OPERATION OF MOTOR CONTROLLER

The motor controller used with PCM control contains magnetic contactors for making the main motor connections and a PC controller for cutting out the motor resistors in the proper sequence. The circuits are so arranged that the PC controller cuts out the resistors during series acceleration by rotating in the forward direction and after the change over from the series to parallel connections by the magnetic contactors, it reverses its movement to again cut out the resistors in the parallel connection of the motors by turning back to its off position.

By referring to the schematic diagram K-2765059 it will be noted that there are four magnetic contactors designated as follows:

LB = line breaker
S = series contactor
P = parallel contactor
G = ground contactor

These contactors are all equipped with powerful blowouts since they function to make and break the main power circuits.

The contactors numbered 1 to 11 inclusive are cam operated resistance contactors and do not require blowout coils as they are arranged to overlap when opening. The eleven resistance contactors are actuated by a small air engine which is governed by one magnet valve.

Resistance contactors 1 and 7 are normally closed in the off position, therefore, in order to apply power to the motors, the line breaker and "S" contactor are closed which completes the circuit through the motors with all resistance in series. As a safety precaution these two contactors are energized from separate control wires, so that in case one wire should become connected accidentally to trolley potential due to a breakdown in insulation, the operator would still be able to cut off power by turning off the master controller.

From the above it will be seen that it is not necessary to have air to operate on the first point. This is of advantage in bringing in a crippled car, moving cars in the barn in case of fire etc.

With the master controller held on the second point, the PC controller will notch up to the full series position under control of the accelerating relay. The connections at this point are shown by Fig. 3 on K-2765059.

Transition is effected by turning the master controller to the third point which energizes the "P" and "G" contactors. When the "G" contactor picks up, an interlock de-energizes the "S" contactor and the magnet valve on the PC controller. The connections at this point are shown by Fig. 5.

The magnet valve being de-energized, the PC controller turns back to its starting position, cutting out resistance in the parallel connection of the motors, but still under control of the accelerating relay. The connections in the full parallel position are shown by Fig. 6 and it will be seen by comparison with Figs. 1 and 2 that the PC controller has returned to its original starting position, the difference in connections being effected by means of the magnetic contactors "P", "S", and "G". This feature is of particular advantage in that when power is cut off it can be re-applied with minimum loss of time.

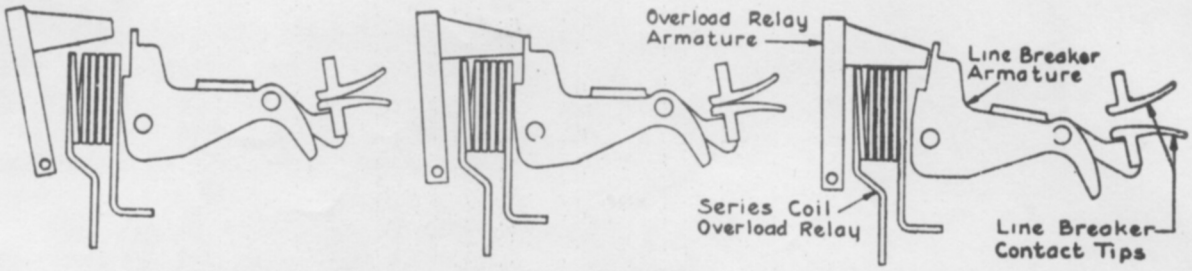
In order to halt the progression of the PC controller the "stop" coil is energized. This may be done in two ways: by turning the master controller to the first point, or by action of the accelerating relay. When the stop coil is energized, a roller on the armature slides into a notch on a starwheel which is mounted on the cam shaft. This locks the cam shaft and prevents further movement until the stop coil is de-energized. By this means the control may be notched up a step at a time, by moving the master controller handle or lever successively from a running point to the first point.

A diagrammatic view of the PC controller mechanism is shown on drawing K-2765581.

When the magnet valve is energized, air is exhausted from the air cylinder "N" and pressure applied on the liquid in the reservoir and the hydraulic cylinder, forcing the piston to rotate the cam shaft toward the full series position.

The de-energized position of the magnet valve, due to the action of the tension spring on the armature, is as shown on drawing K-2765581. In this position full reservoir pressure is applied in the air cylinder and any pressure in the hydraulic cylinder is relieved through the exhaust port on the magnet valve, resulting in the cam shaft turning to the off position, providing the stop coil "F" is not energized.

Any liquid that may leak past the packing "S" will flow down into the pipe leading to the check valve "R". In the off or full parallel position there is no air pressure on the bottom of the check valve and the liquid flows down into the pipe leading to the liquid reservoir "G". At the next operation of the controller the air pressure in the pipe closes the check valve and carries the liquid along into the reservoir, thus preventing waste.

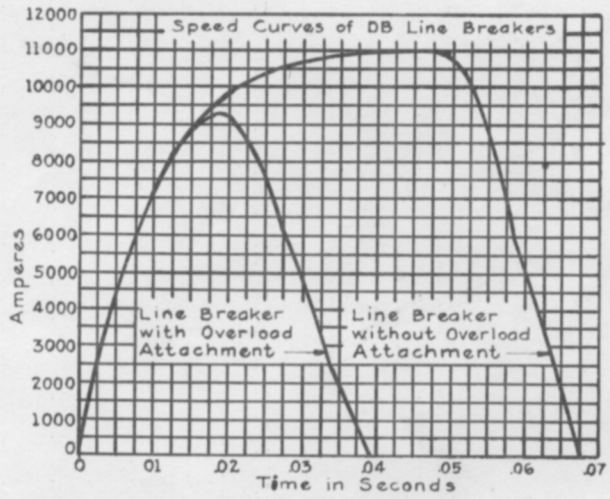


Line Breaker Closed

Action of Overload Relay against Line-breaker Armature

Line Breaker Open

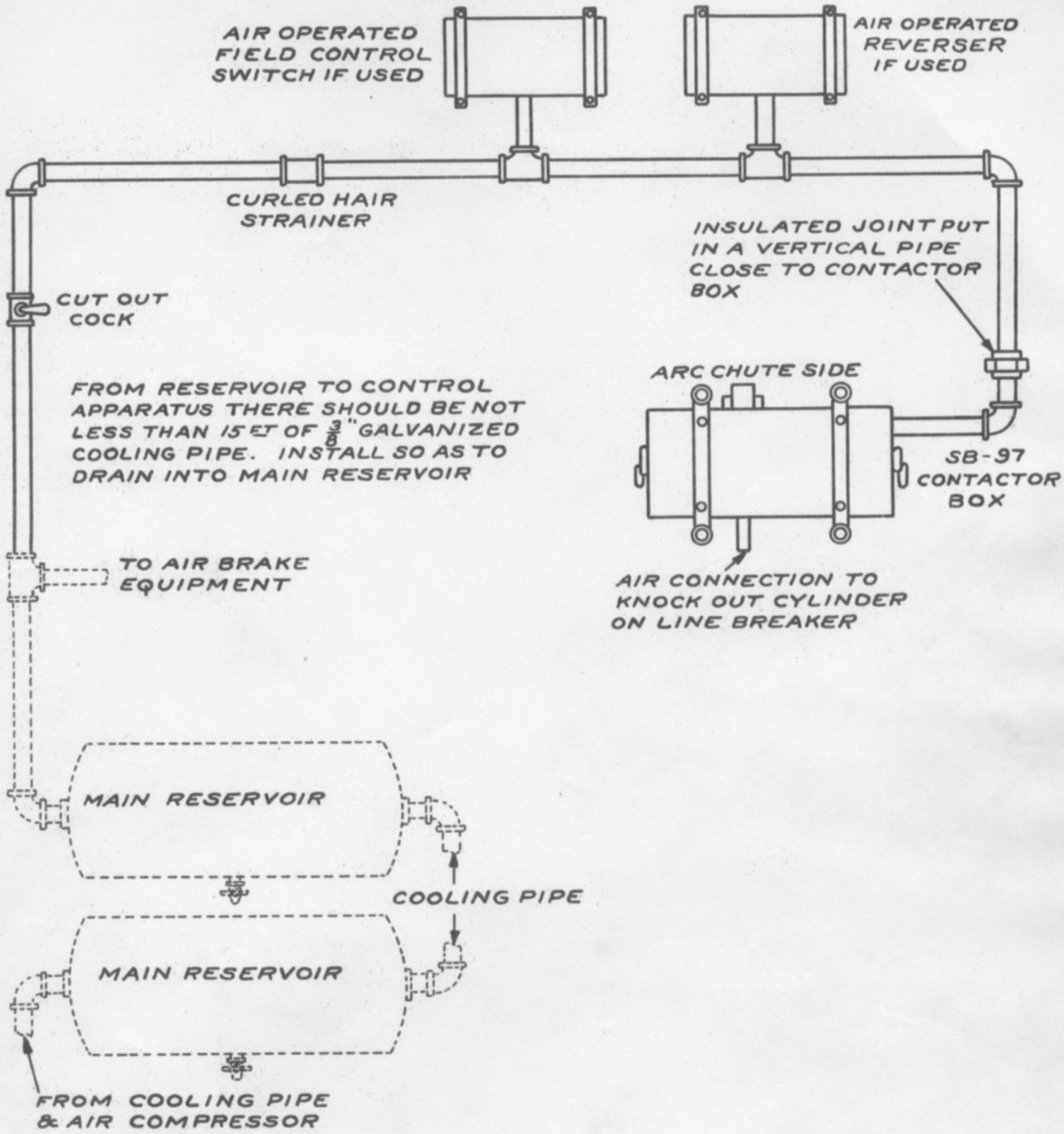
The above sketches show how the mechanical force is transmitted from the relay armature to the contactor armature in order to increase the opening speed of the line breaker.



