Instructions for Pneumatic Operating Mechanism Type AA-10 for Oil and SF6 Circuit Breakers

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Introduction

Type AA-10 circuit breaker operating mechanism is closed by compressed air, opened by springs, and is both electrically and mechanically trip free. Since the closing energy is derived 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, the mechanism is especially suited to applications where it is desired to eliminate large batteries required for solenoid mechanisms, or where fast reclosing is required.

PART 1 - 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 the above precautions and periodic inspections should be made to determine the condition of the apparatus.

PART 2 - DESCRIPTION

General

This instruction book is of composite nature in that it combines all variations of the mechanism assemblies which utilize the same basic AA-10 mechanism. These variations are illustrated in Figures 1, 2, 3, and 4. Figure 1 illustrates the AA-10-60 mechanism assembly which is operated at low to moderate air pressures and is used on oil circuit breakers of 69, 115 and 138 KV with an interrupting capacity of 5000 MVA, and some low voltage breakers with high continuous current ratings. Figure 2 illustrates the AA-10-80 which is operated at high air pressures and is used on oil circuit breakers of 115, 138, and 161 KV with an interrupting capacity of 10,000 MVA and above. Figure 3 illustrates the AA-10 mechanism assembly which is used on the type 1150 GM 5000 oil circuit breaker. Figure 4 illustrates the AA-10-80R mechanism assembly which is used on the 230 KV SF6 circuit breaker.

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 except as shown in Fig. 3 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 system of latches 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, 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 Fig. 1 thru 4.

Compressor and Air System

The assemblies utilize two different sizes of air supply systems depending on the application. For applications on the smaller breakers, (Figures 1 and 3) the unit will consist of a 60 gallon reservoir, and a single stage compressor. For applications on the larger breakers, (Figures 2 and 4) the unit will consist of an 80 gallon reservoir and a two stage compressor. A pressure governor switch regulates the pressure in the storage reservoir. The pressure governor 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 approximately a 20 lb. per sq. in. differential above the starting pressure. The pressure governor switch pressure settings are 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 states 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 to prevent the pressure from building up to a dangerous level; should the pressure governor switch fail to cut off 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 setting 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.

A typical schematic diagram for the air system is shown on drawing Fig. 27. 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.

Pneumatic Mechanism and Control

The Type AA-10 is electrically trip free at all times and is mechanically trip free whenever there is air pressure in the main closing cylinder. The determination of whether the mechanism functions trip free or non trip free is accomplished pneumatically and is called selective tripping. Figs. 7, 8, 9, illustrate and supplement the following description.

Main Frame and Cylinder

The mechanism is built up around the main frame which serves to support and enclose the levers, latches and triggers that provide the releasable connection between the closing piston and the breaker pull rod. The cylinder is attached to and supported on the main frame by four bolts, and consists of a tube clamped between the top plate which is part of the frame and the bottom plate.

Closing Piston Snubber

There are two concentric rings of rubber sandwiched between a recess in the top side of the bottom plate and a steel piston stop ring. These steel plates and the ring are given a corrosion resistant protective finish. This "sandwich" serves to absorb some of the final shock caused by the rapidly moving piston reaching the end of its travel. To decelerate the piston before engaging this resilient stop, a collar on the underside of the piston closes off a concentric, close fitting opening in the bottom plate as the mechanism approaches the closed position Fig. 8. This traps a small volume of air between the underside of the piston and the end of the cylinder providing pneumatic dashpot action.

Retrieving Spring Assembly

The spring housing is part of the bottom plate of the cylinder 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. 9 to the open position Fig. 7.

Closing Piston Assembly

The main closing piston which is forged from a non ferrous alloy is screwed on and locked to the piston rod at approximately its mid point. The lower end of the piston rod is threaded to receive the hand closing jack. An adjustable packing gland around the piston rod, plus a gasket between the mechanism frame and cylinder combined with the piston ring on the main closing piston minimize the air losses during closing operations. The cross-head, which is located on the upper end of the piston rod, carries two pins: The upper pin "E" which is supported by roller bearings at either end, is engaged by the holding latch when the mechanism is in the closed position; the lower pin "B" serves to attach the closing lever to the piston rod, and extensions of this pin carry a roller at either end which travel between guide rails on the frame.

Lever System

The piston is connected to the breaker pull rod rod-end through the closing lever and thrust link which are joined with pin "C". The rod end and thrust link are joined by pin "A". The ends of this pin carry rollers which are guided between two rails and provide straight line motion of point "B". As long as point "C" is restrained to maintain the relative position of A-C-B as shown in Figs. 7 and 8, the movement of the piston will be transmitted to the breaker pull rod. If at any time during the closing operation or after the mechanism is closed, the restraint on point "C" is released, the linkage A-C-B will open up allowing the breaker pull rod and the closing piston to move independently of each other. This provides essentially the mechanically trip free function. The balance of the parts are required to make it possible to control at will the release or retention of the connection between the closing piston and the breaker, and also to reduce the load present at point "C" to a load on the trigger that will make possible low tripping effort. The intermediate link, which is connected to the thrust link and closing lever at one end by pin "C" and at the other end to the mid point on the trip-free lever by pin "D", transfers the load on "C" to the trip free lever. This creates a tendency for the trip free lever to rotate clockwise about the trip free lever fulcrum pin bearings. The trip free fulcrum pin is supported at either end in roller bearings.

Trip Free Trigger

The trip free trigger, which is positioned approximately tangential to the roller on the trip free lever and which is free to rotate on needle bearings about the trigger fulcrum pin, provides the final releasable means for controlling the fixation of point "C". 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 counter-clockwise whenever there is a load on the breaker pull rod. In addition to this moment the trigger is spring biased to the latched position as shown in Figs. 7 & 8. A stop on the trip free lever positions the end of the trigger accurately in respect to the roller insuring definite engagement.

To insure against the possibility of the shock incident to closing causing the trip free trigger to release the trip free lever prematurely, a spring biased 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 is interposed between the trip rod and selector bar which insures the prior release of the catch.

To insure positive latching with early cut-off of the closing air at the end of a closing operation, a spring biased catch, similar to the catch used in conjunction with the trip free trigger, is provided that engages the non trip free trigger as the trigger moves up behind the roller on the main holding latch. Normally there is no load on the catch, however the catch must be released prior to tripping the non trip free trigger. This release is accomplished by having an arm on the catch, extend over immediately behind the catch on the trip-free trigger. Thus as the trip rod rises, it rotates both catches out of the way before the selector bar attempts to disengage either trigger.

Trip Free Lever Stop

The trip free lever accelerates rapidly to a relatively high speed in retrieving from the position shown in Fig. 9 to the open position Fig. 7. To stop this rapidly moving lever, a resilient stop is provided. The body of the stop is screwed into a cross bracing member of the main frame to provide adjustment of the stop. The resilient feature consists of a rubber plug totally enclosed in a steel housing. The outside diameter of the rubber is slightly smaller than the inside diameter of the housing which provides a relatively slow build up of resisting force until the plug has been deformed to fill the inside of the enclosure. The resisting force then builds up very rapidly to bring the trip free lever to rest.

Holding Latch and Trigger

In order to maintain the mechanism and breaker in the closed position after the closing air has been shut off, a sturdy holding latch, fulcrumed to the frame on roller bearings and spring biased toward the latched position is provided to engage pin "E" in the cross head. To provide for non trip free operation, which is required in order to realize high speed reclosing the nose of the latch is machined so that the breaker load at pin "E" creates a moment in a counter-clockwise direction on the latch. The latch is restrained in the latched position shown in Fig. 8 by the non trip free trigger, which is fulcrumed on needle bearings on the trigger fulcrum pin, and engages a needle bearing roller carried on the latch. The trigger is spring biased to the latched position shown in Fig. 8. The trigger stop pin serves to position the non trip free trigger in the latched position and also limits the overtravel of both the non trip free trigger and the trip free trigger in the tripped position.

Trip Magnet Assembly

The trip magnet assembly is located on the underside of the frame directly under the selector bar. 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 triggers, 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 pole faces which also speeds up the retrieving of the armature.

Trip Selector

In order to realize the benefits of short reclosing times made possible by non trip free operation, and still retain the advantages of fast tripping times obtained by mechanical trip free operation when closing in against a fault, it is desirable to be able to choose between trip free and non trip free operation. This is called "selective tripping" and is accomplished pneumatically as follows: - Reference Figs. 23 & 24. The selector bar, which passes at right angles to the planes of the two triggers and is interposed between the trip rod and the triggers has a boss on its upper edge so arranged that the length of the flat upper surface is greater than the spacing between the triggers. Thus the selector bar is always in a position to trip one or both triggers for any position of the selector bar. When the selector bar is over to its extreme left hand position, Fig. 24 the boss is directly under the non trip free trigger and a "valley" is under the trip free trigger. When the selector bar is moved over to its extreme right hand position, Fig. 23 the boss is directly under the trip free trigger and has been moved free of the non trip free trigger. The chamfer on the left hand end serves to prevent the selector bar from accidently interfering with the triggers during the transfer motion. The position of the selector bar is determined by a spring bias that selects the non trip free trigger except when there is air pressure in the closing cylinder. A selector piston located in the control valve on the cylinder side of the inlet valve is connected through a linkage with the selector bar so that whenever the inlet valve is open, the selector piston will shift the selector bar over to the right and select the trip free trigger for tripping. With the inlet valve closed, the spring bias on the linkage returns the selector bar to its normal position for tripping from the non trip free trigger.

Control Valve

Due to the wide range of applications in which the mechanism is involved, two different designs of control valves are employed. One of which has several variations.

The control valve used on the mechanisms illustrated in Figures 1, 2 & 4 is of Westinghouse manufacture. (Fig. 11 thru 16)

Due to a wide range of functions which the mechanism may be called on to perform, there are several combinations required in the control valve assembly as follows:

(1) For the breakers which have a comparatively light starting load, a throttle and adjustable by-pass are required (Fig. 11A - 21 & 22).

(2) For the larger breakers this feature is unnecessary.

(3) For the majority of breakers, a slow acting "poppet" type of exhaust, which allows the pressure to leak down to a low value before exhausting is employed.

(4) Only in the very rare instances where immediate multiple reclosing is required, is the fast acting exhaust valve incorporated.

(5) To provide for selective tripping as described previously in detail, a selector piston (Fig. 24) is required to operate the selective tripping. A valve including a throttle and by-pass, a selector piston, and the slow acting exhaust valve will be described. For particular applications where some of the features may not be required nor included, their function as described here after may be passed over or even blocked out if it is felt desirable to avoid confusion on the part of maintenance personnel who may be using the instruction book for reference.

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. 11 thru 20.

Certain illustration liberties were taken in Figs. 11a, 12a, 12b 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 solenoid pilot valve is double acting i.e., when the inlet seat is closed, the exhaust port is open. The pilot valve inlet has a composition 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 valve stem down and opens the valve. 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 seating 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 and opens the valve by forcing down the valve stem.

The small hole (a) through the bottom of the inlet valve cylinder into the air passage to the main closing cylinder, and the small bleeder hole (b) 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 inlet valve piston has a piston ring to keep the leakage to a minimum and insure obtaining full control air pressure above the piston for positive action.

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

The slow exhaust valve consists of a pusher piston, a poppet type valve with a metal to metal seat spring biased to the open position.

When the pilot valve is energized to close the inlet valve, it applies pressure to the pusher piston which overcomes the spring bias and closes the exhaust valve: Upon de-energizing the pilot valve the air above the pusher piston is exhausted to atmosphere and the pusher piston is forced upward by the air in the valve body. The exhaust valve, however, is held in the closed position by the same air. The air now trapped in the main closing cylinder and valve body bleeds out slowly to atmosphere through holes (a) and (b) until the force on the exhaust valve drops low enough for the spring bias to overcome. The exhaust valve now opens to exhaust the remaining trapped air.

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 piston 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 control air past the piston.

The arrangement of the bypass and throttle as illustrated in Figs. 11A, 12A & 12B 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 close 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. 21 & 22. 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 late 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.

The selector piston shown in Figs. 23 & 24 is located on the main cylinder side of the inlet valve in order that the piston will be responsive to the air pressure conditions in the closing cylinder. The piston and stem are two separate pieces to facilitate disassembly and assembly without removing the valve casting from the mechanism. The spring bias for positioning them in the retrieved position is on the selector lever. Whenever the inlet valve is open, the admission of air to the closing cylinder simultaneously puts air pressure on the selector piston which overbalances the spring bias and shifts the selector linkage.

The control valve used on the mechanism illustrated in Figure 3 is purchased per Westinghouse specifications (Figure 17 thru 20).

The control valve assembly combines both the inlet and exhaust functions in a single compact unit and consists of a main valve operated by an electro pneumatic pilot valve as illustrated in Figs. 17 & 18.

Certain illustration liberties were taken in Figs. 17 & 18 to facilitate the illustration and understanding of the valve construction and operation.

The solenoid pilot valve is identical to the one described in the previous control valve description.

The main control valve is double acting (when the inlet seat is closed the exhaust seat is open) this blocks the high pressure air from entering the mechanism cylinder and at the same time allows the air in the cylinder to exhaust to atmosphere.

As shown in Fig. 17 the operating piston and exhaust poppet seat have a common body. The inlet poppet is driven by a stem attached to the operating piston poppet. The inlet seat is held tightly closed by a spring bias and the air pressure acting upon the under side of the inlet poppet. This also holds the exhaust poppet open and operating piston to the top of its bore.

The operating piston is sealed by an "O" ring which is held captive by a groove in the piston. The inlet and exhaust poppet seats are "O" rings which are held in place by spinning an edge of the poppet over the side of the "O" ring.

