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1 Introduction

1.1 Scope and Purpose

This repair shop manual is intended to support familiarized personnel in the repair of water heaters *Thermo 230, 231, 300, 301 and 350*.

The water heater may only be operated with the specified fuel (Diesel or also fuel oil EL) and the relevant designated type of electrical connection.

Heaters which have Diesel indicated as propellant on their identification label, must not be operated with PME (vegetable oil methylester).

If PME is the designated propellant also Diesel or fuel oil EL may be used.

1.2 Applicability of Manual

This manual is applicable only for heaters identified on the title page. The different appearance of control units (see 2.5) allow to distinguish between model .30 and up with control unit 1572 and the model .030 and up with control unit 1572D.

In combination with control unit 1572D additionally a different type of igniter box is installed (refer to 2.7).

The heaters *Thermo 231* and *301* are variants for vertical or horizontal installation.

1.3 Meaning of Warnings, Cautions and Notes

WARNINGS, CAUTIONS, and NOTES in this manual have the following meaning:

WARNING

This heading is used to highlight that non-compliance with instructions or procedures may cause injuries or lethal accidents to personnel.

CAUTION

This heading is used to highlight that non-compliance with instructions or procedures may cause damage to equipment.

NOTE

This heading is used to highlight and draw specific attention to information.

1.4 Additional Documentation to be used

This workshop manual contains all information and procedures necessary for the repair of heaters *Thermo 230, 231, 300, 301 and 350*.

The use of additional documentation is normally not necessary.

Operating instructions and installation instructions may be used as complementary information as necessary.

1.5 Safety Information and Regulations

The general safety regulations for the prevention of accidents and the relevant operating safety instructions have to be observed at all times.

"General Safety Regulations" beyond the scope of these regulations are detailed in the following.

The specific safety regulations applicable to this manual are highlighted in the individual chapters by Warnings, Cautions, and Notes.

1.5.1 General Safety Notes

Within the scope of the StVZO (Road Licensing Regulations of the Federal Republic of Germany) "Design General Approvals" laid down by the Federal Office for Motor Traffic exist for the Water Heaters *Thermo 230, 231, 300, 301 and 350* with the following official marks of conformity:

- ~ S 230 for water heater *Thermo 230* (type DW 230)
- ~ S 327 for water heater *Thermo 231* (type Thermo 231)
- ~ S 229 for water heater *Thermo 300* (type DW 300)
- ~ S 328 for water heater *Thermo 301* (type Thermo 301) and for
- ~ S 228 for water heater *Thermo 350* (type DW 350)

Installation of the heater is to be performed in accordance with the installation instructions and must be checked in case of

- a) the vehicle type inspection in accordance with § 20 StVZO
- b) the individual inspection in accordance with § 21 StVZO or
- c) the examination in accordance with § 19 StVZO performed by an officially authorized expert or examiner for road traffic, a vehicle inspector or a public servant as per section 7.4a of Annex VIII to the StVZO.

In the event of c) the installation must be certified on the acceptance certificate included in the copy of the "General Operating License" giving details about

- manufacturer
- type of vehicle and
- vehicle identification number.

This validates the "Design General Approval". The acceptance certificate must be kept with the vehicle.

CAUTION

Non-compliance with the installation instructions and the information contained therein will void the Webasto warranty. Installations not legally authorized will void the water heater's "Official Marks of Conformity" and thus the vehicle's permit of operation. The same applies for repairs performed by unskilled personnel and repairs without using original spare parts.

The year of first operation must be permanently marked on the identification label by removing the relevant number of the year.

The heaters are cleared for heating the vehicle engine and the passenger cabin. The use of the heater in vehicles not subject to the StVZO (e.g. ships) is partly governed by regional regulations.

The heaters are **not** cleared for the installation in vehicles intended for the transportation of dangerous goods (ADR).

The heater may only be fitted in vehicles or in independent heating systems with a minimum coolant capacity of 10 liters.

The heater may only be installed in motor vehicles or in independent heating systems with a minimum coolant capacity of 6 liters.

The heater must not be installed in the passenger or driver compartments of vehicles. Should the heater nevertheless be installed in such a compartment, the installation box must be sealed tight against the vehicle interior. There must be sufficient ventilation of the installation box from the exterior in order not to exceed a maximum temperature of 85° C in the installation box. Excessive temperatures may cause malfunctions.

WARNING

Due to the danger of poisoning and suffocation the heater must not be operated, not even with timed operation, in enclosed areas such as garages or workshops not equipped with an exhaust venting facility.

At filling stations and fuel depots the heater must be switched off to prevent explosions.

CAUTION

Where flammable fumes or dust may build up (e.g. in the vicinity of fuel, coal, wood, cereal depots, or similar installations) the heater must be switched off to prevent explosions.

In the vicinity of the water heater a temperature of 110° C (storage temperature) must not be exceeded under any circumstances (e.g. during body paint work).

A violation of this temperature limit may cause permanent damage to the electronics.

When checking the cooling water level proceed in accordance with the vehicle manufacturer's instructions. The water in the heating circuit of the heater must contain a minimum of 20% of a quality brand anti-freeze.

Additives in the heating circuit must not affect metals, plastics and rubber and must leave no deposits.

The opening pressure in the vehicle cooling system - normally indicated on the radiator filler cap - must be between 0.4 and 2.0 bar above operating pressure (also applicable to separate heating circuits).

1.6 Legal Provisions for Installation

For testing the heater in accordance with § 19, 20, or 21 of the StVZO the following regulations are to be observed in particular (§ 22 a StVZO):

NOTE

These regulations are binding within the jurisdiction of the StVZO and should also be observed in countries where no particular regulations exist.

Extracting combustion air from the vehicle interior is prohibited.

The exhaust line outlet is to be positioned to the top, to the side, or in case of exhaust venting below the vehicle floor, to the nearest possible location of the vehicle's or cockpit side or rear end. Exhaust pipes must be routed so that exhaust fumes are unlikely to penetrate into the vehicle's interior. The function of any parts vital for vehicle operation must not be impaired. Condensate accumulations in the exhaust line must be directly drained. A condensation drain hole may be provided as required.

The openings of the combustion air inlet and the exhaust outlet must not allow a ball of 16 mm in diameter to be inserted.

Electrical lines, switch gear, and control gear of the heater must be located in the vehicle so that their proper function cannot be impaired under normal operating conditions.

For the routing of fuel lines and the installation of additional fuel tanks §§ 45 and 46 of the StVZO are to be complied with. The most important regulations are:

- Fuel lines are to be designed in such a way that they remain unaffected by torsional stress in the vehicle, engine movement, and the like. They must be protected against mechanical damage. Fuel-carrying parts are to be protected against excessive heat and are to be arranged so that any dripping or evaporating fuel can neither accumulate nor be ignited by hot components or electrical equipment.
- In busses fuel lines and fuel tanks may be located neither in the passenger area nor in the driver's compartment. In these type of vehicles the fuel tanks must be located such that they do not pose a direct hazard to the exits in the event of a fire. Fuel supply must not be by means of gravity or pressurization of the fuel tank.

Installation Instructions for Webasto fuel tanks for the fuel supply of water heaters in vehicles:

- in busses the installation is not permitted in the passengers' or driver's compartment.
- the fuel filler neck must not be located in the passengers' or driver's compartment of any vehicle.
- fuel containers must either be equipped with a vent cap or any other type of ventilation (vent line).

