ELECTRIC RUNNING SHEDS
BRANCH, HANNA ST.

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.

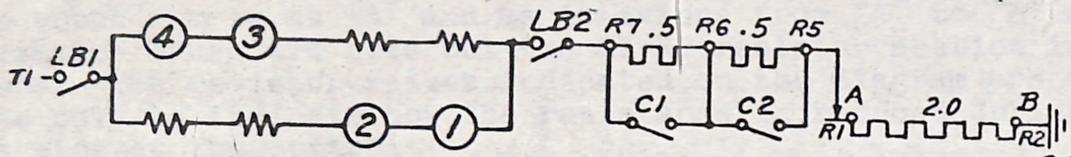
LB2 - Magnetically-operated line contactor, used to complete line circuit during motoring and shift resistor combination for braking.

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.

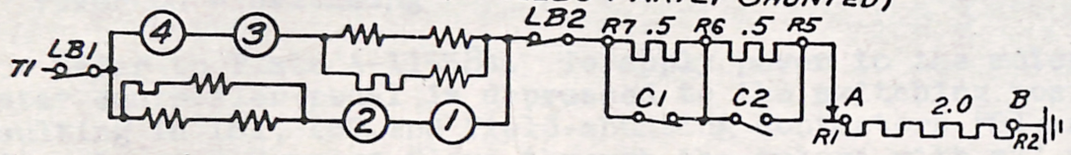
The section of resistance from R1 to R2 represents the commutator controller resistance, consisting of 136 subdivisions

FIG. 1 OFF POSITION



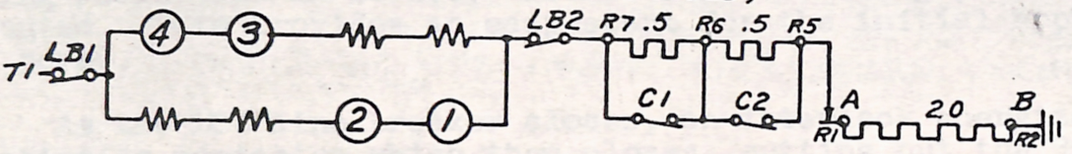
3.0 OHMS

FIG. 2 FIRST POINT POWER (FIELDS PARTLY SHUNTED)



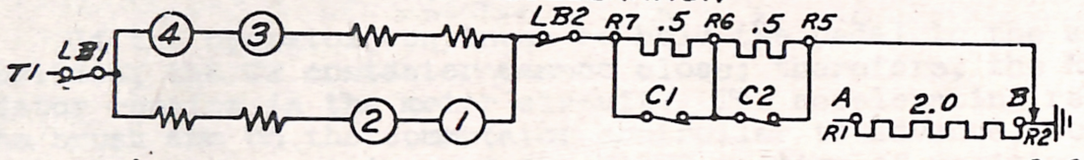
2.5 OHMS

FIG. 3 START OF ACCELERATION (FULL FIELD)



