SPECIFICATIONS FOR SPRAGUE GENERAL ELECTRIC TYPE PC MULTIPLE UNIT CONTROL

The Sprague General Electric PC cam operated control is the Product of evolution, and was designed after a study had been made of all existing types of control, which have been manufactured both in this country and abroad. All the operating troubles which existed in previous equipments have been analyzed with the result that this control has been built along lines which practically eliminate failures in service previously experienced. Particular attention was paid to safety, reliability flexibility and maintenance. It differs principally from other types in that the individual contactors are actuated by an air operated cam shaft, and, hence, must necessarily always open and close in a definite sequence on every car in the train under all conditions. It has always been universally recongized that automatic acceleration possesses great advantages from the standpoint of power saving, passenger comfort and prevention of shocks to the equipment by improper handling of the master controller. Its general use in the past, however, has been prevented by the complications which were inherent in the electrical interlocking. With previous systems, when the master controller was thrown to a running position, the contactors for the first step were energized. When these contactors closed, the interlocking circuits were completed for the contactors on the second step, and so on. The failure, therefore, of any one individual interlock contact prevented the operation of the control. These interlock failures and subsequent lack of proper sequence of the contactors are entirely avoided with the PC controller, since the sequence is

made positive by the mechanical arrangement of the cam shaft. The closing and opening of the motor current circuits is as simple and positive as with the K controller. The method of operation is as follows:

The cam shaft is rotated by a rack and pinion, the rack being connected to the pistons of an air cylinder. Air is admitted to, or exhausted from the air cylinder by means of magnet valves controlled by the master controller. The "off" magnet valve is open when de-energized, while the "on" magnet valve is closed unless energized. When the master controller is turned on, the reverser throws, the line breaker closes, and then both the "on" and "off" magnets are energized. This supplies air to the "on " piston and allows air to escape from the "off" cylinder. The rack moves forward, rotating the pinion and cam shaft until the "off" magnet is de-energized. When this occurs, air pressure is applied to the "off" piston, equalizing the pressure on both pistons, causing the rack to remain stationary on the first position Subsequent positions of the motor controller are obtained by alternately energizing and de-energizing the "off" magnet valve, as the current limit relay drops out and picks up. When the master controller is turned off, both magnet valves are de-energized and air is thus admitted to the "off" piston and exhausted from the "on" piston. This causes the rack to move backwards, rotating, the pinion and shaft to the "off" position.

The equipment here in described is suitable for a car equipped with four GE-258 motors for operation in not more than three car trains.

MOTOR CONTROLLER

The motor controller contains the following elements:

(1) Contactors, which make the electrical combinations of the motors and regulate the starting resistance in circuit with them.

(2) Air engine and cam shaft for operating the contactors.

(3) Line breaker.

(4) Reverser and cutout switches.

(5) Overload relay.

(6) Accelerating current limit relay.

CONTACTOR

Each contactor consists of a movable arm operated by the cam shaft, and a stationary contact with a magnetic blowout coil, both of which are mounted on an insulating base, the latter being supported by two bolts. It is provided with a powerful magnetic blowout, which is sufficiently strong to individually break excessive overload currents. The contactor arc chutes are assembled in a single unit, similar to the arc deflector of a K controller. This unit is swung downward by merely loosening two thumb nuts, and when in this position, the contactors may be readily inspected from every angle. This makes the working parts of the contactor exceptionally accessible, so it is possible to inspect and maintain the control in a most efficient and economical manner. Due to the restricted arc chute used in all previous designs of remote control the contactor parts were necessarily very inaccessible.

MAIN AIR ENGINE AND CAM SHAFT

The air engine consists of a cylinder enclosing air opposed pistons, the air being admitted at either end of the

line breaker, inspection and maintenance are reduced to a minimum.

REVERSER AND CUTOUT SWITCHES

The reverser compartment at one end of the motor controller contains an air operated reversing drum and cutout switches for cutting out either pair of motors. The drum is thrown to the forward or reverse position by energizing the correct magnet valve thru a train wire from the reverse drum of the master controller. These magnet valve circuits are electrically interlocked with the line breakers, so that the drum cannot be thrown unless the line breaker is open and the line breaker cannot be closed unless the drum is either in the full forward or reverse position, as indicated by the reverse handle.