Only vent caps in accordance with DIN 73400 may be used.

All fuel containers offered in the Webasto Accessories Catalogue are suitable for a maximum operating pressure of 0.15 bar overpressure.

All fuel containers offered in the Webasto Accessories Catalogue are subjected during manufacture to individual pressure testing with at least 0.3 bar overpressure.

The operational state of the heater, i.e. at least an indication "on" or "off" must be easily and clearly visible.

For heaters in vehicles not ruled by the StVZO but other regulations, the acceptance by the relevant authority is required as applicable.

1.7 Corrections and Improvements

Deficiencies, improvements, or proposals for correction of this workshop manual are to be mailed to:

Webasto Thermosysteme International GmbH
Abt. Technische Dokumentation
D-82131 Stockdorf
Telephone: ++49 (0) 89 / 8 57 94 - 5 42
Telefax: ++49 (0) 89 / 8 57 94 - 7 57

2 General Description

The water heaters Webasto *Thermo 230, 231, 300, 301* and *350* are used in combination with the vehicle's own heating installation to

- heat the passenger compartment
- defrost the windscreen
- preheat water-cooled engines

The heaters *Thermo 231* and *301* are variants for vertical installation. The difference in appearance are the different labels including the identification label and the Z profiles on the installation interface.

The water heater operates independent from the vehicle engine and is connected to the vehicle cooling system, the fuel system and the electrical system.

The heater designed to the heat exchanging principle operates intermittently controlled by the temperature sensor.

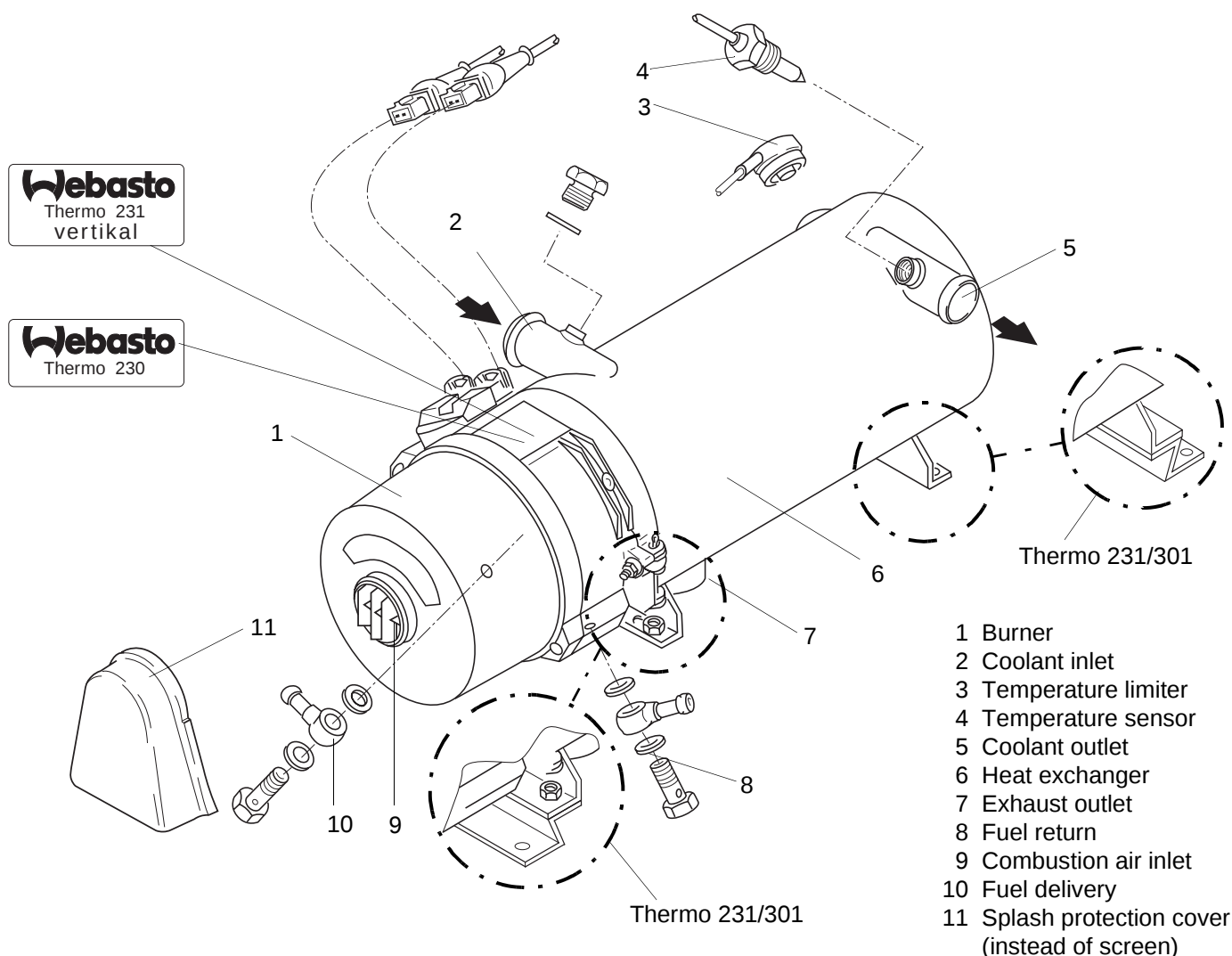
The heaters *Thermo 230, 231, 300, 301* and *350* basically consist of

- the combustion air fan
- the fuel pump with nozzle block and nozzle
- the heat exchanger and
- the combustion chamber
- the igniter box with igniter electrodes

For control and monitoring the heater includes

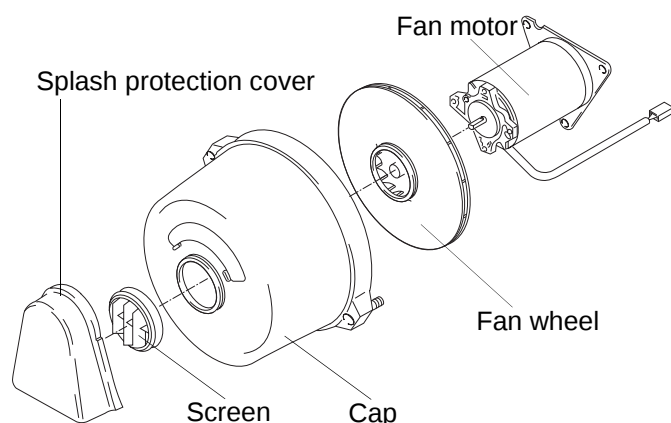
- a control unit
- a flame sensor
- a temperature sensor
- a temperature limiter
- an overheat thermostat on *Thermo 231* and *301*

A circulation pump is an external component mounted in the vehicle.



2.1 Combustion Air Fan

The combustion air fan supplies the air required for combustion from the combustion air inlet to the combustion chamber.



