B.R.33057/16
D.T.S.51

BRITISH RAILWAYS - WESTERN REGION

CLASS 47 LOCOMOTIVES

ELECTRICAL EQUIPMENT

M. & EE. Training Unit,
SWINDON.

July 1975.
1st Edition.

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ELECTRICAL MACHINES.

Main Generator.

The main generator is driven from the engine crankshaft through synchronising gears at 1.44 times engine speed, see Sulzer engine section. It has three fields, a starting field in series with the armature, a self field excited or energised by the generator itself, and a separate field which is excited from the auxiliary generator (series parallel locomotives). or alternator (all parallel locomotives), large alternator E.T.H. locomotives.

The excitement of the auxiliary generator, or alternator, in turn being controlled by Load Regulators, the detail being shown on page 3.

Traction Motors.

The traction motors are series wound machines, so designed to give a high starting torque; they are geared to the axle by a single reduction gearing. Some locomotives have their motors wired in series pairs, in parallel across the main generator (series parallel); others are wired in parallel across the main generator (all parallel).

Overload Relays.

An overload relay is provided for each pair of motors on series parallel locomotives, and for each motor on all parallel locomotives.

These operate at 1800 - 1850 amps series parallel locomotives, and 1550 amps all parallel locomotives but will not operate under normal conditions, only the abnormal, or fault condition, as previously explained in the basic electricity section.

In the event of an overload operating, power will be cut off and the engine returned to idling. The 'Blue' fault light on the desk will become bright as will the 'Overload' fault light on the cubicle.

Auxiliary Generator.

The auxiliary generator is on the same shaft as the main generator. The electrical output from it drives the auxiliary machines and charges the batteries. The voltage is controlled at 110 by an automatic voltage regulator.

Locomotives are being progressively fitted with electrical train heating and the auxiliary generator is being replaced by an alternator. This has two outputs, one set at 110 volts for driving the auxiliaries, control and battery charging; the other at 775 - 920 volts for train heating. One voltage regulator controls both outputs.

A bridge rectifier is used to prevent the battery discharging into the auxiliary generator. A fuse protects the rectifier.

Auxiliaries.

Triple Pump Set.

One 15 h.p. motor drives three pumps, namely Water Circulation, Fuel and Lubricating Oil Priming. This makes for robust construction and easier maintenance.

The pump set runs off the batteries when the engine is not running, and the auxiliary generator when the engine is running. The motor runs at a preset speed with the engine stopped and speeds up when the engine has started. Locomotives are being progressively fitted with a timing relay which stops the motor after two minutes; this is to save battery discharge when the engine is NOT running. The relay may be reset by moving the reverser to 'OFF' and back to E.O. position again.

Compressor Motors.

Two sizes:-

Air/Vacuum Braked Locomotives
1 - 9 h.p. at 2900 r.p.m.

Dual Air Braked Locomotives
2 - 13 h.p. at 3625 r.p.m.

Traction Motor Blowers.

2 Continuous rating of 11.9 h.p. at 1855 r.p.m.

Exhausters.

Two types are being used:-

(i) The Reavell type whose motors have a continuous rating of 2.5 h.p. at 715 r.p.m., and an intermittent rating in 'speed-up' condition of 5.25 h.p. at 1430 r.p.m.

(ii) The 'Northey' exhausters have a continuous rating of 4.25 h.p. at 1250 r.p.m. and 6.5 h.p. at 1850 r.p.m. intermittent rating, 'speed up' condition.

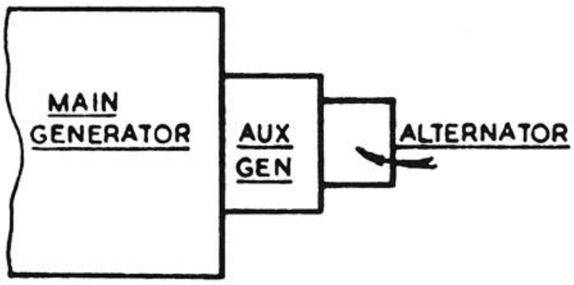


FIG I

Series Parallel Locomotives.

The small alternator provides A.C. current supply for the wheelslip detection circuit.

All Parallel Locomotives.

The large alternator provides the separate field of the main generator.

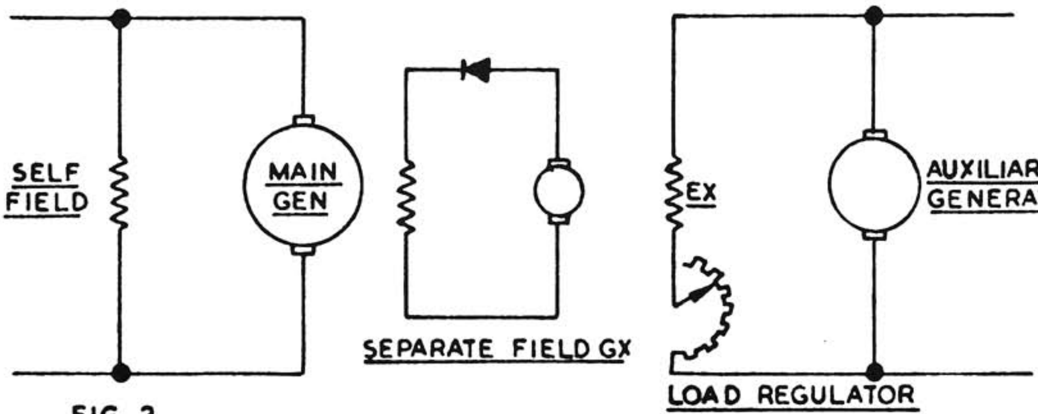


FIG 2

All Parallel Locomotives (Fig. 2).

The auxiliary generator provides the field excitement EX of the alternator under the control of the load regulator; the output of the alternator will depend upon the position of the load regulator arm. The output of the alternator is rectified to DC current to provide the separate field of the main generator, so that the alternator in turn controls the output of the main generator. The main generator also has a 'self field', which is accumalative. On the series/parallel locomotives the separate field is directly excited by the auxiliary generator under control of the load regulator (Fig. 3).