OVERLOAD RELAY

The overload relay consists principally of the main circuit, series coil with its tripping and interlocking mechanism, together with a shunt reset coil, all mounted on an insulated base. The air gap can be accurately adjusted, so that the overload immediately trips the line breaker in case the current exceeds a safe pre-determined value.

CURRENT LIMIT RELAY

The current limit relay includes series and auxiliary shunt coils mounted on an insulated base. The series coil mechanism may be adjusted for a wide range, so that a setting can always be obtained, which will give a uniform increase in speed in passing from etep to step. To provide the increase in torque required on heavy grades and at sharp curves, it is necessary at times to bypass the current limit. This is done

by energizing one of the shunt coils by means of the "advance lever" subsequently described under " Master Controller". This bypass coil is connected to the other shunt coils in such a manner that the cam shaft can be advanced but one step at a time.

MASTER CONTROLLER

The master controller in general is similar to the standard K controller, but, since the current to be handled is of small value, it is very much reduced insize and weight. The frame is weatherproof, with cover designed to facilitate ready inspection, and back made of sheet steel, shaped so as to give strength and rigidity. The main handle in the "off" position is approximately at right angles to the face of the controller and swings thru an arc of only 120°. This makes it possible to mount the controller directly against the car-dash without in any way interfering with the manupulation of the handle. Should the motorman release this handle on any of the running points, it is returned to the "off" position, by means of a coiled spring, thus, immediately cutting off all power from the motors. The handle has three operating positions: number 1 or switching, number 5 or full series, and number 9 or full parallel. The cam shaft may be stopped on any of the intermediate points by swinging the handle back to the first point if it is desired to maintain an intermediate speed. Such an instance would be when following closely behind another car or vehicle where traffic is congested. The usual method, however, to meet this condition if the first point is too slow, is to hold the handle on till the

speed of the car increases to the desired amount, then throw off and coast as is done with hand control. On the controller cap plate, and directly back of the main handle, there is a small arm. This arm is fastened to a shaft which extends into the master controller. The lower end of this shaft makes contact with two fingers when pressure is exerted on the arm. A spring returns the shaft to the open position when the arm is released. The cam shaft is advanced one point at a time by alternately pressing and releasing this arm, obtaining the same result as when using a hand controller. The reverse handle is equipped with a safety catch, which makes it impossible to accidentally remove it, and a mechanical interlock prevents the main drum from turning unless the reverse handle is either in the forward or reverse position. The control drum is mounted on a hexagonal, insulated shaft, the same as has been so successfully used in K controllers. The fingers are so designed that they can never stub and prevent the drum from being turned to the "off" position. Hence, it is unnecessary to adjust them at light inspection. A small control switch containing a cartridge fuse is provided for each controller.

LIGHTNING ARRESTER

The MD-3 lightning arrester consists principally of an adjustable spark gap in series with a resistance. Part of the resistance is in shunt with a blowout coil, between the poles of which is a spark gap. The parts are mounted on a porcelain base, which is enclosed in an asbestos lined, wooden box. This arrester has the following important features:

Small spark gap.

Low series resistance.

Discharge arc blown out by magnetic field.

Magnetic blowout always ready for discharges, no matter how rapidly in succession they may occur.

No moving parts.

Easy to inspect.

GRID RESISTANCES

The grid resistances have grids composed of a metal which has a relatively low temperature coefficient, insuring uniformity of acceleration, regardless of the temperature of the resistance. These grids are extremely flexible, tough and capable of with-standing mechanical abuse. They are supported on tie rods at two points and have open end lugs, which make it possible to replace a grid without removing the entire resistance from the car. These lugs fit into individual sherardized sheet steel sleeves, which effectually protect the mica insulation on the supporting rod. Sheet steel end plates are used, which give the mechanism rigidity and strength. It is the practice of the General Electric Company to insulate the grid resistances from their supports by means of porcelain insulators, securely held between sherardized cup-shaped sheet steel washers. This gives an insulation of the most permanent and fireproof character.