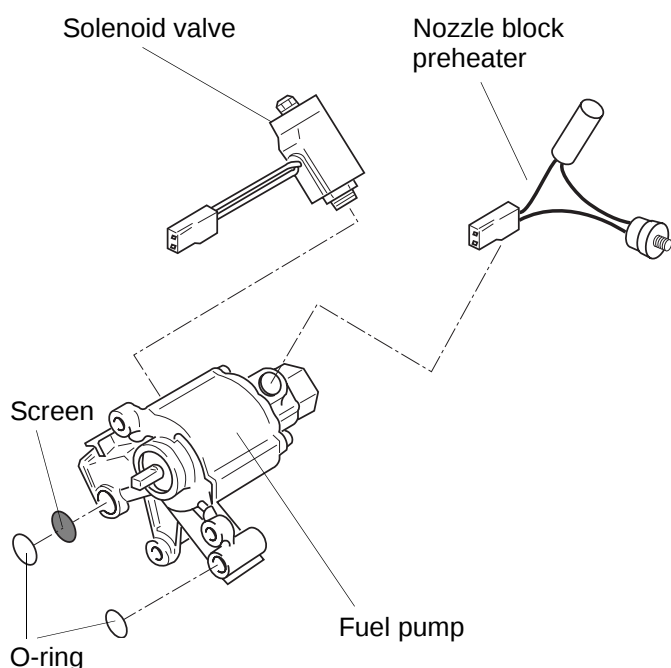
The fan consists of a fan motor with fan wheel. Air is taken in through a splash protection cover or a screen and the cap. The heaters *Thermo 231* and *301* are provided with a splash protection cover only.

2.2 Fuel Pump

NOTE

For operation with PME (Bio Diesel) a special PME fuel pump is installed.

The fuel pump delivers the fuel and is driven by the fan motor via a clutch. The fuel is compressed in the pump to approximately 10 bar and diffused by a high pressure nozzle. A screwed on solenoid valve controls the fuel flow to the nozzle.



2.2.1 Nozzle block preheater

NOTE

For operation with PME (Bio Diesel) the installation of a nozzle block preheater is mandatory.

At extremely low temperatures malfunctions may occur without a nozzle block preheater.

At a temperature of $< 0^{\circ}\text{C}$ a thermostat activates the heater cartridge in the nozzle block. The heating period depends on the heat reflected within the combustion chamber. Preheating is deactivated when the thermostat ambient temperature is $+8^{\circ}\text{C}$.

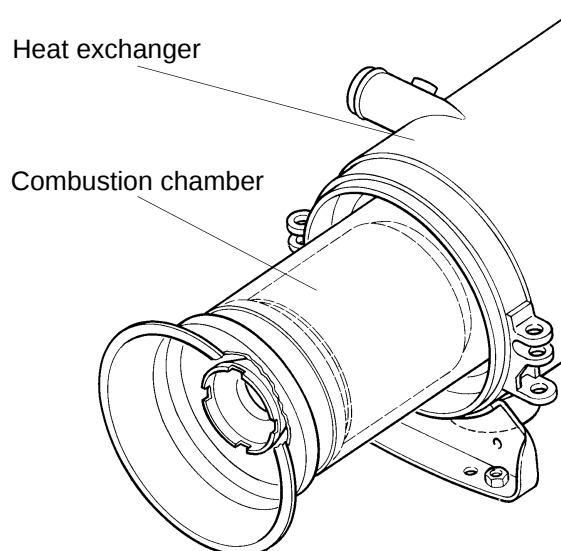
If the heater is not equipped with a nozzle block preheater a retrofit is possible.

2.3 Heat Exchanger

The heat exchanger transfers the heat generated by combustion to the coolant circuit.

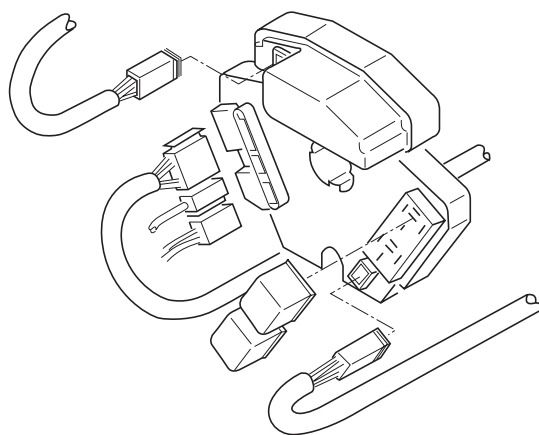
2.4 Combustion Chamber

The fuel/air mix is dispersed in the combustion chamber for combustion to heat the heat exchanger.

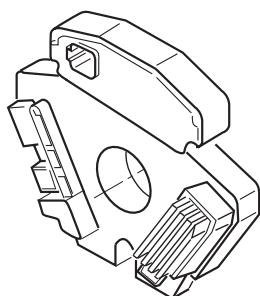


2.5 Control Unit

The control unit 1572 or 1572D is the central component to ensure controlled operation and monitoring of combustion. If the heater has a control unit 1572 installed, a retrofit of control unit 1572D is possible (see Section 9).



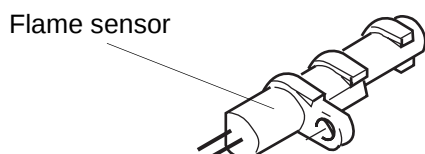
Control Unit 1572



Control Unit 1572D

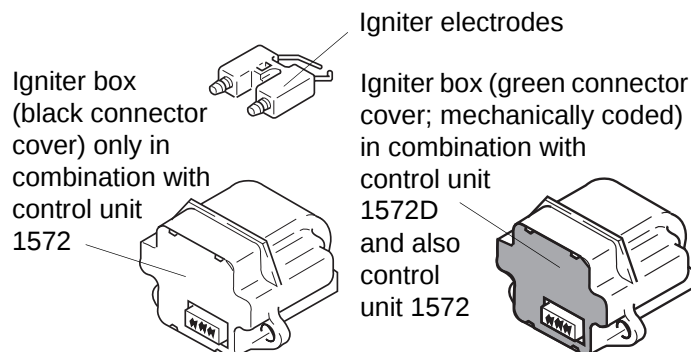
2.6 Flame Sensor

The flame sensor continuously monitors the flame condition during operation. The flame sensor is a photo transistor changing its resistance depending on the flame intensity. The signals are supplied to the control unit for processing.



2.7 Igniter Box with Igniter Electrodes

The igniter box generates the high voltage for igniting the fuel/air mix by a high voltage ignition spark across the electrodes.

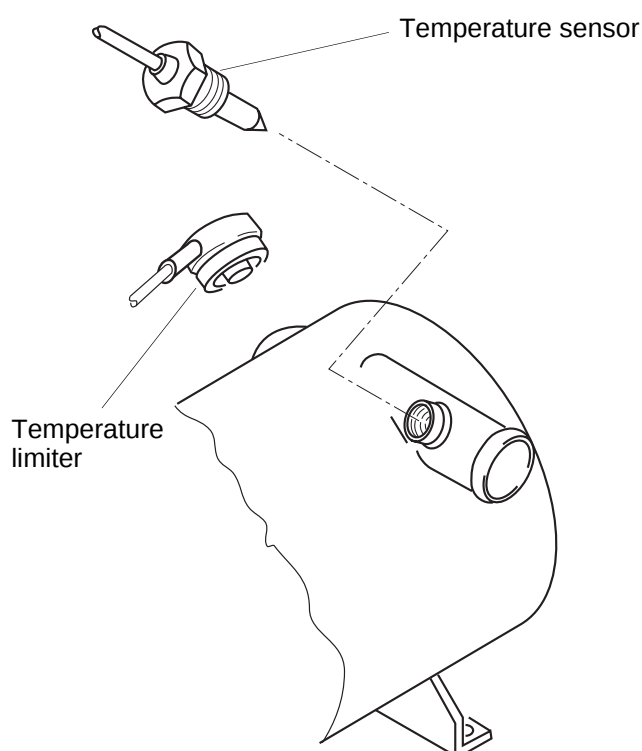


2.8 Temperature Sensor

The temperature sensor senses the coolant temperature at the heat exchanger outlet as an electrical resistance. This signal is supplied to the control unit for processing.