These curves give a comparison of the time required for line breakers with and without overload attachment to open.

The contact tips, arcing horns, magnetic blowouts, and arc-suppressor plates in the arc chutes are constructed to stretch and rupture the arc with minimum burning of the contact tips.

The arc chutes and pole pieces of the contactors may be removed as a unit without the use of tools, leaving the contactor tips accessible for inspection and repair.



CONNECTIONS

PIPING FOR PCM CONTROL EQUIPMENT

CHECKED BY D.J.V.

DRAWN BY V.M. Wolfe MAR. 18. 1930.

APPROVED BY RWY. EQUIPT. DEPT.

INSPECTED BY H.S. Smethurst MAR. 24-30

K2765878

RC

GENERAL ELECTRIC COMPANY ERIE WORKS

FF-449 5M 19 8.28

SA

INSTALLATION

In preparation for the installation of the apparatus, a layout should be made, particular attention being given to the location of each piece of apparatus with respect to the piece from which it gets most of its connections.. Apparatus should be so arranged and located as to give as equal weight distribution as possible. The matter of accessibility for inspection and repair is also important.

INSULATING FROM GROUND

The contactor box is arranged to be insulated from ground and clearance should be provided between all grounded pipes, hangers, brake rods, etc. and the contactor box. The insulation between the supports and the contactor box should be installed so that the bolts fastening the box 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.

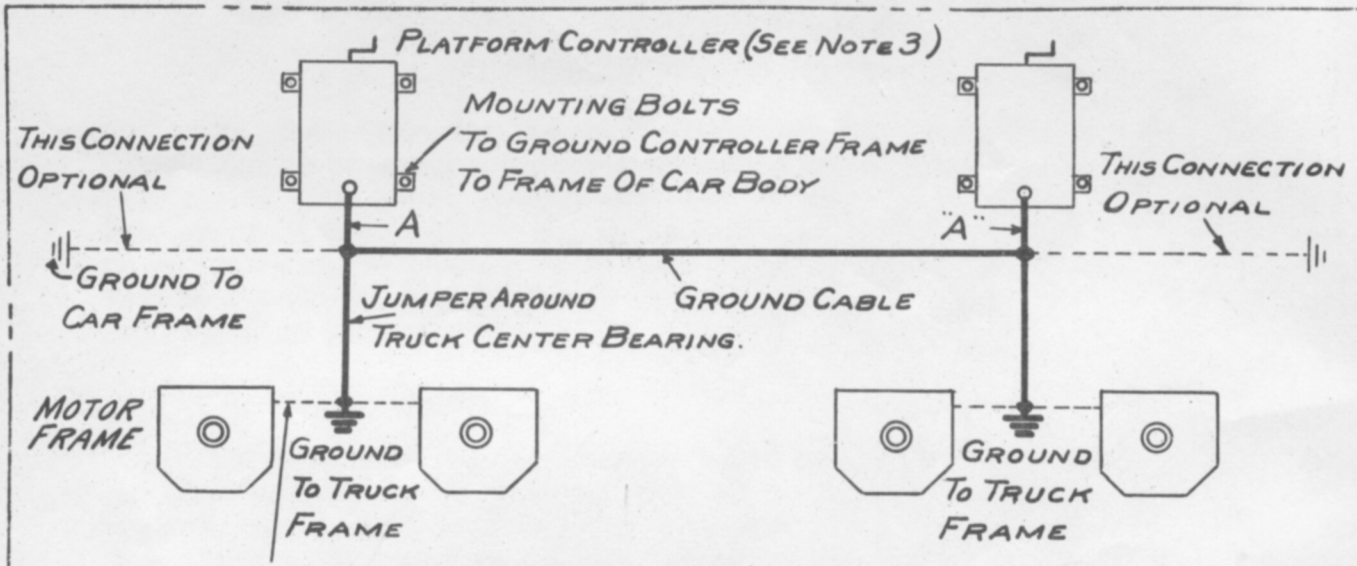
AIR PIPING

Main reservoir air is used for operating the air engine. When the reservoir pressure exceeds 85 lbs. a reducing valve is used, set for 70 lb. on the control side. A control reservoir is not required as the control may be operated on the first point without air.

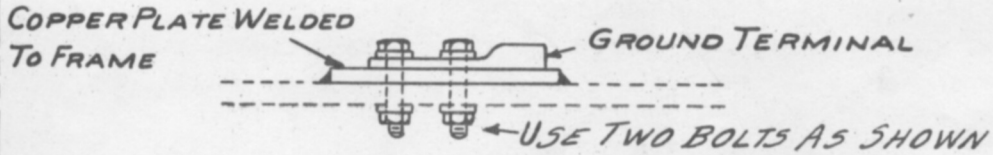
In addition to the cooling pipe supplied for the air brake equipment, at least 15 ft. of 3/8 in. galvanized cooling pipe for the air connection to the control is recommended. This cooling pipe should be installed between the air brake reservoir and the contactor box.

The piping should be arranged to drain the moisture into the reservoirs. Care should be taken to install the piping in such a way as to avoid pockets or water traps. Where this is unavoidable provision should be made for drainage at these points.

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 control apparatus.



CONNECTIONS FROM MOTOR FRAMES TO TRUCK FRAME ADVISABLE.



1. PLATFORM CONTROLLER FRAME MUST BE ELECTRICALLY CONNECTED TO GROUNDED STEEL FRAME WORK OF CAR THROUGH MOUNTING BOLTS.

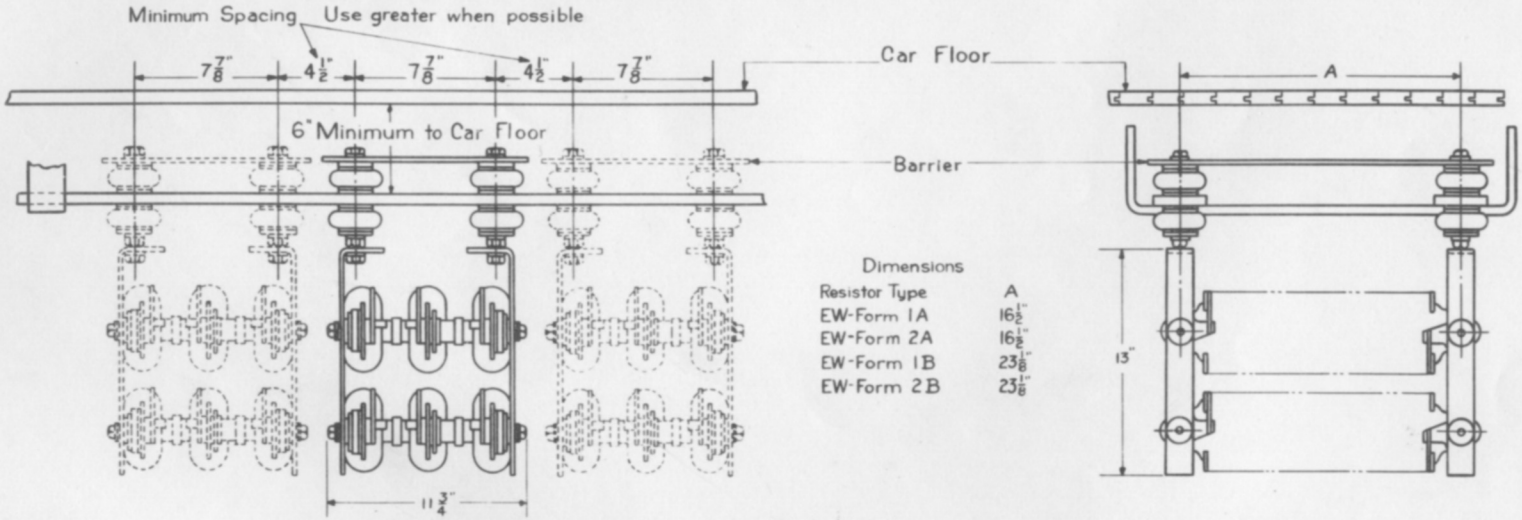
2. ON ALUMINUM FRAME CARS USE INSULATED GROUND TERMINAL INSIDE PLATFORM CONTROLLER AND GROUND CONTROLLER FRAME TO FRAME OF CAR THROUGH MOUNTING BOLTS.

3. WHERE REMOTE TYPE CONTROL IS USED, CONNECTION "A" WILL BE OMITTED BUT MASTER CONTROLLER FRAME MUST BE GROUNDED TO CAR FRAME THROUGH MOUNTING BOLTS FOR SAFETY.

4. METHOD SUGGESTED FOR MAKING GROUND CONNECTIONS SUCH AS ON TRUCK FRAME IS TO WELD A COPPER PLATE TO THE FRAME AND BOLT THE GROUND TERMINAL TO THE PLATE USING A TWO BOLT TERMINAL AS SHOWN ABOVE. THIS PROVIDES A GOOD SUBSTANTIAL COPPER TO COPPER CONTACT.

