C.E.P.S. 24

British Railways Board

Chief Mechanical & Electrical Engineer's Department.

OVERHAUL AND REPAIR OF SMITHS COMBUSTION HEATER

FOR DIESEL MULTIPLE UNITS.

REVISED OCTOBER 1972

SPECIFICATION NO. C.E.P.S. 24

AMENDMENT SHEET

Date of Issue	Amendment
October 1968	Original issue
May 1969	(1) Amendments to B.R. Catalogue numbers of fine grinding paste, and grease. (2) Amendment to "reference specifications". (3) Amendments to operations 1.13, 17, 21.3 and 22.4 to implement the decision not to renew the excess heat thermostat at each overhaul.
October 1972	(1) Tools and materials revised. (2) Amendments to operations 1.7, 1.8, 7.6, 12, 19.15, 21.9, 22.2, 22.3, 22.4. (3) The following operations are deleted:- 1.13, 8.3, 17, 20. (4) Appendix C revised. (5) Drawings Fig.1 modified, Fig.6 replaced by new Fig.11.

ADDITIONAL COPIES OF THIS SPECIFICATION ARE AVAILABLE ON REQUEST TO:-

CHIEF MECHANICAL & ELECTRICAL ENGINEER,
B.R.B.
RAILWAY TECHNICAL CENTRE,
TRENT HOUSE, DERBY.

PROCESS SPECIFICATION NO.C.E.P.S. 24

OVERHAUL AND REPAIR OF SMITHS COMBUSTION HEATERS FOR DIESEL MULTIPLE UNITS

Introduction

The unit functions as an oil fired air heater in which fresh or recirculated warming air flows over a combustion chamber/heat exchanger.

Fuel oil is delivered by a pump, into an atomiser cup which causes the fuel to break up into a fine spray. During the starting cycle, this spray is ignited by a glow plug but combustion is self-sustaining once the run-up has been completed. Air is drawn into the combustion chamber by a combustion air impellor.

The carriage warming air is forced over the heat exchanger by an electric motor driven fan. The auxiliaries, (atomiser cup, fuel pump, combustion air impellor) are driven from an extension of the motor shaft.

General

This specification details the process to be followed for overhaul of the Smith's combustion heater. This revised issue takes into account the replacement of the excess heat thermostat by the combined flame detection and overheat protection unit (see Engineering Instruction MD86) and improved insulation of glow plug (see Engineering Instruction MD68).

Attached appendices

A. Technical Data for motor overhaul

B. Setting Gauges

C. Fault finding chart for complete heater test.

Attached Diagrams

Fig. 1 Mark IIB heater (complete)

Fig. 2 Mark IIB heater (complete)

Fig. 3 Fuel Pump Sub-Assembly

Fig. 4 24-V electric motor

Fig. 5 Fuel solenoid valve

Fig. 8 Resistor Box, Single Relay

Fig. 10 Recommended transportation stands for complete heaters.

Fig. 11 Combined flame detection and overheat protection unit.

Tools and Materials

Fuel Oil Class A.BS2869 (for rail traction use)	BR.Cat. No. 27/12001
Sodium metasilicate BR Spec. 612/3	BR.Cat. No. 7/67035
* Solvent 60 (Esso)	BR.Cat. No. 7/68180
* Solvent SBP11 (Shell)	BR.Cat. No. 7/68268
* Solvent Trichloroethene 1:1:1	BR.Cat. No. 7/21050

* IMPORTANT The relevant safety precautions must be carried out before and during use of these solvents.

Refined Burning Oil (Paraffin)	BR.Cat. No. 27/6900
Fine Grinding Paste	BR.Cat. No. 1/10451
Lithium Based Grease to BR.673/3	BR.Cat. No. 27/1350
Esso Beacon 325 Grease	BR.Cat. No. 27/2050
1" sealing and masking tape (Scotch Tape No.472)	BR.Cat. No. 7/60605
Sealing wax (Chatterton's No.4 compound)	BR.Cat. No. 7/18009
Soft Jointing compound ("Hermetite" Red Paste)	BR.Cat. No. 7/60180
Autostic	BR.Cat. No. 7/1600

Continued....

Tools and Materials (Contd.)

Air-drying varnish, Sterling (B.8) 009-0008.
Glass shot for 'Vacu-blast' plant size 45 - 75 microns
'Vacu-blast' plant with compressed air supply at 45 p.s.i.
Sodium metasillicate Bosch plant
Argon arc welding supply
Voltmeter 0-50V D.C.
Ammeter 0-10A D.C.
Hand Strobosoope
'Fyrite' exhaust gas analyser or equivalent
Spanners and sockets U.N.F., B.A. and B.S.P.
Wire brush BR. Cat. No. 5/4167
Stop clock
Press (bearing extraction)
Date tags
Fuel solenoid blanking plugs

Special Tools

Master test fan A.T. 9181/F
Blanking plate W.A.T. 1492
Adapters for bearing extraction
Flame ring extractor (Smith's tool C.B.H. 1910) or equivalent (See Appx. 'B' fig.4)
Flame ring setting screws (Smith's tool C.B.H. 1900)
Atomiser cup setting gauge (see Appendix B Fig.1)
Fuel delivery pipe setting gauge (see Appendix B Fig.2 and 3)
Dummy atomiser cup.

Test Rigs

Rigs are required to test the following components:-

Fuel solenoid valve
Electric motor
Fuel pump
Complete heater

Reference Specifications

C.E.P.S. 46 Overhaul of D.C. Fractional H.P. Machines.

Operations

1. Dismantling the unit
2. Cleaning of components
3 - 20 Overhauling and testing of components
21. Re-assembling the unit
22. Final testing of complete heater
23. Transportation

1. Dismantling the Unit (see figures 1 and 2)

The following procedure is recommended for dismantling but this may be varied to suit local layout. The figures in brackets refer to items on the diagrams numbered 1 - 9. The appropriate diagram No. is given at the head of each sub-section.

NOTE: All components and sub-assemblies are interchangeable between heaters except the fuel pump piston assembly (see fig. 3) comprising of:-

piston (211)
cylinder (212)
bearing plate (213)

These fuel pump items must be identified and kept in a matched set.

1.1 Circulating air fan (see figure 2)

Lightly grip the circulating air fan (147), loosen the collet nut and withdraw the fan from the motor shaft.

Continued....

Dismantling the Unit (Contd.)

1.2 Combustion air inlet and inlet baffle (see figure 2)

Remove the inlet baffle and unscrew the combustion air inlet tube (134).

1.3 Exhaust tube (see figure 2)

Unscrew the nut (247) inside the exhaust tube (246) and withdraw

1.4 Withdraw the fuel drain union (131) (see figure 2)

1.5 Fuel pipe work (see figure 1)

Remove the fuel solenoid cover (21)

Disconnect the union nuts (12) at the male adapter elbow (14) and the fuel solenoid (24).

Remove the pipe assembly (11) and withdraw the fuel inlet union (15)

1.6 Disconnect and withdraw the glow plug as follows (see figure 1):-

(a) Remove the glow plug cap (1) and terminal (101)
(b) Remove the glow plug cover plate (6) and withdraw the glow plug (7)

1.7 Disconnect and remove the flame detector thermostat as follows (see figure 1):-

(a) Disconnect flame detection/overheat protection unit by releasing the main terminal block cover (item 1 Fig. 11) and disconnect the wiring from the main terminal block (item 2 Fig. 11). Separate thermistor leads by releasing snap-on connectors (item 3 Fig. 11).
the terminal block cover.

(b) Withdraw thermistors (item 4 Fig. 11) complete with PTFE leads attached using care not to exert strain to the thermistor pellet connections.

1.8 Dismantle the terminal box assembly as follows (see figure 1):-

(a) Remove the main terminal block cover (126)
(b) Remove the cable saddle (252) which secures the harness (255)
(c) Disconnect all leads from the main terminal block (127)
(d) Remove the cable harness (255)

1.9 Dismantle the voltage regulator as follows (see figure 1):-

(a) Remove the resistor box assembly (97) from the outer case.

(b) Disconnect the resistor box from the terminal block moulding (123) on the outer case

1.10 Dismantle the fuel solenoid as follows (see figure 1):-

(a) Disconnect the three bayonet connectors (31) to the fuel solenoid

(b) Unscrew the two valve locating bolts (22) and remove the fuel solenoid (24).

1.11 Disconnect the bayonet connectors to the motor (176) (see figure 2)

1.12 Withdraw from the outer case the motor/fuel pump/heat exchanger assembly as follows, and dismantle (see figure 2):-

(a) Unscrew the nuts and remove the bolts securing the rear steady casting (223) to the outer casing.
Withdraw the rear steady casting/motor/fuel pump and heat exchanger assemblies comple

(b) Unscrew the bolts (232) on the motor yoke and remove the rear-steady casting

(c) Separate the motor (151) and fuel pump sub-assembly (178) by removing the motor/pump securing nuts (233)

(d) Use a socket spanner to separate the heat exchanger (238) and fuel pump sub-assembly (178)

(e) Remove by hand the flame ring (242) from the heat exchanger (238). In cases of difficulty, use the special 'Smiths' extractor tool C.B.H.1901, or equivalent.

Dismantling the Unit (Contd.)

(see Appendix 'B' figure 4)

2. Cleaning of Components

Components must be cleaned as detailed in the appropriate overhaul sections (3-20).

Where the 'Vacu-blast' process is indicated, use glass shot size 45 - 75 microns at an air pressure of 45 p.s.i.

Where the 'Vacu-blast' plant is not available or not permitted to be used, all items must be cleaned in a 'Bosch' plant containing an approved cleaner to B.R. Cat. No. 7/67035 followed by a rinse in clear water.

3. Circulating air fan (see figure 2)

3.1 Clean the circulating air fan (147) in a 'Vacu-blast' plant.

3.2 Examine the fan for defects, paying particular attention to the blade roots. If there are any serious defects, the fan must be renewed.

4. Combustion air inlet-tube and exhaust tube (see figure 2)

4.1 Clean the air inlet tube and exhaust tube in a 'Vacu-blast' plant.

4.2 Check for damage the taper thread on the combustion air inlet tube (134) by screwing it into a re-conditioned pump sub-assembly (178). Renew if the threads are damaged.

4.3 Examine for damage, the exhaust tube (246). Check that there is a 3/32" outward swage at the bottom end, for retention of exhaust cowl. Renew on condition.

5. Long fuel drain union. Male adaptor elbow and fuel inlet union (see figures 1 and 2)

5.1 Clean the above components in a 'Vacu-blast' plant.

5.2 Visually examine for damage the union taper surfaces on the fuel inlet union (15 in figure 1) and male adapter elbow (14 in figure 1). Renew on condition.

6. Fuel Pipe Assembly (see figure 1)

6.1 Clean the fuel pipe assembly in 'vacu-blast' plant.

6.2 Examine the fuel pipe assembly (11), paying particular attention to the union taper and nut. Renew this assembly complete if any component is damaged.

7. Glow Plug (position indicated in figure 1 but not illustrated in detail)

7.1 Examine the glow plug cap (1) and cover plate (6). Renew on condition.

7.2 Remove the element shroud and clean with wire brush. Examine the shroud for damage and renew on condition.

7.3 Clean the element in approved solvent B.R. Cat. No. 7/21050.

7.4 Examine the element for breakage, corrosion or distortion and proceed as follows:-

(a) If the element is sound and the spindle is not distorted, proceed as in 7.5.

