Instruction Book

OIL CIRCUIT BREAKER

OPERATING MECHANISM

TYPE AA7

General Order 66-63419

Instruction Book S.O. 17-Y-8981

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WESTINGHOUSE ELECTRIC CORPORATION

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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 dirven 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

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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.

DESCRIPTION

GENERAL

Included within the dust tight sheet metal housing are 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 Dwg. 36-A-2660 (Tab 10).

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 (Tab 7). 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 3/4" pipe plug provided in the underside of the automatic inlet valve as indicated on Dwg. 36-A-2660 (Tab 10).

PNEUMATIC MECHANISM AND CONTROL

Referring to Figs. 1-2-3 (Tab 6) 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, minimize 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 road 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 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 elector-pneumatic pilot valve as illustrated in Figs. 4 to 6, 4A to 5B (Tab 7).

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 pilot valve is double acting i.e.: when the inlet seat is closed, the exhaust ports are open (Fig. 4), and vice-versa (Fig. 5). 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 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 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.

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 (Tab 8). 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.

Opening the small pilot valve either manually by means of the pushbutton on top of the pilot valve coil, or by energizing the coil, admit 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 perponderance 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 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 diagram 16-C-4204 (Tab 10), the closing relay designated as "X" and the cut-off relay designated as "Y" are pictured in the de-energized 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 though 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 see Tab 9. 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

When the mechanism is used on the GO type or frame mounted breakers where the breaker loads to be closed are relatively light, a club type hand closing device is available which will provide for closing the breaker 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 the GM type breakers where the loads are much heavier, 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.

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 ref. see Tab 9. This opens the inlet valve which admits compressed air stored in the reservoir to the closing cylinder. The high pressure air acting 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 its "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.

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.

Service manuals I.D.I. 9352-1 and 9352-3 (Tab 11) of the Westinghouse Air Brake Co. made a part 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, especially 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 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 an all purpose grease and shouldn't require repacking.

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.

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, the inlet valve can be removed for inspection by unscrewing the hex head plug on the bottom side of the housing. In replacing the valve, make sure that the small valve stem enters the hole in the end of the plunger before replacing the plug.

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.

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. The screw on the left hand side of the case under the removable front cover controls the differential. For best switch operation, the differential should be adjusted so that the compressor starts 15 lbs. below the cut-off pressure. *Low Pressure Cur-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 intended 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 115 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.

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 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.

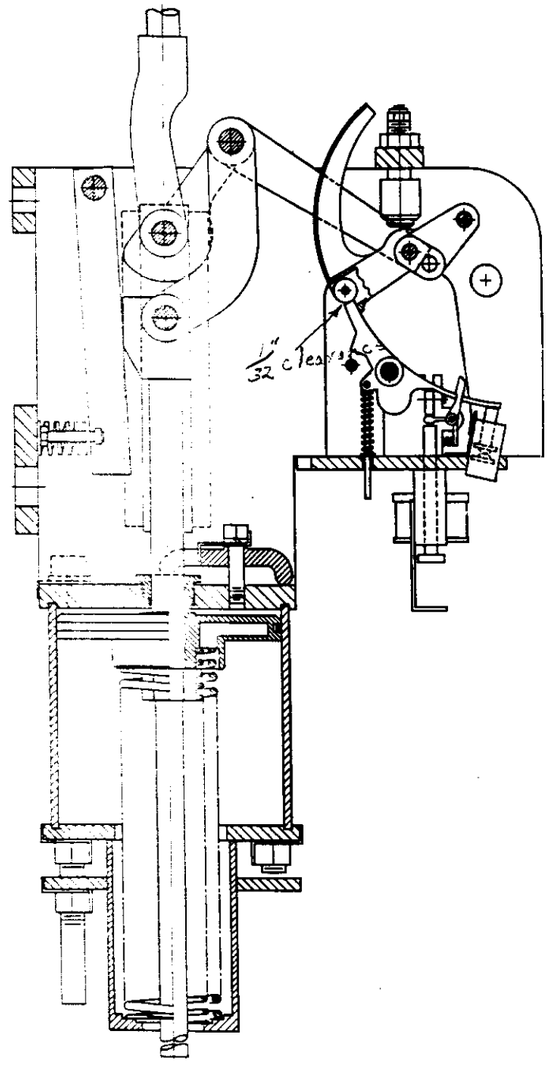
3. Observe whether the trip rod rises when the control switch is moved to the position for tripping.

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:

