

INSTRUCTIONS FOR "PC" CONTROL

INSTALLINGCONTROLLER SUPPORTS

Previous Sprague General Electric control systems have been made up with each contactor a self-contained unit and no particular care in lining up the car-body supports was necessary. With the PC controller, in which all contactors are operated from a cam shaft, it is essential that the supports attached to the car-body, from which the controller is suspended, be accurately installed, as, otherwise, the controller framework will be pulled out of shape and prevent the controller operating in a satisfactory manner. The points of support should not vary more than 1/8" from one plane. Poor alignment may be indicated by the cam shaft not rotating at 45 pounds air pressure, or controller may start slowly and pass beyond the point where it should stop.

INSULATING FROM GROUND

The PC controller is arranged to be insulated from ground and clearance should be provided between all grounded pipes, hangers, brake rods, etc. and the metal box of the PC controller.

The insulation between the supports and the controller should be installed so that the bolts fastening the controller to its supports are not grounded.

The insulating joint used in the air pipe should be placed in a vertical pipe to prevent water collecting on the interior insulating surface.

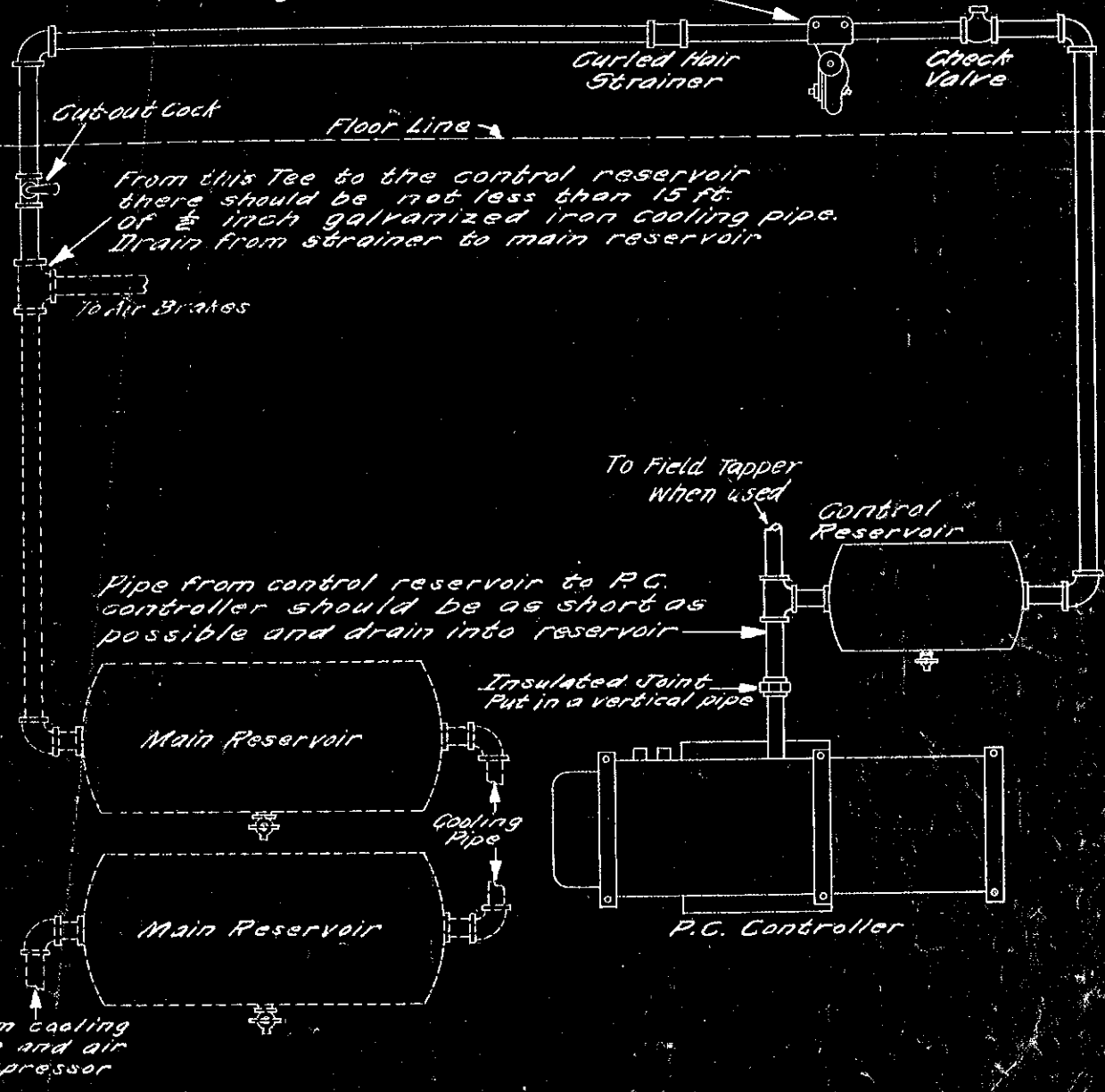
AIR PIPING

For air brake operation, it is ordinarily recommended that the air piping from the compressor be arranged to condense moisture contained in the air. For compressors of 25 cu. ft. per Min. capacity, not less than 25 ft. of cooling pipe is used. With compressors of larger capacity, a greater amount of cooling pipe is required.

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Connections of Piping for P.C. Control

Reducing Valve set for 70 lbs. on control side. When main reservoir pressure does not exceed 80 lbs. reducing valve is omitted



From this Tee to the control reservoir there should be not less than 15 ft. of $\frac{1}{2}$ inch galvanized iron cooling pipe. Drain from strainer to main reservoir

To Air Brakes

To Field Tapper when used

Pipe from control reservoir to P.C. controller should be as short as possible and drain into reservoir

Insulated Joint Put in a vertical pipe

REVISED JULY 1, 1918

K-1631910

Redrawn 8562 1915

Checked RSB

Approved F.E. Case

29 Mar. 1915

Engineering Dept.
General Electric Company

For the PC controller, at least 15 ft. additional 1/2" galvanized cooling pipe is recommended. This cooling pipe should be installed between the air brake reservoir and the control reservoir for the PC controller.

The control reservoir should be located so that not over 15 ft. of pipe is needed to connect it to the PC controller. A shorter length is desirable. The piping Diagram, Page #2 shows the general arrangement and connections of the air details.

The piping should be arranged to drain the moisture into reservoirs.

When installing the air piping for the control, care should be taken to remove all rust and scale. After the piping is installed, it should be pounded with a hammer and blown out before connecting to the strainer or PC controller.

SEQUENCE FOR PC-101 CONTROLLER

When the cam shaft of the PC-101 controller is turned on between points 2 and 3, the tips of the R3 contactor should touch before the tips of either the R4 or R5 contactors separate. Between points 5 and 6, the tips of the P contactor should touch before the tips of R5, S1, and S2 contactors separate and the tips of contactors R5, S1 and S2 should be separated when the tips of contactors R3 and G touch. Between points 8 and 9, the tips of R5 contactor should touch before the tips of R3 contactor separate.