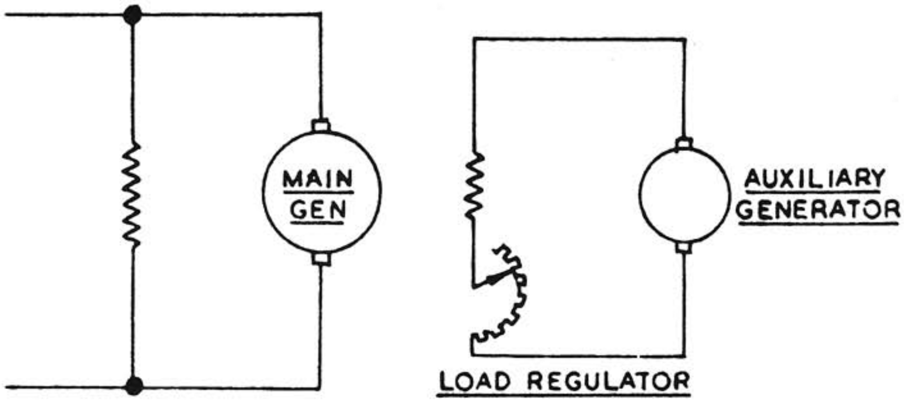
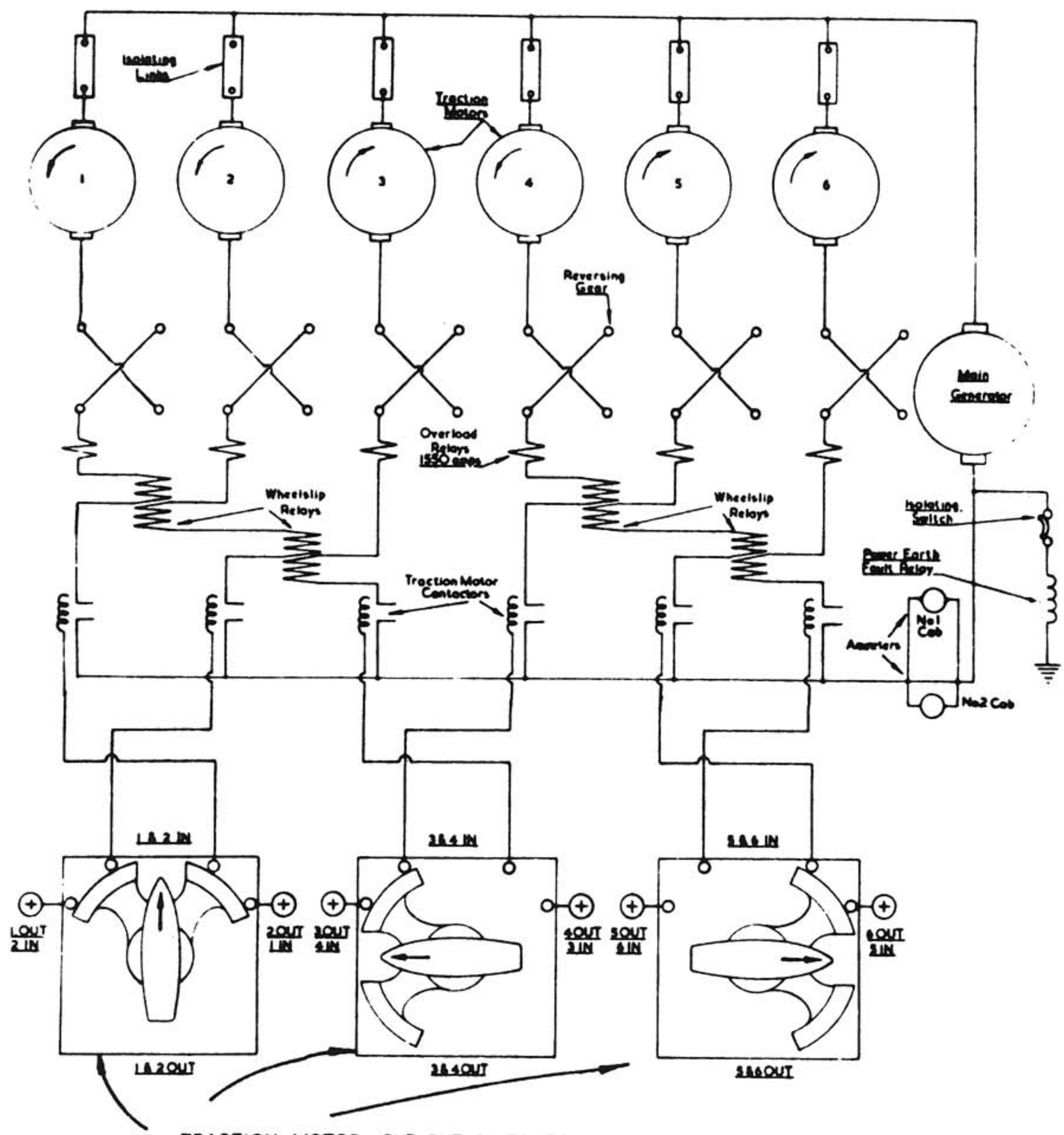


FIG 3

FIG 4 SIMPLIFIED POWER CIRCUIT WITH TRACTION MOTOR CUT-OUT SWITCHES, POWER EARTH FAULT RELAY AND OVERLOAD RELAYS



EARTH FAULT RELAYS.

Power Earth Fault Relay.

There is a connection from the 'Power Circuit' to the frame of the locomotive (earthed), and if a fault to earth occurs an 'earth fault relay' within the circuit will sense the fault and pick up at 24 volts and cut off power.

If the power controller is closed and re-opened after first allowing time for the load regulator to run back, power is again obtained, but if the leakage to earth through the frame is sufficient, the relay will again operate.

If the earth is being caused by a fault on the main generator or associated circuits, an isolating switch, which isolates the earth fault relay, must be opened by turning the switch to the Power Isolated position (Fig. 4, page 4). If upon loss of power the alarm light on the desk (which brightens when the fault occurs) is preceded by an 'Amber' wheelslip light, it is to be assumed that a traction motor/s is at fault, whereupon the offending motor can be isolated instead of isolating the earth fault relay.

WHEELSLIP DETECTION.

Series Parallel Locomotives.

On Series/Parallel locomotives a connection is taken from a point on the power circuit between two motors in series; this detects a change in voltage if one motor accelerates (i.e. wheelspin). This voltage is amplified and used to operate a wheelslip relay.

All Parallel Locomotives.

In each motor circuit is a coil which senses 'current flow'. The coil in one motor circuit is in opposition to the coil in an adjacent motor circuit (Fig. 4, page 4 and Fig. 5, page 8). If one pair of wheels spin,the motor driving them will take less current and the coils become unbalanced when the difference in current reaches 200 amps, and it operates the wheelslip relay.

On both types of locomotives the wheelslip relay will energise the load reducing solenoid in the Governor and cause the load regulator to run back and reduce the generator output, i.e. reduce power and cause the wheelslip light on the desk to brighten.

NOTE:- On the All Parallel locomotives, No. 2 and No. 5 motors have two coils in opposition to the coils of the motor adjacent to them. Isolation of motors 2 or 5 will render the wheelslip detection inoperative for that particular bogie.

Because a defective traction motor would also vary current flow and a change in voltage, the wheelslip detection is also used to detect faulty traction motors.

FIELD DIVERT CONTROL.

Field diversion is effected either by relays which are controlled by the load regulator or an electronic device which is operated by roadspeed (speedo generator), and is independent of relays and the load regulator.

Locomotive with Relays.

Diversion takes place with the locomotive speed increasing at 33-45 and 61 m.p.h., when the load regulator reaches maximum field it closes a switch to initiate the field diversion.

The load reducing solenoid within the governor, and referred to in the engine section, is also energised which causes the load regulator to run back and thus unloading the main generator.

When the sequence is complete, the load regulator is again under control of the engine governor.

In each case if the main generator reaches 500 volts before the load regulator reaches maximum field, a voltage limit relay will initiate field weakening (diversion).

Conversely when the locomotive speed decreases and the traction motor current reaches a preset value, i.e. 800 amps per motor, the respective stages of field reversion (field strengthening) will take place.

When the power controller is closed, all stages that may be in, will drop out.