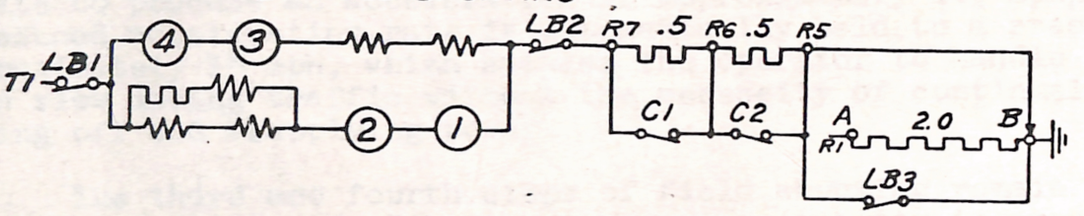
2.0 OHMS

FIG. 4 END OF RESISTANCE ACCELERATION



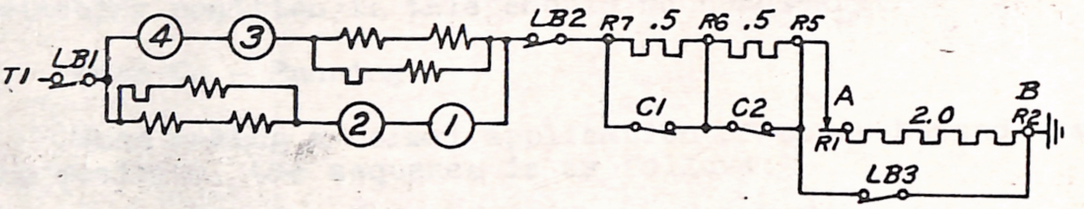
0 OHMS

FIG. 5 START OF FIELD SHUNTING



0 OHMS

FIG. 6 END OF FIELD SHUNTING



0 OHMS

(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

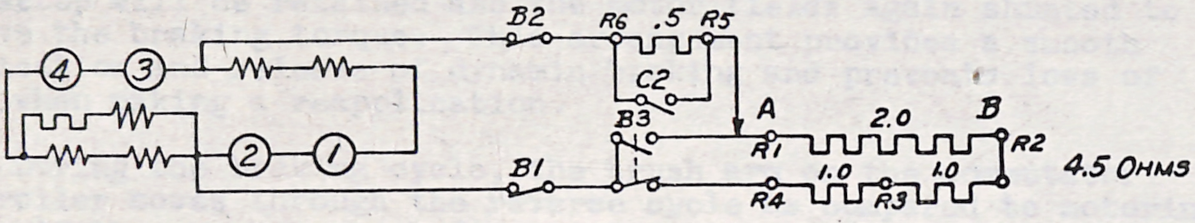


FIG. 2 START OF BRAKING (SAME AS FIG. 1, BUT WITH FIELDS UNSHUNTED)

FIG. 3 END OF FIRST HALF BRAKING CYCLE

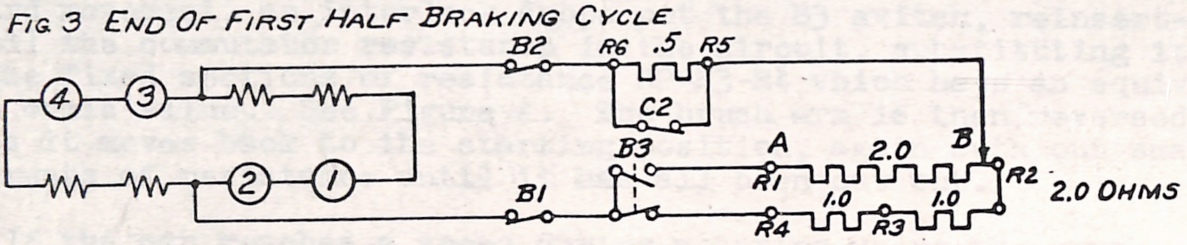


FIG. 4 CONNECTIONS AFTER B3 OPERATES

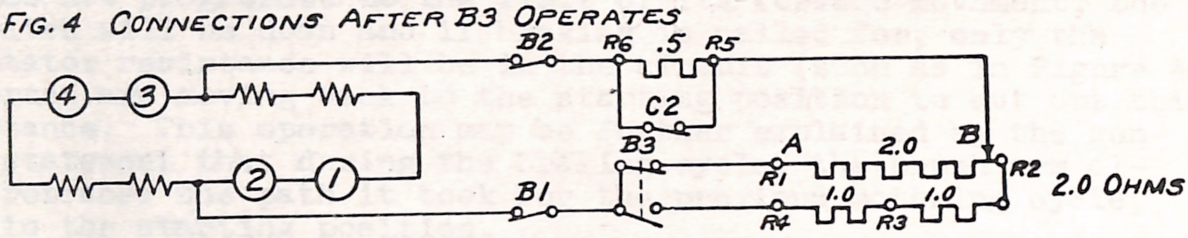
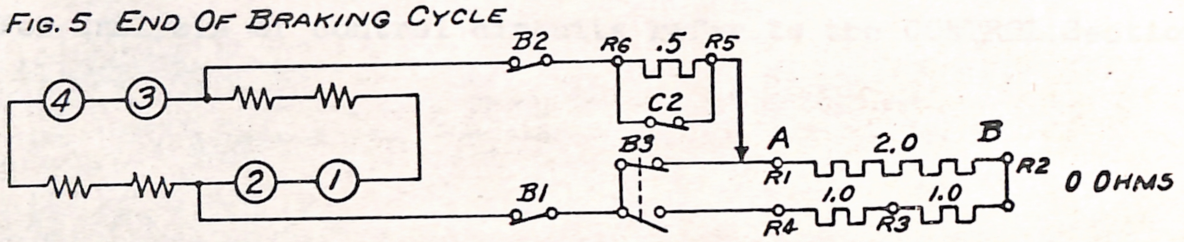


