GEI-25335A

INSTRUCTIONS

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Switchgear

Type ARA-14.4-2500
5000 Amperes

AIR-BLAST CIRCUIT BREAKER

GENERAL ELECTRIC

CONTENTS

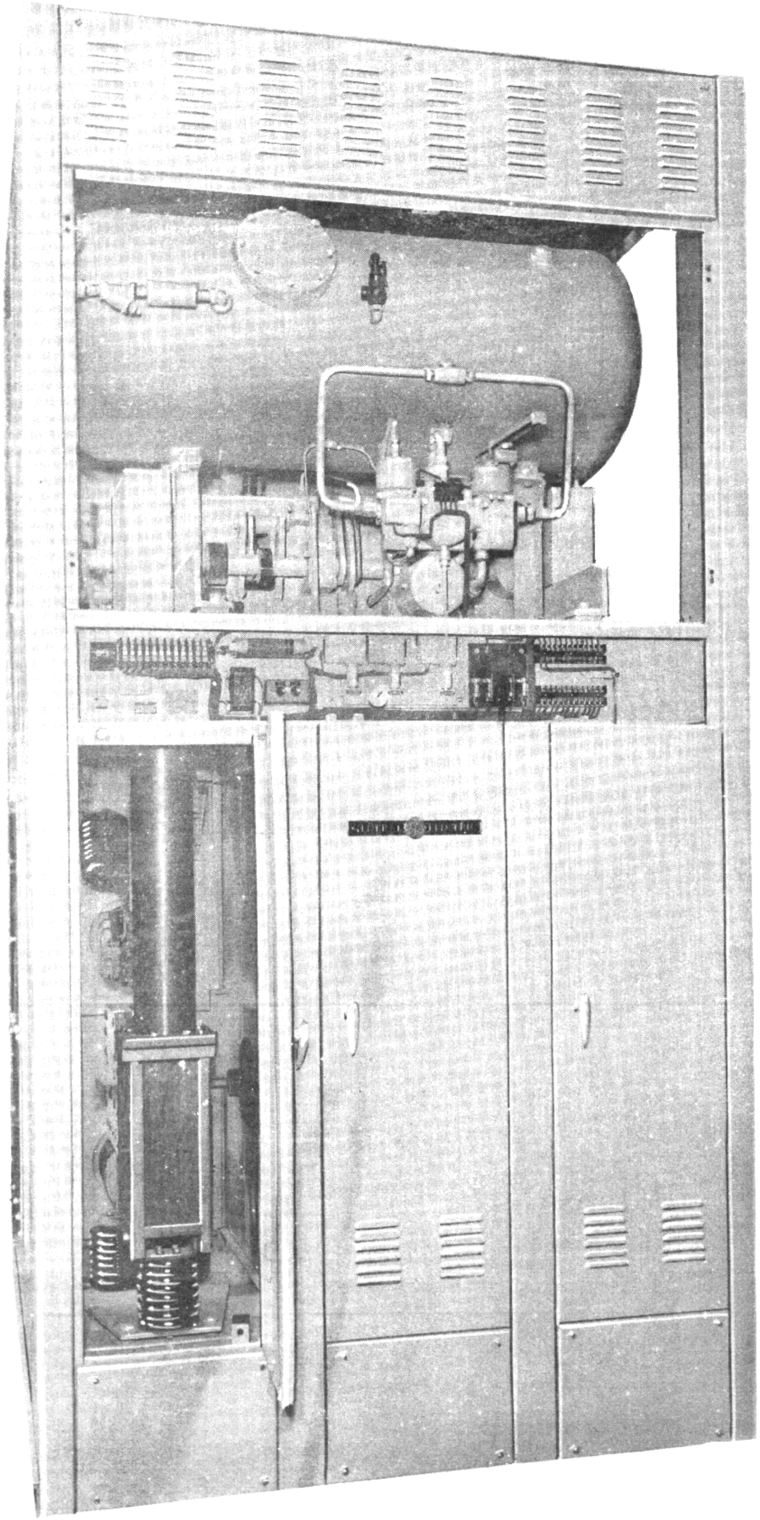


Fig. 1 (8005400)

Fig. 1 Air-blast Circuit Breaker Type ARA-14.4-2500

AIR-BLAST CIRCUIT BREAKER
TYPE ARA-14.4-2500

INTRODUCTION

APPLICATION

The type ARA-14.4-2500 Air-blast Circuit Breaker is designed to meet all requirements of modern switchgear. The breaker is operated by a simple, sturdy pneumatic operating mechanism which gives fast reliable operation of the breaker during both normal and fault operations. The Air-blast principle of arc interruption affords short arc lengths and an early clearing of the fault under all conditions. This faster operating time and short arc duration reduces the system disturbance, the deterioration of interrupter parts and also the required maintenance. Periodic inspection and maintenance is further reduced by the sturdy, reliable breaker design with few critical adjustments.

RATINGS

The Type ARA-14.4-2500 Air-blast Circuit Breaker is a triple pole, single throw, indoor breaker rated 2500 MVA interrupting capacity 14,400 volts, 3 phase, 60 cycle with a continuous current carrying rating of 5000 amperes. If the service voltage is reduced, the 2500 MVA interrupting rating applies provided that a maximum of 120,000 RMS amperes is not exceeded. The momentary or short time rating is 190,000 RMS amperes for any time, however short, up to one second. For any time exceeding one second the 120,000 ampere rating applies. The interrupting time of the breaker will not exceed 8 cycles from energizing the trip coil to final interruption. The breaker is of a design which has been tested and proved to meet the standard dielectric specifications of 50 KV, 60 cycle, withstand and 110 KV, 1.5 x 40 impulse withstand.

OPERATING CHARACTERISTICS

The complete breaker (Refer to Fig. 2) consists of a metal breaker housing 29 enclosing in separate compartments three single pole elements; a pneumatic operating mechanism mounted on top of the breaker house; an air receiver 38; a mechanically operated blast valve 37; connecting air line manifold 28; a control panel on which is mounted a knife switch and fuses, a pressure gage, a veeder counter, low pressure lockout switches, an auxiliary switch, an operating switch and terminal board; a safety valve 2; an inlet valve 39 and an air strainer in the incoming high pressure line. Each single pole compartment consists of an arc chute 16, contact blade 15, operating rod 11, crank 30, air line insulator 23, exhaust tube 12, bushings 20 and 25, wiping contact and support 14, and support insulators 18 and 27.

Electrical energization of control valves, shown in Fig. 3 and Fig. 6, admits high pressure air from the air receiver 38, Fig. 2, into the operating cylinders. For an opening operation the opening control valve is energized and air is passed from the air receiver into opening booster cylinders 4 and 32 and later into the main opening cylinder 7. Dashpot action is afforded by the opening dashpot cylinder 8 and two oil dashpots. For a closing operation high pressure air from the air receiver is passed through the closing control valve into the closing cylinder 33. Dashpot action on closing is obtained by means of the closing dashpot cylinder 31. (A more complete discussion can be found under OPERATING MECHANISM, DESCRIPTION OF COMPONENTS). The high pressure air admitted into either closing or opening cylinders causes movement of the operating pistons which are geared through toothed racks to gear 6. This rotates the mechanism shaft 9 and the three cranks 30. Movement of these cranks operates contact blade 15 through operating rod 11.

The breaker interrupts fault circuits by means of high pressure air in the arc chute 16. Opening operation of the pneumatic mechanism opens blast valve 37 and lifts contact blade 15 from the arc chute 16. The high pressure air released by the operation of the blast valve flows through the air line manifold 28 and air line insulator 23 into the arc chute 16. The flow of air across the arc chute contacts the contact blade tip forces the arc out through the arc chute where it is interrupted. Products of the arc are exhausted through exhaust tube 12 into a top header and hence into atmosphere.

For the closing operation, the blast valve 37 supplies a blast of air into the arc chutes 16 prior to contact making. The presence of high pressure air prevents pre-establishment of the arc before actual contact making. A damper 34 operates on the closing stroke to limit the flow of air on closing. This is done to conserve air. The requirements for air on closing are much less than for opening for there is no arc to interrupt.

When electrically energized, the opening and closing control valves are held open pneumatically for the proper duration of the working stroke. Pneumatic preference of the opening control valve by the blocking of the closing control valve assures proper trip free operation during any part of the breaker stroke. The mechanism is latched in both the closed or open position due to the overcenter toggle positions assumed by the crank 30 and operating rod 11.

The breaker operates at air supply pressures from 185 to 250 p.s.i. The breaker panel is provided with a control switch for electrical operation at the breaker. Pressure switches are provided to prevent electrical operation when the supply pressure is below the minimum required for interruption. The manual trip device is an integral part of the opening valve for manual tripping in the event of loss of electrical control. A low pressure locknut is provided to block the operation of the manual trip when the storage pressure is below the minimum required for interruption.

RECEIVING, HANDLING AND STORAGE

RECEIVING

Each Air-blast Circuit Breaker is carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment. Immediately upon receipt of a circuit breaker, an examination should be made for any damage sustained during shipment. If injury through rough handling is evident, a damage claim should be filed at once with the Transportation Company.

HANDLING

It is expected that due care will be observed when unpacking the apparatus so that no damage will occur from careless or rough handling. Frequently "loose parts" are included in the crates and these should not be overlooked.

Porcelain air line and support insulators are amply strong when used under the conditions for which they were designed. However, caution should be exercised during unpacking and installation.

STORAGE

When the breaker can be set up immediately in its permanent location, it is advisable to do so even though it will not be placed in service for some time. If the breaker cannot be installed in the proper location immediately, and it is necessary to store the equipment, it should be kept in a clean, dry place. It must not be exposed to dirt, the action of corrosive gases, such as chlorine, or to possible mechanical injury.

Machined parts of the operating mechanism should be treated with slushing oil to prevent rusting and if the breaker is stored for any long period of time, it should be inspected periodically to insure good mechanical condition. Particular care should be taken to protect insulating parts which might absorb moisture.

INSTALLATION

FIELD ASSEMBLY

The breakers are shipped as a complete metal clad unit to facilitate erection. For proper operation the breaker unit should be set up on a solid foundation and should be mounted level with floor bolts as indicated on the outline drawing. After locating the breaker and leveling, all that remains to complete the field assembly is to make power connections, control connections, air line connections, and to give the breaker a preliminary inspection and adjustment check.

CONNECTIONS

Before making an electrical connection every precaution must be taken to see that all leads to be connected to the breaker are de-energized and properly grounded.

The power connections are made to the bushing terminals as indicated on the outline drawing. Sufficient electrical clearance must be provided between the power connections and ground to withstand the rated high potential test voltage. The bus work must be properly supported and braced so that the breaker bushings are not required to carry bus work strains. This includes both static loading and magnetic stresses from short circuit conditions. The bus must have sufficient current carrying capacity to be equal to the current carrying capacity of the breaker parts. All the power connection contact surfaces must be clean, bright, and free from dents, burrs, or dirt.

All control wires should be run in conduits, if possible. The control wires must be run separately and remote from the power connections and must not be run parallel to the power leads unless the distance separating the two sets of wiring is sufficient to prevent communication between them as a result of short circuits. All control wiring should be connected to the terminal boards provided on the breaker panel. In no instance is it necessary to carry control wiring beyond the points on these breaker terminal boards.

The framework of each breaker should be connected to a good permanent low resistance ground. The ground cable should be capable of carrying at least 25 per cent of the rated breaker current but in no case should be smaller than a 4/0 wire. A poor ground may be worse than no ground at all in that it gives a false feeling of security to those working around the equipment.

ADJUSTMENTS

Although the breaker has been completely assembled, adjusted, and thoroughly tested at the factory, it is advisable to review all adjustments before placing the breaker in service. It is possible that some of the adjustments may have changed slightly during shipment and installation. A maintenance closing device is provided for manual operation of the breaker during these adjustment checks. Pneumatic operation should not be attempted until the breaker has been operated through its complete stroke and all adjustments checked.

The breaker is shipped in the closed position and since the drain valve interlock would normally prevent installation of the maintenance closing device with the breaker in this position, the interlock has been partially disassembled for shipping and installation purposes. Two pins have been removed from the fork and guard that covers the end of the mechanism shaft and the guard has been wired back and out of the way. This allows the maintenance closing device to be installed on the breaker as it is received.

After the breaker has been once opened with the maintenance closing device, the wire should be removed and the guard assembled to the drain valve and the frame by means of the two pins, washers and cotter pins. The interlock will then be able to function in its normal manner as described later in this instruction book.

STROKE - CONTACT AND MECHANISM

Measure the stroke of each pole of the breaker from fully closed to fully open position. With the breaker fully closed, make a mark on the contact blade 15, Fig. 2, at some convenient place such as the top of the wiping contact support 14 and then open the breaker slowly with the manual device and in the fully open position, again mark the blade at the same reference point. Measure the breaker stroke which should check 14-1/2 in. $\pm$ 1/16 in.

