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GENERAL DESCRIPTION

The Sprague General Electric multiple unit control system was designed primarily to permit a train of motor cars, when coupled in any combination, to be operated as a single unit from either end of any car of the train.

The system has been very generally used on individual equipments where it has been desired to remove from the car platform all apparatus carrying motor current.

Fundamentally, the system for each motor car may be considered as consisting of a motor controller and a master controller. The motor controller comprises a set of apparatus, which handles directly the current for the motors, while the master controller merely governs the operation of the motor controller, and consequently, does not handle the larger currents necessary in the motor circuit.

The latest development in the Sprague General Electric multiple unit control system is the cam operated motor controller, known as type PC. Before designing this controller, a thoro analysis of all existing control systems was made. The result is the following improvements in design and operation.

1st. A definite sequence of contactor operation, preventing the trouble sometimes encountered from improper functioning of independently operated contactors.

2nd. Interlocks on individual contactors eliminated.

3rd. Simplicity of electric control circuits.

4th. The contactor arc chutes assembled in a single group that swings downward, exposing all contactor parts.

5th. The simplicity and compactness of the apparatus, which permits the assembly of the contactors, reverser, line breaker, relays, etc. in one box.

6th. Less weight.

In general, car equipments may be divided into two classes, one being for city and light interurban service, and the other for elevated, subway and heavy interurban work. To furnish car equipments that will be best adapted to these services, Type PC controllers are manufactured in two sizes, for both two-motor and four-motor equipments. In designing the small PC controller, particular attention was given to the

restricted space available for equipment underneath the modern car with low steps and small wheels. At the same time, all the ruggedness, accessibility and safety features of the large PC controller are maintained in the smaller size.

AUTOMATIC CONTROL.

The cam operated contactors with their definite sequence of opening and closing and elimination of electrical interlocks makes possible the design of an automatic control that is simpler than former non-automatic types.

With automatic control, the master controller operates directly thru the train wires, the motor reverser, line breaker and the rotation of the cam shaft closing the contactors for the first step, but the succeeding positions of the cam shaft and closing of the contactors is controlled indirectly by the master controller thru the current limit relay and under its direct control.

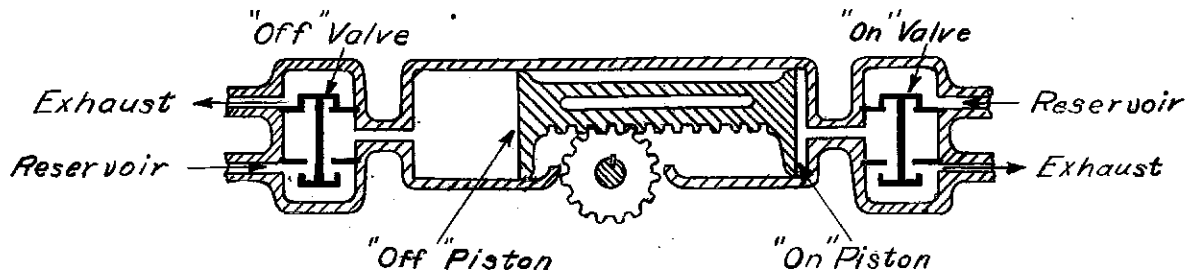
The scheme of operation is, that as each section of resistance is cut out of circuit, an increased current passes thru the motor and series coil of the current limit relay. If this current is sufficient to open the relay contacts, the progression of the cam shaft is arrested until the current falls to a predetermined value, and, in this manner, the automatic current limiting feature is secured.

One of the objections to automatic control has been the inflexibility of the current limit in so far as overcoming grades, pulling a dead car or other emergency conditions. The General Electric Company have overcome these objections by devising an automatic control from which the same results may be obtained as a non-automatic control under emergency conditions.

When a car will not accelerate at the current the notching relay is set, the operator moves the advance lever on the controller cap plate forward. This will advance the motor controller one point. This operation is repeated for succeeding notches. By this means the motor controller may be notched up to and held on any point desired, as may be done with a non-automatic control.

OPERATION OF MOTOR CONTROLLER

The line breaker, reverser and contactors are actuated by air pressure controlled by magnet valves. The line breaker and reverser are provided with individual magnet valves and air cylinders, while a single cylinder with a double piston and two valves is used for the operation of all the contactors. The contactors are actuated by cams mounted on a shaft, which is rotated by a rack and pinion, as shown on sketch A. Air is



Sketch A.

admitted to, or exhausted from, the air cylinder, by means of magnet valves, controlled by the master controller.