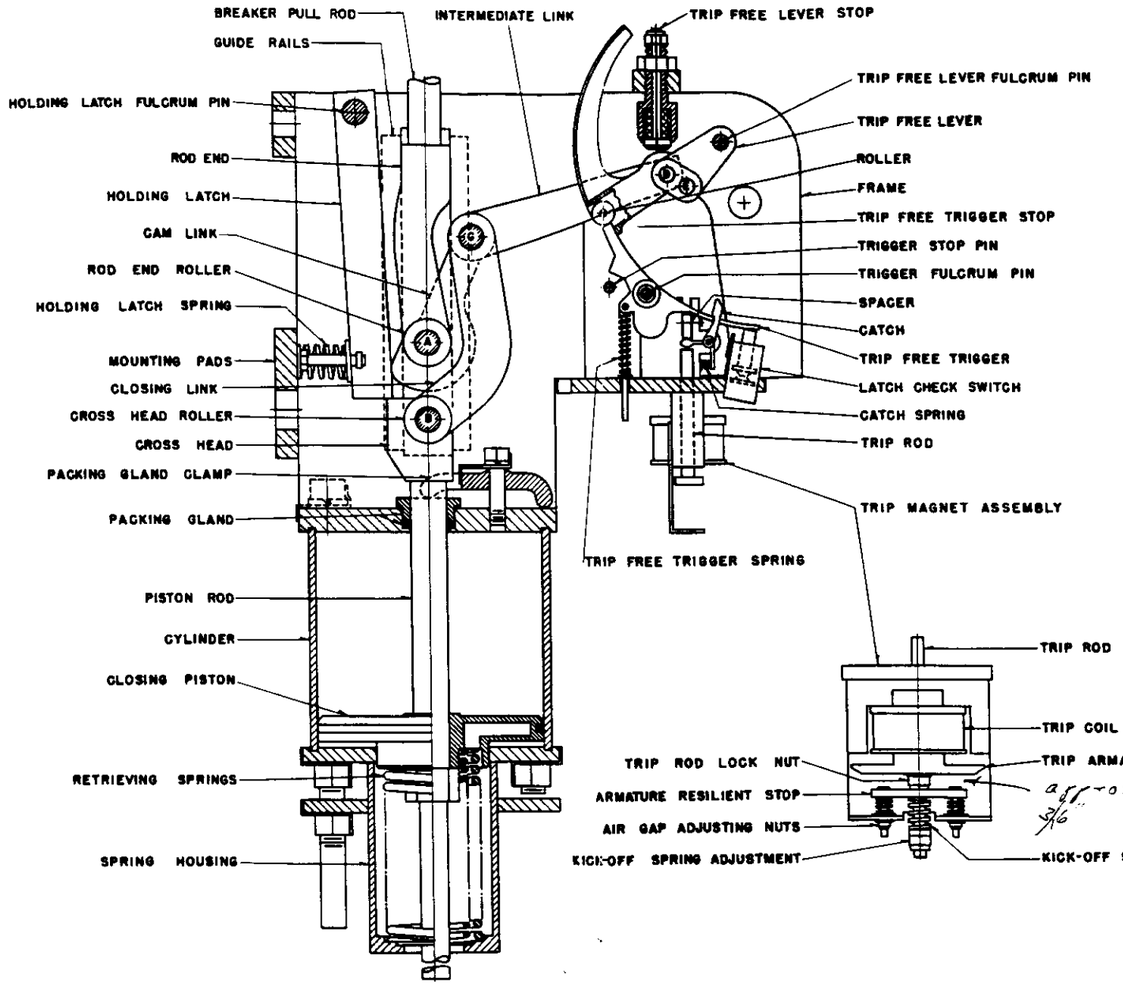
1. Check the contacts on the latch check switch to see that they are making good contact.

