INSTRUCTION BOOK

PNEUMATIC OPERATING MECHANISM

Type AA-7

for

OIL CIRCUIT BREAKERS

Westinghouse Electric Corporation

I.B. 33-125-C2D

I. B. 33-125-C2-D

INSTRUCTIONS

Pneumatic Operating Mechanism Type AA-7 for Oil Circuit Breakers

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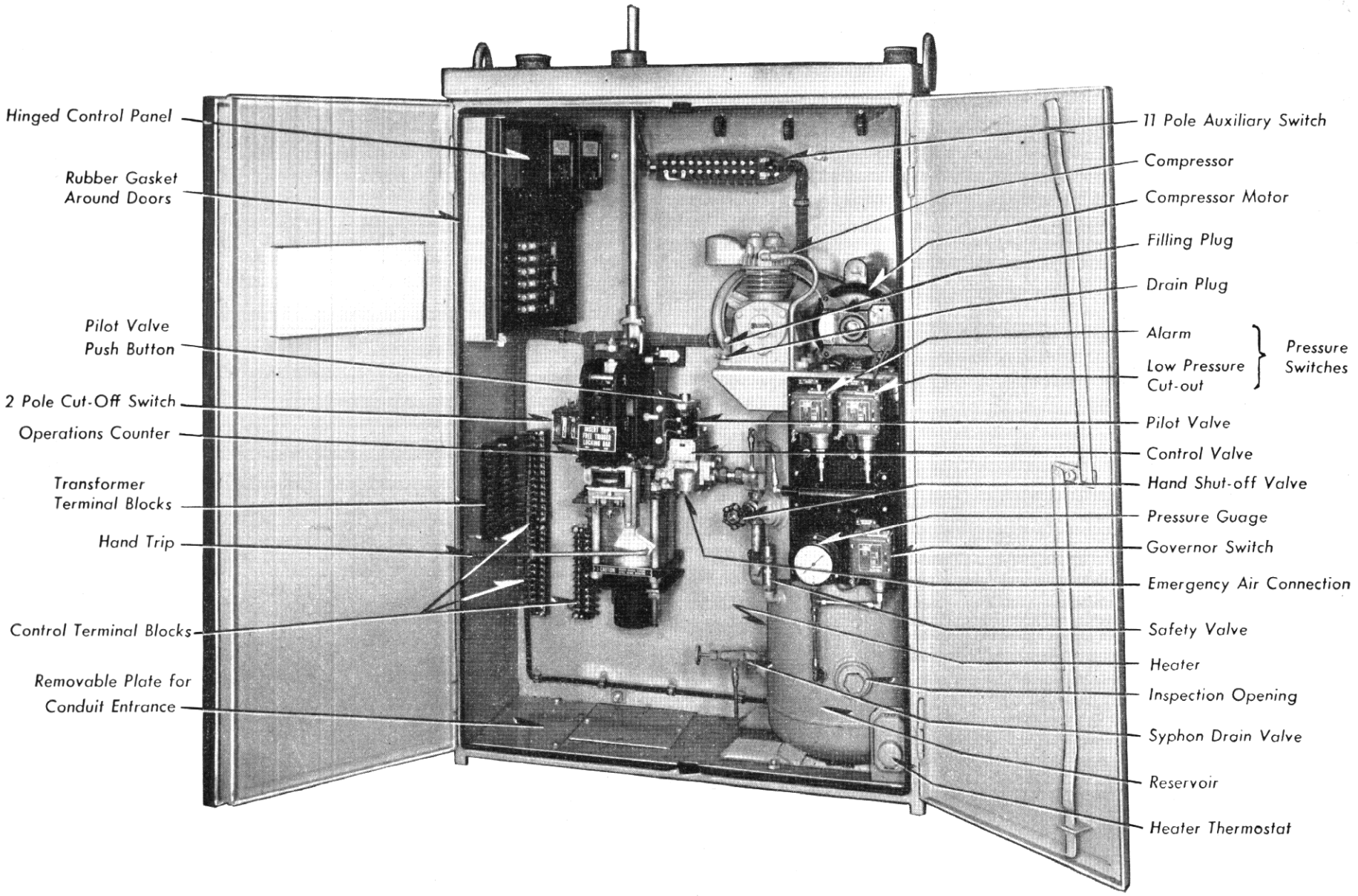

Type AA-7 Mechanism

INTRODUCTION

The Type AA7 circuit breaker operating mechanism is closed by compressed air, opened by springs, and is both electrically and mechanically trip free. Since it derives its closing energy from compressed air which can be stored up in a reservoir over a relatively long period of time with a low current consumption by means of a motor driven compressor, it is especially suited to applications where it is desired to eliminate large batteries required for solenoid mechanisms, or where fast reclosing is required.

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DRAWINGS

(Drawings listed below follow page 22 in sequence)

Pneumatic Operating Mechanism—Type AA7

PART I—RECEIVING, HANDLING, AND STORAGE

Each mechanism and its associated equipment is tested at the factory and should be in good condition when received. Inspection should be made immediately to see that no damage has occurred in shipment. If injury is evident, or indication of rough handling is visible, a claim for damage should be filed at once with the carrier (Transportation Company), and the nearest Westinghouse Sales Office notified promptly.

Unpacking should be done carefully to prevent damage, and all parts should be checked with the shipping list to insure against leaving any parts in the packing material. The mechanism should be accompanied by the proper identification tag and this instruction book.

Be sure to remove the blocks and wires which were used to hold moving parts, mechanism triggers and latches in place during transit.

If the mechanism is not placed in service immediately, it should be kept in a clean dry place, protected from corrosion and moisture. This may be accomplished by closing the mechanism housing and energizing the space heaters provided in it. This procedure is recommended even if it requires the use of a temporary wire circuit to the heaters. In case this is impracticable, all machined parts, especially on the latching surfaces of the latch and rollers should be coated with grease or some rust inhibiting material. Additional protection may be obtained by the use of silica gel, activated alumina or similar dehydrating agents. Two or three small bags of the material should be hung in the mechanism housing near the parts requiring protection. It should be remembered that complete protection may not be provided in spite of all of the above precautions and periodic inspections should be made to determine the condition of the apparatus.

PART II—DESCRIPTION

GENERAL

Included within the dust tight sheet metal housing the following pieces of apparatus which combined are designated as a complete operating mechanism:

(1) An air compressor, air storage reservoir and the necessary attachments and accessories for controlling the air supply.

(2) A pneumatic mechanism consisting of the air cylinder and piston, a lever system for connecting the piston to the pull rod of the breaker, and a trigger for rapidly disengaging the breaker pull rod from the piston, a holding latch for maintaining the mechanism and breaker closed.

(3) A control panel to provide the necessary relays and interlocks for remote electrical control

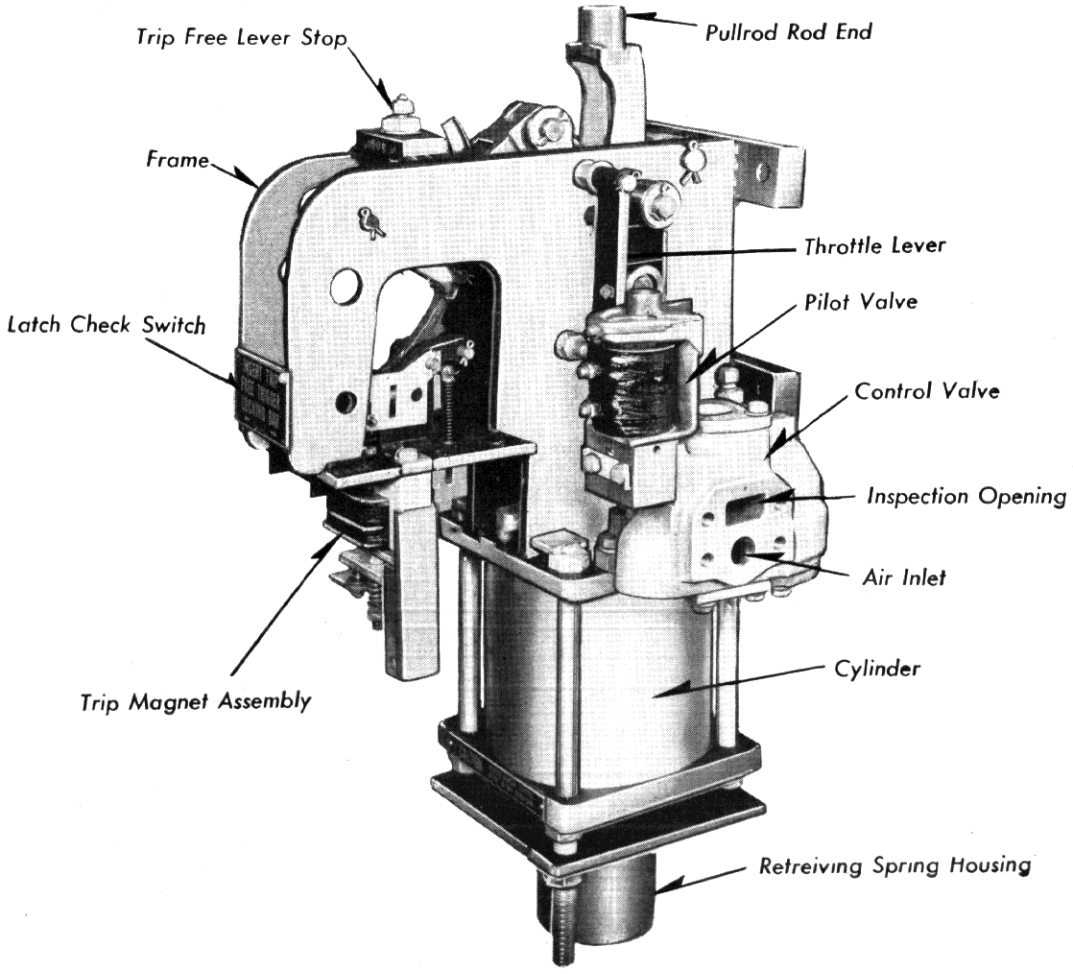
(4) A number of accessories essential to the proper functioning of the unit such as a trip magnet assembly, control valve, 2 pole or 5 pole and 11 pole auxiliary switches, a latch check switch, space heaters, thermostat, fused knife switches for the establishing and protection of the electrical circuits, and terminal blocks for terminating all wiring where it will be readily accessible for connections on installation. See Frontispiece.

COMPRESSOR AND AIR SYSTEM

The compressor is a single stage, air cooled type. The pressure governor switch which regulates the pressure in the storage reservoir, operates to start the compressor as soon as the pressure in the reservoir has dropped to a predetermined value, depending on the size of the circuit breaker to which the mechanism is applied, and stops the compressor as soon as the pressure has been raised to a predetermined differential above the starting pressure settings as shown on the mechanism nameplate for each application. Power to operate the compressor is furnished by a 230/115 volt, single phase motor through a "V" belt drive. Unless the order specifically specifies differently, the motors when shipped will be connected for 230 V. a-c to prevent damage to the motor from overvoltage. D.C. or 3 phase motors may be supplied for special applications.

The reservoir tank fulfills the requirements of State Inspection Codes and all equipment is manufactured under A. S. M. E. requirements with close inspection. A safety valve is supplied on the reservoir to prevent pressure from building up to a dangerous level, should the pressure governor switch fail to cutoff the compressor motor.

At a pressure slightly above the minimum satisfactory operating pressure, a low pressure cut-off switch operates to open the closing circuit, thus preventing the mechanism from attempting to operate the breaker when there is insufficient air pressure to complete the operation. A seal-in interlock on the closing relay is wired in parallel with this low pressure cut-off switch so that should the low pressure cut-off switch open its contacts during a closing operation, the breaker will complete the closing operation. The minimum setting of the low pressure cut-off switch



is set high enough above the actual minimum to insure enough air to complete the closing operation. The operating range of all pressure switches and safety valves are made at the factory and should not need changing.

If anything should go wrong with the compressor or air equipment so that normal pressure is not maintained, a low pressure alarm switch is provided that can be used to sound an alarm at the substation indicating that the pressure is only slightly above the setting of the low pressure cut-off switch.

A hand shut-off valve is provided in the air piping between the reservoir and the pneumatic mechanism that can be used as a safety measure to prevent accidental operation while working around the mechanism.

The schematic diagram for the air system is shown on drawing 57-J-322. This diagram together with the control diagram, the various position figures, and the explanation of the mechanism operation should give a more complete understanding of the overall operation. The low pressure alarm and cut-off switches are connected to the mechanism side of the hand shut-off valve as an added safety feature, so that it is impossible to energize the closing control when the hand shut-off valve is closed. If an emergency source of air supply is available in case the compressor is out of service, it may be connected by removing the $\frac{3}{4}$" pipe plug provided in the underside of the automatic inlet valve as indicated on Dwg. Frontispiece.

PNEUMATIC MECHANISM AND CONTROL

Referring to Figs 1-2-3 while following this description will facilitate the understanding of the construction and functioning of the mechanism.

The mechanism is both electrically and mechanically trip-free in all positions. The mechanically trip-free feature is obtained by maintaining a system of linkages, which serve to transmit the movement of the closing piston to the breaker pull rod, in a releasable relative position by a trigger. Fig. 1 illustrates this arrangement of the linkage for the open position of the mechanism. Tripping the trigger, frees the system of linkages, permitting movement of the closing piston independent of the breaker. This condition is illustrated by Fig. 3 which shows the mechanism in the trip-free position.

Main Frame

The mechanism is built up about the main frame which serves as a housing for all of the levers and triggers, supports the control valve, main cylinder and auxiliaries and includes the mounting pads for mounting the mechanism to the breaker.

Cylinder and Closing Piston

The cylinder consists of a non ferrous tube clamped by four studs between the top plate which is a part of the frame, and the removable bottom plate. While these plates are made of steel, they are given a corrosion resistant protective finish. The main closing piston which is cast from a non ferrous alloy is fastened to and approximately at the center of the piston rod. The upper end of the piston rod carries the cross-head, which serves as a means of attaching the system of linkages and also provides an engagement surface for the main holding latch to maintain the mechanism in the closed position. The lower end of the piston rod extends through the spring housing and serves as a means for attaching the hand closing device. An adjustable packing gland around the piston rod, plus the piston ring on the main closing piston, minimizes the air losses during closing operations.

