9-4-52

GEI-25803

GENERAL ELECTRIC EQUIPMENT

FOR

DOUBLE END

PRESIDENTS' CONFERENCE COMMITTEE TYPE CAR

FURNISHED

MELBOURNE AND METROPOLITAN TRAMWAYS BOARD

AUSTRALIA

G.E. CO. REQUISITION I-72104

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

APPARATUS DEPARTMENT
GENERAL ELECTRIC COMPANY
SCHENECTADY, N. Y.

-49

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OPERATION SECTION

GENERAL DESCRIPTION AND OPERATION OF CONTROL

GENERAL DESCRIPTION

This control was developed to meet the specifications of the Electric Railway Presidents' Conference Committee which, briefly, call for high acceleration and braking rates combined with quick response and smooth operation.

This control equipment provides rheostatic acceleration of the motors, that is, two motors are connected permanently in series and the two series groups are connected in parallel.

To meet the requirement of smooth operation with high accelerating and braking rates, a commutator-type motor controller is used which provides a large number of accelerating and braking steps. This controller consists of a stationary commutator with sections of the motor resistors connected between adjacent commutator segments.

A brush arm driven by a small electric motor, is arranged to rotate around the commutator, cutting out small sections of resistance as it passes from one bar to the next. One continuous movement of the brush arm over the commutator surface cuts out 136 sections of resistance, providing this number of steps for acceleration. Since the number of steps required for dynamic braking varies directly with the car speed, the control is arranged to provide a varying number of steps up to a maximum of 272 for braking. This larger number of steps is obtained by using the commutator resistance twice, thus doubling its effectiveness, as explained on the following pages.

The motor control group is designed to mount in the same control compartment as the motor controller and contains the switches and contactors required to set up the motoring and braking circuits. This group also includes the field-shunting contactors.

A magnetically-operated line breaker, mounted as a separate unit, is used to make and break the main power circuit to the motors.

Two frames of motor resistors and the commutator-controller resistor are mounted in an enclosed compartment underneath the car. These resistors are cooled by forced ventilation, the heat dissipated being used to warm the interior of the car in winter and discharged to atmosphere in summer.

Two master controllers and two hand reversers, each combination mounted in a common frame, are located underneath the car, one at each end. This location has the advantage of keeping power

wiring off the platform and results in minimum cable runs underneath the car. The master brake controller, which governs the operation of the dynamic track and friction brakes is mounted beside the master power controller. On the inner end of both the master brake controller and the master brake controller shaft is mounted a rate control rheostat. The rheostat on the main power shaft controls the accelerating rate while the rheostat on the brake shaft controls the dynamic braking rate. Levers are provided so suitable pull rods can be attached for foot or hand operation.

A magnetically-operated motor reverser, controlled by the hand reverser on each master controller, is mounted underneath the car.

A motor-generator set provides low-voltage power for battery charging and drives ventilating fans, one at each end which provides ventilation for the interior of the car, cooling air for the resistors, and forced ventilation for the traction motors.

There are four motors on each car. They are connected for field-shunting operation. A description of the motor and M-G set is found in the section on MOTORS and GENERATORS.

OPERATION OF CONTROL

Plate A-115584 shows the various steps of the control during an accelerating cycle. The devices shown on this diagram are designated as follows:

LB1 - Magnetically-operated line breaker, used to open and close power circuit to motors.

C1 - Magnetically-operated cushioning contactor, provides easy start and shut off during power operation. This contactor has a 600-volt operating coil and operates on line voltage to hold up the control progression during motoring when line voltage is lost and reapplies power with cushioning resistance in the circuit after line voltage is restored.

C2 - Magnetically-operated cushioning contactor, provides easy start and shut off during power operation.

LB2 - Magnetically-operated line contactor, used to complete line circuit during motoring and shift resistor combination for braking.

LB3 - Magnetically-operated motoring contactor, used during motoring only to by-pass the commutator resistance at the end of acceleration.