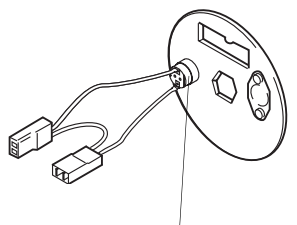
2.9 Temperature Limiter

The temperature limiter (bimetal) protects the heater against undue high operating temperatures. The temperature limiter can be reset manually. The temperature limiter responds at a temperature in excess of 125° C to switch off the heater. The *Thermo 231* and *301* temperature limiter with auto-reset switches the heater off at a temperature of 105° C.



2.10 Overheat Thermostat (Thermo 231 and 301 only)

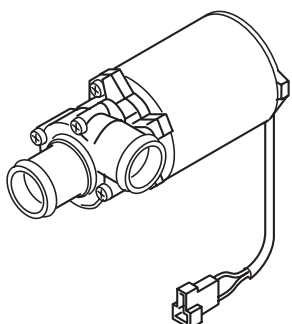
The overheat thermostat is screwed onto the disk and connected to the solenoid valve of the fuel pump. When the burner overheats the thermostat causes an error lockout.



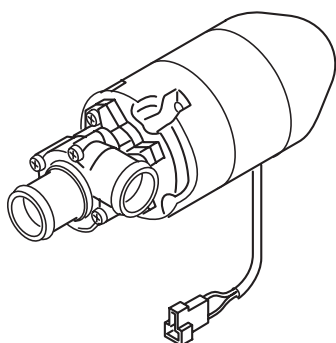
Overheat Thermostat

2.11 Circulation Pump

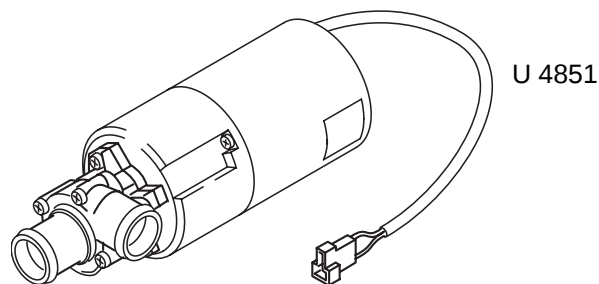
The circulation pump mounted externally ensures the coolant circulation in the vehicle and heater circuit. The pump is activated by the control unit to operate as long as the heater is in operation. The heaters may be operated with circulation pump U 4814, U 4816, U 4851 or U 4852.



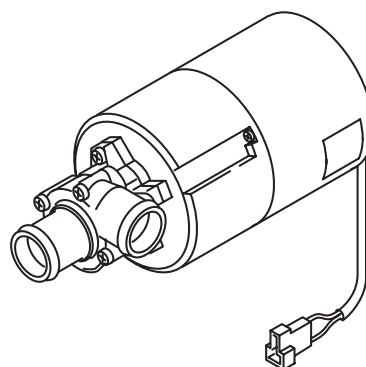
U 4814



U 4816



U 4851



U 4852

2.11.1 Circulation Pump U 4851 and U 4852

The circulation pump U 4851 / U 4852 is equipped with a brushless motor.

Soft start

Motor run-up is slow with no stress for the material. It takes 5 seconds to reach maximum speed.

Dry run protection

Integrated in the motor is a dry run protection for speeds > 3300 rpm.

If the motor in a time window of 1018 revolutions has a power consumption less than 4 A a dry run condition is identified. The motor is switched off by means of the failure mode (after approx. 10 seconds when in operation or approx. 15 seconds after activation).

Seizure protection

When operating speed drops below 57 rpm the motor is switched off after approx. 1 seconds by means of the failure mode.

If no complete revolution is achieved within 1 second with the motor powered, the motor is switched off by means of the failure mode.

Overload protection

After completion of the soft start an overload protection is activated to limit the power consumption and keep the speed at 5550 rpm. That means that the motor is not damaged in case of circulation pump hydraulic over-pressure.

Failure mode

The failure mode stops the motor in case of malfunctions. After approx. 5 seconds the failure mode switches the motor to the power saving sleep mode.

Sleep mode

In the sleep mode the internal consumers of the motor electronics are switched off. The power consumption in this mode then amounts to < 2 mA.

Motor reactivation

The motor can be reactivated out of the sleep mode by disconnection of the power supply for approx. 2 minutes. After power reconnection the motor will again run up with a soft start.

Reverse pole protection

The motor **is not equipped with an internal reverse pole protection**. In combination with a wiring harness and a 25 A fuse the motor is protected against reverse poling.

3 Functional Description

Activation and deactivation is by means of a

- switch
- timer
- air conditioning

dependent on the type of installation.

For monitoring operation at least an operating indicator light is provided.

Switch off releases a run-down procedure (see "Switch off").

The heaters may be

- operated with power save for reduced fuel consumption (see circuit diagram)
- equipped or retrofitted with a nozzle block preheater for extreme low temperatures (required for operation with PME).

Heaters with control unit 1572D only

When connecting terminal +15 or +61 the heaters may operate in the auxiliary heating mode of operation.

3.1 Switch On

Upon switch on the operating indicator light goes on. Combustion air fan, fuel pump and circulation pump start operation. (If fitted and temperature is $< 0^{\circ}\text{C}$ nozzle block preheater is also activated).

After approximately 12 seconds (run-up time) the high voltage igniter spark is available. Approximately 1 second later the solenoid valve in the fuel pump opens and the nozzle sprays fuel into the combustion chamber to be ignited by the igniter spark. A photo control circuit deactivates the igniter box after flame-up.

3.2 Heating Operation

After reaching operating temperature the control unit takes over to provide controlled operation by activation and deactivation of the burner in order to maintain a nearly constant temperature of the heat exchanger (coolant).

Heaters with control unit 1572D only

At a low rate of flow or in case of bad venting the control unit sets the thresholds automatically to low values. This prevents the temperature limiter from responding to retarded heat.

A rise in temperature above the upper switching point makes the solenoid valve in the fuel pump shut off the fuel supply initiating the run-down. The flame extinguishes, the combustion air fan and the circulation pump however continue their operation. After approximately 90 seconds (120 seconds for heaters with control unit 1572D)

run-down is completed with deactivation of the combustion air fan.

The circulation pump remains in operation during the control idle period. The operating indicator light is on.

3.3 Switch Off

Switching off the heater stops combustion. The operating indicator light goes out and run-down commences. The combustion air fan and circulation pump are deactivated after approximately 90 to 120 seconds (120 seconds for heaters with control unit 1572D).

Reactivation of the heater during run-down is permitted. The burner immediately resumes operation after the run-up time.

3.4 Power Save

With power save on the control temperatures of the heating circuit are kept low. Combustion performance is not reduced.

This results in a reduced heat radiation loss when limited heating performance is required (e.g. in heat hold operation) cutting down fuel consumption.

3.5 Auxiliary Heating Operation (heaters with control unit 1572D only)

When terminal +15 (ignition ON) is connected and powered or terminal +61 (engine running), the heater operates in the auxiliary heating mode. The lower temperature threshold for reactivation of the burner after control idle is raised above that for normal operation and is automatically shifted up or down dependent on the combustion time of the heater.