When the pilot valve is opened, it allows high pressure air to enter above the operating piston, forcing it down. (The pilot valve receives its air supply through an internal passage in the main valve body.) Thus it closes the exhaust seat and opens the inlet seat allowing the air to flow to the mechanism cylinder. When the pilot valve is closed, the air from above the operating piston is exhausted and allows the exhaust seat to open and the inlet seat to close. The air flows from the control valve to the mechanism cylinder via an adapter. This adapter is cast of a non-ferrous alloy. Its principal function is to direct the flow of air to the cylinder unrestricted. The adapter, however, also provides a means for mounting the piston and cylinder which serve to actuate the trip selector. Figs. 23 & 24. The air which operates the selector piston is taken from the adapter casting directly above the entrance to the mechanism cylinder. This insures that the selector piston will be responsive to the air pressure conditions of the closing cylinder. The piston and stem are one piece. The spring bias for positioning it in the retrieved position is on the selector lever. When the control valve is opened, the admission of air to the closing cylinder simultaneously puts air pressure on the selector piston which overbalances the spring bias and shifts the selector linkage.

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 which is located on the left hand side of the sheet metal housing in order to provide the maximum unrestricted working space around the mechanism, is mounted on hinges enabling 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 three fused knife switches. Referring to Fig. 27, 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 by a switch operating lever to an extension of the crosshead roller pin. 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 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 mal-functioning 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.

For those special applications where multiple immediate reclosures are required, the 2 pole cut-off switch is replaced with a 5 pole switch which permits two "bb" switch contacts to be inserted in the pilot valve coil circuit in series with the cut-off relay contacts. The "bb" contacts open the pilot valve coil circuit, resulting in faster cutting off of the closing air by eliminating the pickup time of the cut-off relay. This speeds up the retrieving action of the mechanism levers and triggers and makes possible faster successive reclosing times. Leaving the cut-off relay contacts in the circuit retains the anti-pumping feature.

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. Another fused knife switch is provided for the same reason for the compressor motor circuit. The third fused knife switch is provided in the heater 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. The low pressure cut-out switch contact is normally closed, but opens before the critical operating pressure is reached.

A small auxiliary air reservoir supplies the low pressure alarm and low pressure cutout switches and in turn is fed from the air manifold through a restrictive orifice 0.016 inch diameter. This arrangement de-sensitizes these switches to momentary pressure transients.

To further insure against a possible faulty operation due to the low pressure cut-out switch opening its contacts during a closing operation, a "make" contact of the closing relay is provided in parallel with the low pressure cut-out switch. As soon as the closing relay is energized, the "make" contact "seals itself in" and insures the admission of air to the mechanism to complete the closing operation. This "seal-in" contact also insures 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 cut-out 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 the "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.

Reclosing Adjustment Switch

Reference diagram Fig. 27. For reclosing duty, besides the addition of a reclosing relay such as the Type SGR-12 shown, an auxiliary switch indicated as "bb" on the diagram and located in the circuit from the recloser to the control relays is required. This switch which is normally open when the mechanism is closed, is capable of adjustment so that the point in the opening stroke at which it makes up its contact can be varied. The setting of this switch controls the amount of opening of the breaker before reclosing and consequently determines the reclosing time. The "bb" contact is located on the 2 pole or 5 pole auxiliary switch and has adjustable finger contacts for varying the switch setting.

Additional contacts of the closing relay are situated in the intake pilot valve coil circuit to provide additional adjustment in the closing or reclosing time. Should it be desirable to speed up the reclosing time beyond the adjustment provided in the adjustable contact fingers on the 2 pole or 5 pole switch, a connection between "Y" and "MAG" on Fig. 27 can be made which eliminates the "X" relay pick-up time. Two contacts of the cut-off relay are also placed in this same circuit in order to speed up the de-energizing of the intake valve at the conclusion of the closing stroke as much as possible, and thus minimize the consumption of the stored compressed air per operation.

Latch Check Switch

Reference diagram Fig. 27. To insure that the mechanism is completely retrieved and the trip free trigger is fully engaged before any closing or reclosing operation (2nd or 3rd Reclosure on multiple reclosing) is attempted electrically, an auxiliary switch indicated as LCH (latch check) on the diagram and located in the circuit between the closing circuit at the mechanism and the lead coming from the point of remote control is provided. This switch is operated mechanically by an extension on the trip free trigger and is normally closed except while the trigger is disengaged.

For applications where the Type AA-10 mechanism is used for multiple reclosing duty, the switch 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 following the tripping out of the breaker.

Accessories

Auxiliary Switches

In addition to the 2 pole or 5 pole cut-off switch, an 11 pole auxiliary switch with independently adjustable contacts is provided for use in interlocking, indicating, alarm and trip circuits. The 11 pole switch is connected to the vertical pull rod and hence indicates the position of the connected load or breaker.

Operation Counter

An operation counter is mounted on the cut-off switch, and 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 mechanism housing back and is operated from the vertical pull rod.

Heaters

Depending on the application, the mechanism will have two or three heaters. 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 heaters, thermostatically controlled, are suitably located to provide better heat distribution in colder weather.

Hand Closing Device

A removable ratchet type jack hand closing device, which attaches to the lower threaded end of the piston rod and is supported by the underside of the spring housing, is provided for closing the mechanism and its connected load during adjustment of the breaker. A power operated manual closing device is available. It consists of a special electric gear motor attached to a specially machined rachet type hand closing device. The assembly is capable of opening or closing the mechanism in three minutes. *Either device is not to be used for emergency manual closing of the breaker on a live line.*

Trip Free Locking Bar

A trip free locking bar is provided which when inserted through two holes in the side plates on the frame prevents the breaker from being tripped trip free. The bar passes behind the two catches and just above the tail section on the trip free trigger thus preventing trip free tripping.

Warning: *The trip free locking bar does not prevent non-trip free tripping of the mechanism and consequential opening of the breaker. To prevent accidental tripping under all conditions apply both the hand closing jack and the trip free locking bar, and in the case of breakers with mechanical interlocks on the hand trip, first disconnect* *the hand trip rod from the bracket which lifts the trip armature, and then insert the trip free locking bar.*

Mechanical Interlocks

Mechanical interlocks are supplied when there is the requirement for locking the breaker in the open position. On breakers furnished with mechanical interlocks, when tripping by pulling the hand trip knob, the selector bar is moved to the trip free position and the breaker will open fast to full open trip free. The mechanism can then be locked open by the key interlock while the hand trip is held in the tripped position.

PART 3 - OPERATION

Closing

Starting with the mechanism and breaker in the open position (Fig. 7) with the trip-free trigger engaged to restrain the trip-free lever, closing the control switch energizes the closing relay "X" and in turn the pilot valve coil "MAG"; reference Fig. 27, which admits compressed air stored in the reservoir to the closing cylinder. The trip-free trigger by restraining the trip free lever maintains the thrust link and closing lever in the relative position shown in Fig. 7 which effectively connects the closing piston to the breaker pull rod. When the breaker is nearly closed, the "aa" auxiliary switch contacts close 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 circuit causing the "seal-in" contacts "X" to open and (3) closes the "seal-in" "Y" contact in parallel with the "aa" switch and the "Y" contact in parallel with the low pressure switch to maintain the control relays locked out until the control switch is released. The point where the "aa" switch makes up its contact 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. 8), the holding latch engages the cross-head pin and the non trip-free trigger engages the roller on the holding latch, keeping the mechanism and breaker closed. The closing air in the cylinder is exhausted and the selector bar shifts back to its normal position setting up the non trip-free trigger for the next tripping operation.

Opening

Starting with the mechanism in the closed position (Fig. 8), 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 non trip-free trigger which has been restraining the holding latch to keep the breaker closed. Since the trip-free trigger remains in engagement with the trip free lever, the piston remains connected to and is retrieved with the breaker to the open position (Fig. 3). The two strong retrieving springs under the piston help to accelerate the piston and hence contribute partially to the opening speed of the breaker.

Close-Open

Starting with the mechanism in the open position (Fig. 7) as the air pressure builds up in the cylinder following opening of the inlet valve, the selector piston shifts the selector bar to set up the trip-free trigger ready for tripping. Tripping the mechanism by the protective relay as the breaker contacts touch, (Fig. 8) disengages the trip free trigger which releases the trip-free lever. A projection on the side of the trip-free trigger, engages the non trip-free trigger moving it clear of its engagement with the roller on the holding latch, as the trip-free trigger clears the roller on the trip-free lever. The horn on the trip free lever maintains the trigger in the released position until the mechanism is fully retrieved. Release of the restraint on point "C" allows it to rotate about pin "B" which rotates the trip-free lever clockwise until points "A" and "C" are opposite each other horizontally. As pin "A" in the breaker rod end continues toward the full open position, point "C" moves to the right which reverses the rotation of the trip-free lever (Fig. 9). Going back to nearly the beginning of the trip free action, as soon as the closing lever starts to rotate about pin "B" the "kicker", which is a part of the closing lever, forces the holding latch out of engagement with the cross head pin, which insures unimpeded retrieving of the closing piston to the open position as soon as the closing air has been exhausted. As the closing air is exhausted, the selector bar shifts back to its original position. As the mechanism moves from the extreme trip-free position Fig. 9 to the open position Fig. 7 point "C" now rotates about point "A" which is a fixed center due to the breaker having reached the full open position. For the early part of the retrieving stroke, the trip-free lever will again rotate clockwise until points A-C-D are in a straight line. As soon as the piston has retrieved far enough for point "C" to get above the line between A-D, the trip-free lever reverses motion and rotates very rapidly back to the relatched position on Fig. 7. The resilient trip free lever stop provides sufficient overtravel of the trip free lever to permit the trip free trigger to snap into position under the trip free lever roller.

Open-Close

Starting with the mechanism in the closed position Fig. 8, with no air pressure in the closing cylinder, the selective tripping causes the mechanism to trip from the non trip free trigger when the protective relays energize the trip coil. As soon as the mechanism has opened sufficiently to close the "bb" contact on the 2 pole or 5 pole auxiliary switch, the closing circuit is energized admitting high pressure air on top of the piston. This retards and then reverses the direction of the mechanism and breaker and the mechanism recloses the breaker as in a normal closing operation.

Should the fault still exist that caused the protective relay to trip the mechanism the first time as the mechanism recloses the breaker, the mechanism will function as described in detail under the description of the CLOSE-OPEN section, 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 4 - INSPECTION-MAINTENANCE-ADJUSTMENT

Since operating conditions vary so 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.

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 in front of 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 latch is made of hardened steel machined to shape with the latching surfaces ground smooth after hardening. The triggers are cast from a tough high strength non-ferrous alloy with corrosion resistant stellite inserts at the latching points. The engaging surfaces of the latches and triggers 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 inhibitor S#1802 395 (M-55213 AG) to the latch and rollers on the engaging surfaces. This inhibitor 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 that they are not gummed up.

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, first insert the trip-free locking bar to prevent accidental trip-free tripping of the mechanism, then pull the mechanism slightly into the overtravel position to take the load off from the latch and then while holding the trip armature in the tripped position, reverse the jack and back out the breaker. The most convenient method of raising the trip armature is to insert a wood rod 1-1/2" x 1-1/2" x 18" under the trip rod with one end placed on top of mechanism cylinder top plate. Raise the outer end of rod with one hand to raise trip armature while backing out the jack with the other hand. This same bar is excellent for making sneak trip checks. The hand trip armature can be released as soon as the latch starts to back off from the crosshead pin.

If adjusting the breaker contacts on a breaker furnished with mechanical interlocks DO NOT trip by pulling the hand trip knob as the trip selector bar is shifted to the trip free position and the breaker will open to full open trip free. First disconnect the trip rod and then insert the trip free locking bar. The preceding paragraph may then be followed for safe opening and closing of the breaker for contact adjustment.

Beacon 325 grease (Westinghouse S#1802395-M55213-AG) is used to pack all roller and needle bearings and lubricate the pins associated with them. The pins which do not pass through bearings (needle or roller) are lubricated with Molycote "G" (Westinghouse S#513A209-H01 - M53701-DB).

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 pounds 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 five 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.

Pilot Valve

The first place to check for leaks is the pilot valve. This may be done by applying a soap solution to the pilot valve exhaust port. (Located directly below the nameplate on pilot). Leakage here is generally due to dirt particles on the valve seat. "Cracking" the valve several times by pressing the manual operating button will usually serve to dislodge the dirt and make the valve seal properly. At this point, it should be stated that general recommendations require that the 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 who 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 the faulty valve may be removed and repaired when convenient. Close the hand shutoff valve and proceed as follows: Remove the two screws which hold the pilot valve cover. This will allow the solenoid assembly to be removed. Now remove the rubber cushion and the retaining ring which holds the insert assembly. The insert assembly may now be removed and the valve and valve seat be inspected. Clean the valve and valve seat with a clean cloth.

Control Valve (Westinghouse Type)

Checking for leaks past the main inlet valve can be accomplished easily for the valve assembly employing the "fast exhaust". 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 valve body. For valve assemblies using the "slow exhaust", it is necessary to first remove the exhaust assembly from the valve body and seal the exhaust opening before checking for a leak through the bleeder hole.

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

Control Valve (Ross Type)

Checking for leaks past the main inlet poppet seat can be accomplished easily. Obtain a standard pipe plug and drill a small hole through it. Insert the plug in the exhaust port and apply soap solution to the hole and threads. Caution: Immediately remove pipe plug upon determining if leakage exists. If a leak is detected here after having previously determined that the pilot valve is tight, it indicates that the main inlet poppet seat is not sealing properly. The quickest method and one that is generally successful is to "crack" the valve by bumping the manual operating button on the pilot valve several times. If this does not stop the leakage, the inlet poppet seat may be removed for inspection and cleaning by proceeding as follows: Close the hand shutoff valve. Remove the two socket head cap screws which hold the end cap on the bottom of the valve. This will allow the spring and inlet poppet assembly to be removed.

If the control valve "blows" through the exhaust port when the coil is energized it is an indication that the exhaust poppet is not seating properly. If this cannot be corrected by bumping the manual operating button, proceed to remove the piston poppet assembly as follows: Remove the two socket head cap screws which attach the pilot to the adaptor. Remove the four cap screws which attach the adaptor to the main valve body. The piston poppet assembly may now be removed by pushing up on the assembly through the exhaust port.