2. Make the checks outlined in A1 to A8.



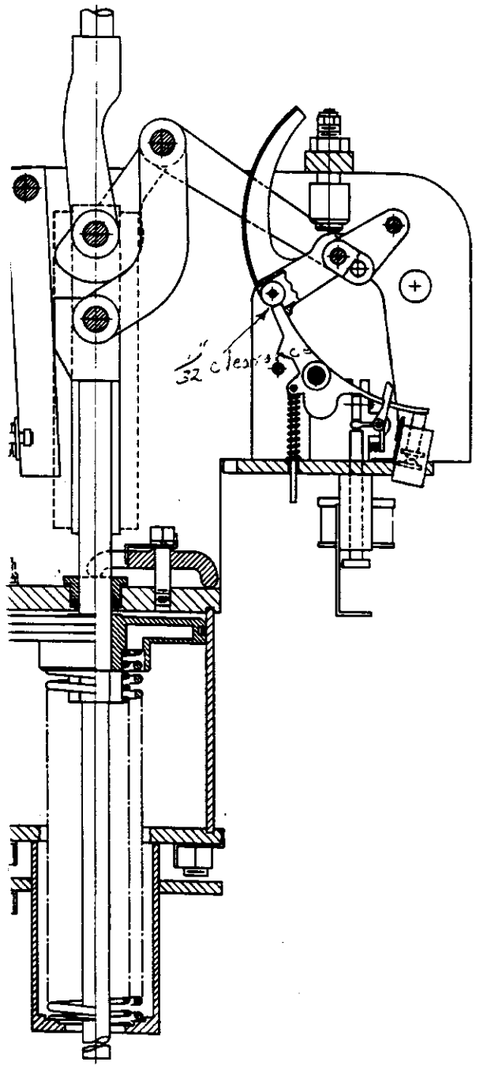
OPEN POSITION

FIGURE 1



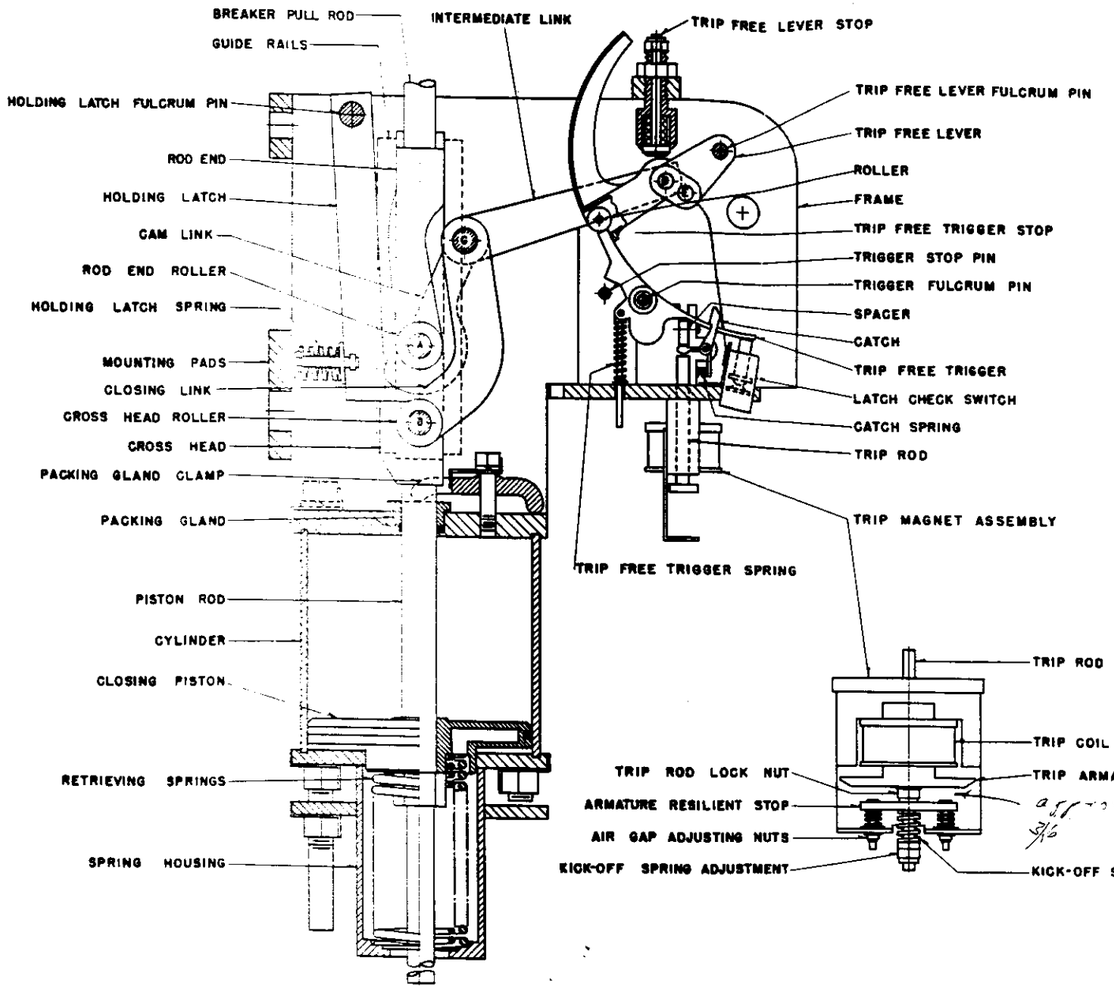
CLOSED POSITION

FIGURE 2



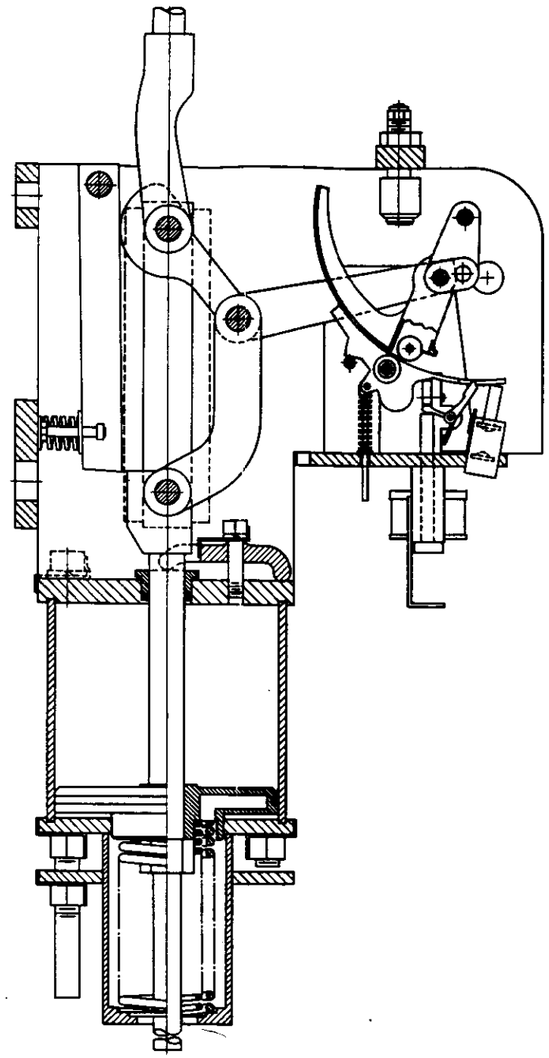
OPEN POSITION

FIGURE 1



CLOSED POSITION

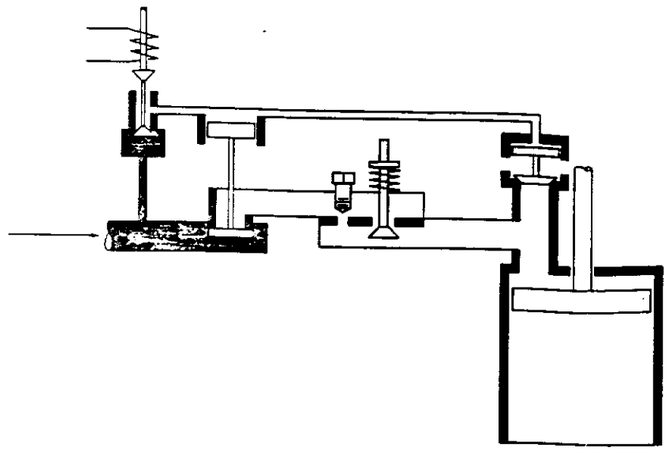
FIGURE 2



TRIP-FREE POSITION

FIGURE 3

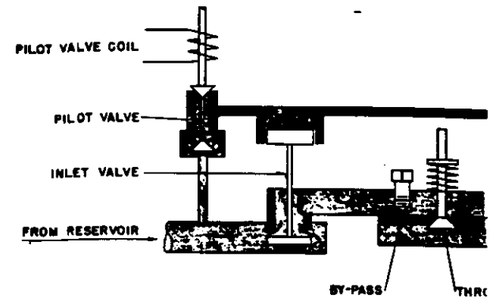
WESTINGHOUSE ELECTRIC CORPORATION			
TITLE: PNEUMATIC OPERATING MECHANISM TYPE AR-7			
DIMENSIONS IN INCHES-SCALE 1:2			
DETD. D-MONTH	11/21	APPD.	57-J-318
		APPD.	
DRWD.		APPD.	
DIV.& PLANT LOCATION SWGR., P&S.			EAST PITTSBURGH, PA., U.S.A.



