DIESEL MULTIPLE UNITS

GENERATING EQUIPMENT & COMBUSTION HEATERS

19 APR 89

TSU/89/99

MECHANICAL & ELECTRICAL
ENGINEERING

TRAINING

SMITHS COMBUSTION HEATERS.

Introduction.

The Smiths heater used on Diesel Multiple Units functions as an oil fired air heater in which air from the atmosphere flows over a combustion chamber/heat exchanger.

The heater is designed to operate on diesel oil which 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. Combustion air is drawn into the combustion chamber by an air impeller.

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

It is a simple system to understand, set up, and maintain provided the operating environment remains reasonably constant. However use on a Diesel Multiple Unit is about as severe a test as could be devised, the heater being exposed to all external weather conditions including varying road speeds from 0 - 70 m.p.h. and tremendous variations in heat loss as passengers open and close doors and windows.

Operation and Maintenance.

In dealing with the operation and maintenance the heater is best considered by splitting the system into its three main functions, i.e. COMBUSTION, HEAT TRANSFER AND DISTRIBUTION AND CONTROL.

(a) Combustion.

The aim is to burn the fuel oil as efficiently as possible under the varying conditions of combustion air flow, combustion chamber temperatures, fuel delivery, and the mixing of air and fuel, while at the same time avoiding the build up of carbon residues in the combustion spaces. To burn the fuel oil efficiently requires an exact amount of air, enough to just complete the combustion and no more. Too little air results in unburnt fuel (soot) while too much increases the volume of flue gas and loss of heat to atmosphere via the exhaust.

The air/fuel ratio must be larger than the minimum value because:-

(1) The mixing of the air and fuel may be incomplete.

(2) The process is taking place rapid-y and excess air must be provided in an attempt to ensure complete combustion.

(b) Heat Transfer and Distribution.

Here the object is to ensure that as much of the heat produced as possible is transferred through the walls of the steel combustion chamber into the air flow passing over the outer surfaces.

It should be noted that the build up of soot etc., has the same thermal insulation effect as a layer of asbestos.

The heating air flow is then forced through the vehicle ducting which has outlets arranged so that the heating air is distributed as evenly as possible. With a particular ducting arrangement the heat is only evenly distributed provided the delivery temperature and air flow are within reasonable limits. This will not be the case if air intake filters and grilles are blocked.

(c) Control.

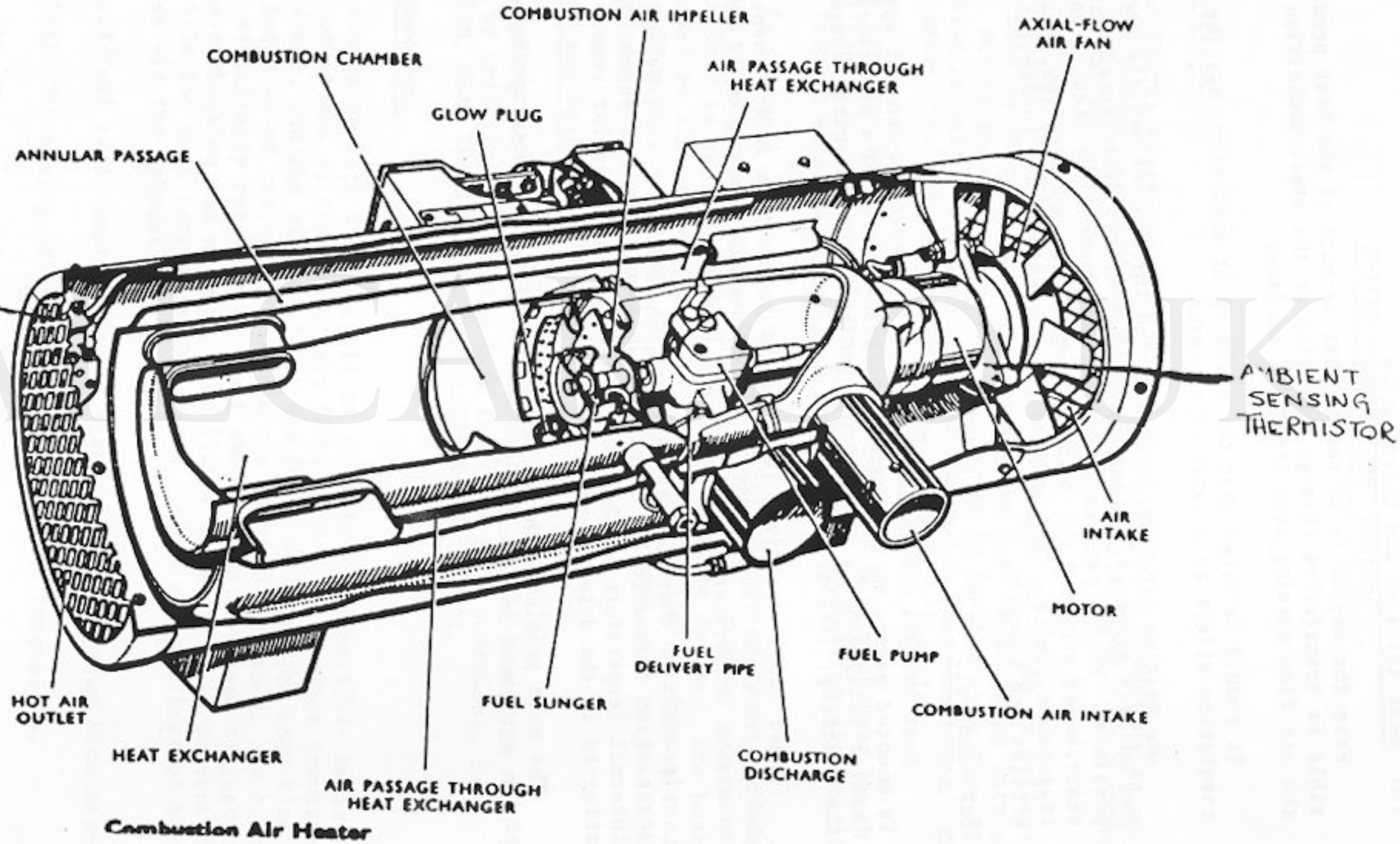
Most heaters now encountered have an electronic control system which is mounted partly on the heater casing and partly in a separately mounted 'heater relay panel', under normal conditions this control system determines the starting, firing, and shutting down sequences.

Under fault conditions it shuts the heater down in the event of a failure to establish a flame in the combustion chamber, or if there is an excessive temperature rise inside the heater.

In addition there is separate control equipment, i.e. saloon thermostats which automatically start or shut down the heater depending on the internal temperature in the vehicle and control boxes for remote control situated in the drivers and guards compartments, etc.