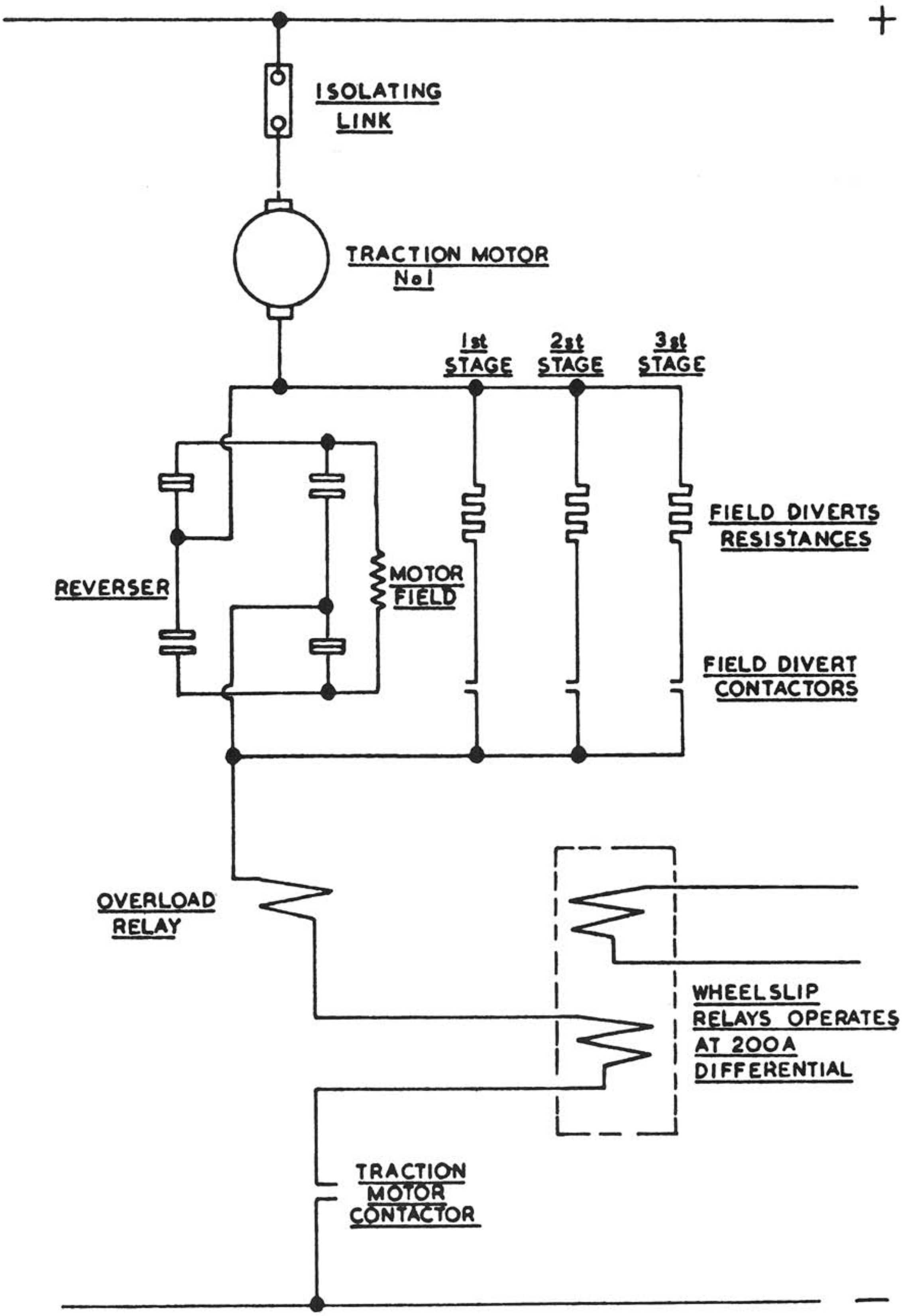


FIG. 5. SHOWING ONE TRACTION MOTOR CIRCUIT AND FIELD DIVERSION SYSTEM

SPEED INDICATING EQUIPMENT.

On some locomotives the speed indicating equipment is used to obtain field weakening (diversion). This consists of a toothed wheel on the axle which disturbs the magnetic field which is sensed by a probe; this small signal is amplified by an electronic circuit and fed to the speedometers in the cabs, and will also initiate the field weakening.

Prior to the operation of the field divert contactors, a load reducing solenoid in the governor (referred to in engine section) is energised as before to reduce generator output for a short period. The operation of the field divert system is dependent purely on road speed. Once a stage has come in, it will not drop out until the speed has fallen to a certain figure as follows:-

	Stage In.	Stage Out.
1st Stage	30 - 32 m.p.h.	27 - 29 m.p.h.
2nd Stage	40 - 41 m.p.h.	38 - 40 m.p.h.
3rd Stage	58 - 60 m.p.h.	60 - 57 m.p.h.

Being entirely dependent on road speed, the field weakening stages do not drop out when the controller is closed, as happens when the field control is by a load regulator, so that if the controller is re-opened at speed, full power is quickly available as distinct from the load regulator operated circuits.

TRACTION CURRENT LIMITER.

The traction current limiter, when fitted, is situated above the instrument panel slightly to the right of the driver's power controller; it consists of a box with a knurled controlling knob.

The limiter enables the driver to select any maximum generator current between 0 and approximately 7200 amps, provided the load is such that the generator current demand is at; or above, the preselected value. When the demand falls below the preselected value, the load regulator will control the current in the normal way.

The device is only operative in the traction motor full field condition, i.e. up to approximately 30 m.p.h. It is not operative in the fully RAISE position.

Turning the controlling knob in a clockwise direction, towards the 'Raise' position, increases the current limit. Likewise, turning the knob in an anti-clockwise direction, towards the 'lower' position, decreases the current limit.

Operation.

In normal conditions, when the load and road conditions are good, the control knob should be in the fully 'raise' position.

Should difficulty be experienced in starting a train due to bad rail conditions, or a heavy load, the driver should set the control knob of the traction current limiter approximately halfway between the 'raise' and 'lower' positions and open the power controller to full position. The main generator output will rise to between 4500 and 5500 amps and remain steady.

If on a rising gradient, when sufficient amps have built up to ensure that the applied power will safely hold the train weight, the straight air brake should be released. The controlling knob should then be moved slowly to increase, or decrease, the amps as required to avoid wheelslip.

The antislip brake should be used in conjunction with the control knob until the risk of wheelslip is eliminated.

NOTE:- Attention is drawn to a condition which can arise, particularly when changing ends.

If after changing ends a condition of no power is experienced, it is advisable to check the traction current limiter controlling knob in both cabs is in the fully raise position.

DRIVING CONTROL CIRCUITS (FIG. 6).

To move the locomotive from rest under its own power it is necessary for the control circuits to:-

(a) Set the reverser switches to the required direction of travel.

(b) Close the motor contactors.

(c) Excite the generator separate field.

Before this sequence can take place a number of protective devives must be in their normal functioning positions, and for these to be effective it is usual to have a power control relay (P.C.R).

The P.C.R. is energised when the master switch is placed in the FORWARD or REVERSE position providing:-

(a) The automatic warning system A.W.S. is in use.

(b) The exhauster switches EXIS 1 and 2 are in the normal position.

(c) The load regulator has run back.

(d) The starting contactors have not stuck in, or the overload relay operated.

When the power controller is moved to the 'ON' position, the overlapping of the cams allows P.C.R. to remain energised until the 'ON' position is reached when, providing the following protective devices are correct, P.C.R. will be kept energised.

NOTE:- Its own auxiliary contacts P.C.R(b) ensures the power controller is returned to 'OFF' before power can be regained after a fault occurs.

(a) The air pressure in the brake system is high enough to close the Control Circuit Governor (C.G.G. 87½ p.s.i.) and brake pipe pressure to close the Auto Air Governor (A.A.G. 60 p.s.i.).

(b) The vacuum is 15" Hg, or more, which will close the Vacuum Control Governor (V.C.G.).

(c) The Vacuum Control Governor (V.C.G.) is shorted out by the Brake Selector Switch (B.S.S.) when in an air braked position.

With P.C.R. now maintained in the energised position, its auxiliary contacts will maintain the circuit to energise the generator separate field, providing the engine maintenance switch (E.M.S.) is in the NORMAL position, and all traction motor contactors have made contact.