Utilizing a light indication or a bell set, close the breaker manually until the contact blade just touches the secondary contact fingers 29, Fig. 4, as indicated by the bell or light. From this point measure the remaining stroke until the breaker is fully closed. This measurement indicates the wipe of the secondary contact fingers and should measure 1-7/8 in. $\pm$ 1/16 in. During the same operation, the contact point of the blade should be checked to determine that all three blades make contact at approximately the same time. The three blades should make and break contacts within 1/16 in. of each other.

After checking the stroke and wipe of each blade, observe the clearance between the contact blade and the arc chute guide block 38, Fig. 4, throughout the entire stroke. There should be clearance at all times between the contact blade and the arc chute on all four sides. The clearance to the arc chute should not be less than .002 in. If this is not the case, the arc chutes should be realigned. See section ADJUSTMENTS OF ARC CHUTE.

During the operation of the breaker, the amount of lift on the blast valve stem should be checked. With the breaker in the closed position, first check the clearance between the blast valve operator button 33, Fig. 7, and the blast valve stem cap 35. This should measure 3/32 in. $\pm$ 1/32 in. Slowly opening the breaker, check the point in the breaker stroke that the blast valve first begins to open. On the opening stroke, the blast valve should begin to open prior to the actual breaker stroke in the opening direction. In other words, the blast valve should be lifted during the movement of the mechanism out of toggle. From this point check the maximum lift of the blast valve and also the point in the breaker stroke at which the blast valve 15 closed. The lift of the blast valve should measure 1 in. $\pm$ 1/16". The point in the breaker stroke at which the blast valve 15 fully closed is shown on the typical operation curve, Fig. 11, and is approximately 10 1/2 in. from the fully closed position of the breaker.

A scribe mark on the contact blade 41, Fig. 4 is made during the factory assembly indicating penetration of the blade in the arc chute when it touches the contact support 25. The differences between this scribe mark and the guide block 38 of the arc chute indicates the clearance between the contact blade arcing tip and the contact support. This dimension should check 5/16 in. $\pm$ 1/16 in. in the closed position. If either the contact blade or the arc chute are replaced, a new scribe mark should be made on the blade, the position of which is determined by inserting the blade in the arc chute until it touches the contact support.

PRESSURE SWITCHES

Each breaker is provided with four pressure switches similar to that shown on Fig. 9. Three of these are located on the panel, the fourth on the closing control valve. One of these pressure switches on the panel is a lockout device in the closing circuit, one switch is a lockout in the opening circuit, and the remaining one is an alarm switch to indicate loss of pressure in the air storage tank.

The low pressure lockout 63C, see Typical Wiring Diagram, Fig. 12, in the closing circuit has been set to open its contacts at 200 p.s.i. under the conditions of descending air pressure and to close its contacts at 210 p.s.i. with ascending air pressure.

Low pressure lockout 63 T, Fig. 12, in the opening circuit is set to open its contacts at 185 p.s.i. descending air pressure and to close its contacts at 195 p.s.i. ascending air pressure.

The alarm switch 63A has been set in the factory to close its contacts at 230 p.s.i. descending air pressure and to open its contacts at 245 p.s.i. ascending air pressure.

The closing pneumatic interlock switch 63 CI, Fig. 12, has been set in the factory to close its contacts at 30 p.s.i. descending air pressure and to open its contacts approximately at 80 p.s.i. ascending pressure. The operation of this switch, mounted on the closing control valve, is described in the Section DESCRIPTION OF COMPONENTS.

Each of these pressure switches, Fig. 9 have two adjustments. Adjusting screw 19 selects the range of operation in that the spring pressure of spring 16 is varied to balance the force of the pressure acting on the pressure bellows 10. Adjusting screw 19 can be reached by inserting a screw driver through the hole provided in the top of the breaker housing into the slot in the top of the moulded case of the pressure switch. The differential between pick up and drop out is set by adjusting cam 2 which can also be rotated by means of a screw driver inserted through the hole in the top of the breaker housing. Should the pressure switches operate at values different from those given, adjust screw 19 and check the operation of the switches with decreasing air pressure. A pointer on the front of the pressure switch case indicates whether the operating point is being raised or lowered. Check the pick up of the switches with ascending air pressure and adjust to as small a differential as possible with the adjusting cam 2 making sure that snap-action operation is maintained. It is not expected that the adjustments of the pressure switches and other pressure operated devices will be held any closer than $\pm$ 2# of the nominal settings as listed in this Instruction Book.

The pressure gauge mounted on the panel is for indication purposes only and is not to be used to check pressure switches or breaker operation.

AUXILIARY SWITCH

The Type SB-1 auxiliary switch is mechanically operated by the breaker mechanism. Each contact has been set and adjusted for correct breaker operation at the factory. Readjustment, maintenance or repair should not be attempted without referring to Instructions GEI-18080 appended as part of this Instruction Book.

ADJUSTMENT OF ARC CHUTE

At installation, or if the arc chutes are removed during normal maintenance and inspection, alignment and contact making point of each phase must be checked. Should the contact points vary or the arc chutes be in misalignment with the contact blade, readjust the arc chute and blade as follows.

Leveling screws 19, Fig. 2, are furnished for the purpose of leveling the arc chute and obtaining alignment with the contact blade. There are six of these leveling screws and by making adjustments with three of them the support insulators serve as a tripod enabling the arc chute to be aligned accurately. If this operation is necessary, first loosen the clamping bolts securing pedestal 22 to the contact stud of bushing 20. Next loosen the socket head screws in the center of leveling screws 19. Loosen the two front leveling screws and the center rear leveling screw. Adjust the other three leveling screws until the recommended clearance is obtained between the contact blade and the arc chute at all points of the stroke. (See Para. 3 under "Stroke"). Tighten the socket head screws in the center of these three leveling screws. Tighten the remaining three leveling screws and then tighten the socket head screws. Fasten securely the clamping bolts securing the pedestal 22 to the contact stud of bushing 20.

When adjustments to the arc chute 16 displace to any extent the positions of the pedestal 22 in relation to the bushing contact stud, such as may possibly occur when installing a replacement arc chute, loosen the four bolts securing the bushing to the breaker housing and align the bushing contact stud with the contact of the pedestal. After tightening the bolts securing the bushing 20 to the breaker housing, it will be necessary to check the alignment of the attached disconnect switch.

Coupling 13 on operating rod 11 provides the adjustment necessary for synchronizing the contact point of all three phases. (See Para. 2 under "Stroke"). To make any adjustment, loosen the set screw in coupling 13. Remove the pin between the coupling and the contact blade 15. Lift the operating rod 11 so that the coupling is free from the contact blade. Make the necessary half-turns of the coupling and reassemble to the contact blade after securing the clamping nut and set screw on coupling.

MANUAL TRIP AND LOW PRESSURE LOCKOUT

Mounted on the top of the opening control valve is a manual trip device coupled with a low pressure lockout to prevent operation of the manual trip at pressures below those required for satisfactory operation of the breaker. Refer to Fig. 8. Operation of the manual trip lever 23 lifts the trip valve shaft 26 of the opening control valve 20 and operates the valve. Lockout arm 3 engages the manual trip lever on low pressure conditions to prevent the operation. As set in the factory the lockout arm 3 blocks the trip lever at 185 lbs. descending air pressure. Under the conditions of ascending air pressure the lockout arm frees the trip lever at 205 p.s.i. approximately. The operation of this device at the before mentioned pressures should be checked and if not in correct adjustment be readjusted. The range of this device is adjusted by changing the spring pressure on springs 14 and 18 by means of adjusting nuts 16 and 19. If the lockout arm engages the manual trip lever 23 at a pressure greater than 185 lbs., decrease the tension on springs 14 and 18. Continue with this adjustment until the 185 value is obtained. If this pressure is less than 185, increase the spring pressure.

FINAL INSPECTION

After the air-blast circuit breaker has been installed with all mechanical and electrical connections located, the following final inspection should be made.

1. Make a final check that the breaker is securely fastened to the foundation and properly leveled.
2. Inspect all wiring to see that no damage has been done to the insulation during installation. Check terminals for loose connections.
3. Check that all nuts, bolts, washers, cotter pins, and terminal connections are in place and properly tightened.
4. Check that all air line connections and plugs are tight.
5. Go over the pneumatically operated mechanism completely and check that all plugs and grease fittings in the operating cylinders have been securely tightened. Check that needle valves are securely locked.
6. Operate the breaker slowly with removable maintenance closing device and note that there is no excessive binding or friction and that the breaker can be moved to the fully open and fully closed position.
7. With the breaker in the closed position check the oil level in the oil dashpots and fill to the marked level with Umivis J-43 (Esso Standard Oil Co.) oil if required through the cap at the top of the gauge glass.
8. Fill the air receiver to a normal pressure of 250 p.s.i. and operate the breaker open

and close from the control button provided on the breaker panel. Close the incoming air line valve and with the breaker in the open position see that two complete close-open operations can be obtained before the opening of the minimum operating pressure switches prevents further operation

9. For ease of reviewing adjustments, the following are recapitulated.

   a. Breaker stroke 14 1/2 in. ± 1/16 in.

   b. Contact wipe 1 7/8 in. ± 1/16 in.

   c. Clearance between contact blade tip and contact block 5/16 in. ± 1/16 in.

   d. Variation between contact make between the three phases 1/16 in.

   e. Clearance between blast valve operator and valve stem cap 3/32 in. ± 1/32 in.

   f. Maximum lift of blast valve 1 in. ± 1/16 in.

   g. Minimum clearance between blade and arc chute .002 in.

   h. Lockout of pressure switch in closing circuit 200 p.s.i., decreasing.

   i. Lockout of pressure switch in open circuit 185 p.s.i., decreasing.

   j. Operation of low pressure alarm switch 230 p.s.i., decreasing.

   k. Operation of manual trip lockout 185 p.s.i.

When all the foregoing inspection details have been checked, breakers may be safely placed in service.

MAINTENANCE

Dependable service and safety of power equipment are contingent on the unfailing performance of the Power Circuit Breaker. To maintain such service, it is recommended that a definite schedule be set up and adhered to for the purpose of properly lubricating the wearing parts. A dependable and observant attendant can be expected to forestall mishaps by reporting loosened nuts, scored surfaces, and other evidences of potential trouble.

PERIODIC INSPECTION

At regular intervals, depending upon the service in which the breaker is used, periodic inspection should be made and the apparatus given such maintenance as may be found desirable or necessary. Routing inspection should be made at no less intervals than every six months and after any severe fault operation. During these inspection periods the following details should be carefully checked.

BREAKER CONTACTS

The breaker contacts should be carefully inspected at each inspection period. A good indication of the condition of the contacts can be readily obtained without any disassembly work by observing the appearance of the arcing tips on the contact blades. Severe burning on these tips will indicate a relative amount of burning on the arc chute contacts. If such is the case the arc chutes should be removed from the breaker cell and disassembled for inspection of the contacts. The method of doing this is described in detail under the section DESCRIPTION OF COMPONENTS. Unless very severe fault conditions have been experienced, it is not anticipated that the contacts or blades will require replacement for a considerable period of time.

CONTACT BLADE

In addition to the condition of the contact blade tip, the surface of the contact blade should be inspected to insure that no excessive wear or scoring of the surface has taken place. If scoring is at all evident, the wiping contact fingers should be removed and replaced if inspection reveals a necessity for so doing.

MECHANISM

At regular inspection, the mechanism should be checked to see that it is lubricated and operates freely through the entire stroke. It is not necessary to make a complete inspection at every maintenance period, but at occasional intervals remove the pins connecting crank (Fig. 2, P-30), and operating rod (Fig. 2, P-11), and check for binding of the mechanism. See that the operating shaft maintains proper alignment and fits in its bearings and that the mounting bolts in these bearings remain tight. Check the keys holding gear, crank, and cam to the shaft to insure their remaining tight and in place. Check the oil level in the oil dashpots.

PRESSURE SWITCHES

Review the adjustment of all pressure switches and lockout devices to insure that no change has taken place in their settings.

AIR STRAINER

The breaker air supply line is equipped with a strainer to remove foreign particles from the air. At the regular periodic inspection remove the plug in the strainer and withdraw the strainer screen for inspection. If the strainer screen indicates an accumulation of dirt, rinse in cleaning fluid or gasoline. If the screen has been punctured or is rusting, a new screen should be installed. Take care that these parts are completely dry after being submerged in the cleaning fluid before reinstalling in the breaker. The pipe threads on the plug should be carefully coated with G.E. Compound GED 50H8A (#250 Lead-Plate).

CONTROL RELAY AND AUXILIARY SWITCH

Inspect the contacts of the control relay and auxiliary switch to see that the contacts have no excessive burning and are in good operating condition. Refer to Instructions GEI-18080 included as part of this Instruction Book.

AIR LINES

At regular intervals the porcelain air line insulators should be inspected for mechanical damage. Once a year these insulators should be removed and the interior inspected for accumulation of carbon or dirt. It is best to clean the interior of these porcelains by swabbing with clean cloths and carbon tetrachloride.

At the end of each maintenance program a complete inspection should be made as outlined under the section INSTALLATION.