7		ALSO FOR RATING AS SHOWN ON THE REVERSE SIDE OF THIS PRINT		
6		FIRST MADE FOR:		
5		CONNECTIONS		
4		GROUND WIRE CONNECTIONS FOR CAR EQUIPMENTS.		
3				
2	SEPT. 30, 1932 V. M. Westcott	DRAWN BY V. M. Westcott APR. 4. 1932	INSPECTED W. R. Post Apr. 11-32	J. U.
1	Apr. 28-32 V. M. Westcott	GENERAL ELECTRIC CO. ERIE WORKS	K-4766292	
	REVISIONS			DISTR.

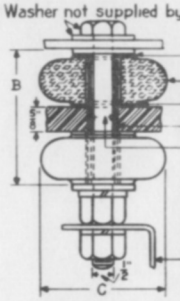
FF-566 3m 1-27-31



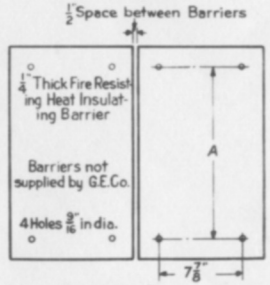
Dimensions

Resistor Type	A
EW-Form 1A	16 1/2"
EW-Form 2A	16 1/2"
EW-Form 1B	23 1/8"
EW-Form 2B	23 1/8"

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



	600 Volts	1500 Volts
Packing Washer	Cat No. 1435581	Cat No. 1435581
Porcelain Insulator	Cat No. 450869	Cat No. 450880
Packing Washer	Cat No. 1435582	Cat No. 1435796
Insulating Tube	Cat No. 180547284	Cat No. 1436075
Hole in Support	13/16"	13/16"
Complete Insulator	Cat No. 180347261	Cat No. 1949194G2
Weight	1 lb.	2 lb.
Dimension B	3 1/8"	4 1/8"
Dimension C	3"	3 1/8"
Resistor Foot		



Drilling for Barriers

METHOD OF SUPPORTING RAILWAY RESISTORS USING PORCELAIN BOLT INSULATORS

FIRST MADE FOR:- EW-RESISTORS - 600 & 1500 VOLT WORK

BEGUN BY Wm Rudder May 2-30 TRACED BY L. DeBall MAY 12, 1930

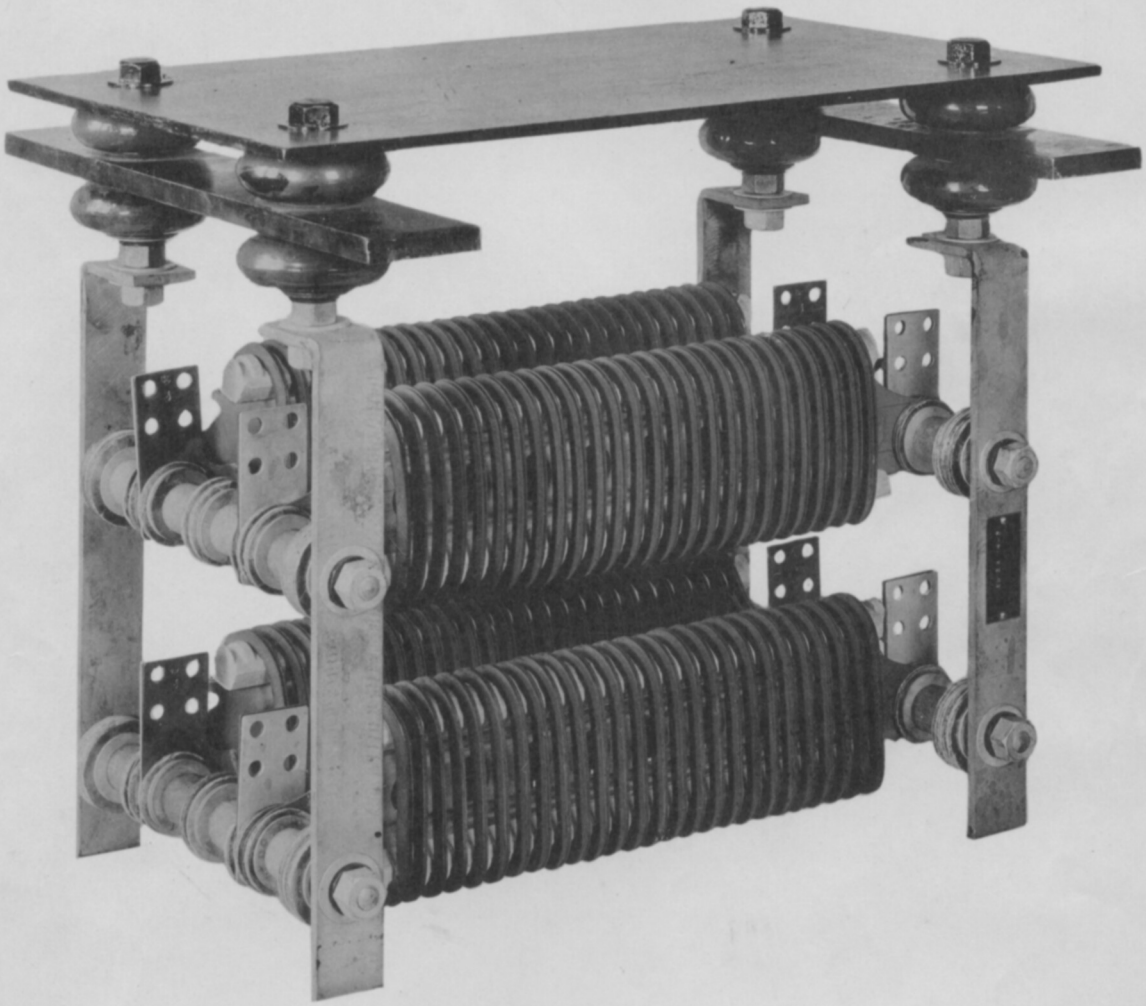
FINISHED BY Wm Rudder May 2-30 INSPECTED H. Swetland MAY 13-30

GENERAL ELECTRIC CO.
ERIE WORKS M-2725480

R.C.

REVISIONS

69



345256 G-E TYPE EW-2A RESISTOR. (RAILWAY CONTROL) APPROX. 1/4 SIZE.

E355.6 5-2-30

6c

PC CONTROLLER

The PC controller which is mounted in the SB contactor box or DJ control group is shipped from the factory with the liquid reservoir filled with oil. In order to prevent leakage during shipment the air pipe from the liquid reservoir to the magnet valve is disconnected at the magnet valve and capped. After the contactor box is mounted on the car, the cap should be removed and the pipe reconnected to the magnet valve, care being taken to obtain a tight connection.

After complete air and electrical connections have been made the controller should be operated a few times with the main switch open. The cap on the filling pipe located on the side of the liquid reservoir should then be removed and the height of liquid in the reservoir checked. With the controller in the off position the liquid should come to within 1/2 in. of the top of the filling pipe.

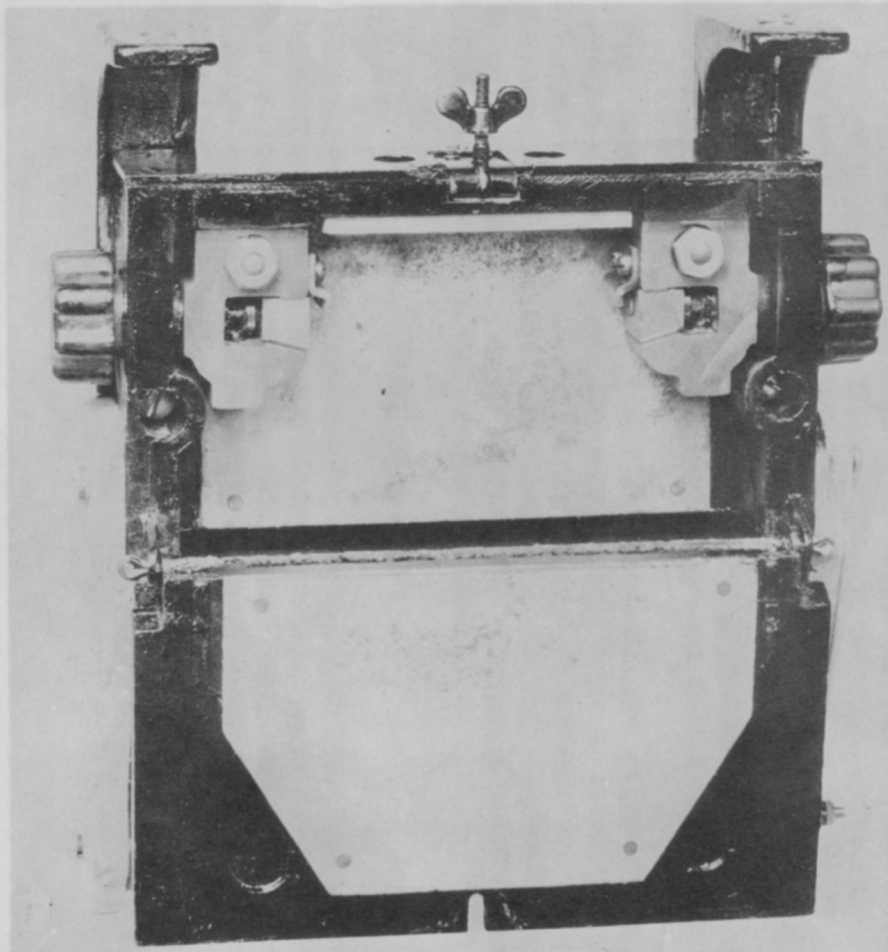
The PC controller is adjusted at the factory to turn to the full series position (full forward position) and back to the full parallel position (reverse to original starting position) in a total of four seconds without any current in the main circuits and with a reservoir pressure of 70 lb. This adjustment should be checked again with maximum air pressure just after the compressor governor stops the air compressor. This should be made by turning the orifice adjusting screw located in the end of the hydraulic cylinder. It is necessary to remove the cap in order to get at the adjusting screw.