Retrieving Spring Assembly

The spring housing, which is attached to the bottom plate of the cylinder by an extension of two of the main cylinder studs, encloses and supports the retrieving springs. The retrieving springs, which are compressed during the closing stroke, supply the force required to move the piston back to the open or starting position following a trip-free operation, and reset the system of linkages from the position shown in Fig. 3 to the open position Fig. 1.

Lever System

The closing links are attached to the cross-head by pin "B". Rollers on either end of pin "B" run between the guide rails and serve the dual purpose of guiding the upper end of the piston rod and reducing the friction resulting from the side thrust of the closing links. Pin "C" joins the upper end of the closing links to one end each of the intermediate link and the cam lever. Pin "A" connects the other end of the cam lever to the breaker pull rod rod-end. Rollers at either end of this pin run between the guide rails to constrain pin "A" to move in a vertical plane.

In order to transmit the motion of the closing piston to the breaker pull rod, points A, B and C must be maintained in approximately the same relative position as shown in Fig. 1 or Fig. 2. This is accomplished by the following arrangement. The intermediate link is connected at one end by pin "C" to the cam lever and closing links, and at the other end by pin "D" to the trip free lever through either hole "D" or "E" depending on the breaker load to which the mechanism is applied. To simplify the description, it is assumed that the pin is located in hole D. As long as point "D" remains a fixed point, the intermediate link will maintain points A, B and C in the same relative position of Fig. 1, and the closing piston and breaker pull rod are effectively coupled and move in unison. By regulating point "D" so that it can either be maintained as a fixed center or released at will, the means are at hand to make the mechanism mechanically trip-free. The releasable function of point "D" is accomplished by locating pin "D" midway between the fulcrum point of the trip free lever and the free or roller end. It will be noted from Fig. 1 and Fig. 2 that the line through C-D about point "D" is always above the line through the trip-free lever fulcrum pin and the roller. Thus the component of the breaker load, which appears as a thrust on the intermediate link will tend to rotate the trip free lever in a counter clockwise direction about the trip-free lever fulcrum pin. In order to keep about the same thrust on pin D with lightly loaded breakers and heavily loaded breakers, pin D is assembled in hole D for the larger breaker applications and in hole E for the smaller breakers. A different cam link is used when the pin is assembled in hole E in order to keep the same engagement between the holding latch and cross-head for the latched position.

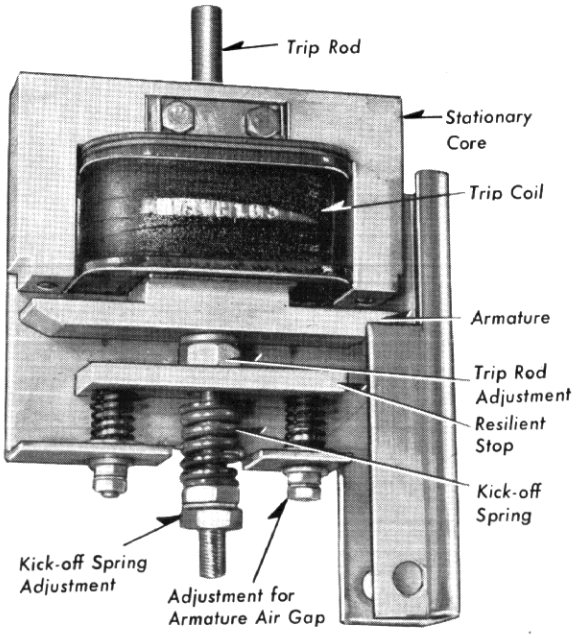
Trip Free Trigger

A trigger, free to rotate on needle bearings about a fulcrum pin and positioned approximately tangential to the direction of motion of the free end of the trip-free lever, provides the final releasable means of regulating the fixation of point "D". The end of the trigger in engagement with the roller on the trip free lever is shaped in such a manner that there is a slight tendency for the trigger to rotate clockwise whenever there is a load on the breaker pull rod. This moment, in addition to the moment provided by the trip-free trigger spring, keeps the trigger against the trip free trigger stop on the trip free lever, insuring a definite engagement of the trigger with the roller. The long horn on the trip free lever serves to maintain the trip free trigger in the tripped position whenever the mechanism is in any intermediate position between fully closed or fully retrieved positions.

To guard against the possibility of a shock, incident to stopping all the moving parts at the end of a closing operation, causing the trip free trigger to release the trip free lever, a catch is provided that engages the trip free trigger in the latched position. Normally there is no load on the catch, however the catch must be released prior to tripping the trip free trigger. An arm on the catch, interposed between the trip rod and the trip-free trigger, serves to release the catch before the trip rod engages the trip free trigger.

Trip Magnet Assembly

The trip magnet assembly is located on the underside of the frame directly under the trip free trigger. The trip rod is screwed into and locked to the trip armature. The upper end passes up through the stationary "E" frame to disengage the trigger, and the lower end extends down through a clearance hole in the resilient stop plate and carries a "kick-off" spring. The "kick-off" spring serves to force the armature away from the stationary core immediately after the trip coil is de-energized to insure rapid



Trip Magnet Assembly

resetting of the triggers. 1/32" thick copper rivets on the underside of the pole faces creates a 1/32" air gap between the armature and the pole faces which also speeds up the retrieving of the armature.

A spring mounted bar supports the armature in the open position and prevents vertical shocks from driving the armature upward. The position of the bar is adjustable providing a means for setting the armature air gap.

Holding Latch

In order to maintain the mechanism and its connected load in a closed position (Fig. 2). a spring biased holding latch engages the upper edge of the cross head. The relation between the engaging surface at the lower end and the fulcrum point at the upper end of the latch is such that the load on the pull rod tends to hold the latch in engagement.

Closing Piston Snubber

To help absorb the energy of all of the rapidly moving parts that must be suddenly decelerated at the end of a closing stroke, a collar extension on the underside of the closing piston seals off the large opening in the bottom plate as the piston approaches the closed position. This traps air between the underside of the piston and the bottom plate and rapidly builds up a back pressure to cushion the shock.

When the piston is moving in the other direction, a check valve prevents the formation of a partial vacuum in this chamber which would reduce the acceleration of the piston and delay the resetting of the trip free latches.

Control Valve

The control valve combines both the inlet and exhaust functions in a single compact unit and is controlled by a single electro-pneumatic pilot valve as illustrated in Figs. 4 to 6, 4A to 5B.

Certain illustration liberties were taken in Figs. 4A, 5A and 5B especially in respect to the shape and arrangement of the by-pass and throttle piston to facilitate the illustration and understanding of the valve construction and functioning.

The control valve can be furnished with either one of two exhaust arrangements. They differ basically in rate at which the closing air is exhausted from the closing cylinder after the mechanism has closed and latched, and the pilot valve has been de-energized. Both exhaust arrangements are illustrated on 57-J-322 and described in the following paragraphs.

The pilot magnet valve is double acting i.e.: when the inlet seat is closed, the exhaust ports are open; see pilot valve assembly page 11. The pilot valve inlet has a lapped in metal to metal seat and is spring biased closed. The valve is opened either by energizing the pilot valve coil or by manually operating the pushbutton on top of the coil which in both cases moves the pilot valve plunger down. The valve remains open only while the coil is kept energized or the button held down. As soon as the coil is de-energized or the button is released, the spring bias closes the inlet seat and opens the exhaust seat.

The main inlet valve has a metal reinforced neoprene rubber disc seat to insure positive sealing and dependable service. The valve is held tightly closed by a spring bias and the air pressure acting on the underside of the seat. The valve is opened by a separate piston which is located directly above it and opens the valve by forcing down the valve stem.

The small hole through the bottom of the inlet valve cylinder into the air passage to the main closing cylinder, and the small bleeder hole through the side wall of the valve body near the bottom of the same cylinder serve to regulate the back pressure inherently present under the piston due to leakage around the valve stem and the inlet valve piston.

The fast exhaust valve consists of a freely floating piston which is maintained in the closed position by gravity when there is no air pressure through the control valve. The valve seat is undercut to provide access for the air pressure in the main closing cylinder to act on the underside of the exhaust valve seat. The piston on top of the valve has a larger area than the exposed area of the valve seat. Thus when the control air is admitted above the exhaust valve piston, there is a preponderance of force to maintain the valve closed. Whenever the control air is exhausted from above the piston, the closing air, acting on the exposed surface of the valve seat, creates a preponderance of force upwards to open the valve. Since the exhaust valve only has to retain the air during the short interval while the mechanism is closing, a metal to metal seat is satisfactory. The four holes through the step on the piston serve the dual purpose of (1)

preventing the air being trapped in the space above the step on the piston when the valve opens and (2) preventing a build up of pressure in this space due to leakage of air past the piston.

An air passage between the top sides of the inlet and exhaust valve pistons is connected with the pilot valve between its inlet and exhaust ports. This arrangement permits a single pilot valve to control the opening and closing of both the inlet and exhaust valves.

For control valves employing the slow speed hexaust, a spring biased poppet type valve is closed by operating pressure on top of a pusher piston.

The arrangement of the by-pass and throttle as illustrated in Figs. 4A, 5A and 5B does not conform exactly to the actual physical arrangement of the valve, but the deviations were considered necessary in order to illustrate the continuity of air flow. There are two parallel air passages between the inlet valve and the closing cylinder: (a) one via the small port directly under the by-pass adjusting screw, and (b) the other a much larger passage via the throttle piston. The larger passage is so arranged that the throttle piston, which is spring biased closed, can block off this path completely leaving only the restricted opening via the by-pass port as a connection between the inlet valve and the cylinder. The by-pass adjusting screw provides a means of regulating the flow of air through the by-pass port.

The position of the throttle piston is regulated by the throttle cam lever, which in turn is controlled by the position of the breaker as illustrated in Figs. 10-11. For the start and early part of the closing operation, the breaker load is relatively light for most breakers. In order to prevent the breaker lift rod from attaining unnecessarily high velocities during this lightly loaded portion of the closing stroke, with a corresponding drop in pressure in the closing cylinder, the flow of air is restricted by having the throttle piston closed and the air forced to reach the cylinder via the by pass port. Shortly before the breaker contact load is picked up, the large passage through the valve is opened up to provide maximum air flow to meet the rapid increase in load which the mechanism is called on to close. The opening of the throttle piston is accomplished by a roller on the breaker pull rod, rod end pin engaging a cam on the throttle lever during the closing movement of the mechanism. The position in the closing stroke where the throttle opens can be set for early or later opening by shifting the position of the cam plate on the throttle lever.

The main components of the valve are made of a non-ferrous alloy. All moving parts such as valve stems and pistons are chromium plated to minimize galling and insure trouble free performance.

Control Valve Employing High Speed Exhaust

Opening the small pilot valve either manually by means of the pushbutton on top of the pilot valve coil, or by energizing the coil, admits high pressure air above the inlet and exhaust valve pistons simultaneously. The inlet valve piston is forced down opening the inlet valve and the air from the storage reservoir is free to flow via the by-pass port into the main cylinder. The exhaust valve is held closed by the preponderance of force created downwardly on the valve by virtue of the control air acting on the larger area of the piston, versus the closing air acting on the exposed surface of the valve seat (Fig. 5-5A). After the mechanism has traveled sufficiently for the rod end roller to engage the throttle cam plate, the throttle piston is opened (Figs. 5B-11).

Closing the pilot valve by either releasing the manual pushbutton or de-energizing the pilot valve coil opens up the exhaust ports and closes off the inlet seat. This allows the control air above the inlet and exhaust pistons to exhaust down to atmospheric pressure which causes two actions to take place practically simultaneously; (1) the inlet valve closes under the combined action of the valve spring and the pressure differential across the valve seat, and (2) the exhaust valve opens due to the shift in preponderance of force upwardly on the valve, since the only force now is created by the closing air acting on the exposed surface of the valve seat (Fig. 6). This opens up a large and direct passage from the main closing cylinder to the atmosphere and results in a very rapid "dumping" of the closing air.

Control Valve Employing Slow Speed Exhaust

For control valves employing the slow exhaust, the function described above is essentially correct except that the exhaust valve closes as soon as the air admitted to the cylinder builds up to a pressure sufficient to overcome the spring bias,

and remains closed following the closing of the inlet valve until the air leakage out of the cylinder drops the pressure sufficiently to permit the spring bias to overcome the air pressure on the top side of the valve seat and pusher piston.

Control Scheme

To provide for remote and semi-automatic control of the admission of air to the mechanism, and the cutting off of the air at the end of a closing operation, a control panel is included as part of the standard equipment. The steel panel is located in a convenient position on the left hand side of the housing in order to provide maximum accessibility and unrestricted working space around the mechanism. A hinged mounting enables the panel to be swung out providing convenient access to the wiring on the rear. The equipment on the standard panel includes a closing relay, a cut-off relay, and 3 fused knife switches. Referring to a typical diagram 16C4204 in back of book, the closing relay designated as "X" and the cut-off relay designated as "Y" are pictured in the deenergized position. The arrangement of the two relays as shown provides an electrically trip-free, non pumping device and is commonly designated as an X-Y control scheme.

The electrically trip-free feature is provided by inserting an auxiliary switch contact designated as "aa" in the cut-off relay coil circuit, and a circuit opening contact of the cut-off relay in the closing relay circuit. The auxiliary switch known as the cut-off switch is mounted on the pneumatic mechanism and connected through an operating lever to an extension of the pin through the cross head. Thus the position of its contacts are determined by the position of the mechanism closing piston. On a closing operation, as the mechanism approaches the closed position, the "aa" switch makes up its contact energizing the cut-off relay coil, and this in turn opens the cut-off relay contact in the closing relay coil circuit, which returns the closing relay to the de-energized position. Simultaneously the two normally closed cut-off relay contacts in the pilot valve coil (MAG) circuit, open. To provide the non pumping feature, a normally open cut-off relay contact is connected in parallel with the cut-off switch "aa" contact, and another normally open cut-off relay contact is connected in parallel with the low pressure cut-off and latch check switches. If the mechanism and its connected load fail to remain closed due to some malfunctioning part such as a broken latch, as soon as the mechanism has dropped open far enough to re-open the cut-off switch "aa" contacts, the cut-off relay contact in parallel with the "aa" contact remains closed maintaining the closing circuit "locked out." The closing circuit will continue to be "locked out" until the operator releases the control switch de-energizing the control circuit.