SERVICING

BLOW OFF VALVE

The breaker air receiver is furnished with a blow off or drain valve for draining the air pressure at periodic inspection periods. This drain valve is interlocked with the mechanism shaft so that the valve can only be operated with the breaker in the fully open position. At regular intervals this valve should be opened to remove any water which may have accumulated in the receiver. This will require but slight opening of the valve so that little loss of air will result. This valve is also interlocked with the manual device, see section MAINTENANCE CLOSING DEVICE.

SAFETY VALVES

Each breaker air receiver is equipped with a safety valve which has been set to operate at a pressure which will afford adequate protection for the air receiver. No attempt should be made to readjust this valve in the field.

The state code on Unfired Pressure Vessels should be consulted for specific information regarding the use of safety valves. Some states require that the valve be operated at least once a day. This practice is not recommended by the valve manufacturer unless specifically required by the State Code. Experience has shown that operating safety valves by the hand lever has a tendency to disturb the seat which may result in air leakage at lower than the set pressure.

Under no conditions should the safety valve be used to exhaust the air from the air receiver. The blow-off valve is provided for this purpose.

LUBRICATION

During assembly at the factory all moving and bearing surfaces of the breaker have been lubricated with the proper grease. It is recommended that on periodical inspections, the following procedure should be followed.

1. Mechanism Cylinders.
   Use a good grade lubricating oil S.A.E.-30, apply eight drops at six month intervals in each cylinder.

2. Mechanism Gear and Bearings.
   Coat the gear and rack teeth with a thin coating of G.E. D50H15 at every six month interval.

   The bearings are equipped with Alemite fittings and should be given one shot of G.E. D50H15 compound.

3. Contact Blade and Wiping Contacts.
   At periodic inspections wipe the contact blade clean from all grease. Clean with cleaning fluid, if necessary. Coat the blade with a thin covering of G.E. D50H15 compound.

   This should be done every six months at least, and oftener in dust filled atmospheres.

4. Mechanism Pins.
   Lubricate at inspection with G.E. D50H15 Compound.

5. Control Valves
   No lubrication required.

6. Oil Dashpots.
   Check oil level and add oil if necessary.

DESCRIPTION OF COMPONENTS

OPERATING MECHANISM

The operating mechanism for the type ARA Air-blast Circuit Breaker is of the electro-pneumatic trip free type. This mechanism does not employ a mechanical trip free linkage but assures trip free operation during any part of the breaker stroke by the proper control of pneumatic devices. The operation of the pneumatic system will be explained at the end of this section.

The mechanism is mounted on top of the breaker housing as is shown in Fig. 2. The mechanism has been correctly aligned in the factory and is bolted and welded in position. There should be no occasion to change the location of the mechanism after the breaker leaves the factory except for possible replacement.

The primary purpose of the mechanism is to operate the contact blades and blast valve to perform the functions of interruption and closing.

It operates with positive high speed closing under no load and maximum fault conditions and provides early contact parting, after trip impulse, to assure fast interruption of all fault conditions.

To explain the operation of the mechanism a detailed description of each operation will be given.

OPENING OPERATION

Referring to Fig. 3, which shows the mechanism in the closed position, the opening control valve 7 is energized electrically thereby admitting air simultaneously into the booster cylinders 11 and 36 and into the opening dashpot cylinder 26 through air line coupling 28. The volume to fill in the booster cylinders is small and in contrast that of the dashpot cylinder is large. Consequently, pressure builds up rapidly behind the booster pistons 9 and 34 and the breaker is driven in the opening direction. The booster pistons drive the mechanism through the racks 31 and 45 and gear 44 until the blades part from the arc chute contacts. In this region, the air is by-passed into the main opening cylinder through air by-pass line 6 behind the main opening piston 12.

During the booster piston stroke the blast valve 37, Fig. 2, has been opened by the blast valve operator 35 and the breaker contact blade has moved into the contact parting position. Upon the opening of the blast valve, compressed air is admitted to each arc chute 16 through the air line manifold 28. The blast valve cam is so arranged that the full required pressure is available in the arc chutes before the contact blades 15 separate from the contact 29, Fig. 4. By this time the opening dashpot cylinder 26, Fig. 3, has been charged. In addition to this the rotation of the mechanism shaft, shown at both 20 and 43 in Fig. 3, has caused the cam and crank 19 to operate the oil dashpot piston stem 23 through the crank 22 and rollers 21 and 17. The oil dashpot 25, in conjunction with the dashpot piston 29 prevents excessive opening speed of the breaker.

After the contact blades have moved approximately 5 inches from the closed position, the opening dahspot piston 29 has moved beyond by-pass 27, while the main opening piston 12 has moved to the position so that air by-passed through by-pass 6 from the booster cylinder acts on the main opening piston. The main opening piston now drives the breaker positively for the remainder of the stroke. Dashpot action at the end of the stroke is afforded by the oil dashpot 25 and the dashpot piston 29 which moves beyond and closes up the by-pass 27. A bleed hole in the end of the opening dashpot cylinder allows the air remaining in the dashpot cylinder to escape.

CLOSING OPERATION

When the closing control valve 5 is energized electrically, air is transmitted to the closing dump valve 38 through the air line 8. This air holds the dump valve in its normally closed position but the flapper valve 40 in the dump valve is forced open by the air pressure, thus admitting the air into the closing cylinder 42. This high pressure air acting behind the closing piston 41 moves the breaker in the closing direction. The blast valve cam is so arranged that the required pressure is available in the arc chute before the contact blade touches the secondary contacts. The closing piston drives the breaker to the closed position unretarded except at the end of the stroke when the closing dashpot piston 33 becomes effective due to the compression of the air within the cylinder 32. After the closing control valve is cut-off, the compressed air remaining in the closing cylinder automatically opens the dump valve 38 against its return spring and escapes through the exhaust ports into atmosphere.

TRIP FREE OPERATION

To obtain the electro-pneumatic trip free feature the opening control valve is given preferred control over the closing control valve. To accomplish this air line 3 is connected from the downstream side of the opening control valve 7 to the pneumatic timing chamber of the closing control valve 5. By this arrangement energizing the opening control valve immediately closes the closing control valve regardless of whether the closing control valve coil is energized or not. A more complete description of the pneumatic operation and characteristics is given under CONTROL VALVES later in this section of the Instruction Book.

When the closing control valve is closed by this action described above, the air accumulated behind the closing piston 41 is immediately exhausted to atmosphere by the dump valve 38. Reversal of the mechanism for trip free operation is thus accomplished.

ASSEMBLY

Under ordinary conditions the operating mechanism should require no disassembly other than the regular service and inspection requirements as outlined under MAINTENANCE. In order to examine and clean the cylinder it is suggested that one cylinder be removed at a time. This will prevent the change of any setting of cranks, cams, stroke, etc. Should it be necessary to disassemble the mechanism, the following outlined procedure should be followed.

1. Disconnect the cranks 30, Fig. 2, from the operating rods 11 by removing the coupling pins from all three cranks.

2. Disconnect the air line piping from the opening and closing control valves to the operating cylinders and air receiver; then remove the control valves by removing the clamping bolts holding the valves to the front booster cylinder.

3. Loosen set screws in the end crank 30 (Pole 3) and slide the crank from the mechanism shaft 9.

4. Remove the holding bolts from the split bearings on the mechanism frame at Poles 2 and 3 and disassemble the removable half of the bearing.

5. Disengage the set screws in the center output crank 30 and slide the output crank along the mechanism shaft approximately three inches toward the cylinder housing.

6. Remove the remaining split bearing on Pole 1 and slide the shaft to disengage the gear 44, Fig. 3, from the piston racks 31 and 45. Continue in the same direction and remove the mechanism shaft 43 with cam gear and two cranks.

7. The remaining parts such as the two operating cranks 30, Fig. 2, the gear 44, Fig. 3, and the blast valve cam can be removed by sliding them one after the other from the operating shaft after loosening all set screws. These parts tightly fit the shaft and in some instances a press may be required.

8. Remove each cylinder by removing the four clamping bolts. The operating pistons can then be readily removed from the mechanism frame. The piston and cylinder should be marked so that on reassembly the correct matching parts are placed together.

9. To inspect the booster pistons 9 and 34, Fig. 3, remove the booster cylinders 11 and 36 from the ends of the main cylinders by loosening the four clamping bolts. Note the position and quantity of any spacers behind the rear booster piston and make sure that these spacers are replaced.

10. To disassemble the dump valve remove the end plate from the closing cylinder 42 and remove the dump valve 38 by sliding it out the rear of the closing cylinder.

11. To remove the oil dashpots 25, Fig. 3, first remove the four mounting bolts and lower the dashpot until it can be removed from the mechanism frame 15.

The mechanism as shipped from the factory requires no adjustment. In the event of disassembly and reassembly all parts should go together readily and in the same relation as before removed. All parts on the main operating shaft are keyed so that the correct position is easily found. Care should be observed to correctly locate the final open and closed positions. To do this, move the closing piston to the fully open breaker position and the opening dashpot piston to the fully open breaker position. Then engage the gear teeth in the rack teeth being careful to hold the pin centers of the cranks 30, Fig. 2, 1 7/16 inches back beyond the vertical center line through the mechanism shaft 9. With the open position correctly located with respect to pistons and main shaft, all other adjustments will follow automatically providing no changes have been made.

ARC CHUTE

The purpose of the arc chute is to perform the task of circuit interruption at all current conditions from load current to maximum fault current and to provide contact between the contact blade and the stationary current carrying fingers. The distress of interruption is confined within the arc chute except for that portion of the gases which is exhausted up the exhaust tube into the exhaust header.

Referring to Fig. 4, which shows the arc chute with one side plate removed, the functions of operation are performed as follows:

Prior to parting of the arcing tip 40, on contact blade 41, from the secondary contact fingers 29, high pressure air is admitted to the arc chute through air line insulator 31. As the arc forms on parting of the arcing tip and the secondary fingers, it is transferred from the secondary fingers to arcing electrode 24 due to the flow of high pressure air. This arc between the arcing electrode and the arcing tip is blow down stream in the chute splitting on arc barriers 9, 11, and 13 into several parts. Each section of the arc is blown and expanded along the arc barriers until interruption takes place. Immediately after the current is interrupted and the recovery voltage surges toward crest, a part of the original arc is re-established through probe 8 and resistor 22 if the recovery rate is sufficiently high. The resistor is connected between points 20 and 30. This in effect places the resistor and the arc from the resistor probe to the blade tip in series across the arc chute. At next resistor current zero, this smaller current is interrupted entirely without voltage distress and at a low recovery rate. The products of interruption are rapidly moved through cooler plates 12 and thence up exhaust tube 2 through muffler plates 1 into the exhaust header. The contact blade continues its opening stroke out of the arc chute to the fully open position.

To remove the arc chute from the breaker and disassemble proceed as follows:

1. Loosen the bolts holding the clamping plate and gasket at the upper end of the exhaust tube. Remove exhaust tube 2 by removing bolts 3 through clamp plates 4 and 6.

2. Remove the flat interphase insulators attached between the arc chute and the side of the breaker housing.

3. Remove nuts 33 holding the air line insulator clamp plate 35 and slide the clamp plate toward the rear of the air line insulator. Remove the bolts holding the clamp plate and spacer block on the air manifold end of the air line insulator. By sliding out the spacer block, there is sufficient clearance to remove the air line insulator 31.

4. Remove bolts 23 from pedestal 21 and bolts attaching the arc chute support 18 to the arc chute. Remove the arc chute through front of the breaker cell.

5. Remove the bolts holding the contact support 25 to the contact adapter 27 and slide the stationary contact assembly out through the bottom of the chute.

6. For purposes of inspection, the condition of the arc chute can be observed through the opening from which the stationary contact assembly has been removed. The condition of the bottom plate 15, arc barriers 9, 11, 13 and throat block 37 should be particularly noted. In general the bottom arc barrier 13 can erode approximately 1 1/4" in length before replacement is necessary.

For replacement of the internal parts of the arc chute the side plate should be removed. Remove all nuts and screws from one side of the arc chute. Use a soft mallet and tap the side plate upward, when lying flat on one side, being careful to keep the plate as near level as possible to prevent forcing the fibre joints, or producing undue strains on any of the parts. With the side plate removed, the internal parts can be easily replaced. Fibre warps rapidly under changing moisture conditions and the arc chute, once disassembled, should be reassembled as soon as possible to eliminate unnecessary work in matching the parts.

ASSEMBLY OF THE ARC CHUTE

In the explanation of the assembly, it will be assumed that the arc chute has been completely disassembled.