Sketch A shows the position of the magnet valves and the pistons when the master and motor controllers are in the "off" position. In this position, the air pressure is applied to the "off" piston thru the "off" magnet valve, while the "on" magnet valve allows any air in the "on" cylinder to pass thru to atmosphere. When the master controller is turned on, and the reverser throws, the line breaker closes, and then both the "on" and "off" magnet valves are energized. This applies air pressure to the "on" piston and allows air to escape from the "off" cylinder; the rack moves toward the "off" magnet valve, rotating the pinion and cam shaft until the "off" magnet valve is de-energized. When this occurs air pressure is applied to the "off" piston, and, as the "on" magnet valve applies air pressure to the "on" piston, all movement of the rack and pinion ceases with the motor controller in the first operating position. Subsequent positions on the motor controller are obtained by alternately energizing and de-energizing the "off" magnet valve. When the master controller is turned off, the "on" and "off" magnet valves are de-energized and air pressure is applied to the "off" piston and released from the "on" piston. This causes the rack to move toward the "on" magnet valve and rotates the pinion and cam shaft, turning the motor controller to the "off" position.

EQUIPMENT

The list of apparatus comprising a complete PC control equipment for multiple unit operation is as follows:

600 VOLTS

- / 2 - Master controllers,
- / 1 - PC motor controller with bolt insulators,
- / 2 - Master control and reset switches,
- / 1 - Switch and fuse for the control circuits,
- / 1 - Set control coupler sockets,
- 1 - Control jumper,
- 1 - Set air accessories,
Necessary control cable,
- 2 - Current collectors
- 1 - Main switch in box
- 1 - Lightning arrester
- 1 - Set cast grid motor resistors with bolt insulators,
Main and Motor wiring
Car Lighting material,

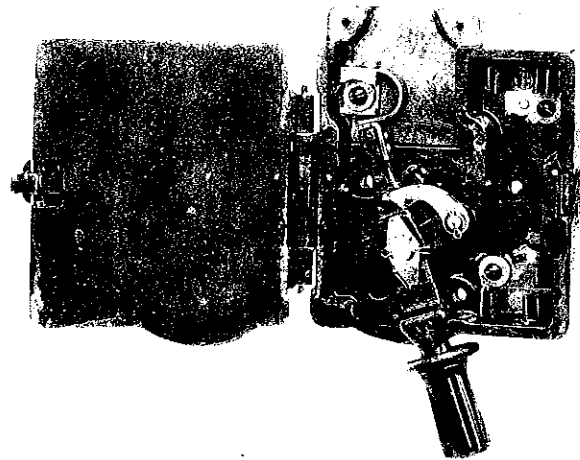
1200 and 1500 VOLTS.

- 2 - Master controllers.
- 1 - PC - Motor controller with bolt insulators.
- 1 - 1 1/2 Kw. Motor Generator with 32 volt generator for control, Lights and headlight.
- 2 - Master control and reset switches with fuses.
- 1 - Set control coupler sockets.
- 1 - Control jumper.
- 1 - Set air accessories.
Necessary control cable.
- 2 - Current collectors.
- 1 - Main switch in box.
- 1 - Lightning arrester.
- 1 - Main fuse box.
- 1 - Set motor resistors with bolt insulators.
Main motor wiring.
Car Lighting material.
- 1 - Change over device. (When operation on 600 volts is required).



TYPE C-129 CONTROLLER.
INDEX E-353.2 - E-353.7

239846



TYPE MS-46 SWITCH

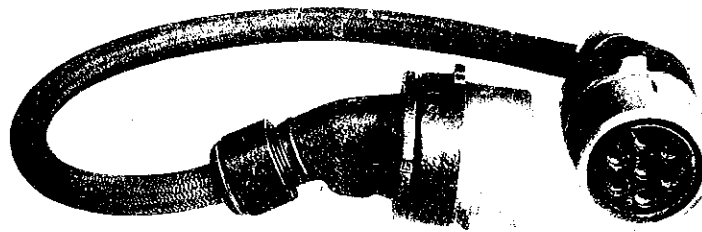


TYPE MS-14 SWITCH

*Master Controller and Control Switches
for PC Control Equipment.*

6 6 17

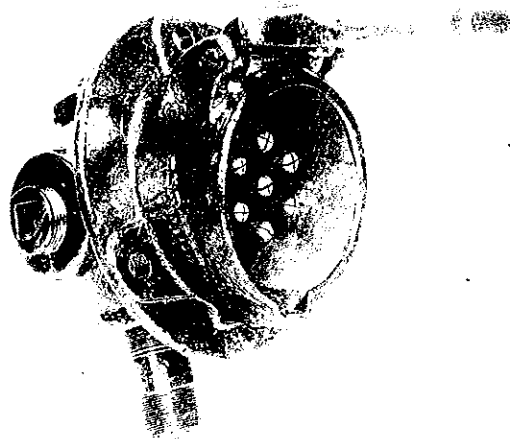
84700-5



TYPE DC-54-C COUPLER SOCKETS.