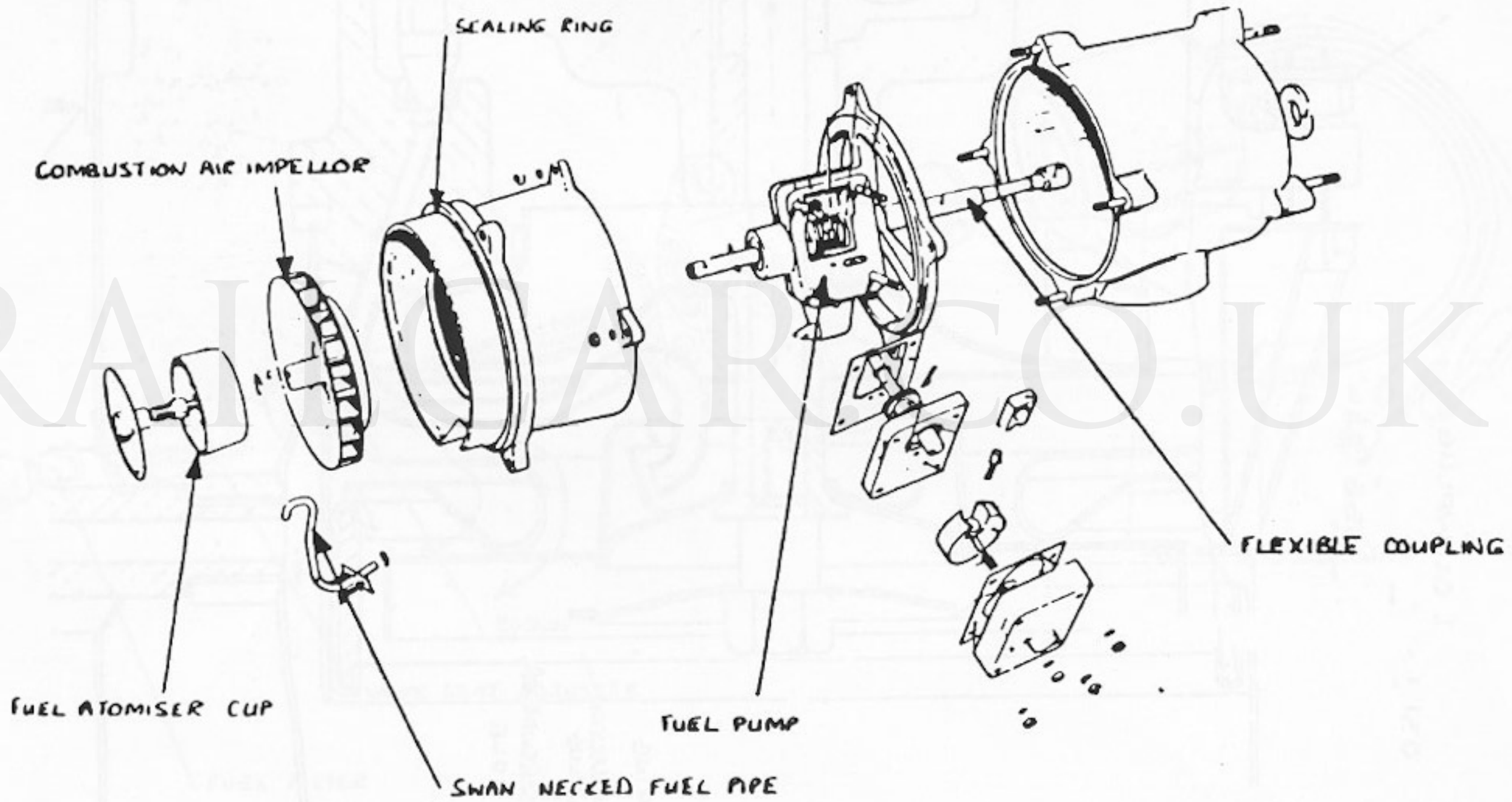
The main problem with the fault diagnosis is in determining which part of the equipment is defective.