TROLLEY

The US-13-D trolley base is our standard for use with polesup to 14 ft. in length. It is constructed of malleable iron of such proportions as to give an ample factor of safety, and, at the same time the least weight consistent with service-

ability. The pole-cap is clamped in place by means of two 5/8" bolts. The swivel bearing consists of 34 - 1/4" steel rollers carried in a bearing cup so designed as to be both water and dustproof, and to form a retaining wall for the lubricating oil. Thin wearing sleeves, which can be easily removed and replaced are provided around the stud and in the seat about which the rollers swivel. There are four heavy tension springs, insuring a good pressure at the trolley wire. The pressure may be adjusted from 20 to 45 pounds at the wire by simply turning a single screw. This base is extremely sensitive, permitting high speed on curves without danger of dislodging the current collector. Arcing, pounding, wrenching, etc., are practically eliminated, thus reducing wear on the collector to a minimum.

MAIN SWITCH

The main switch consists of a rugged, knife blade, switch mounted on a slate base and installed in a substantial wooden box. The box is provided with a cover held closed by means of two thumb screws.

DISTRIBUTING BOX

In order to facilitate car wiring a sheet steel pull box is furnished. This box has no terminals being merely an easy means of distributing the motor leads to each motor.

TRAIN LINE RECEPTACLES

The mechanical design of the receptacles is such as to facilitate installation, inspection and maintenance. Many advantages are incorporated in the design of these receptacles which make them extremely reliable and desirable. Proper in-

sulation and ample creepage distances insure positive operation under all reasonable conditions. The terminals for attaching the individual train cables are of a special design, which insures the clamping of both the insulation and the contact securely and permanently, thus, distributing the stress on the connections and preventing breakage.

TRAIN LINE JUMPER

The jumper consists of two plugs connected by means of special train cable with triple insulation. The cable entrance to these plugs is shaped like a goose-neck to facilitate handling when cars are being coupled. The individual conductor connections are made the same as those in the receptacles and a supplemental clamping device, which is integral with the plug, prevent stress being made on the soldered connections of the electrical conductors. Each conductor of the jumper cable has a steel wire center, which strengthens the cable and prevents localizing the bending of the individual conductors. This prolongs the life of the jumper conductors and gives the most reliable operation which it is possible to obtain. A rubber gasket is inserted in the cable entrance, which prevents moisture from entering the plug, and also gives a cushion seat to the conductors at a point where bending of the jumper cable would be most likely to occur.

BUS LINE EQUIPMENT

The bus line provides a means of furnishing current to each car of a train, with only one current collector in contact with the trolley wire.

Fig. 2 Drawing K-1920392 gives the connections of the equipment included in our proposal.

The couplers have ample capacity for a three car train if the current collector on the middle car of the train is used. Their general design is similar to the train line couplers.

The bus line fuse box is the well known MA-B copper ribbon type.

The bus line switch provides a means of disconnecting the bus line at such times as desirable and consists of a single pole quick break knife switch in a wood box.

GENERAL

The following important features are included in this PC control equipment:

(1) Automatic acceleration with resulting power saving, improved passenger comfort, and low maintenance.

(2) Elimination of complicated interlocking.

(3) The master controller has a dead man's release, self-adjusting and non-stubbing fingers. The reverse handle has a safety catch, and is interlocked with the main drum.

(4) Line breaker and contactors have powerful blowout coils, insuring positive arc rupturing with low maintenance.

(5) The overload relay trips line breaker before excessive currents can harm the equipment.

(6) The reverser is interlocked with the line breaker, so that the former cannot be thrown unless the latter is open.

(7) Power cannot be applied to the motors unless the reverser is in the position indicated by the reverse handle at the master controller.

(8) Should the power fail, the motor controller returns automatically to the "off" position, and if the master controller handle is retained in an operating position, the car starts automatically without jar when power is restored.

(9) In case the line breaker sticks, any one of the contactors can rupture an overload. This makes the equipment doubly safe.

(10) Bypassing the current limit provides increased torque when required.

(11) All parts of the motor controller are particularly accessible for inspection and maintenance.

