OIL CIRCUIT BREAKER OPERATING MECHANISM (Type AA-14)

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 occured 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 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 trigger, 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 (Pg. 22) 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; a system of latches for rapidly disengaging the breaker pull rod from the piston, and 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 Page 23)

COMPRESSOR AND AIR SYSTEM

The air supply system provided with the AA-14 mechanism consists of a 130 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 switch, through an auxiliary relay, 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 specifies differently, the motors when shipped will be connected for 230 V. a-c to prevent damage to the motor from overvoltage.

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

The air line between the reservoir and the pneumatic mechanism can be closed by a hand shut-off valve. Air trapped between it and the control valve can be discharged by manually operating a pilot valve.

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 they perform their functions if the closing control is energized when the hand shut-off valve is closed and the trapped air has been bled. In case the compressor is out of service, an emergency source of air may be connected by removing the 2" pipe plug provided in the piping between the hand shut-off valve and the control valve as indicated on drawing 47-A-3035 (Page 22).

PNEUMATIC MECHANISM

The type AA-14 mechanism 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. The following description is illustrated and supplemented by figures 1 through 7 (Pages 17, 18 and 19)

Main Frame and Cylinder

The main frame serves a number of purposes which insure accurate alignment. It contains the bearings for the stationary pins of the linkage, forms the upper cylinder head and provides holes for the locating dowel pin and four mounting bolts. The wall of the main operating cylinder fits into a locating groove on the under side of the frame and is clamped between the frame and a lower steel cylinder head. Auxiliaries such as trip magnet, air valve and auxiliary switches are bolted directly to the frame.

Closing Piston Assembly

The main closing piston which is cast from a non-ferrous alloy is screwed on and locked to the chromium-plated alloy-steel piston rod. An adjustable packing gland around the piston rod, a gasket between the mechanism frame and cylinder, and two piston rings on the main closing piston minimize the air-losses during closing operations. The lower end of the piston rod is threaded for a nut which transmits the hand jack load to the piston rod.

Closing Piston Dashpot

To decelerate the piston at the end of the closing stroke, a skirt on the piston seals a hole in the lower cylinder head and traps air below the piston. The air is compressed and exhausted through orifices in the bottom cylinder head, thereby absorbing the kinetic energy at the end of the closing stroke.

Retrieving Spring Assembly

Immediately below the lower cylinder head, or bottom plate, is the spring housing which encloses the retrieving spring. The spring, which is compressed during the closing stroke, supplies the force required to retrieve the piston to the open position whenever the mechanism is tripped free.

Lever System

The upper end of the piston rod (point A in Fig. 2) is guided by a straight-line linkage consisting of the triangular link and the two guide links pivoted in the frame. The closing force on the piston is transmitted through the piston rod to pin A (Fig. 2). Pin B to which the breaker pull rod is attached, is guided by the pull rod guide link and is connected to pin A by two links labeled "closing link" and "toggle link." These two links form an inverted toggle restrained at point C by the trip-free link so that they maintain throughout the normal closing operation their relative positions shown for the end positions in Fig. 1 and 2. The piston rod and the breaker pull rod are positively coupled as long as point D is held stationary by the trip-free latch system, requiring point C to move in a arc restrained by the trip-free link. The mechanism is held in the closed position by the non-trip-free latching system which restrains the straight-line linkage and thereby holds the piston closed (Fig. 1).

The inverted toggle linkage (A-C-B) is the basic element of the mechanically trip-free system. Point D is carried on the reversing lever and is part of the trip-free latch system consisting of the reversing-lever, trip-free latch, trip-free roller lever, trip-free trigger, interlock and their biasing springs. Releasing of the trip-free latch system will allow the point D on the reversing lever to move under the action of the trip-free link, thereby, allowing the toggle linkage (A-C-B) to open and the breaker to return to the open position. As the breaker moves to the open position the reversing lever will rotate counter-clockwise until points B, C and D are in a straight line. Continued upward motion of point B will return the reversing lever to a position shown in Fig. 3 just short of its latched position.

With the trip-free latch disengaged, the interlock prevents the non-trip-free latch from engaging the triangular link and the inverted toggle linkage is returned to its toggle relationship by the piston retrieving springs as soon as the closing air has been exhausted. As the piston moves from the extreme trip-free position (Fig. 3) to the open position (Fig. 2) point C rotates about point B which is now a fixed center located by the full-open position of the breaker. For the early part of the retrieving stroke, the reversing lever will rotate counter-clockwise until points B-C-D are in a straight line, after which the reversing lever reverses its motion and rotates rapidly back to the latched position of Fig. 2. The resilient stop for the reversing lever provides sufficient overtravel of the reversing lever to permit the trip-free latch to snap into the latched position. With the latch engaged, the latch check switch makes contact. The trip-free roller lever and trigger, having previously returned to the latched position, the mechanism is ready for another closing operation.

Non-Trip-Free Latch System

The breaker is held in the closed position by a non-trip-free latch system which consists of the triangular link, the non-trip-free latch, the non-trip-free retrieving spring, the non-trip-free roller lever and non-trip-free trigger. The castings are made of a non-ferrous alloy with stellite inserts to form latch surfaces. The non-trip-free latch which is pivoted in the roller lever and the roller lever which is pivoted in the frame rotate on roller bearings. The non-trip-free roller lever carries a roller which engages the non-trip-free trigger also pivoted on a roller bearing. Non-skewing type roller bearings are used throughout to prevent the possibility of locking of the rollers.

Latched Position (Fig. 5)

To hold the mechanism in the closed position, the non-trip-free latch engages the latching surface on the triangle, thereby restraining the straight-line linkage and holding the mechanism closed. A rest on the triangular link positions the non-trip-free latch in the latched position. A clearance exists between the nose of the latch and the triangular link. The latch load develops a torque tending to rotate the non-trip-free lever clockwise. This movement is prevented by the non-trip-free trigger.

Tripping (Fig. 6)

With the breaker in the latched position and no air pressure in the cylinder, energizing of the trip coil will accelerate the non-trip-free trigger counter-clockwise and release the non-trip-free roller lever allowing it to accelerate clockwise under the action of the latch load. After a short movement of the non-trip-free latch pivot, the nose, or extension of the non-trip-free latch beyond its latch surface comes into contact with the triangle and insures quick and positive disengagement of the latching surfaces. The acceleration of the roller lever will cause it to overtravel and stop against the non-trip-free stop pin, which is mounted on springs to decrease the shock in stopping the roller lever.

Open (Fig. 4)

The roller lever containing the pivot for the latch is retrieved by the retrieving spring and located by the stop pin previous to latching. The trigger then resets. The retrieving spring now biases the non-trip-free latch against the surface of the triangular lever. With the breaker in the open position the parts have the positions shown in Fig. 4. When the breaker is being closed the latch rides on the cam surface of the triangular link ready to engage the latching surface with a very short movement as soon as the latching conditions have been reached.

Trip-Free Latch System

The trip-free latch system consists of the reversing lever, trip-free latch, trip-free retrieving spring, trip-free roller lever, trip-free trigger and interlock. The construction of the members is similar to those of the non-trip-free latch system using non-ferrous alloy and with pivots rotating on non-skewing bearings.

Latched (Fig. 5)

The mechanism piston remains connected to the breaker pull rod through the inverted toggle linkage A-C-B (Fig. 1 and 2) as long as the trip-free link is restrained at point D in the upper end of the reversing lever. The force in the trip-free link tends to rotate the reversing lever counter-clockwise but the lever is restrained by the trip-free latch system, which holds the reversing lever in the same manner in which the non-trip-free latch system holds the triangular link.

Tripping (Fig. 7)

If at any time during a closing stroke or while compressed air is in the cylinder, the mechanism is tripped the trip-free trigger will be operated and the trip-free roller lever will accelerate counter-clockwise and the latch will release the reversing lever in the same way the non-trip-free latch releases the triangle. The inverted toggle, no longer restrained by the trip-free link and reversing lever, opens as the breaker moves to the open

position under the action of the accelerating springs. As soon as the latch surfaces disengage, the roller lever and trigger are retrieved by their respective springs. The trip-free latch rides the surface of the reversing lever ready to snap into the latched position when the toggle linkage is returned to the selected relation.

Interlock

The opening of the trip-free latch rotates the interlock which lifts the non-trip-free latch and prevents it from engaging the triangle. (Fig. 7). This will allow the piston to move upward as soon as the force of the retrieving springs exceed the downward forces of gravity and the compressed air. While the piston is returning to the open position, the closing link and toggle link will again come into toggle relationship, returning the reversing lever to its original position so that the trip-free latch will again engage and the spring-biased interlock will return to the normal position. An arm on the interlock operates a latch checking switch (Fig. 1) and opens the closing circuit so that the pilot valve cannot be operated electrically with the trip-free latch disengaged.

Triggers (Fig. 4-7)

The trip-free and non-trip-free triggers rotate on roller bearings about a common fulcrum pin. They are spring-biased to the latched position. Stops on the roller levers position the triggers accurately with respect to the engaging rollers. The latch surface of each trigger is at an angle which causes a component of the load of the roller to press the trigger against the roller lever trigger stop.

The trigger stop pin supported in the frame limits the overtravel of the triggers during tripping conditions.

To insure against the possibility of the shock incident to closing causing the triggers to release, both triggers are balanced, and a spring-biased, balanced catch engages the triggers in the latched position. Normally the catch has no load but it must be released prior to tripping the triggers. This is accomplished by an arm on the catch which engages the trip rod so that the catch clears the end of the trigger as the trip rod moves upward.