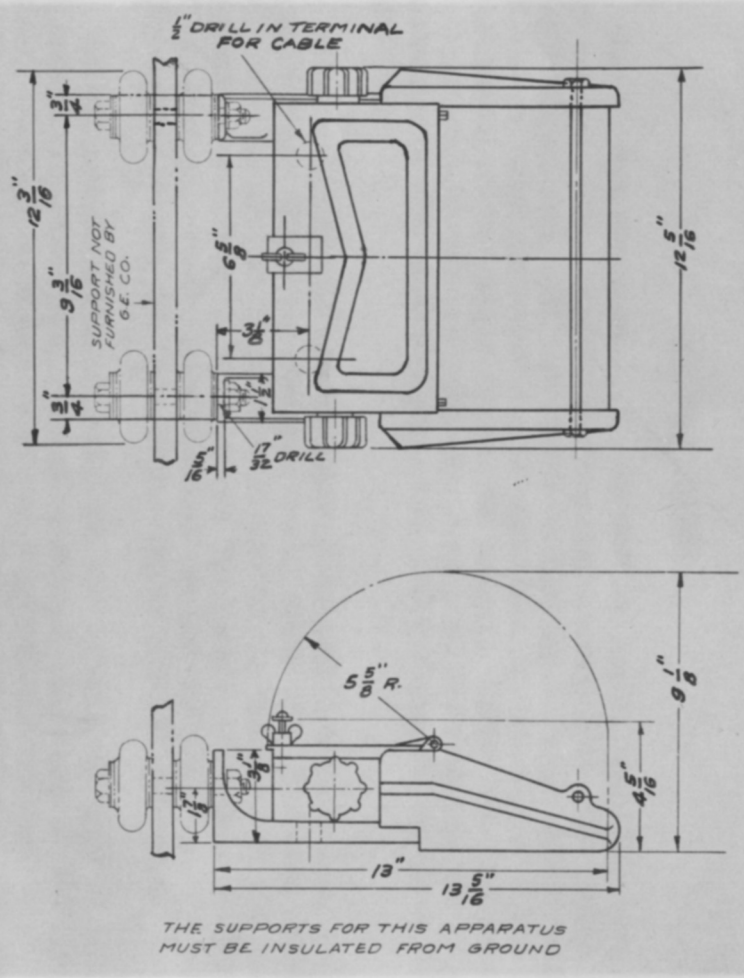
Make sure that the air strainer and insulated joint are installed and inspect the piping and magnet valve for air leaks.

The controller is shipped with the accelerating relay set for the particular motor equipment with which it is to be used. Under normal conditions the accelerating relay will retard the control progression only when the current reaches the safe commutating limit of the motors. With this arrangement the by-pass feature sometimes used with automatic control is not required.

MOTOR RESISTORS

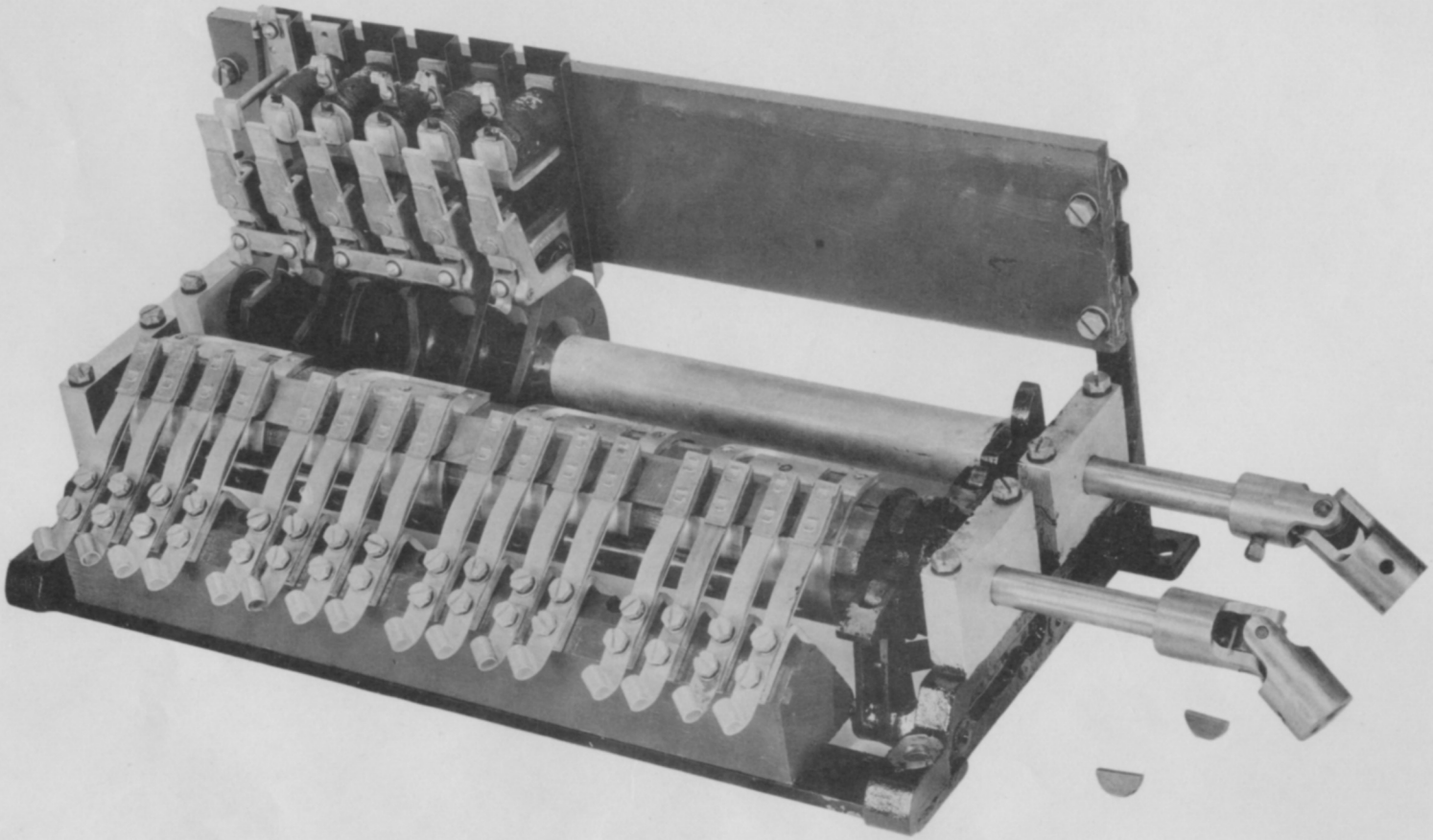
Porcelain bolt insulators are furnished for the supplemental insulation between the individual resistor frames and their hangers as shown on M-2725480. When installing, the bolt insulators should be arranged to prevent the short circuiting of the porcelain portion by mud or grounded metal. Conduit should not be supported from the resistor frames.





345083 TYPE MA-13-F FUSE BOX (RAILWAY CONTROL)

E356.4 4-8-30



348394 GENERAL ELECTRIC FOOT-OPERATED MASTER CONTROLLER, TYPE 17KC8A1, 600 VOLTS. FOR USE WITH PCM CONTROL. WEIGHT 58 LB. APPROX. 1/4 SIZE.

E353.7 11-4-32

MAIN FUSE

When the copper ribbon type fuse box is used it should be mounted on porcelain insulators as shown on Photo. 345083. In case wood is used for insulation there should be at least three inches creepage distance between the fuse box supporting bracket and ground for 600 volt systems.

MASTER CONTROLLER

Two general types of master controllers are used - hand operated and foot operated. With either type of controller the frame should always be grounded to the car frame for safety.

The following points should be noted when installing foot operated controllers. Operating rods and pull rods should be installed in such a manner as to require the least amount of effort to operate, consistent with positive operation. The return spring for the master controller pedal must have enough tension to positively return the pedal to the off position when released from any operating position and still not require excessive effort to operate.

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 this type of equipment should be inspected approximately every 500 to 1000 miles. This usually amounts to a "light inspection" weekly. A "heavy inspection" should be made every three to six months depending upon the service.

OPERATING TEST

At each inspection the main switch should be opened and the control operated from each master controller, with normal air pressure in the reservoir. This test, when made with the reverse handle in the forward and then the reverse position, tells immediately whether the pieces of apparatus are working.