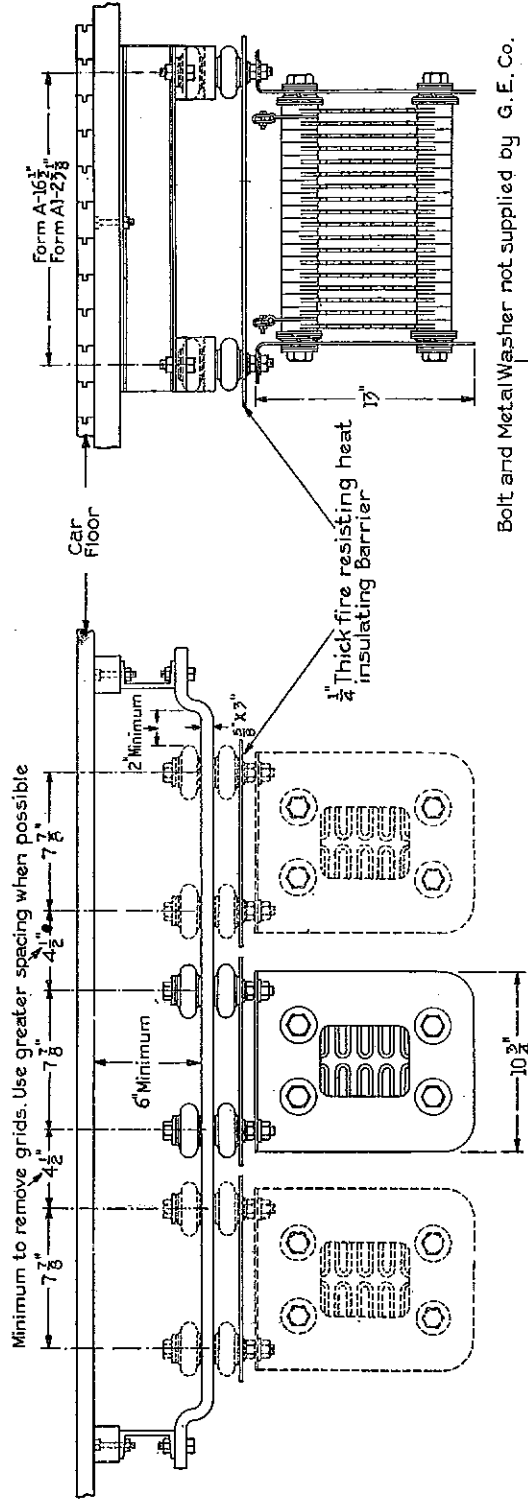
PC-10 AND PC-12 CONTROLLERS

CONTACTOR UNITS

When a complete contactor is put in the PC-10 or PC-12 controller, its position may be located from its cam roller. Slotted holes in the contactor support provide means of adjustments. As all of the cam rollers are in line, a straight edge held against those in position will locate the one being put in.

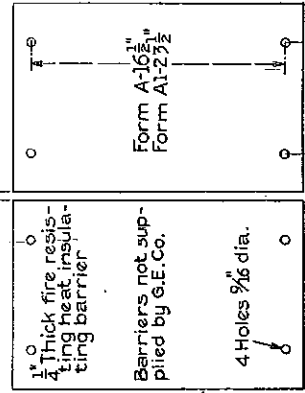
The arc chute should be closed before the cap screws fastening the contactor in place are finally tightened, in order that the contactor may shift sideways until it takes its correct position.

METHOD OF SUPPORTING TYPE RG RESISTORS USING PORCELAIN BOLT INSULATORS, FOR 600- AND 1500-VOLT WORK

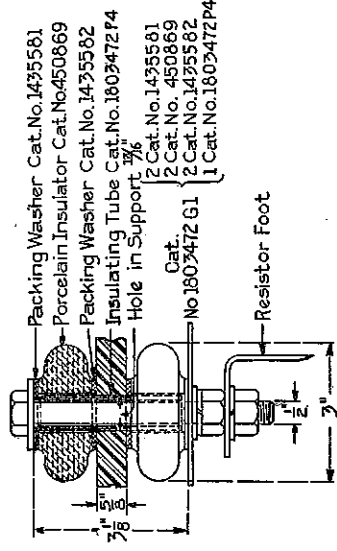


Bolt and Metal Washer not supplied by G. E. Co.

$\frac{1}{2}$ " Space between barriers

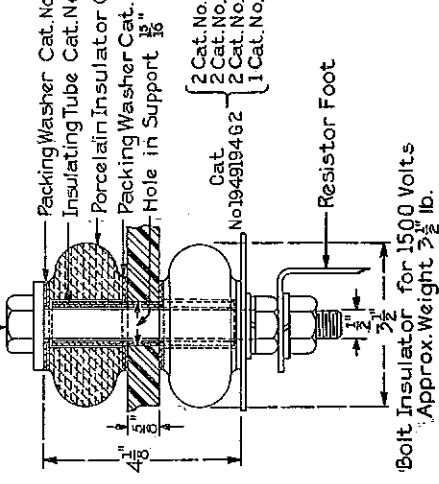


Bolt and Metal Washer not supplied by G. E. Co.



Bolt Insulator for 600 Volts
Approx. Weight 2 lb.

Bolt and Metal Washer not supplied by G. E. Co.



Bolt Insulator for 1500 Volts
Approx. Weight $2\frac{1}{2}$ lb.

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15 FEB., 1921

ENGINEERING DEPT.
GENERAL ELECTRIC COMPANY

No. 15249

3m 2-14-21

CONTROL DRUM

In order to remove the control drum, take out the cap screws holding the bearing at the line breaker end of the cylinder. Then slip the bearing off the shaft and the drum can be easily disengaged from the clutch and removed.

It is possible to put the control drum in place 180° from its correct position, and to prevent this, the two parts of the clutch, between the drum and the cam shaft, are marked.

CAM SHAFT AND PINION

To remove the cam shaft, first take out the control drum, then take off the steel strap used as a stop for the covers. The cam bolts holding the cam shaft bearings can now be taken out and the cam shaft removed.

In order that the cam shaft and pinion may be correctly assembled in the rack, the best method is to mark the pinion and rack before taking these parts out. In case this is not done, the rack and pistons should be pushed toward the "on" magnet valve as far as they will go. The cam shaft and pinion are then put in place, so that none of the gears touch the cam rollers on the contactors.

LINE BREAKER

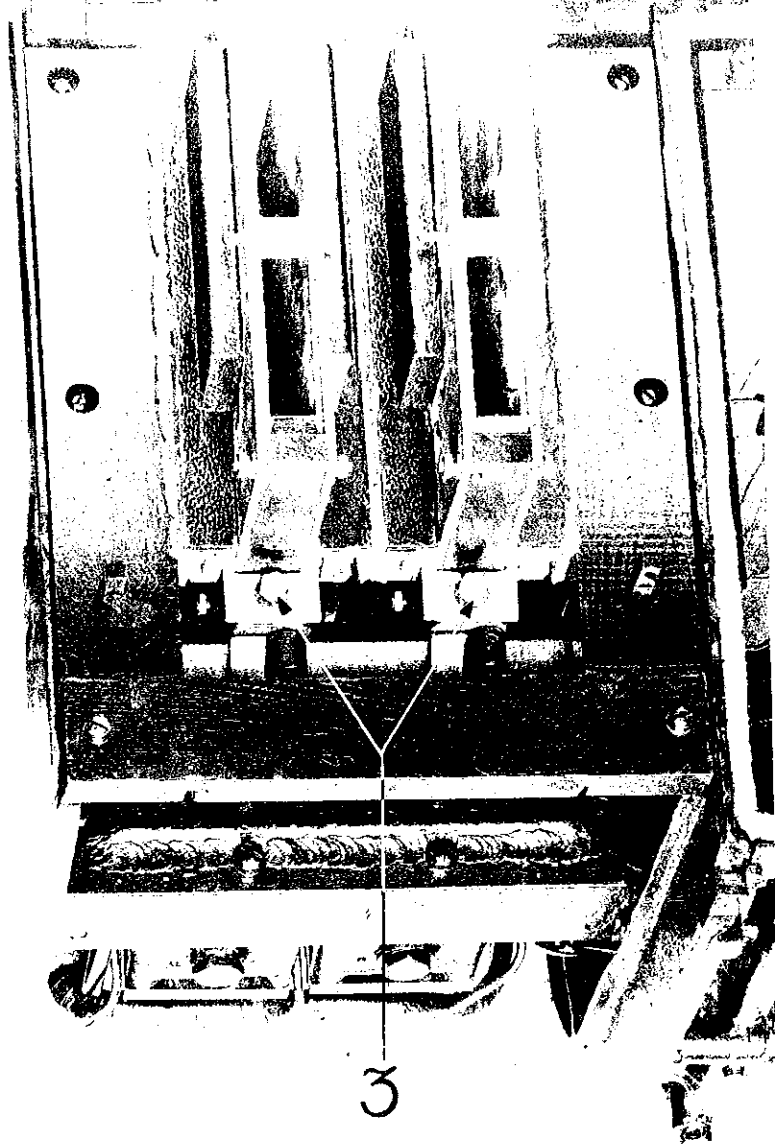
The PNEUMATIC PORTION of the line breaker is removed by disconnecting the control leads on the magnet valves, breaking the air connection at the pipe union and removing the four cap screws holding these parts to the controller frame. The air cylinders and magnet valves may then be removed toward the back of the controller until the yoke is disconnected from the pin thru the contact arm. Page 12 shows this yoke and pin.

