INSPECTION AND MAINTENANCE OF CONTROL EQUIPMENT

NEW YORK CITY TRANSIT AUTHORITY

SUBWAY CARS

Car Numbers	Division	Contract Number	General Order
7175-7299	IRT	R-21	ST-62600

WESTINGHOUSE ELECTRIC CORPORATION
EAST PITTSBURGH, PA.

CONTENTS

SAFETY RULES

Only Authorized Persons shall be permitted to work on car or associated equipment and these persons shall not disregard any safety rules under any circumstances.

Open All Main Knife Switches before working on any main or control circuits to prevent accidental starting of train or injury by "live" circuits. Opening these switches does not de-energize control circuits, but prevents power being applied on main motors.

Exercise Extreme Caution while working on or around any "live" circuits.

Disconnect Third-Rail Shoes from third-rail by placing insulated paddles between shoe and rail.

Do Not Break Current with Main Knife Switch. Remove all reverse levers and open all auxiliary switches before opening main knife switch.

Do Not Attempt to Move Cars when main air reservoir pressure is less than 85 pounds.

Do Not Permit more than one air brake valve handle and one reverse handle to be used on one train.

Before Leaving Train for any length of time, remove reverse handle and brake handle, open all control and auxiliary switches, open main knife switch, and set hand brakes.

Observe Operating Rules at all times.

Printed in U.S.A. (8-55)

OPERATING RULES

Only Authorized Trained Persons shall operate cars.

Before Starting Cars, check operation of air brake system. Open drain cocks to blow water out of reservoirs and air brake system when cars are put into daily service. Do not operate train without full air supply.

Release Hand and Air Brakes before starting trip.

Do Not Overspeed Cars. Maximum safe speed for motors is 55 miles per hour.

Do Not move reverse handle while car is in motion.

Make Full Report of all troubles or defects that develop on any car during shift.

Observe Safety Rules at all times.

Printed in U.S.A. (8-55)

CAR MAINTENANCE

I. GENERAL.

This Manual is submitted primarily as a guide for control apparatus only. General reference is occasionally made to other equipment. However, specific maintenance and descriptive material must be obtained from hand books supplied by the manufacturers of this other equipment.

The material presented in this manual has been generally divided into sections, each covering an individual piece of apparatus as to description, operation, and maintenance requirements. In some instances, however, when several pieces of apparatus are assembled in the same protective container, the material covering this entire assembly gives a description of the specific application of the individual apparatus referring to another section which gives recommendations regarding maintenance requirements. These latter sections cover apparatus of the same general type but which have different applications.

In submitting a System of Inspection for rapid transit equipments, it is fully realized that no one definite scheme will apply to all properties; also that whatever suggestions are made will not entirely meet the demands of the many varying conditions offered by rapid transit service. However, it is fair to assume that by having a definite program of instructions outlined to meet the average conditions existing in the Electric Railway field, some operators will be benefited by using this plan as a guide in rearranging or planning a system to meet their own requirements. With this in view the following outline is suggested for regular and systematic inspection of rapid transit equipment.

A. Keep accurate Maintenance Records of mileage and service time of each car, the dates and type of repairs made, and dates and type of inspection, lubrication and overhaul. Complete records serve as a guide in analyzing and correcting troubles due to improper operation, inspection, repairs and lubrication. Records for each car should be kept in groups with enough detail so it is possible to determine quickly the life of switches, contactors, magnet valves, cams, relay contacts, resistors, etc.

B. Set Up and Follow Definite Fixed Schedule of Maintenance in order to operate at least cost with fewest number of unscheduled interruptions to service. Maintenance men should follow carefully arranged inspection reports. Use this handbook to set up your own inspection reports for each piece of apparatus.

C. Maintenance Men should be Familiar with Methods of Operating, Testing and Repairing Cars. This handbook outlines the operation, lubrication, testing and repair of each piece of control apparatus.

D. Keep Adequate Supply of Spare Parts in Stock. After cars are received, study this handbook and renewal parts catalogs, and order parts which are required to overhaul cars.

E. The frequency of Inspection depends upon the hours of operation per week and severity of dirt and moisture conditions. Under average conditions, a light inspection should be made every week, a heavy inspection every month, and complete overhaul every year, or whenever major parts of the equipment are worn to the replacement or rebuilding stage. Actual experience with cars will show whether time between inspections should be decreased or increased.

F. Set Up and Follow Definite Fixed Schedule of Lubrication. A proper schedule of lubrication will pay for itself many times by reducing wear and maintenance. Frequency of lubrication depends upon the local condition of operation. The schedule given under "Lubrication" (Sec. 5-D) should be followed until actual experience shows whether the time between lubrications should be increased or decreased.