To one of the side plates 7 Fig. 4, attach the throat block 37 being careful that the slots in the throat block line up properly with the grooves in the side plate. Place this assembly flat on a work bench or table with the grooves up so that other fibre parts can be fitted. Fit the guide block 38, top plate 34, and block 39 to the back plate 36. By means of a short bolt through block 39 and top plate secure the tapped metal plate in position. Then place this assembly on the side plate with tongues and grooves properly aligned. Drive the assembly tight using a soft mallet. A smooth drive fit is required but in no case should the parts be forced. Place the end plate 16 and front plate 10 in the proper grooves, and drive tight. Drive bottom plate 15 in place, making sure that the packing 17 is fitted properly. Put the contact adapter 27 in place. Place packing 14 and the spacing block between bottom plate and contact adapter as shown and fasten with screws to the contact adapter. Place arc barriers 9, 11, 13, in proper grooves making sure that the tapered section on the leading edge of barrier 13 is placed with the longer taper adjacent to barrier 11. Place cooler plates 12 between the proper arc barriers, and put the remaining throat block in place and drive it down until flush with the outside edges of the arc barriers and back plate.

Start the remaining side plate from the back being sure to have the tongue and groove properly aligned. Insert three of the studs that pass through the back plate and tighten the nuts hand tight. Work the side plate on from the back to the front being careful not to force on overstress the fibre parts.

Put the remaining studs through the arc chute with the center studs passing through the cooler plates 12. Tighten all studs being careful to tighten all equally. Tighten the screws holding the side plates to the contact adapter and the throat block.

With the gasket 26 in position, place contact support 25, complete with the stationary contact assembly in the arc chute and hold in place with screws.

It must be remembered during the assembly of the arc chute that all joints must be tight and all gaskets must be flat and compressed to prevent leakage of gas during the interruption of a fault.

Due to the tendency of fibre to warp slightly after being machined, it is possible that a certain amount of fitting will have to be done during assembly of the arc chute. Parts which must be fitted should be worked with care to assure tight joints on the finished chute.

Recheck all nuts and screws holding side plates and be sure they are properly tightened before final assembly in the Air-blast Circuit Breaker housing.

To replace the arc chute in the breaker housing proceed in the reverse order with instructions describing removal.

Before operation the breaker should be manually closed and the clearance between contact blade 41 and the arc chute checked. (See section on "Adjustment of Arc Chute").

STATIONARY CONTACTS

The stationary contact assembly is mounted in the arc chute as shown in Fig. 4. It consists of main contact fingers, 28, secondary contact fingers 29 and arcing electrode 24 which are mounted on contact support 25.

The assembly of one half of the main contact fingers in cross section is shown in Fig. 5A. The outside fingers are held by lighter springs than the inside pair of fingers. The fingers 1, and springs 2, 3, and 5, are assembled with the finger bolt 4 through the hole in the contact support. The nut on the end not shown is tightened until the bolt projects approximately 1/16" and the end of the bolt should then be spun over to prevent loosening.

The assembly of one-half of the secondary fingers is also shown in Fig. 5A, which is a cross section through one of these fingers. To assemble, fasten the laminations 9 to the secondary contact fingers 15. Place the finger bolt 10, through the secondary fingers, place springs 13 and 14 over the finger bolt, then place the bolt into the retainer 12 and tighten nut 11 until the bolt shoulders. Spin the end of the bolt over to prevent loosening. Fasten this assembly to the contact support 6, with the bolts 8.

After all fingers are assembled on the contact support fasten the arcing electrode 24, Fig. 4, to the contact support with the shouldered screws provided. The stationary contact assembly is then ready to be placed in the arc chute as previously described.

WIPING CONTACTS

The wiping contact assembly maintains the electrical connection between the contact stud of bushing 25, Fig. 2, and the contact blade 15 by means of contact fingers which provide a wiping contact when the breaker mechanism is operated. The detailed assembly of the wiping contact is shown in Fig. 5B.

To remove the wiping contact fingers it is first necessary to remove the split connector 7 and then the pins 6. To assemble the contact fingers in the retainer, cross a pair of fingers 5 and place the springs 4 in the countersunk holes, as shown. Insert a pair of fingers and slide the pin 6 in to hold the fingers until the next pair is in place. The wiper 2 is used to wipe the movable contact to prevent grit and dust from entering the wiping contact assembly. The wiper is held in place with retainer 3.

It will be necessary to check the alignment of the assembly if the connectors 7 are removed and reassembled. In some cases it might be more advisable to remove the contact blade from the assembly and remove the fingers toward the center by removing the central pins 6 instead of the outside pins. This method should not affect the alignment of the assembly.

There is no adjustment of this assembly other than to align the entire contact support to place the contact blade on the center line of the arc chute. This should not be required unless the entire assembly or supporting insulator 27, Fig. 2 is replaced or the contact fingers are removed by the first method given above. The supporting insulator assembly is furnished with four leveling screws secured by socket head screws. Line up of the assembly is afforded by the four leveling and adjusting screws.

CONTROL VALVES

The closing and opening control valves are identical in principle of operation and largely so in physical parts. The main distinction between the opening and the closing control valve is the addition of a manual trip and low pressure lockout device to the opening valve. For the purpose of description, the opening control valve is shown in cross section in Fig. 6. This description applies equally well to the closing control valve except as herein noted.

The opening and closing control valves are electro-pneumatically operated to control the flow of high pressure air from the air receiver to the operating cylinders of the breaker mechanism. Both valves are attached to the end of the front booster cylinder. The opening control valve is pneumatically connected from the air receiver to the two opening booster cylinders and the opening dashpot cylinder. The closing control valve, mounted on the front booster cylinder for convenience, is connected pneumatically from the air receiver to the closing cylinder. Both valves consist of the following principle parts. (Refer to Fig. 6).

1. An enclosing valve body 19.
2. A main valve piston 18.
3. An armature and pilot valve piston 12.
4. A solenoid operating coil 10.
5. A pressure timing chamber 32.
6. In the case of the opening control valve only, an operating shaft 1 for the manual trip and lockout device.

OPERATION

The operation of the opening and closing control valves is fundamentally the same, therefore this section will also be treated collectively.

When the control valves are in the normal or closed position, the spring 16 plus an unbalance of air pressure above the main valve 18 holds the main valve against the seat 22, thereby closing the valve The leakage of air around the top flange of the main valve equalizes the pressure between the air space 24 and the upstream side. The area on which this pressure acts is greater than that exposed to the downstream air so an unbalance condition is obtained which holds the valve against the seat 22. The air trapped in the space 24 above the main valve is retained by the pilot valve 12 which is held against its seat 15 by spring 9.

To operate the valve, the solenoid coil 10 is energized electrically and attracts the pilot valve 12 into the coil frame 31 causing it to move upward off its seat 15. When the pilot valve moves, the trapped air escapes through the pilot valve seat 15 into the timing chamber 32. The release of the air above the main valve no longer maintains the unbalanced force condition necessary to hold the main valve closed, therefore the main valve 18 moves up off its seat 22 and allows the passage of air through the valve from the air receiver to the operating cylinder. When the main valve moves up, the probe 26 seated in the main valve engages the pilot valve and holds it up after the solenoid coil has been deenergized by the opening of an auxiliary switch in the breaker control circuit. The pilot valve 12 therefore can not return to its seat 15 until the main valve 18 has returned to its seat 22. The main valve is closed by means of an unbalance of forces on the piston. During the time that the main valve is lifted from its seat, air leakage around the valve fills the timing chamber air space 32, air passage 27 and air space 24 to the required pressure necessary to close the main valve 18. As soon as the pressure in the timing chamber reaches the necessary valve, the main valve returns to its normal position. The probe 26 allows the pilot valve 12 to seat, the high pressure air trapped in the timing chamber 32 bleeds into the atmosphere through the timing port 4, and the conditions for normal opening are restored.

The area of timing port 4 as compared with the leakage around the main valve piston determines the time required to build up sufficient pressure in the timing chamber air space to close the valve, as adjusted in the factory, the valve is held open 8 to 10 cycles after the mechanism has completed an operation. By this arrangement, the valve timing is pneumatically controlled, both seal-in and cutoff.

In order to obtain trip free operation, it is necessary to give preference to the opening control valve over the closing control valve. This is especially important with the pneumatic seal-in arrangement. Referring to Fig. 3, the air line 3 is connected between the down-stream side of the opening valve and the timing chamber of the closing valve. When the opening valve is energized the flow of air through this line closes the closing control valve and holds it closed by rapidly increasing the pressure in the closing valve timing chamber. This air line 3 is provided with a check valve to prevent the flow of air from the closing valve timing chamber to the opening line when the closing valve is operated normally.

The pneumatic interlock pressure switch 63CI which mounts on the opening control valve deflector is also connected to the timing chamber of the closing control valve. Its contact, Fig. 12, which is in series with the closing relay coil, is normally closed and opens when the pressure in the timing chamber is greater than 80 p.s.i. and closes when the pressure falls to 30 p.s.i. Since operation of the opening valve builds up pressure in the closing valve timing chamber, the function of the switch is to prevent energization of the closing valve solenoid coil until the pressure in the timing chamber has dropped sufficiently to allow a complete normal operation of the closing control valve.

DISASSEMBLY

To disassemble the control valves, proceed as follows, referring to Fig. 6.

1. Remove all air fittings and the four holding bolts between the valve and the booster cylinder casting.

2. Remove the cap 3 from the timing chamber body 6 and push the coil leads inside after loosening the grommets 33. Remove the timing chamber which is held in place by three socket headscrews inserted from below.

3. Note carefully the position of the coil frame so it can be reassembled to the same position. After loosening the set screws 29 remove the coil frame and coil assembly from the valve body using spanner wrench M-6318667 P-1. The pilot valve 12 is free to be removed from the coil frame which still contains the solenoid coil 10.

4. After removing shims remove retaining ring 14 using special wrench M-6318623 G-1. Then remove pilot valve seat 15, gasket 25, spring 16, probe 26, and main valve 18. In reassembling place gasket 25 over pilot valve seat 15 and use retaining ring 14 to locate the pilot valve seat correctly and tightly.

5. To replace the main valve disc 23, unscrew the valve stem 21 from the valve piston after first removing the set screw 17.

6. The pilot valve disc 13 is crimped in place and replacement of it will require a new pilot valve and armature 12.

7. To replace the solenoid coil 10 disassemble the two coil frames 30 and 31 which are screwed together and locked by means of two prick punches in V-grooves in the lower coil frame 30.

ADJUSTMENT

If no parts have been replaced, the valve should require no adjustments when reassembled provided the coil frame has been located in its original position.

If the pilot valve and armature 12 has been replaced it may be necessary to adjust the position of the coil frame. The probe lift, amount probe 26 lifts pilot valve 12, (.045" minimum to .065" maximum) can be measured by pushing the valve stem from the bottom until the main valves stops against the bottom of the pilot valve seat 15. Adjust the coil frame by inserting shims on top of the retaining ring 14 so that the lift of the pilot valve when the coil is energized is from .005" to .010" greater than the probe lift.

If the main valve 18 is replaced it will be necessary to check the timing of the valve to see that the valve closes between 18 and 25 cycles. Since the clearance between the main valve and the valve body may be different it may be necessary to change the size of the timing port 4. Increasing the size of the timing port will increase the valve time.

BLAST VALVE AND DAMPER

The mechanically operated blast valve, Fig. 7, regulates the flow of high pressure air from the air receiver through the air line manifold and into each arc chute. Operation of the blast valve supplies high pressure air to the arc chute prior to contact parting on the opening stroke and prior to contact making on the closing stroke. The valve is held open mechanically long enough to insure maximum chute pressure during the period of interruption. The typical operating curves, Fig. 11, show the position of the breaker stroke at which the blast valve operates.

Referring to Fig. 7, when the mechanism is operated either closing or opening, rotation of the main mechanism shaft 13 moves the blast valve cam 12 until it engages the roller 14 of the valve operator 10. The blast valve operator then engages the blast valve stem cap 35 moving the valve stem 37 upward and lifting the blast valve disc 4 from the valve body 34. This opens the valve and admits air through the valve body into the air line manifold 22. Further rotation of the mechanism disengages the blast valve cam 12 from the blast valve operator 10. The combined force of the spring 36 and the unbalanced pressure on top of the valve disc retainer 2 causes the blast valve to rest inself.

In order to conserve air in the air receiver, a damper mechanism is incorporated with the blast valve to limit the flow of air into the arc chute on a closing operation. This is possible because the need for high pressure air is much less on closing than on opening.

The damper 26, rotates about the shaft 28 and is actuated by air piston 21 and spring 20. Air cylinder 18 has two air inlets 15 and 16. Spring 20 normally holds the damper 26 open but on an opening operation air entering inlet 16 coming from the front opening booster cylinder holds the piston 21 as shown. Air is admitted through the air inlet 16 on opening to assure, if necessary, fast opening of the damper following a closing operation.

On a closing operation, air from the closing cylinder enters air inlet 15 behind the piston 21 and moves connecting rod 30 which rotates crank 29 and closes the damper during the closing operation.

To disassemble the blast valve for inspection of the blast valve disc 4, proceed as follows:

1. Remove the bolts and the inspection cover 1, Fig. 2 from the top of the air receiver. This inspection hole is directly opposite the blast valve assembly.

2. Move spring retainer 7, Fig. 7, upward compressing spring 36 to expose pin 8. With the spring retainer held in this position, drive the pin 8 out of the blast valve stem 37. This allows removal of the blast valve stem cap 35 from the blast valve stem.