An interlock between the trip-free and non-trip-free triggers is provided to assist the operation of the main interlock under conditions of trip-free operation when only a low air pressure still remains in the mechanism cylinder and the non-trip-free latch is already carrying considerable load. Under these conditions, the interlock would have to exert a large force to lift the latch from engagement. A projection on the trip-free trigger will unlatch the non-trip-free trigger just before the roller on the trip-free-roller lever clears the trigger. This permits the non-trip-free roller lever to accelerate clockwise and unload the non-trip-free latch, thereby allowing the interlock to operate easily.

Reversing Lever Stop

The reversing lever attains a relatively high speed in retrieving from the position shown in Fig. 3 to the open position Fig. 2. It is brought to rest by a resilient stop adjustably mounted on a cross bracing member of the main frame.

Trip Assembly (Fig. 2)

The trip-magnet assembly is located on the underside of the frame directly under the selector bar. It is a completely self-contained unit attached to the frame by two bolts. The trip rod is screwed into and locked to the trip armature. The upper end passes up through the stationary core to the tripping assembly, and the lower end extends down through a clearance hole in the resiliently mounted 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 permit rapid resetting of the triggers. Copper rivets on the underside of the pole faces provide about 1/32" air gap between the armature and pole faces which also facilitates the retrieving of the armature. The resiliently mounted stop plate prevents a shock on the frame from driving the armature upward and causing an undesired tripping operation.

Trip Selector (Page 21)

To obtain the benefits of short reclosing times made possible by non-trip-free operation, and the advantages of trip-free operation when closing in against a fault, this mechanism operates both trip-free and non-trip-free as conditions require. The selection of non-trip-free or trip-free operation is determined by cylinder air pressure. In the same casting as the exhaust valve, is a small cylinder with an open passage to the main air cylinder. Its piston when acted upon by main cylinder air pressure, moves the selector bar into a position under the trip-free trigger so that any tripping impulse will be transmitted from the trip magnet to the trip-free trigger (Fig. 12). After the air is shut off, air pressure falls slowly to a pressure at which the exhaust valve opens. As soon as the cylinder air pressure approaches atmospheric, a biasing spring returns the selector bar to a position in which it transmits any tripping impulse to the non-trip-free trigger (Fig. 11). The trip magnet can trip the circuit breaker in any intermediate position of the selector bar.

Control Valve

The control valve combines both inlet and exhaust functions in a single compact unit and is controlled by two pneumatic pilot valves as illustrated in Figures 9 and 10, Pg. 20. The use of two pilot valves to supply only a small volume of control air produces rapid action.

The pilot valve is double acting, i.e. when the inlet seat is closed, the exhaust ports are open (Fig. 9) and vice versa (Fig. 10). The pilot valve inlet has a lapped-in metal-to-metal seat and is spring-biased closed. The pilot valve is opened either by energizing the pilot valve coil or by manually operating the push button on top of either of the coils 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 released, the spring-biased valve closes the inlet and opens the exhaust.

The inlets supplying control air to the two pilot valves take air from the air chamber immediately below the main valve seat. Energizing the pilot valves coils, opens the pilot valve and allows control air to flow through them into the check valve assembly, and from there into the valve operating cylinder (Fig. 10). Control air pressure above the valve piston will force the piston and moving valve assembly down, opening the main valve and allowing compressed air to flow into the mechanism cylinder. Air pressure in the valve passage to the main cylinder closes the spring-biased exhaust valve.

At the end of the closing stroke the pilot valves are de-energized. This will allow the pilot valve plunger to be reseated by the biasing spring and air pressure, thereby closing the pilot valve inlet and opening its exhaust ports (Fig. 9). The control air above the valve piston escapes through the pilot valve exhaust ports and allows the main inlet valve to close under the combined action of the valve spring and the pressure differential across the valve seat. The air in the cylinder slowly escapes until the exhaust valve opens by spring pressure, thereby venting the remaining air. The small hole through the bottom of the valve operating cylinder into the air passage to the main closing cylinder, and the small bleeder hole through the side wall of the valve body near the bottom of the same cylinder controls the back pressure under the piston by making it relatively independent of leakage around the valve stem and the inlet valve piston. This back pressure insures prompt raising of the piston and closing of the main valve following the exhaust of the control air through the pilot valve.

Hand operation of the pilot valves is simplified by providing a ball check valve in the control air system to make possible a closing operation by operating a single pilot valve. The ball check valve (Fig. 8) is located in the control air line connecting the two pilot valves. Operation of either pilot valve will force the stainless steel ball to the opposite valve seat, (designated in Fig. 10) thereby preventing control air from escaping through the exhaust ports of the valve not in opera-

tion, and resulting in full air pressure on the valve piston.

The main inlet valve has a metal reinforced neoprene disc 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 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 insure trouble-free performance.

The exhaust valve (spring-biased open), and selector piston are located in a small casting (Pg. 21) which is bolted to the main valve body directly above the air inlet port to the main cylinder. A small orifice admits air from the main cylinder into the selector cylinder.

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 169-C-300 (Pg. 23) 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 five-pole auxiliary switch, known as the cut-off switch, is mounted on the pneumatic mechanism and connected to an extension on the pin of the piston rod end by a switch operating lever. Therefore, the position of its contacts are determined by the position of the mechanism closing piston. The pilot valve coils are connected in parallel and are cut off directly by four contacts in series designated as "bb" contacts on the 5-pole auxiliary switch. This quickly cuts off the closing air, and thereby keeps to a minimum the amount of air used per operation.

At approximately the same time, the "aa" switch makes up its contacts energizing the cut-off relay coil. The cut-off relay opens both the circuit through the coil of the closing relay and the circuit through the coils of the pilot valves, and closes both a contact in parallel with the "aa" contacts of the cut-off switch and a contact in parallel with the low pressure cut-off and latch check switch. The relay thereby cuts off the air and prevents pumping of the breaker. If the mechanism and its connected load fail to remain closed due to a tripping impulse or some malfunctioning part, the cut-off switch will open the "aa" contacts, but the cut-off relay contact in parallel with the "aa" contact remains closed and keeps 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 and returning the cut-off relay to its normal position.

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 pilot valve coil circuit to provide additional adjustment in the closing or reclosing time. Should it be desirable to slow up the reclosing time beyond the adjustment provided in the adjustable contact fingers on the 2 pole or 5 pole switch, the connection between C3 and MG1 can be disconnected which introduces the "X" relay pick-up time.

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. The other switches are provided for the same reason for the compressor motor circuit and housing heater circuit.

Reclosing Adjustment Switch

Reference diagram 169-C-300 (Pg. 23). 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 169-C-300 (Pg. 23). To insure that the mechanism is completely retrieved and the trip free latch system is fully engaged before any closing or reclosing operation 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 normally closed switch is operated mechanically by an extension on the interlock and is open whenever the trip free latch is disengaged (Fig. 3 Pg. 17).

ACCESSORIES

Auxiliary Switches

In addition to the 5 pole cut-off switch, an 11 pole auxiliary switch with independently adjustable contacts is provided to use for 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 mechanism frame just to the left of the trip assembly, and is operated by the 5 pole auxiliary switch operating arm. The counter advances 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

The hand closing device is a ratchet-type jack, which may be bolted permanently to the underside of the spring housing. It is used for closing and opening the mechanism and its connected load during adjustment of the breaker. The lower end of the piston rod passes through the hollow jack screw. The jack load is transmitted from the jack screw to the mechanism piston rod by a nut which is fixed to the lower end of the piston rod. Since the jack is not rigidly attached to the piston rod, the screw can be raised above the point where it can touch the nut in the open position. The mechanism can then be operated pneumatically with the lower end of the piston rod sliding through the stationary jack. A chamber inside the retrieving spring and around the jack screw prevents the jack screw from being raised too high and interfering with the piston.

When using the jack, the trip free locking bar should be inserted in its designated hole so as to make the mechanism safe from accidental tripping.

Caution should be taken to be sure that the bottom of the jackscrew is within 1/16 inch of the bottom of the jack housing before power operation. The jack should be well lubricated with Stuaraco grease (Westinghouse material number 1082-4) which is especially designed for high pressures.

This device is not to be used for emergency manual closing of the breaker on a live line.

PART III - OPERATION

CLOSING

Starting with the mechanism in the open position (Fig. 2) with the trip-free latch system engaged, closing the control switch energizes the pilot valves coils which admits compressed air stored in the reservoir to the closing cylinder The force on the piston is transmitted to the breaker pull rod through the inverted toggle linkage.

When the breaker is nearly closed, the "bb" auxiliary switch contacts open, thereby shutting off the compressed air to the piston. The point where the "bb" switch makes up its contact is so near the end of the closing stroke, that the mechanism and breaker continue on into the overtravel position before the closing air is actually shut off. As the mechanism reaches the fully closed position (Fig. 1), the non-trip-free latch, biased by a spring engages the triangular link thereby restraining the straight-line linkage and holding 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.

NON-TRIP-FREE OPERATION

Energizing the control switch or protective relay to trip the breaker while the mechanism is in the closed position with no air pressure on the mechanism cylinder will energize the trip coil, thereby releasing the non-trip-free latch system. The trip-free linkage keeps the breaker and piston connected and both move to the open position (Fig. 2). The retrieving spring under the piston assists in the opening.

CLOSE-OPEN

Energizing of the trip coil during a closing operation will release the trip-free latch system. The breaker will move to the open position while compressed air in the mechanism cylinder forces the piston to or holds it in the closed position (Fig. 3). Near the end position the "bb" contacts on the five-pole switch open and de-energize the pilot valve coils thereby shutting off the air supply. As soon as the air in the cylinder is exhausted the piston will be returned to the open position by the retrieving springs. The trip-free latch and latch checking switch will be reset by their biasing springs to be ready for another closing operation.

