INSTRUCTION BOOK

Pneumatic
Operating Mechanism
Type AA-10
for
Oil Circuit Breakers

Westinghouse Electric Corporation

I.B. 33-125-C3C

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INSTRUCTIONS

Pneumatic Operating Mechanism Type AA-10 for Oil Circuit Breakers

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WESTINGHOUSE ELECTRIC CORPORATION

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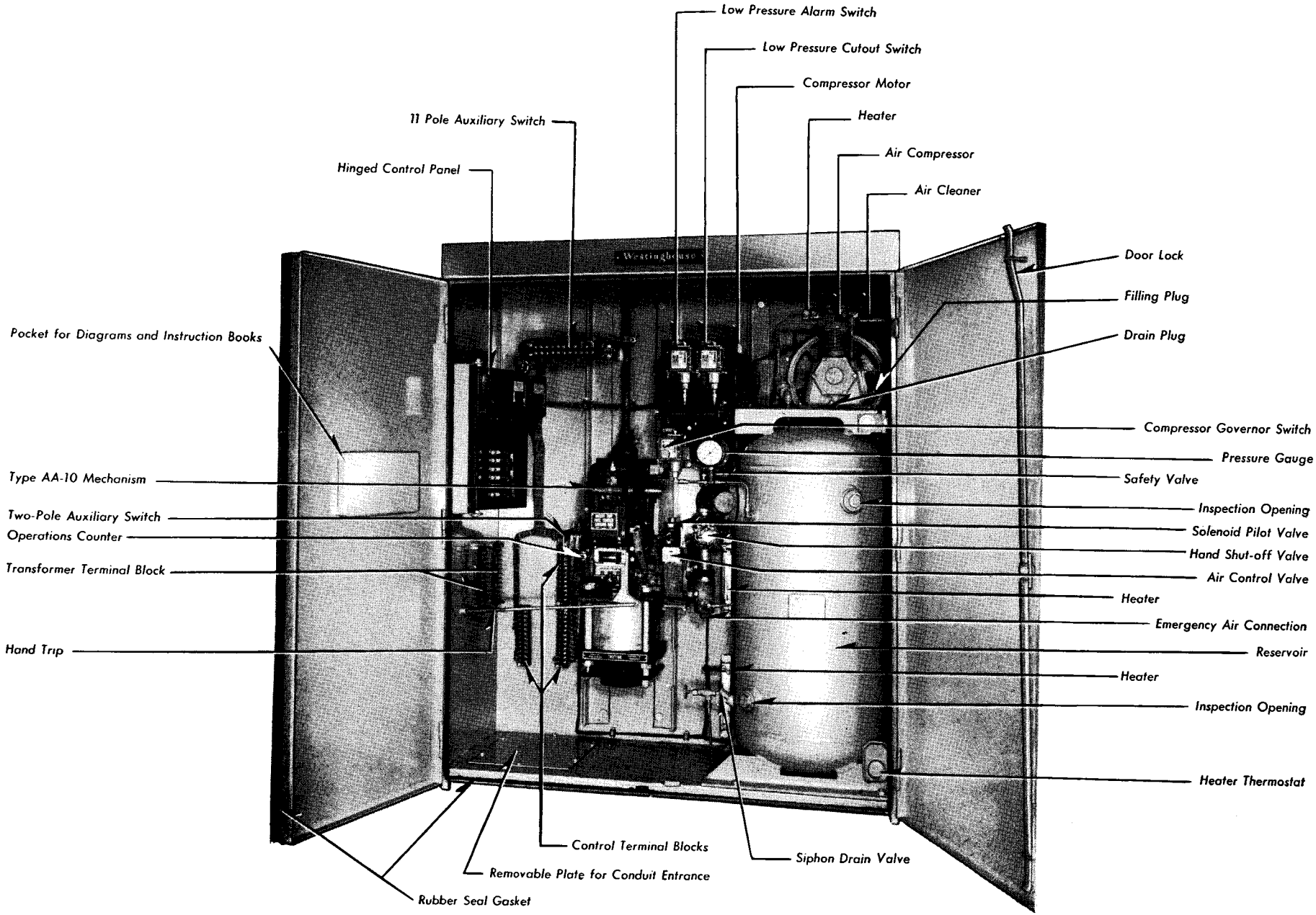

FIG. 1—AA-10 OPERATING MECHANISM IN HOUSING

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.

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DRAWINGS

Pneumatic Operating Mechanism—Type AA-10

PART I—RECEIVING, HANDLING, AND STORAGE

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

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

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

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

PART II—DESCRIPTION

GENERAL

Included within the dust tight sheet metal housing 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 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.

COMPRESSOR AND AIR SYSTEM

The unit is available with two sizes of air supply systems. For applications on the smaller breakers, the unit will consist of a 60 gallon reservoir, and a single stage (illustrated Fig.1) or two stage compressor depending on the normal operating pressure. For applications on the larger breakers, the unit will have an 80 gallon reservoir, and a two stage compressor with intercooling between the low pressure and high pressure cylinders. 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 a 15 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 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 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.

The schematic diagram for the air system is shown on drawing 57-J-365. 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 $1\frac{1}{2}''$ pipe plug provided in the piping between the hand shut-off valve and the control valve as indicated on Fig. 1.

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. 3, 4 and 5 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 nonferrous seamless tube clamped between the top plate which is part of the frame and the bottom plate.

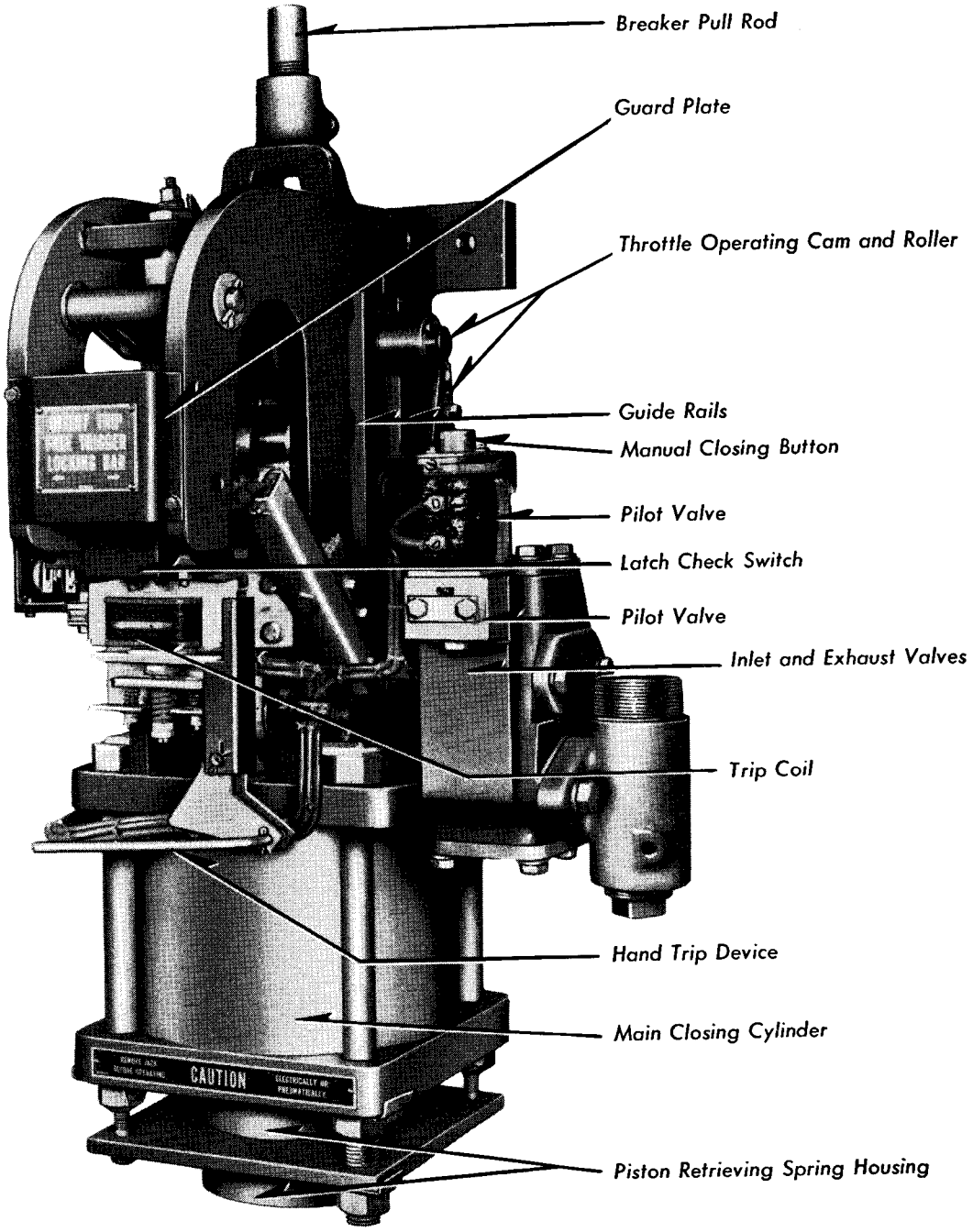


FIG. 2—TYPE AA-10 MECHANISM

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. 4. 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

Immediately below the bottom plate and clamped to it by extensions on two of the bolts

holding the cylinder assembly to the main frame is the spring housing which supports and encloses the two heavy retrieving springs. These springs, which are compressed during the closing stroke, supply the force required to rapidly retrieve the piston to the open position whenever the mechanism is tripped.

Closing Piston Assembly

The main closing piston which is cast 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 two piston rings 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. 3 and 4, 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. 3 and 4. 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. 5 to the open position Fig. 3. 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. 4 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. 4. 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.

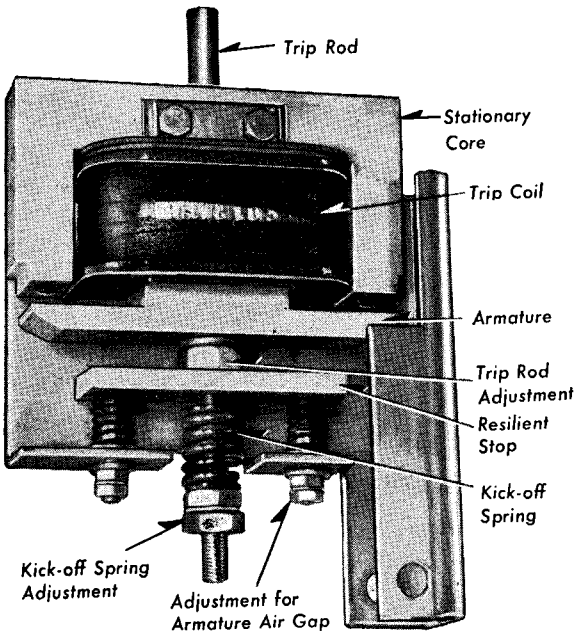


FIG. 6—TRIP MAGNET ASSEMBLY

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. 16-17. 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. 17 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. 16 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 a wide range of functions which the mechanism may be called on to perform, there

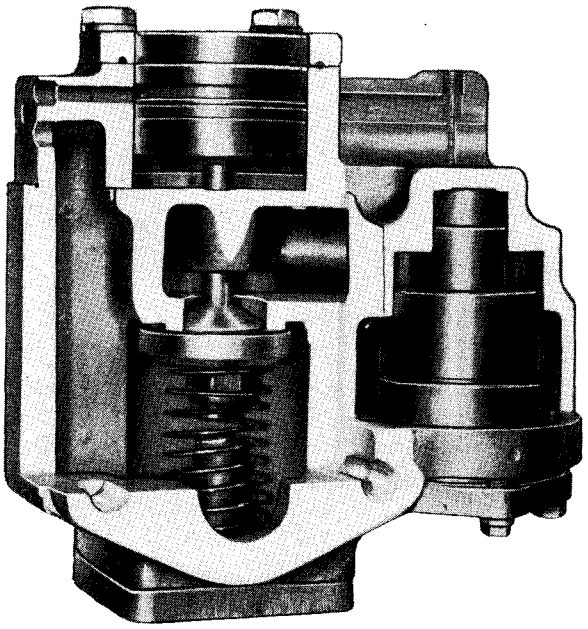


FIG. 7—AA-10 CONTROL VALVE
(with high speed exhaust)

are several combinations required in the control valve assembly as follows:

(1) For the majority of breakers, which have a comparatively light starting load, a throttle and adjustable by-pass are required (Fig. 8A-14-15).

(2) For the largest breakers this feature is omitted.

(3) For all breakers where immediate multiple reclosures are required, a fast acting exhaust valve is incorporated (Fig. 8).

(4) Where only one reclosure is required, a slow acting "poppet" type of exhaust, which allows the pressure to leak down to a low value before exhausting is permissible (Fig. 8B).

(5) To provide for selective tripping as described previously in detail, a selector piston (Fig. 17) is required to operate the selective tripping. It is possible that some applications may require a combination of all of these features except that either (3) or (4) will be used but not both at the same time. A valve including a throttle and by-pass, a selector piston, and the fast 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. 8 to 10, 8A to 9B.

Certain illustration liberties were taken in Figs. 8A, 9A and 9B 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 magnet valve is double acting i.e.: when the inlet seat is closed, the exhaust ports are open; see pilot magnet valve assembly on page 14. 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 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.

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.

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

For control valves employing the slow exhaust, the air passage for the control air connecting the inlet and exhaust valves is omitted.

The slow exhaust valve consists of a poppet type valve, with a metal to metal seat, spring biased to the open position. The adjustable spring bias is set so that the valve will be forced closed whenever the air pressure in the cylinder which acts on top of the valve seat is at or above the actual minimum operating pressure.

The arrangement of the by-pass and throttle as illustrated in Figs. 8A, 9A and 9B 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 14-15. 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.

Opening the small pilot valve either manually by means of the pushbutton on top of the pilot valve coil, or by energizing the coil, admits high pressure air above the inlet and exhaust valve pistons simultaneously. The inlet valve piston is forced down opening the inlet valve and the air from the storage reservoir is free to flow via the by-pass port into the main cylinder. The exhaust valve is held closed by the preponderance of force created downwardly on the valve by virtue of the control air acting on the larger area of the piston versus the closing air acting on the exposed surface of the valve seat (Fig. 9). After the mechanism has traveled sufficiently for the rod end roller to engage the throttle cam plate, the throttle piston is opened (Figs. 9B-15).

Closing the pilot valve by either releasing the manual pushbutton or de-energizing the pilot valve coil opens up the exhaust ports and closes off the inlet seat. This allows the control air above the inlet and exhaust pistons to exhaust down to atmospheric pressure which causes two actions to take place practically simultaneously:

(1) The inlet valve closes under the combined action of the valve spring and the pressure differential across the valve seat, and

(2) The exhaust valve opens due to the shift in preponderance of force upwardly on the valve, since the only force now is created by the closing air acting on the exposed surface of the valve seat. (Fig. 10). 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.

For control valves employing the slow exhaust, the function described above is essentially correct except that the exhaust valve closes as soon as the air admitted to the cylinder builds up to a pressure sufficient to overcome the spring bias, and remains closed following the closing of the inlet valve until the air leakage out of the cylinder drops the pressure sufficiently to permit the spring bias to overcome the air pressure on the top side of the valve seat.

The selector piston shown in Figs. 16-17 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 slow exhaust assembly shown in Fig. 8B, is used in place of the piston and valve seat of the fast exhaust. Due to differences in machining of the control valve body, the two types of exhaust are not interchangeable without replacing the complete control valve assembly.

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 Diagram 53-C-4000, 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

cross-head 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.

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.

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.

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 53-C-4000 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.

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.

Reclosing Adjustment Switch

Reference diagram 53-C-4000. 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.

Latch Check Switch

Reference diagram 53-C-4000. 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, a 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

Three heaters are provided in the mechanism 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 two 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. *This 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.

Caution

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 III—OPERATION

Closing

Starting with the mechanism and breaker in the open position (Fig. 3) with the trip-free trigger engaged to restrain the trip-free lever, closing the control switch energizes the closing relay "X" and inturn the pilot valve coil "MAG", reference 53-C-4000, which admits compressed air stored in the reservoir to the closing cylinder. The trip-free trigger by restraining the trip free lever maintains the trust link and closing lever in the relative position shown in Fig. 3 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. 4), 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. 4), 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. 3) 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. 4) 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. 5). 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. 5 to the open position Fig. 3 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. 3. 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. 4, 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 IV—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.

Page 15 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.

For applications where the fast exhaust valve is used and the normal operating pressure is 250 psi or above, an exhaust tube connected to the under side of the exhaust valve and passing through the bottom of the housing is used to carry the exhausted air safely to the outside of the housing. For lower operating pressures, the air is exhausted directly out of the exhaust valve into the housing. In either case, personnel should keep clear of the area immediately below the exhaust 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 nonferrous alloy with corrosion resistant stellite inserts at the latching points. The engaging surfaces of the latches and triggers may be polished with fine

* Data contained herein, prepared especially for Westinghouse Electric Corp. Reprinted from Westinghouse Air Brake Instruction 9352-1, 3 and Repair Parts List 9352-1A1, 9402-3.10B1 and 9402-3.11B1.

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 (M9921-4) 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 over-travel 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 1½" x 1½" 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 while 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.

The needle bearings are packed with Westinghouse Grease Style 1802 395 and should not require repacking more often than every 18 months.

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

Since the acme threads on the lower end of the piston rod and the mating threads in the jack body are very heavily loaded on some of the largest breakers, a special heavy duty grease S# 1649 901 is supplied for use with the jack. It is recommended that the threads be relubricated liberally with this grease after a maximum of 4 closing and opening operations.

AIR LEAKAGES

Overall

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 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 port. Leakage here is generally due to dirt particles on the valve seat. "Cracking" the valve several times by pressing on the pushbutton momentarily will generally serve to dislodge the dirt and make the valve seal properly. However if this proves unsuccessful, refer to instructions on pilot magnet valve.

Checking for leaks past the main inlet valve can be accomplished easily 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 underside of the valve body. For valve assemblies using the "slow exhaust", it is necessary to first remove the exhaust assembly from the valve body and either close off the exhaust by tightening up the nut on the lower end of the valve stem and then reassembling the exhaust assembly in the valve body or otherwise sealing of 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.