(b) If the element is defective proceed as in 7.6.

7.5 (a) Ensure that the element is in position and check the insulation to earth by 'Flash' testing at 240/250 volts for 15 seconds. Using test probes connected to a main supply and in series with a lamp not exceeding 100 watts. Apply one probe to a point on the body of the glow plug and the other to one of the terminals. If the lamp does not glow, then the insulation is acceptable. If the lamp glows proceed as in 7.6.

(b) Wipe the glow plug body using a clean fluffless cloth damped in approved solvent to B.R. Cat. No. 7/68180 or 68268.

(c) Renew any damaged washers and sealing rings.

(d) Refit the element shroud.

Continued....

7. Glow Plug (position indicated in figure 1 but not illustrated in detail)(Contd.)

7.6 (a) Remove the element and the ceramic base in which the element is secured. Discard the element.

(b) Wipe the ceramic base with a clean fluffless cloth damped in approved solvent B.R. Cat. No. 7/68266 or 68180/21050. Examine the base for damage and renew on condition.

(c) If the spindle is free from distortion clean the glow plug body in approved solvent B.R. Cat. No. 7/21050. Renew the glow plug complete if there is distortion.

(d) Dismantle the glow plug and examine:-

glow plug body
spindle
washers and sealing rings
(ceramic, copper and rubber)
spring
retaining collets.

Renew on condition.

(e) Make up a new element. Use 19 S.W.G. KANTHAL 'A' wire to make a 5 turn coil of 7mm. former diameter and re-assemble the glow plug complete.

(f) Test the insulation resistance as detailed in section 7.5(a).

(g) Insulate the space behind the ceramic washer with a light coating of Autostic (B.R. Cat. No. 7/1600) to prevent carbon deposits from causing earth faults. 24 hours should be allowed for the Autostic to dry before the glow plug is used. The method of coating is by means of a brush (B.R. Cat. No. 5/2396).

8. Outer Case (see figures 1 and 2)

8.1 Secure loose leads and protect the terminal pillars with appropriate nuts before cleaning.

8.2 Immerse the outer case in a 'Bosch' containing an approved cleaner to B.R. Cat. No. 7/67035. Rinse with a water jet and dry.

8.3 Renew the grommets (129) and (130) on condition.

8.4 Check terminal block for damage. Renew individual units as necessary.

9. Rear Steady Casting (see figure 2)

9.1 Clean the rear steady casting (223) in 'Vacu-blast' plant.

9.2 Examine the bosses on the yoke which supports the motor. Argon arc weld any fractures on the yoke.

10. Fuel Solenoid Cover (21), Main Terminal Block Cover (126), and Vented Resistor Box Lid (98) (see figure 1)

10.1 Clean the above components in 'Vacu-blast' plant.

10.2 Examine covers. Repair or renew on condition.

11. Harness Assembly (255) (see figure 1)

11.1 Wipe the Harness assembly with a clean fluffless cloth damped in approved solvent to B.R. Cat. No. 7/68266 or 7/68180.

11.2 (a) Examine the plug (256) for damaged pins. Dismantle the plug and repair or renew on condition.

(b) Examine the plug for damage on the outer cover. Renew complete if the outer cover is distorted.

(c) Visually examine the bakelite moulding without dismantling the cover. Renew the plug complete if the moulding is cracked.

11.3 (a) Examine the outer sleeve (257) for tears or signs of damage where connected to the plug. Renew the outer sleeve if any damage is found.

(b) Examine the outer sleeve/plug clip and ensure that it is nipping but not biting into the insulation.

Continued....

12. Combined Flame Detection and Overheat Unit. (See Fig. 11)

12.1 (a) Examine thermistors for signs of mechanical damage and replace as necessary.

(b) Test the resistance of thermistors with Avometer for electrical continuity. Replace TH1 if resistance is lower than 30 Ohms or greater than 90 Ohms. Replace TH2 if resistance is less than 20 Ohms or greater than 250 Ohms.

Take care not to handle the pellets with the fingers while making this test as readings will be affected by body heat.

12.2 Remove cover from the control box (item 5 Fig. 11) and visually examine the components in the box for any signs of mechanical damage. Renew relay RL1 (Item 6 Fig. 11) if the contacts are badly worn.

13. Fuel Solenoid Valve (see figure 5)

13.1 Unscrew the locking screw (36) and withdraw the spring washer (45), locking plate (35) and spacer (34).

13.2 Unscrew the filter adapter (42) and valve seat adjuster (39).

13.3 Withdraw the bobbin (38) and spring (37) from the valve body (32).

13.4 Clean all other components by wiping with a clean fluffless cloth damped in approved solvent to B.R. Cat. No. 7/21050 or 68180 or 7/68266.

13.5 Examine:-

(a) the 'O' ring (40) on the valve seat adjuster (39) for signs of deterioration.

(b) the filter adapter (42) to ensure that the gauze is undamaged. Renew as necessary.

(c) the sealing ring (41) on the filter adapter (42) for signs of damage. Renew as necessary.

(d) the valve body (32) for cracks at changes in section. If any are detected, then unscrew the valve body securing nut (44) withdraw the solenoid valve coil (25) and renew the valve body.

(e) Examine the three lead terminations (31) for damage. Renew as necessary.

(f) Check for broken or weak springs (37) and renew as necessary.

13.6 Re-assemble the fuel solenoid valve without the locking plate (35).

13.7 Resetting the fuel solenoid valve:-

(a) Connect the fuel solenoid valve to the test rig. Energise the coil from a 24 volt D.C. supply and screw up the valve seat adjuster (39) until the bobbin (38) is heard to strike the pole piece. Note this position.

(b) Continue screwing in the valve seat adjuster (39) while repeatedly de-energising and energising the coil circuit.

The striking noise will become less pronounced until it ceases completely. This is the position of zero 'air gap'.

(c) Unscrew the valve seat adjuster (39) to the noted position in 13.7(a). This must be at least one third turn from the position of zero 'air gap'.

13.8 Testing the fuel solenoid:-

(a) Connect the fuel solenoid valve to a slave fuel pump running at 3500 r.p.m. with a suction lift of 4ft. With 0 volts supplied to both solenoid coils the valve should not open. Slowly increase the voltage to both coils and note the value when the valve operates. This should be between 16 and 18 volts. If the voltage is outside this tolerance then adjust by means of the valve seat adjuster (39) until the correct value is obtained. If the correct setting still cannot be obtained strip the valve body as detailed in item 13.5 and renew the coils.

(b) With the valve connected as in 13.8(a), open the valve by applying 18 volts to both coils. Switch out one coil and reduce the voltage on the holding coil. The valve should close when the voltage across one coil falls below 12 volts. If the valve closes above 12 volts, adjust the valve seat adjuster (39) until the correct value is attained. If the valve cannot be corrected by adjustment then strip and change the coil as detailed in item 13.5.

Continued....

13. Fuel Solenoid Valve (see figure 5) (Contd.)

(c) With the valve connected as in 13.8(a) apply 31 volts to each coil in turn. Ensure that the valve does not open with either coil energised.

(d) Apply fuel oil pressure of 150lbs. per square inch to the valve inlet and check that there is no leakage from the valve seat. Apply the same pressure to the valve outlet and ensure that there is no leakage from the castings (32) or valve seat.

(e) Refit the locking plate (35) and ensure that the fuel solenoid still operates within the limits specified in 13.8(a) - (c).

13.9 Apply varnish seal to the valve body securing nut (44).

14. Flame Ring (see figure 2)

14.1 Lift the tongues which secure the asbestos strips (243) and (244) in the flame ring (242) and withdraw.

14.2 Clean the flame ring in a 'Vacu-blast' plant.

14.3 Examine the flame ring, paying particular attention to distortion in the blades. Reform these to their original profile.

14.4 Renew the asbestos strips.

15. Heat Exchanger (see figure 2)

15.1 Examine the heat exchanger (245) for evidence of serious distortion. The baffle in the combustion chamber portion, should be circular and not oval. Renew the heat exchanger if distortion is found.

15.2 Dislodge the carbon deposits by shaking and lightly tapping the exterior. Use a compressed air supply as necessary.

15.3 Clean the heat exchanger in a 'Bosch' containing an approved cleaner to B.R. Cat. No. 7/67035.

15.4 Examine the heat exchanger for leaks as follows:-

Place the heat exchanger on its end, pump end upwards, and fill the combustion chamber with cold water almost up to the glow plug port, taking care not to spill any down the circulating air jacket around it. Examine the area around the four radial ports for water seeping through into the circulation air jackets. If the heat exchanger is of the later type with fillet welded radial ports, it must be renewed if leaking. Earlier types with feather welded radial ports must be repaired as in section 15.5.

15.5 Repair leaking heat exchanger as follows:-
(HEAT EXCHANGER WITH FEATHER WELDED RADIAL PORTS ONLY)

(a) Grind off the feather weld seam on the forward end of the combustion chamber and remove the inner chamber.

(b) Weld the defective radial port using argon-arc or another approved method.

(c) Replace in position, the inner chamber in the outer chamber, and argon-arc weld.

(d) Test for leaks as indicated in 15.4.

16. Voltage Regulator (see figure 8)

16.1 Clean the voltage regulator by blowing over the resistors and relay with clean dry compressed air.

16.2 Examine the resistors, cables and relay for mechanical damage. If damaged, dismantle the regulator as detailed in 16.4 and renew damaged components.

16.3 Check the operation of the voltage regulator as follows:-

NOTE : If the voltage regulator is correct or can be adjusted to satisfy the test schedule no further overhaul is required. If the regulator cannot be adjusted to operate within the limits specified then the regulator must be dismantled and repaired as detailed in item 16.4 - 16.8 incl.

Continued....

16. Voltage Regulator (see figure 8) (Contd.)

(a) Connect the regulator in series with an overhauled glow plug. Connect a 20-30 volt D.C. supply to the regulator, with the positive connected to the input terminal of the tapped resistor, R4, and the negative to the glow plug spade terminal.

(b) Place the regulator horizontally with the vented cover upwards.

(c) Adjust the input voltage to 20 volts and measure the voltage across the glow plug. This must not be less than 3.7 volts. Adjust the variable resister R4 to suit.

NOTE : The regulator relay should not operate.

(d) Increase the voltage slowly and note the glow plug voltage at which the regulator relay operates. This should be between 4.6 and 4.8 volts. Adjust the relay to suit.

NOTE : When the relay operates the voltage across the glow plug should fall to between 4.1 and 4.3 volts. If this is not obtained adjust the variable resistor R4 (with regard to the minimum low voltage set out in c above), to suit. If the correct value still cannot be obtained check the wiring and if correct dismantle the regulator and check as detailed in 16.4.

(e) Increase the input voltage to 30 volts. The voltage across the glow plug must not exceed 5 volts.

16.4 If the voltage regulator is damaged or fails the test sequence set out in 16.3 dismantle the voltage regulator as follows:-

(a) Remove the vented lid (98).

(b) Disconnect the resistor cables.

(c) Disconnect the insulation strips (110) and withdraw the resistors complete with insulated strips from their housing.

(d) Remove the relay.

16.5 Examine resistors for broken or damaged coils and loose or missing fixing screws. Check that the sliding collar is tight on variable resister R4 and ensure that adjacent resistor elements are not touching each other. Repair or replace as necessary.