Hold the master controller on the first point to see that the stop coil halts the progression of the cam shaft. With the master controller held in an operating position, trip the overload relay by hand. The holding coil should hold the overload relay armature in the tripped position until the master controller is turned off, when the overload relay should reset automatically. With the latched type of overload relay it is necessary to reset the overload relay by operating the MS control switch in the cab.

INSPECTION

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

CONTACTOR BOX (MOTOR CONTROLLER)

(1) General:

(a) Remove covers and blow out with dry air.

(b) Clean porcelain insulators on supports.

(c) Check condition of felt between covers and replace if worn through.

(2) PC-19 Controller:

(a) Check piping for liquid or air leaks. If any leak is indicated, locate, repair and refill liquid reservoir if necessary.

(b) Remove cap from filling pipe and check height of liquid in PC controller reservoir, which should not be allowed to drop more than 1 inch below top of filling pipe.

(c) Remove plug or cylinder head on air end of cylinder and grease cylinder walls with a thin film of PC CONTROL LUBRICANT NO.2.

(d) The two cam shaft bearings are ball bearings and should be cleaned and packed with grease once a year.

(e) Examine contact tips (main and control) for burning or wear. If there is any burning on main contacts it is caused by faulty resistors, faulty resistor connections to contactors or stuck moving contact assembly.

(f) Replace contact tips when worn halfway through.

(g) When renewing a contact tip, if the surface against which it rests has become rough or pitted due to poor contact, it should be smoothed up or a new part installed.

(h) Examine screws holding contact tips and shunts and tighten if loose.

(i) Examine all shunts for wear and breakage. Shunts showing any indication of breaking should be replaced.

(j) Check interpoint interlock contacts for wear, and replace when the contacts are worn through the silver facing.

(k) Check tip gap of interpoint interlock which should be 3/16 to 1/4 inch.

(l) Test stop coil armature for free action.

(m) Oil all bearings, rollers and hinge pins with a thin lubricating oil such as PC CONTROL LUBRICATION NO.1

(n) Refer to "Magnet Valves" on page 14 for information concerning maintenance of this part of the equipment.

(3) Line breaker, P, S and G Contactors:

(a) Remove arc chutes, examine contact tips and tighten 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

it should be smoothed up or a new part installed.

(d) Examine screws holding shunts and tighten if necessary.

(e) Examine all shunts for wear and breakage. Shunts showing any indication of breaking should be replaced.

(f) Examine all terminal connections for tightness and inspect cables and wires for any indication of chafing.

(g) Test all armatures for free action.

(h) Work overload trip on line breaker by hand to see if it is free.

(i) Clean arc chutes and replace any burned side plates or arc suppressors.

(j) Check interlocks mounted on back of line breaker and contactors for wear, burning and cleanliness. See that interlocks work freely.

(k) The interlocks are equipped with silver faced contacts which should be replaced when the silver is worn through.

(l) Oil all bearings and hinge pins with a thin lubricating oil such as PC CONTROL LUBRICANT NO.1 .

(4) Accelerating Relay:

(a) Inspect contacts for wear and cleanliness.

(b) Move armature by hand and see that it moves freely.

(c) See Page 19 for information concerning operation and adjustment of accelerating relay.

(5) Resistor Tubes and Connection Board:

(a) See that connections are tight.

(b) See that the tubes are not discolored or burned and that they are properly mounted.

MASTER CONTROLLER (HAND OPERATED)

(a) Remove cover and blow out with dry air.

(b) Inspect for weak fingers, imperfect contact and loose connections.

(c) Clean contacts and lubricate with a light grease having a high melting point.

(d) Lubricate bearings with a few drops of light oil.

MASTER CONTROLLER (FOOT OPERATED)

(a) Remove cover and blow out with dry air.

(b) Inspect for weak fingers, imperfect contact and loose connections.

(c) Clean control contacts with fine sand paper if they show signs of burning.

(d) See that moving contact assemblies are free on master control contacts.

(e) Clean reversor contacts and lubricate with a light grease having a high melting point.

(f) See that operating rods are in correct adjustment.

(g) Lubricate rollers and pawls with a few drops of light oil.

(h) The main shaft bearings are ball bearings which should be cleaned and repacked with grease during overhaul.

AIR OPERATED REVERSER (WHEN USED)

(a) Remove cover and blow out with dry air.

(b) Inspect for weak fingers, imperfect contact and loose connections.

(c) Clean contacts and lubricate with a light grease having a high melting point.

(d) Lubricate bearings with a few drops of light oil.

(e) Operate the reverser by pressing on the valve pin. It should throw in less than one second. If slow, and segments and bearings are well lubricated, the cylinder may require lubrication or the difficulty may be with the magnet valves. See Page 14 on maintenance of magnet valves.

(f) Remove cylinder heads and grease cylinder walls with a thin film of PC CONTROL LUBRICANT NO.2.

MAIN SWITCH AND FUSE BOX

(a) Inspect for loose terminals and poor contact.

MOTOR RESISTORS

(a) Wipe off supporting insulators and blow off resistors with dry air.

(b) See that all connections are tight.

(c) See that resistance ribbon has no foreign matter between turns.

CONTROL SWITCHES

(a) Examine all control switches and fuses for proper mounting.

(b) See that all terminal connections are tight and that all cables are properly mounted to avoid chafing of insulation.

FIELD SHUNTING CONTROL GROUP

(a) Remove covers and blow out with dry air.

(b) Clean porcelain insulators on supports.

(c) Inspect for frayed or broken shunts. Shunts showing any indication of breaking should be replaced.

(d) Examine all terminal connections for tightness and inspect cables and wires for any indication of chafing.

(e) Inspect contact tips for burning or wear.

(f) Smooth up any rough contact tip surfaces and replace tips when the silver facing is worn through.

(g) Try all armatures for free action.

(h) Inspect relay contacts for wear and cleanliness.

(i) Lubricate hinge pins sparingly, using only a few drops of light oil.

(j) Particular attention should be given to the interlock mounted on one of the shunting contactors. It is essential to the proper operation of the equipment that this interlock and the circuit it controls be in good condition. This interlock completes the "sealing in" circuit of the contactors and if inoperative due to poor contact or open circuit, fluttering of the contactors will take place resulting in excessive arcing and burning at the contact tips.

MAGNET VALVES

Magnet valves must receive proper maintenance to produce satisfactory operation of electro-pneumatic devices. It is probably a natural tendency to slight this device as all working parts are enclosed, but when the frequency of operation is considered, it becomes evident that proper attention to the maintenance of magnet valves is an important factor in reducing total maintenance expense of the equipment.

In general, magnet valves should be inspected for air leaks, sluggish operation and once a year the air gap and travel should be checked.

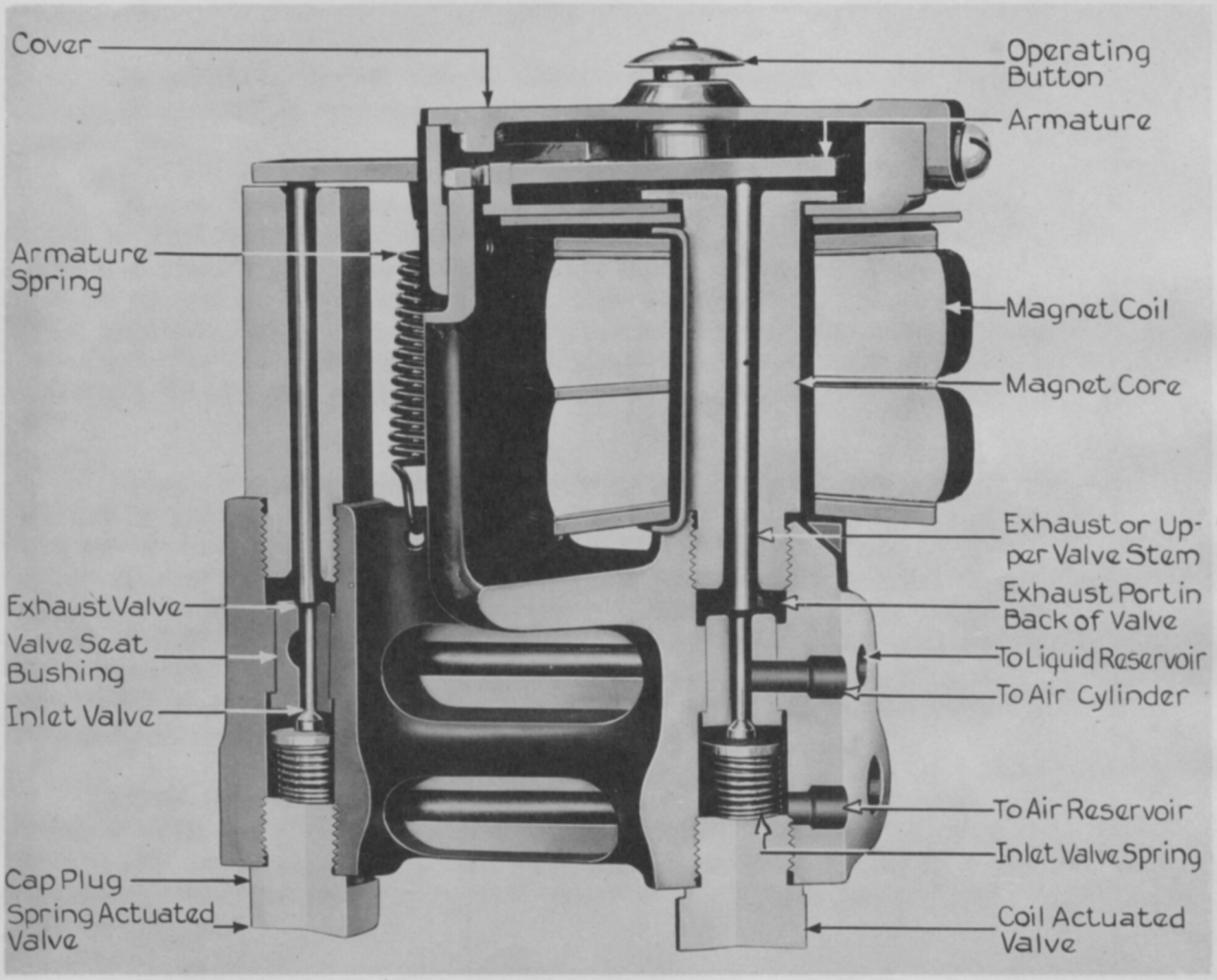
When a valve leaks air it is usually due to foreign matter such as pipe scale getting on the valve seat or else the valve stem has worn beyond the permissible limit. Sluggish operation may be caused by a sticky valve stem or insufficient travel. Wash with gasoline, also pour a little gasoline through 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 should be ground in. Apply a small amount of grinding compound on the valve seat and spin the valve back and forth by means of a screw driver held in the slot in the end of the valve stem. When grinding in the lower valve, the upper valve should be in place so as to center the lower valve. To determine when a good seat has been obtained, wipe all parts clean and with a screw driver roll the valve stem back and forth on the valve seat. A bright ring all around the stem indicates a good seat.