3. Reach through the inspection hole in the air receiver and remove the blast valve assembly of stem 37, valve disc 4, valve disc retainer 2 and ring 3. Visual inspection can then be made of the condition of the blast valve disc.

To remove the entire blast valve body, proceed as follows:

1. Remove the pin coupling connecting rod 30 to crank 29.

2. Remove the bolts holding the clamping ring 23 and adapter 25 to valve body 34 and slide the clamping ring, gasket 24, and adapter down on the air line manifold 22.

3. Remove bolts 38 which fasten the blast valve body to the air receiver. Lower and turn the blast valve body to remove it from the breaker.

To complete the disassembly of the operating mechanism of the damper:

1. Remove air lines from air inlets 15 and 16.

2. Remove bolts holding cylinder 18 to mechanism frame 9. This will permit removal of the spring 20 and piston 21.

The blast valve has been correctly installed and adjusted in the factory. However, after each inspection of the blast valve disc, or removal of the blast valve, it is necessary to check the clearance between the blast valve stem cap 35 and the operating button 33 in the fully closed position. With 250 p.s.i. in the air receiver, this clearance should be 3/32 in. + 1/32 in. and is obtained by varying the shims 32 under the operating button 33.

MANUAL TRIP AND LOW PRESSURE LOCKOUT

The ARA circuit breaker is equipped with a manual trip and low pressure lockout device which is attached to the manual trip shaft of the opening control valve. This device is to allow operation of the breaker when electrical control is lost but to prevent operation at tank pressures lower than required for satisfactory interruption of any fault current. The device prevents the manual tripping of the breaker when the pressure in the air storage tank is below 185 p.s.i. This device is shown in Fig. 8 and mounts on the top of the opening control valve. Operation of the manual trip lever 23 lifts the trip valve shaft 26 picking up the pilot piston of the control valve. Operation of the control valve follows as outlined under the section CONTROL VALVE. The principle of operation of this device is as follows:

Air storage tank pressure is admitted into air chamber 10, and actuates the pressure bellows 9. Action of the pressure bellows is transmitted to the lockout arm 3 by means of bellows rod 11. The lockout arm pivots about pivot pin 12. Under low pressure conditions the lockout arm assumes the position as shown in Fig. 8 which prevents operation of manual trip lever 23. Under normal pressure conditions the lockout arm moves to the right of position shown in Fig. 8 and allows operation of the manual trip lever. The action of the pressure bellows 9 is counterbalanced by springs 14 and 18 which can be adjusted by adjusting nuts 16 and 19. By use of these nuts, the operating range of the device can be selected. The differential between pick up and drop out is adjusted by positioning of the magnets 4 and 6 by means of adjusting screws 5 and 7. These magnets tend to hold the lockout arm in each position and determine the differential of air pressure on the bellows 9 to cause operation. The lockout arm 3 should always stop on the frame stop 8 and not on either magnet 4 or 6. As set in the factory there is a slight clearance between these magnets and the lockout arm.

The holding magnet 22 assures that a definite force is required to move the manual trip lever 23. This assures that the opening control valve cannot be shocked open. Stop nut 21 is adjusted so that the manual trip shaft neither lifts or tends to close the pilot piston of the opening control valve. Auxiliary manual trip lever 24 is provided as an extension for manual trip lever 23 on breakers with deep operating mechanisms.

PRESSURE SWITCH

There are four pressure switches furnished with the ARA circuit breaker similar to that shown on Fig. 9. There is a pressure switch in both the closing and opening control circuits as shown in the wiring diagram, Fig. 12. The object of these switches is to prevent the operation of the breaker at a pressure lower than that required for satisfactory operation. The third pressure switch operates an alarm indicating a condition of low pressure in the air receiver. These pressure switches are located on the breaker control panel at the front of the metal cell. The fourth pressure switch has been described in the section on CONTROL VALVES. Referring to Fig. 9, the mechanics of these switches is as follows:

Each of the first three switches is connected to an air manifold which in turn is piped to the air receiver. Pressure for operating the switch enters the pressure cylinder 12 through the air inlet 11. The air pressure then acts on the pressure bellows 10 to move the piston rod 14. Piston rod 14 acts on beam 9 which is pivoted at the beam pivot 15. When beam 9 is actuated by piston rod 14, it in turn loads the contact arm 4 which is free to turn about the contact arm pivot 6. The force of the piston rod 14 is counterbalanced by spring 16 and the adjusting screw 19. When the force exerted on beam 9 by spring 16 is greater than the force exerted by the piston rod 14, the contacts 1 are held in the open position. As the pressure in the air storage tank increases the force exerted by the pressure bellows 10 through piston rod 14 on beam 9 increases and the contacts 1 close.

There are two adjustments on the pressure switch. Adjusting screw 19 can be turned through the top of the moulded case 17 by means of a screw driver. Thus the compression of spring 16 can be varied. Adjusting cam 2 can also be rotated by means of a screwdriver through a slot in the moulded case 17 to vary the contact point of contacts 1. This later adjustment determines the differential between contact making and contact parting. Electrical connection is made to the switch at terminal screws 3 and 7.

As set in the factory the pressure switch in the closing control circuit is set to open at 200 lbs. on the condition of decreasing air pressure. On increasing air pressure the contacts should close approximately 10 lbs. higher than drop out value.

The alarm switch is set to close its contacts when the pressure in the air receiver falls below 230. All of these pressure switches are provided with a cover which can be removed for inspection of the contacts and internal parts. The adjustment of these switches should be checked at every major inspection period as outlined in the section SERVICING.

DOUBLE ACTING CHECK VALVE

Each breaker is equipped with a double acting check valve, Fig. 10, in the air supply line. The purpose of this valve is to block too rapid a flow of air into the breaker air receiver and to prevent any reverse flow of air from the breaker air receiver back into the air compressor system. Thus, should the compressor system fail, there will be sufficient air retained in the breaker air receiver to operate the breaker and also should the blast valve stick in the open position, the entire air system will be protected from exhaustion.

The piston 3, Fig. 10, seats against the valve body 1 under normal conditions as shown so that the gasket 2 forms an air tight seal to prevent reverse flow: When the supply valve is opened, the air pressure on the upstream side of the piston 3 overcomes the force of springs 6 and 7 and forces piston 3 and gasket 2 away from its seat. Flow is thus established through the valve. If the rate of flow is too great (60 p.s.i. differential approximately) the valve surface 4 of the piston 3 seats on the valve cap 5 and hence shuts off the flow of air. The valve will thus remain closed until the upstream pressure at the check valve body is decreased to less than the spring force. This can be effected by closing the breaker inlet valve; the seat of the valve surface 4 on the valve cap 5, being metal to metal will leak slightly so that air trapped between the inlet valve and check valve will gradually leak past the piston, allowing the pressure to drop and the check valve to reset.

When filling the breaker air receiver, the inlet valve should be opened slowly in order to prevent the check valve from sealing shut because of excessive pressure differential. If this occurs, the inlet valve should be closed until the check valve resets as described above. Resetting can be determined by a slight "thump" at the check valve.

To replace or inspect the gasket 2, disassemble as follows:

1. Remove valve cap 5 by unscrewing from valve body 1.
2. Remove springs 6 and 7.
3. Remove piston 3 from valve body.
4. If necessary, the gasket 2 can be replaced by removing retaining screw 8.

SAFETY VALVE

Each breaker air receiver is equipped with a safety valve for protection against over pressure conditions. This valve has been adjusted by the valve manufacturer to blow off at the value indicated on the valve nameplate. Each valve has been tested for leakage before installation on the breaker. No attempt should be made to readjust or change the setting of these valves.

DRAIN VALVE INTERLOCK

The drain valve or blow-off valve, is interlocked with the mechanism and the maintenance closing device so that the maintenance closing device cannot be used unless the drain valve is open and the drain valve cannot be opened, or closed, unless the breaker mechanism is in the fully open position. Figure 14 shows the drain valve in the fully opened position.

An extension to the handle of the drain valve 6 and a guard 4 are connected so that the guard covers the end of the mechanism shaft 3 when the drain valve is closed and leaves the end of the shaft free to receive the maintenance closing device when the drain valve is open. A pin 5 welded to the guard rides in a slot in the shaft and prevents movement of the guard, and consequently operation of the drain valve, except when the breaker mechanism is in the fully open position.

MAINTENANCE CLOSING DEVICE

A maintenance closing or manual device, Fig. 13, is provided in order to manually close and open the breaker during installation adjustments and maintenance. The manual device fits over the right hand end of the mechanism operating shaft, the end of which is machined in the shape of a hexagon. A hook bolt and wing nut hold the manual down to the channel across the front of the breaker housing. The manual and breaker receiver drain valve are interlocked so that it is necessary to open the drain valve before the manual can be installed. This is done by a cover over the end of the shaft which also serves to interlock the manual with the breaker mechanism by preventing the placing or removal of the manual device on the shaft unless the breaker is in the fully open position.

RENEWAL PARTS

When ordering renewal parts, address the nearest Sales Office of the General Electric Co.

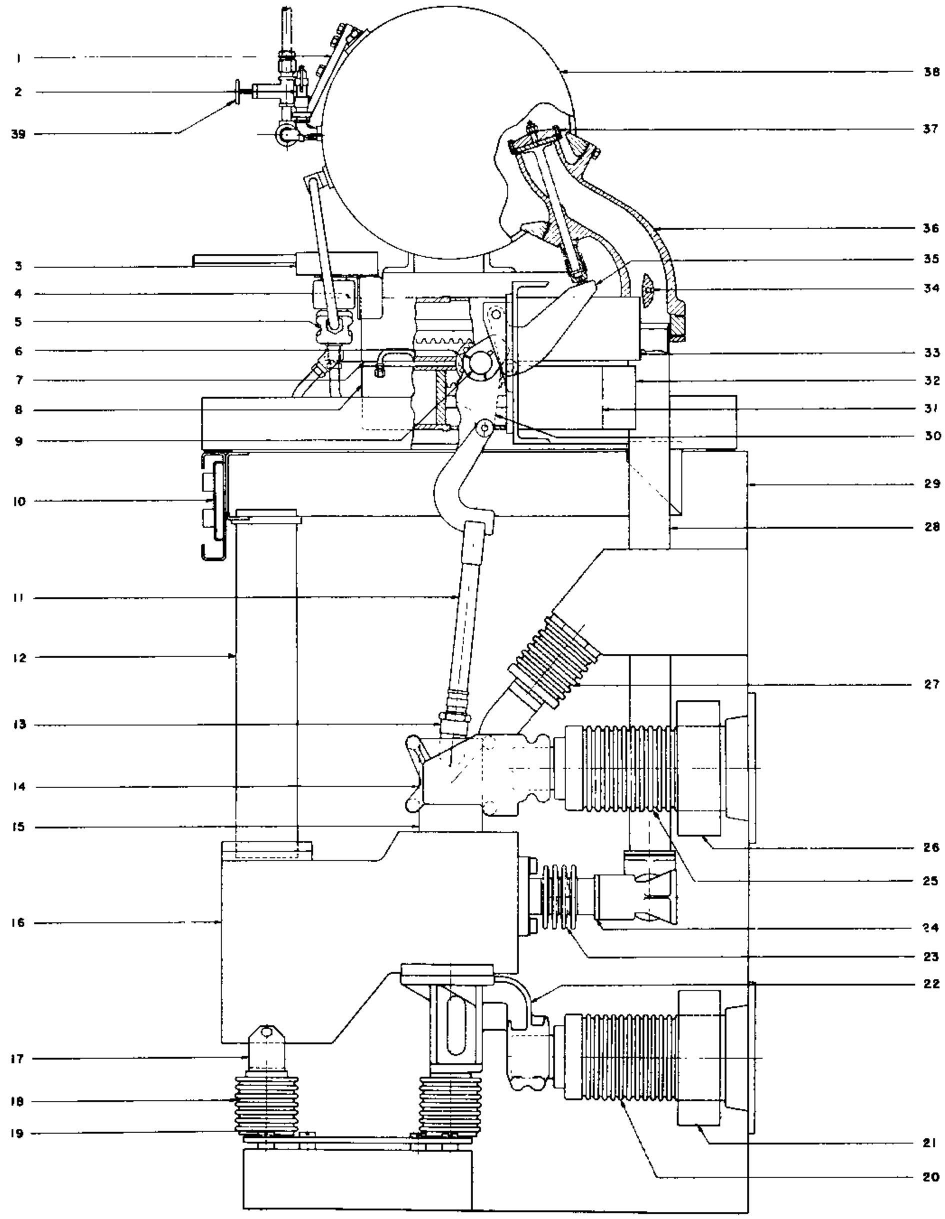
Give the Reference Number and Name of the part as shown in this Instruction Book; together with all the information that appears on the Nameplate on the mechanism.

Specify the quantity of each part required.

If available, furnish also the Requisition Number under which the apparatus was furnished.