16.6 Examine and overhaul the relay as follows -

(a) Remove the relay cover

(b) Examine the relay for signs of mechanical damage, overheating, dry soldered joints on the terminals or broken connections. Where dry joints are found, remove the old solder, clean the terminal with a small wire brush and re-solder. Renew the relay if any of the other defects are found.

(c) Replace the relay cover.

16.7 Examine the vented lid (98) and case (100). Correct any minor distortions, or replace, as appropriate.

16.8 Re-assemble the regulator and test as detailed in item 16.3.

18. Electric Motor (see figure 4)

18.1 Dismantle as follows:-

(a) Remove the commutator cover (152)

(b) Lift the brushes (160)

(c) Remove the rear clamp plate (154) and front clamp plate (153)

(d) Remove the nuts (44) from the O.C.E. of the fixing studs

(e) Withdraw the armature (158) complete with the end shield

(f) Hold in a vice each bearing locking nut (174) and remove from both ends of the armature spindle. Remove the spring (170).

Continued....

18. Electric Motor (see figure 4) (Contd.)

(g) Use a hide mallet to separate the armature (158) and O.C.E. housing (155)

(h) Use press and adaptors to remove the ball bearings (173) from the armature.

18.2 Clean the motor in accordance with Process Specification C.E.P.S.46.

18.3 Examine and Recondition the Carcase and Field System in accordance with Process Specification C.E.P.S.46.

18.4 Examine and Recondition the Armature in accordance with Process Specification C.E.P.S.46.

18.5 Examine and Recondition Brushes in accordance with Process Specification C.E.P.S.46.

18.6 Examine and recondition Ball Bearings in accordance with Process Specification C.E.P.S.46.

NOTE : Technical data required for overhaul in 18.3 - 18.6 is given in Appendix 'A'.

18.7 Re-assemble in reverse order to 18.1 carrying out the following operations -

(a) Fit bearings using press and adaptors to ensure that they are correctly fitted and run true.

(b) Use a sealing wax to B.R. Cat. No. 7/18009 to fill the interstice where the motor leads pass from the capacitors into the body of the motor.

(c) Seal the commutator cover (152) to the motor carcase with 1" sealing tape to B.R. Cat. No. 7/60605.

(d) To seal the rear clamp plate (154) to the motor carcase use a soft jointing compound, to B.R. Cat. No. 2/31828.

18.8 Test as follows -

(a) Fit the master test fan AT.9181/F which is designed to reproduce full load conditions on a service heater.

(b) Using a stroboscope, adjust the supply volts to obtain a motor speed of 3500 r.p.m. Run the motor for 5 minutes at this speed.

(c) After 5 minutes measure the current and voltage. For :-

Mk. I heaters, these must not exceed 7.5 amps, 24 volts

Mk. II IIA and IIB heaters, these must not exceed 7.9 amps, 24 volts.

If these currents are exceeded check that the motor is correctly assembled paying particular attention to the bearings.

(d) Check the insulation to earth by 'flash' testing at 240/250 volts for 15 seconds, using test probes connected to a mains supply and in series with a lamp not exceeding 100 watts. Wrap a single turn of bare wire around the commutator periphery. Apply one probe to this wire and the other probe to the shaft or core. If the lamp does not light then the insulation is acceptable.

NOTE : The reconditioned and tested motor should now be fitted to a reconditioned pump and the pump tested for correct output, see item 19.15. Should the motor require replacing, the pump must be re-checked as the combination is a matched set.

19. Fuel Pump Sub-Assembly (see figure 3)

19.1 Dismantle the Fuel Pump Sub-Assembly as follows:-

(a) Remove the swan-neck fuel delivery pipe (188)

(b) Unscrew the anti-radiation disc (180)

(c) Remove the anti-radiation disc adaptor (181)

(d) Remove the atomiser cup (182), shims (183/184), and combustion air fan (185) from the driving shaft (205).

Continued....

19. Fuel Pump Sub-Assembly (see figure 3) (Contd.)

(e) Remove the ring seal (186) and sealing washer (222).

(f) Unscrew the main assembly securing nuts (63). This splits the sub-assembly into three major components as follows -

Rear casting 219)
)
basic pump assembly)
)
forward casting (187))

19.1.1 Basic Pump Assembly Dismantle the pump assembly as follows -

(a) Remove the cylinder cover (217), outer gasket (214), cylinder spring (215) and cylinder flat washer (216) from the pump.

(b) Remove the cylinder (212) and gate piece (207) piston (211) complete. Withdraw the gate-piece (207) and piston (211) from the cylinder (212) after removal from the basic pump assembly.

(c) Remove the bearing plate (213) and eccentric shaft (202).

NOTE : The piston (211), cylinder (212) and bearing plate (213) must be kept as a matched set during repair. They are identified by a number stamped on the cylinder and bearing plate for this purpose.

(d) Remove the inner gasket (204).

(e) Examine the inside of the pump body (194). If there is no grease, then the driving shaft (205) bearing bush is defective. Dismantle the bearing assembly as detailed in item 19.9 (b).

19.2 Cleaning

Clean the following components in 'Vacu -blast'plant (see notes in section 2).

(a) forward casting (187)
rear casting (219)
anti-radiation disc (180)
Atomiser Cup (182)
Combustion Air Fan (185)

(b) Remove the dummy plug in the pump body (194) and clear the worn gear housing of grease. Clean this and all other components by wiping with a CLEAN fluffless cloth damped in paraffin to B.R. Cat. No. 27/6900.

Care must be taken not to scratch or damage the piston cylinder and bearing plate during cleaning.

NOTE : Abrasives MUST NOT be used on any of these components.

Examination and Repair

19.3 Rear Casting (219)

Ensure that the studs are not loose and the threads are in good condition.

19.4 Forward Casting (187)

Examine the lugs on the casting and Argon-arc weld any that are fractured. Examine the ring (190) and renew on condition. Examine the ring seal (186) and renew on condition.

19.5 Anti-Radiation Disc (180)

Renew if distorted.

19.6 Atomiser Cup (182)

Ensure that the cleaning process has dislodged all carbon in the enclosed area of the cup by tapping on a hard surface.

Continued....

19. Fuel Pump Sub-Assembly (Contd.)

19.7 Combustion Air Fan (185)

Fasten down the locating tongues of loose blades. Renew the fan if any blades are excessively distorted.

19.8 Swan-neck fuel delivery pipe (188)

Ensure that the pipe is clear by blowing through with clean dry compressed air.

19.9 Pump Body (194)

(a) Examine the lugs on the casting. Argon-arc weld any that are fractured.

(b) Insert a feeler gauge between the worm and pump body to check the longitudinal play in the driving shaft. If the play exceeds 0.003" or the lateral play is excessive, OR the bush was found to be defective as a result of examination in 19.1.1(e), dismantle the pump and renew the bush as follows:-

Remove the flexible shaft (218)
combustion air fan pin (196)
and worm locating pin (198)
Withdraw the driving shaft (205) and worm (199).
Press out the bushes and renew
Re-assemble the driving shaft.

(c) Renew the neoprene washer (191).

(d) Examine the flexible coupling (218). If the flexibility has deteriorated, remove the pin and renew the coupling. The pin must be renewed with a new 3/32" split pin.

(e) Check the studs (193) for damaged threads. Renew as necessary.

(f) Examine the connecting nipple (195). Renew on condition.

19.10 Bearing Plate Sub-Assembly (210)

This comprises Pistons (211)) These items must be identified and kept as a matched
Cylinder (212)) set. If one or more of these items have to be
Bearing Plate (213)) renewed then all three items must be replaced togeth

(a) Examine the pivot spindle on the cylinder (212) for excessive wear. Ensure that the cylinder pivots freely when the spindle is inserted in the bearing plate (213). Check the spindle bores in the bearing plate (213) and cylinder cover (217) for concentricity.

Renew cylinder cover (217) or bearing plate sub-assembly (210) as necessary.

(b) Examine the bearing surface between the cylinder (212) and bearing plate (213). If there is no fuel leakage the bearing surface should appear as a complete circular band on the bearing plate, with no high or low spots or scoring.

Apply a small quantity of fine grinding paste to B.R. Cat. No. 1/10451 to the cylinder bearing surface, and bed in until the bearing surface is an even matt finish.

All traces of grinding paste MUST afterwards be removed by application of a paraffin wash.

(c) Check the gate piece (207) and its groove in the cylinder (212) for excessive wear. Renew the gate piece or bearing plate sub-assembly (210) as necessary.

19.11 Worm Wheel (200) and Eccentric Shaft (202)

(a) Remove the wheel locating Mills pin (201) and withdraw the worm wheel (200).

(b) Renew the oil seal (209) in the bearing plate (213).

(c) Check the eccentric shaft (202) for wear at the oil seal. If the wear is excessive, the shaft must be renewed.

(d) Examine the worm wheel (200) and renew on condition.

(e) Re-assemble the reconditioned items.

Continued....

19. Fuel Pump Sub-Assembly (Contd.)

19.12 Thrust Washer (203)

Examine the steel thrust washer for wear. Renew on condition.

19.13 Inner and Outer Gaskets (204) and (214)

Renew.

19.14 Re-assembly of the fuel pump

(a) Repack the pump body with grease to B.R. Cat. No. 27/1350.

(b) Re-assemble the following components to the pump body with driving shaft (205) and flexible coupling (218) installed in the sequence below:-

inner gasket	(204)	
thrust washer	(203)	) assembled complete
eccentric shaft	(202)	)
worm wheel	(200)	)
bearing plate	(213)	)
gate piece	(207)	) assembled
cylinder	(212)	) complete

NOTE : The gate piece is assembled on the eccentric shaft.

Spring	(215)
Outer gasket	(214)
Flat cylinder washer	(216)
Cylinder cover	(217)

All rubbing surfaces MUST be wetted with fuel oil. This is to provide a lubricating film for running in when the pump is run without a fuel supply.

(c) Secure the forward casting (187) and rear casting (219) to the pump yoke. Ensure that the air inlet (rear casting), fuel delivery nozzle (pump) and delivery pipe cutaway (forward casting) are aligned.

(d) Fit an overhauled electric motor to the rear casting (219). This is primarily for test purposes but once attached, the pump and motor must remain assembled as a matched set.

(e) Screw the adaptor (181) into the driving shaft (205) and assemble the anti-radiation disc (180). This is assembled on the driving shaft without assembling the combustion air impellor and atomiser cup purely for test purposes. If a stroboscope is used, the disc provides a focus for the illumination.

19.15 Testing

Each pump shall be tested using clean filtered diesel oil to B.R. Cat. No. 27/12001. The test shall be made at room temperature. The fuel supply to the test rig must be arranged for a constant suction lift of 4ft. Procedure as follows:-

(a) Connect the motor leads and the fuel supply. The delivery pipe from the pump is fitted to the orifice provided for the swan-neck fuel delivery pipe (188).

(b) Run the pump for 3 minutes with fuel wetted rubbing surfaces at a constant speed in the range of 3400 - 3500 r.p.m. The input current and voltage to maintain this speed under these conditions must not exceed 3 amps at 12 volts.

(c) Set the motor speed at 3500 r.p.m. and turn on the fuel supply to the pump. Ensure that the pump is self priming.

(d) With the motor speed at 3500 r.p.m., the fuel delivery rates against a 4ft. suction lift must be as follows:-

40 A.S.M. pumps	(New type CBH 2082)
27 - 29 cc/min	25 - 27 cc/min
OR	OR
30cc in 62.3-66.7 seconds	30cc in 66-72 seconds
25cc in 51.9-55.5 seconds	

Continued....