G. Use only Recommended Oils and Greases listed under "Lubrication" (Sec. 5-E).

H. Use Only Best Grade Red Insulating Paint. The use of the best grade of insulating paint will eliminate much trouble. The best grade of paint is an air-drying red-oxide type which dries quickly if applied to properly cleaned surfaces. If the paint is applied to dirty, greasy surfaces, it dries with a characteristic wrinkled surface which shows that surface was improperly cleaned. If inspection finds such a condition, the paint should be removed, the surface cleaned and repainted, to avoid future trouble. *DO NOT PUT PAINTED EQUIPMENT IN SERVICE UNTIL PAINT IS THOROUGHLY DRY.*

I. Use Clean Dry Compressed Air to blow dirt from outside of equipment before removing protective covers. After covers are removed, blow dirt out of equipment with an air hose fitted with a fan-like nozzle. *TOO MUCH AIR PRESSURE AND IMPROPERLY FORMED NOZZLES MAY DAMAGE INSULATION.*

2. INSPECTING CARS.

When New Cars are Shipped from the car builder, various parts have been removed and crated separately and numerous pieces of apparatus secured in inoperative positions. Similarly, when a car has just been overhauled, there is a definite inspection routine which should be followed before placing cars in service, in order to save time and reduce the number of road failures. Therefore, the following is suggested as a guide to enable the transportation department to rearrange or plan a procedure to meet their own requirements.

A. Follow All Safety Rules given in this manual.

B. Install and Connect all Equipment and loose parts shipped separately.

C. Remove all Wired and Taped Fastenings securing switches, levers, handles and protective coverings.

D. Inspect and Test Traction Motors, motor and journal bearings, gears, and other rotating equipment according to instructions supplied.

E. Refer to Air Brake Instructions, check air system and set all valves and cut-out cocks in normal operating positions.

F. Refer to Battery Instruction Book and check condition of charge and water level accordingly.

G. Test and Repair Control Apparatus as outlined in this manual.

H. Tighten all Bolts and Nuts. This includes all mounting details and electrical connections.

I. Disconnect All Third Rail Shoes by means of insulated "paddles" placed between shoes and rail if car is standing on track to which rail voltage is supplied.

J. Place all Controller Handles, brake handles, control, light, and auxiliary switches in "off" or "open" positions.

K. Check All Fuses to see that they are good and of the correct size. Replace defective fuses or fuses of the wrong size with new fuses of the correct size.

L. Place Main Knife Switch in test position, which disconnects motors and power circuits to permit inspection and control sequence testing and also connects 600 volt auxiliaries to a barn plug through an enclosed fuse.

M. Start air compressor with switch on panel board #1. Air acts as the operating medium for much of the control

apparatus. Therefore, control air reservoir pressure should be between 50 and 70 lbs. Pressures of compressor cut-out and cut-in, and brake pressures must agree with those given in air brake equipment instructions.

N. With battery switch closed, start motor-generator with m-g switch on panel #2. Generator voltage should be a nominal of 40 volts.

3. TESTING OPERATION OF CONTROL EQUIPMENT.

A. If testing on third rail-open main knife switch to test position. If testing in the shop where there is no third rail power, open switch to shop test position and put 600 volt supply on knife switch jack; this will permit compressor, MG Set, and line relay to operate.

B. Block open contacts of CR and SR relays on UC-480-A limit relay panel in the package unit.

C. Place Reverser Handle of master controller in forward position and main handle in third position. Keep main handle depressed to prevent applying emergency brakes.

D. Close CR Limit Relay Contacts momentarily and check sequence of control against sequence chart through the 16 power notches. (See schematic diagram).

E. Return Master Controller handle to "Off" position and apply full brake, keeping master controller handle in depressed position. Close CR limit relay contacts momentarily and check sequence of 16 braking notches.

F. Place Reverser Handle in reverse position and repeat Sec. 3-D and 3-F.

G. Repeat Sec. 3-C to 3-F from other control stations.

H. Place all controller and brake handles and control and auxiliary switches in "off" or open positions.

I. Remove 600 volts supply, close knife switch and remove blocks from CR and SR relays (Sec. 3-B.)

J. Remove Insulating Paddles between third rail shoes and rail, if used.

K. Close all Control and Auxiliary Switches as previously outlined.

L. Insert Brake and Reverser Handles. Release emergency brakes and apply sufficient service to hold car at standstill.

M. Release Hand Brake.

N. Operate Car Slowly and check brake and dead man control for proper operation.

O. Car is now ready for operation at any desired speed within maximum limit.

NOTE:

When operating more than one car in train, reference to opening or closing main, control or auxiliary switches applies to all cars except where such circuits are controlled for entire train from operating station at head end.

