VICTORIAN RAILWAYS

ELECTRIC TRAIN EQUIPMENTS

DESCRIPTION AND OPERATION OF COACHES

INSTRUCTION BOOK [illegible] VOL. I

The ENGLISH ELECTRIC Company Ltd.
TRACTION DEPARTMENT
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VICTORIAN RAILWAYS

INSTRUCTIONS TO ELECTRIC TRAIN DRIVERS AND OTHER EMPLOYEES

engaged in the operation of

ELECTRIC TRAINS

fitted with

NON-RHEOSTATIC E.E. EQUIPMENT 1955

Prepared by the Electric Traction Division
Electrical Engineering Branch

The instructions contained in this book are supplementary to those in the book of instructions to Electric Train Drivers, Guards, Shunters and other employees engaged in the operation of Electric Trains.

Those instructions relating to that equipment or method of operation which is common to all types of electric train stock are not included in this book, and must be obtained from the book of instructions referred to above.

These instructions deal with electric trains fitted with non-rheostatic E.E. equipment and should be read in conjunction with other relevant instructions issued by the Department.

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GENERAL

1.0 GENERAL DATA

Type of train	Electric, multiple unit, 1,500 volts D.C.
Weight of motor coach	46 tons
Weight of trailer	31 tons
No. of passengers: motor coach seated	59
No. of passengers: motor coach crush loaded	181
No. of passengers: trailer coach seated	72
No. of passengers: trailer coach crush loaded	195
Horsepower of motor coach weak field 1 hour rating	812 h.p.
Tractive effort of motor coach at starting	23,000 lb.
Tractive effort of motor coach at 1 hour weak field rating	8,000 lb.
Maximum safe speed of traction equipment	80 m.p.h.
Track gauge	5 ft. 3 in.
(convertible to	4 ft. 8½ in.)
Wheel base of motor coach	51 ft. 0 in.
Wheel base of trailer coach	50 ft. 6 in.
Distance between bogie centres (motor and trailer)	43 ft. 6 in.
Wheel base of motor coach bogie	8 ft. 0 in.
Wheel base of trailer coach bogie	7 ft. 6 in.
Length of coach over coupler centres (motor and trailer)	62 ft. 11 in.
Maximum width of coach over handrails	10 ft. 0 in.
Wheel diameter (new)-motor and trailer	3 ft. 0¼ in.
Bearings – axle – motors and trailers	S.K.F. Roller
Bearings – motor suspension	White metal
Earth return on motor coach	Suspension bearing shunted with brush
Earth return on trailer coach	Axle bearing shunted with brush.
Maximum height (pantograph housed)	13 ft. 10 in.
Operating height of pantograph from rail:	
– Minimum	14 ft. 1 in.
– Maximum	21 ft. 0 in.
Clearance to rail with maximum permissible wheel wear (loaded)	3 in.
Type of brake equipment	Westinghouse compressed air self-lapping electro-pneumatic.

1.0 GENERAL DATA – *continued*

Compressor:	Make and type	Westinghouse DHC.3
	Number of stages	2 Stages reciprocating
	Displacement	38 cu. ft. per min.
Air Pressure:	Main reservoir maximum	100 lb./sq. in.
	Control reservoir maximum	70 lb./sq. in.
	Minimum for control	40 lb./sq. in.
Speedometer		Elliott with axle-driven alternator
Line voltage:	Maximum	1,570 volts D.C.
	Minimum	1,150 volts D.C.
Control voltage		115 volts D.C.
Coach lighting voltage		230 volts A.C.
Coach lighting		Fluorescent – cold cathode
No. of traction motors per motor coach		4
Type of traction motor		E.E.528A
Horsepower of motor:		
Weak field 1 hour rating		203 h.p.
Full field continuous rating		144 h.p.
Tractive effort of the motor at the wheels:		
At starting		5,750 lb.
At weak field 1 hour rating		2,000 lb.
Current per motor circuit on high acceleration:		
Series	peak	382 amps.
	average	345 amps.
	notching value	320 amps.
Parallel	peak	357 amps.
	average	312 amps.
	notching value	280 amps.
No. of running notches:	Forward	4
	Reverse	4
Motor generator (M.-G.) set type		E.E. 753A.
Generator voltage		115 volts D.C.
Generator output (max. continuous)		90 amps.
Lighting inverters:		
Working voltage		115 volts D.C.
Output voltage and Frequency		230 volts, 50 cycles
Inverter output		500 VA.

1.1 BRIEF DESCRIPTION OF THE ELECTRICAL EQUIPMENT

Each motor coach has a driver's compartment at one end.

The power circuits are supplied direct from the 1,500 volt contact wire by the pantograph mounted on insulators on the EARTHED roof of the motor coach. The 1,500 volt supply is also used to drive an air compressor, and a motor-generator set which supplies power at 115 volts for the control of the train and for lighting in the motor coach and its attached trailer coach or coaches.

All four axles on each motor coach are motored. Electro-pneumatic (E.P.) control is provided for the self-lapping air brake. Up to five motor coaches in a train may be operated in multiple unit.

1.2 CONTROL

The driver's compartment contains a master controller, brake controller, and the necessary switches for the control of the train while running.

The master controller has two controls, namely:

(i) Controller handle, in which is incorporated the deadman's button; and

(ii) Reverse lever, which may be locked in the 'off' position by a standard electric train driver's controller key.

The controller handle has 5 positions, namely:

1. Off	OFF
2. Shunting or 1st notch	1
3. Series	S
4. Parallel	P
5. Weak Field	WF

Operation of the controller handle to the position marked '1' connects the motors in series with all resistance in the circuit.

Operation of the controller handle to the position marked 'S' causes the resistance to be progressively cut out until the motors are in 'full series' with no resistance in the circuit.

1.2 CONTROL – *continued*

The next operation of the equipment occurs when the controller handle is moved to position marked 'P'. This connects the motors in two parallel paths, each path consisting of two motors in series with resistance again in the circuit. The resistance is then progressively cut out until full parallel is reached, that is, there is no resistance left in the circuits.

To obtain a further increase in tractive effort for higher speeds, the fields of the traction motors may be weakened by moving the controller handle to the position 'WF'. As the fields are weakened, resistance is placed in the field circuit, and this resistance is then automatically cut out as the train accelerates until 'parallel weak field' is reached.

This progression from the shunting notch with motors in series and all resistance in the circuit takes place automatically under control of a current limit relay (CLR'M') right up to parallel weak field. The progression, however, may be halted at the stage corresponding to any one of the controller handle positions.

The equipment is provided with the facility for notching back from weak field to full field. Further movement of the controller towards the 'off' position has no effect until the 'off' position is reached, when the motors are immediately disconnected from the 1,500 volt supply.

LAYOUT OF EQUIPMENT

Layout of the equipment is illustrated on Drawing H.3523.

2.1 DRIVER'S AND GUARD'S COMPARTMENTS

Each motor coach has a guard's compartment containing a hand brake, guard's cock for application of the automatic air brake, and a pressure gauge showing brake pipe pressure. In the guard's compartment above each external doorway is an H-key operated switch which actuates a signal bell. This enables the driver to receive an audible signal from the guard, or vice versa, for starting the train, etc. The guard's view forward is obtained by means of a periscope.

Accessible from each guard's compartment (through a door which is locked with an H-key) is a driver's compartment.

The driver's compartment contains a driver's brake controller, air gauges and main reservoir low pressure signal, a master controller, traction ammeter, speed indicator, switches for the control of lighting etc. throughout the train, and a motorman's radiator.

Forming one wall of the motorman's compartment is the auxiliary equipment cupboard, which contains the main and auxiliary isolating switches, auxiliary circuit breaker and contactors, and the various switches, MCB's etc. used when driving the train. The pantograph E.P. valve and the pantograph hand pump and emergency jumper are also housed in this cabinet.

The layout of equipment in this cupboard is shown on drawing No. D.281.

2.2 UNDERFRAME EQUIPMENT

The brake gear and the remainder of the electrical equipment are mounted between the bogies, suspended from the underframe as shown on drawing H.3523 and consist of the following:

2.21 ON THE LEFT HAND ('B') SIDE of the underframe are mounted (from front to back):

(i) The compressor.

2.21 ON THE LEFT HAND ('B') SIDE – *continued*

(ii) No.1 lighting inverter for supplying 230 volts 50 cycles alternating current for that half of the fluorescent coach lighting mounted on 'A' side.

(iii) The main reservoir.

(iv) Contactor case containing the electro-pneumatic (E.P.) resistance contactors (R and RR).

(v) The E.P. brake unit.

(vi) The auxiliary resistances.

(vii) No.2 lighting inverter for supplying 230 volts 50 cycles alternating current for the other half of the fluorescent coach lighting which is mounted on 'B' side of the coach.

(viii) A frame containing the traction circuit accelerating resistances.

2.22 ON THE RIGHT HAND ('A') SIDE of the underframe are mounted (from front to back):

(i) A case containing the line breakers (LB1–3) and the power contactors for motor connections (P, S1–2, G) and the overload relays (OL1–2).

(ii) A case containing cam group switches for reversing (K) and field tapping (F), the motor cut-out switch (MCS) and the control relays (TR, PR, NCR, CLR'M').

(iii) The brake cylinder.

(iv) The motor-generator set.

2.23 CENTRALLY ON THE UNDERFRAME and adjacent to the motor-generator set are placed the control reservoir for control E.P. equipment, and the auxiliary reservoir for the automatic brake.

2.3 TRACTION MOTORS

The four traction motors are axle hung and nose suspended from the bogie frames. They drive the axles through solid spur gears mounted on the axles.

The ventilating air is drawn, by a fan built into the motor armature, through ducts which pass down through the coach body from a cowled inlet on the coach roof at the pantograph end, and from a louvred inlet beside the end coach window at the trailing end.

2.4 PANTOGRAPH

The single pan pantograph is mounted on insulators on the roof near the guard's compartment.

The roof of the coach is *earthed.*

Personal contact with any part of the overhead equipment, or equipment in contact with it, while standing on the roof, *WILL CAUSE DEATH.*

SECTION 3

CONTROL CIRCUITS

3.1 METHOD OF OPERATION

The contactors and cam operated group switches used to control motor speeds and groupings are operated by compressed air. The air is admitted to, or released from, the operating cylinders of the apparatus by electrically operated valves (called magnet valves) working under control of the master controller and the auxiliary contacts mounted on certain items of equipment or other switches.

The auxiliary contacts ensure that all operations are carried out in correct sequence by controlling the actuating circuits of the contactors, etc., in conjunction with the master controller.

The master controller initiates an operation, but such operation can only reach completion after every item of apparatus has functioned in correct sequence.

In addition to the air operated apparatus there are electro-magnetic contactors and relays. Some of these are controlled by push buttons in the driver's compartment, some by the master controller, and some by auxiliary contacts on other apparatus.

The control circuits of the motor coach are shown in diagrammatic form on Drawings Nos. L.6352 and L.6527. These diagrams show how the apparatus is interconnected, and if they are studied together with the notching chart (Drawing No. L.6351) the sequence of operations can be understood.

The power circuits are shown on Drawings Nos. L.6351 and L.6527 and if these diagrams are studied together, the complete operations involved in starting and running the train can be readily followed.

3.2 READING DIAGRAMS

When reading the diagrams certain conventions should be borne in mind, or it will be impossible to understand the operation of the apparatus. These conventions are set out below:

3.21 SYMBOLS

The contacts, operating coils, etc. of the various pieces of apparatus are indicated by the graphical symbols shown on Drawing No. D.276.

3.21 SYMBOLS – *continued*

If these are memorised no difficulty will be experienced in identifying the apparatus on the diagrams.

In addition, each piece of apparatus is given a symbol letter or letters and in some cases an additional number, e.g., K, F, CLR'M', LB2, R4, etc.

The contacts, operating coils, etc., of each piece of apparatus all bear the same symbol so that it can be easily seen to which item of apparatus any particular coil or contact belongs.

A table showing the symbol allotted to each item of control gear is given on the main schematic diagram drawing No. L.6527.

3.22 STATE OF APPARATUS

In general, the apparatus is always shown on the diagram in the de-energised state, with the controller handle and reverse lever in the 'off' position, and all push-button switches in the 'open' or normal position. For greater clarity, however, cam switches are shown thrown to the position they occupy for *forward* travel in *full field*, and isolating switches are all shown closed for normal operation.

Auxiliary machines are at rest and their contactors etc. are open.

When reading the diagrams, therefore, it should be assumed that contacts shown open will close and contacts shown closed will open when their associated operating coils are energised.

SECTION 4

APPARATUS USED

4.1 ELECTRO-MAGNETIC AIR VALVES

There are two types of magnet valves (or E.P. valves) used to control the air supplies to and from the operating cylinders of the various air-operated pieces of apparatus in the equipment. These are:

1. **Standard Valves.** These *admit* air when energised and exhaust the cylinder when de-energised.
2. **Exhaust Valves.** When these valves are energised they close a large exhaust port in the cylinder distinct from the port operated by the standard valve. When they are de-energised, the large exhaust port opens as well as the normal exhaust port, thereby enabling a quick release of air from the cylinder to take place.

   Exhaust valves are used only on the line breakers (see 4.2 below).

The symbols in brackets are those allotted to the apparatus as shown on the diagram.

4.2 LINE BREAKERS (LB1, LB2, LB3)

These are electro-pneumatic contactors, each having one standard and one exhaust magnet valve. For normal operation the exhaust valve coil is continuously energised, and the contactor is operated by the standard magnet valve. When the overload relay operates, both magnet valves are de-energised. This allows very rapid escape of air from the cylinder and causes the contactor to open more rapidly than with normal operation.

The interlocks (or auxiliary contacts) on these contactors are shown on the diagrams in the position they assume when the contactor is de-energised (open).

4.3 RESISTANCE CONTACTORS (R1 to R5, RR1 to RR5) POWER CONTACTORS (S1, S2, G, P)

These are electro-pneumatic contactors with one standard magnet valve only. The interlocks are shown in a similar manner to those on the line breakers.

4.4 REVERSER CAM SWITCH (K)

This switch is a *two*-position group switch controlled through cams by two standard magnet valves, the first of which (K_F) closes the switch in one position (forward) and the second (K_R) closes the switch in the other position (reverse). The two magnet valves cannot be energised at the one time, but both may be de-energised at the one time.

On the diagrams, the main contacts and interlock contacts are shown in the position they assume when the switch is lying in the position for forward operation. This switch may be in any position when power is shut off, but will take up its correct position on the first notch before the line breakers close.

4.5 FIELD WEAKENING CAM SWITCH (F)

This switch is a *three*-position group switch controlled through cams by *two* standard magnet valves, the first of which (F_F) closes the switch in one position (for full field operation) and the second (F_W) operates to the central position (for intermediate field operation) and again to the third position (for weak field operation).

4.51 FULL FIELD POSITION

When the F_F magnet valve is energised, the switch moves to the full field position from either intermediate or weak field positions if it is not already lying in its full field position.

4.52 INTERMEDIATE FIELD POSITION

With the switch lying in the full field position, energising the F_W magnet valve moves the switch towards the intermediate field position. When the main contacts for this position touch, the F_W magnet valve would be de-energised due to the operation of CLR'M' described in para 4.82, but the F_W magnet valve is kept energised through an auxiliary contact (the positioning interlock) until the main contacts are fully closed in the central (intermediate field) position. The switch will remain in this position with both magnet valves de-energised.

4.53 WEAK FIELD POSITION

With the switch lying in the central position, energising the F_W magnet valve again (by the next operation of CLR'M') moves the switch towards the weak field position. The operation of the positioning interlock is repeated to ensure the switch completes its movement to the weak field position.

4.6 MOTOR CUT-OUT SWITCH (MCS)

Two hand-operated double-pole double-throw knife switches are mounted so that a common set of contacts is used for one (the central) position of both switches. This ensures that only one switch may be closed in the central (cut-out) position at one time, but both switches may be closed in the outer (normal) position at the same time.

Auxiliary contacts are fitted, which are operated by a central peg between the two blades of each switch.

The motor cut-out switch is mounted in the reverser case on the 'A' side of the underframe.

4.7 CONTROL CONTACTORS AND RELAYS

4.71 TRAIN LINE CONTACTORS (TL1, TL2, TL3)

These are electro-magnetic contactors which are operated by the master controller (Drawing L.6352). They are shown in the diagram in the de-energised position with contacts open. Their contacts close when the operating coils are energised.

The purpose of these relays is to relieve the duty on the contacts of the master controller.

4.72 TRANSITION RELAY (TR)

The operating coil and contacts of this relay are shown on Drawing L.6352 in the de-energised position.

The purpose of this relay is to initiate transition, the first step of which is the opening of R4, RR4, R5 and RR5 resistance contactors.

4.73 POSITION RELAY (PR)

The operating coil and contacts of this relay are shown on Drawing L.6352 in the de-energised position.

The purpose of this relay is to give the facility for notching back from weak field to full field.

4.74 CONTROL CIRCUIT GOVERNOR

The contacts of this device are shown in the normally open position on Drawing L.6352. Its place in the air system is shown on Drawing L.6354.

The purpose of this device is to ensure that power is not available for traction without there being sufficient air in the train pipe to allow the brakes to be applied by an automatic application.

It can be by-passed in the circuit by operation of the *Control Governor Cut-Out Switch* (shown on Drawing L.6352 in the normally open position). The control governor cut-out switch is so located that it can only be used when a second person is present in addition to the driver.

4.75 AUXILIARY (REMOTE) CONTROL CONTACTORS

The circuit of these contactors is shown with operating coils de-energised and contacts open on Drawing L.6353.

These contactors are a 'latch' type and may be operated by hand by means of push buttons set into the cover of the contactor, or they may be operated electrically from the auxiliary control circuits shown on Drawing L.6353.

These contactors control the supply to:

(i) Motor-generator.

(ii) End Lights (destination, marker, cab etc.)

(iii) Coach lighting in the Motor Coach.

(iv) Lighting in the Trailer Coaches.

The operating coils of these contactors need only be energised momentarily to effect an operation of the contactor.

4.751 Contactors Controlling Lighting Inverters

These contactors – see 4.75(iii) and 4.75(iv) – are similar to those described above (4.75), but have in addition a delay contact mechanism (D) which, when the inverter starting current has fallen to a pre-determined value, cuts out the starting resistance which is normally in series with the D.C. armature winding of the inverter.

4.8 1,500 VOLT RELAYS

4.81 OVERLOAD RELAY (OL1–OL2)

The operating coils of this relay are shown on the power schematic diagram L.6351. Its contacts are shown on the control circuit schematic diagram L.6352.

The overload relay is normally de-energised with contacts closed. Its operation is such that the contacts open only in the event of excessive current passing through a coil.

When the contacts open they break the circuits to line breaker exhaust and standard magnet valve coils thus causing rapid opening of the line breakers.

4.82 NO-CURRENT RELAY (N.C.R.)

The contacts of the no-current relay are normally open when the current coil is de-energised.

In the event of interruption to the traction current, the contacts of the N.C.R. open and ensure that the control equipment reverts to the set up for the shunting (1st) step.

4.83 CURRENT LIMIT RELAY (CLR'M')

This electromagnetic relay has three coils affecting its operation:

(i) *The current coil* is in the power circuit of Nos. 3 and 4 motors (see Drawing No. L.6351). The armature of this relay is set so that with the current coil alone energised, the contacts close when the current falls below 280 amps.

4.83 CURRENT LIMIT RELAY (CLR'M') – *continued*

(ii) *The series voltage coil*, which is energised through a resistance during series notching (as shown in Drawing No. L.6352) is mounted on the same iron core as the current coil. It is connected so that it supplies opposing ampere-turns of such an amount that the contacts close when the current in the current coil falls below 320 amps.

(iii) *The reduced-acceleration voltage coil*, which can be energised or de-energised at will by the driver, supplies ampere-turns which assist those of the current coil, so that when this coil is energised, the previous drop-out currents of 280 amps. and 320 amps. are reduced to 220 amps. and 260 amps. respectively.
The contacts of this relay are normally closed. A high current in the current coil opens the contacts until the current falls to the values given above under appropriate conditions.
The purpose of this device is to automatically control the stepping of the control equipment during acceleration.

4.9 ELECTRO-PNEUMATIC (E.P.) BRAKE EQUIPMENT

4.91 DRIVER'S BRAKE CONTROLLER

A detailed description of this controller and its electrical contacts is given in para 8.22.

4.92 BRAKE APPLICATION AND BRAKE HOLDING RELAYS

The coils of these relays are energised through the contacts in the driver's brake valve and are shown de-energised with their contacts open. The primary purpose of these relays is to relieve the duty of the driver's brake valve contacts.