OPEN-CLOSE

Reclosing requires the use of a separately mounted reclosing relay of the SGR-12 type. Energizing of the trip coil by the protective relays with the mechanism closed and no air pressure in the mechanism cylinder will cause the mechanism to trip non-trip-free. The piston remains coupled to the pull rod and the SGR-12 relay can energize the closing circuit.

As soon as the "bb" contacts on the five-pole switch in the "C" circuit are closed, admission of compressed air into the mechanism cylinder decelerates and reverses the direction of motion of the breaker to reclose the breaker. The completion of the operation is similar to a normal closing operation.

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

PART IV - INSPECTION, MAINTENANCE, ADJUSTMENT

INSPECTION

Since operating conditions vary 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 be 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.

A complete description of the compressor unit with recommendations for inspection and maintenance will be found at the back of this book following the drawings. These are Westinghouse Air Brake Company publications prepared especially for Westinghouse Electric Corporation.

MAINTENANCE

General Precautions

When working around the mechanism or breaker, OPEN the control circuit at the control panel, CLOSE the hand valve between the reservoir and mechanism, and OPERATE the pushbutton on top of the pilot valve to exhaust the high pressure air between the hand shut off valve and the control valve.

Accidental tripping of the breaker should be prevented by inserting the trip-free locking bar in its designated hole in front of the reversing lever and by lowering the screw of the hand closing jack until it engages the nut on the lower end of the piston rod. These

two devices make the mechanism completely safe from accidental tripping. Either device without the other leaves a hazard. The hand closing jack can be used to remove the load from the non-trip-free latches. The insertion of the trip-free locking bar does not remove the load from the trip-free latches, consequently they remain under load and any accidental release of the trip-free latch system causes it to release in the usual manner and the latch parts to attain high velocities before the locking bar stops the reversing lever. Because of the high mechanical ratio the movement at the breaker pull rod can hardly be detected.

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

The use of Dresser type fittings which do not exert any longitudinal restraining force make it necessary to tie the piping together with steel tie bars. If at any time it is required to work on the air piping while air pressure is in the reservoir, be sure that the tie bar holding the hand closing valve to the reservoir is secure. After reassembly of the piping, and before turning on the air, be sure all the tie bars are secure.

Personnel should be cautioned to keep all tools and especially their hands clear of mechanism whenever it is in the closed and latched position. Special attention is called to the moving parts which are outside the mechanism frame.

In order to be sure of the mechanism's good condition and to check its readiness for satisfactory operation, several operations should be made at each inspection period. This is especially important when the mechanism is not called on to operate for extended periods of time.

Latches and Triggers

All the latching members, non-trip-free and trip-free triggers, non-trip-free and trip-free latches, triangle and reversing levers are cast from a high strength non-ferrous alloy with corrosion resistant stellite inserts at the latching points. The engaging surfaces of the latches and triggers may be polished with fine emery cloth if they become dirty. DO NOT ATTEMPT TO GRIND THE SURFACES NOR CHANGE THEIR ANGLE. Apply a thin film of rust inhibitor to the latch and rollers in 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 are visible from the left side and front and should be examined at every inspection to make sure that they are not gummed up. Rollers should turn freely on their inner races.

The bearings are packed with a grease suitable for a wide range of ambient temperatures and should not require repacking for several years. The Westinghouse material number for this grease is 9921-4.

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 trip-free locking bar to prevent accidental tripping trip free. Pull the mechanism slightly into the overtravel position to take the load off the latch. Then reverse the jack and while holding the hand trip knob in the tripped position, operate the jack slowly to open the breaker. The hand trip knob can be released as soon as the non-trip-free roller lever moves to release the non-trip-free latch.

Hand Closing Jack

High pressure Sturaco grease (Westinghouse M1082-4) should be used to lubricate the hand closing jack. The jack screw should be lubricated with this grease every 4 or 5 operations in order to minimize wear.

Mechanism Closing Cylinder

If for any reason the cylinder is removed such as for inspection of cylinder, piston and rings on re-assembly care should be exercised in pulling up the four nuts on the holding bolts evenly and to tightness of 450 Ft. Lbs. with a torque wrench.

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.

Pilot Valve

The first place to check for leaks is in 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, the valve plunger can be removed for inspection by unscrewing the hex-head plug on the bottom of the housing. In replacing the valve, make sure that the small valve stem enters the hole in the end of the plunger before replacing the plug.

Inlet Valve

Checking for leaks past the main inlet valve can be accomplished by applying a soap solution over the bleeder hole through the left side of the valve body. However, it is necessary to close off the exhaust by tightening up the nut on the upper end of the exhaust valve stem. 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. With the supply of compressed air shut off, the valve can be removed for inspection of the rubber disc seat by removing the cover on the underside of the valve body.

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

ADJUSTMENTS

Pressure Gauge

It is advisable to check the pressure gauge with a calibrated gauge to verify the corrections 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. The slotted knurled stud protruding through the top of the switch case controls the pressure range setting. 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 that are possible from a fully charge reservoir. The governor switch is normally set to start up the compressor at a pressure well above the operating pressure of the cut-out switch, thus the cut-out switch is not normally called on to operate except in the event the compressor is out of operation. Since this switch may remain idle over long periods, its readiness to operate in an emergency should be checked at each inspection period. LOW PRESSURE ALARM - The low pressure alarm switch is intended to give a warning to the operator in the event that the compressor fails to recharge the reservoir. Therefore, in order to forestall erroneous indication of the alarm, the setting of the alarm switch should be checked. SAFETY VALVE - To insure against overloading the compressor unit or damage to the mechanism and breaker from operating at excessive pressures in the event of failure of the governor switch to cut off the compressor, the safety valve is set to open at 115 to 120 per cent 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.

11-Pole Auxiliary Switch

It is important to adjust the 11-pole auxiliary switch on a closing stroke so that the trip circuit is made up by the time it is possible to have the relay contacts close in response to a fault current. However, it is also important not to have this switch energize the trip circuit too early, so as not to punish the pneumatic mechanism too severely, on trip-free operations made during testing without benefit of relay time. The proper setting which will satisfy both of the above conditions is to have the auxiliary contacts close when the breaker lift rod is 1.3 to 1.4 inches from the full-closed position. This position of the lift rod may be held by means of the hand closing jack and measured on a timer rod connected to the lift rod through the tank top.

Trip-free operations are rather severe at low operating pressures when initiating the trip circuit directly by the auxiliary switch on test operations, because the slower speed allows the piston to be released farther from the closed position. For this reason, it is considered good practice to confine trip-free operations for breaker test or relay checks to higher pressures within the range of the pneumatic governor switch. If trip-free operations at minimum pressure are considered essential for breaker testing, then the 11-pole auxiliary switch should be adjusted temporarily to energize the trip circuit no farther than 3/4" from full-closed position.

Tripping

The latch and triggers on this mechanism are made to close tolerances and therefore no adjustment is provided.

The adjustment of the stop limiting the overtravel of the reversing lever should be checked occasionally. With the mechanism in the open position Fig. 2, there should be approximately 1/32 to 1/16 clearance between the latching surface of the reversing lever and the latching surface of the trip-free latch to insure positive resetting of the trigger. More clearance than is necessary at this point will impose severe hammering of the surfaces 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 end of the steel follower stem should be positioned to hold the steel follower against the rubber bumper without putting any initial compression on the rubber bumper.

The travel for the trip armature should be approximately 1/8". This adjustment is made by varying the height of the resiliently supported stop (Fig. 2). For positive operation,

the length of the trip rod should be just long enough to release the non-trip-free trigger without using the last 1/32 inch of armature travel. This adjustment has been made at the factory and should not require changing. It can be changed, 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 until it is just long enough to trip the mechanism with 1/32 inch spacers in the air gaps.

The "Kick-Off" spring on the lower end of trip rod hastens the retrieving of the armature after the trip coil is de-energized. When the armature is against the pole faces of the magnet, this spring should be compressed about 1/16". Thus for an armature travel of 1/8", the gap between the underside of the resilient stop bar and the top of the kick-off spring should be 1/16". If it is ever necessary to change this factory-set adjustment, be sure to keep the trip rod from turning in 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 1/8" to allow time and clearance for the non-trip-free latch to snap into place. There is no adjustment of the overtravel, but it should be checked to determine that it exists. 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 pin at the piston rod end. If no overtravel is present, it may indicate that the stops in the breaker pole unit are engaging too much ahead of the overtravel stop on the mechanism.

PART V - TROUBLE SHOOTING SUGGESTIONS

1. FAILURE OF THE MECHANISM TO CLOSE THE BREAKER

A. If the mechanism closes all the way but the non-trip-free latch does not hold, the breaker will "drift" open as the air in the operating cylinder exhausts.

1. Check the position of the non-trip-free trigger, making sure that the upper end of the trigger is against the stop of the non-trip-free roller lever and the gap between the roller and the trigger is approximately 1/32".

2. Check for damage to the triangular link, non-trip-free latch, non-trip-free roller lever, non-trip-free trigger and their springs.

3. Close the mechanism by operating the pushbutton on the pilot valve and while holding mechanism closed with air.

(a) Check the mechanism overtravel, making sure there is sufficient travel for the non-trip-free latch and triangle to engage. If there is not sufficient overtravel, check the closed position of the breaker.

(b) Check that the non-trip-free latch is located in the engaging position by the rest on the triangular link.

B. If the breaker closes all the way but releases trip-free.

1. Check the position of the trip-free trigger making sure that the trigger is against the stop on the trip-free roller lever and the gap between the roller on the trip-free roller lever and the trip-free trigger is approximately 1/32".

2. Check trip-free latch, reversing lever, trip-free roller lever, trip-free trigger and their springs for damage.

3. Check possibility of the trip circuit being energized during the closing.

4. Check for abnormal shock on closing, probably resulting from mechanical failure and loss of load in the breaker causing extreme velocities at the end of the stroke.