19. Fuel Pump Sub-Assembly (Contd.)

50 A.S.M. pumps	(New type CBH 2083)
31 - 33 cc/min	29 - 31 cc/min
OR	OR
30cc in 54.5-58.1 seconds	30cc in 58-62 seconds
25cc in 45.4-48.5 seconds	

In the suction lift condition there must be no evidence of air being delivered with the fuel. If the pump does not conform to the test figures, check that all unions are tight before dismantling the pump. Also check for porous pump castings, i.e. fuel seeping through casting.

19.16 Setting of the Atomiser Cup (182) and Swan-Neck Fuel Delivery Pipe (188)

(a) Remove the anti-radiation disc (180).

(b) Slide the combustion air fan (185) and atomiser cup (182) on to the driving shaft (205).

(c) Assemble the atomiser cup setting gauge (see Appendix 'B') to the forward casting so that it seats on to the ring seal flange.

(d) Add shims (183) and (184) until the gap between the lip of the atomiser cup and the cross-bar of the setting gauge is only just visible.

(e) Insert feeler gauges to measure the gap. This must not exceed 0.032". Add shims to attain a gap of less than 0.032". Remove the setting gauge.

(f) Remove the atomiser cup and combustion air fan and secure the swan-neck fuel delivery pipe (188).

(g) Assemble the combustion air fan and a dummy atomiser cup (with a 120° segment removed) on the driving shaft. Use the fuel delivery pipe setting gauge to set a normal gap of 2mm between the dummy atomiser cup and the nozzle of the swan-neck fuel delivery pipe. The nozzle must be central in the groove of the dummy atomiser cup.

NOTE : See Appendix 'B' for details and setting up of the fuel delivery pipe gauge.

(h) Slacken off the swan-neck fuel delivery pipe and replace the dummy atomiser cup with the service cup (182), taking care not to knock the delivery pipe which is critically set. Now secure the swan-neck fuel delivery pipe.

(i) Ensure that the atomiser cup rotates concentrically and does not foul the swan-neck fuel delivery pipe.

(j) Assemble the anti-radiation disc (180).

21. Re-Assembly of the Heater (see figures 1 and 2)

21.1 Re-assemble flame ring in the heat exchanger as follows -

(a) Remove the blanking plug (9) from the heat exchanger (245) and insert the screw setting gauges, Smith's tool No. C.B.H.1900, into the glow plug positions of the heat exchanger.

(b) Assemble the flame ring (242) into the combustion chamber by aligning it radially so that the cutaways correspond to the glow plug position and press into the chamber until the annular ring plate seats on the extension pins of the screw setting gauge. Ensure that the flame ring is a good fit (if necessary remove and spread the lip periphery with a hide mallet). With the ring correctly located remove the screw setting gauges. Replace blanking plug (9).

21.2 Re-assemble motor/pump/heat exchanger as follows:-

(a) Refit the pump (178) and motor(151) assembly to the heat exchanger (238) making sure that the air inlet on the rear casting (219) of the pump is aligned with the fuel drain hole on the heat exchanger.

(b) Assemble the rear steady casting (223) to the unit formed after assembly of the above (21.2(a)).

21.4 Carefully lower the heat exchanger (238)/pump (178)/motor (151)/rear steady casting unit into the outer casing and refit the outer casing to the rear steady casting.

Continued....

21. Re-Assembly of the Heater (Cont'd)

21.5 Locate and fit the exhaust tube (246), fuel drain union (131), male adaptor elbow (14) and combustion air inlet tube (134). Attach the air inlet baffle to the inlet tube so that the vanes are in line with the axis of the heater.

21.6 Refit the fuel inlet union (15) into the pump casting, using new washers (16) and (17). It is important that the union be fully tightened.

21.7 Refit the voltage regulator as follows:-

(a) Connect the resistor box leads to the terminal block moulding (123) on the outer case.

(b) Refit the voltage regulator assembly (97) to the outer case.

21.8 (a) Check that the glow plug element shroud is fitted and replace the glow plug.

(b) Replace glow plug cover plate (6).

(c) Replace the terminal (101) from the voltage regulator box and attach the glow plug cap (1).

21.9 Refit the combined flame detection/overheat protection unit as follows:-

Re-assemble thermistors in mounting bracket and thread PTFE leads through the heater body wiring duct to the main terminal housing. Attach the combined unit (Item 5 Fig. 11) loosely to the right hand terminal cover bracket and re-connect flying leads to the main terminal blocks (Item 2 Fig. 11). Re-fasten thermistor connectors. See table of connections (Item 9 Fig.11).

21.10 (a) Refit the harness assembly (255) and make all connections to the main terminal blocks.

(b) Refit the main terminal block cover (126)

21.11 Assemble the fuel solenoid as follows:-

(a) Refit the fuel solenoid (24) to the fuel solenoid cover (21).

(b) Connect the three bayonet cable connectors.

(c) Refit the fuel solenoid cover (21) to the outer case.

(d) Connect the fuel pipe assembly (11) to the male adapter elbow (14) and fuel solenoid (24) outlet.

21.12 Refit the circulating air fan (147).

22. Final Testing of Heater

NOTE 1: It is important that the rig for final testing and the fuel supply and control circuits external to the reconditioned heater should be checked periodically; this will help to ensure that faults will be isolated to overhauled items.

NOTE 2: Section 22 is a test schedule. Possible faults and action required are listed in Appendix "C".

22.1 Connect each heater to the master control panel and test as follows from a fuel supply of constant suction lift of 4 ft. or a gravity feed of 2 ft. head as indicated.

Select ventilating position on control panel and ensure that the heater motor runs. Check that the over-heat relay contacts are closed. If the motor fails to start, see Appendix "C", section 1.

SETTING OF FLAME DETECTION FUNCTION (OVER-HEAT FEATURE DOES NOT REQUIRE SETTING)

Loosen spindle lock on RP1 (item 7, fig 11).

Continued....

22. Final Testing of Heater (Cont'd)

22.1 Set the heater control panel switch to ventilation, and with the motor running rotate RP1 anti-clockwise until relay RL1 (item 6, fig .11) energises.

Turn the control panel switch to "off" (fully automatic heaters isolator off). The motor will continue to run.

Slowly rotate RP1 clockwise until relay RL1 de-energises. The motor will stop. Continue to rotate RP1 for a further 15° approximately.

22.2 (a) Make one start at 20 V (NOTE: 20 Volts at actual heater) from a fuel supply of 4 ft suction lift from a cold, fully primed condition. When the motor has started ensure that combustion is fully initiated within :-

15 seconds for 50 A.S.M. heaters.

20 seconds for 40 A.S.M. heaters.

See Appendix "C" Section 2 to trace the cause of failure to initiate combustion.

(b) Repeat the test in 22.2 (a) but starting the heater at 30 volts.

(c) Repeat the above test but starting the heater at 24 volts from a fuel supply of 2 ft gravity head. In this condition ensure that heat is detected within 40-60 seconds of the initiation of combustion. See Appendix "C", Section 3, to trace the cause of failure of the flame detection thermostat to perform within the specified limit.

(d) Switch off and check the following:-

That the fuel solenoide valve has closed;
That the motor continues to run for between 2 and 4 minutes.
Should this limit not be obtainable see Appendix "C". Item 4.

22.3 Run the heater continuously for 30 minutes at full heat. With an applied voltage of 24 volts and from a suction lift of 4ft. check the following:-

(a) Total current input does not exceed 7.8 amps. (Mk1 Heaters), or 8.2 amps (Mk IIA/B Heaters).

(b) Motor speed is 3400 - 3500 r.p.m. Check this using a hand stroboscope.

(c) Carbon dioxide content of the exhaust gas does not exceed:-

7.5% for 50 A.S.M. heaters
7.0% for 40 A.S.M. heaters

Use a 'Fyrite' exhaust gas analyser or equivalent.

See Appendix 'C' Section 7 if carbon dioxide content is excessive.

(d) That the fuel delivery rate confirms to the tables of allowable fuel rates below.

Time to pump 30 cc of fuel:-

Shaft Speed (r.p.m.)	Time to pump 30 cc fuel (seconds)			
	40 A.S.M. Pumps		50 A.S.M. Pumps	
	Max	Min.	Max.	Min.
3400	68.6	64.0	59.7	56.2
3410	68.4	63.8	59.5	56.0
3420	68.2	63.7	59.3	55.8
3430	68.0	63.5	59.2	55.6
3440	67.8	63.3	59.1	55.4
3450	67.6	63.1	59.0	55.2
3460	67.5	63.0	58.9	55.1
3470	67.3	62.8	58.7	54.9
3480	67.1	62.6	58.5	54.8
3490	66.9	62.4	58.3	54.6
3500	66.7	62.3	58.1	54.5

Continued....

22. Final Testing of Heater (Contd.)

Time to pump 25cc of fuel:-

Shaft Speed (r.p.m.)	Time to pump 25cc fuel (seconds)			
	40 A.S.M. Pumps		50 A.S.M. Pumps	
	Max.	Min.	Max.	Min.
3400	57.2	53.3	49.7	46.8
3410	57.0	53.2	49.5	46.6
3420	56.8	52.9	49.4	46.5
3430	56.6	52.8	49.3	46.3
3440	56.5	52.7	49.2	46.1
3450	56.4	52.6	49.1	46.0
3460	56.2	52.5	49.0	45.9
3470	56.0	52.4	48.9	45.7
3480	55.9	52.2	48.7	45.6
3490	55.7	52.0	48.6	45.5
3500	55.5	51.8	48.5	45.4

Time to pump 30cc of fuel with new type pump:-

Shaft Speed (r.p.m.)	Time to pump 30cc fuel (seconds)			
	40 A.S.M. Pumps		50 A.S.M. Pumps	
	Max.	Min.	Max.	Min.
3400	74	68.7	63.7	59.9
3450	73.2	67.6	63.0	58.8
3500	72.0	66.6	62.0	58.0
3550	70.9	65.7	61.2	57.3
3600	70.0	64.8	60.4	56.5
3650	69.2	63.7	59.9	55.5

Fuel delivery rate (old type pump):-

Shaft Speed (r.p.m.)	Fuel delivery rate (cc/Min.)			
	40 A.S.M. heaters		50 A.S.M. heaters	
	Min.	Max.	Min.	Max.
3400	26.2	28.1	30.2	32.0
3410	26.4	28.2	30.3	32.2
3420	26.4	28.3	30.3	32.3
3430	26.5	28.4	30.4	32.4
3440	26.6	28.5	30.4	32.6
3450	26.6	28.6	30.5	32.6
3460	26.7	28.6	30.6	32.7
3470	26.8	28.7	30.7	32.8
2480	26.8	28.8	30.8	32.9
3490	26.9	28.9	30.9	33.0
3500	27.0	28.9	31.0	33.0

Fuel delivery rate (new type pump):-

Shaft Speed (r.p.m.)	Fuel delivery rate (cc/Min.)			
	40 A.S.M. heaters		50 A.S.M. heaters	
	Min.	Max.	Min.	Max.
3400	24.3	26.2	28.2	30.1
3450	24.6	26.2	28.6	30.6
3500	25.0	27.0	29.0	31.0
3550	25.4	27.4	29.4	31.4
3600	25.7	27.8	29.8	31.9
3650	26.0	28.2	30.1	32.4

Continued....

