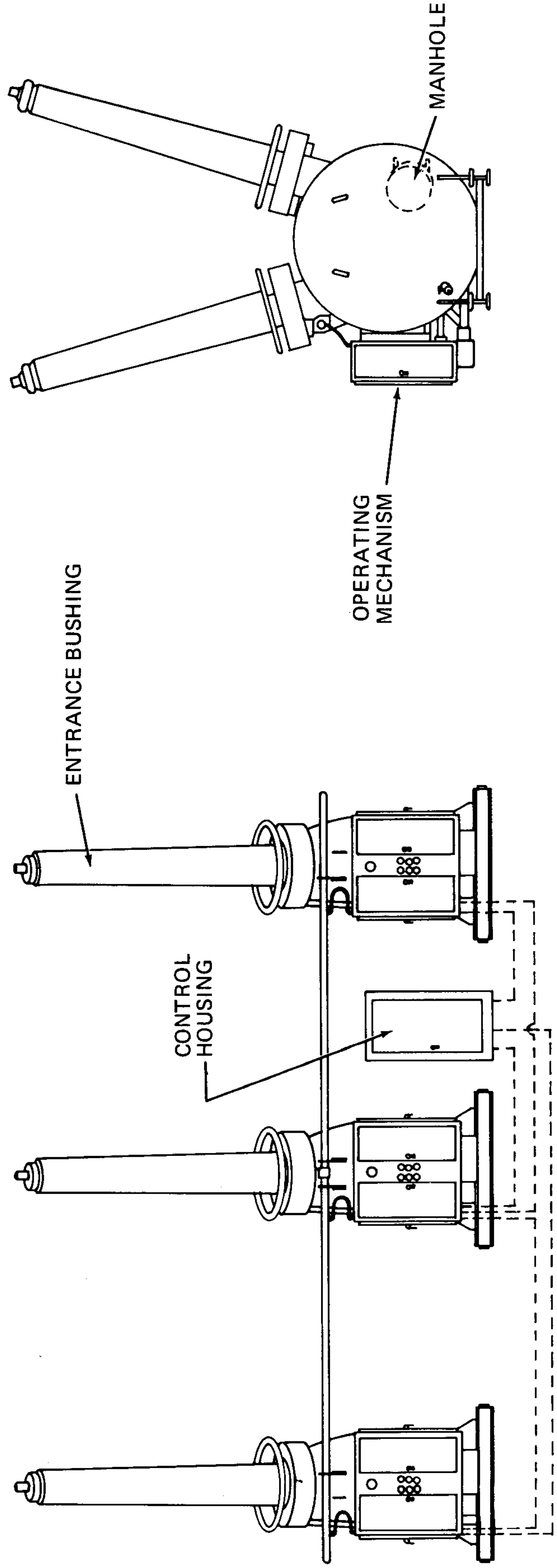


FIGURE 1
BREAKER OUTLINE

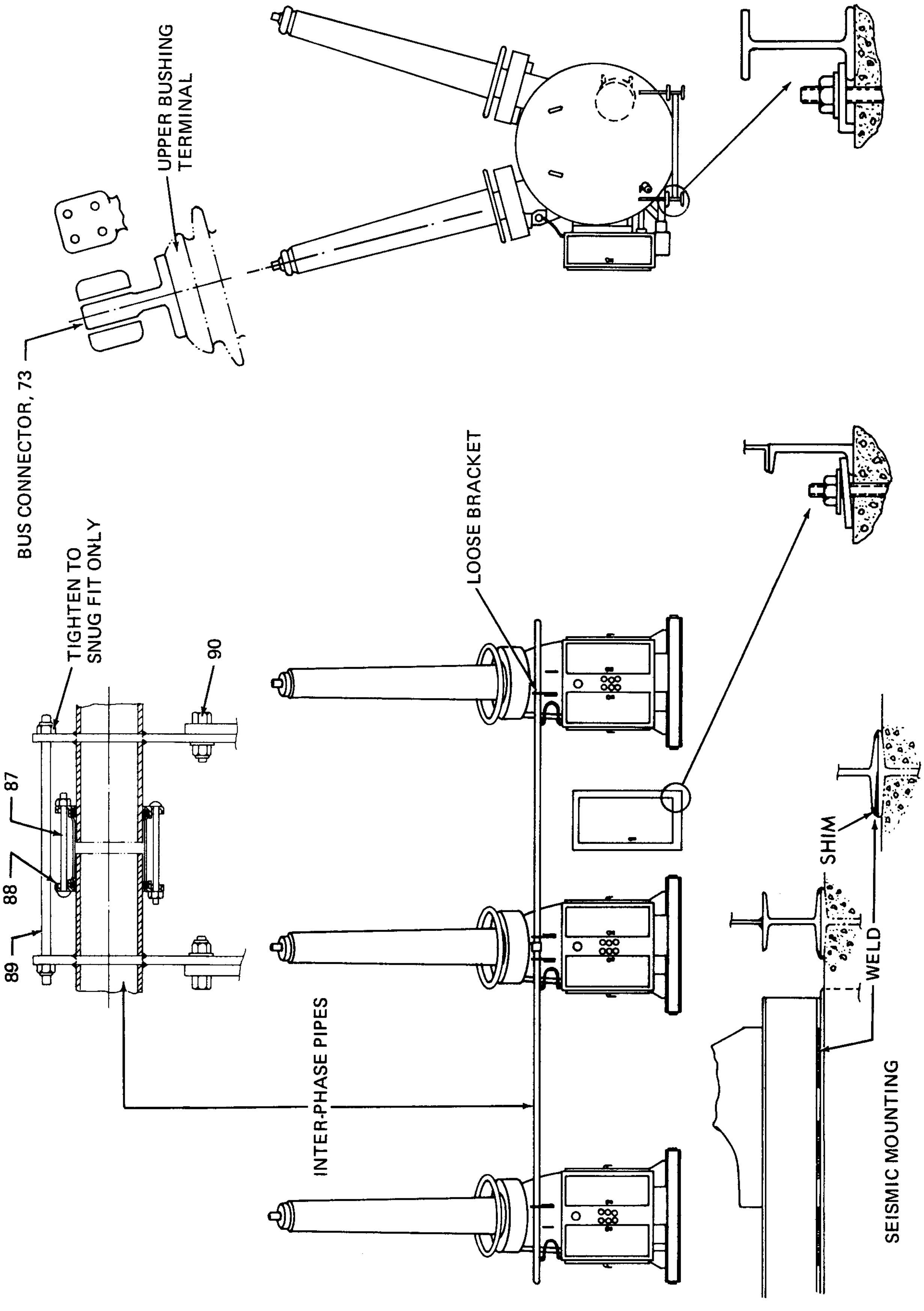


FIGURE 2
FIELD ERECTION

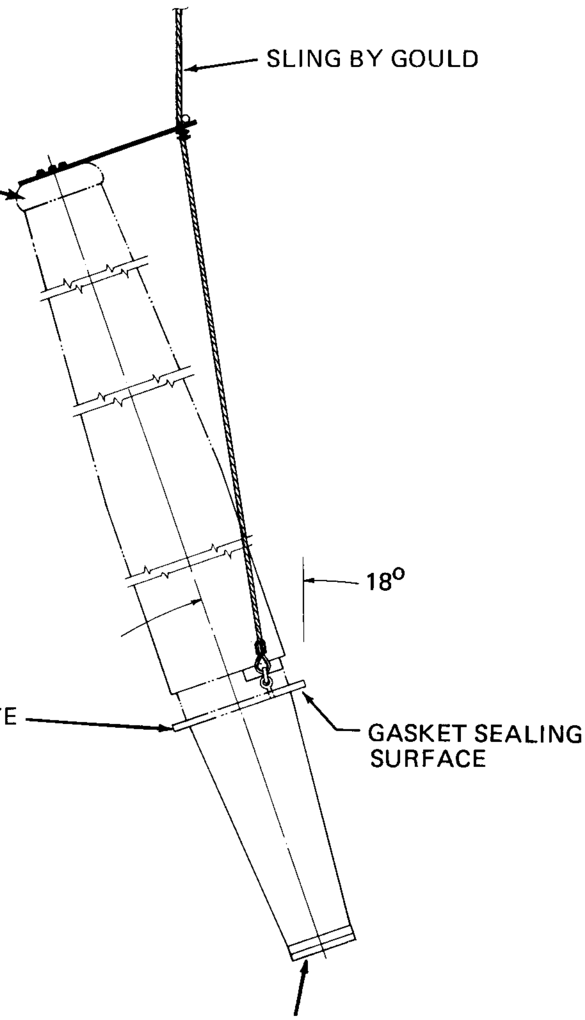


FIGURE 3
LIFTING BUSHING

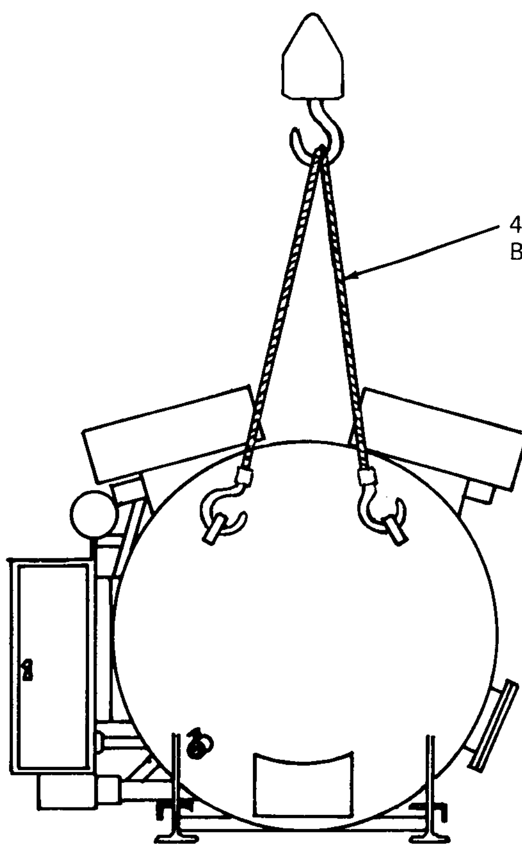


FIGURE 4
LIFTING BREAKER

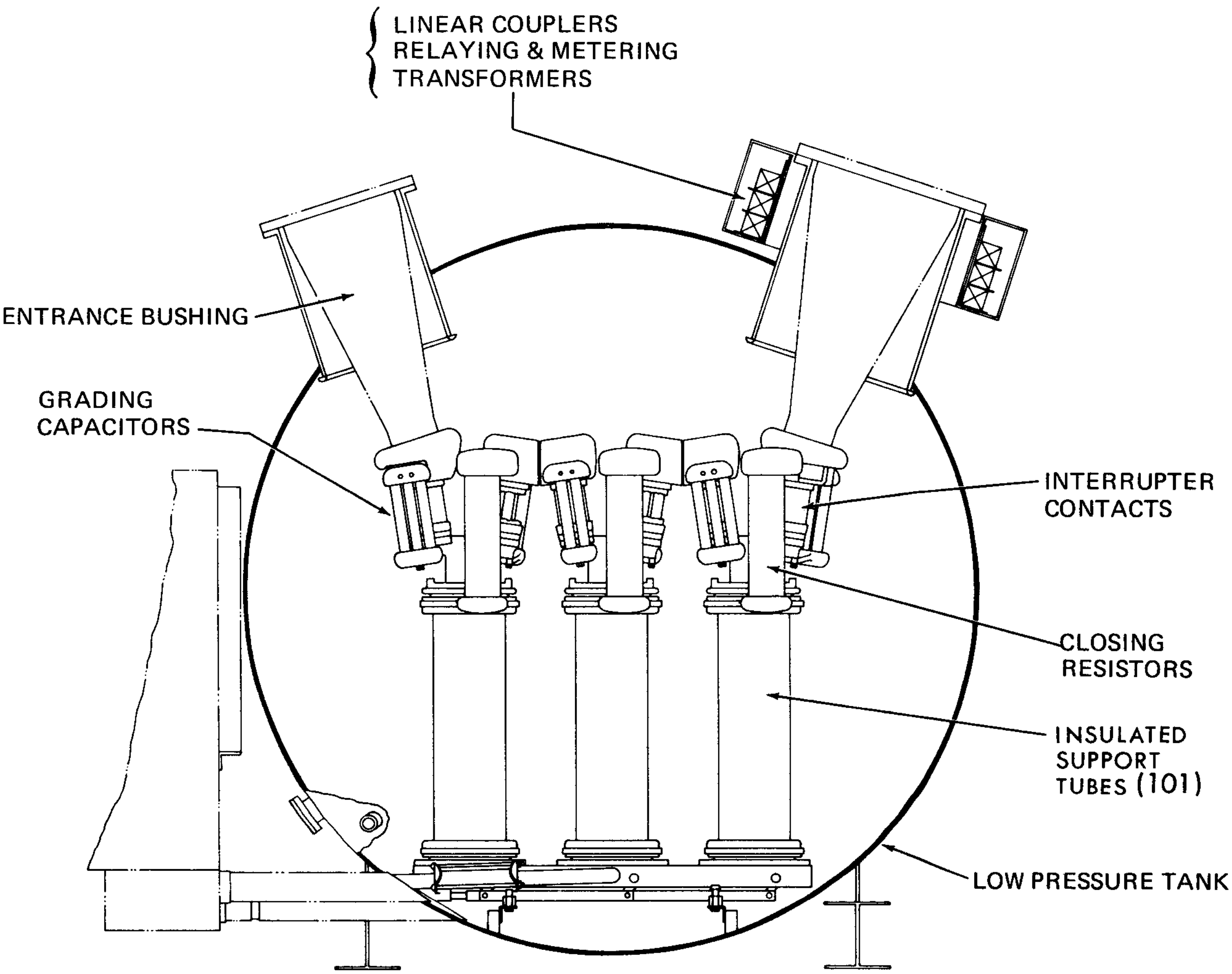


FIGURE 5
SINGLE POLE CROSS SECTION

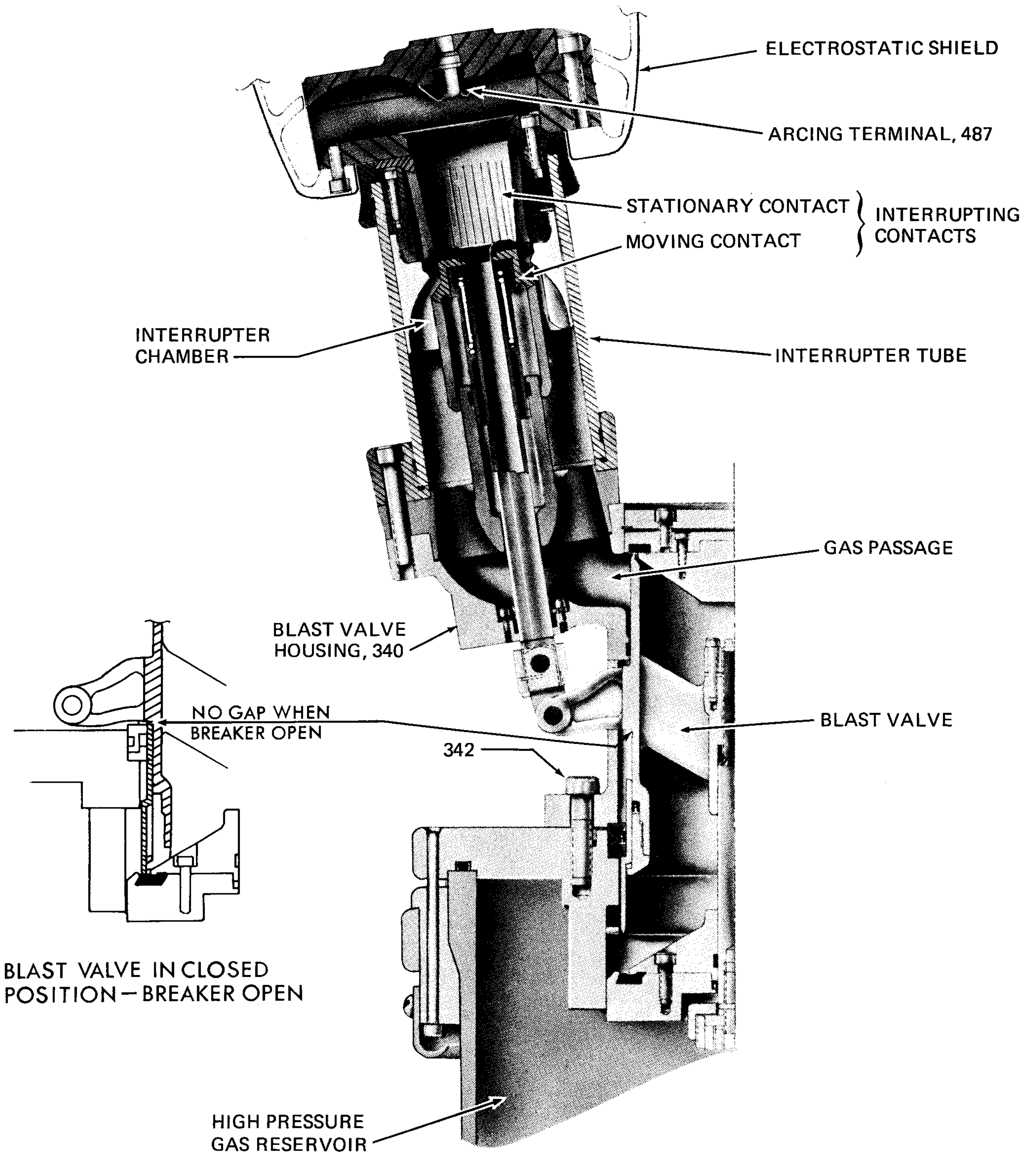


FIGURE 6
INTERRUPTER NOMENCLATURE

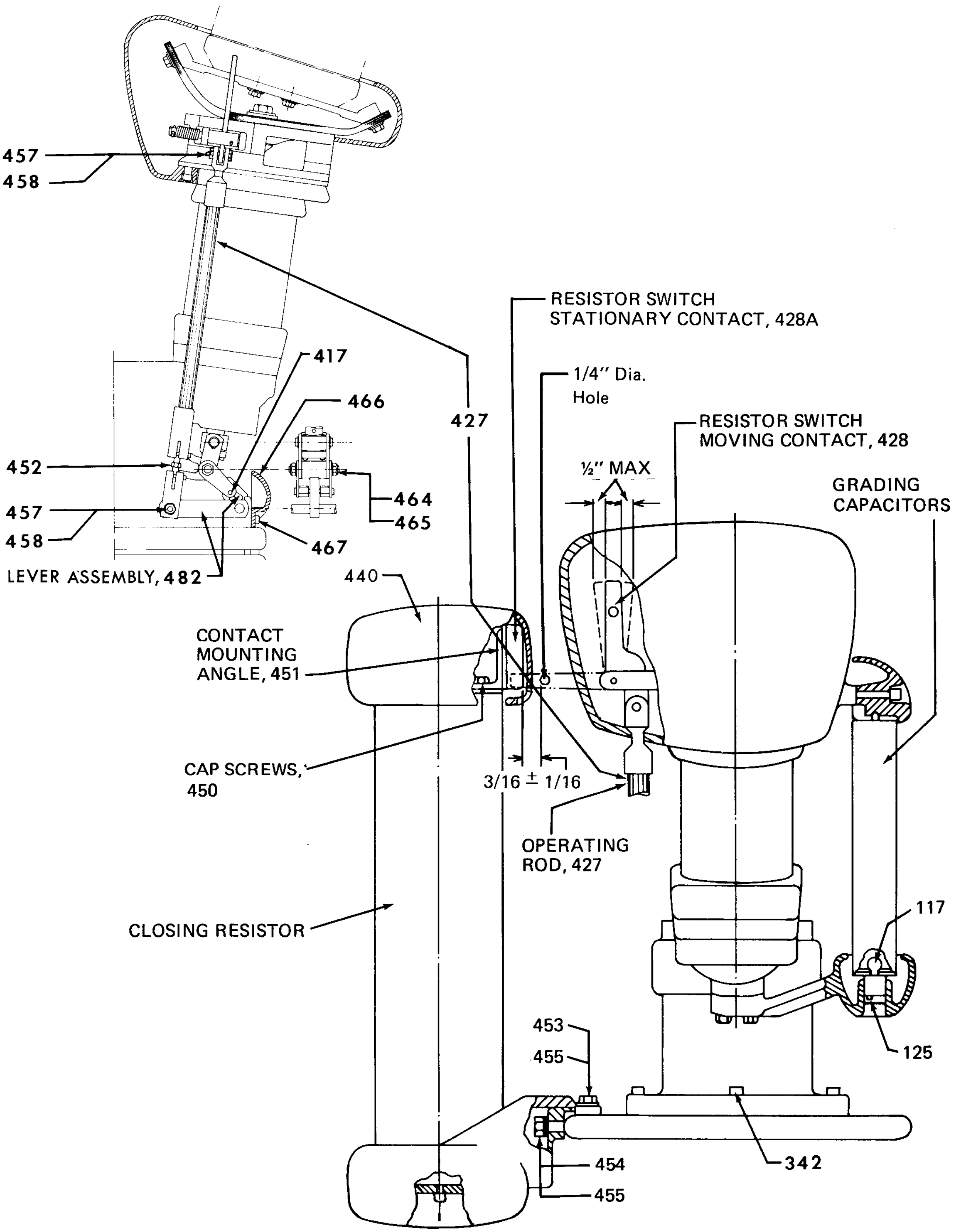
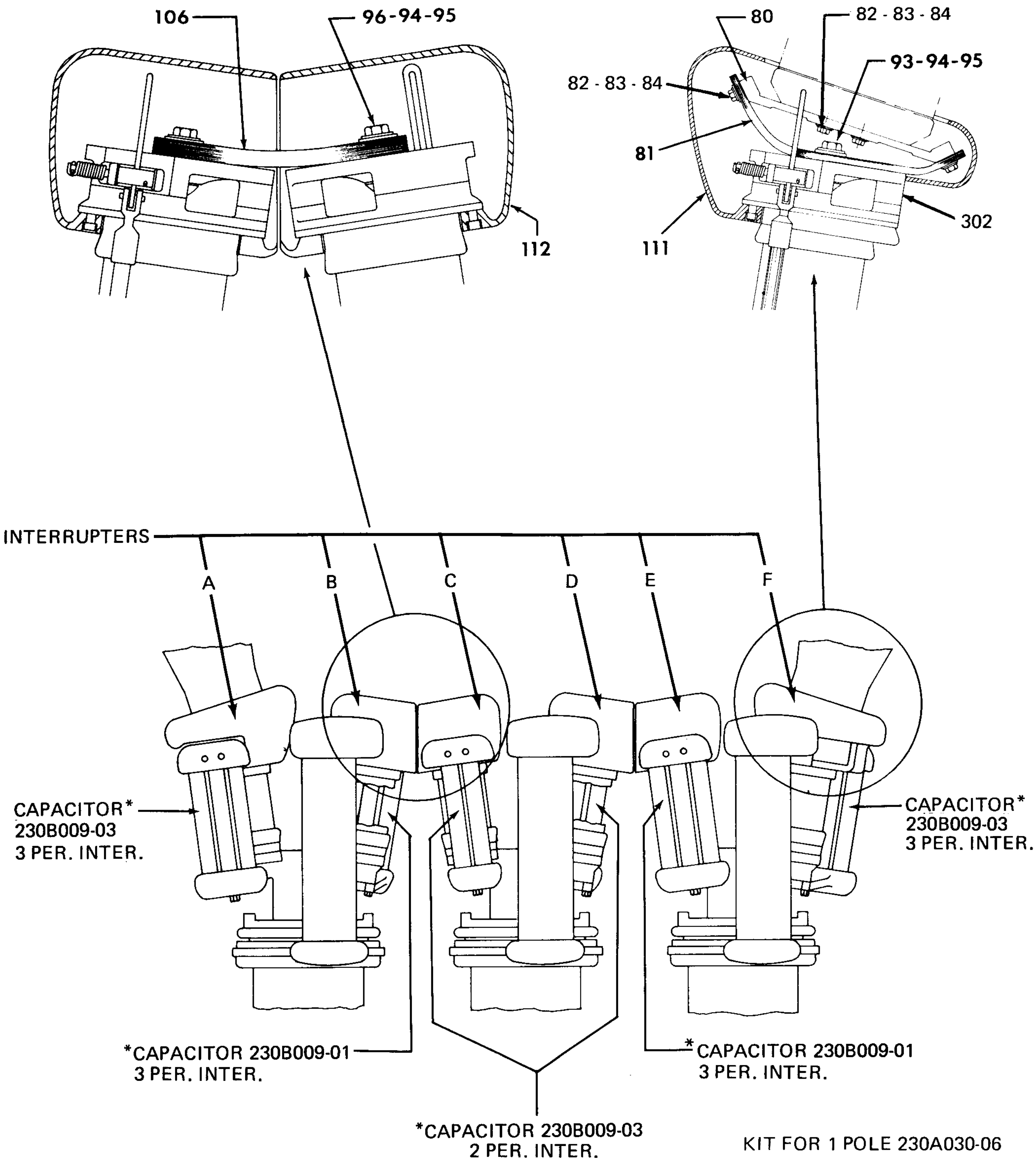


FIGURE 7
RESISTOR AND GRADING CAPACITOR INSTALLATION



(*NOTE: CAPACITORS, ONLY ONE COLOR IN ANY ONE PHASE . . . DO NOT MIX)

FIGURE 8

CAPACITOR ARRANGEMENT, ONE POLE

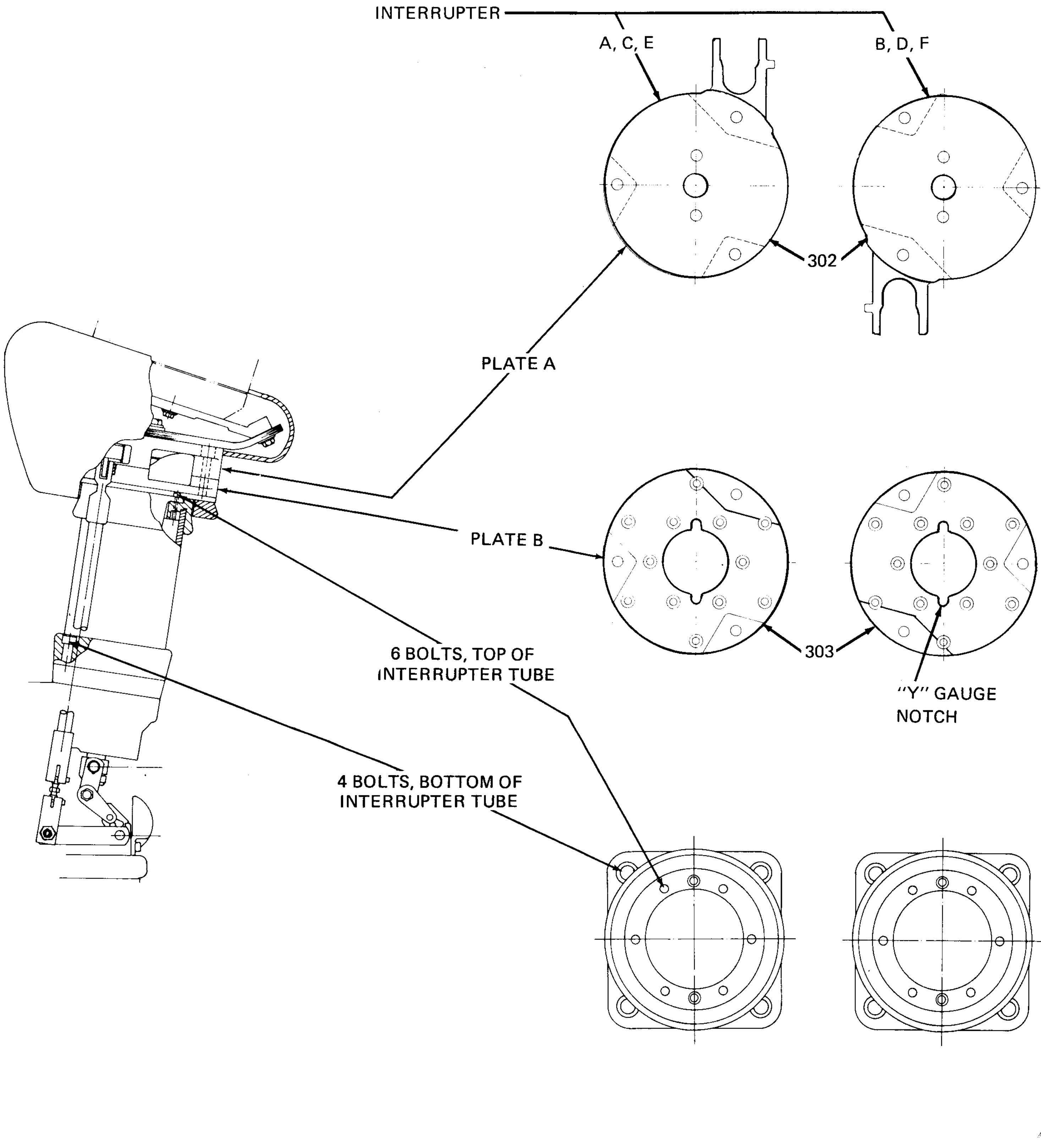
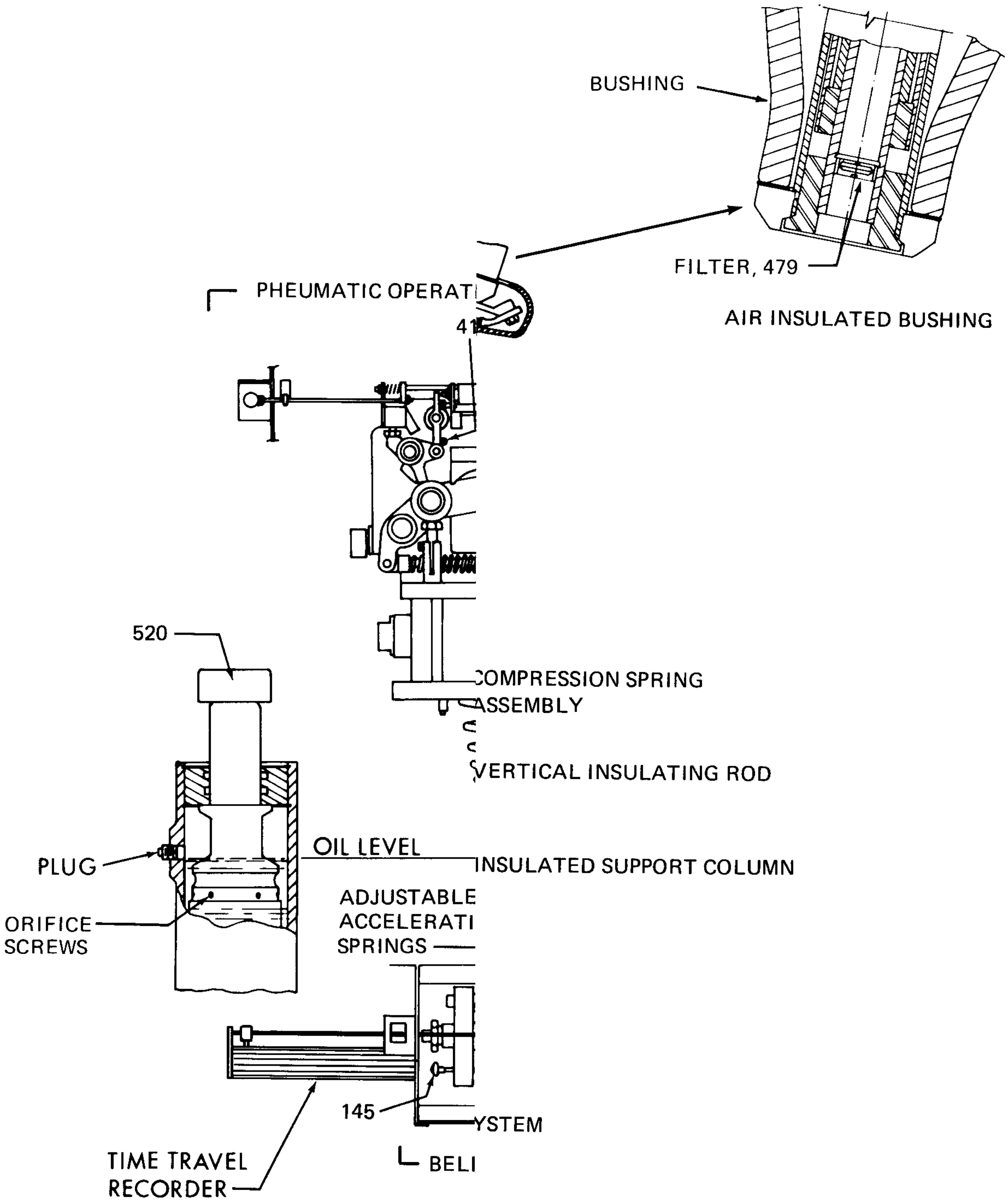