The ARC CHUTE is removed by taking out two cap screws. These cap screws are accessible from the bottom of the controller and are located in the arc chute pole pieces, on the outside of the arc chute, adjacent to the contact tips.

PC 101 CONTROLLER - 1500 VOLTS

The removal and replacement of the contactor units, reverser, control drum, cam shaft and main engine parts are practically the same for the PC-10 and 12 controllers.

The arc chute is removed by taking out screw and parts as indicated by numbers 1, 2, and 3, on page 6.

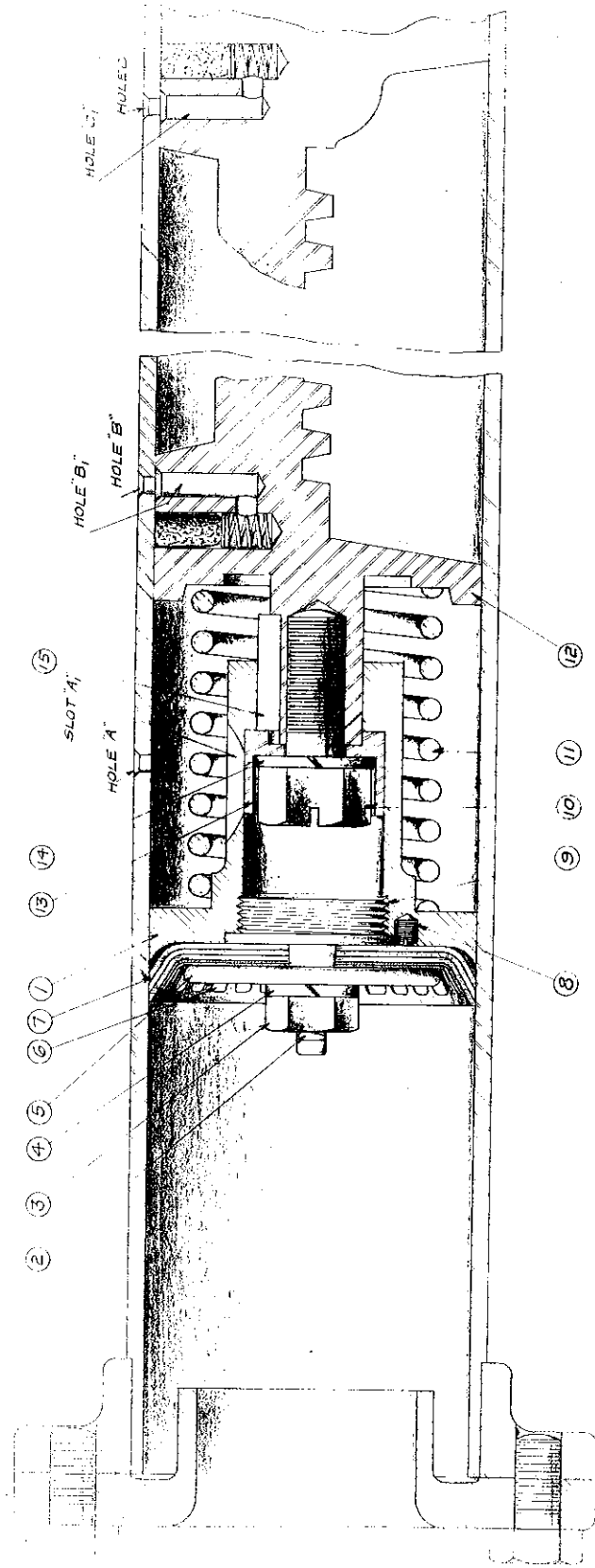


316958

TYPE PC-101 CONTROLLER. PARTS TO BE DETACHED TO REMOVE
ARC CHUTES OF LINE BREAKER.

INDEX P.353.7

12 7 17



237483 SECTION THRU MAIN CYLINDER SHOWING PISTON FOR TYPES PC-10,
 PC-12 AND PC-101 CONTROLLERS.

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MAIN ENGINE

(PC-10, PC-12 and PC-101 Controllers)

REMOVING PISTON SPRING

In order to take the mechanism apart, refer to Page 8.

First, remove cylinder head on "off" magnet end of main cylinder and revolve cam shaft by means of wrench -Cat. #176776 until piston head (#1) is near enough to the outer end of the cylinder to be accessible.

Second, remove cotter pin (#2), nut (#3), washers (#4), and follower (#5), expansion spring (#6) and leather packing cups (#7).

Third, remove lock screw (#8).

Fourth, remove stud cap (#9) by means of a pin wrench, Cat. #176775.

Fifth, fasten ring (#16) - Cat. #176773 to cylinder flange, in place of cylinder head and revolve cam shaft until piston head (#1) is forced against it with considerable pressure.

Sixth, remove cap screw (#10) by means of a screw-driver, Cat. #189905, and, then turn cam shaft in the opposite direction until the pressure on ring (#16) is relieved.

Seventh, remove ring (#16). Piston head (#1) can now be slipped out, giving access to spring (#11).

REPLACING PISTON SPRING

With the rack (#12) in place, turn the cam shaft until the end of the rack is accessible thru the opening in the end of the cylinder.

Insert spring (#11) and piston head (#1), taking care that the spring (#11) is properly placed over the shoulder on rack (#12) and that the key (#15) in rack lines up with the keyway in piston head (#1).

Fasten ring (#16) to the cylinder flange and turn the cam shaft until spring (#11) is compressed. While doing this, it will be necessary to see that rack (#12) is guided into the hole in piston head (#1).

Put piston guide (#13) and lock washer (#14) in place and screw cap-screw (#10) down firmly on the washer by means of screw-driver -Cat. #189905.

Remove wrench from cam shaft, thus allowing spring (#11) to drive rack (#12) out until piston guide (#13) bears against the shoulder in the bore of piston head (#1). See that the parts which slide are perfectly free and that the spring forces rack (#12) back without hesitation.

Remove ring (#16).