FIG. 5 END OF BRAKING CYCLE



(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.

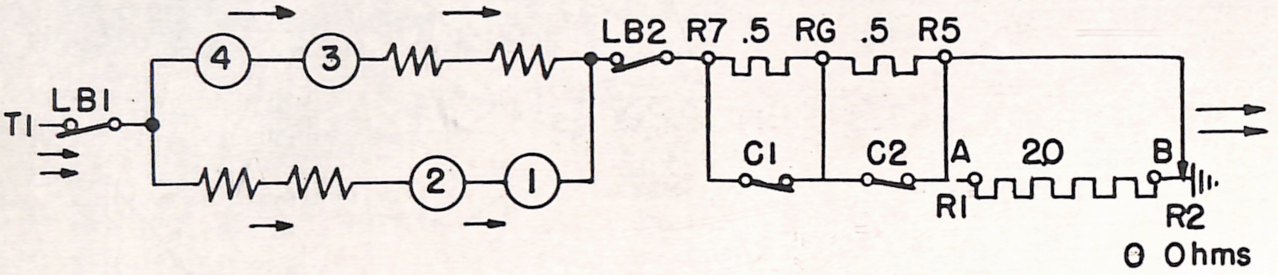
During the braking cycle, the brush arm on the commutator controller moves through the reverse cycle as compared to motoring. Thus, if the car has reached a speed during motoring where the brush arm is back near its starting position, all the resistance indicated as R1-R2-R3-R4 will be in the braking 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.

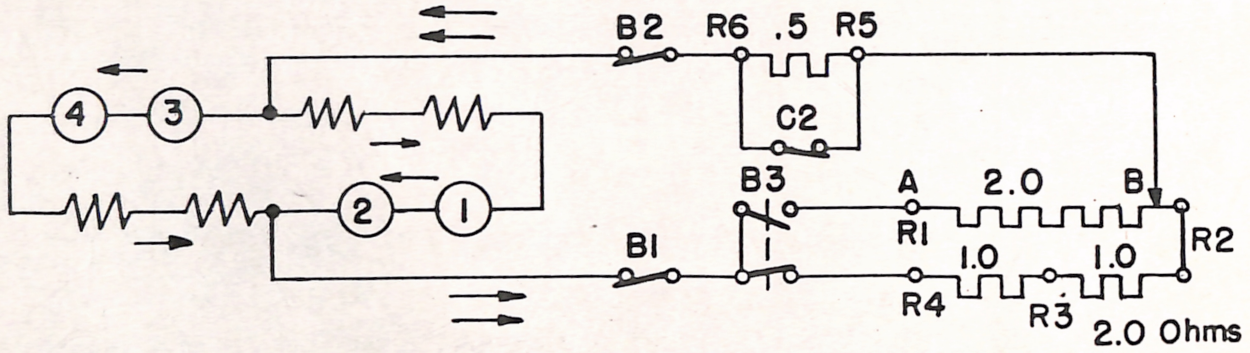
For analysis of control circuits refer to the CONTROL Section.