CLOSED

SCHEMATIC OF CONTROL VALVE

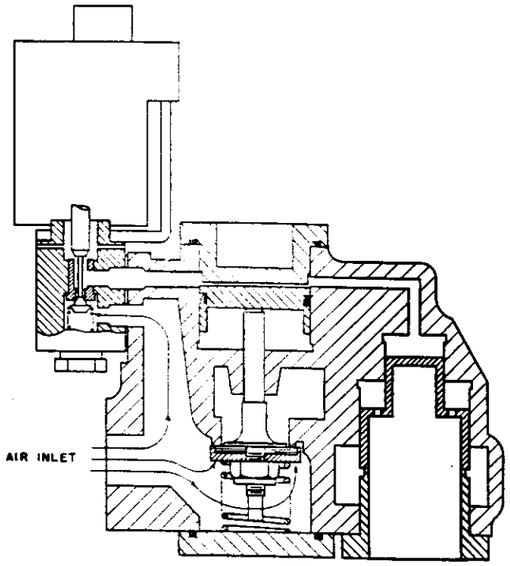
FIG. 7



OPEN

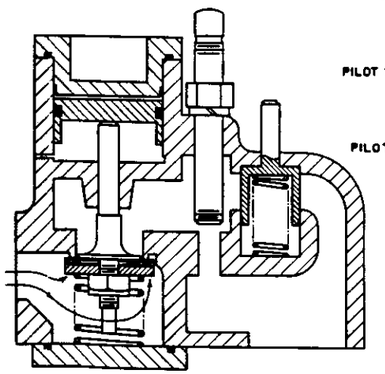
SCHEMATIC OF CONTROL

FIG. 8



CLOSED

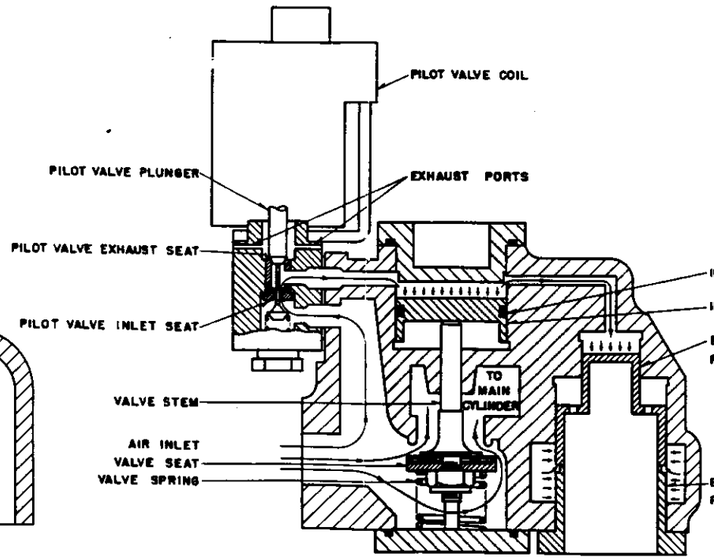
FIG. 4



CLOSED

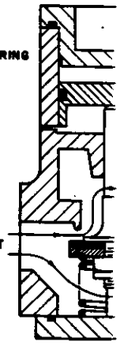
MECHANISM FULL OPEN

FIG. 4 A

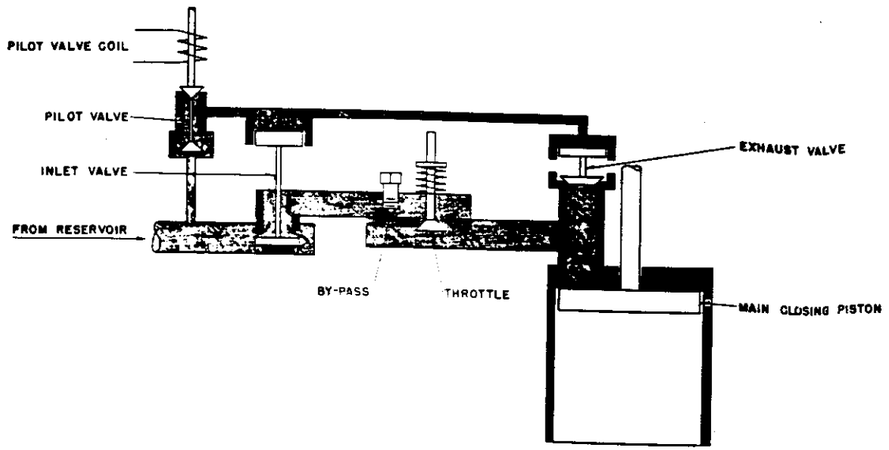


OPEN

FIG. 5



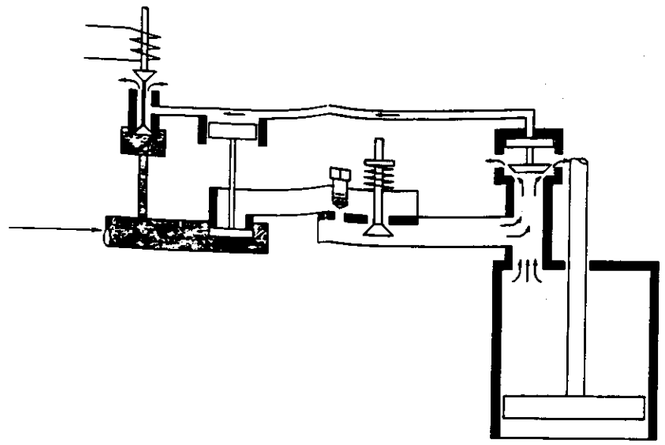