PILOT MAGNET VALVE

General Description

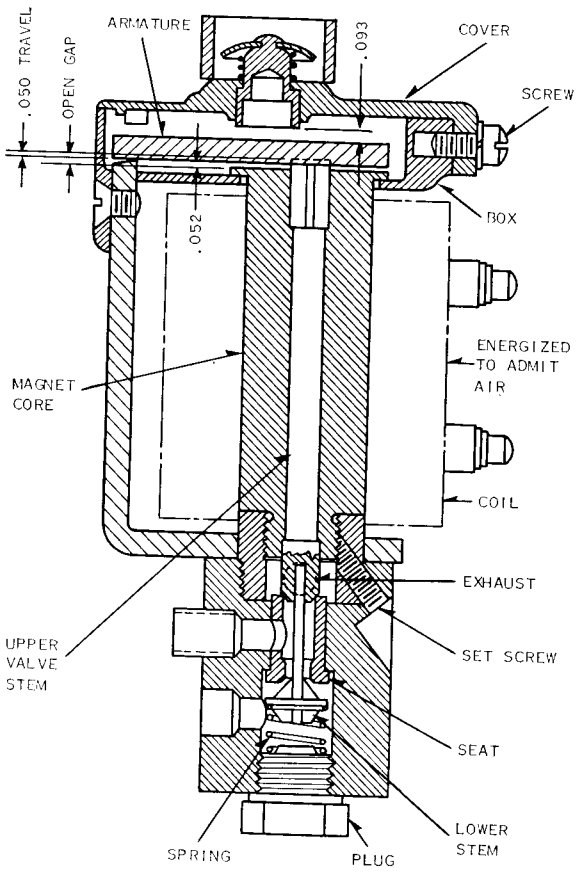
Referring to Pilot Valve Assembly, when the pilot valve coil is energized, the armature depresses stem down which in turn pushes lower stem to admit air from the storage reservoir through a small port (lower valve seat). At the same time, the lower end of stem seats on the upper valve seat to prevent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

Repair

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

Inlet Valve Leakage

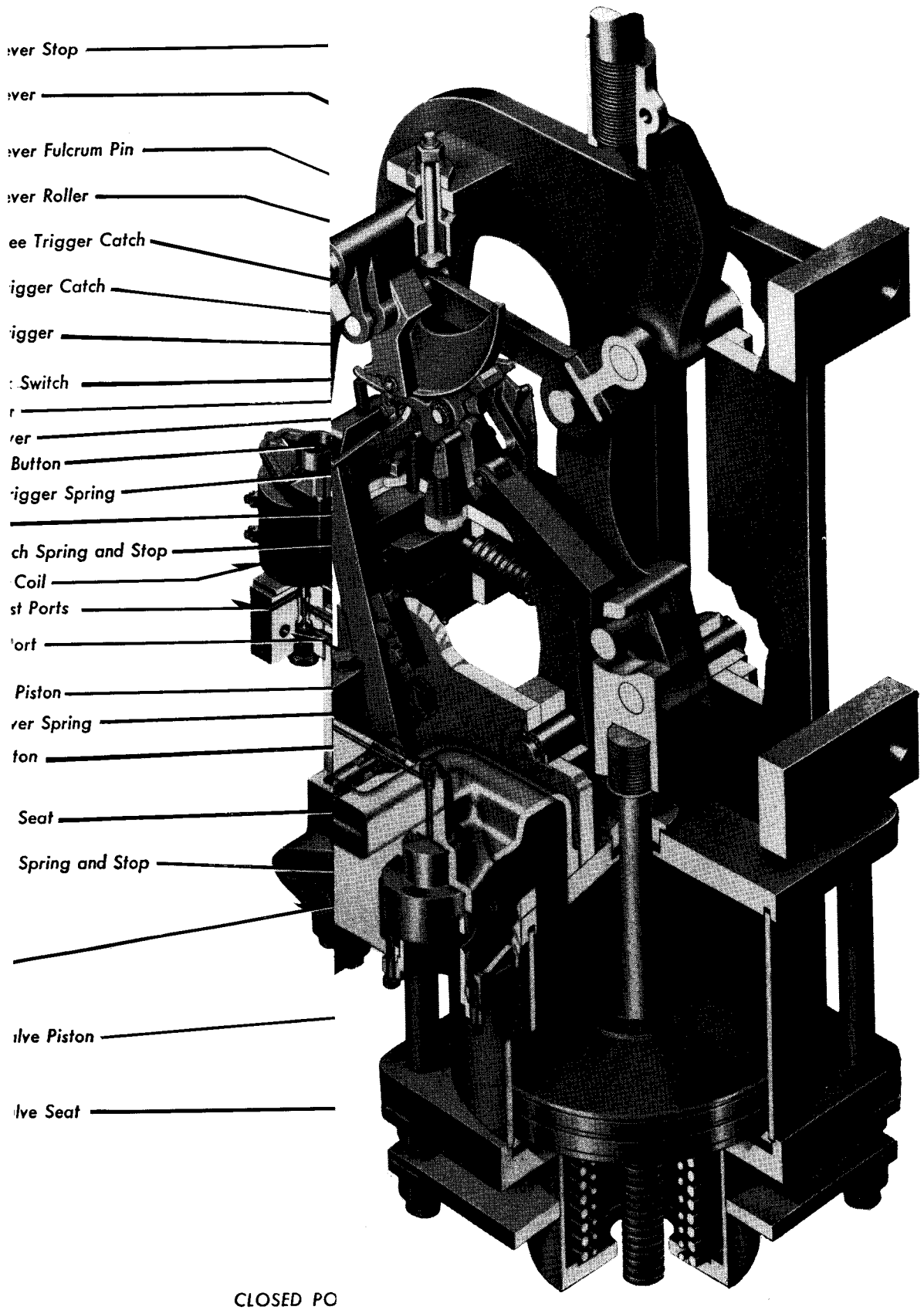
Occasionally a pilot valve may "blow" (that is, give out a hissing sound) due to leakage of air; if this occurs when the magnet coil is de-energized and the air blows out the exhaust



PILOT MAGNET VALVE ASSEMBLY

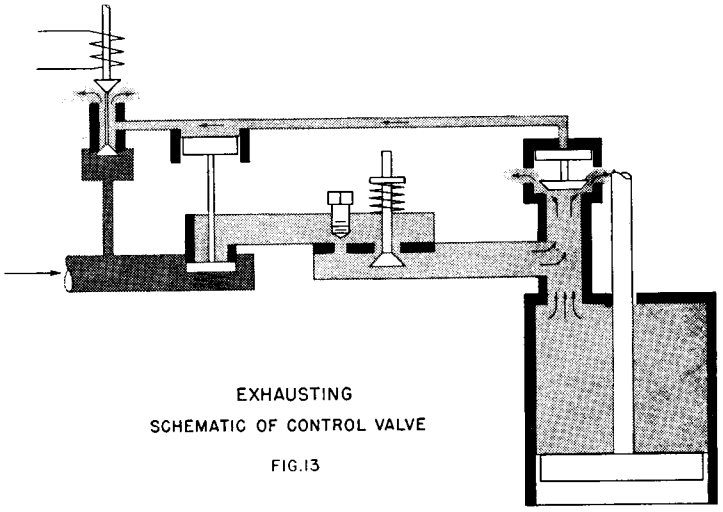
port, it is an indication that the lower (inlet) valve is not seating properly. This trouble is caused generally by the presence of a little dirt on the valve seat and in most cases can be relieved by popping the valve quickly with the manual button several times. If the blowing persists, shut off the hand valve in the supply line from the storage reservoir and unscrew the plug at the bottom of the magnet valve. Carefully lower the plug straight down, so that the spring and lower valve stem drop down with it. Wipe the valve stem perfectly clean and also clean the valve seat with a small stick and piece of cloth. It is also helpful to smooth the valve seat by spinning the lower stem on its seat with a screw driver several times. The upper stem should be in place to act as a guide. Use machine oil on the seat to prevent scoring.

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



CLOSED PO

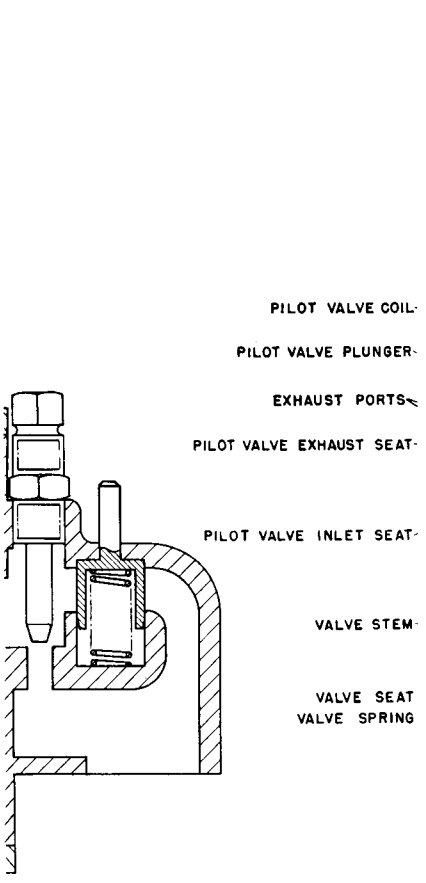
FIG.



EXHAUSTING

SCHEMATIC OF CONTROL VALVE

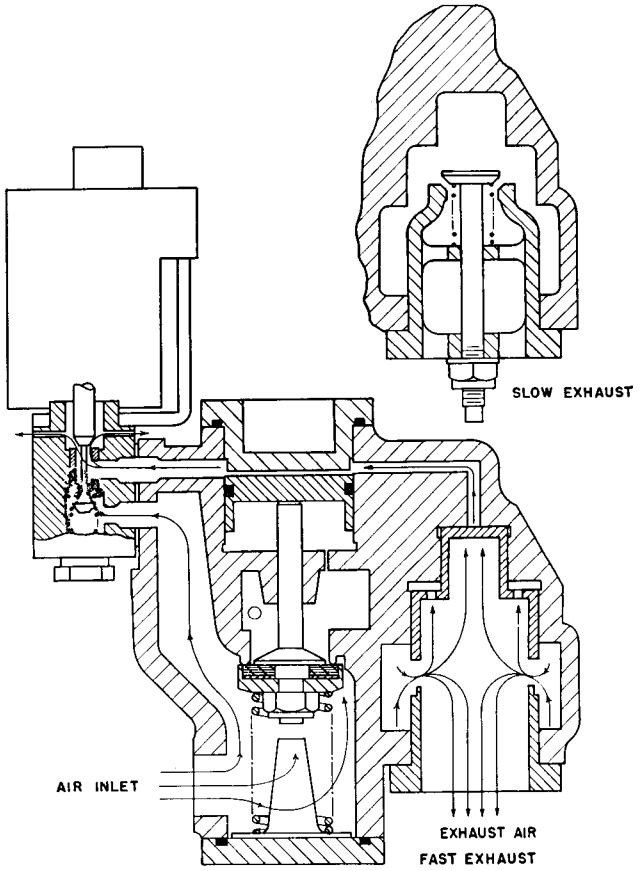
FIG.13



ED

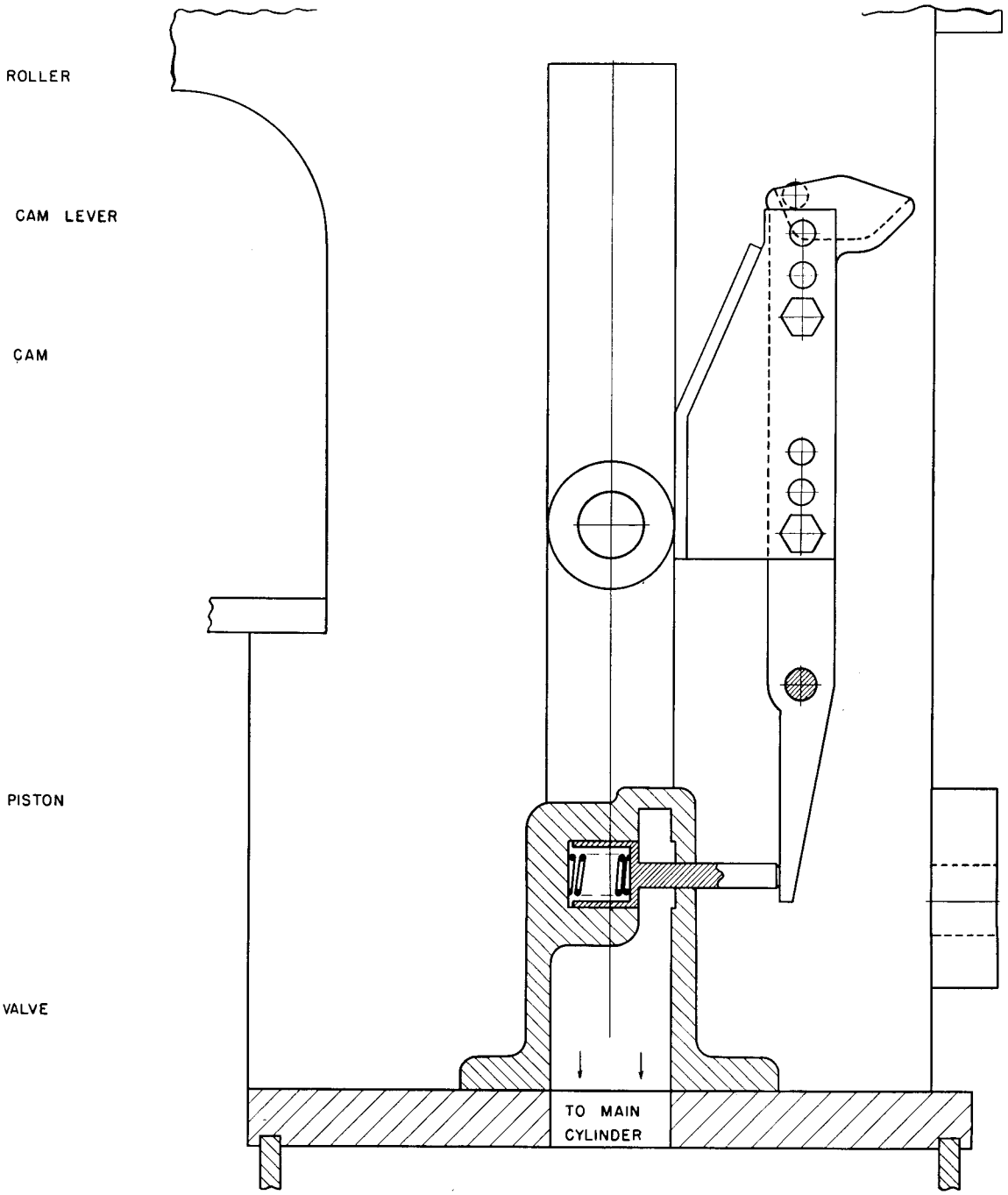
FULL OPEN

-A



EXHAUSTING

FIG.10



MECHANISM CLOSED-THROTTLE OPEN

FIG 15

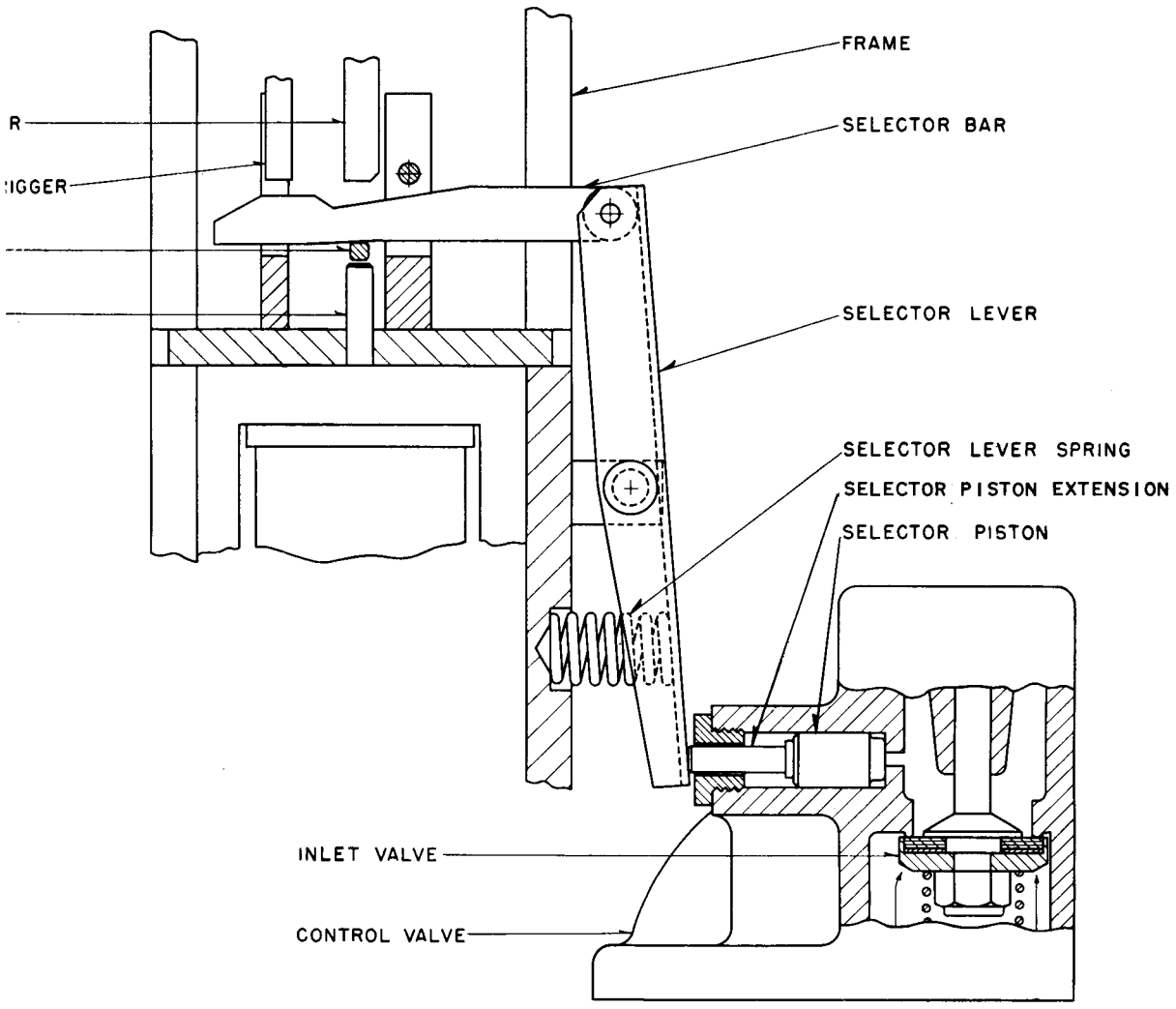
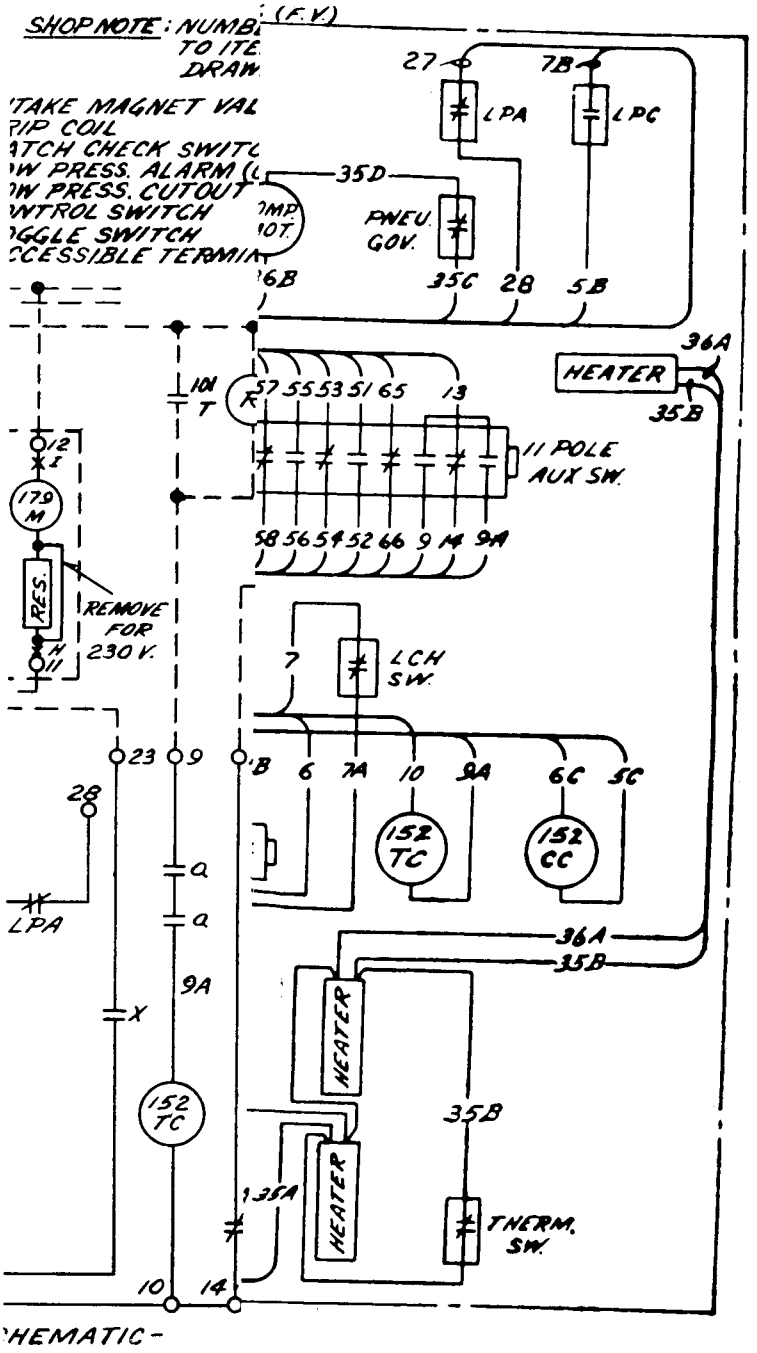