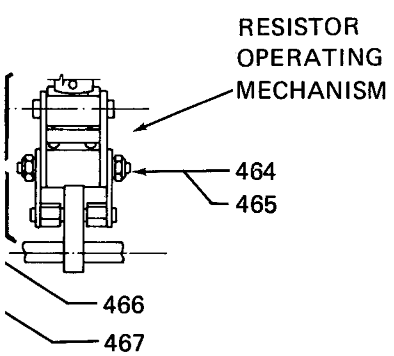
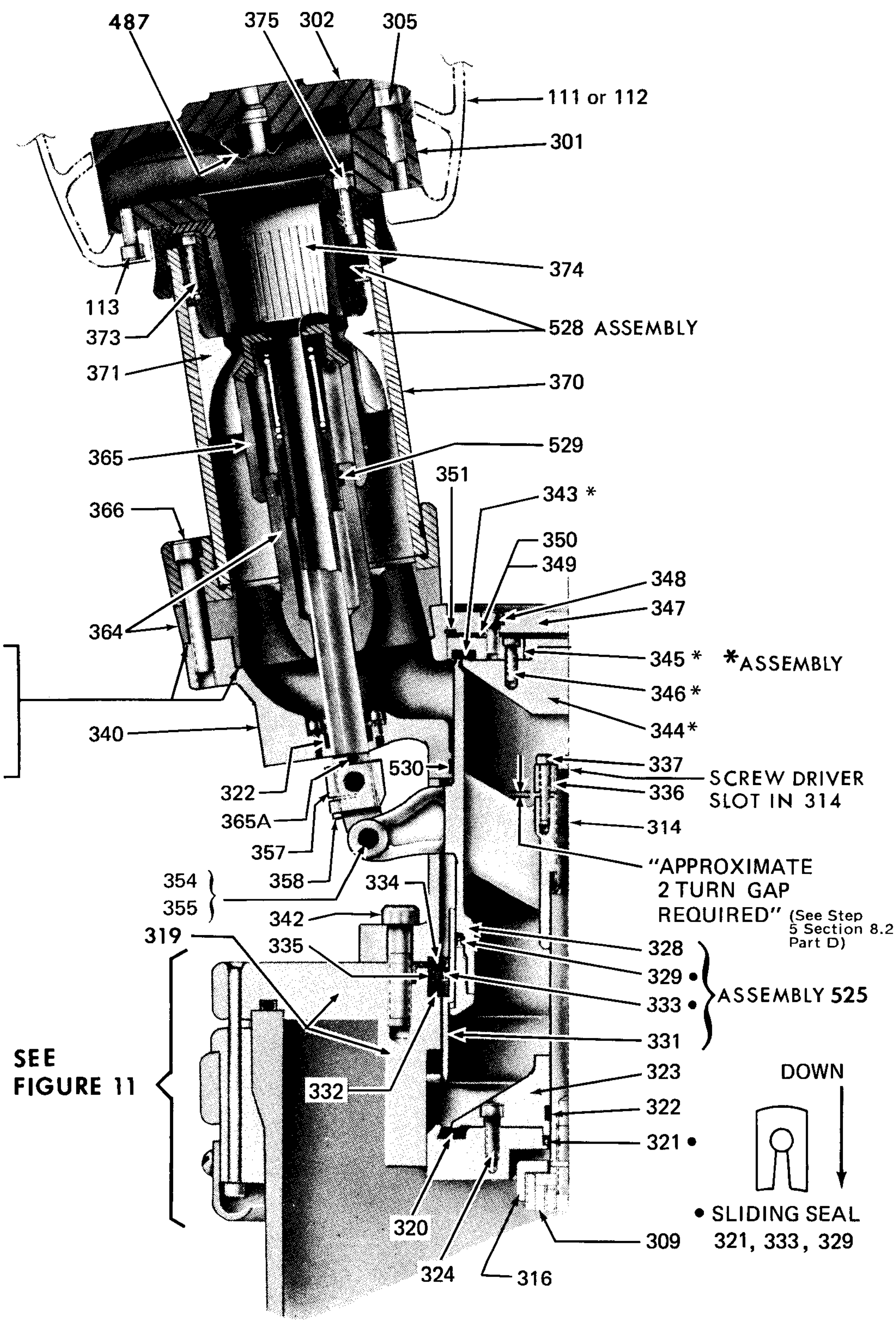


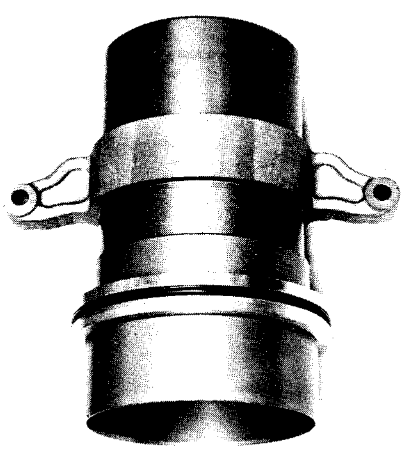
FIGURE 9

INTERRUPTER TUBE ASSEMBLY


BUSHING
FILTER, 479
AIR INSULATED BUSHING
PHEUMATIC OPERAT
41
520
COMPRESSION SPRING
ASSEMBLY
VERTICAL INSULATING ROD
OIL LEVEL
PLUG
INSULATED SUPPORT COLUMN
ORIFICE
SCREWS
ADJUSTABLE
ACCELERATI
SPRINGS
145
YSTEM
TIME TRAVEL
RECORDER
BELI







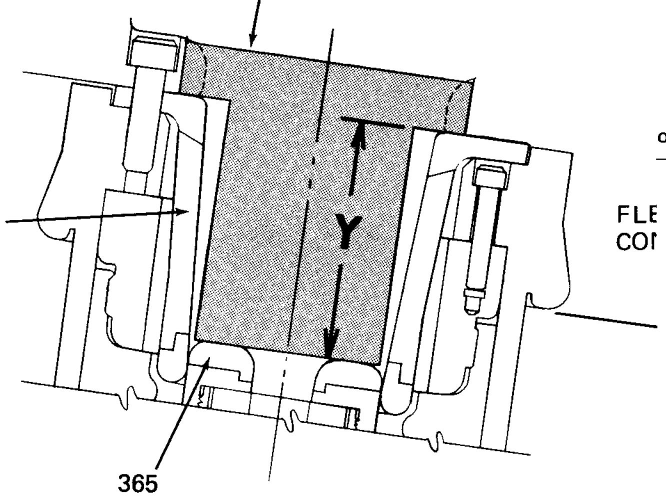
BLAST VALVE ASSEM. 525

527, UPPER BLAST VALVE SEAL KIT

526 LOWER BLAST VALVE SEAL KIT

FIGURE 12
INTERRUPTER CROSS SECTION

ion	Fig.
ote 1	14
ote 6	14
ote 6	14
	14
	13
	13
	13
	13
ote 5*	13



SECTION R-R

GENERAL NOTES:

Never reset dimension P without readjusting T, U, and V; dimension T without readjusting U and V.