MECHANISM I



OPEN

SCHEMATIC OF CONTROL VALVE

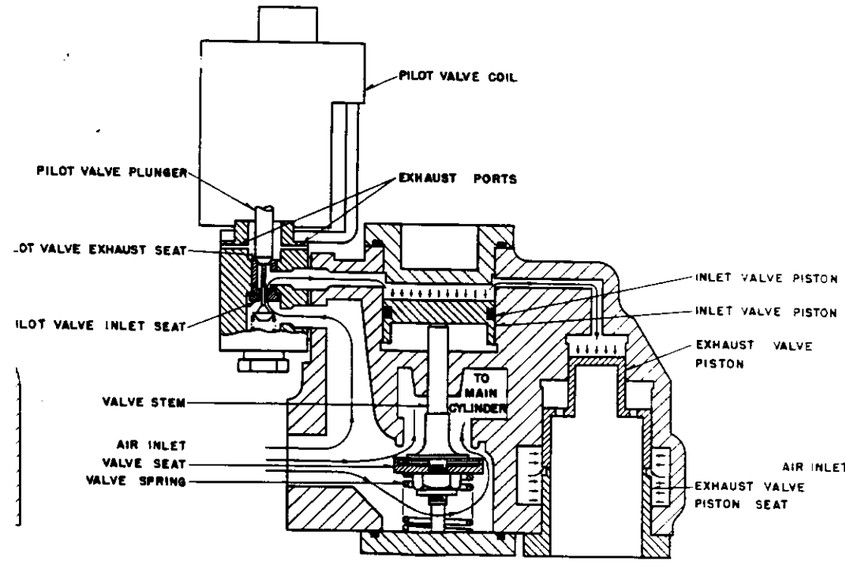
FIG. 8



EXHAUSTING

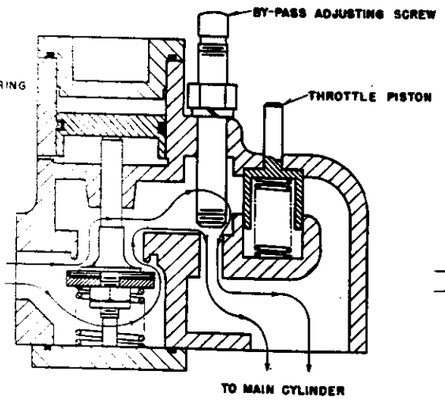
SCHEMATIC OF CONTROL VALVE

FIG. 9



OPEN

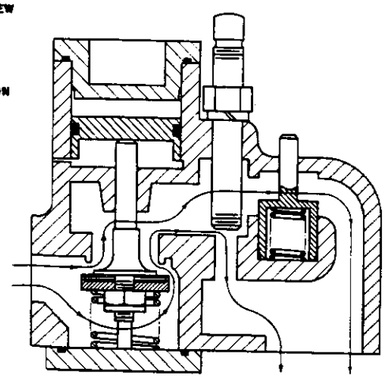
FIG. 5



OPEN

MECHANISM IN EARLY PART OF CLOSING STROKE

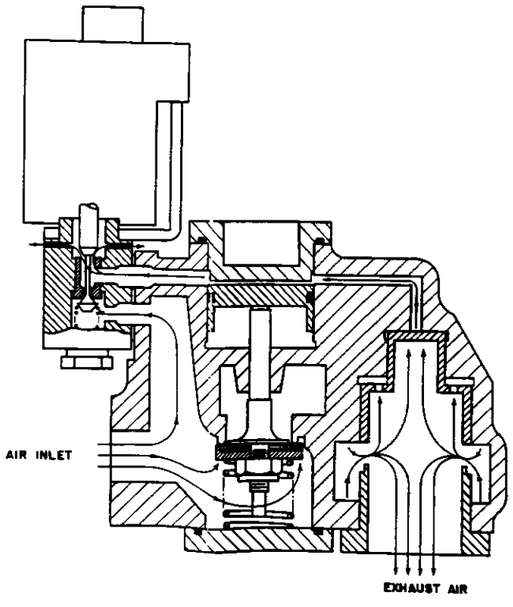
FIG. 5A



OPEN

MECHANISM NEARING END OF CLOSING STROKE

