GEI-23962 → Superseded 22768

INSTRUCTIONS

AIR-BLAST CIRCUIT BREAKER

TYPE ARA-15

Switchgear

GENERAL ELECTRIC

SCHENECTADY, N.Y.

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RENEWAL PARTS

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AIR BLAST CIRCUIT BREAKER
TYPE ARA-15

GENERAL INFORMATION

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

APPLICATION

The Type ARA-15 Air Blast Circuit Breaker shown in Fig. 1 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.

RATING

The type ARA-15 Air Blast Circuit Breaker is a triple pole, single throw, indoor breaker built for service at a maximum of 15,000 volts, 3 phase. These instructions cover breakers of 1200 to 4000 ampere capacity with interrupting ratings of 500 to 1500 MVA. 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 cycles, withstand and 110 KV, 1.5 X 40 impulse withstand.

OPERATING CHARACTERISTICS

The complete breaker (Refer to Fig. 3) consists of a metal breaker cell enclosing in separate compartments three single pole elements; a pneumatic operating mechanism mounted on top of the breaker cell; an air receiver 32; a mechanically operated blast valve 31; connecting air line manifold 24; a safety valve 1, an inlet valve 33; an air strainer in the incoming high pressure line; a control panel shown in Fig. 2 on which is mounted a knife switch and fuses, a pressure gage, a veeder

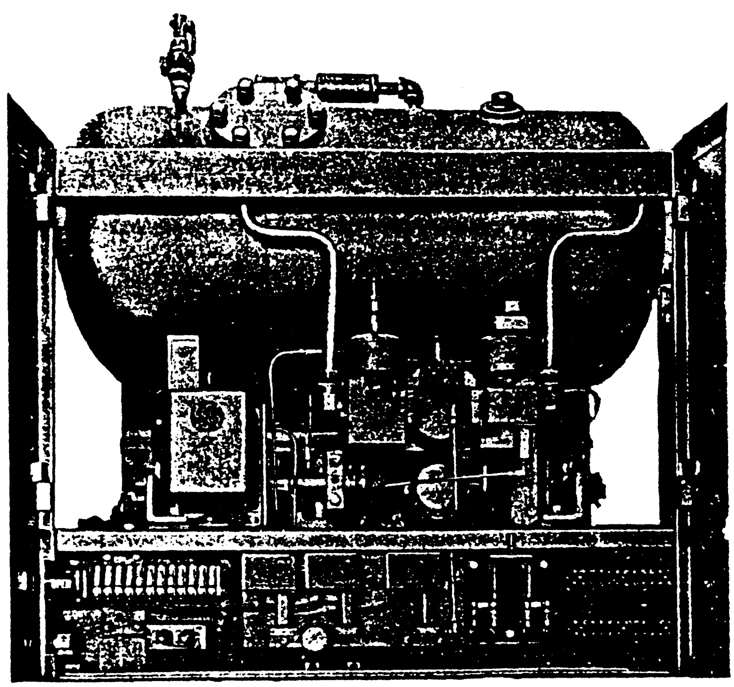


FIG. 2
MECHANISM AND CONTROL PANEL

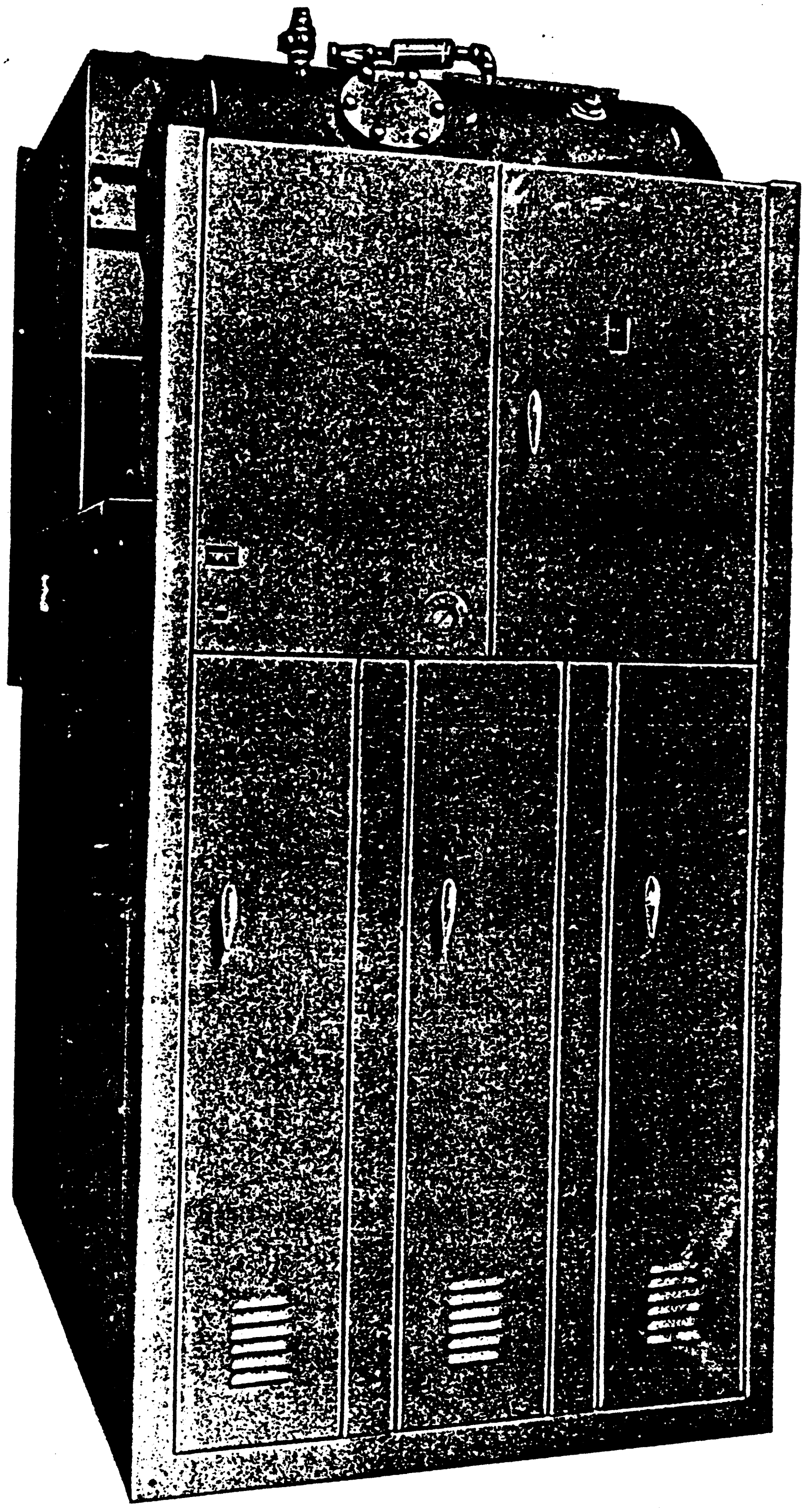


FIG. 1
AIR BLAST CIRCUIT BREAKER, TYPE ARA-15

counter, pressure switches, an auxiliary switch, operating switch and terminal board. Each single pole compartment consists of an arc chute 13, Fig. 3 contact blade 12, operating rod 8, crank 26, air line insulator 19, exhaust tube 9, bushings 17 and 21, wiping contact support 11, and support insulators 15 and 23.

Electrical energization of control valves, seen in Fig. 2, admits high pressure air from the air receiver 32, Fig. 3, 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 28 and later into the main opening cylinder 3. Dashpot action is afforded by the opening dashpot cylinder 6. For a closing operation high pressure air from the air receiver is passed through the closing control valve into the closing cylinder 29. Dashpot action on closing is obtained by means of the closing dashpot cylinder 27. (A more complete discussion can be found under OPERATING MECHANISM, DESCRIPTION OF COMPONENTS, Page 9). 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 5. This rotates the main mechanism shaft 7 and rotates the three cranks 26. Movement of these cranks operates contact blades 12 through operating rods 8.

The breaker interrupts fault circuits by means of high pressure air in the arc chute 13. Opening operation of the pneumatic mechanism opens blast valve 31 by means of a cam on the mechanism shaft and lifts contact blade 12 from the arc chute 13. The high pressure air released by the operation of the blast valve 31 flows through the air line manifold 24 and air line insulator 19 into the arc chute 13. The flow of air across the arc chute contacts and contact blade tip forces the arc out through the arc chute where it is interrupted. Products of the arc are exhausted through exhaust tube 9 into a top header in the breaker housing and hence into atmosphere.

For the closing operation, the blast valve 31 supplies a blast of air into the arc chutes 13 prior to contact making. The presence of high pressure air prevents pre-establishment of the arc before actual contact making. The air requirements on closing are much less than an opening, for there is no arc to interrupt; therefore in order to conserve air, a damper, located just below the blast valve is operated on the closing stroke to limit the flow of air on closing.

When electrically energized, the opening and closing control valves are held open pneumatically for the proper duration of the working stroke. The mechanism is latched in both the closed or open position due to the overcenter toggle positions assumed by the crank 26, Fig. 3, and operating rod.

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

SHIPPING-UNPACKING-STORAGE

SHIPMENT

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 and the nearest General Electric Sales Office should be notified.

UNPACKING

It is expected that due care will be observed when unpacking the apparatus so that no damage will occur from careless or rough handling.

Porcelain air line and support insulators are amply strong when used under the conditions for which they were designed. However, caution should be excercised 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 shou'd 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 any electrical connections every precaution must be taken to see that all leads to be connected to the breaker are de-energized (dead).

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, see Page 22, is provided for 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.

STROKE - CONTACT BLADE AND STATIONARY CONTACTS

Measure the stroke of each pole of the breaker from fully closed to fully open position. With the breaker fully closed, make a light pencil mark on the blade 12, Fig. 3, at some convenient place such as the top of the wiping contact support 11 and then open the breaker slowly with the maintenance closing device and in the fully open position, again mark the blade at the same reference point. Measure the breaker stroke which should check 12-1/2 in. ± 1/16 inch.