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

INSPECT

DEVICE	Diagram Identification	Type	Value of X See Plate A-118727	Kind of Tips	Tip Gap 32nd Inch New Tips	Wear Al 32nd New Tips
Control Group		17KG99A4				
Line Breaker	LB1	DB-1805-N14		Copper	18-21	11-13
		Set OLR to trip at 650 amps. See Plate A-118385 for adjustm				
Field-Shunting Contactors	FS1,FS2, FS3,FS4	17CM26A1	2 5/8 in.	Silver Insert	27-33	8-10
Cushioning Contactor	C1	17CM42H3		Copper	14-16	
Cushioning Contactor	C2	17CM42H2		Copper	14-16	
Motoring Contactor	LB2	17CM42A1		Copper	14-16	
Motoring Contactor	LB3	17CM42A1		Copper	14-16	
Braking Contactor	B1	17CM42A1		Copper	14-16	
Braking Contactor	B2	17CM42A1		Copper	14-16	
Braking Transfer Switch	B3	17GM8A1				
		Normally Open	2 3/4 in.	Copper	11-15	16-20
		Normally Closed	3 1/4 in.	Copper	16-22	10-12
Generator Contactor	GC	17CM15AR64	2 1/4 in.	Silver Insert	11-13	7-9
Brake Reset Contactor	BRC	17CM15CC74	2 1/4 in.	Copper	19-21	7-9
M-G Contactor	MG	17CM15CC74	2 1/4 in.	Copper	19-21	7-9
Track Switch Throwing Contactor	TS	17CM15MM74	2 1/4 in.	Copper	19-21	7-9
Track Brake Contactor	TA	17CM22C6	2 1/4 in.	Copper		
		Main			11-13	5-7
		Aux.			7-8	4-5
Track Brake Contactor	TB	17CM15V1	2 1/4 in.	Copper	11-13	5-7
Interlock		17AF20B32				
Interlock		17AF20B24				
Interlock		17AF20B18				
Interlock		17AF20B34		Single Throw	9 (min)	3
Interlock		17AF20B35		Double Throw	6 (min.)	
Interlock		17AF20B26				
Interlock		17AF20B33				
Interlock		17AF24B14			7-9	5/64-7/6
Interlock		F1-127-H7				
		Normally Open			16 (min.)	2
		Double Throw			7 (min.)	4-6
Interlock		17AF14K23			7 (min.)	3-4
Lockout Relay	LOR	17LC30E5		Silver	3 (min.)	2-3
		Energize shunt coil circuit to 0.45 amperes and when circuit is opened				
		Set travel by adjusting top screws. Both screws should touch at the s				
Accelerating and Braking Relay	ABR	17LC29C4		Tungsten		See Plate A-1
Time Delay Relay	TDR	Agastat ND-11, 36-volt operating coil. Time delay opening 2 secc				
Master Controller		17KC56D1	Power and Brake Fingers		11-13	3-4
Braking Controller	BC		Reverser Fingers			
Accelerating Controller	PC		Reverser (emergency fingers)			
Reversing Controller	RC				Set travel on car ped	
Motor Controller	KM	17KM12N2	Control Fingers		10-13	3-4
			Main Finger			8 m
Motor Reverser		17DM1A1	See Plate A-120499			
		Armature in forward	position, interlocks 1 and 2		2 (min.)	3
		Armature in reverse	position, interlocks 5 and 6		2 (min.)	3
Operating Mechanism	MK	17KM16J1	Minimum reset operating coil volts 24. Operating cc			
			down to 0.11 amps. Make wear adjustment by setting			
			with spring application; for 0.030 in. brake shoe cl			
			0.27 inch for 60 per cent, 0.360 inch for 80 per cer			
			clock spring for 95-100 inch-pounds torque.			
Regulator Panel		17FM69A7				
Regulating Relay	RR	17LV23AA37	Refer to Plate A-118581 for adjustments. Set to hold			
Emergency Relay	ER	17LV41C4			9-11	2-3
Gang Switch		17HP11J1	Single throw units		10 (min.)	4 (m
			Double throw units		8 (min.)	4 (m
Track Brake Control Panel		17FM58A1				
Electric Shoe Brake		ES-109-E11				
Friction Brake Control Panel		17FM92B1				
Box No. 1 Resistors		17EWF204C4	R2-R3 = 1.107 ohms. R3-R4 = 0.979 ohms. R5-R6			
Box No. 2 Resistors		17EWF204D4	S1-S3 = 0.201 ohms. S2-S3 = 0.086 ohms. S4-S6			
Pilot Motor	PM	5BC42AB965	Armature resistance 3.4 ohms, field resistance			
Traction Motor		5GE1220E1	Exciting field = 0.0506 ohms. Commutating field			
Motor-Generator Set	M-G	5GMG153B1	Motor - Shunt field - 2641 ohms, series and com			
			Generator - Exciting field - 10.85 ohms, commut			