4. OVERHAULING CARS.

A. Overhaul all Apparatus as outlined in this manual for control equipment and handbooks for other equipment.

B. Reassemble equipment. Rewire with new insulated cable specified on "Wiring Diagram".

C. Inspect and Test Cars as outlined in Secs. 2 and 3.

5. LUBRICATION.

A. Use Only Recommended Oil and Grease. The use of too much lubricant or the use of the wrong kind of lubricants

may do more harm than good. *DO NOT LUBRICATE SELF-LUBRICATED BEARINGS.*

B. The Amount of Grease should be carefully gauged by determining the number of turns of grease gun handle for one ounce of grease.

C. The Amount of Oil should be carefully gauged by using a plunger type oil can. Determine the number of strokes of the plunger for one ounce of oil.

D. The Following Lubrication Schedule is intended only as a guide. Operating company must determine by inspection and experience the lubrication periods best suited to their operation. The following is a schedule based on operation of equipment for one shift (or equivalent) each day. If operation is for longer periods, the schedule should be revised accordingly.

Lubricate Each Electro-pneumatic Switch and Reverser Cylinder monthly with 1/16 ounce M-3179 oil.

Lubricate Drums with Sliding Fingers Weekly. Dip a cloth into SAE-20 oil and wring out as dry as possible. Wipe copper contacts with this oily cloth. Operate drum several times and wipe off surplus oil. *DO NOT USE TOO MUCH OIL.*

Lubrication of All Other Electrical Equipment should be made by maintenance men when inspecting and repairing electrical equipment.

E. Recommended Lubricants.

M-3179	
Gulf Eskimo Oil B	Gulf Refining Co., Pgh., Pa.
M-7280-1	
Regal Starfak #2	The Texas Co., New York City
Lubrico M6	Master Lubricants Co., Phila., Pa.
High Grade Automotive Engine Oil SAE-20	Any Reputable Refiner

CAR OPERATION

Before Operating a Car or Train, a person must be familiar with sequence of operations necessary to start and stop car or train.

Thoroughly Understand and Follow all safety and operating rules. The car should be operated from a standing position until the operator gets the "feel" of controller and brake.

I. STARTING CAR.

A. Assume that Cars Have Been Properly Inspected and Tested for Operation.

B. Select Control Station and insert brake and reverse handles.

C. Main and Reverse Handles must be in "Off" positions.

D. Close All Auxiliary Switches to light, compressor, door and motor-generator set circuits.

E. Throw Control Switch to "On" position. Move reverse handle of master controller to the desired position (Forward or Reverse). Throw reset switch to "Reset" to insure all overload relays on train are set.

F. Release Emergency Brakes and apply service brake sufficiently to hold train at standstill. Release hand brakes.

G. Move Reverse Handle in proper direction. Depress main handle and release air brakes. Move main control handle to first or "switching" position. Train will start to move. *DO NOT USE THIS AS A RUNNING POSITION.*

H. Move Controller Handle to second or "series" position. Cars may be operated continuously in this position.

I. To Increase Speed move handle to third or "parallel" position, also a running notch.

J. *DO NOT ALLOW MAIN HANDLE TO RISE UNLESS SERVICE BRAKES HAVE BEEN APPLIED*, otherwise emergency brakes will be applied. This "dead man" feature is effective whenever the air brake handle is in the "release" position.

K. *DO NOT MOVE REVERSE HANDLE WHILE CAR IS IN MOTION.*

2. STOPPING CAR.

A. Move Main Controller Handle to "Off" position.

B. Apply Brakes by moving brake handle to give desired retardation effort.

NOTE: In the event of an application of emergency brake, the operator must wait at least ten seconds after release of emergency brake before re-applying power, to allow air pressure to come up to operating value.

3. CHANGING CONTROL STATIONS.

A. When Leaving One Control Station to go to another, throw main and reverse handles to "Off" positions. Upon release of main handle, emergency brakes are applied. This action is supplemented by application of emergency brakes through brake valve when brake handle is removed through "handle off" position.

B. Throw Control Switch to "Off" position.

C. Remove Reverse and Brake Handles.

D. At New Control Station insert reverse handle and brake valve handle. Throw control switch to "On" position and throw reset switch to "Reset" position to insure that all overload relays on train are set.

4. LEAVING TRAIN.

A. Throw All Control Handles to "Off" position and open all control switches.

B. Remove Brake and Reverse Handles.

C. Open all auxiliary circuits, except auxiliary line charger for batteries.

D. Apply Hand Brakes to prevent train from moving of its own accord when air pressure on brake system leaks off.

MAIN AND CONTROL SCHEMATIC DIAGRAM

Assume this to be the diagram of the head car of a train made up of several cars, all of which have been properly inspected and tested for operation.