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

The section of resistance from R1 to R2 represents the commutator controller resistance, consisting of 136 subdivisions

FIG. 1 OFF POSITION

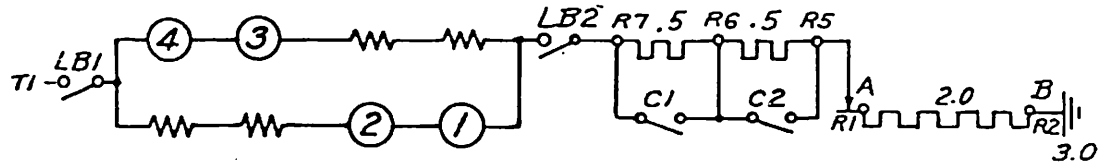


FIG. 2 FIRST POINT POWER (FIELDS PARTLY SHUNTED)

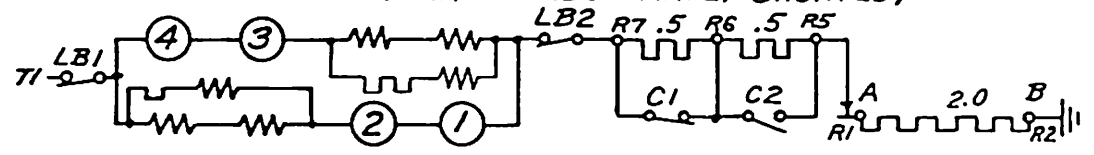


FIG. 3 START OF ACCELERATION (FULL FIELD)

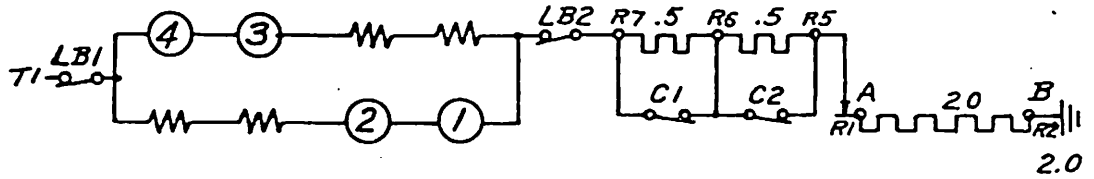


FIG. 4 END OF RESISTANCE ACCELERATION

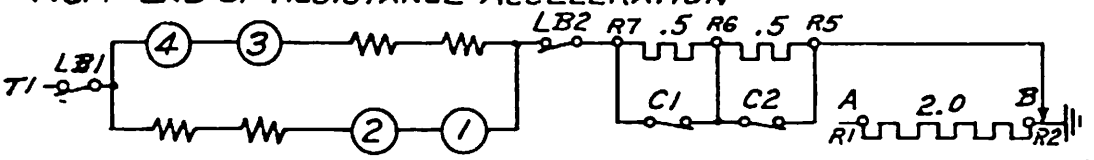


FIG. 5 START OF FIELD SHUNTING

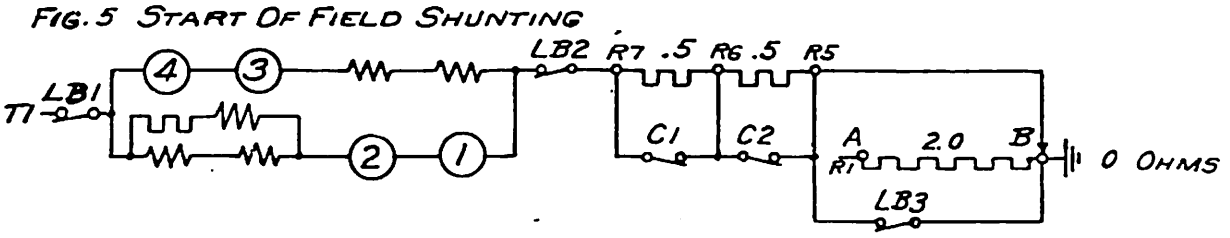
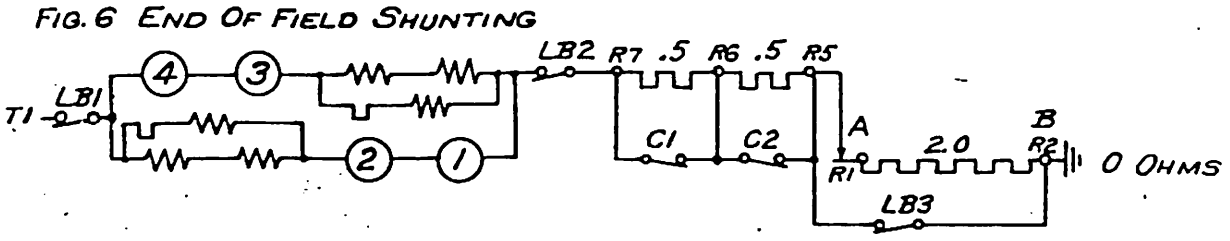