4.93 BRAKE E.P. VALVES (Holding Valve, Application Valve)

These electro-pneumatic valves control the flow of air out of (Holding Valve) and into (Application Valve) the brake cylinder.

When the *holding valve* coil is de-energised the valve is normally open. Energising the coil, closes the valve to retain air in the brake cylinder.

When the *application valve* coil is de-energised, the valve is normally closed. Energising the coil opens the valve to admit air into the brake cylinder.

AUXILIARY CIRCUITS

5.0 GENERAL

The auxiliary circuits are shown on Drawings L.6353 and L.6527 and comprise arrangements for the following supplies:

A **At 1,500 volts D.C.**

From the pantograph to the compressor motor, and to the motor of the motor-generator set. See paragraph 5.1.

B **At 115 volts D.C.**

From the generator of the motor-generator set to the various circuits for control, heating, and lighting and to the inverters for coach lighting. Supply is also given from this source via a bus line to other coaches in the unit for lighting. See paragraph 5.2.

C **At 230 volts A.C. Single Phase, 50 cycles**

From each inverter to the corresponding half of the fluorescent coach lighting on each motor coach. See paragraph 5.3.

Note: Two inverters are also mounted under each trailer coach for supplying the fluorescent lighting in that coach.

5.1 AT 1,500 VOLTS D.C.

5.11 MOTOR-GENERATOR

The motor-generator set, in common with the compressor motor, receives its 1,500 volt supply from the pantograph through an auxiliary isolating switch (AIS) (which in the OFF position earths the auxiliary equipment), a fault limiting resistance (ALZ) and a high-tension circuit breaker (MB).

From the H.T. circuit breaker (MB) the supply is taken to the motor through a contactor (MG) which can be closed or tripped by hand, or electrically by remote control.

5.11 MOTOR-GENERATOR – *continued*

A starting current limiting resistance (MZ) is permanently in series with, and on the earth side of, the motor.

The 115 volt generator has a high tension field connected in series with the motor armature, to ensure correct polarity of the generator. The motor has a high tension series compensating field, and also a low tension field excited by the generator.

The voltage of the 115 volt generator is maintained at a steady value by a carbon pile voltage regulator which regulates the current in the generator shunt field as the generator load and armature speed vary.

5.12 COMPRESSOR

From the H.T. circuit breaker (MB) described in 5.11 above, the supply to the compressor motor is taken through an electro-magnetic contactor (CC), the operating coil of which can be energised by 115 volt supply from the air operated compressor governor.

The coil of the contactor can be isolated by a L.T. isolating switch (CCS), the coil being controlled by the compressor governor (CG) which cuts in or out the compressor as the main reservoir pressure falls or rises within predetermined limits.

When coaches are running in multiple unit, the compressor governors are linked together through the synchronising train line, SY, and all compressors in the train run until the compressor governor with the highest cut-out setting opens its contacts.

As the air pressure falls, the governor with the highest cut-in setting will close its contacts first, and bring all compressors into operation until the cutting out pressure is reached.

5.2 AT 115 VOLTS D.C.

5.21 SUPPLY FOR COMPRESSOR CONTACTORS

The 115 volt sides of all compressor contactor coil isolating switches are connected together by means of the supply (CP) train line. This line is supplied from any one motor-generator set on the train by closing the appropriate miniature circuit breaker (MCB). An indication when this line is alive is given by a supply indicator lamp in each driving cab.

If an attempt is made to supply this line simultaneously from more than one motor-generator, thus paralleling the generators, any resulting circulating current will cause the MCB to trip.

This 115 volt supply through the train is also used to enable the guard's signal circuit to be operated from the rear van when the motor-generator of that car is not operating.

5.22 SIGNALLING BELL

Provision is made for the immediate transmission of start, stop and other signals between the guard and the driver by means of an electric bell system worked from the 115 volt supply from the supply train line (CP) described in 5.21 above.

In the guard's compartment, above each external doorway is mounted a bell switch which can only be operated by means of an H-key. Operation of any one of these switches by a key sounds the bell in each driving cab of the train. Each bell is fitted with an isolating switch which may be operated should the bell become defective.

5.23 AUXILIARY (REMOTE) CONTROL

A MCB on the panel beside the driver protests the 115 volt supply to the 3 push buttons for operating, by remote control, the motor-generators and lighting throughout the train.

The 'trip' and 'set' operating coils for remote control contactors throughout the train are fitted with isolating switches.

5.24 CONTROL SUPPLY

A MCB on the driver's panel controls the 115 volt supply from the motor-generator bus (GA) to:

(a) the master controller

(b) The common positive wire BR for all E.P. brake equipment via a cut-out switch (EPS).

(c) the push buttons for energising the pantograph 'raise' or 'lower' magnet valves throughout the train.

5.241 Supply to the Master Controller

The 115 volt supply is obtained from the motor-generator via the emergency jumper, the bus-bar (GA), and the 'control' MCB which feeds wire P. See Drawing L.6353.

5.242 E.P. Brake Supply

All the E.P. brake equipment is so arranged that there is one common connection (BR) to the positive side of the 115 volt supply. The various relays, brake valve contacts, etc. are all arranged on the negative side of operating coils.

When the combined isolating valve and switch on the driver's brake controller pedestal is in the correct position for operating the brake, and when the supply connections are correctly made, a brake indicating lamp lights to show that the E.P. brake equipment can be used.

For details of the operation of the E.P. brake see (8).

5.25 HEADLIGHT AND RADIATOR

Separate MCB's in the cab supply 115 volts to the motorman's radiator, and to the headlight. The headlight can be dimmed by the operation of a switch, mounted below the driver's air gauges, and which normally short circuits the dimming resistance.

5.26 END LIGHTS

Supply at 115 volts from the generator bus bar is fed by a MCB in the cab to a hand electro-magnetic contactor, from which switches mounted on the driver's panel supply incandescent lighting used for:

Destination Sign

Marker Lights

Instrument Lights; and

Guard's Compartment Lights.

5.27 L.T. BUS LINE

A 50 amp. M.C.B. connects the motor-generator bus to a heavy bus line which has separate jumper connections to enable current at 115 volts to be supplied to the lighting inverters of a limited number of trailer coaches.

5.271 Bus Line Emergency Conditions

Should the motor-generator become defective, the bus (GA) can be supplied with 115 volt current from another motor coach by means of this L.T. bus line. This is done by removing the emergency jumper from the motor coach with the defective motor-generator and using it to make the connection to the other coach.

In the event of the bus line being used under emergency conditions as above, the lighting is to be so arranged that not more than 8 lighting inverters in addition to control circuits are supplied by the one motor-generator.

This may be done by:

(i) re-arrangement of the bus-line jumpers; or

(ii) switching off one inverter on some coaches thus giving those coaches only half of their available lighting.

5.28 COACH LIGHTING

Motor coach lighting is supplied through a MCB from inverters. These inverters are fed from the 115 volt bus (GA) via a MCB in the driver's cab and two lighting switch boxes mounted above the parcel rack, one at each end of the coach.

Each lighting switchbox contains a contactor starter (described in 4.751) together with the 'trip' and 'set' isolating switches and MCB's for one inverter.

Trailer coach lighting is similarly supplied. The trailer coach inverters, however, are fed from the L.T. bus line (GA1) and two lighting switch-boxes mounted above the parcel rack are at each end of the coach.

Each lighting switchbox in the trailer coach is similar to the corresponding item in the motor coach.

5.29 INDICATION LIGHTS

Indication lights for E.P. brake supply and compressor contactor and signalling bell supply are provided in the driver's compartment, the circuits being shown as on Drawing L.6353.

5.3 AT 230 VOLTS A.C.

5.31 COACH LIGHTING

All coach lighting (not including end lights as described in 5.26 above) is of the fluorescent type operating from the 230 volts A.C., 50 cycles supply obtained from the lighting inverters.

5.311 Inverters

Two of these machines are mounted under each motor coach and each trailer coach. They are supplied from the 115 volt system as shown on Drawing L.6353. The output of each is at 230 volts. 50 cycles alternating current, and supplies half of the lighting of the coach under which it is mounted.

5.312 Lighting Switchgear

The lighting switchbox above the parcel rack in the saloon at each end of each motor coach and trailer coach is opened by an H-key and contains the following 115 volt D.C. equipment:

(i) A 50 amp. MCB protecting the lighting contactor and the inverter.

(ii) Isolating switches for the 'trip' and 'set' feeds to the operating coils of the contactor.

(iii) The lighting contactor described in (4.751).

Also in each switchbox there is a 10 amp. MCB protecting the 230 volt A.C. load on the lighting inverter.

5.313 Fluorescent Lamps

All the fluorescent lamps, with their ballasts, arranged on the 'A' side of a coach are supplied from No.1 inverter and controlled by the switchgear at No.1 end of the coach.

All the fluorescent lamps, with their ballasts, arranged on the 'B' side of the coach are supplied from No.2 inverter and controlled by the switchgear at No.2 end of the coach.

SECTION 6

SEQUENCE OF OPERATIONS OF CONTROL CIRCUITS DURING NOTCHING

6.1 NOTE RE WIRE NUMBERS AND DEVICES

The sequence of operations when driving a train is given hereafter. The circuits are described by quoting the wire numbers and devices starting from the control positive wire P which feeds the master controller, and progressing through to the negative wire N. Each change of wire number indicates that the circuit has been interrupted by a switch, relay contacts, or the auxiliary contacts of a cam switch, E.P. contactor, etc. or other device.

6.2 STATE OF APPARATUS

In the diagrams quoted below, the reverser (K) and field switch (F) are shown in the positions they occupy for forward full field running.

In the description of the control circuits for normal motoring (6.4 to 6.6 inclusive) the motor cut-out switch (MCS) is assumed to be in the normal position, i.e., all motors in circuit.

6.3 SUPPLY TO MASTER CONTROLLER

The 115 volt supply to wire P is obtained, as described in 5.241 above, through the 'control' MCB for the particular driver's cab from which the train is being driven.

6.4 NORMAL MOTORING

Notching up for 'forward' or 'reverse' movements are similar, except that for forward motion the coils for K_F and TL2 are energised whereas for the reverse motion the coils for K_R and TL3 are energised.

6.41 REVERSE LEVER. (Diagram 1, Drawing L.6532).

The reverse lever is unlocked by using the driver's controller key. The deadman's button is held depressed, and the reverse lever is moved to the 'forward' (or 'reverse)' position, with the result that:

The exhaust magnet valve coils of LB_1, LB_2 and LB_3 are energised from wire P through train line H, control cut-out switch, and wire H1.

The negative side of the circuit is completed as follows:

For LB_1 and LB_2 exhaust valves:

Via wire N2 through a normally closed contact of overload device OL1–2 to N.

For LB_3 exhaust valve:

Via wire N3 through another normally closed contact of overload device OL1–2 to N.

6.42 CONTROLLER HANDLE MOVED FROM THE 'OFF' POSITION TO NOTCH 1 – (see Diagram 2, Drawing L.6532).

This mechanically locks the reverse lever which can only be moved when the controller handle is in the 'off' position.

Assuming that the driver's brake controller isolating valve switch has been opened and the train pipe charged with air to a pressure ensuring safe working (62 lb./sq. in.) the control circuit governor will close its contacts thus completing the circuit between wires P1 and P2, then the circuits made in the master controller on this notch are:

A Wire P to No. 1 train line.

B Wire P through the controller contacts to wire P1 and the control circuit governor to wire P2 from which train line F (or R) is energised by the reverse handle contacts.

These are continued as follows:

A **No.1 Train Line**

The TL1 contactor coil is energised from No.1 train line via the control cut-out switch and wire 1A to the coil, the negative side of the circuit being completed via wire N2 and the normally closed contacts of OL1–2.

B **F (or R) Train Line**

The TL2 (or TL3) contactor coil is energised from F (or R) train line via the control cut-out switch and F1 (or R1) wire to the coil, thence to N.

6.42 B F (or R) Train Line – *continued*

The energising of the coils indicated above results in the following additional circuits being energised.

C **Due to TL1 closing** (see Diagram 3, Drawing L.6532).

From P, control circuit governor and reverse lever contacts, train line H, control cut-out switch, wire H1 and contacts of TL1 to wire H6, the following circuits are made:

(i) Through the normally closed G interlock to wire H17 to energise the coils of contactors S1 and S2, and from wire H17 through a normally closed interlock on resistance contactor RR5, wire H18 and the limiting resistance to wire H19, to energise the reduced acceleration voltage coil of the current limit relay (CLR'M'). The negative sides of S1, S2 and CLR'M' coils are all connected to N.

(ii) Through the normally closed contacts of position relay PR to wire H23 and the F_F coil of the field weakening cam group switch to wire N.
If this cam group switch is already lying in the full field position, there will be no effect, otherwise it will move to that position.
The closing of the line breakers LB1 and LB2 described in D(ii) below, is only possible when the field switch F has reached this full field position.

D **Due to TL2 (or TL3) Closing** (see Diagram 3, Drawing L.6532).

(i) From P, reverse lever contacts, train line H, control cut-out switch, wire H1, and the contacts of TL2 (or TL3) to wire H2 (or H3) which energises the coil K_F (or K_R).

6.42 D Due to TL2 (or TL3) Closing (i) – *continued*

If the reverser cam group switch (K) is lying in its correct position there is no effect, but if lying in the opposite position, then energising the coil K_F (or K_R) causes this switch to throw to its correct position.

(ii) (Diagram 4, Drawing L.6532).
With K lying in its correct position the coils of the operating magnet valves of line breakers LB1 and LB2 are energised from wire P through to wire H2 as above, then through the normally closed (or open) K interlock to wire FR, then through the network of motor cut-out switch (MCS) interlocks to wire FR3 and the normally closed interlock of the field weakening cam group switch F, then via wire FR4 to the coils. The purpose of the network of MCS interlocks is to ensure that the power blades of the MCS are fully closed in either 'in' or 'out' positions. The negative side of the circuit is completed through wire N1 and a normally closed interlock on OL1–2 to N.

(iii) When LB1 has closed, the operating coil of LB3 is energised from P to wire FR4 as above, then through the normally open LB1 interlock to wire FR5 and the coil. The negative side of this circuit being completed via wire N3 and the same interlock on OL1–2 as is used for the coil of the exhaust magnet valve of LB3, thence to N.

(iv) When LB3 has closed, one of its normally open interlocks parallels each of the OL1–2 interlocks in the negative circuits of the operating and exhaust valve coils of LB1 and LB2.
This ensures that operation of the overload device OL1–2 opens line breaker LB3 first, followed by the opening of LB1 and LB2.

E **With LB1, LB2, LB3, S1 and S2 all closed,** current flows through the motors and the contacts of the no-current relay (NCR) close to allow further operation of the control circuits.

If the controller handle is kept on notch '1', the control circuits will remain at this stage. If the control handle is moved beyond notch '1', the control circuits must be completed up to this stage before any further progression can take place.

6.43 CONTROLLER HANDLE MOVED TO NOTCH 'S' (See Diagram 5, Drawing L.6533).

After completion of the circuits described in 6.42 above, the circuit from P to train line 2 is made through the controller contacts for this notch.

This enables a progressive operation of the resistance contactors R1 to RR5 to cut out resistance from the traction motor circuit and give a smooth acceleration to the train. The progressive operation occurs as follows:

A **R1 Coil is energised** as follows: (Diagram 5, Drawing L.6533).

From train line 2 through the control cut-out switch to wire 2A, then through a normally open S1 interlock, wire 2B, a normally closed RR5 interlock, wire 2C and a normally open interlock on LB3 to the current limit relay (CLR'M') contacts. At the commencement of the progression these will be closed, thus causing the 'actuating wire' 2E to be energised. At this stage the only coil which can be energised is that of resistance contactor R1 via its own interlock and wire H7.

The negative side of this circuit is via wire N4 and contacts of NCR to N.

When R1 closes, its interlock between the 'retaining wire' H6 and the wire H7 closes, thus maintaining R1 energised when its interlock between 2E and H7 opens.

6.43 A **R1 Coil is energised** – *continued*

On this step the traction motor current does not increase sufficiently to open the contacts of CLR'M' and so further progression will occur.

B **RR1 Coil is energised** as follows:

With the CLR'M' contacts closed as described above, and since R1 is closed, the coil of RR1 will now become energised from wire 2E through the R1 interlock, wire 2F, and the RR1 interlock to wire H8 and the coil. The negative side of this circuit is again via wire N4 and the contacts of NCR to N.

RR1 coil is kept energised from wire H6 by its own interlock.

C **R2 coil is energised** in a manner similar to that described for RR1 coil in B above.

The negative side of the circuit for R2 coil, however, is completed via wire N8, a normally closed RR3 interlock, wire N7, the normally closed interlock of RR4 and wire N5 to the normally closed contacts of TR and wire N4, thence through the NCR contacts to N.

When R2 closes, the current increase is sufficient to open the contacts of CLR'M'. Therefore the actuation of RR2 is held up until the train speed increases with consequent decrease in traction current to the pre-determined drop-off setting of the CLR'M'.

D **Actuating, self-retaining and progression setting** of the contactors RR2, R3 and RR3 occur in a similar manner to that shown in Diagram 6, Drawing L.6533 and as described in C above for contactor R2.

The negative side of the circuit for RR2 coil is completed in a similar manner to that described in C above for the coil of R2.

6.43 D Actuating, self-retaining and progression setting – *continued*

The negative side of the circuit for R3 and RR3 coils is completed through wire N7, then through the normally closed RR4 interlock to wire N5, thence as for R2 coil to N.

When RR3 contactor closes, R2 and RR2 are then 'overlapped' in the traction circuit by contactors R3 and RR3. To relieve the breaking duty on the contacts of TR and NCR between wires N5 and N, these 'overlapped' contactors drop out by the opening of RR3 interlock between wires N8 and N7.

E **R4, RR4, R5 and RR5, contactors then close in sequence** under the control of CLR'M' as described for contactors RR2, R3 and RR3 in D above. The negative side of these coils is connected to wire N5.

When RR4 closes, R3 and RR3 coils are de-energised in a similar manner to R2 and RR2 as described in D above.

The motors are then connected in 'full series'. Unless the controller handle is moved beyond position 'S', the progression will be halted at this stage by the opening of RR5 interlock between wires 2B and 2C.

Before any further progression is possible, however, even by movement of the controller handle, the progression must first reach this stage.

6.44 CONTROLLER HANDLE MOVED TO NOTCH 'P'. (Diagram 7, Drawing L.6533).

The circuit from P to train line 3 is made by the contacts of the master controller.

Since train line 2 is also energised, progression will take place as described in 6.43 above, during which time the supply on wire 3 cannot extend to wire 2C, since contactor S1 is closed and its normally closed interlock between wire 3C and 2B will be open, and until the progression is completed up to the closing of RR5, its interlock between wires 4B and 2C will remain open.

Note: Change of Acceleration from Series to Parallel

When the progression up to 'full series' is complete, a greater drop in motor current than was necessary during progression in series is required to allow the contacts of CLR'M' to close. This occurs because when RR5 closes, its interlock between wires H17 and H18 in the feed to the series voltage coil of CLR'M' opens, which in effect reduces the current setting at which the contacts of CLR'M' close.

A **Transition Commences**

When, in 'full series', the contacts of CLR'M' close, the coil of the transition relay TR is energised as follows:

From P to train line 3 as described above, then through the control cut-out switch, wire 3A, the MCS interlocks to wire 3C, then G interlock, wire 4B, RR5 normally open interlock, wire 2C, LB3 interlock and wire 2D to the contacts of CLR'M'. Wire 2E is energised with these contacts now closed, and the RR5 normally open interlock energises wire 2R. From wire 2R the circuit is made through the MCS interlocks via wires 2S and 2T, and contactor S2 being closed, via wire H24 to the coil of TR. The negative side of the coil is connected to N via wire N9 and contacts of NCR.

B **This initiates the following sequence** of events known collectively as **'transition'** – see Drawing D.236:

(i) Resistance is replaced in the traction motor circuit.

(ii) One pair of motors (3 and 4) is short circuited, the other pair being therefore connected, together with the power resistance necessary for the first step in parallel, across 1,500 volts.

6.44 B This initiates the following sequence – *continued*

(iii) The short circuited pair of motors is then open circuited.

(iv) These motors are then, with their resistance, connected across 1,500 V.

The operation of the control circuits which cause this sequence of events is as follows:—

C (i) **When TR closes** (see Diagram 8, Drawing L.6533), one set of its contacts connects the positive side of its coil via wire R24 to wire H6 thus retaining TR closed, another set of its contacts between wires N4 and N5 opens the resistance contactors R4, RR4, R5 and RR5. R2, RR2, R3 and RR3 are already open, but R1 and RR1 remain closed. This replaces the necessary resistance in the main motor circuit.