If the leak is not in the control valve unit all other connections, including the safety valve should be checked with a soap solution.

Tripping

The latch and triggers 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. 7 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 is factory set and should not require adjustment.

The air gap for the trip armature should be approximately 3/16". This adjustment is made by varying the height of the resilient stop Fig. 10. 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 .030" ± .005". This adjustment has been made at the factory and should not require changing. It can be changed however, if it is found necessary by loosening the lock nut on the underside of the armature and screwing the trip rod either in or out of the armature. If adjustment is found necessary recheck free travel of trip armature before picking up "kick-off" spring as described below.

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 spring adjusting nuts.

One last check which should be made is to ascertain that there is a minimum of twelve thousandths clearance between the top of the trip rod and the catch which it strikes. Clearance at this point is necessary to prevent shock-out of the mechanism on a closing operation. This clearance may be obtained by varying the air gap (3/16 dim.). Care should be exercised in widening the air gap excessively as this will increase the minimum operating voltage of the trip unit and slow down its operation.

Overtravel

The overtravel of the closing 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 lift rod 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 pushbutton on the inlet valve, and observe the travel of the crosshead roller pin.

Throttle and By-Pass

There is only one adjustment provided on the throttle (for those mechanisms where a throttle is supplied) and that is to vary the position in the closing stroke of the mechanism where the throttle is opened up. This adjustment is made by shifting the location of the cam plate on the throttle lever.

The by-pass is fully closed when the threads on the by-pass adjusting screw are flush with the lock nut.

The by-pass is fully open when the by-pass adjusting screw is backed off 8 full turns from the closed position.

A taper on the lower end of the by-pass adjusting screw provides a metering adjustment to the flow of air for positions between the closed and open position. The setting of the by-pass has been determined at the factory and shouldn't normally require further attention.

Air Compressor Units

The air compressor unit is equipped with either a single stage Model FW-60 (Fig. 25) or a two stage Type 1VC (Fig. 26) air compressor and the complete outfit is fully automatic in operation.

The air compressor and motor are mounted on a bed-plate. Power is transmitted by single "V" belt drive with adjustable belt take-up. The air tank is fitted with the 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 checking the level of compressor 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 the National Electrical Code 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.

The two stage, two cylinder compressor is lubricated by a positive pressure oil pump.

Proper rotation of the compressor is right hand (clockwise) when facing the oil fill plug end of the crankcase. On three phase installations, the direction of rotation should be checked regularly.

The compressor is filled with oil before leaving factory. Check oil level before starting compressor.

Approximate Oil Capacity

Type "FW-60"	1/3 Pint
Type "1VC"	7/8 Quart

The oil filling plug should be removed and the oil level observed periodically. If the oil level is not up to the tapped opening on the Type "1VC" add sufficient oil to raise the level to this opening. On the type FW-60, if the oil level is the low mark on the exterior of the crankcase, add sufficient oil to raise the level to a point one thread below the top of the fill hole. A high grade non detergent automobile engine oil - SAE-20 for temperature above freezing or SAE-20W for temperatures below freezing may be used.

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.

Also at six month intervals or more often if the environment dictates the condition of the air filter should be checked. The filter in the type FW-60 is a cellular type material and may be cleaned in kerosene or other solvent. The Type 1-VC compressor is equipped with a cartridge type filter which must be replaced when necessary. The valves in the cylinder head should be removed periodically and the inlet and discharge valves and their seats thoroughly cleaned.

Leakage of air back through the compressor air intake indicates a faulty check valve. Dis-assemble the check valve by removing the snap ring at the bottom and clean all parts thoroughly. Examine the teflon valve disk, the corresponding seat in the valve body and the spring. If any of these items appears to be faulty, the entire valve should be replaced.

Mechanisms which have the reservoir mounted inside the mechanism housing utilize a syphon type drain on the side of the reservoir. When the reservoir is mounted outside the housing, the drain valve will be on the extreme bottom. Regardless of the type, the valve should be opened during inspection or maintenance of the breaker to drain accumulated water resulting from condensation. Leave the drain valve 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 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 ring on its stem, with the compressor running, usually cleans the valve seat and restores proper seal.

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. When installing new belt or adjusting old belt for normal wear, the correct tension is obtained by having a deflection of between 3/8 to 3/4 inch with approximately 5 pounds pressure applied vertically at center of belt.

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 stud on top of the switch. *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 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.

Auxiliary Air Reservoir

The auxiliary air reservoir which supplies the low pressure alarm and cut-off is in turn fed from the air manifold through a restrictive orifice 0.016 inch diameter. The orifice is installed in the auxiliary reservoir end of the 1/8 inch tube connecting to the air supply manifold. When pressure is dropped in the manifold system, check that the cutoff switch responds without abnormal delay. A clogged orifice can result in a damaged breaker.

PART 5 - 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 inlet 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 the mechanism starts to close when the button on the pilot valve is bumped and also that there is a momentary discharge from the exhaust, when the button on the pilot valve is released.

7. Check the four studs that clamp the cylinder to the frame and the 3 bolts that fasten the control valve to the frame to make sure that both are clamped securely.

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 thus 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 breaker stops to make sure there is no interference.

2. Check the minimum operating voltage of the cut-off relay and increase it if it is too low.

3. Check the 2 pole or 5 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.

4. Close the mechanism by means of the pushbutton on top of the pilot valve and observe the over travel of the vertical pull rod. This should be about 1/8" to allow the latch time to reset.

5. While the mechanism is in the overtraveled position of check #4, observe whether the end of the non trip-free trigger resets properly behind the roller on the holding latch.

6. If the non trip free trigger does not reset, close the mechanism with the hand closing jack to the overtravel position and (1) Check the clearance between the "Kicker" and the nose of the holding latch to make sure that the latch is free to move forward for its full travel and (2) check the movement of the non trip free trigger to make sure that it is free to rotate between the limits of the trigger stops.

7. 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 trip free lever roller.

8. Block the moving armature of the trip unit and close the breaker. If this eliminates the problem, the shunt trip unit is shocking the trip free trigger out of position. This may be caused by one of the following.

a. Insufficient clearance between the top of the trip rod plunger and the trigger catch.

b. The large bolts which attach the mechanism to the breaker frame not being tight.

C. If the mechanism fails to trip.

1. Check the voltage at the trip coil.

2. Check the terminals 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.

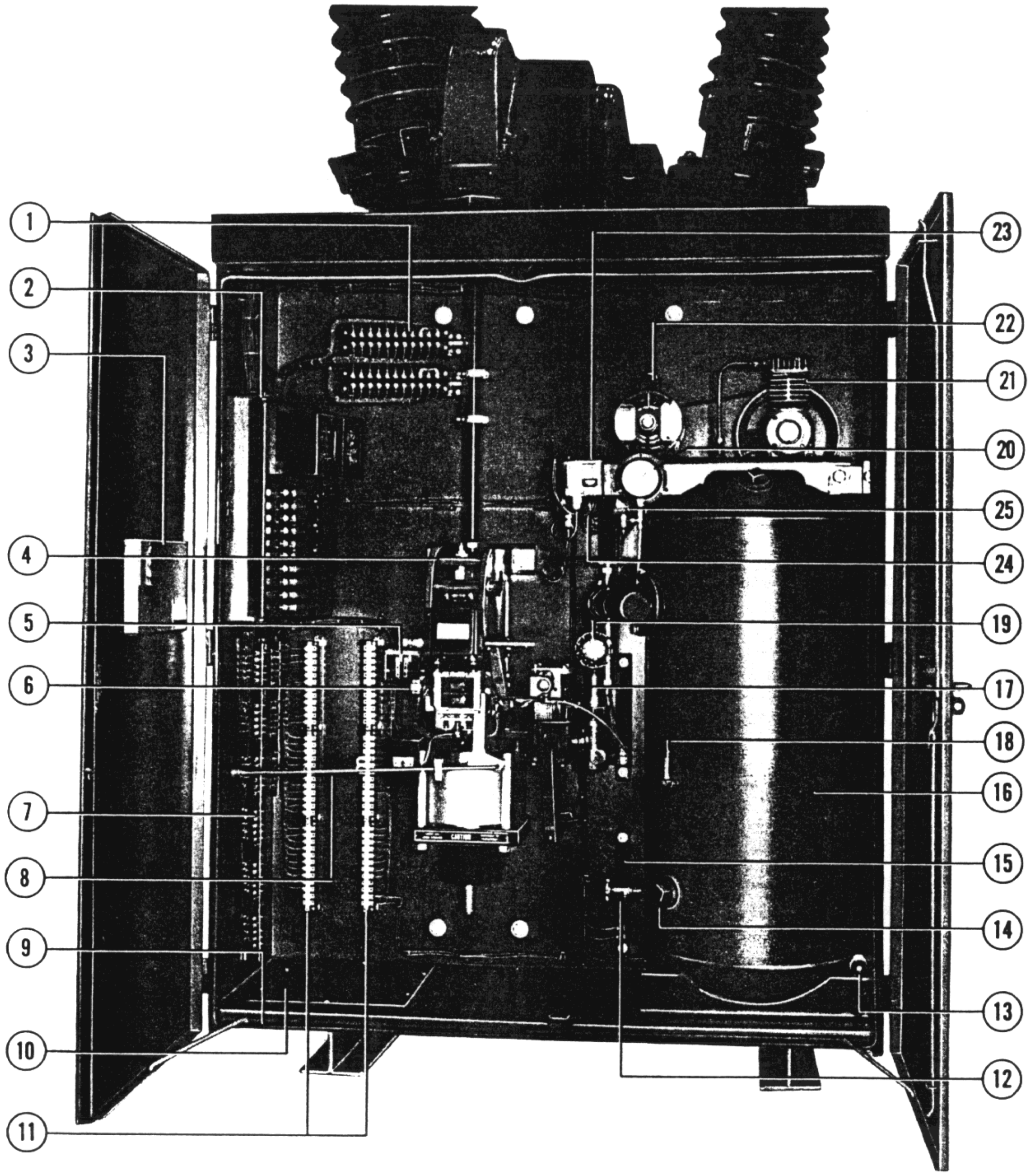
4. Put the hand closing jack on and take the breaker load off from the latch. Then raise the trip rod manually and observe whether the non trip free trigger is disengaged and the latch is free to rotate releasing the cross-head pin. Also check that the tripping armature seats up against the stationary armature.

5. Check the overlap of the trigger on the latch as in Section B-4 above.

D. On Reclosing Duty, if the mechanism trips but fails to reclose.

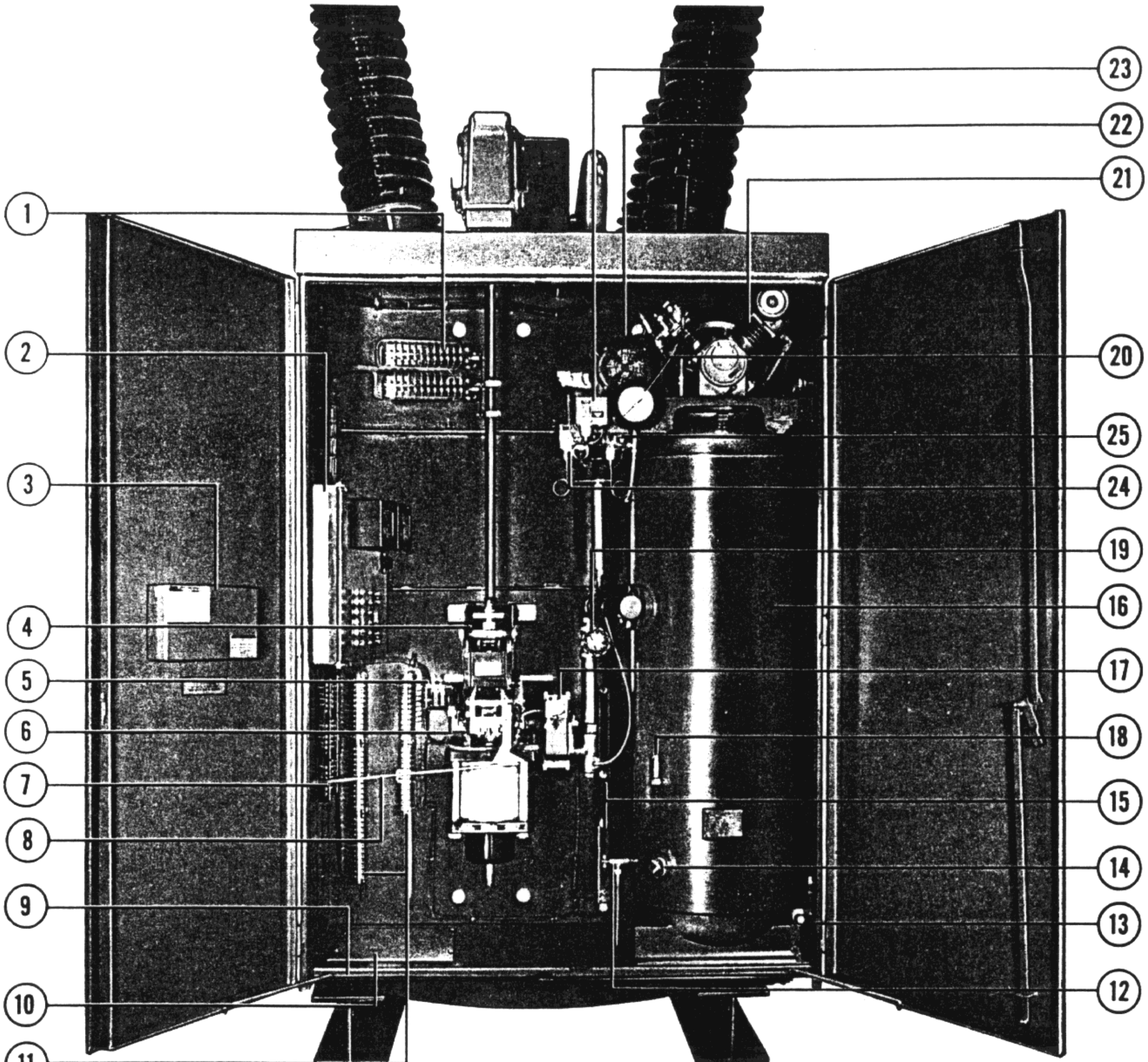
1. Check the "bb" contact on the two pole switch to see that it is making good contact.