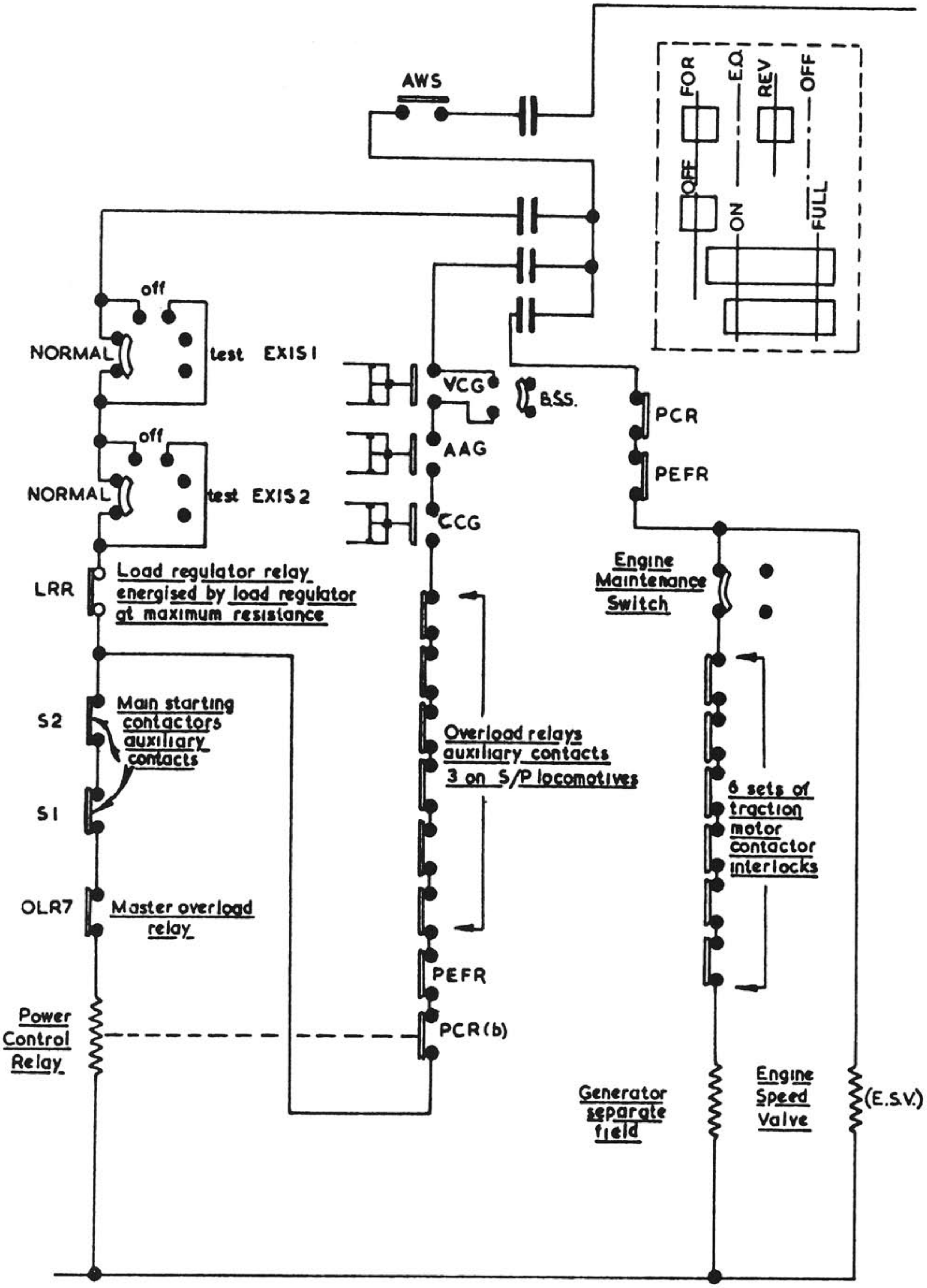


FIG 6 DRIVING CONTROL CIRCUITS

The engine speed valve (E.S.V.) will also become energised but is not interlocked by the traction motor auxiliary contacts, thus allowing the engine to be accelerated under maintenance without current flowing to the traction motors.

From the foregoing it will be seen that when the locomotive is in power that, if the following faults occur, power will be cut-off and the engine returned to idling.

(a) Electrical overload or earth fault.

(b) Loss of main air pressure below 65 p.s.i.

(c) Loss of Auto Air Brake Pipe pressure to below 42½ p.s.i.

(d) Loss of vacuum below 12½" Hg.

REVERSER CIRCUITS (FIG. 7).

The reverser circuits of locomtoves are not energised until the controller is advanced to notch 1 'ON'. Therefore, if the reverser contacts are set for the wrong direction of travel, they will not operate merely by the movement of the driver's master switch to the selected direction of travel, but they will function when the power controller handle is moved to notch 1 'ON'. When the reverser is in the desired direction the motor contactors will close.

In the circuit shown in Fig. 7 (page 14) the positive supply from the battery is fed to a switch in the master controller. When the handle is moved to 'ON', the supply is fed to the master switch. With the direction of travel set by this and provided all the traction motor contactors are out, the current will pass to the appropriate EP valve, which moves the reverser to the required direction of travel. Providing this happens correctly, the appropriate interlock will close.

Current will then flow to the traction motor contactor EP valves providing:-

(a) The starting contactors for engine start No. 1 and 2 came out after the engine started.

(b) The load regulator has run back to the minimum field position.

Referring now to the driving control circuits (Fig. 6, page 12), it will be seen that providing the traction motor contactor interlocks are made the generator separate field will now be energised and the locomotive will move off.