TYPE DA-35 COUPLER SOCKET AND DC-28 PLUGS.

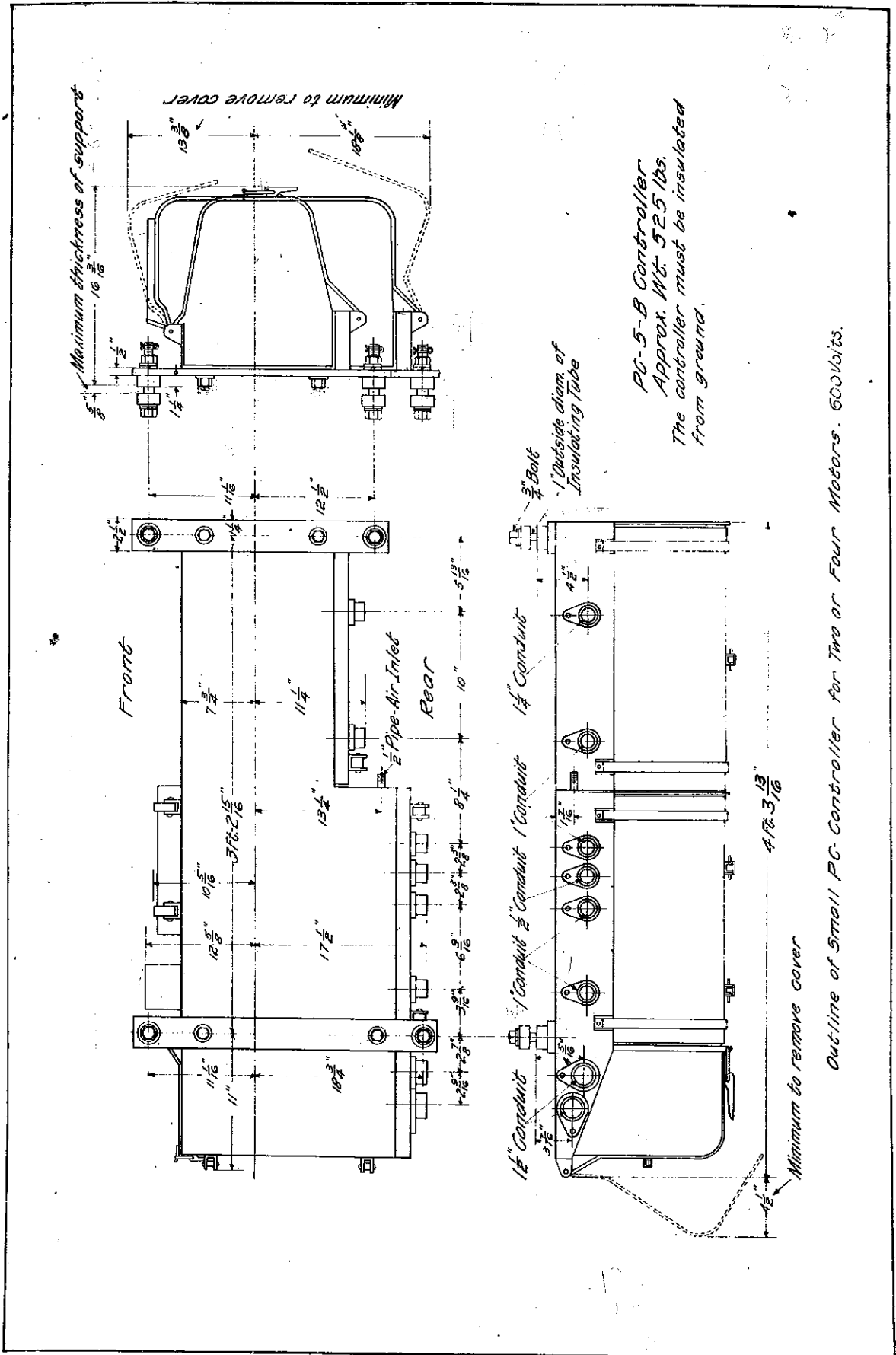