3.6 Heater Lockout (heaters with control unit 1572D only)

After the heater has performed eight consecutive start attempts due to a malfunction or after five consecutive subsequent flame-outs the heater enters a lockout and start attempts are suspended. This lockout is superior to the normal error lockout. Unlocking is performed by starting the heater and disconnection of the main power supply of the heater during error run-down.

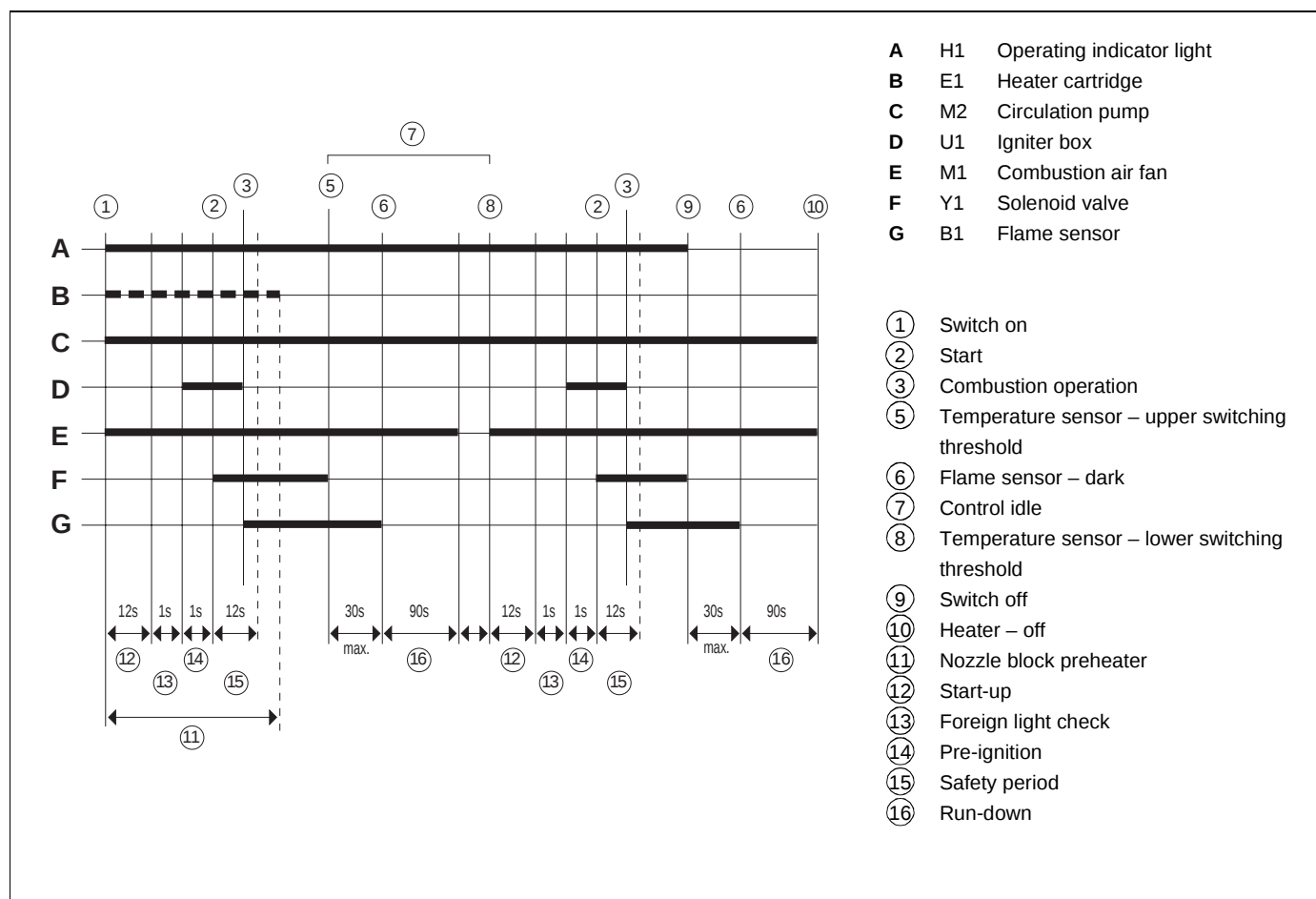


Fig. 301 Functional Sequence (heaters with control unit 1572)

3.7 Switch-off upon Failure (heaters with control unit 1572)

The heater switches off automatically when detecting one of the following malfunctions.

The operating indicator light goes off. Combustion air fan and circulation pump are deactivated after approximately 90 to 120 seconds.

Malfunctions during switch-on

- short or open circuit of temperature sensor.
- short or open circuit of flame sensor.
- open circuit of solenoid valve.

Malfunctions during start-up:

- flame detected by photo control circuit prior to high voltage igniter spark.
- no flame detected after approximately 25 seconds after heater start.

Malfunctions during heating operation:

- low voltage threshold of approximately 20V violated for a duration of 12 seconds.
- no combustion for more than 10 seconds.

- temperature sensor short circuit during control idle.
- temperature sensor open circuit during combustion.
- flame sensor short circuit during combustion.
- solenoid valve short circuit during combustion.

Malfunctions during run-down:

Detection of a flame after more than 30 seconds after start of run-down with the circulation pump and combustion air fan maintaining operation for the following 90 seconds.

Malfunctions by overheating:

Overheating results in deactivation of the heater by the temperature limiter. After cool down of the unit and correction of the fault the button of the temperature limiter must be reset.

An error reset for a new start standby is achieved by switching the heater off and on again.