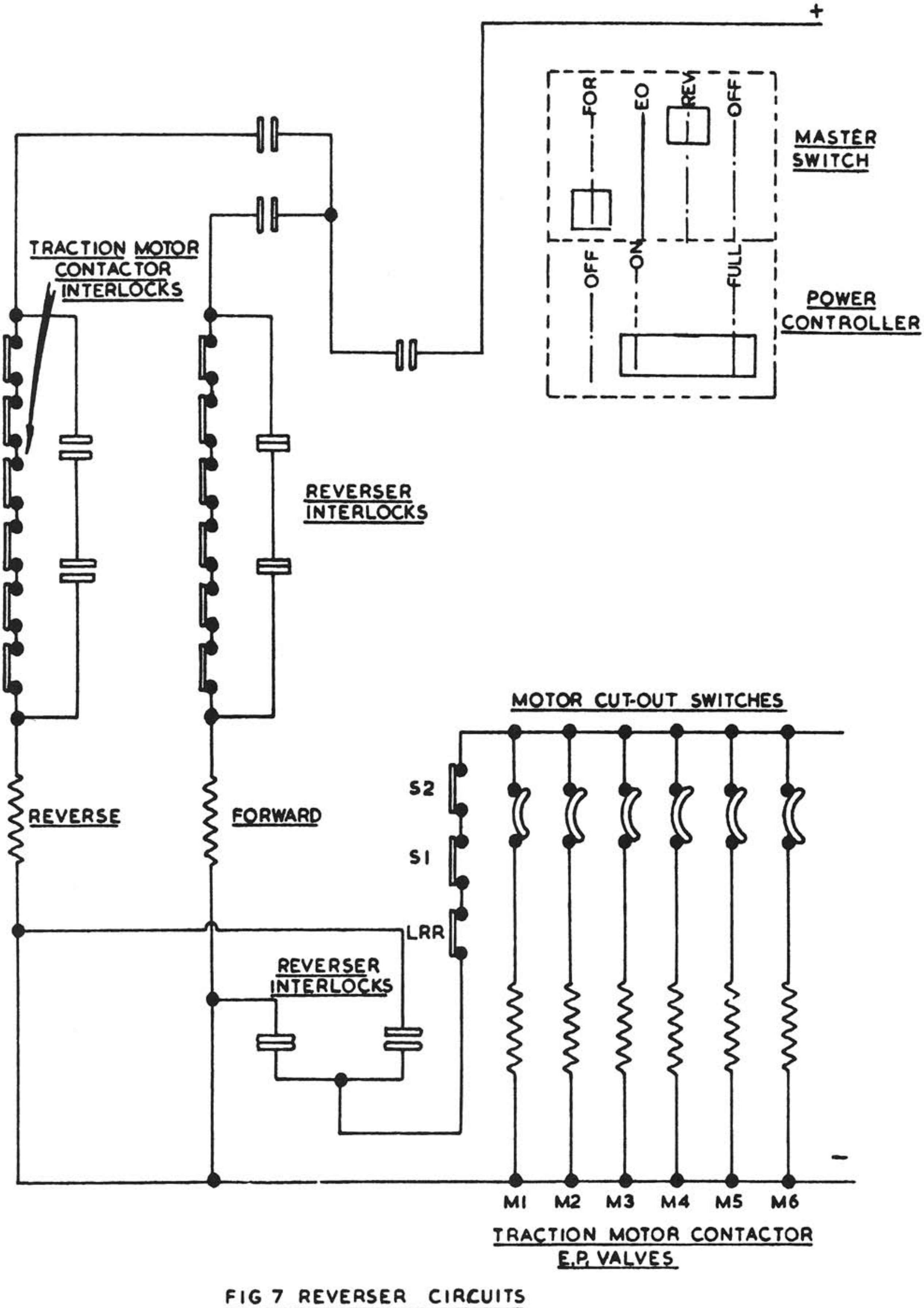


FIG 7 REVERSER CIRCUITS

STARTING THE ENGINE.

The two basic requirements for the starting of the diesel are:-

(a) Crank the engine around above the minimum firing speed 200 r.p.m.

(b) Open the fuel racks and inject fuel into the cylinders.

The engine is cranked by using the main generator as a motor, supplied with electrical power from the battery, two starting contactors are used; thus the generator is completely isolated from the battery circuits, except when starting.

The admission of fuel into the cylinders is controlled by the engine run valve, in conjunction with the dictates of the engine speed governor.

Together with these two basic requirements, there are a number of safeguards which are incorporated in the start control system:-

(a) The master switch must be put to the EO position before the engine start button will become effective.

(b) Certain auxiliary machines will have to be run before attempting to start the engine, i.e. triple pump set, compressor if prestart air is necessary. The triple pump set ensures that the fuel racks will open quickly, and that the fuel oil and water pressure are available.

(c) Before connecting the battery to the main generator, it is important to ensure the traction motor contactors are open and this detection is achieved by tell-tale, or interlock, auxilairy contacts. The auxiliary contacts are closed only if the main contactors are open. (Note that modifications are now being made on some locomotives so that traction motor contactors will close when direction is selected. This is to overcome the problem of burnt contacts.)

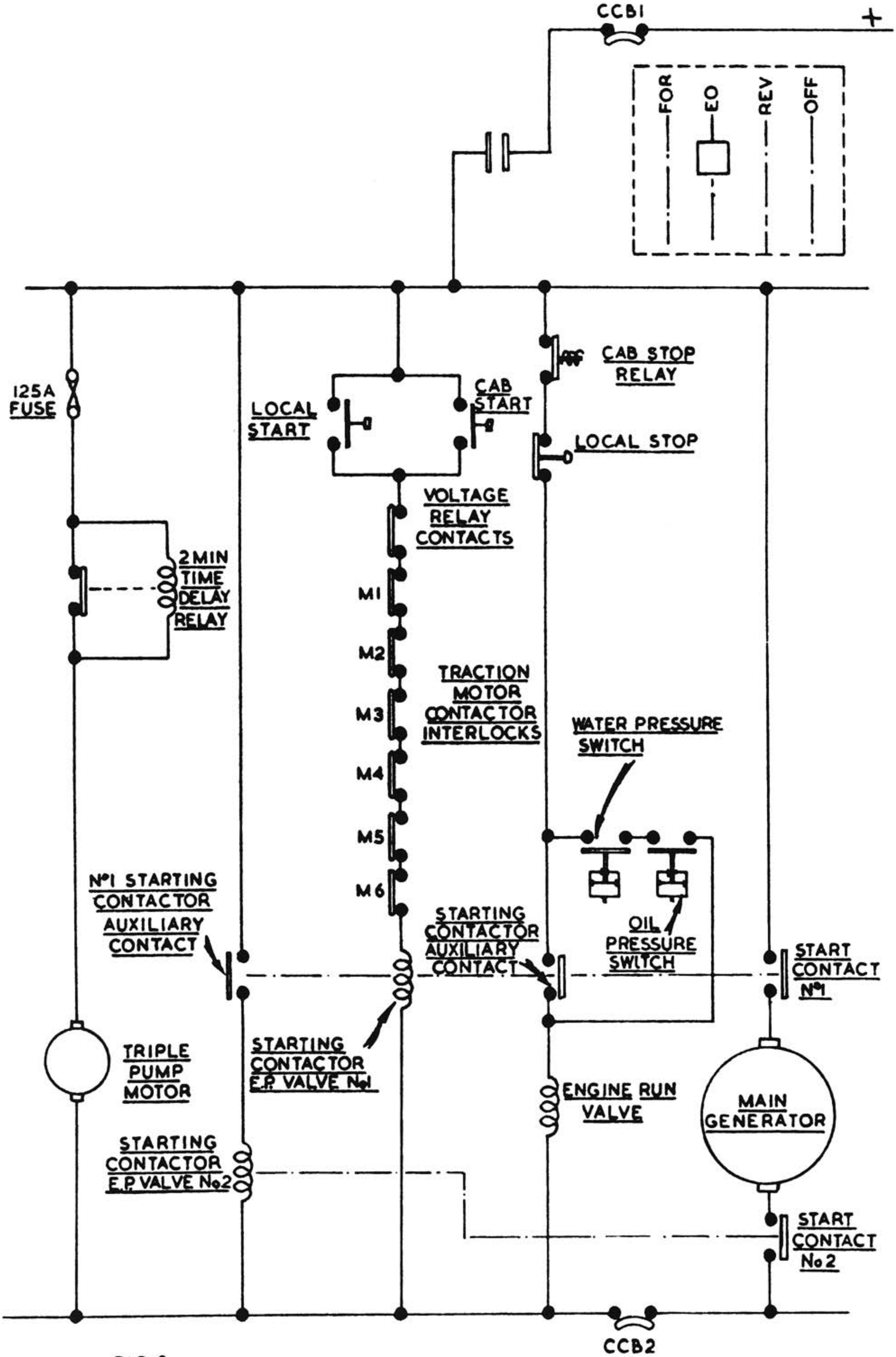

CCB1
+
FOR
EO
REV
OFF
125A FUSE
LOCAL START
CAB START
CAB STOP RELAY
LOCAL STOP
VOLTAGE RELAY CONTACTS
2 MIN TIME DELAY RELAY
M1
M2
M3
M4
M5
M6
TRACTION MOTOR CONTACTOR INTERLOCKS
WATER PRESSURE SWITCH
Nº1 STARTING CONTACTOR AUXILIARY CONTACT
STARTING CONTACTOR AUXILIARY CONTACT
OIL PRESSURE SWITCH
START CONTACT Nº1
TRIPLE PUMP MOTOR
STARTING CONTACTOR E.P. VALVE No1
ENGINE RUN VALVE
MAIN GENERATOR
STARTING CONTACTOR E.P. VALVE No2
START CONTACT No2
CCB2

FIG 8

ENGINE START SEQUENCE (FIG. 8).

(i) Close battery isolating switch.

(ii) Check control circuit breakers 'ON'.

(iii) Insert key in master controller and select 'EO' position.

NOTE:- If 'EP' starting contactors are fitted the compressor will run to build up prestart air; at 48 p.s.i. the prestart governor will operate to stop the compressor.

Triple Pump runs to provide:-

(a) Fuel for engine fuel pumps.

(b) Lubricating oil for engine and governor.

(c) Engine cooling water circulation.

Press Cab Start Button.

All traction motor contactors out, No. 1 starting contactor will become energised and its contacts will make.