FIG. 5B



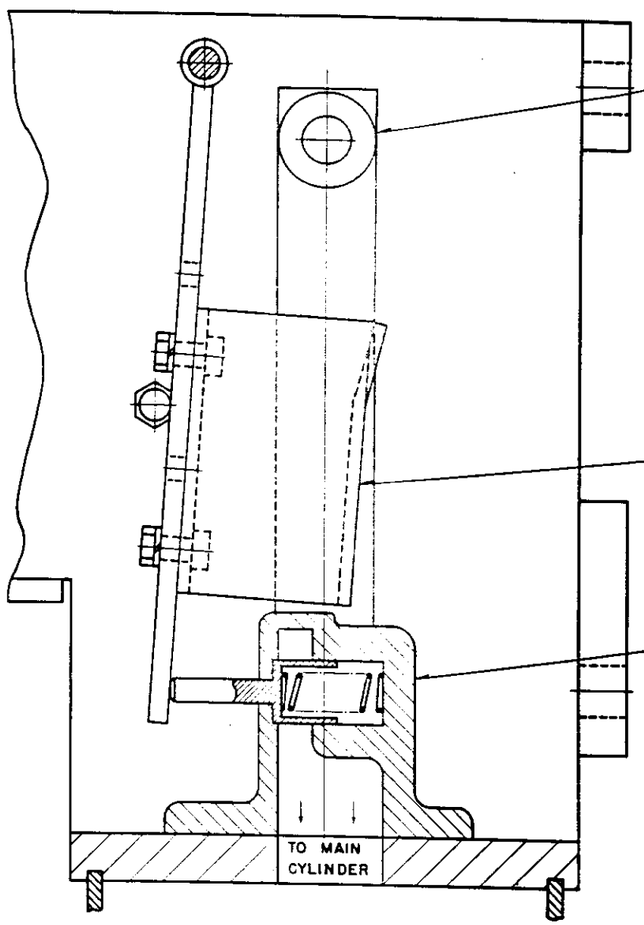
EXHAUSTING

FIG. 6

WESTINGHOUSE ELECTRIC CORPORATION

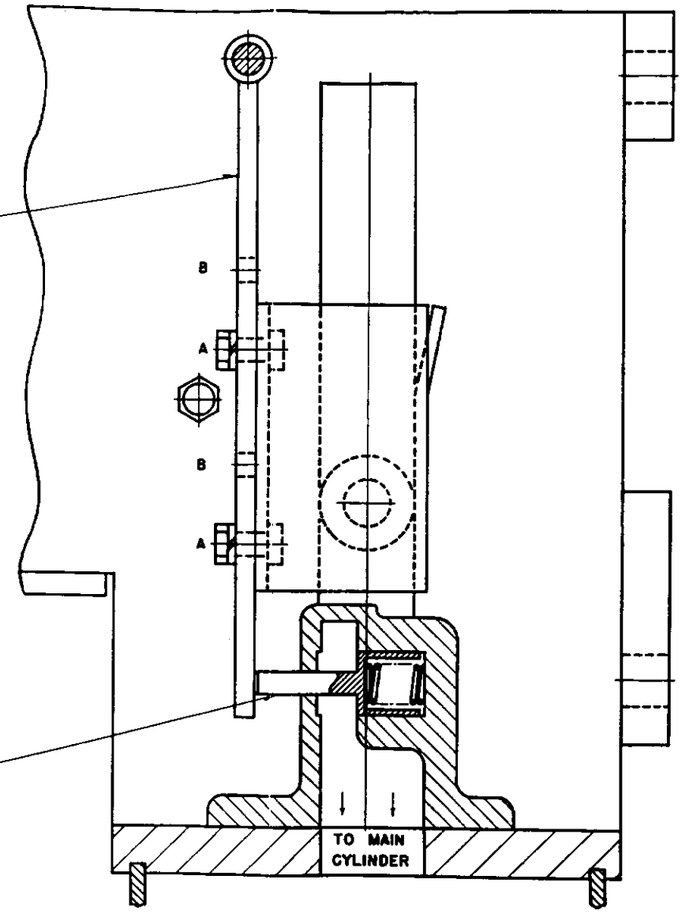
TITLE PNEUMATIC OPERATING MECHANISM - TYPE AA-7
CONTROL VALVE

57-J-322



MECHANISM OPEN-THROTTLE CLOSED

FIG.10



MECHANISM CLOSED-THROTTLE OPEN

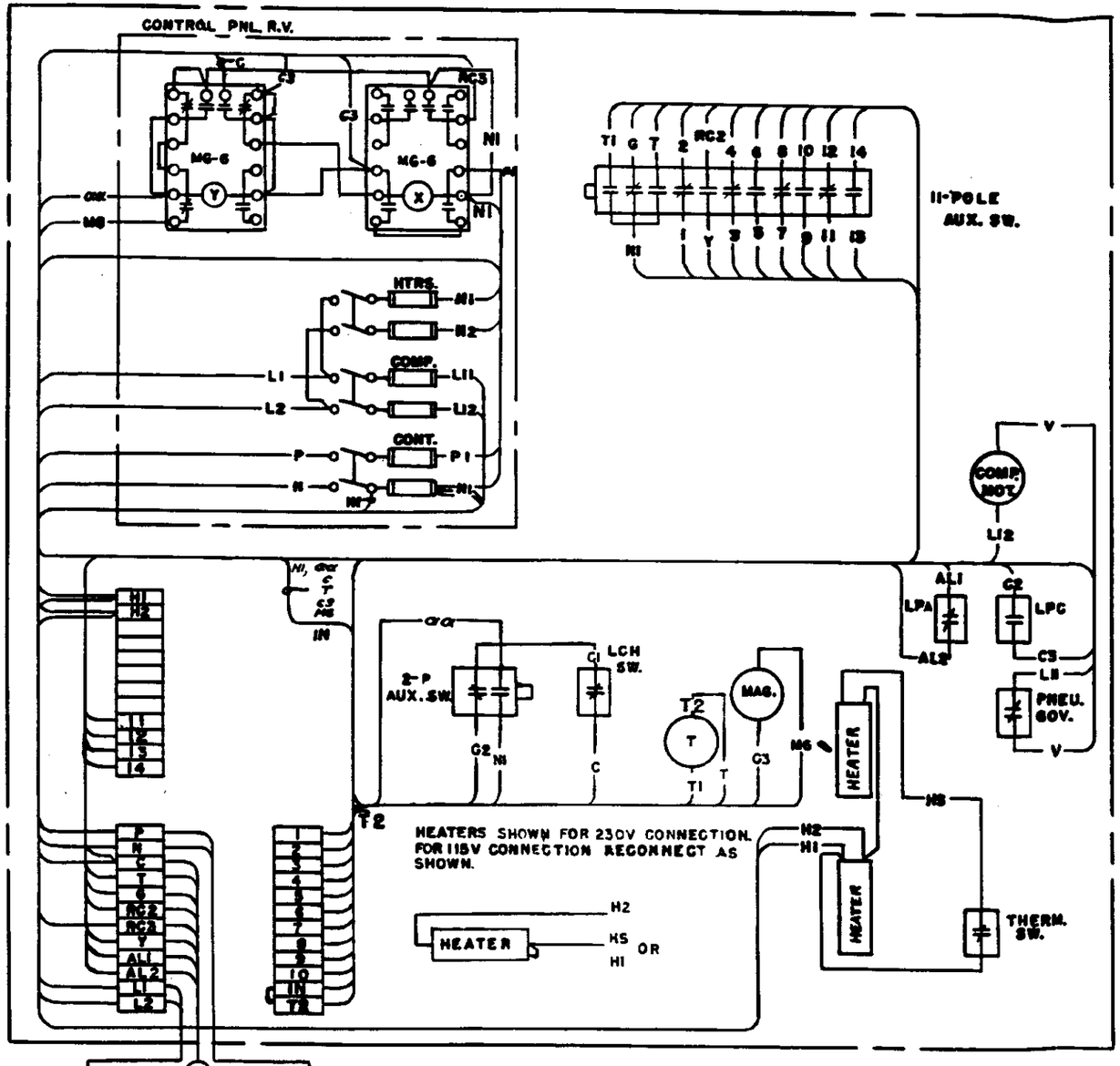
FIG.11

WESTINGHOUSE ELECTRIC CORPORATION