2. Check to make sure that the cut-off relay is not picking up prematurely and locking out the closing relay and the pilot valve coil. Advancing the setting of the "bb" switch contact too far will cause this to occur.



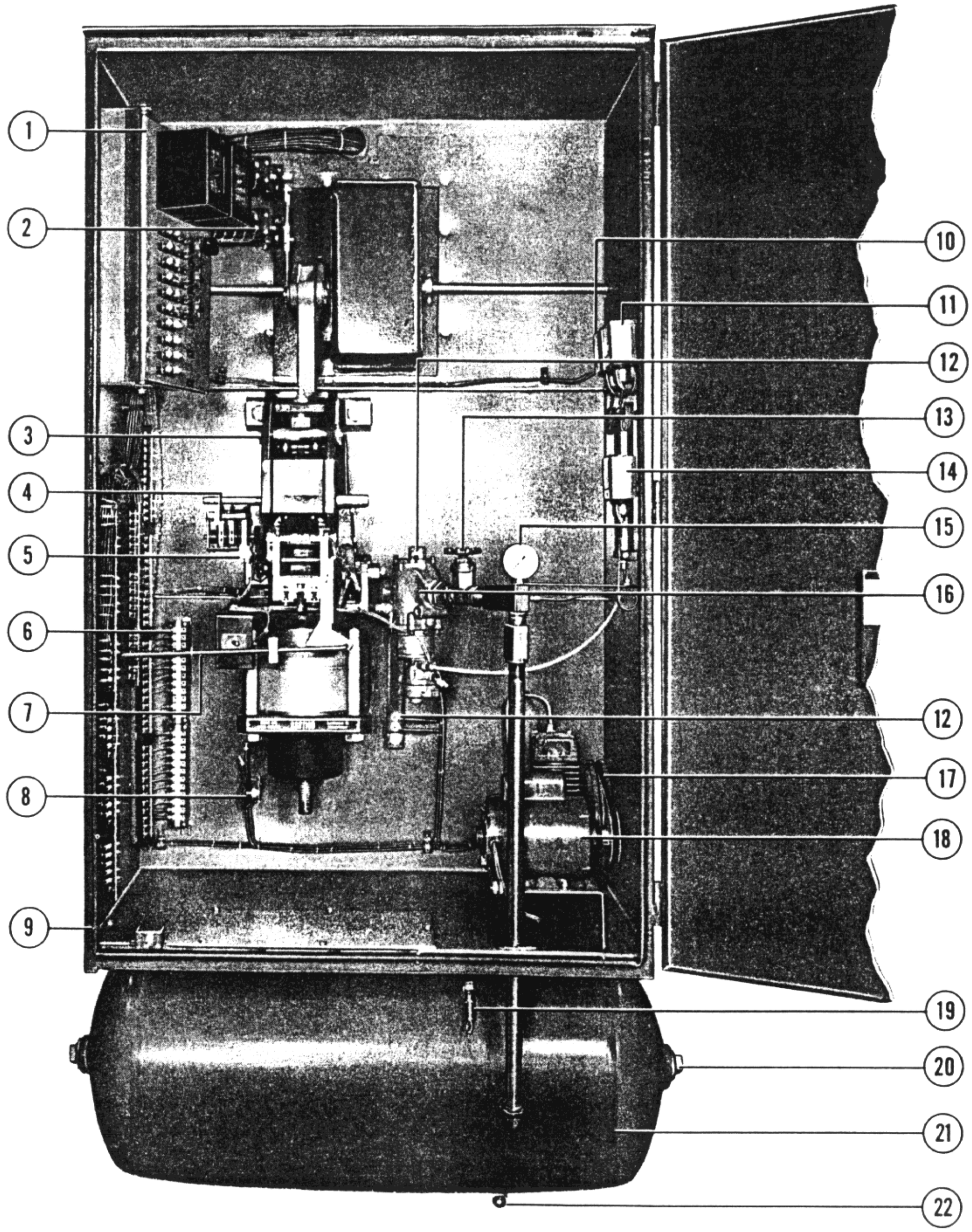
1. 11 - Pole Auxiliary Switch
2. Hinged Control Panel
3. Pocket for Diagrams & Instruction Books
4. AA - 10 Mechanism
5. 2 - Pole-Auxiliary Switch
6. Operations Counter
7. Transformer Terminal Blocks
8. Hand Trip
9. Rubber Seal Gasket
10. Removable Floor Plate
11. Control Terminal Blocks
12. Siphon Drain Valve
13. Heater Thermostat
14. Inspection Opening
15. Heaters
16. Reservoir
17. Air Control Valve
18. Safety Valve
19. Hand Shut - Off Valve
20. Pressure Gauge
21. Compressor
22. Motor
23. Compressor Governor Switch
24. Low Pressure Cut - Off Switch
25. Low Pressure Alarm Switch

Fig. 1 *AA-10-60 Mechanism Assembly*



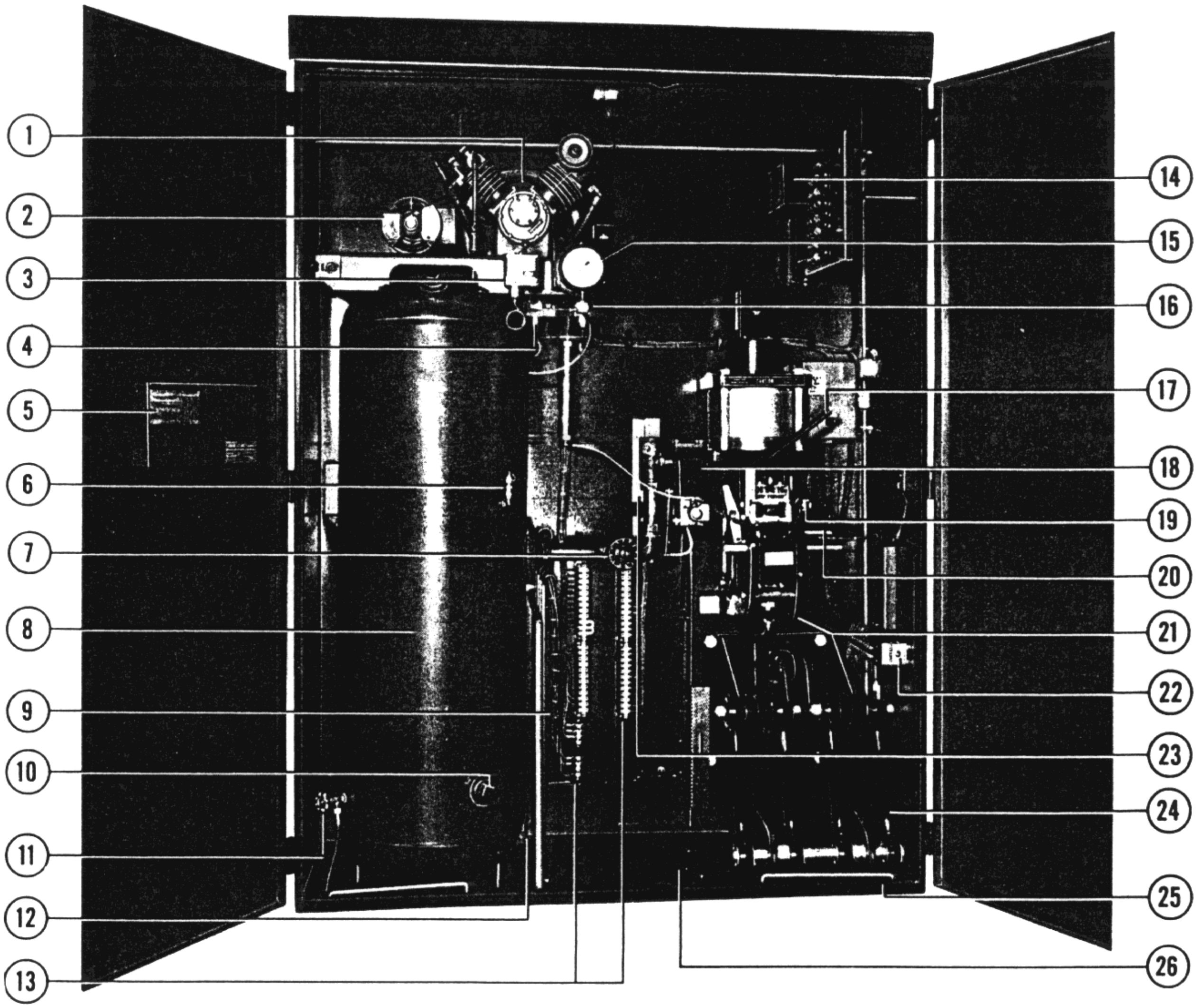
1. 11 - Pole Auxiliary Switch
2. Hinged Control Panel
3. Pocket for Diagrams & Instruction Books
4. AA - 10 Mechanism
5. 2 - Pole-Auxiliary Switch
6. Operations Counter
7. Transformer Terminal Blocks
8. Hand Trip
9. Rubber Seal Gasket
10. Removable Floor Plate
11. Control Terminal Blocks
12. Siphon Drain Valve
13. Heater Thermostat
14. Inspection Opening
15. Heaters
16. Reservoir
17. Air Control Valve
18. Safety Valve
19. Hand Shut - Off Valve
20. Pressure Gauge
21. Compressor
22. Motor
23. Compressor Governor Switch
24. Low Pressure Cut - Off Switch
25. Low Pressure Alarm Switch

Fig. 2 *AA-10-80 Mechanism Assembly*



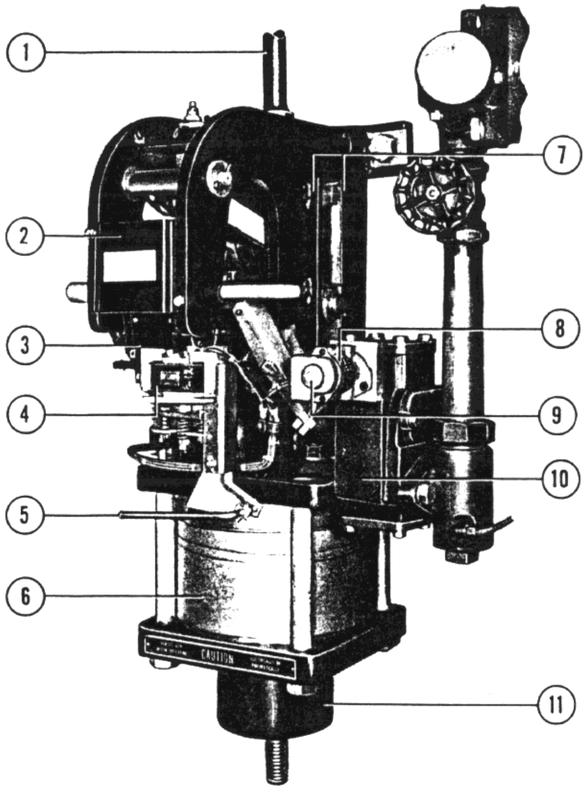
1. Hinged Control Panel
2. 11 Pole Auxiliary Switch
3. Type AA-10 Mechanism
4. Two Pole Auxiliary Switch
5. Operations Counter
6. Terminal Blocks Control (Rear) Transformer (Front)
7. Hand Trip
8. Heater Thermostat
9. Rubber Seal Gasket
10. Low Pressure Alarm Switch
11. Low Pressure Cutout Switch
12. Heater
13. Hand Shutoff Valve
14. Governor Switch
15. Pressure Gauge
16. Control Valve
17. Compressor
18. Compressor Motor
19. Safety Valve
20. Inspection Opening
21. Reservoir
22. Drain Valve

Fig. 3 *AA-10 Mechanism as used on the 1150GM 5000 Oil Circuit Breaker*



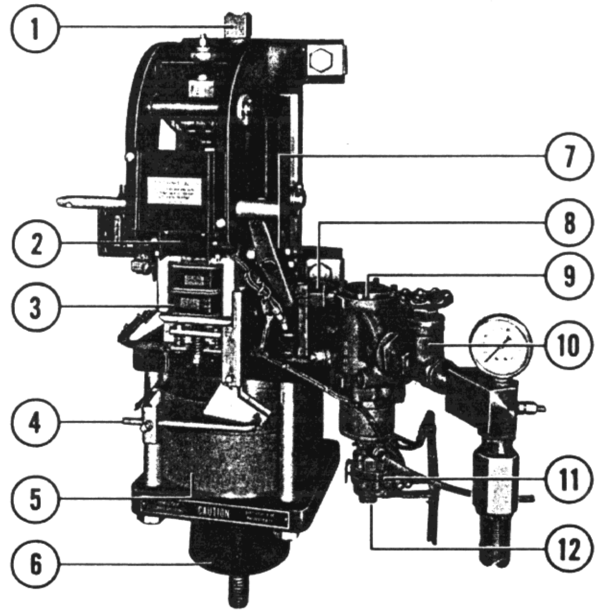
1. Compressor
2. Motor
3. Compressor Governor Switch
4. Low Pressure Cut - Off Switch
5. Pocket for Diagrams & Instruction Books
6. Safety Valve
7. Hand Shut - Off Valve
8. Reservoir
9. Transformer Terminal Blocks
10. Inspection Opening
11. Siphon Drain Valve
12. Heater Thermostat
13. Control Terminal Blocks
14. Hinged Control Panel
15. Pressure Gauge
16. Low Pressure Alarm Switch
17. Hand Trip
18. Air Control Valve
19. Operations Counter
20. 2 - Pole-Auxiliary Switch
21. AA - 10 Mechanism
22. 11 - Pole Auxiliary Switch
23. Heaters
24. Shock Absorber Assembly
25. Rubber Seal Gasket
26. Removable Floor Plate