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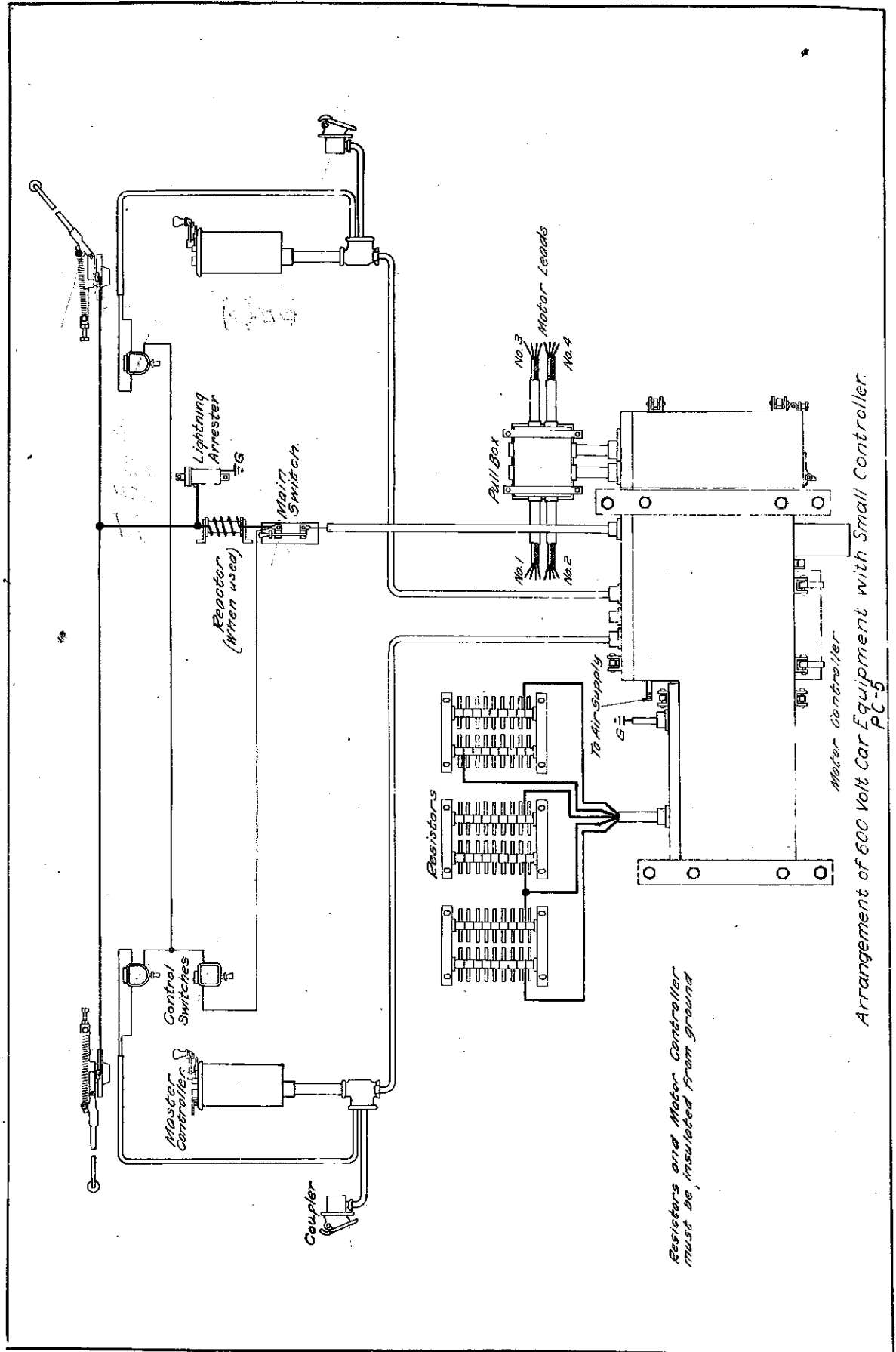
TYPE DA-82 COUPLER SOCKET.
INDEX E-341.4