NOTE: All resistance values at 25 C.
Tip gap may be greater than limit shown
*Set pickup at 310 volts across the coil

NSPECTION DATA

Tips	Tip Gap 32nd Inch New Tips	Wear Allowance 32nd Inch New Tips	Wear Allowance 32nd Inch Min. (Worn)	Tip Pressure in Pounds Initial New Tips	Tip Pressure in Pounds Initial Min. (Worn)	Tip Pressure in Pounds Final New Tips	Tip Pressure in Pounds Final Min. (Worn)	Gap at Heel Toe Touching 32nd Inch New Tips	Gap at Heel Toe Touching 32nd Inch Min. (Worn)	Gap at Toe Tips Fully Wiped 32nd Inch New Tips	Gap at Toe Tips Fully Wiped 32nd Inch Min. (Worn)	Resis. Ohms.
-	18-21	11-13	-	2-3	1	10-12	6	-	-	Operating Coil		33
e Plate A-118385 for adjustments.										Holding Coil		31.2
Insert	27-33	8-10	5	2-3	1	4-6	2	-	-	-	-	37
-	14-16	-	-	2-4	1	13½-22½	7	5-6	2	4-6	2	5850
-	14-16	-	-	2-4	1	13½-22½	7	5-6	2	4-6	2	33.
-	14-16	-	-	1-2	1/2	15-25	8	5-6	2	4-6	2	38.
-	14-16	-	-	1-2	1/2	15-25	8	5-6	2	4-6	2	38.
-	14-16	-	-	1-2	1/2	15-25	8	5-6	2	4-6	2	38.
-	14-16	-	-	1-2	1/2	15-25	8	5-6	2	4-6	2	38.
-	-	-	-	-	-	-	-	-	-	-	-	5.
-	11-15	16-20	8	2-3	1	9-11	4	Max. gap on one, when the other touches 1/				
-	16-22	10-12	5	1½-2½	1/2	3½-4½	1½					
Insert	11-13	7-9	3	1-2	1/2	3-4	1 3/4	-	-	-	-	2780
-	19-21	7-9	3	1½-2	1/2	3-4	1-3/4	-	-	-	-	73
-	19-21	7-9	3	1½-2	1/2	3-4	1 3/4	-	-	-	-	73
-	19-21	7-9	3	1½-2	1/2	3-4	1 3/4	-	-	-	-	73
-	-	-	-	-	-	-	-	-	-	-	-	73
-	11-13	5-7	2	1½-2	1/2	3-4	1 3/4					
-	7-8	4-5	1½	-	-	1-2						
-	11-13	5-7	2	1½-2	1/2	3-4	1 3/4	-	-	-	-	73
-	9 (min) 6 (min.)	3	1	-	-	6 oz.	3 oz.					
-	7-9	5/64-7/64	-	-	-	6 oz.(min.)	3 oz.					
-	16 (min.)	2	1	-	-	6 oz.(min.)	3 oz.					
-	7 (min.)	4-6	2	-	-	6 oz. (min.)	3 oz.					
-	7 (min.)	3-4	1	-	-	6 oz.(min.)	4 oz.					
-	3 (min.)	2-3	-	-	-	-	-	-	-	Operating Coil		58
s and when circuit is opened, time delay should be approx. 0.8 second.												
screws should touch at the same time.												
n	-	See Plate A-125176-A	-	-	-	6 oz.(min.)	-	-	-	Regulating Coil		21
										Shunt Coil		0.
										Rate Coil		204.
. Time delay opening 2 seconds. Quick release.												158
	11-13	3-4	-	-	-	3/4-1	-	-	Travel	-	-	(a) Main Power Lever - full off to fu
						2-5						(b) Brake Lever - full off to fu
ers)						8-12						(c) Reverser Lever - reverse to for forward to em
	Set travel on car pedal pull rods to 1/16 in. clearance at controller stops											
-	10-13	3-4	-	-	-	12-16 oz.	-	-	-	Speed 3.5-4.5 sec. round trip of brush arm		
-	-	8 min. drop	-	-	-	3-5						
-	-	-	6 (min.)	-	-	-	-	-	-	Operating Coil		1.
d 2	2 (min.)	3 (interlocks 7&8)		2-5								
d 6	2 (min.)	3 (interlocks 3&4)		2-5								
coil volts 24. Operating coil de-energized, holding coil should hold in										Holding		69.
we adjustment by setting gap between two halves of armature										Operating		3.
for 0.030 in. brake shoe clearance set gap as follows:												
t, 0.360 inch for 80 per cent and 0.450 inch for 100 per cent braking. Set emergency												
inch-pounds torque.												
for adjustments. Set to hold 35.5 volts cold, 36.5 volts at normal operating temperature; using a 16 cell lead battery. Shunt												3.
-	9-11	2-3	1	-	-	-	-	-	-	-	-	38.
its	10 (min.)	4 (min.)	- Pressure to pull contacts apart when snapped to contact next to base 1 1/2 pounds (min.)									
its	8 (min.)	4 (min.)										
-	-	-	-	-	-	-	-	-	-	-	-	3.