NORMAL OPERATION

Off:

With the brake handle, reverse lever and main handle in the "Off" positions, the contacts and interlocks of all devices are in the open or closed position as shown on the diagram. It may be noted that switches "LS1" and "G1" being open prevent power, and switches "M" and "G" being open prevent dynamic brake.

In this condition, all trainline wires which control electric apparatus are de-energized.

Switching

Assume that the control switch is closed, the reverse lever is moved to the desired position (forward or reverse), the main handle is moved to the "switching" position, and the brake handle is moved to "release".

In the main circuit, switch "G1" will close, the reverser will throw to the desired position if not already in that position, then switch "LS1" will close, and then switch "JR" will close. This will connect the four traction motors in series with maximum resistance in the circuit from the third rail to ground.

The control circuits will function to establish the above main circuit as follows:

(a) Train line wire 6 will be energized immediately through master controller and control switch contacts.

(b) If the car doors are closed, the "SIG" relay of each car will be energized.

(c) The "ER" relay of each car will pick up when train is not in emergency.

(d) The door relay "DR" will be energized from the battery of the rear car, through reverse drum off contacts (wires 24 to 25) of the rear car, through the closed coupler switch (wires 25 to 21) at the rear end of the rear car, through the "SIG" and "ER" "in" contacts of each car in the train, through the closed coupler switch at the front of the head car, through the reverse drum (wires 25 to D) of the head car.

(e) Train line wire GS will be energized when the "DR" contacts (wires 6 to 14) close and switch "GI" will close and relay "DB" will pick up.

(f) Train line wire 1 (or 2 depending on reverse drum position) will be energized to throw the reverser in the desired position.

(g) Switch "LSI" will close when the reverser is in the proper position, and the line relay is "in" and neither overload relay is tripped.

(h) Switch "JR" will close when its magnet valve is energized from wire 6 through "LSI" and "G" "in" interlocks.

(j) The "BP" relay will pick up from wire 6.

If the main handle is now to move to "Off", spotting "brake" would be obtained since the "BP" relay is energized.

Series

With all other control remaining in the position outlined under switching, assume the main handle is moved to "series" or position 2.

In the main circuit, switch "LS2" will close under the control of limit CR to cut out the first step of resistance. Then the resistor switches will close to cut out resistance, step by step, under control of the limit relay. On the final step, notch 11, switch "J" will close to connect the four traction motors in series will all resistance shorted out of the circuit. Then the resistor switches will open to prepare the main circuit for transition in the event parallel operation is called for.

The control circuits perform these main circuit changes automatically as follows:

(a) Train line wire 4 is energized from the master controller when the main drum is moved to position 2.

(b) Switches "LS2" closes when its magnet valve is energized from wire 4 and holds itself in from wire 1 (or 2).

(c) Then the progression circuit (wire 47) is energized from wire 4 under control of the limit relay "CR". The first time the "CR" contact closes, resistor switch "R1" close and is held in from the hold circuit (wire 67). This sets up the close circuit the next resistor switch "R2" by "R1" interlock wires (47-154). However, switch timing is arranged so that the next switch will not close before main circuit current increase through the "CR" coil, due to a step of resistance being shorted, causes the "CR" contact to open. Therefore, main circuit current must decrease to the drop out value of the "CR" relay before the "CR" contacts close to pick up the next resistor switch. Note as each resistor switch close, the preceding switches are caused to open up to notch 8. Switching progresses in this manner until switches "R7" and "R8" close.

(d) When "R8" switch close, "J" switch magnet valve is connected to the progress circuit. "CR" contacts will then close "J" switch and "J" interlock wires 109 to G, will open the progress and hold circuits to all resistor switches.

If the main handle is now moved back to the switching position, there would be no change--the main circuit would remain in series. If it were moved to off, spotting brake would be set up. Had the main handle been moved directly to position 2 from "off" full series would have been obtained automatically in the sequence described above including the switching notches.

Parallel

With all other control remaining in the positions of full series, assume that the main handle is moved to "parallel" or position 3.

In the main circuit, bridge type transition will take place to change the main circuit connection from four motors in series with no resistance to two parallel circuits of two series connected motors with maximum resistance in each circuit. Switches "M" and "G" will close immediately to connect equal resistance in each pair of motors. "M" switch closing causes "J" switch to open to complete transition.

Now the resistor switches will close alternately (first in motor circuit 3 & 4 and then motor circuit 1 & 2) to cut out resistance, step by step, in each circuit, under control of the limit relay. After all the resistance is cut out by switches "R7" and "R8", the field controller operates, also under control of the limit relay to connect a shunting circuit across each main field circuit and to increase the amount of field shunting by cutting out resistance in four steps. On the final step (notch 24), the motors are connected in series parallel directly from third rail to ground with maximum field shunting.