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.

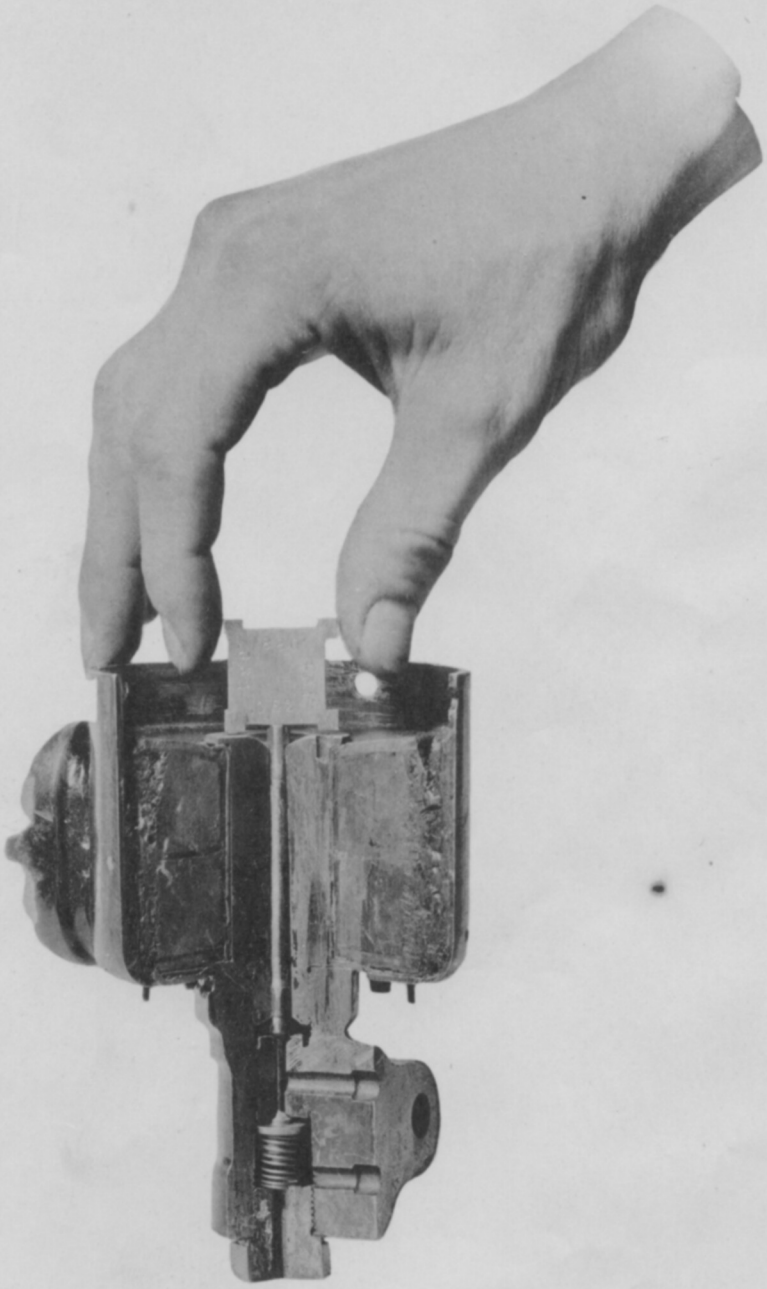
The valve travel, which is the distance the valve moves from the closed to the open position, is stamped on the bottom surface of the cap plug on all magnet valves, and may be checked with gauges as described later.

The air gap, which is the distance between the armature and magnet core, must be maintained within proper limits, as too large a gap will require excessive voltage to operate the valve, and too small a gap may result in the valve sticking in due to residual magnetism.



345386 MAGNET VALVE FOR PC-19 CONTROLLER.

625.25 6-14-30



A-41420 "ON" TYPE MAGNET VALVE SHOWING METHOD OF USING GAUGE.

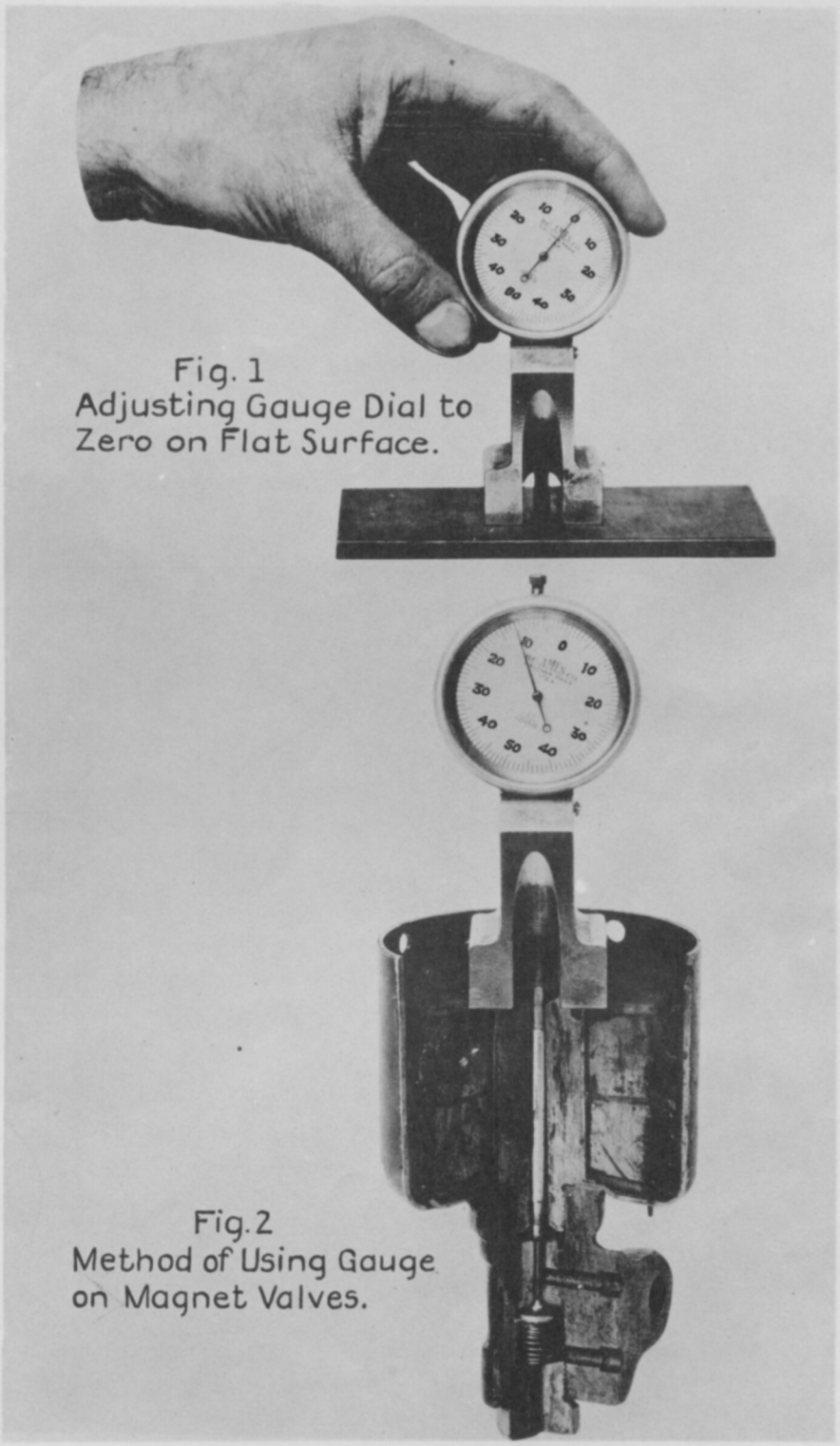


Fig. 1
Adjusting Gauge Dial to
Zero on Flat Surface.