(ii) **When these contactors have opened,** the interlock on RR5 opens the feed to wire 2R thus for the time being preventing any further progression beyond this point. However, now that transition has been initiated, it continues. The coil of G is then energised from the retaining wire H6 via the TR contacts to wire H25 then the R4 interlock, which is now closed, to wire H20. The negative side of the coil is connected to N. The closing of G shorts out this R4 interlock and connects the coil of G to wire H6, via its interlock, wire H25 and TR contacts, thus retaining G closed.

(iii) **The closing of G** also opens S1 and S2 by means of the interlock between wires H6 and H17.

6.44 C – *continued*

(iv) **When S2 opens** (see Diagram 9, Drawing L.6533), P is closed by energising its coil from wire H6, TR contacts and G interlock to wire H20, through the S2 interlock to H21 and the motors are then connected for the 1st step of parallel (as shown for step 12 on the sequence chart of drawing L.6351). The negative side of P coil is connected to N.

D **When the speed in 1st parallel step has increased** sufficiently to cause a reduction in motor current which allows the contacts of CLR'M' to close, the 'actuating wire' (2E) is energised again as follows:

From P to wire 3C as described in 6.44A above, then through the S1 interlock to wire 2B, the RR5 interlock to wire 2C and the LB3 interlock to wire 2D and the contacts of CLR'M', thus energising wire 2E. The feed from wire 2A to wire 2B is broken by the S1 interlock between them which is now in its normal (open) position.

E **R2 Coil is next energised from wire 2E** (Diagram 10, Drawing L.6534) as described in 6.43C above, since contactors R1 and RR1 remain closed throughout transition. The closing of R2 contactor cuts out the appropriate section of resistance from the circuit of Nos.1 and 2 motors, but this does not affect the current in the circuit of Nos.3 and 4 motors. The current through the main coil of CLR'M' is unaltered and its contacts do not open. Therefore wire 2E remains energised after R2 closes.

RR2 then closes as soon as the R2 interlock to wire 2H closes. Only then will the contacts of CLR'M' open, i.e., when the current in motors 3 and 4 increases due to RR2 contactor cutting out the appropriate section of resistance in that circuit.

F **R3 and RR3 contactors close** as described for R2 and RR2 contactors in E above.

Further operation of CLR'M' causes R4 and RR4 contactors to close similarly, followed again by the closing of R5 and RR5 contactors.

G **As soon as RR5 closes,** all resistance has then been cut out of the motor circuits, and the motors are running in 'full parallel'.

The actuating wire 2E can then no longer be energised from wire 2A or wire 3A since the RR5 interlock between wires 2B and 2C is open and the normally closed G interlock between wires 3C and 4B is open.

6.45 CONTROLLER HANDLE MOVED TO NOTCH 'WF' (Diagram 11, Drawing L.6534).

Wire 4A is energised through the controller contacts from P to train line 4 and the control cut-out switch.

Wire 2C cannot become energised from wire 4A until the progression has been completed up to 'full parallel', since in series and during transition the P interlock between wires 4A and 4B remains open, and during parallel notching when this is closed, the RR5 interlock between wires 4B and 2C remains open.

A **When CLR'M' contacts are closed again** by a sufficient drop in motor current in full parallel, the actuating wire 2E is once more energised from wire 4A, the P interlock wire 4B, RR5 interlock, wire 2C, LB3 interlock, wire 2D and the contacts of CLR'M' – see Diagram 12, Drawing L.6534.

The position relay PR is energised from wire 4A, P interlock and wire 4C – see Diagram 11, Drawing L.6534. The coil of PR is connected to N via wire N9 and the contacts of NCR.

6.45 A **When CLR'M' contacts are closed again** – *continued*

RR5 contactor is closed, so wire 2R is energised from wire 2E. This allows the F_W magnet valve coil of the field weakening switch F to be energised through PR contacts to wire 2V and the coil, the negative side of which is connected to N.

B (Diagram 12, Drawing L.6534.)

The F switch moves towards the central (IF) position and with its F1–F4 contacts still closed, F2–F5 contacts just touch. The resultant increase in current in the motor circuits opens the contacts of CLR'M', and the F_W magnet valve coil is no longer energised from the actuating wire 2E.

The F switch would remain in this position but for the positioning interlock F between wires H22 and 2V which closes as the F switch moves from the full field position, and this interlock does not open until the main contacts F2–F5 are fully closed.

C **When the motor current** in the intermediate field step **has fallen** sufficiently, the contacts of CLR'M' close, and the F_W coil is energised again from wire 2E, through RR5 interlock, wire 2R, PR contacts and wire 2V.

The F switch then moves towards the weak field position. The operation performed by the positioning interlock F is repeated, this time covering the closing of F3–F6 contacts, and the switch completes its movement to the weak field position, with F1–F4 contacts open.

The F switch will then remain in the weak field position whether or not the F_W magnet valve coil is energised, so long as F_F magnet valve coil is not energised. With PR energised its contacts between wires H6 and H23 prevent F_F coil from being energised.

6.46 CONTROLLER HANDLE MOVED FROM 'WF' BACK TO POSITION 'P'.

Wire 4A becomes de-energised since the controller contact between wire P and wire 4 is opened.

6.46 CONTROLLER HANDLE MOVED FROM 'WF' BACK TO POSITION 'P' – *continued*

The position relay PR is therefore de-energised and its contacts open the connections between wires 2R and 2V, and wires H6 and H22 so that the magnet valve coil F_W cannot remain energised. At the same time, the normally closed pair of contacts of PR close the circuit from wire H6 to H23 so that the magnet valve coil F_F is energised. The field weakening switch F then moves directly to the full field position.

The controller may therefore be moved between notch 'P' and notch 'WF' at will, to suit service requirements.

6.47 CONTROLLER MOVED BACK TO NOTCH '1'

As the controller contacts open the connections between wires P and 3 and between wires P and 2, there is no operation of any contactors or relays, since the retaining wire H6 remains energised.

6.48 CONTROLLER MOVED BACK FROM NOTCH '1' TO THE 'OFF' POSITION.

(a) The first action of the controller during this movement is to open the contact between wires P and P1 which de-energises wires F and F1 (or R and R1). This causes TL2 (or TL3) to open.

The following coils are therefore de-energised due to wire H2 (or H3) being de-energised: K_F (or K_R) and LB1, LB2 and LB3 standard magnet valve coils.

(b) The next action of the controller during this movement is to open the contact between wire P and wire 1 which therefore causes TL1 to open. This de-energises wire H6, and any resistance contactors which are closed will open. Also any of the coils of S1, S2, CLR'M', G, P, TR or F_F which are energised then become de-energised and the contactors will all open and F switch will remain in the full field position.

(c) The only coils now remaining energised are those of the exhaust valves of the line breakers.

6.49 REVERSE LEVER MOVED TO 'OFF' POSITION

With the controller handle in the 'off' position, the reverse lever may be moved to the 'off' position, which –

(i) de-energises wire H thus de-energising all the line breaker exhaust magnet valve coils,

(ii) locks the controller handle in the 'off' position,

(iii) renders the deadman's button inoperative,

(iv) allows the controller key to be turned and removed, thus locking the reverse lever in its 'off' position, consequently locking the whole controller.

6.50 REDUCED ACCELERATION

Depressing the 'Reduced Acceleration' button connects train line 5 to the supply P from the 'control MCB'. Through the control cut-out switch, wire 5A is energised, which supplies, through a series resistance, the reduced acceleration voltage coil of the current limit relay CLR'M' described in para 4.83, thus reducing the current 'drop-off' values.

At this reduced operating level the CLR'M' takes control of the sequence notching with the closing of RR1 instead of after the closing of R2 as described in 6.43C.

6.6 MOTORING WITH MOTORS CUT OUT

6.61 GENERAL NOTES

A The hand operated motor cut-out switch MCS can be set in any one of three positions depending on whether all traction motors are to be in the circuit or whether two motors are required to be cut out. These positions are as follows:

All motors in – Both double pole knife switches outwards.

6.61 GENERAL NOTES – *continued*

1–2 Motors cut out – The upper double pole knife switch moved down to the central position, with the other in its normal (outward) position.

3–4 Motors cut out – The lower double pole knife switch moved up to the central position, with the other in its normal (outward) position.

B Reference to drawing No. L.6352 will show that the MCS 1–2 'out', 3–4 'out' interlock between wires 2A and 3A will close when either pair of motors is cut out. This connects together train line 2 and train line 3, thus ensuring that normal coaches running in multiple unit with one on which a pair of motors is cut out cannot remain running in full series, but will progress to the full parallel position even when the controller handle is in position 'S'. Such precaution prevents overloading of the motors and starting resistances in use on the defective coach.

6.62 CONTROL CIRCUITS DURING NOTCHING WITH MOTORS CUT OUT

6.621 Controller in Notch '1'

The following magnet valves and relays are energised:

(i) Line breaker exhausts

(ii) LB1, LB2, LB3

(iii) S1, S2, FF

(iv) KF (or KR)

(v) TL1, TL2 (or TL3), CLR'M' series voltage coil.

6.622 Controller Handle in Notch 'S' or Notch 'P'

Progressive cutting out of resistance by the operation of the resistance contactors occurs under the control of CLR'M'. The progression takes place as described in 6.43 above.

When all resistance has been cut out of the circuit no further progression takes place since one of the MCS interlocks which is in the feed to the transition relay TR prevents it from being energised.

However, all normal coaches running in multiple unit with the coach on which motors are cut out, will continue their progression through transition and all the parallel steps up to full parallel, *no matter whether the controller is in notch 'S' or notch 'P'*.

6.623 Controller Handle in Notch WF

The field weakening switch F will, after all resistance has been removed from the circuit, move through the IF position to WF position under the control of CLR'M' as described in 6.45 above, except that the position relay PR will be energised from wire 4A as follows:

From wire 4A through the MCS interlock to the coil of PR.

The CLR'M' contacts complete the feed to wire 2E and thence to the F_W magnet valve coil from wire 4A via the MCS interlock to wire 4B, RR5 interlock to wire 2C and LB3 interlock to wire 2D.

SECTION 7

PROTECTIVE DEVICES

7.1 OVERLOAD RELAY OL1–OL2

This relay has two operating coils OL1 and OL2, the coils being inserted in the following circuits:

(a) OL1 for protecting the circuit of Nos.1 and 2 traction motors.

(b) OL2 for protecting the circuit of Nos.3 and 4 traction motors.

When motors are connected in series, the circuit of all the motors is protected by OL1.

The contacts of the overload relay are so arranged in the circuits of the line breaker normal and exhaust magnet valves as shown in Drawing L.6352, that when the overload relay trips, LB3 opens first, thus inserting the fault current limiting resistance LZ in the circuit before the fault current is finally broken by the opening of LB1 and LB2. The overload contacts open both normal and exhaust magnet valves of the line breakers, resulting in a very rapid operation.

After the overload relay trips, its reset coil cannot be energised until the controller is returned to the 'off' position. The line breakers cannot be closed until the relay is reset.

7.2 NO-CURRENT RELAY (NCR)

This relay has its coil in the circuit of Nos.1 and 2 motors, to ensure that, in the event of a failure in the power supply to the motors, all of the resistance contactors open, and the motor grouping contactors (P. S1, S2, G) revert to the positions they assume for running in series, and the field weakening cam switch F reverts to the full field position.

When power supply is restored and current again flows through the traction motor circuit, the equipment will notch up in proper sequence and under the control of the CLR'M'.

7.3 CONTROL CIRCUIT GOVERNOR

This is an air-operated switch connected to the brake pipe, so that when there is a reduction of brake pipe pressure its contacts open, thus interrupting the feed to wire F (or R) between the controller handle contacts and the reverse lever contacts.

7.3 CONTROL CIRCUIT GOVERNOR – *continued*

This feature ensures that the brake pipe pressure is sufficient for effective braking (*viz.* 62 lb./sq. in.) before power can be applied to the traction motors, and that the protective equipment (deadman device, and train trip) is cut in. It cuts off power in the event of reduction in brake pipe pressure due to:

(i) emergency application of the air brake,

(ii) operation of the deadman device,

(iii) operation of the train trip.

7.4 MECHANICAL INTERLOCKING OF THE MASTER CONTROLLER

7.41 REVERSE LEVER

(i) With the reverse lever in the 'off' position the controller handle is locked in the 'off' position, and the deadman's button is locked in the depressed position. The key, which is the Department's standard electric train controller key, may then be turned and removed, thus locking the reverse lever in this 'off' position.

(ii) With the key inserted and the controller unlocked, the reverse lever may be moved to either forward or reverse positions. In either of these positions the deadman's button is released, and must be grasped with the hand to prevent operation of this emergency feature.
The controller handle may then be moved from the 'off' position.

7.42 THE CONTROLLER HANDLE

(i) With the controller handle in the 'off' position the reverse lever is free to move and the deadman's button must be held depressed to prevent operation of the emergency feature when the reverse lever is in other than its 'off' position.

7.42 THE CONTROLLER HANDLE – *continued*

(ii) So long as the reverse lever is not in the 'off' position, the deadman's button must be grasped, *irrespective of the position of the controller handle*. An emergency application of the automatic brake is produced by releasing the deadman's button, the drop in brake pipe pressure causing the control circuit governor to open the feed from wire P to train line F (or R), thus opening the line breakers.

7.43 DEADMAN DEVICE

A description of the operation of the deadman device, controlled by the deadman's button, is given in para 8.30.

AIR BRAKE EQUIPMENT

8.1 GENERAL NOTE

The brake equipment is known as the Westinghouse Self-lapping Electro-Pneumatic Brake.

The brake normally used in service is an electrically-controlled compressed air brake (E.P. Brake) providing simultaneous and rapid application or release on all coaches, irrespective of the length of the train. This brake can be graduated in application or release by the driver's brake controller, and is self-lapping to give brake force according to the degree of handle movement, the self-lapping principle being illustrated diagrammatically on Drawing H.3515.

The Westinghouse Automatic Brake, which operates by reduction of pressure in a brake pipe continuous through the train, is added to the E.P. Brake. This allows normal automatic braking in the event of failure of the E.P. Brake. Emergency applications of this brake may be made by the driver's brake controller, the deadman's pilot valve, shunter's cock or guard's cock, by a break-away, or by operation of the train trip.

The Automatic Brake is so called because it applies the brake automatically in the event of a failure causing pressure to be lost from the brake pipe. It also provides for graduated service applications should the E.P. Brake be rendered inoperative for any reason.

Throughout this manual, the electrically-controlled brake is referred to as the '*E.P. Brake*'. The purely automatic portion which operates by reduction of brake pipe pressure is termed the '*Automatic Brake*'.

A line diagram of the air system for both motor coach and trailer coach is shown on Drawing L.6354.

8.2 and 8.3 PARTS OF THE AIR BRAKE EQUIPMENT

8.21 COMPRESSOR AND MAIN RESERVOIR

A type DHC3 motor-driven air compressor for operation at 1,500 volts D.C. is fitted to each motor coach. The motor and compressor are constructed as one unit. It is intended for normal intermittent running pumping against pressures up to 100 lb./sq. in., but can be allowed to run continuously without damage. The compressor handles 38 cubic feet of free air per minute.

8.21 COMPRESSOR AND MAIN RESERVOIR – *continued*

The machine has two cylinders giving two stages of compression. A suction strainer for cleaning the intake air, an intercooler and a safety valve between the two compression stages, and a silencer are supplied to work in conjunction with the machine.

One main reservoir is provided on each motor coach. Drain cocks are provided for the intercooler and for the main reservoir. Main reservoir safety valves are fitted to safeguard the system against excessive pressure. A tubular check valve is fitted before the main reservoir to act as a non-return valve from the reservoir.

The main reservoir is connected to a main reservoir pipe which is continuous throughout the train. The compressor and main reservoir on each motor coach can be isolated from the main reservoir pipe by a cock, if required, for maintenance or any other reason.

A compressor governor, as described in 5.12 above, is fitted for each compressor. An isolating cock is provided for each governor.

8.22 DRIVER'S BRAKE CONTROLLER AND EQUALISING RESERVOIR

The driver's brake controller in each motor coach driving compartment provides control for both the E.P. brake and the automatic brake.

The driver's brake controller handle has six positions as follows:

1. Release and Running.
2. Rheostatic (not used on these coaches).
3. Full Service, E.P.
4. Lap.
5. Service, automatic.
6. Emergency (E.P. and automatic).

In position 1 the brakes are fully released and in Position 3 maximum E.P. braking is obtained. A full E.P. application gives a brake cylinder pressure of approximately 56 lb./sq. in.

8.22 DRIVER'S BRAKE CONTROLLER AND EQUALISING RESERVOIR – *continued*

Movement of the handle between positions 2 and 3 provides self-lapping E.P. braking in application or release according to the degree of handle movement. The principle of operation of the brake controller between these positions is shown on Drawing H.3515.

Positions 4 and 5 are used for automatic braking. Movement of the handle from position 1, direct to position 4 brings the brake valve to lap position ready for automatic braking.

To make an automatic application, the handle is then moved to position 5 until the required braking is obtained, after which it is moved back to position 4. For release of the automatic brake the handle must be moved to position 1 and left there until the brakes are fully released. In normal operation, movement of the handle from position 4 (lap) direct to position 1 (release) does not apply the E.P. brake.

In position 6 – the emergency – the E.P. brake and the automatic brake apply together. A more rapid and slightly higher brake cylinder pressure is available than would be the case if the E.P. or automatic brake was applied separately, the governing factor being the brake cylinder safety valve.

8.23 REDUCING VALVE

The purpose of this valve is to feed air from the main reservoir through the driver's brake valve to the brake pipe at a predetermined maximum brake pipe pressure of 77 lb./sq. in. for use with the automatic brake.

8.24 EQUALISING DISCHARGE VALVE

This valve (combined with the driver's brake valve) is for relaying to the brake pipe reductions of pressure made in the equalising reservoir by the automatic part of the driver's brake controller. The use of this equalising discharge valve and its associated equalising reservoir ensures smooth operation of the triple valves at the forward end of the train, and also makes the control of the automatic brake independent of the length of the train when operated by the driver's brake controller for service (automatic) applications.

8.25 DRIVER'S BRAKE CONTROLLER ISOLATING VALVE AND SWITCH

This combined valve and switch is 'opened' in the operative driving position only and serves to:

(i) Admit main reservoir air to the reducing valve for charging the brake pipe.

(ii) Admit brake cylinder air to the self-lapping mechanism of the E.P. portion of the driver's brake controller.

(iii) Make the electrical circuits for operation of the E.P. brake.

(iv) Connect the equalising reservoir to the equalising discharge valve of the driver's brake valve.

In non-operative driving positions the isolating valve and switch is 'closed' to:

(i) Isolate the main reservoir air and brake cylinder air from the brake controller.

(ii) Isolate the equalising reservoir from the driver's brake valve.

(iii) Isolate the electrical supply from the E.P. brake.

Note: The electrical circuits are 'made' when the valve is 'open'.

8.26 E.P. BRAKE UNIT

An E.P. brake unit is provided on each motor coach and each trailer coach and comprises magnet valves and other equipment described below for operating the E.P. brake and the Automatic brake.

During E.P. braking, electrical contacts on the driver's brake controller, when operated by movement of the brake controller handle, control the energising and de-energising of the magnet valves which control the application and release of the brakes. Compressed air for brake applications is taken direct from the main reservoir pipe, which is continuous throughout the train.

8.26 E.P. BRAKE UNIT – *continued*

Fittings which make up the complete E.P. brake unit are as follows:

8.261 Holding Magnet Valve

The holding magnet valve is energised from the control MCB via the isolating switch E.P.S., wire BP, the driver's brake controller isolating valve switch and train line BR. The return circuit of the holding magnet valve coil is made through train line BH to the holding contacts of the brake application relay on the control coach and thence to earth E via wire BN and the driver's brake controller isolating valve switch.

Energising the holding magnet valve closes the brake cylinder exhaust.

8.262 Application Magnet Valve

The application magnet valve is energised from train line BR as described for the holding magnet valve. The return circuit of the application magnet valve coil is made through train line BA to the application contact of the brake application relay and thence to earth E as in 8.261 above.

Energising the application magnet valve admits main reservoir air into the brake cylinder.

8.263 Limiting Valve

This valve limits the brake cylinder pressure to a predetermined maximum during E.P. braking.