Its auxiliary contacts will energise No. 2 starting contactor and the engine run valve to open the fuel racks.

The battery is now connected across the main generator and the engine is motored.

Diesel Engine Fires.

Engine driven mechanical oil pump runs and builds up lubricating oil pressure; at 16 p.s.i. run oil pressure switch R.O.P.S. closes.

Release Start Button.

Starting contactors de-energised and contacts open. Engine Run Valve kept energised through Water Pressure and Run Oil Pressure Switches.

If Local Start Button is used, controller must be in 'E.O.' position.

Stop Sequence.

PRESS CAB STOP BUTTON.

Stop Relay energised to de-energise Engine Run Valve.

PRESS LOCAL STOP BUTTON.

Stop button contacts open to de-energise Engine Run Valve.

FAULT INDICATOR LIGHTS AT THE DRIVING DESK.

RED (Engine Stopped).

BRIGHT when the engine is stopped.

DIM when the engine is running.

The diesel engine is automatically shut down should any of the following faults occur:-

(a) Low lubricating oil pressure.

(b) Low water pressure.

(c) Engine overspeed.

The corresponding Fault Light on the control cubicle becomes BRIGHT. The diesel engine will also stop through fuel starvation.

AMBER (Wheelspin) Normally DIM.

This becomes BRIGHT in the event of one or more pairs of wheels spinning. If this occurs, power is automatically reduced. This, however, does not relieve the driver of any responsibility in taking the necessary action to avoid wheelspin.

Alternatively, persistent wheelspin indication when wheelspin is NOT apparent indicates that a traction motor is defective, or that one of the locomotive hand brakes is on.

BLUE (Fault) Normally DIM.

This becomes BRIGHT should any of the following faults occur:-

(a) High water temperature (185°F) (195°F modified locomotive) WATER TEMPERATURE FAULT light on control cubicle also BRIGHT. Both lights DIM when water temperature is restored to NORMAL (170/175°F).

(b) Loss of air pressure or vacuum causing loss of traction power when the power controller is open. DIMS when the controller is returned to OFF.

(c) Power Earth Fault. DIMS when the controller is returned to the OFF position. EARTH FAULT light on control cubicle also becomes BRIGHT.

(d) Overload relays tripped remains BRIGHT when controller is returned to the OFF position. OVERLOAD FAULT light on control cubicle also becomes BRIGHT.

(e) Blower motor stopped. BLOWER FAULT light on control cubicle is also BRIGHT. Both lights DIM again if blower is restarted.

(f) Fuel oil supply is only 38 gallons. FUEL FAULT light on control cubicle is also BRIGHT. Both lights DIM when supply is restored.

(g) Load regulator arm not run back to the 40 or 300 position after coasting and power cannot be regained on opening the controller. No other fault is indicated.

(h) Low water level in header tank pressurised cooling groups only, coolant level down to 12 gallons.

The blue fault lights are normally DIM and become BRIGHT when a fault occurs.

FAULT INDICATOR LIGHTS ON CONTROL CUBICLE (FIG. 9).

Oil Pressure.

This light becomes BRIGHT if the diesel engine is stopped because of low lubricating oil pressure (below 12 p.s.i.). The RED (Engine Stopped) light at the driving position also becomes BRIGHT.

If the diesel engine is subsequently restarted, the oil pressure light will remain BRIGHT as an indication that an oil pressure fault has occurred. See description of the lubrication system for action to be taken.

Water Pressure.

This light becomes BRIGHT if the diesel engine is stopped because of low cooling water pressure (below 4 p.s.i.). The RED (Engine Stopped) light at the driving position also becomes bright.

If the diesel engine is subsequently restarted, the water pressure light will remain BRIGHT as an indication that a water pressure fault has occurred. See description of the cooling water circuit for action to be taken. On the 'pressurised' systems this light also becomes bright when the level in the header tank reaches 12 gallons.

Water Temperature.

This light becomes BRIGHT if the cooling water temperature reaches 185°F. The BLUE (warning) light becomes bright at the driving position whether the power controller is open or closed. Both lights DIM when the correct water temperature is restored. See description of the cooling water system for action to be taken.

On the 'pressurised' systems the light becomes bright when the cooling water temperature reaches 195°F.

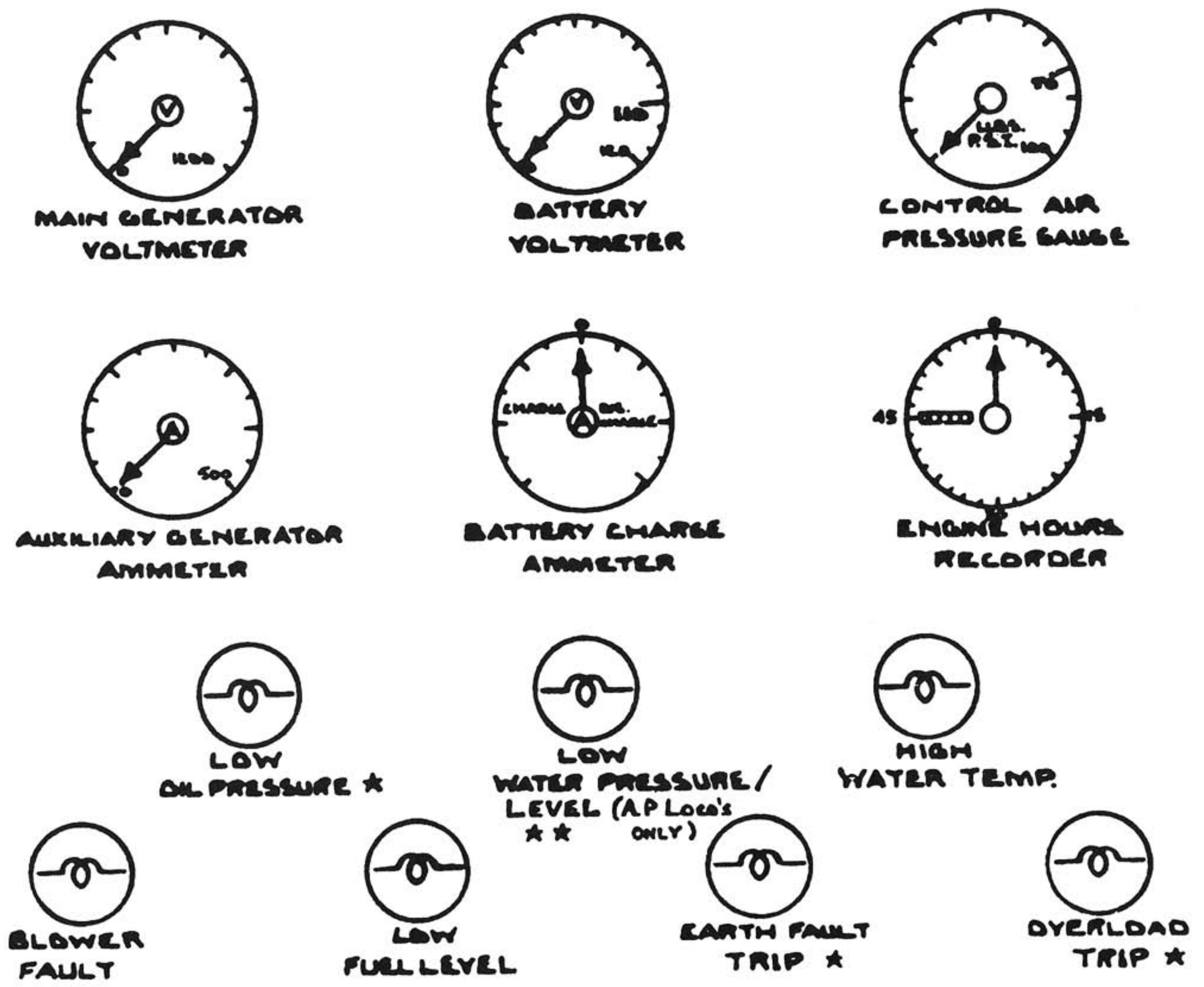


FIG 9 INSTRUMENT & FAULT LIGHT PANEL

★ LATCHED RELAY
★★ LATCHED FOR LOW WATER PRESSURE ONLY

Blowers.