*These dimensions shall be set and checked by hydraulic jack operation only.

SPECIFIC NOTES

1. Measure clearance after linkage and blast valves are adjusted. B dimension adjusted with shims (240).

*2. Set linkage to dimension T=3-1/32" *with the upper valve seal assembly removed;* Check. *Dimension T to chart the upper valve seal installed.

*3. Use TUV gauge; set valve in open seal position.

*4. Use TUV gauge; set upper value seat in closed seal position.

*5. a. With valve housing turned to expose contacts, and upper valve seal assembly in place, use hole 365A to turn contact (See Fig. 12).

b. To increase dimension Y, open pole, turn contact rod 365 downward, close pole with jack, then adjust per a. above (See Fig. 12).

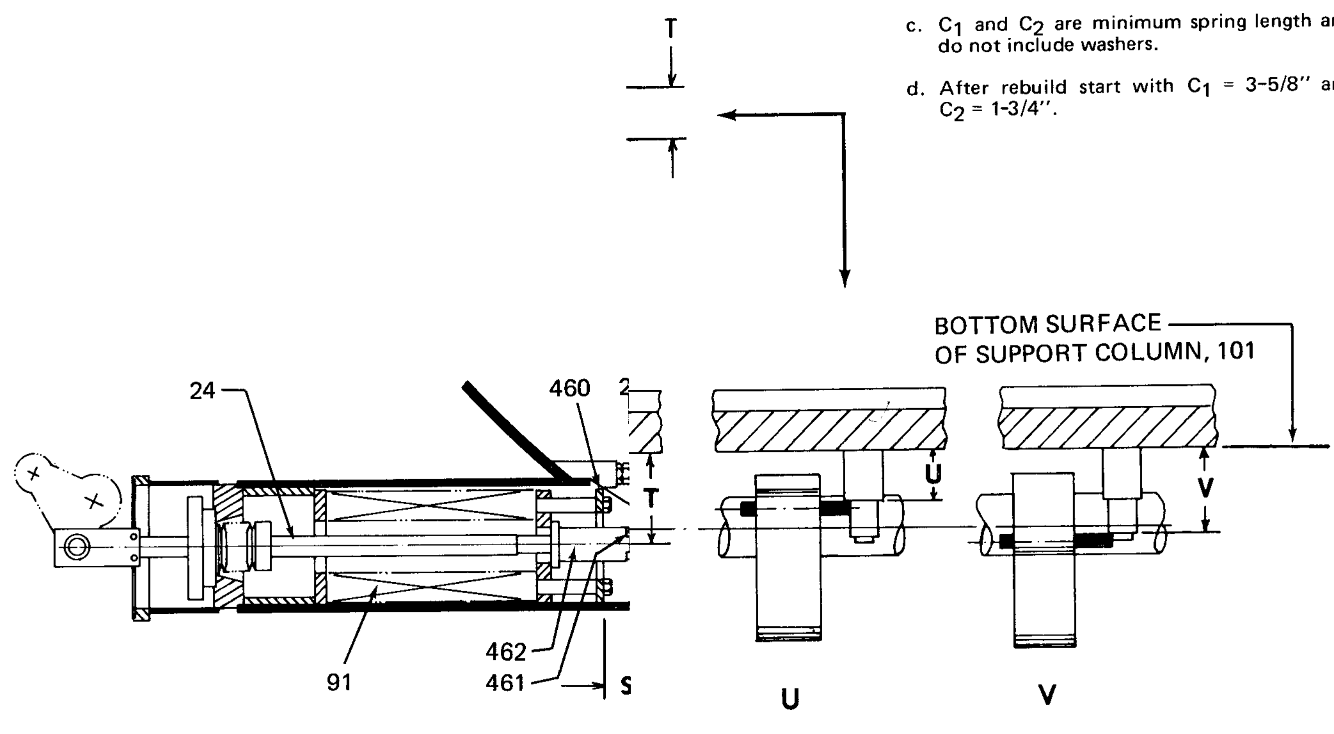
6. Adjust opening speed as required with dimensions C_1 and C_2 as follows. (See Fig. 4).

a. Fine speed adjustment is accomplished by tightening nut (601) which compresses springs (604) only. Dimension C_1 effected.

b. Opening time adjustment is accomplished by turning out (600) which compresses springs (603 and 604) by movement of plate (602). Dimensions C_1 and C_2 effected.

c. C_1 and C_2 are minimum spring length and do not include washers.

d. After rebuild start with C_1 = 3-5/8" and C_2 = 1-3/4".



DETAIL T-U-V

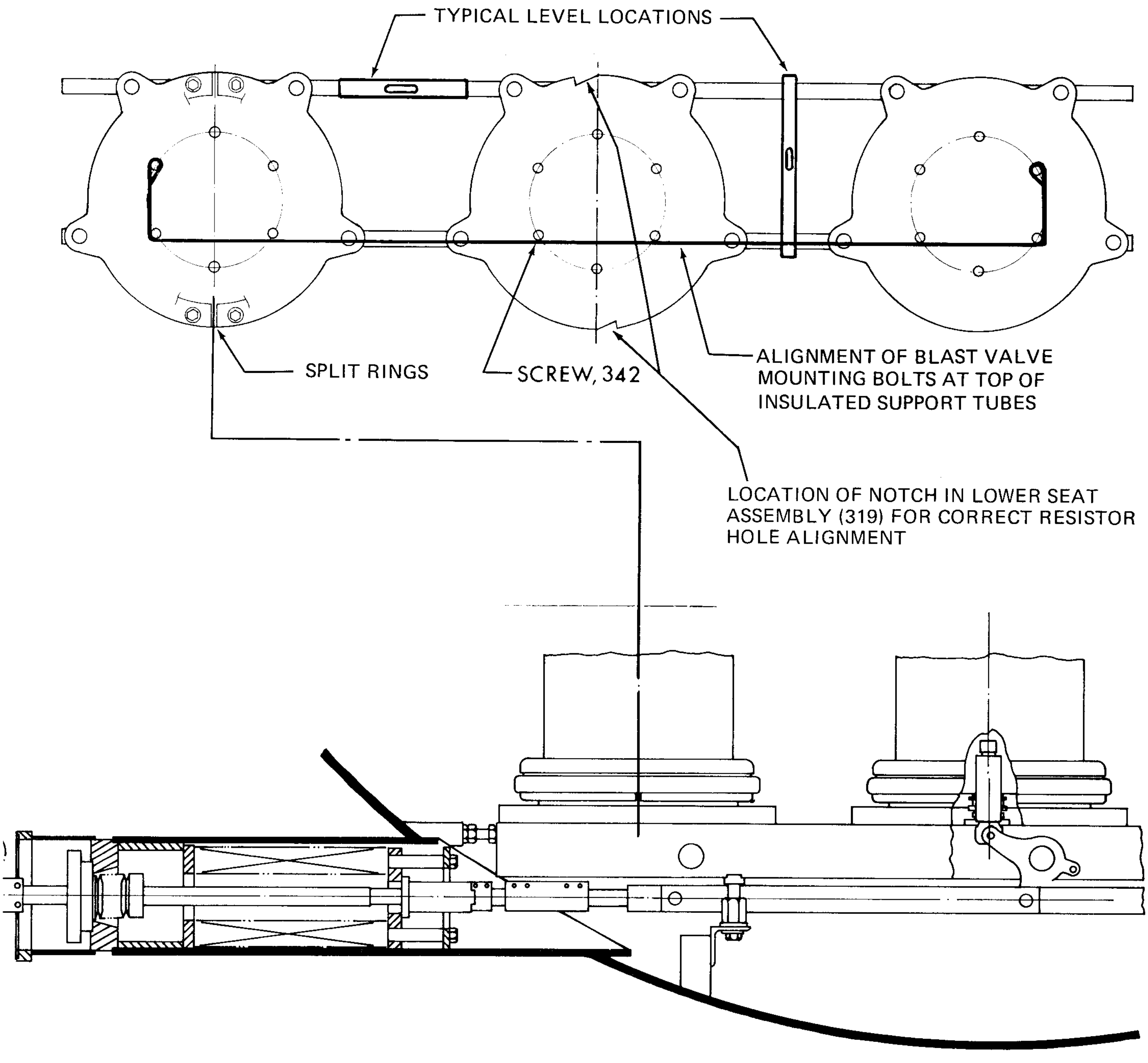
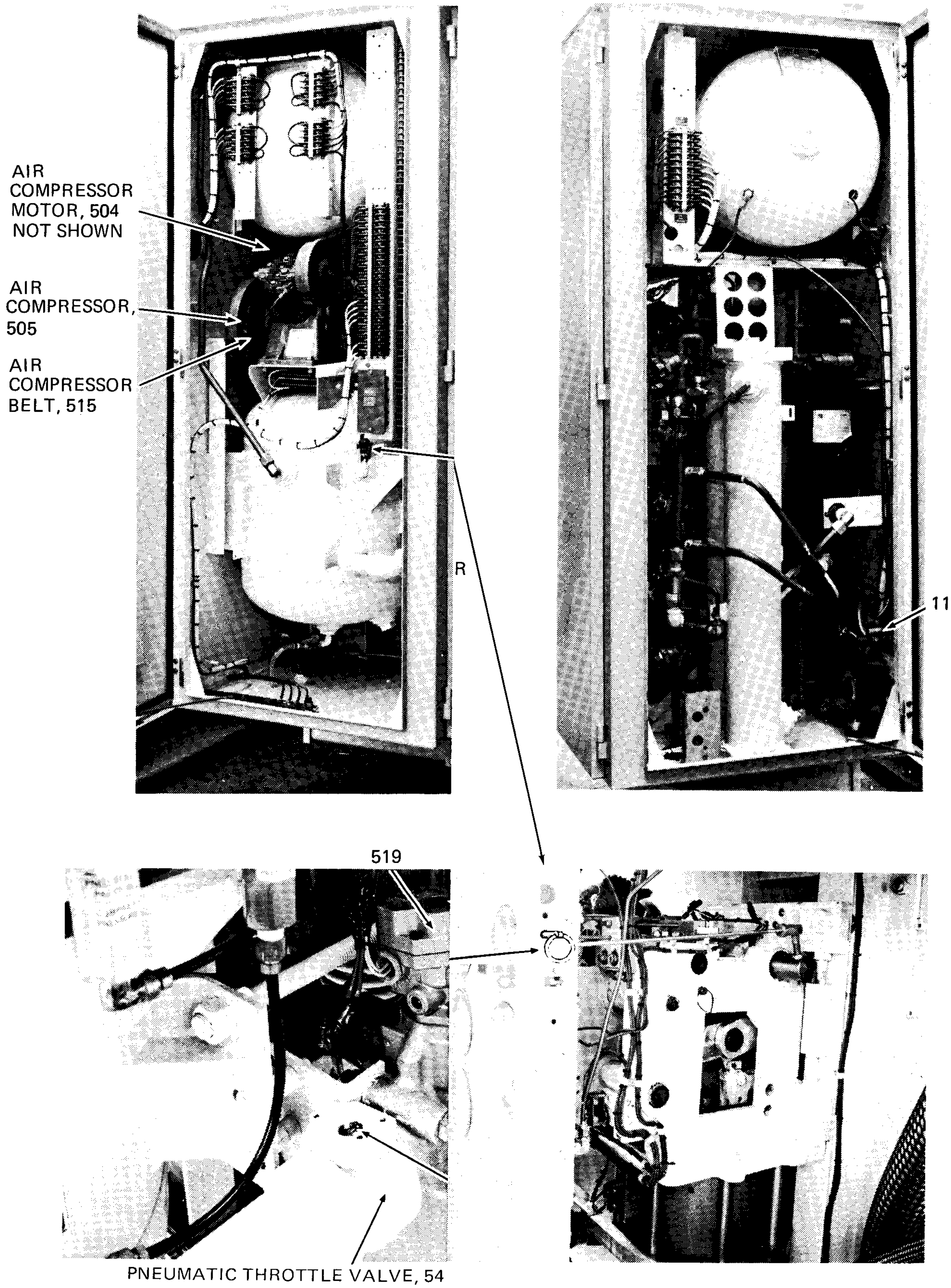


FIGURE 15

MOUNTING INSULATED SUPPORT COLUMN


AIR COMPRESSOR MOTOR, 504 NOT SHOWN
AIR COMPRESSOR, 505
AIR COMPRESSOR BELT, 515
11
519
PNEUMATIC THROTTLE VALVE, 54

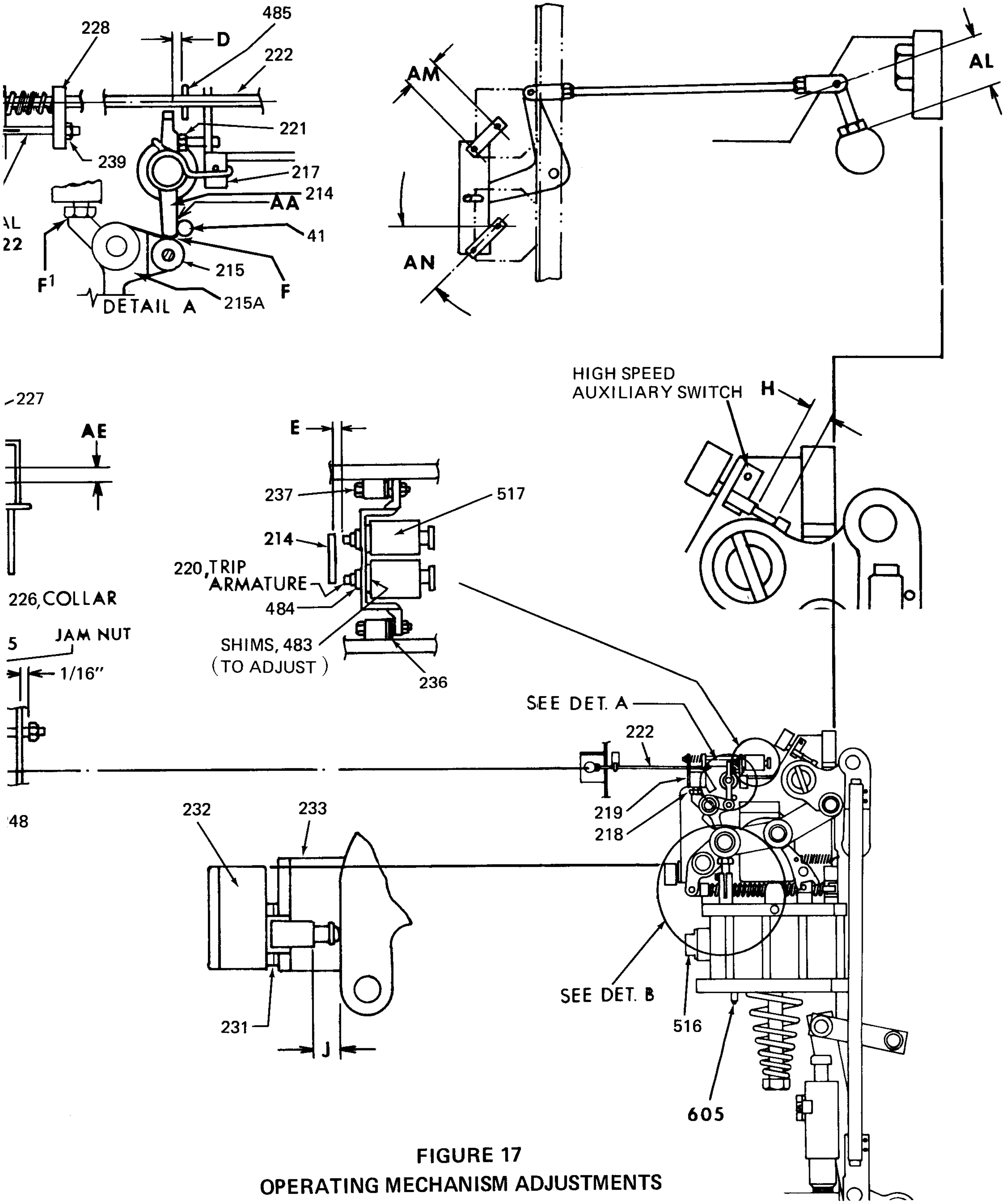
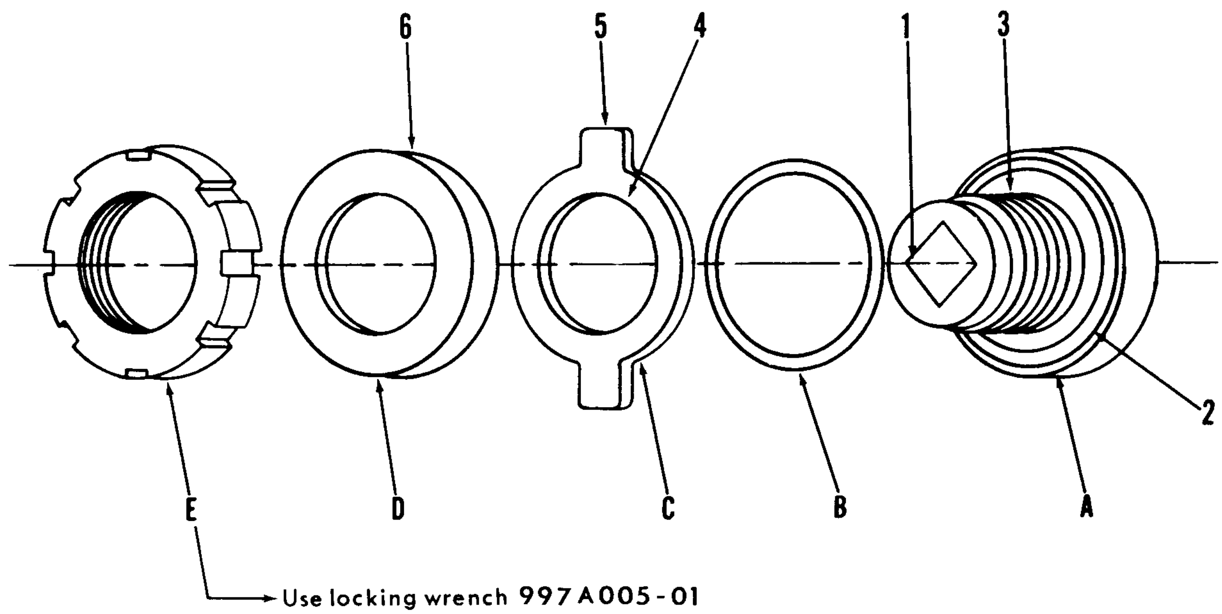