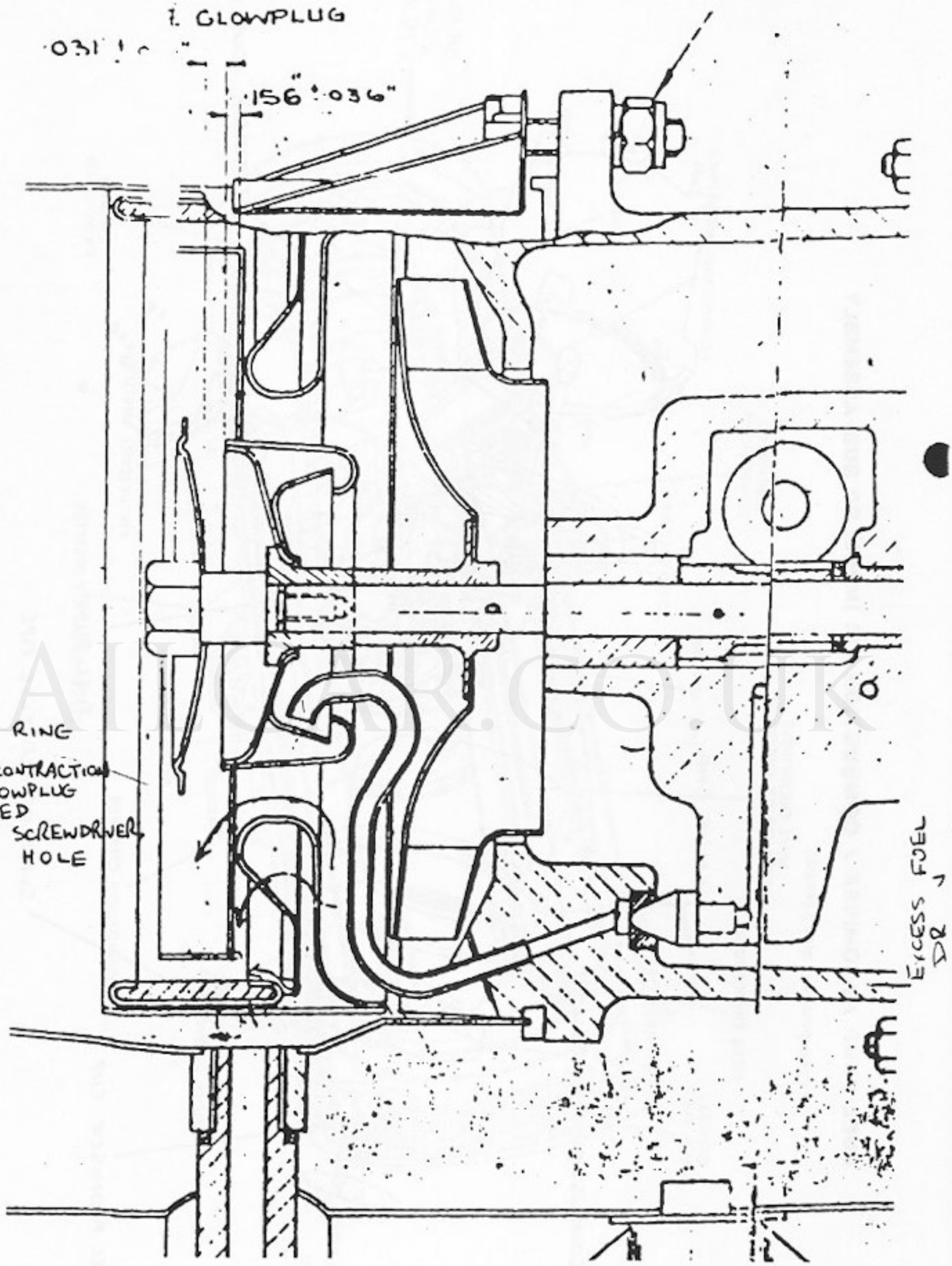
SMITHS HEATER



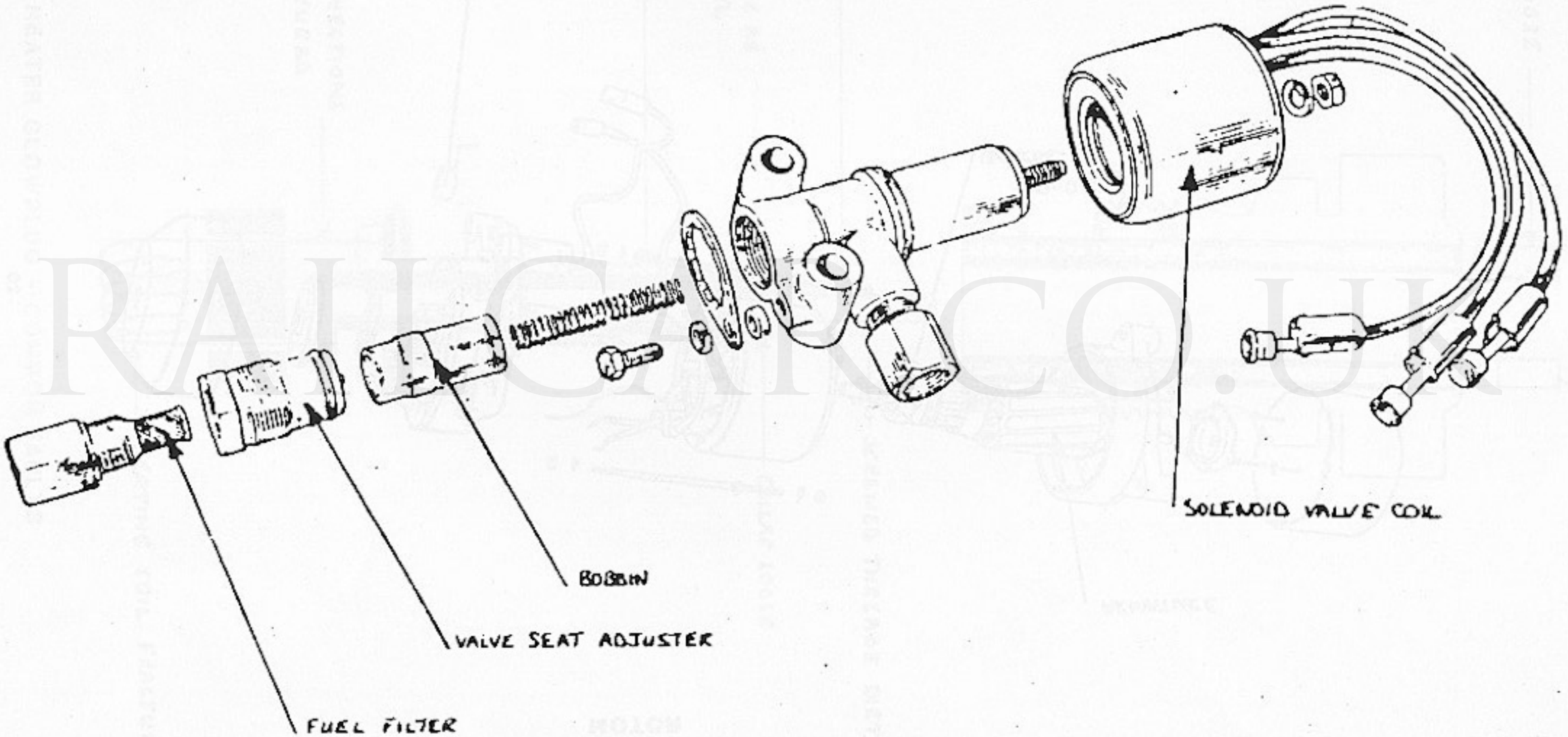
Combustion Air Heater

FUEL PUMP / ATOMISER / COMBUSTION AIR IMPELLOR SUB-ASSEMBLY

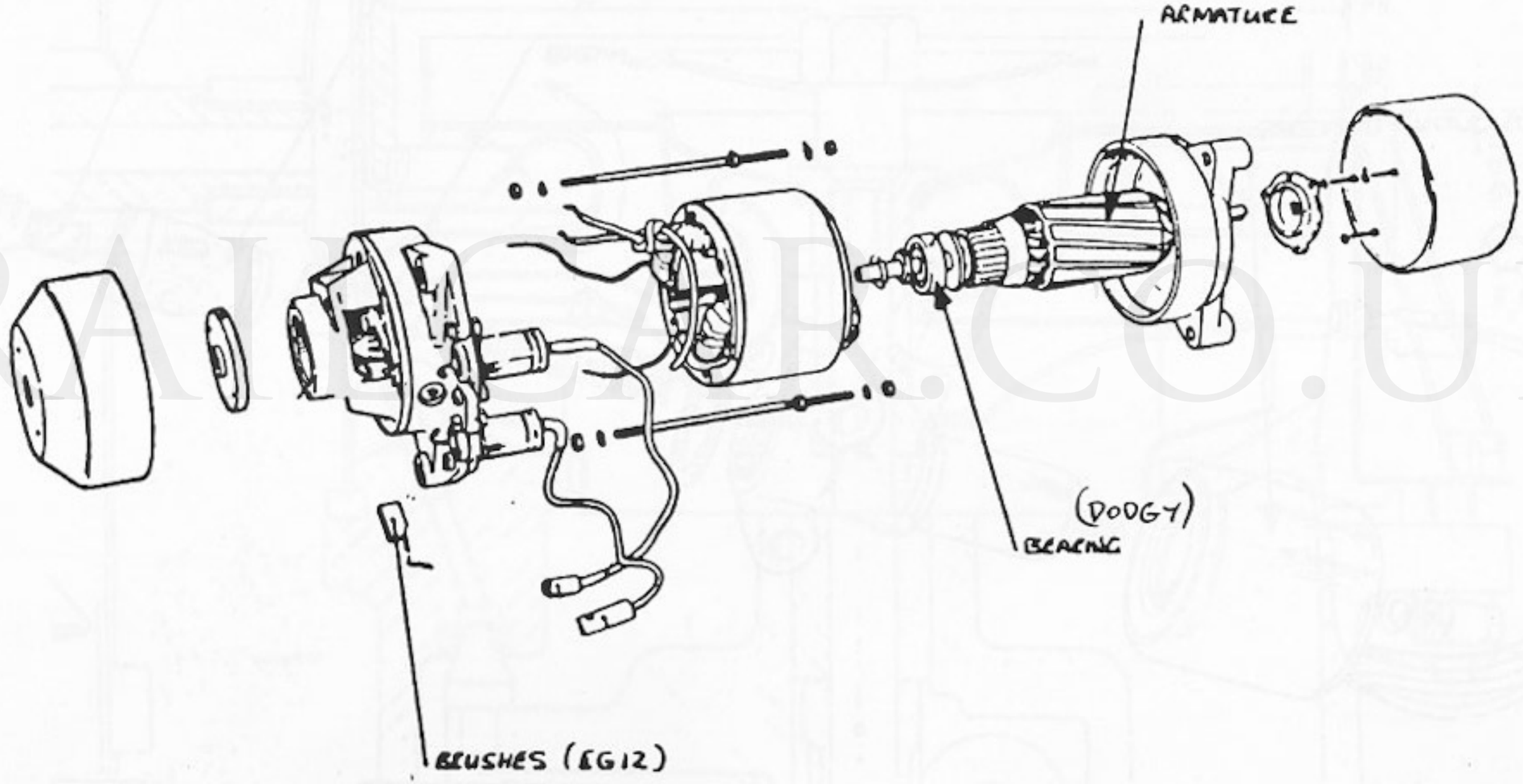


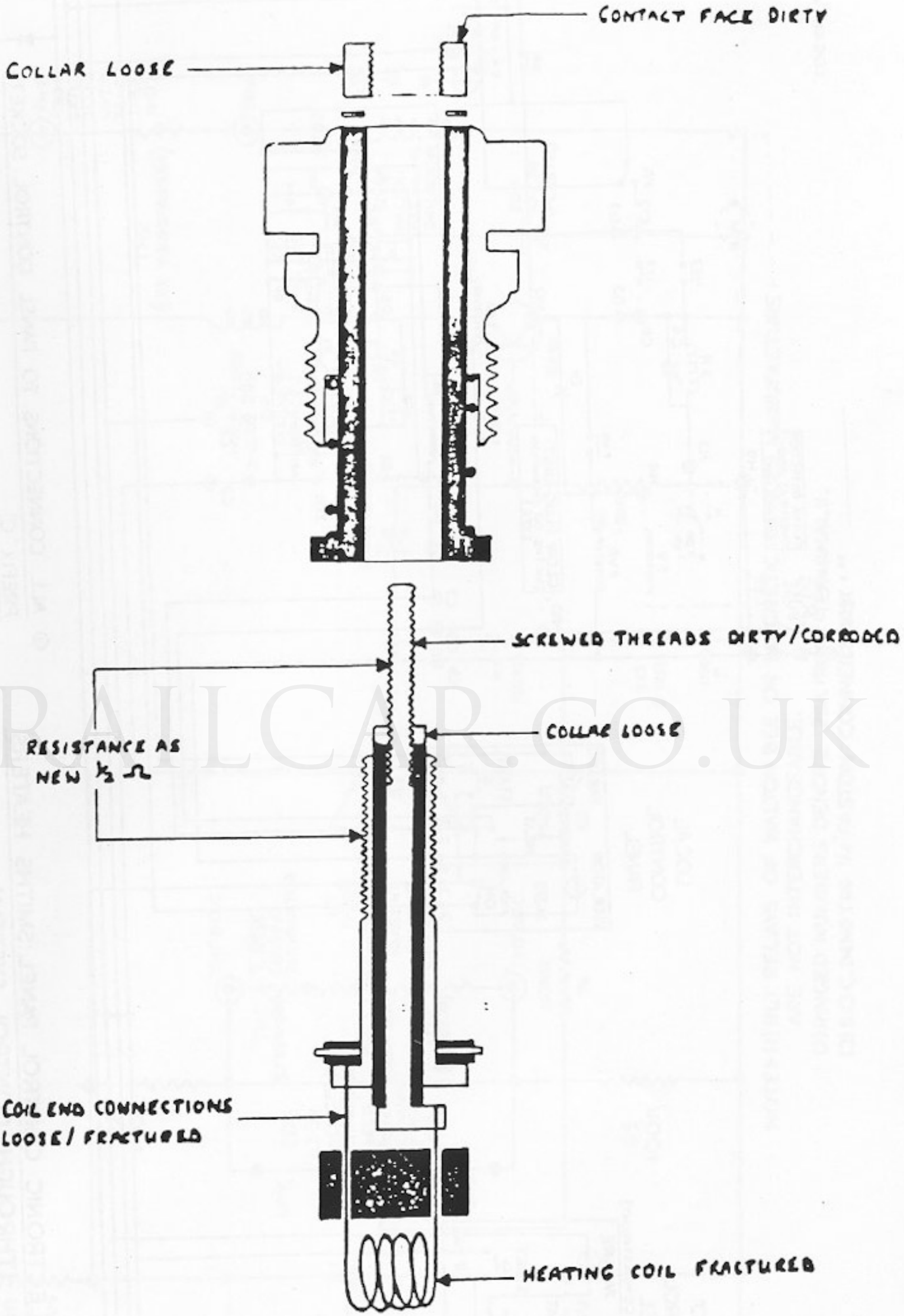


FUEL SOLENOID VALVE



MOTOR





SMITH HEATER GLOWPLUG - COMMON FAULTS

THRO' CONTROL PANEL (GUARD'S COMPARTMENT)

ISOLATOR FAILURE VENT HEAT ISOLATOR ON START

3 1 8 2 4

28

LOCAL +ve FEED (GUARD'S VEHICLE)

LOCAL CONTROL PANEL

ISOLATOR FAILURE D9 VENT HEAT ISOLATOR ON START

3 1 8 7 5 2 4

C LOCAL + ve

LOCAL - ve

MF GLOW PLUG FUSE

FLAME DETECTION OVERHEAT PROTECTION UNIT

MR1 H9 M

H H11/6 H3 SR C4 MR2

FDR FV H4 C11 ATT C12 FR D2 D3

FVR FVR D1

H10 GLOW PLUG UNIT (SMITHS OR CHAMPION TYPE) H12 SR1

MR C4 D8 C10 C9 D7

C8 C5 C7 H2 H5 R17 C1

R1 C3 D5 TR2 TR4 ZD2 ZD5

ZD1 R2 R3 R6 A1 R8 R7 R10 R14 TR3 R15

R4 R5 R11 C5 D4 D6 C2 C6

43 44 45 41

C3 -ve Fuse. LOCAL -VE FEED (GUARDS VEHICLE).