With the breaker in the closed position and utilizing a light indication or a bell set, open the breaker manually until the contact blade just leaves the secondary contact fingers 10, Fig. 5, Page 11, as indicated by the bell or light. Measure this point from the fully closed position as previously marked. This measurement indicates the wipe of the secondary contact fingers and should measure 1-5/8 inch ± 1/8 inch. 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 1/8 inch of each other

After checking the stroke and wipe of each blade, observe the clearance between the contact blade and the arc chute top plate 17, Fig. 5, 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 inch. If this is not the case, the arc chutes should be re-aligned. See next section under ARC CHUTE.

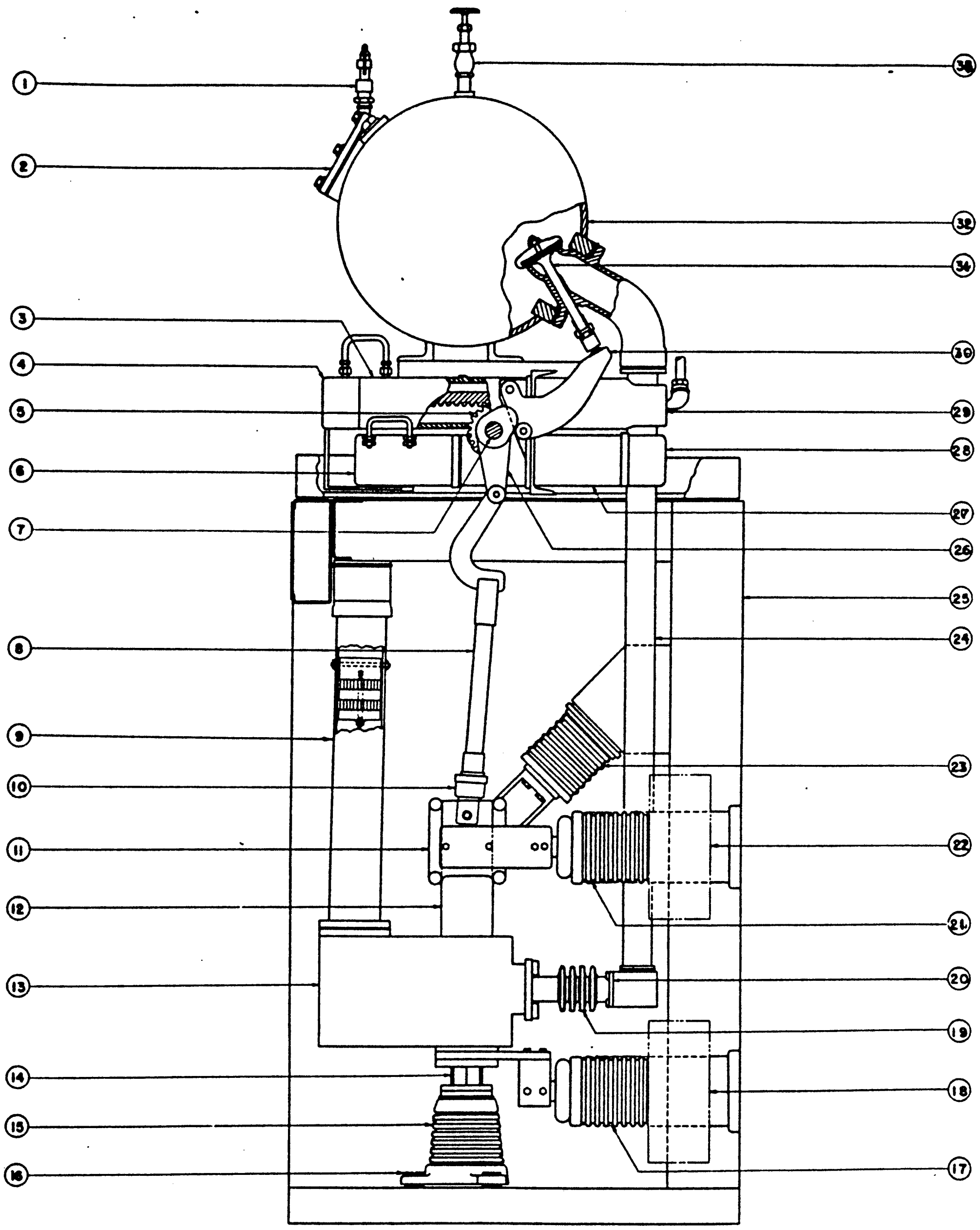
A scribe mark on the front of the contact blade 12, Fig. 3, is made during the factory assembly indicating maximum possible penetration of the blade in the arc chute, when it touches the contact block 8, Fig. 5. The difference between this scribe mark and the top plate of the arc chute indicates the clearance between the contact blade arcing tip and the contact block. This dimension should check 1/4 in. ± 1/16 inch 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 block.

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 16, Fig. 3, are furnished for the purpose of leveling the arc chute and obtaining alignment with the contact blade. There are three of these leveling screws so that the support insulator 15 serves as a tripod enabling the arc chute to be aligned accurately. If this operation is necessary, first loosen the bolts that clamp the connection bars from the arc chute pedestal 14 to the bushing 17. On breakers rated 3000 and 4000 amperes this connection is made by means of a forked casting that clamps over the contact stud of the bushing. Next loosen the socket head screws in the center of the leveling screws 16. Adjust leveling screws until the proper position of the arc chute is obtained. When the final position has been obtained with the leveling screws, the socket head screws should be tightened to secure this position. Fasten securely the bolts on the arc chute pedestal connection to the bushing contact stud. By this means the recommended clearance can be obtained between the contact blade and the arc chute at all points of the stroke. (See Para. 3 under STROKE).

Coupling 10 on operating rod 8 provides the adjustment necessary for synchronizing the contact point of all three phases. To make any adjustment loosen the set screw in the locknut of coupling 10. Remove the pin between the coupling and the contact blade 12. Lift the operating rod 8 so that the coupling



1 SAFETY VALVE
2 INSPECTION COVER
3 MAIN OPENING CYLINDER
4 FRONT BOOSTER CYLINDER
5 GEAR
6 OPENING DASHPOT CYLINDER
7 MECHANISM SHAFT
8 OPERATING ROD
9 EXHAUST TUBE
10 COUPLING
11 WIPING CONTACT SUPPORT
12 CONTACT BLADE
13 ARC CHUTE
14 ARC CHUTE PEDESTAL
15 SUPPORT INSULATOR
16 LEVELING SCREW
17 BUSHING
18 BUSHING CURRENT TRANSFORMER
19 AIR LINE INSULATOR
20 CLAMP PLATE
21 BUSHING
22 BUSHING CURRENT TRANSFORMER
23 SUPPORT INSULATOR
24 AIR LINE MANIFOLD
25 BREAKER HOUSING
26 CRANK
27 CLOSING DASHPOT CYLINDER
28 REAR BOOSTER CYLINDER
29 CLOSING CYLINDER
30 BLAST VALVE OPERATOR
31 BLAST VALVE
32 AIR STORAGE RECEIVER
36 INLET VALVE

FIG. 3
TYPICAL SIDE VIEW

(W-6190600)

is free from the contact blade. Make the necessary half-turns of the coupling and reassemble to the contact blade after securing the locking nut and set screw. (See Para. 2 under STROKE).

BLAST VALVE

During the manual 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 operating button 33, Fig. 12, and the blast valve stem cap 35. This should measure 3/32 inch ± 1/32 inch; see Page 18.

MECHANISM

The mechanism as shipped from the factory has been adjusted for proper operation. Needle valves 15, Fig. 4, are located in the top front of the opening cylinder, bottom front of the opening dashpot and side rear of the closing dashpot. These needle valves have been adjusted in order to obtain correct dashpot action and then locked in position with a locknut. In some cases proper adjustment has been obtained with these needle valves completely removed. Where this has been done in the opening cylinder, a venting plug is used to replace the needle valve. The setting of these valves should not be changed but they should be checked to see that they are securely locked.

PRESSURE SWITCHES

Each breaker is provided with four pressure switches similar to that shown in Fig. 14, Page 20. Three of these are located on the panel, the fourth on the opening control valve. One of these pressure switches on the panel is a lockout switch 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 fourth switch, on the opening control valve, is a closing pneumatic interlock switch.

The low pressure lockout switch 63C, see Typical Wiring Diagram, Fig. 19, 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 approximately 210 p.s.i. with ascending air pressure.

Low pressure lockout switch 63T, Fig. 19, in the opening circuit is set to open its contacts at 185 p.s.i. descending air pressure and to close its contacts at approximately 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 approximately 245 p.s.i. ascending air pressure.

The closing pneumatic interlock switch 63CI, Fig. 19, has been set in the factory to close its contacts at 30 p.s.i. descending air pressure and to open its contacts at approximately 80 p.s.i. ascending pressure. The operation of this switch, mounted on the closing control valve, is described in the section CONTROL VALVES, DESCRIPTION OF COMPONENTS, Page **16**.

Each of these pressure switches, Fig. 14, have two adjustments. Adjusting screw 12 selects the range of operation and can be reached by inserting a screw driver through the hole provided in the top of the breaker housing. The differential between pick up and drop out is set by adjusting cam 1 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 12 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 1 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 ± 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.

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. 13. Operation of the manual trip lever 4 lifts the trip valve shaft 1 of the opening control valve 7 and operates the valve. Lockout arm 24 engages the manual trip lever on low pressure conditions to prevent the operation. As set in the factory the lockout arm 24 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 195 p.s.i. approximately. The operation of this device at the before mentioned pressure should be checked and if not in correct adjustment be readjusted. The range of this device is adjusted by changing the spring pressure on spring 9 and 13 by means of adjusting nuts 8 and 11. If the lockout arm engages the manual trip lever 4 at a pressure greater than 185 lbs., decrease the tension on springs 9 and 13. Continue with this adjustment until the 185 value is obtained. If this pressure is less than 185, increase the spring pressure.

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, maintanance or repair should not be attempted without referring to Instructions GEI-18080 appended as part of this Instruction Book.

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 the 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. 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 low pressure lockout switches prevent further operation.