Fig. 4 *AA10-80R Mechanism Assembly*



1. Breaker Pull Rod
2. Guard Plate
3. Latch Check Switch
4. Trip Coil
5. Hand Trip Device
6. Main Closing Cylinder
7. Guide Rails
8. Pilot Valve
9. Manual Closing Button
10. Inlet and Exhaust Valves
11. Piston Retrieving Spring Housing

Fig. 5 *Type AA-10 Mechanism with Westinghouse Control Valve*



1. Breaker Pull Rod
2. Latch Check Switch
3. Trip Coils
4. Hand Trip Device
5. Main Closing Cylinder
6. Piston Retrieving Spring Housing
7. Selector Operating Lever
8. Adaptor Block
9. Control Valve
10. Hand Shutoff Valve
11. Pilot Valve
12. Manual Closing Button

Fig. 6 *Type AA-10 Mechanism with Ross Control Valve*

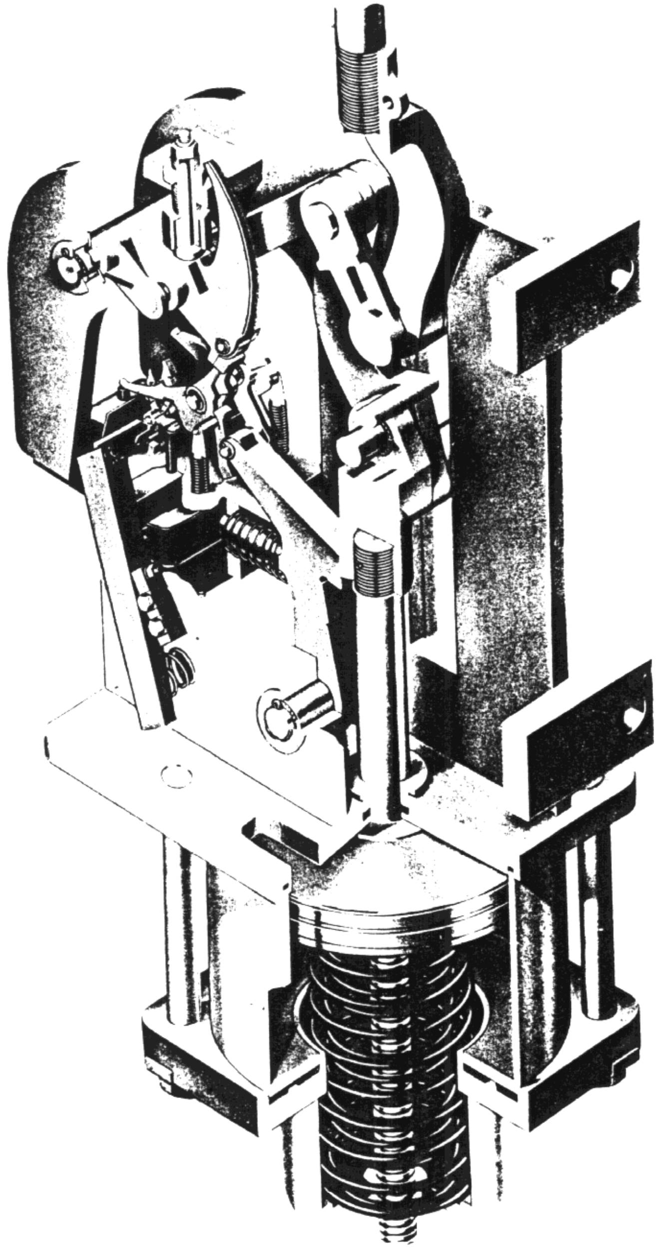


Fig. 7 *Open Position*

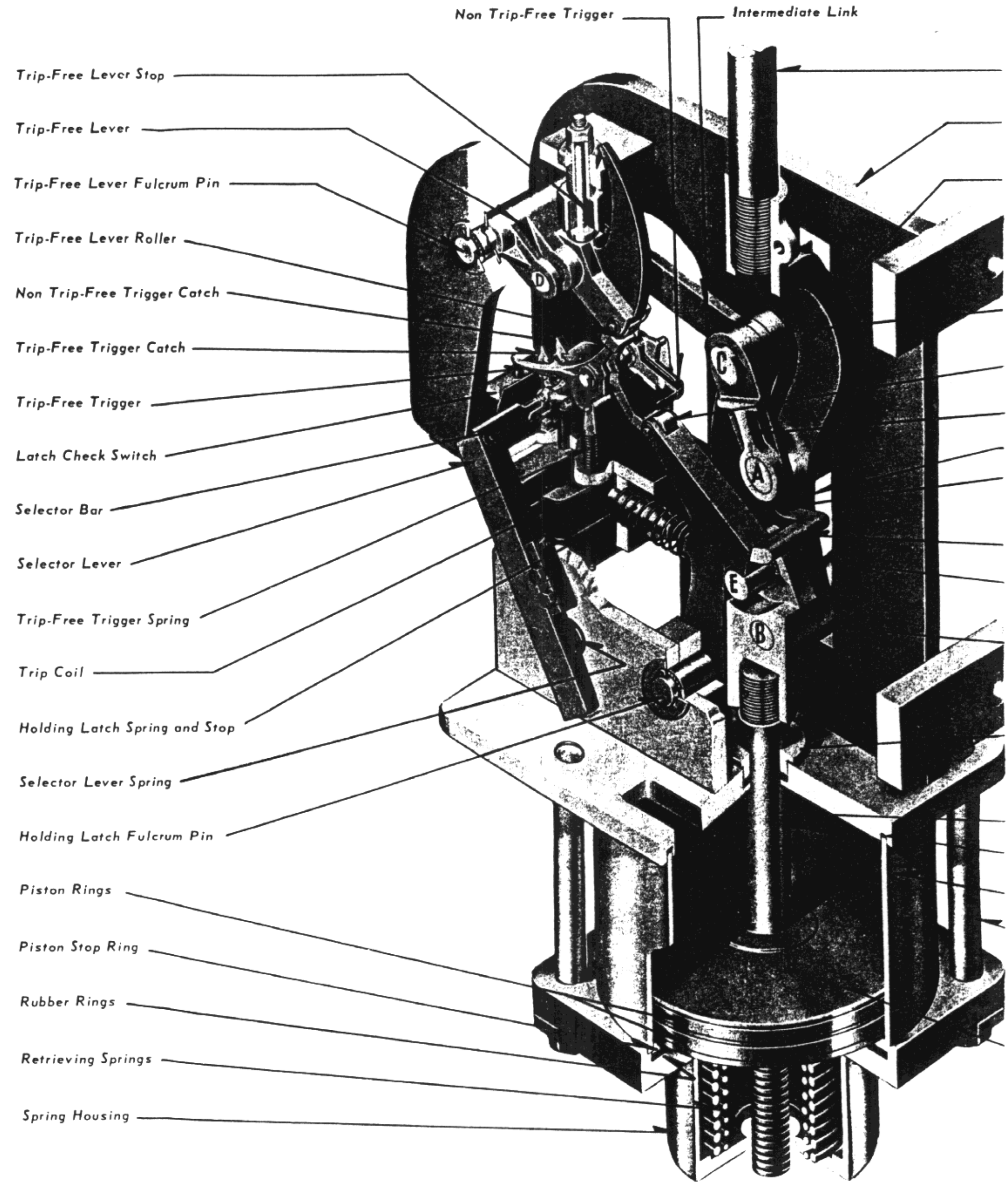


Fig. 8 *Closed Position*

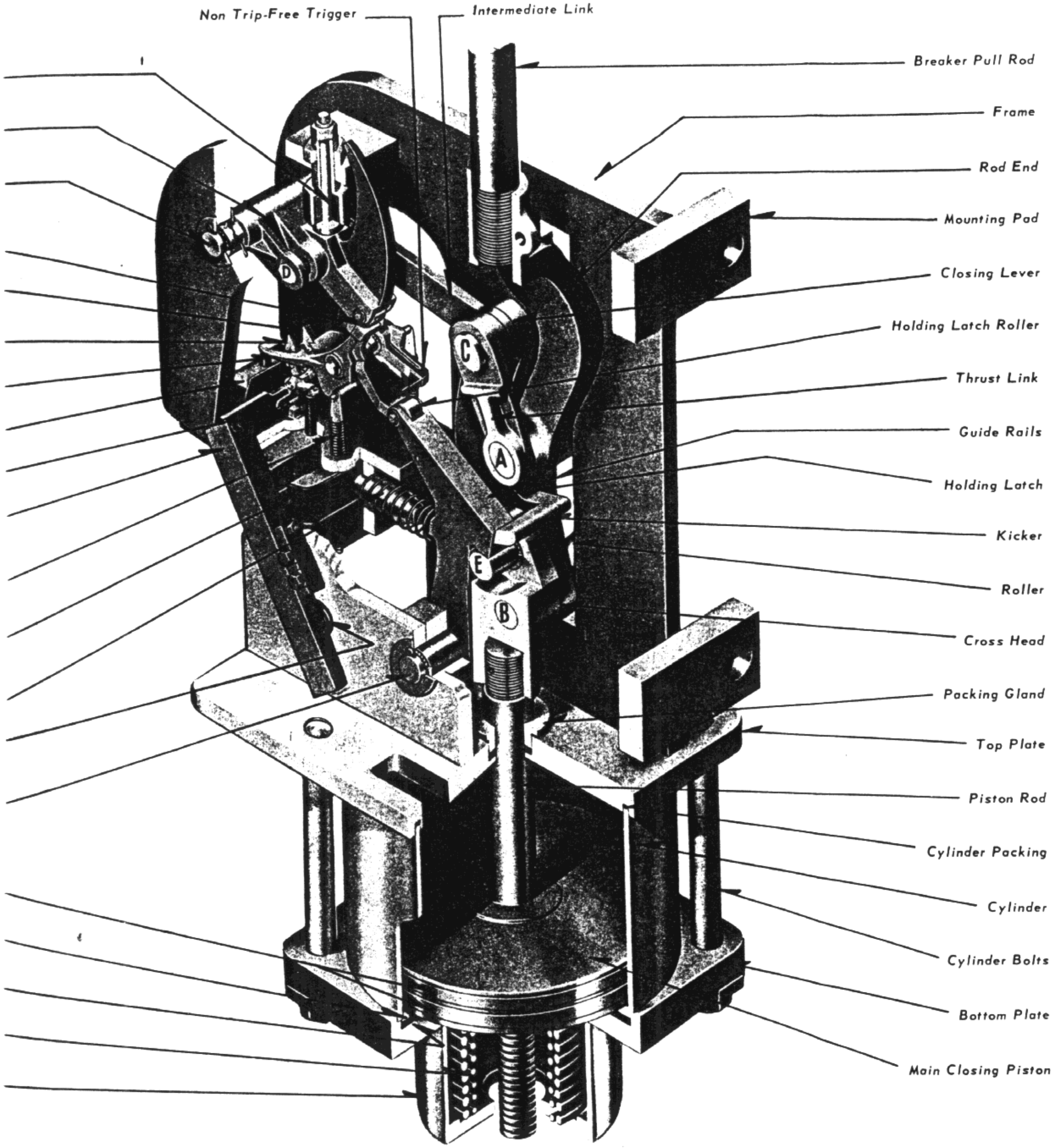


Fig. 8 *Closed Position*

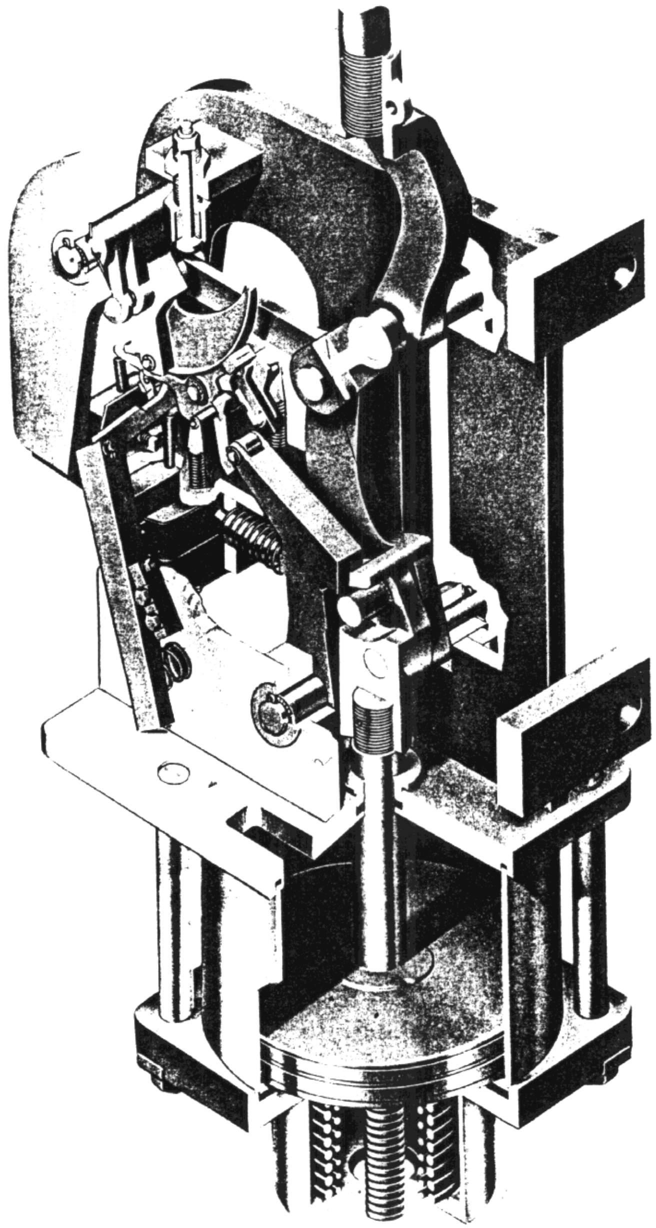


Fig. 9 *Trip Free Position*

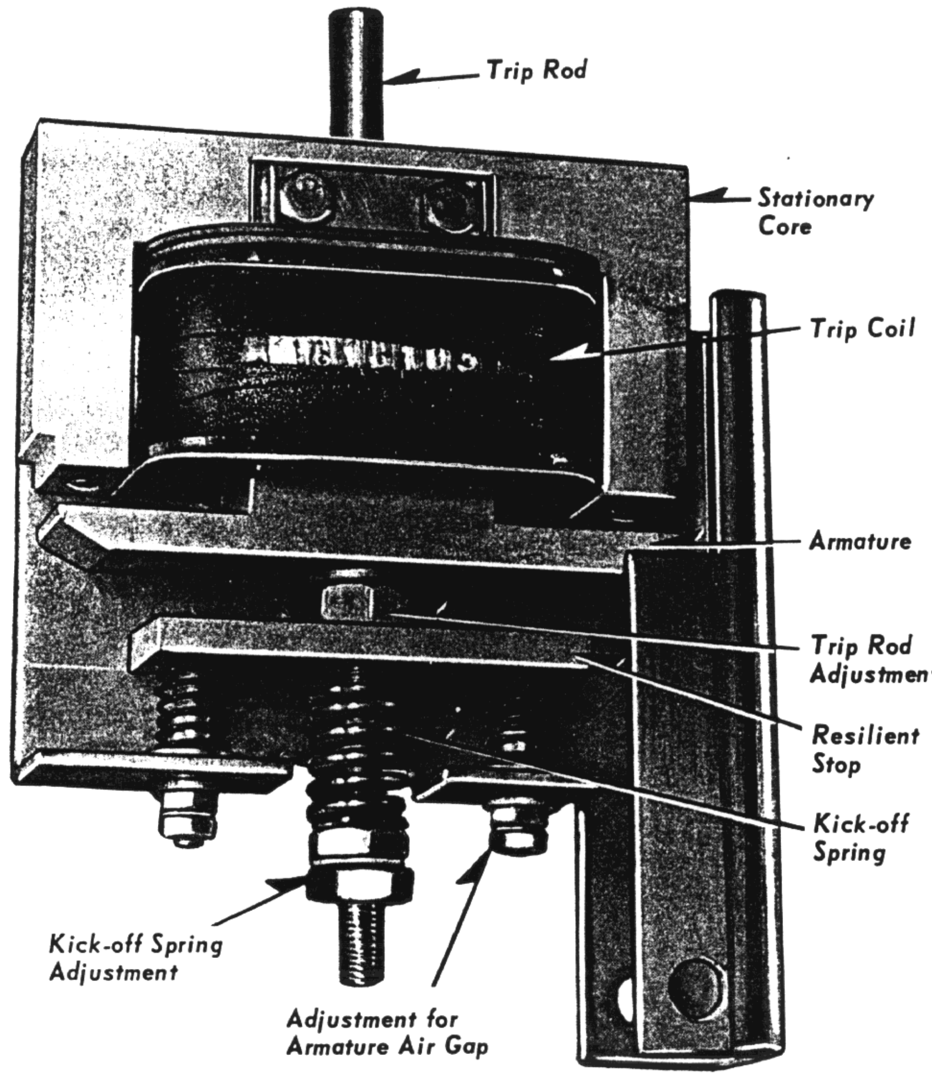
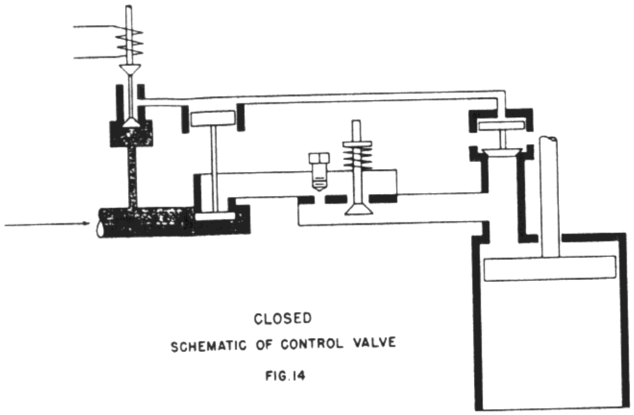