5 26 17

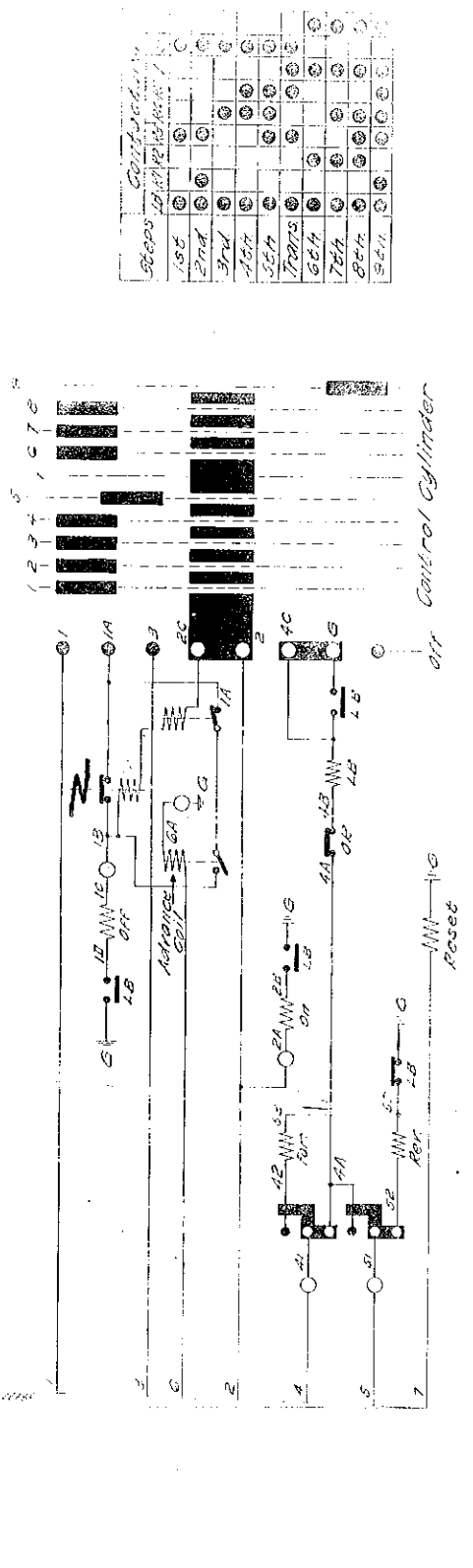
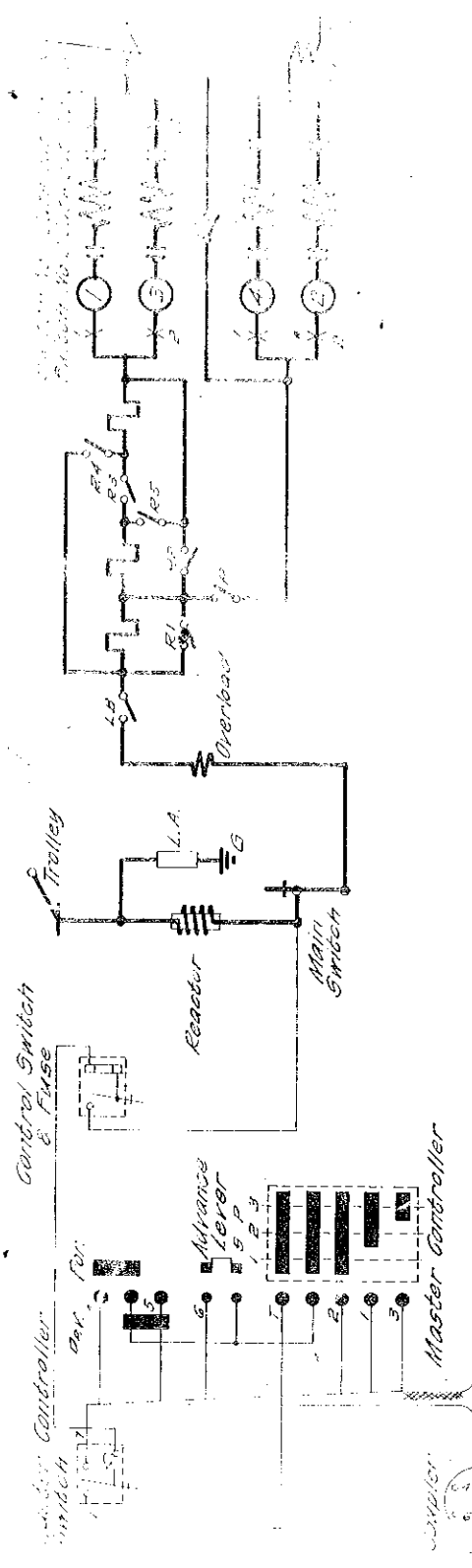
84700-6



Outline of Small PC-Controller for Two or Four Motors. 600Volts.