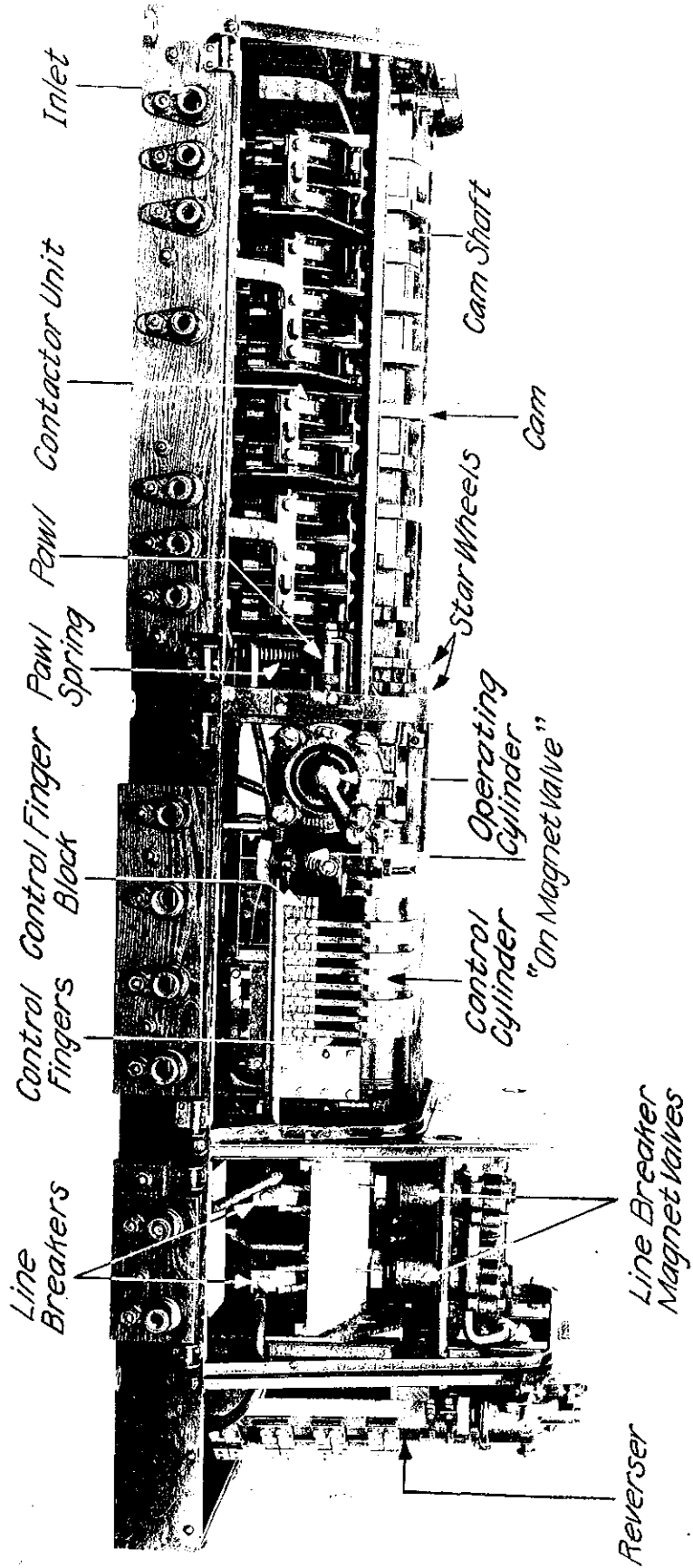
Oil the bore of the piston head (#1) in order that piston guide (#13) will slide easily.

Put stud cap (#9) in place, by means of pin wrench Cut. #176775, and lock it in by means of lock screw (#8).

Replace leather caps (#7), expansion ring (#6), follower (#5) and washer (#4), nut (#3) and cotter pin (#2).

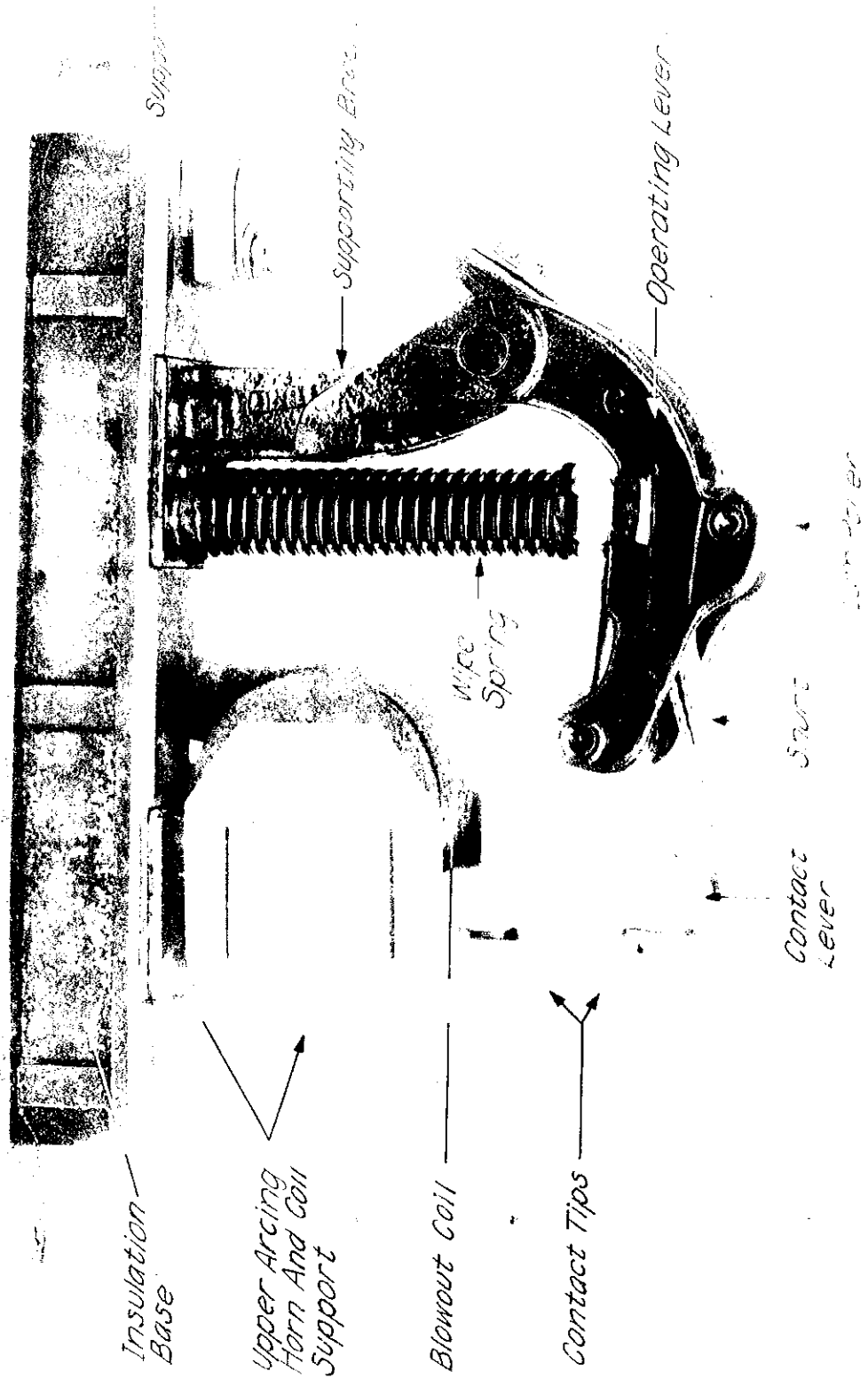
Replace cylinder head.

When the assembly is completed, turn the cam shaft to the "off" position, fill the air tanks, admit air to the "on" cylinder by pressing down the operating pin of the "on" magnet valve. The cam shaft should turn from the "off" to the first position, which may be noted by the contactors closed. When the air is released from the "on" cylinder, the cam shaft should turn to the "off" position. If this does not occur, or the operation is sluggish, there is some fault in the assembly of the piston spring.