8.264 Positive Acting Check Valve

This prevents flow back of brake cylinder air to atmosphere through the application magnet valve when the latter is de-energised after an application sequence.

8.265 Triple Valve and its Stabilising Valve

A triple valve is used in the normal way with the automatic brake.

8.265 Triple Valve and its stabilising Valve – *continued*

The stabilising valve ensures that when the E.P. brake is released, the triple valve slide valve is returned to release position should it have inadvertently moved to a lap position.

8.266 Brake Cylinder Safety Valve

To limit the maximum brake cylinder pressure which can be obtained, a safety valve is fitted to the brake cylinder. This becomes necessary if an E.P. application and an automatic application are made simultaneously, such as by an emergency application.

8.27 BRAKE APPLICATION RELAYS

These relays are in circuit between the electrical contacts of the driver's brake controller and the magnet valves of the E.P. brake units. The brake controller contacts carry only sufficient current to operate the relays and are not subjected to the electrical loading of the E.P. unit magnet valves. Relays, mounted in the space behind the headlight, are fitted for each driver's brake controller.

8.28 BRAKE CYLINDER AND AUXILIARY RESERVOIR

One 18-inch brake cylinder is fitted to each motor coach and one 14-inch brake cylinder is fitted to each trailer coach. Each cylinder, which operates the brake blocks on that coach through rigging, has a slack adjuster to compensate for brake block wear and to maintain the piston travel between close limits. The slack adjuster is operated by brake cylinder air.

The auxiliary reservoir on each coach is charged with compressed air from the brake pipe when the triple valve is in the release position.

8.29 LOW PRESSURE SIGNAL

The low pressure signal is located at the lower edge of the driving window on each motor coach. It is connected to the main reservoir pipe, and indicates when the air pressure has dropped below a predetermined value. This gives a *visual* warning to the driver when this pressure is below its minimum setting.

8.30 AIR OPERATED SAFETY APPARATUS

The components comprising the air-operated safety apparatus are as follows, *viz*:

The emergency application valve.
The pilot or deadman's valve.
The trip valve.
The control circuit governor (see paragraph 4.74).
The safety apparatus isolating cock.

8.301 Emergency application Valve

An emergency application valve for each motor coach is connected to the brake pipe and to a deadman's pilot valve incorporated in the master controller.

8.302 Pilot or Deadman's Valve

The handle of the master controller is fitted with a plunger (deadman's button) which operates a pilot valve connected to the air brake equipment. The pilot valve is normally held closed by the driver by his operation of the master controller, but should he become incapacitated or take his hand from the controller with the reverse lever in any but the 'off' position the pilot valve is released to open, thereby operating the emergency application valve to vent the brake pipe which –

(i) causes an emergency application of the brakes,

(ii) causes the control governor to open its contacts thus ensuring that the line breakers are open.

8.303 Trip Valve

The trip valve is fitted on the left hand leading axle box (the same axle box as the speedometer generator) of each motor coach. The trip valve is 'set' when the valve is closed and the tripping handle is pointing vertically downwards. The operating handle of the safety apparatus isolating cock is connected to the trip valve handle by a wire connection.

8.304 Safety Apparatus Isolating Cock

(a) This cock, which is located on the left hand side of the motor coach immediately under the driver's window, is connected to the brake pipe. By enclosing this cock the air-operated safety apparatus is isolated and all air in the emergency application valve, control governor, and trip gear is exhausted.

(b) When, owing to a defect in the air-operated safety apparatus, it is necessary to close this cock, the train cannot be driven from that cab unless the control circuit governor cut-out switch is held depressed. The driver must obtain the assistance of the guard or other competent employee to perform this duty.

8.31 GAUGES

Two gauges are provided in every driving compartment:

(i) A duplex gauge indicating:
  (a) main reservoir pressure;
  (b) brake pipe pressure.

(ii) A single gauge, mounted above the duplex gauge, indicating brake cylinder pressure.

A pantograph storage reservoir gauge is mounted in the auxiliary control cupboard adjacent to the pantograph E.P. valve.

A control reservoir gauge is mounted on the underframe near the control reservoir.

A brake cylinder gauge is mounted on the underframe of each trailer coach, so that any necessary inspection or adjustment to the E.P. brake unit valves can be made without moving the unit from the coach.

A gauge indicating brake pipe pressure is mounted adjacent to the guard's valve in each guard's compartment.

8.32 GUARD'S VALVE

Each guard's compartment is provided with a guard's valve connected to the brake pipe. When opened, it vents the brake pipe to cause an emergency application of the Automatic Brake.

8.33 SHUNTER'S VALVE, HOSE COUPLINGS AND COCKS

Hose couplings are provided at each end of the coaches to make a continuous brake pipe and a continuous main reservoir pipe throughout the train. The brake pipe coupling cock at one end of each trailer coach is fitted with a side connection to the shunter's valves which are mounted on the outside of the coach adjacent to the doorways at that end. These shunter's valves vent the brake pipe when operated, thus making an emergency application of the Automatic Brake. When the coupling cock is open, these valves are isolated, and thus are only operative at the end of a train or unit at which the coupling cock is shut.

The electrical connections for the E.P. Brake are included in the train cable jumpers between the coaches (train lines, BR, BH and BA).

8.34 CONTROL AND PANTOGRAPH EQUIPMENT

Cocks, check valve, strainer, pantograph storage reservoir and gauge are included in the pantograph equipment, together with a hand operated two stage compressor. The hand operated compressor is used to raise the pantograph only if pantograph storage or main reservoir pressure is not available.

Cocks, dirt collector, strainers, reducing valve, check valve and control reservoir are included in the air equipment for supplying air to the equipment cases.

One pressure gauge, mounted in the auxiliary equipment cupboard, indicates pressure in the pantograph storage reservoir, and another, mounted on the underframe, indicates the control reservoir pressure.

8.35 SUPPLEMENTARY RESERVOIR

Each trailer coach is fitted with a supplementary main reservoir to give local capacity to the main reservoir system.

SECTION 9

OPERATING INSTRUCTIONS

9.1 PREPARATION FOR SERVICE

The relevant portions of Instruction No.78(a) and 78(b) as set out in the book of Instructions to Electric Train Drivers, Guards, Shunters and other employees engaged in the operation of Electric Trains (304/48) must be complied with in the preparation of trains as described below.

9.11, 9.12 MULTIPLE UNIT TRAIN

The electric train driver must commence the preparation of the train at the end from which the train is to be driven to the platform. This end is referred to as the 'front' of the train for the purpose of preparation. The train must be prepared in the sequence set out in paragraphs 9.111–9.121.

9.111 Set up the front motor coach

(i) *Close* the safety apparatus isolating cock and see that the handle of trip valve is raised thereby.

(ii) Check that the main (I.S.) and auxiliary (A.I.S.) isolating switches are closed.

These switches are housed in the H.T. (upper) section of the auxiliary equipment cupboard and are accessible from the guard's compartment by unlocking the interlock gear with a controller key and operating the pantograph interlock cock. After checking the switches, the H.T. portion of the cupboard should be locked and interlocked, and the key withdrawn.

(iii) Check that the auxiliary H.T. circuit breaker (MB) is closed.
The operating handle for this breaker is on the face of the auxiliary equipment cupboard in the driver's cab.

9.111 Set up the front motor coach – *continued*

(iv) (a) Check that the following MCB's are closed:

LT BUS

Coach Lights.

(b) Check that the following isolating switches are closed.

MG trip isolating switch (MGTS)

MG set isolating switch (MGSS)

Compressor isolating switch (CCS)

Compressor governor isolating switch (GS)

E.P. brake isolating switch (EPS)

Pantograph lower isolating switch (PDS)

Pantograph raise isolating switch (PUS)

(c) Check that the control cut-out switch is closed.

These MCB's and switches are in the auxiliary equipment cupboard, accessible from the driver's cab. The door of this cupboard can be unlocked with a carriage key.

(v) Trip the contactor MG by hand.

(vi) Raise the pantograph as follows:

(a) If the main reservoir gauge shows not less than 45 lb./sq. in., operate the pantograph E.P. valve by hand, thus raising the pantograph.

(b) If there is insufficient air in the main reservoir system, open the pantograph reservoir diaphragm cock and then operate the pantograph E.P. valve by hand, thus raising the pantograph.

When the pantograph is raised in accordance with (a) or (b) above and is at rest in contact with the overhead, close the contactor MG and the MCB 'supply train line'.

The M-G set will start and the 'supply' indicator lamp will light and the compressor will start up after the M-G set.

(c) If instruction (vi) (b) cannot be carried out because of insufficient air being available from the pantograph storage reservoir, then –

9.111 Set up the front motor coach (vi) (c) – *continued*

Place the hand pump isolating cock to 'Hand Pump' and disengage the hand pump from its housing clips and pump until the pantograph is raised.

The pantograph air equipment is housed in the lowest portion of the auxiliary equipment cupboard accessible from the driver's cab behind a door locked with a carriage key.

When the pantograph is raised and is at rest against the contact wire, close the contactor MG and close the MCB 'supply train line'.

The M-G set will start and the 'supply' indicator lamp will light, and the compressor will start up after the M-G set. Several additional strokes of the hand pump will be necessary to keep the pantograph against the contact wire until the main reservoir system has built up to at least 45 lb./sq. in – shown on the duplex gauge.

When this pressure is reached, the hand pump isolating cock should be set to 'Main Reservoir' position, and the hand pump telescoped and housed.

(vii) When the compressor cuts out, check that the main reservoir system is charged to 100 lb./sq. in. The pantograph storage reservoir gauge should also read 100 lb./sq. in. With this pressure in the storage reservoir, close the pantograph reservoir diaphragm cock, thus sealing off a supply of air for future raising of the pantograph.

(viii) Check that the handbrake is applied.

(ix) Place the driver's brake controller handle in Position 1 – Release and Running – and see that the driver's brake controller isolating valve and switch is *closed.*

(x) Open the MCB 'control'.

9.111 Set up the front motor coach – *continued*

(xi) Unlock the master controller, check that it is free to operate to all positions (including a check to see that the deadman's button will release). Then lock the master controller and withdraw the key.

(xii) Close MCB 'Auxiliary control' and push the button marked 'Remote Set'.

(xiii) Close MCB 'end lights' and check that the following lights are produced by operation of the appropriate switches:

Van lights.
Instrument lights.
Marker lights.
Destination sign lights.

Close MCB 'headlight' and check the operation of the headlight and its dimming.

Note: Set up front end lights as required.

(xiv) See that the driver's seat, rear vision mirror and whistle are in good order, and check that the bell switches operate and that the van equipment is in order.

(xv) Take the switch stick and leave the guard's compartment on the driver's side. View the pantograph from that side of the train, to see that satisfactory contact is being made with the overhead.

(xvi) Go around the front end of the train, and check that:

(a) brake pipe and main reservoir cocks are closed,

(b) hoses are coupled to dummy couplings,

(c) the automatic coupling is in order, and the knuckle is open,

(d) train cable and bus line sockets are in order,

(e) markers are in order.

9.112 Proceed to next motor coach

Walk along the train, on the side opposite to the driving cab, towards the rear, and en route to the next motor coach of the train carry out the following procedure:

(i) View the pantograph again.

(ii) See that the control reservoir gauge reads 70 lb./sq. in.

(iii) Check that the lighting of each coach of the front unit is working.

(iv) Check that each automatic brake cut-out cock and each E.P. brake unit isolating cock on this side of the train is open.

(v) Drain each main reservoir and each supplementary main reservoir and each compressor intercooler on this side of the train.

(vi) Check the couplings and connections and make a superficial examination of the undergear on this side of the train.

If this motor coach is intermediate, follow the procedure set out in 9.113 and 9.114, but if this motor coach is at the rear of the train, carry out at this stage the procedure set out in 9.115.

9.113 Set up each intermediate motor coach

(i) *Close* the safety apparatus isolating cock and see that the handle of the trip valve is raised thereby.

9.113 Set up each intermediate motor coach – *continued*

(ii) Check that the main (I.S.) and Auxiliary (A.I.S.) isolating switches are closed.

(iii) Check that the auxiliary H.T. circuit breaker (MB) is closed.

(iv) (a) Check that the following MCB's are closed:

L.T. Bus
Coach lights.

(b) Check that the following isolating switches are closed:

MGTS
MGSS
CCS
GS
EPS
PDS
PUS

(c) Check that the control cut-out switch is closed.

(v) Trip the contactor MG by hand.

(vi) Raise the pantograph by operating the pantograph E.P. valve by hand. When the pantograph is raised and at rest against the contact wire close the contactor MG but do *NOT* close MCB 'supply train line'.

The 'supply' indicator lamp should already be alight and the M-G set will start up.

(vii) Check that the pantograph storage reservoir gauge shows 100 lb./sq.in. If not, then recharge the reservoir to that pressure.

(viii) Release and secure the handbrake.

(ix) Place the driver's brake controller handle in Position 1 – Release and Running – and see that the driver's brake controller isolating valve and switch is *closed.*

(x) Open MCB 'control'.

9.113 Set up each intermediate motor coach – *continued*

(xi) Unlock and test the master controller, then lock the master controller and withdraw the key.

(xii) Close MCB 'end lights' and check that the following lights are produced by operation of the appropriate switches:

Van lights.

Instrument lights.

Marker lights.

Destination sign lights.

Close MCB 'headlight' and check the operation of the headlight and its dimming.

Note: All end lighting switches should be left 'off' with the red–white two way marker light switch in the 'white' position.

(xiii) See that the driver's seat, rear vision mirror and whistle are in good order, and check that the bell switches operate and that the van equipment is in order.

9.114 Proceed from each intermediate motor coach

Walk along the train on the side opposite to the front driving cab towards the rear, and en route to the next motor coach of the train, carry out the following procedure:

(i) View the pantograph.

(ii) See that the control reservoir pressure gauge reads 70 lb./sq. in. if on this side of the train.

(iii) Check that the lighting of each coach of this unit is working.

9.114 Proceed from each intermediate motor coach – *continued*

(iv) Check that each automatic brake cut-out cock and each E.P. brake unit isolating cock on this side of the train is open.

(v) Drain each main reservoir and each supplementary main reservoir and each compressor intercooler on this side of the train.

(vi) Check the couplings and connections and make a superficial examination of the undergear on this side of the train.

If this motor coach is again intermediate, repeat the procedure set out in 9.113 and 9.114, but if this motor coach is at the rear of the train, carry out the procedure set out in 9.115.

9.115 Set up the rear motor coach

(i) *Open* the safety apparatus isolating cock and see that the handle of the trip valve is set thereby.

(ii) Check that the main (I.S.) and auxiliary (A.I.S.) isolating switches are closed.

(iii) Check that the auxiliary H.T. circuit breaker (MB) is closed.

(iv) (a) Check that the following MCB'S are closed:

L.T. Bus
Coach Lights.

(b) Check that the following isolating switches are closed:

MGTS
MGSS
CCS
GS
EPS
PDS
PUS

(c) Check that the control cut-out switch is closed.

(v) Trip the contactor MG by hand.

9.115 Set up the rear motor coach – *continued*

(vi) Raise the pantograph by operating the pantograph E.P. valve by hand. When the pantograph is raised and at rest against the contact wire close the contactor MG but do *NOT* close MCB 'supply train line'.

(vii) Check that the pantograph storage reservoir gauge shows 100 lb./sq. in. If not, then recharge the reservoir to that pressure. Check that the pantograph reservoir diaphragm cock is screwed shut.

(viii) Release and secure the handbrake.

(ix) Place the driver's brake controller handle in Position I – Release and Running – and *open* the driver's brake controller isolating valve and switch.

(x) Check that the brake pipe pressure builds up to 77 lb./sq. in. and that the brake cylinder pressure gauge reads zero.

(xi) Open the MCB 'control'.

(xii) Unlock and test the master controller. Then lock the master controller and withdraw the key.

(xiii) Close MCB 'end lights' and check that the following lights are produced by operation of the appropriate switches:

Van lights.
Instrument lights.
Marker lights.
Destination sign lights.

Close MCB 'headlight' and check the operation of the headlight and its dimming.

Note: Leave 'on':

Van lights.
Red marker lights.
Destination sign lights.

(xiv) See that the driver's seat, rear vision mirror and whistle are in good order, and check that the bell switches operate and that the van equipment is in order.

9.116 Test the rear motor coach

(i) Apply the automatic air brake by moving the driver's brake controller handle to position V – Service Application – and when the brake pipe gauge shows a reduction of about 10 lb./sq. in., return the handle to position IV – Lap.

(ii) Check that brake pipe pressure remains steady at this reduced valve and that the brake cylinder pressure has risen to a value appropriate to the reduction in brake pipe pressure.

Note: When the brake controller handle is returned to position IV – Lap, brake pipe air will continue to exhaust due to the action of the equalising discharge valve. Gauge pressure, however, should remain steady since the gauge is connected to the equalising reservoir with which the brake pipe pressure eventually equalises.

(iii) Move the handle again to position V – Service Application – and continue to reduce brake pipe pressure until a total reduction of 20 lb./sq. in. has been made. Then move the handle back again to position IV – Lap.

(iv) Check that the brake pipe pressure again remains steady and that the brake cylinder pressure has increased to approximately 56 lb./sq. in.

(v) Release the brake.

(vi) Throw the brake controller handle to position VI – Emergency.

(vii) Check that brake pipe pressure falls to zero and brake cylinder pressure rises rapidly to about 56 lb./sq. in.

(viii) Release the brake, and note that the compressors cut in as the main reservoir pressure falls to 87 lb./sq. in. and cut out again when it has risen to 100 lb./sq. in. (Verify that the compressor on this coach is working.)

9.116 Test the rear motor coach – *continued*

(ix) Switch on the MCB 'control' and note that the brake indicating lamp lights.

(x) Make a partial E.P. application by putting the brake controller handle midway between position II – Rheostatic, and position III – Full E.P.

Check that brake cylinder pressure builds up a corresponding amount (about 20–30 lb./sq. in).

(xi) Partially release the E.P. brake and note that the brake cylinder pressure falls a corresponding amount.

(xii) Move the brake controller handle to position III – Full E.P.
Check that brake cylinder pressure builds up to about 56 lb./sq. in.

(xiii) Release the brake and check that the pressure gauges read:

Main reservoir: 87 to 100 lb./sq. in.
Brake pipe: 77 lb./sq. in.
Brake cylinder: zero.

(xiv) Test the guard's brake valve.

(xv) *Close* the driver's brake controller isolating valve and switch and open the MCB 'control'.

(xvi) Lock the cab door.

(xvii) Apply the brake by operating the trip valve.

(xviii) *Close* the safety aparatus isolating cock and see that the trip valve handle is raised thereby. Reset the trip valve.

(xix) View the pantograph.

(xx) Go around the rear of the train and check that:

(a) brake pipe and main reservoir cocks are properly closed,

(b) hoses are coupled to dummy couplings,

9.116 Test the rear motor coach – *continued*

(c) the automatic coupling is in order and the knuckle is open,

(d) train cable and bus line sockets are in order,

(e) markers are in order.

9.117 Return to next motor coach

Walk along the train, on the same side as the front driving cab, towards the front of the train, and en route to the next motor coach of the train, carry out the following procedures:

(i) View the pantograph again.

(ii) See that the control reservoir gauge reads 70 lb./sq. in.

(iii) Check that the lighting of each coach is working.

(iv) Check that each automatic brake cut-out cock and each E.P. brake unit isolating cock on this side of the train is open.

(v) Drain each main reservoir and each supplementary main reservoir and each compressor intercooler on this side of the train.

(vi) Check the couplings and connections and make a superficial inspection of the undergear on this side of the train.

(vii) Check that the brake on each coach is applied and that none of the brake cylinder pistons is unduly extended.

(viii) On arrival at the motor coach *open* the safety apparatus isolating cock, and see that the handle of the trip valve is set thereby.

9.117 Return to next motor coach – *continued*

If this motor coach be intermediate, follow the procedure set out in 9.118 and 9.119, but if this motor coach be at the front of the train, carry out at this stage the procedure set out in 9.120.

9.118 Test each intermediate motor coach

(i) *Open* the driver's brake controller isolating valve and switch.

(ii) Apply the automatic brake by moving the driver's brake controller handle to position V – Service Application – and when the brake pipe gauge shows a reduction of about 10 lb./sq. in., return the handle to position IV – Lap.

(iii) Check that brake pipe pressure remains steady at this reduced value.

(iv) Move the handle again to position V – Service Application – and continue to reduce brake pipe pressure until a total reduction of 20 lb./sq. in. has been made. Then move the handle back again to position IV – Lap.