LIST OF APPARATUS WITH WEIGHTS

APPARATUS	WEIGHT
1 - PC-5 motor controller	525
2 - CJ-129 master controllers	90
1 - Cat. # 164406 MD-3 lightning arrester with reactor core.	21
2 - RG Rheostats with insulators	167
2 - US-13 Trolleys	290
1 - MS-118 main switch	26
1 - Distributing box	18
1 - Set of couplers	26
3 - Control switches	12
1 - Set air accessories	52
1 - Bus line equipment	74
2 - J-15 headlights	32
Miscellaneous	20
TOTAL	1353

FIG. 1

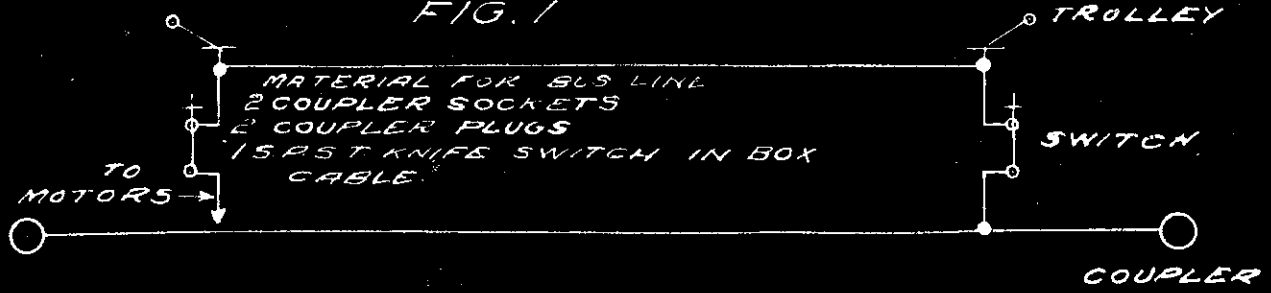


FIG. 2

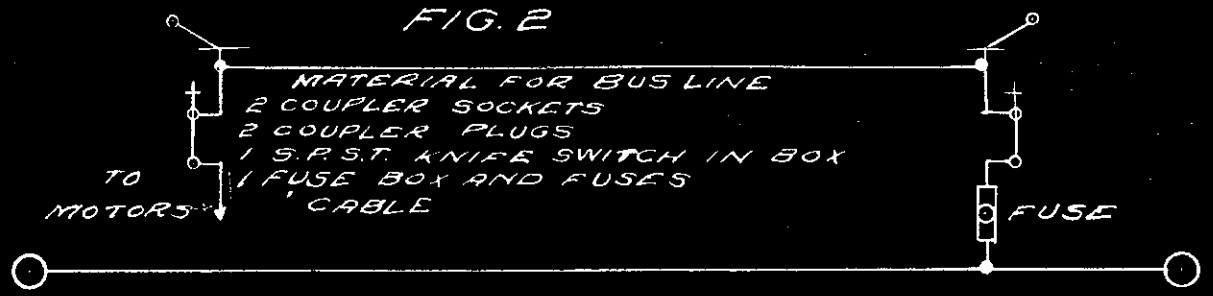
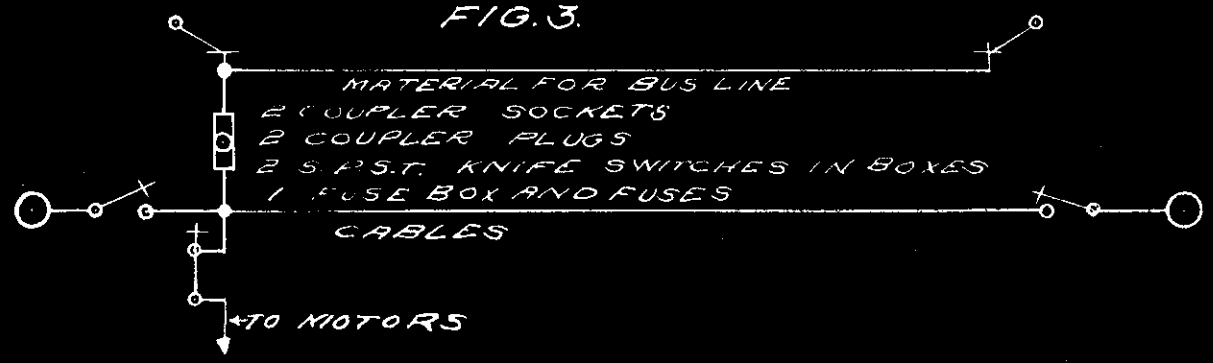


FIG. 3.