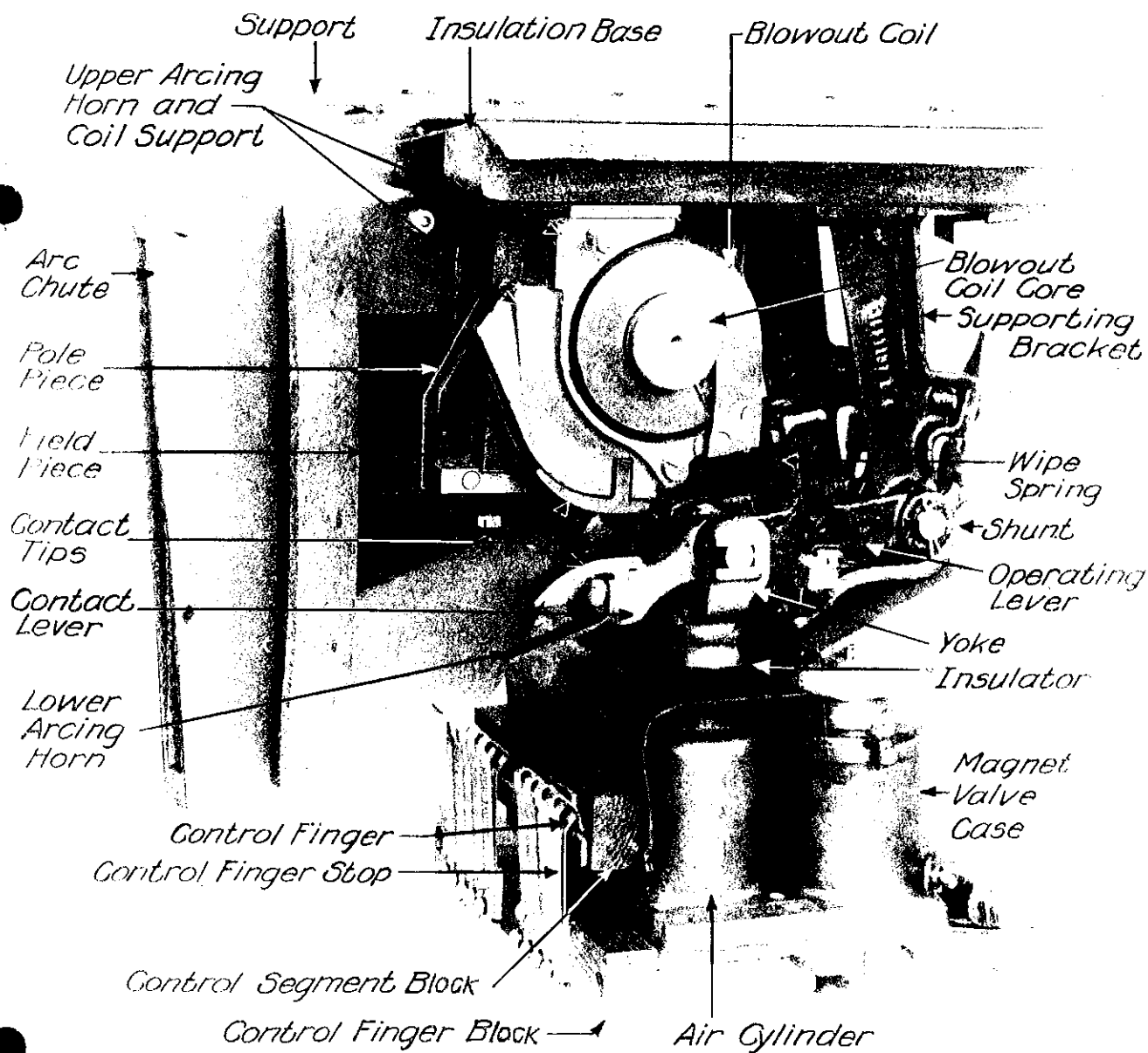


PC-10-A Controller

315600

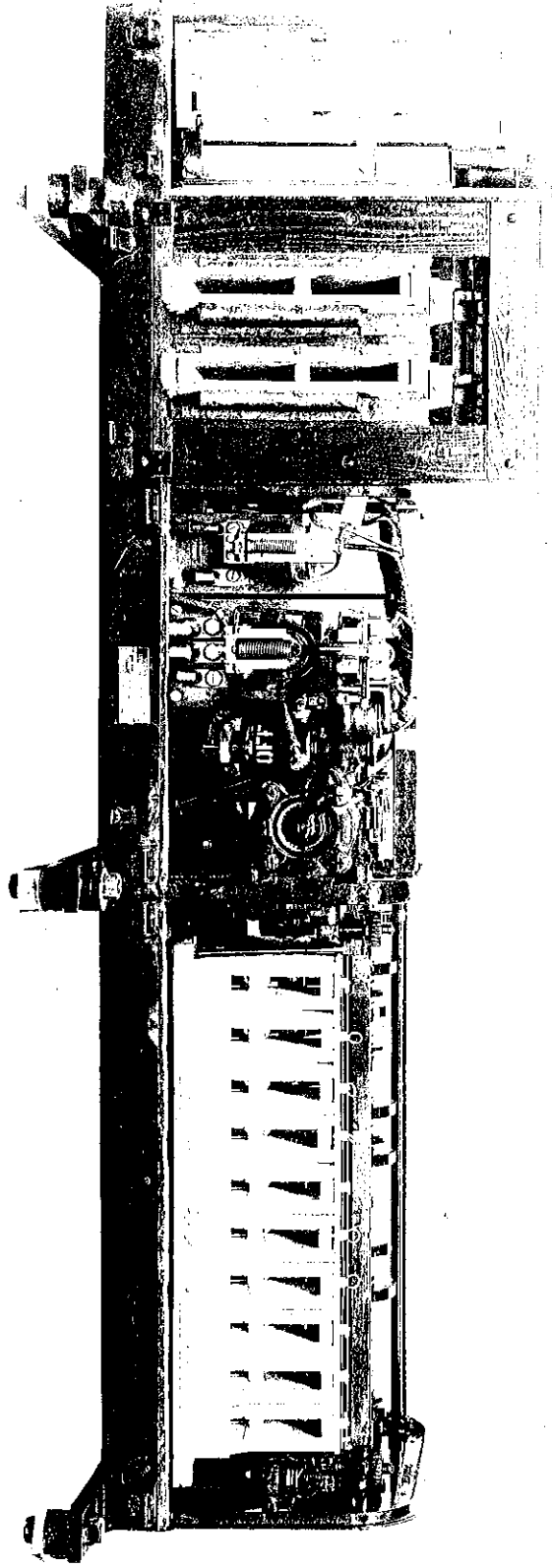


313601 CONTACTOR UNIT FOR TYPES PC-10 AND PC-12 CONTROLLERS.
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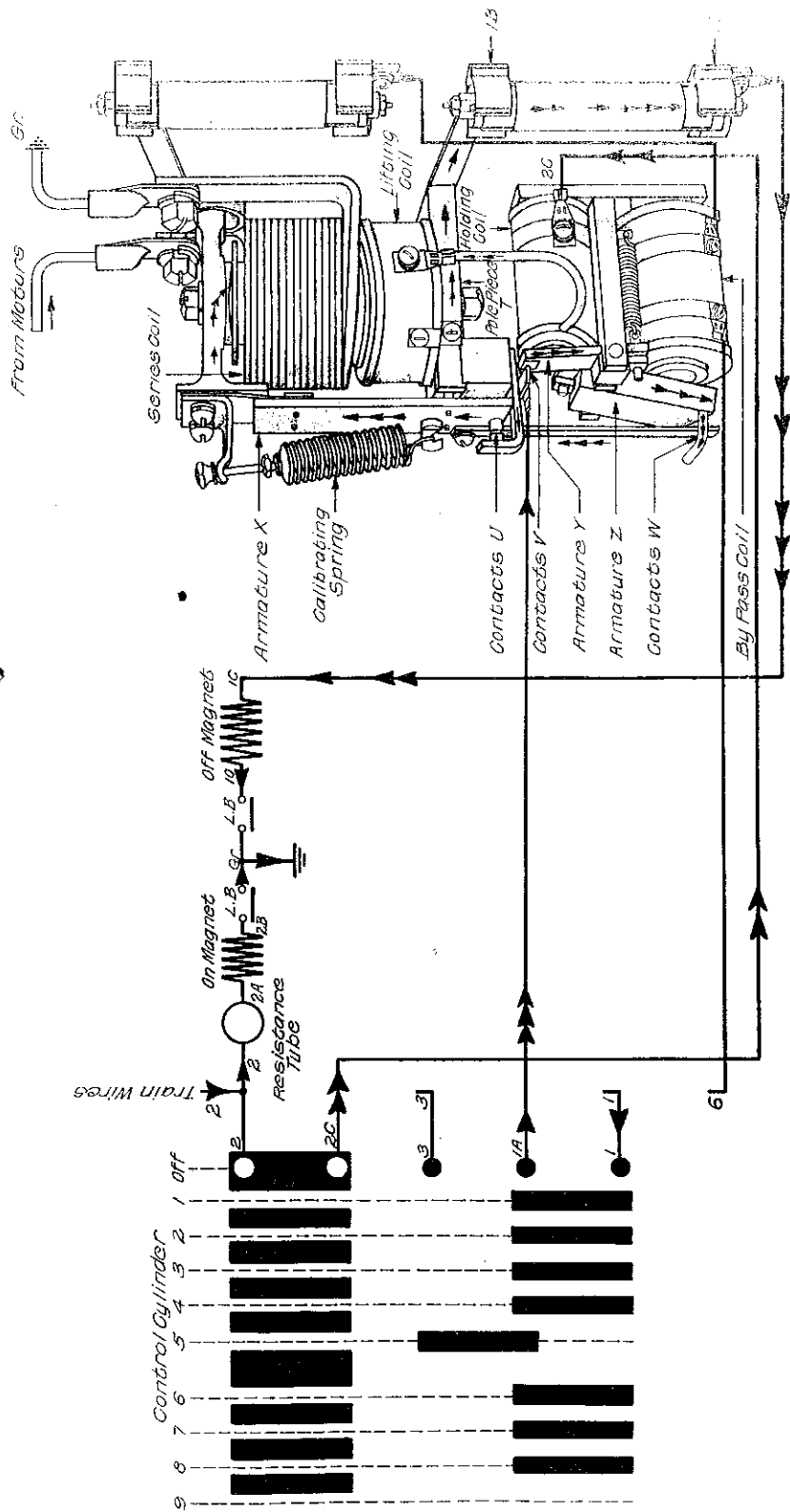


