



British Rail

TECHNICAL TRAINING NOTE E22

AUXILIARY CIRCUITS - DIESEL MULTIPLE UNITS

CONTENTS :-

1. Fire extinguishing equipment.
2. Battery charging.
3. Combustion heaters.

BRITISH RAILWAYS
SCHOOL OF TRANSPORT, DERBY.

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BRITISH RAIL

TECHNICAL TRAINING NOTE E.22

AUXILIARY CIRCUITS - DIESEL MULTIPLE UNITS

1. FIRE EXTINGUISHING EQUIPMENT

1.1 Hand Equipment

Each vehicle in a diesel train is provided, where applicable, with the following hand-operated equipment.

- (1) B.C.F. extinguishers in each driving cab.
- (2) B.C.F. hand extinguisher at the lobby end of each non-brake vehicle.
- (3) B.C.F. hand extinguisher in each brake compartment.

1.2 Automatic Extinguishing System

In addition to hand-operated equipment, a 'GRAVINER' - type automatic extinguisher system is fitted on the underframes of the power coaches.

The circuit for this equipment is described overleaf.

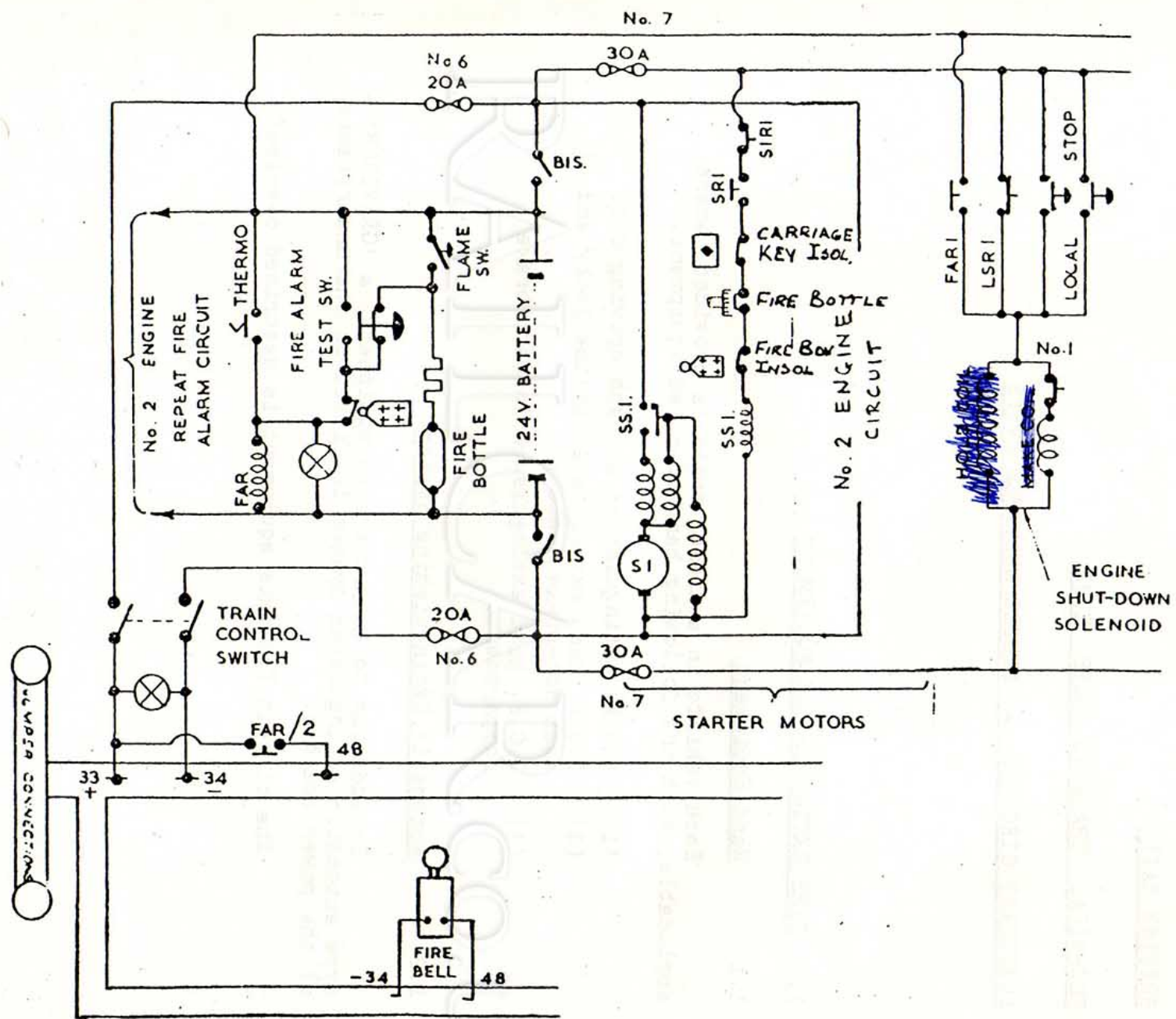


Figure 1. Automatic Extinguishing Equipment
(Electrical circuit for 1 engine shown)

1.2 (Cont'd)

Referring to the schematic diagram opposite, it will be noted that there is a constant supply from the battery to one side of the flame switch. The other side of this switch connects to two separate circuits.

The flame switch can be operated in two ways :-

- (1) By hand
- (2) By the action of excessive heat (over 250°C) on the Pyro-technic cord (explosive wick) within the capillary tube.

Whenever the flame switch closes :-

(1) a current operates the detonator under the fire bottle, and releases a heavy inert gas (chlorobromomethane), which blankets the engine, smothering the fire.

(2) a current flows through the 2-pole switch, illuminating the warning light on the fire-control relay panel and energising the fire-control relay (FAR).

Relay FAR has two contacts, one of which is arranged to energise the shut-down solenoid of the appropriate engine. The second contact passes a feed from positive train wire 33 to train wire 48 to ring all the fire bells on the train.

When the fire has been extinguished, and in order to stop the fire bells ringing, the alloy tab plate on the fire-control relay panel must be pulled off and the 2-pole switch operated. This puts out the light and stops the bells ringing but isolates the starter relay from the starter button for that engine, making it impossible to restart.