R3-R4 = 0.979 ohms. R5-R6 = 0.474 ohms. R6-R7 = 0.610 ohms.
S2-S3 = 0.086 ohms. S4-S6 = 0.247 ohms. S5-S6 = 0.086 ohms. TS-G = 8 ohms.
3.4 ohms, field resistance 0.70 ohms. Each ±10 percent.
506 ohms. Commutating field = 0.0214 ohms. Armature 0.0483 ohms.
- 2641 ohms, series and commutating field 1.72 ohms; armature 2.650 ohms.
field - 10.85 ohms, commutating field 0.01859 ohms, armature 0.044 ohms.

e values at 25 C.
e greater than limit shown by amount of wear on contact tip surfaces.
310 volts across the coil and 4000 ohm resistor, coil cold (25 C), dropout should not be less than 100 volts (coil cold)

ON DATA

ce in. rn)	Tip Pressure in Pounds Initial New Tips	Initial Min. (Worn)	Final New Tips	Final Min. (Worn)	Gap at Heel Toe Touching 32nd Inch New Tips	Gap at Heel Toe Touching 32nd Inch Min. (Worn)	Gap at Toe Tips Fully Wiped 32nd Inch New Tips	Gap at Toe Tips Fully Wiped 32nd Inch Min. (Worn)	Coil	Resis. Ohms.	Min. Amps. to Operate	Interlock
	2-3	1	10-12	6					Operating Coil Holding Coil	33 31.2	0.60 25V	FI-127-H7
	2-3	1	4-6	2						37	0.49 (FS1)	17AF24B14
	2-4	1	13½-22½	7	5-6	2	4-6	2		5850	0.045	17AF20B18
	2-4	1	13½-22½	7	5-6	2	4-6	2		33.5	0.60	17AF20B35
	1-2	1/2	15-25	8	5-6	2	4-6	2		38.6	0.53	17AF20B24
	1-2	1/2	15-25	8	5-6	2	4-6	2		38.6	0.53	17AF20B32
	1-2	1/2	15-25	8	5-6	2	4-6	2		38.6	0.53	17AF20B33
	1-2	1/2	15-25	8	5-6	2	4-6	2		38.6	0.53	17AF20B34
										5.79	2.2	17AF20B26
	2-3	1	9-11	4	Max. gap on one, when the other touches 1/32 in.							
	1½-2½	1/2	3½-4½	1½								
	1-2	1/2	3-4	1 3/4						2780		
	1½-2	1/2	3-4	1-3/4						73	0.25	17AF14K23
	1½-2	1/2	3-4	1 3/4						73	0.25	
	1½-2	1/2	3-4	1 3/4						73	0.25	
										73	0.25	
	1½-2	1/2	3-4	1 3/4								
				1-2								
	1½-2	1/2	3-4	1 3/4						73	0.25	

6 oz. 3 oz.