FIG. 6 END OF FIELD SHUNTING



(From Drg. K-8823154)

SEQUENCE CONNECTION DIAGRAM
FLOATING CONTROL-SIMPLIFIED MOTORING

PLATE
A 115584

connected to the commutator bars. The normal or off position of the brush arm is at "A" and as it swings from "A" to "B" or vice versa the brush arm cuts out the R1-R2 resistor section in 136 steps. The resistor values indicated on the diagram are approximate only to indicate how the resistance is reduced during progression of the control.

a. Power On - Switching

Refer to Plate A-115584. To apply power to the motors, the master controller pedal is depressed to the switching position resulting in LB1, LB2 and field-shunting contactors FS1 and FS2 being closed. Current flows through the motors with all accelerating resistance in series, the motor fields being partially shunted. This provides an easy start for the initial application of power.

As the LB1 line breaker closes, an interlock energizes the C1 cushioning contactor which then closes, cutting out the R6-R7 section of accelerating resistance. See Figure 2.

If the operator continues to hold the pedal in the switching position, the C2 contactor cannot close; therefore, the R5-R6 resistor remains in the motor circuit. The accelerating relay allows the brush arm on the commutator controller to advance, but at a very slow rate, cutting out the R1-R2 section of resistance at a rate to produce an acceleration of approximately 1.0 mphps. This reduced accelerating rate is automatically held to a speed of approximately 18 mph, which enables the operator to handle the car in slow moving traffic without the necessity of continually cutting off and reapplying power.

The third and fourth steps of field shunting remain open in switch position. Ample current-carrying capacity is provided in the R5-R6 resistor section to permit prolonged operation on the switching position if this should be necessary.

b. Power On - Running

When making a normal application of power beyond the switching position, the sequence is as follows:

1. LB2 and LB1 close.
2. Interlock on LB1 picks up C1, cushioning contactor.
3. Interlock on C1 picks up C2, cushioning contactor.
4. Brush arm moves around commutator under control of accelerating and braking relay ABR.

When the brush arm reaches the "B" position, all accelerating resistance has been cut out and the motors are connected "across the line". See Figure 4.

At this point the motoring contactor LB3 closes, by-passing the commutator resistance and brush arm completely from the motor

circuit. See Figure 5. The braking switch B3 also closes at this point as a preparatory step for braking, but causes no change in the motoring circuit. The brush arm reverses and starts back toward the "A" position, interlock circuits operating the field-shunting contactors in sequence on the way back to obtain additional car speed. See Figure 6.

c. Power Off - Cushion Shut-Off

A smooth shut-off of power is automatically obtained regardless of the speed at which the operator manipulates pedals, by providing reverse interlocking, control circuits being so arranged that the cushioning contactors always open first, inserting the cushioning resistance in the motor circuit to obtain a graduated reduction in torque. The sequence in shutting off is to open C2, then C1, and finally the line breakers which rupture the power circuit.

d. Reapplication of Power

When making a reapplication of power at speed, the cushioning contactors always close in sequence to provide smooth operation, followed by normal progression of the remainder of the control devices. The brush arm advances from its coasting or braking position without having to return to its off position, thus restoring power to the motors smoothly and with minimum loss of time.

e. Coasting

With both power and brake control "off" (coasting), dynamic braking connections are established. The amount of current generated by the motors is held to a very low value and, as the motor fields are partially shunted, the retardation caused by the "coasting" current is negligible. As the car speed decreases during coasting, the control progresses slowly through braking sequence to maintain the small value of coasting current. A continuous "follow-up" is thus provided, insuring a prompt application of dynamic braking when called for.

f. Braking

Plate A-115585 (see page 0-6) shows the various steps of control during the complete braking cycle. The commutator controller resistance is represented by the section of resistance between R1 and R2. Resistor values indicated on the diagram are approximate only to indicate how the resistance is reduced during progression of the control.