(1) REVISED OCT. 1, 1918

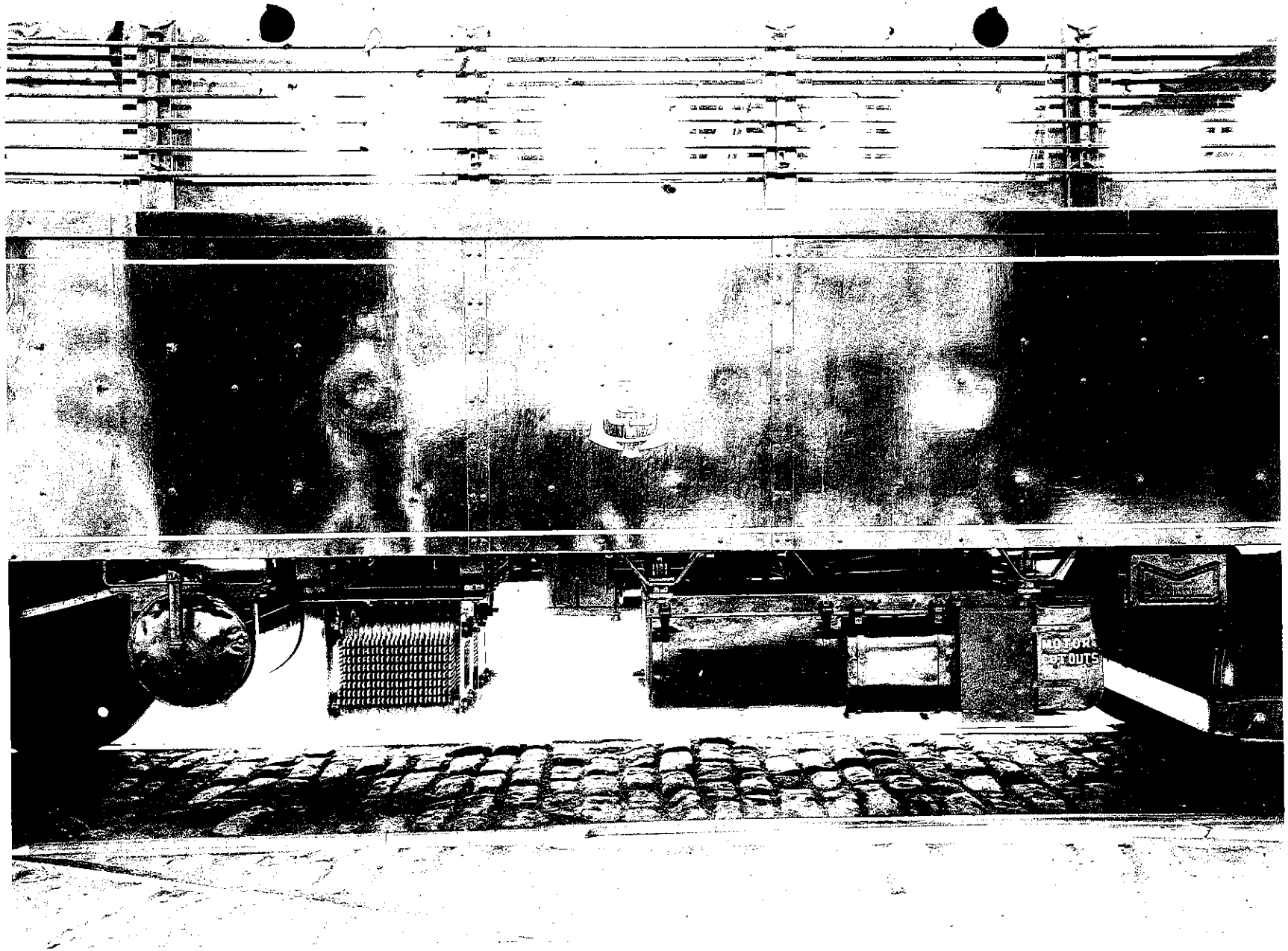
CONNECTIONS OF TROLLEY BUS LINES

K1920392

CHECKED _____ APPROVED RWY. EQUIP. DEPT.

GENERAL ELECTRIC COMPANY SCHENECTADY, N.Y.