RECOMMENDED RENEWAL PARTS

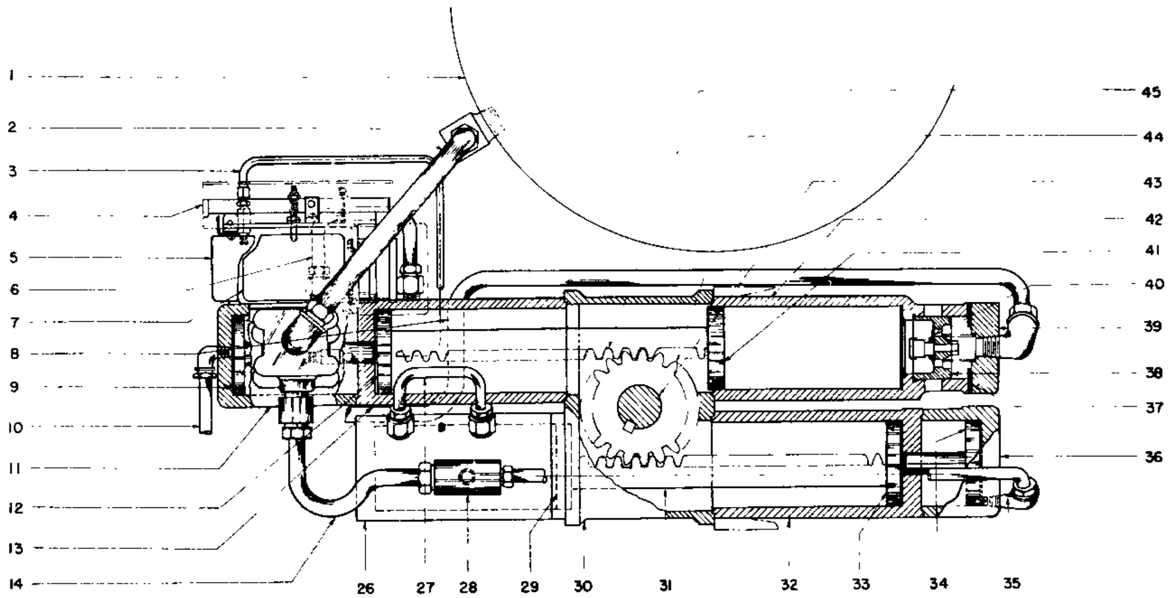
For a list of renewal parts recommended for retention as stock, refer to the initial pages of the Instruction Book of which these breaker instructions form a subdivision.

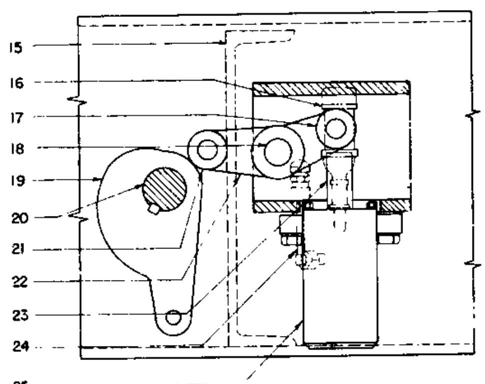


1. Inspection Cover
2. Safety Valve
3. Manual Trip Mechanism
4. Front Booster Cylinder
5. Control Valves
6. Gear
7. Main Opening Cylinder
8. Opening Dashpot Cylinder
9. Mechanism Shaft
10. Control Panel
11. Operating Rod
12. Exhaust Tube
13. Coupling
14. Wiping Contact Support
15. Contact Blade
16. Arc Chute
17. Arc Chute Support
18. Support Insulator
19. Leveling Screw
20. Bushing
21. Bushing Current Transformer
22. Pedestal
23. Air Line Insulator
24. Clamp Plate
25. Bushing
26. Bushing Current Transformer
27. Support Insulator
28. Air Line Manifold
29. Breaker Housing
30. Crank
31. Closing Dashpot Cylinder
32. Rear Booster Cylinder
33. Closing Cylinder
34. Blast Valve Damper
35. Blast Valve Operator
36. Blast Valve Body
37. Blast Valve
38. Air Storage Receiver
39. Inlet Valve

Fig. 2 Typical Single Pole Unit

Fig. 2 (W-6190609)

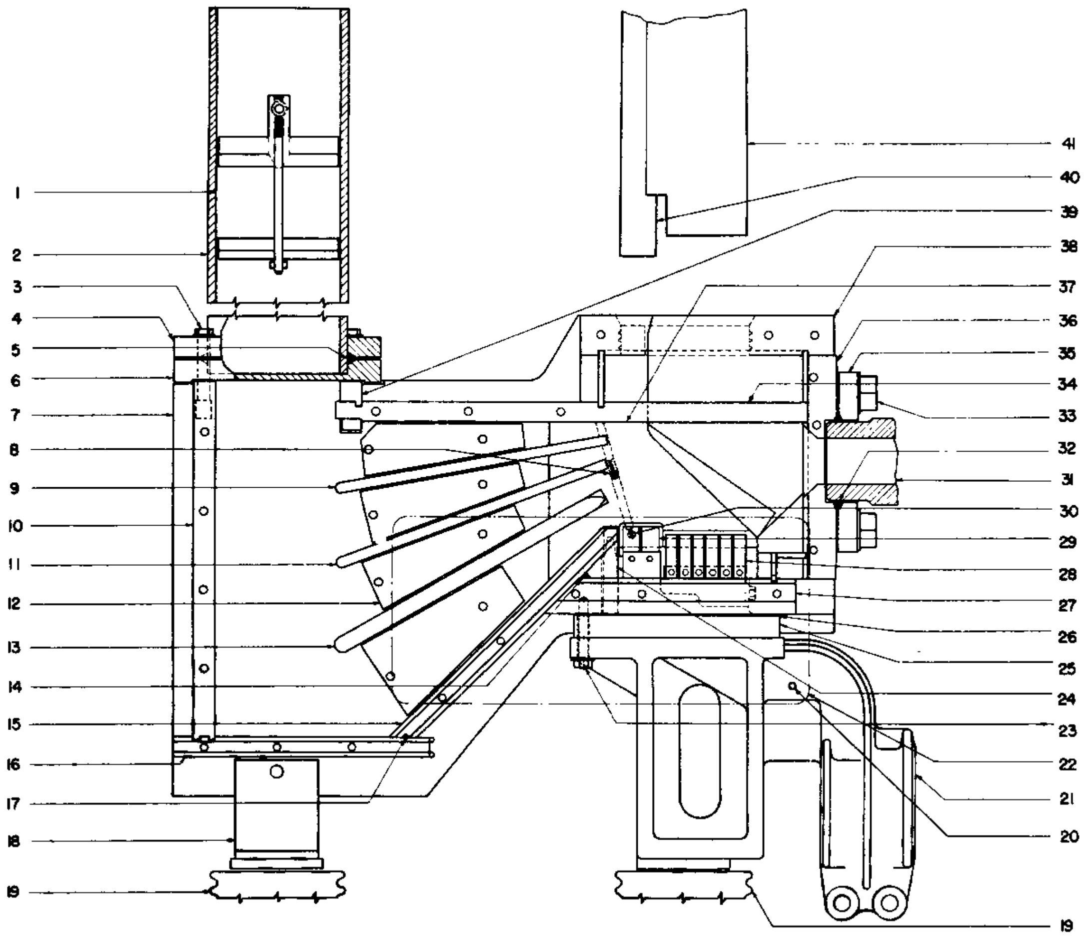




1. Air Receiver
2. Air Line
3. Air Line
4. Manual Trip
5. Closing Control Valve
6. By Pass
7. Opening Control Valve
8. Air Line
9. Front Booster Piston
10. Air Line
11. Front Booster Cylinder
12. Main Opening Piston
13. Main Opening Cylinder
14. Air Line
15. Mechanism Frame
16. Breather
17. Roller
18. Pin
19. Cam and Crank
20. Mechanism Shaft
21. Roller
22. Crank
23. Dashpot Piston Stem
24. Oil Level Gauge
25. Oil Dashpot
26. Opening Dashpot Cylinder
27. By Pass
28. Air Line Coupling
29. Opening Dashpot Piston
30. Gear Housing
31. Rack
32. Closing Dashpot Cylinder
33. Closing Dashpot Cylinder
34. Rear Booster Piston
35. Air Line
36. Rear Booster Cylinder
37. Buffer
38. Dump Valve Piston
39. Dump Valve Cap
40. Dump Valve Flapper
41. Closing Piston
42. Closing Cylinder
43. Mechanism Shaft
44. Gear
45. Rack

Fig. 3 Operating Mechanism

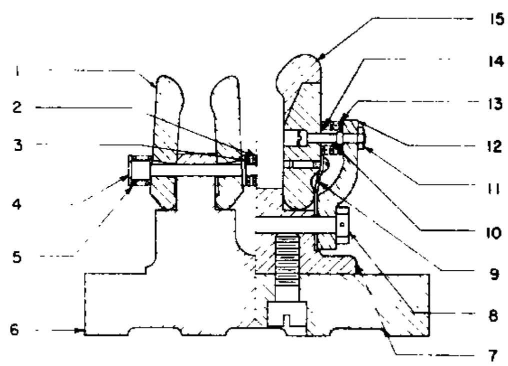
Fig. 3 (W-6190603)



1. Muffler Plates
2. Exhaust Tube
3. Bolt
4. Clamp Plate
5. Gasket
6. Clamp Plate
7. Side Plate
8. Probe
9. Arc Barrier
10. Front Plate
11. Arc Barrier
12. Cooler Plates
13. Arc Barrier
14. Packing
15. Bottom Plate
16. End Plate
17. Packing
18. Arc Chute Support
19. Support Insulator
20. Resistor Connection
21. Pedestal
22. Resistor
23. Bolt
24. Arcing Electrode
25. Contact Support
26. Gasket
27. Contact Adapter
28. Main Contact Finger
29. Secondary Contact Finger
30. Resistor Connection
31. Air Line Insulator
32. Gasket
33. Nut
34. Top Plate
35. Clamp Plate
36. Back Plate
37. Throat Block
38. Guide Block
39. Block
40. Arcing Tip
41. Contact Blade

Fig. 4 (W-6190615)

Fig. 4 Arc Chute



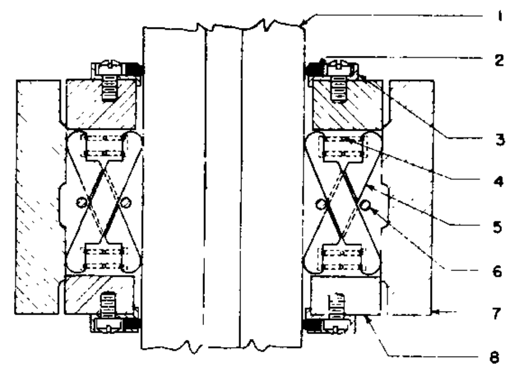


Fig. 5 (W-6190613)

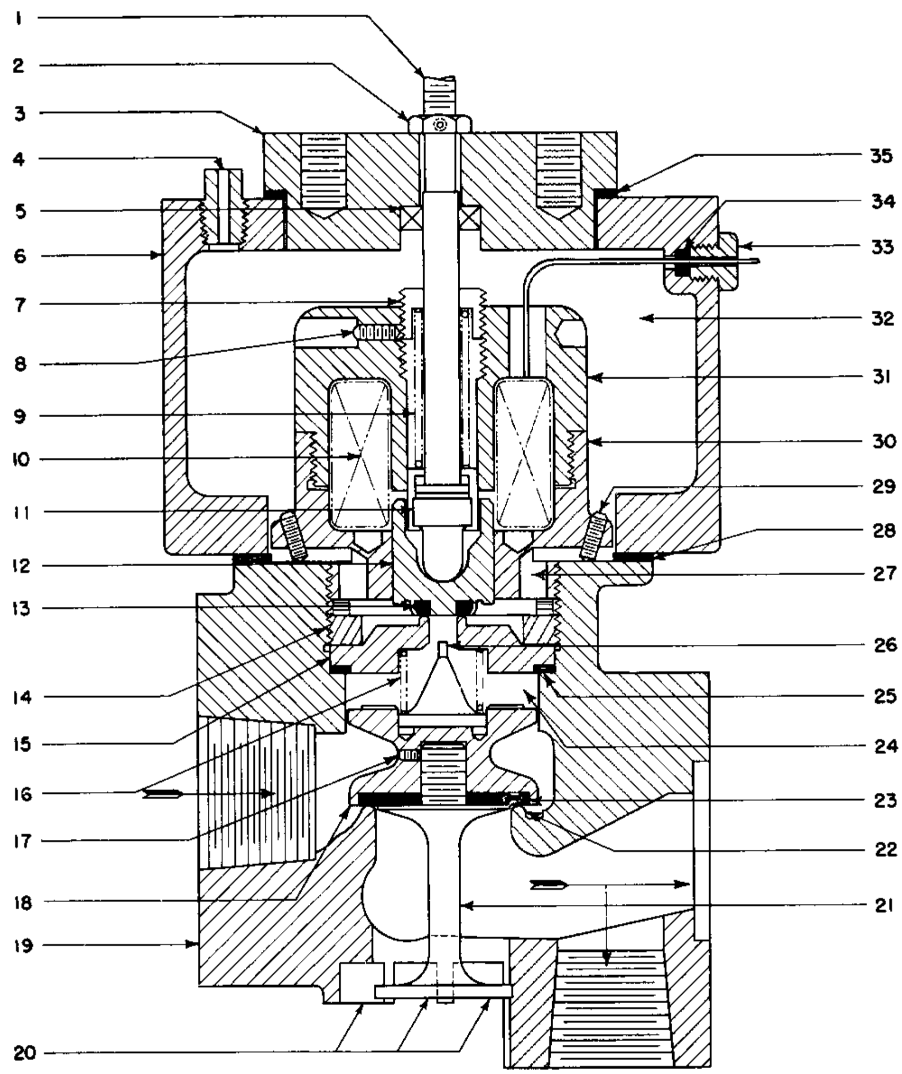
A-Stationary Contacts

1. Main Contact Finger
2. Spring
3. Spring
4. Finger Bolt
5. Spring
6. Contact Support
7. Contact Block
8. Bolt
9. Laminations
10. Finger Bolt
11. Nut
12. Retainer
13. Spring
14. Spring
15. Secondary Contact Finger