The control circuits perform these main circuit changes automatically as follows:

(a) Train line wire 7 is energized from the master controller when the main drum is moved to position 3.

(b) Switches "M" and "G" close when their magnet valves are energized from wire 7.

(c) Switch "J" is opened by "M" interlocks, wires 44 to 65.

(d) "J" interlocks, wires 109 to G, then reconnects the progress and hold circuits of the resistor switches, and the resistor switches close in proper sequence under control of the limit relay as described above until switch "R8" close.

(e) "R8" interlocks, wires 38 to 39, then connects the "upper" magnet valve to the field controller (FC-SF) to progress wire 47, and the field controller will move to the maximum field shunt position under control of the limit relay.

If the main handle is now moved back to either the series or switching position, there will be no change - the main circuit would remain in parallel. If it were moved to off, spotting brake would be set up. Had the main handle been moved directly to position 3 from "Off", the main circuit would have progressed automatically from switching, through all the steps of series, through transition, through all the steps of parallel to full parallel running position.

Dynamic Braking

Dynamic braking, with the motors connected to a resistance load, has been used for many years, but has recently been revived and refined to supplement mechanical brakes by relieving brake shoe wear, and in some instances to recover braking losses for heating purposes.--What is dynamic braking? From the standpoint of basic terminology "Dynamic Braking" could cover any and all forms of retardation created by an electric motor acting as a generator. However, in traction parlance, the term is recognized as referring to a system of dissipating the generated energy in resistors carried on the vehicle, as

distinguished from "Regenerative Braking" where the generated energy is returned to the power system, necessarily at line voltage.

When a group of series motors are converted to generators they must be so excited to produce stability and equal division of loading. This is done by cross connecting the motors so that the field of each motor is excited by the current generated from the armature of another motor. The transfer circuits from power to brake are simplified by permanently connecting the fields of one pair on the line side and the fields of the other pair on the ground side. A single cross-connection thus completes the braking loop for both pairs of motors.

The dynamic brake circuits should include a "spot" system which will provide a prompt build-up to current when the dynamic brake is required. There are three methods of obtaining spotting, namely:-

(a) Manipulation of the shunt field controller.

(b) Manipulation of the field controller and resistor switches.

(c) Manipulation of the resistor switches only. On the Westinghouse equipped cars the spotting is by the field controller method.

For simplicity of operation, the dynamic and mechanical brake is controlled by a single handle which is part of the air brake equipment. When dynamic and air brakes are applied simultaneously, a lock out or suppression feature is used for automatically limiting brake cylinder pressure. This is in the form of a pressure regulating magnet valve, energized in portion to dynamic current, and also permits the brake cylinder pressure to build up to the full desired value, as the dynamic brake fades out at speeds below 10 m.p.h.

Spotting Brake

Assume the main handle is now moved to the "off" position.

In the main circuit, switch "LS1", "LS2", "G1", "R7" and "R8" will open, switches "M" and "G" will remain closed and switch "B1" will close. Dynamic brake is now established with maximum resistance in the circuit and maximum shunting on the motor field. The field controller now will move forward to full field in four steps under control of the brake spotting relay (SR) as the cars speed decreases.

The control circuits perform the main circuit changes automatically as follows:

(a) Train line wire 3 is energized and train line wires 7, 4, 6, GS and 1 or 2 are de-energized by master controller main drum contacts. Switches "LS1", "LS2", "G1", "R7" and "R8" open when these wires are de-energized.

(b) There is an overlapping of DB relay contacts which permits the "BP-hold" coil to be energized from 3D wire before the "BP-close" coil is de-energized when wire 6 is disconnected so that the "BP" relay remains closed. This overlap also holds switches "M" and "G" closed.

(c) "B1" switch closes when wire 3D is energized.

(d) The field controller "bottom" magnet valve coil (FC-FF) is energized from the 3D wire under control of the brake spotting relay (SR).

Braking

With the main handle in the "off" position, assume that the brake handle is moved to a "service" position.

In the main circuit, "B" switches will close according to the sequence of switches shown on Diagram 55-B-3891 under control of the limit relay as the car speed decreases. Braking notches 5 through 12 are obtained by the various "B" switch combinations under the control of the limit relay CR, which reduce the ohmic value of the resistor common on both sets of motors. After all the "B" switches are closed, the "R" switches will close,

alternately in each motor circuit, under control of the limit relay to cut out resistance in each two motor circuits in sequence to provide notches 13 through 20.

The control circuits perform the main circuit changes as follows:

(a) Train line wire 5 is energized by contacts in the brake valve, and wire 3 remains energized.

(b) "BR" relay picks up from wire 5.

(c) The "progress" wire is energized from wire 5 through "CR" contacts when the "BR" relay picks up. "B" and "R" switches operate in proper sequence as the "CR" contacts open and close in response to main circuit current changes.