C3 -ve FUSE LOCAL -VE FEED

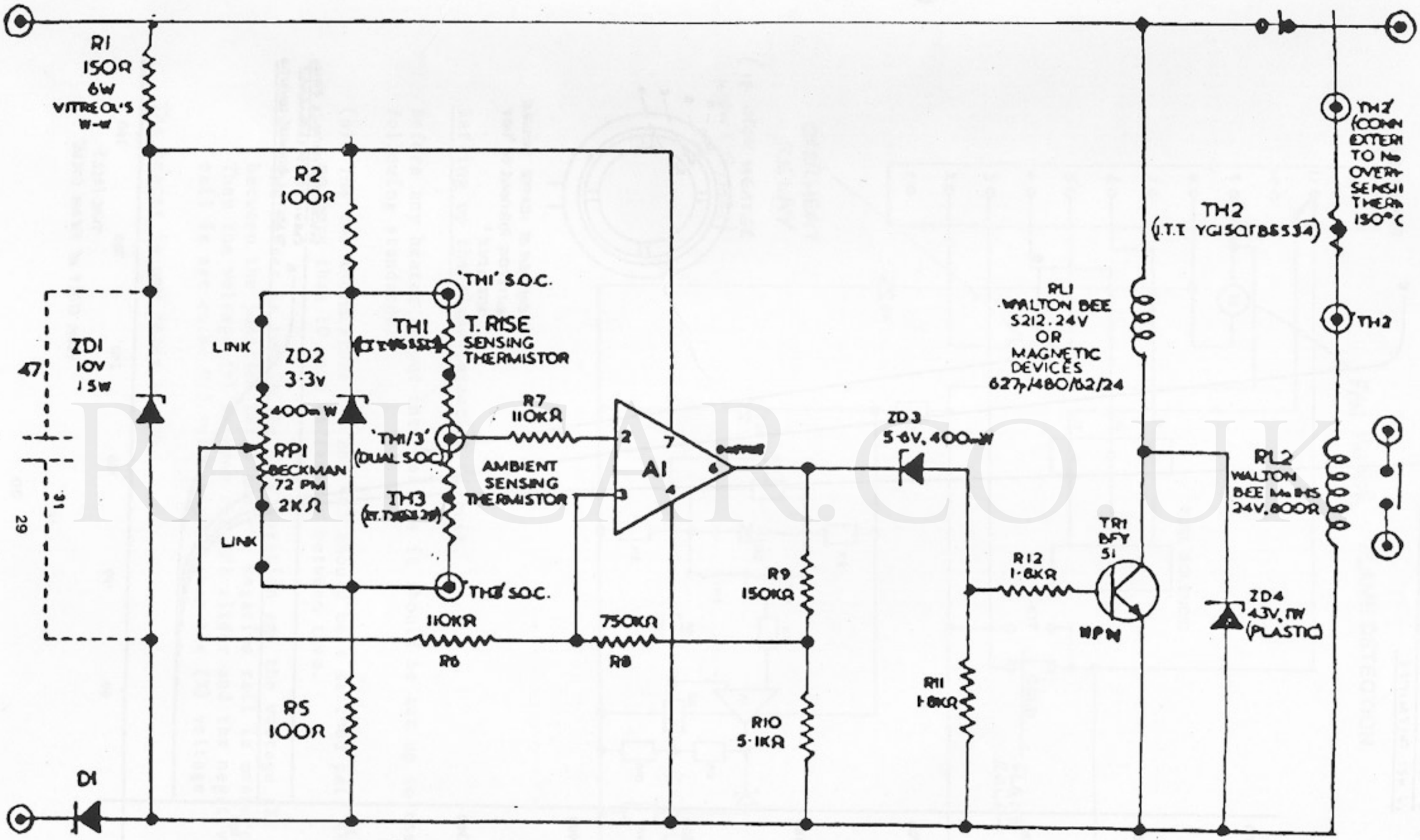
ELECTRONIC CONTROL PANEL: SMITHS HEATERS (THROUGH CONTROL SYSTEM).

Electronic Flame Detection and Overheat Protection Unit Series II.

⊙ ALL CONNECTIONS TO PANEL CONTROL SOCKET PREFIX 'C'.

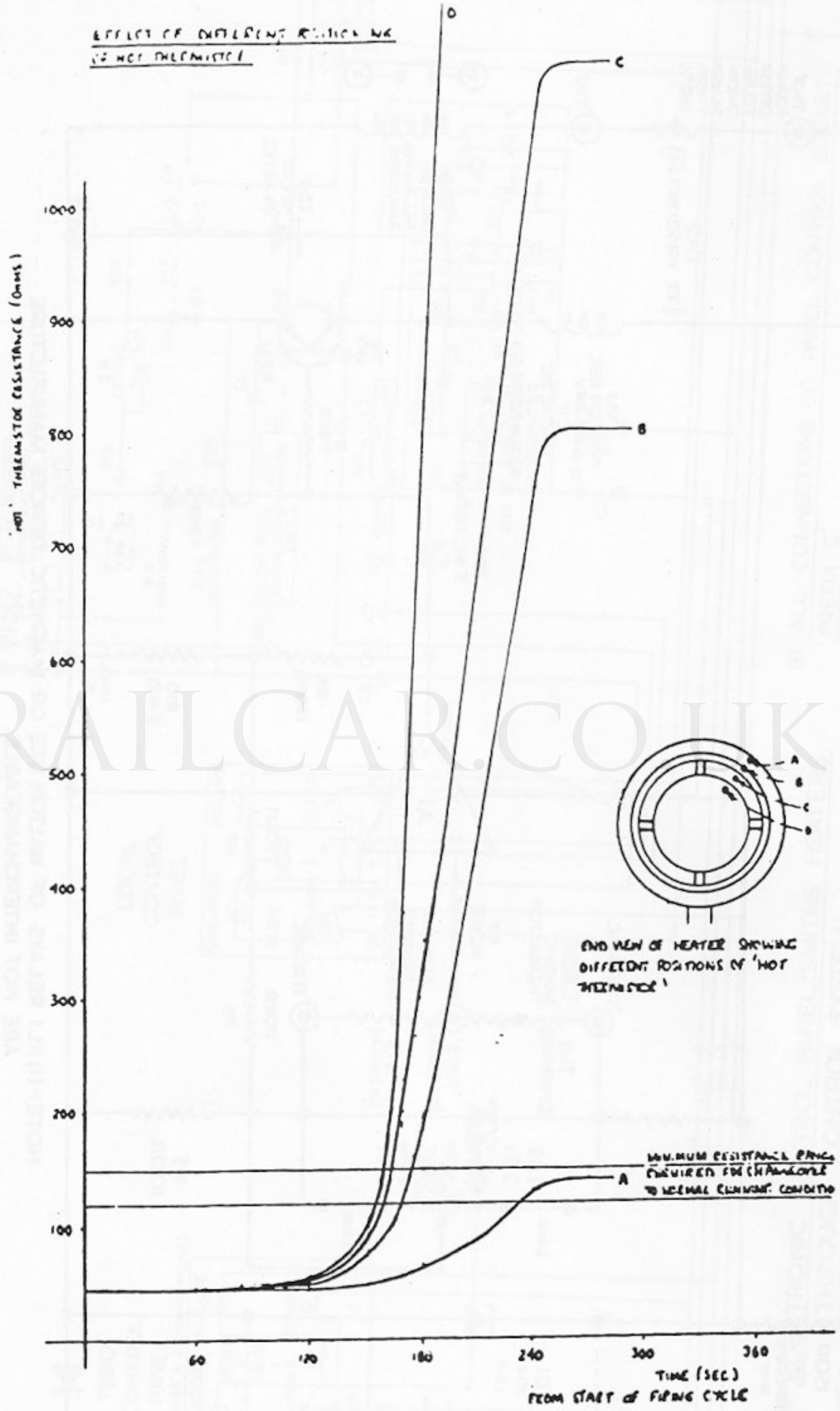
⊙ ALL CONNECTIONS TO PANEL HEATER SOCKET PREFIX 'H'.