When the master brake control is turned "on", the motor fields are unshunted and the setting of the braking relay increased, resulting in dynamic braking building up at once. From this point on the control devices continue to progress automatically in sequence under control of the braking relay. If, at any time during

FIG. 1 COASTING - BRAKES RELEASED

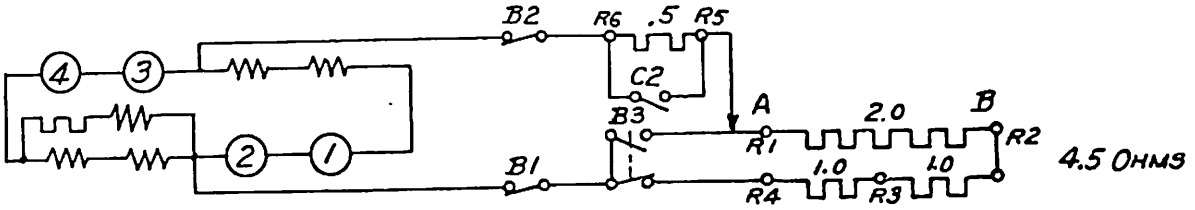


FIG. 2 START OF BRAKING (SAME AS FIG. 1, BUT WITH FIELDS UNSHUNTED)

FIG. 3 END OF FIRST HALF BRAKING CYCLE

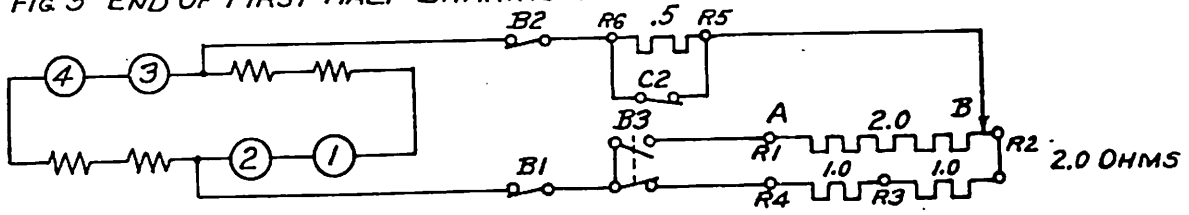


FIG. 4 CONNECTIONS AFTER B3 OPERATES

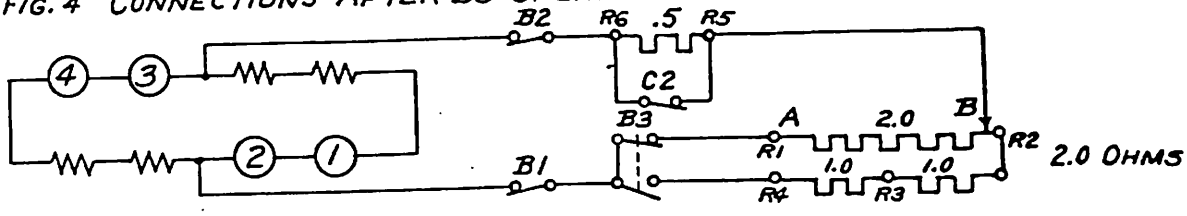
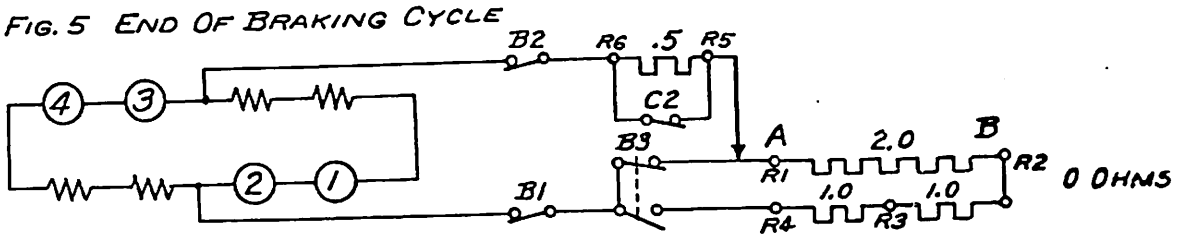


FIG. 5 END OF BRAKING CYCLE



(From Drg. K-8823155)
SEQUENCE CONNECTION DIAGRAM
FLOATING CONTROL - SIMPLIFIED BRAKING

A115585

the braking sequence, the master brake control is returned to the off (coasting) position, before the car has been stopped, the braking setup will be retained and the motor fields again shunted to remove the braking torque. This arrangement provides a smooth application and release of dynamic braking and prevents loss of time when making a reapplication.