22. Final Testing of Heater (Contd.)

22.4 With 24 volts applied to the input terminals and the heater operating with a 2ft. gravity feed, blank off the main circulating air inlet with the standard blanking plate W.A.T. 1492 and check that:-

(a) The overheat protection relay RL2 (Item 8 Fig. 11) de-energises in 2½-4½ minutes and the fuel valve closes. Remove WAT1492.

(b) The fuel valve remains closed after relay RL2 re-energises.

(c) The motor shuts down in 3-5 minutes.

If the purge time exceeds 5 minutes, rotate RP1 slowly clockwise until motor stops. Relock spindle (Item 7 Fig. 11). Replace control box cover.

See Appendix C Section 4 if the motor continues to run.

22.5 Switch to the cold position and check that the motor operates and that the fuel valve remains closed. See Appendix 'C', Section 8 if the motor fails to operate. Check wiring if the fuel solenoid valve opens.

22.6 Check the function of the voltage regulator as follows:-

Turn to the full heat position and increase the applied input voltage from 20 volts. Check that there is a drop in input current when the value of input voltage reaches that noted during voltage regulator test 16.3(d). This drop in voltage indicates the cutting in of the additional resistor. If abnormality is noted, check the wiring.

NOTE : For the above test, a sheet with the following information is required:-

Serial No. of voltage regulator.

Input voltage at which the relay operates and switches in additional resistor (taken at the time of testing the component in 16.3).

22.7 Check the insulation of wiring to earth by 'flash' testing at 240/250 volts for 15 seconds using test probes connected to a mains supply and in series with a lamp not exceeding 100 watts. Apply one probe to a terminal and the other to the outer case. Check all input terminals. If the lamp does not light then the insulation is acceptable.

22.8 (a) On completion of the test, tighten the three nuts securing the pump to the heat exchanger.

(b) Fit a blanking plug to the fuel inlet of the solenoid valve.

(c) Stamp an overhaul date tag with the month and year and attach it to the heater.

23. Transportation

It is recommended that the heater is placed in a transportation crate at this stage in readiness for despatch. It is important that the heater be protected in transit and Fig. 10 shows a crate fulfilling the MINIMUM requirements.

APPENDIX 'A' TO RECOMMENDED PROCESS SPECIFICATION C.E.P.S.24

Technical Data for 24V Motor

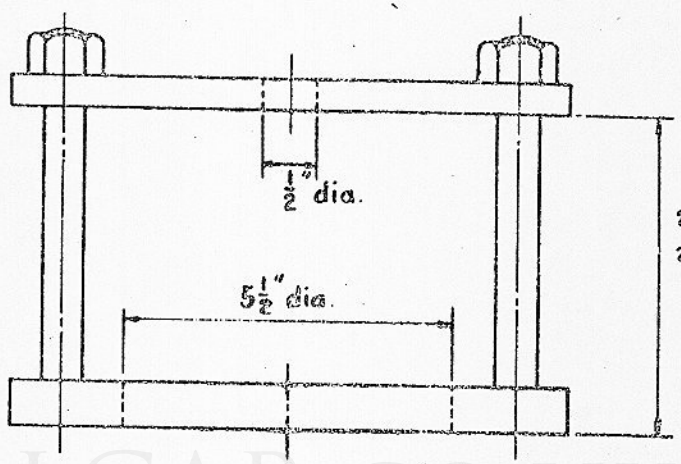
Minimum commutator diameter	-	1.075 in.
Minimum brush length	-	0.43 in.
Ball bearing grease Esso Beacon 325	-	BR Cat. No.27/2050

APPENDIX 'B' TO PROCESS SPECIFICATION C.E.P.S. 24.

SETTING GAUGES

Flame ring setting gauge, Screw extension pins, Smiths tool No. C.B.H.

Atomiser Cup Setting Gauge Used in



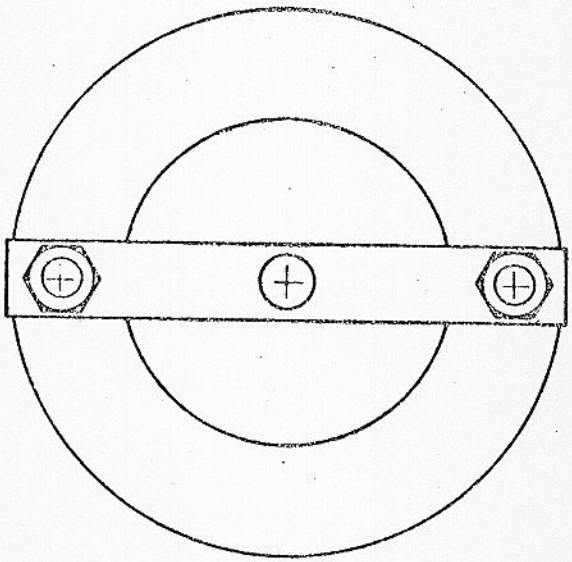


FIG. 1.

Used in conjunction with a feeler gauge of 0.032 in. thickness.

APPENDIX 'B' (cont'd)

Swan Neck Fuel Delivery Pipe Setting Gauge

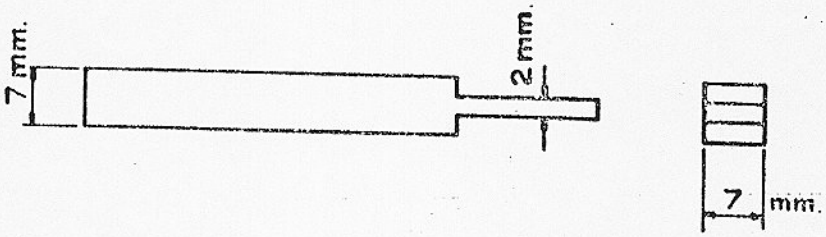
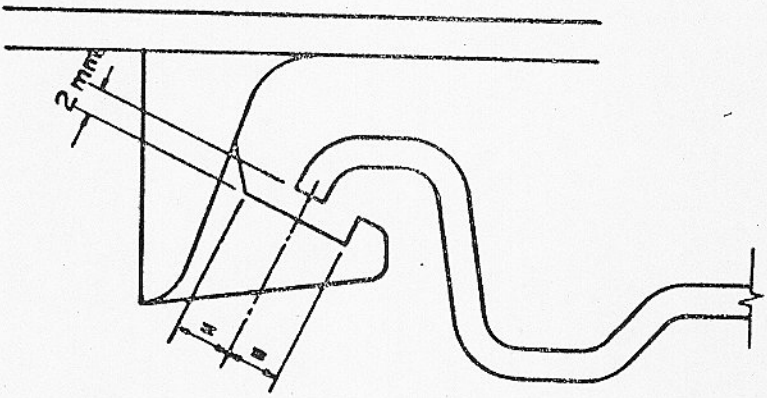


Fig. 2

Fig. 3



Use of Fuel Delivery Pipe Setting Gauge

APPENDIX 'B' (CONTINUED)

Flame Ring Extractor

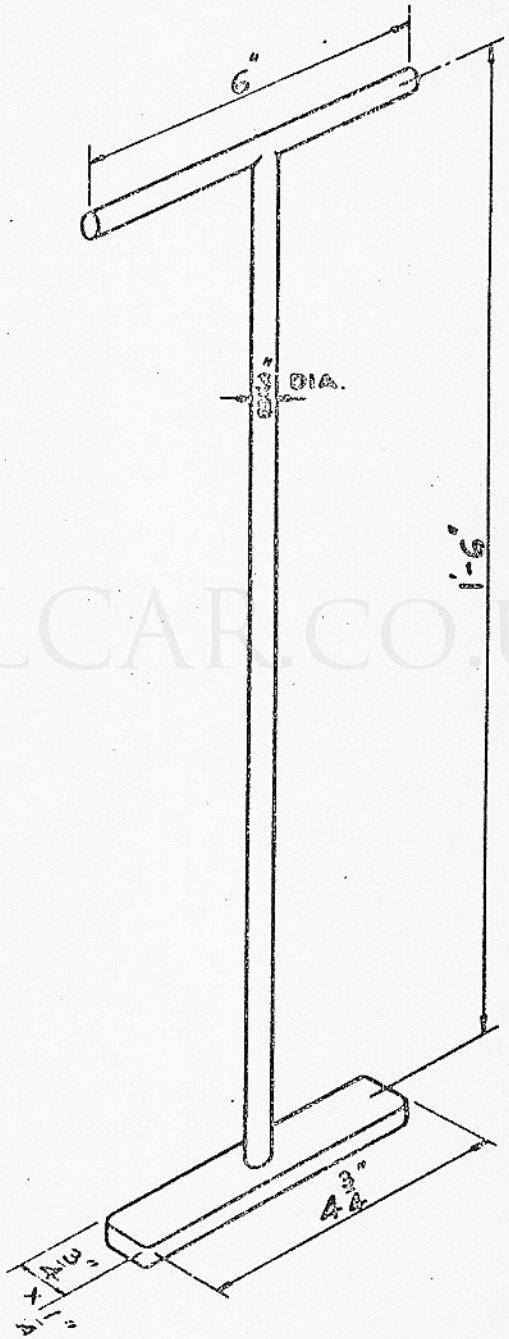
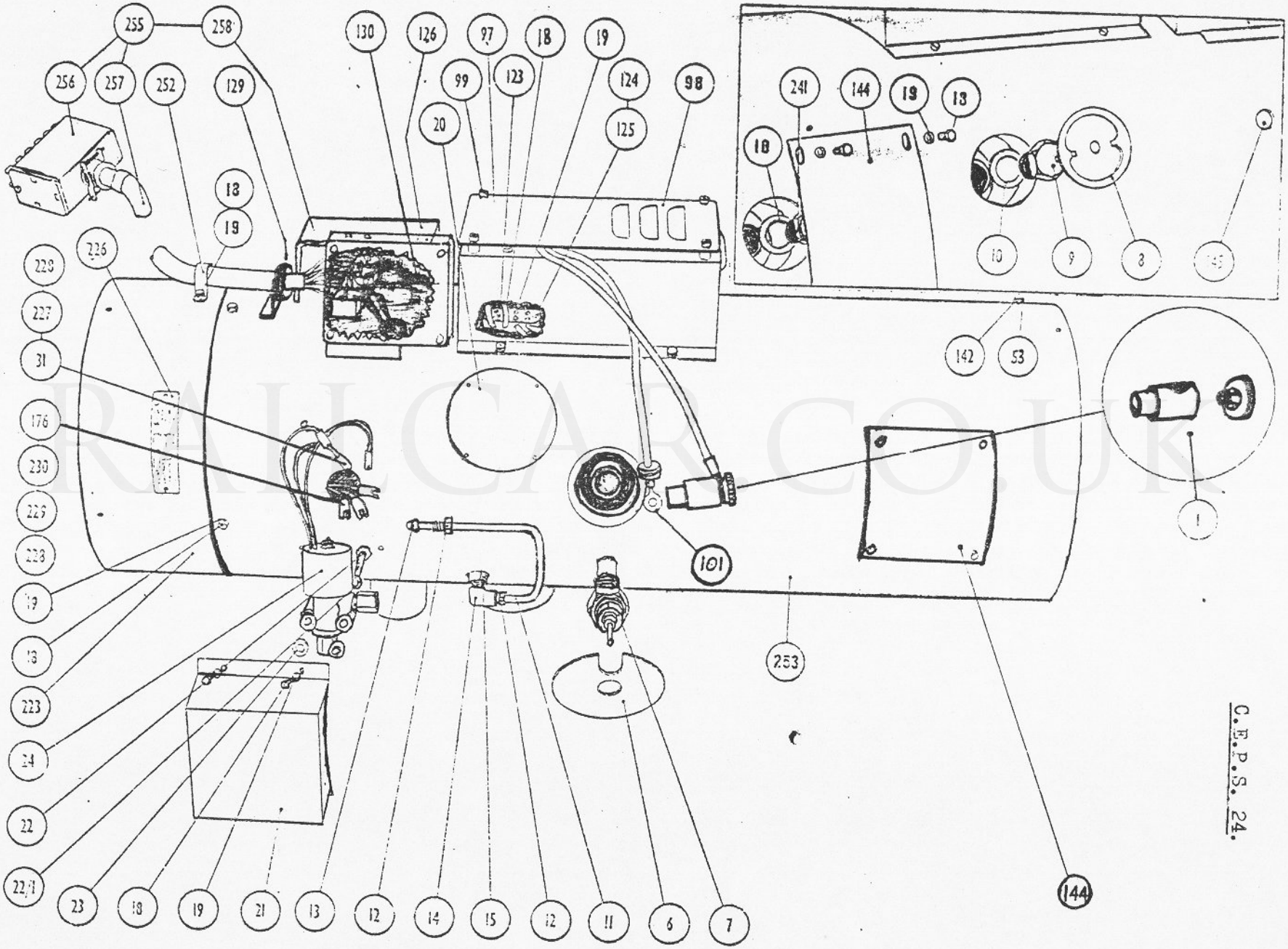


FIG. 4.