OPERATION UNDER SPECIAL CONDITIONS

Line Relay Operation

To obtain normal operation, the line relay (LR) must be picked up. In the event third rail voltage is lost during motoring, such as occurs on third rail gaps, the line relay will drop out. "LR" contacts (wires 110 to 19A) then opens to open the line switches "LS1" and "LS2". Line switch interlocks then cause all other main circuit unit switches to open except "G1" switch.

When third rail voltage is regained, the line relay will pick up, the "LS1" switch will close. Main circuit switches then progress in the normal manner to give the motoring combination (switching, series or parallel) called for by the master controller main handle.

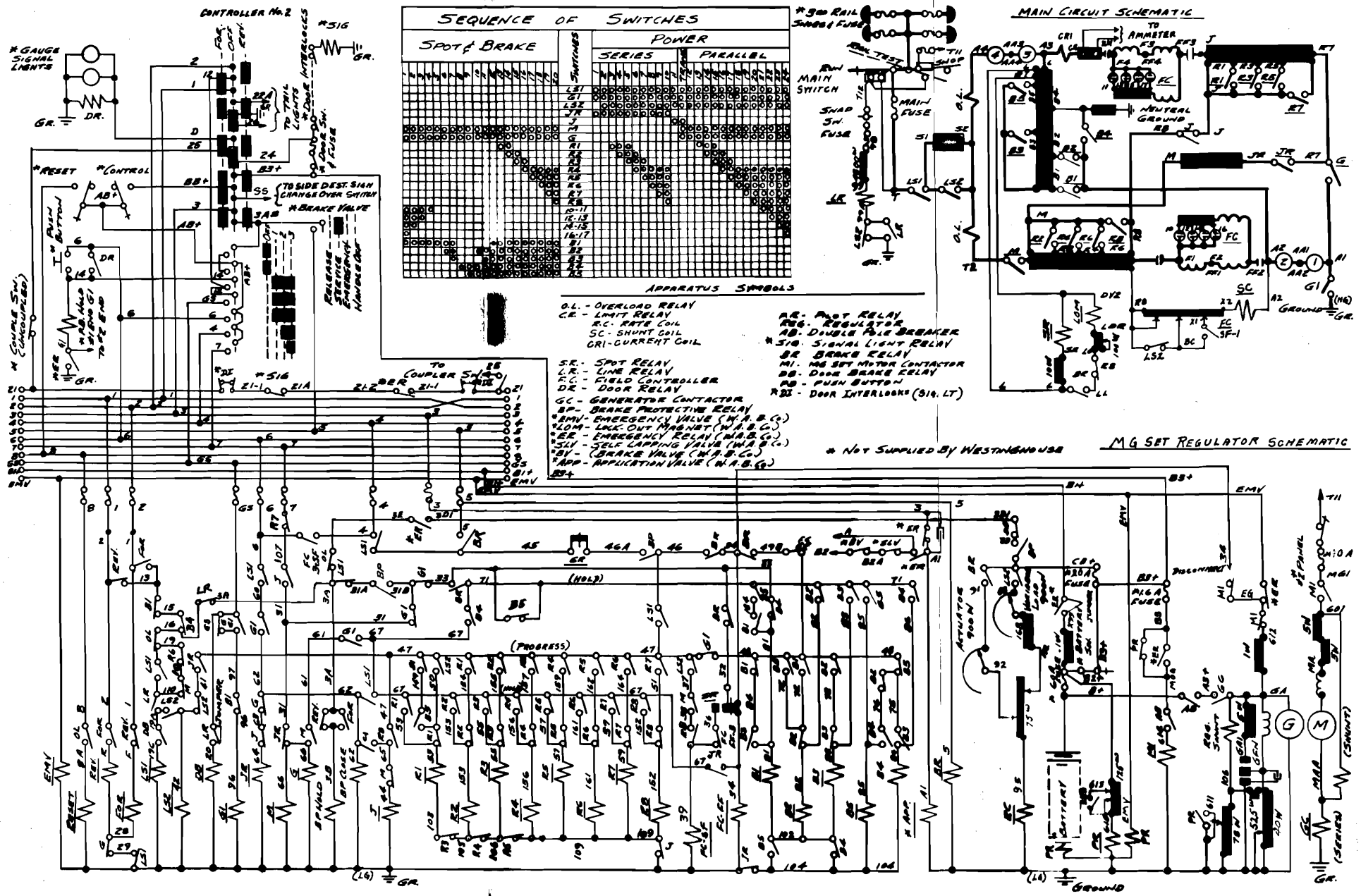
Line relay operation is ineffective, of course, in spotting or brake.