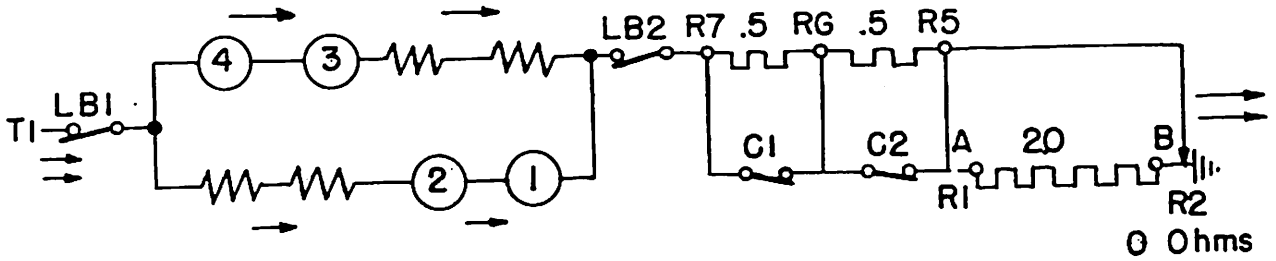
During the braking cycle, the brush arm on the commutator controller moves through the reverse cycle as compared to motoring. Thus, if the car has reached a speed during motoring where the brush arm is back near its starting position, all the resistance indicated as R1-R2-R3-R4 will be in the braking circuit because the B3 braking switch will be up. See Figure 2. When braking is called for, the brush arm will move forward cutting out the commutator resistance R1-R2. See Figure 3. At the limit of its forward movement, an interlock drops out the B3 switch, reinserting all the commutator resistance in the circuit, substituting it for the fixed sections of resistance R2-R3-R4 which have an equivalent ohmic value. See Figure 4. The brush arm is then reversed and as it moves back to the starting position, again cuts out small increments of resistance until it has all been cut out.

If the car reaches a speed during motoring where the brush arm has not progressed to the limit of its forward movement, the B3 switch will be down and if braking is called for, only the commutator resistance will be in the circuit (such as in Figure 4), the brush arm moving back to the starting position to cut out this resistance. This operation may be further explained by the general statement that during the braking cycle, the brush arm always retraces the path it took for the previous motoring cycle, back to the starting position.

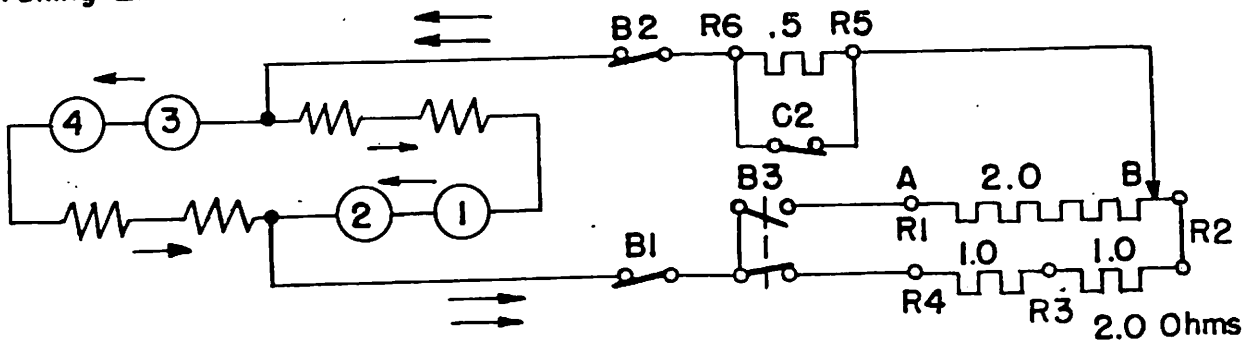
For analysis of control circuits refer to the CONTROL Section.

The direction of the flow of current in the power circuits for motoring and braking is shown on Plate A-125458.