RC
DRAWN C.L. BROWN JUNE 13, 1918 INSPECTED OCT. 8, 1918
RETRACED OCT. 1, 1918

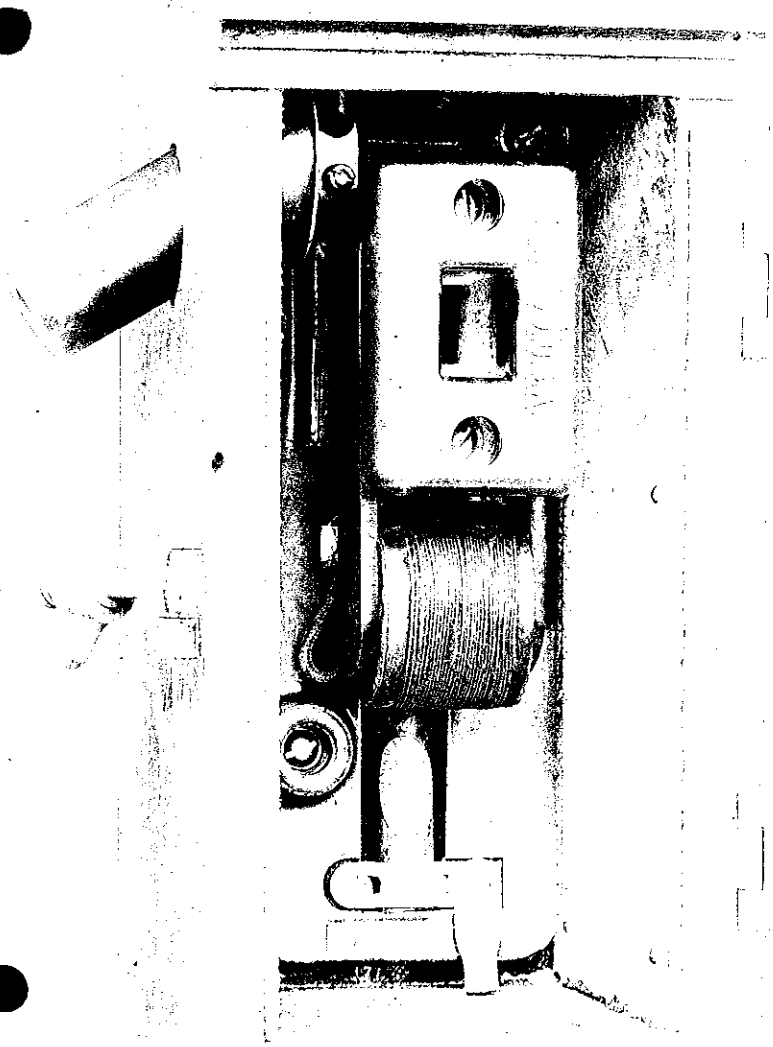


319938 SMALL PC CONTROL EQUIPMENT UNITED TRACTION CO., ALBANY, N. Y.