Overload Relay Trip

The overload relays will trip when the main circuit current, which must pass through their operating coils

(OLT #1 and OLT #2) becomes excessive. If one of the overload relays trip during motoring, the line switches will be opened by contacts "OL #1" or "OL #2" (wires 16 to 19), and eventually all other main circuit switches will open except "G1". If a trip occurs during braking, contacts "OL #1" or "OL #2" (wires 3E to 3A) will open to open all "B" and "R" switches and switches M and G.

When an overload relay trips, a latch on the relay holds it in the tripped position, and it is not possible to get either motoring or braking until the relay is reset. To reset the overload relay, the "reset" switch must be closed to energize the reset coils from train line wire 8. If an overload trip occurs in braking, dynamic braking cannot be re-established when the relay is reset until a motoring application is made, because tripping of the overload relay causes the "BP" to open.


SEQUENCE OF SWITCHES
SPOT & BRAKE
POWER
SERIES
PARALLEL
MAIN CIRCUIT SCHEMATIC
M.G SET REGULATOR SCHEMATIC
CONTROLLER No. 2
APPARATUS SYMBOLS
O.L. - OVERLOAD RELAY
C.R. - LIMIT RELAY
R.C. - RATE COIL
SC - SHUNT COIL
CRI-CURRENT COIL
S.R. - SPOT RELAY
L.R. - LINE RELAY
F.C. - FIELD CONTROLLER
DR - DOOR RELAY
GC - GENERATOR CONTACTOR
BP - BRAKE PROTECTING RELAY
*EMV - EMERGENCY VALVE (W.A.B.Co.)
*LOM - LOCK OUT MAGNET (W.A.B.Co.)
*EP - EMERGENCY RELAY (W.A.B.Co.)
*SLV - SELF LAPPING VALVE (W.A.B.Co.)
*BV - (BRAKE VALVE (W.A.B.Co.)
*APP - APPLICATION VALVE (W.A.B.Co.)
AR - PILOT RELAY
MG - REGULATOR
AB - DOUBLE POLE BREAKER
*SIG - SIGNAL LIGHT RELAY
BR BRAKE RELAY
MI - MG SET MOTOR CONTACTOR
DB - DOOR BRAKE RELAY
PB - PUSH BUTTON
*DI - DOOR INTERLOCKS (SIG. LT)
* NOT SUPPLIED BY WESTINGHOUSE
MAIN & CONTROL SCHEMATIC DIAGRAM
FROM 55-B-3910

BATTERY CHARGING

BATTERY CHARGING

The battery is charged from the generator of the "MG" set. Whenever the car is in service, the "MG" set is running and the battery is receiving a charge.

When the car is out of service, the "MG" set is normally shut down. Since there may be a small load on the battery when the car is out of service such as the potential coil of the "PR" relay and some emergency lights the battery will gradually become discharged. To insure that the battery is always in a condition to supply power for ready service, a boosting charge must be provided. The Schematic Diagram shows how the equipment is connected and should be referred to in order to understand the following explanation. The "PR" relay is calibrated for a pick up of 40 volts and a drop out of 30 volts. When the voltage drops to 30 volts, the "PR" relay drops out and this closes the "MG" set contactor M1 (circuit B3 to MOG) and starts the "MG" set. Once the "MG" is started, it will operate until it is shut down manually or until the "PR" relay picks up.

To avoid starting every "MG" set in a train of cars out of service, the "ER" interlock in circuit X99 to B1+ is eliminated which raises the voltage on the B1+ wire in the whole train whenever one "MG" set starts and prevents other "PR" relays from dropping out, thus there will be not more than one or at the best two "MG" sets in a train of eight or nine cars operating during lay up.

The battery charging equipment consists of the "MG" set and the "MG" set control panel (Type UVB-980-C).

When the car is put into service, the operator closes the battery switch and starts the compressor. When air pressure has built up and the emergency relay has closed, the "M1" coil is energized and the "MG" set starts. The emergency relay also cuts out some of the resistance in the "PR" coil circuit 613 to 615 to insure that the "PR" relay cannot drop out in normal service. When the emergency relay drops out, contactor "M1" drops out and wire "EMV" is energized from wire "GA". A special winding is incorporated in the "PR" relay coil EMV to G to prevent the "PR" dropping out immediately, which it might do if the battery was in a discharged condition, and thus de-energize the EMV wire instantly. Thus the "EMV" wire remains energized until the "MG" set slows down to the point where the voltage dies away which is about the length of time desired.

When the car is taken out of service, the brake handle is thrown to the "Handle Off" position and the emergency relay drops out, stopping the "MG" set.

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TROUBLE SHOOTING

A complete account of possible troubles and probable remedies would be too voluminous for practical considerations, so these instructions are given as a guide for trouble shooting.