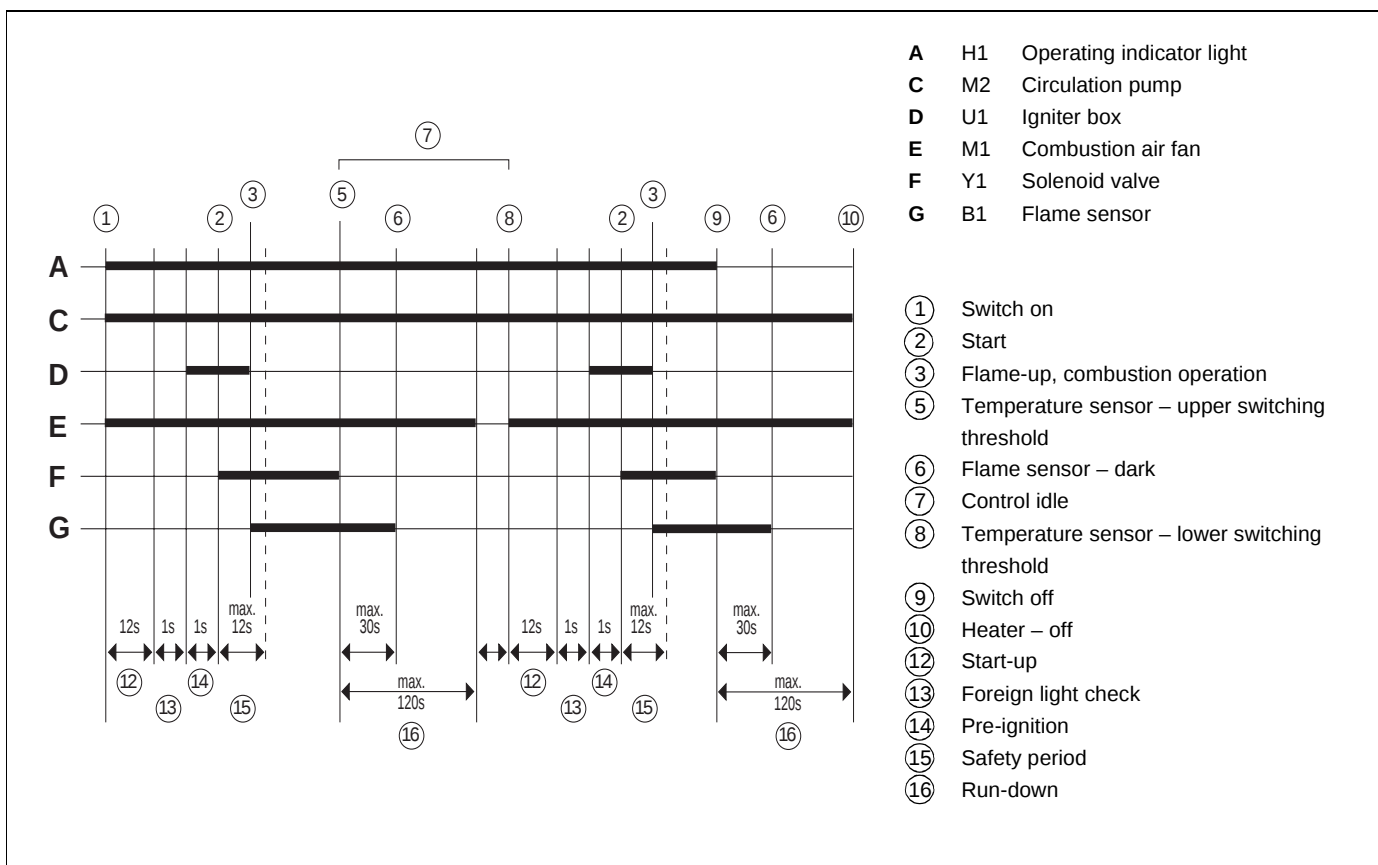


Fig. 302 Functional Sequence (heaters with control unit 1572D)

3.8 Switch-off upon Failure (heaters with control unit 1572D)

The heater switches off automatically when detecting one of the following malfunctions.

Several subsequent switch-offs due to a malfunction will cause the heater to enter an error lockout condition.

Flash pulses are output via the operating indicator light. The combustion air fan and the circulation pump are switched off after approx. 120 seconds.

Malfunctions during switch-on:

Short or open circuit of

- temperature sensor
- flame sensor
- burner motor
- solenoid valve
- igniter box

Malfunctions during start-up:

- flame detected by photo control circuit prior to high voltage igniter spark.
- no flame detected after approximately 25 seconds after heater start.

- short/open circuit or dry run (if programmed) of circulation pump.
- when using the circulation pump U 4851 approximately 15 seconds after switch-on the circulation pump is automatically stopped and may only be reactivated after approximately 2 minutes should coolant be missing or the pump wheel be seized.

Malfunctions during heating operation:

- low voltage threshold of approximately 21 V violated for a duration of 20 seconds.
- no combustion for more than 10 seconds.
- temperature sensor short circuit.
- flame sensor short circuit.
- flame sensor open circuit.
- solenoid valve short circuit.
- igniter box short circuit.
- igniter box open circuit.

Malfunctions during run-down:

Detection of a flame after more than 30 seconds after start of run-down with the circulation pump and combustion air fan only maintaining operation for the following 90 seconds.

Malfunctions by overheating:

Overheating results in deactivation of the heater by the temperature limiter/thermostat. Dependent on heater configuration:

- the reset button on the temperature limiter must be reset.
- the reset of the thermostat is performed automatically after cool down.

An error reset for a new start standby is achieved by switching the heater off and on again.

Malfunctions by overheating (Thermo 231 and 301):

Overheating of the burner causes the overheat thermostat to initiate an error lockout at 150° C.

The solenoid valve closes, the fuel supply is cut off and a run-down is launched. An auto-reset occurs after cool-down of the thermostat.

3.9 Error Code Output (heaters with control unit 1572D)

When equipped with a standard timer an error code readout appears on the display of the timer after a malfunction.

NOTE

When the heater is operated by means of a switch the type of error is output during heater run-down via a flash code of the operating indicator light. After five short signals the long flash pulses are counted. The flash pulses correspond to the error number in the table below:

- F 01 no start (after 2 start attempts)
- F 02 flame-out* (at least 5 times)
- F 03 low voltage or excess voltage
- F 04 foreign light detected during run-up and run-down
- F 05 flame sensor defective
- F 06 temperature sensor defective
- F 07 solenoid valve defective
- F 08 fan motor defective
- F 09 circulation pump defective
- F 10 temperature limiter defective / overheating
- F 11 igniter box defective
- F 12 error lockout due to repeated malfunction or repeated flame-out

* A response of the overheat thermostat will be stored in the control unit as a flame-out (F 02) (*Thermo 231 and 301*).

3.10 Error Lockout Reset

The error lockout reset is performed by switching the heater on and disconnecting the power supply during start-up.

4 Technical Data

Where no threshold values are specified technical data are understood to include standard tolerances for heater units of $\pm 10\%$ at ambient temperature of $+ 20^{\circ}\text{C}$ and at nominal voltage.

Electrical components

Control unit, fan and circulation pump motors, solenoid valve, igniter box, heater cartridge, nozzle block preheater and timer are 24 V components. Temperature limiter, flame sensor, temperature sensor and switches are voltage independent components.

NOTE

The allocation of circulation pumps to heater units must be in accordance with coolant resistances.

Propellant

The suitable propellant is the Diesel fuel or PME (vegetable oil methyl ester) specified by the vehicle manufacturer. Only the type of fuel indicated on the identification plate may be used. Also class EL fuel oils (not fuel oil L)

may be used if their quality is in accordance with the German standard.

A bad influence caused by additives is not known.

When using fuel out of the vehicle tank the information about additives of the vehicle manufacturer must be observed.

When using fuel out of a separate fuel tank and at temperatures below 0°C , winter Diesel fuel must be used or petroleum or petrol added to the Diesel fuel observing the relevant mixing ratios. The use of flow improvers is permitted.

Mixing ratio for separate fuel tank

Temperature	Winter Diesel fuel	Additive petroleum or petrol
0°C to -20°C	100 %	—
-20°C to -30°C	70 %	30 %
	or special low temperature Diesel fuel	
-30°C to -40°C	special low temperature Diesel fuel or 100 % petroleum	

Circulation pump	Thermo 230	Thermo 231	Thermo 300	Thermo 301	Thermo 350
Type	DW 230	Thermo 231	DW 300	Thermo 301	DW 350
Mark of conformity	~ S230	~ S327	~ S229	~ S328	~ S228
Heater principle	High pressure atomizer				
Heating flow KW (kcal/h)	23 (20 000)		30 (26 000)		35 (30 000)
Fuel	Diesel / fuel oil / PME *				
Fuel consumption kg/h	2.5		3.3		3.7
Nominal voltage V-	24				
Operating voltage V-	20 ... 28				
Nominal power consumption (without circulation pump) W	65		110		140
Permissible operating ambient temperature range (heater, control unit, circulation pump) $^{\circ}\text{C}$	$-40 \dots +85$				
Permissible storage temperature $^{\circ}\text{C}$	$+110$ max.				
Permissible operating overpressure bar	0.4 ... 2.0				
Heat exchanger capacity l	1.8				
Minimum capacity of circuit l	10.00				
CO ₂ in exhaust at nominal voltage Vol.-%	10 $\pm$ 0.5 related to 500 m above S.L.				
Dimensions heater (tolerance ± 3 mm) mm mm mm	Length 610 Width 246 Height 220				
Weight kg	19				