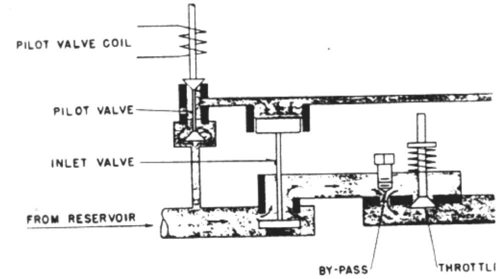
Fig. 10 *Trip Magnet Assembly*



CLOSED

SCHEMATIC OF CONTROL VALVE

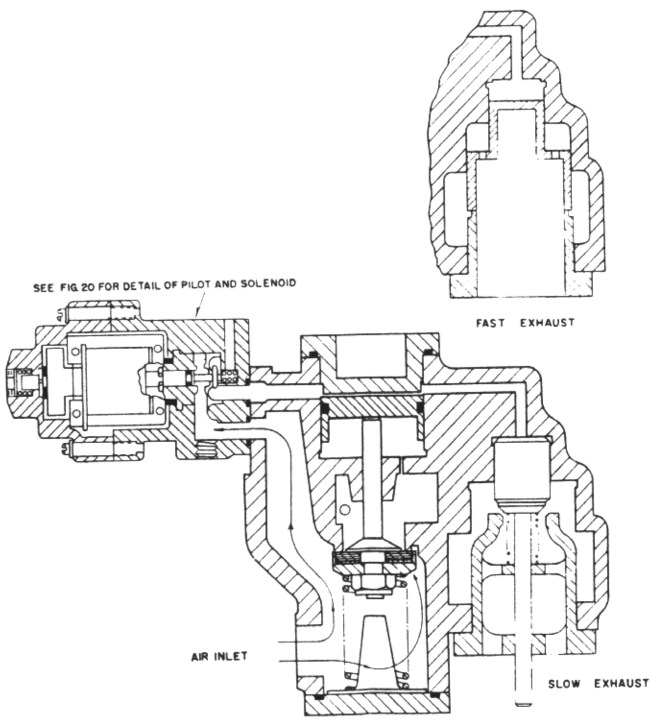
FIG. 14



OPEN

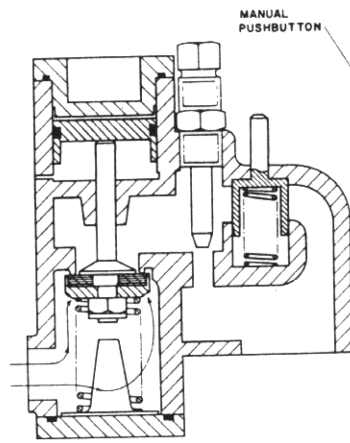
SCHEMATIC OF CONTROL VALVE

FIG. 15



CLOSED

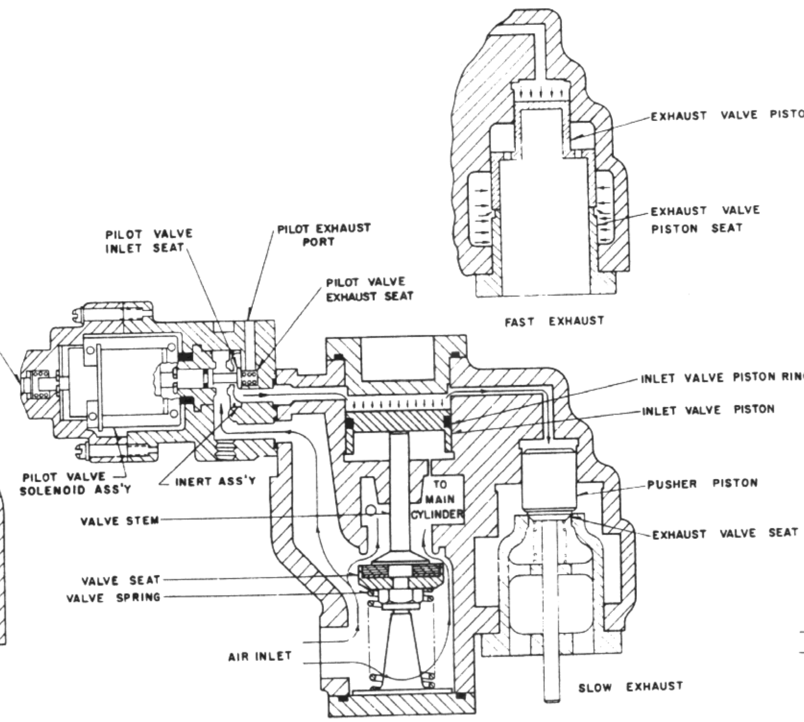
FIG. 11



CLOSED

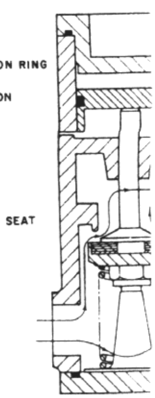
MECHANISM FULL OPEN

FIG. 11A

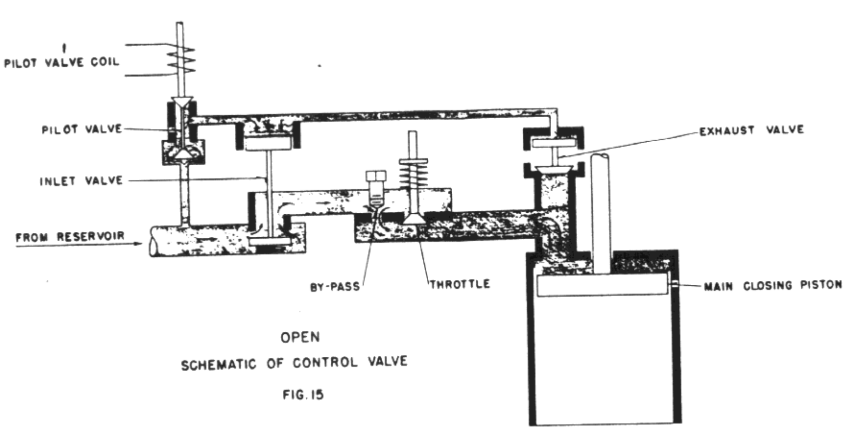


OPEN

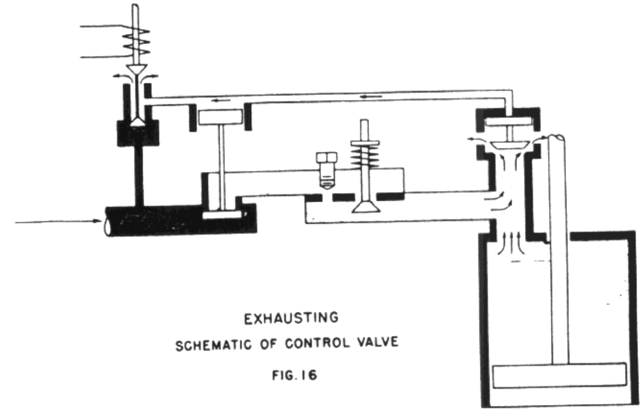
FIG. 12



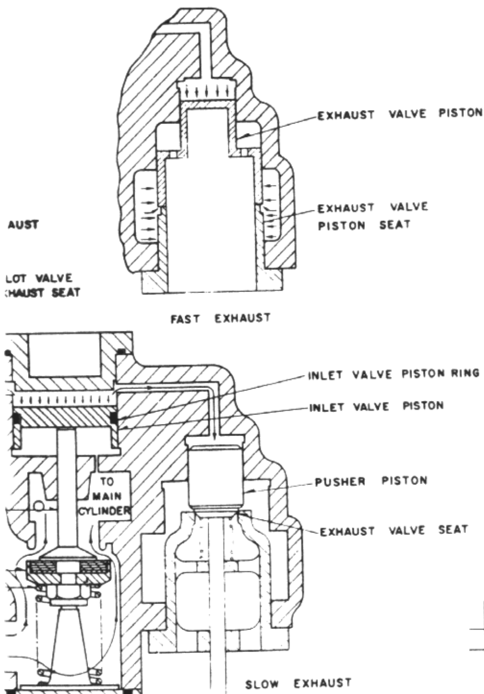
MECHANISM IN



OPEN
SCHEMATIC OF CONTROL VALVE
FIG. 15

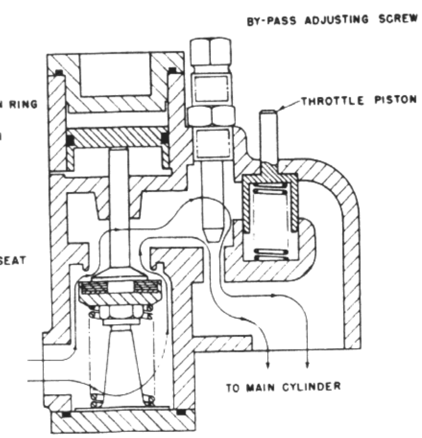


EXHAUSTING
SCHEMATIC OF CONTROL VALVE
FIG. 16

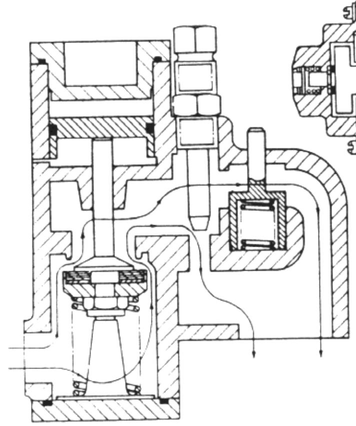


OPEN

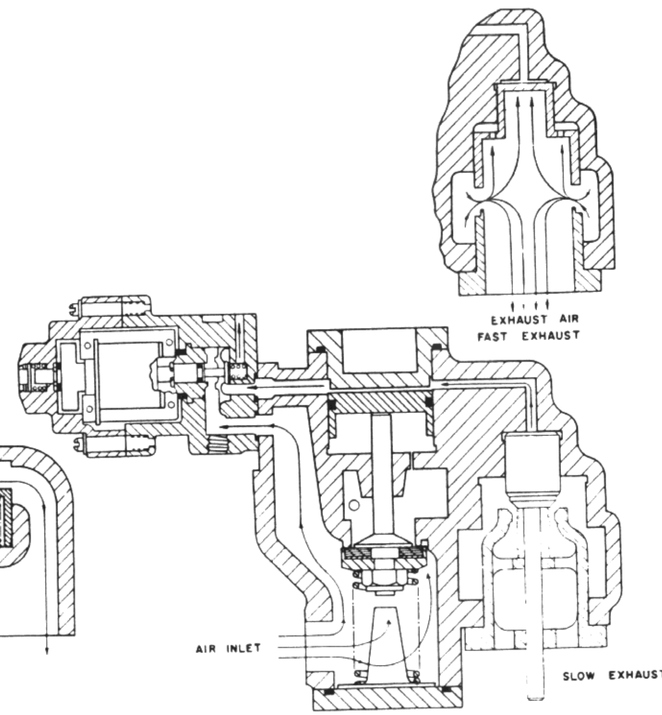