FIGURE 17
OPERATING MECHANISM ADJUSTMENTS



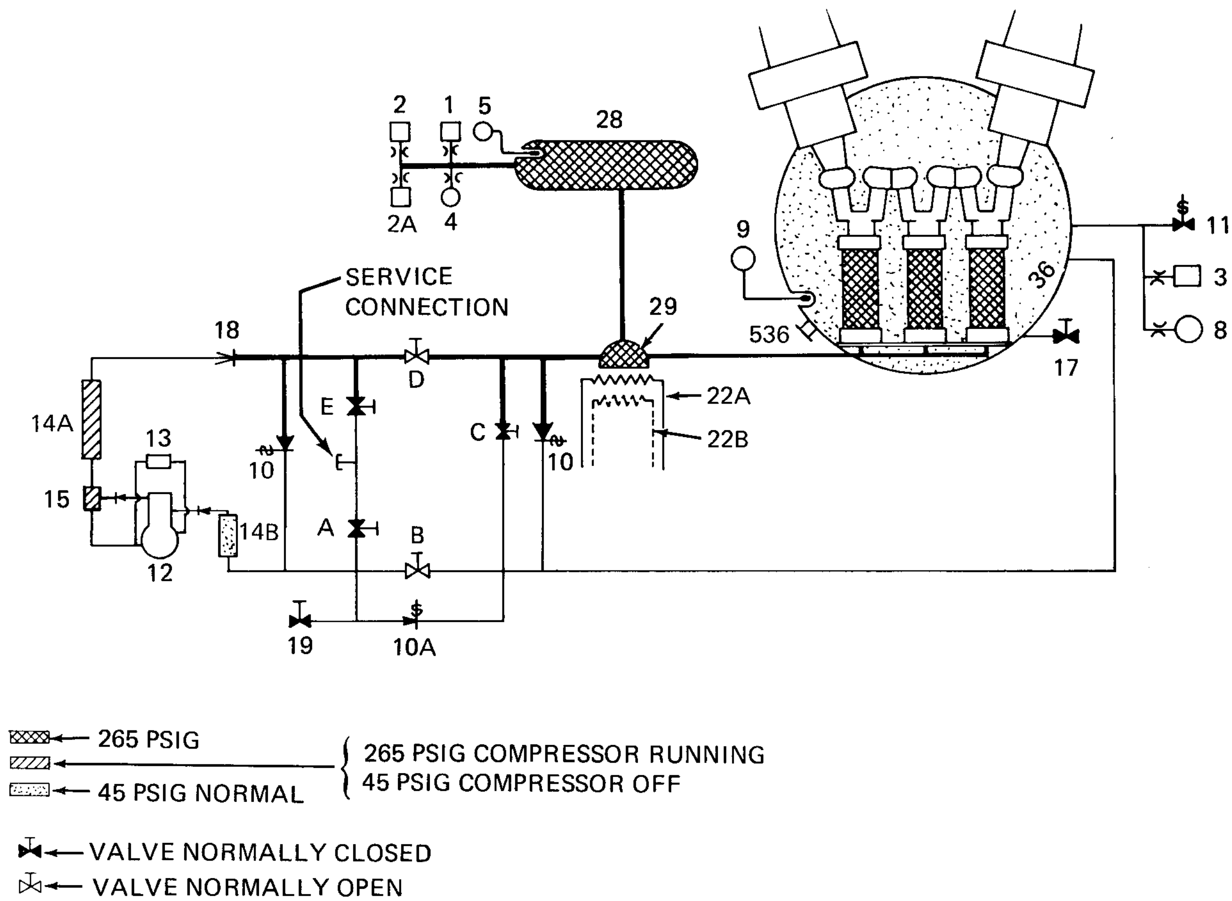
The Contact Base (A) has a square hole (1) through the center which fits the operating shaft of the switch; a groove (2) on the inside face to receive "O" Ring (B); and a threaded shank (3) for mounting and locking the other components.

Contact (C) is mounted on the shank and pressed against the "O" Ring. The Pressure Washer (D) is next mounted. The flange (6) of the Pressure Washer protects surface (4) on the contact from an arc being drawn from point (5) when the switch is rotated under heavy current load.

The Locking Ring (E) is mounted last and is tightened to exert lateral pressure on the components, locking them into position, to provide non-slip action. Slots are provided on the Locking Ring for ease of locking and unlocking the entire assembly. This allows the points on the Contact to be freely adjusted through 360° to fit any electrical requirements relative to contact make or break positions.

FIGURE 18

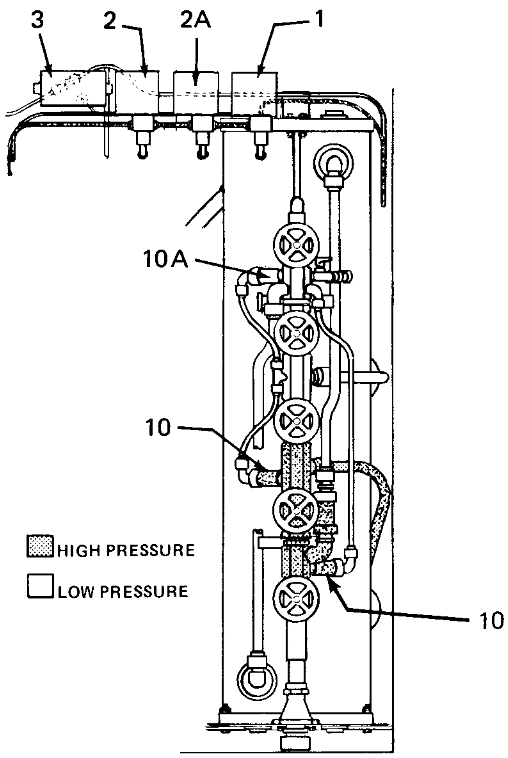
**INSTRUCTIONS FOR
CONTACT ASSEMBLY OF
ADJUSTABLE AUXILIARY SWITCH**

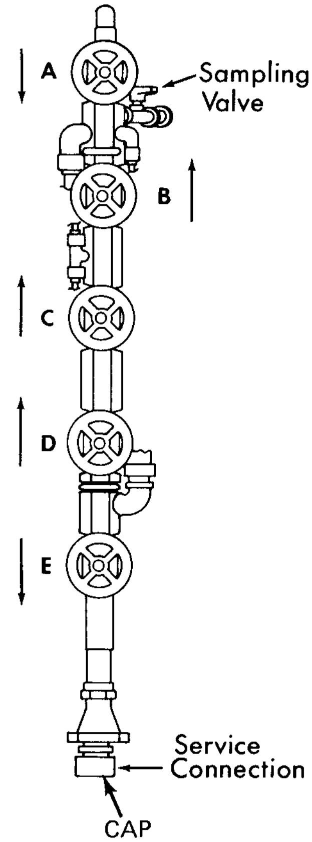


ITEM	DESCRIPTION
1	Govern Switch
2	High Pressure System - Low Pressure Lockout Switch
2A	High Pressure System - Low Pressure Alarm Switch
3	Low Pressure System - Low Pressure Alarm - Low Pressure Lockout Temp. Compensated Switch
4	High Pressure System - Pressure Gauge
5	High Pressure System - Temp. Gauge
8	Low Pressure System - Pressure Gauge
9	Low Pressure System - Temp. Gauge
10	Relief Valves - HP System
10A	Relief Valves - LP System
11	Safety Valve
12	Gas Compressor
13	Oil Pressure Safety Control
14A	Filter & Dryer
14B	Filter & Dryer
15	Oil Separator
17	Vacuum Valve
18	Check Valve
19	Sampling Valve
28	High Pressure Tank
29	Vaporizing Chamber
22A	Primary Heaters
22B	Secondary, Heaters
536	Rupture Disc
A-E	Valves

FIGURE 19

GAS CONTROL SYSTEM





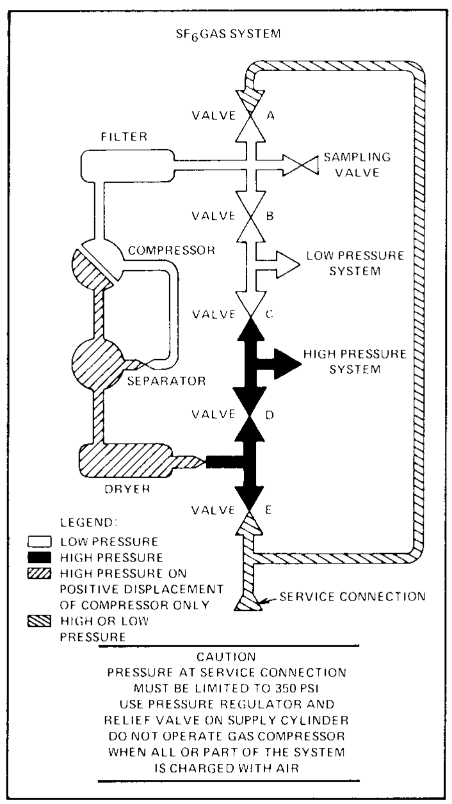


FIGURE 20

MIMIC DIAGRAM AND GAS MANIFOLD

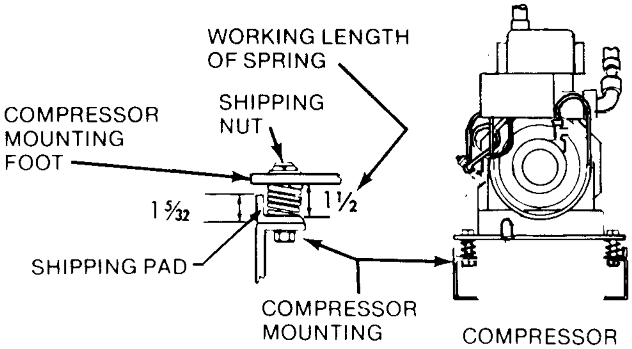


FIGURE 21
GAS COMPRESSOR MOUNTING

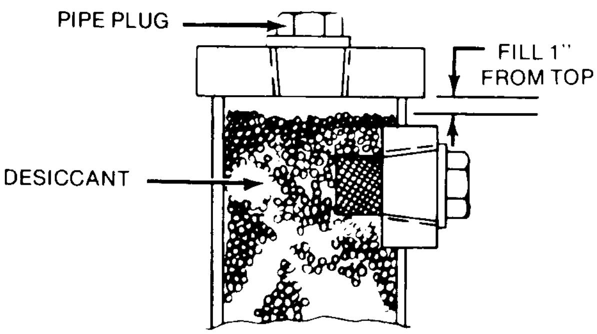


FIGURE 24
FILLING FILTER-DRYERS

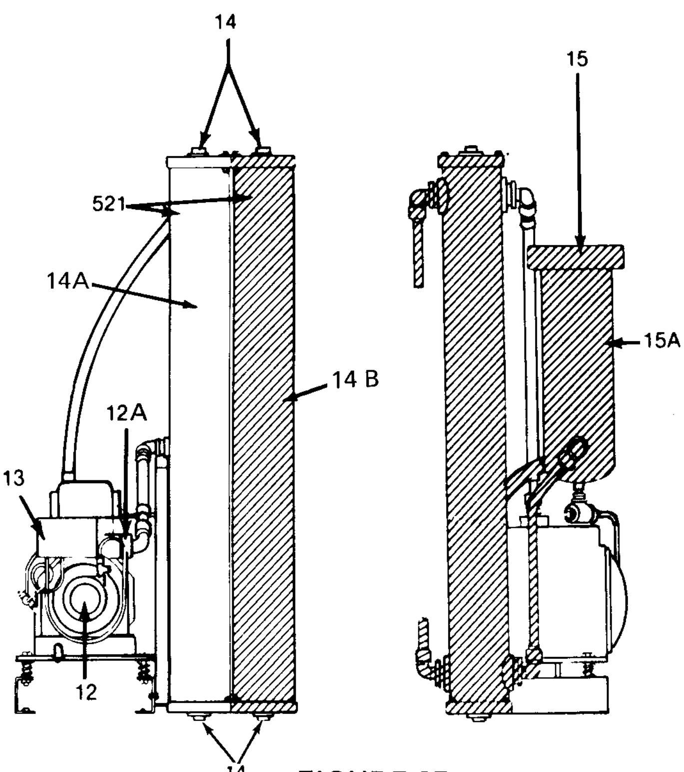


FIGURE 25
COMPRESSOR, FILTER - DRIER UNITS
AND OIL SEPARATOR

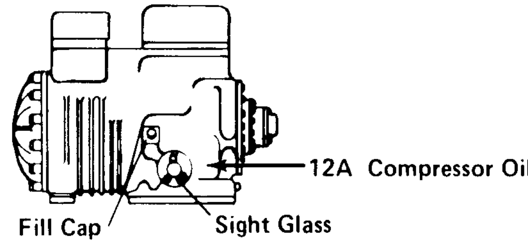


FIGURE 22
GAS COMPRESSOR

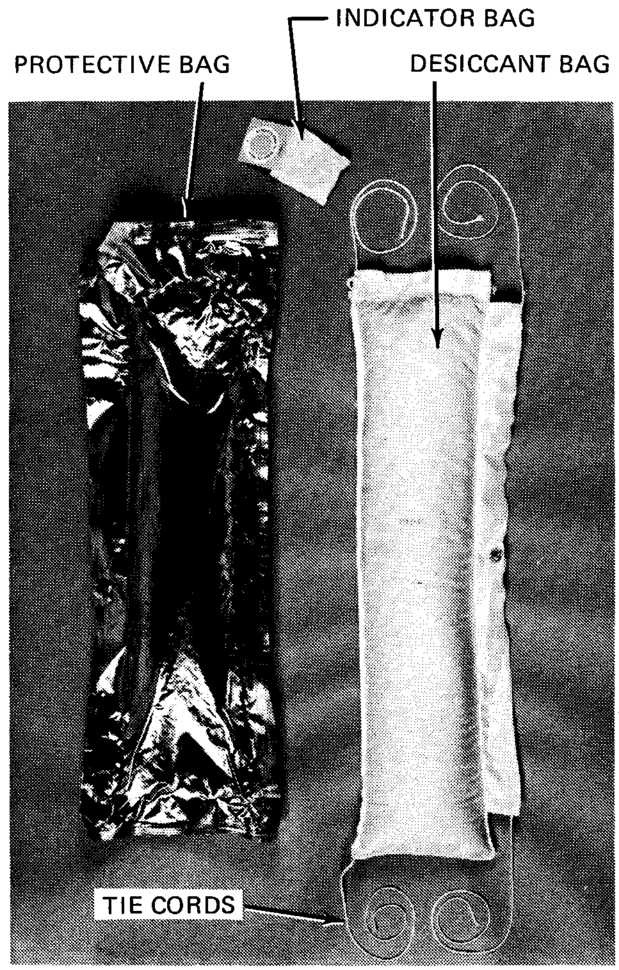


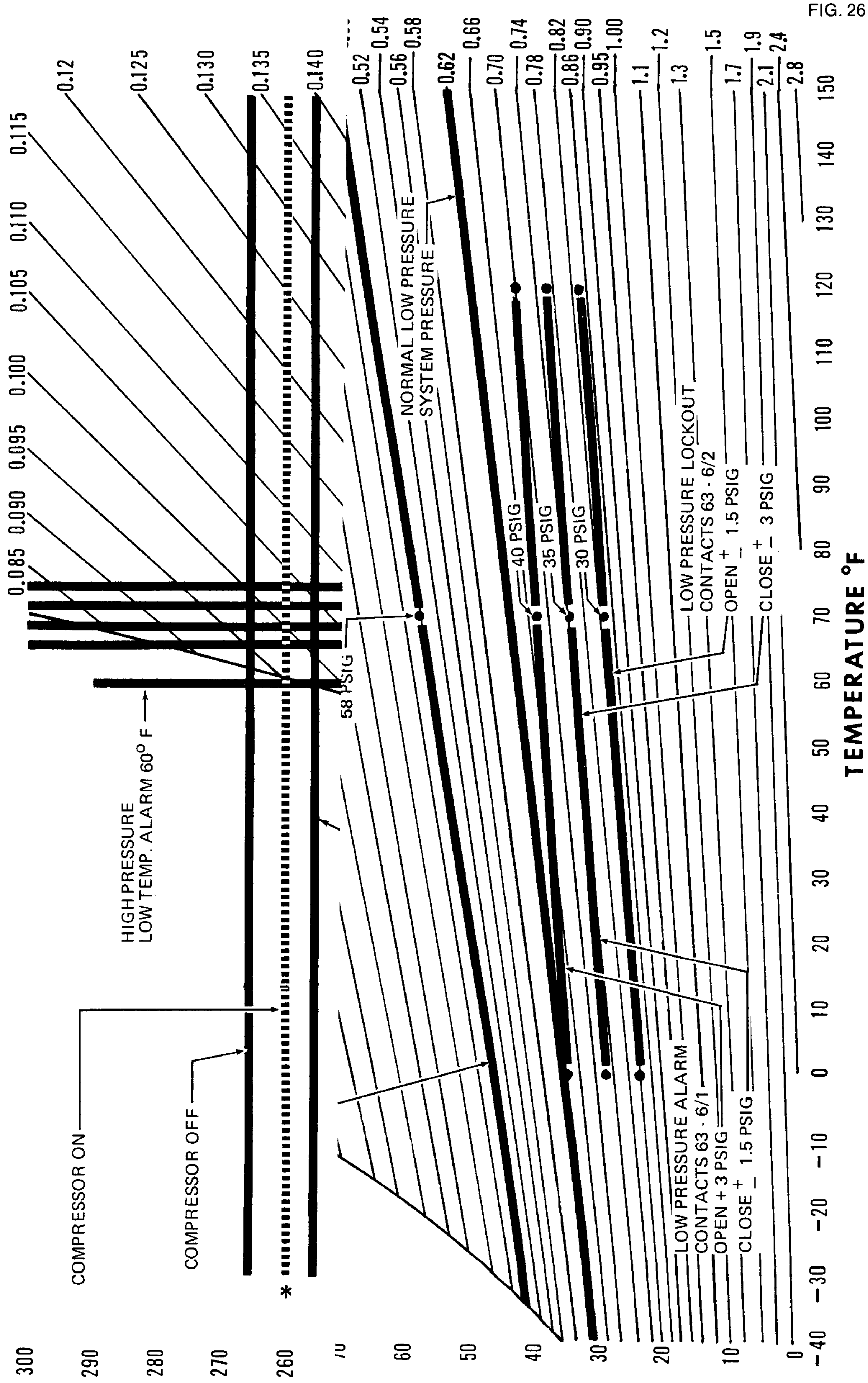
FIGURE 23
DESICCANT BAG

12 - GAS COMPRESSOR
13 - OIL PRESSURE SAFETY CONTROL
14A & 14B - FILTERS AND DRYERS
15 - OIL SEPARATOR
15A - OIL SEPARATOR SEAL KIT