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

   a. Breaker stroke 12-1/2 in. ± 1/16 inch
   b. Contact wipe 1-5/8 inch ± 1/8 inch.
   c. Clearance between contact blade tip and contact block 1/4 in. ± 1/16 inch.
   d. Variation between contact make between the three phases 1/8 inch.
   e. Clearance between blast valve operator and valve stem cap 3/32 inch ± 1/32 inch.
   f. Minimum clearance between blade and arc chute .002 inch.
   g. Lockout of pressure switch in closing circuit 200 p.s.i., decreasing.
   h. Lockout of pressure switch in opening circuit 185 p.s.i., decreasing.
   i. Operation of low pressure alarm switch 230 p.s.i., decreasing.
   j. Operation of manual trip lockout 185 p.s.i., decreasing.

When all the foregoing inspection details have been checked, the breaker 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. Routine inspection should be made at intervals no greater than 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 and fibre parts. The method of doing this is described in detail under the section DESCRIPTION OF COMPONENTS, Page 10. Unless very severe fault conditions have been experienced, it is not anticipated 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 regular maintenance period but at regular intervals the mechanism operating cylinders and shaft should be checked for any possible scoring or excessive wear. This can best be done by removing the pins connecting the crank 25, Fig. 3 and the operating rod 8 on all three phases. Scoring or excessive wear can be determined by operating the mechanism manually and checking for binding or excess play. See that the operating shaft maintains proper alignment and fit in its bearings and that the mounting bolts in these bearings remain tight. Check the keys and set screws holding gear, crank and cam to the shaft to insure their remaining tight and in place.

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 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 GED50H8A (#250 Led-plate).

CLOSING RELAY AND AUXILIARY SWITCH

Inspect the contacts of the closing relay and auxiliary switch to see that the contacts show 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, see Fig. 16, 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 maintenance closing device, see **DRAIN VALVE INTERLOCK, Page 22.**

SAFETY VALVE

Each breaker air receiver is equipped with a safety valve which has been set 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 periodic inspections, the following procedure should be followed:

1. <u>Mechanism Cylinders</u>

   Oilers are provided for the two operating cylinders, two dashpot cylinders, two booster cylinders, and the blast valve damper cylinder. Using a good grade lubricating oil S.A. E.-30, apply eight drops in the oilers at six month intervals in each cylinder.

2. <u>Mechanism Gear and Bearings</u>

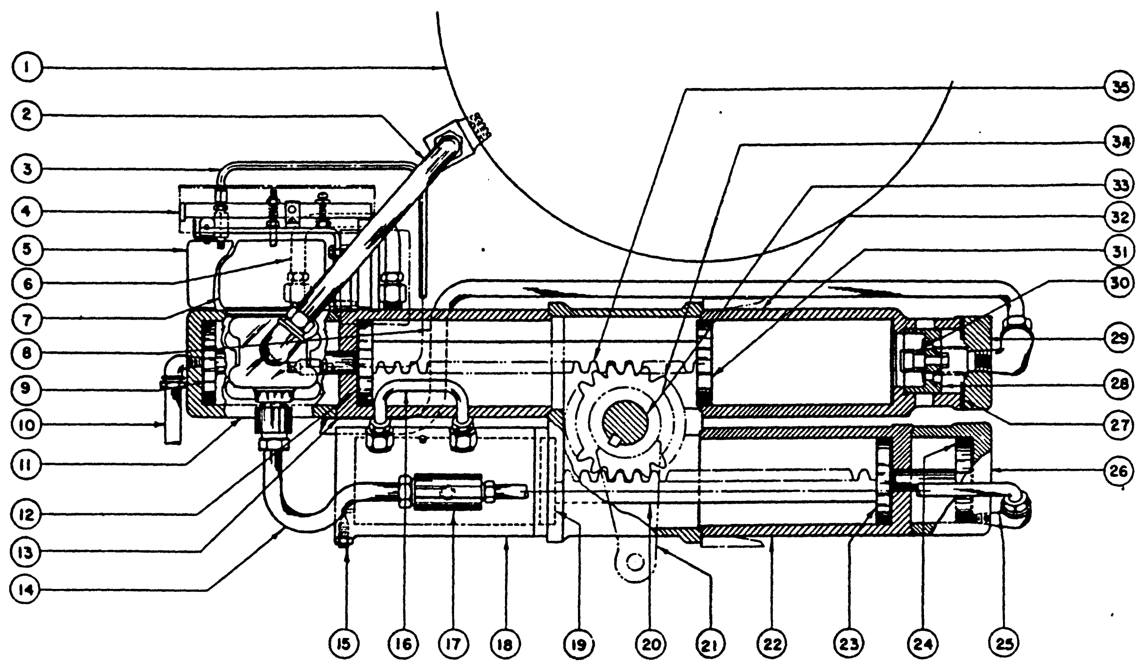
   Coat the gear rack teeth and mechanism pins with a thin coating of G.E.50HIC (Lubriplate No. 110) at six month intervals. The operating shaft bearings are equipped with Alemite fittings and should be given one shot of G.E.50HIC compound at six month intervals.

3. <u>Contact Blade and Wiping Contacts</u>

   At periodic inspections wipe all grease from the contact blade and clean with a cleaning fluid if necessary. Remove connectors 9, Fig. 10, Page 15 and contact fingers 5 and apply Solvarex L-1 (Socony Vacuum Oil Company) to the contact fingers. This should be done at six month intervals or after 250 operations of the breaker, whichever occurs sooner.

4. <u>Control Valves</u>

   No lubrication required.



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. NEEDLE VALVE
16. BY PASS
17. AIR LINE COUPLING
18. OPENING DASHPOT CYLINDER
19. OPENING DASHPOT PISTON
20. RACK
21. CRANK
22. CLOSING DASHPOT CYLINDER
23. CLOSING DASHPOT PISTON
24. REAR BOOSTER PISTON
25. AIR LINE
26. REAR BOOSTER CYLINDER
27. BUFFER
28. DUMP VALVE PISTON
29. DUMP VALVE CAP
30. DUMP VALVE FLAPPER
31. CLOSING PISTON
32. CLOSING CYLINDER
33. MECHANISM SHAFT
34. GEAR
35. RACK

FIG. 4
OPERATING MECHANISM

OPERATION AND 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 later in this section.

The mechanism is mounted on top of the breaker housing as is shown in Fig. 2, and the mechanism has been correctly aligned in the factory and bolted 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 in order 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. 4, 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 26 and into the opening dashpot cylinder 18 through coupling 17. 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 24 and the breaker is driven in the opening direction. The booster pistons drive the mechanism through the racks 20 and 35 and gear 34 until the blades part from the arc chute contacts. In this region, the air is by-passed into the main opening cylinder 13 through air by-pass line 6 behind the main opening piston 12.

During the booster piston stroke the blast valve 31. Fig. 3, has been opened by the blast valve operator 30 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 13 through the air line manifold 24. The blast valve cam is so arranged that the full required pressure is available in the arc chutes before the contact blades 12 separate from the secondary contacts 10, Fig. 6. By this time the opening dashpot cylinder 18, Fig. 4, has been charged and the dashpot piston 19 prevents excessive opening speed of the mechanism.

At the time when the contact blades leave the auxiliary contacts 13, Fig. 5, in the arc chute, the opening dashpot piston 19, Fig. 4, has moved beyond by-pass 16 while the main opening piston 12 has moved to the position so that air by-passed through air 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 dashpot piston which moves beyond and closes up the by-pass 16. 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 28 through the air line 8. This air holds the dump valve in its normally closed position but the flapper valve 30 in the dump valve is forced open by the air pressure, thus admitting the air into the closing cylinder 32. This high pressure air acting behind the closing piston 31 moves the breaker in the closing direction. The closing piston drives the breaker to the closed position unretarded except at the end of the stroke when the closing dashpot piston 23 becomes effective due to the compression of the air within the cylinder 22. After the closing control valve is cut-off, the compressed air remaining in the closing cylinder automatically opens the dump valve piston 28 against its return spring and escapes through the exhaust ports into atmosphere. 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.

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 operation of 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 this pneumatic operation and characteristic 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 31 is immediately exhausted to atmosphere by the dump valve 28. Reversal of the mechanism for trip free operations is thus accomplished.

Disassembly

Under ordinary conditions the operating mechanism should require no disassembly other than the regular service and inspection requirements as outlined under MAINTENANCE. If it becomes necessary 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 21, Fig. 4 from the wooden operating rods 8, Fig. 3, 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 bolts holding the valves to the front booster cylinder.

3. Remove set screws in the end crank 21 (Pole 3), Fig. 4, and slide the crank from the mechanism shaft 33. Care must be taken to remove both set screws from each hole before attempting to remove any crank or cam.

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 21 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 34, from the piston racks 20 and 35. Continue in the same direction and remove the mechanism shaft 33 with blast valve cam, gear, and two cranks.

7. The remaining parts such as the two operating cranks 21, the gear 34, 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 mounting bolts. The operating pistons can then be readily removed from the mechanism frame. The pistons and cylinders should be marked so that on re-assembly the correct matching parts are placed together.

9. To inspect the booster pistons 9 and 24, remove the booster cylinders 11 and 26 from the ends of the main cylinders by loosening the four mounting 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 dump valve cap 29 from the closing cylinder 32 and remove the valve 28 by sliding the assembly out the rear of the closing cylinder.

The mechanism is shipped from the factory re-ires no adjustment. In the event of disassembly d reassembly all parts should go together readily d in the same relation as before removal. All rts on the main operating shaft are keyed so that correct position is easily found. Care should be served to locate correctly the final open and clos- positions. To do this, move the closing piston to fully open breaker position and the opening dash-pot 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 21, 1-1/4 inches back beyond the vertical center line through the mechanism shaft 33. 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.