This light becomes bright if one or both motor blowers stop. The BLUE (warning) light at the driving position also becomes bright whether the power controller is open or closed. If a change of fuse fails to restart the blower, the locomotive may proceed normally (subject to any maximum or temporary speed restriction) keeping speed as high as possible with a minimum MAIN AMMETER reading, i.e. do not exceed 2100 amps series parallel locomotives, 4200 amps all parallel locomotives.

Low Fuel Level.

This light becomes BRIGHT if the fuel supply has fallen to 38 gallons. The BLUE fault light at the driving position becomes BRIGHT. See description of the fuel oil system for action to be taken.

Earth Fault.

This light becomes BRIGHT should a power earth fault or an auxiliary earth fault occur. If it is a power earth fault, traction power only will be lost; the BLUE (warning) light at the driving position will become BRIGHT also, but ONLY when the power controller is open, it will DIM when the controller is returned to the OFF position. If it is an auxiliary earth fault, traction power may not be lost, though it is possible for this fault to trip out the control circuit breakers. The Earth Fault light remains bright even if the fault is subsequently rectified.

NOTE:- On E.T.H. locomotives the light will become bright when there is an earth fault on the train heating circuits. Train heat will be cut off.

Overload.

This light becomes bright in the event of excessive current or 'flashover' conditions occurring on any traction motor so causing the appropriate overload relays to 'trip'. The light will remain BRIGHT although the relay may be reset when the Overload Reset Button on the driving desk is pressed.

NOTE:- The Oil Pressure, Water Pressure, Earth Fault and Overload fault lights will remain BRIGHT even though the particular fault may have been subsequently rectified. This serves to indicate that a fault has occurred. Electrical relays in the control cubicle should not be reset by the driver.

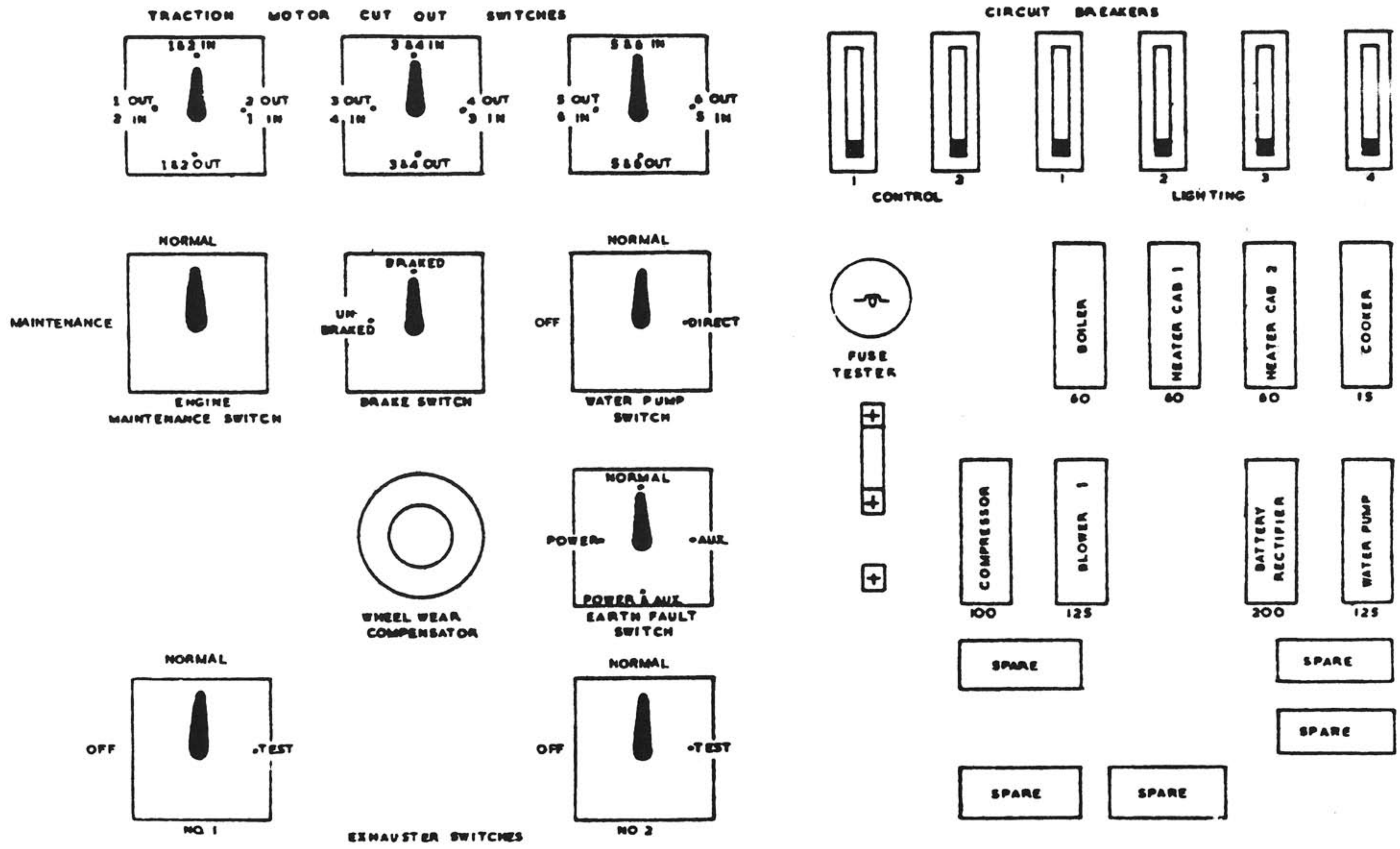


FIG 10 SWITCH, CIRCUIT BREAKER & FUSE PANEL PARALLEL LOCOMOTIVES

SWITCHES ON CONTROL PANEL (FIGS. 10 AND 11).

Traction Motor Cut-out Switches.

Either of three switches, when placed in the OUT position, will isolate one pair of motors series parallel locomotives, one motor all parallel locomotives, as indicated on the appropriate switch.

NOTE:- On no account must these switches be operated when the power controller is in a power position.

Water Pump.

This switch should normally be in the AUTO position. If for any reason the water pump stops, the diesel engine will stop (or cannot be started). In this event place the switch to the DIRECT position and check if the pump starts to run; if not return switch to AUTO position, check and renew the pump fuse if necessary. The OFF position stops the pump.

Brake Selector Switch.

This will be placed in a position appropriate to the class of train to be worked, see Davies and Metcalfe brake section.

Earth Fault Isolating Switch.

This switch should be in the NORMAL position. In the POWER position the Power Earth Fault relay is isolated. In the AUXILIARY position the Auxiliary Earth Fault relay is isolated.

If a Power Earth Fault develops, causing a complete loss of traction power, which does not clear after resetting (not more than twice) and only the EARTH FAULT light on the control cubicle is BRIGHT, then the switch should be placed in the POWER position. If, however, the FAULT light on the desk was preceeded by the AMBER fault light, the switch should be left in the NORMAL position and the traction motors isolated and tested in turn as detailed in the Electrical Equipment notes.

In both cases just described the matter MUST be reported at once with a request for a replacement locomotive.

Engine Maintenance Switch.

This switch must be in the NORMAL position. The MAINTENANCE position is for the use of maintenance staff, TRACTION POWER CANNOT BE APPLIED IN THIS POSITION.