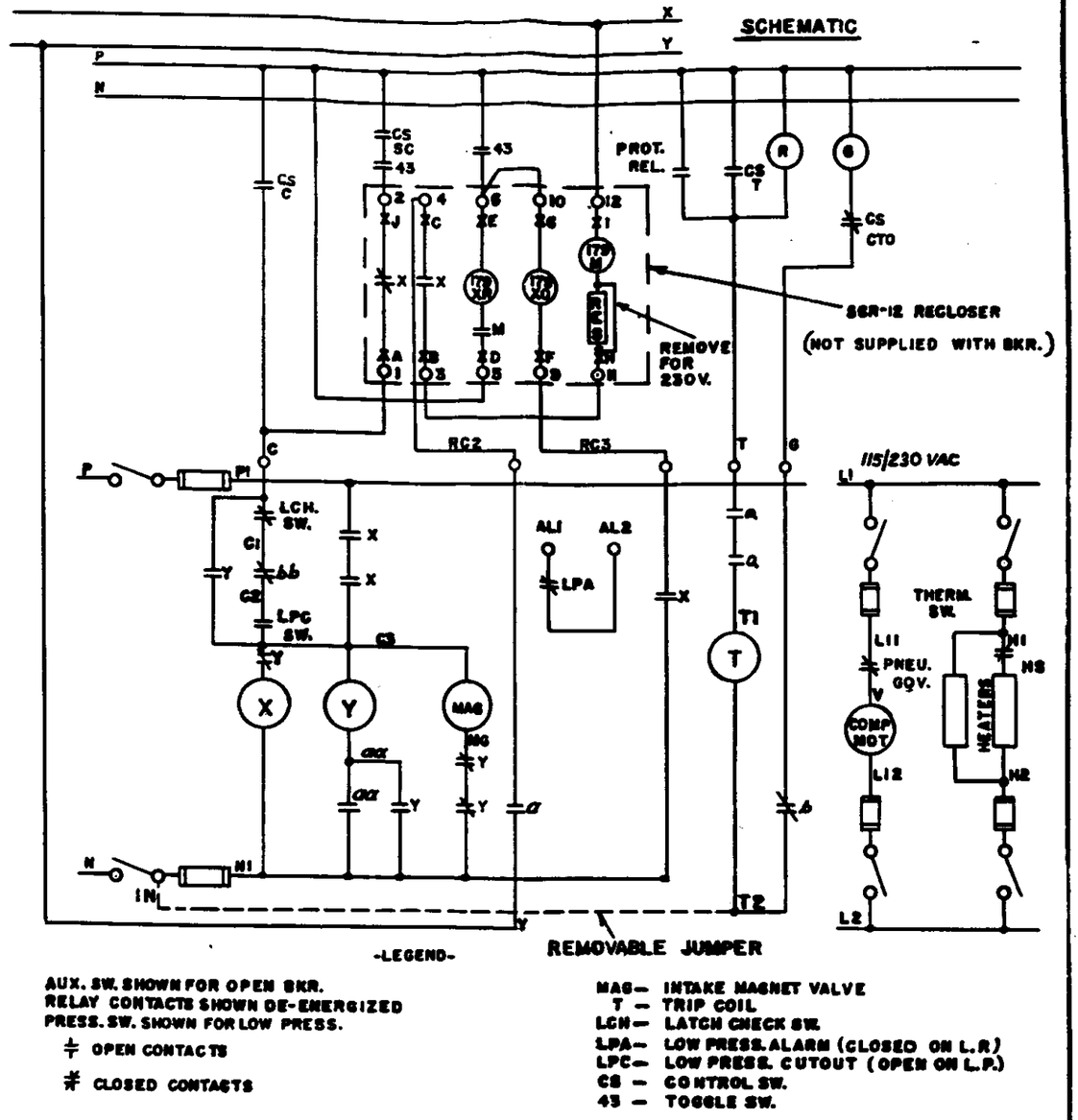
TITLE PNEUMATIC CAR BRK. OPER. MECH. TYPE AR-1

THROTTLE LEVER

36-A-2662



SHOP NOTE— USE STD. WIRING HARNESS PER DIAG. 16-C-4205



-LEGEND-

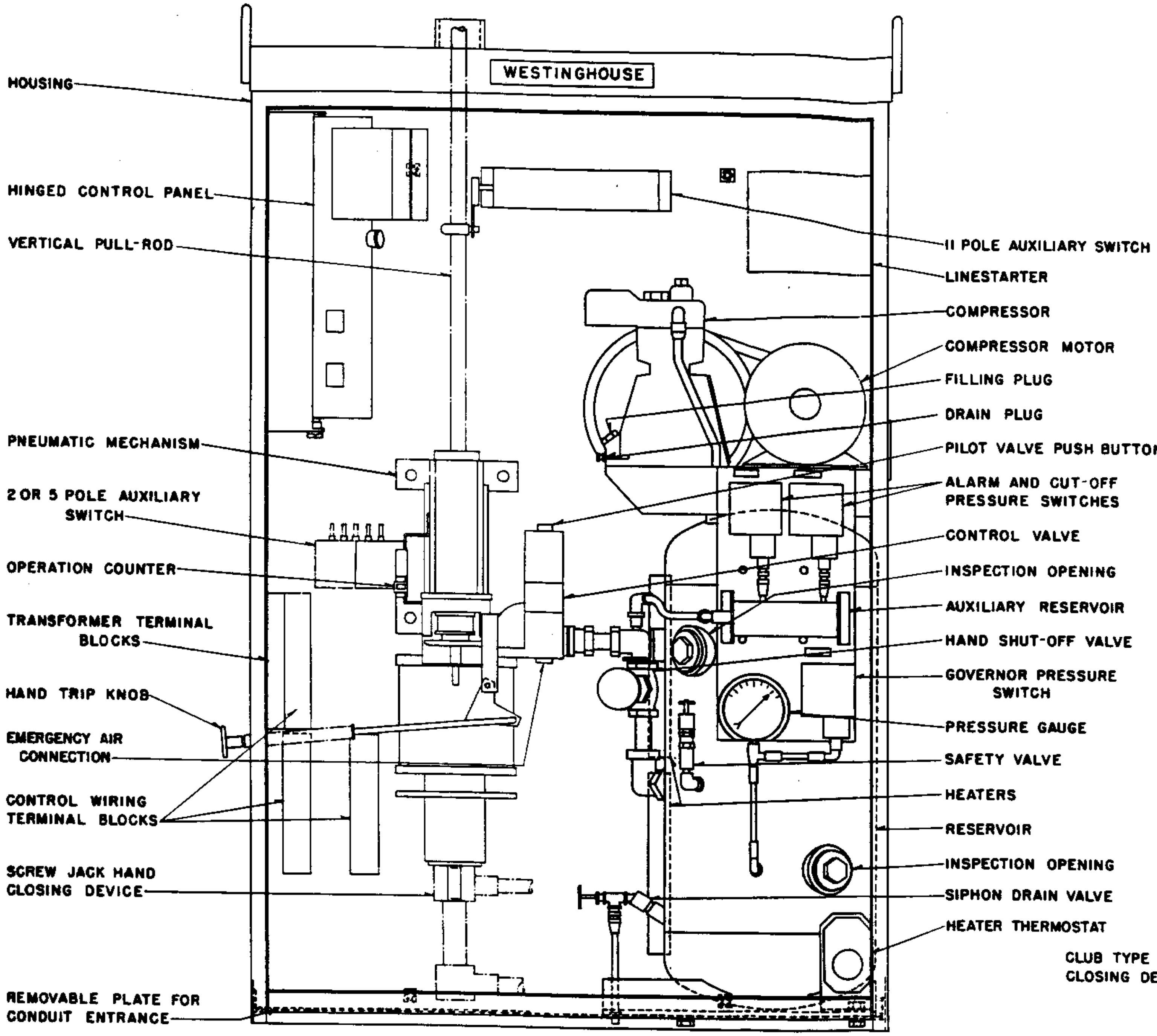
AUX. SW. SHOWN FOR OPEN BKR.
RELAY CONTACTS SHOWN DE-ENERGIZED
PRESS. SW. SHOWN FOR LOW PRESS.

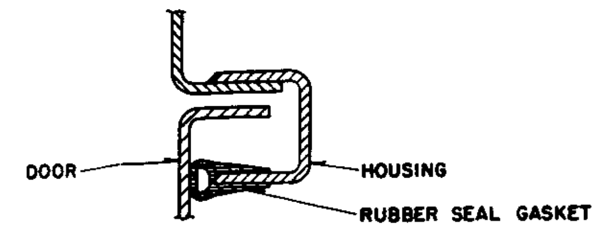
⏚ OPEN CONTACTS

≠ CLOSED CONTACTS