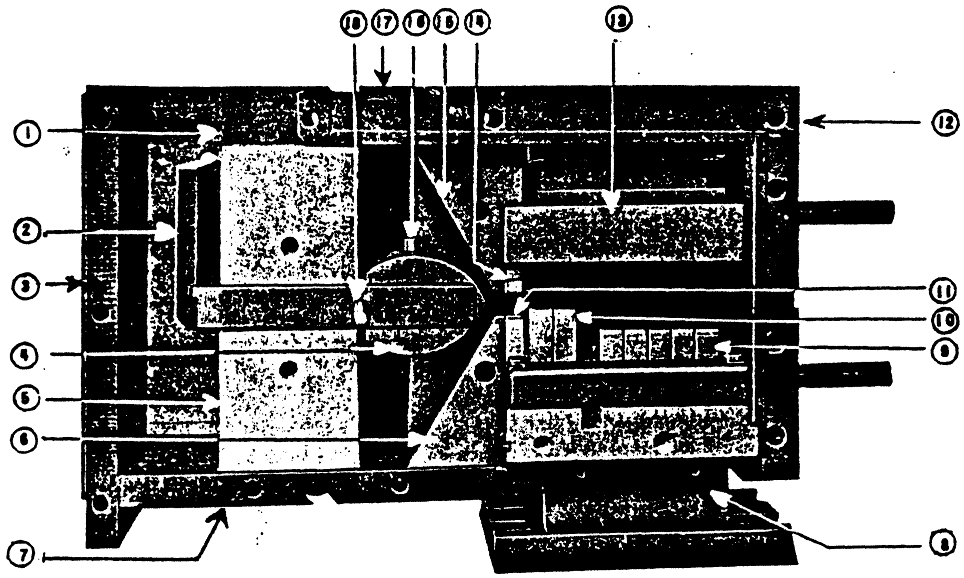
ARC CHUTE

The arc chute for the type ARA circuit breaker utilizes a principle of interruption known as the fixed gap principle. By this principle, the arc is largely confined to two arc gap electrodes. This affords earlier interruption, shorter arc lengths and reduced contact maintenance. A cut-away view of this arc chute is shown in Fig. 5. From Fig. 6 it can be seen that the arc chute 3 is mounted on a support insulator 9, is connected to the air line insulator 14, and receives the contact blade 19. There is an arc chute for each phase of a trip pole breaker and each is enclosed in a metal compartment. The distress of interruption is confined within the arc chute except for that portion of the gases which is exhausted up the exhaust tube 1 into the exhaust header.

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 arc chute performs its interrupting function as follows:

Prior to the parting of the contact blade arcing tip 18, Fig. 6 and the secondary contact fingers 10, Fig. 5, high pressure air is admitted to the arc chute through the air line insulator 14. As the blade tip parts contact from the secondary contacts, an arc is drawn between the blade tip and the contacts. Immediately this arc is transferred between the upper gap electrode 14 and the lower gap electrode 11 due to the flow of high pressure air. The arc is blown downstream in the chute splitting on the arc barrier 4 into two sections. Each section of the arc is blown and expanded between the arc barrier and the lower arc wedge 6 or the upper arc wedge (part of the auxiliary contact block 15) until interruption takes place. The products of interruption are then rapidly moved through cooler plates 5 and thence up the exhaust tube through muffler plates located at the upper end of the exhaust tube. Immediately after the current is interrupted and the recovery voltage surges toward crest, a part of the original arc is re-established through probe 16 Fig. 5 and resistor 4, Fig. 6 if the circuit recovery rate is sufficiently high. The resistor is connected in the circuit at the two points 5. This in effect places the resistor and the arc from the resistor probe to the upper gap electrode in series across the arc chute. At the next resistor current zero, this smaller resistor current is interrupted entirely without voltage distress and at a low recovery rate. Contact blade 19 continues its opening stroke leaving the auxiliary contacts and continuing out of the arc chute to the fully open position shown in Fig. 6. This gives a large air gap between the contact blade and the arc chute.



1. SIDE PLATE	7. BOTTOM PLATE	13. AUXILIARY CONTACTS
2. TAIL BARRIER	8. CONTACT BLOCK	14. UPPER GAP ELECTRODE
3. FRONT PLATE	9. MAIN CONTACT FINGER	15. AUXILIARY CONTACT BLOCK
4. ARC BARRIER	10. SECONDARY CONTACT FINGER	16. PROBE
5. COOLING PLATE	11. LOWER GAP ELECTRODE	17. TOP PLATE
6. LOWER ARC WEDGE	12. BACK PLATE	18. RESISTOR CONNECTION

FIG 5
ARC CHUTE

Disassembly

To remove the arc chute from the breaker and disassemble, referring to Fig. 6, proceed as follows:

1. At the front of the arc chute remove the nuts holding the clamp plate 2 to the top of the arc chute. Loosen bolts holding clamp plate at the top of the exhaust tube 1. Lift the clamp plates and the entire exhuast tube 1 until sufficient clearance is available to remove the entire assembly by swinging the bottom outward through the front of the breaker cell.

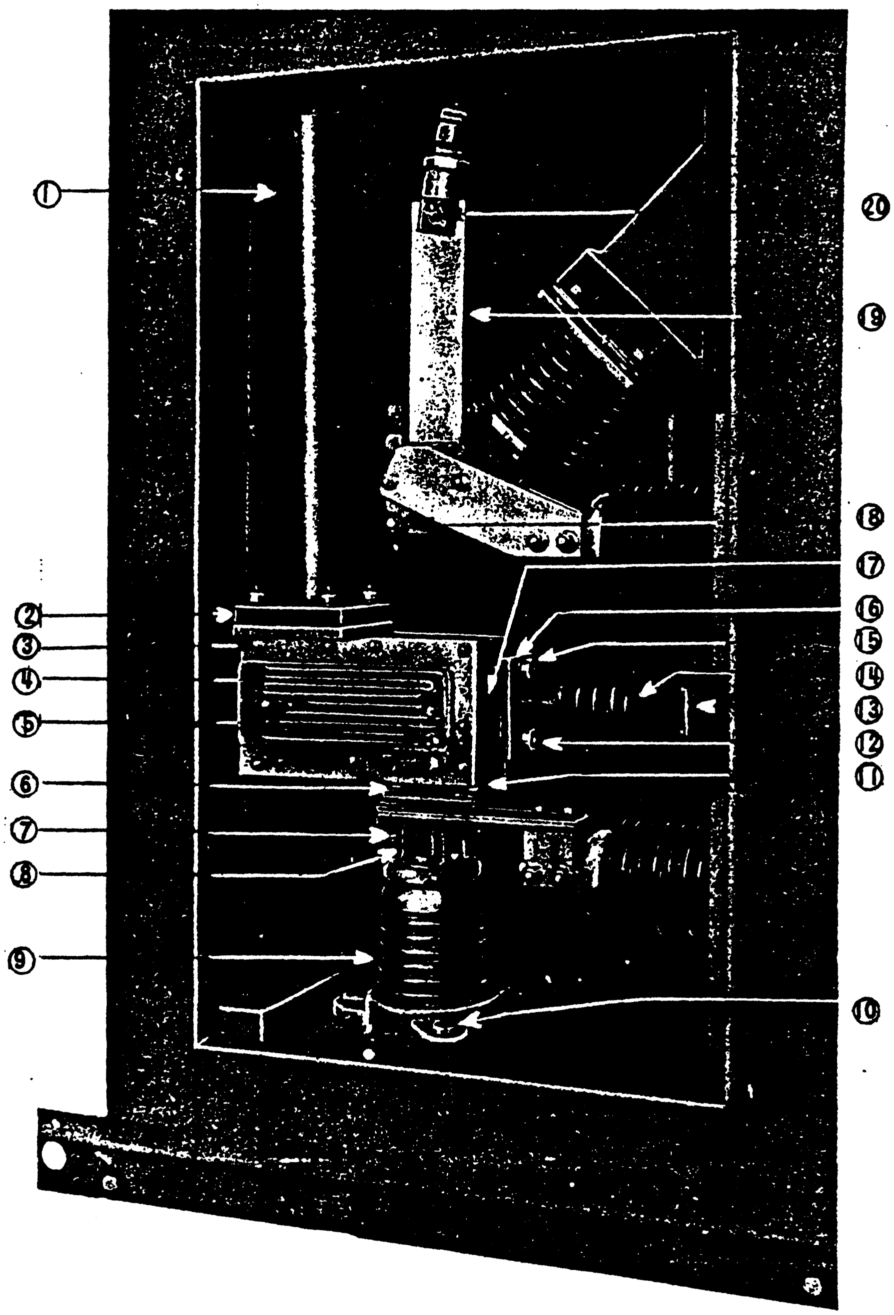
2. Remove nuts 15 from fibre studs 12 and slide clamp plate 16 toward the rear of the air line insulator 14. Remove bolts from clamping plate 13, and slide clamping plate toward the front of air line insulator 14. Remove the orifice plate between air line insulator and air line manifold. The air line insulator 14, with its gaskets can then be removed along with adapter block 17 and its gasket. Care should be exercised in this operation so as not to fracture the air line insulator.

3. Loosen nut 7 and remove bolt 6, loosen bolt 11 and the arc chute can then be removed by sliding along pedestal 8 toward the front of the breaker cell.

4. Remove the screws holding resistor 4 to the side of the arc chute. The resistor will then be supported by the stud assembly at connections 5 and is readily removed by a slight pull.

5. Remove the nuts on all studs extending through the arc chute. In the case of the socket head screws, remove the screws entirely along with the half round clamping plates. Then remove one side plate from the remainder of the assembly by the proper use of a soft mallet. This will leave the chute available for complete inspection similar to the view shown in Fig. 5. All the internal parts can then be removed.

6. If it is necessary to remove the contacts and arc barrier 4, Fig. 5, first remove front plate 3 and bottom plate 7. Remove auxiliary contact block 15 and lift the auxiliary contact assembly 13 from the arc chute. By hammering the other side plate the contact block 8 complete with main contact fingers 9, secondary contact fingers 10, lower gap electrode 11, and lower arc wedge 6 can be removed. The arc barrier 4 can then be removed.