FRAME
R
SELECTOR BAR
IGGER
SELECTOR LEVER
SELECTOR LEVER SPRING
SELECTOR PISTON EXTENSION
SELECTOR PISTON
INLET VALVE
CONTROL VALVE

FIG.17


SHOP NOTE: NUMBI (F.V.)
TO ITE
DRAW
TAKE MAGNET VAL
PIP COIL
ATCH CHECK SWITC
W PRESS. ALARM (L
W PRESS. CUTOUT
NTROL SWITCH
GGLE SWITCH
CCESSIBLE TERMIN
27
7B
LPA
LPC
35D
PNEU. GOV.
35C
28
5B
6B
36A
HEATER
35B
101 T
57 55 53 51 65 13
11 POLE AUX SW.
58 56 54 52 66 9 14 9A
12 1
179 M
RES.
REMOVE FOR 230 V.
H 11
7
LCH SW.
23
9
28
8 6 7A 10 9A 6C 5C
152 TC
152 CC
a
a
LPA
9A
X
36A
35B
HEATER
35B
135A
HEATER
THERM. SW.
10
14
SCHEMATIC-

Exhaust Valve Leakage

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

(a) Dirt on valve seat.
(b) Dirt under magnet armature.
(c) Low voltage applied to coil.
(d) Upper valve stem worn down so that armature strikes the core before valve seats.

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

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

Grinding Valves

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

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

Replacing Coil

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

Type "G" Air Compressor Units

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

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

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

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

Air Compressor

The single stage, single cylinder air compressor is lubricated by the controlled splash system and is air cooled. Deep cast circular fins on the air cylinder provide a large radiating surface, and a six-blade fan flywheel maintains a constant air stream through the fins. The crankcase and cylinder is a single casting with a side cover providing access to the interior of the crankcase, and an end cover which serves as a bearing support for one end of the crankshaft. The crankshaft operates in two large ball bearings, and the connecting rod bearing is of the adjustable split type. The piston is fitted with two compression rings and one oil ring. The cylinder head is finned for efficient cooling and incorporates two valve units, each of which is accessible upon removal of a cap nut and cage.

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

Before starting the compressor, fill the crankcase with high grade automobile engine oil—

S.A.E.-20 for temperatures above freezing or S.A.E.-20W for temperatures below freezing. Excessive carbonization will not occur if the proper grade of oil is used and if the limits of operation applying to the particular outfit are not exceeded.

Approximate Oil Capacity.....1 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, add sufficient oil to raise the level to this opening and replace plug. Never remove the oil plug while the compressor is operating.

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

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

The cap of the check valve (which is a part of the unloading system) in the discharge line should be removed and the valve and its seat cleaned periodically. If the check valve leaks, the valve and valve seat should be lapped.

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

The oil strainer 4 in the crankcase should be taken out and cleaned whenever the cover is removed. If sediment or sludge is found in the bottom of the crankcase, it should be thoroughly cleaned out.

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

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

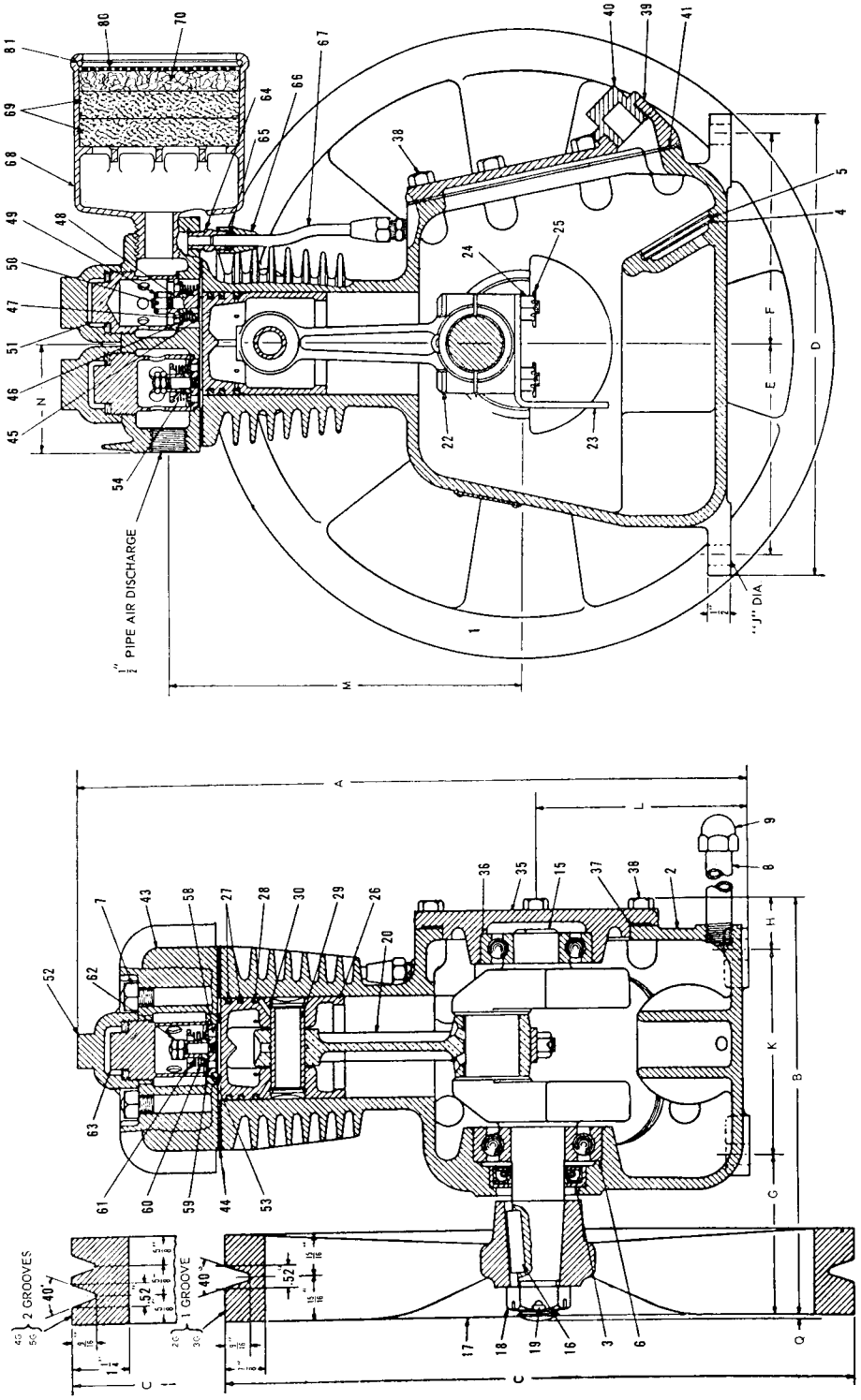
The belt should be maintained tight enough to prevent excessive slippage, but not tight enough to place undue strain on the motor and compressor bearings which will result in excessive heating of these bearings and increase the power required.

Air Compressor Operation

On the down stroke of piston 26, air passes through the intake filter into the chamber above the inlet valve 47 and past this valve into the cylinder. Partial vacuum created in the cylinder and underneath the disc valve by the downward stroke of the piston permits atmospheric pressure above the inlet valve to overcome the resistance of spring 46 under the valve and force the valve from its seat. Air thus flows into the cylinder until pressures above and below the valve are about equal when the inlet valve is closed by its spring.

On the upward stroke of the piston, the air in the cylinder is compressed, lifting discharge valve 59 against the resistance of its spring 60 (plus tank air pressure) and passing through the discharge pipe to the storage tank. Any accumulation of pressure in the crankcase is prevented by the vent tube 67 which connects to the air inlet.

An oil dipper attached to the connecting rod operates through an oil channel or trough cast in the bottom of the crankcase to direct the splash upward and lubricate the moving parts. The oil level in the trough is maintained by oil running down the walls of the crankcase and passing into the trough through perforated plate 4 and a drilled choke. The perforated plate serves as an oil strainer to prevent the passage into the oil trough of dirt or sediment that may be present in the bottom of the crankcase.


1" PIPE AIR DISCHARGE
"J" DIA
2 GROOVES
1 GROOVE
40°
.52

REPAIR PARTS LIST (2GV)

2-G AIR COMPRESSORS WITH BRASS CYLINDER HEAD, STAINLESS STEEL VALVES AND PLUGS SUPPLIED WITH AA10-60G UNITS

PIECE NO.	DESCRIPTION
188815	2-GV Compressor Unit, Complete
188813	Compressor Portion (See Repair Parts List Page 17)
188911	Reservoir
7978	3/8" x 1" Cap Screw (4 req'd)
17173	3/8" Lock Washer (4 req'd)
104470	3/8" x 5/8" Cap Screw (4 req'd)
16677	3/8" Washer (4 req'd)
17173	3/8" Lock Washer (4 req'd)
187791	Check Valve
519973	1/2" Disc Type Check Valve
516685	Inspection Plug Gasket
16311	1/2" x 3" Nipple
41891	1/2" Street Elbow (2 req'd)
86921	1/2" Reinforced Compression Union Stud for 1/2" O.D. Tube (2 req'd)
187533	1/2" O.D. x 7/16" I.D. Discharge Tube
188708	Syphon Drain Fitting, Complete (Includes Pc. 188709 and Pc. 188710)
188709	Syphon Drain Fitting
188710	1/4" I.P.S. Copper Tube 14 1/8" Long
53922	1/4" x 1 1/4" Nipple
P80062	1/4" Angle Valve
†186044	Motor Pulley
†181295	5/16" x 3/8" Cup Pt. Set Screw
†187330	"A" Section Belt 57" Pitch Length

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

PIECE NO.	REF. NO.	DESCRIPTION
187905		Air Compressor, Complete, with Single-groove Pulley and 5 1/2" Nipple for Drain
188612		Air Compressor, Complete, with Two-groove Pulley and 8 1/8" Nipple for Drain
188813		Air Compressor, Complete, with Single-groove Pulley and 8 1/8" Nipple for Drain
183645	2	Cylinder and Crankcase (Includes 3, 4, 5, 6 and four of 7)
186068	3	Oil Retainer
183647	4	Oil Strainer
183648	5	Oil Strainer Retaining Ring
141552	6	Large Ball Bearing
183144	7	Cylinder Head Stud and Nut (4 req'd)
133122	8	1/4" x 5 1/2" Nipple for Drain (For Pc. No. 187905)
541975	8	1/4" x 8 1/8" Nipple for Drain (For Pc. Nos. 188612 and 188813)

PIECE NO.	REF. NO.	DESCRIPTION
184379	9	1/4" Oil Drain Cap
183649	15	Crankshaft
530032	16	Key
183668	17	Flywheel Pulley (Single-groove) (For Pc. Nos. 187905 and 188813)
184780	17	Flywheel Pulley (Two-groove) (For Pc. No. 188612)
92751	18	7/8" Jam Nut
183468	19	Lock Washer
183653	20	Connecting Rod (Includes 23, two of 22, 24 and Pc. 542616)
183655	22	Connecting Rod Bolt (2 req'd)
183656	23	Connecting Rod Dipper
73757	24	5/16" Connecting Rod Nut (2 req'd)
542616		5/16" Connecting Rod Lock Nut (2 req'd)
183658		Piston, Complete (Includes 26, 28 and two of 27)
183659	26	Piston, without Rings
183660	27	Compression Ring (2 req'd)
183661	28	Oil Ring
183662	29	Wrist Pin
183663	30	Wrist Pin Retaining Ring (2 req'd)
183651	35	End Cover
141551	36	Small Ball Bearing
183652	37	End Cover Gasket
17116	38	End Cover Cap Screw (6 req'd)
11773	38	Side Cover Cap Screw (8 req'd)
183664	39	Side Cover
529209	40	Cap Nut
183665	41	Side Cover Gasket
187907		Cylinder Head, Complete
187901	43	Cylinder Head
183667	44	Cylinder Head Gasket
187458		Inlet Valve, Complete (Includes 45, 46, 47, 48, 49, 50 and 54)
187456	45	Inlet Valve Spring Seat
184549	46	Inlet Valve Spring
181782	47	Inlet Valve
187457	48	Inlet Valve Seat
523166	49	Inlet Valve Nut
521200	50	1/16" x 1/2" Cotter
187449	51	Inlet Valve Plug
187447	52	Valve Cap (2 req'd)
99720	53	Valve Gasket (2 req'd)
187455		Discharge Valve, Complete (Includes 54, 58, 59, 60, 61 and two of 62)
187451	54	Inlet and Discharge Valve Guide (2 req'd)
187454	58	Discharge Valve Seat
181782	59	Discharge Valve
184549	60	Discharge Valve Spring
187450	61	Discharge Valve Spring Seat
521440	62	Discharge Valve Nut (2 req'd)
187448	63	Discharge Valve Plug
504411		1/8" Compression Fitting, Complete (Includes 64, 65 and 66) (2 req'd)
504447	64	Union Stud (2 req'd)
88976	65	Union Sleeve (2 req'd)
89098	66	Union Nut (2 req'd)
186069	67	Breather Tube
183685		1/2" M-1 Intake Filter

PIECE NO.	REF. NO.	DESCRIPTION
183686	68	Body
183687	69	Felt Washers (2 Req'd)
1/8 oz.	70	Curled Hair
183688	80	Strainer Plate
183689	81	Retaining Ring
185124		Cleaning Instruction Label

REPAIR OVERSIZE PISTONS AND PISTON RINGS

REF. NO.	DESCRIPTION	PIECE NUMBERS		
		.010" Oversize	.020" Oversize	.030" Oversize
	Piston, Complete	185452	185453	185454
26	Piston without Rings	185329	185330	185331
27	Compression Ring	184093	184095	185468
28	Oil Ring	184097	184099	185469

Prices will be quoted upon application.

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

TYPE "Y" AIR COMPRESSOR UNITS

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

Proper rotation of the compressor is indicated by the arrow on the flywheel. On three phase installations, the direction of rotation should be checked regularly.

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

Approximate Oil Capacity.....1¼ Quarts

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

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

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

The unloader in this compressor is controlled by oil pressure, and the failure of this device to function will result from lack of proper oil pressure. In such event investigate the oil

level, strainer in base of pump, ball check in the plunger and pneumatic cushion port plug 65. If these parts are functioning properly and the oil supply is normal, failure to compress air may be due to the unloader valve ball check not seating because of dirt on the ball check or seat, thereby allowing air from the high pressure cylinder to escape through the crankcase.

To inspect the unloader device parts, drain the oil, disconnect the tubing to the unloader valve in the end cover and then remove the end cover. The oil pump can then be pulled out of its bearing and the strainer released by removing a snap ring. If sediment or sludge is found in crankcase, clean out, since it will interfere with oil pump operation.

Relief ball check 70 in the crankshaft counter-weight should also be inspected, since leakage past the ball check will result in reduced oil pressure. Remove the valve cap 71 and if dirt is found on the ball or seat, clean thoroughly. Also see that ports in the valve cap and the opening in the counter-weight are open.

The syphon cock at the side of the tank should be opened at least once each week to drain accumulated water resulting from condensation. Leave the drain cock open only as long as solid water runs, then close tightly.