In the event of subsequent over-heating or fire, the resetting thermostat will close, causing the bell to ring and the appropriate light to be illuminated, but in this case the bells will continue to ring until the fire has been put out with the hand-operated equipment.

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2. BATTERY CHARGING

2.1 D.C. Generator

On some railcars battery charging (and hence the lighting and auxiliary loads) is supplied from a totally enclosed shunt generator (dynamo).

The dynamo is belt driven from either a road wheel (Trailer Car) axle or from the engine gearbox output shaft (Power Car).

On trailer cars the dynamo has brush gear which is rotated through 90° according to direction of travel; this acts as an automatic reversing switch and ensures that the dynamo polarity is unaffected by a change in direction of rotation.

Two carbon type regulators are provided, one working on current and the other on voltage, the combined effects of the two regulators being such that the maximum rated charging current is held reasonably constant up to approximately 30 volts after which the generator voltage is held constant, giving a taper current characteristic.

This arrangement has the following merits :-

- (a) batteries can be recharged at a fast rate.
- (b) the final taper current characteristic prevents undue gassing and temperature rise.
- (c) size and weight of dynamo is a minimum when charging current is held constant.
- (d) the voltage variations produced at the lamps under varying battery charge and speed conditions are relatively small.

2.1.1 Circuit operation (simplified)

As the train accelerates from rest the voltage produced by the dynamo slowly increases until at approximately 27 volts the cut-out relay energises and connects the cut-out contactor in circuit, which in turn, connects the dynamo to the battery via a swamp resistance.

At the same time a lamp resistance is connected in series with the battery feed to the lamps.

The swamp resistance helps to maintain a steady charging current and the lamp resistance helps to maintain steady voltage across the lamps when charging is in progress.

2.2 A.C. Alternator

Many railcars now use a totally enclosed 24 volt 50 amp 3-phase generator (alternator). The output of the machine is full wave rectified via silicon or germanium type rectifiers mounted away from the alternator in a convection air-cooled box. In addition to housing the rectifiers, the box also houses the current and voltage regulators and the protection unit which safeguards the charging system from damage in the event of a rectifier diode failing.