(a) Shock resulting from the piston hitting the end at the high velocities and bouncing so that the triangular link hits the non-trip-free latch may be detected by observing if the roller lever is subjected to shock during an operation. Repeated shock may bend the pivot pin of the non-trip-free roller lever. This can be checked by rotating the pin.

(b) Shock on closing may cause the trip rod to bounce and trip the trip-free trigger. This may be checked by blocking the armature during an operation.

C. If the mechanism closes only part way, repeat the operation by manually operating the pilot valve pushbutton.

1. If the manual operation is successful it would indicate that the trouble was electrical.

(a) While mechanism is latched, check the five pole auxiliary switch for wide gaps at the "bb" contacts causing early cut-off of the air.

(b) While the mechanism is latched, check the 5 pole auxiliary switch for large contact overlap at "aa" contact causing early energizing of cut-off relay.

(c) Check minimum operating voltage of the cut-off relay. If it is too low it could cut the air off early.

2. If the manual operation does not completely close the mechanism, the trouble is probably mechanical.

(a) Check the air pressure to be sure it is above the minimum closing pressure.

(b) Check that the hand shut-off valve between the air reservoir and mechanism is completely open.

(c) Check to see if the bleeder hole on the left side of the main valve is open. Obstruction of this hole could cause a pressure to build up beneath the valve piston, thereby allowing the spring to close the main valve.

(d) Check the condition of the main valve disc, fracture of this or separation of the neoprene from the backing plate could block the main valve opening. An operation with a slightly damaged valve disc is characterized by a short admission of only a very small amount of air into the main cylinder.

(e) Check for excessive air leakage around the main operating piston which indicates that the piston rings are not in or that the cylinder is damaged. Check the leakage at outlets in the underside of the cylinder when the operating mechanism is held partially closed by air pressure below the minimum operating pressure.

(f) Check the 5/16" travel of the moving valve assembly of the main valve by removing the top cover on the valve body and pushing the valve piston down. Be sure the hand shut-off valve is closed and air bled through the pilot valve.

D. If the mechanism does not close at all, attempt a close operation by manually operating the pilot valve pushbutton.

1. If the manual operation is successful the trouble is probably electrical.

(a) Check to see that the correct control voltage is available.

(b) Check the closing relay to see that it closes its contacts.

(c) Check to see if the latch-check switch is closed. If it is open, the trip-free latch may not be engaged, which would indicate that either the resilient stop locating the reversing lever was too close or that the vertical pull-rod travel should be checked. The piston movement must be limited by the resetting of the trip-free levers and not by the top of the cylinder.

(d) Check the circuit of the pilot valve coils.

(e) Check the circuit through the 5 pole auxiliary switch.

2. If the manual operation was not successful it would probably indicate that the trouble was mechanical.

(a) Check that the hand shut-off valve is completely open.

(b) Check the condition of the main valve disc, fracture of this could block the main valve opening. This condition is characterized by the pilot valve operating and allowing the control air in but no air will get by the main valve as the damage disc keeps the opening sealed.

II. THE MECHANISM FAILS TO TRIP

A. Check the voltage at the trip coil.

B. Check the terminals at the 11 pole auxiliary switch to be sure that they are making good contact.

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

D. With the bar preventing trip-free operation in place, use the hand closing jack to take the breaker load off the latch. Then raise the trip rod manually and observe whether the non-trip-free trigger is disengaged and the non-trip-free roller lever is free to rotate and let the latch release the triangular link.

III. ON A RECLOSING OPERATION, THE MECHANISM TRIPPED BUT FAILED TO RECLOSE

A. Check the "bb" contact on the 5 pole switch to see that it is making good contact after a short opening movement. The setting determines the reclosing time.

B. Check to make sure that the cut-off relay is not picking up prematurely and locking out the closing relay. The cut-off relay is energized if the "bb" contacts make before the "aa" contact part.

C. Make the normal closing operation, if this is not successful refer to the suggestions listed in topic No. I.

IV. THE MECHANISM FAILS TO TRIP-FREE DURING A CLOSE-OPEN OPERATION

A. Check to see if the trip-free locking bar preventing trip-free operation is in.

B. Check that the "a" contact on the 11 pole auxiliary switch is making good contact when the mechanism is closed.

C. Check that the selector assembly including the selector piston is free, and operates when compressed air is admitted to the mechanism cylinder.

D. With the mechanism in the open position, raise the trip rod manually and observe whether the trip-free trigger is disengaged and the trip-free trigger is free to rotate and let the latch release the reversing lever.