B-Wiping Contacts

1. Contact Blade
2. Felt Wiper
3. Retainer
4. Spring
5. Contact Finger
6. Pin
7. Connector
8. Contact Support

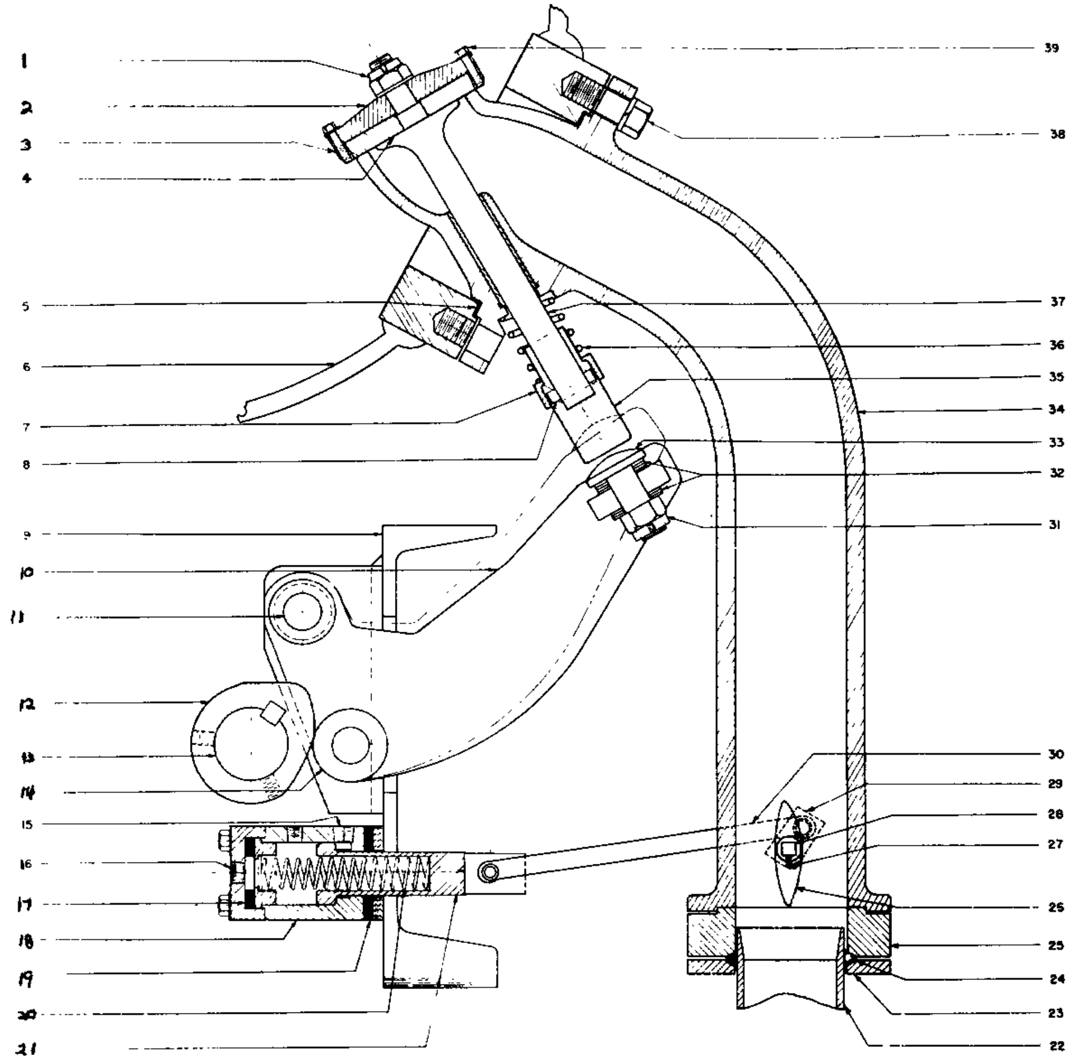
Fig. 5 Contacts



1. Shaft (Manual Trip)
2. Stop Nut
3. Cap
4. Timing Port
5. Packing
6. Timing Chamber Body
7. Adjusting Nut
8. Set Screw
9. Spring
10. Solenoid Operating Coil
11. Plunger
12. Pilot Valve and Armature
13. Pilot Valve Disc
14. Retaining Ring
15. Pilot Valve Seat
16. Spring
17. Set Screw
18. Main Valve
19. Valve Body
20. Dump Port
21. Valve Stem
22. Main Valve Seat
23. Main Valve Disc
24. Air Space
25. Gasket
26. Probe
27. Air Passage
28. Gasket
29. Set Screw
30. Coil Frame
31. Coil Frame
32. Timing Chamber
33. Grommet
34. Gasket
35. Gasket

Fig. 6 Control Valve

Fig. 6 (T-6199655)



1. Nut	14. Roller	27. Set Screw
2. Valve Disc Retainer	15. Air Inlet (Closing)	28. Shaft
3. Ring	16. Air Inlet (Opening)	29. Crank
4. Valve Disc	17. Buffer	30. Connecting Rod
5. Gasket	18. Cylinder	31. Nut
6. Air Receiver	19. Buffer	32. Shims
7. Spring Retainer	20. Spring	33. Operating Button
8. Pin	21. Piston	34. Valve Body
9. Mechanism Frame	22. Air Line Manifold	35. Valve Stem Cap
10. Valve Operator	23. Clamping Ring	36. Spring
11. Pin	24. Gasket	37. Valve Stem
12. Cam	25. Adapter	38. Bolt
13. Mechanism Shaft	26. Damper	39. Screw

Fig. 7 .Blast Valve and Damper

Fig. 7 (W-6190611)

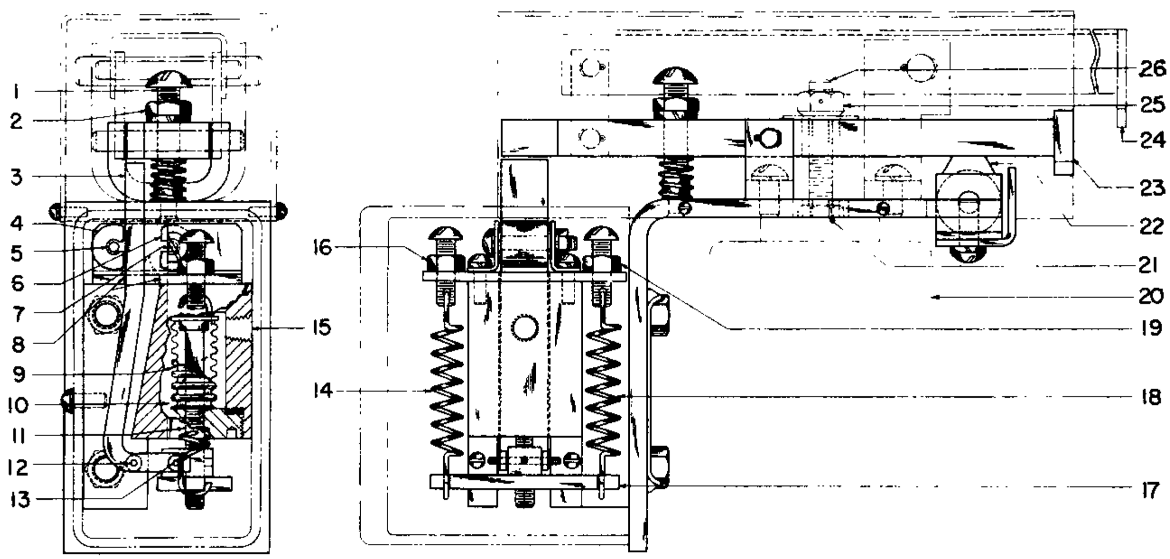


Fig. 8 (W-6190610)

1. Stop Screw
2. Locknut
3. Lockout Arm
4. Magnet
5. Adjusting Screw
6. Magnet
7. Adjusting Screw
8. Frame Stop
9. Pressure Bellows
10. Air Chamber
11. Bellows Rod
12. Pivot Pin
13. Pivot Pin
14. Spring
15. Air Inlet Connection
16. Adjusting Nut
17. Spring Plate
18. Spring
19. Adjusting Nut
20. Opening Control Valve
21. Stopnut
22. Holding Magnet
23. Manual Trip Lever
24. Auxiliary Manual Trip Lever
25. Nut
26. Trip Valve Shaft

Fig. 8 Manual Trip and Low Pressure Lockout

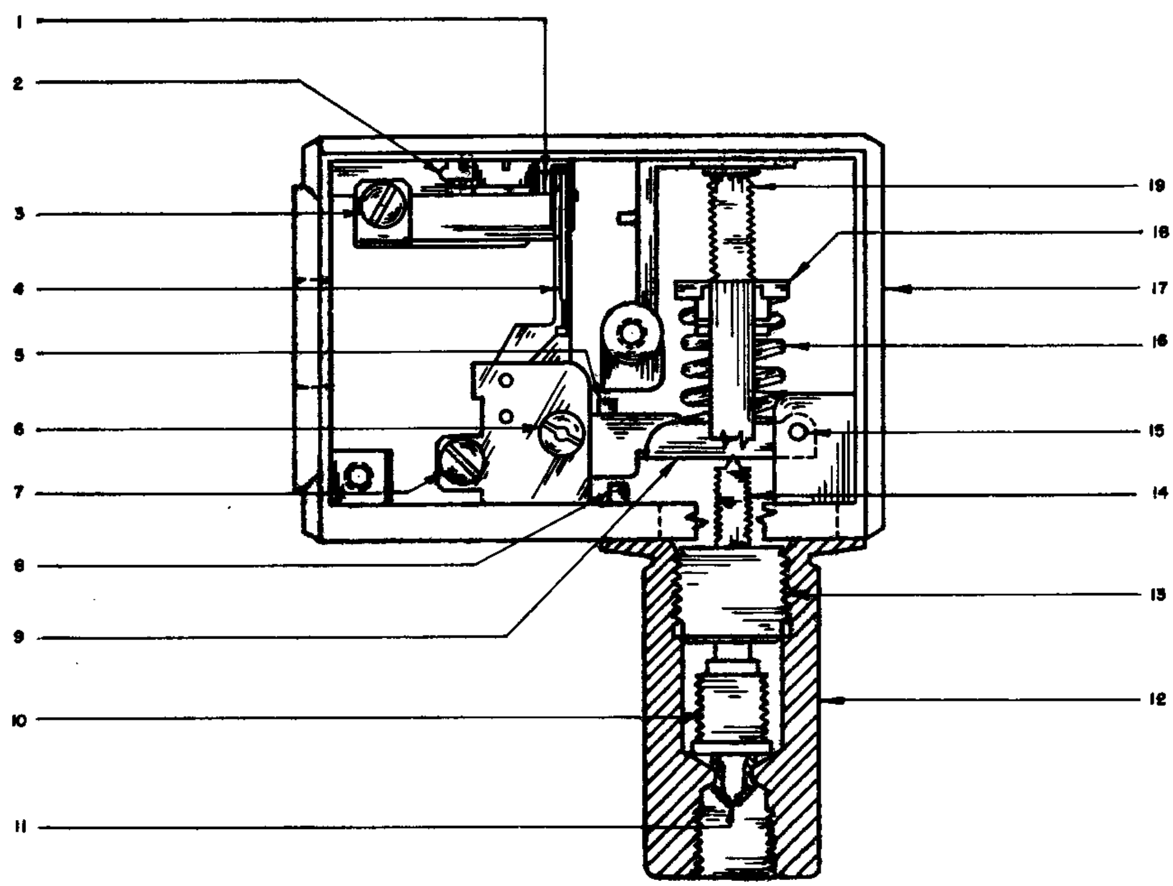
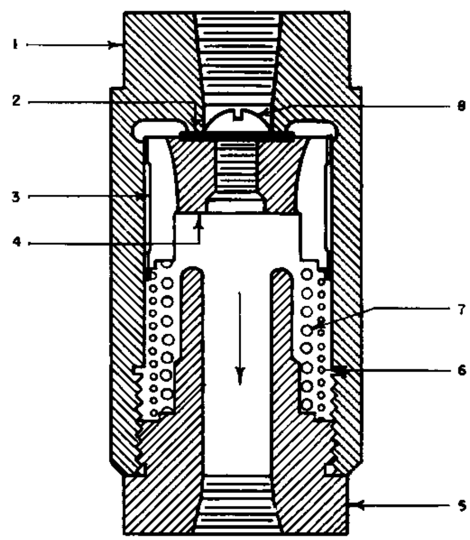