The Safety valve ordinarily requires no attention. It is set to blow off at 10% to 25% above the working pressure of the tank. 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 very slowly by means of the cross bar on its stem, with the compressor running, usually clean the valve seat and restores the proper seal. If not, the safety valve should be dis-assembled and both the valve and the seat wiped clean. If the seat has not been cut, a little oil should be applied; if cut, the valve should be reseated.

The belts 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 belt replacement is necessary, replace all belts with a matched set.

The two stage type YC air compressor units are air cooled and pressure lubricated. Deep cast circular fins on the cylinders provide a large radiating surface, and a fan flywheel maintains a constant cooling air stream through the fins.

Separately cast crankcase, cylinders and cylinder heads provide ready access to any part of the compressor. A counter-balanced crankshaft operates in two large ball bearings. Both connecting rods are operated by the single throw crankshaft. Each piston has two compression rings and one oil ring. Each cylinder head has two valve units, each of which is accessible upon the removal of a cap nut and cage.

The two stage compressor has two different size cylinders, a large low pressure cylinder and a smaller high pressure cylinder. The low pressure cylinder, which is fitted with an intake filter, performs the first stage of compression and discharges through an intercooler into the high pressure cylinder where the second stage of compression is performed.

AIR COMPRESSOR OPERATION

On the down stroke of the low pressure piston (large cylinder), air passes through the intake filter 156 into the chamber above the inlet valve 107 and past this valve into the cylinder. Partial vacuum created in the cylinder underneath the disc valve by the downward stroke of the piston 13 permits atmospheric pressure above the inlet valve to overcome the resistance of spring 108 under the valve and force the valve from its seat. Air thus flows into the cylinder until pressures above and below valve are about equal when the inlet valve is closed by its spring.

On the upward stroke of the piston, the air in the cylinder is compressed, lifting discharge valve 111 against the resistance of its spring 112 and passing through the intercooler pipe to the high pressure cylinder. The discharge valve is seated by its spring when pressure above the valve becomes almost equal to that underneath.

The cycle of operation described for the low pressure cylinder is repeated in the high pressure cylinder, increasing pressure from an intermediate value to the final stage or tank pressure.

Accumulation of pressure in the crankcase is prevented by a crankcase vent 94 which connects to the air intake.

Interlocked with the oil supply, a starting unloading feature provides that compression does not begin until the motor has reached its full speed. The high pressure cylinder has a connection 61 to the unloader valve in the end

cover. When the compressor is not running, or oil pressure is low (on account of insufficient oil or low compressor speed), connection 61 between the high pressure cylinder and the crankcase vent is opened by the unloader valve 49 as a by-pass to unload the compressor and prevent the compression of air. With the compressor running and oil pressure normal, the oil pump unloader piston 74 moves the unloader lever 47 to a position where the unloader ball check valve 49 is seated. This closes the connection between the high pressure cylinder and the crankcase vent, thereby loading the compressor which operates to compress the air as already described.

The ball check in the unloader pipe connection to the cylinder prevents backflow from this pipe during the intake stroke, thereby increasing efficiency of the compressor by eliminating during each operating cycle the filling and emptying of the unloader pipe.

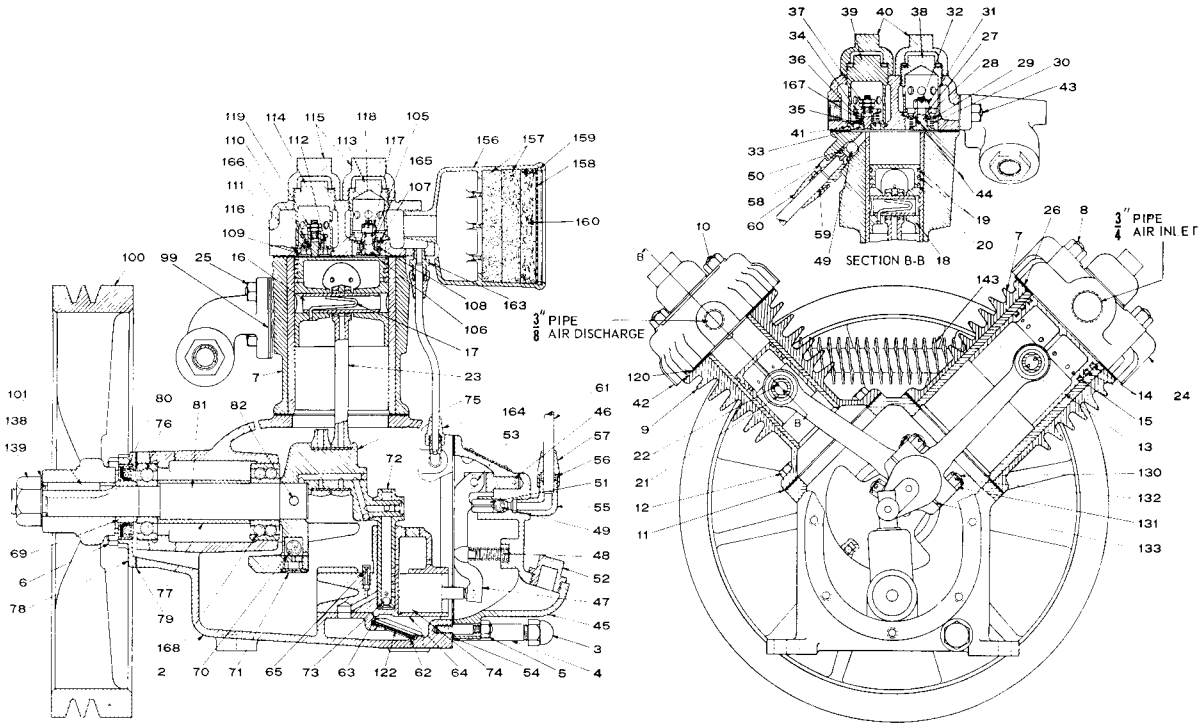
The oil pump 64, which is of the piston type, oscillates in a bearing (in the bottom of the crankcase) that is almost entirely submerged in an oil bath. The pump is driven directly from the crankshaft. Oil enters the pump through a strainer and on the down stroke of plunger 72 is forced into the plunger (past ball check 73) up to the connecting rod bearings thence through the crankshaft and counter-weight to the relief ball check 70. Pneumatic cushion port plug 65 admits air to the oil plunger cylinder on the up stroke, which provides a cushioning effect on the succeeding down stroke of the plunger. From the connecting rod bearings the oil is forced up through the drilled connecting rods to the wrist pin bearings. The cylinder walls are lubricated by oil mist sprayed from the connecting rod bearings. When oil line pressure exceeds the set maximum for any speed, it unseats the relief ball check valve and allows oil to pass out to the crankcase through an opening in the counter weight. Oil thus deposited in a trough on the back wall of the crankcase supplies the two main bearings. The relief ball check valve regulates oil pressure in proportion to crankshaft speed, maintaining an even rate of oil circulation. The ball check is held to its seat by centrifugal force and, as this force varies with the speed, oil line pressure varies accordingly.

REPAIR PARTS LIST (1-YCV)

1-YC AIR COMPRESSOR WITH BRASS HIGH PRESSURE CYLINDER HEAD, STAINLESS STEEL VALVES AND PLUGS SUPPLIED WITH AA10-60Y UNITS

PIECE NO.	DESCRIPTION
188912	1-YCV Compressor Unit, Complete
187915	Compressor Portion (See Repair Parts List Page 22)
188911	Reservoir
24286	3/8" x 7/8" Cap Screw (4 req'd)
17173	3/8" Lock Washer (4 req'd)
181293	3/8" x 1 1/2" Carriage Bolt and Nut (4 req'd)
17173	3/8" Lock Washer (4 req'd)
86922	3/8" Reinforced Compression Stud for 1/2" O.D. Tube
86921	1/2" Reinforced Compression Stud for 1/2" O.D. Tube
188913	1/2" O.D. x 7/16" I.D. Discharge Tube
53922	1/4" x 1 1/4" Long Nipple
P80062	1/4" Angle Valve
188708	Syphon Drain Fitting, Complete (Includes Pc. 188709 and Pc. 188710)
188709	Syphon Drain Fitting
188710	1/4" I.P.S. Copper Tube 14 1/8" Long
†187654	"A" Section Belt (2 req'd)
†186717	Motor Pulley
†181295	5/16" x 3/8" Cup Pt. Set Screw
516685	Inspection Plug Gasket

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



PIECE NO.	REF. NO.	DESCRIPTION
187915		1-YC Air Compressor, Complete
187916		1-YC Air Compressor, Complete, less Air Filter
183859	2	Crankcase (includes seven of 5)
184379	3	Oil Drain Cap
129445	4	1/4" x 3 1/4" Nipple for Drain
57683	5	3/8" x 1 5/8" End Cover Stud and Nut (7 req'd)
3210	6	3/8" x 1 1/4" Shaft End Flange Cap Screw (4 req'd)
183349	7	L.P. Cylinder (includes four of 8)
183144	8	3/8" x 2 11/16" L.P. Cylinder Head Stud and Nut (4 req'd)
183346	9	H.P. Cylinder (includes four of 10)
183144	10	3/8" x 2 11/16" H.P. Cylinder Head Stud and Nut (4 req'd)
181853	11	Cylinder Gasket (2 req'd)
16239	12	3/8" x 3/4" Cylinder Cap Screw (8 req'd)
181285		L.P. Piston, Complete (includes 13, 15 and two of 14)
181840	13	L.P. Piston, without Rings
181841	14	L.P. Piston Ring (2 req'd)
181842	15	L.P. Oil Ring
181845	16	L.P. Piston Wrist Pin
181847	17	L.P. Piston Wrist Pin Lock Wire
181286		H.P. Piston, complete (includes 18, 20 and two of 19)
181850	18	H.P. Piston, without Rings
181843	19	H.P. Piston Ring (2 req'd)
181844	20	H.P. Oil Ring
181846	21	H.P. Piston Wrist Pin
181849	22	H.P. Piston Wrist Pin Lock Wire
183488	23	Connecting Rod (includes two of 130, 131 and Pc. 542616) (2 req'd)

PIECE NO.	REF. NO.	DESCRIPTION
187566		L.P. Cylinder Head, complete
186724	24	L.P. Cylinder Head (includes two of 25)
85476	25	3/8" x 1 1/4" Intercooler Stud and Nut (2 req'd)
181839	26	L.P. Cylinder Head Gasket
187458		H.P. Inlet Valve, complete (includes 27, 28, 29, 30, 31, 32, and 44)
187457	27	H.P. Inlet Valve Seat
187456	28	H.P. Inlet Valve Spring Seat
181782	29	H.P. Inlet Valve
184549	30	H.P. Inlet Valve Spring
523166	31	H.P. Inlet Valve Nut
521200	32	1/16" x 1/2" Cotter
187455		H.P. Discharge Valve, complete (incl. 33, 34, 35, 36, 167 & two of 37)
187454	33	H.P. Discharge Valve Seat
187450	34	H.P. Discharge Valve Spring Seat
181782	35	H.P. Discharge Valve
184549	36	H.P. Discharge Valve Spring
521440	37	H.P. Discharge Valve Nut (2 req'd)
187449	38	H.P. Inlet Valve Plug
187448	39	H.P. Discharge Valve Plug
187447	40	H.P. Inlet and Discharge Valve Cap (2 req'd)
99720	41	H.P. Inlet and Discharge Valve Seat Gasket (2 req'd)
187460		H.P. Cylinder Head, complete
188932	42	H.P. Cylinder Head (includes two of 43)
85476	43	3/8" x 1 1/4" Intercooler Stud and Nut (2 req'd)
187451	44	H.P. Inlet Valve Guide
181857	45	End Cover (includes 46)
181794	46	Unloader Operating Lever Support
181795	47	Unloader Operating Lever, complete
18469	48	Unloader Operating Lever Spring
93765	49	3/8" Ball Check for Unloader Valve (2 req'd)
181797	50	Unloader Ball Check Spring
181827	51	Unloader Ball Check Plunger
529209	52	Cap Nut
90286	53	Unloader Operating Lever Hinge Pin with Cotter
181858	54	End Cover Gasket
87205		1/4" Compression Elbow for 3/8" O.D. Copper Tube, complete (incl. 55, 56 & 57)
87195	55	Elbow
86828	56	Sleeve
86827	57	Nut
183996		1/4" Compression Type Unloader top Fitting for 3/8" O.D. Copper Tube, complete (includes 58, 59 and 60)
183994	58	Unloader Stop Fitting Body
86828	59	Sleeve
86827	60	Nut
181292	61	Copper Tube (Unloader Pipe Connection)
184874	62	Oil Strainer Washer
517441	63	Oil Strainer Snap Ring
183556	64	Oil Pump Body
181800	65	Pneumatic Cushion Port Plug
183471	69	Sleeve for Oil Seal
179192	70	9/16" Ball (Oil Control Valve)
181862	71	Oil Control Valve Cap

PIECE NO.	REF. NO.	DESCRIPTION
181856	72	Oil Pump Plunger, complete (includes 73)
133064	73	1/4" Ball Check
185283	74	Oil Pump Unloader Piston
184740	75	Crank Shaft, complete
141551	76	Crank Shaft Ball Bearing
184741	77	Ball Bearing Spacing Tube
181864	78	Shaft End Flange
181865	79	Shaft End Flange Gasket
186039	80	Oil Seal
186900	94	Crankcase Vent Pipe Connection
181869	99	Intercooler Gasket (2 req'd)
182799	100	Flywheel Pulley
183459	101	Key for Pulley
187458		L.P. Inlet Valve, complete (incl. 105, 106, 107, 108, 117, 118 & 165)
187457	105	L.P. Inlet Valve Seat
187456	106	L.P. Inlet Valve Spring Seat
181782	107	L.P. Inlet Valve
184549	108	L.P. Inlet Valve Spring
187455		L.P. Discharge Valve, complete (includes 109, 110, 111, 112, 166 and two of 119)
187454	109	L.P. Discharge Valve Seat
187450	110	L.P. Discharge Valve Spring Seat
181782	111	L.P. Discharge Valve
184549	112	L.P. Discharge Valve Spring
187449	113	L.P. Inlet Valve P ug
187448	114	L.P. Discharge Valve Plug
187447	115	L.P. Inlet and Discharge Valve Cap (2 req'd)
99720	116	L.P. Inlet and Discharge Valve Seat Gasket (2 req'd)
523166	117	L.P. Inlet Valve Nut
521200	118	1/16" x 1/2" Cotter
521440	119	L.P. Discharge Valve Nut (2 req'd)
181837	120	H.P. Cylinder Head Gasket
525105	122	Oil Strainer
183462	130	Connecting Rod Stud (4 req'd)
73757	131	5/16" Connecting Rod Nut (4 req'd)
542616		5/16" Connecting Rod Lock Nut (4 req'd)
183468	138	Lock Washer
8183	139	Crankshaft Nut
181872	143	Intercooler (includes Pc. 97588)
183811		3/4" M-2 Intake Filter
183812	156	Body
183813	157	Felt Washer (2 req'd)
183814	158	Strainer Plate
183815	159	Retaining Ring
1/4 oz.	160	Curled Hair
185124		Cleaning Instruction Label
504411	163	Compression Stud Fitting, Complete
504411	164	Compression Stud Fitting, Complete
187451	165	L.P. Inlet Valve Guide
187451	166	L.P. Discharge Valve Guide
187451	167	H.P. Discharge Valve Guide
181038	168	Crank Shaft Double Ball Bearing
97588		1/4" Pipe Plug

REPAIR OVERSIZE PISTONS AND PISTON RINGS

REF. NO.	DESCRIPTION	PIECE NUMBERS		
		.010″ Oversize	.020″ Oversize	.030″ Oversize
	L.P. Piston complete (Includes 13, 15, and two of 14)	185439	185440	185441
13	L.P. Piston (Without Rings)	185341	185342	185343
14	L.P. Piston Ring (2 req'd)	184136	184138	185294
15	L.P. Oil Ring	184140	184142	185296
	H.P. Piston, complete (Includes 18, 20 and two of 19)	185436	185437	185438
18	H.P. Piston (Without Rings)	185338	185339	185340
19	H.P. Piston Ring (2 req'd)	184144	184146	185298
20	H.P. Oil Ring	184148	184150	185300

Prices will be quoted upon application.

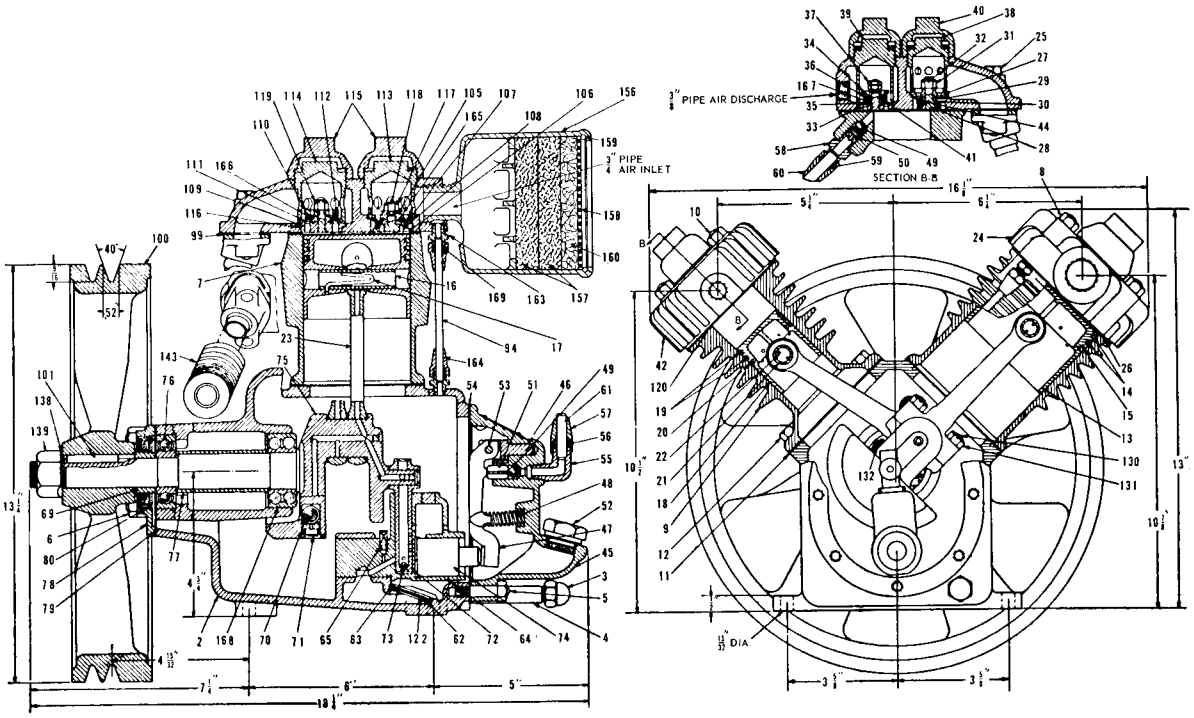
Orders should give SIZE and SERIAL NUMBER of Compressor as well as PIECE NUMBER and NAME or part wanted.