* Heaters Thermo 350 for use of PME (vegetable oil methyl ester) not available
Heaters Thermo 230/231/300/301 for use of PME are special type heaters

4 Technical Data

Thermo 230 / 231 / 300 / 301 / 350

Circulation pump		U 4814	U 4816	U 4851	U 4852
Volume flow	l/h	5200 (against 0.15 bar)	6000 (against 0.4 bar)	6000 (against 0.4 bar)	6000 (against 0.4 bar)
Nominal voltage	V-	24			
Operating voltage range	V-	20 ... 28			
Nominal power consumption	W	104	215	209	209
Dimensions	mm	Lenght 221	Lenght 295	Lenght 279	Lenght 284
	mm	Width 100	Width 113	Width 115	Width 110
	mm	Height 105	Height 114	Height 118	Height 115
Weight	kg	2.1	4.75	2.7	2.95

5 Troubleshooting

5.1 General

This section describes troubleshooting procedures for the heaters *Thermo 230, 231, 300, 301* and *350*.

CAUTION

Troubleshooting requires profound knowledge about components and their theory of operation and may only be performed by trained personnel.

In case of doubt functional interrelations may be derived from Sections 2 and 3.

CAUTION

Troubleshooting is normally limited to the isolation of defective components.
The following possible causes for trouble have not been taken into consideration and must always be excluded as a possible cause for malfunction:

- corrosion on connector
- loose contact on connector
- wrong crimping on connector
- corrosion on wiring and fuses
- corrosion on battery terminals

After any fault correction a functional checkout in the vehicle has to be performed.

5.2 General Fault Symptoms

The following table (Fig. 501) lists possible fault symptoms of general nature.

Symptom	Probable Cause
Fault in electrical system Operating indicator light is not on, no heater operation. Fuse F2 blows. Fuse F3 blows. Normal heater operation, operating indicator light is out.	- no power supply - fuses - wiring to terminals of connector A of control unit. Short circuit in circulation pump or in wiring to heater. Short circuit in wiring to heater/motor/nozzle block preheater (if installed). Operating indicator light defective or wiring to light open or shorted.
Fault in water system Circulation pump not operating (U 4851 and U 4852 only)	Failure mode activated The failure mode switches the motor off in case of malfunctions. After approx. 5 sec the failure mode switches the motor to the power saving sleep mode. In the sleep mode the internal consumers of the motor electronics are switched off. The power consumption in this mode then amounts to < 2 mA. The motor can be reactivated out of the sleep mode by disconnection of the power supply for approx. 2 minutes. After power reconnection the motor will again run up with a soft start.

Fig. 501 General Fault Symptoms (Sheet 1 of 3)

Symptom	Probable Cause
Heater operation stops because heat exchangers connected do not dissipate enough heat.	<u>Rate of flow too low, because</u> - air in heater, in heat exchangers or in system sections. - cocks (flow regulator) throttled, contaminated or closed. - contamination in system, e.g. in areas of restricted flow. - circulation pump rate of delivery insufficient (air in pump housing). wrong sense of rotation – check wiring colors (black + / brown –). - not enough anti-freeze. - excessive system resistance (especially high when cold). - circulation pump defective. <u>Heat exchanger dissipate not enough heat, because</u> - air in heat exchangers or in system sections. - contaminated heat exchanger surfaces (external). - insufficient air intake or exit. - fan: rate of delivery low / wrong sense of rotation / resistance too high. - too much anti-freeze. - heat exchanger of too low capacity.
Rough calculation of rate of flow Rate of flow in [l/h] = $\frac{\text{heat flow [kW] acc. to ident. label}}{\text{temperature difference } \Delta t \text{ in [K] or [}^{\circ}\text{C] measured between heater water inlet and outlet (e.g. with contact thermometer)}} \times 860$	
Fault in fuel supply No fuel delivery to heater.	- fuel tank empty. - kinked, closed, contaminated or leaking lines. - paraffin deposits or water captured in fuel filter or fuel lines. - vent in tank clogged. - fuel lines interchanged. - fuel filter contaminated. - fuel screen in pump contaminated.

Fig. 501 General Fault Symptoms (Sheet 2 of 3)

Symptom	Probable Cause
Wrong combustion CO ₂ value cannot be set to rated value, combustion irregular.	• air bubbles in suction line (suction line leaking). • fuel filter contaminated or leaking. • fuel system integration leak (suction height, low pressure in tank); observe installation instructions. • fuel pump defective (pump pressure). • return line throttled. • filter screen in pump contaminated. • O-ring sealing on fuel pump no longer effective (ageing) • nozzle jet defective. • combustion air or exhaust lines throttled or closed. • fan motor speed too low.

Fig. 501 General Fault Symptoms (Sheet 3 of 3)

5.3 Fault Symptoms during Functional Checkouts and Error Code Output or Tests with Diagnostic Computer, Components Tester or PC Heater Diagnosis

5.3.1 General

Error Code Output

NOTE

Only heaters with a control unit 1572D provide an error code output.

When equipped with a standard timer an error code readout is available after a malfunction on the display of the timer.

When the heater is operated by means of a switch a coded flashing of the operating indicator light during run-down of the heater or until switch-off indicates the type of error (see 3.9).

Diagnostic Computer

NOTE

Checks with the diagnostic computer may only be performed on heaters equipped with control unit 1572.

By use of the diagnostic computer heaters may be checked in the vehicle. The following tests are available:

- indication of measured values: water temperature, control unit supply voltage, flame sensor bright/dark.
- indication and erasure of faults stored in the control unit.

Operation of the diagnostic computer is menu controlled by means of four push button switches.

For details refer to operating instructions for "Diagnostic Computer".

Components Tester

NOTE

Checks with the components tester may only be performed on heaters equipped with control unit 1572.

Using the components tester several types of faults and component malfunctions may be analyzed in the vehicle. The test of the individual components with the components tester is not intended. Faults like short or open circuits may be detected with the components tester but cannot be localized.

For details refer to operating instructions for "Components Tester".

PC Heater Diagnosis

By use of the PC heater diagnosis heaters (with control unit 1572 or 1572D) may be tested in the vehicle.

For details refer to operating instructions for "PC Heater Diagnosis".