LINK

LEVER STOP

LEVER

LATCH
SPRING

LATCH

ROLLER LEVER

EVER STOP PIN

TRIGGER

STOP PIN

BAR

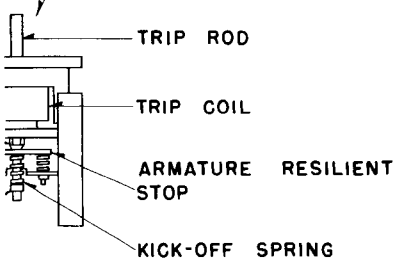
RING

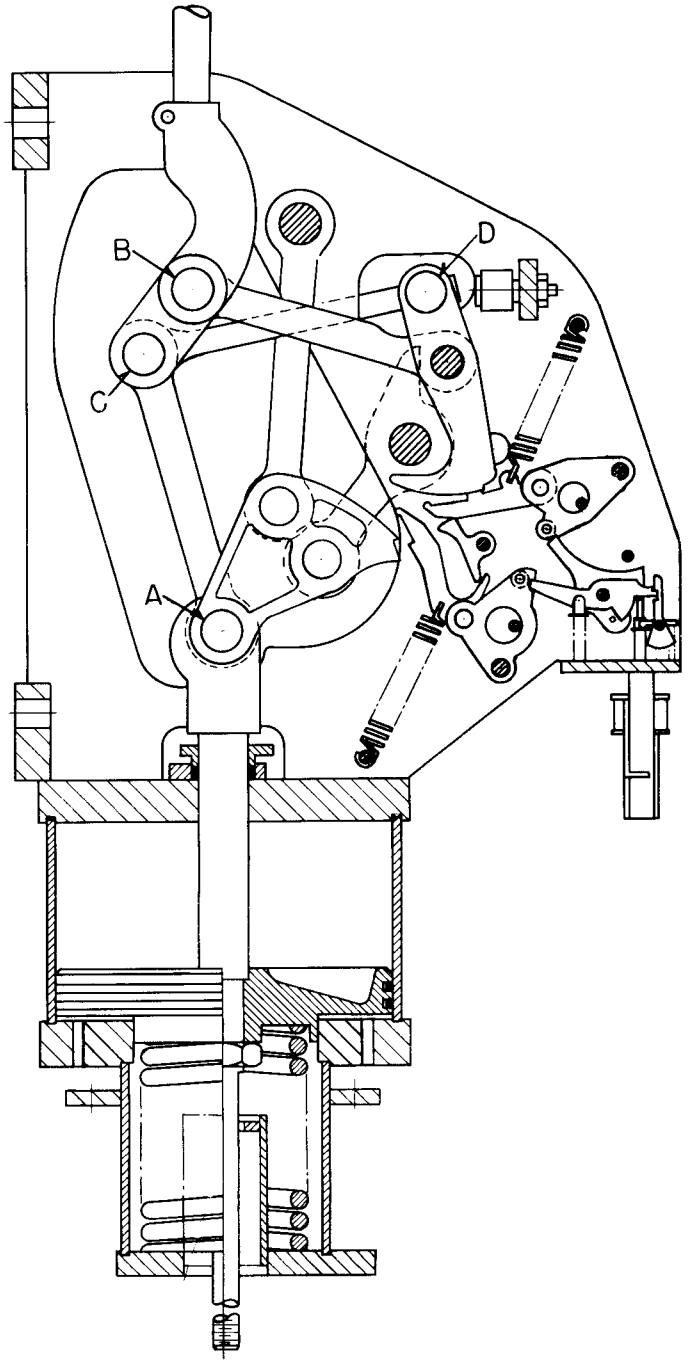
PRING

ET ASSEMBLY

LEVER

N



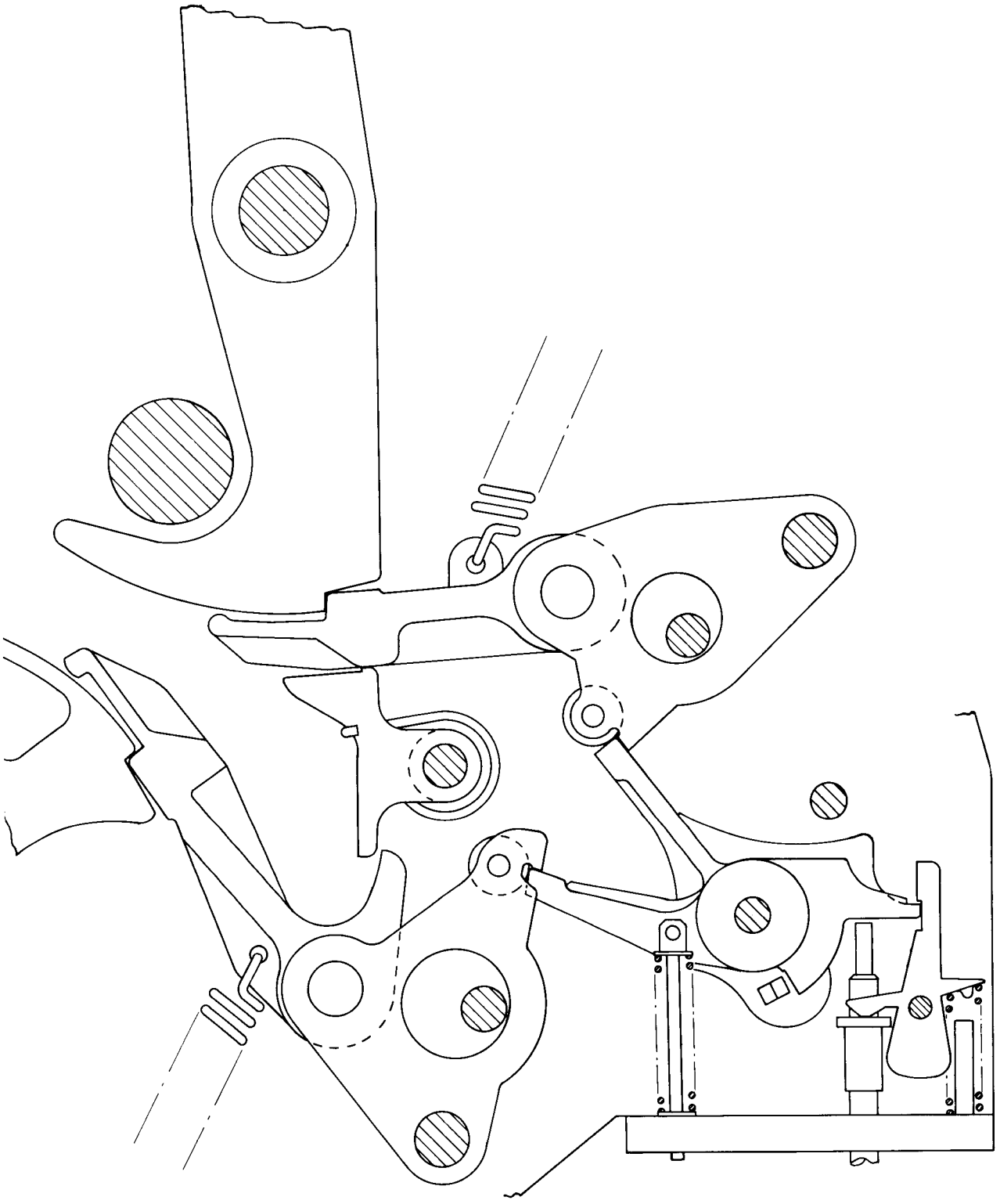


TRIP-FREE POSITION

FIG. 3