Fig. 2
Method of Using Gauge
on Magnet Valves.

426979 MICROMETER GAUGE CAT. 2812735 FOR ADJUSTING MAGNET VALVE.

533.82

The PC-19 controller has a double acting magnet valve, the general construction being shown on photograph 345386. The spring attached to the valve body and armature holds one valve normally open and the other closed. When the magnet coil is energized the reverse action takes place.

In order to check the air gap remove the magnet valve cover and armature. Starting with the valve which is actuated by means of the coil, press down the upper valve stem and note the distance the stem projects above the core. This valve is designed so that the upper stem can wear down until it is nearly flush with the magnet core when depressed, but it is recommended that new stems be installed when the old ones are worn to within .010 in. of the top of the core when depressed. Check the spring actuated valve in the same manner.

To check the air gap on the reverser magnet valves use the gauge Cat. 2716194. Place the 0.032 in. gap over the upper valve stem and press down. This is a condemning gauge and if the upper valve stem is too short it will not seat and air will pass through, in which case a new upper valve stem must be installed.

INSTALLING AND ADJUSTING NEW VALVES

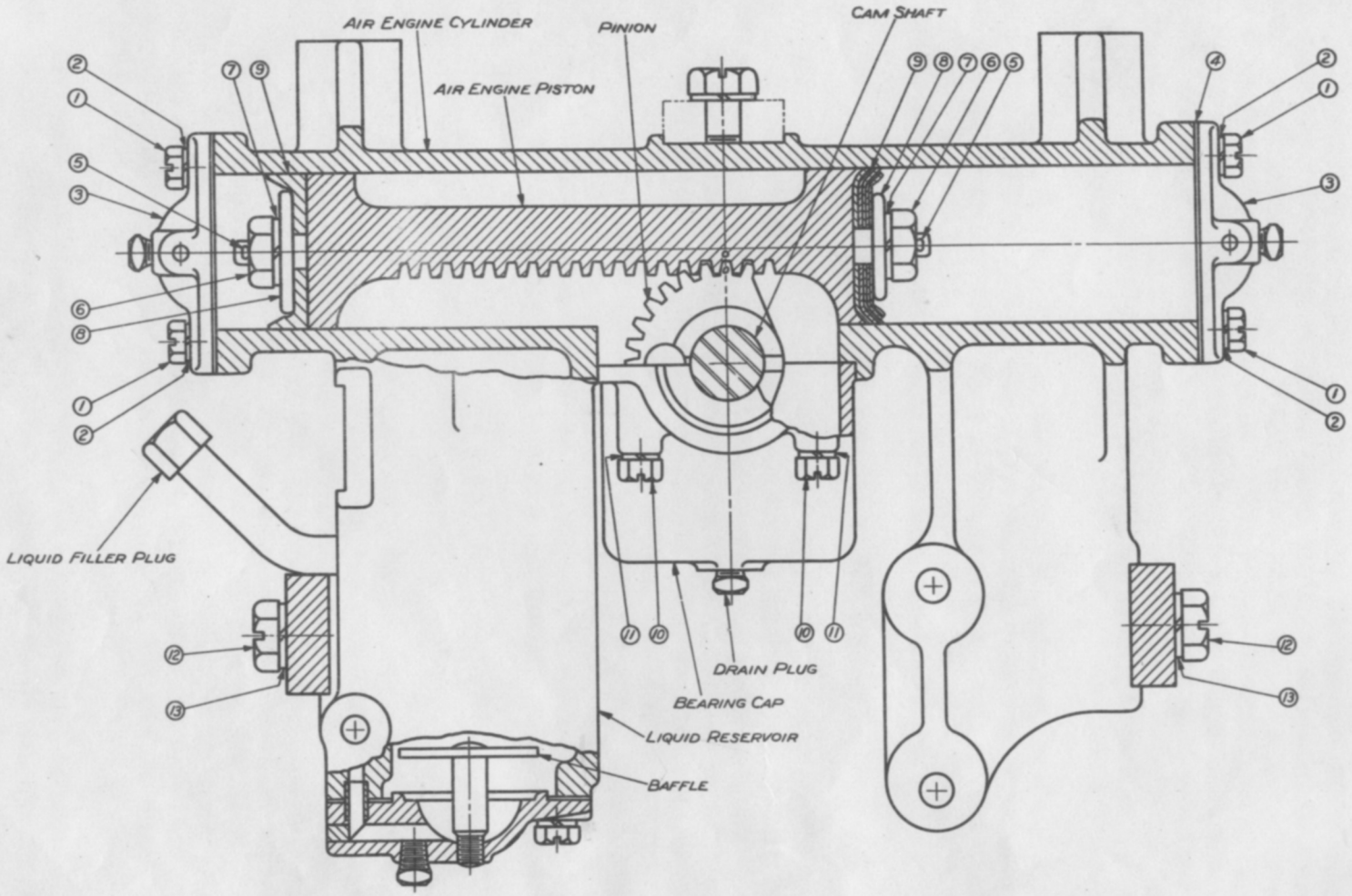
After making any changes in the valve parts such as grinding in or installing new parts, the travel and air gap should be checked and adjustments made if necessary. To compensate for wear on the valve seats, new valve stems are furnished slightly longer than required, and when installed must be filed so as to come within the proper limits. When making adjustments remove the magnet valve cover and armature and use the gauge Cat. 2716194 which has four slot depths:- 0.032 in., 0.052 in., 0.068 in. and 0.088 in. When a large number of valves are to be maintained it will be found more convenient to use a micrometer gauge as shown on photo. 426979.

EXHAUST VALVE (PC-19 CONTROLLER)

Place the 0.032 in. gap over the exhaust valve stem on the coil operated valve and press down. If the valve stem is of the correct length the exhaust valve will seat and air will not pass through the valve; the legs of the gauge will rest on the top of the magnet core. If the stem is too long so that the feet of the gauge do not touch the magnet core, file the top of the stem. A convenient way of doing this is to use a small steel block with a hole drilled to take the stem and a thumb screw to hold the stem firmly while filing. This will insure filing the end of the stem perfectly flat.

The same procedure is followed in adjusting the exhaust valve on the spring actuated valve, using the 0.032 in. gap on the

P-2743109 THIRD ANGLE PROJECTION



CROSS-SECTION OPERATING MECHANISM

FIRST MADE FOR PC-19 CONTROLLER

BEGUN BY [illegible] TRACED BY D. [illegible] JUNE 12,'30

FINISHED BY [illegible] INSPECTED [illegible] JUNE 13,'30

GENERAL ELECTRIC CO. ERIE WORKS P-2743109

R.C.

ISA

gauge.

INLET VLAVE (PC-19-CONTROLLER)

Place the 0.068 in. gap over the exhaust valve stem with the gauge legs resting on the top of the magnet core. If the inlet valve stem is of the proper length, the end of the exhaust valve stem will be flush with the gap surface and air will not pass through inlet valve.

If air passes through the inlet valve, file a small amount from the end of the inlet valve stem and repeat test.

If there is a space between the top of the exhaust valve stem and gauge gap, peen out the inlet valve stem or install a new stem and repeat test.

The above applies to both the coil and spring actuated sections of the PC-19 controller valve.

EXHAUST VALVE (REVERSER)

Follow same procedure as for PC-19 valve except use 0.052 in. gap on gauge.

INLET VALVE (REVERSER)

Follow same procedure as for PC-19 valve except use 0.088 in. gap on gauge.

REMOVING PISTON

Refer to P-2743109.

(a) Shut off air supply.

(b) Disconnect piping from bearing cap.

(c) Remove cap screws (1) and washers (2) so as to enable taking off cylinder heads (3). In doing this care should be taken not to ruin gaskets (4).

(d) With controller in off position the piston will be near the hydraulic end of the cylinder as shown, in which position cotter pin (5), nut (6), lockwasher and follower (8) may be removed. Note position of end of piston with respect to end of cylinder. This will be of help in reassembling.

(e) Turn the cam shaft using wrench V-2715895 as far as it will go in the opposite direction. It will be found that the piston moves away from the piston packing (9) and the latter may be pulled out by using a hooked rod inserted through the hole in the center.

(f) Remove cotter pin, nut lockwasher and follower on the air end of the piston in the same manner. Turn the cam shaft back and the piston packing will remain near the end of the cylinder where it may be removed by means of the hooked rod.

(g) Remove the four cap screws (12) on the end of the bars supporting the cam operated contactors.

(h) Remove cap screws (10) which hold the bearing caps on both ends of the shaft. This will allow the cam shaft to be lowered, disengaging the pinion with the rack so that the piston may be slid out either end of the cylinder.

REPLACING PISTON

(a) Insert piston (without packings) in cylinder with flat end of piston in hydraulic end of cylinder.

(b) Replace cam shaft, lining up teeth in rack and pinion in accordance with marks on teeth.

(c) Fasten cam shaft in place with cap screws (10).

(d) Insert piston packing (9) and place follower (8) lockwasher, nut (6) and cotter pin (5), on hydraulic end of piston.