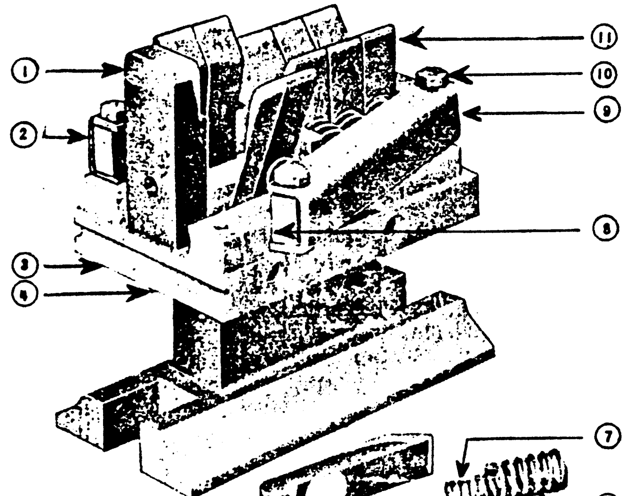
1. EXHAUST TUBE
2. CLAMP PLATE
3. ARC CHUTE
4. RESISTOR
5. RESISTOR CONNECTION
6. BOLT
7. NUT
8. PEDESTAL
9. SUPPORT INSULATOR
0. LEVELING SCREW
11. BOLT
12. STUD
13. CLAMP PLATE
14. AIR LINE INSULATOR
15. NUT
16. CLAMP PLATE
17. ADAPTER
18. ARCING TIP
19. CONTACT BLADE
20. PIN

FIG. 6

ARC CHUTE COMPARTMENT

For assembly, proceed in the reverse order.

Once the arc chute has been correctly reassembled, there are no adjustments necessary. The arc chute can be placed back in the breaker and bolted snugly in position on pedestal 8, Fig. 6. If the support insulator 9 has not been moved or replacement parts have not been used in the arc chute, the proper clearance between contact blade 9 and the arc chute can be obtained by manually lowering the blade until it enters the arc chute and adjusting the arc chute on pedestal 8. See section on ADJUSTMENTS, page 3 for proper clearances. This clearance must be checked after the arc chute is securely bolted in place. If the support insulator has been moved or replacement parts used in the arc chute, it may not be possible to obtain proper blade clearance by the above assembly method. In this case the procedure should be followed as outlined in section ADJUSTMENTS, ARC CHUTE, Page 3.



1. LOWER GAP ELECTRODE
2. SPACER
3. CONTACT BLOCK
4. SCREW
5. SECONDARY CONTACT FINGER
6. SPRING (OUTER)
7. SPRING (INNER)
8. SPACER
9. SPRING RETAINER
10. SCREW
11. MAIN CONTACT FINGER

FIG. 7

MAIN CONTACT ASSEMBLY 1200 & 2000 AMPERE

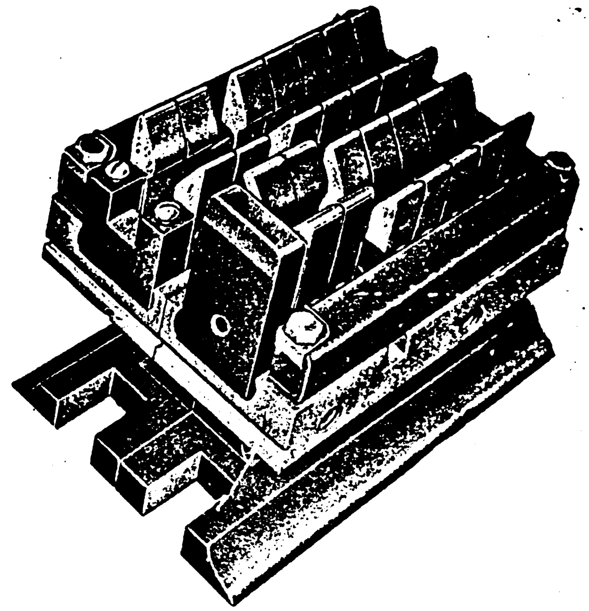


FIG. 8

MAIN CONTACT ASSEMBLY 3000 & 4000 AMPERE.

MAIN CONTACTS.

The main contacts for a 1200 ampere arc chute are shown in Fig. 7. To disassemble proceed as follows:

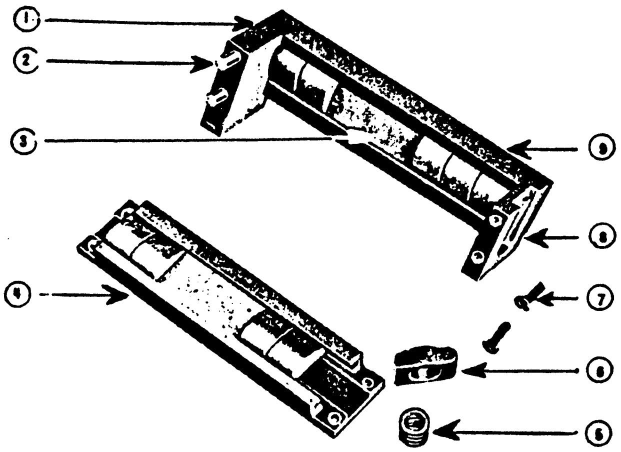
1. Remove socket head screws 4 which clamp the lower gap electrode 1 to the contact block 3. This allows the removal of the gap electrode together with the lower arc wedge 6, Fig. 5. The lower arc wedge is held to the lower gap electrode by a flat head screw.

2. Place clamps on spring retainers 9 to offset pressure of springs 6 and 7. Remove screws 10 front and rear which hold spring retainers to contact block 3.

3. With these screws removed, spring retainers, springs and spacer blocks 2 and 8 can be removed.

4. The secondary contact fingers 5 and main contact fingers 11 can then be removed by sliding out of the contact blocks 3.

5. The main contact assembly for a 2000 ampere arc chute is similar to the one shown in Fig. 7 except there are more main contact fingers. On breakers rated 3000 and 4000 ampere, the contact blade is of double blade construction. Only the right hand blade is furnished with an arcing tip. The contact block assembly for a 3000 or 4000 ampere arc chute is shown in Fig. 8.



1. UPPER GAP ELECTRODE
2. RIVET
3. SPACER
4. CHANNEL
5. SPRING
6. FINGER
7. SCREW
8. REAR PLATE
9. CHANNEL

FIG. 9

AUXILIARY CONTACTS

ARC CHUTE AUXILIARY CONTACTS

To replace the upper gap electrode or the auxiliary contact fingers, proceed as follows with the arc chute previously dis-assembled as described in the section on the ARC CHUTE. Refer to Fig. 9.

1. Remove the auxiliary contact assembly from the arc chute.
2. Remove the rear plate 8 from the channels by loosening the four holding screws 7.
3. At this point the contact fingers 6 and springs 5 can be removed by sliding each finger out of the retaining channels 4 and 9.
4. To replace the upper gap electrode 1, the rivets 2 must be driven out of the channels and the upper gap electrode.
5. The entire assembly is now completely apart.
6. To replace the contact fingers 6 insert spring 5 in the recess provided in contact finger. Insert the edge of the rounded end of the finger into the channel. Rotate the finger compressing spring 5 until the upper end of the contact finger can be inserted into the top of the channel.
7. The channels and fingers are assembled so that the rounded end of the finger and the wide flange of the channel are at the bottom as shown in Fig. 9.
8. The upper gap electrode 1 must be re-assembled with new rivets 2.

WIPING CONTACTS

The wiping contact is an assembly of contact fingers which are positioned in such a manner as to maintain contact with the contact blade when the breaker mechanism is operated. The wiping contact assembly for a 1200 ampere breaker is shown in Fig. 10.

The wiping contact is assembled to the top contact stud of each phase and is supported by an insulator 14.

The wiping contact assembly serves two functions, namely:

1. It transfers the current from the upper bushing to the contact blade through line contact of the wiping contact fingers against the blade.
2. It also acts as a guide for the vertical motion of the contact blade throughout the operation of the breaker mechanism.

When the breaker mechanism operates, the contact blade 1, is moved vertically through the wiping contact assembly. The pressure of springs 8 behind each pair of contact fingers 5 gives a line contact against both the connector 9 and the contact blade 1. The operation of the blade causes the contact fingers to give a wiping effect thereby maintaining contact at all times with the blade. There are rollers 2 front and rear of the wiping contact assembly which keep the contact blade in line with the arc chute and the stationary contacts. Felt wipers 3 are provided to prevent grit from entering and to maintain grease in the region of the contact fingers.

Disassembly

A. To disassemble the wiping contact assembly:

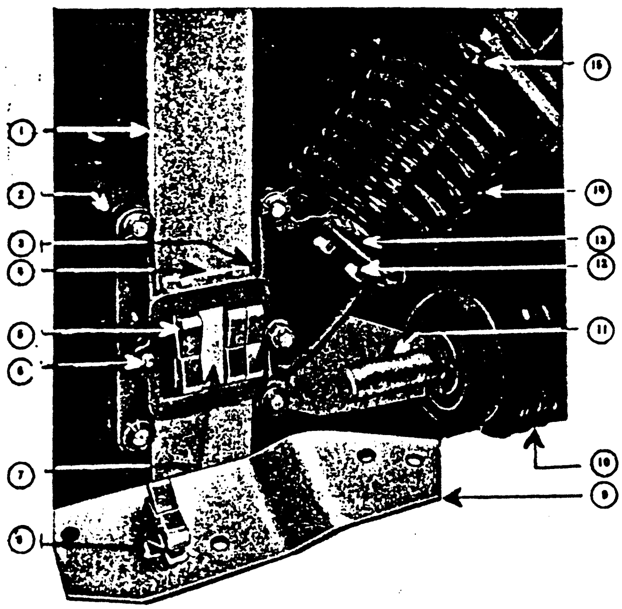
1. First disconnect the terminal connectors 9 from bushing contact stud 11.
2. Remove bolts 6, and terminal connectors.
3. Contact fingers 5 can then be removed.

B. Removal of the wiping contact assembly from the breaker should be necessary only to replace the support insulator 14. Proceed as follows:

1. Disconnect terminal connectors from bushing contact stud.
2. Remove the pin coupling, the wood operating rod to contact blade 1, and lift the rod so that it is free from the blade.
3. Remove the four screws 12 holding the wiping contact support to the support insulator 14 and remove the wiping contact assembly complete with blade from the breaker.