(v) Check that the brake pipe pressure again remains steady and that the brake cylinder pressure has increased to approximately 56 lb./ sq. in.

(vi) Release the brake.

(vii) Throw the brake controller handle to position VI – Emergency.

(viii) Check that the brake pipe pressure falls to zero and brake cylinder pressure rises rapidly to about 56 lb./sq. in.

(ix) Release the brake and note that the compressors cut in when the main reservoir pressure falls to 87 lb./sq. in. and cut out again when it has risen to 100 lb./sq. in. (Verify that the compressor on this coach is working.)

(x) Switch on the MCB 'control' and note that the brake indicating lamp lights.

9.118 Test each intermediate motor coach – *continued*

(xi) Make a partial E.P. application by putting the brake controller handle midway between position II – Rheostatic and position III – Full E.P.
Check that the brake cylinder pressure builds up to a corresponding amount (about 20–30 lb./sq. in.).

(xii) Partially release the E.P. brake and note that the brake cylinder pressure falls a corresponding amount.

(xiii) Move the brake controller handle to position III – Full E.P. Check that the brake cylinder pressure builds up to about 56 lb./sq. in.

(xiv) Release the brake and check that the pressure gauges read:
Main reservoir: 87 to 100 lb./sq. in.
Brake pipe: 77 lb./sq. in.
Brake cylinder: zero.

(xv) Test the guard's brake valve.

(xvi) *Close* the driver's brake controller isolating valve and switch and open the MCB 'control'.

(xvii) Lock the cab door.

(xviii) Apply the brake by operating the trip valve.

(xix) *Close* the safety apparatus isolating cock and see that the trip valve handle is raised thereby. Reset the trip valve.

(xx) View the pantograph.

(xxi) Lock the van doors.

9.119 Return from each intermediate motor coach

Walk along the train on the same side as the front driving cab, towards the front of the train, and en route to the next motor coach carry out the following procedure.

(i) View the pantograph.

9.119 Return from each intermediate motor coach – *continued*

(ii) See that any control reservoir gauge on this side of the train reads 70 lb./sq. in.

(iii) Check that the lighting of each coach is working.

(iv) Check that each automatic brake cut-out cock and each E.P. brake isolating cock on this side of the train is open.

(v) Drain each main reservoir and each supplementary main reservoir and each compressor intercooler on this side of the train.

(vi) Check the couplings and connections and make a superficial inspection of the undergear on this side of the train.

(vii) Check that the brake on each coach is applied and that none of the brake cylinder pistons is unduly extended.

(viii) On arrival at the motor coach, *open* the safety apparatus isolating cock and see that the handle of the trip valve is set thereby.

If this motor coach is again an intermediate motor coach, repeat the procedure set out in 9.118 and 9.119, but if this motor coach is at the front of the train, carry out the procedure set out in 9.120.

9.120 Test the front motor coach

(i) Test the trip valve and reset it then replace the switch stick.

(ii) Open the driver's brake controller isolating valve and switch.

9.120 Test the front motor coach – *continued*

(iii) Apply the automatic brake by moving the driver's brake controller handle to position V – Service Application – and when the brake pipe gauge shows a reduction of about 10 lb./sq. in., return the handle to position IV – Lap.

(iv) Check that the brake pipe pressure remains steady at this reduced value.

(v) Move the handle again to position V – Service Application – and continue to reduce brake pipe pressure until a total reduction of 20 lb./sq. in. has been made. Then move the handle back again to position IV – Lap.

(vi) Check that the brake pipe pressure again remains steady, and that the brake cylinder pressure has increased approximately to 56 lb./sq. in.

(vii) Release the brake.

(viii) Throw the brake controller handle to position VI – Emergency.

(ix) Check that the brake pipe pressure falls to zero and brake cylinder pressure rises rapidly to about 56 lb./sq. in.

(x) Release the brake and note that the compressors cut in when the main reservoir pressure falls to 87 lb./sq. in., and cut out again when it has risen to 100 lb./sq. in.

(xi) Close the MCB 'control' and note that the brake indicating lamp lights.

(xii) Make a partial E.P. application by putting the brake controller handle midway between position II – Rheostatic and position III – Full E.P. Check that the brake cylinder pressure builds up to a corresponding amount (about 20–30 lb./sq. in.).

(xiii) Partially release the E.P. brake and note that the brake cylinder pressure falls a corresponding amount.

9.120 Test the front motor coach – *continued*

(xiv) Move the brake controller handle to position III – Full E.P. Check that the brake cylinder pressure builds up to about 56 lb./sq. in.

(xv) Release the brake and check that the pressure gauges read:

Main reservoir: 87 to 100 lb./sq. in.

Brake pipe: 77 lb./sq. in.

Brake cylinder: zero.

(xvi) Test the guard's brake valve.

9.121 Test the whole train as follows:

(i) Push the button marked 'Remote Trip' (the lights will go out).

(ii) Push the button marked 'Pantograph Lower'.

(iii) Trip contactor MG by hand.

(iv) View the pantographs.

(v) Raise the front pantograph by operating the pantograph E.P. valve by hand.

(vi) When the pantograph is at rest in contact with the overhead, close the contactor MG by hand.

(vii) When the 'supply' indicating lamp lights push the button marked 'Panto Raise'.

(viii) View the other pantographs.

(ix) If lighting is required push button marked 'Remote Set'.

(x) Unlock the master controller and cautiously move the train forward, stopping it by releasing the deadman's button. As soon as the train stops, grasp the deadman's button which will prevent further escape of main reservoir air through the feed valve to the vented brake pipe.

9.121 Test the whole train as follows – *continued*

(xi) With the brake pipe again charged to 77 lb. sq./in., make a partial E.P. application by moving the brake controller handle to halfway between positions II – Rheostatic and III – Full E.P.

(xii) The employee assisting the driver must now walk along the side of the train to the rear van, examining each coach in passing to see that the brake has applied.

(xiii) On arrival at the rear end of the train, the employee must signal the driver to release the brake by using the signalling bell and the code '1 pause 2 pause 1' given in 9.341.

(xiv) The driver must then place the brake controller handle in position I – Release and Running.

(xv) The employee must then test, release and secure the hand brake of the rear van.

(xvi) The employee must then make a reduction of at least 20 lb./sq. in. in the brake pipe pressure by means of the guard's brake valve in the rear van, and after closing it, see that the pressure rises in the van gauge.

(xvii) The driver, on receiving the set back signal from the employee, must move the train back cautiously and stop it by using the driver's brake controller.

If the above procedure has revealed no fault, the train is ready to proceed.

9.13 SINGLE UNIT TRAIN

9.131 Set up the motor coach

(i) *Close* the safety apparatus isolating cock and see that the handle of trip valve is raised thereby.

(ii) Check that the main (I.S.) and auxiliary (A.I.S.) isolating switches are closed.

9.131 Set up the motor coach – *continued*

These switches are housed in the H.T. (upper) section of the auxiliary equipment cupboard and are accessible from the guard's compartment by unlocking the interlock gear with a controller key and operating the pantograph interlock cock. After checking the switches, the H.T. portion of the cupboard should be locked and interlocked, and the key withdrawn.

(iii) Check that the auxiliary H.T. circuit breaker (MB) is closed.
The operating handle for this breaker is on the face of the auxiliary equipment cupboard in the driver's cab.

(iv) (a) Check that the following MCB's are closed:

LT Bus

Coach Lights.

(b) Check that the following isolating switches are closed:

MG trip isolating switch (MGTS)

MG set isolating switch (MGSS)

Compressor isolating switch (CCS)

Compressor governor isolating switch (GS)

E.P. brake isolating switch (EPS)

Pantograph lower isolating switch (PDS)

Pantograph raise isolating switch (PUS)

(c) Check that the control cut-out switch is closed.

These M.C.B.'s and switches are in the auxiliary equipment cupboard, accessible from the driver's cab. The door of this cupboard can be unlocked with a carriage key.

(v) Trip the contactor MG by hand.

9.131 Set up the motor coach – *continued*

(vi) Raise the pantograph as follows:

(a) If the main reservoir gauge shows not less than 45 lb./sq. in., operate the pantograph E.P. valve by hand.

(b) If there is insufficient air in the main reservoir system, open the pantograph reservoir diaphragm cock and then operate the pantograph E.P. valve by hand, thus raising the pantograph.

When the pantograph is raised in accordance with (a) or (b) above and is at rest in contact with the overhead, close the contactor MG and the MCB 'supply train line'.

The M-G set will start and the 'supply' indicator lamp will light and the compressor will start up after the M-G set.

(c) If instruction (vi) (b) cannot be carried out because of insufficient air being available from the pantograph storage reservoir, then- Place the hand pump isolating cock to 'Hand Pump' and disengage the hand pump from its housing clips and pump until the pantograph is raised.

The pantograph air equipment is housed in the lowest portion of the auxiliary equipment cupboard accessible from the driver's cab behind a door locked with a carriage key.

When the pantograph is raised and is at rest against the contact wire, close the contactor MG and close the MCB 'supply train line'.

9.131 Set up the motor coach – *continued*

The M-G set will start and the 'supply' indicator lamp will light, and the compressor will start up after the M-G set. Several additional strokes of the hand pump will be necessary to keep the pantograph against the contact wire until the main reservoir system has built up to at least 45 lb./sq. in. – shown on the duplex gauge.

When this pressure is reached, the hand pump isolating cock should be set to 'Main Reservoir' position, and the hand pump telescoped and housed.

(vii) When the compressor cuts out, check that the main reservoir system is charged to 100 lb./sq. in. The pantograph storage reservoir gauge should also read 100 lb./sq. in. With this pressure in the storage reservoir, close the pantograph reservoir diaphragm cock, thus sealing off a supply of air for future raising of the pantograph.

(viii) Check that the hand brake is applied.

(ix) Place the driver's brake controller handle in position I – Release and Running – and see that the driver's brake controller isolating valve and switch is *closed.*

(x) Open the MCB 'control'.

(xi) Unlock the master controller, check that it is free to operate to all positions (including a check to see that the deadman's button will release). Then lock the master controller and withdraw the key.

(xii) Close MCB 'Auxiliary control' and push the button marked 'Remote Set'.

(xiii) Close MCB 'end lights' and check that the following lights are produced by operation of the appropriate switches:

Van lights.
Instrument lights.
Marker lights.
Destination sign lights.

9.131 Set up the motor coach – *continued*

Close the MCB 'headlight' and check the operation of the headlight and its dimming.

Note: Set up front 'end lights' as required.

(xiv) See that the driver's seat, rear vision mirror and whistle are in good order, and check that the bell switches operate and that the van equipment is in order.

(xv) Open the driver's brake controller isolating valve and switch, charge the brake pipe to 77 lb./sq. in., and close the brake controller isolating valve and switch.

(xvi) Take the switch stick and leave the guard's compartment on the driver's side. View the pantograph from that side of the train, to see that satisfactory contact is being made with the overhead.

(xvii) Go around the front end of the train, and check that:

(a) brake pipe and main reservoir cocks are closed,

(b) hoses are coupled to dummy couplings,

(c) the automatic coupling is in order, and the knuckle is open,

(d) train cable and bus line sockets are in order,

(e) markers are in order.

9.132 Proceed to the rear of the unit

Walk along the train, on the side opposite to the driving cab, towards the rear, and en route carry out the following procedure:

(i) View the pantograph again.

9.132 Proceed to the rear of the unit – *continued*

(ii) See that the control reservoir gauge reads 70 lb./sq. in.

(iii) Check that the lighting of each coach of the unit is working.

(iv) Check that each automatic brake cut-out cock and each E.P. brake unit isolating cock on this side of the train is open.

(v) Drain each supplementary main reservoir on that side of the train.

(vi) Check the couplings and connections and make a superficial examination of the undergear on this side of the train.

9.133 At the rear of the unit

(i) Apply the brake by means of the brake pipe cock.

(ii) Check that:

(a) brake pipe and main reservoir cocks are closed,

(b) the automatic coupling is in order and the knuckle is open,

(c) train cable and bus line couplings are in order and that the end of the train cable jumper is inserted in the dummy socket.

9.134 Return to the motor coach

Walk along the train, on the same side as the driving cab, towards the front of the unit. En route carry out the following procedure:

(i) Check that the lighting of each coach of the unit is working.

(ii) Check that each automatic brake cut-out cock and each E.P. brake unit isolating cock on this side of the train is open.

(iii) Drain each supplementary main reservoir on that side of the train, and the main reservoir and the compressor intercooler.

(iv) Check the couplings and connections and make a superficial examination of the undergear of this side of the train.

(v) Check that the brake on each car has applied and that none of the brake cylinder pistons is unduly extended.

(vi) *Open* the safety apparatus isolating cock and see that the handle of the trip valve is set thereby.

9.135 Test the motor coach

(i) Test the trip valve and reset it and replace the switch stick.

(ii) Apply the automatic air brake by moving the driver's brake controller handle to position V – Service Application – and when the brake pipe gauge shows a reduction of about 10 lb./sq. in., return the handle to position IV – Lap.

(iii) Check that brake pipe pressure remains steady at this reduced value and that the brake cylinder pressure has risen to a value appropriate to the reduction in brake pipe pressure.

9.135 Test the motor coach – *continued*

Note: When the brake valve handle is returned to position IV – Lap, brake pipe air will continue to exhaust due to the action of the equalising discharge valve. Gauge pressure, however, should remain steady since the gauge is connected to the equalising reservoir with which the brake pipe pressure eventually equalises.

(iv) Move the handle again to position V – Service Application – and continue to reduce brake pipe pressure until a total reduction of 20 lb./sq. in. has been made. Then move the handle back again to position IV – Lap.

(v) Check that the brake pipe pressure again remains steady and that the brake cylinder pressure has increased to approximately 56 lb./sq. in

(vi) Release the brake.

(vii) Throw the brake controller handle to position VI – Emergency.

(viii) Check that brake pipe pressure falls to zero and brake cylinder pressure rises rapidly to about 56 lb./sq. in.

(ix) Release the brake, and note that the compressors cut in as the main reservoir pressure falls to 87 lb./sq. in. and cut out again when it has risen to 100 lb./sq. in.

(x) Switch on the MCB 'control' and note that the brake indicating lamp lights.

(xi) Make a partial E.P. application by putting the brake controller handle midway between position II – Rheostatic and position III – Full E.P. Check that brake cylinder pressure builds up a corrresponding amount (about 20–30 lb. /sq. in.).

9.135 Test the motor coach – *continued*

(xii) Partially release the E.P. brake and note that the brake cylinder pressure falls a corresponding amount.

(xiii) Move the brake controller handle to position III – Full E.P. Check that brake cylinder pressure builds up to about 56 lb./sq. in.

(xiv) Release the brake and check that the pressure gauges read:

Main reservoir: 87 to 100 lb./sq. in.

Brake pipe: 77 lb./sq. in.

Brake cylinder: zero.

(xv) Test the guard's brake valve.

9.136 Test the whole unit as follows

(i) Push the button marked 'Remote Trip'. See that the lights go out.

(ii) Push the button marked 'Panto Lower'.

(iii) Trip contactor MG by hand.

(iv) View the pantograph.

(v) Raise the pantograph by operating the pantograph E.P. valve by hand.

(vi) When the pantograph is at rest in contact with the overhead, close the MG contactor by hand.

(vii) If lights are required, when the 'supply' indicator lamp lights, push button marked 'Remote Set'.

(viii) Unlock the master controller and cautiously move the train forward, stopping it by releasing the deadman's button. As soon as the train stops grasp the deadman's button which will prevent further escape of main reservoir air through the feed valve to the vented brake pipe.

9.136 Test the whole unit as follows – *continued*

(ix) With the brake pipe again charged to 77 lb./sq. in., make a partial E.P. application by moving the brake controller handle to halfway between positions II – Rheostatic and III – Full E.P.

(x) The employee assisting the driver must now walk along the side of the train to the rear of the unit, examining each coach in passing to see that the brake has applied.

(xi) On arrival at the rear of the unit the employee must give a hand signal to the driver to release the brake.

(xii) The driver must then place the brake controller handle in position I – Release and Running.

(xiii) The employee must then test the shunter's cock of the end coach of the unit before giving a signal to set back.

(xiv) The driver, on receiving the set back hand signal from this employee must move the train back cautiously and stop it by using the driver's brake controller.

If the above procedure has revealed no fault, the unit is ready to proceed.

9.2 AUXILIARY CONTROL

9.21 CONTROL

Only one M-G set per train is necessary to provide a control supply. This M-G set is started as described in 9.111 (vi) above, i.e. by manually closing contactor (MG).

9.22 LIGHTING

As required by lighting conditions the other M-G sets on the train may be started and stopped by remote control from the push buttons 'Remote Set' and 'Remote Trip'.

9.22 LIGHTING – *continued*

The contactors which control the lighting inverters and which are mounted in each coach also may be closed or opened by the operation of these 'Remote Set' and 'Remote Trip' push buttons. The lighting of each *unit* of the train is supplied from the M-G set on the motor coach of that unit.

9.23 ACCELERATION

To suit traffic requirements, the rate of acceleration may be reduced by depressing the push button 'Reduced Acceleration'. This push button is not spring returned, and will remain depressed until lifted when the higher acceleration rate will result.

9.3 DRIVING THE TRAIN

9.31 MOTORING

After unlocking the master controller depress the deadman's button and move the reverse lever to FWD (or to REV). This energises the line breaker exhaust valves and unlocks the controller handle.

Move the controller direct to the notch in which it is proposed to travel. This sets up the powering circuits as described in 6.4–6.5 and as shown in diagrams 1 to 4 of Drawing L.6532. When the line breakers close the ammeter will indicate traction current and the train will commence to move. This occurs with the controller handle in any position notch 1 or beyond.

If the controller handle is in a position notch 'S' or beyond, the ammeter will rapidly rise, after the circuits have been set up as described for notch '1' to more than 320 amps., after which it will fall to 320 amps. before a further rise occurs, indicating that the resistance contactors are stepping under the control of CLR'M'. This automatic stepping of the current as the train accelerates continues up to 9 mph, when the train will be running in *full series*.

9.31 MOTORING – *continued*

With the controller handle in a position notch 'P' or notch 'WF', and after the stepping has progressed to full series, transition takes place. The only indication of this will be a momentary kick back of the ammeter, which will rise again and, as the train accelerates further, will 'step' at a value of 280 amps. up to a speed of 19 mph, when the train will be running in *full parallel.*

If the controller handle is in the notch 'WF', two further 'steps' will occur as the F switch weakens the traction motor fields with consequent increase in tractive effort and therefore acceleration.

The control scheme is arranged for 'notching back' from position 'WF' to position 'P' on the controller. The controller handle can be moved between these two positions to regulate the T.E., or speed as dictated by service requirements.

9.32 SHUTTING OFF POWER AND COASTING

As the controller handle is moved from 'P' or 'S' towards the 'off' position, the motors continue powering until after the handle has been moved to 'off', when the line breakers open.

The deadman's button must be depressed during coasting and the reverse lever must not be moved to 'off' until the train has stopped with the brakes applied.

9.33 BRAKING

9.331 Before Moving Off

(a) Ensure that all hand brakes are released.

(b) See that the brake controller handle is in position I – Release and Running.

(c) Ensure that the E.P. brake indicating lamp is alight.

(d) Check from the gauges that the air system pressures are as follows:

Main reservoir: 87 to 100 lb./sq. in.
Brake pipe: 77 lb./sq. in.
Brake cylinder: zero.

9.322 Running

(a) Frequent observation of the gauges, to see that the system is correctly charged, should be made during running.

(b) The driver's brake controller handle must be kept in position I – Release and Running – except when braking is required.

Note: All drivers' brake controller handles in non-operative driving compartments are to be left in position I.

(c) If the brakes apply whilst running, due to opening of a guard's valve or loss of brake pipe pressure for any other reason, the driver must move the brake controller handle to position VI – Emergency – and *leave it there until the train* is to be moved. This action expedites the discharge of brake pipe air to atmosphere and also prevents loss of main reservoir air to the vented brake pipe.

9.333 Service Application (E.P.)

(a) To apply the E.P. brake, move the brake controller handle from position I towards position III. From position I to position II no braking results, but from position II to position III brake cylinder pressure builds up rapidly to a value dependent upon the position of the handle (as illustrated in Drawing H.3515.)

(b) As train speed approaches zero the driver should move the brake handle towards position II – Release and Running – so that the final stop is made with little pressure in the brake cylinders.

(c) Braking up to the maximum available may always be obtained by moving the brake controller handle towards position III, according to the braking required, and *gradually* releasing by slow movement of the brake controller handle towards position II – Release and Running – as the speed of the train decreases.