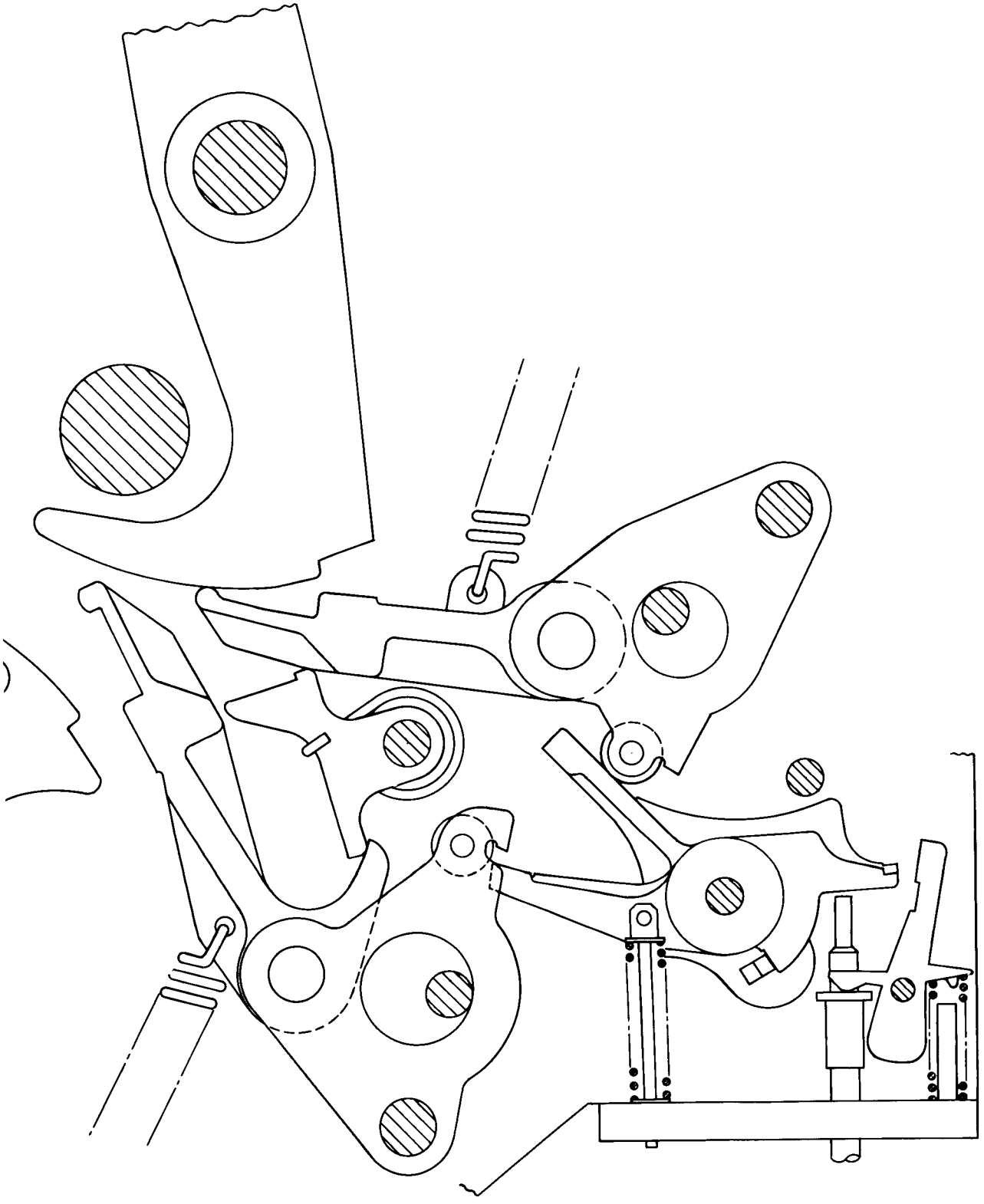
LATCHED POSITION

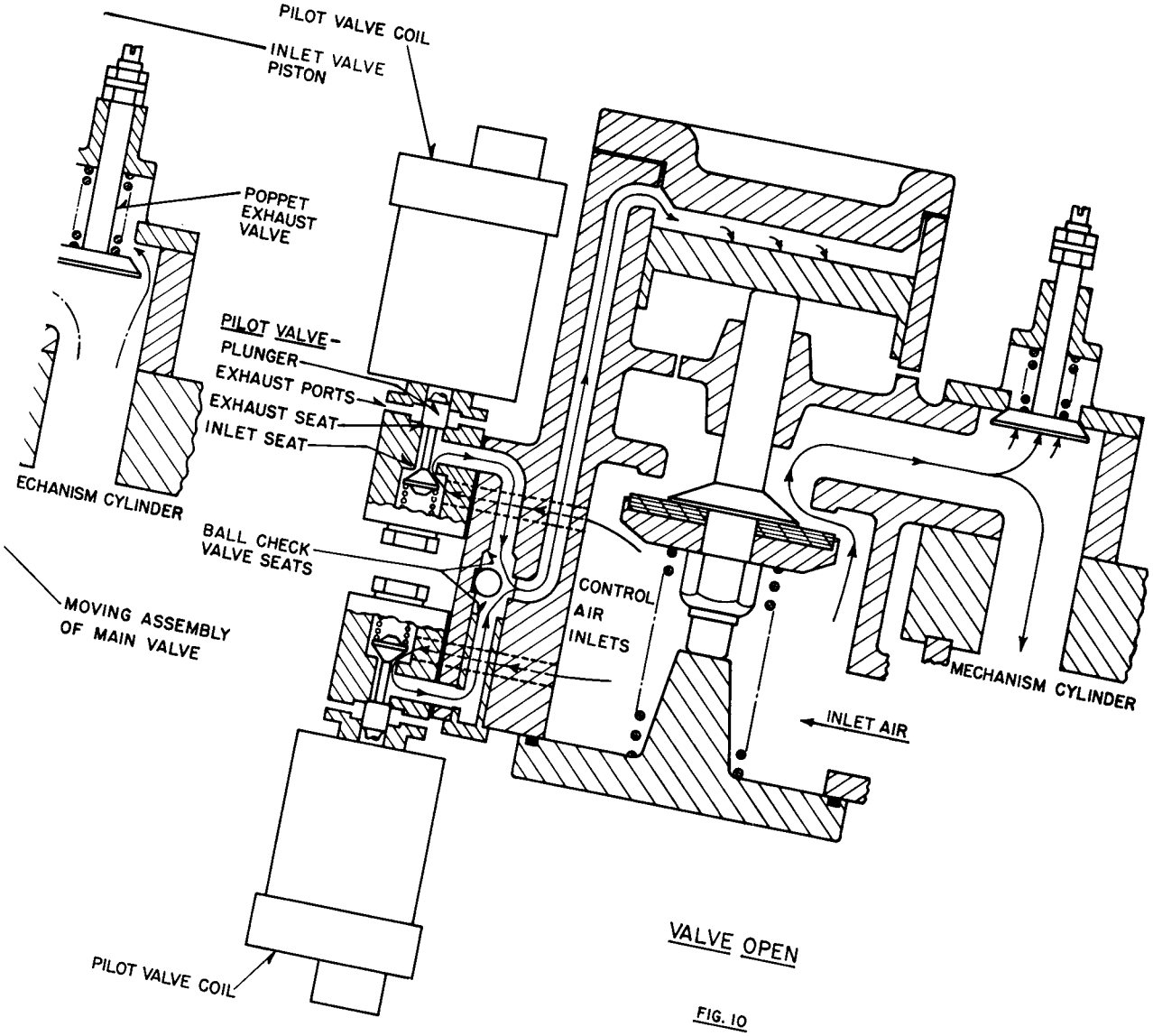
FIG.5



TRIP-FREE TRIP

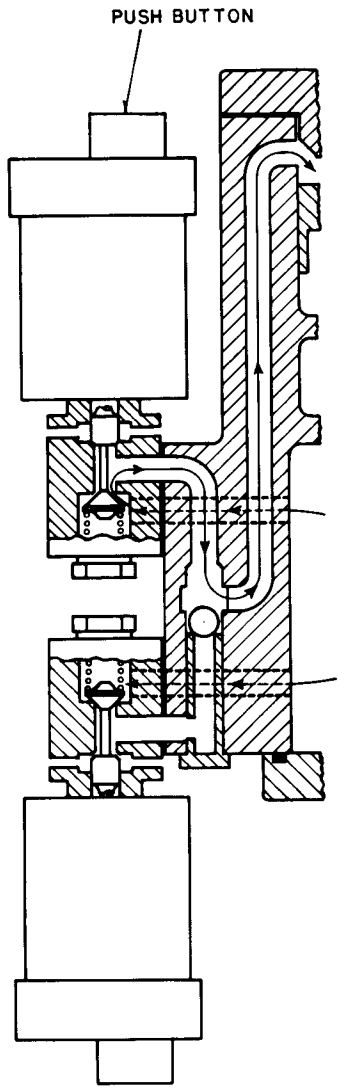
FIG. 7





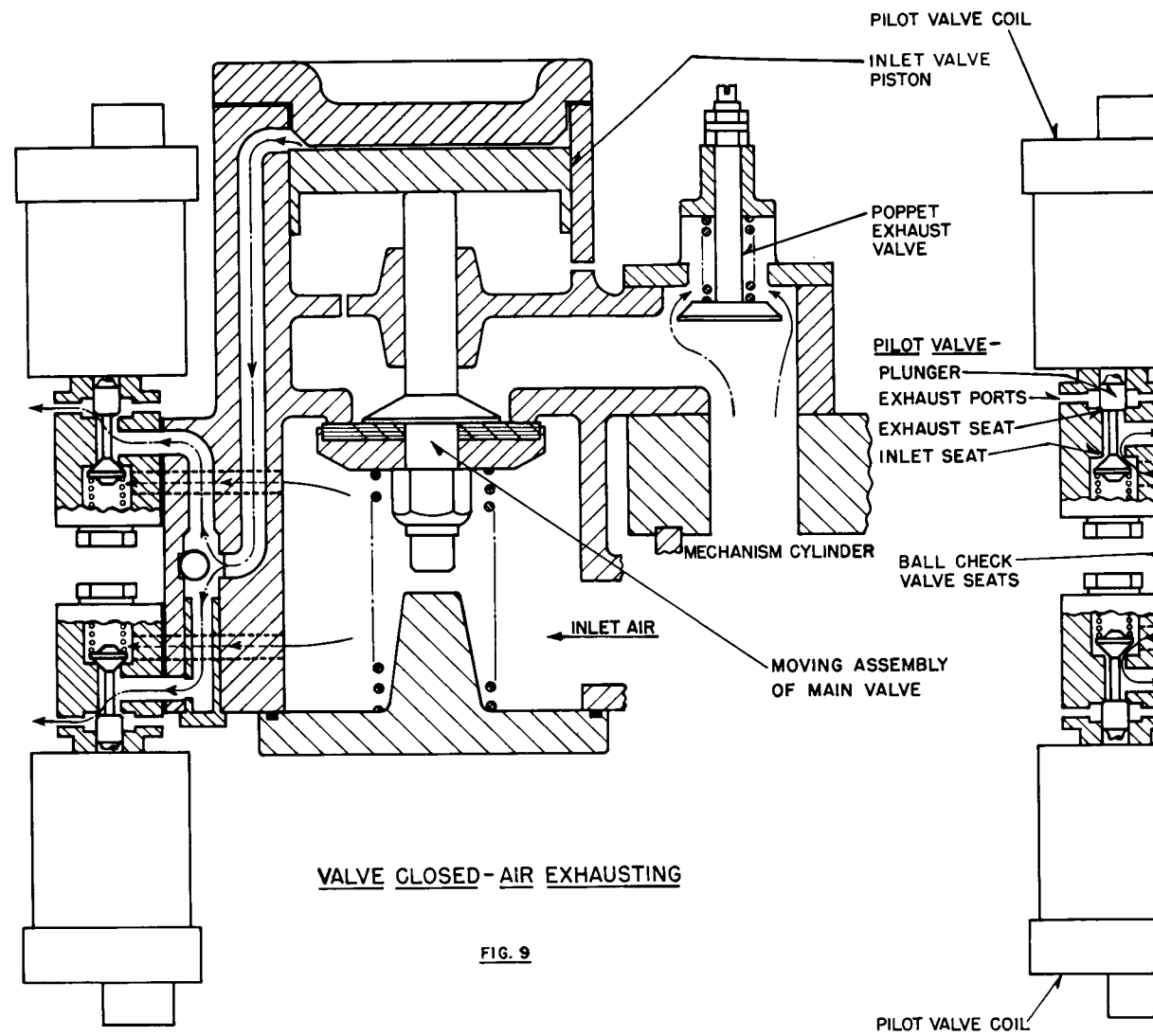
VALVE OPEN

FIG. 10



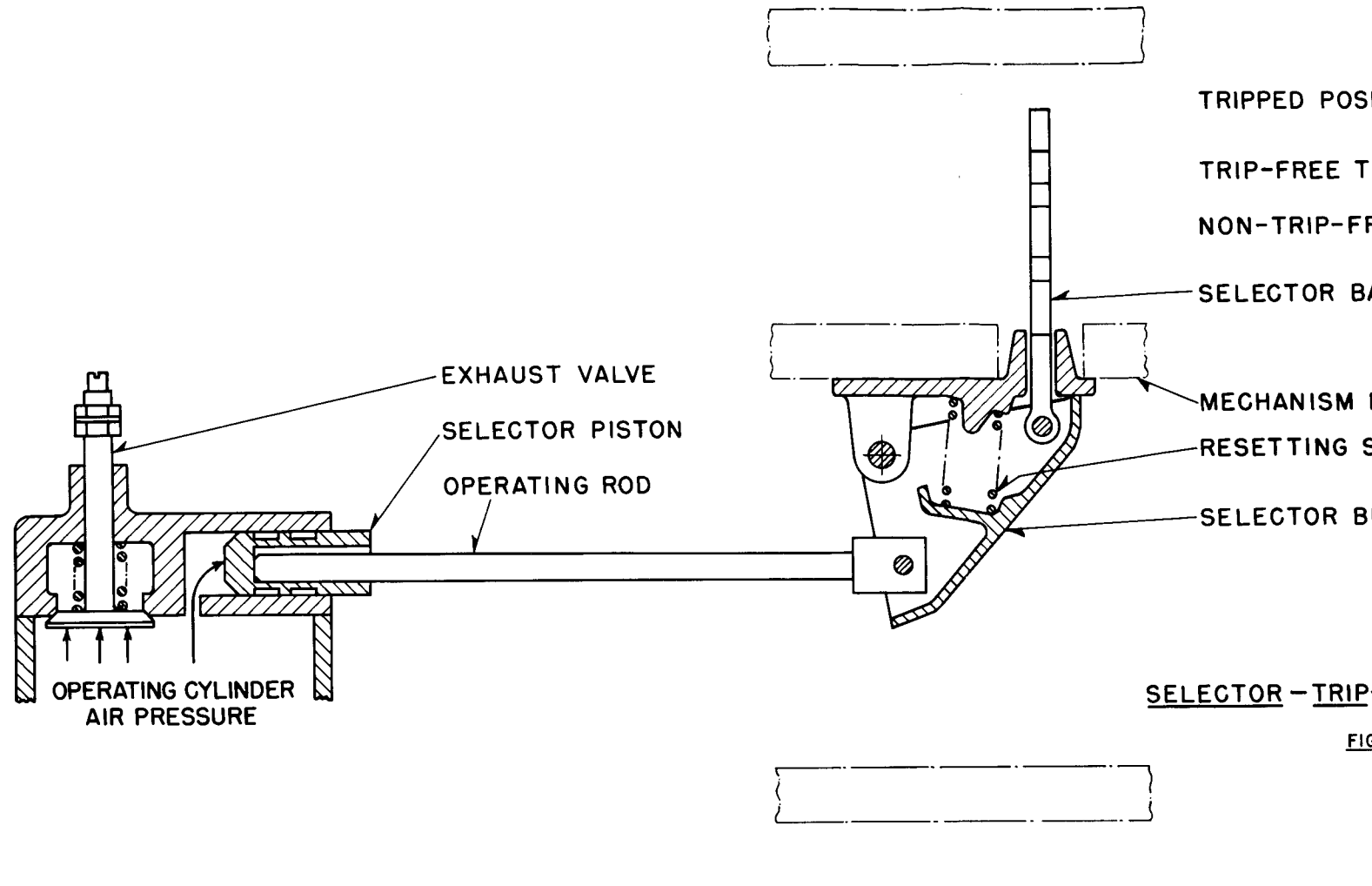
HAND OPERATION THRU