Low Pressure Cut-Out Switch

To insure against the mechanism attempting to close when there is insufficient air pressure in the reservoir to complete the operation, a low pressure cut-out switch, located in the air supply system between the inlet valve and the reservoir and on the mechanism side of the shut-off valve, has its contact connected in the closing circuit between the operators control switch and the closing circuit. The low pressure cut-out switch contact is normally closed, but opens before the critical operating pressure is reached.

To further insure against a possible faulty operation due to the low pressure cut-out switch opening its contacts during a closing operation, "make" contacts of the closing relay are provided to by-pass the low pressure cut-out switch. As soon as the closing relay is energized, the "make" contacts "seal in" and insures the admission of air to the mechanism to complete the closing operation. These "seal-in" contacts also insure the completion of any closing operation once started, even through the operator might release the control switch before the mechanism has had time to complete the operation.

If the breaker is closed on a fault, and the operating pressure is near the lower limit the low pressure cutout switch contacts may open momentarily just after the breaker reaches the closed position. Should this occur while the operator is still maintaining the control switch closed, and after the cut off relay has caused "X" seal-in to drop out, the breaker would reclose. Employing a normally open cut-off relay contact in parallel with the low pressure cut off switch insures against this faulty operation.

Two contacts of the cut-off relay are situated in the pilot valve coil circuit to de-energize the inlet valve at the conclusion of the closing stroke.

One of the fused knife switches on the control panel is provided to take the power off from the control circuit locally during maintenance periods and also provide overload protection. One of the other fused knife switches is provided for the

compressor motor circuit, and the other for the heater circuit.

Latch Check Switch

Reference diagram in back of book. For reclosing duty, besides the addition of a reclosing relay such as the Type SGR-12 shown, an auxiliary switch indicated as LCH (latch check) on the diagram and located in the circuit from the recloser to the control relays is required. This switch which is normally closed except while the trip-free trigger is disengaged, determines the reclosing time by requiring that the energizing of the closing circuit be delayed until the mechanism is fully retrieved and the trigger reset.

ACCESSORIES

Auxiliary Switches

In addition to the 2 pole cut-off switch, a 11 pole auxiliary switch with independently adjustable contacts is provided for the Customers use for interlocking, indicating, alarm and trip circuits. This switch which is mounted on the back of the housing and connected through a linkage to the breaker pull rod, indicates the position of the breaker contacts.

Operation Counter

An operation counter mounted on the 2 pole auxiliary switch, is operated by the switch operating arm. The counter records on the opening stroke.

High Speed Switch

A high speed switch is available on special request which mounts on the back of the housing and is operated from the vertical pull rod.

Heaters

Two heaters are provided in the housing. One of these heaters is to be energized continuously winter and summer to maintain a temperature differential between the inside and outside in order to prevent undesirable moisture condensation within the housing. The other heater, which is thermostatically controlled is provided to maintain this differential in cold weather.

Hand Closing Device

For the lightly loaded frame mounted breakers, a club type hand closing device is used which permits the breaker being closed with one sweep of the handle. The handle and socket are easily removable for transfer from one mechanism to another.

When the mechanism is used on heavy current or 69 KV frame mounted breakers or on the Type GM breakers where the loads are much greater, a screw type jack, with a ratchet handle is available for closing the breaker during maintenance and inspection periods. This device is NOT to be used for emergency manual closing of the breaker on a live line.

The two types of closing devices cannot be used interchangeably on the same mechanism as the lower end of the piston rod is constructed quite differently for either type.

Both types MUST be removed before attempting to operate the mechanism pneumatically.

If it is considered desirable from a safety standpoint in order to insure against accidental opening while men are working on the breaker, the pin, which is supplied with the mechanism, may be inserted through two holes provided in the side plates of the frame. The pin passes behind the catch and directly above the tail section of the trip free trigger blocking the trigger in the latched position. *This pin must be removed before putting the breaker back in service.*

PART III—OPERATION

CLOSING

Starting with the mechanism and breaker in the open position (Fig. 1), and with the trigger engaging the trip-free lever to maintain the linkages in the relative position shown, closing the control switch energizes the pilot valve coil. This opens the inlet valve which admits compressed air stored in the reservoir to the closing cylinder. The high pressure air acts on the piston to close the mechanism. When the breaker is nearly closed, the "aa" auxiliary switch contact closes energizing the cut-off relay "Y" which simultaneously (1) opens it "Y" contacts in the pilot valve coil circuit initiating the shutting off of compressed air to the closing piston, (2) opens its contact in the closing relay coil circuit de-energizing the closing relay and opening its "seal-in" contact "X" and (3) closes the "seal-in" "Y"

contact in parallel with the "aa" switch and the "Y" contact in parallel with the latch check switch and low pressure cut-out switch to maintain the control relays locked out until the control switch is released. The point where the "aa" switch makes up its contacts is so near the end of the closing stroke, that the mechanism and breaker continue on in to the fully closed position before the closing air is actually shut off. As the mechanism reaches the fully closed position (Fig. 2), the holding latch engages the cross head on the upper end of the piston rod, keeping the mechanism and breaker closed.

OPENING

Starting with the breaker in the closed position (Fig. 2), when the control switch or protective relay energizes the trip coil circuit, the trip rod on the moving armature of the trip magnet disengages the trigger which has been restraining the roller on the trip-free lever. The connected breaker load, acting through the cam lever and intermediate links on the trip-free lever cause it to rotate about its fulcrum pin releasing the breaker (Fig. 3). The horn on the trip free lever maintains the trigger in the released position until the mechanism is fully retrieved. As the cam lever rotates about pin A, the cam extension disengages the holding latch. This action permits two heavy retrieving springs, which are confined between the main closing piston and the bottom of the spring housing, and which were compressed during the closing operation, to move the piston to the open position. If the speed of the breaker pull rod is greater than the piston speed, the extreme trip-free position shown in Fig. 3 may be approached. If the piston retrieving speed is greater than the breaker pull rod speed, as will be the case in some applications, the piston will "overtake" the breaker, completely retrieving the levers and resetting the trigger as shown in Fig. 1, before the breaker and mechanism have reached the full open position.

CLOSE-OPEN

The close-open operation is merely a combination of the closing and tripping operations described previously. When the breaker closes on a fault, the protective relay energizes the trip coil disengaging the trigger just before the mechanism reaches the closed position. This releases the connection between the piston and the breaker pull rod and the breaker is allowed to immediately reopen unimpeded, (Fig. 3). The cam lever being in a released position keeps the holding latch from engaging the cross head as the piston reaches the closed position. Opening the exhaust valve exhausts the air from the main cylinder releasing the closing piston. In this instance however, there is enough delay introduced by exhausting the air from the cylinder to allow the breaker to reach the full open position (Fig. 3) before the piston starts to return to the open position. Once the piston starts to move however, the retrieving action is rapidly accomplished.

OPEN-CLOSE

Reclosing requires the use of a separately mounted reclosing relay of either the SGR-12 or RC-3 type. When the trip-free trigger is disengaged by the protective relay energizing the trip coil, the action described previously under "Opening" takes place. As the trigger resets, a latch checking switch makes contact completing the reclosing circuit, energizing the pilot valve coil. This admits high pressure air to the cylinder and the mechanism immediately recloses.

Should the fault that caused the protective relay to trip the mechanism still exist as the mechanism recloses the breaker, the mechanism will function as described in detail under the description of the "close-open" operation, and the breaker and mechanism will return to the open position. Due to the lockout feature of the Type SGR-12 relay, the mechanism must be closed by the operator before another reclosing operation can be performed.

PART IV—INSPECTION—MAINTENANCE—ADJUSTMENT

INSPECTION

Since operating conditions vary greatly from one area to another and even between installations in the same locality, it is difficult to recommend any time interval for inspection and maintenance. The important consideration in this respect is that a regular schedule is established and maintained in order that the condition of the equipment is known, and any deficiencies corrected before they can develop into a serious condition. The circuit breaker is highly dependent upon the proper functioning of the mechanism. Therefore, it should always be kept in good condition.

Page 11 of this instruction book, contains a complete description of the compressor* unit with recommendations for inspection and maintenance.

MAINTENANCE

Caution

When working around the mechanism or breaker, close the hand valve between the reservoir and mechanism and open the control circuit at the control panel so that accidental operation of the intake valve or closing contactor will not cause the breaker to close unexpectedly. As a further safety precaution, it is recommended that the pushbutton on top of the pilot valve be held down to exhaust the high pressure air between the hand shut off valve and the control valve.

Keep the area immediately below the spring housing free whenever operating the mechanism, as the lower end of the piston rod protrudes through the opening in the spring housing when the mechanism is in the closed position.

There is a considerable blast from the exhaust valve when the closing air is exhausted from the main cylinder. Therefore maintenance personnel should be cautioned to keep clear of the area immediately below the valve whenever the mechanism is operated pneumatically.

Personnel should be cautioned to keep all tools and especially their hands outside of the side plates of the frame whenever the mechanism is in the closed and latched position. This is especially true of the space immediately in front of the trip free lever, as this lever travels at a very fast speed and could result in serious injury if this precaution is not observed.

In order to be sure of the mechanisms good condition and check its readiness for satisfactory operation, expecially in applications where the mechanism is not called on to operate for extended periods of time, several operations should be made at each inspection period.

Latches and Triggers

The holding latch and cross-head are made of hardened steel machined to shape. The engaging surfaces of the latch and cross-head may be polished with fine emery cloth if they become dirty. *Do not attempt to grind the surfaces nor change their angle.* Apply a thin film of rust inhibiter S# 1802 395 (M 9921-4) to the latch, cross-head, and outside surface of the roller on the trip free lever. This inhibiter should be carefully selected to be free flowing at all anticipated temperatures, non-hardening, and self-healing (does not completely wipe off in one operation). The latching surfaces should be examined at every inspection to make sure of their condition.

If while adjusting the breaker contacts, it becomes desirable to open the mechanism slowly with the hand closing device after the mechanism has been closed and latched, the main holding latch can be disengaged easily by first taking the load off the latch by pulling the mechanism slightly into the overtravel position and then keeping the latch disengaged until the cross-head passes the end of the latch as the mechanism is let out.

The trip-free trigger is cast from a tough, high strength non-ferrous alloy, tipped with a highly corrosion resistant, file hard stellite latching face. The latching face has been accurately ground to the correct angle. *Do not attempt to regrind this surface nor change the angle.* The needle bearings in the roller and the trip-free trigger are packed with Westinghouse Grease Style 1802 395 and should not require repacking more often than every 18 months.

The grease on the roller guides should be examined periodically for contamination with dust or other foreign matter and if this condition is evident, the old coating should be washed off with a solvent and a new coating of grease applied.

Air Leakages

A good overall check for air leaks in the air supply system is to make a "leak test". Observe the loss in pressure on the pressure gauge over a sufficiently long time in order to determine the rate of pressure drop. When checking leakage, allow the system to cool for about 2 hours before reading pressures if the reservoir has just been filled from atmospheric pressure; otherwise a pressure drop of a few lbs. will be observed due to contraction of the air on cooling. When the mechanisms leave the factory, the air system will not lose more than two or three pounds per square inch per hour, but there is no need for alarm if the leakage exceeds this figure somewhat, unless it becomes progressively worse.

* Data contained herein, prepared especially for Westinghouse Electric Corp. Reprinted from Westinghouse Air Brake Instructions 9352-1 and Repair Parts List 9352-1.3A1.

As a protective measure before the mechanism assembly leaves the factory, the air cleaner is removed and the compressor run for several minutes while atomized oil is drawn in through the air intake. Therefore when the breaker is first put into service, this oil may show up either in the air exhausted from the control valve or in the air discharge from the reservoir whenever the condensate is blown out. Evidence of oil at these points is normal and expected and should not be cause for alarm.

Inlet Valve

The first place to check for leaks is the pilot valve. Cover one of the two exhaust ports, that come out of either side of the housing directly under the coil, with a finger and apply a soap solution over the other part. Leakage here is generally due to dirt particles on the valve seat. "Cracking" the valve several times by pressing on the pushbutton momentarily will generally serve to dislodge the dirt and make the valve seal properly. However if this proves unsuccessful, refer to instructions on pilot magnet valve.

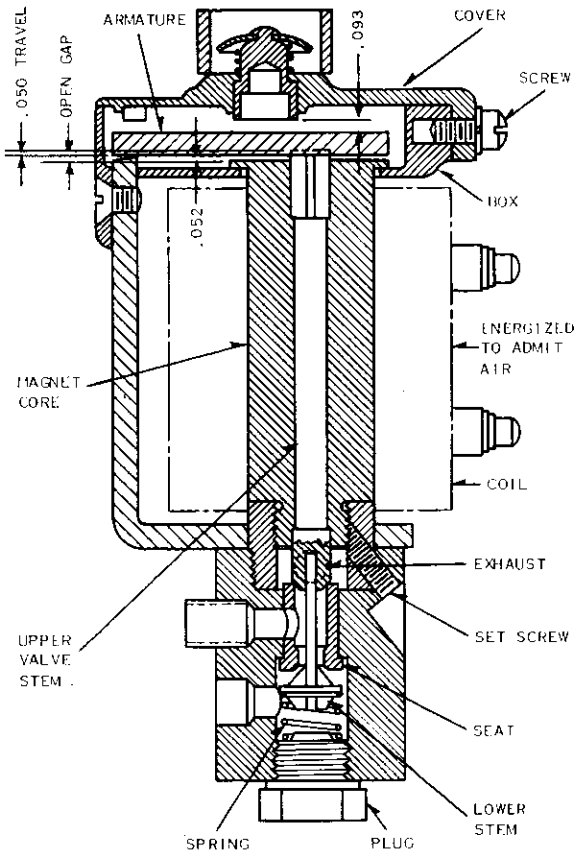
Checking for leaks past the main inlet valve can be accomplished easily. Apply a soap solution over the bleeder hole through the right hand side of the valve body. If a leak is detected here, after having previously determined that the pilot valve is tight, it indicates that the main inlet valve is not sealing properly. The quickest method and one that generally is successful is to "crack" the valve by bumping the pushbutton on the pilot valve several times. The valve can be removed for inspection of the rubber disc seat by removing the cover on the underside of the valve body. Be sure that the hand shut-off valve has been previously closed, and the air between the shut-off valve and control valve exhausted before attempting to remove the bottom cover.

If the leak is not connected with the control valve all air connections including the safety valve should be checked with soap solution.