REPAIR PARTS LIST (1-BYCV)

1-BYC AIR COMPRESSOR WITH BRASS HIGH PRESSURE CYLINDER HEAD, STAINLESS STEEL VALVES AND PLUGS SUPPLIED WITH AA10-80Y UNITS

PIECE NO.	DESCRIPTION
P80242	1-BYCV Compressor Unit, Complete
188095	Compressor Portion (See Repair Parts List Page 26)
188553	Reservoir
72754	3/8″ x 1 3/8″ Bolt and Nut (4 req'd)
17173	3/8″ Lock Washer (4 req'd)
86922	3/8″ Reinforced Compression Stud for 1/2″ O.D. Tube
86921	1/2″ Reinforced Compression Stud for 1/2″ O.D. Tube
188564	1/2″ O.D. x 7/16″ I.D. Discharge Tube
186824	3/8″ x 1 1/2″ Carriage Bolt (4 req'd)
2220	3/8″ Hex Nut (4 req'd)
17173	3/8″ Lock Washer (4 req'd)
188708	Syphon Drain Fitting, Complete (Includes Pc. 188709 and Pc. 188710)
188709	Syphon Drain Fitting
188710	1/4″ I.P.S. Copper Tube 14 1/8″ Long
53922	1/4″ x 1 1/4″ Nipple
P80062	1/4″ Angle Valve
†188547	Motor Pulley
†188565	"A" Section Belt 54″ Pitch Length (2 req'd)
†181295	5/16″ x 3/8″ Cup Pt. Set Screw
516685	Inspection Plug Gasket

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



PIECE NO.	REF. NO.	DESCRIPTION
188095		1-BYC Air Compressor, Complete
188096		1-BYC Air Compressor, Complete, less Air Filter
186888	2	Crank Case (Includes four of 6 and seven of 5)
184379	3	Oil Drain Cap
129445	4	$\frac{1}{4}$″ x $3\frac{1}{4}$″ Nipple for Oil Drain
57683	5	$\frac{3}{8}$″ x $1\frac{5}{8}$″ End Cover Stud and Nut (7 req'd)
84909	6	$\frac{3}{8}$″ x $1\frac{1}{2}$″ Shaft End Flange Stud and Nut (4 req'd)
186889	7	L.P. Cylinder (Includes four of 8)
183144	8	$\frac{3}{8}$″ x $2\frac{11}{16}$″ L.P. Cylinder Head Stud and Nut (4 req'd)
187268	9	H.P. Cylinder (Includes four of 10)
183144	10	$\frac{3}{8}$″ x $2\frac{11}{16}$″ H.P. Cylinder Head Stud and Nut (4 req'd)
186817	11	Cylinder Gasket (2 req'd)
16239	12	$\frac{3}{8}$″ x $\frac{3}{4}$″ Cylinder Cap Screw (8 req'd)
‡186793		L.P. Piston, Complete (Includes 13, 15 and two of 14)
‡186775	13	L.P. Piston, without Rings
‡186772	14	L.P. Compression Ring (2 req'd)
‡524731	15	L.P. Oil Ring
181845	16	L.P. Piston Wrist Pin
181847	17	L.P. Piston Wrist Pin Lock Wire
‡186794		H.P. Piston, Complete (Includes 18, 20 and two of 19)
‡186774	18	H.P. Piston, without Rings
‡185503	19	H.P. Compression Ring (2 req'd)
‡186773	20	H.P. Oil Ring
181846	21	H.P. Piston Wrist Pin
181849	22	H.P. Piston Wrist Pin Lock Wire
183488	23	Connecting Rod (Includes two of 130, 131, and 132) (2 req'd)
188097		L.P. Cylinder Head, Complete (Includes 24, 113, 114, Pc. 184556, 184561, two of 115 and 116)

‡ For Oversize Pistons and Rings, see page 30.

PIECE NO.	REF. NO.	DESCRIPTION
186783	24	L.P. Cylinder Head
6897	25	3/8" x 1 7/8" Intercooler Flange Cap Screw (4 req'd)
186784	26	L.P. Cylinder Head Gasket
187458		H.P. Inlet Valve, Complete (Includes 27, 28, 29, 30, 31, 32 and 44)
187457	27	H.P. Inlet Valve Seat
187456	28	H.P. Inlet Valve Spring Seat
181782	29	H.P. Inlet Valve
184549	30	H.P. Inlet Valve Spring
523166	31	H.P. Inlet Valve Nut
521200	32	1/16" x 1/2" Cotter
187455		H.P. Discharge Valve, Complete (Includes 33, 34, 35, 36, 167 and two of 37)
187454	33	H.P. Discharge Valve Seat with Stud
187450	34	H.P. Discharge Valve Spring Seat
181782	35	H.P. Discharge Valve
184549	36	H.P. Discharge Valve Spring
521440	37	H.P. Discharge Valve Nut (2 req'd)
187449	38	H.P. Inlet Valve Plug
187448	39	H.P. Discharge Valve Plug
187447	40	H.P. Valve Cap (2 req'd)
99720	41	H.P. Valve Gasket (2 req'd)
188100		H.P. Cylinder Head, Complete (Includes 38, 39, 42, Pc. 184546, 184551, two of 40 and 41)
188094	42	H.P. Cylinder Head
187451	44	H.P. Inlet Valve Guide
181857	45	End Cover (Includes 46)
181794	46	Unloading Operating Lever Support
181795	47	Unloading Operating Lever
18469	48	Unloading Operating Lever Spring
93765	49	3/8" Ball Check for Unloader Valve (2 req'd)
181797	50	Unloader Ball Check Spring
181827	51	Unloader Ball Check Plunger
529209	52	Oil Filling Cap Nut
90286	53	Unloader Operating Lever Hinge Pin with Cotter
181858	54	End Cover Gasket
87205		1/4" Compression Elbow for 3/8" O.D. Tube, Complete (incl. 55, 56 & 57)
87195	55	1/4" Compression Elbow
86828	56	Elbow Sleeve
86827	57	Elbow Nut
193996		1/4" Compression Type Unloader Stop Fitting for 3/8" O.D. Tube, Complete (Includes 58, 59 and 60)
183994	58	1/4" Unloader Stop Fitting Body
86828	59	Stop Fitting Sleeve
86827	60	Stop Fitting Nut
181292	61	3/8" O.D. x 8 5/8" Tube (Unloader Pipe Connection)
184874	62	Oil Strainer Washer
517441	63	Oil Strainer Snap Ring
183556	64	Oil Pump Body
181800	65	Pneumatic Cushion Port Plug
183471	69	Sleeve for Oil Seal
179192	70	9/16" Ball (Oil Control Valve)

PIECE NO.	REF. NO.	DESCRIPTION
181862	71	Oil Control Valve Cap
181856	72	Oil Pump Plunger (Includes 73)
133064	73	1/4" Ball Check
185283	74	Oil Pump Unloader Piston
186787	75	Crank Shaft
141551	76	Crank Shaft Ball Bearing
184741	77	Ball Bearing Spacing Tube
181864	78	Shaft End Flange
181865	79	Shaft End Flange Gasket
186039	80	Oil Seal
186900	94	1/4" O.D. Tube (Crank Case Vent Pipe Connection)
186792	99	Intercooler Flange Gasket (2 req'd)
182799	100	Flywheel Pulley
183459	101	Flywheel Pulley Key
188098		L.P. Inlet Valve, Complete (Incl. 105, 106, 107, 108, 117, 118 & 165)
188092	105	L.P. Inlet Valve Seat
188088	106	L.P. Inlet Valve Spring Seat
181768	107	L.P. Inlet Valve
184559	108	L.P. Inlet Valve Spring
188099		L.P. Discharge Valve, Complete (Includes 109, 110, 111, 112, 118, 119 and 166)
188091	109	L.P. Discharge Valve Seat with Stud
188087	110	L.P. Discharge Valve Spring Seat
181768	111	L.P. Discharge Valve
184559	112	L.P. Discharge Valve Spring
188085	113	L.P. Inlet Valve Plug
188086	114	L.P. Discharge Valve Plug
188084	115	L.P. Valve Cap (2 req'd)
99721	116	L.P. Valve Gasket (2 req'd)
523166	117	L.P. Inlet Valve Nut
521200	118	1/16" x 1/2" Cotter (2 req'd)
77787	119	L.P. Discharge Valve Nut
182875	120	H.P. Cylinder Head Gasket
182847	122	Oil Strainer
183462	130	5/16" x 1 1/2" Connecting Rod Stud (4 req'd)
79069	131	5/16" connecting Rod Castle Nut (4 req'd)
5735	132	1/16" x 1/2" Connecting Rod Cotter (4 req'd)
183468	138	Lock Washer
8183	139	7/8" Crankshaft Nut
186791	143	Intercooler
504411		1/8" Compression Stud for 1/4" O.D. Tube, Complete (Includes 163, 164 and 169) (2 req'd)
183811		3/4" M-2 Intake Filter
183812	156	Body
183813	157	Felt Washer (2 req'd)
183814	158	Strainer Plate
183815	159	Retaining Ring
1/4 oz.	160	Curled Hair
185124		Cleaning Instruction Label
504447	163	1/8" Compression Stud (2 req'd)

PIECE NO.	REF. NO.	DESCRIPTION
89098	164	Compression Stud Nut (2 req'd)
188093	165	L.P. Inlet Valve Guide
188093	166	L.P. Discharge Valve Guide
187451	167	H.P. Discharge Valve Guide
181038	168	Crank Shaft Double Ball Bearing
88976	169	Compression Stud Sleeve (2 req'd)

REPAIR OVERSIZE PISTONS AND PISTON RINGS

REF. NO.	DESCRIPTION	PIECE NUMBERS		
		.010″ Oversize	.020″ Oversize	.030″ Oversize
	L.P. Piston, complete (Includes 13, 15 and two of 14).	187514	187515	187516
13	L.P. Piston (without Rings)	187508	187509	187510
14	L.P. Piston Ring (2 req'd)	187505	187506	187507
15	L.P. Oil Ring	524733	524735	524737
	H.P. Piston, complete (Includes 18, 20 and two of 19).	187517	187518	187519
18	H.P. Piston (without Rings)	187511	187512	187513
19	H.P. Piston Ring (2 req'd)	184289	184291	185299
20	H.P. Oil Ring	187502	187503	187504

Prices will be quoted upon application.

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

ADJUSTMENTS

Pressure Gauge

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

Pressure Switches

The settings of the pressure switches should be checked against the values stamped on the mechanism nameplate at each regular inspection period. *Governor Switch.* Pressures higher than normal will cause the breaker to slam hard on closing, while pressures lower than normal reduce the reserve capacity stored in the reservoir. If the pressure gauge reading at the time the compressor has just completed recharging the reservoir indicates that the switch is not cutting off at the proper pressure, it may be corrected with adjustment of the slotted knurled stud on top of the switch. This assumes that the differential has been previously adjusted correctly at the factory. With the differential set, adjustment of the slotted knurled stud on top of the switch will change the cut-in and cut-out pressure by a like amount. If the settings are off excessively, as would be the case when installing a complete new pressure switch, the procedure to follow is as follows: Set the cut-in pressure to the value stamped on the mechanism name plate by adjusting the slotted knurled stud on top of the switch and set the cut-out pressure by adjusting the differential adjusting screw located on the right hand side of switch box under the cover. *Low Pressure Cut-Off Switch.* Too low a setting of the low pressure cut-off switch, nullifies the purpose of the switch: i.e., to prevent the mechanism from attempting to close when there is insufficient air to complete the operation. Too high a setting would result in the switch opening prematurely and thereby cut down the number of operations unnecessarily that are possible from a fully charged reservoir.

The governor switch is normally set to start up the compressor at a pressure well above the operating pressure of the cut-out switch, thus the cut-out switch is not normally called on to operate except in the event the compressor is

out of operation. Since this switch may remain idle over long periods, its readiness to operate in an emergency should be checked at each inspection period. *Low Pressure Alarm.* The low pressure alarm switch is 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 110 to 125 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 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. 3, there should be approximately $\frac{1}{32}$" 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, to insure against putting any initial compression on the rubber bumper.

The air gap for the trip armature should be approximately $\frac{3}{16}$". This adjustment is made by varying the height of the resilient stop Fig. 6. 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 $\frac{1}{32}$". 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 $\frac{1}{16}$". Thus for an armature air gap of $\frac{3}{16}$", the gap between the underside of the resilient stop bar and the top of the kick off spring should be $\frac{1}{8}$". 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.

Overtravel

The overtravel of the closing piston should be approximately $\frac{1}{8}$". 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 cross-head 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.

PART V—TROUBLE SHOOTING SUGGESTIONS

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

A. If the mechanism fails to close the breaker.

1. Check to see that the correct control voltage is available.
2. Check the closing relay to see that it closes its contacts.
3. Check the 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 the breaker stops to make sure there is no interference.
9. 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 minimum operating voltage of the cut-off relay and increase it if it is too low.
2. 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.
3. Close the mechanism by means of the pushbutton on top of the pilot valve and observe the over travel between the roller on the cross-head pin. This should be about $\frac{1}{8}$" to allow the latch time to reset.
4. While the mechanism is in the over-traveled position of check #3, observe whether the end of the non trip-free trigger resets properly behind the roller on the holding latch.
5. 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.
6. 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.

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.

MEMORANDUM

MEMORANDUM

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WESTINGHOUSE

INSTRUCTION BOOK

Pneumatic
Operating Mechanism
Type AA-10
for
Oil Circuit Breakers

Westinghouse Electric Corporation

I. B. 33-125-C3B

I.B. 33-125-C3B

INSTRUCTIONS

Pneumatic Operating Mechanism Type AA-10 for Oil Circuit Breakers

August, 1954

WESTINGHOUSE ELECTRIC CORPORATION

Switchgear Division • East Pittsburgh Plant, East Pittsburgh, Pa.

SUPERSEDES I.B. 33-125-C3A

MH-721-A

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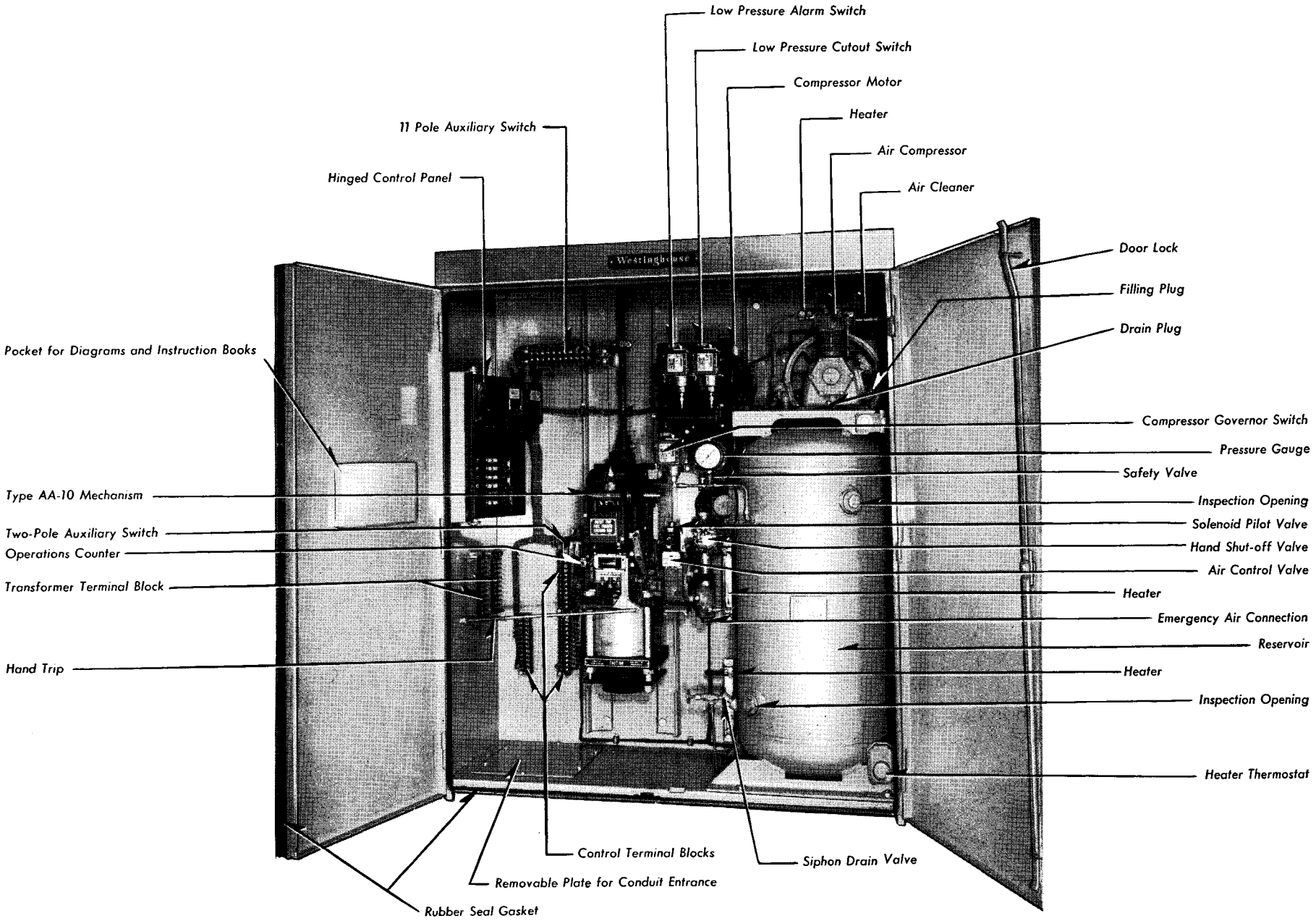


FIG. 1—AA-10 OPERATING MECHANISM IN HOUSING

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.

CONTENTS

CONTENTS—Continued

DRAWINGS

Pneumatic Operating Mechanism—Type AA10

PART I—RECEIVING, HANDLING, AND STORAGE

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

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

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

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

PART II—DESCRIPTION

GENERAL

Included within the dust tight sheet metal housing 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 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.

holding the cylinder assembly to the main frame is the spring housing which supports and encloses the two heavy retrieving springs. These springs, which are compressed during the closing stroke, supply the force required to rapidly retrieve the piston to the open position whenever the mechanism is tripped.