Motoring End Of Resistance Acceleration



Braking End Of First Half Cycle



CURRENT FLOW IN POWER CIRCUITS DURING MOTORING AND BRAKING

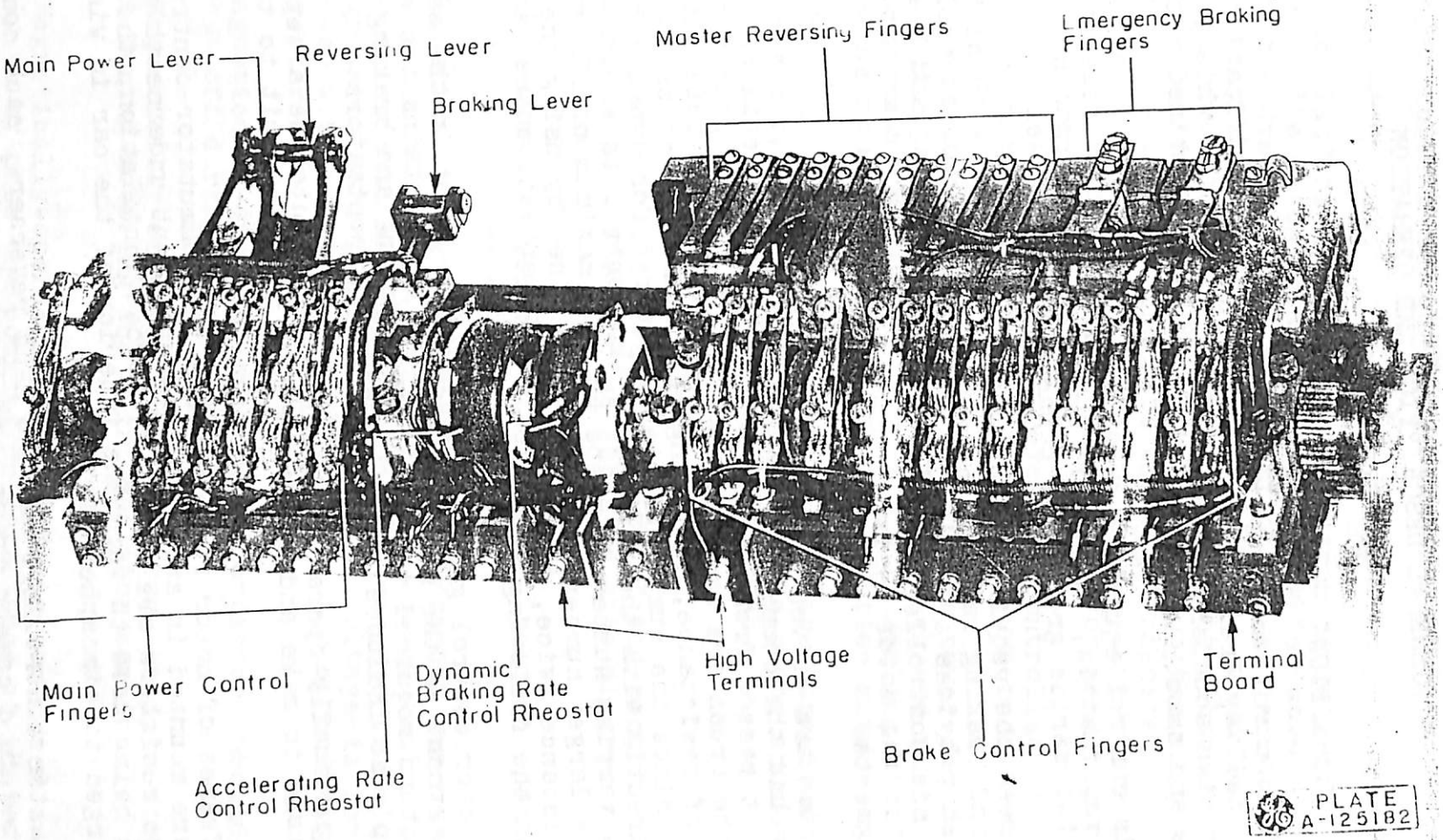
PLATE A-125458

INSPECTION SECTION

In order that a car give uninterrupted service, it is essential that all parts of the equipment receive efficient, systematic inspection, lubrication and repairs.

Frequency of inspection will be largely determined by local conditions; but until sufficient operating data and experience has been obtained, follow the schedule as given under each type of apparatus.

Traction Motors, see	Motor Section
Motor-Generator Set, see	Motor Generator Section
Control Apparatus, see	Control Section
Brake Control Apparatus, see	Brake Control Section



TYPE 17KC56BI MASTER CONTROLLER