PILOT MAGNET VALVE

General Description

Referring to Pilot Valve Assembly, when the pilot valve coil is energized, the armature depresses stem down which in turn pushes lower stem to admit air from the storage reservoir through a small part (lower valve seat). At the same time, the lower end of stem seats on the upper valve seat to prevent air from escaping through the exhaust port. When the pilot valve



Pilot Magnet Valve Assembly

is de-energized, spring closes lower valve, while the upper valve opens to exhaust air from the main control valve to atmosphere.

Repair

It is generally recommended that complete valve with coil be carried as a renewal part for important power station installations rather than attempting repair of this small pilot valve. However, for those operators that do wish to attempt maintenance of this valve, the following paragraphs may be helpful. In any case, we seriously recommend carrying at least one complete spare valve with coil for emergency use, so that faulty valve may be removed and repaired when convenient.

Inlet Valve Leakage

Occasionally a pilot valve may "blow" (that is give out a hissing sound) due to leakage of air; if this occurs when the magnet coil is de-energized and the air blows out the exhaust port, it is an indication that the lower (inlet) valve is not seating properly. This trouble is caused generally by the presence of a little dirt on the valve seat and in most cases can be relieved by popping the

valve quickly with the manual button several times. If the blowing persists, shut off the hand valve in the supply line from the storage reservoir and unscrew the plug at the bottom of the magnet valve. Carefully lower the plug straight down, so that the spring and lower valve stem drop down with it. Wipe the valve stem perfectly clean and also clean the valve seat with a small stick and piece of cloth. It is also helpful to smooth the valve seat by spinning the lower stem on its seat with a screw driver several times. The upper stem should be in place to act as a guide. Use machine oil on the seat to prevent scoring.

When replacing the lower valve stem spring, and plug, *first remove cover by taking out screw in order to prevent bending stem.* With the cover and armature removed, it will be obvious if the lower stem does not enter the upper stem properly, as the latter would be raised.

Exhaust Valve Leakage

If the valve "blows" through the exhaust part when the coil is energized, it is an indicaton that the exhaust valve is not seating properly. This may be due to any one of the following causes:

A. Dirt on valve seat.

B. Dirt under magnet armature.

C. Low voltage applied to coil.

D. Upper valve stem worn down so that armature strikes the core before valve seats.

To remove upper stem it is not necessary to shut off the air. First remove cover and armature. Next place fingers over exhaust parts and press down valve stem and release quickly so that air pressure will raise stem for enough to grasp for removal. Wipe valve stem clean and examine for seating imperfections. If grinding appears to be necessary, follow instructions below.

Another possible but not too likely cause of a blowing exhaust valve is a stem worn down so short that the armature strikes the magnet core before the valve seats. Shut off the air and carefully measure how far the stem protrudes above the magnet core when depressed and seated. This dimension corresponds to the closed armature air gap which is .052 normal as shown. Valve stem may be used as long as this dimension is not less than .032" before being replaced. If it is necessary to install a new stem, the end must be filed down to get .052—.054" dimension, since new stems always come long.

Grinding Valves

If it becomes necessary to grind the valves to cure leakage, use a fine grade of regular valve grinding compound or make a thin paste of finely ground pumice and machine oil. Apply a little grinding compound on the valve seat, and spin valve stems back and forth on their seats with a screw driver. When grinding the lower valve, the upper stem should be in place to act as a guide.

After grinding, the stems and valve seats should be thoroughly cleaned with gasoline and blown out with air.

Replacing Coil

If it becomes necessary to replace a coil, first remove cover (held by one screw), armature, and set screw. Next remove magnet core, using special spanner wrench S# 757 466. Finally remove box, and coil may be removed readily.

TYPE "GA" AIR COMPRESSOR UNITS

The Type "GA" Air Compressor Unit is a complete air compressing outfit which is fully automatic in operation.

The air compressor and motor are mounted on a bedplate. Power is transmitted by single "V" belt drive with adjustable belt take-up. The bedplate is mounted on a vertical air tank which is fitted with supporting legs and a syphon type drain cock.

Completely equipped with motor and electrical protective and control devices, the compressor unit is ready to connect to the line, and start operation after filling the compressor with oil and lubricating the motor bearings as per instructions under "Installation and Maintenance."

It is important that the wiring to the motor be strictly in accordance with National Board regulations. Consult regulations or local inspector regarding size of wire and proper fuse protection. The use of wire smaller than required for the installation will result in unsatisfactory operation and possible damage to the motor.

Air Compressor

The single stage, single cylinder air compressor is lubricated by the controlled splash system and is air cooled. Deep cast circular fins on the air cylinder provide a large radiating surface, and a six-blade fan flywheel maintains

a constant air stream through the fins. The crankcase and cylinder is a single casting with a side cover providing access to the interior of the crankcase, and an end cover which serves as a bearing support for one end of the crankshaft. The crankshaft operates in two sleeve bearings, and the connecting rod bearing is of the adjustable split type. The piston is fitted with two compression rings and one oil ring. The cylinder head is finned for efficient cooling and incorporates two valve units, each of which is accessible upon removal of a cap nut and cage.

Proper rotation of the compressor is left-hand (counter clockwise) when facing the flywheel (as indicated by the arrow). On three phase installations, the direction of rotation should be checked regularly.

Before starting the compressor, fill the crankcase with high grade automobile engine oil—S.A.E.-20 for temperatures above freezing or S.A.E.-20W for temperatures below freezing. Excessive carbonization will not occur if the proper grade of oil is used and if the limits of operation applying to the particular outfit are not exceeded.

Approximate Oil Capacity.....1 Pint

The oil filling plug should be removed and the oil level observed periodically. If the oil level is not up to the tapped opening, add sufficient oil to raise the level to this opening and replace plug. Never remove the oil plug while compressor is operating.

At least every six months a sample of oil should be drained from the crankcase to determine its condition which will govern the necessity for complete draining and refilling the crankcase. The necessity for this should conform to good automobile engine practice.

Every three months, or oftener if required, the curled hair and felt discs should be removed from the air strainer, washed in an alkali free hydrocarbon solvent and replaced. The valve caps in the cylinder head should be removed periodically and the inlet and discharge valves and their seats thoroughly cleaned.

If it should ever become necessary to disassemble the check valve, care should be exercised in re-assembling the check valve. The valve should be held in the spring cage and against the spring by means of a blunt tool. This tool should be inserted through the seat of the valve from the tubing side, and used to hold the valve inside the spring cage while the seat is screwed in place. This will prevent the valve from being bent during assembly.

The syphon cock at the side of the tank should be opened during inspection or maintenance of the breaker to drain accumulated water resulting from condensation. Leave the drain cock open only as long as solid water runs, then close tightly.

The Safety Valve ordinarily requires no attention. It is set to blow off at 10% to 20% above the working pressure of the apparatus. If, after blowing off, the valve fails to seat tightly, it is usually due to dirt on the seat. Opening and closing the safety valve slowly by means of the cross bar on its stem, with the compressor running, usually cleans the valve seat and restores the proper seal. If not, the safety valve should be dis-assembled and both the valve and the seat wiped clean. If the seat has not been cut, a little oil should be applied; if cut, the valve should be reseated.

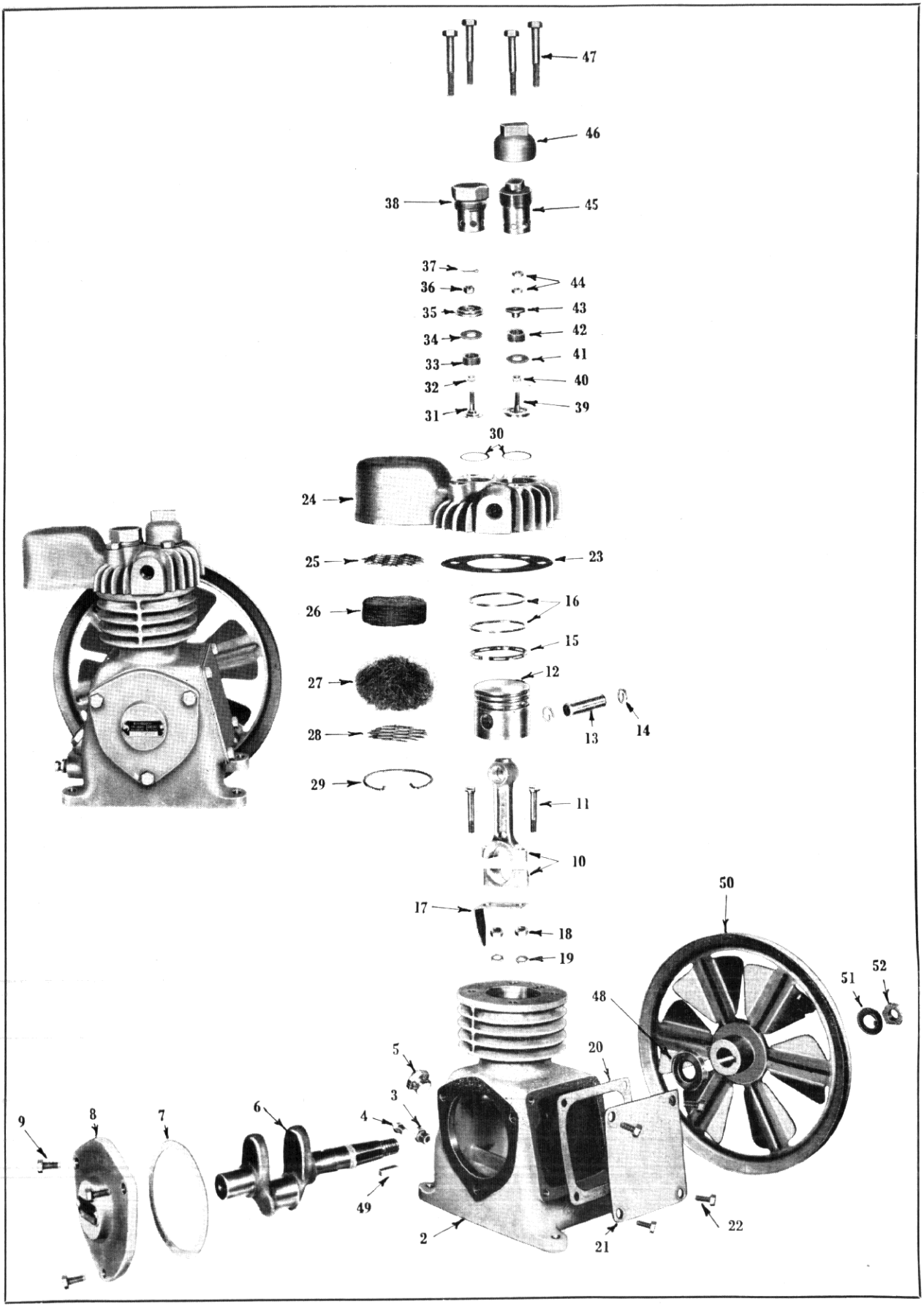
The belt should be maintained tight enough to prevent excessive slippage, but not tight enough to place undue strain on the motor and compressor bearings which will result in excessive heating of these bearings and increase the power required.

Air Compressor Operation

On the down stroke of piston, air passes through the intake filter into the chamber above the inlet valve and past this valve into the cylinder. Partial vacuum created in the cylinder and underneath the disc valve by the downward stroke of the piston permits atmospheric pressure above the inlet valve to overcome the resistance of spring under the valve and force the valve from its seat. Air thus flows into the cylinder until pressures above and below the valve are about equal when the inlet valve is closed by its spring.

On the upward stroke of the piston, the air in the cylinder is compressed, lifting discharge valve against the resistance of its spring (plus tank air pressure) and passing through the discharge pipe to the storage tank.

An oil dipper attached to the connecting rod operates through an oil channel or trough cast in the bottom of the crankcase to direct the splash upward and lubricate the moving parts. The oil level in the trough is maintained by oil running down the walls of the crankcase and passing into the trough.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REPAIR PARTS LIST

2-GA AIR COMPRESSOR WITH BRASS CYLINDER HEAD, STAINLESS STEEL VALVES AND PLUGS SUPPLIED WITH AA7 UNITS

PIECE NO.	DESCRIPTION
188526 P-80374	2-GAV Compressor Unit, Complete
188524	Compressor Portion (See Repair Parts List below)
188525	Reservoir
7978	3/8" x 1" Cap Screw (4 req'd)
17173	3/8" Lock Washer (4 req'd)
81221	3/8" Check Valve AD-15-649 (O" Ring Seat)
188719	1/2" O.D. x 7/16" I.D. x 12 3/4" Discharge Tube
86914	3/8" Reinforced Compression Union Elbow for 1/2" O.D. Tube
41889	1/4" Street Elbow
850152-0175	1/4" FA Safety Valve
66947	1/4" x 7/8" Long Nipple
P80062	1/4" Angle Valve
188717	Syphon Drain Fitting, Complete (Includes Pc. 188709 and Pc. 188718)
188709	Syphon Drain Fitting
188718	1/4" I.P.S. Copper Pipe 10 5/8" Long
†80358-2	Motor Pulley
†537873	5/16" x 1/4" Cup Pt. Set Screw
†49955-7	Belt
516685	Inspection Plug Gasket

† These items are not included in the Complete Piece Number but must be ordered separately.