APPENDIX 'C' TO PROCESS SPECIFICATION C.E.P.S.24

Fault Finding Chart for Complete Heater Test

Section	Sympton	Fault and Action
1.	Motor fails to start on 'ventilating' position.	Check the motor supply.
2(a)	Combustion is not initiated within specified time limit after motor has started. FUEL IS OBSERVED TO DRIP FROM THE DRAIN UNION	Check the supply to the glow plug and voltage relay. Check the glow plug junction. Check that the fuel flow conforms to the fuel rate table in 22.3(d). If the fuel flow is outside the limits in section 22.3(d), check the fuel solenoid, supply pipes and pump for defects.
2(b)	Combustion is not initiated within specified time limit after motor has started. NO FUEL IS OBSERVED TO DRIP FHOM THE DRAIN UNION	Check the electrical supply to the fuel valve solenoid and operation of solenoid valve.
3.	Heater combusts but flame detector thermostat fails to detect heat within specified time limit of the motor starting.	Re-start and slowly rotate RP1 anti-clockwise after combustion has been established for 45 seconds. Relay RL1 (Item 6 Fig. 11 should then energise. If not, check wiring and thermistor TH1.
4.	Heater motor runs for more than specified time after switching off the heater.	If heater has not shut-down in 4 minutes, slowly rotate RP1 clockwise until RL1 (item 6 Fig. 11) de-energises. If not, check associated thermistor TH1 wiring to ensure that it is not open circuit.
5.	Heater shuts down after running for a short period. On restarting, it runs for the same period and shuts down again.	Overheat thermostat tripping due to lack of circulation air or component fault. Check relay RL2 and thermistor TH2.
6.	Total input current exceeds 7.7A on continuous running.	Check that there is no supply to the glow plug. If there is a supply, check circuit. Check motor current. If this is exceeded, check the main drive shaft to ensure that nothing is catching or binding on rotation. Check the motor for incorrect overhaul e.g. bearings.
7.	Carbon dioxide (CO_2) content exceeds specified limit.	Dismantle the heater and check the following:- that the seal ring (186) is not defective. Renew as necessary. that the heat exchanger has been cleaned properly. Reprocess through the bosch if necessary. that the heat exchanger is not leaking. Test for leaks and repair or renew as appropriate.



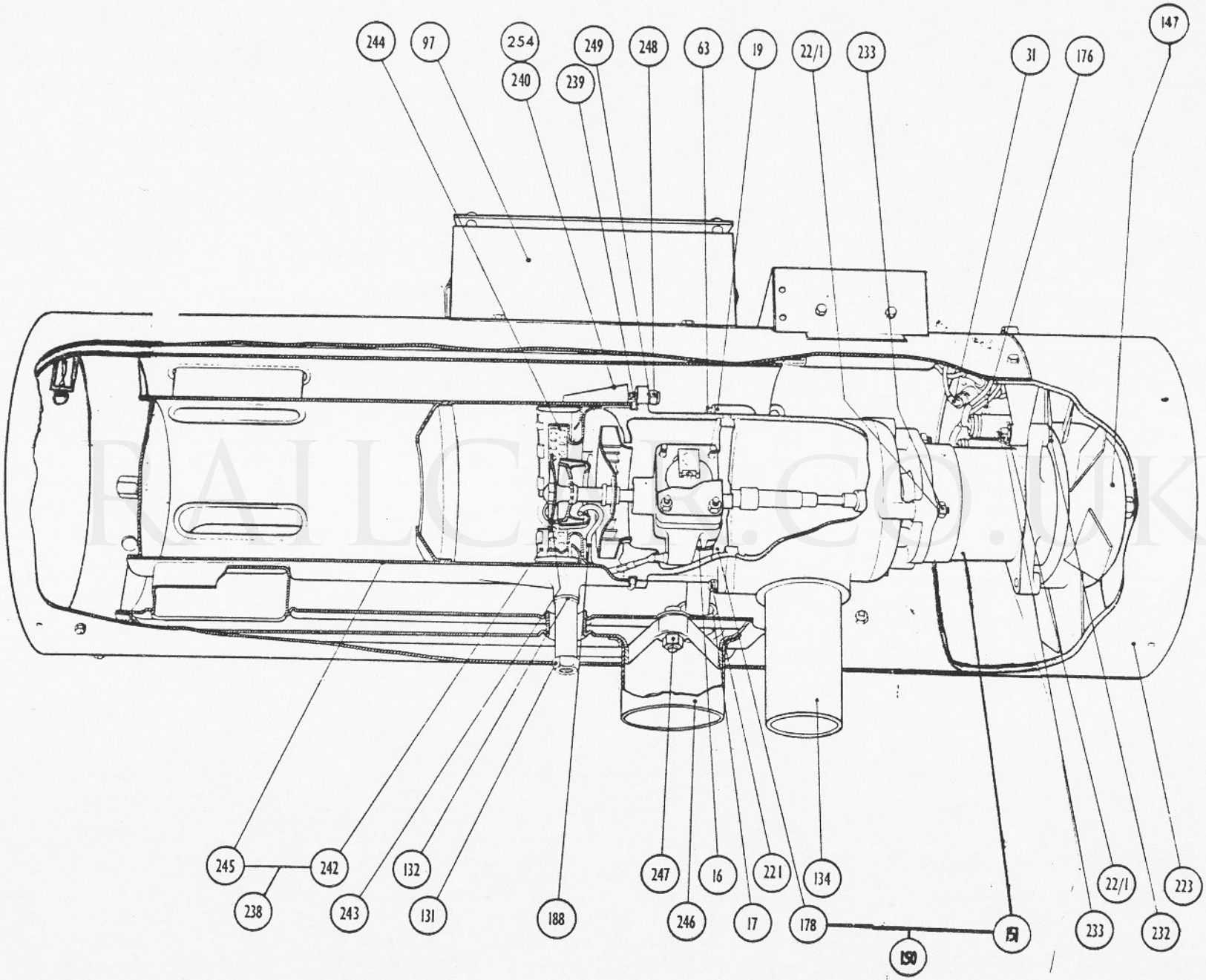
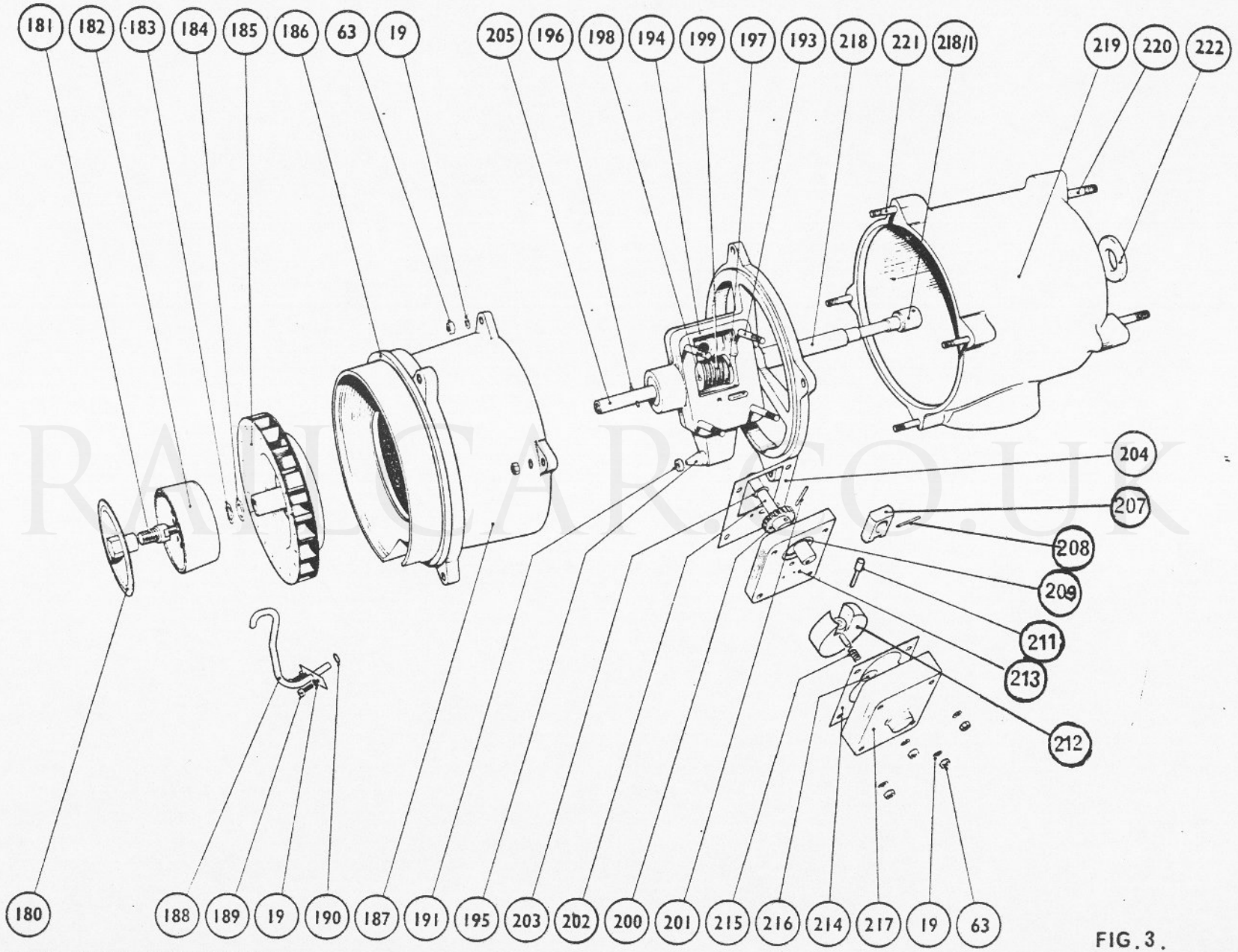
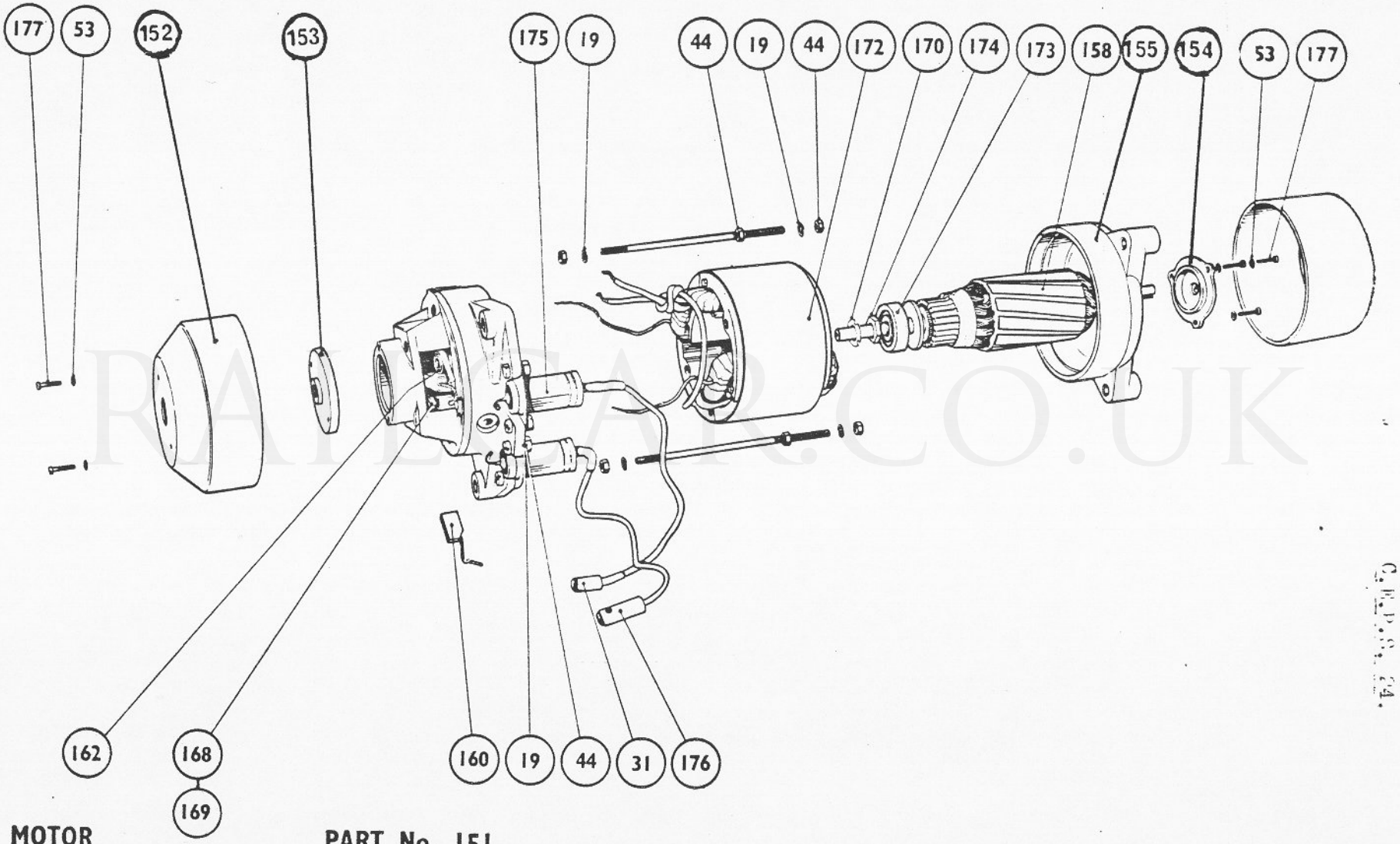