LOW PRESSURE

HIGH PRESSURE ON POSITIVE DIS-
PLACEMENT OF COMPRESSOR ONLY

IB—9.8.3.7-17
FIG. 26



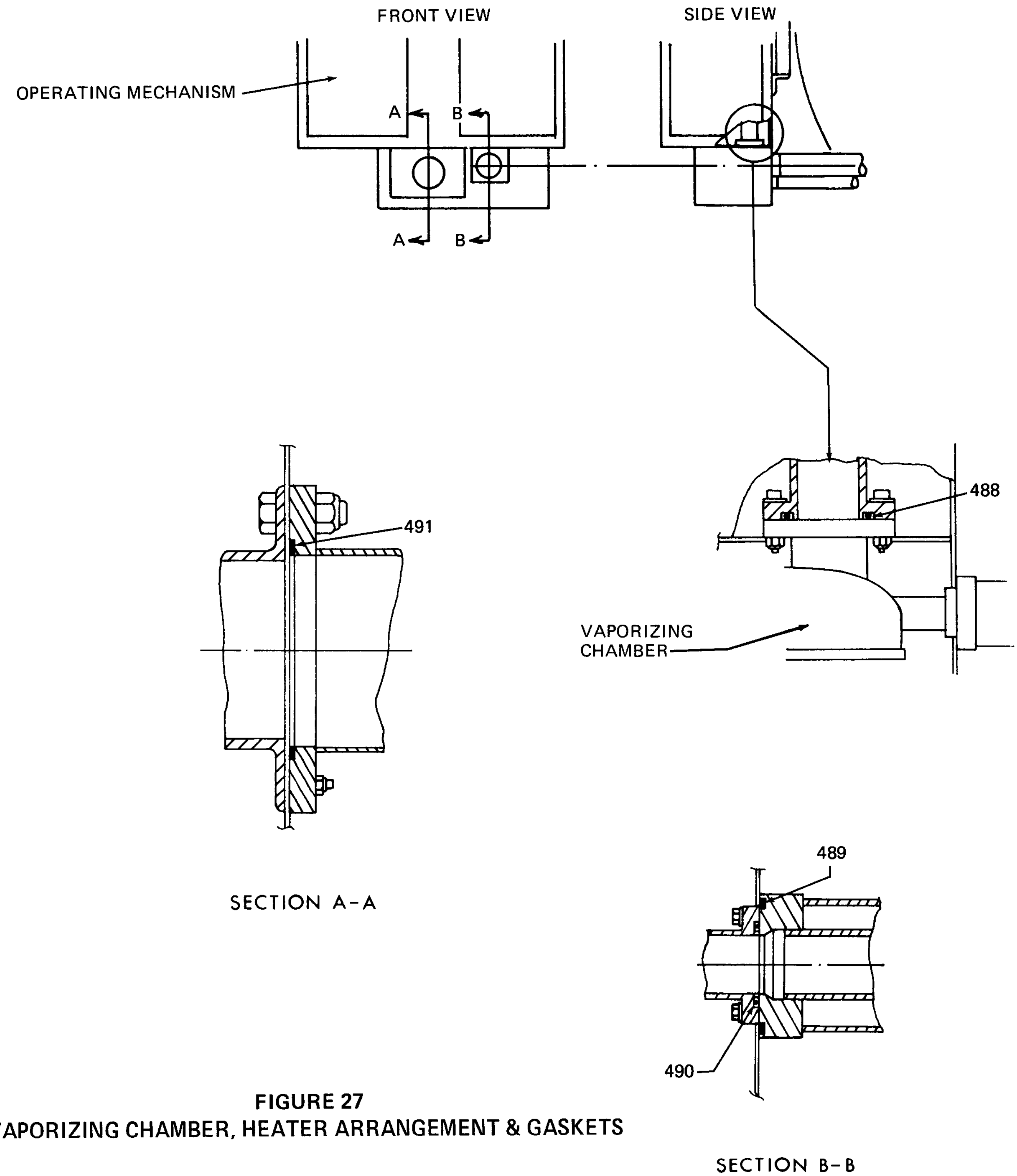
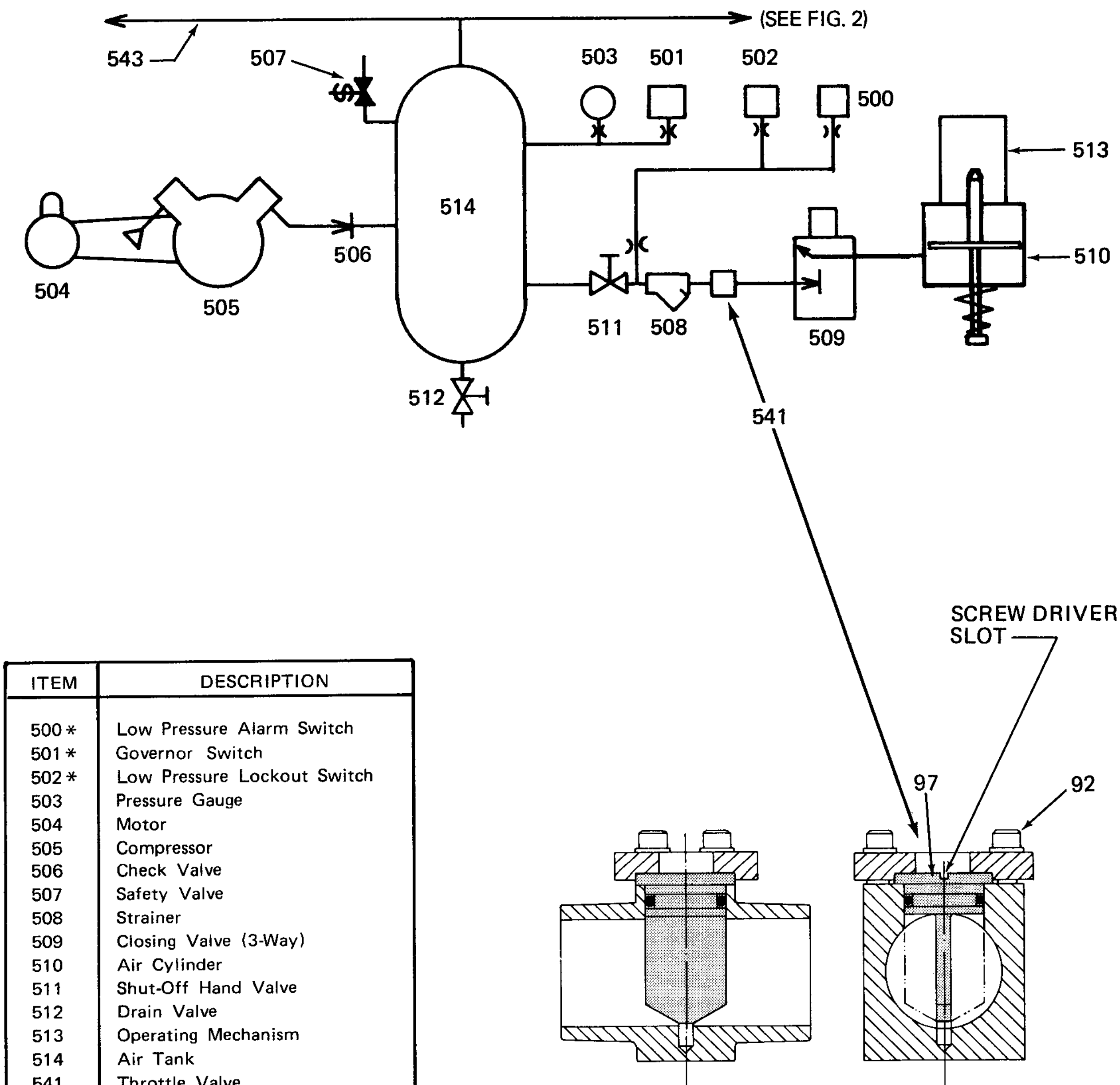


FIGURE 27
/APORIZING CHAMBER, HEATER ARRANGEMENT & GASKETS



ITEM	DESCRIPTION
500*	Low Pressure Alarm Switch
501*	Governor Switch
502*	Low Pressure Lockout Switch
503	Pressure Gauge
504	Motor
505	Compressor
506	Check Valve
507	Safety Valve
508	Strainer
509	Closing Valve (3-Way)
510	Air Cylinder
511	Shut-Off Hand Valve
512	Drain Valve
513	Operating Mechanism
514	Air Tank
541	Throttle Valve
543	Interphase Storage Pipe

*on pole #1 only

FIGURE 28
PNEUMATIC OPERATING SYSTEM
(EACH POLE)

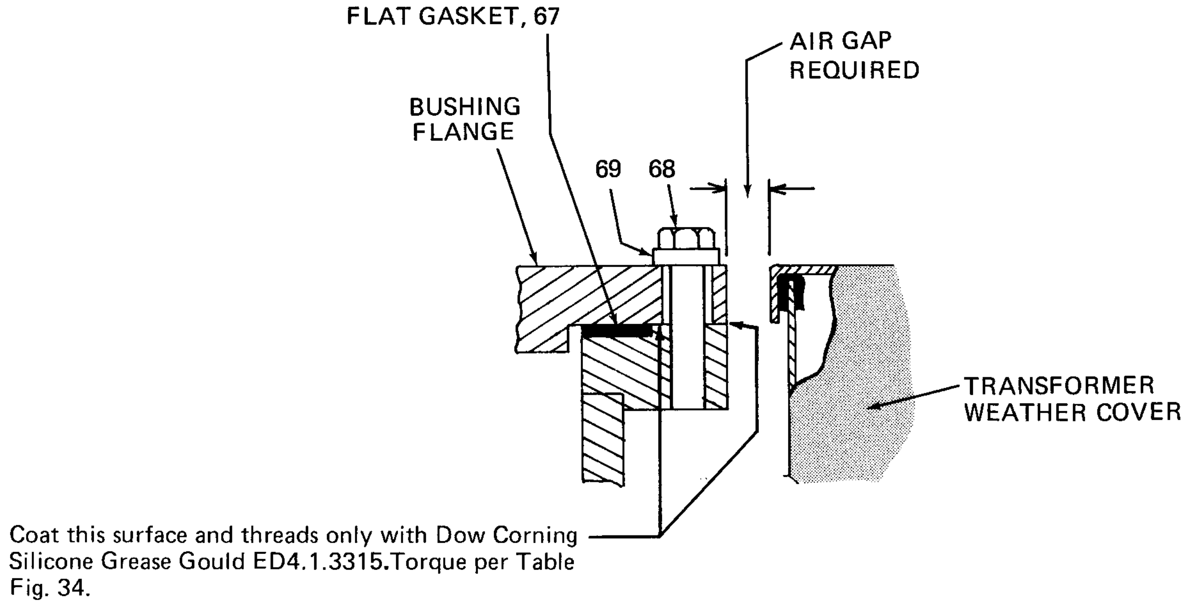


FIGURE 29
BUSHING INSTALLATION

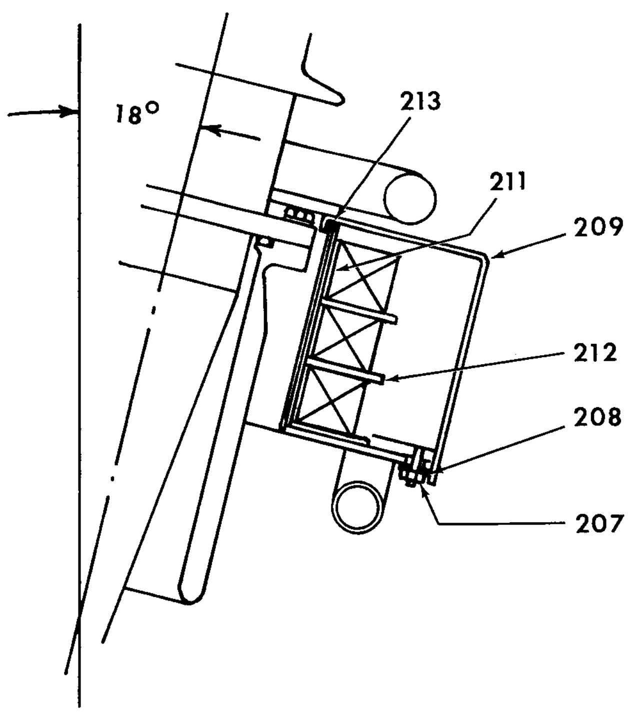
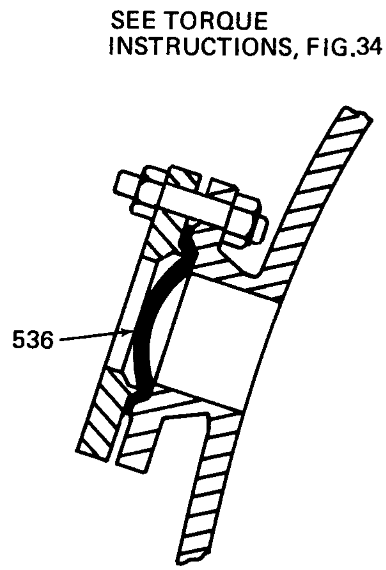


FIGURE 30
CURRENT TRANSFORMERS AND LINEAR COUPLERS



1. Foreign matter or rough surfaces may damage rupture disk or cause leakage. Clean seating surfaces of both inlet and outlet fittings before installing rupture disk. Polish with a fine emery cloth. DO NOT MACHINE WITHOUT CONSULTING FACTORY.

2. Handle rupture disk carefully. – Examine seating and pre-bulged surfaces. DO NOT INSTALL A DAMAGED DISK! Damage to seating area may cause leakage. Damage to pre-bulged surface of disk may affect disk rating. Vacuum support, is permenently attached to concave side of disk.

3. Place rupture disk on inlet fitting with crown out. SYSTEM PRESSURE MUST BE AGAINST CONCAVE SIDE OF DISK.

4. Install studs and nuts. Torque nuts evenly. Consult Maximum Torque table on Fig. 34 when installing rupture disks with plastic seals. Make sure flanges are not "cocked". Use feeler gauge if necessary to assure even spacing all around. DO NOT OVERTIGHTEN. Angular seating surfaces help seal disc with minimum bolt loading. Excessive tightening may damage rupture disk.