312493 LINE BREAKER UNITS FOR TYPES PC-10 AND PC-12 CONTROLLERS.

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314853 TYPE PC-101 FORM A MOTOR CONTROLLER.
APPROX. 1/10 SIZE INDEX E-353.7



317831 TYPE DB-908 RELAY

The accompanying diagram page 14 shows the simplified control connections of the DB-808 accelerating relay with by-pass feature.

NORMAL OPERATION

Assume the master controller is advanced to the third or full parallel position, connecting wires #1, #2, #3, and #4 to their source of energy. This causes the line breaker in the PC controller to close which closes the interlocks "LB" in the "on" and "off" magnet valve circuit, and the PC controller is advanced to the first position. If the current through the motors and the series coil of the relay exceeds a predetermined value causing the series coil armature to be attracted, holding contacts "A" open, then the "off" magnet valve will not be energized until current through the motors decreases to such a value that this relay armature is released allowing contact "A" to close. The circuit will then be through wires 1, 1A, 1B, 1C, as indicated by the full heavy line, causing current to flow through the "off" magnet valve coil, advancing the PC controller toward the second point. As wire 1A leaves the segment, wire 2C makes contact with its segment energizing the holding and lifting coils. The latter aids the series coil in attracting its armature. This circuit, indicated by the full light line, insures that the PC controller will advance to the next point even though the rise of current in the series coil between points cause contacts "A" to open.

This sequence of operation continues until the full series, or 5th point on diagram page 37 is reached when the 1A wire is energized by the segment making contact with the #3 wire. This

allows the PC controller to advance to the parallel position after the current through the motors drops to the proper value. The sequence of operation then continues as in the series positions.

EMERGENCY OPERATION

If the PC controller is on some point where the current through the series coil is too great to release its armature altho not enough to start the car an additional point on the PC controller can be obtained by energizing wire #6 with the advance lever on the master controller, thus energizing the bypass coil, attracting its armature and closing contact "C". The current will then flow through wire 1A, through contacts B, C, etc. as indicated by the heavy dotted line, thereby bypassing contacts "A", thus energizing the 'off' magnet and advancing the PC controller even though these contacts "A" remain open.

The magnetic circuits of the bypass and holding coils are so arranged that with the bypass coil energized the flux leakage from the coil will hold the contacts "B" open after they have been opened by the holding coil being energized. By energizing wire #6 the PC controller can be advanced but a single point as wire 2C is energized during the advance, between points, causing the holding coil to attract its armature opening contacts "B" breaking the circuit through the 'off' magnet coil. This causes the PC controller to pause on each point until the advance lever is again released allowing contacts "B" to close preparing the circuit for the next bypass around contacts "A".

When the relay is used on equipments the control of

which operates from a low voltage source resistor tubes are omitted.

USE OF THE BYPASS FEATURE FOR TESTING THE CONTROL

By inserting a piece of mica or other insulation between contacts "A" the advance lever can also be used in testing the control, when there is no current in the series coil, to see that it advances properly from step to step. When the PC controller is on any point except the last and the bypass coil is energized contacts "C" are closed completing the circuit through the 1 and 1A wire and contacts "B" and "C" through the 'off' magnet coil, as indicated by the heavy dotted line, causing the PC controller to start to advance to the next step. When advancing between points wire 2C is energized and the circuit closed through the 'off' magnet coils which insure that the PC controller advances one step. The holding coil being energized attracts its armature causing contacts "B" to open, thus making it necessary to release the advance lever, opening the circuit in the bypass coil, before contacts "B" will again close.

MAINTENANCE

The work of maintaining equipments and the frequency of inspections necessary, depend greatly on local conditions, which are the real determining factors.

As a general rule, city equipments should be inspected every 500 to 1000 miles and interurban equipments from 1000 to 2000 miles.

OPERATING TEST

At each inspection the main switch should be opened and with an air pressure of not less than 60 lbs., the PC controller operated from each master controller, with the reverse handle thrown in the forward and reverse positions. This test immediately tells whether the pieces of apparatus are working. The PC controller will "notch up" in 3-1/2 to 4 seconds when properly lubricated and adjusted. This speed will decrease as the main engine piston leathers become dry. When the speed is 6 seconds, the cylinder should be lubricated.

The master controller should be held on points 1 and 2 long enough to insure that the PC controller definitely stops on the corresponding positions. The controller should be advanced a step at a time, the same as during acceleration, by using the "advance" lever on the master controller, or, by repeating the current limit relay by hand. The overload relay should be tripped by hand and reset from the cab.

INSPECTION

At each inspection the master controller, master control switches, main switch, fuse box and PC controller should be opened, examined, cleaned, adjusted or repaired as needed. The following points should be noted.

MASTER CONTROLLER:

- (a) Inspect for weak fingers, imperfect contact and loose connections.
- (b) When dirty, clean contacts and apply a small quantity of thin, lubricating oil to the contacts with a piece of cheesecloth.

CONTROL SWITCHES

- (a) Inspect for poor contacts.
- (b) Clean and lubricate when needed.

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MAIN SWITCH AND FUSE BOX:

- (a) Inspect for loose terminals and poor contact.

PC CONTROLLER

At the first four or five inspections after the equipments are put in service, the cap screws fastening the main cable connections to the contactors, line breaker, reverser and relays should be examined to insure they are tight.

With the PC controller, the line breaker shunts and contactor shunts, contact tips and arc chutes as well as the control and reverse fingers and segments should be given particular attention. Valves and cylinders should be tried for air leaks. Relay contacts should be examined, and such parts as require it, lubricated.

Below is given a detailed description for the maintenance of these parts.

CONTACTORS AND LINE BREAKER

- (a) Examine contact tips and tighten screws holding them if loose.
- (b) Renew contact tips when worn halfway through.
- (c) When renewing a contact tip, if the surface against which it rests has become rough or pitted due to poor contact from a loose screw or similar cause, it should be smoothed up or else a new part installed.
- (d) The contact tips of the line breaker and contactors close with a butting and rolling movement, which tends to remove any roughness caused by arcing. If, for any reason, the tips get extremely rough, they should be filed smooth.
- (e) The screws holding the contactor and line breaker shunts should be examined to see that they are tight.
- (f) The contactor and line breaker shunts should be examined for wear and breakage.
- (g) Operate the line breaker by pressing the valve operating pin and note if the line breaker opens quickly. If it is sluggish, the operating cylinder and leather packings should be cleaned and lubricated.
- (h) Examine the arc chute sides. When they are half burned through, they should be replaced by new ones.

REVERSER

- (a) Inspect for weak fingers, poor contact and loose connections.
- (b) When the contacts are dry or dirty, clean and lubricate with vaseline or lubricating oil.
- (c) Operate the reverser by pressing on the valve pin. If the segments are clean and lubricated and the reverser is slow in operating, the air cylinders and packing leathers should be lubricated.

CONTROL FINGERS:

- (a) At each inspection, the control fingers on the reverser, line breakers and control drum and their segments should be wiped clean with a piece of cheese-cloth that has been moistened with a thin lubricating oil. This is more essential when the control is operated from low potential (32 volts) than when trolley voltage is used.
- (b) The control fingers when in contact with a segment should have sufficient pressure to make a good contact.
- (c) The fingers should be replaced when worn half way thru, thereby, preventing delays to service from a broken finger.