Exhauster 1 and 2.

The NORMAL and OFF positions are self-explanatory. In the TEST position, the exhausters will run but TRACTION POWER CANNOT BE APPLIED, or the auxiliary generator field contactor circuit is broken and the engine will stop when the TRIPLE PUMP stops.

NOTE:- Fuses are not provided in the exhauster motor circuits. If a defect arises in either exhauster, it can be isolated by placing the appropriate switch to OFF.

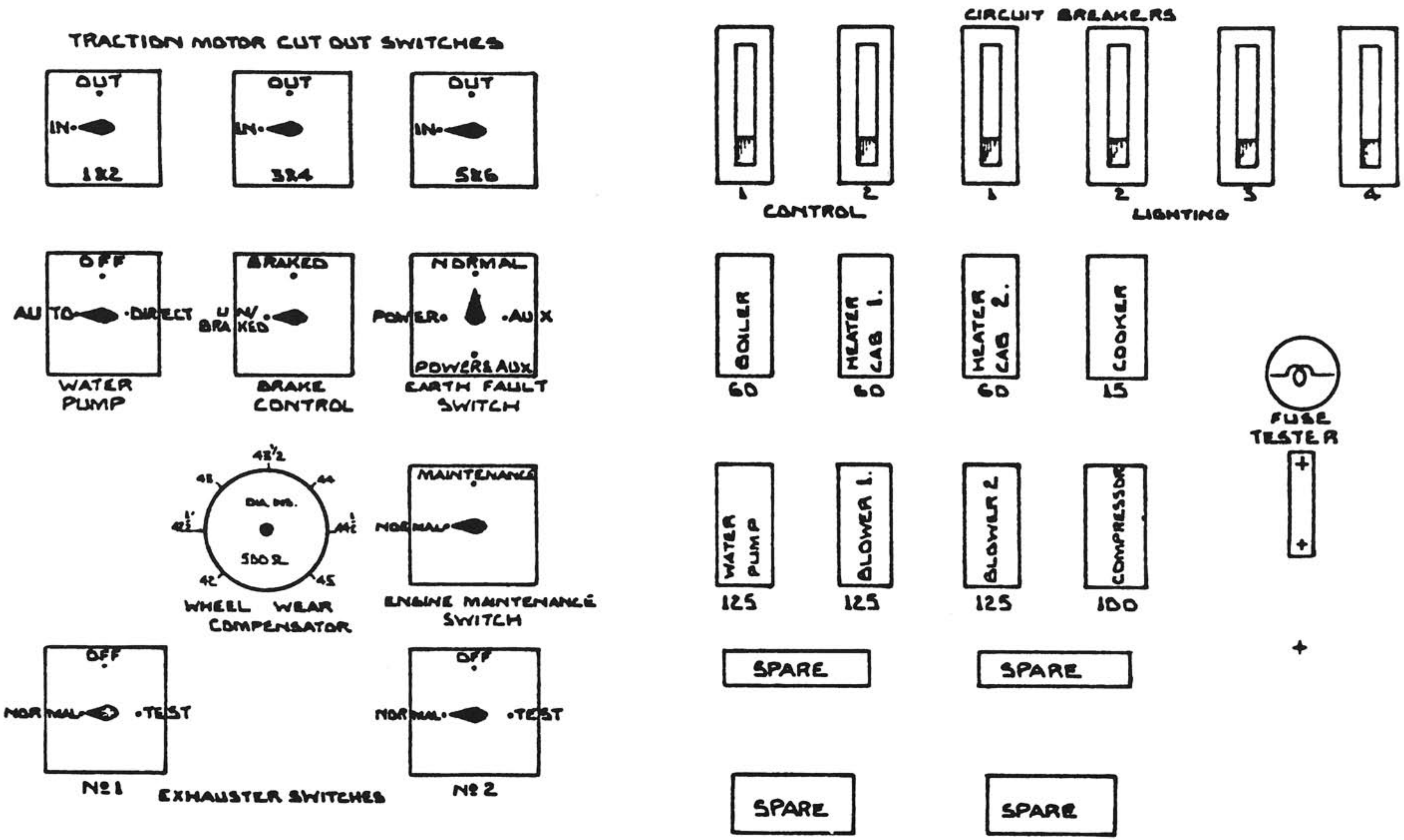


FIG 11 SWITCHES, CIRCUIT BREAKER AND FUSE PANEL
SERIES PARALLEL LOCOMOTIVES

Circuit Breakers.

Control 1 and 2.

These breakers control the electrical supply to ALL the locomotive control circuits. If either or both 'trip' to the OFF position, all control of the locomotive is lost. If the engine is running it will stop and if the locomotive is under power, power will be lost. The brake will be fully applied through the drivers safety device and, in addition, all indicator lights will go OUT. Reset the breaker/s not more than twice. If the Earth Fault light is BRIGHT, place the Earth Fault Switch to AUXILIARY. If the fault persists, the locomotive is a failure.

Lighting 1, 2, 3 and 4.

These control sections of the locomotive lighting circuits and are shown on the accompanying diagram.

ELECTRIC TRAIN HEATING.

An alternator driven by the diesel engine supplies both auxiliary and train heating power. The alternator has two separate three-phase output windings, both of which are rectified by means of a silicon diode full-wave bridge rectifiers. The rectified output of one winding provides auxiliary power at 110v D.C. and the rectified output of the other provides train heating power at 825v D.C.

The D.C. field of the alternator is controlled by an Automatic Voltage Regulator (A.V.R.) which maintains the correct auxiliary supply voltage at 110v D.C. (nominal), but with voltage reduction to suit battery charge conditions. The maximum battery charge current is set by means of a control on the A.V.R. Because the D.C. field of the alternator is controlled by the auxiliary supply (110v), the train heating supply voltage will vary within a range of 775v - 920v, depending upon the auxiliary load, battery condition, engine speed and train heating load.

The auxiliary and train heating supply rectifiers are positioned in front of the alternator so that the diodes and heatsinks are cooled by air passing through the alternator. The train heating control equipment (relays, contactors, resistors and fuses etc.) is mounted in cubicles above the two rectifiers.

The alternator output windings are protected by thermal overload detection elements in conjunction with current transformers and an Alternator Field Contactor.

The train heating control circuits are protected by their own circuit breaker which is mounted in the train heating control cubicle.

To avoid engine overload when the train heating load is heavy, the engine idling speed is permanently increased to 380 r.p.m.

Before train heating can be applied the following conditions must be satisfied:-

(a) The train heating plugs and sockets must be connected to the vehicles to be heated or the plugs must be fitted in the 'dummy' sockets, if not heating vehicles, to complete the interlock circuit.

(b) Circuit breakers CCB and THCB must be switched ON.

(c) An air supply exceeding 50 p.s.i. must be available to the heating contactors.

(d) The heating indicator lamps must not be illuminated. If heating is being supplied from another source, i.e. another locomotive or shore supply, the heating indicator lamps will be lit. However, a control interlock will prevent the heating contactors from closing if the 'TRAIN HEAT ON' button is pressed.

The train heat indicator lamps will light when the train heat ON button is pressed even when there is a fault and train heating is not available.

Normally the train heat indicator lights will remain illuminated when the heating supply is connected after the train heat ON button is released. However, if there is a fault the lights will not remain on after the ON button is released.

Train Heat Interlocks.

Should a train heat supply plug be removed, or a connection be accidentally broken when the train heating supply is switched on, the train control loop will be broken and contactors will drop out. The supply cannot be regained until the loop is restored and the train heat ON button is pressed.

If the train heating supply is being provided from another source, and the heating supply cables are connected between the locomotive and leading vehicle, then the control loop is completed by train heat relay contacts. Its other contacts isolate the train heat control circuit from those on the alternative source.