Adjustment

There is no adjustment of this assembly other than to align the entire wiping contact assembly to



1. CONTACT BLADE
2. ROLLER
3. WIPER
4. WIPER RETAINER
5. CONTACT FINGER
6. BOLT
7. SPACER
8. SPRING
9. CONNECTOR
10. BUSHING
11. BUSHING CONTACT STUD
12. SCREW
13. WIPING CONTACT SUPPORT
14. SUPPORT INSULATOR
15. LEVELING SCREW

FIG. 10

WIPING CONTACT ASSEMBLY

place the contact blade on the center line of the arc chute. This should not be required unless the entire assembly or supporting insulator is furnished with four leveling screws 15 secured by socket head screws. Line up of the contact block is afforded by the four leveling screws.

The contact fingers 5 are self-adjusting and depend on the correct machining of the wiping contact support 13 for the proper contact pressure.

If contact fingers are disassembled or new fingers installed, it should be checked that the fingers can be compressed and moved freely without binding.

Other Ampere Rating

The wiping contact assembly for 2000 ampere is similar to Fig. 10 except that there are more pairs of contact fingers.

Since the contact blades for the 3000 and 4000 ampere breaker are of the double blade construction, the wiping contact assembly is slightly different than shown in Fig. 10. The wiping contact support includes a guide between the double blades and the connectors are of cast copper construction rather than flat copper bars. Guide bars to position the contact fingers bolt to the connectors and the fingers may be removed for inspection by first removing these guide bars.

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. 11. 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 principal parts. (Refer to Fig. 11).

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 de-energized 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

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

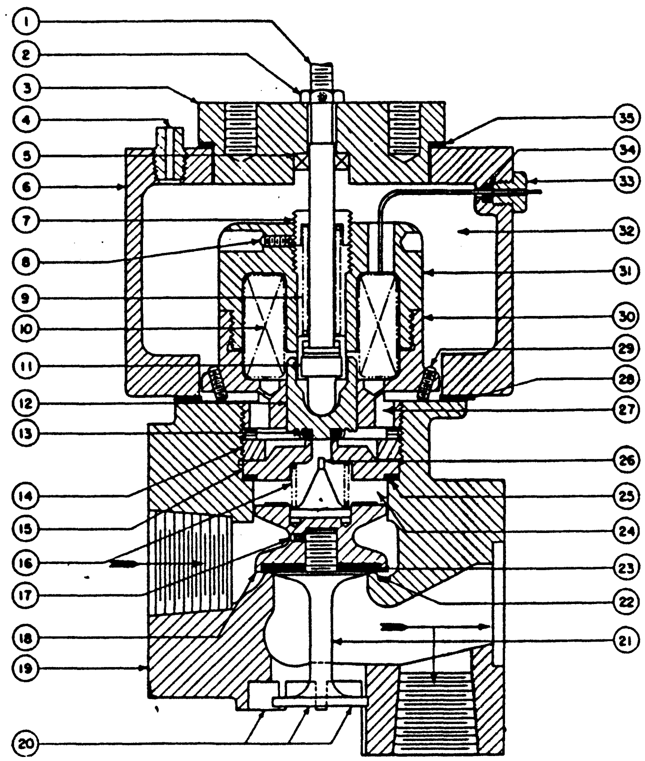


FIG. 11

CONTROL VALVE

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 cut-off.

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. 4, 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. 19, 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. 11.

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 head screws 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, (.030" minimum to .060" 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 .015" 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 20 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. 12, 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. 18, show the position of the breaker stroke at which the blast valve operates.

Operation

Referring to Fig. 12, when the mechanism is operated either closing or opening, rotation of the main mechanism shaft 12 moves the blast valve cam 11 until it engages the roller 13 of the valve operator 9 and rotates it about the pin 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 3 from the valve body 34. This opens the valve and admits air through the valve body and the damper housing 30 into the air manifold 21. Further rotation of the mechanism disengages the blast valve cam 11 from the blast valve operator 9. The combined force of the spring 36 and the unbalanced pressure on the top of the valve disc retainer 2 causes the blast valve to reset itself.

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 25, rotates with the shaft 27 and is actuated by air piston 20 and spring 19. Air cylinder 17 has two air inlets 14 and 15. Spring 19 normally holds the damper 25 open but on an opening operation air entering inlet 15 coming from the opening control valve holds the piston 20 as shown. Air is admitted through the air inlet 15 on opening to assure, if necessary, fast opening of the damper following a closing operation.

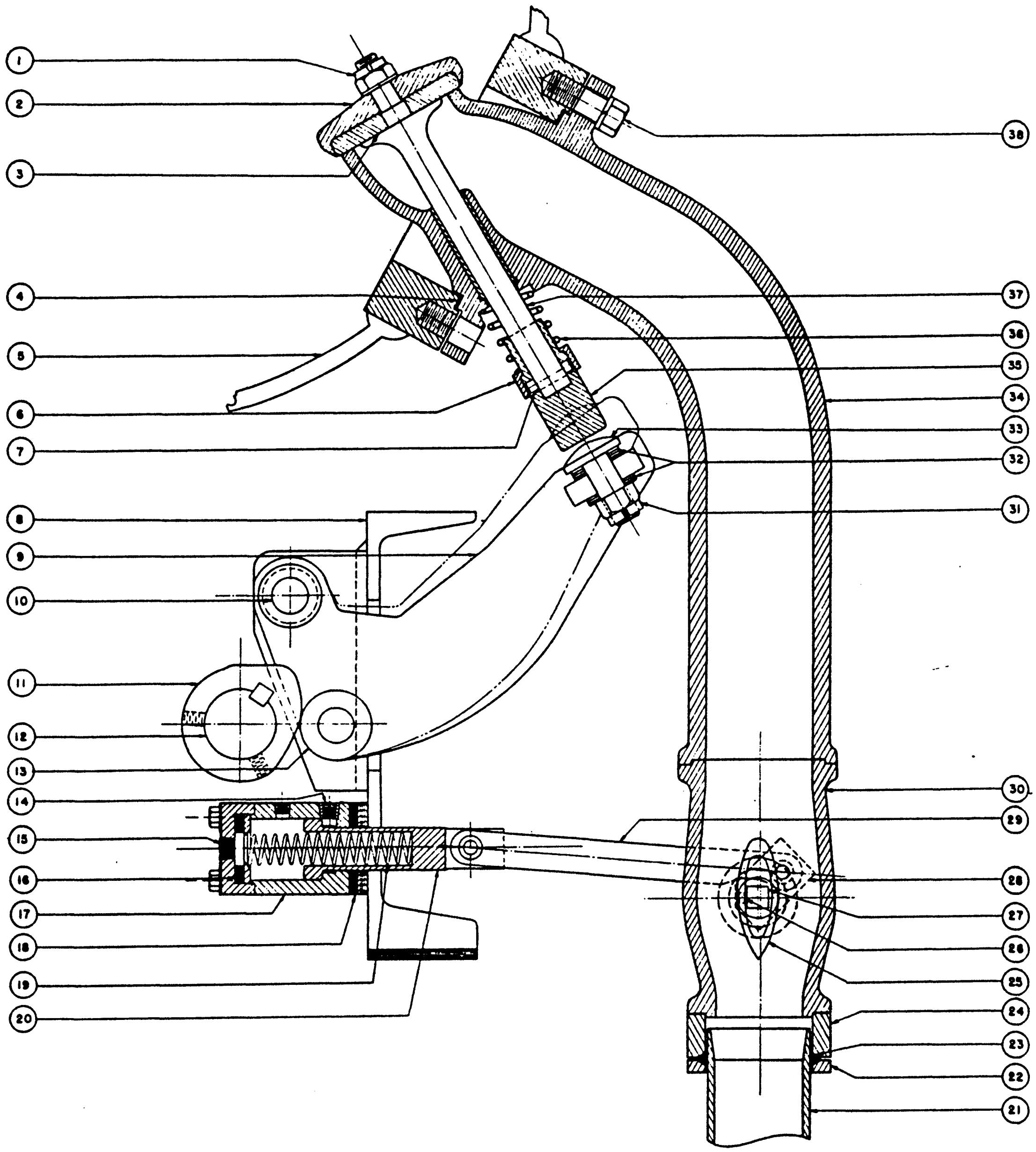
On a closing operation, air from the closing control valve enters air inlet 14 behind the piston 20 and moves connecting rod 29 which rotates crank 28 and closes the damper during the closing operation.

Disassembly

To disassmble the blast valve for inspection of the blast valve disc 3, Fig. 12 proceed as follows:

1. Remove the bolts and the inspection cover 2, Fig. 3, from the top of the air receiver. This inspection hole is directly opposite the blast valve assembly.

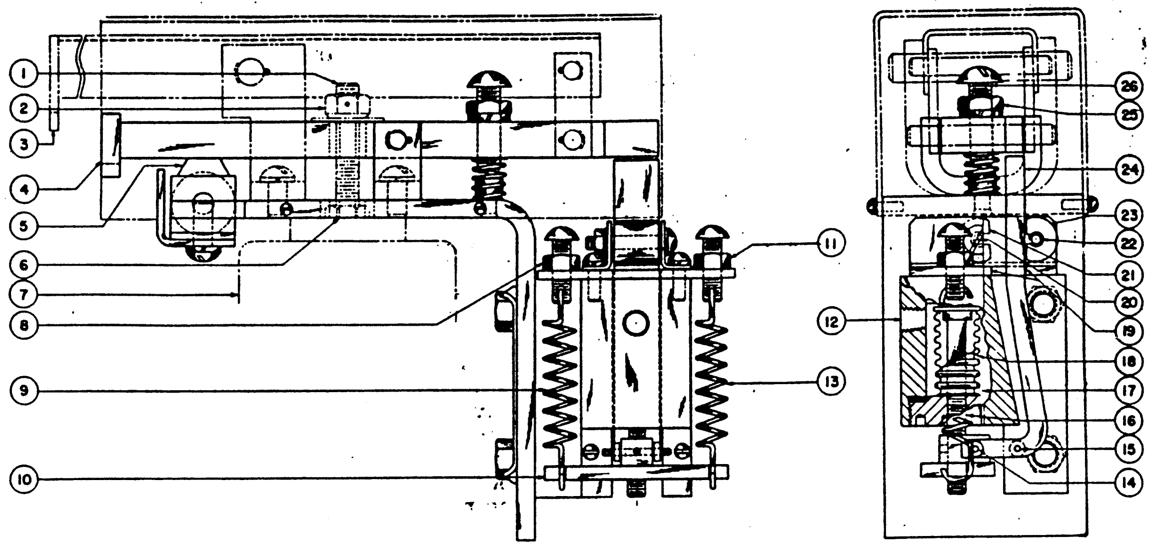
2. Move spring retainer 6, Fig. 12 upward compressing spring 36 to expose pin 7. With the spring retainer held in this position, drive the pin 7 out of the blast valve stem 37. This