(e) Turn cam shaft so that piston is accessible from air end of cylinder and insert piston packing on end of piston. Fasten with follower, lockwasher, nut and cotter pin.

(f) Replace cylinder heads (3) and fasten with cap screws (1).

(g) Fasten contactor supporting bars in place with cap screws (12).

(h) Re-connect piping to bearing cap.

REMOVING CAM SHAFT

To take down cam shaft, remove cap screws (12), which hold the supporting bars for contactor units in place, and remove cap screws (10) on both ends of the shaft. The entire cam shaft may then be removed.

OPERATION AND ADJUSTMENT OF ACCELERATING RELAY

CONSTRUCTION

The accelerating relay used with PCM control consists essentially of two series coils and one shunt coil mounted on a steel core and a steel armature, the latter held in its normal open position by a tension spring. A knife edge bearing extending the width of the armature reduces friction on the moving parts to a minimum and insures that the calibration will remain constant. Silver contact tips are used to reduce contact resistance.

One set of series coils is connected in each motor circuit on two motor equipments and in series with each pair of motors on four motor equipments. This method is used so that the relay will operate on the average current through both sets of motors.

OPERATION

The function of the relay is to stop the progression of the control whenever the current through the motors exceeds a predetermined value and allow the progression to continue as soon as the motor current has dropped to this predetermined value. Whenever the motor current exceeds the relay setting the magnetic pull on the armature is great enough to overcome the spring tension and the contacts are closed. This completes a circuit through the "stop" coil which halts the movement of the PC controller until the motor current falls to the value at which the relay is set to drop out, at which point the contacts are opened, allowing the PC controller to continue cutting out resistance. This action is carried out throughout the entire acceleration.

The shunt coil on the relay is connected so that its flux adds to that of the series coils. The purpose of this coil is two fold:

1 - It acts as a lifting coil and helps the series coils pick up the relay.

2 - It is also used to vary the relay calibration on equipments which include the selective acceleration feature.

Under conditions of maximum acceleration, the shunt coil is energized only when the interpoint interlock closes. As its name indicates, this interlock is arranged so as to close only between points, and when it does close, it completes a circuit through the relay shunt coil and the "stop" coil. The reason for including the stop coil in this circuit is to start building up the flux in the stop coil so as to insure that the progression of the PC controller will be stopped on the following point in

case the motor current is above the drop out setting of the accelerating relay. Under conditions of maximum acceleration therefore, the relay shunt coil is energized only between the points, and when on a given point the only factor affecting the dropout of the relay is the motor current through the series coils.

To obtain selective acceleration, which is intermediate or lower rates of acceleration, it is not necessary to change the adjustment on the relay. This is accomplished by continuously energizing the shunt coil through a high resistance, a different amount of resistance being used for each additional rate desired. This, however, does not affect the operation of the interpoint interlock which functions as described previously. Under these conditions, the result is that with the same adjustment on the relay, the current through the series coils will have to drop to a lower value before the relay will drop out and allow the PC controller to move to the next point.

ADJUSTMENT

The accelerating relay is shipped from the factory with the proper setting for the motors with which it is to be used. In case the desired acceleration is not being obtained, it is recommended that other parts of the equipment be checked thoroughly before making any change in the relay adjustment.

Apparent mis-functioning of the relay may be cause by the following:

(a) On metallic return circuits such as used on trolley buses, particular attention should be given to the wiring of the control circuits with respect to the main circuits. If the polarity of these two circuits is not alike, the relay shunt coil will buck the series coils, resulting in erratic operation.

(b) If the timing on the PC controller is too slow, it may take so long to cut out each step of resistance that the current will never be high enough to cause the relay to operate. Under this condition, if the relay adjustment is raised, it will have no effect and if lowered, will only result in a still lower rate of acceleration. The average timing of the PC controller should be approximately four seconds for a complete cycle, i.e., up and back, this time to be measured while operating the control without current in the motor circuit.

(c) Jerky acceleration is usually caused by incorrect resistor connections which may be mistaken for failure of the relay to function.

(d) The successful operation of the relay depends to a large extent on the condition of the interpoint interlock. Insufficient contact on the interpoint interlock may prevent the relay from picking up, allowing the controller to skip points. The tip gap on the interpoint interlock contacts should be 1/4 inch. The tip gap on the relay contacts should be 1/16 inch when a condenser is used and 1/8 inch when the condenser is not included.

In case it should be necessary to change the relay adjustment, this can be done by changing the spring tension on the armature. Turning the adjusting screw to the right will increase the spring tension, raising the drop out setting of the relay so that it will be less effective in retarding the time for the controller to turn on. Turning the screw to the left will decrease the spring tension, lowering the drop out point of the relay so that the relay will be more effective in slowing up the time required for the controller to turn on.

LINE BREAKER AND CONTACTORS

The line breaker and contactors are magnetically operated. Arc chutes are readily removable without the use of tools, and the line breaker is provided with arc suppressor plates to increase the efficiency of the powerful blowouts. The four contactors have magnetic blowouts of modern design capable of rupturing all overloads as well as normal currents.

On the back of the line breaker frame is mounted an overload relay of new design, which not only opens up the control circuit of the coil when an overload occurs but also utilizes the energy of the overload to quickly and forcibly open up the contact tips of the line breaker, thus reducing the destructive effect of the overload or short circuit current to about one third of that of the former types of line breakers.

PC CONTROLLER

The PC controller has eleven small and rugged cam contactors of a new design. These are spring closed and positively opened by cams on a rotating cam shaft. The cam operated controller assures a definite and positive sequence of closing the cam contactors without the introduction of interlocks.

MOTOR REVERSER

The motor reverser is of the electro-pneumatic type. Two magnet valves are provided for operating an air cylinder which throws the drum to the forward or reverse position. Fingers mounted on both sides of the drum make contact with segments to provide the proper motor connections. Six control fingers are included which insure proper interlocking.

MASTER CONTROLLER

The master controller is of the drum type with four positions as follows:

1 - Off
2 - Switching
3 - Full series running
4 - Full parallel running

Frame and cover are of sheet steel. The shaft is of hexagonal steel covered with moulded insulation which conforms to modern controller construction. The reverse handle is separate from the main handle and is arranged so that the reverser drum cannot be thrown while the main handle is in an operating position and the main handle cannot be operated while the reverser drum is in the "off" position. The controller is provided with a dead man's release, that is, the cylinder returns to the "off" position when the handle is released.

MA-13 FUSE BOX

Type:

Moulded compound box with moulded compound arc chute and contact parts enclosed.

Capacity:

225 amps. (Will rate 500 amps. with special adaptors)

Fuse:

Copper ribbon held by wedge clamp terminals, latter operated by insulated hand screws which extend out of ends of box.

General:

Pole pieces embedded in compound. Cover hinged at bottom, held closed by wing nut.

MS-118-A MAIN SWITCH

Type:

Knife blade switch S.P.S.T. with quick break feature.

Capacity:

400 amps. continuous.

General:

Mounted on a slate base and enclosed in a wooden box fitted with hinged cover.

MD LIGHTNING ARRESTER

Type:

Magnetic blowout.

Construction:

This arrester consists of a spark gap in series with a resistance. Part of the resistance is in shunt with a blowout coil, between the poles of which is the spark gap. The parts are mounted on a porcelain base, which for outdoor service is in turn mounted in a substantial asbestos-lined, wooden box.

For the 750 volt arrester, the resistance is 70 ohms, and the spark gap 0.025 inch.

Operation:

When the lightning potential comes on the line, it causes the spark gap to break down and a discharge occurs through the gap and resistance rod to ground. Part of the line current following the discharge shunts through the blowout coil, producing a strong magnetic field across the spark gap thereby blowing out the discharge arc and restoring normal conditions.

The resistance rods will not crack or blister under the heat of the current, nor will they lose their resistance.

The blowout coil is not in the main circuit but merely shunts it, so that there is no danger of its taking the lightning discharge and burning out.

LIST OF MATERIAL

DOUBLE END PCM CONTROL
FOR
4- 40 H.P.- 600 VOLT MOTORS.

Quan.	Apparatus	Wt.	Outline	Photo.
2-	US-24-B trolley bases	154	K-764627	
1-	M-D3 lightning arrester	15		249426
1-	MA-13-F fuse box with porcelain bolt insulators	19 188	K-2182727	406844
1-	MS-118-A main switch	24	"	249475
2-	C-506 master controllers	80	K-2765504	343773
1-	Reverse handle	1		
2-	MS-46-H control switches with fuses	9	K-1666092	245862
1-	ME-59 reverser	86	K-2765556	344156
1-	SB-97 contactor box, containing	446	L-2793503	
	1- PC-19 controller			345672
	1- DB-999 line breaker			345673
	3- DB-920 contactors			345674
	1- Motor cutout switch			
	1- Accelerating relay			
1-	Set of resistors consisting of	135		
	1 box 17EW203B6		K-21D473	GEA-842-C
	1 box 17EW202C6		K-21D474	
8-	Porcelain bolt insulators	8		
1-	Set air accessories	3		
1-	17KG1A field shunting control group	55		GEA-1396-A
1 -	Inductive Shunt	160		
	Total weight	1035# 160 1195 188 1005		

(1662) C.M.

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