The alternator is driven from the freewheel (Power Car) or from the axle (Trailer Car). The reversal of direction of rotation which occurs on Trailer Cars does not create any problem with an alternator.

The current and voltage regulators produce a similar output characteristic to that achieved with the dynamo.

2.2.1 Circuit operation (simplified)

As the train accelerates from rest the voltage produced by the alternator slowly increases until the rectified output voltage is above the battery voltage at which point charging will commence.

The alternator field circuit normally obtains its energising current from the rectified output of the alternator, but in the initial build up period the field current is supplied by the batteries. However, once the rectifier output reaches charging potential the field current is supplied from the output, i.e. the machine becomes "self-excited".

At all times the field current is fully regulated by the current and voltage regulators in the rectifier box.

The use of a 3-phase alternator and rectifier unit reduces the maintenance requirements but introduces an additional problem in that any rectifier diode breakdown in the generator output circuit will cause an unbalance in the 3-phase supply from the alternator, will seriously overload the machine, and will drastically reduce the amount of d.c. current available for battery charging.

To safeguard the system against such a contingency an automatically operated protection unit consisting of a relay, a green testing light and push operated test button is incorporated with the rectifier unit.

This relay normally operates with the contacts closed, and as long as a balanced current from the positive and negative lines of the rectifier unit flows through the two opposite wound coils of the relay's common bobbin, the contacts will remain closed.

In the event of a failure of any diode of the rectifier these contacts will open and the green test light will no longer function. When this occurs a diode failure condition is indicated.

3. COMBUSTION HEATER

A large number of diesel multiple-unit trains make use of what are termed combustion heaters, by which hot air is circulated through ducting in the coach. The air to be heated may be drawn from the atmosphere or it may be re-circulated.

Heat is supplied to the air by the heat-exchange principle, which completely separates the heated air supply from the gases resulting from the combustion of fuel in the combustion unit.

This type of heater is almost self-contained, the only requirements being a suitable fuel tank and pipework and an external electrical supply. It is generally mounted beneath the floor of the vehicle.

The principal components of the heater are shown by the sectioned diagram (Figure 2). The combustion unit comprises a fuel pump, a fan for combustion air, a fuel 'slinger' and a glow plug, all within a circular chamber which forms the combustion chamber. Air for combustion is drawn by the fan through the intake tube into the motor housing, past the fuel pump into the impeller inlet and from the impeller through a diffuser into the combustion chamber.

Fuel is drawn from the fuel tank by the pump and delivered through a small pipe into the periphery of the fuel 'slinger'. As this is rotating at approximately 3,500 r.p.m. the fuel is discharged radially in a finely divided spray which ensures a thorough mixing with the incoming combustion air.

Ignition of the mixture of fuel and air is by a glow plug when the heater is first put into operation from cold; once combustion has begun it is self-sustaining. The heat exchanger is formed from a continuation of the wall of the combustion chamber beyond the baffle, so placed as to confine combustion but to provide an outlet for the hot gases. Four radial ports lead from the heat exchanger through the heated-air passage to the exhaust outlet.

The air to be heated is drawn into the heater by an axial-flow fan. The cold air passes over the walls of the heat exchanger, from which it picks up a portion of the heat of combustion, and so through the action of the fan to the distribution ducting in the vehicle.

A single electric motor is provided to drive the fuel pump, the fan for combustion air, the fuel 'slinger' and the fan for hot-air circulation. By this arrangement the fuel quantity and the combustion-air quantity are in a permanently fixed ratio, and the volume of air circulated has a fixed ratio to the heat produced by the combustion of the fuel.

The heater is provided with safety features which protect it from the effects of mal-operation.