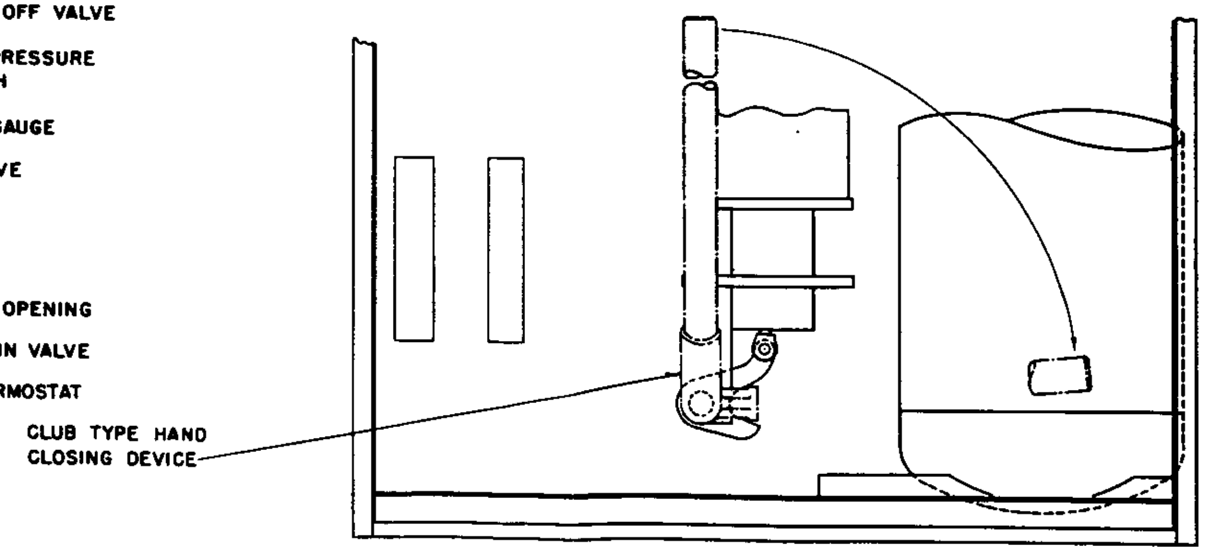
MAG— INTAKE MAGNET VALVE
T — TRIP COIL
LCH— LATCH CHECK SW.
LPA— LOW PRESS. ALARM (CLOSED ON L.R)
LPC— LOW PRESS. CUTOUT (OPEN ON L.P.)
CS — CONTROL SW.
43 — TOGGLE SW.

Compressed Air Operated Oil Circuit Breaker
AA-7 Pneumatic Mechanism





TYPICAL DUST SEAL AROUND DOORS



WESTINGHOUSE ELECTRIC CORPORATION

TITLE

APPD.

APPD.

CHKD. APPD.

36A2660