244
97
254
240
249
239
248
63
19
22/1
233
31
176
147
245
242
238
243
132
131
188
247
246
16
17
221
134
178
190
22/1
223
233
232

FIG. 2.



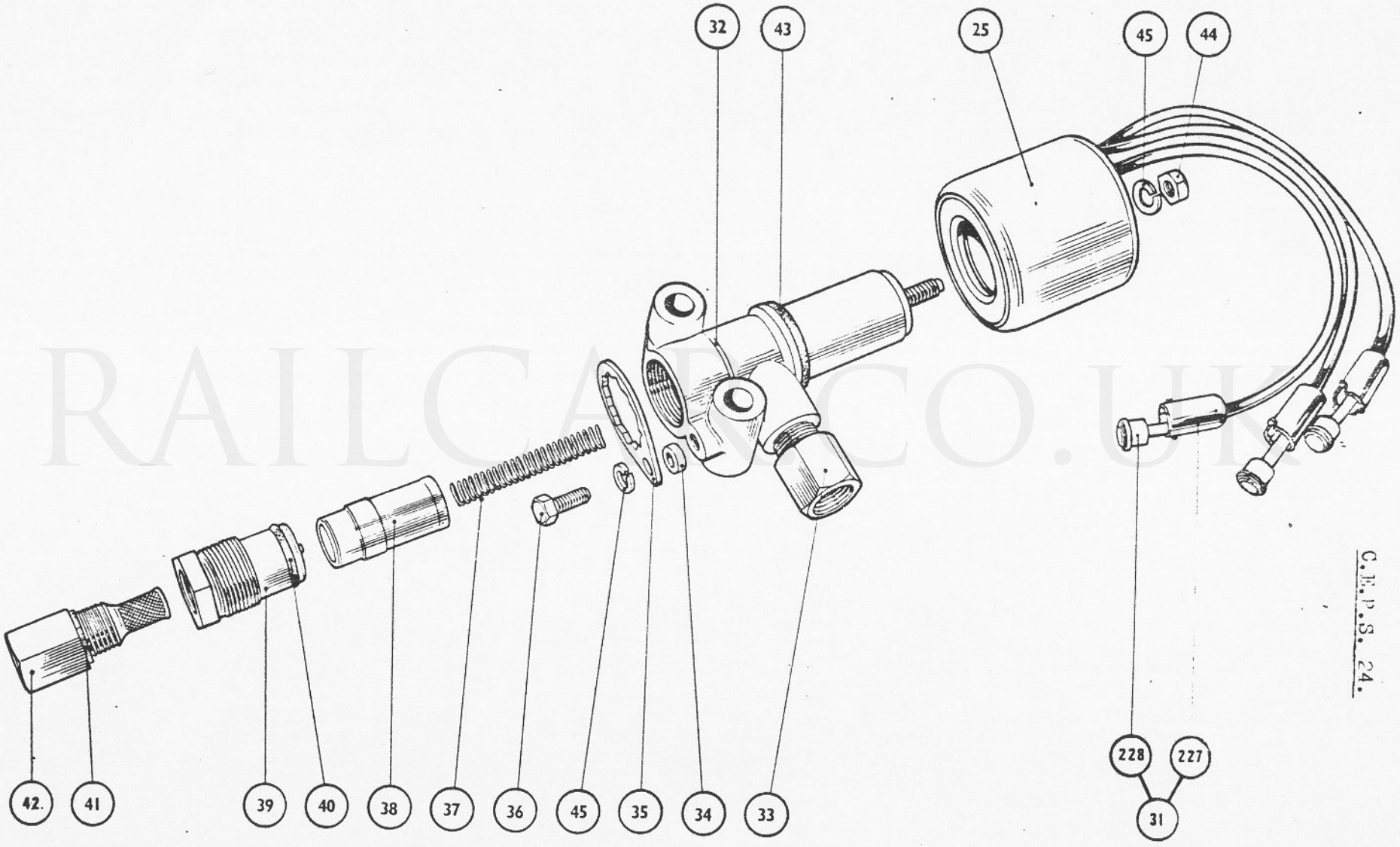
FUEL PUMP SUB-ASSEMBLY PART No. 178

FIG. 3.



MOTOR **PART No. 151**

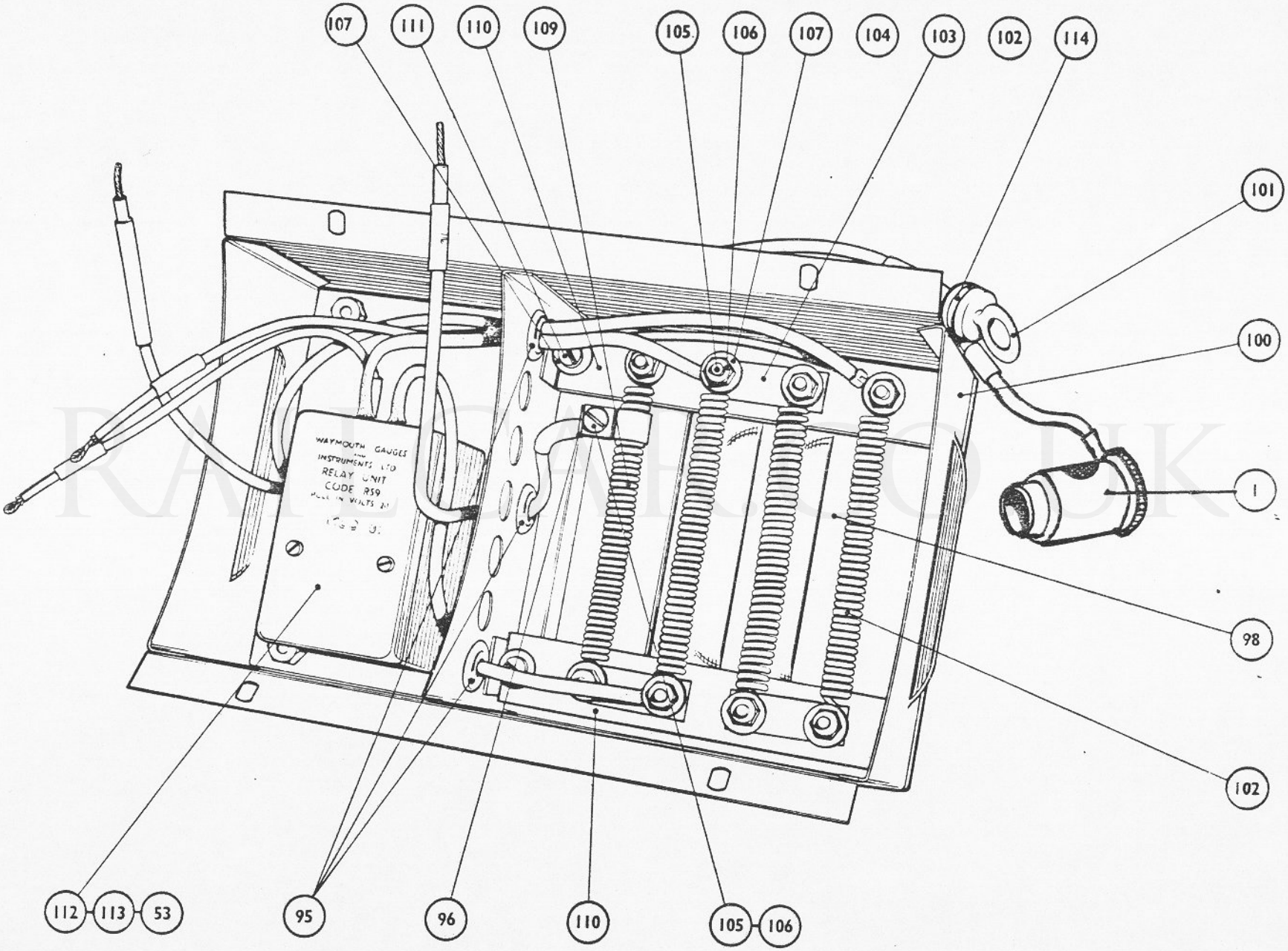
FIG. 4



C.E.P.S. 24.