FIGURE 31

RUPTURE DISC

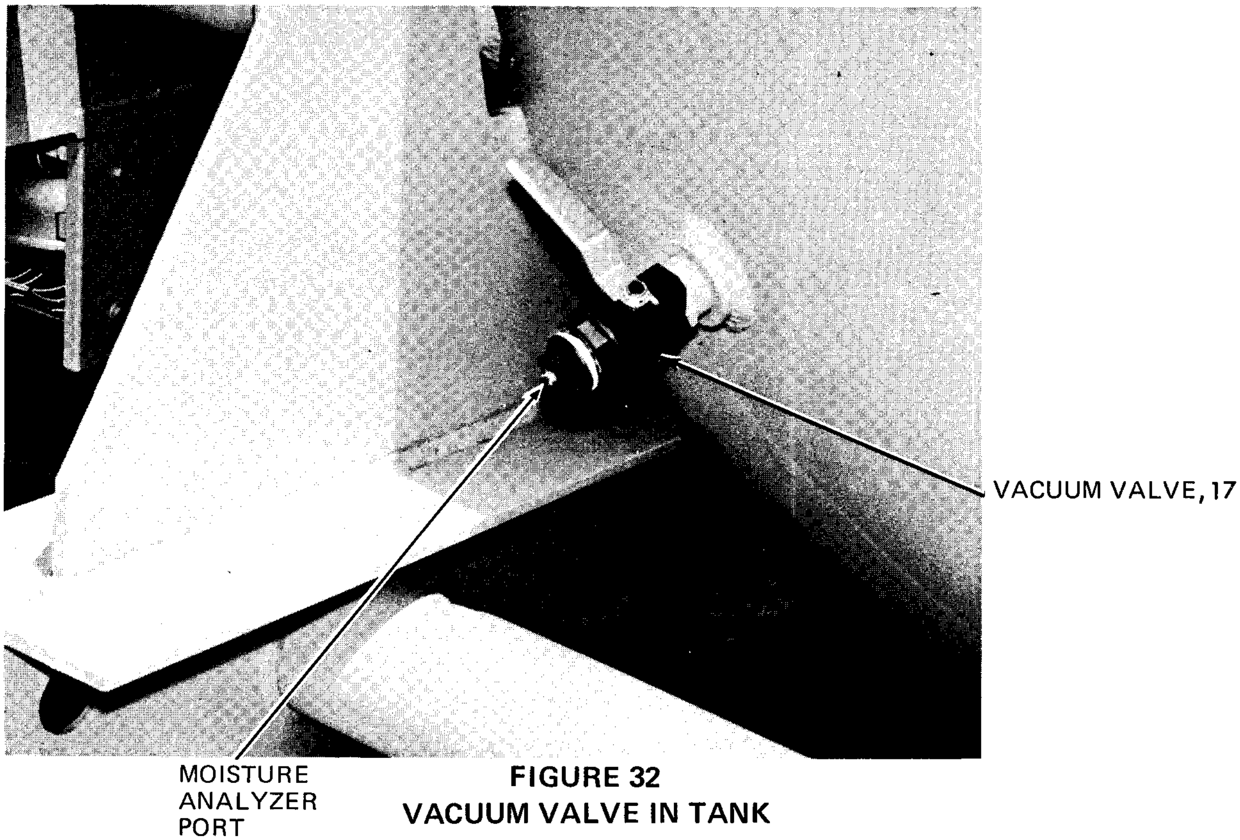


FIGURE 32
VACUUM VALVE IN TANK

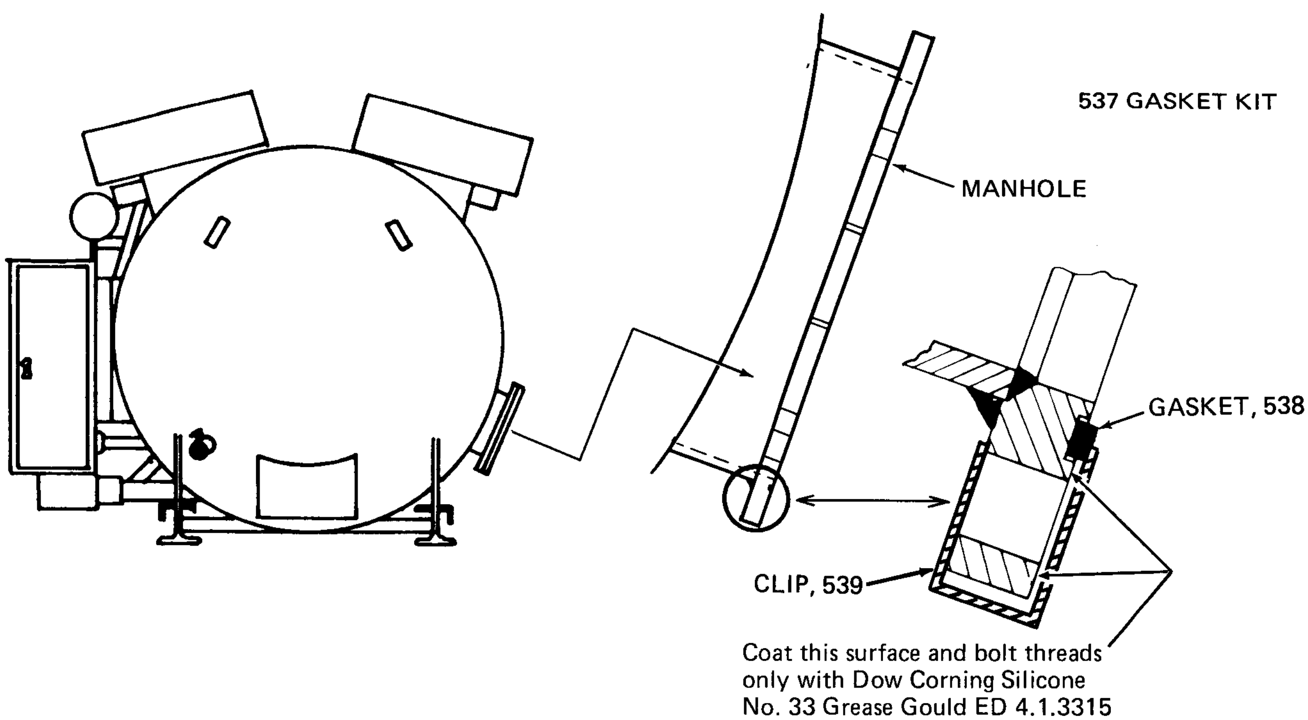


FIGURE 33
MANHOLE GASKET INSTALLATION

TORQUE VALUES FOR KEY BOLTS AND SCREWS

FT-LBS	BOLT SIZE	DESCRIPTION
300 Min.	1-8" UNC	Bolts for manhole cover, Fig. 2
250 to 265	7/8" - 9 UNC	Bushing mounting bolts (68) Fig. 29
80 to 120	5/8" - 11 UNC	Screws (342 for blast valve housing, Fig. 12)
55 to 80	5/8" UNC	Bushing Jumper bolts (93), Fig. 13
55 to 75	1/2" UNC	Screws (366), (305), Fig. 12 and (93), Fig. 13
55 to 75	1/2" UNC	Screws (470) for support tube, Fig. 11
15 to 20	1/2" UNC	For rupture disc, Fig. 31
30 to 35	3/8" UNC	Lock screw for insulated rod (78) Fig. 11 Lock screws for pull rods, rod ends and turn buckles, Fig. 10
10 to 15	3/8" UNC	Bushing jumper bolts (82), Fig. 13

All screws that are used without external locking means will be locked with Loctite Grade 242 (color blue). The screw will be considered lubricated when Loctite 242 (it. no. Gould Ed 4.1.3034.2) is applied to the screw threads. Best results are obtained when the screws are washed in cleaning solvent, sprayed with Loctite Primer Grade "T" (Gould Ed 4.1.3036) dried, and then the threads coated with Loctite 242 and the bearing surface coated with amber petrolatum (Gould Ed 4.1.3325). Loctite is effective even when used without a primer and over a light film of oil. However,the cure time will be extended and the breakaway Torque somewhat reduced. Each time the screw is reused a new application of Lotite 242 and amber petrolatum will be required.

Note: Loctite materials have a shelf life of about 1 year.

FIGURE 34

TORQUE VALUES, KEY BOLTS, SCREWS
AND LOCKING INFORMATION

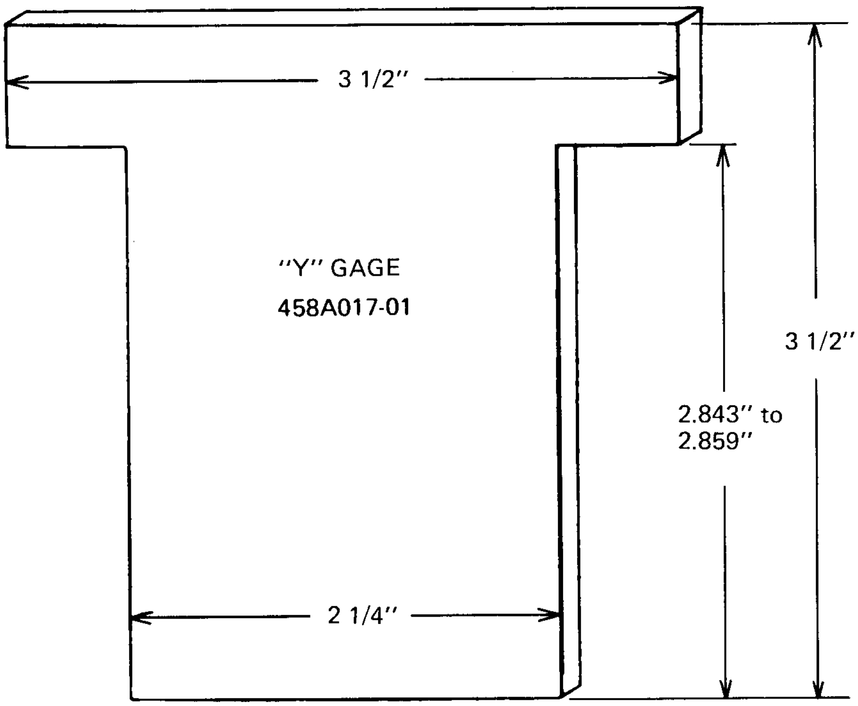
LUBRICATION CODE:

A — Do not lubricate
B — Light coat of machine oil (SAE 10)
C — Light coat of Dow Corning Silicone # 33 grease only Gould ED 4.1.3315
D — Light coat of grease Gould ED 4.1.3321
E — Dow Corning Fluid DC 200 w/viscosity 10 centistokes 25° C, or equivalent Gould ED 4.1.3316
F — Compressor oil Suniso Type 3GS Gould ED 4.1.3314
G — Light coat of Amber Petrolatum Gould ED 4.1.3325
H — Gould # 109A003
J — Gould # 301A003

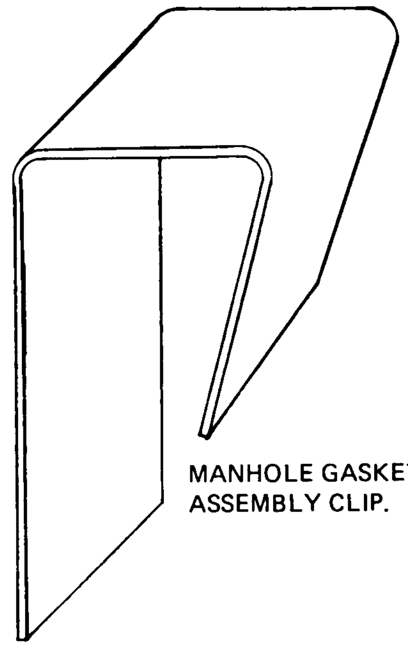
TYPE OF ASSEMBLY OR PART	INITIAL ASSEMBLY LUBRICATION	LUBRICATION AT ANNUAL MAINTENANCE	5-YEAR MAINTENANCE LUBRICATION
Mechanism Parts Solenoids-Relays & Pilot controlled Air Valves	A	A	A
Air Piston Rings & Cylinder Walls	B	B — Inject a few drops into top breather holes.	*B — Inject a few drops into top breather holes
Piston Rods	B	B — Clean exposed surface & apply	*B — Clean exposed surface & apply
Ground Surfaces Latches & Rollers	C	C — Clean exposed surface & apply	C — Clean exposed surface & apply
Sleeve Bearing & Pins	C	A	*A
Roller & Needle Bearings	C	A	*A
Sealed Ball Bearings	A	A	A
Compressors Compressor (Air)	H — Crankcase J — Air Intake	H — Crankcase J — Air Intake	H — Crankcase J — Air Intake
Compressor (Gas)	F — Fill when sight glass indicates low oil level.		
Motors Motor (Air Compressor Bearings)	30 to 70 drops SAE #10 machine oil	30 to 70 drops SAE #10 machine oil	30 to 70 drops SAE #10 machine oil
Motor (Gas Compressor)	A	A	A
Breaker Parts Breaker Linkage & Pins *Outside* Tank	C	A	*A
Breaker Linkage & Pins *Inside* Tank	D	A	D
• *Threaded Joints *Inside* Tanks (Except Screws)	D	A	A
• *Threaded Joints *Outside* Tanks (Except Screws)	C	A	A
Auxiliary Seal (Back up Seal for Bellows) All Sliding Surfaces	C	A	*A
Interrupter Linkage, Pins-Bearings Sliding Surfaces (Including Contacts) Blast Valves	D	A	Any time interrupters are disassembled & cleaned, lubricate per D
Gaskets, Flat	A	A	A
Dashpots	E	Check level E	Check level E
Door Latch and Hinges	A	A	A
O-Rings	G	A	A

Lubrication of caskets promotes leaks; do not lubricate.
*Under extreme conditons of dust or temperature where the life of the lubricant has been shortened, clean and repeat Initial Assembly Lubrication.
• Note for lubrication of screws see Torque Chart.

FIGURE 35
LUBRICATION CHART

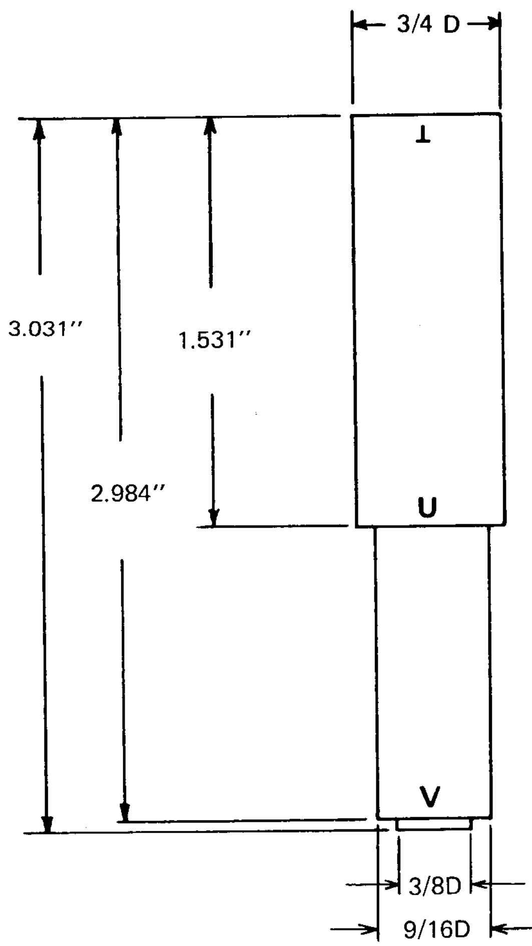


CONTACT PENETRATION
GAUGE

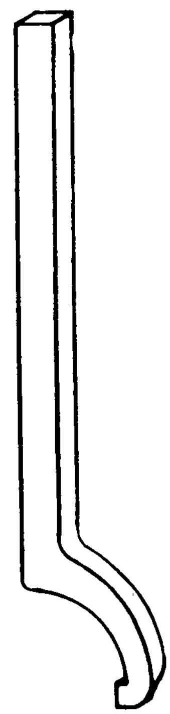


MANHOLE GASKET
ASSEMBLY CLIP.

266A034-01

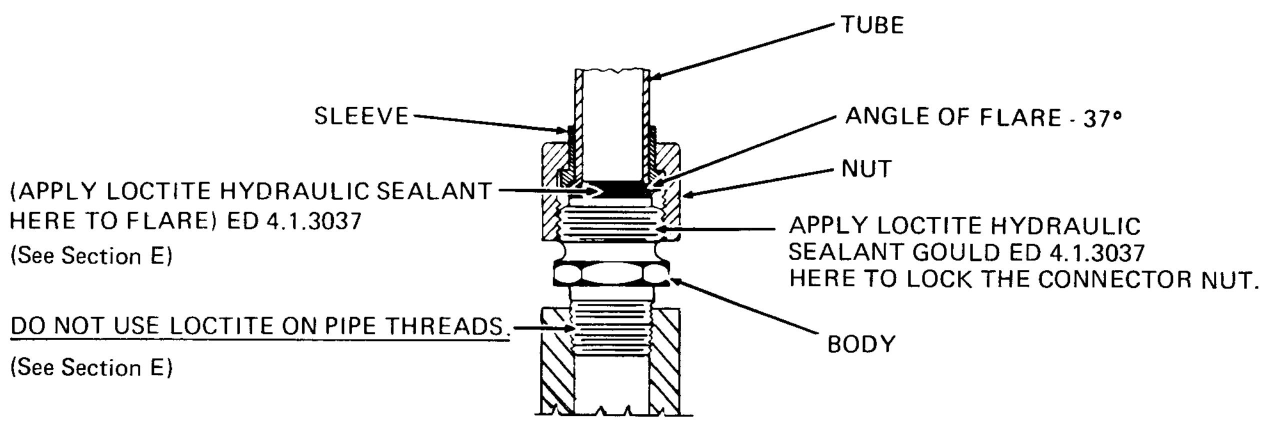


TUV GAUGE
458A058-01



997A005-01
ADJUSTING WRENCH
FOR AUXILIARY SWITCH

FIGURE 36
SPECIAL TOOLS



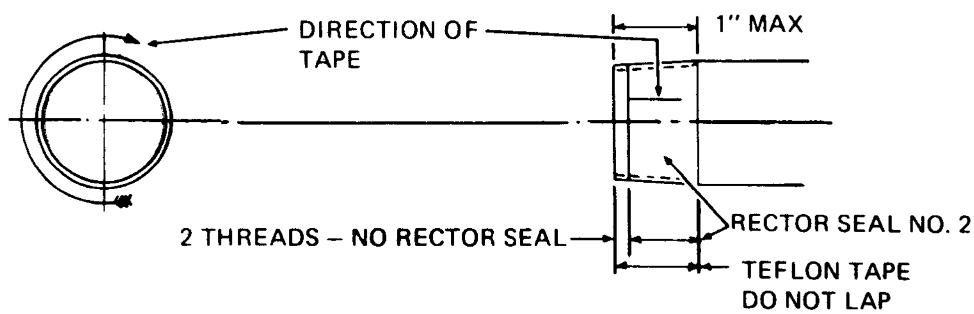
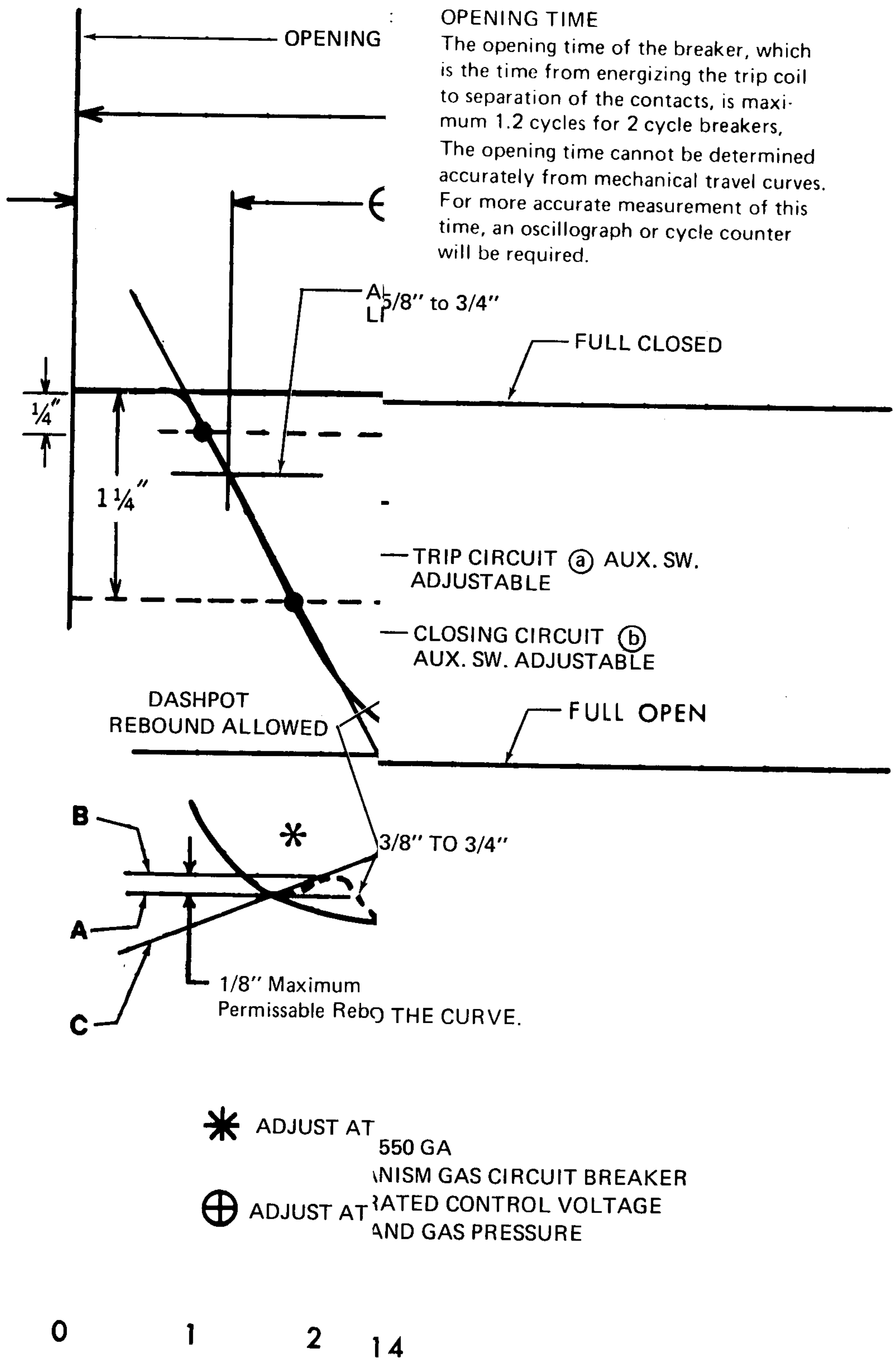
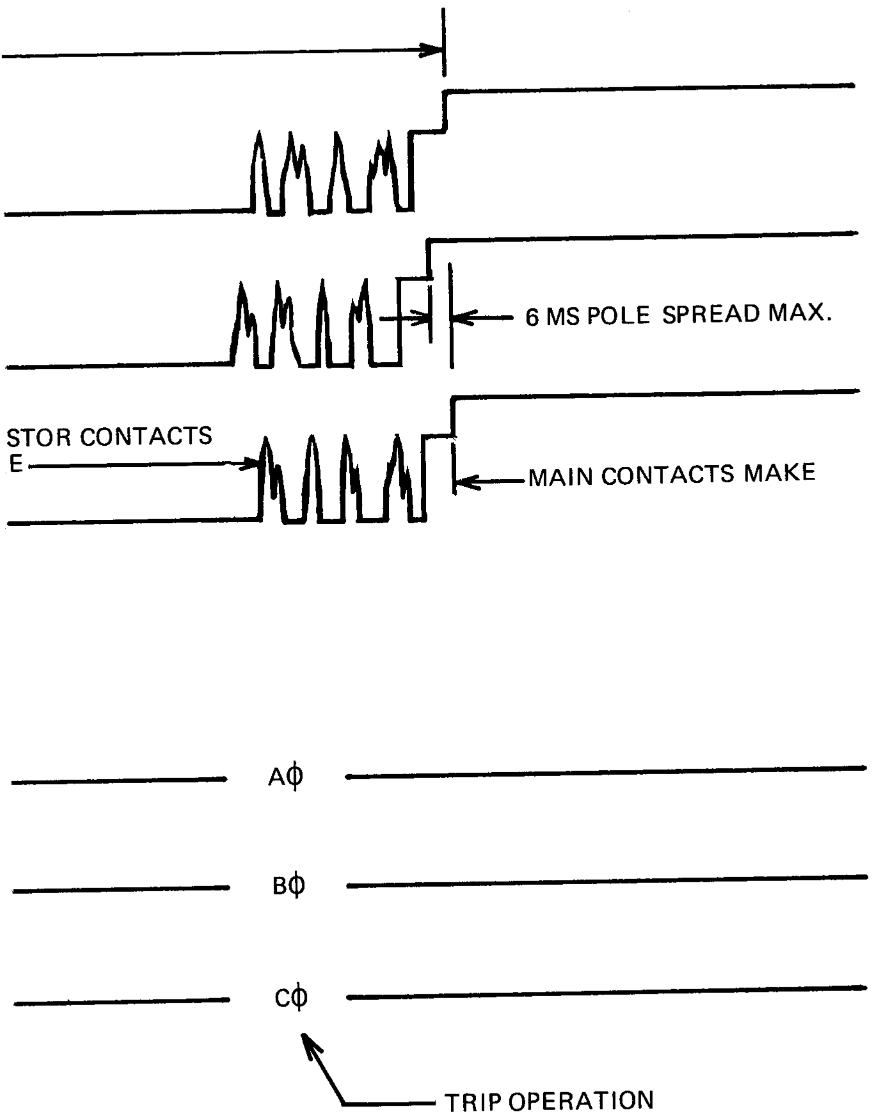