ONE PILOT VALVE

FIG. 8



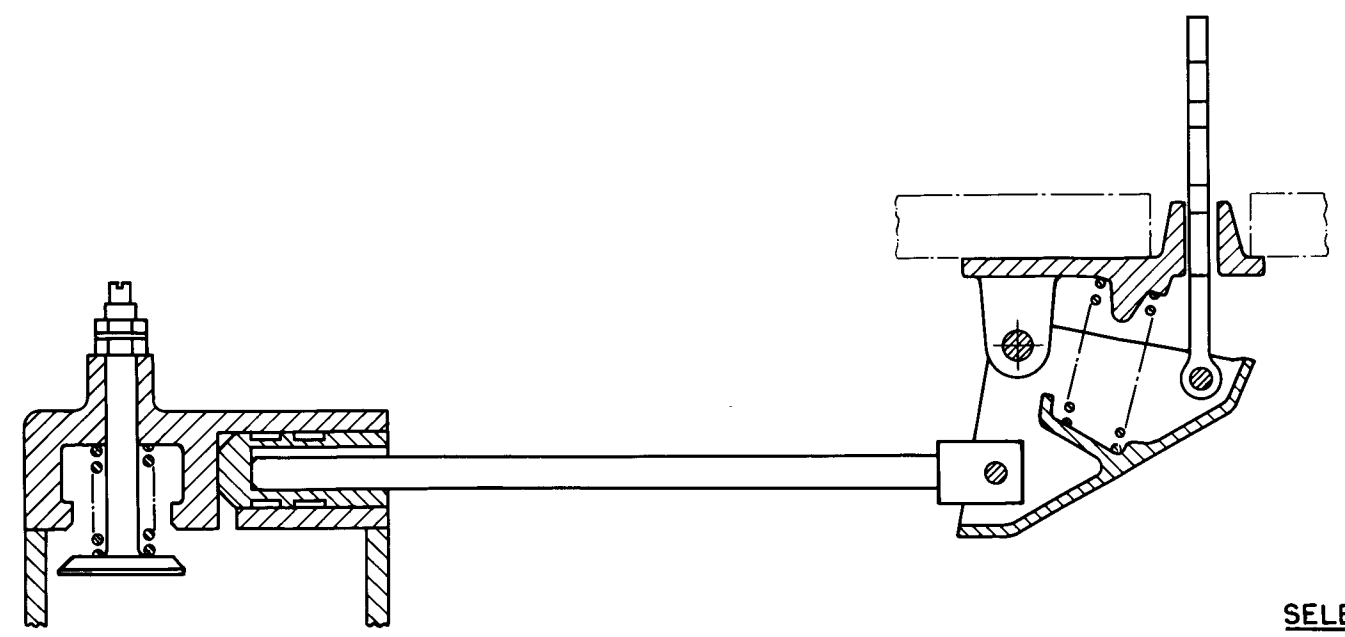
VALVE CLOSED - AIR EXHAUSTING

FIG. 9



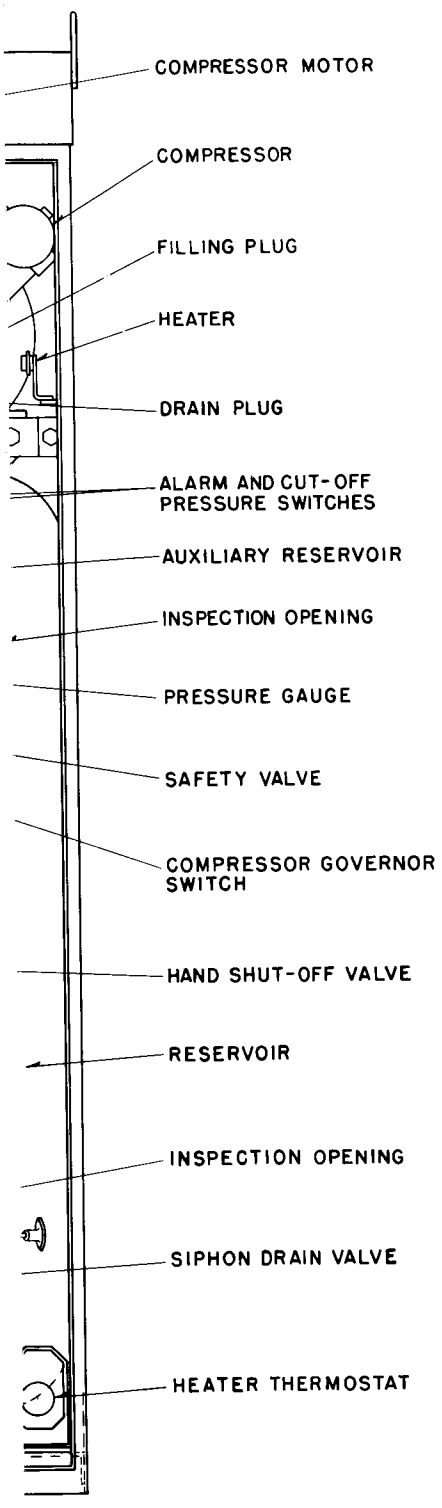
SELECTOR – TRIP-

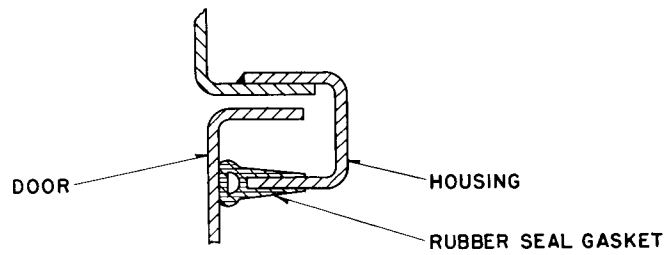
FIG.



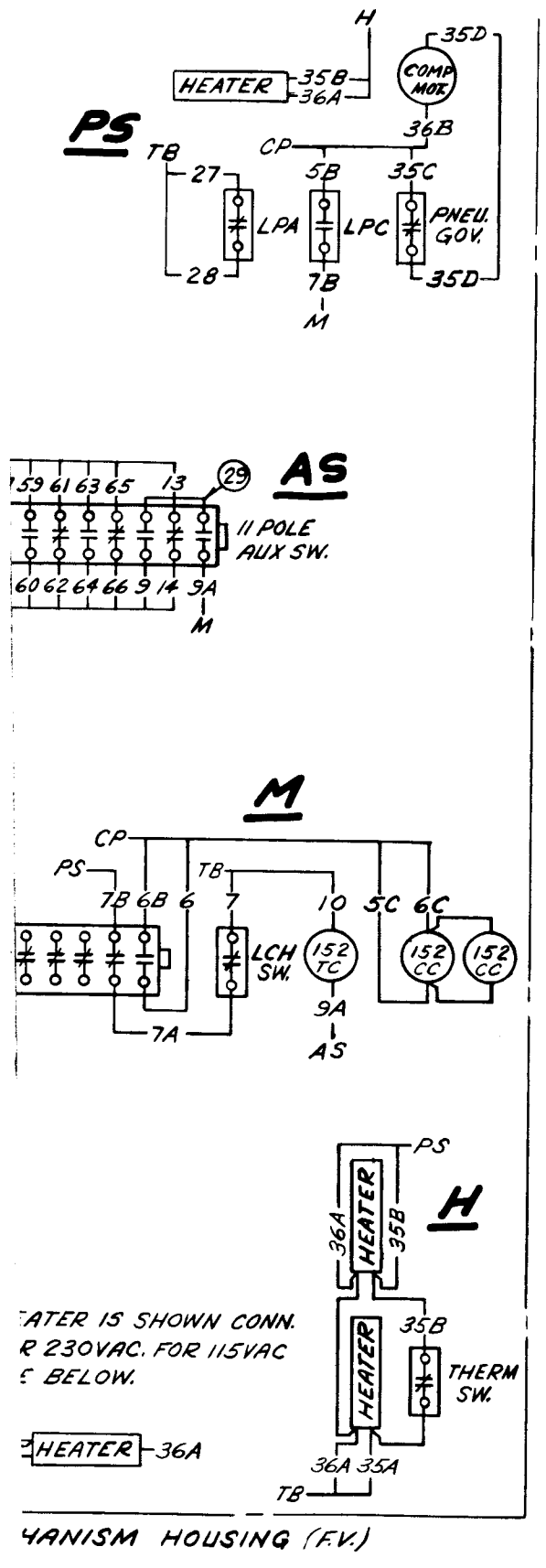
SELECTOR – NON-TRIP

FIG.