PIECE NO.	REF. NO.	DESCRIPTION
188524		Air Compressor, Complete
188303	2	Cylinder and Crankcase
65860	3	1/8" x 1/4" Pipe Reducer
97592	4	Oil Drain Plug
522866	5	Oil Filler Cap
187969	6	Crankshaft
187972	7	End Cover Gasket
188306	8	End Cover
16239	9	3/8" x 3/4" End Cover Cap Screw (3 req'd)
187973	10	Connecting Rod, Complete (Includes 17, two or 11, 18 and 19)
187975	11	5/16" x 1 3/4" Connecting Rod Bolt (2 req'd)
187991	12	Piston with Wrist Pin (Includes 13)
187980	13	Wrist Pin
187981	14	Wrist Pin Retaining Ring (2 req'd)
187979	15	Oil Ring
183660	16	Compression Ring (2 req'd)
187976	17	Oil Dipper
73757	18	5/16" Connecting Rod Nut (2 req'd)
542616	19	5/16" Connecting Rod Locking Nut (2 req'd)
187983	20	Side Cover Gasket
187982	21	Side Cover
15683	22	5/16" x 5/8" Side Cover Cap Screw (4 req'd)

PIECE NO.	REF. NO.	DESCRIPTION
188030	23	Cylinder Head Gasket
188523		Cylinder Head, Complete (Includes 24, 25, 26, 27, 28, 29, 38, 45, 46, Pc. 187458, 187455, 184551 and two of 30)
188522	24	Cylinder Head
188032	25	Inner Strainer Plate
183687	26	Felt Washer
	27	1/8 Oz. Curled Hair
183688	28	Outer Strainer Plate
183689	29	Strainer Retaining Ring
99720	30	Valve Gasket (2 req'd)
187458		Inlet Valve, Complete (Includes 31, 32, 33, 34, 35, 36 and 37)
187456	31	Spring Seat
187451	32	Inlet Valve Guide
184549	33	Inlet Valve Spring
181782	34	Inlet Valve
187457	35	Inlet Valve Seat
523166	36	1/4" Inlet Valve Castle Nut
521200	37	1/16" x 1/2" Cotter
187449	38	Inlet Valve Plug
187455		Discharge Valve, Complete (Includes 39, 40, 41, 42, 43 and 44)
187454	39	Discharge Valve Seat with Stud
187451	40	Valve Guide
181782	41	Discharge Valve
184549	42	Discharge Valve Spring
187450	43	Discharge Valve Spring Seat
521440	44	1/4" Discharge Valve Nut (2 req'd)
187448	45	Discharge Valve Plug
187447	46	Valve Cap (2 req'd)
15691	47	3/8" x 2 1/2" Cylinder Head Cap Screw (4 req'd)
187968	48	Oil Retainer
64577	49	Key for Pulley
80354	50	Flywheel Pulley
187984	51	Lock Washer
27009	52	5/8" Crankshaft Nut
519848	53	1/4" Fluted Socket Pipe Plug

REPAIR PISTONS AND RINGS

REF. NO.	DESCRIPTION	PIECE NUMBERS		
		.010" Oversize	.020" Oversize	.030" Oversize
12	Piston with Pin	188235	188237	188239
15	Oil Ring	188203	188204	188205
16	Compression Ring	184093	184095	185468

Prices will be quoted upon application.

Orders should give SIZE and SERIAL NUMBER of Compressor as well as PIECE NUMBER and NAME of part wanted.

ADJUSTMENTS

Pressure Gauge

It is advisable to check the pressure gauge with a master gauge to verify the correctness of its indication before checking the pressure switch adjustments.

Pressure Switches

The settings of the pressure switches should be checked against the values stamped on the mechanism nameplate at each regular inspection period. *Governor Switch* Pressures higher than normal will cause the breaker to slam hard on closing, while pressures lower than normal reduce the reserve capacity stored in the reservoir. If the pressure gauge reading at the time the compressor has just completed recharging the reservoir indicates that the switch is not cutting off at the proper pressure, it may be corrected with adjustment of the slotted knurled stud on top of the switch. This assumes that the differential has been previously adjusted correctly at the factory. With the differential set, adjustment of the slotted knurled stud on top of the switch will change the cut-in and cut-out pressure by a like amount. If the settings are off excessively, as would be the case when installing a complete new pressure switch, the procedure to follow is as follows: Set the cut-in pressure to the value stamped on the mechanism name plate by adjusting the slotted knurled stud on top of the switch and set the cut-out pressure by adjusting the differential adjusting screw located on the right hand side of switch box under the cover. *Low Pressure Cut-Off Switch.* Too low a setting of the low pressure cut-off switch, nullifies the purpose of the switch, i.e., to prevent the mechanism from attempting to close when there is insufficient air to complete the operation. Too high a setting would result in the switch opening prematurely and thereby cut down the number of operations unnecessarily that are possible from a fully charged reservoir. The governor switch is normally set to start up the compressor at a pressure well above the operating pressure of the cut-out switch, thus the cut-out switch is not normally called on to operate except in the event the compressor is out of operation. Since this switch may remain idle over long periods, its readiness to operate in an emergency should be checked at each inspection period. *Low Pressure Alarm.* The low pressure alarm switch is intened to give a warning to the operator in the event that the compressor fails to recharge the reservoir. Therefore in order to forestall erroneous indication of the alarm, the setting of the alarm switch should be checked. *Safety Valve.* To insure against overloading the compressor unit or damage to the mechanism and breaker from operating at excessive pressures in the event of failure of the governor switch to cut off the compressor, the safety valve is set to open at 110 to 120 percent of normal pressure. To verify the safety valve setting, place a jumper across the governor switch contacts and allow the compressor to operate beyond the normal cut off pressure.

Tripping

The latch and trigger on this mechanism do not require delicate adjustment and therefore no adjustment is provided.

An adjustment for the overtravel of the trip free lever is provided and should be checked occasionally. With the mechanism in the open position Fig. 1, there should be approximately 1/32 clearance between the trip free lever roller and the stellite tip on the trip free trigger to insure positive resetting of the trigger. More clearance than is necessary at this point will impose severe hammering of the trip free lever roller and the trigger when the closing air is admitted to the cylinder. Adjustment of this clearance is made by turning the resilient stop housing in or out of the strut on the main frame. The small nut on the upper end of the steel follower stem should be finger tight only when the mechanism is in the open position to insure against putting any initial compression on the rubber bumper.

The air gap for the trip armature should be approximately 3/16". This adjustment is made by varying the height of the resilient stop assembly Fig. 2. For maximum tripping speed, the length of the trip rod should be just long enough to release the trip free lever when the armature air gap is 1/32". This adjustment has been made at the factory and should not require changing. The adjustment is made by loosening the hex nut on the underside of the armature and screwing up or down on the trip plunger.

The "kick off" spring on the lower end of the trip rod serves to speed up the retrieving of the armature after the trip coil is de-energized. When the armature is sealed in against the pole faces of the magnet, this spring should be compressed about 1/16". Thus for an armature

air gap of 3/16", the gap between the underside of the resilient stop bar and the top of the kick off spring should be 1/8". If it is ever necessary to change this factory set adjustment, be sure to keep the trip rod from turning in respect to the armature, by holding the trip rod with a screw driver while loosening and tightening the kick off adjusting nuts.

Overtravel

The overtravel of the piston should be approximately 1/8". There is no adjustment of the overtravel, but it should be checked to determine that it exists, as it is essential in order to allow time for the latch to snap into place. Furthermore if it is not present, it may indicate that the stops in the breaker pole unit are engaging too much ahead of the overtravel stop on the mechanism. To check the overtravel with the mechanism in the closed position, hold down the push button on the intake valve, and note the travel of the cross-head roller pin extension that operates the auxiliary switch.

Throttle and By Pass

The throttle has been set at the factory to give the most satisfactory closing performance of the breaker and should not require adjustment. The only adjustment provided is to vary the position in the closing stroke of the mechanism where the throttle piston is opened. This adjustment is made by shifting the location of the cam plate on the throttle lever.

The setting of the by-pass adjusting screw has been determined on test at the factory and should not require change.

Too wide an opening of the by-pass adjusting screw or too early opening of the throttle piston may result in excessive acceleration during the early part of the closing stroke which is undesirable, as it imposses unnecessarily severe duty on the breaker contacts and results in a reduction of the air pressure in the closing cylinder near the end of the stroke.

PART V—TROUBLE SHOOTING SUGGESTIONS

In case unsatisfactory operation develops, the following are suggested points to check in order to isolate the trouble.

A. IF THE MECHANISM FAILS TO CLOSE THE BREAKER

1. Check to see that the correct control voltage is available.
2. Check the closing relay to see that it closes its contacts.
3. Check the intake valve coil circuit.
4. Check the pressure of the air in the reservoir to see that it agrees with the normal pressure given on the nameplate.
5. Check the position of the hand shut off valve between the reservoir and the mechanism.
6. Check the admission of air to the main closing cylinder by observing whether there is a momentary discharge of air from the exhaust valve, when the button on the pilot valve is momentarily closed then released.
7. Check the breaker stops to make sure there is no interference.
8. Check to see that the trip-free trigger is reset properly. Two things to look for if the trigger does not reset are (1) The trip free lever stop being set too low thus limiting the travel of the trip free lever and (2) The breaker traveling too far in the open position so that the main closing piston hits the top plate, preventing the retrieving springs from resetting the trip free lever.

B. IF THE MECHANISM CLOSES THE BREAKER, BUT FAILS TO KEEP IT CLOSED

1. Check the minimum operating voltage of the cut-off relay and increase it if it is too low.
2. Check the two pole switch contacts to see if they are closing too soon, so as to cut-off the air to the cylinder before the mechanism is closed and latched.
3. Close the mechanism by means of the pushbutton on top of the pilot valve and

observe the overtravel of the roller on the cross-head pin. This should be about $\frac{1}{8}$" to allow the latch time to reset.

4. Check the resetting of the trip-free trigger to make sure that the upper end of the trigger is against the stop on the trip-free lever, and that the trigger is in full engagement with the roller on the trip-free lever.
5. Check the engagement between the catch and the trip-free trigger to make sure that it resets properly.

C. IF THE MECHANISM FAILS TO TRIP

1. Check the voltage at the trip coil.
2. Check the terminals and contacts on the 11 pole auxiliary switch to be sure that they are making good contact.
3. Observe whether the trip rod rises when the control switch is moved to the position for tripping.
4. Raise the trip rod manually and observe whether the catch is disengaged prior to attempting to rotate the trigger, and that the trigger is moved sufficiently to release the roller on the trip free lever. Also check that the armature seats up against the stationary armature.

D. ON RECLOSING DUTY, IF THE MECHANISM TRIPS BUT FAILS TO RECLOSE

1. Check the contacts on the latch check switch to see that they are making good contact.
2. Make the checks outlined in A1 to A8.

WESTINGHOUSE ELECTRIC CORPORATION • HEADQUARTERS: 3 GATEWAY CENTER, P. O. BOX 2278, PITTSBURGH 30, PA.

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DES MOINES 17, IOWA, 2515 Dean Ave.
DETROIT 32, MICH, 5757 Trumbull Ave., P.O. Box 502
DULUTH 2, MINN., 408 Bradley Bldg., 10 East Superior St.
EL PASO, TEXAS, 611 Electric Bldg., 215 N. Stanton St.
EMERYVILLE 8, CALIF., 5815 Peladeau St.
ERIE 2, PA., 1003 State St.
EUGENE, ORE., 62 West 13th St.
EVANSVILLE 7, IND., 1253 Diamond St.
FAIRMONT, W. VA., 10th and Beltline Sts., P.O. Box 1147
FERGUS FALLS, MINN., 101½ W. Lincoln Ave.
FLINT, MICH., 508 Church St.
FORT WAYNE 2, IND., 124 Washington St.
FT. WORTH 2, TEXAS, 1205 Electric Bldg.
FRESNO 1, CALIF., 2608 California Ave.
GRAND RAPIDS 2, MICH., 148 Monroe Ave., N.W.
GREENSBORO, N. C., 707 Guilford Bldg., P.O. Box 3072
GREENVILE, S. C., 135 S. Main St., P.O. Box 1559
HAGERSTOWN, MD., 5 Public Square
HAMMOND, IND., 6341 Indianapolis Blvd.
HARTFORD 3, CONN., 119 Ann St.
HOUSTON 2, TEXAS, 507 Dallas Ave.
HUNTINGTON 1, W. VA., 1029 Seventh Ave., P.O. Box 1150
HUNTSVILLE, ALA., P.O. Box 42, 436 Locust St.
INDIANAPOLIS 2, IND., 1560 Stadium Drive
JACKSON, MICH., 120 West Michigan Ave.
JACKSON, MISS., 607 Electric Bldg., P.O. Box 484
JACKSONVILLE 6, FLA., 1520 Prudential Building, 841 Miami Rd.
JOHNSON CITY, N. Y., 419 Grand Ave.
JOHNSTOWN, PA., Wallace Bldg., 406 Main St.
KANSAS CITY 6, MO., 101 W. Eleventh St.
KINGSPORT, TENN., 145 Commerce St.
KNOXVILLE 8, TENN., Gay and Clinch St.
LAKE CHARLES, LA., Gayle Bldg., 500 Broad St., P.O. Box 1336
LINCOLN, NEBR., 414 Federal Securities Bldg.
LITTLE ROCK, ARK., 103 W. Capitol St.
LONG BEACH, CALIF., 2129 Pacific Ave.
LOS ANGELES 17, CALIF., 600 St. Paul Ave.
LOUISVILLE 2, KY., 332 West Broadway
MADISON 3, WIS., 110 N. Thornton Ave.
MEDFORD, ORE., 1233 Court St., P.O. Box 1308
MEMPHIS 3, TENN., 130 Madison Ave.
MIAMI 32, FLA., 730 Ingraham Bldg.
MILWAUKEE 2, WIS., 538 N. Broadway
MINNEAPOLIS 13, MINN., 2303 Kennedy St., N.E.
MOBILE, ALA., 1511 Merchants Nat'l Bank Bldg.
NASHVILLE 4, TENN., 401—6th Ave. S.
NEWARK 2, N. J., 1180 Raymond Blvd.
NEW ORLEANS 12, LA., 228 St. Charles St.
NEW YORK 5, N. Y., 40 Wall St.
NIAGARA FALLS, N. Y., 253 Second St.
NORFOLK 10, VA., 915 W. 21st St.
OKLAHOMA CITY 2, OKLA., 120 N. Robinson St.
OLEAN, N. Y., Exchange Nat'l Bank Bldg., 201 N. Union St.
OMAHA 2, NEBR., 117 North Thirteenth St.
PEORIA 3, ILL., 2800 N. Adams St.
PHILADELPHIA 4, PA., 3001 Walnut St.
PHOENIX, ARIZ., 1102 N. 21st Ave., P.O. Box 6144
PITTSBURGH 30, PA., 306 4th Ave., P.O. Box 1017
PORTLAND 4, ORE., 309 S. W. Sixth Ave.
PROVIDENCE 3, R. I., 51 Empire St.
RALEIGH, N. C., Warren Bldg., 306 S. Dawson St., P.O. Box 2146
READING, PA., 524 Court St.
RICHMOND 11, VA., Travelers Bldg., 1110 East Main St.
RIVERSIDE, CALIF., 3830 Eighth St.
ROANOKE 4, VA., 303 1st St., S.W.
ROCHESTER 11, N. Y., 1 McKee Rd.
ROCKFORD, ILL., 323 South Main St.
RUTLAND, VT., 98 Merchants Row
SACRAMENTO 14, CALIF., 1720—14th St.
SAGINAW, MICH., 221 So. Jefferson St.
ST. LOUIS 1, MO., 411 North Seventh St.
SALT LAKE CITY 1, UTAH, 235 W. South Temple St.
SAN ANTONIO 5, TEXAS, 115 W. Travis St.
SAN DIEGO 1, CALIF., 525 "E" St.
SAN FRANCISCO 8, CALIF., 410 Bush St.
SAVANNAH, GA., 204 Realty Bldg., P.O. Box 2008
SEATTLE 4, WASH., 3451 East Marginal Way
SHREVEPORT, LA., P.O. Box 541, 412 Milam St.
SIOUX CITY 7, IOWA, 1005 Dace St.
SOUTH BEND 4, IND., 216 East Wayne St.
SPOKANE 1, WASH., North 1023 Monroe St.
SPRINGFIELD, ILL., 607 E. Adams St., P.O. Box 37
SPRINGFIELD 3, MASS., 26 Vernon St.
SUNNYVALE, CALIF., Hendy Avenue
SYRACUSE 6, N. Y., 4030 New Court Rd.
TACOMA 2, WASH., 950 Pacific Ave.
TAMPA, FLA., 608 Tampa St.
TOLEDO 4, OHIO, 245 Summit St.
TRENTON 8, N. J., 28 W. State St.
TUCSON, ARIZ., 2020 E. 13th Street
TULSA 3, OKLA., 703 Enterprise Bldg.
UTICA 2, N. Y., 255 N. Genesee St.
WASHINGTON 6, D. C., 1625 K St., N.W.
WATERLOO, IOWA, 300 West 3rd St.
WATERTOWN, N. Y., 341 Woolworth Bldg.
WHEELING, W. VA., 12th and Main St. (Nat'l Bank of W. Va.)
WICHITA, KANS., 213 So. Main St.
WILKES-BARRE, PA., 267 N. Pennsylvania Ave.
WILLIAMSPORT, PA., 221 Williamsport Bldg., 460 Market St.
WINSTON-SALEM, N. C., P.O. Box 5463, Ardmore Station
WORCESTER 8, MASS., 507 Main St.
YORK, PA., 153 East Market St.
YOUNGSTOWN 3, OHIO, 25 E. Boardman St.