OVERLOAD RELAY:

- (a) Clean contacts when dirty.
- (b) Trip the relay and see that the armatures move easily.

CURRENT LIMIT RELAY:

- (a) Clean contacts when dirty.
- (b) Move armatures by hand and see that they are free and move easily.

CONTROL DRUM

When segments are replaced on the control drum, they should be located with respect to the control fingers. This is quite necessary, as the circuit, which controls the stopping of the cam shaft for each controller point, is broken by these segments and control fingers.

Where other information is not available, it is suggested that measurements between the control finger and the old segment be made before its removal and used in locating the new segment.

STAR WHEELS

The star wheels of the PC controllers, like those in a K controller, locate the controller notches. If the pawl springs are broken or become weak, the controller notches are not as definitely located as they will be when the spring pressure is normal. The pressure of the pawl roller against the star wheel, with the controller in the "off" position, for the PC-5, PC-6, and PC-9 controllers should be between 13 and 25 pounds, and for the PC-10, PC-12 and PC-101 controllers should be between 20 and 30 pounds.

MAGNET VALVES

The general construction of the magnet valves used on the reverser line breaker and "on" cylinders is shown on Page 21, while the "off" magnet valve is shown on Page 22.

When the valves are sticky, wash with gasoline or kerosene, also pour a little gasoline thru the magnet core to clean the valve seats. WHEN VALVES ARE REMOVED, EACH MUST BE RETURNED TO ITS OWN SEAT, as each stem is ground to fit its own seat.

Whenever a new valve is installed, or a valve leaks, it must be ground in. After a good seat is obtained, blow out all grinding materials with air and wash with gasoline. When a large number of valves are to be ground in, the cost may be reduced by using special reamers on the valves and valve seats before the valves are ground in.

To grind in the INLET VALVE of the "off" magnet, remove the valve and its seat from the valve case and use the grinding jig - Cat. #1419139 (shown on Page No. 24). The screw threads in the jig form a holder for the valve seat, and the hole in the jig acts as a guide for the inlet valve. A thin paper gasket is used between the inlet valve seat and the valve case; be sure that this is in good condition before replacing the valve seat. The screw-driver - Cat. #189905 may be used for removing and replacing the inlet valve seat.

MEASURING AIR GAP AND TRAVEL

The air gap and travel of the magnet valves should be measured once a year. This measurement is made by removing the magnet valve cover and armature. The .20" gauge - Cat. #1420997, is placed around the upper valve stem or plunger and the armature pressed on top of the valve stem. The exhaust valve of the reverser, line breaker and "on" magnet valves should seat (i.e., air should not escape thru the exhaust valve). For the "off" valve, this test should seat the inlet valve (i.e., air should not pass thru the valve). If air passes thru, new valves must be installed.

INSTALLING AND ADJUSTING NEW VALVES

REVERSER, LINE BREAKER AND "ON" MAGNET VALVES

First, place the .052" gauge (Cat. #1419137) around the exhaust valve stem. Then press down on the valve stem. When the exhaust valve seats (i.e., air does not pass thru the valve), the top of the valve stem should be flush with the surface of the gauge. If it is not flush, it should be shortened or lengthened until it is flush.

Second, place the .036" gauge (Cat. #1419136) on top of the .052" gauge. If the inlet valve stem is the proper length, the upper or exhaust valve stem will be just flush with the gauges, and, when the armature is pressed down, no action will result (i.e., air will not pass thru the inlet valve). If the upper valve stem is above the surface of the gauges, a small amount should be filed off the inlet valve stem. If the upper valve stem is below the surface of the gauges, a new inlet valve with a longer stem should be put in.

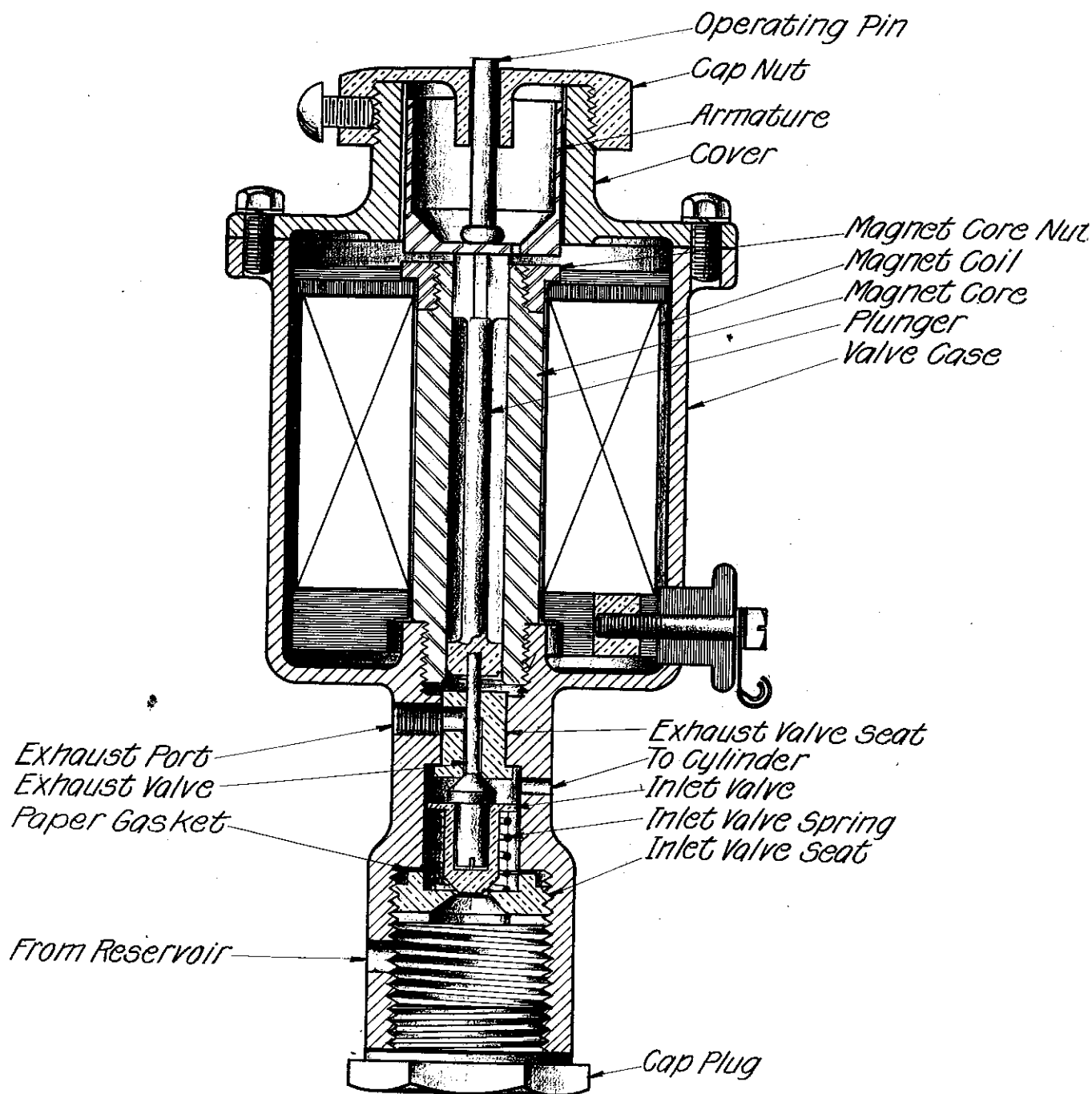
Third, replace the .036" gauge with the .020" gauge, and press down on the exhaust stem with the armature. Air should pass thru both the inlet and exhaust valves.

ADJUSTING "OFF" MAGNET VALVE

First, place the .052" and .036" gauges around the plunger. If the plunger and exhaust valve stem are the proper length, the top of the plunger will be flush with the gauges, and, when the armature is pressed down on the plunger, air will not escape from the exhaust valve. If the top of the plunger is above the surface of the gauges, either the plunger or the exhaust valve stem should be shortened. If the plunger is below the surface of the gauge, either the plunger or exhaust valve stem is too short and a new one should be used.