FIG 12



OPEN
MECHANISM IN EARLY PART OF CLOSING STROKE
FIG. 12A



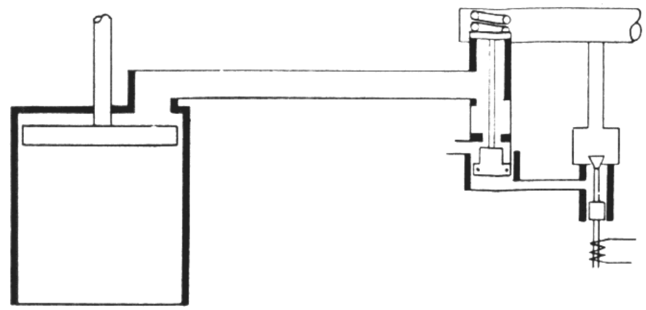
OPEN
MECHANISM NEARING END OF CLOSING STROKE
FIG. 12B



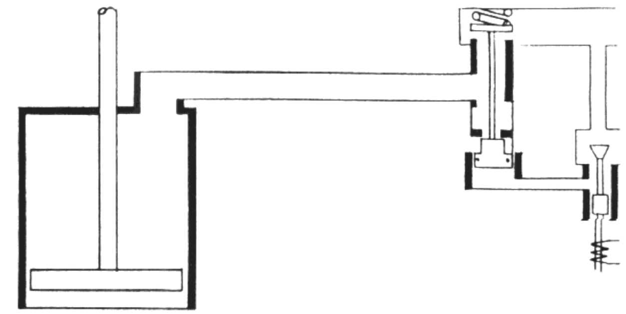
EXHAUSTING

FIG. 13

Fig. 11 thru 16 *Control Valve - Westinghouse*



CLOSED SCHEMATIC OF
CONTROL VALVE
FIG. 19



OPEN SCHEMATIC OF
CONTROL VALVE
FIG. 20

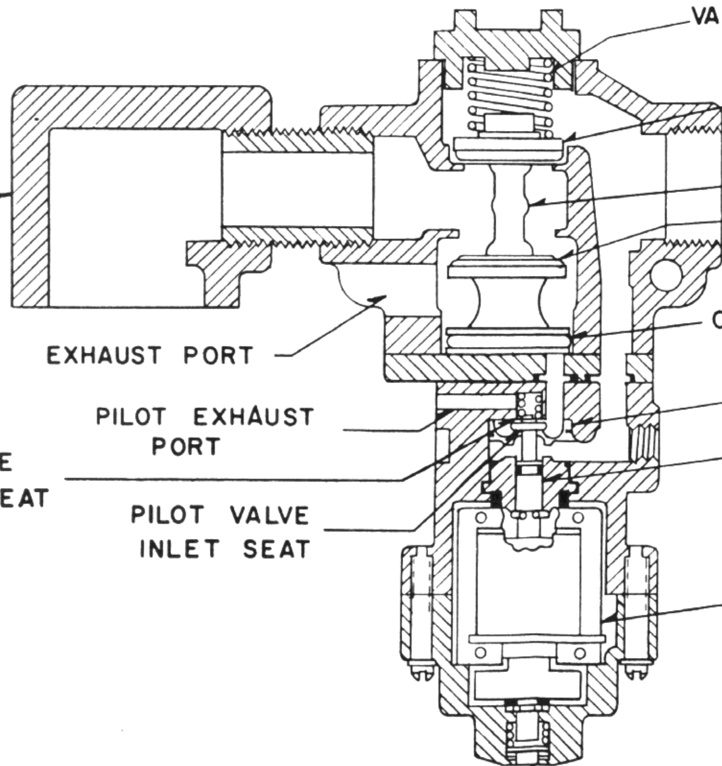


FIG. 17
CLOSED

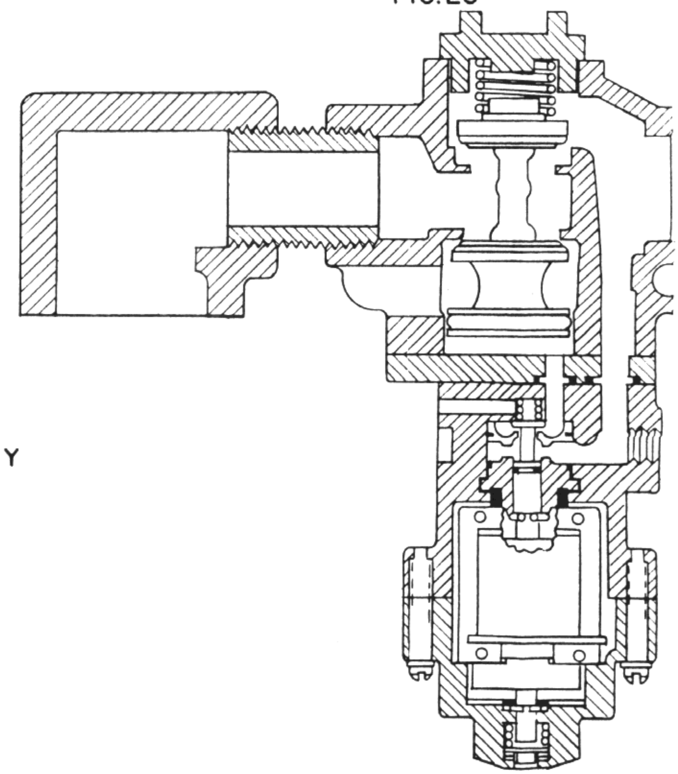
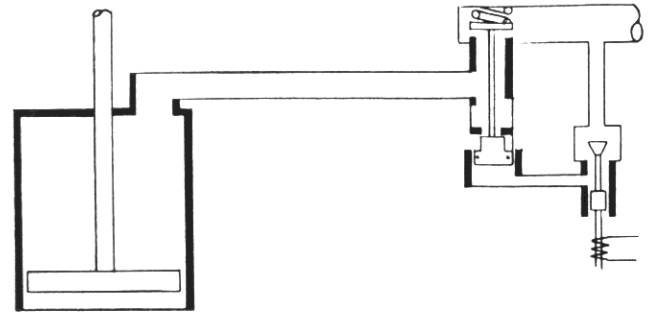


FIG. 18
OPEN

Fig. 17 thru 20 *Control Valve - Ross*



OPEN SCHEMATIC OF
CONTROL VALVE
FIG. 20

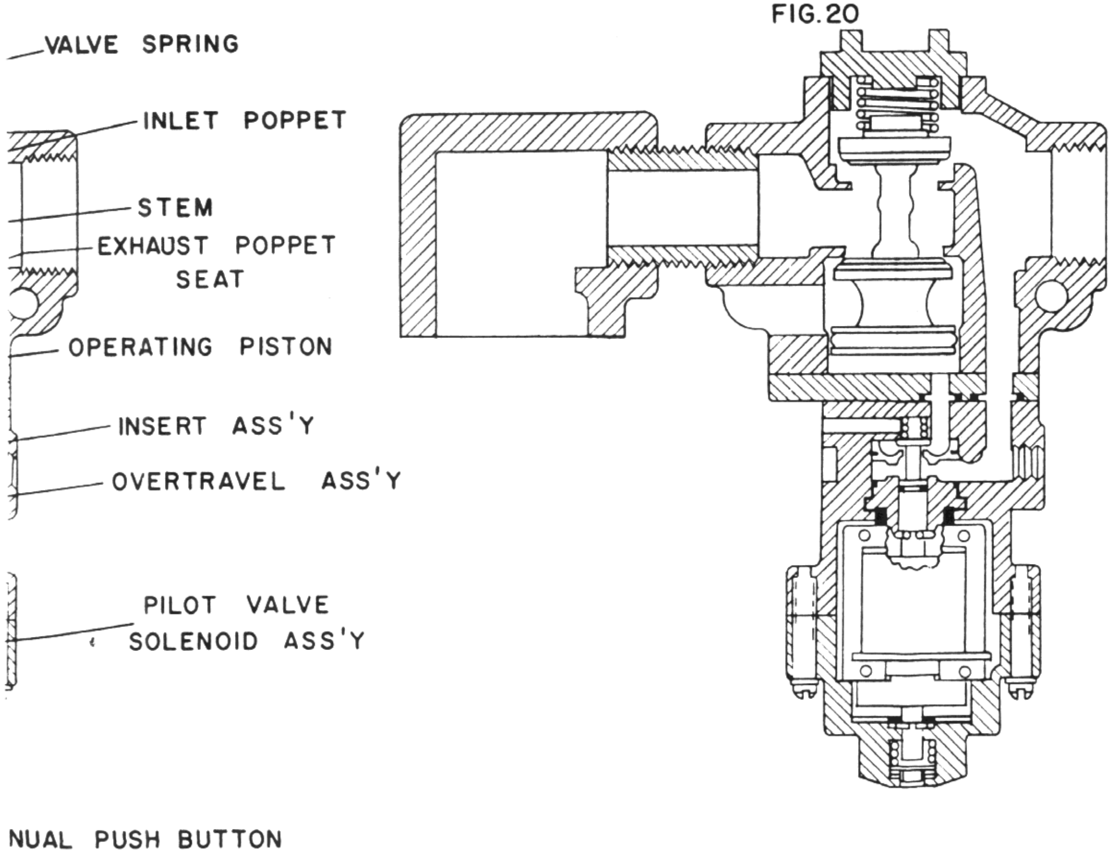
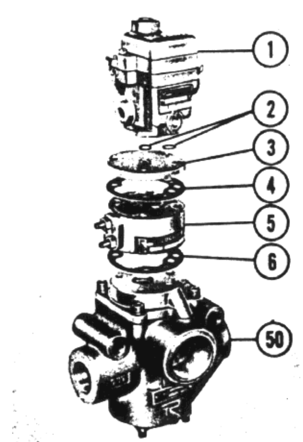
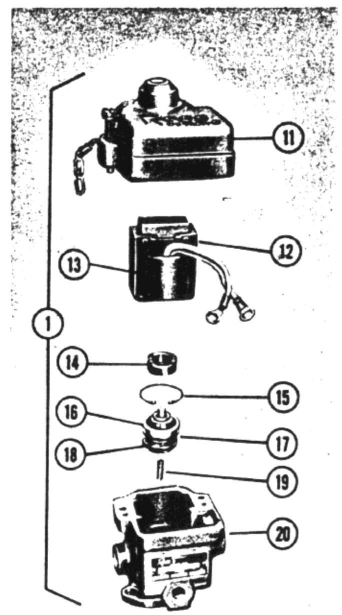