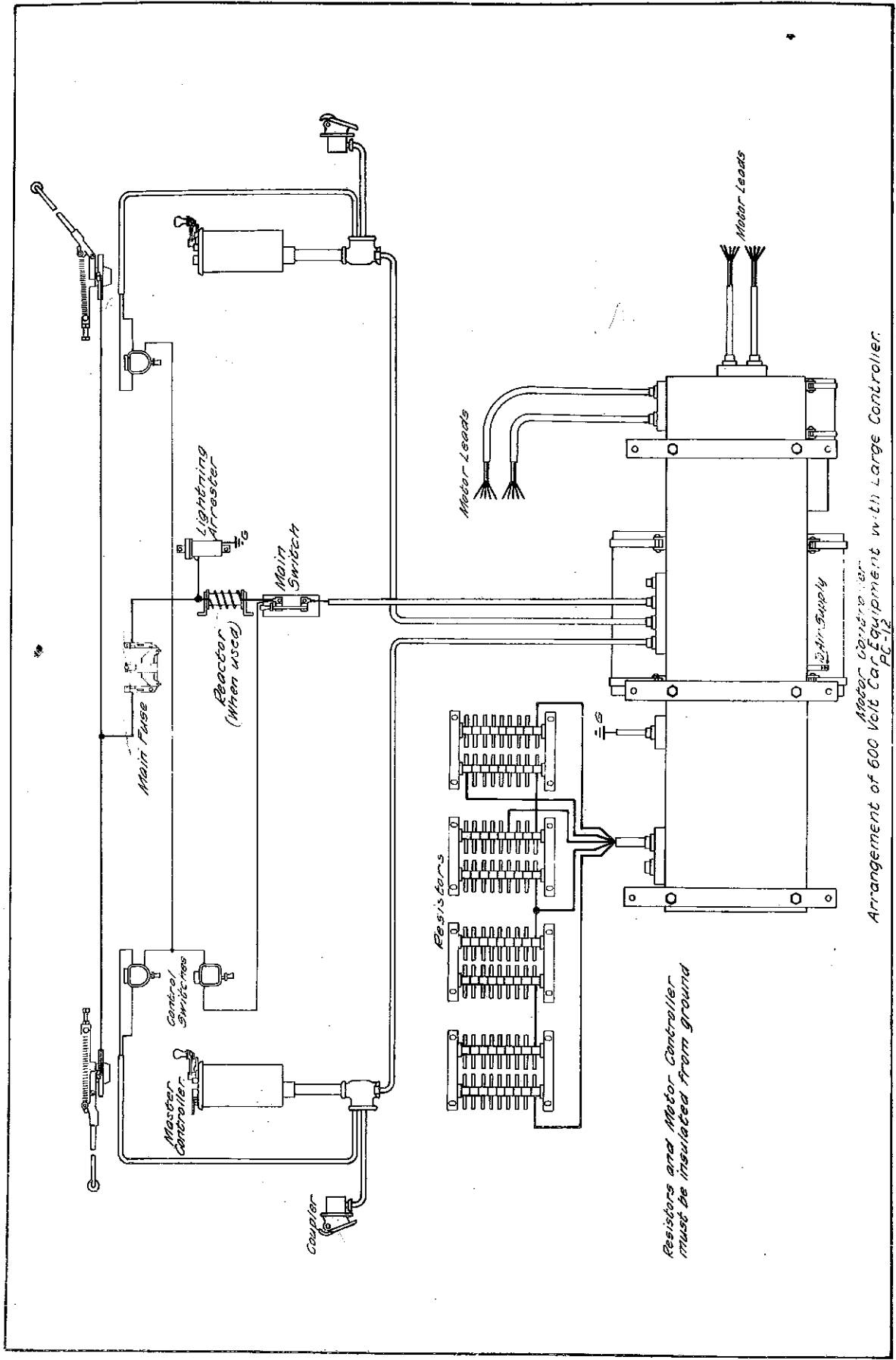
Arrangement of 600 Volt Car Equipment with Small Controller.
PC-5

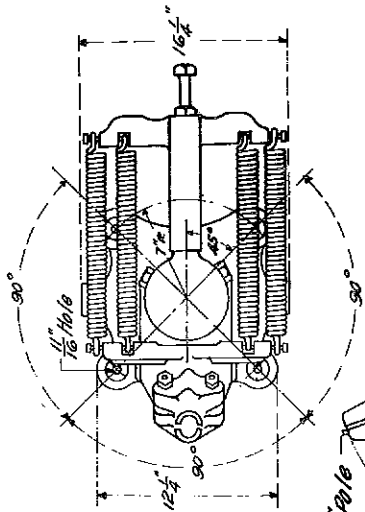


Configuration

Stops	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
1	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
2	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
3	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
4	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
5	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
6	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
7	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
8	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
9	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗

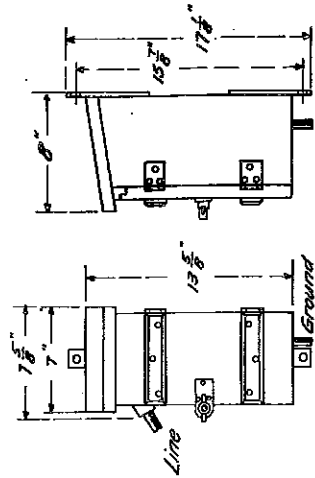




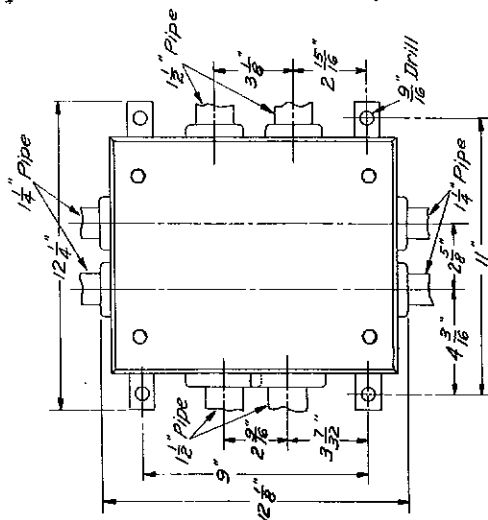


For 1 1/2" Hole

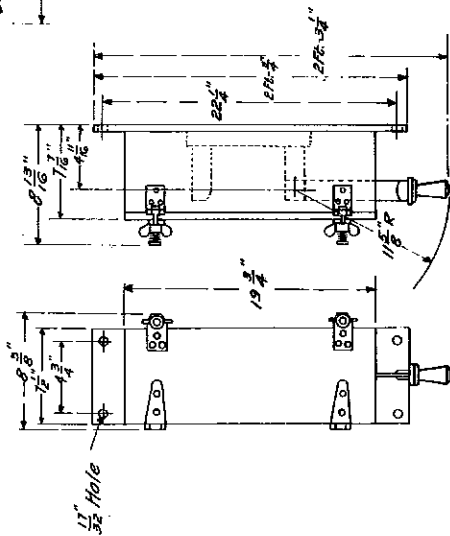
U.S. 13-J Trolley Base
Approx. Wt. 15 lbs.



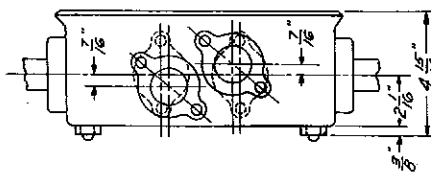
MD-3 Lightning Arrestor
Approx. Wt. 15 lbs.



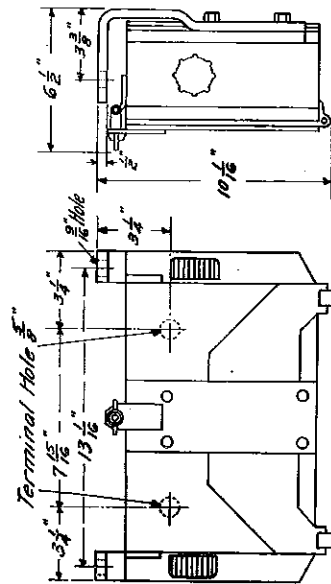
BU-386-B Distributing Box
Approx. Wt. 18 lbs.



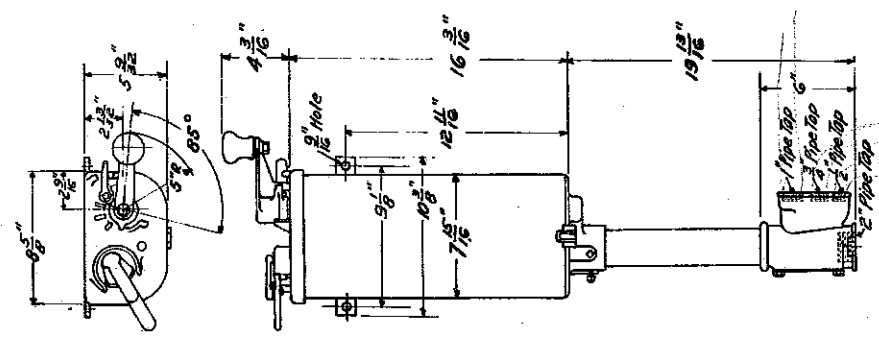
MS-118-A Main Switch
Approx. Wt. 20 lbs.



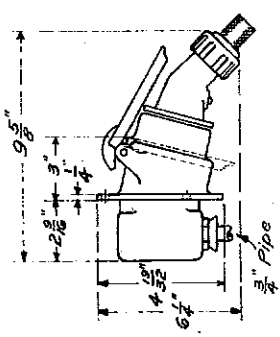
MA-19-A Fuse Box
Approx. Wt. 16 lbs.
Box must be insulated from ground



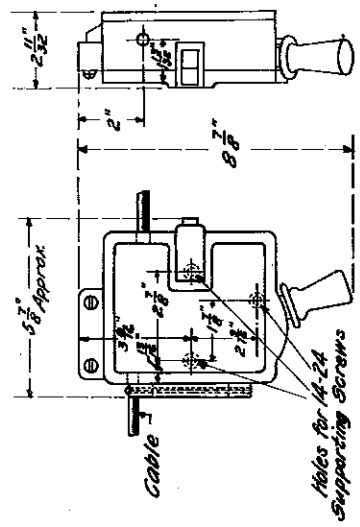
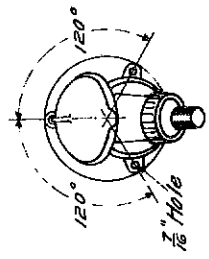
Outlines of Electrical Apparatus Used With 600 Volt PC Equipments.