SEE D[redacted] C-A2-14952 COMPONENT LIST DRG C-A4-1051

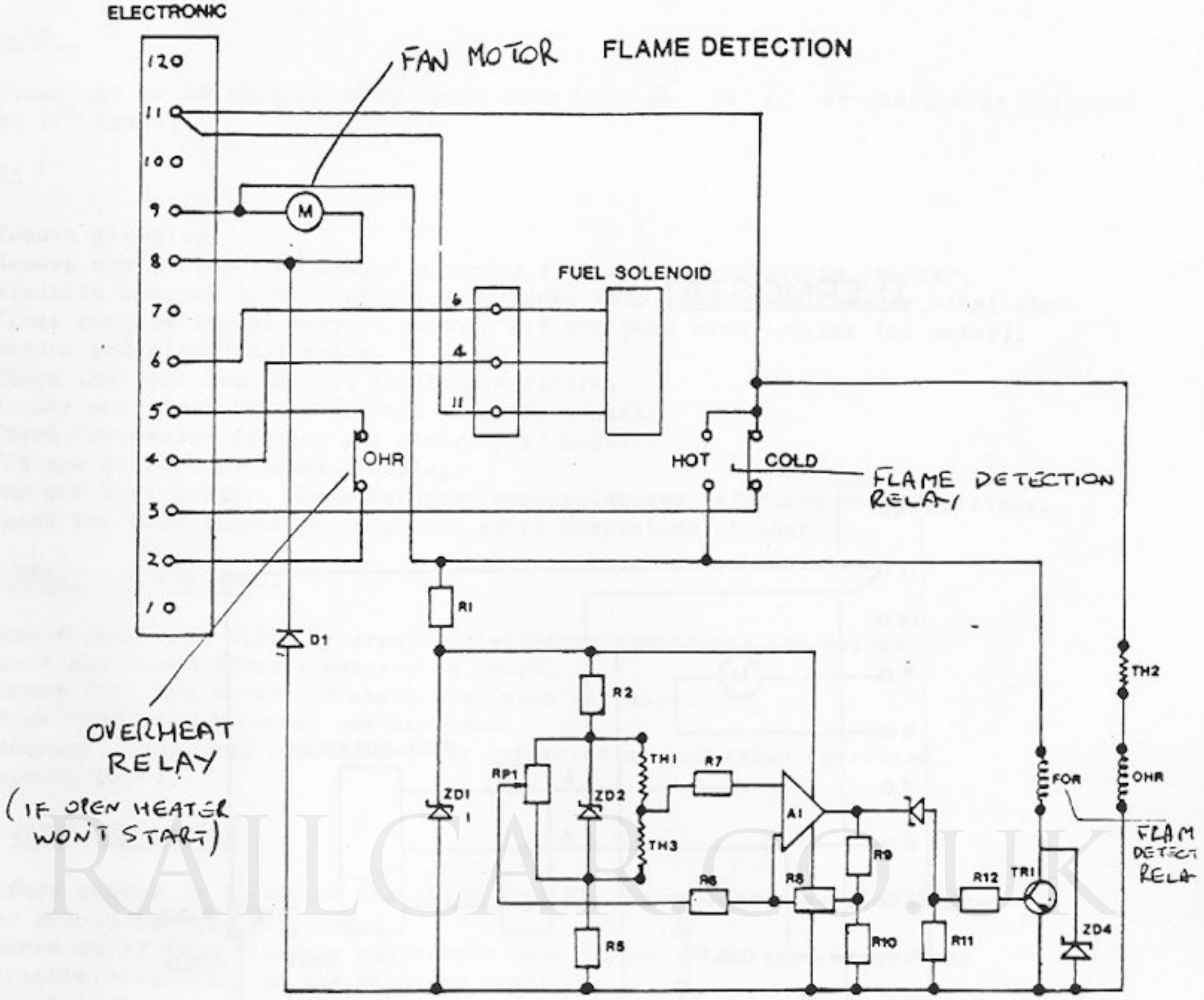


NOTE:- (1) RL1 RELAYS OF WALTON BEE OR MAGNETIC DEVICES MANUFACTURE ARE NOT INTERCHANGEABLE.
(2) RINGED NUMBERS DENOTE 2BA RING TERMINALS.
(3) S.O.C. DENOTES 1/4" FASTON CONNECTORS.

EFFECT OF DIFFERENT RELATIVE MOUNTING OF HOT THERMISTOR



END VIEW OF HEATER SHOWING DIFFERENT POSITIONS OF 'HOT THERMISTOR'



Setting up the Flame Detection Circuit.