SOLENOID VALVE **PART No. 24**

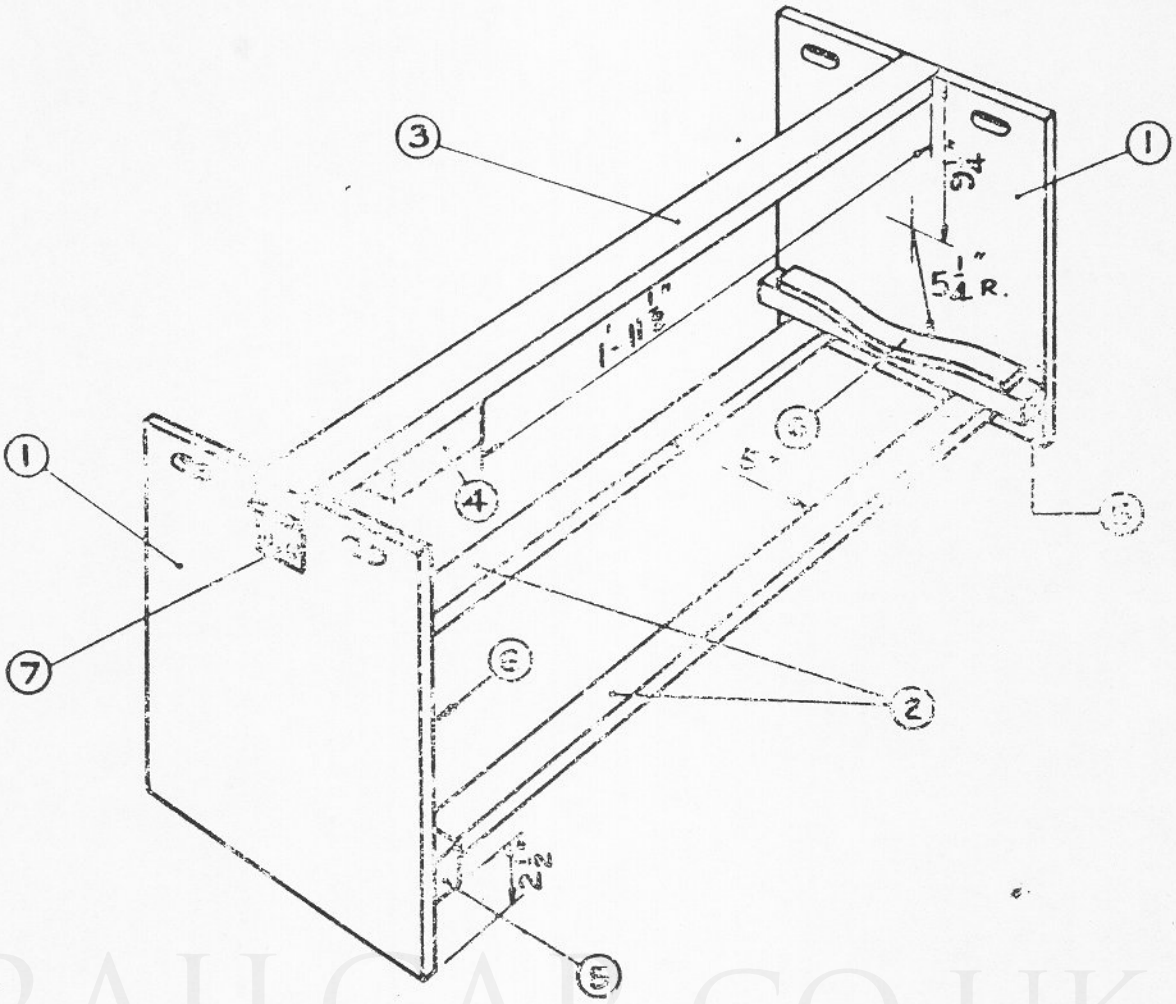
FIG. 5.



C.E.P.S. 24.

RESISTOR BOX **PART No. 97**

FIG. 8.



① $\frac{3}{4}$" Ply 1'-7" x 1'-7"

② $1\frac{1}{2}$" x $3\frac{1}{4}$" x 2'-$10\frac{1}{2}$"

③ 1" x $3\frac{1}{4}$" x 3'-0"

④ 3" x $3\frac{1}{4}$" x 7"

⑤ $2\frac{1}{2}$" x $2\frac{1}{2}$" x 1'-7"

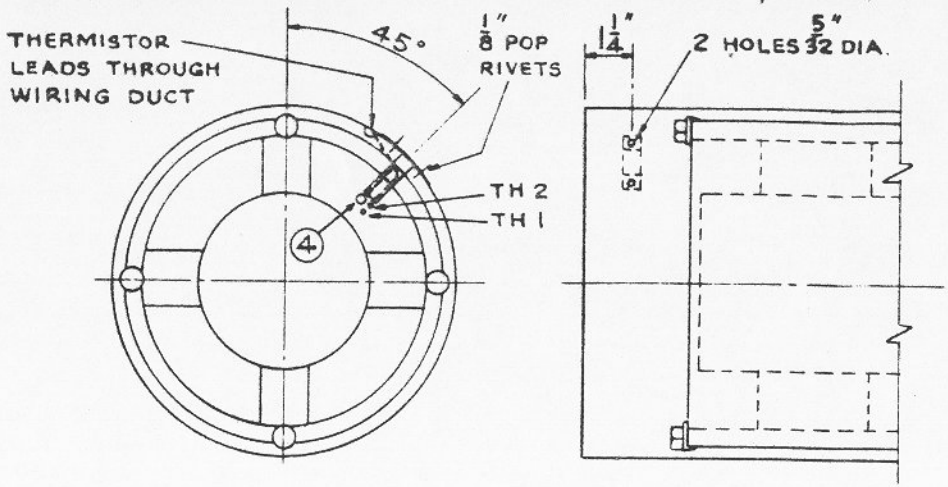
⑥ $\frac{7}{8}$" x $2\frac{1}{2}$" x 1'-7" Sponge Rubber

⑦ Hinge, fastened by 2 - $\frac{1}{4}$" dia. bolts to plywood and wood-screwed to bar.

FIG. 10

RECOMMENDED PROCESS SPECIFICATION No. C.E.P.S. 24

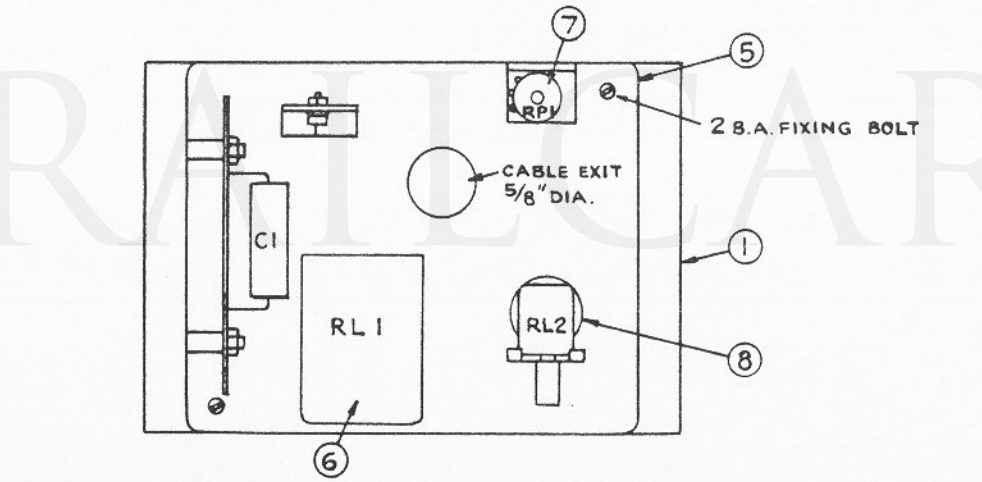
TRANSPORTATION CRATE

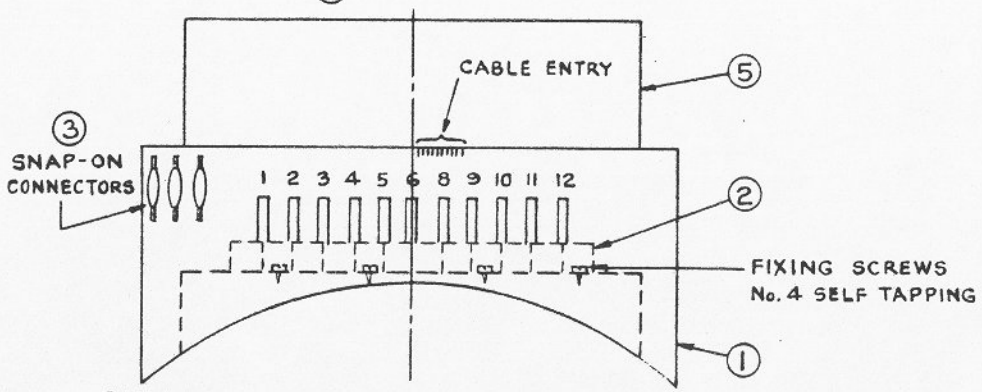


POSITION OF THERMISTORS - DELIVERY END OF HEATER

CONTROL BOX CABLE No.	SNAP-ON CONNECTOR	TERMATE CONNECTOR No.	
		MANUAL HEATERS	AUTOMATIC HEATERS
+		8	9
−		9	8
2		2	2
3		3	3
9/4 DUAL MARKED		4	9
5		5	5
11		11	11
0	0 (TH1)		
0	0 (TH1)		
1	1 (TH2)		
TH 2 TERMINAL LEAD MARKED 1		8	11

⑨ TABLE OF CONNECTIONS



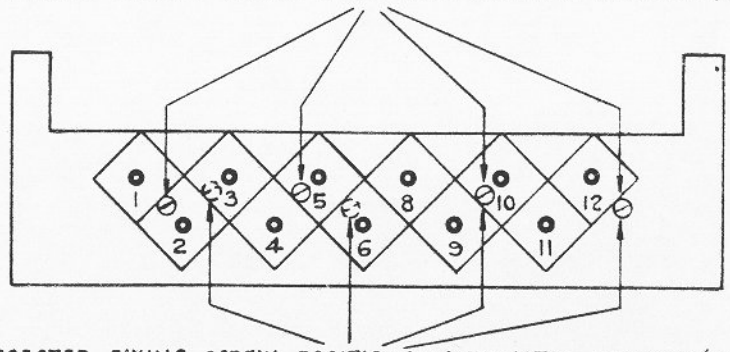


CONTROL BOX MOUNTED ON TERMINAL COVER

APPROX. LAYOUT OF COMPONENTS (LID REMOVED, WIRING NOT SHOWN)

N.B. No. 7 DOES NOT EXIST.

SUGGESTED FIXING SCREW POSITIONS - MANUAL HEATERS (No. 1 PRESENT)



SUGGESTED FIXING SCREW POSITIONS - AUTOMATIC HEATERS (No. 1 ABSENT)

STAGGERED ARRANGEMENT OF 'TERMATE' CONNECTORS

FIG. 11

TRIM LINE