Closing Piston Assembly

The main closing piston which is cast 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 two piston rings 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. 3 and 4, 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. 3 and 4. 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. 5 to the open position Fig. 3. 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. 4 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. 4. 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. $\frac{1}{32}$" thick copper rivets on the underside of the pole faces creates a $\frac{1}{32}$" air gap between the armature and pole faces which also speeds up the retrieving of the armature.

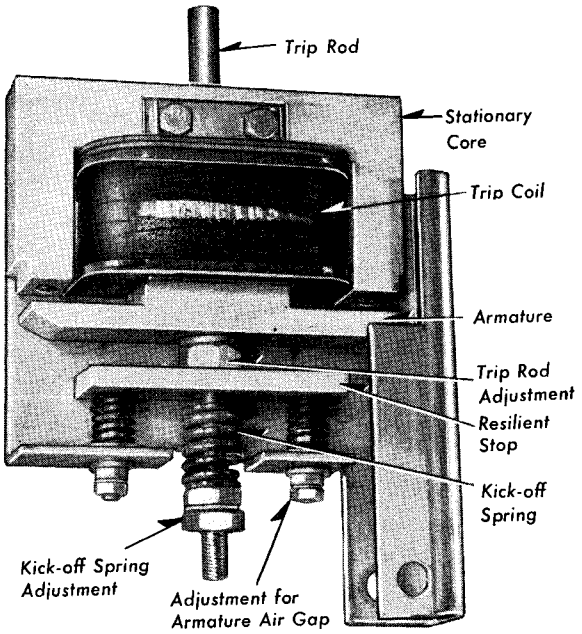


FIG. 6—TRIP MAGNET ASSEMBLY

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. 16-17. 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. 17 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. 16 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 a wide range of functions which the mechanism may be called on to perform, there

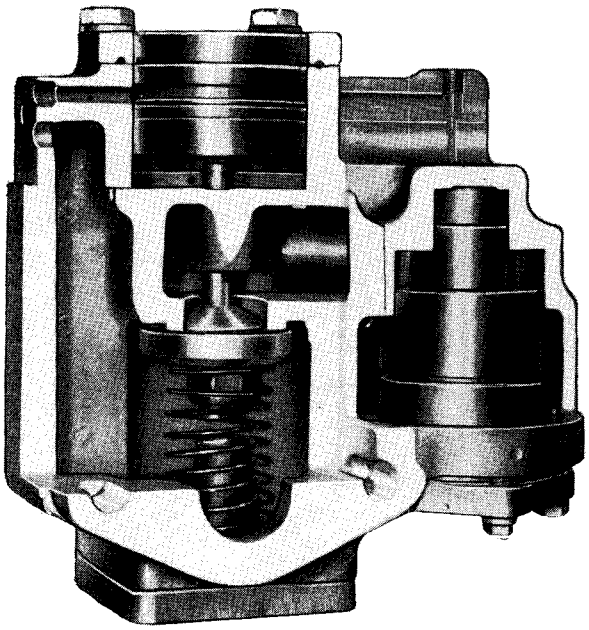


FIG. 7—AA-10 CONTROL VALVE
(with high speed exhaust)

are several combinations required in the control valve assembly as follows:

(1) For the majority of breakers, which have a comparatively light starting load, a throttle and adjustable by-pass are required (Fig. 8A-14-15).

(2) For the largest breakers this feature is omitted.

(3) For all breakers where immediate multiple reclosures are required, a fast acting exhaust valve is incorporated (Fig. 8).

(4) Where only one reclosure is required, a slow acting "poppet" type of exhaust, which allows the pressure to leak down to a low value before exhausting is permissible (Fig. 8B).

(5) To provide for selective tripping as described previously in detail, a selector piston (Fig. 17) is required to operate the selective tripping. It is possible that some applications may require a combination of all of these features except that either (3) or (4) will be used but not both at the same time. A valve including a throttle and by-pass, a selector piston, and the fast 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. 8 to 10, 8A to 9B.

Certain illustration liberties were taken in Figs. 8A, 9A and 9B 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. 8), and vice versa (Fig. 9). 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 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.

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.

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

For control valves employing the slow exhaust, the air passage for the control air connecting the inlet and exhaust valves is omitted.

The slow exhaust valve consists of a poppet type valve, with a metal to metal seat, spring biased to the open position. The adjustable spring bias is set so that the valve will be forced closed whenever the air pressure in the cylinder which acts on top of the valve seat is at or above the actual minimum operating pressure.

The arrangement of the by-pass and throttle as illustrated in Figs. 8A, 9A and 9B 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. 14-15. 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.

Opening the small pilot valve either manually by means of the pushbutton on top of the pilot valve coil, or by energizing the coil, admits high pressure air above the inlet and exhaust valve pistons simultaneously. The inlet valve piston is forced down opening the inlet valve and the air from the storage reservoir is free to flow via the by-pass port into the main cylinder. The exhaust valve is held closed by the preponderance of force created downwardly on the valve by virtue of the control air acting on the larger area of the piston versus the closing air acting on the exposed surface of the valve seat (Fig. 9). After the mechanism has traveled sufficiently for the rod end roller to engage the throttle cam plate, the throttle piston is opened (Figs. 9B-15).

Closing the pilot valve by either releasing the manual pushbutton or de-energizing the pilot valve coil opens up the exhaust ports and closes off the inlet seat. This allows the control air above the inlet and exhaust pistons to exhaust down to atmospheric pressure which causes two actions to take place practically simultaneously:

(1) The inlet valve closes under the combined action of the valve spring and the pressure differential across the valve seat, and

(2) The exhaust valve opens due to the shift in preponderance of force upwardly on the valve, since the only force now is created by the closing air acting on the exposed surface of the valve seat. (Fig. 10). 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.

For control valves employing the slow exhaust, the function described above is essentially correct except that the exhaust valve closes as soon as the air admitted to the cylinder builds up to a pressure sufficient to overcome the spring bias, and remains closed following the closing of the inlet valve until the air leakage out of the cylinder drops the pressure sufficiently to permit the spring bias to overcome the air pressure on the top side of the valve seat.

The selector piston shown in Figs. 16-17 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 slow exhaust assembly shown in Fig. 8B, is used in place of the piston and valve seat of the fast exhaust. Due to differences in machining of the control valve body, the two types of exhaust are not interchangeable without replacing the complete control valve assembly.

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 Diagram 16-C-4200, 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

cross-head 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.

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.

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.

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 16-C-4200 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.

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.

Reclosing Adjustment Switch

Reference diagram 16-C-4200. 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.

Latch Check Switch

Reference diagram 16-C-4200. 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, a 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

Three heaters are provided in the mechanism 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 two 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. This device is not to be used for emergency manual closing of the breaker on a live line. If it is considered desirable from a safety stand-point while workmen are inside the breaker tank to insure against accidental opening of the breaker, a pin is provided which may be inserted through two holes in the side plates on the frame. The pin passes immediately behind the two catches and just above the tail section on the trip free trigger and prevents accidental tripping of the mechanism and consequently unintentional opening of the breaker. *This pin must be removed before putting the breaker back in service.*

PART III—OPERATION

AA-10

Closing

Starting with the mechanism and breaker in the open position (Fig. 3) with the trip free trigger engaged to restrain the trip free lever, closing the control switch energizes the closing relay "X" and inturn the pilot valve coil "MAG", reference 16-C-4200, which admits compressed air stored in the reservoir to the closing cylinder. The trip-free trigger by restraining the trip free lever maintains the trust link and closing lever in the relative position shown in Fig. 3 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. 4), 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. 4), 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. 3) 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. 4) 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. 5). 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. 5 to the open position Fig. 3 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. 3. The resilient trip

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. For valve assemblies using the "slow exhaust", it is necessary to first remove the exhaust assembly from the valve body and either close off the exhaust by tightening up the nut on the lower end of the valve stem and then reassembling the exhaust assembly in the valve body or otherwise sealing of 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.

Type "G" Air Compressor Units

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

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

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

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

Air Compressor

The single stage, single cylinder air compressor is lubricated by the controlled splash system and is air cooled. Deep cast circular fins on the air cylinder provide a large radiating surface, and a six-blade fan flywheel maintains a constant air stream through the fins. The crankcase and cylinder is a single casting with a side cover providing access to the interior of the crankcase, and an end cover which serves as a bearing support for one end of the crankshaft. The crankshaft operates in two large ball bearings, and the connecting rod bearing is of the adjustable split type. The piston is fitted with two compression rings and one oil ring. The cylinder head is finned for efficient cooling and incorporates two valve units, each of which is accessible upon removal of a cap nut and cage.

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

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

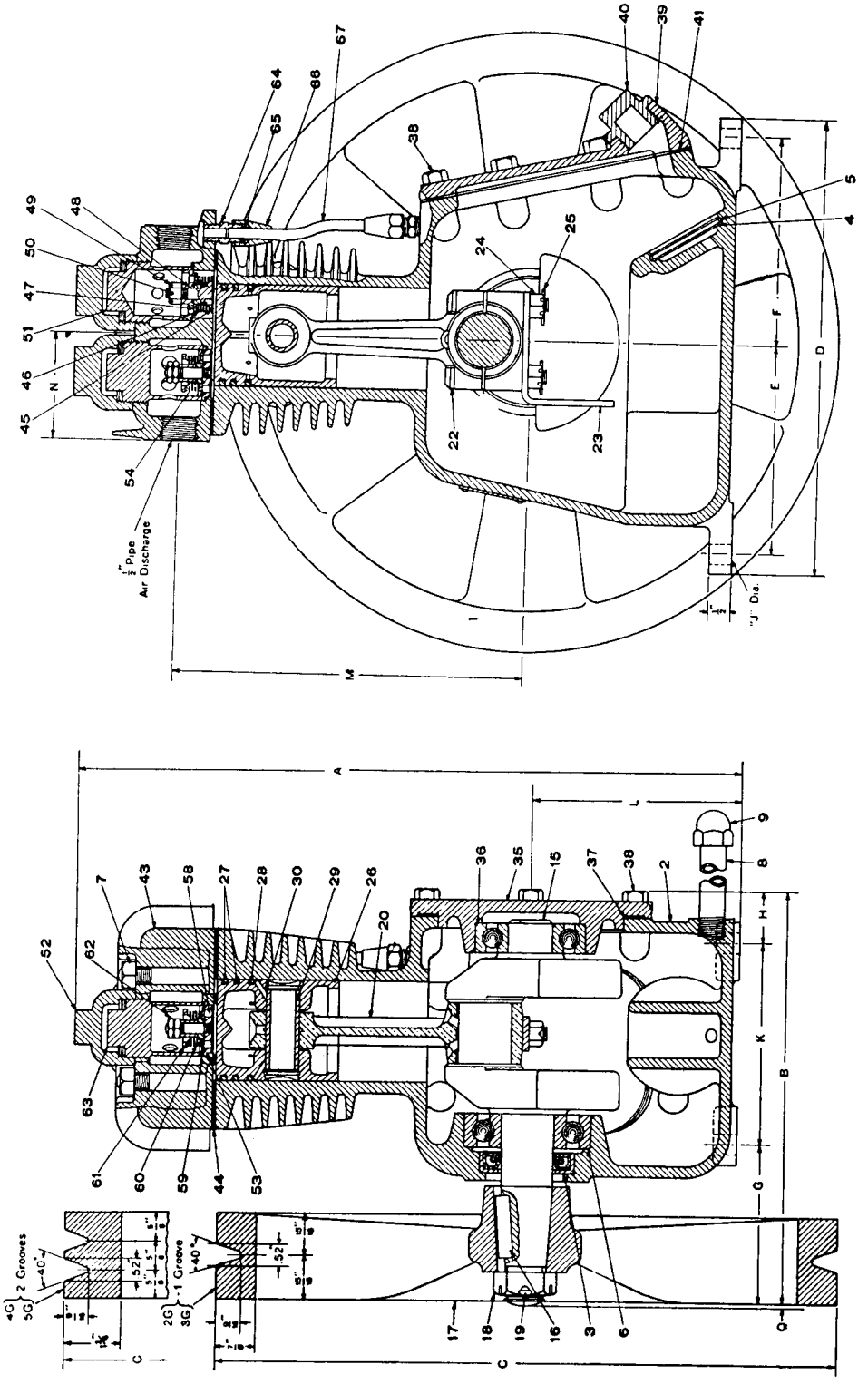
Approximate Oil Capacity..... 1 Quart

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

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

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

The cap of the check valve (which is a part of the unloading system) in the discharge line


1" Pipe
Air Discharge
J" Dia.
2 Grooves
1 Groove

should be removed and the valve and its seat cleaned periodically. If the check valve leaks, the valve and valve seat should be lapped.

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

The oil strainer 4 in the crankcase should be taken out and cleaned whenever the cover is removed. If sediment or sludge is found in the bottom of the crankcase, it should be thoroughly cleaned out.

The syphon cock at the side of the tank should be opened at least once each week to drain accumulated water from condensation. Leave the drain cock open only as long as solid water runs, then close tightly.

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

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

Air Compressor Operation

On the down stroke of piston 26, air passes through the intake filter into the chamber above the inlet valve 47 and past this valve into the cylinder. Partial vacuum created in the cylinder and underneath the disc valve by the downward stroke of the piston permits atmospheric pressure above the inlet valve to overcome the resistance of spring 46 under the valve and force the valve from its seat. Air thus flows into the cylinder until pressures above and below the valve are about equal when the inlet valve is closed by its spring.

On the upward stroke of the piston, the air in the cylinder is compressed, lifting discharge valve 59 against the resistance of its spring 60 (plus tank air pressure) and passing through the discharge pipe to the storage tank. Any accumulation of pressure in the crankcase is prevented by the vent tube 67 which connects to the air inlet.

An oil dipper attached to the connecting rod operates through an oil channel or trough cast in the bottom of the crankcase to direct the splash upward and lubricate the moving parts. The oil level in the trough is maintained by oil running down the walls of the crankcase and passing into the trough through perforated plate 4 and a drilled choke. The perforated plate serves as an oil strainer to prevent the passage into the oil trough of dirt or sediment that may be present in the bottom of the crankcase.

REPAIR PARTS LIST (2GV)

2-G AIR COMPRESSORS WITH BRASS CYLINDER HEAD, STAINLESS STEEL VALVES AND PLUGS SUPPLIED WITH AA10-60G UNITS

PIECE NO.	DESCRIPTION
188815	2-GV Compressor Unit, Complete
188813	Compressor Portion (See Repair Parts List Page 17)
188911	Reservoir
7978	3/8" x 1" Cap Screw (4 req'd)
17173	3/8" Lock Washer (4 req'd)

PIECE NO.	DESCRIPTION
104470	3/8″ x 5/8″ Cap Screw (4 req'd)
16677	3/8″ Washer (4 req'd)
17173	3/8″ Lock Washer (4 req'd)
187791	Check Valve
519973	1/2″ Disc Type Check Valve
16311	1/2″ x 3″ Nipple
41891	1/2″ Street Elbow (2 req'd)
86921	1/2″ Reinforced Compression Union Stud for 1/2″ O.D. Tube (2 req'd)
187533	1/2″ O.D. x 7/16″ I.D. Discharge Tube
188708	Syphon Drain Fitting, Complete (Includes Pc. 188709 and Pc. 188710)
188709	Syphon Drain Fitting
188710	1/4″ I.P.S. Copper Tube 14 1/8″ Long
53922	1/4″ x 1 1/4″ Nipple
P80062	1/4″ Angle Valve
†186044	Motor Pulley
†181295	5/16″ x 3/8″ Cup Pt. Set Screw
†187330	"A" Section Belt 57″ Pitch Length

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

PIECE NO.	REF. NO.	DESCRIPTION
187905		Air Compressor, Complete, with Single-groove Pulley and 5 1/2″ Nipple for Drain
188612		Air Compressor, Complete, with Two-groove Pulley and 8 1/8″ Nipple for Drain
188813		Air Compressor, Complete, with Single-groove Pulley and 8 1/8″ Nipple for Drain
183645	2	Cylinder and Crankcase (Includes 3, 4, 5, 6 and four of 7)
186068	3	Oil Retainer
183647	4	Oil Strainer
183648	5	Oil Strainer Retaining Ring
141552	6	Large Ball Bearing
183144	7	Cylinder Head Stud and Nut (4 req'd)
133122	8	1/4″ x 5 1/2″ Nipple for Drain (For Pc. No. 187905)
541975	8	1/4″ x 8 1/8″ Nipple for Drain (For Pc. Nos. 188612 and 188813)
184379	9	1/4″ Oil Drain Cap
183649	15	Crankshaft
530032	16	Key
183668	17	Flywheel Pulley (Single-groove) (For Pc. Nos. 187905 and 188813)
184780	17	Flywheel Pulley (Two-groove) (For Pc. No. 188612)
92751	18	7/8″ Jam Nut
183468	19	Lock Washer

PIECE NO.	REF. NO.	DESCRIPTION
183653	20	Connecting Rod (Includes 23, two of 22, 24 and Pc. 542616)
183655	22	Connecting Rod Bolt (2 req'd)
183656	23	Connecting Rod Dipper
73757	24	5/16" Connecting Rod Nut (2 req'd)
542616		5/16" Connecting Rod Lock Nut (2 req'd)
183658		Piston, Complete (Includes 26, 28 and two of 27)
183659	26	Piston, without Rings
183660	27	Compression Ring (2 req'd)
183661	28	Oil Ring
183662	29	Wrist Pin
183663	30	Wrist Pin Retaining Ring (2 req'd)
183651	35	End Cover
141551	36	Small Ball Bearing
183652	37	End Cover Gasket
17116	38	End Cover Cap Screw (6 req'd)
11773	38	Side Cover Cap Screw (8 req'd)
183664	39	Side Cover
529209	40	Cap Nut
183665	41	Side Cover Gasket
187907		Cylinder Head, Complete
187901	43	Cylinder Head
183667	44	Cylinder Head Gasket
187458		Inlet Valve, Complete (Includes 45, 46, 47, 48, 49, 50 and 54)
187456	45	Inlet Valve Spring Seat
184549	46	Inlet Valve Spring
181782	47	Inlet Valve
187457	48	Inlet Valve Seat
523166	49	Inlet Valve Nut
521200	50	1/16" x 1/2" Cotter
187449	51	Inlet Valve Plug
187447	52	Valve Cap (2 req'd)
99720	53	Valve Gasket (2 req'd)
187455		Discharge Valve, Complete (Includes 54, 58, 59, 60, 61 and two of 62)
187451	54	Inlet and Discharge Valve Guide (2 req'd)
187454	58	Discharge Valve Seat
181782	59	Discharge Valve
184549	60	Discharge Valve Spring
187450	61	Discharge Valve Spring Seat
521440	62	Discharge Valve Nut (2 req'd)
187448	63	Discharge Valve Plug
504411		1/8" Compression Fitting, Complete (Includes 64, 65 and 66) (2 req'd)
504447	64	Union Stud (2 req'd)
88976	65	Union Sleeve (2 req'd)
89098	66	Union Nut (2 req'd)
186069	67	Breather Tube
183685		1/2" M-1 Intake Filter (For Details, see Repair Parts List 9418-1)

REPAIR OVERSIZE PISTONS AND PISTON RINGS

REF. NO.	DESCRIPTION	PIECE NUMBERS		
		.010″ Oversize	.020″ Oversize	.030* Oversize
	Piston, Complete	185452	185453	185454
26	Piston without Rings	185329	185330	185331
27	Compression Ring	184093	184095	185468
28	Oil Ring	184097	184099	185469

Prices will be quoted upon application.