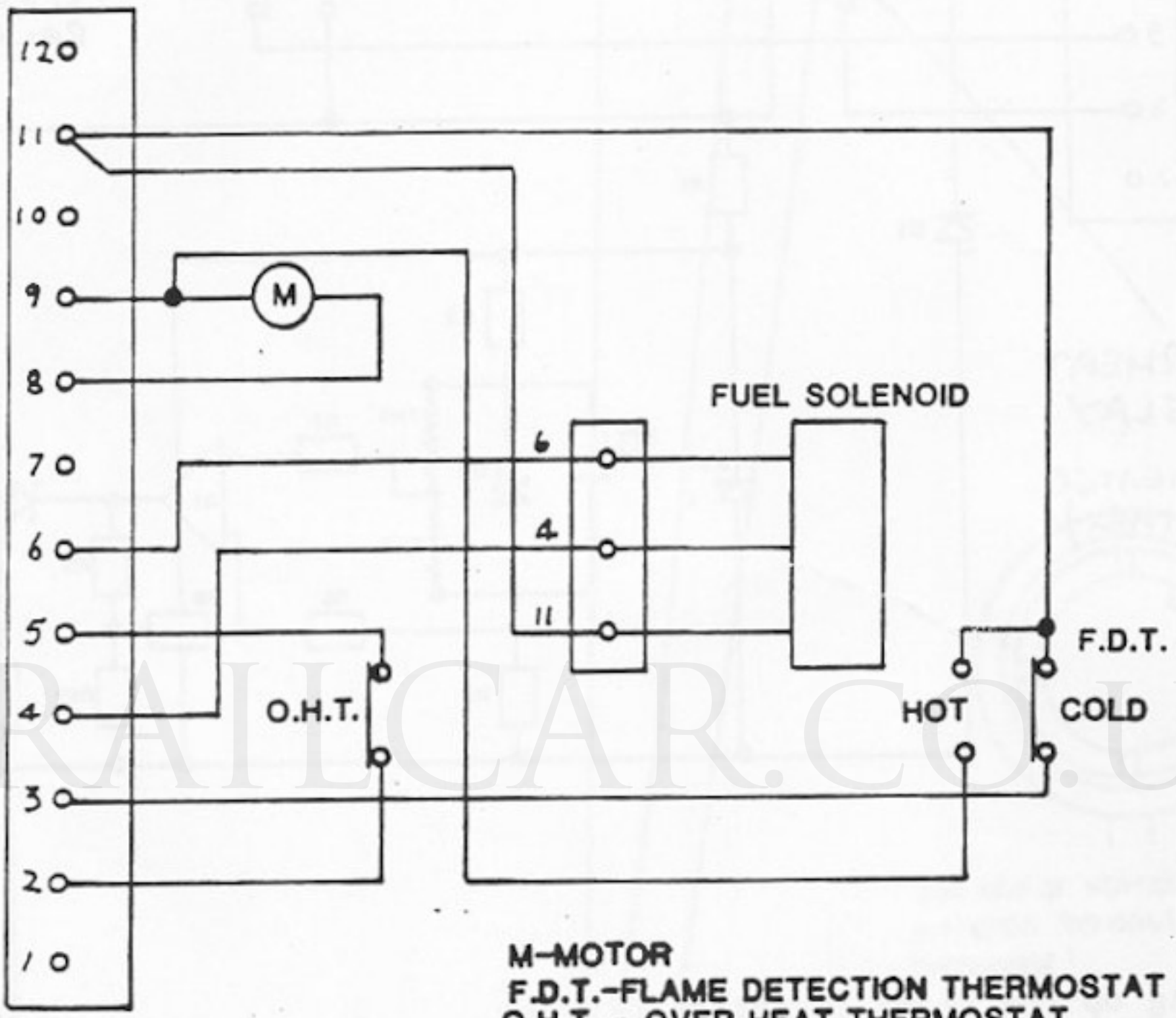
Before any heater is put into service it should be set up to the following standards:-

(a) The two thermistors TH1 and TH3 should be a matched pair with no more than 10 ohms difference between them.

(b) The heater is run in the VENT position and the voltage (X) between the junction TH1/3 and the negative rail is measured. Then the voltage (Y) between the RP1 slider and the negative rail is set to be 0.3 volts higher than the (X) voltage.

The heater is now ready to run.

THERMOSTAT



M–MOTOR
F.D.T.–FLAME DETECTION THERMOSTAT
O.H.T. – OVER HEAT THERMOSTAT

PRESENT SYSTEM

DEPOT MAINTENANCE

SMITH'S COMBUSTION HEATERS

GLOWPLUGS

1. Glowplugs to be changed every depot exam from A to E or changed as required on F/P exams.

HEATERS

1. Remove glowplug.
2. Remove any carbon from around glowplug entrance to combustion chamber.
3. Visually examine through glowplug entrance into combustion chamber, that the flame ring is in the correct postion (if not push back towards fan motor).
4. Remove and clean fuel drain.
5. Check that air and exhaust intake are secure.
6. Remove and check heater Jones's plug and socket.
7. Check forcorrect fitting and security of heater.
8. Fit new or reconditioned glowplug.
9. Run and test heater. Check for poor combustion and defective motor bearings.
10. Check for heat output in coach and split combustion chamber.

HEATER RELAY CONTROL PANEL

1. Remove panel and visually examine electronic components and relays.
2. Check and clean Jones's sockets on panel.
3. Remove fuse box cover and check condition of fuses.
4. Check condition of panel weather seal.
5. Reconnect panel and check panel for correct time and relay operation.
6. Replace panel.

WHEN FITTING NEW HEATER

1. Before heater is placed on car check that the thermisters are not damaged and are in correct position.
2. Remove cover from glowplug resistande unit on top of heater. Adjust the variable resistance to the half way position.
3. When heater in position on car run in vent position and set up flame detection circuit using a model eight AVO.

STARTING.

1. PRESS START BUTTON GLOW PLUG WILL HEAT FOR 45-55 secs
2. AFTER 45—55 secs WITH FUEL: SOLENOID ENERGISED FAN MOTOR WILL START TO PUMP FUEL ON TO GLOWPLUG.
3. HEATER SHOULD ESTABLISH A FLAME WITHIN 3min 45secs.
4. IF FLAME IS ESTABLISHED HEATER CONTROL PANEL WILL SHUTDOWN GLOWPLUG & HEATER WILL BE CONTROLLED BY COACH THERMOSTAT
5. IF FLAME IS NOT ESTABLISHED THEN HEATER WILL FAIL.

Heater Test Unit.

Foreward.

The test unit is designed to prove whether the heater or the relay panel is at fault.

Use of Test Unit.

The unit should be plugged into the relay panel (heater connection) and the heater connection plugged into the test box.