Fig. 9 (M-6197697)

1. Contacts
2. Adjusting Cam
3. Terminal Screw
4. Contact Arm
5. Stop Block
6. Contact Arm Pivot
7. Terminal Screw
8. Stop Block
9. Beam
10. Pressure Bellows
11. Air Inlet
12. Pressure Cylinder
13. Gland Nut
14. Piston Rod
15. Beam Pivot
16. Spring
17. Moulded Case
18. Spring Retainer
19. Adjusting Screw

Fig. 9 Pressure Switch

Fig. 10 (M-6197699)



1. Valve Body
2. Valve Disc
3. Piston
4. Valve Surface
5. Valve Cap
6. Spring
7. Spring
8. Retaining Screw

Fig. 10 Double-Acting Check Valve

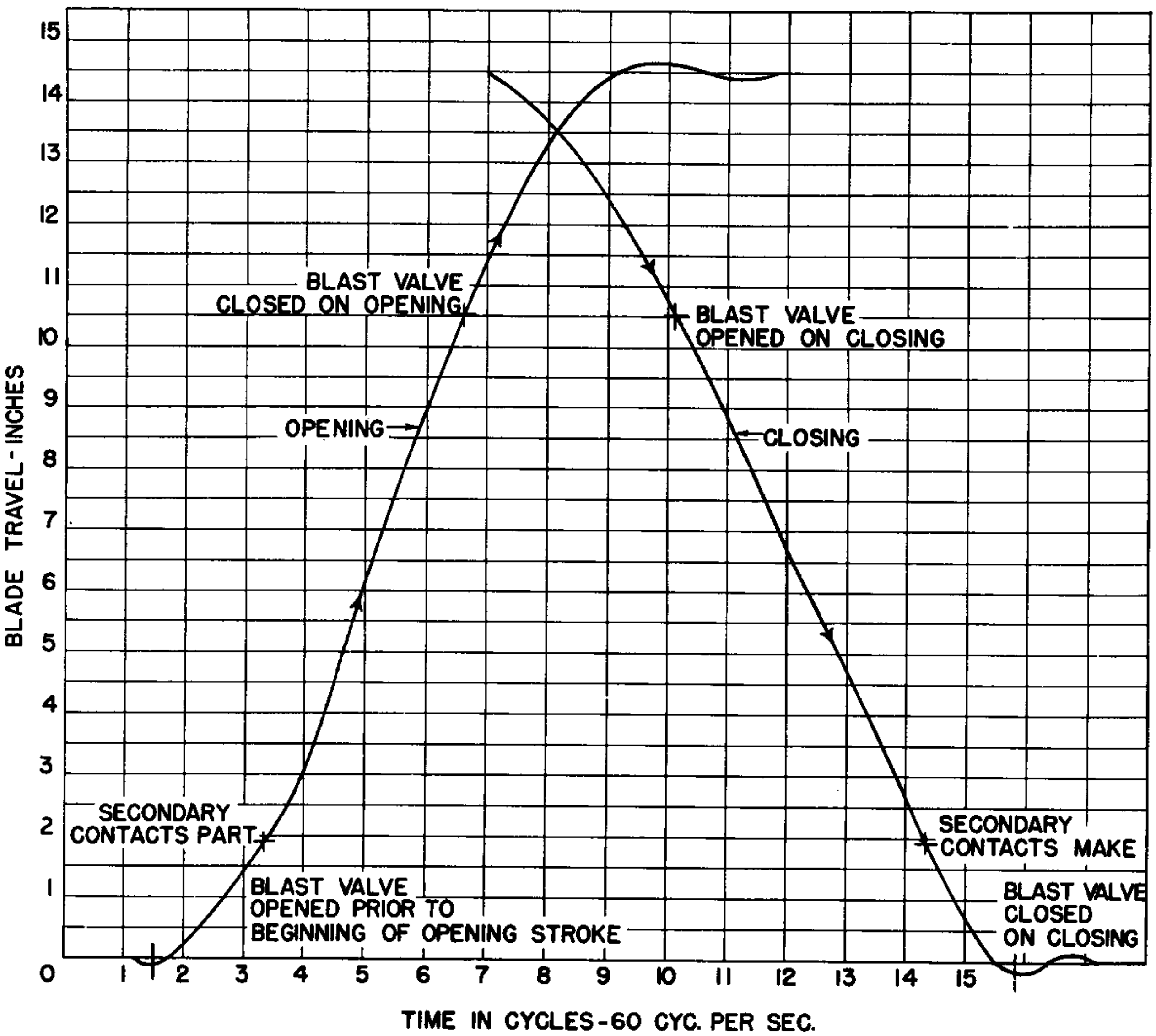
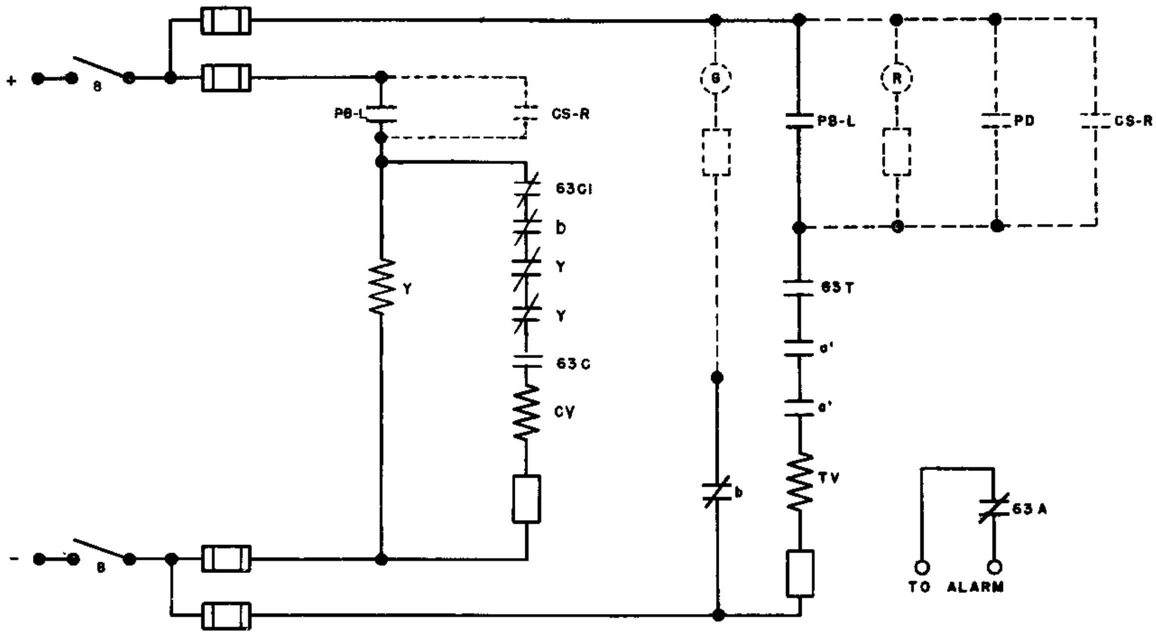
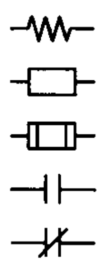


Fig. 11 Typical Operation Curves

Fig. 11 (T-6199654)



8	CONTROL POWER SWITCH	63A	LOW PRESSURE ALARM
PB-L	CONTROL SWITCH (PUSH BUTTON)	63C	LOW PRESSURE LOCKOUT (CLOSING)
CS-R	CONTROL SWITCH (REMOTE)	63T	LOW PRESSURE LOCKOUT (OPENING)
TV	OPENING CONTROL VALVE	63CI	CLOSING PNEUMATIC INTERLOCK SWITCH
CV	CLOSING CONTROL VALVE	a	NORMALLY OPEN AUXILIARY SWITCH (STANDARD)
Y	ANTI-PUMP RELAY	b	NORMALLY CLOSED AUXILIARY SWITCH (STANDARD)
PD	PROTECTIVE DEVICE	a'	NORMALLY OPEN AUXILIARY SWITCH (SPECIAL)



NOTE: CONTACTS ARE SHOWN IN THE DE-ENERGIZED AND NO AIR PRESSURE POSITION

Fig. 12 Typical Elementary Wiring Diagram

Fig. 12 (P-6195348)

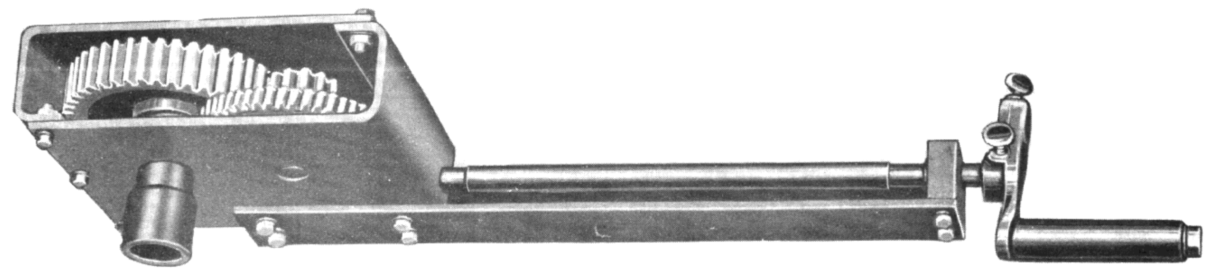
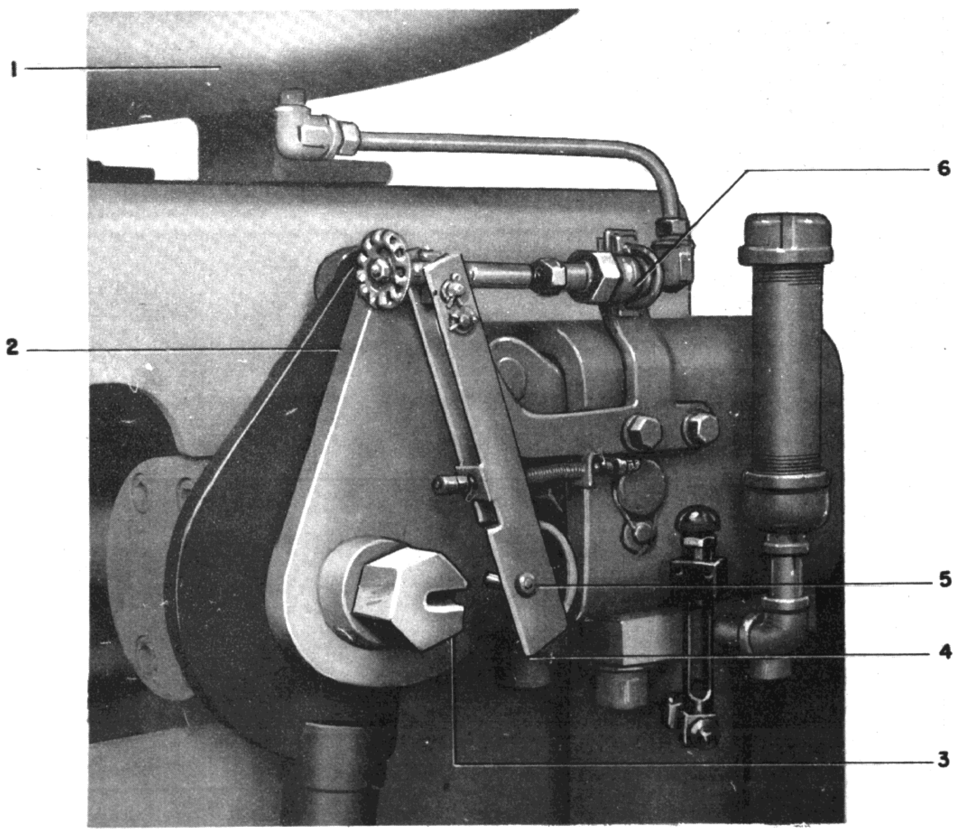


Fig. 13 Maintenance Closing Device

Fig. 13 (8001186)



1. Air Receiver
2. Mechanism Crank
3. Mechanism Shaft
4. Guard
5. Pin
6. Drain Valve

Fig. 14 Drain Valve Interlock

(8005327)

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