9.334 Holding the E.P. Brake applied

When the brake controller handle has been moved to give the braking required, it may be *left in that position* until it is desired to release, partially release or increase the braking.

9.335 Release (E.P.)

(a) To release the brake completely move the brake controller handle to position I.

(b) To graduate or partially release the brakes, move the handle towards position II a distance corresponding to the amount of partial release which is desired and *leave the handle in that position* until a further release or application is required.

9.336 Service Application (Automatic)

When it is necessary to change over from E.P. operation to Automatic brake, the latter may be operated in the normal manner, no other action being required.

To make a service application of the automatic brake, proceed as follows:

(a) Move the handle quickly from position I – Release and Running – to position IV – Lap.

(b) Move the brake controller handle to position V – Service Automatic – to make a reduction in the brake pipe pressure of not less than 5 lb./sq. in. When required brake pipe pressure reduction is obtained return the handle to position IV – Lap.

(c) Further reduction in brake pipe pressure, in the manner described in 9.336(b) above, will increase the brake cylinder pressure obtained.

To test the satisfactory operation of the Automatic Brake it is advisable to stop the train, using the automatic brake, at least once per journey. This should be made at first station encountered on the 'up' run of the journey.

9.337 Release (Automatic)

(a) Move the brake controller handle to position I and leave it there. If the movement from position IV – Lap – to position I is made reasonably quickly, the E.P. brake will not apply during the movement.

(b) Note that the brake pipe fully charges.

9.338 Emergency Application

(a) Move the brake controller handle to position VI – Emergency – and *leave it there until the train stops.*

Note: An emergency application must not be made by releasing the deadman's handle unless the driver is incapacitated. If the deadman's handle is inadvertently released it must not be depressed again until after the train has stopped.

(b) If the brakes are applied by other than the driver's brake controller, for example by operation of the guard's valve or a broken brake pipe hose, the driver is to move the brake controller handle to position VI – Emergency – and *leave it there until the train is to be moved.*

9.34 BELL INTERCOMMUNICATION SYSTEM

The bell intercommunication system has been so arranged that it is unnecessary for the driver to leave his controls in order to receive an audible signal from the guard during the course of train running. The bell system is operated by means of a switch which is worked with an H-key. One of these switches is mounted in each guard's compartment above each external doorway, and the operation of any one switch rings the signal bell in each driver's cab on the train.

Supply for operation of the bell system is obtained from the supply train line (CP).

9.341 The Code of Bell Signals is set out hereunder: (ring '0'; pause '.')

(a) Guard communicating to driver:

(i) Guard's signal to proceed	00
(ii) Stop (or cancelling signal)	0
(iii) Set back	000
(iv) Brake test O.K.	0.00.0
(v) Answering signal	0

(b) Driver communicating to guard:

(i) Calling guard's attention	00.00.00
(ii) Calling guard to front of train	0000
(iii) Brake test signal	0.00.0
(iv) Answering signal	0

9.4 FAULTS AND EMERGENCY OPERATION

9.41 INTERRUPTION OF THE 1,500 VOLT SUPPLY

When the 1,500 volt supply fails while the train is powering, the no-current relay (NCR) opens, and the control equipment then returns to the notch '1' condition. When the 1,500 volt supply is restored with the controller handle in other than the 'off' position, the NCR closes and the equipment steps up on controlled progression to the notch selected on the master controller.

If it appears that the 1,500 volt supply has failed while the train is in motion, the controller handle should be returned to the series position 'S'. If it appears that the supply is not available by the time the train has come to rest or by the time it is desired to bring the train to rest, the controller should then be moved to the 'off' position.

When the train has stopped, the driver must not then assume that power is off, but he must secure the train and proceed to test it in accordance with the Driver's Trouble Chart, Drawing H.3528 (or Drawing H.3529 if applicable).

9.42 A TRACTION CIRCUIT FAULT WHILE MOTORING

This will be indicated by a reduction in tractive effort. Watch the driver's ammeter, then:

A If the ammeter of the coach being driven reads zero when the controller is held in series 'S' position, the fault is on that coach.

B If this ammeter behaves normally but tractive effort is reduced, the fault is on one of the other motor coaches of the train.

In the event of this reduction in tractive effort, the master controller should be returned to 'off' and the 'Overload Re-set' push button pressed to reset any overloads which may have tripped. If the fault persists when the controller is notched up again, the train must be stopped at the first available stopping place, If superficial examination reveals no defect, proceed to Flinders Street if possible. If insufficient tractive effort is available to proceed thus, lock the controller and lower the pantographs, and guided by the previous indication on the driving ammeter as described above, the overload relays must be examined to locate which has tripped. On the coach on which an overload has tripped, if OL2 has operated cut-out 3–4 motors by suitable operation of the motor cut-out switch but if OL1 has operated cut out 1–2 motors. If after cutting out 1–2 motors the fault still persists, cut in 1–2 motors, and cut-out 3–4 motors. If no overload has tripped, the fault must be assumed to be in the control gear, and the control cut-out switch of the faulty car should be opened before proceeding.

9.43 IF THE TRAIN WILL NOT MOVE WHEN THE MASTER CONTROLLER IS OPERATED

Examine the train and operate in accordance with 'Driver's Trouble Chart' – Drawing H.3528 (or H.3529 if appropriate).

9.44 MOTORING WITH MOTORS CUT OUT

If the motor cut-out switch has been operated, i.e. only two motors cut out of a 4–car or 7–car train, the defective car may remain in service, but if the control cut-out switch has been operated, thereby cutting out all four motors on that car, the train must be withdrawn from service as soon as possible at the discretion of the equipment examiner.

Note: With the motor cut-out switch operated, auxiliary contacts connect together train lines 2 and 3 and therefore series running is not available, i.e. if the master controller is held in notch 'S', all equipments will notch up to full parallel. This is to ensure that the defective equipment does not 'balance' on a resistance step or otherwise overheat the operative pair of motors on the defective car.
Weak field operation on the remaining motors of a defective coach is available.

9.45 AUXILIARY MACHINE FAULTS

If the auxiliary H.T. circuit breaker (MB) trips, reclose the breaker. If the fault persists, open the compressor isolating switch (CCS) and again attempt to reclose the circuit breaker (MB). If the fault is in the compressor and has therefore been isolated by the above procedure, no further action is necessary (except for a single unit), as the remaining compressors can maintain sufficient air.

If the fault still persists, close CCS and use the emergency jumper as described in 9.46.

9.46 PROCEDURE FOR DRIVING USING EMERGENCY JUMPER ARRANGEMENT

(i) Open MG contactor (MG) by hand.

(ii) Open the MG set isolating switch (MGSS).

(iii) Remove from the faulty coach the emergency jumper (housed in the rear portion of the auxiliary equipment cupboard and accessible from the guard's compartment).

(iv) Insert the jumper between the unjumpered coaches nearest the faulty coach.

(v) If necessary, carry out the instructions set out in 5.271 – Bus line emergency conditions.

(vi) Open the MG trip isolating switch (MGTS) on the motor coach nearest the faulty coach. This will prevent this M-G set from shutting down when the train lights are tripped.

9.46 PROCEDURE FOR DRIVING USING EMERGENCY JUMPER ARRANGEMENT – *continued*

(vii) Start the M-G set on this associated motor coach by closing the MG contactor (MG) on that coach by hand.

(viii) Close L.T. Bus MCB on the associated motor coach.

(ix) Close L.T. Bus MCB on the faulty motor coach then proceed, driving from the leading motor coach.

9.5 CHANGING ENDS

When changing ends at terminal stations carry out the following procedure:

(i) Apply the *automatic* air brake and close the driver's brake controller combined isolating valve and switch. Then place handle to 'Release and Running' position.

(ii) Lock the master controller and remove the key.

(iii) If lighting is not in use – shut down the M-G set by pushing the 'local trip' push button.

(iv) Switch the marker lights changeover switch to *red.*

(v) Open the following MCB's:

Auxiliary Control.

Control.

Supply Train Line.

(vi) Fold in the driver's rear vision mirror and close and lock driver's cab window and door.

(vii) Close the safety apparatus isolating cock and see that the handle of the trip valve is raised thereby.

(viii) Proceed to the other end of the train, and continue the procedure thus:

(ix) Open the safety apparatus isolating cock and check that the handle of the trip valve is lowered thereby.

9.5 CHANGING ENDS – *continued*

(x) Close the following MCB's:

Auxiliary Control.

Control.

Supply Train Line.

(xi) Close the MG contactor (MG) by hand if the M-G set is not already in use.

(xii) Switch the marker lights change-over switch to 'white' and set up markers.

(xiii) Open the driver's brake controller isolating valve and switch. This charges the brake pipe and lights the 'brake' indicating lamp.

(xiv) Fit controller key to the master controller and unlock the reverse lever.

9.6 SHUTTING DOWN – STABLING

When stabling a train, the driver must carry out the following procedure:

(i) Lock the master controller, withdraw and retain the key.

(ii) Apply the *automatic* air brake, apply the hand brake, then release the air brake and close the driver's brake controller isolating valve and switch.

(iii) Check that the pantograph storage reservoir is charged with air at 100 lb./sq. in. and that the pantograph storage reservoir diaphragm cock is screwed shut.

(iv) Open the following MCB's:

Auxiliary Control.

Control.

Supply Train Line.

(v) Shut down the M-G set by manually operating the contactor MG.

9.6 SHUTTING DOWN – STABLING – *continued*

(vi) Lower the pantograph by manually operating the pantograph E.P. valve.

(vii) Fold in the driver's rear vision mirror and close and lock the driver's cab window.

(viii) Close the safety apparatus isolating cock.

(ix) Pass along one side of the train towards the rear, keeping a sharp look-out en route for any obvious defects in the equipment, and enter each driving compartment.

(x) In each driving compartment, see that the pantograph storage reservoir is charged with air at 100 lb./sq. in. and that the pantograph storage reservoir diaphragm cock is screwed shut.

(xi) If the M-G set is working on the coach, open the MG contactor by hand.

(xii) Lower each pantograph by manually operating the pantograph E.P. valve.

(xiii) Close and lock the doors of each driver's cab and van.

(xiv) After seeing that all is right at the end of the train, pass along the opposite side, keeping a sharp look-out en route for any obvious defects in the equipment. See that all defects have been duly entered on the report forms, that the face copy of the report is fixed in the frame for the equipment examiner and lock the doors of the driving compartment and van.

SECTION 10

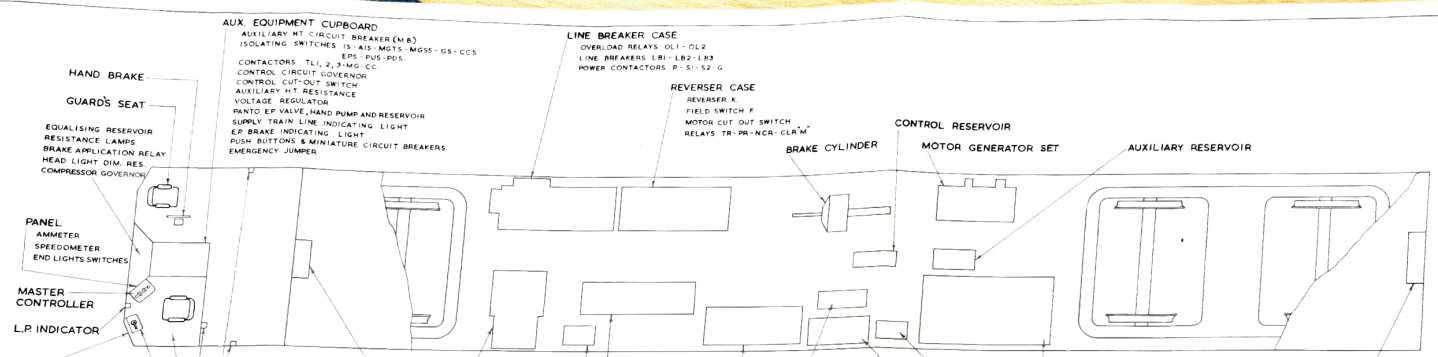
DIAGRAMS

10.0 GENERAL NOTE

The diagrams which follow hereafter are included to give the electric train driver or other employee engaged in the operation of these electric trains a clearer understanding, where necessary, of the instructions contained in this book.

10.1 LIST OF DIAGRAMS

Drawing No.	Title
H.3523	Layout of Equipment
D.281	Auxiliary Equipment Cupboard
D.276	Symbols
L.6527	Motor Coach Wiring – Schematic
L.6351	Power Circuits and Notching Chart
D.236	Power Circuits during Transition
L.6353	Auxiliary Circuits – Schematic
L.6352	Control Circuits – Schematic
L.6532	Control Circuits during Notching – 1st Notch
L.6533	Control Circuits during Notching – Series Notching and Transition
L.6534	Control Circuits during Notching – Parallel Notching and Weak Field
H.3515	Self-Lapping E.P. Brake Operating Principle
L.6354	Air System – Schematic
H.3528	Driver's Trouble Chart – Multiple Unit
H.3529	Driver's Trouble Chart – Single Unit
F.5940	E.P. Valve



(NON-RHEOSTATIC "M" CAR) *

Revision	Date	Description	Revised	Checked	Passed
A	20-7-55	Control & Panto. Reservoirs added	K.P.	W. Bell	W. Bell

V. R. ELEC. ENG. BRANCH

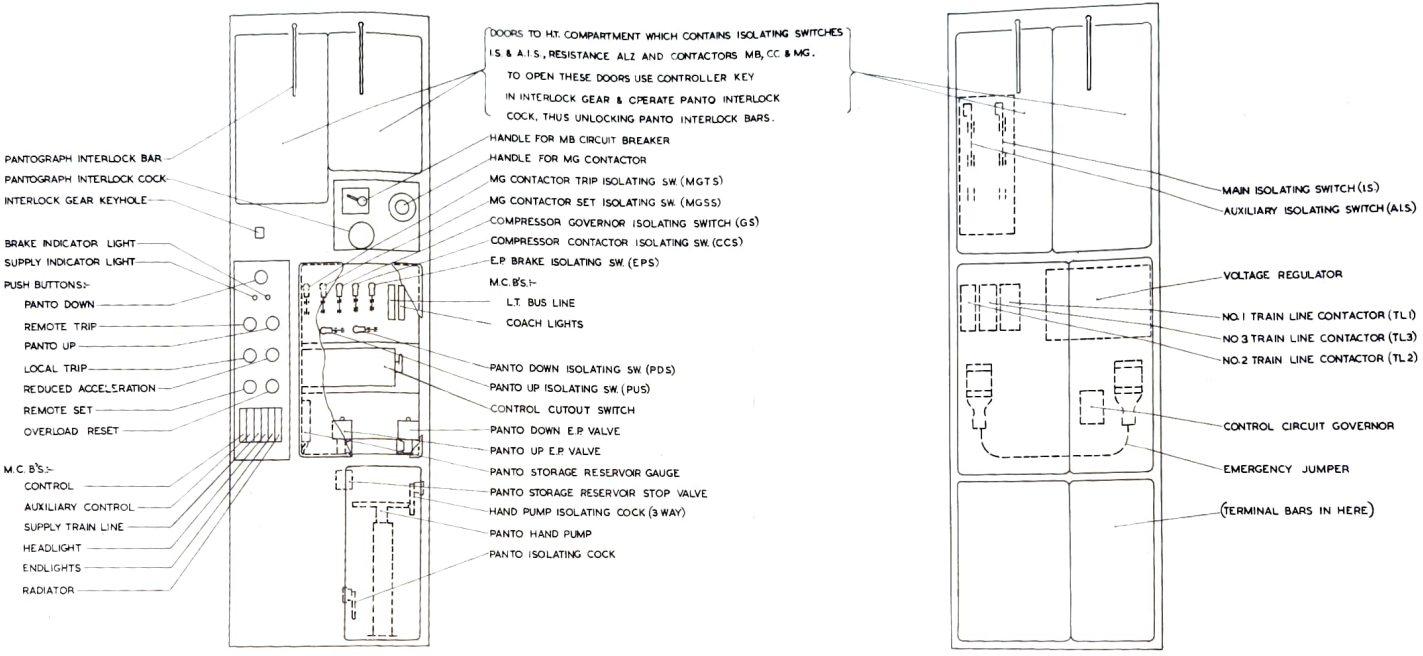
DRAWN		6-5-55	TRACTION (RLYS)
TRACED		10-5-55	RULE BOOK

EQUIPMENT LAYOUT
E.E. M.U. TRAINS *

	ENG. DSN	DRG. OFF.
CHECKED		
PASSED		

APPROVED
C.E.E.

H 3523 A



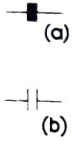
AUXILIARY EQUIPMENT CUPBOARD

E.E. MU TRAINS – NON RHEOSTATIC 'M' CAR

D 281
25-6-55/M

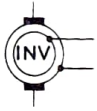
WIRING SYMBOLS E.E. MULTIPLE UNIT TRAINS

CONTROLLER
CAM DEVELOPMENT.



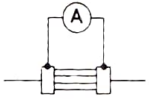
CONTACT OF CONTROLLER
HANDLE OR REVERSE LEVER.
(a) NORMALLY CLOSED.
(b) NORMALLY OPEN.

MOTOR (M)
GENERATOR (G) } ARMATURE.
COMPRESSOR (C)



D.C.-A.C. INVERTER ARMATURE.

PANTOGRAPH.

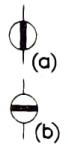


AMMETER
AND
SHUNT.

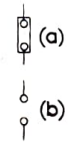
VOLTAGE REGULATOR.

OPERATING COIL OF RELAY,
CONTACTOR, VALVE OR
CAM GROUP SWITCH.

MAIN CONTACT OF
CONTACTOR.

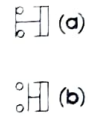


MAIN CONTACT OF
CAM GROUP SWITCH.
(a) NORMALLY CLOSED.
(b) NORMALLY OPEN.



AUXILIARY CONTACT OF
CONTACTOR, CAM GROUP
SWITCH OR RELAY.
(a) NORMALLY CLOSED.
(b) NORMALLY OPEN.

KNIFE OR TUMBLER
ISOLATING SWITCH.
(a) NORMALLY CLOSED.
(b) NORMALLY OPEN.
(c) DOUBLE THROW OR
2-WAY.



AIR OPERATED SWITCH.
(a) NORMALLY CLOSED.
(b) NORMALLY OPEN.

LAMP.

CIRCUIT BREAKER.

RESISTANCE.

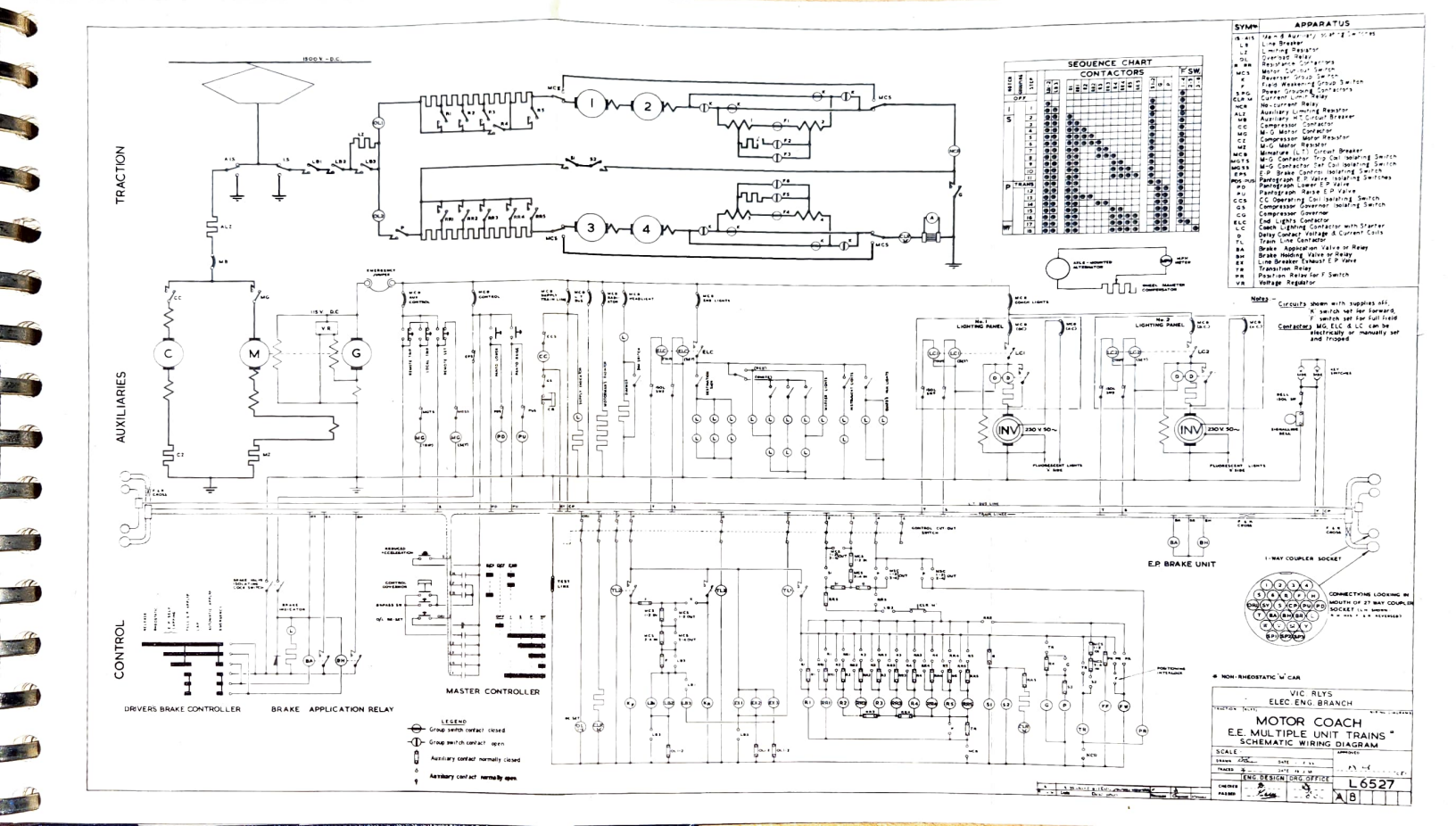
FIELD COIL.