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ATLANTA 2, GA., 1250 Chattahoochee Ave., N.W.
ATLANTA 2, GA., 1103 Glidden St., N.W.
AUGUSTA, MAINE, 9 Bowman St., P.O. Box 667
BALTIMORE 24, MD., 4015 Foster Ave.
BATON ROUGE 2, LA., 555 Choctaw Drive, P.O. Box 1150
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BOSTON 27, MASS., 235 Old Colony Ave. (So. Boston)
BRIDGEPORT 8, CONN., 540 Grant St.
BUFFALO 10, N. Y., 1132 Seneca St.
CHARLOTTE 1, N. C., 210 East Sixth St.
CHICAGO 32, ILL., 3900 W. 41st St.
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CLEVELAND 11, OHIO, 4600 W. 160th St.
DENVER 23, COLO., 200 Rio Grande Blvd.
DETROIT 32, MICH., 5757 Trumbull Ave., P.O. Box 502
DULUTH 8, MINN., 9320 Grand Ave.
EMERYVILLE 8, CALIF., 5840 Landregan St.
FAIRMONT, W. VA., 10th and Beltline Sts., P.O. Box 1147
FORT WORTH 7, TEXAS, 100 Rupert St.
HILLSIDE 5, N. J., 1441 Chestnut Ave.
HOUSTON 20, TEXAS, 5730 Clinton Dr.
HUNTINGTON 1, W. VA., 1029 Seventh Ave., P.O. Box 1150
INDIANAPOLIS 25, IND., 551 West Merrill St.
JOHNSTOWN, PA., 107 Station St.
KANSAS CITY 6, MO., 1300 Oak St.
LOS ANGELES, CALIF., 3383 E. Gage Ave., P.O. Box 629, Huntington Park
MILWAUKEE 9, WIS., 1500 W. Cornell St.
MINNEAPOLIS 13, MINN., 2303 Kennedy St., N. E.
PHILADELPHIA 4, PA., 3001 Walnut St.
PHILADELPHIA 34, PA., Erie Ave. & D St.
PITTSBURGH 8, PA., 543 N. Lang Ave.
PORTLAND 12, ORE., 626 North Tillamook St.
PROVIDENCE 9, R. I., 127 Hartford Ave.
ST. LOUIS 10, MO., 1601 S. Vandeventer Ave.
SALT LAKE CITY 1, UTAH, 235 W. South Temple St.
SEATTLE 4, WASH., 3451 East Marginal Way
SPRINGFIELD 1, MASS., 395 Liberty St., P.O. Box 641
SUNNYVALE, CALIF. (Sunnyvale Plant), P.O. Box 37
SYRACUSE 6, N. Y., 4030 New Court Rd., P.O. Box 117, Eastwood Station
UTICA 1, N. Y., 113 N. Genesee St., P. O. Box 270
WILKES-BARRE, PA., 267 N. Pennsylvania Ave.

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ATLANTA 2, GA., P.O. Box 4808
BALTIMORE 2, MD., 501 St. Paul Pl.
BALTIMORE 3, MD., 2519 Wilkens Ave. (X-Ray Div.)
BEAUMONT, TEXAS, 1014 American National Bank Bldg.
BIRMINGHAM 3, ALA., 1407 Comer Bldg.
BOSTON 10, MASS., 10 High St.
BUFFALO 3, N. Y., Ellicott Square Bldg.
BUTTE, MONT., 1 East Broadway
CHARLOTTE 1, N. C., 210 East Sixth St.
CHICAGO, ILL., Merchandise Mart Plaza, P.O. Box 3426
CINCINNATI 2, OHIO, Gwynne Bldg.
CLEVELAND 13, OHIO, 1370 Ontario St.
COLUMBUS 15, OHIO, 262 N. 4th St.
DALLAS 1, TEXAS, 1232 Fidelity Union Life Bldg.
DAVENPORT, IOWA, 2212 E. 12th St.
DENVER, COLO., 55 W. 5th Ave.
DES MOINES 17, IOWA, 2515 Dean Ave.
DETROIT 32, MICH., 5757 Trumbull Ave., P.O. Box 502
DULUTH 2, MINN., 408 Bradley Bldg., 10 East Superior St.
EL PASO, TEXAS, 611 Electric Bldg., 215 N. Stanton St.
FRESNO 1, CALIF., 2608 California Ave.
GRAND RAPIDS 2, MICH., 148 Monroe Ave., N. W.
HARTFORD 3, CONN., 119 Ann St.
HOUSTON 2, TEXAS, 507 Dallas Ave.
HUNTINGTON 1, W. VA., 1029 Seventh Ave., P.O. Box 1150
INDIANAPOLIS 2, IND., 1560 Stadium Drive
JACKSON, MICH., 120 W. Michigan Ave.
JACKSONVILLE 6, FLA., 1520 Prudential Bldg., 841 Miami Road
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LOS ANGELES 17, CALIF., 600 St. Paul Ave.
LOUISVILLE 2, KY., 332 West Broadway
MEMPHIS 3, TENN., 825 Exchange Bldg., 130 Madison Ave.
MILWAUKEE 2, WIS., 538 N. Broadway
MINNEAPOLIS 13, MINN., 2303 Kennedy St., N. E.
NEWARK 2, N. J., 1180 Raymond Blvd.
NEW ORLEANS 12, LA., 1226 Whitney Bldg., 228 St. Charles St.
NEW YORK 5, N. Y., 40 Wall St.
NORFOLK 10, VA., 915 W. 21st St.
OMAHA 2, NEBR., 117 N. 13th St.
PHILADELPHIA 4, PA., 3001 Walnut St.
PHOENIX, ARIZ., 1102 N. 21st Ave., P.O. Box 6144
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ROANOKE 4, VA., 303 1st St., S. W.
ROCKFORD, ILL., 323 S. Main St.
ST. LOUIS, MO., 411 North Seventh St.
SALT LAKE CITY 1, UTAH, 235 W. South Temple St.
SAN DIEGO 1, CALIF., 525 "E" St.
SAN FRANCISCO 8, CALIF., 410 Bush St.
SEATTLE 4, WASH., 3451 East Marginal Way
SIOUX CITY 7, IOWA, 1005 Dace St.
SPOKANE 1, WASH., N. 1023 Monroe St.
SPRINGFIELD 3, MASS., 26 Vernon St.
SYRACUSE 6, N. Y., 4030 New Court Rd.
TOLEDO 4, OHIO, 245 Summit St.
TULSA 3, OKLA., 703 Enterprise Bldg.
UTICA 2, N. Y., 255 Genesee St.
WASHINGTON 6, D. C., 1625 K Street, N.W.
WILKES-BARRE, PA., 267 N. Pennsylvania Ave.
YOUNGSTOWN 3, OHIO, 25 E. Boardman St.


WESTINGHOUSE

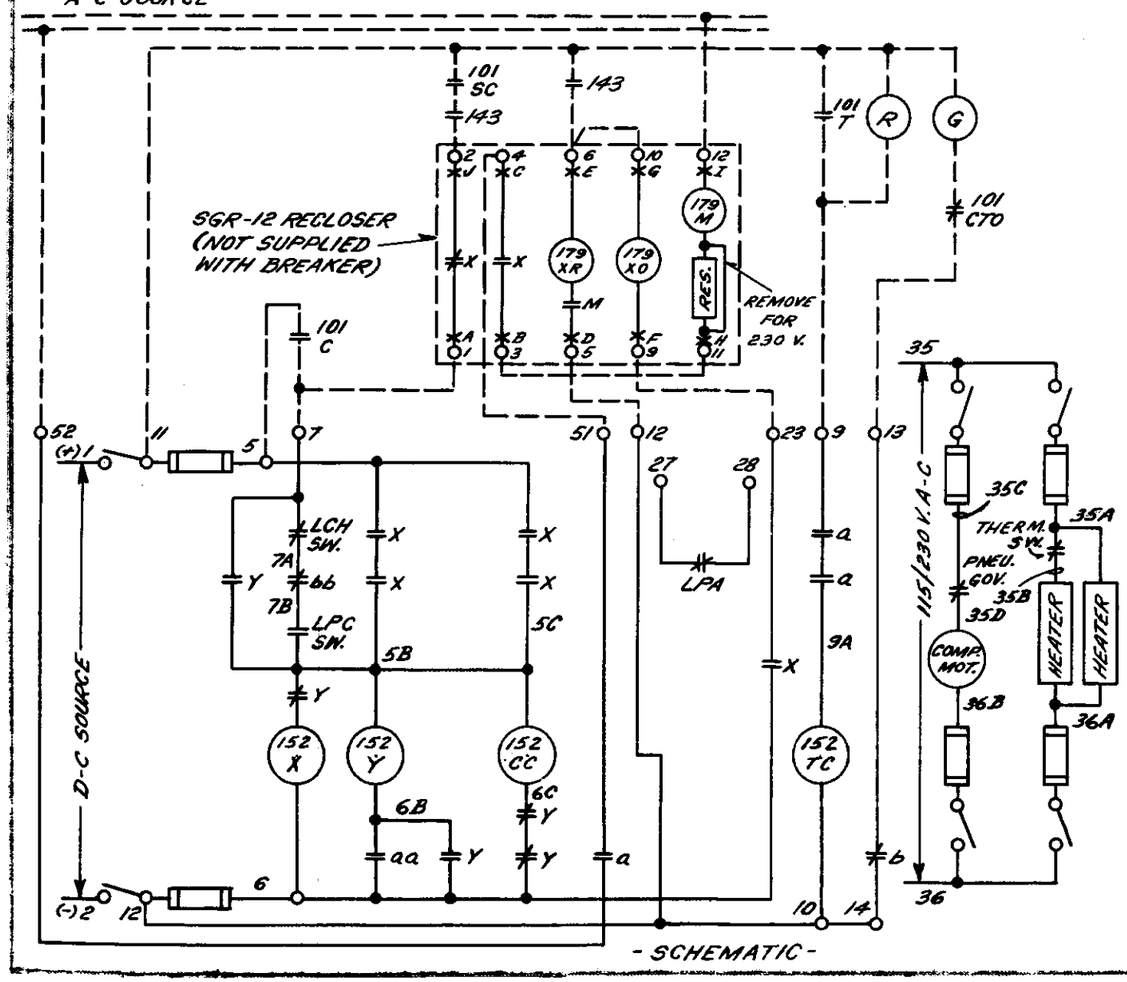
SHOP NOTE: NUMBER IN CIRCLE CORRESPONDS TO ITEM NUMBER ON JUMPER DRAWING 32B8000.