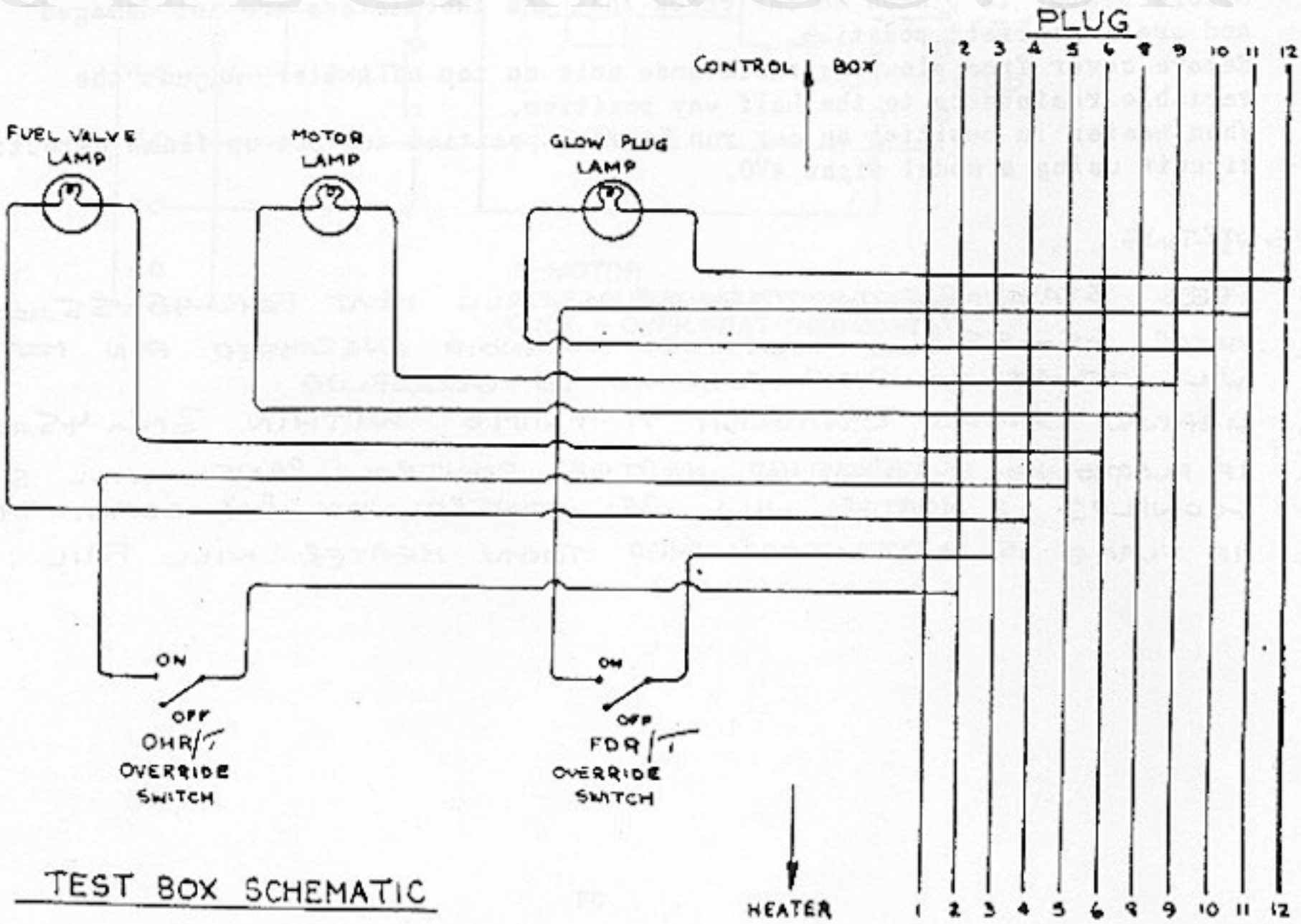
(a) Start the heater from the local control panel.

(b) Firstly the glow plug light and fuel valve light on the test unit should be illuminated and then after 45-60 seconds the motor light should illuminate and the motor should run.

(c) The lights only prove that the glow plug and fuel valve have electrical feeds to them - a physical check that the glow plug is energised and that the fuel valve is open should be made if the heater runs but combustion does not take place.

(d) If the lamps do not light operate the OHR/T and FDR/T switches. Try starting the heater again. If the heater now operates correctly the fault lies with the heater. Individual operation of the fault switches OHR/T and FDR/T will prove which circuit is defective and a visual investigation of the heater electronic panel may show up the fault).

(e) If after OHR/T and FDR/T have been operated the heater is still dead, check all fuses and then change the relay panel.



TEST BOX SCHEMATIC

FAULT FINDING GUIDE

This guide is divided into two sections:

(A) Heater does not fire .
(B) Heater fires but does not operate correctly.

(A) (1) If the motor does not run, switch the heater control to vent. If the motor still does not run check the " Motor fuse ", check that MR relay energises and the MR1 interlocks have closed correctly. Check that the OHR relay has energised and that its interlocks are closed. Check the positive and negative supply to the control panel. Finally remove the heater and examine the brushes. Renew the heater if unable to find or rectify fault.

(20 If the motor runs only in "vent" check that the saloon thermostat is not open. Unbolt the relay panel and check that FR relay is energised after pressing the start button. Check that SR energises after FR picks up and that the glow plug switches on. If the glow plug switches on but the motor does not run after 40–60 seconds change the control panel.

(3) If the motor runs after the glow plug has been on for 40–60 seconds but combustion does not take place and the heater fails after a complet cycle (3 minutes 45 seconds) check the glow plug and change if necessary. Check that the glow plug resistance is set at 4 volts and that the heating element gives a good glow.

Examine the combustion chamber with the glow plug removed and check that:

(a) The flame ring is pushed back (towards the motor) clear of the glow plug hole.

(b) The fuel slinger is in a postion, complete and that it revolves with the motor.

Switch the motor to "vent" and energise the FVR relay (manually). Check that fuel is thrown into the glow plug aperture. If no fuel is seen, Check the fuel tank level and the heater fuel valve. Finally check alignment of fuel slinger and glow plug hole. If unable to find or rectify faults, change the heater.

(4) If the start button is operated but the failure light does not extinguish check that the OHR has energised. Check, examine and clean the plug pins on the heater jumper. If the OHR still does not energise, change the heater.

(8)

(1) If the heater fires, but switches off when the FDR relay operates, check the saloon thermostat has not operated. Check that the FVR relay had energised when the motor starts to run and remains energised when the FDR operates.

(2) If the heater runs a glow plug cycle (40-60 seconds) but the moter only runs for a short period (10-15 seconds) before commencing another glow plug cycle, switch the heater to "vent". Run the heater in "vent" for approximately one minute and then repeat heating cycle. If the heater still exhibits the same symptoms leave it cycling for five minutes. If fault persists set up flame detection circuit using a model 8 AVO. If unable to rectify fault change the heater.

(3) If the heater fires but switches off after a full heater cycle (3 mins 45 secs), check wether the flame detection relay has picked up. If it did not operate recycle the heater and check the hot air is being pumped into the saloon. If hot air is blown into the saloon but the FDR does not operate change the heate

(4) If the heater fires, the FDR operates, but the heater subsequently shuts down with a failure light showing on the control panel, check whether the OHR has de-energised. If the OHR has de-energised, remove and clean the heater filter. If a clean filter is not available fit a blanking plate. Rerun the heater and ensure that it does not shut down through the overheat relay. If the fault persists change heater.

(5) After shutting down the heater it should not take longer than six minutes to switch off. If the heater continues to blow cold air set up flame detection circuit using a model 8 AVO. If fault persists change heater.