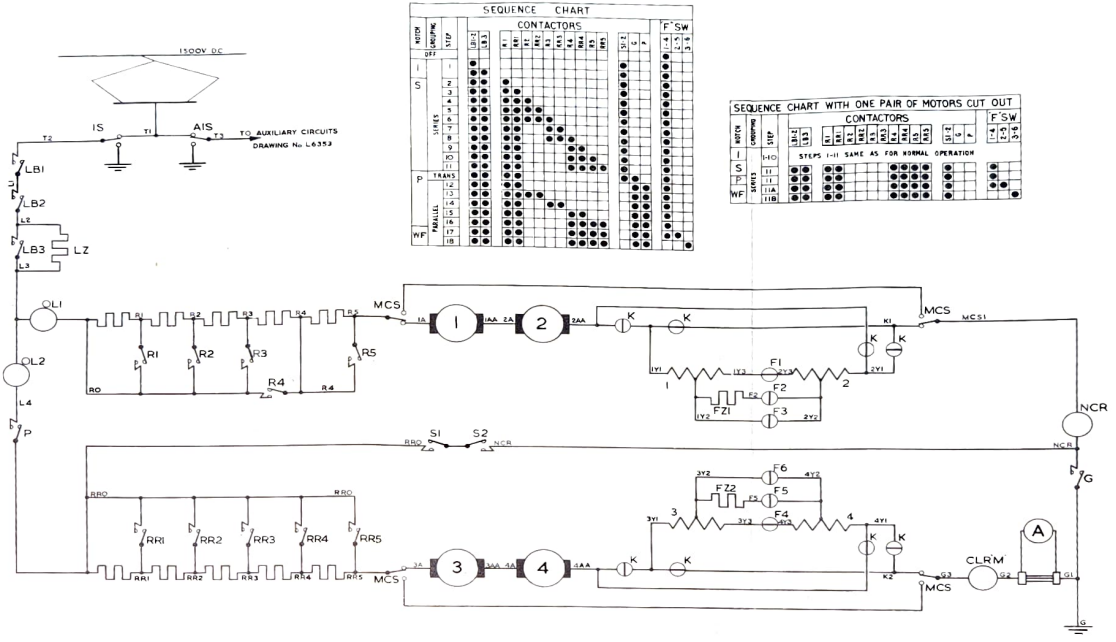
RECTIFIER (ARROW
INDICATES DIRECTION
OF CURRENT FLOW.)

EARTH CONNECTION.

PUSH SWITCH.
(SPRING RETURN.)

PUSH-PULL SWITCH.
(PUSH ON - PULL OFF.)


TRACTION
AUXILIARIES
CONTROL
1500 V. D.C.
110 V. D.C.
SEQUENCE CHART
CONTACTORS
APPARATUS
Notes –
Circuits shown with supplies off.
K switch set for Forward.
F switch set for Full field
Contactors MG, ELC & LC can be electrically or manually set and tripped
No. 1 LIGHTING PANEL
No. 2 LIGHTING PANEL
230 V 50~
E.P BRAKE UNIT
1-WAY COUPLER SOCKET
CONNECTIONS LOOKING IN MOUTH OF 27 WAY COUPLER SOCKET
DRIVERS BRAKE CONTROLLER
BRAKE APPLICATION RELAY
MASTER CONTROLLER
LEGEND
Group switch contact closed
Group switch contact open
Auxiliary contact normally closed
Auxiliary contact normally open.
* NON-RHEOSTATIC 'M' CAR
VIC. RLYS
ELEC. ENG. BRANCH
MOTOR COACH
E.E. MULTIPLE UNIT TRAINS "
SCHEMATIC WIRING DIAGRAM
ENG. DESIGN
DRG. OFFICE
L6527
AB



SEQUENCE CHART

CONTACTORS

NOTCH	GROUPING	STEP	LB1-2	LB3	A1	AA1	A2	AA2	AA3	A3	A4	AA4	A5	AA5	SF1-2	L	P	F SW 1-4	F SW 2-5	F SW 3-6
OFF																				
I	SERIES	1																		
S		2																		
		3																		
		4																		
		5																		
		6																		
		7																		
		8																		
		9																		
		10																		
		11																		
P	TRANS	12																		
		13																		
		14																		
	PARALLEL	15																		
		16																		
WF		17																		
		18																		

SEQUENCE CHART WITH ONE PAIR OF MOTORS CUT OUT

CONTACTORS

NOTCH	GROUPING	STEP	LB1-2	LB3	A1	AA1	A2	AA2	AA3	A3	A4	AA4	A5	AA5	SF1-2	L	P	F SW 1-4	F SW 2-5	F SW 3-6
I		1-10	STEPS 1-11 SAME AS FOR NORMAL OPERATION																	
S	SERIES	11																		
P		11A																		
WF		11B																		

* NON-RHEOSTATIC 'M' CAR

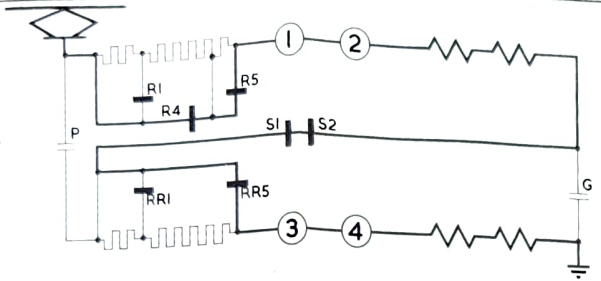
VIC. RLYS.
ELEC. ENG. BRANCH

TRACTION(RLYS) — WIRING DIAGRAMS

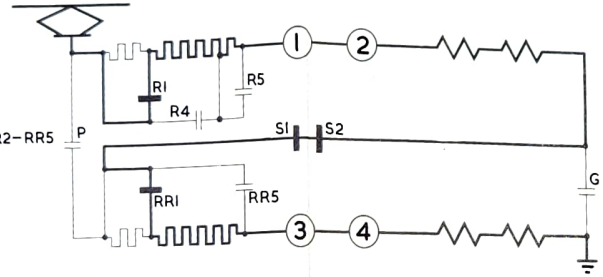
POWER CIRCUIT & SEQUENCE CHART
E.E. MULTIPLE UNIT TRAINS *
SCHEMATIC

SCALE			APPROVED:
DRAWN	DATE		
TRACED	DATE		CEE
	ENG. DESIGN	DRG OFFICE	L6351
CHECKED			
PASSED			

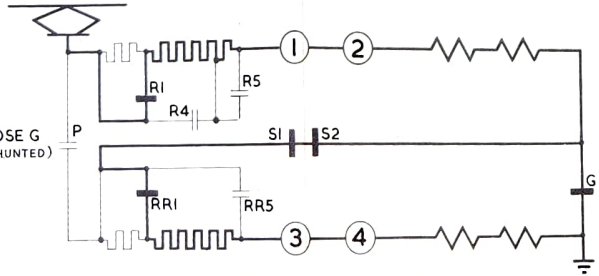
1. FULL SERIES
(T.R. ENERGISED)



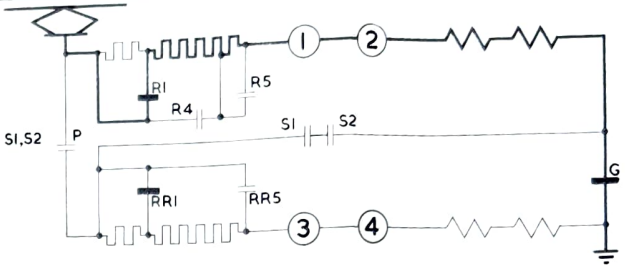
2. T.R. OPENS R2–RR5



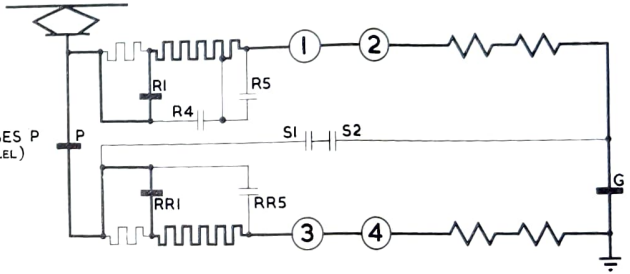
3. T.R. & R4 CLOSE G
(3 & 4 MOTORS SHUNTED)



4. G OPENS S1, S2

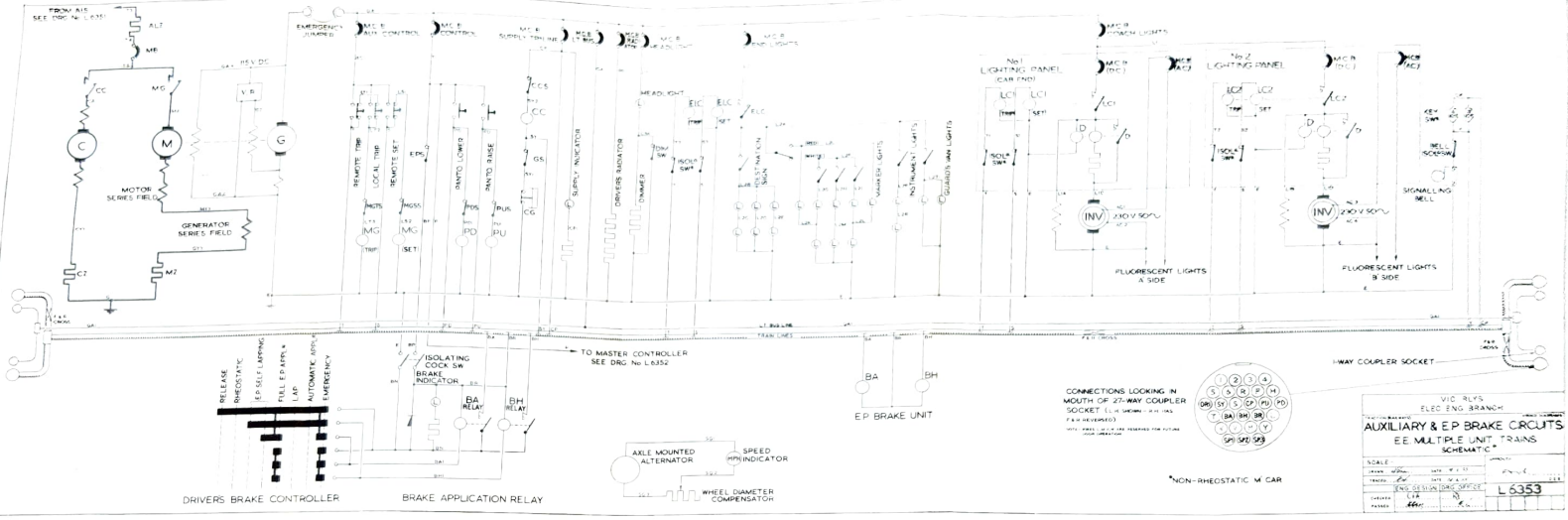


5. S2 CLOSES P
(1ST. PARALLEL)



V. R. ELEC. ENG. BRANCH

DRAWN 12-10-54			TRACTION (RLYS.) RULE BOOK DIAGS.
TRACED 21-3-55			**TRANSITION**
	ENG. DSN.	DRG. OFF.	ELEC. TRAINS E.E.–SCHEMATIC
CHECKED			APPROVED C.E.E.
PASSED			D 236

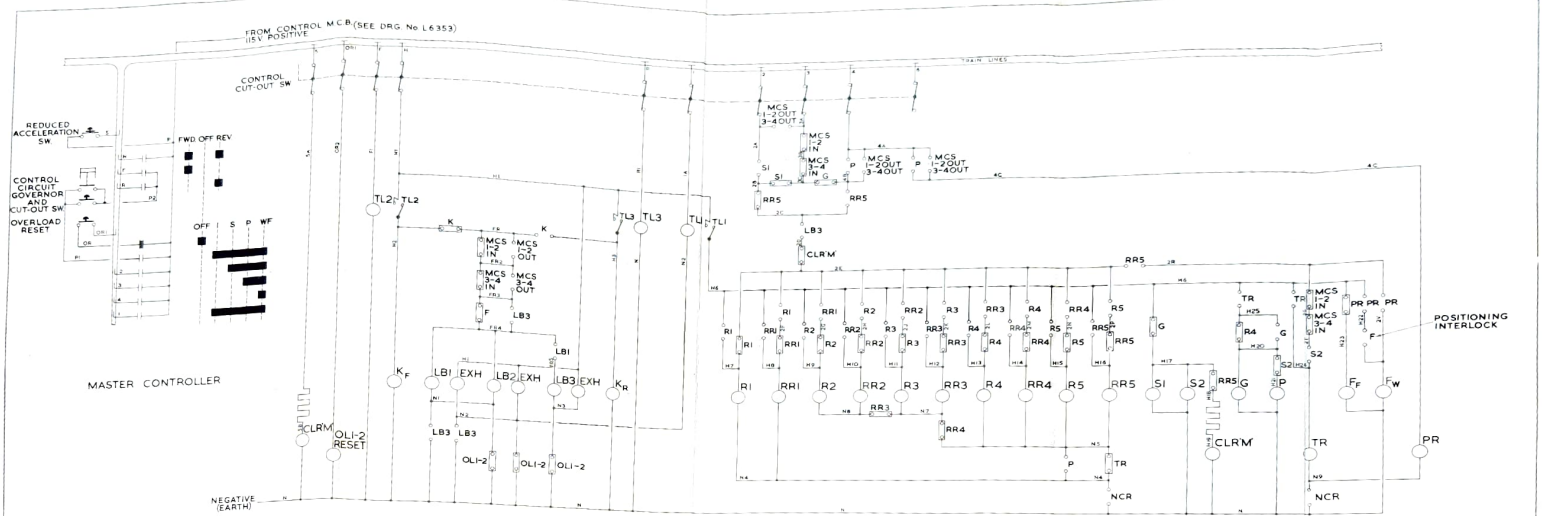


VIC RLYS
ELEC. ENG. BRANCH

AUXILIARY & E.P. BRAKE CIRCUITS
E.E. MULTIPLE UNIT TRAINS
SCHEMATIC

SCALE	
DRAWN	DATE 9.57
TRACED	DATE
ENG. DESIGN DRG. OFFICE	
CHECKED	DATE
PASSED	DATE

DRG. No. L6353



CONTROL CIRCUIT – SCHEMATIC

E.E. MULTIPLE UNIT TRAINS, NON-RHEOSTATIC M.CAR

L6352B

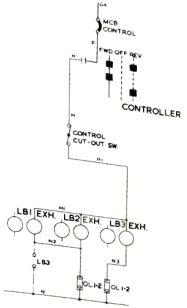


DIAGRAM 1. - REVERSE LEVER UNLOCKED AND MOVED TO POSITION MARKED "FWD". LINE BREAKER EXHAUST VALVES CLOSE. LB3 INTERLOCK CLOSES LATER - SEE DIAGRAM 4.

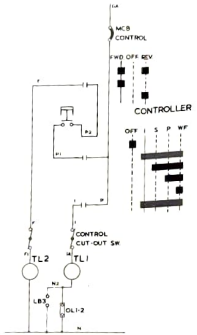


DIAGRAM 2. CONTROLLER HANDLE MOVED TO POSITION MARKED "I" - TL1 AND TL2 BECOME ENERGISED. LB3 INTERLOCK CLOSES LATER - SEE DIAGRAM 4.

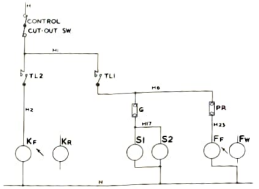


DIAGRAM 3. - TL2 ENERGISES K_F, TL1 ENERGISES S1, S2 AND F_F. K AND F MOVE TO FWD AND FF POSITIONS IF NOT ALREADY LYING IN CORRECT POSITION.

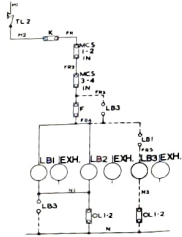


DIAGRAM 4. - LB1-2 ARE ENERGISED WHEN K AND F ARE IN CORRECT POSITIONS. LB1 WHEN CLOSED ENERGISES LB3. LB3 WHEN CLOSED PARALLELS OL1-2 CONTACTS FOR LB1-2 AND PARALLELS F CONTACT.

SHUNTING NOTCH - FIRST SERIES.

E.E. MULTIPLE UNIT TRAINS.

L 6532

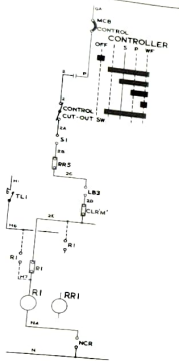


DIAGRAM 5. - CONTROLLER HANDLE MOVED TO POSITION MARKED 'S' - WIRE 2 ENERGISES RI WHICH WHEN CLOSED IS RETAINED FROM WIRE H6.

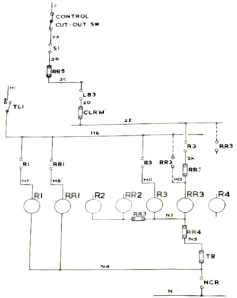


DIAGRAM 6. - TYPICAL NOTCHING STEP SHOWING RR3 ENERGISED VIA CLRM AFTER R3 HAS CLOSED.

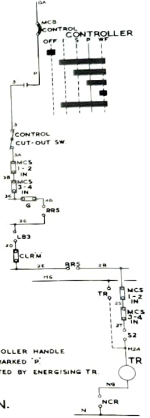


DIAGRAM 7. - CONTROLLER HANDLE MOVED TO POSITION MARKED 'P' TRANSITION IS INITIATED BY ENERGISING TR.

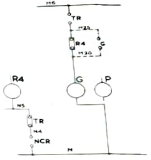


DIAGRAM 8. - TR OPENS R4, RR4, R5 AND RR5. THEN R4 ALLOWS G TO BE ENERGISED AND RETAINED FROM WIRE H6.

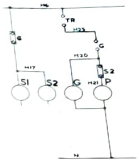


DIAGRAM 9. - G OPENS S1-2 THEN S2 ALLOWS P TO BE ENERGISED FROM WIRE H20.

SERIES NOTCHING & TRANSITION.

E.E. MULTIPLE UNIT TRAINS.

L 6533 A

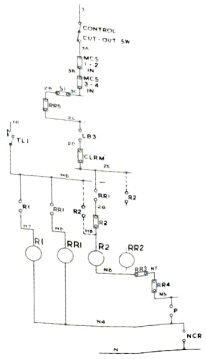


DIAGRAM 10 - WHEN P CLOSES, NOTCHING PROGRESSION RE-COMMENCES AT R2 NOTCHING CONTINUES UNDER CONTROL OF CLRW UNTIL RRS CLOSES.