Second, remove the .036" gauge.

Press the armature on the plunger; this should seat the inlet valve (i.e., air should not pass thru the valves). If the valves are the proper length, the top of the plunger will be flush with the surface of the .052" gauge. If the plunger is above the surface of the gauge, remove the inlet valve seat and place additional paper washers between the valve seat and valve casing until the top of the plunger is flush with the surface of the .052" gauge, with the plunger pressed down. If the top of the plunger is below the surface of the gauge, either use a new valve or make a metal washer, which should be placed between the inlet and exhaust valves, increasing the length between these valves.

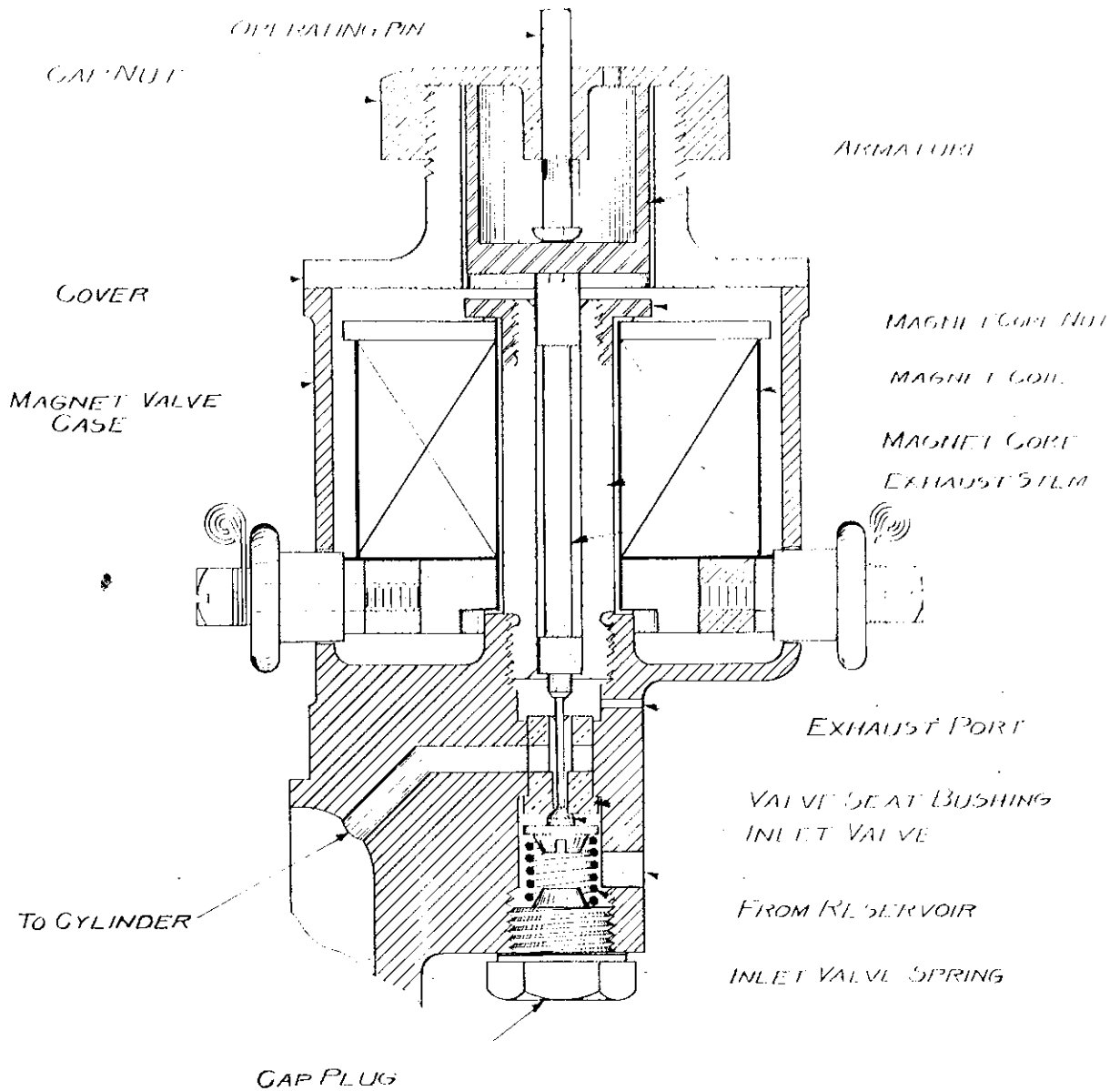


2.37038

INLET VALVE FOR "OFF" CYLINDER

INDENTED

11-11-17



234829

MAGNET VALVE FOR REVERSER, LINE BREAKER AND "ON" CYLINDER.

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LUBRICATION

Intervals of Three Months or Less

AIR ENGINES -

(1) Lubricate all pneumatic cylinders with P.C. lubricant #1 using one teaspoonful for each cylinder.

(2) This lubricant can best be applied by means of an oil gun as shown on page 25.

(3) The line breakers are lubricated by squirting oil thru the hole in the cylinder casting above the piston. The main and reverse cylinders by removing the pipe plug in cylinder head and squirting on the top wall of the cylinder. If pipe plugs are not provided, remove the cylinder heads and apply the lubricant with a swab.

(4) Refer to page 8, put P.C. lubricant # 1 in holes A and B with controller in "off" position. Then turn controller to full "on" before cutting it in hole C. The small controllers. (PC-5, PC-6 and PC-9) have hole A omitted.

BEARINGS -

(1) The roller bearings on the contactor units and star wheel parts should be lubricated with a small amount of P.C. lubricant # 1, applied at each end, and the bearing rotated to cause the oil to enter between the end washer and the outside rollway.

(2) The hinge pin bearings of the line breaker and contactor units should be lubricated with a small amount of P.C. lubricant # 1.

(3) Lubricate the reverser main bearings and also the slating bearing and pin between the piston and the crank, if the controller is of the PC-10-11-12 or 101 type, with a small amount of P.C. lubricant # 1.

Overhauling Period, or at least once a year.

AIR ENGINE -

(1) Dismantle the air operating cylinders sufficiently so that the cylinder walls and piston parts may be thoroughly cleaned. This should include for the large PC controllers, (PC-10, PC-11, PC-12 and PC-101) removing and cleaning the spring and piston head in the "off" end of the main air engine as indicated on pages 7, 8, and 9. When re-assembling, lubricate with P.C. lubricant #2. The three leather washers constitute a single packing and even when soaking them in oil should never be separated.

(2) If the leather packing is soft and pliable rub it over with P.C. lubricant # 2. If the packing is dry and hard, soak it for several hours in P.C. lubricant # 1. Do not knead the leather to soften it as it distorts the packing with the possibility of leaking when reassembled.

(3) Apply to the clean cylinder walls with a swab or brush an even film of P.C. lubricant # 2. For cylinders 3-1/2" diameter use 1/5 ounce (heaping teaspoonful). For cylinders 1-3/4" and 2-1/4" diameter use 1/8 ounce (level teaspoonful).

BALL BEARINGS -

Remove bearing and bearing housing from the cam shaft and pry out the plate holding the bearing in the housing. Clean thoroughly, pack with P.C. lubricant #2 and use new felt washers when reassembling.

SLEEVE AND SPHERICAL BEARINGS--(WICK OILED)

Clean the oil wells and bearings, wash the felt wick in gasoline rather than signal oil or kerosene. Fill with P.C. lubricant #1.



GREASE GUN

316958

APPROX. 5 1/2" NET I.D. X 1 1/2" L. O.D.



Technical drawing showing a perspective view of the grease gun nozzle assembly, including the nozzle, body, and base.

THE MUNICIPAL TRAMWAYS TRUST, ADELAIDE.

Received Correspondence office 7/7/22

accompanying letter from

Inst. Genl. Elect. Station

No. 75153. Dated 5/7/22

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