6 oz.(min.) 3 oz.

6 oz.(min.) 3 oz.
6 oz. (min.) 3 oz.
6 oz.(min.) 4 oz.

delay should be approx. 0.8 second.

Operating Coil 58 0.26

e.

6 oz.(min.)

Regulating Coil 21
Shunt Coil 0.47
Rate Coil 204.0

uick release. 158 0.210

3/4-1 Travel
2-5
8-12

(a) Main Power Lever – full off to full on – 2 1/8 in.
(b) Brake Lever – full off to full on 2 1/8 in.
(c) Reverser Lever – reverse to forward 3 7/16 in.
forward to emergency 1 1/16 in.

rods to 1/16 in. clearance at controller stops

12-16 oz. Speed 3.5-4.5 sec. round trip of brush arm – coasting connection.

3-5

6 (min.)

Operating Coil 1.44 15

ks 7&8) 2-5
ks 3&4) 2-5

nergized, holding coil should hold in

Holding 69. 0.418
Operating 3.47 4.9

weer halves of armature
set up as follows:
.450 inch for 100 per cent braking. Set emergency

lts cold, 36.5 volts at normal operating temperature; using a 16 cell lead battery. Shunt 3.14

38.6 0.456

Pressure to pull contacts apart when snapped to contact next to base 1 1/2 pounds (min.)

3.24

ohms. R6-R7 = 0.610 ohms.
ohms. S5-S6 = 0.086 ohms. TS-G = 8 ohms.
. Each ±10 percent.
4 ohms. Armature 0.0483 ohms.
field 1.72 ohms; armature 2.650 ohms.
ld 0.01859 ohms, armature 0.044 ohms.

of wear on contact tip surfaces.
ohm resistor, coil cold (25 C), dropout should not be less than 100 volts (coil cold)

ELECTRIC RAILWAYS
BRANCH HANNA ST.

LUBRICATION SECTION

LUBRICATION CHART

EVERY 10,000 MILES OR 2 MONTHS

CONTROL	
Commutator Controller	Check and maintain oil level in gear box. Use SAE-30 oil. Add G-E ball bearing grease, type EWM-3S (G-E No. D6A2A5) to brush contact arm, Alemite fitting.
Master Controller	Clean reverser segments and apply a very thin film of Stazrite No. 30 grease or equal. Add a few drops of light machine oil to Oilite shaft bearings.
Brake Operating Mechanism	Lubricate Alemite fittings for crank trunnion and main shaft bearings with G-E ball bearing grease, type EWM-3S (G-E No. D6A2A5). Remove plunger and clean plunger and coil shell and coat surfaces with oil. Grease in main shaft bearings prevents entrance of water.

EVERY 25,000 MILES OR 4 MONTHS

MOTOR-GENERATOR SET	Add 1/2 ounce of G-E ball bearing grease, type EWM-3S (G-E No. D6A2A5) to each armature bearing.

EVERY 50,000 MILES OR 1 YEAR

MOTOR	Add 1 ounce of G-E ball bearing grease type EWM-3S (G-E No. D6A2A5) to commutator-end bearing and 1 1/4 ounce to pinion-end bearing.

EVERY 3 YEARS

CONTROL	
Commutator Controller	Clean and repack ball bearings 1/3 full on commutator end of pilot motor. Use G-E ball bearing grease, type EWM-3S (G-E No. D6A2A5). Add a few drops of light machine oil to roller pins of

	both commutator controller and master controller roller-type fingers, when controllers are taken down for overhaul.
MOTOR-GENERATOR SET	Overhaul, clean and repack bearings with G-E ball bearing grease, type EWM-3S (G-E No. D6A2A5).

CONTROL

LINE BREAKERS, CONTACTORS AND CONTROL GROUPS

The life of the bearings and hinge pins can be substantially increased by adding a small amount of grease or oil whenever the various pieces are taken apart or at overhaul periods. Use grease and oil very sparingly, for an excessive amount will cause an accumulation of dirt and grit which will give trouble due to wear or poor contact.