TYPICAL DUST SEAL
AROUND DOORS

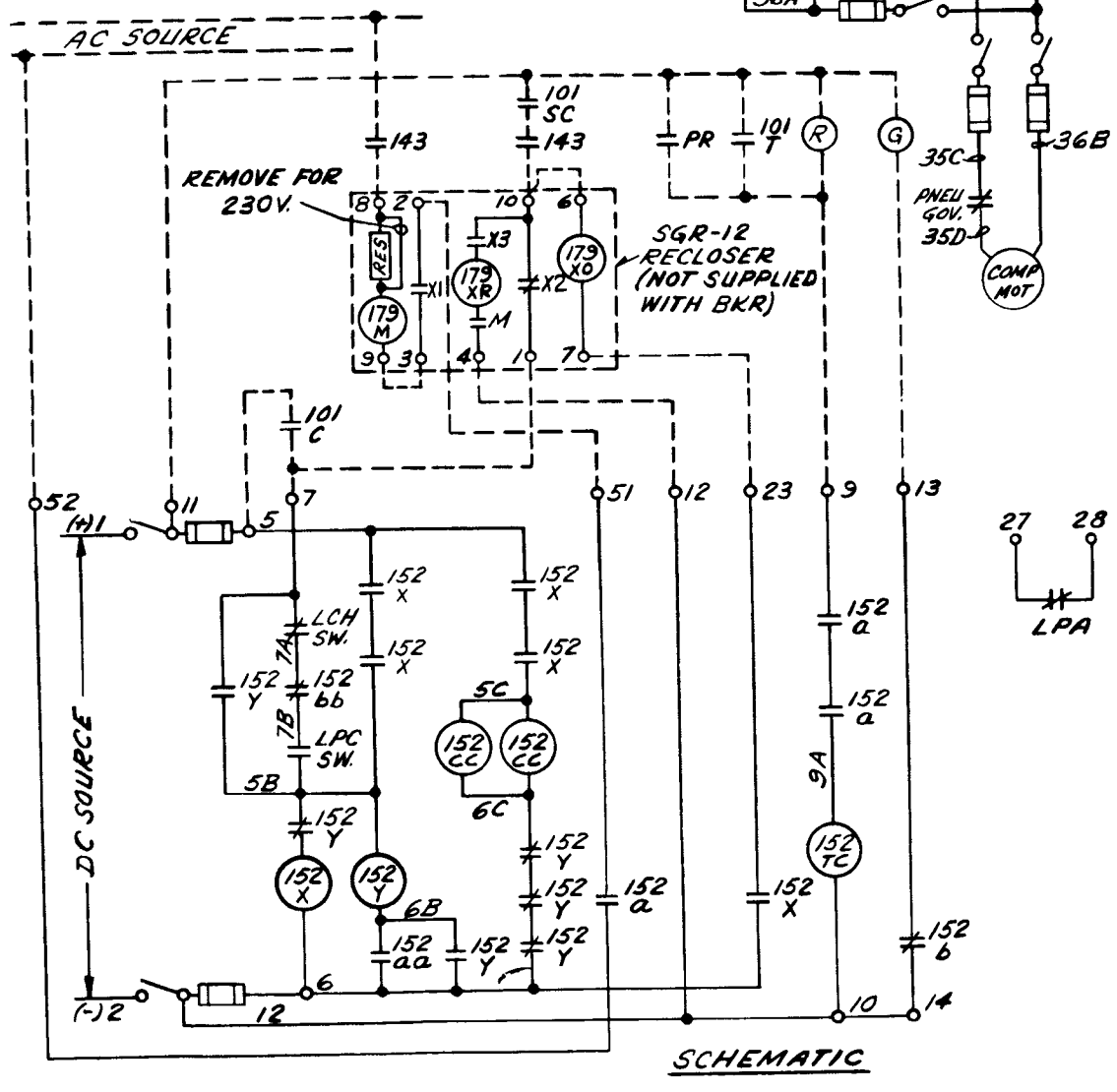


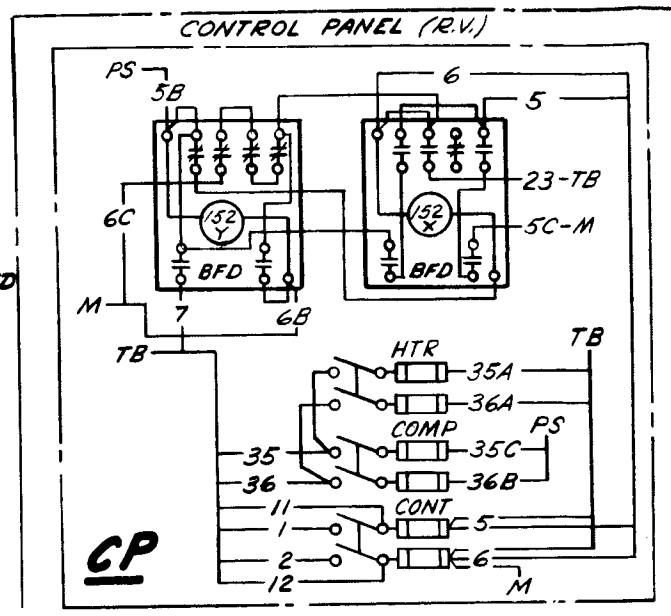
DWG. 1691C300

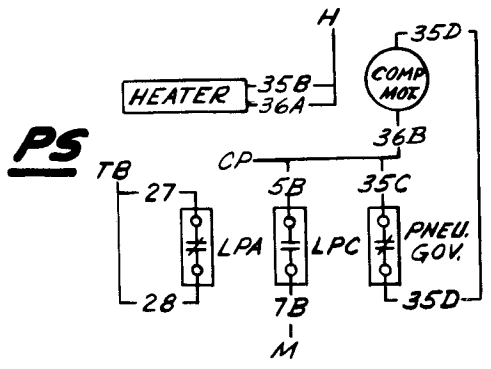
AUX SW. SHOWN FOR OPEN BKR
RELAY CONTACTS SHOWN DE-ENERGIZED
PRESS. SW. SHOWN FOR LOW PRESSURE
⊣⊢ OPEN CONTACT
⊣⊢ CLOSED CONTACT
o - ACCESSIBLE TERMINALS
152CC - INTAKE MAGNET VALVE COIL
152TC - TRIP COIL
LCH - LATCH CHECK SW.
LPA - LOW PRESS. ALARM (CLOSED ON L.P.)
LPC - LOW PRESS CUTOUT (OPEN ON L.P.)
152X - BKR CLOSING RELAY
152Y - BKR CLOSING CUTOFF RELAY
143 - REMOTE TOGGLE SW.
101 - REMOTE CONTROL SW.
PR - PROTECTIVE RELAY

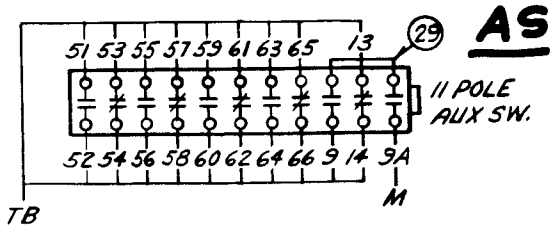
SHOP NOTE:
NUMBER IN CIRCLE CORRESPONDS TO ITEM NO. ON JUMPER DWG. 3288000

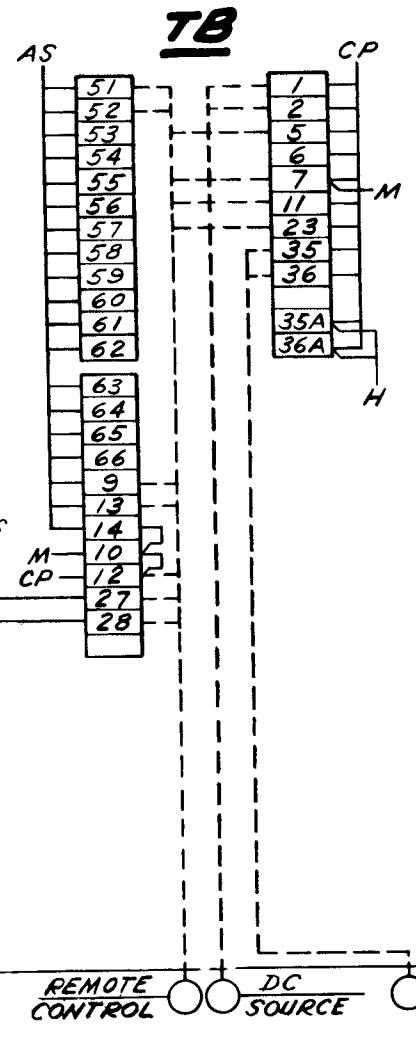
NOTE:
CP, PS, AS, TB, M & H ARE INDIVIDUAL WIRING AREAS INTERCONNECTED AS INDICATED

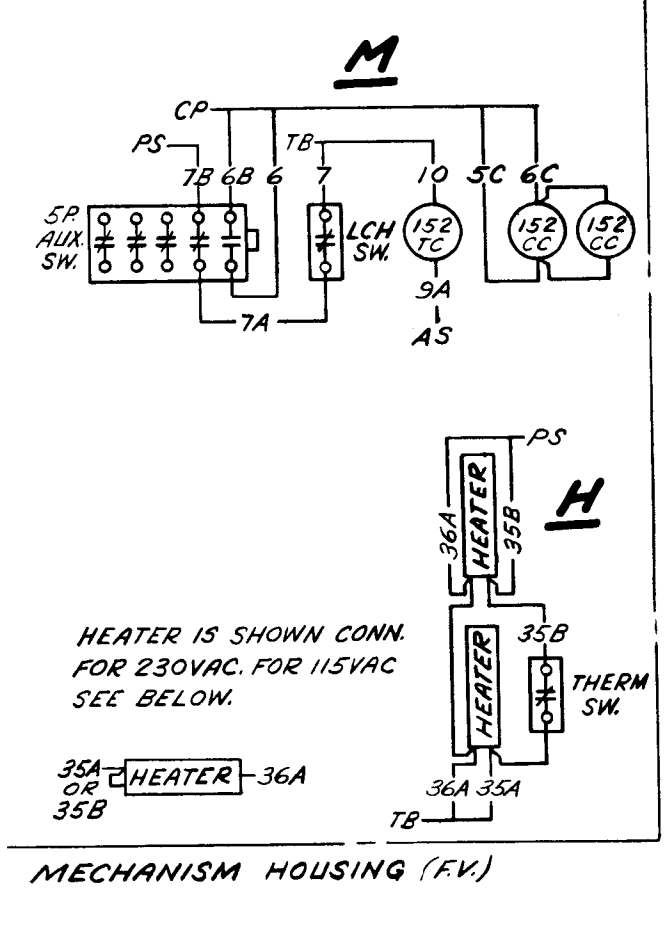












REMOTE CONTROL — DC SOURCE — 230VAC SOURCE

MECHANISM HOUSING (F.V.)