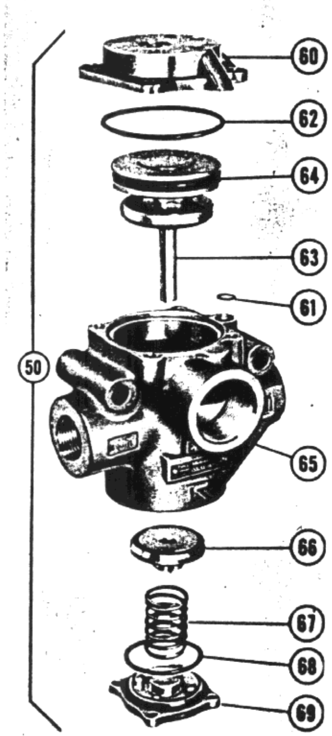
Fig. 17 thru 20 *Control Valve - Ross*

FIG. 18
OPEN





PILOT & SOLENOID



VALVE BODY ASSEMBLY

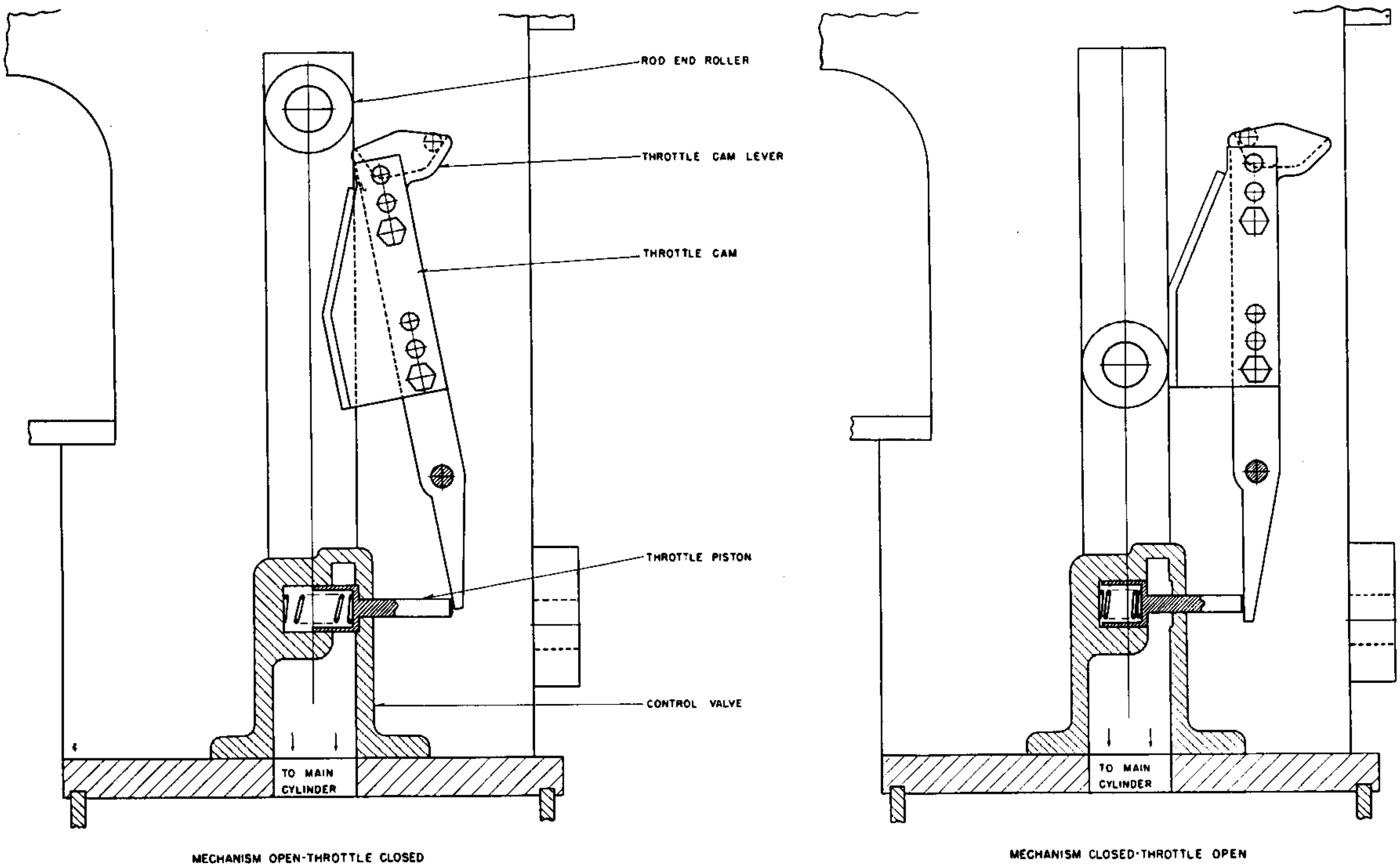


Fig. 21 & 22 *Throttle Operation*

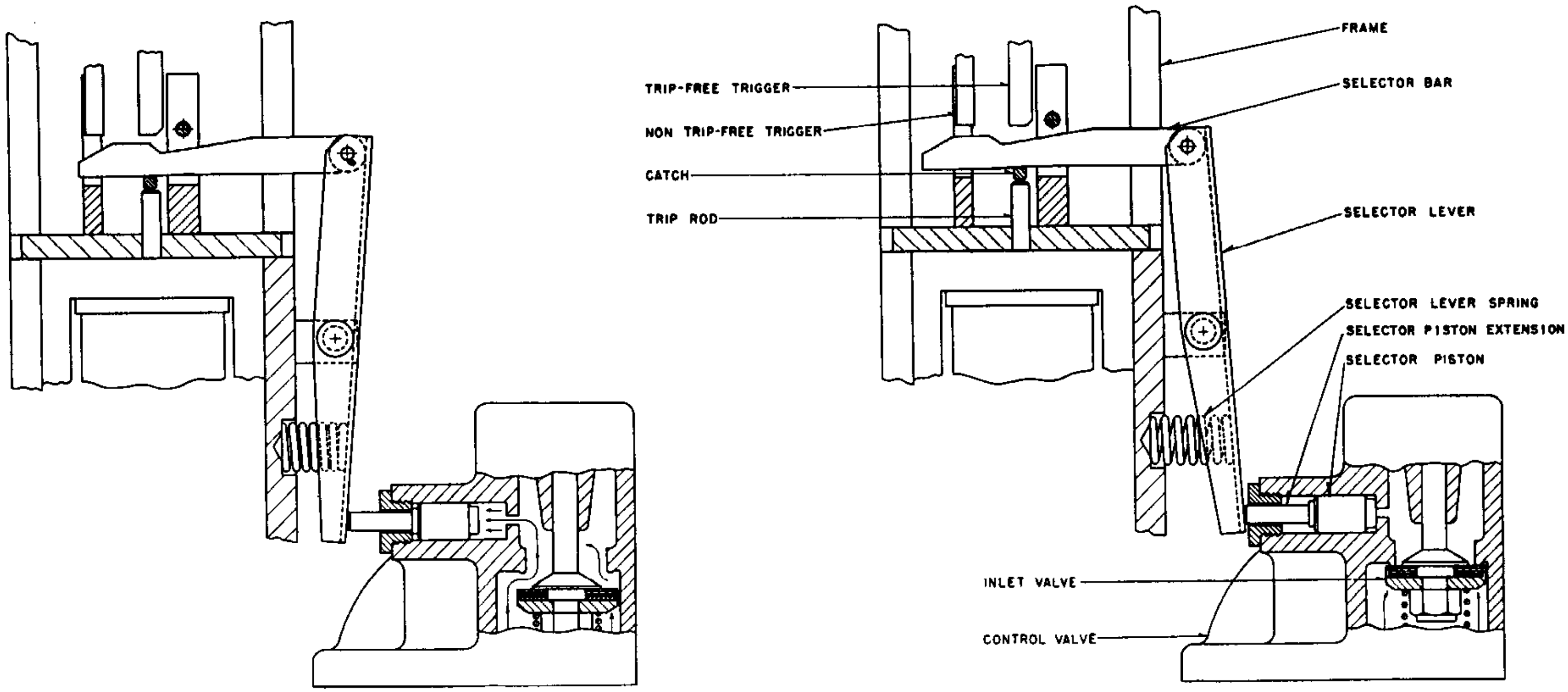


Fig. 23 & 24 *Selector Operation*

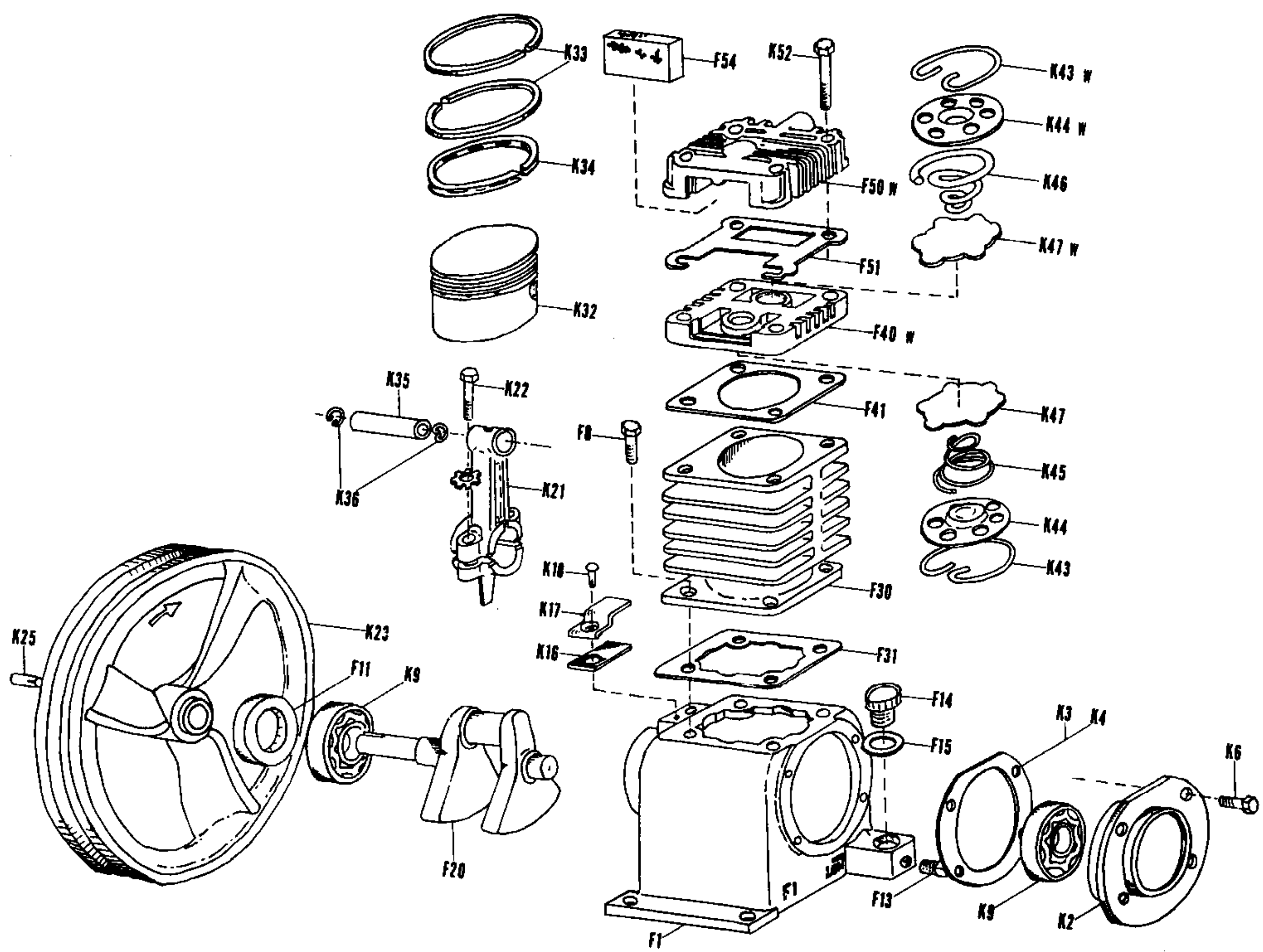


Fig. 25 *"FW-60" Air Compressor Parts*

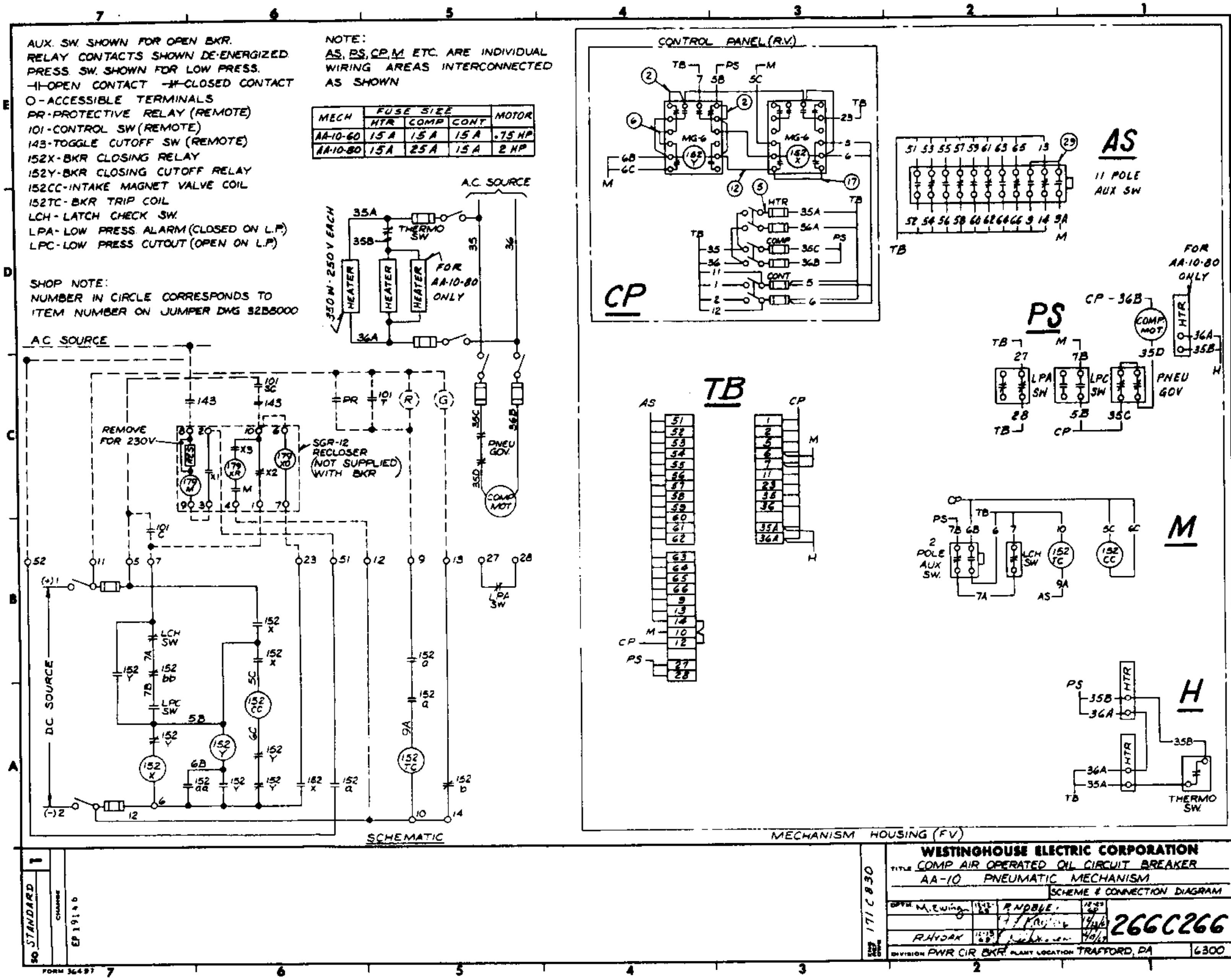


Fig. 27 *Schematic Diagram (Typical)*