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

TYPE "Y" AIR COMPRESSOR UNITS

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

Proper rotation of the compressor is indicated by the arrow on the flywheel. On three phase installations, the direction of rotation should be checked regularly.

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

Approximate Oil Capacity..... 1¼ Quarts

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

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

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

The unloader in this compressor is controlled by oil pressure, and the failure of this device to function will result from lack of proper oil pressure. In such event investigate the oil level, strainer in base of pump, ball check in the plunger and pneumatic cushion port plug 65. If these parts are functioning properly and the oil supply is normal, failure to compress air may be due to the unloader valve ball check not seating because of dirt on the ball check or seat, thereby allowing air from the high pressure cylinder to escape through the crankcase.

To inspect the unloader device parts, drain the oil, disconnect the tubing to the unloader valve in the end cover and then remove the end cover. The oil pump can then be pulled out of its bearing and the strainer released by removing a snap ring. If sediment or sludge is

found in crankcase, clean out, since it will interfere with oil pump operation.

Relief ball check 70 in the crankshaft counter-weight should also be inspected, since leakage past the ball check will result in reduced oil pressure. Remove the valve cap 71 and if dirt is found on the ball or seat, clean thoroughly. Also see that ports in the valve cap and the opening in the counter-weight are open.

The syphon cock at the side of the tank should be opened at least once each week to drain accumulated water resulting from condensation. Leave the drain cock open only as long as solid water runs, then close tightly.

The Safety valve ordinarily requires no attention. It is set to blow off at 10% to 25% above the working pressure of the tank. 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 very slowly by means of the cross bar on its stem, with the compressor running, usually clean the valve seat and restores the proper seal. If not, the safety valve should be dis-assembled and both the valve and the seat wiped clean. If the seat has not been cut, a little oil should be applied; if cut, the valve should be reseated.

The belts 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 belt replacement is necessary, replace all belts with a matched set.

The two stage type YC air compressor units are air cooled and pressure lubricated. Deep cast circular fins on the cylinders provide a large radiating surface, and a fan flywheel maintains a constant cooling air stream through the fins.

Separately cast crankcase, cylinders and cylinder heads provide ready access to any part of the compressor. A counter-balanced crankshaft operates in two large ball bearings. Both connecting rods are operated by the single throw crankshaft. Each piston has two compression rings and one oil ring. Each cylinder head has two valve units, each of which is accessible upon the removal of a cap nut and cage.

The two stage compressor has two different size cylinders, a large low pressure cylinder and a smaller high pressure cylinder. The low pressure cylinder, which is fitted with an intake filter, performs the first stage of compression and discharges through an intercooler into the high pressure cylinder where the second stage of compression is performed.

AIR COMPRESSOR OPERATION

On the down stroke of the low pressure piston (large cylinder), air passes through the intake filter 156 into the chamber above the inlet valve 107 and past this valve into the cylinder. Partial vacuum created in the cylinder underneath the disc valve by the downward stroke of the piston 13 permits atmospheric pressure above the inlet valve to overcome the resistance of spring 108 under the valve and force the valve from its seat. Air thur flows into the cylinder until pressures above and below valve are about equal when the inlet valve is closed by its spring.

On the upward stroke of the piston, the air in the cylinder is compressed, lifting discharge valve 111 against the resistance of its spring 112 and passing through the intercooler pipe to the high pressure cylinder. The discharge valve is seated by its spring when pressure above the valve becomes almost equal to that underneath.

The cycle of operation described for the low pressure cylinder is repeated in the high pressure cylinder, increasing pressure from an intermediate value to the final stage or tank pressure.

Accumulation of pressure in the crankcase is prevented by a crankcase vent 94 which connects to the air intake.

Interlocked with the oil supply, a starting unloading feature provides that compression does not begin until the motor has reached its full speed. The high pressure cylinder has a connection 61 to the unloader valve in the end cover. When the compressor is not running, or oil pressure is low (on account of insufficient oil or low compressor speed), connection 61 between the high pressure cylinder and the crankcase vent is opened by the unloader valve 49 as a by-pass to unload the compressor and prevent the compression of air. With the compressor running and oil pressure normal, the oil pump

unloader piston 74 moves the unloader lever 47 to a position where the unloader ball check valve 49 is seated. This closes the connection between the high pressure cylinder and the crankcase vent, thereby loading the compressor which operates to compress the air as already described.

The ball check in the unloader pipe connection to the cylinder prevents backflow from this pipe during the intake stroke, thereby increasing efficiency of the compressor by eliminating during each operating cycle the filling and emptying of the unloader pipe.

The oil pump 64, which is of the piston type, oscillates in a bearing (in the bottom of the crankcase) that is almost entirely submerged in an oil bath. The pump is driven directly from the crankshaft. Oil enters the pump through a strainer and on the down stroke of plunger 72 is forced into the plunger (past ball check 73) up to the connecting rod bearings thence through the crankshaft and counter-weight to the relief ball check 70. Pneumatic cushion port plug 65 admits air to the oil plunger cylinder on the up stroke, which provides a cushioning effect on the succeeding down stroke of the plunger. From the connecting rod bearings the oil is forced up through the drilled connecting rods to the wrist pin bearings. The cylinder walls are lubricated by oil mist sprayed from the connecting rod bearings. When oil line pressure exceeds the set maximum for any speed, it unseats the relief ball check valve and allows oil to pass out to the crankcase through an opening in the counter weight. Oil thus deposited in a trough on the back wall of the crankcase supplies the two main bearings. The relief ball check valve regulates oil pressure in proportion to crankshaft speed, maintaining an even rate of oil circulation. The ball check is held to its seat by centrifugal force and, as this force varies with the speed, oil line pressure varies accordingly.

REPAIR PARTS LIST (1-YCV)

1-YC AIR COMPRESSOR WITH BRASS HIGH PRESSURE CYLINDER HEAD, STAINLESS STEEL VALVES AND PLUGS SUPPLIED WITH AA10-60Y UNITS

PIECE NO.	DESCRIPTION
188912	1-YCV Compressor Unit, Complete
187915	Compressor Portion (See Repair Parts List Page 22)
188911	Reservoir
24286	3/8" x 7/8" Cap Screw (4 req'd)
17173	3/8" Lock Washer (4 req'd)
181293	3/8" x 1 1/2" Carriage Bolt and Nut (4 req'd)
17173	3/8" Lock Washer (4 req'd)
86922	3/8" Reinforced Compression Stud for 1/2" O.D. Tube
86921	1/2" Reinforced Compression Stud for 1/2" O.D. Tube
188913	1/2" O.D. x 7/16" I.D. Discharge Tube
53922	1/4" x 1 1/4" Long Nipple
P80062	1/4" Angle Valve
188708	Syphon Drain Fitting, Complete (Includes Pc. 188709 and Pc. 188710)
188709	Syphon Drain Fitting
188710	1/4" I.P.S. Copper Tube 14 1/8" Long
†187654	"A" Section Belt (2 req'd)
†186717	Motor Pulley
†181295	5/16" x 3/8" Cup Pt. Set Screw

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

PIECE NO.	REF. NO.	DESCRIPTION
181800	65	Pneumatic Cushion Port Plug
183471	69	Sleeve for Oil Seal
179192	70	9/16" Ball (Oil Control Valve)
181862	71	Oil Control Valve Cap
181856	72	Oil Pump Plunger, complete (includes 73)
133064	73	1/4" Ball Check
185283	74	Oil Pump Unloader Piston
184740	75	Crank Shaft, complete
141551	76	Crank Shaft Ball Bearing
184741	77	Ball Bearing Spacing Tube
181864	78	Shaft End Flange
181865	79	Shaft End Flange Gasket
186039	80	Oil Seal
186900	94	Crankcase Vent Pipe Connection
181869	99	Intercooler Gasket (2 req'd)
182799	100	Flywheel Pulley
183459	101	Key for Pulley
187458		L.P. Inlet Valve, complete (includes 105, 106, 107, 108, 117, 118 and 165)
187457	105	L.P. Inlet Valve Seat
187456	106	L.P. Inlet Valve Spring Seat
181782	107	L.P. Inlet Valve
184549	108	L.P. Inlet Valve Spring
187455		L.P. Discharge Valve, complete (includes 109, 110, 111, 112, 166 and two of 119)
187454	109	L.P. Discharge Valve Seat
187450	110	L.P. Discharge Valve Spring Seat
181782	111	L.P. Discharge Valve
184549	112	L.P. Discharge Valve Spring
187449	113	L.P. Inlet Valve Plug
187448	114	L.P. Discharge Valve Plug
187447	115	L.P. Inlet and Discharge Valve Cap (2 req'd)
99720	116	L.P. Inlet and Discharge Valve Seat Gasket (2 req'd)
523166	117	L.P. Inlet Valve Nut
521200	118	1/16" x 1/2" Cotter
521440	119	L.P. Discharge Valve Nut (2 req'd)
181837	120	H.P. Cylinder Head Gasket
525105	122	Oil Strainer
183462	130	Connecting Rod Stud (4 req'd)
73757	131	5/16" Connecting Rod Nut (4 req'd)
542616		5/16" Connecting Rod Lock Nut (4 req'd)
183468	138	Lock Washer
8183	139	Crankshaft Nut
181872	143	Intercooler (includes Pc. 97588)
504411	163	Compression Stud Fitting, Complete
504411	164	Compression Stud Fitting, Complete
187451	165	L.P. Inlet Valve Guide
187451	166	L.P. Discharge Valve Guide
187451	167	H.P. Discharge Valve Guide
181038	168	Crank Shaft Double Ball Bearing
183811		3/4" M-2 Intake Filter (for details, See Leaflet No. 9368-6)
97588		1/4" Pipe Plug

REPAIR OVERSIZE PISTONS AND PISTON RINGS

REF. NO.	DESCRIPTION	PIECE NUMBERS		
		.010″ Oversize	.020″ Oversize	.030* Oversize
	L.P. Piston complete (Includes 13, 15, and two of 14)	185439	185440	185441
13	L.P. Piston (Without Rings)	185341	185342	185343
14	L.P. Piston Ring (2 req'd)	184136	184138	185294
15	L.P. Oil Ring	184140	184142	185296
	H.P. Piston, complete (Includes 18, 20 and two of 19)	185436	185437	185438
18	H.P. Piston (Without Rings)	185338	185339	185340
19	H.P. Piston Ring (2 req'd)	184144	184146	185298
20	H.P. Oil Ring	184148	184150	185300

Prices will be quoted upon application.

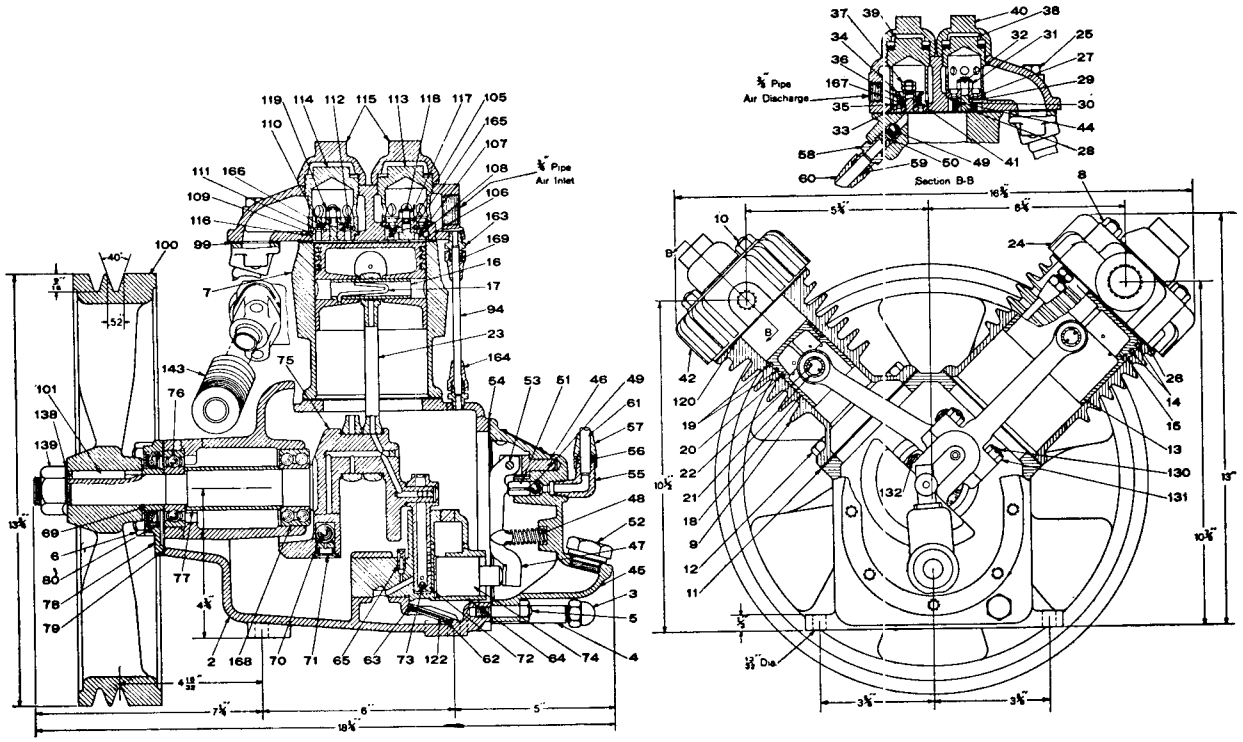
Orders should give SIZE and SERIAL NUMBER of Compressor as well as PIECE NUMBER and NAME or part wanted.

REPAIR PARTS LIST (1-BYCV)

1-BYC AIR COMPRESSOR WITH BRASS HIGH PRESSURE CYLINDER HEAD, STAINLESS STEEL VALVES AND PLUGS SUPPLIED WITH AA10-80Y UNITS

PIECE NO.	DESCRIPTION
P80242	1-BYCV Compressor Unit, Complete
188095	Compressor Portion (See Repair Parts List Page 26)
188553	Reservoir
72754	3/8″ x 1 3/8″ Bolt and Nut (4 req'd)
17173	3/8″ Lock Washer (4 req'd)
86922	3/8″ Reinforced Compression Stud for 1/2″ O.D. Tube
86921	1/2″ Reinforced Compression Stud for 1/2″ O.D. Tube
188564	1/2″ O.D. x 7/16″ I.D. Discharge Tube
186824	3/8″ x 1 1/2″ Carriage Bolt (4 req'd)
2220	3/8″ Hex Nut (4 req'd)
17173	3/8″ Lock Washer (4 req'd)
188708	Syphon Drain Fitting, Complete (Includes Pc. 188709 and Pc. 188710)
188709	Syphon Drain Fitting
188710	1/4″ I.P.S. Copper Tube 14 1/8″ Long
53922	1/4″ x 1 1/4″ Nipple
P80062	1/4″ Angle Valve
†188547	Motor Pulley
†188565	"A" Section Belt 54″ Pitch Length (2 req'd)
†181295	5/16″ x 3/8″ Cup Pt. Set Screw

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



PIECE NO.	REF. NO.	DESCRIPTION
188095		1-BYC Air Compressor, Complete
188096		1-BYC Air Compressor, Complete, less Air Filter
186888	2	Crank Case (Includes four of 6 and seven of 5)
184379	3	Oil Drain Cap
129445	4	$\frac{1}{4}$″ x $3\frac{1}{4}$″ Nipple for Oil Drain
57683	5	$\frac{3}{8}$″ x $1\frac{5}{8}$″ End Cover Stud and Nut (7 req'd)
84909	6	$\frac{3}{8}$″ x $1\frac{1}{2}$″ Shaft End Flange Stud and Nut (4 req'd)
186889	7	L.P. Cylinder (Includes four of 8)
183144	8	$\frac{3}{8}$″ x $2\frac{11}{16}$″ L.P. Cylinder Head Stud and Nut (4 req'd)
187268	9	H.P. Cylinder (Includes four of 10)
183144	10	$\frac{3}{8}$″ x $2\frac{11}{16}$″ H.P. Cylinder Head Stud and Nut (4 req'd)
186817	11	Cylinder Gasket (2 req'd)
16239	12	$\frac{3}{8}$″ x $\frac{3}{4}$″ Cylinder Cap Screw (8 req'd)
‡186793		L.P. Piston, Complete (Includes 13, 15 and two of 14)
‡186775	13	L.P. Piston, without Rings
‡186772	14	L.P. Compression Ring (2 req'd)
‡524731	15	L.P. Oil Ring
181845	16	L.P. Piston Wrist Pin
181847	17	L.P. Piston Wrist Pin Lock Wire
‡186794		H.P. Piston, Complete (Includes 18, 20 and two of 19)
‡186774	18	H.P. Piston, without Rings
‡185503	19	H.P. Compression Ring (2 req'd)
‡186773	20	H.P. Oil Ring
181846	21	H.P. Piston Wrist Pin
181849	22	H.P. Piston Wrist Pin Lock Wire
183488	23	Connecting Rod (Includes two of 130, 131, and 132) (2 req'd)

‡ For Oversize Pistons and Rings, see page 29.