1. NUT
2. VALVE DISC RETAINER
3. VALVE DISC
4. GASKET
5. AIR RECEIVER
6. SPRING RETAINER
7. PIN
8. MECHANISM FRAME
9. VALVE OPERATOR
10. PIN
11. CAM
12. MECHANISM SHAFT
13. ROLLER
14. AIR INLET (CLOSING)
15. AIR INLET (OPENING)
16. BUFFER
17. CYLINDER
18. BUFFER
19. SPRING
20. PISTON
21. AIR LINE MANIFOLD
22. CLAMPING RING
23. GASKET
24. ADAPTER
25. DAMPER
26. SET SCREW
27. SHAFT
28. CRANK
29. CONNECTING ROD
30. DAMPER HOUSING
31. NUT
32. SHIMS
33. OPERATING BUTTON
34. VALVE BODY
35. VALVE STEM CAP
36. SPRING
37. VALVE STEM
38. BOLT

FIG. 12

BLAST VALVE AND DAMPER



1. TRIP VALVE SHAFT
2. NUT
3. AUXILIARY MANUAL TRIP LEVER
4. MANUAL TRIP LEVER
5. HOLDING MAGNET
6. STOP NUT
7. OPENING CONTROL VALVE
8. ADJUSTING NUT
9. SPRING
10. SPRING PLATE
11. ADJUSTING NUT
12. AIR INLET CONNECTION
13. SPRING
14. PIVOT PIN
15. PIVOT PIN
16. BELLOWS ROD
17. AIR CHAMBER
18. PRESSURE BELLOWS
19. FRAME STOP
20. ADJUSTING SCREW
21. MAGNET
22. ADJUSTING SCREW
23. MAGNET
24. LOCKOUT ARM
25. LOCK NUT
26. STOP SCREW

FIG. 13

MANUAL TRIP AND LOW PRESSURE LOCKOUT

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 3, and the valve disc retainer 2. Visual inspection can then be made of the condition of the blast valve disc.

Remove cotter pin and nut 1 from valve stem 37 to replace valve disc 3 and valve disc retainer 2 assembly.

To remove the entire blast valve body, it is first necessary to remove the damper and damper housing. Proceed as follows:

1. Remove the pin coupling connecting rod 29 to crank 28.

2. Remove the bolts holding the clamping ring 22 and adapter 24 to damper housing 30 and slide the clamping ring, gasket 23, and damper down on the air line manifold 21.

3. Remove bolts fastening damper housing tc blast valve body 34.

4. Remove damper housing with damper 25 shaft 27 and crank 28.

5. Remove bolts 38 which fasten the blast valv body to the air receiver. Lower and turn th blast valve body to remove it from the break er.

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

1. Remove air lines from air inlets 14 and 15

2. Remove bolts holding cylinder 17 to mech anism frame 8. This will permit remova of the spring 19 and piston 20.

The blast valve has been correctly installe and adjusted in the factory. However, after eac inspection of the blast valve disc, or removal of th blast valve, it is necessary to check the clearanc between the blast valve stem cap 35 and the operat ing button 33 in the fully closed position. With 25 p.s.i. in the air receiver, this clearance should be 3/32 inch + 1/32 inch 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 contact is lost, but to prevent operation at receiver 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 receiver is below 185 p.s.i. This device is shown in Fig. 13 and mounts on the top of the opening control valve. Operation of the manual trip lever 4 lifts the trip valve shaft 1 picking up the pilot valve and armature of the control valve. Operation of the control valve follows as outlined under the section CONTROL VALVE, see Pages 15 and 16.

Operation

The principle of operation of the lockout is as follows:

Air storage receiver pressure is admitted into air chamber 17 and actuates the pressure bellows 18. Action of the pressure bellows is transmitted to the lockout arm 24 by means of bellows rod 16. The lockout arm pivots about pivot pin 15. Under low pressure conditions the lockout arm assumes the position as shown in Fig. 13 which prevents operation of manual trip lever 4. Under normal pressure conditions the lockout arm moves to the left of position shown and allows operation of the manual trip lever. The action of the pressure bellows 18 is counterbalanced by springs 9 and 13 which can be adjusted by adjusting nuts 8 and 11. 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 21 and 23 by means of the adjusting screws 20 and 22. These magnets tend to hold the lockout arm in each position and determine the differential of air pressure on the bellows 18 to cause operation. The lockout arm 24 should always stop on the frame stop 19 and not on either magnet 21 or 23. As set in the factory there is a slight clearance between these magnets and the lockout arm.

The holding magnet 5 assures that a definite force is required to move the manual trip lever 4. This assures that the opening control valve cannot be shocked open. Stop nut 6 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 3 is provided as an extension for manual trip lever 4 on breakers with deep operating mechanisms.

PRESSURE SWITCHES

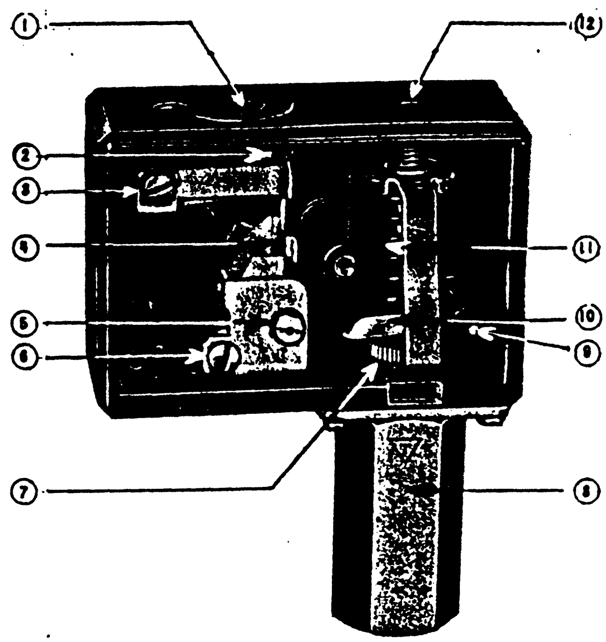
There are four pressure switches furnished with the ARA circuit breaker similar to that shown on Fig. 14. There is a pressure switch in both the closing and opening control circuits as shown in the wiring diagram, Fig. 19. The object of these switches is to prevent the operation of the breaker at a pressure 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, see Fig. 2. The fourth pressure switch has been described in the section on CONTROL VALVES.

Operation

Referring to Fig. 14, the operation of these switches is as follows:

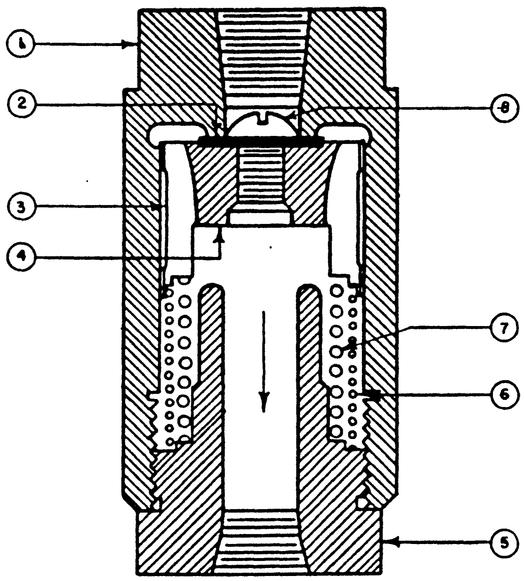
Each of the first three switches is connected to an air manifold which in turn is piped to the air receiver. Pressure for operating the switch enters through the air inlet at the bottom of the pressure chamber 8. The air pressure then acts on a bellows located in the pressure chamber. This moves piston rod 7 which acts on beam 10 pivoted at the beam pivot 9. This in turn loads the contact arm 4 which is free to turn about the contact arm pivot 5. The force of the piston rod 7 is counterbalanced by spring 11. When the force exerted on beam 10 by spring 11 is greater than the force exerted by the piston rod 7, the contacts 2 are held in the closed position. As the pressure in the air storage receiver increases the force exerted by the pressure bellows through piston rod 7 on beam 10 increases and the contacts 2 open.

There are two adjustments on the pressure switch. Adjusting screw 12 can be turned through the top of the moulded case by means of a screw driver. Thus the compression of spring 11 can be varied. Adjusting cam 1 can also be rotated by means of a screw driver through the top of the



1. ADJUSTING CAM
2. CONTACTS
3. TERMINAL
4. CONTACT ARM
5. CONTACT ARM PIVOT
6. TERMINAL
7. PISTON ROD
8. PRESSURE CHAMBER
9. BEAM PIVOT
10. BEAM
11. SPRING
12. ADJUSTING SCREW

FIG. 14
PRESSURE SWITCH



1. VALVE BODY
2. VALVE DISC
3. PISTON
4. VALVE SURFACE
5. VALVE CAP
6. SPRING
7. SPRING
8. RETAINING SCREW

FIG. 15
DOUBLE-ACTING CHECK VALVE

moulded case to vary the electrical point. This later adjustment determines the differential between contact making and contact parting. Electrical connection is made to the switch at terminal screws 3 and 6.

The above description applies to pressure switches 63A and 63CI whose contacts are closed with zero air pressure. The construction of pressure switches 63C and 63T whose contacts are open with zero air pressure is similar except for the location of contact arm pivot 5.

The adjustment of these switches should be checked at every major inspection period as outlined in the section ADJUSTMENTS, Page 5.

DOUBLE ACTING CHECK VALVE

Each breaker is equipped with a double acting check valve, Fig. 15, 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.