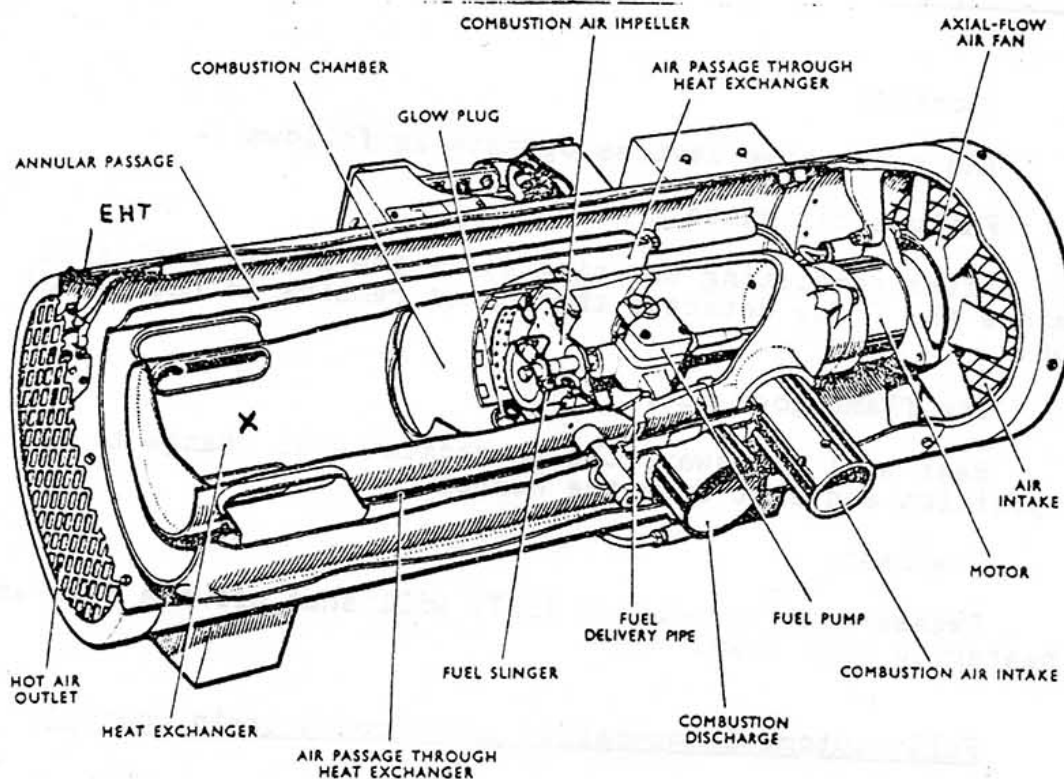


Figure 2. Combustion Air Heater

3.1 Semi-automatic operation

The heater is fitted with a flame detector switch (at position 'X' on Figure 2), which is a 2-way snap-action switch operated by an expansion rod.

The starting procedure is completed by means of a timing mechanism which is automatically set when the main switch is operated. Within the mechanism are two sets of contacts, one set operating the glow plug and the other set operating the motor. When the time cycle has been completed both contacts return to the open condition.

The sequence of operation during starting is :-

1. Glowplug is switched on and come up to operating temperature.
2. Fuel valve opens and motor starts.
3. Combustion starts.
4. Flame detector operates and holds the fuel valve open and the motor on.
5. Timed cycle complete. Glow plug, motor and fuel-valve contacts in time switch open.

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3.1 (Cont'd)

The protective devices operate as follows :-

(a) Failure to ignite.

After completing the time cycle the heater will shut down, since the flame detector thermostat remains in the 'cold' position.

(b) The flame goes out.

Heat will die away, the thermostat will change to the 'cold' position and shut down the heater.

(c) Overheat.

Excess-heat thermostat (EHT) will shut off the fuel and cause heater to shut down.

3.2 Fully automatic operation and through train control.

In a fully automatic system the heaters are under the control of thermostats fitted in the passenger accommodation and these are arranged to cycle the local heaters on and off as required.

Through train control is also possible, using train wires. This allows all the heaters on the train to be switched on or off from one point.

END OF SECTION E22

REPAIR/MAINTENANCE INSTRUCTIONS RELATING TO COMPONENTS
REFERRED TO IN THIS SECTION.

Component	Reference ENG INSTR.	Reference S.E.S.	Reference STANDING ORDER B.R.B.	Reference REPAIR PROCEDURE

NOTE:- REGIONAL STANDING ORDERS of an issue date LATER than
that of the above may be applicable.

S.O.T.