INDEX E-318.32 8 31 18

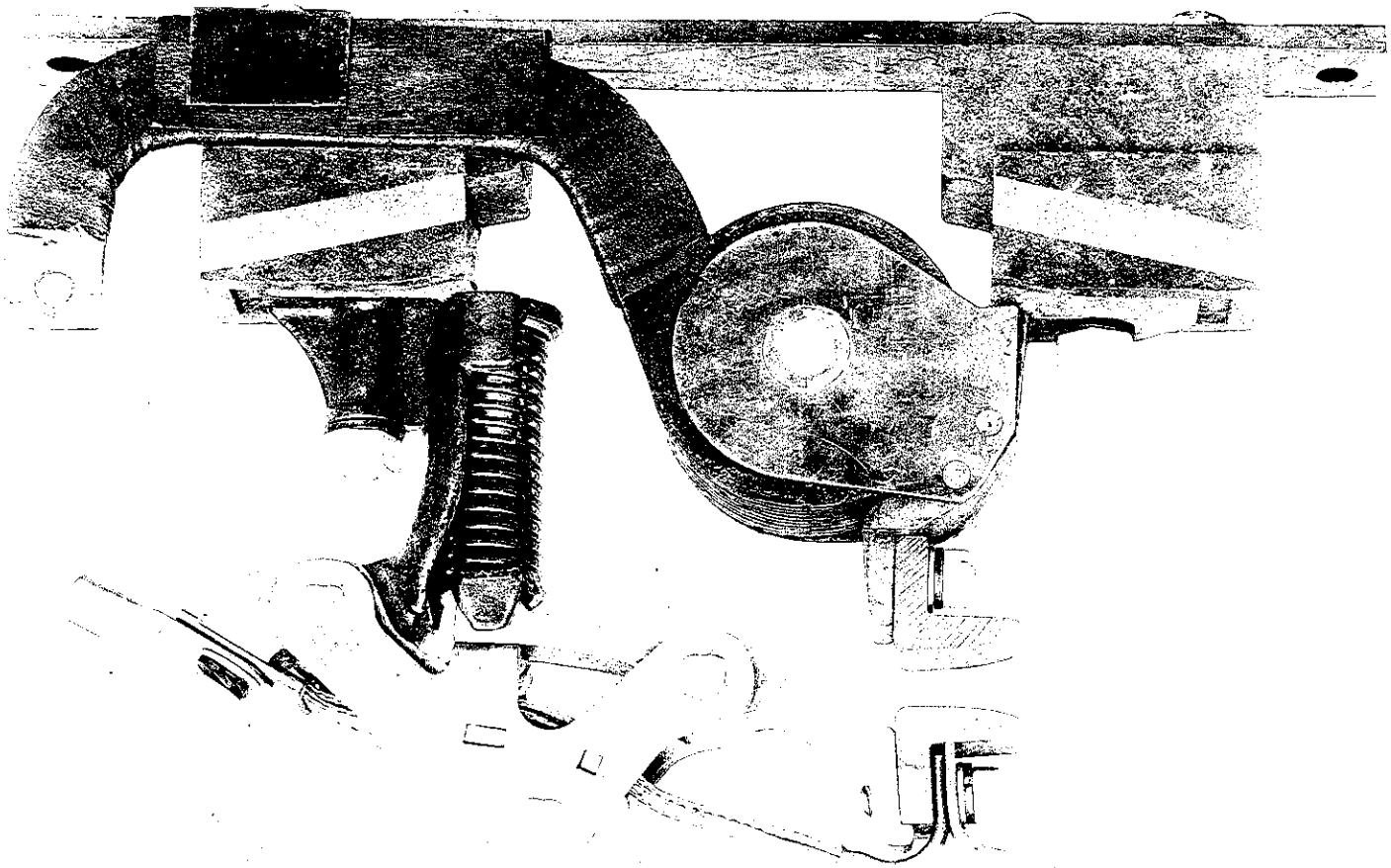
319937 COUPLER ARRANGEMENT SMALL PC CONTROL UNITED TRACTION CO., ALBANY, N. Y.