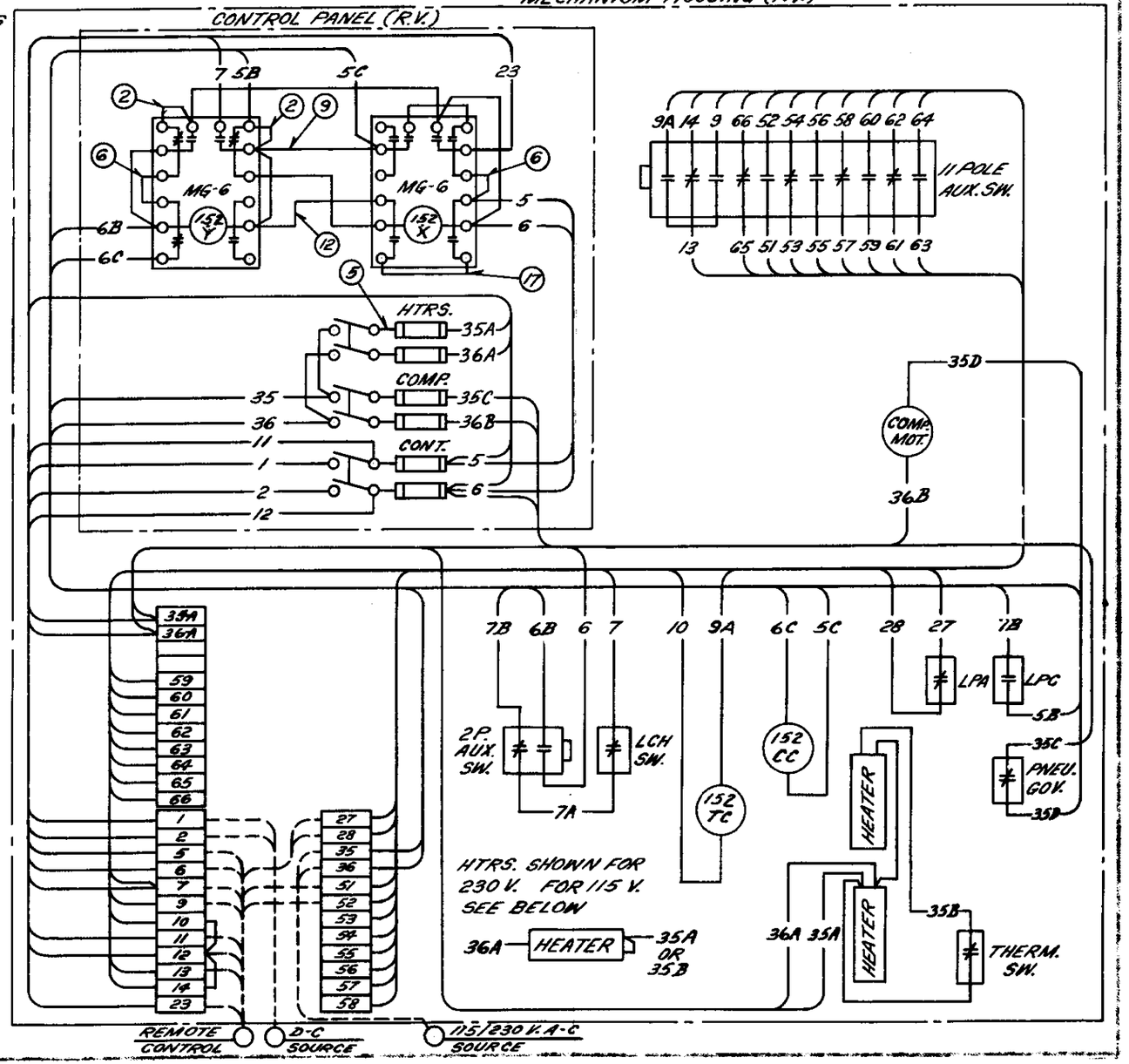
LEGEND

AUX. SW. SHOWN FOR OPEN BKR.
RELAY CONTACTS SHOWN DE-ENERGIZED
PRESS. SW. SHOWN FOR LOW PRESS.

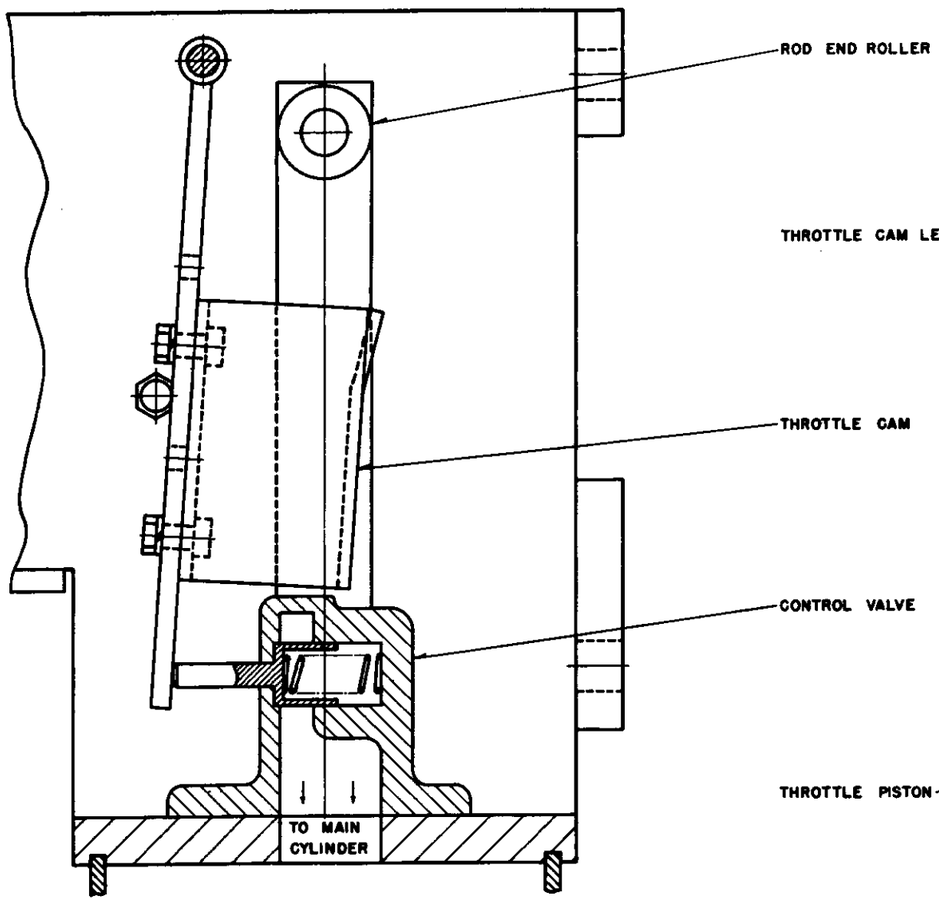
— OPEN CONTACTS
— CLOSED CONTACTS

152 CC — INTAKE MAGNET VALVE COIL
152 TC — TRIP COIL
LCH — LATCH CHECK SWITCH
LPA — LOW PRESS. ALARM (CLOSED ON L.P.)
LPC — LOW PRESS. CUTOUT (OPEN ON L.P.)
101 — CONTROL SWITCH
143 — TOGGLE SWITCH
○ — ACCESSIBLE TERMINALS