PIECE NO.	REF. NO.	DESCRIPTION
188097		L.P. Cylinder Head, Complete (Includes 24, 113, 114, Pc. 184556, 184561, two of 115 and 116)
186783	24	L.P. Cylinder Head
6897	25	3/8" x 1 7/8" Intercooler Flange Cap Screw (4 req'd)
186784	26	L.P. Cylinder Head Gasket
187458		H.P. Inlet Valve, Complete (Includes 27, 28, 29, 30, 31, 32 and 44)
187457	27	H.P. Inlet Valve Seat
187456	28	H.P. Inlet Valve Spring Seat
181782	29	H.P. Inlet Valve
184549	30	H.P. Inlet Valve Spring
523166	31	H.P. Inlet Valve Nut
521200	32	1/16" x 1/2" Cotter
187455		H.P. Discharge Valve, Complete (Includes 33, 34, 35, 36, 167 and two of 37)
187454	33	H.P. Discharge Valve Seat with Stud
187450	34	H.P. Discharge Valve Spring Seat
181782	35	H.P. Discharge Valve
184549	36	H.P. Discharge Valve Spring
521440	37	H.P. Discharge Valve Nut (2 req'd)
187449	38	H.P. Inlet Valve Plug
187448	39	H.P. Discharge Valve Plug
187447	40	H.P. Valve Cap (2 req'd)
99720	41	H.P. Valve Gasket (2 req'd)
188100		H.P. Cylinder Head, Complete (Includes 38, 39, 42, Pc. 184546, 184551, two of 40 and 41)
188094	42	H.P. Cylinder Head
187451	44	H.P. Inlet Valve Guide
181857	45	End Cover (Includes 46)
181794	46	Unloading Operating Lever Support
181795	47	Unloading Operating Lever
18469	48	Unloading Operating Lever Spring
93765	49	3/8" Ball Check for Unloader Valve (2 req'd)
181797	50	Unloader Ball Check Spring
181827	51	Unloader Ball Check Plunger
529209	52	Oil Filling Cap Nut
90286	53	Unloader Operating Lever Hinge Pin with Cotter
181858	54	End Cover Gasket
87205		1/4" Compression Elbow for 3/8" O.D. Tube, Complete (Includes 55, 56 and 57)
87195	55	1/4" Compression Elbow
86828	56	Elbow Sleeve
86827	57	Elbow Nut
193996		1/4" Compression Type Unloader Stop Fitting for 3/8" O.D. Tube, Complete (Includes 58, 59 and 60)
183994	58	1/4" Unloader Stop Fitting Body
86828	59	Stop Fitting Sleeve
86827	60	Stop Fitting Nut
181292	61	3/8" O.D. x 8 5/8" Tube (Unloader Pipe Connection)
184874	62	Oil Strainer Washer
517441	63	Oil Strainer Snap Ring
183556	64	Oil Pump Body

PIECE NO.	REF. NO.	DESCRIPTION
181800	65	Pneumatic Cushion Port Plug
183471	69	Sleeve for Oil Seal
179192	70	9/16" Ball (Oil Control Valve)
181862	71	Oil Control Valve Cap
181856	72	Oil Pump Plunger (Includes 73)
133064	73	1/4" Ball Check
185283	74	Oil Pump Unloader Piston
186787	75	Crank Shaft
141551	76	Crank Shaft Ball Bearing
184741	77	Ball Bearing Spacing Tube
181864	78	Shaft End Flange
181865	79	Shaft End Flange Gasket
186039	80	Oil Seal
186900	94	1/4" O.D. Tube (Crank Case Vent Pipe Connection)
186792	99	Intercooler Flange Gasket (2 req'd)
182799	100	Flywheel Pulley
183459	101	Flywheel Pulley Key
188098		L.P. Inlet Valve, Complete (Includes 105, 106, 107, 108, 117, 118 and 165)
188092	105	L.P. Inlet Valve Seat
188088	106	L.P. Inlet Valve Spring Seat
181768	107	L.P. Inlet Valve
184559	108	L.P. Inlet Valve Spring
188099		L.P. Discharge Valve, Complete (Includes 109, 110, 111, 112, 118, 119 and 166)
188091	109	L.P. Discharge Valve Seat with Stud
188087	110	L.P. Discharge Valve Spring Seat
181768	111	L.P. Discharge Valve
184559	112	L.P. Discharge Valve Spring
188085	113	L.P. Inlet Valve Plug
188086	114	L.P. Discharge Valve Plug
188084	115	L.P. Valve Cap (2 req'd)
99721	116	L.P. Valve Gasket (2 req'd)
523166	117	L.P. Inlet Valve Nut
521200	118	1/16" x 1/2" Cotter (2 req'd)
77787	119	L.P. Discharge Valve Nut
182875	120	H.P. Cylinder Head Gasket
182847	122	Oil Strainer
183462	130	5/16" x 1 1/2" Connecting Rod Stud (4 req'd)
79069	131	5/16" connecting Rod Castle Nut (4 req'd)
5735	132	1/16" x 1/2" Connecting Rod Cotter (4 req'd)
183468	138	Lock Washer
8183	139	7/8" Crankshaft Nut
186791	143	Intercooler
504411		1/8" Compression Stud for 1/4" O.D. Tube, Complete (Includes 163, 164 and 169) (2 req'd)
504447	163	1/8" Compression Stud (2 req'd)
89098	164	Compression Stud Nut (2 req'd)
188093	165	L.P. Inlet Valve Guide

PIECE NO.	REF. NO.	DESCRIPTION
188093	166	L.P. Discharge Valve Guide
187451	167	H.P. Discharge Valve Guide
181038	168	Crank Shaft Double Ball Bearing
88976	169	Compression Stud Sleeve (2 req'd)
183811		¾" M-2 Intake Filter (for details, see Leaflet No. 9368-6)

REPAIR OVERSIZE PISTONS AND PISTON RINGS

REF. NO.	DESCRIPTION	PIECE NUMBERS		
		.010" Oversize	.020" Oversize	.030* Oversize
	L.P. Piston, complete (Includes 13, 15 and two of 14)	187514	187515	187516
13	L.P. Piston (without Rings)	187508	187509	187510
14	L.P. Piston Ring (2 req'd)	187505	187506	187507
15	L.P. Oil Ring	524733	524735	524737
	H.P. Piston, complete (Includes 18, 20 and two of 19)	187517	187518	187519
18	H.P. Piston (without Rings)	187511	187512	187513
19	H.P. Piston Ring (2 req'd)	184289	184291	185299
20	H.P. Oil Ring	187502	187503	187504

Prices will be quoted upon application.

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

ADJUSTMENTS

Pressure Gauge

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

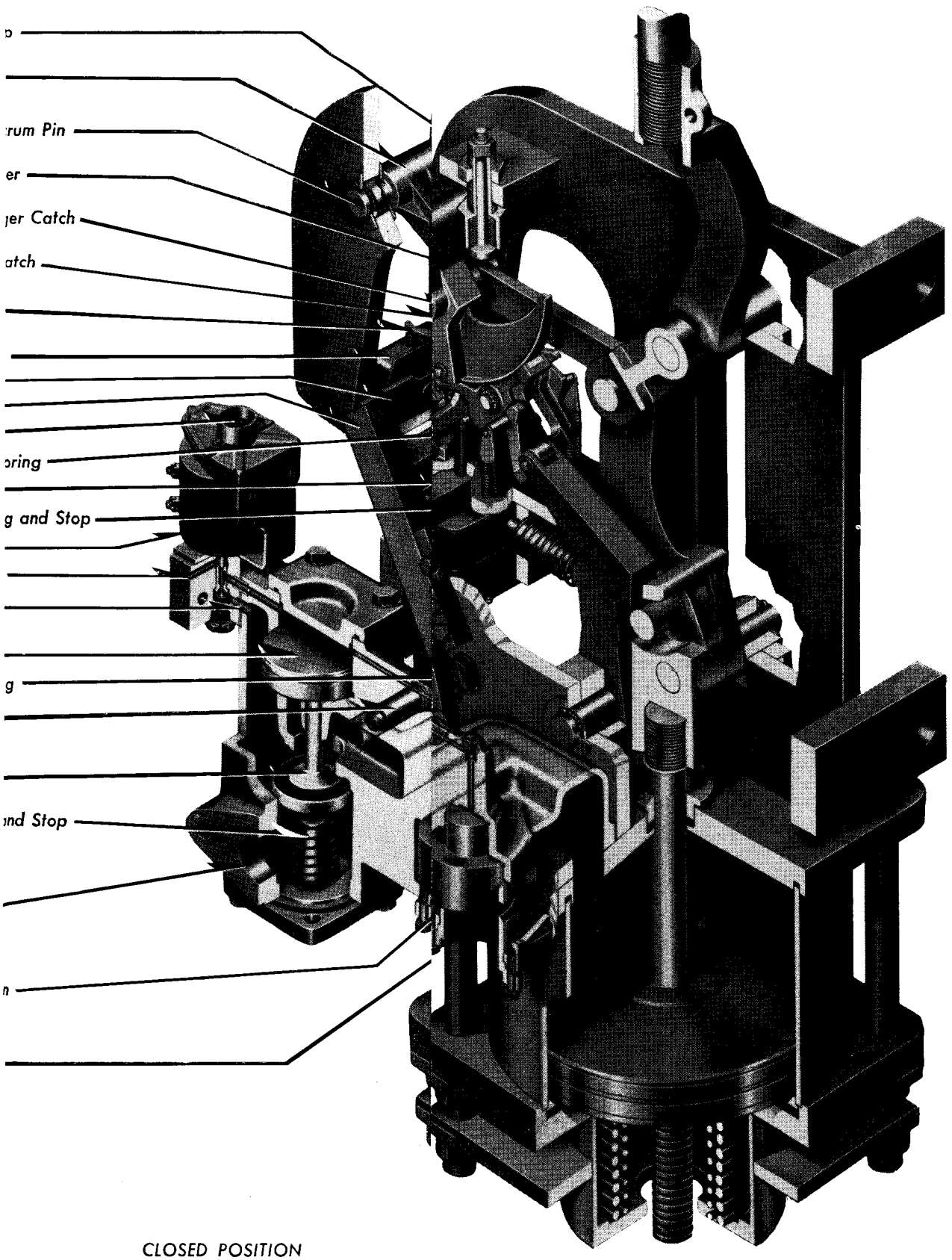
Pressure Switches

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 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.

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.



CLOSED POSITION

FIG. 4

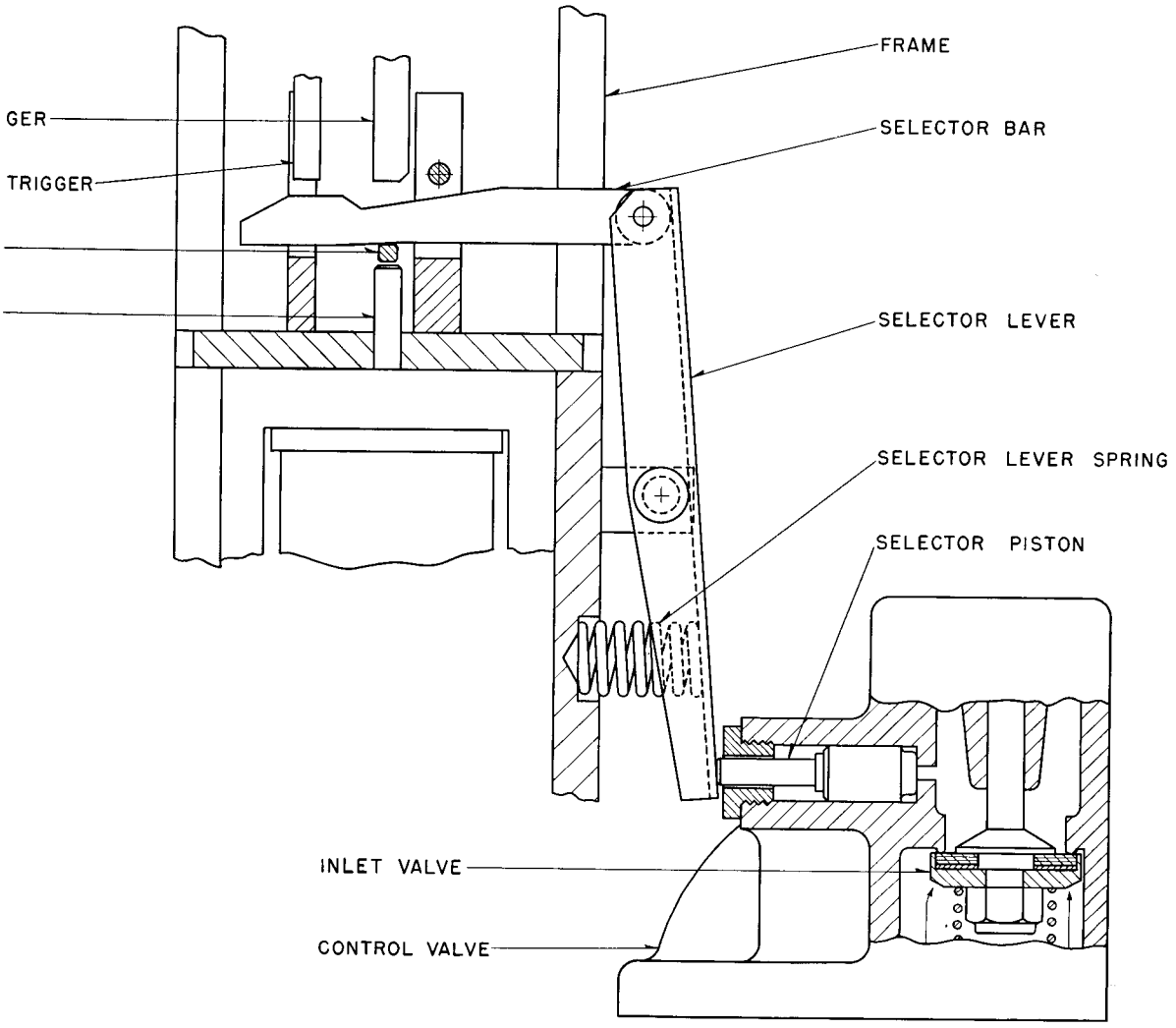
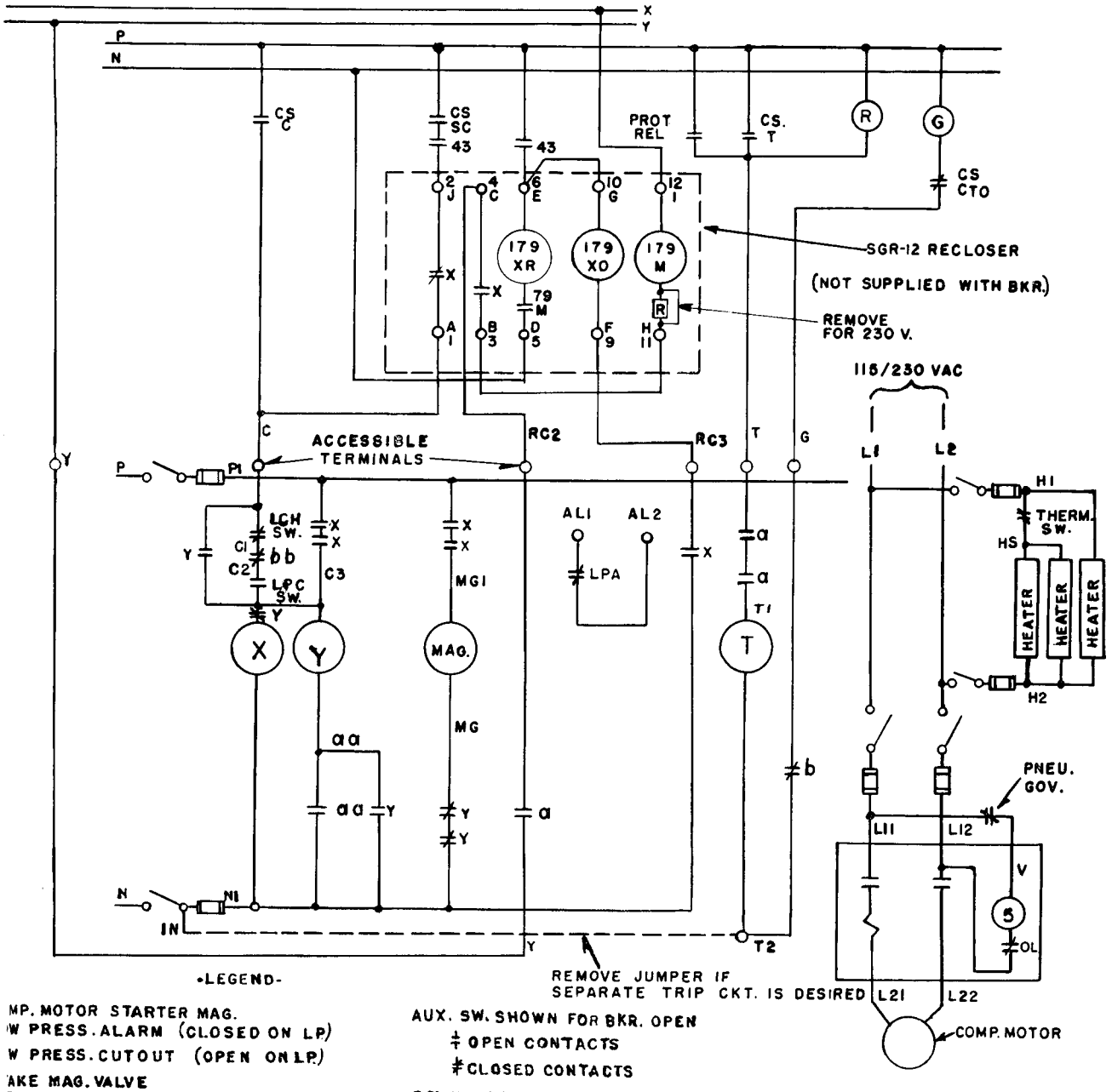

FRAME
GER
SELECTOR BAR
TRIGGER
SELECTOR LEVER
SELECTOR LEVER SPRING
SELECTOR PISTON
INLET VALVE
CONTROL VALVE

FIG.17



•LEGEND-

MP. MOTOR STARTER MAG.
W PRESS. ALARM (CLOSED ON LP)
W PRESS. CUTOUT (OPEN ON LP)
AKE MAG. VALVE
TCH CHECK SW.

AUX. SW. SHOWN FOR BKR. OPEN
÷ OPEN CONTACTS
≠ CLOSED CONTACTS
RELAY CONTACTS SHOWN FOR DE-ENERG. RELAY
PRESS. SW. SHOWN FOR LOW PRESS.

- USE STD. WIRING HARNESS PER DIAG. 16-C-4201

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