FIGURE 37
HYDRAULIC SEALANT
FOR FLARE FITTINGS AND PIPE THREADS


OPENING
OPENING TIME
The opening time of the breaker, which is the time from energizing the trip coil to separation of the contacts, is maximum 1.2 cycles for 2 cycle breakers.
The opening time cannot be determined accurately from mechanical travel curves. For more accurate measurement of this time, an oscillograph or cycle counter will be required.
5/8" to 3/4"
FULL CLOSED
¼"
1¼"
TRIP CIRCUIT ⓐ AUX. SW. ADJUSTABLE
CLOSING CIRCUIT ⓑ AUX. SW. ADJUSTABLE
DASHPOT REBOUND ALLOWED
FULL OPEN
B
*
3/8" TO 3/4"
A
C
1/8" Maximum Permissable Rebo
THE CURVE.
✱ ADJUST AT
⊕ ADJUST AT
550 GA
NISM GAS CIRCUIT BREAKER
RATED CONTROL VOLTAGE
AND GAS PRESSURE
0
1
2
14



RE 39
TRACE, SAMPLE

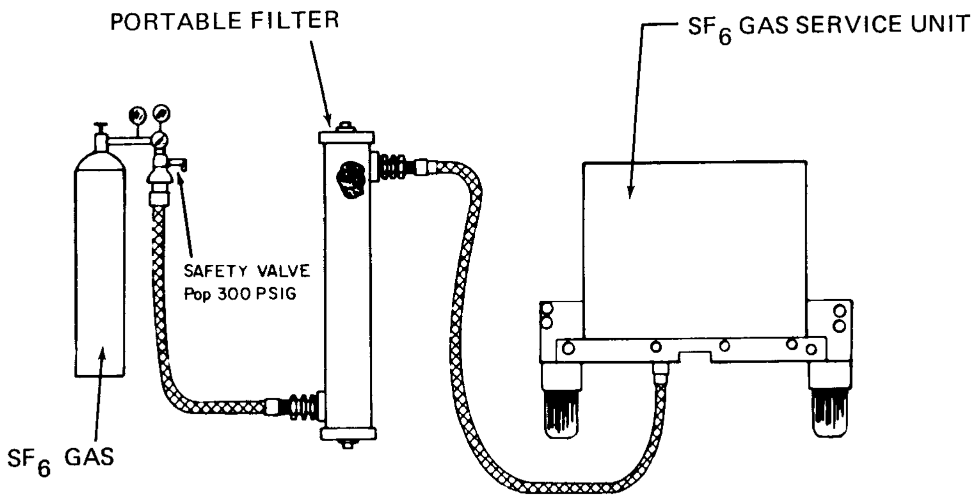


FIGURE 40
HOSE TO PORTABLE FILTER
TO SF_6 SERVICE UNIT

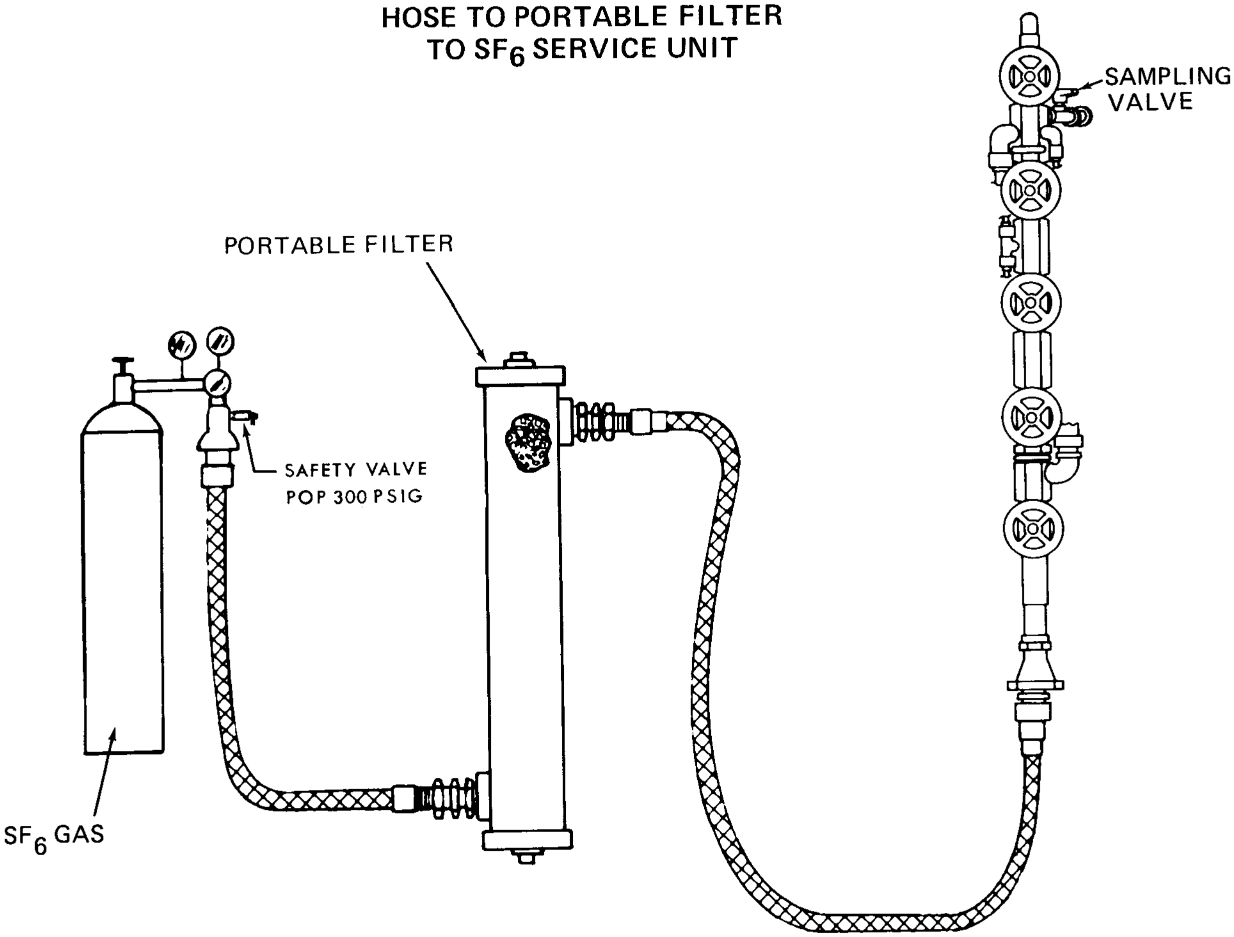


FIGURE 41
HOSE TO PORTABLE FILTER
TO BREAKER POLE

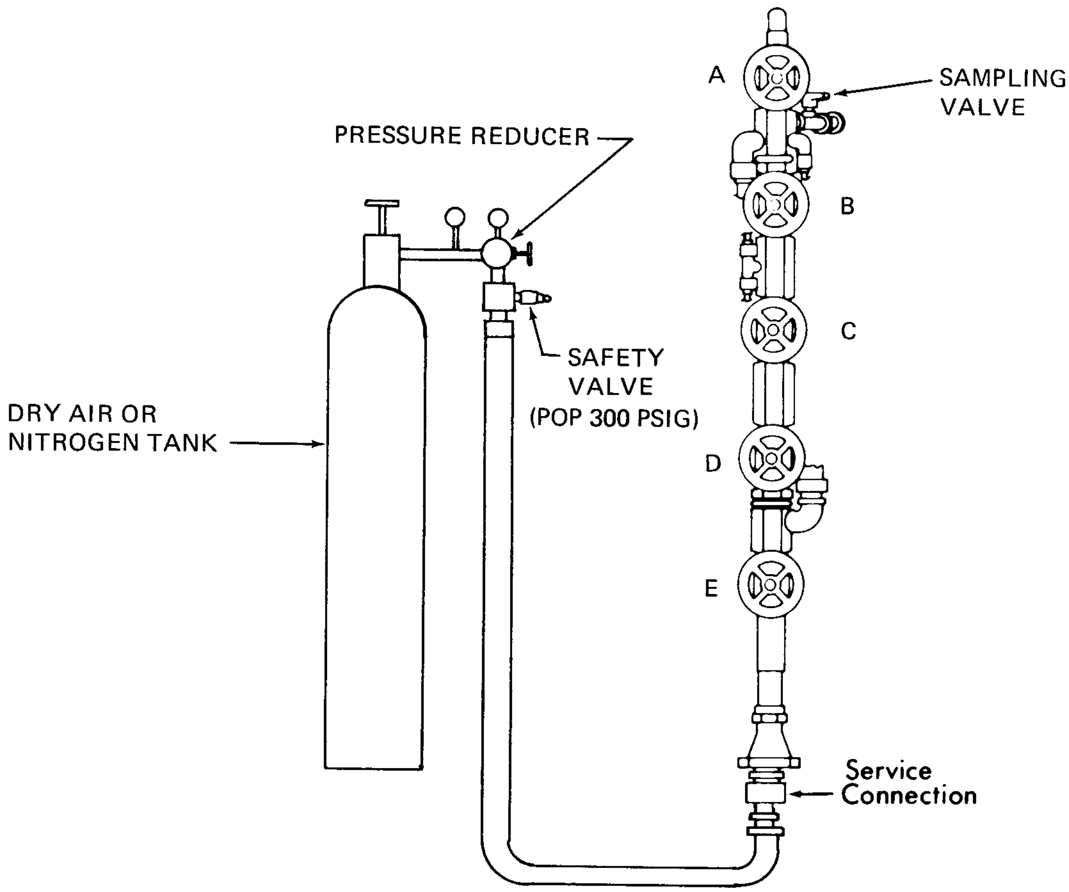


FIGURE 42
PRESSURE REDUCER AND SAFETY VALVE IN GAS SUPPLY LINE

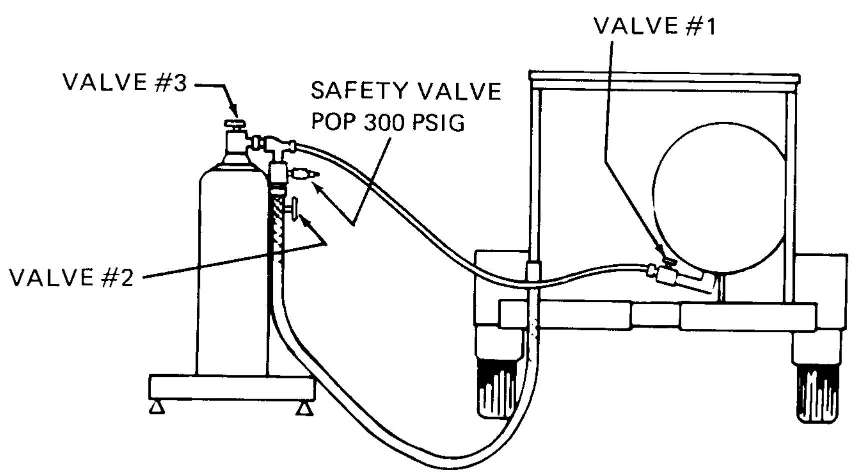


FIGURE 43
TRANSFERRING SF_6 FROM SERVICE UNIT TO EMPTY CYLINDER

ITEM	DESCRIPTION (WHEN USED)
8-1	Control Power Switch (DC)
8-2	Air Compressor Power Switch
8-3	Main AC Power Switch in Control Housing
8-5	Mechanism Housing Heater Power Switch
8-6	Gas Compressor Power Switch
8-7	Primary Tank Heater Power Switch
8-8	Secondary Tank Heater Power Switch
8-10	Trip Circuit Power Switch (DC)
8-11	Control Housing Heater Power Switch
8-13	Gas Buggy Receptacle Power Switch
23-1	Thermostat Air Compressor Heater
23-2	Thermostat Primary Tank Heaters
23-2X	Auxiliary Relay, Primary Tank Heaters
23-3	Thermostat, Secondary Tank Heaters
23-3X	Auxiliary Relay, Secondary Tank Heaters
23-4	Thermostat, Gas Compressor Heater
23-5	Thermostat, High Temperature Lockout Primary Tank Heaters
23-6	Thermostat, High Temperature Lockout Secondary Tank Heaters
23-8	Thermostat, High Temp. Alarm, High Pressure Gas System
23-9	Thermostat, Control Housing Heaters
42-1	Motor Starter, Air Compressor
42-2	Motor Starter, Gas Compressor
43	Local - Remote Switch
49	Motor Overload Relay
62	Time Delay Reclosing Relay
62A & B	Time Delay Air Compressor Sequential Relays
62C & D	Time Delay Gas Compressor Sequential Relays
63-1	Compressor Pressure Relay, Air Compressor
63-1X	Auxiliary Relay for 63-1
63-2	Lockout Pressure Relay, Air System
63-3	Alarm Pressure Relay, Air System
63-4	Compressor Relay, High Pressure Gas System
63-5	Alarm Pressure Relay, High Pressure Gas System
63-6	Alarm & Lockout Pressure Relay, Low Pressure Gas System

ITEM	DESCRIPTION (WHEN USED)
63-7	Lockout Pressure Relay, High Pressure Gas System
63-7X	Auxiliary Relay for 63-7
69	Permissive Control Switch
88-1	Motor, Air Compressor (1-1/2 H.P.)
88-2	Motor, Gas Compressor (4 H.P.)
94	Disagreement Relay
a or b	Auxiliary Switch Contact
ⓐor ⓑ	Adjustable Auxiliary Switch Contact
CC	Closing Coil
CS	Control Switch
FU	Fuse
GIL	Green Indicator Light
H-1	Heater, Air Valve
H-2	Heater, Air Tank Drain Valve
H-3	Heater, Air Compressor
H-4	Heater, Gas Compressor
H-5	Heater, Manifold & High Pressure Dryer
H-6 & H-7	Heaters, Control Housing Space
H-10 – H-12	Heaters, High Pressure Gas Tank, Primary System
H-13 – H-15	Heaters, High Pressure Gas Tank, Secondary System
H-18	Heater, Air Valve & Closing Coil
ITD	Impulse Trip Device
LC	Latch Checking Switch
LS	Limit Switch
OPSC	Oil Pressure Safety Control
REC	Receptacle
RIL	Red Indicator Light
RTM	Running Time Meter
TC-P	Trip Coil, Primary
TC-S	Trip Coil, Secondary
X	Closing Relay
Y	Antipump Relay