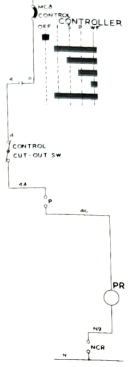


DIAGRAM 11 - CONTROLLER HANDLE MOVED TO POSITION MARKED WF WEAK FIELD STEPS ARE INITIATED BY ENERGISING PR

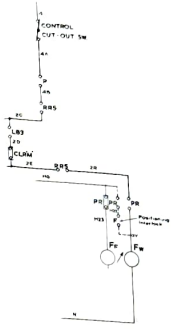
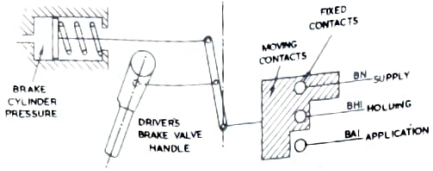


DIAGRAM 12.-PR DE-ENERGISES F AND ENERGISES FW FROM WIRE 4 VIA WIRE 28 WHEN CLRW OPENS, F-SWITCH MOVEMENT TO IF POSITION IS COMPLETED BY F POSITIONING INTERLOCK

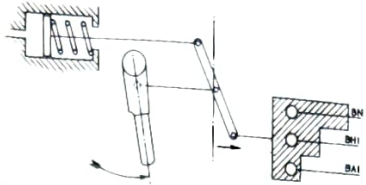
PARALLELING NOTCHING & WEAK FIELD

E.E. MULTIPLE UNIT TRAINS

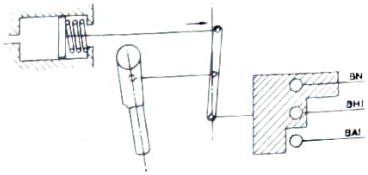
L 6534



1. E.P. self lap-Brake cylinder pressure corresponding to position of handle- Holding valve energised- Application valve de-energised.

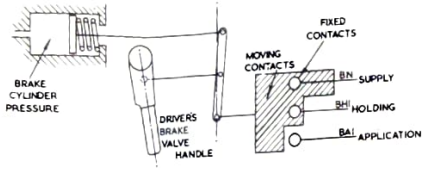


2. Brake valve handle moved to increase braking Application valve energised thus admitting more air to brake cylinder.

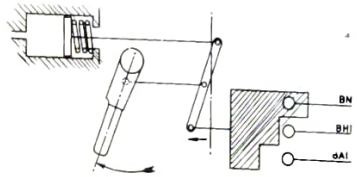


3. As brake cylinder pressure increases, contacts return to lap position. Application valve becomes de-energised preventing further increase.

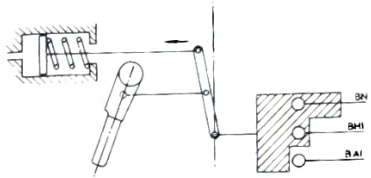
BRAKE APPLICATION INCREASED



4. E.P. self lap- Brake cylinder pressure corresponding to position of handle.



5. Brake valve handle moved to decrease braking Holding valve de-energised thus releasing air from brake valve cylinder.



6. As brake cylinder pressure decreases, contacts return to lap position. Holding valve becomes energised again thus halting the reduction.

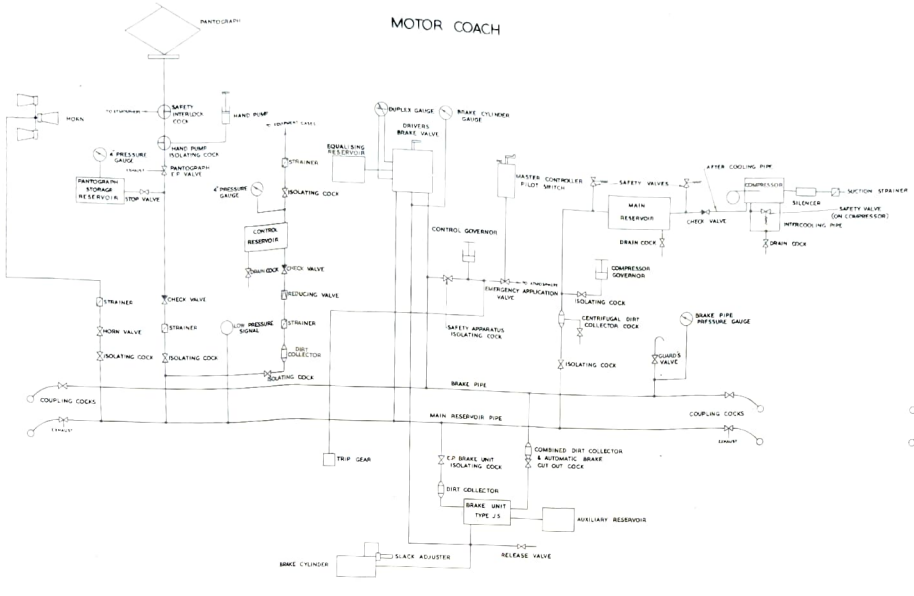
PARTIAL RELEASE OF BRAKE

VIC. RLYS.
ELEC. ENG. BRANCH

TRACTION RLYS. RULE BOOK DIAGRAMS

E.P. BRAKE. DRIVER'S VALVE
SELF-LAPPING PRINCIPLE
SCHEMATIC

SCALE:- NOT TO SCALE			APPROVED
DRAWN	DATE 27.10.34		C.E.E.
TRACED	DATE 22.1.35		
	ENG. DESIGN	DRG. OFFICE	H3515
CHECKED			
PASSED			


MOTOR COACH
PANTOGRAPH
HORN
SAFETY INTERLOCK COCK
HAND PUMP
HAND PUMP ISOLATING COCK
4 PRESSURE GAUGE
PANTOGRAPH E.P. VALVE
PANTOGRAPH STORAGE RESERVOIR
STOP VALVE
STRAINER
EQUALISING RESERVOIR
4 PRESSURE GAUGE
ISOLATING COCK
CONTROL RESERVOIR
DRAIN COCK
CHECK VALVE
REDUCING VALVE
STRAINER
CHECK VALVE
HORN VALVE
STRAINER
LOW PRESSURE SIGNAL
STRAINER
ISOLATING COCK
ISOLATING COCK
DIRT COLLECTOR
ISOLATING COCK
COUPLING COCKS
EXHAUST
BRAKE PIPE
MAIN RESERVOIR PIPE
COUPLING COCKS
EXHAUST
TRIP GEAR
DUPLEX GAUGE
BRAKE CYLINDER GAUGE
DRIVERS BRAKE VALVE
MASTER CONTROLLER PILOT SWITCH
CONTROL GOVERNOR
EMERGENCY APPLICATION VALVE
SAFETY APPARATUS ISOLATING COCK
ISOLATING COCK
CENTRIFUGAL DIRT COLLECTOR COCK
ISOLATING COCK
GUARD'S VALVE
BRAKE PIPE PRESSURE GAUGE
COMBINED DIRT COLLECTOR & AUTOMATIC BRAKE CUT OUT COCK
E.P. BRAKE UNIT ISOLATING COCK
DIRT COLLECTOR
BRAKE UNIT TYPE J5
AUXILIARY RESERVOIR
BRAKE CYLINDER
SLACK ADJUSTER
RELEASE VALVE
SAFETY VALVES
MAIN RESERVOIR
DRAIN COCK
AFTER COOLING PIPE
COMPRESSOR
SILENCER
SUCTION STRAINER
SAFETY VALVE (ON COMPRESSOR)
INTERCOOLING PIPE
CHECK VALVE
DRAIN COCK
COMPRESSOR GOVERNOR
TRAILER COACH
SHUNTERS COCKS
SUPPLEMENTARY MAIN RESERVOIR
DRAIN COCK
BRAKE PIPE
COUPLING COCK WITH SIDE CONNECTION
COUPLING COCKS
EXHAUST
MAIN RESERVOIR PIPE
COUPLING COCK
EXHAUST
BRAKE CYLINDER PRESSURE GAUGE WITH SHIELD
E.P. BRAKE UNIT ISOLATING COCK
COMBINED DIRT COLLECTOR & AUTOMATIC BRAKE CUT OUT COCK
DIRT COLLECTOR
BRAKE UNIT TYPE J5
AUXILIARY RESERVOIR
BRAKE CYLINDER
SLACK ADJUSTER
RELEASE VALVE
* NON-RHEOSTATIC M CAR
VIC. RLYS.
ELEC. ENG. BRANCH
AIR SYSTEM
E.E. MULTIPLE UNIT TRAINS *
SCHEMATIC
SCALE
APPROVED
ENG. DESIGN
DRG. OFFICE
L6354

MULTIPLE UNIT TRAIN

TRAIN WILL NOT MOVE
Check gauges, control & supply M.C.B's
Reset if necessary. Try to drive.

TRAIN WILL NOT MOVE
Push O/L reset button.
Try to drive.

IF TRAIN GOES
Proceed.
Report occurrence.

TRAIN WILL NOT MOVE
Try to drive in reverse.

IF TRAIN GOES IN REVERSE
Arrange for guard to apply power from another controller.

TRAIN WILL NOT MOVE
Push O/L reset button.
Try E.P. Brake.

E.P. BRAKE WILL NOT WORK
Try lights and check that supply indicator lights.

IF LIGHTS WORK
Arrange for guard to apply power from another controller.

LIGHTS WILL NOT WORK
Check that emergency jumper makes good contact.

IF LIGHTS WORK
Proceed.

LIGHTS WILL NOT WORK
Check that M.G. set is working.

M.G. SET IS WORKING
Open M.G. contactor & M.G.S.S.
Then use emergency jumper.

M.G. SET IS NOT WORKING
Check M.B. & M.G. contactors.
Reset them if necessary.

IF M.G. SET WORKS
Proceed.

M.G. SET WILL NOT WORK
Check that pantograph operates & makes contact.

IF M.G. SET WORKS
Proceed.

M.G. SET WILL NOT WORK
Open supply M.C.B. Start up 2nd. M.G. set. Close its supply M.C.B.

SECOND M.G. SET WILL NOT WORK
Await restoration of power.

IF PANTOGRAPH FAULTY
Lower panto. Open P.U.S. & P.D.S.
Use emergency jumper.

IF SECOND M.G. SET WORKS
Use emergency jumper.

CONTROL M.C.B. WILL NOT RESET
Open E.P.S.
Try to reset M.C.B.

IF M.C.B. RESETS
Proceed using automatic brake.

CONTROL M.C.B. WILL NOT RESET
Arrange for guard to apply power from another controller.

IF E.P. BRAKE WORKS
Check safety apparatus isolating cock. Try to drive.

TRAIN WILL NOT MOVE
Call guard to hold control govr. cut-out switch. Try to drive.

TRAIN WILL NOT MOVE
Arrange for guard to apply power from another controller.

IF TRAIN GOES
Proceed.

IF TRAIN GOES
Proceed.
Report fault from next station.

CONTROL M.C.B. TRIPS
Open control cut-out switch.
Reset M.C.B. Try to drive.

CONTROL M.C.B. TRIPS
Reset M.C.B.
Try E.P. Brake.

IF E.P. BRAKE WORKS
Remove 1st. jumper. Close control cut-out sw. Try to drive.

IF 1st. M. CAR WORKS
Consider grades to be encountered.

MORE THAN 4 CARS ON 1 in 50
Remove jumper behind 2nd. M.car.
Try to drive 2nd. M.car.

2nd. M.CAR CONTROL M.C.B. TRIPS
Open control cut-out sw. on 2nd. M.car. Reset M.C.B. Try to drive.

2nd. M.CAR CONTROL M.C.B. TRIPS
Obtain emerg. key. With guards help drive 1st & 3rd. M.cars.

IF TRAIN GOES
Proceed.

IF TRAIN GOES
Proceed with 1st. M car cut out.

CONTROL M.C.B. TRIPS
Open E.P.S. Proceed using automatic brake.

CONTROL M.C.B. TRIPS
Arrange for guard to apply power from another controller.

ON 1 in 50 GRADE 4 CARS OR LESS } Either case.
Proceed with 1st. jumper out.

IF 2nd. M. CAR WORKS
Replace 1st. jumper. Proceed with 2nd. jumper out.

2nd. M.CAR CONTROL M.C.B. O.K.
Replace jumpers. Proceed with 2nd. M.car cut-out.

USE OF CHART

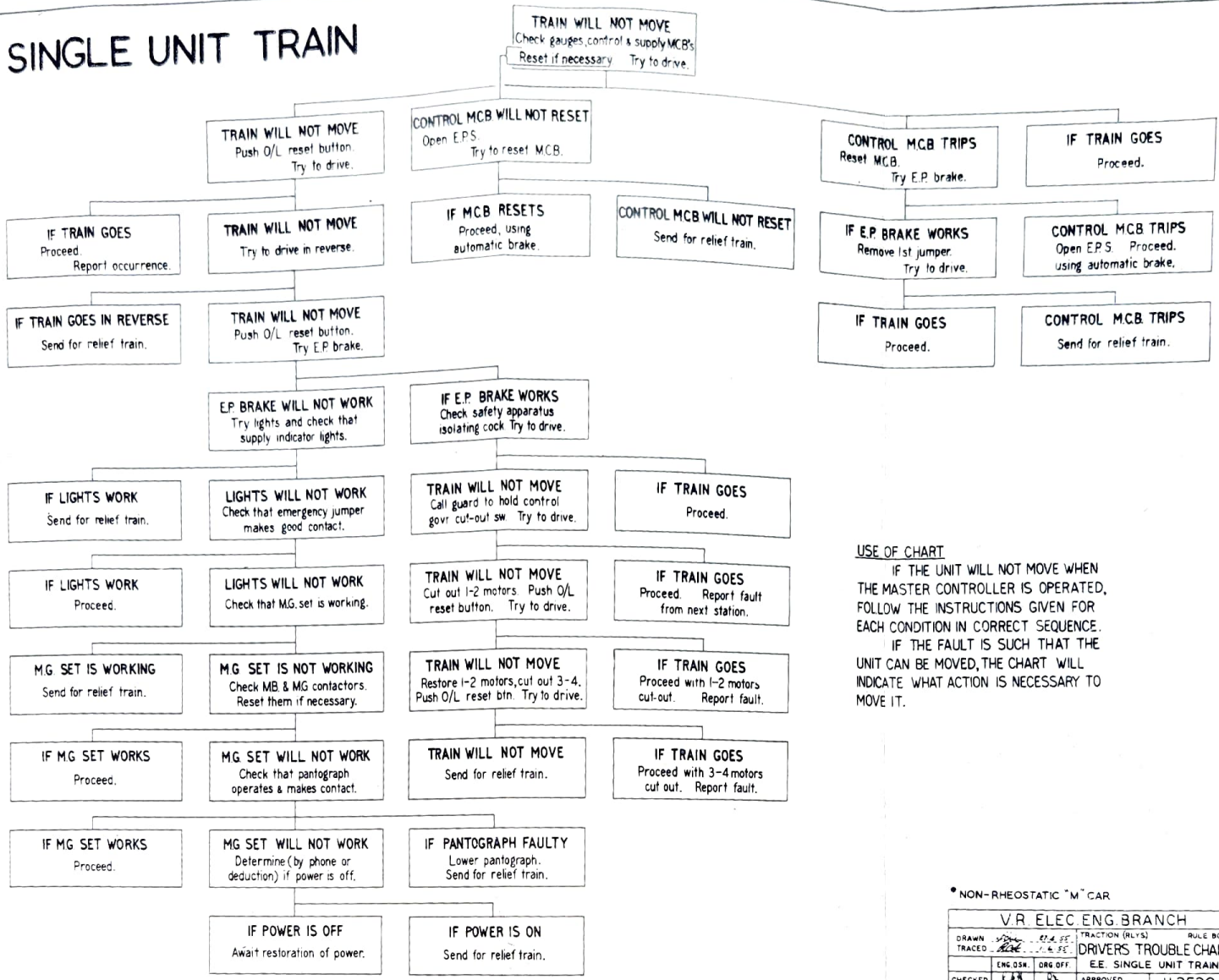
IF THE TRAIN WILL NOT MOVE WHEN THE MASTER CONTROLLER IS OPERATED, FOLLOW THE INSTRUCTIONS GIVEN FOR EACH CONDITION IN CORRECT SEQUENCE. IF THE FAULT IS SUCH THAT THE TRAIN CAN BE MOVED, THE CHART WILL INDICATE WHAT ACTION IS NECESSARY TO MOVE IT.

* NON - RHEOSTATIC M CARS

V.R. ELEC. ENG. BRANCH.

DRAWN J. [illegible]	27-2-59	TRACTION (RLY.)	RULE BOOK	
TRACED [illegible]	20-3-59	DRIVERS TROUBLE CHART		
	ENG. DSN.	DRG. OFF.	E E MU TRAINS *	
CHECKED [illegible]	[illegible]	[illegible]	APPROVED [illegible] CEE	H 3528
PASSED [illegible]	[illegible]			

SINGLE UNIT TRAIN



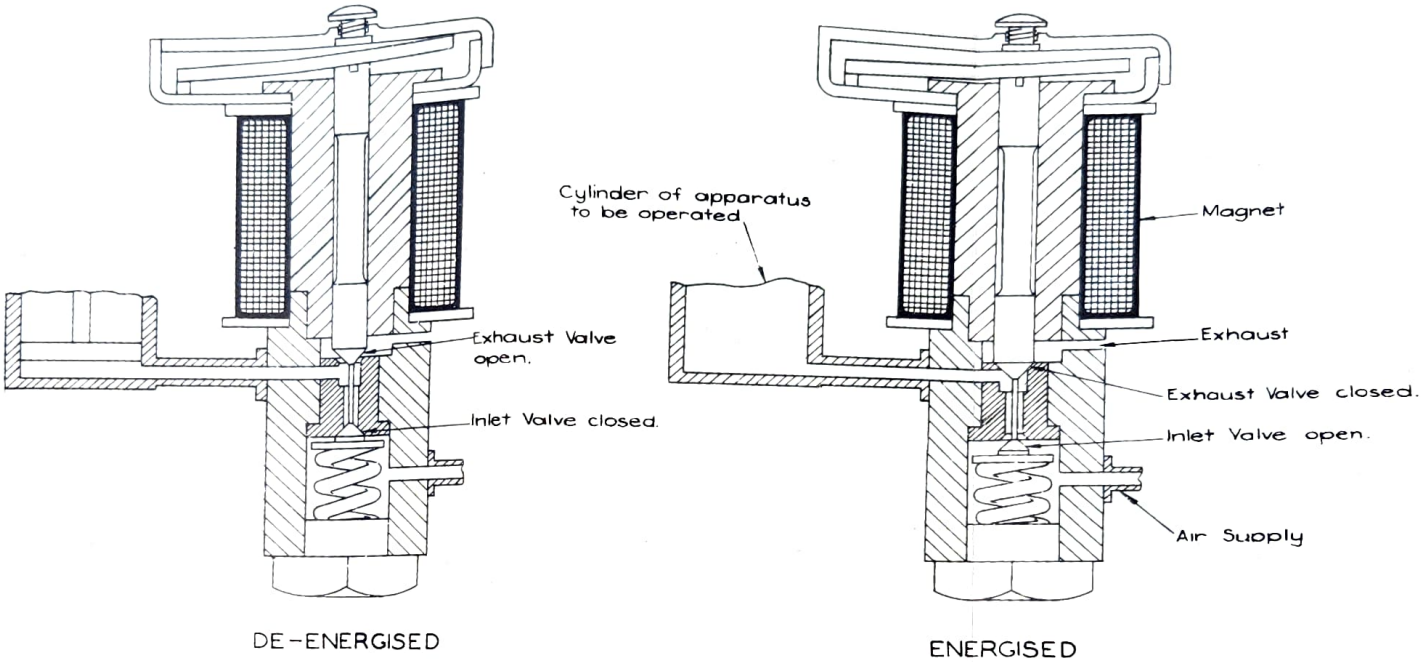
USE OF CHART

IF THE UNIT WILL NOT MOVE WHEN THE MASTER CONTROLLER IS OPERATED, FOLLOW THE INSTRUCTIONS GIVEN FOR EACH CONDITION IN CORRECT SEQUENCE.

IF THE FAULT IS SUCH THAT THE UNIT CAN BE MOVED, THE CHART WILL INDICATE WHAT ACTION IS NECESSARY TO MOVE IT.

• NON-RHEOSTATIC "M" CAR

V.R. ELEC. ENG. BRANCH				
DRAWN		17.4.55.	TRACTION (RLYS.)	RULE BOOK
TRACED		4.5.55.	DRIVERS TROUBLE CHART	
	ENG. DSN.	ORG. OFF.	E.E. SINGLE UNIT TRAIN •	
CHECKED			APPROVED	H 3529
PASSED			C.E.E.	



ELECTRO-PNEUMATIC VALVE

F 5940