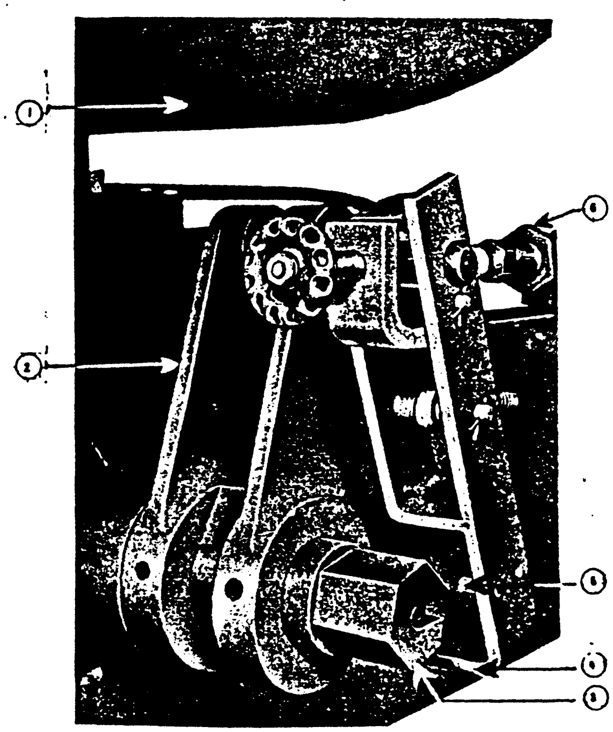
Operation

The piston 3, Fig. 15, seats against the valve body 1 under normal conditions as shown so that the valve disc 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 disc 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 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.

Disassembly

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



1. AIR RECEIVER
2. MECHANISM CRANK
3. MECHANISM SHAFT
4. GUARD
5. PIN
6. DRAIN VALVE

FIG. 16
DRAIN VALVE INTERLOCK

1. Remove the 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 disc 2 can be replaced by removing 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 16 shows the drain valve in the fully opened position.

An extension to the handle of the drain valve 5 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.

FIG. 17
MAINTENANCE CLOSING DEVICE 3000 AND 4000 AMPERES

MAINTENANCE CLOSING DEVICE

A removable maintenance closing or manual device is provided in order to manually close and open the breaker during installation adjustments and maintenance. This 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. The manual cannot be placed on the shaft until the drain valve is open as explained previously.

For breakers rated 1200 and 2000 amperes the maintenance closing device consists of a box wrench with an extension handle. Fig. 17 shows the maintenance closing device for breakers rated 3000 and 4000 amperes. A hook bolt and wing nut are provided to hold the manual to the channel across the front of the breaker housing.

RENEWAL PARTS

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

Give the Reference Number and Name of the part as shown in this Instruction Book, together with all the information that appears on the Air Blast Circuit Breaker Nameplate of the equipment.

Specify the quantity of each part required.

If available, furnish also the Requistion 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.

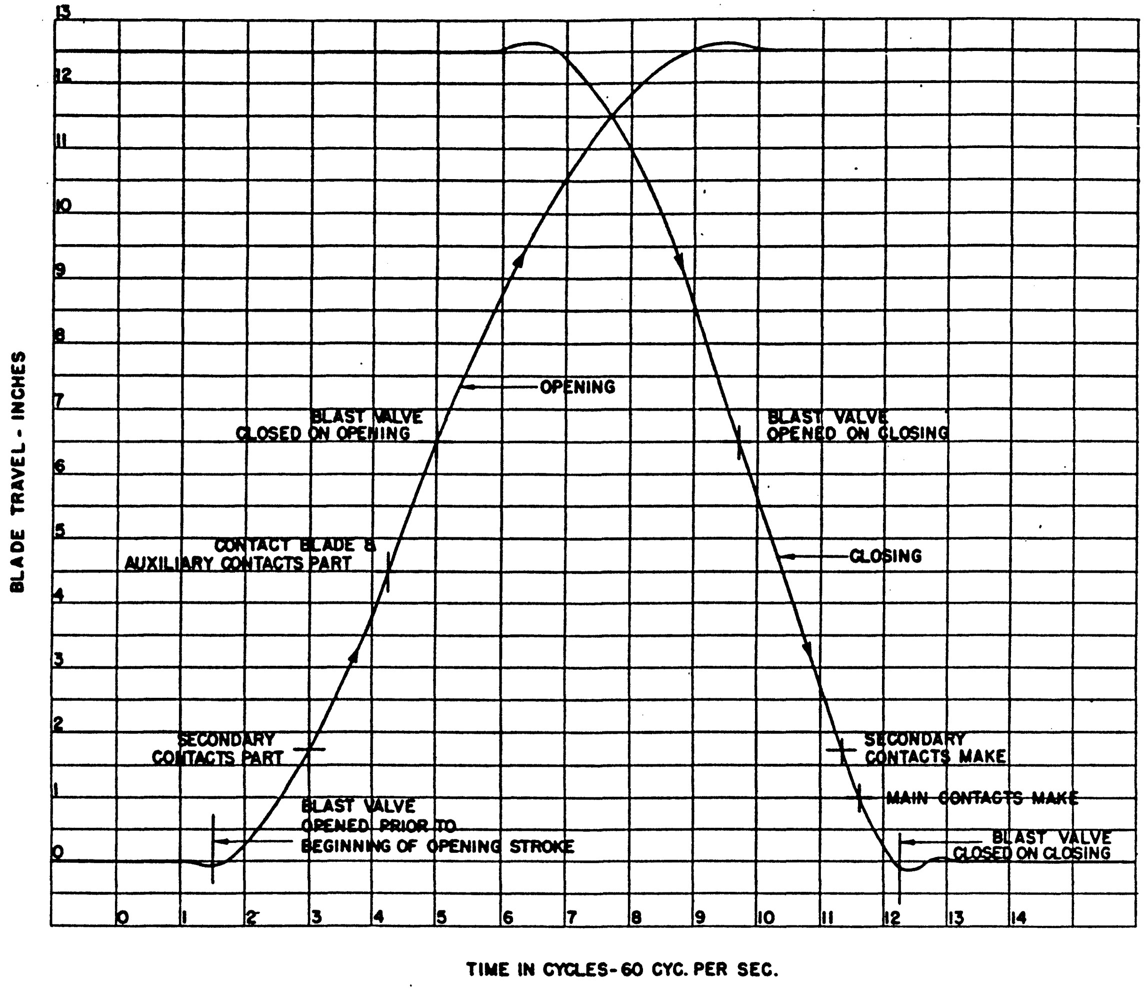


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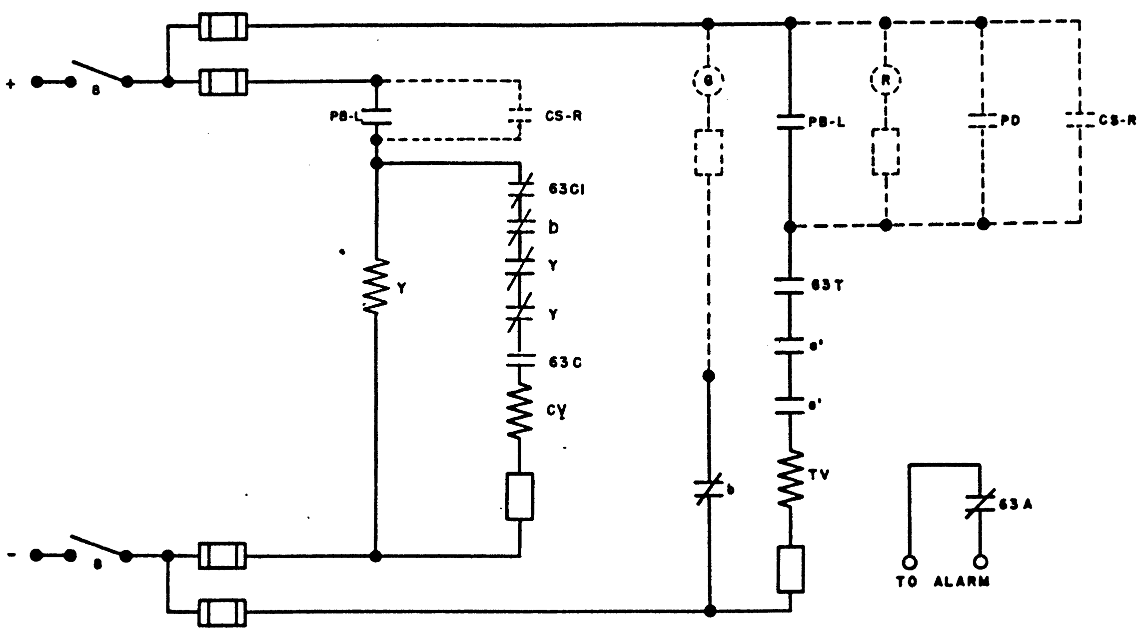
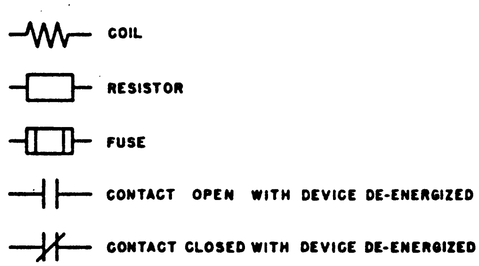
FIG. 18

TYPICAL OPERATION CURVES



S CONTROL POWER SWITCH
PB-L CONTROL SWITCH (PUSH BUTTON)
CS-R CONTROL SWITCH (REMOTE)
TV OPENING CONTROL VALVE
CV CLOSING CONTROL VALVE
Y ANTI-PUMP RELAY
PD PROTECTIVE DEVICE

63A LOW PRESSURE ALARM
63C LOW PRESSURE LOCKOUT (CLOSING)
63T LOW PRESSURE LOCKOUT (OPENING)
63CI CLOSING PNEUMATIC INTERLOCK SWITCH
a NORMALLY OPEN AUXILIARY SWITCH (STANDARD)
b NORMALLY CLOSED AUXILIARY SWITCH (STANDARD)
a' NORMALLY OPEN AUXILIARY SWITCH (SPECIAL)



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

FIG. 19

TYPICAL ELEMENTARY WIRING DIAGRAM