FIGURE 44
SCHEMATIC DIAGRAM DESCRIPTIVE CHART

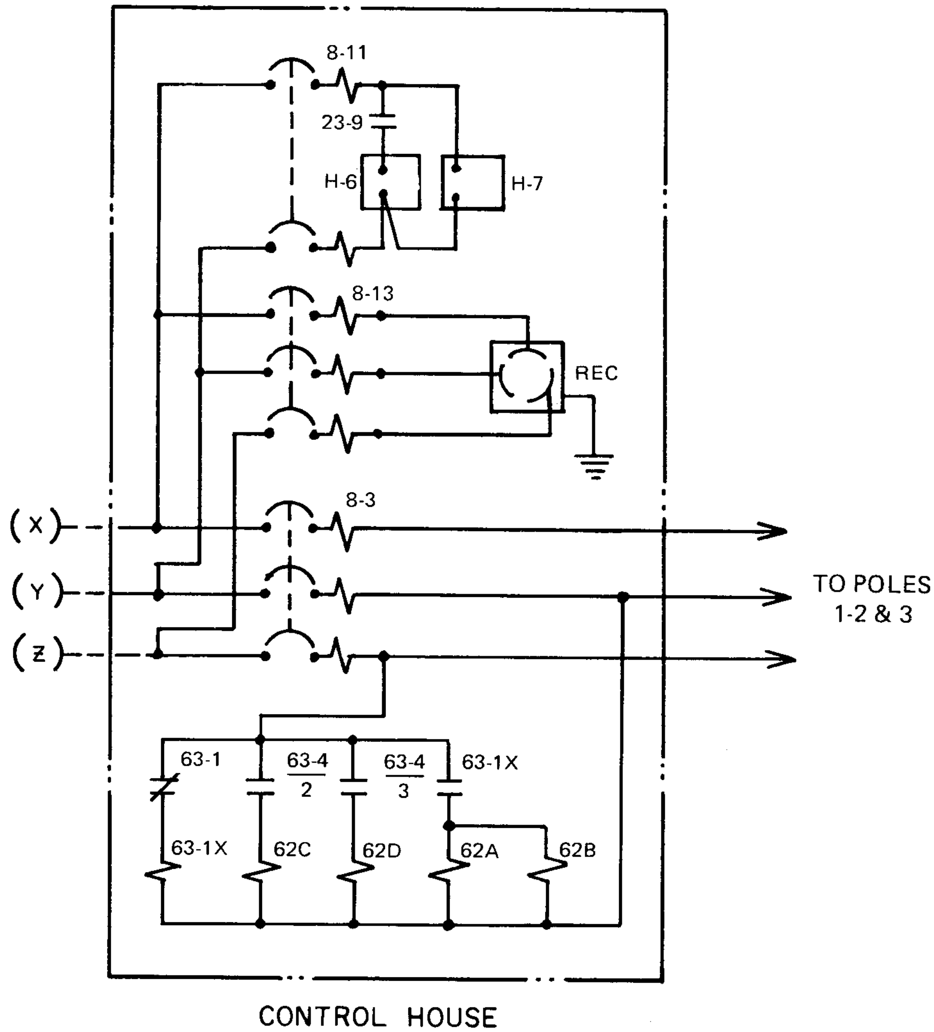
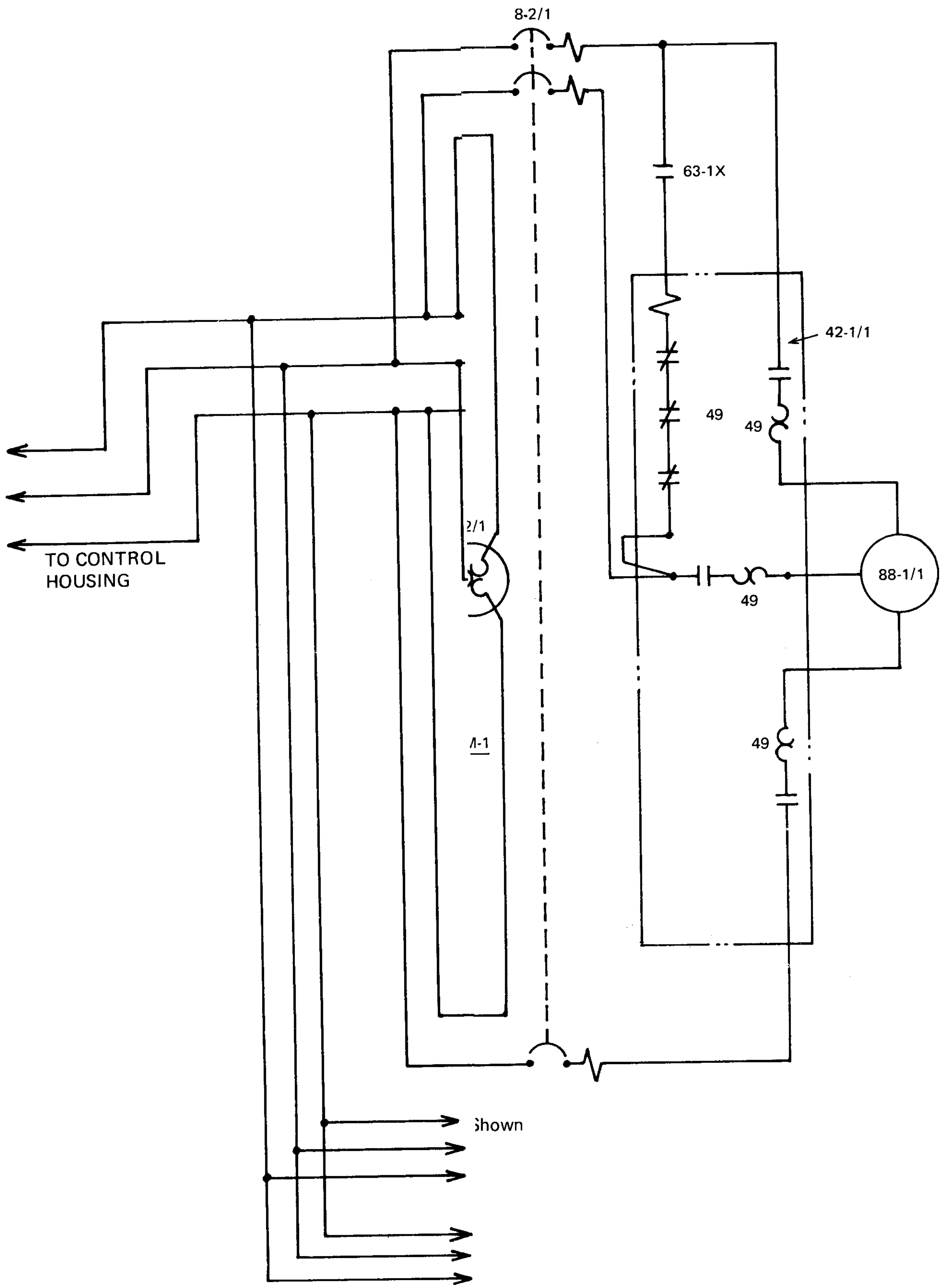
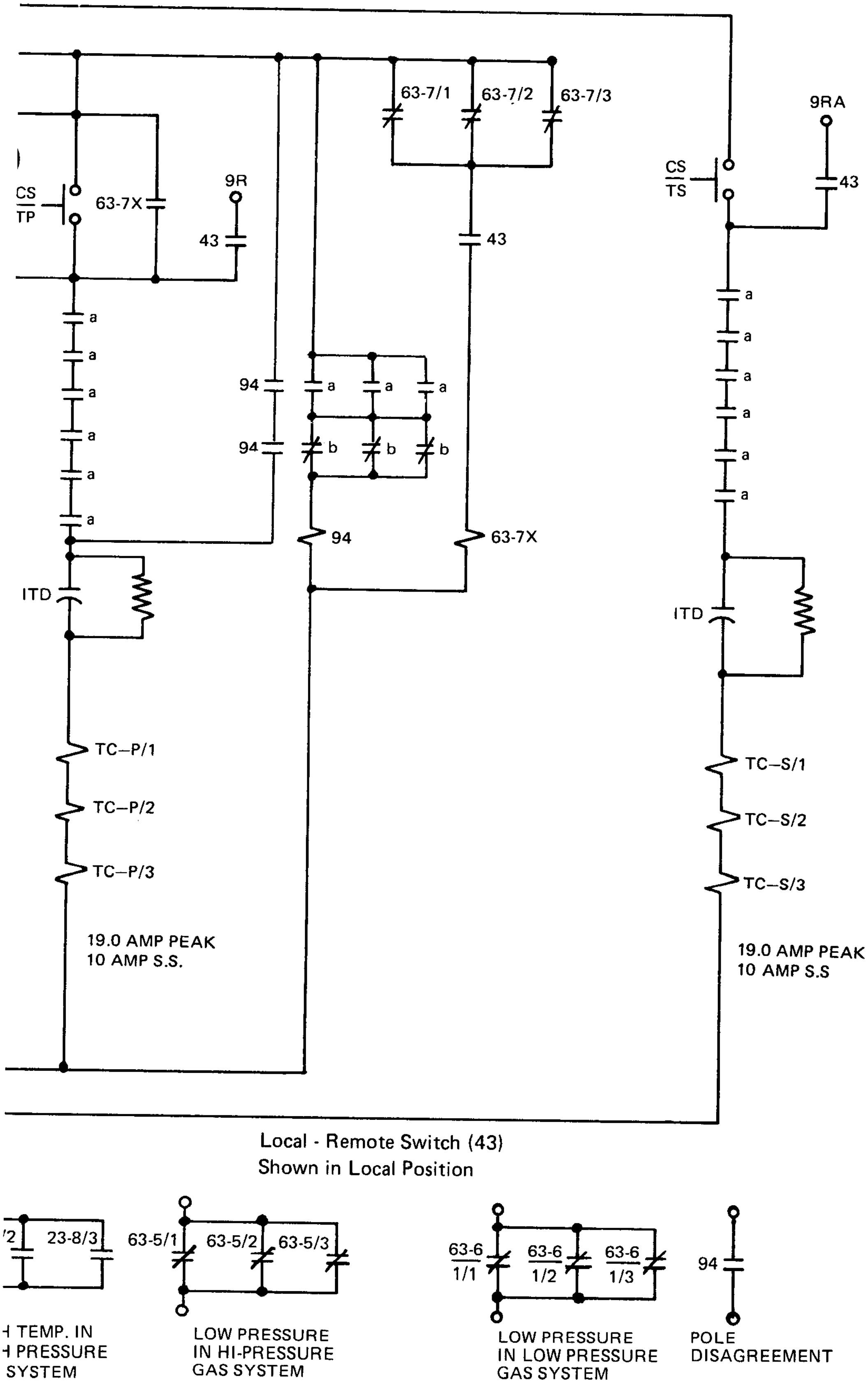
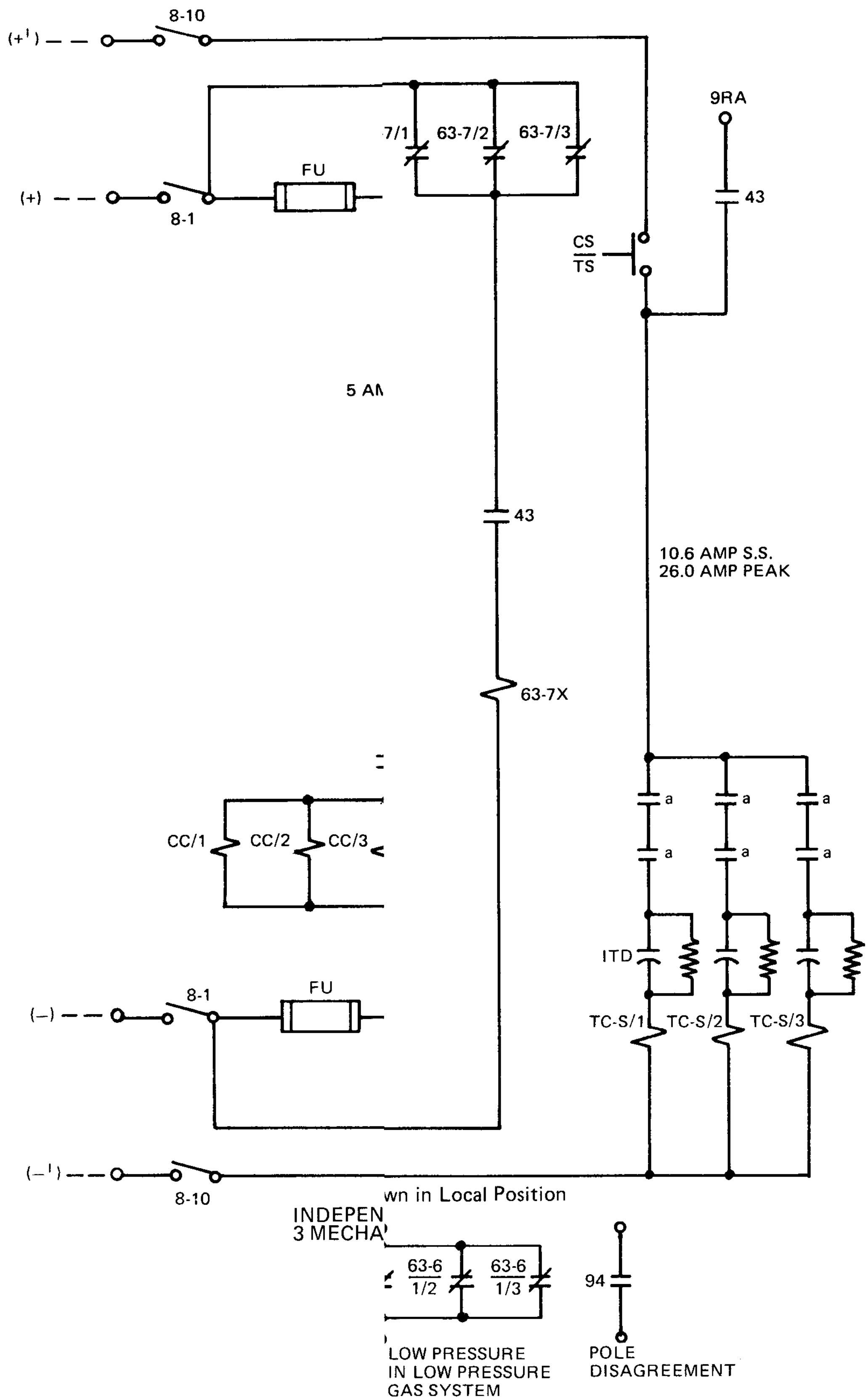

8-11
23-9
H-6
H-7
8-13
REC
8-3
(X)
(Y)
(Z)
TO POLES
1-2 & 3
63-1
63-4
2
63-4
3
63-1X
63-1X
62C
62D
62A
62B
CONTROL HOUSE

FIGURE 45

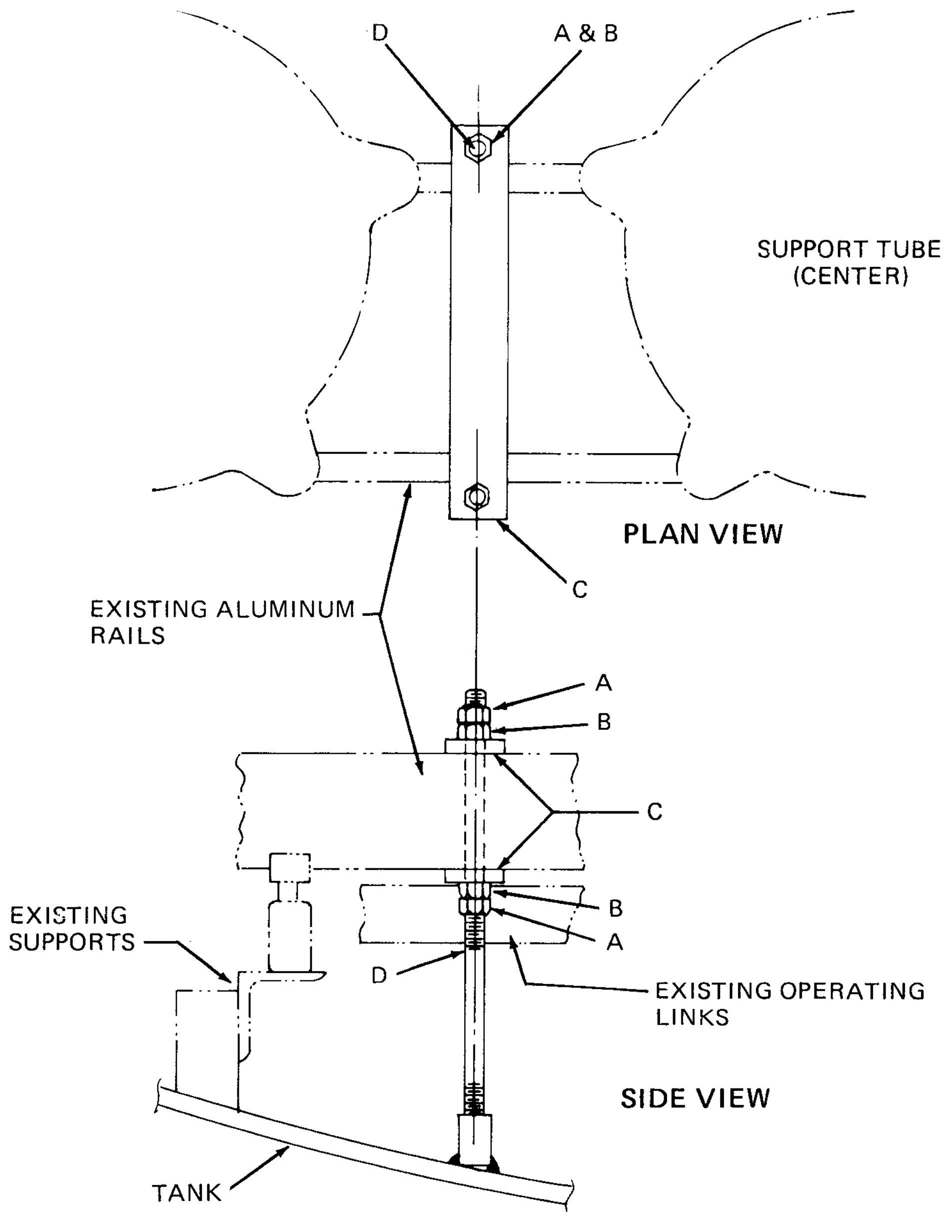

8-2/1
63-1X
42-1/1
49
49
49
49
88-1/1
2/1
TO CONTROL
HOUSING
Л-1
Shown



STANDARD ALARMS


8-10
(+')
9RA
7/1
63-7/2
63-7/3
FU
(+)
8-1
43
CS
TS
5 AM
43
10.6 AMP S.S.
26.0 AMP PEAK
63-7X
a
a
CC/1
CC/2
CC/3
ITD
8-1
FU
(–)
TC-S/1
TC-S/2
TC-S/3
(–')
8-10
wn in Local Position
INDEPEN
3 MECHA
63-6
1/2
63-6
1/3
94
LOW PRESSURE
IN LOW PRESSURE
GAS SYSTEM
POLE
DISAGREEMENT

BASIC DC PAF



Instructions for removing the two shipping supports located between the center and two outside support tubes in each tank. Remove each support as follows:

1. Remove the upper lock nuts (item A) and nuts (item B).
2. Lift off upper bar (item C).
3. Looses lower lock nuts (item A) and nuts (item B) and run the nuts down on the threaded studs (item D) about 1-1/2".
4. Unscrew studs (item D) from bosses on tank wall.
5. Remove lower bar (item C) and studs (item D).

FIGURE 49
INSTRUCTIONS FOR REMOVING
INTERNAL SHIPPING SUPPORTS

Gould Inc., Power Systems Division
Downey, Calif.

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