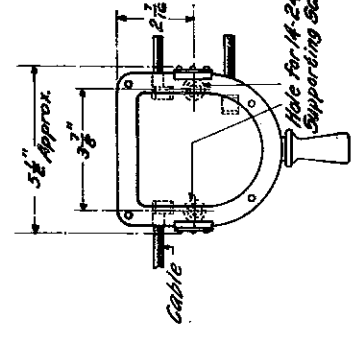
C-129-A Master Controller
Approx. Wt. 45 lbs.



IA-82-B Coupler Socket & JIG-54-C Coupler Plug
Approx. Wt. 12 1/2 lbs.

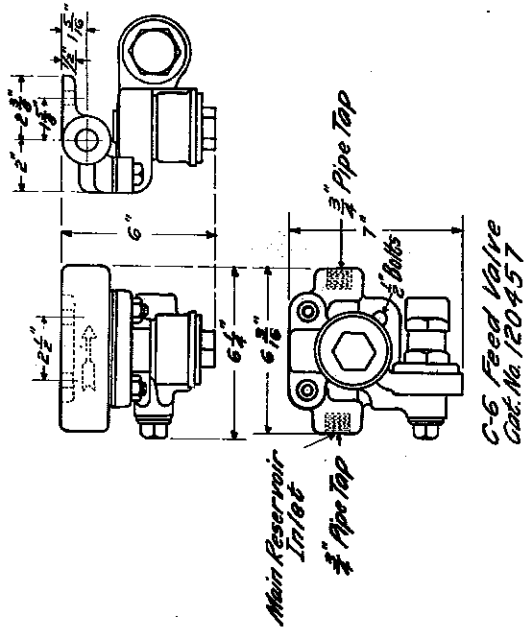
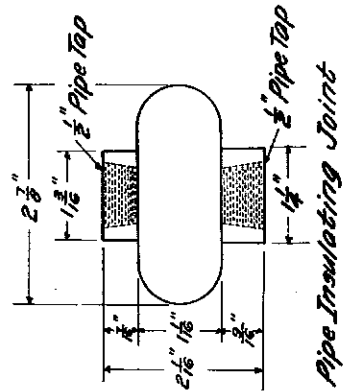
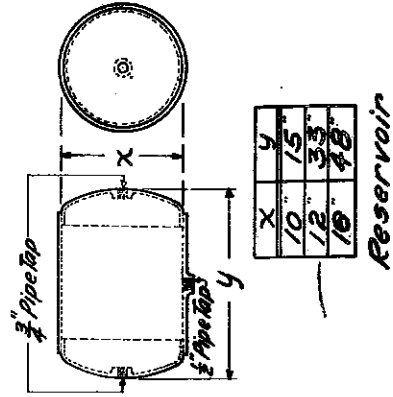
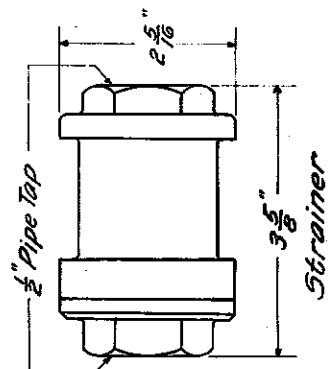
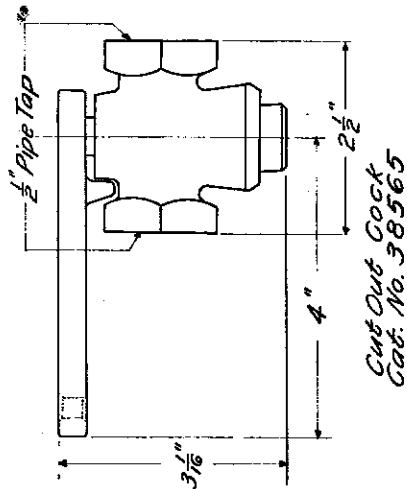
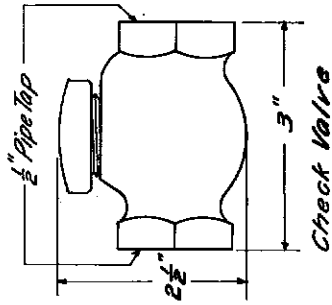
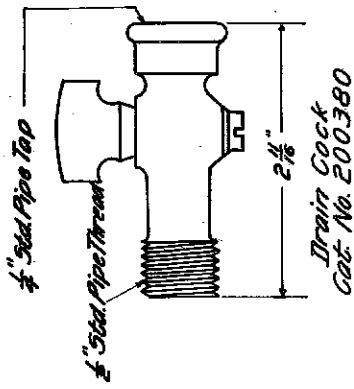


MS-46-H Switch
Approx. Wt. 4 1/2 lbs.



MS-14-G Switch
Approx. Wt. 4 lbs.

Outlines of Electrical Apparatus Used With 600 Volt P.C. Controllers



Outlines of Air Accessories Used With PC Equipments.