If car or train will not start after steps 1A to 1G under "CAR OPERATION" have been followed, make these preliminary tests:

1. Make sure air brakes are released.

2. Reset overloads and try operation again.

3. Try operation with door cutout switch closed. Satisfactory operation indicates fault in door interlocks or door relay in master controller.

4. Try operation in opposite direction. Satisfactory operation indicates open circuit in master controller blown train line fuse on panel #2 or faulty reverser interlocks.

5. Try operation from another operating position. Successful operation indicates fault in original master controller or control switch.

6. Check for blown fuses on panel #2 and replace blown fuses with new fuses of proper size and rating.

7. Check for blown third rail or main fuses.

CAUTION: BEFORE REPLACING A FUSE, FIRST DE-ENERGIZE FUSE CIRCUIT; in the case of a main fuse, OPEN MAIN KNIFE SWITCH FIRST, and in the case of a third rail fuse, IN-

SERT INSULATED PADDLES BETWEEN THIRD RAIL AND *ALL* SHOES ON CAR FIRST. MAKE SURE *ALL* MAIN KNIFE SWITCHES ON TRAIN ARE OPEN BEFORE DOING ANY WORK ON CIRCUITS, to prevent accidental starting of car or injury from "live" circuits.

If these preliminary tests do not locate the trouble, MAKE CERTAIN ALL MAIN KNIFE SWITCHES ARE OPEN. By-pass the line relay contacts with jumpers, block open both main and spotting limit relay contacts, and check sequence. (NOTE: AFTER CHECKING SEQUENCE, REMOVE ALL JUMPERS AND BLOCKS.) "Inch" the control through progression by manual control of the limit relays. Use the sequence chart on the schematic diagram (See "Car Data") and check through the schematic diagram to learn why a switch does not close or open as specified in the sequence chart. Look for faults in the interlocks and relay contacts which energize or de-energize the switch. Check switch or relay for sluggish operation. (See instructions for individual switches or relays).

Typical sources of trouble are broken or dirty interlocks, loose connections, broken control wires, blown fuses, defective coupler contacts, sluggish switches, poor contact in switches, low battery voltage and low control air pressure.

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CAR DATA

Max. Safe Armature Speed	4420 R.P.M.
Max. Operating Voltage	750 Volts
Max. Safe/Car Speed	55 M.P.H.

Selective Dynamic Braking Rates of 1.5 to 3.0 M.P.H.P.S. for Seated Loads.
Full Dynamic Braking from 42 M.P.H. to 10 M.P.H. with fadeout at 5 M.P.H.
Reduced Rate Dynamic Braking with Shunted Fields above 42 M.P.H.

Fixed Rate of Automatic Acceleration of 2.5 M.P.H.P.S.

Contract R-21
Reference Diagrams

Main and Control Schematic	55-B-3910*
Main and Control Wiring	620-J-507**
Resistor Diagram	395-C-950**

*See Section 5
**Not included in this book.

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ELECTRICAL APPARATUS

Contact R-21

TYPE NUMBER	APPARATUS	WEIGHT PER CAR	NO. PER CAR
1447-C	Traction Motor	6270	4
	Ground Brush Holder	30	4
WN-44B-GS	Gear Unit and Coupling	3920	4
XM-179	Master Controller	114	2
TX 29-K	M.C. Junction Box #1	19	1
TX 29-J	M.C. Junction Box #2	18	1
TX 37-I	Train Line Junction Box #1	40	1
TX 37-J	Train Line Junction Box #2	40	1
TX 314-G	Door Control Junction Box #1	29	1
TX 314-H	Door Control Junction Box #2	29	1
TK 34-N	Knife Sw. & Fuse Box	105	1
UPB 31B	Package Unit, containing:	1640	1
UPB 132	Unit Switch		2
UPB 31	Unit Switch		17
UPB 131	Unit Switch		1
XRB 982	Reverser		1
XC 149-Y	Field Controller		1
UTA 25-A	Overload Relay		1
UV 856-A	Line Relay Panel		1
UC 630-A	Limit Relay Panel		1
UVB 980-C	Regulator Panel		1
TS 48-E	Actuator Panel		1
UG 616	Brake Relay		1
FS 33-A	Field Shunts		2

TYPE NUMBER	APPARATUS	WEIGHT PER CAR	NO. PER CAR
MA	Accelerating & Braking Resistors (6 Frames)	557	1
UG 566-B	Emergency Light Relay	5	1
YX-300-D	Motor Generator Set	475	1
A1	Control Air Supply Unit	28	1
S#418130-A	Knuckle Joint Connector	3	2
S#1527553	Variable Load Rheostat	2	1
5 Feet	Wire, Resistor Connectors	4	1
	TOTAL	13,628	

NOTE: The above does not include Motor Disconnect Switch.

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