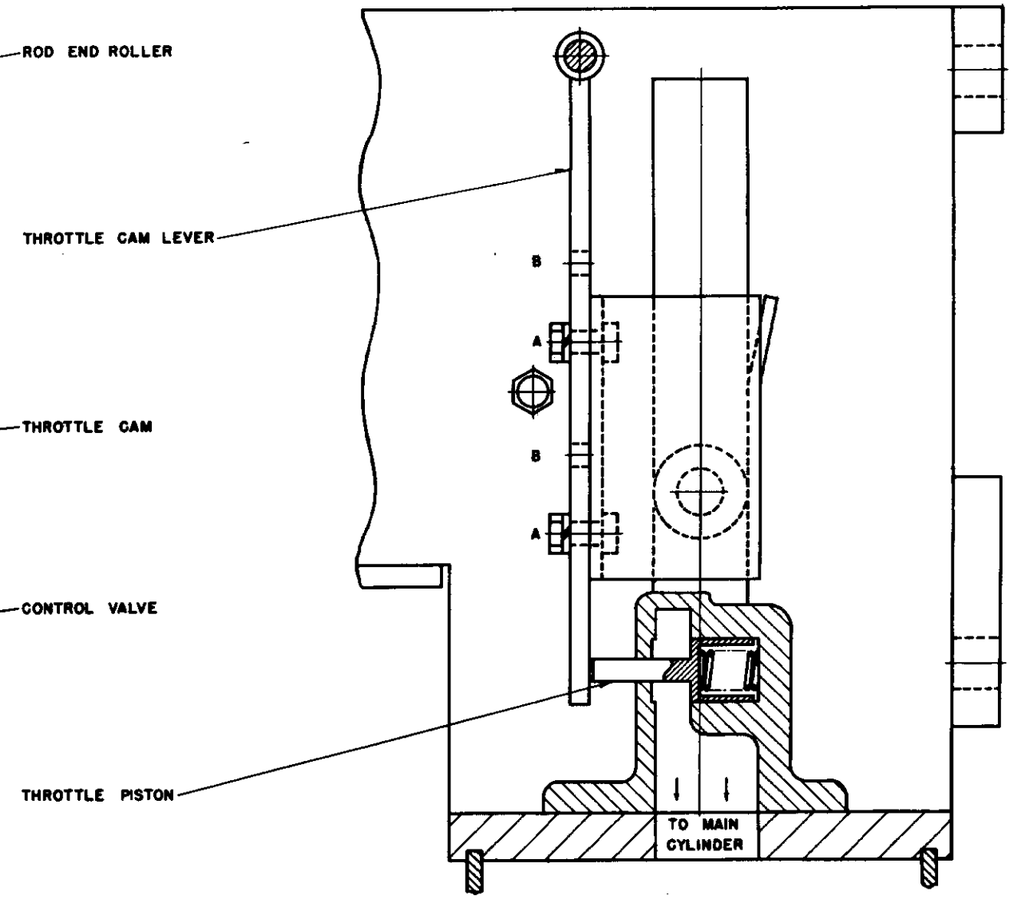


Compressed Air Operated Oil Circuit Breaker
AA-7 Pneumatic Mechanism
53-C-3700-5



MECHANISM OPEN-THROTTLE CLOSED

FIG.10

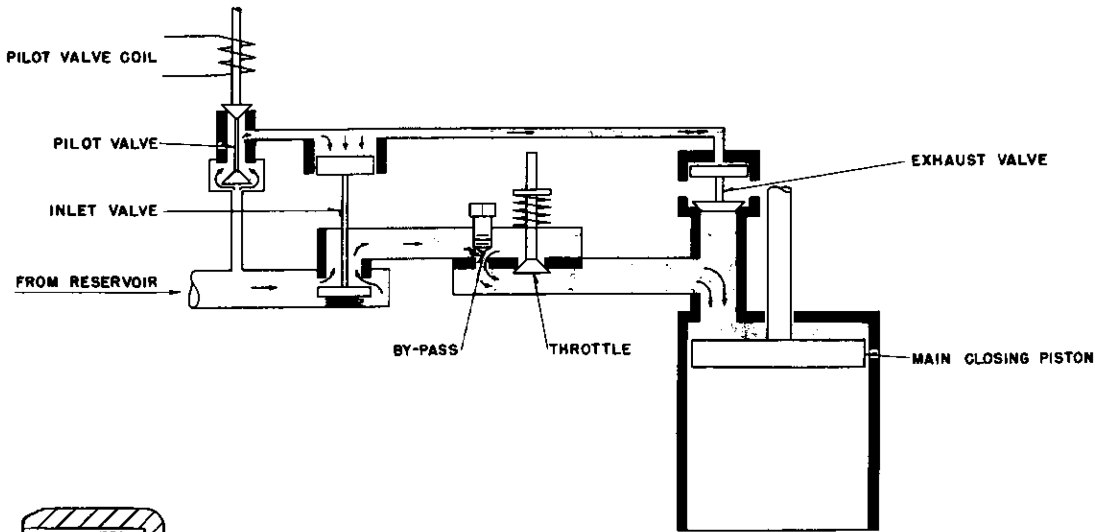


MECHANISM CLOSED-THROTTLE OPEN

FIG.11

WESTINGHOUSE ELECTRIC CORPORATION

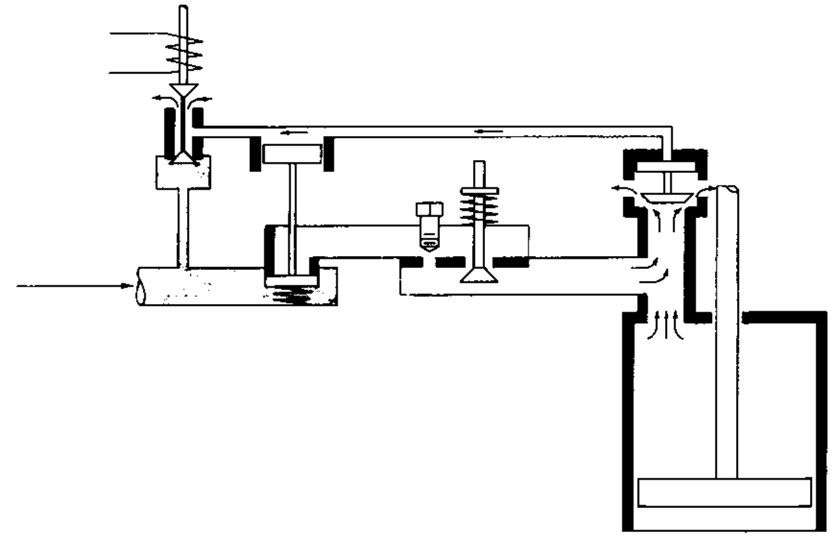
36-A-2662



OPEN

SCHEMATIC OF CONTROL VALVE

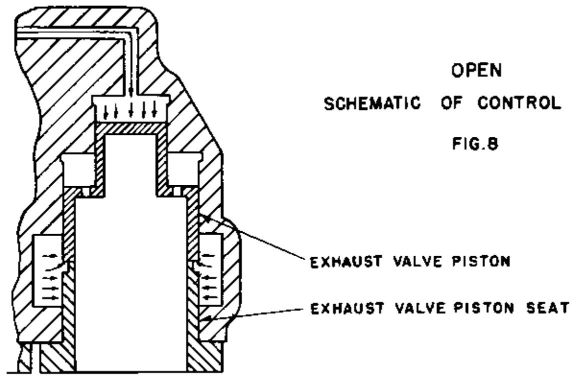
FIG.8



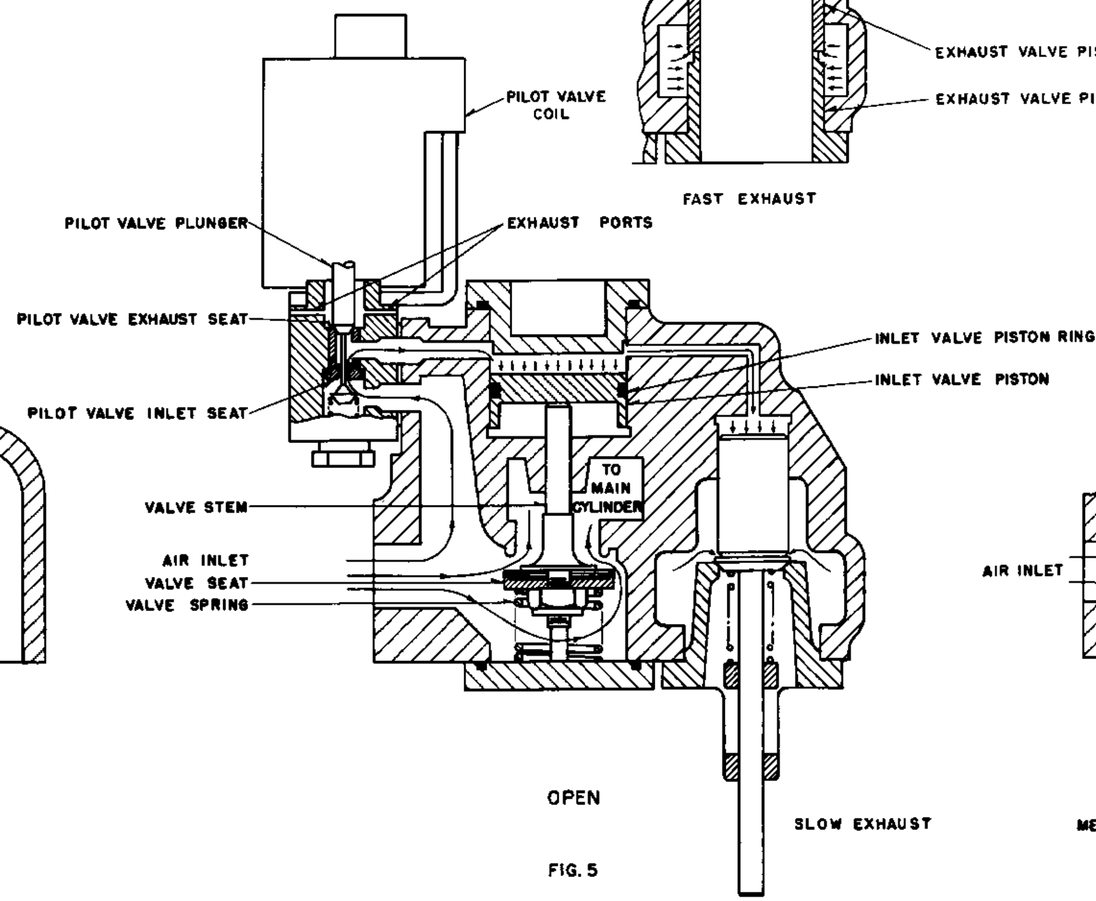
EXHAUSTING

SCHEMATIC OF CONTROL VALVE

FIG.9



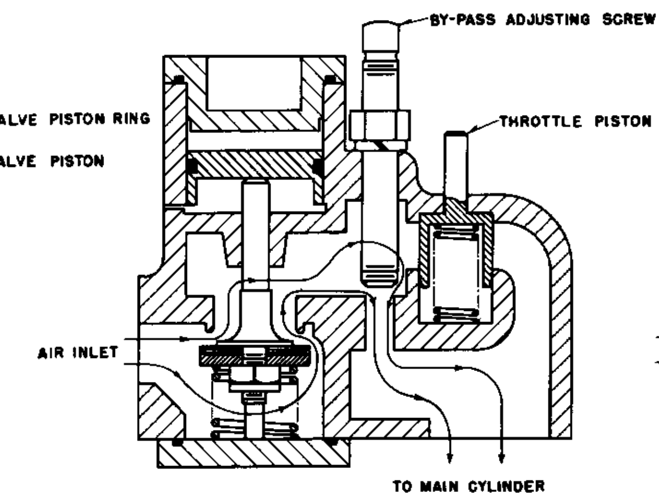
FAST EXHAUST



OPEN

SLOW EXHAUST

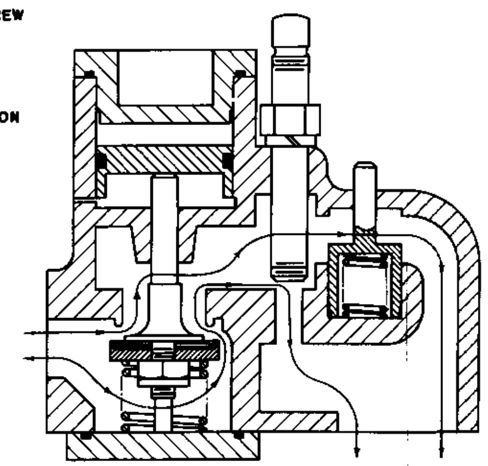
FIG. 5



OPEN

MECHANISM IN EARLY PART OF CLOSING STROKE

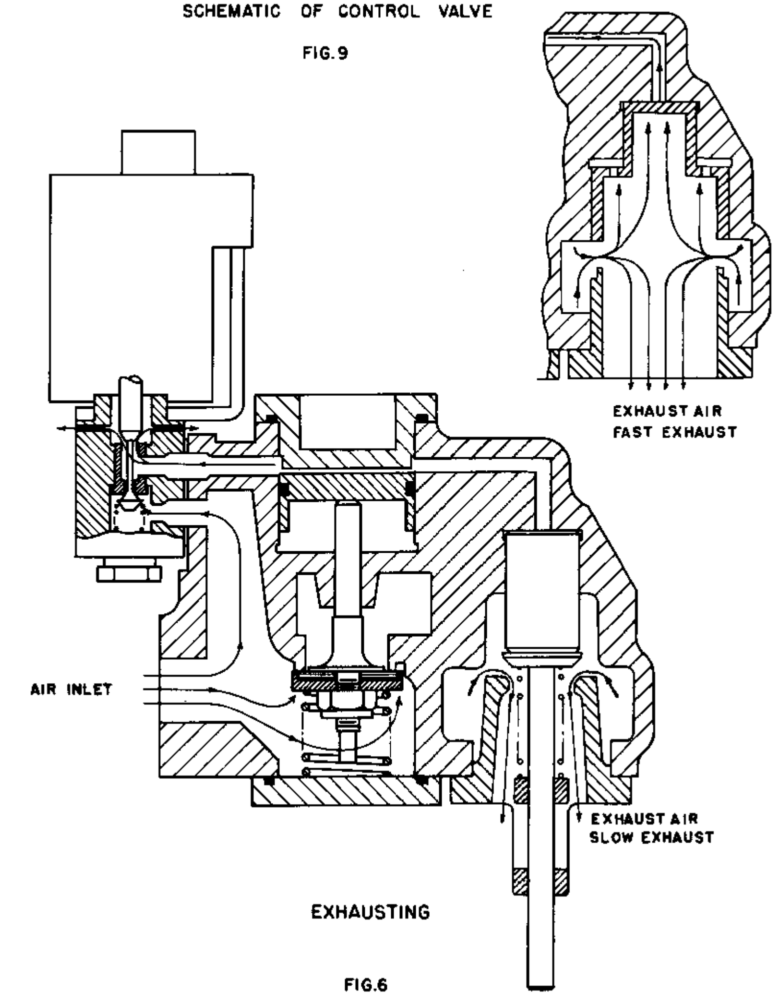
FIG.5A



OPEN

MECHANISM NEARING END OF CLOSING STROKE

FIG.5B



EXHAUSTING

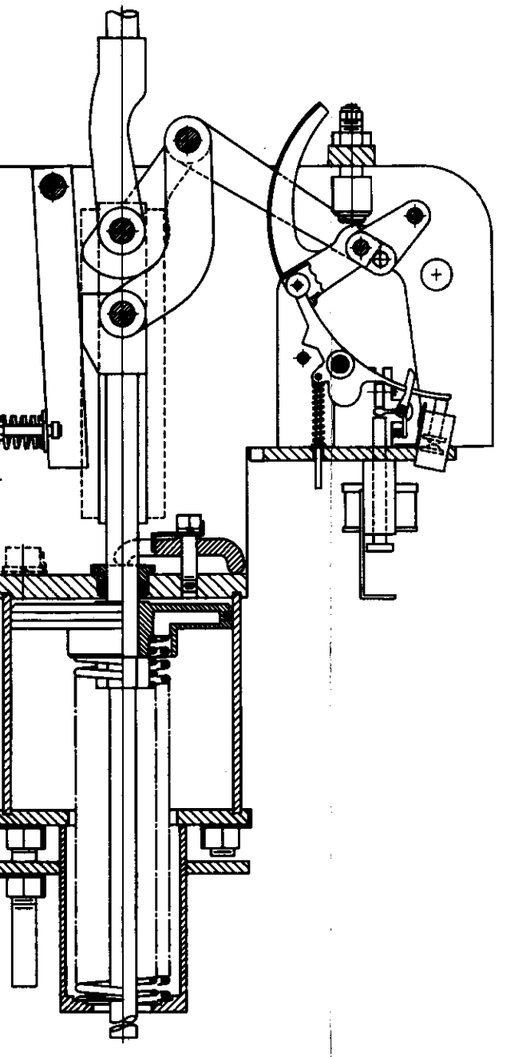
FIG.6

WESTINGHOUSE ELECTRIC CORPORATION

TITLE PNEUMATIC OPERATING MECHANISM - TYPE AA-7

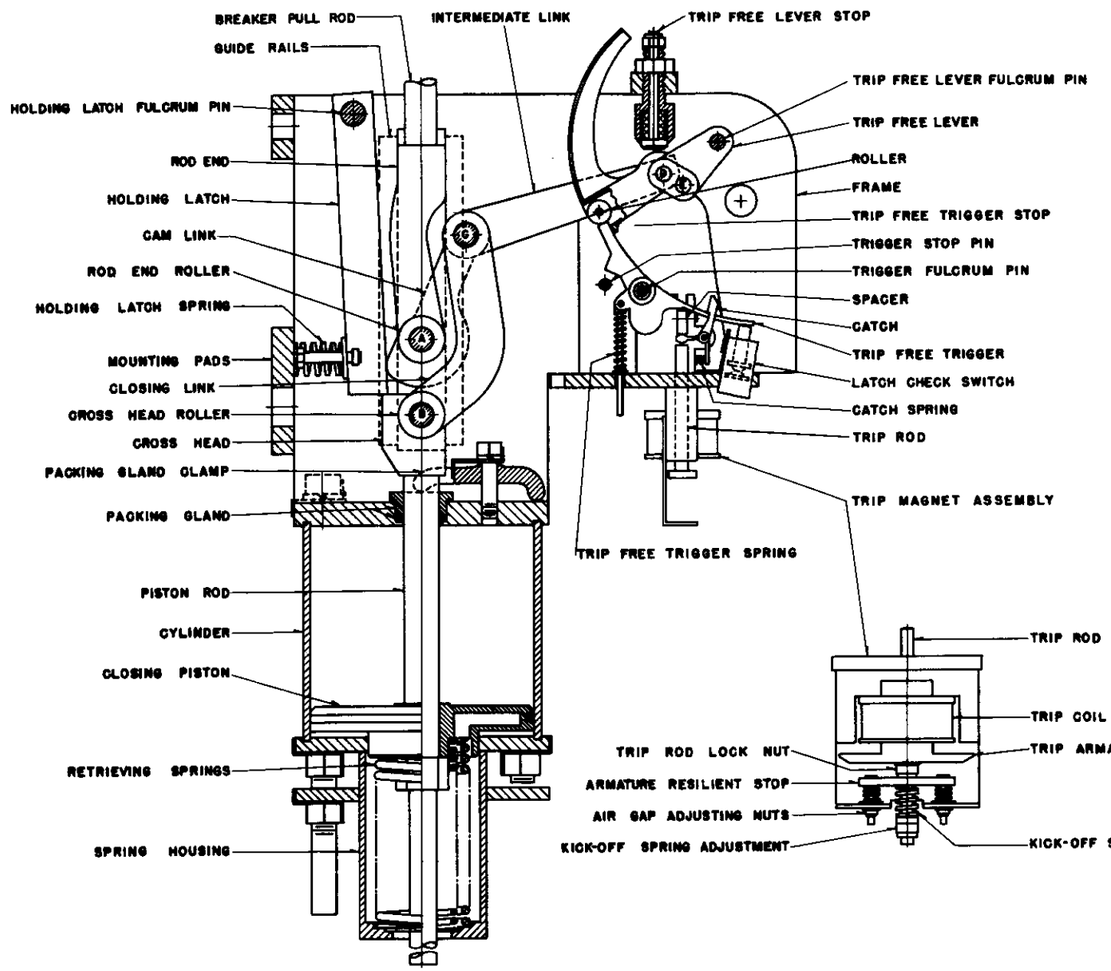
CONTROL VALVE

57-J-322



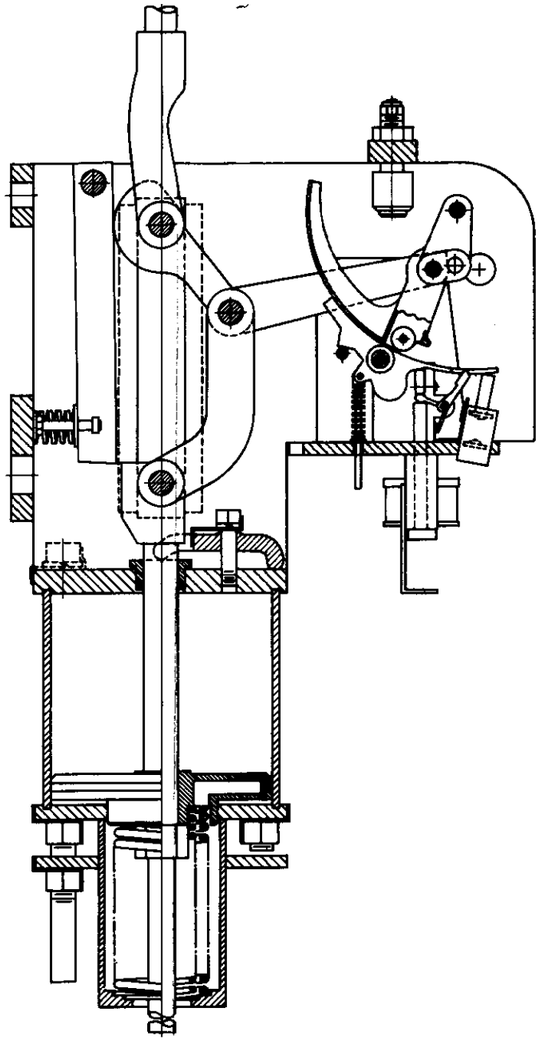
OPEN POSITION

FIGURE 1



CLOSED POSITION

FIGURE 2



TRIP-FREE POSITION

FIGURE 3

WESTINGHOUSE ELECTRIC CORPORATION

TITLE PNEUMATIC OPERATING MECHANISM TYPE AA-7

DIMENSIONS IN INCHES - SCALE 1:2

DRAWN APPD.

APPD.

CHKD. APPD.

57-J-318

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