INDEX E-316.32 8 31 18



392189 TYPE M FORM D-3 DIRECT CURRENT LIGHTNING ARRESTER FOR LINE SERVICE ON 350-750 VOLT CIRCUITS. CAT. NO.164406.

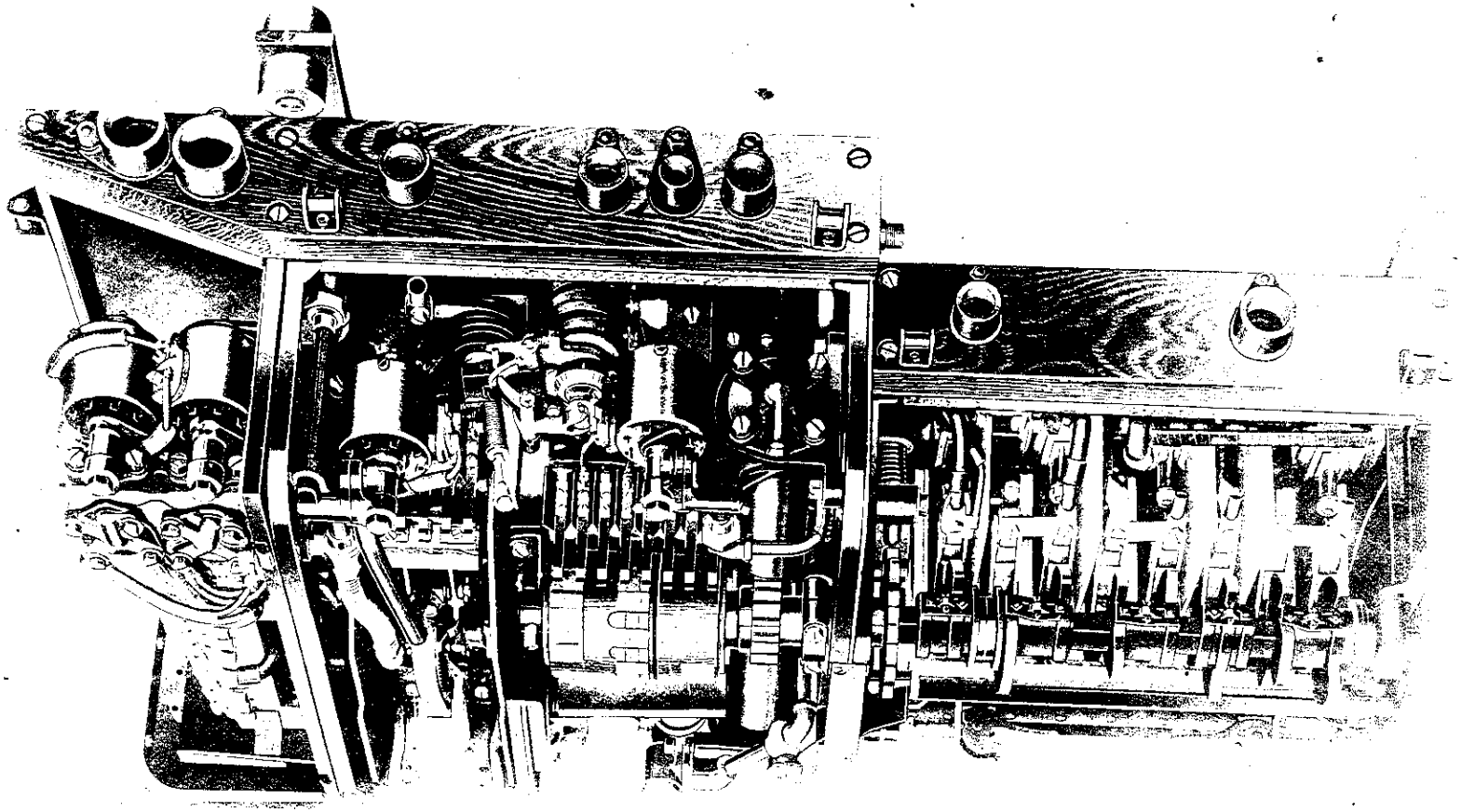
INDEX E-356.1



315247 TYPE PC 5, PC 6 AND PC 9 CONTROLLER (CONTACTOR UNIT)

INDEX E-353.7

6 15 17



319986 TYPE PC-5 FORM C-2 CONTROLLER.

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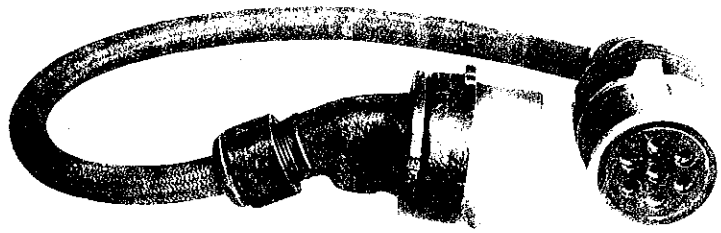
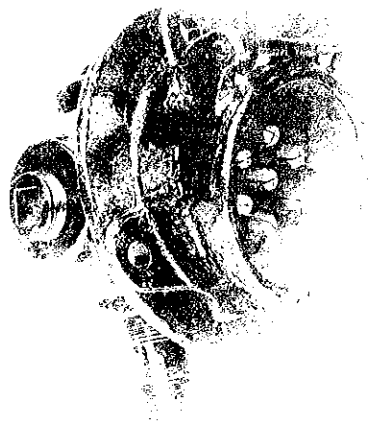


TYPE DC-54-C COUPLER SOCKETS.

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



239847

TYPE DA-82 COUPLER SOCKET.