5.3.2 Fault Symptoms

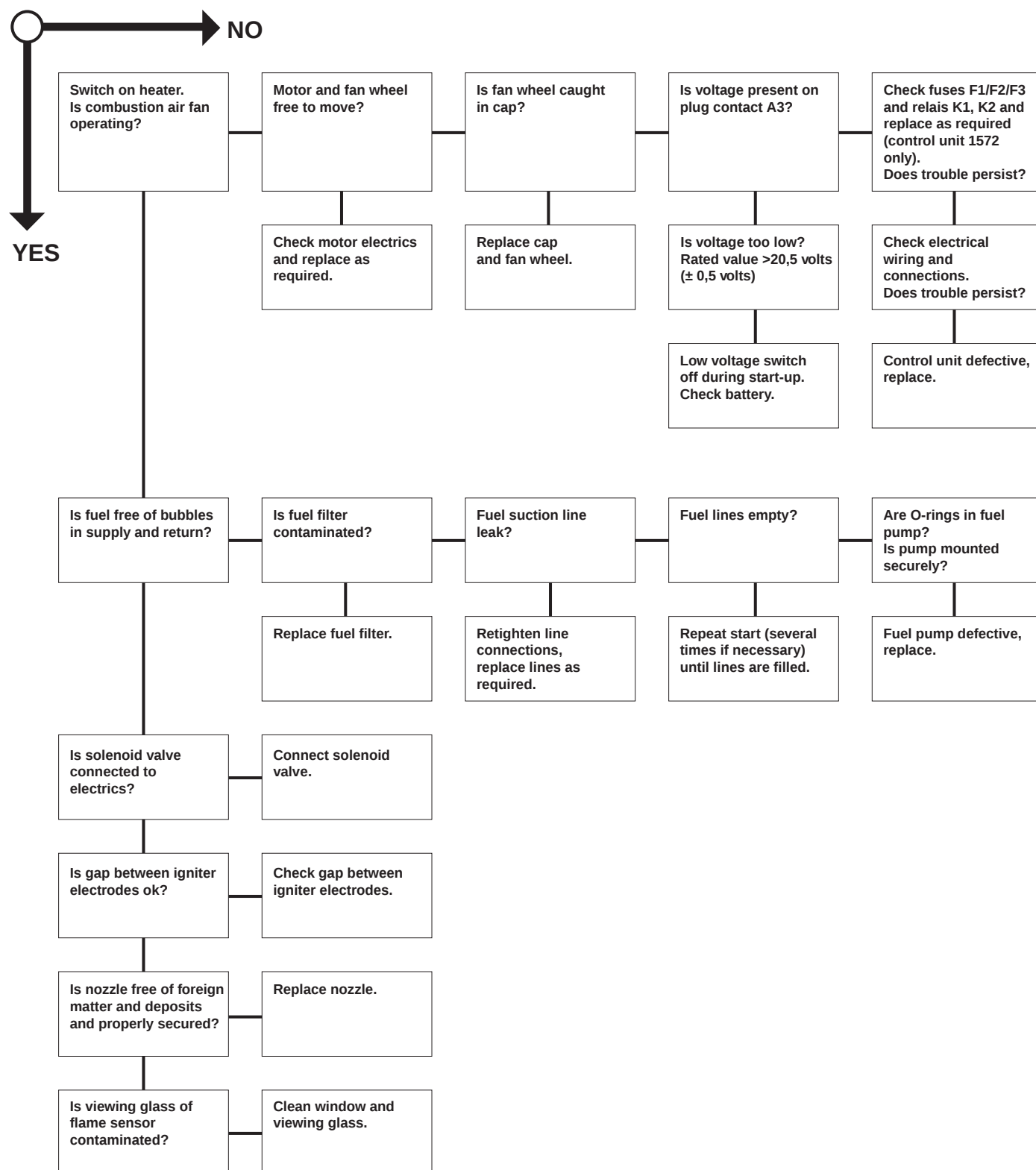
5.3.2.1 Fault Symptom "No Start"

NOTE

Heaters with control unit 1572D:

If the heater performs 8 consecutive attempts to start due

to a malfunction, the heater enters an error lockout and stops any further attempts to start. This error lockout is superior to the normal error lockout condition. The error lockout reset is achieved by switching the heater on and disconnection of the heater power supply during run-down.



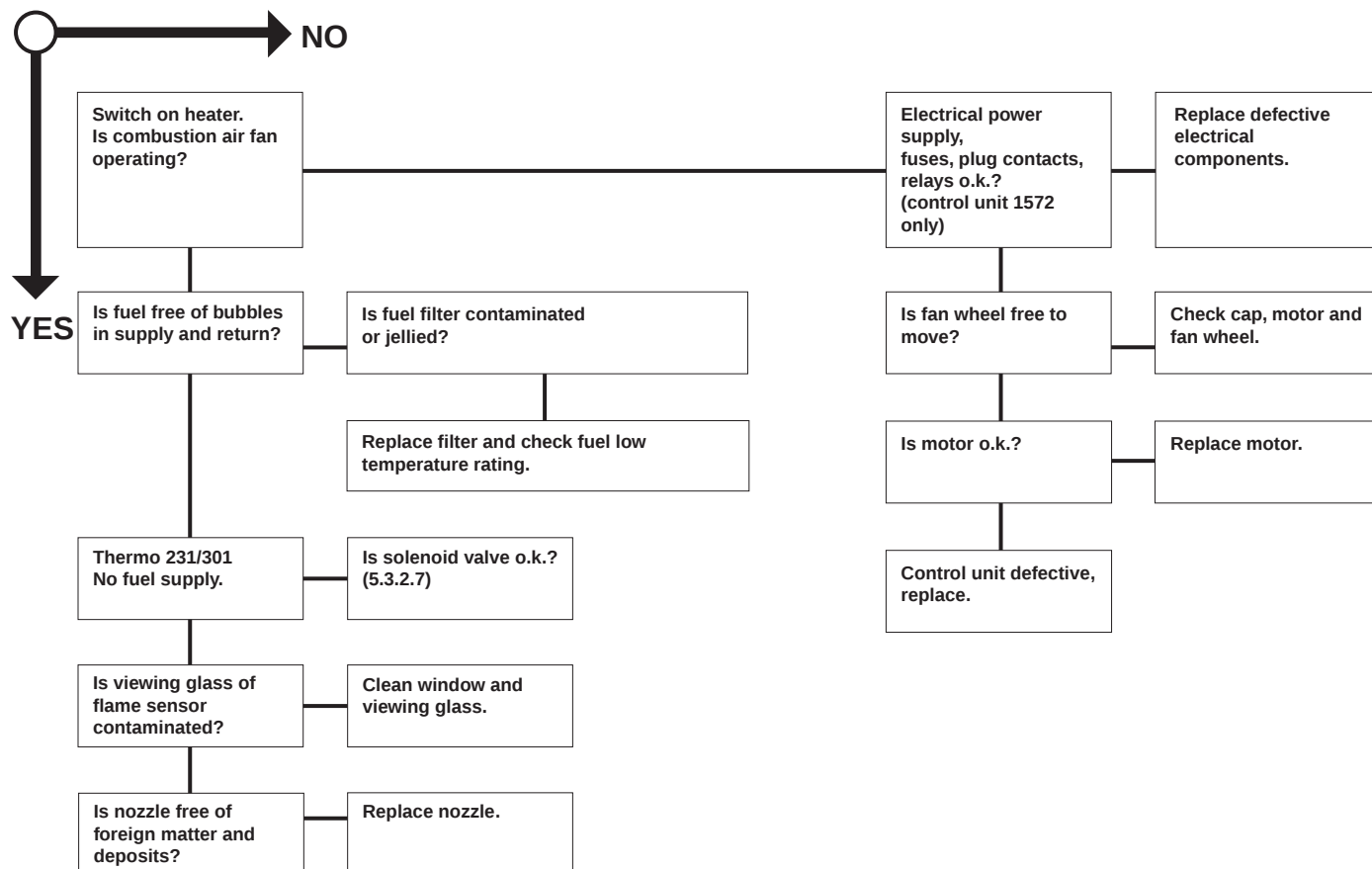
5.3.2.2 Fault Symptom "Flame-out"

NOTE

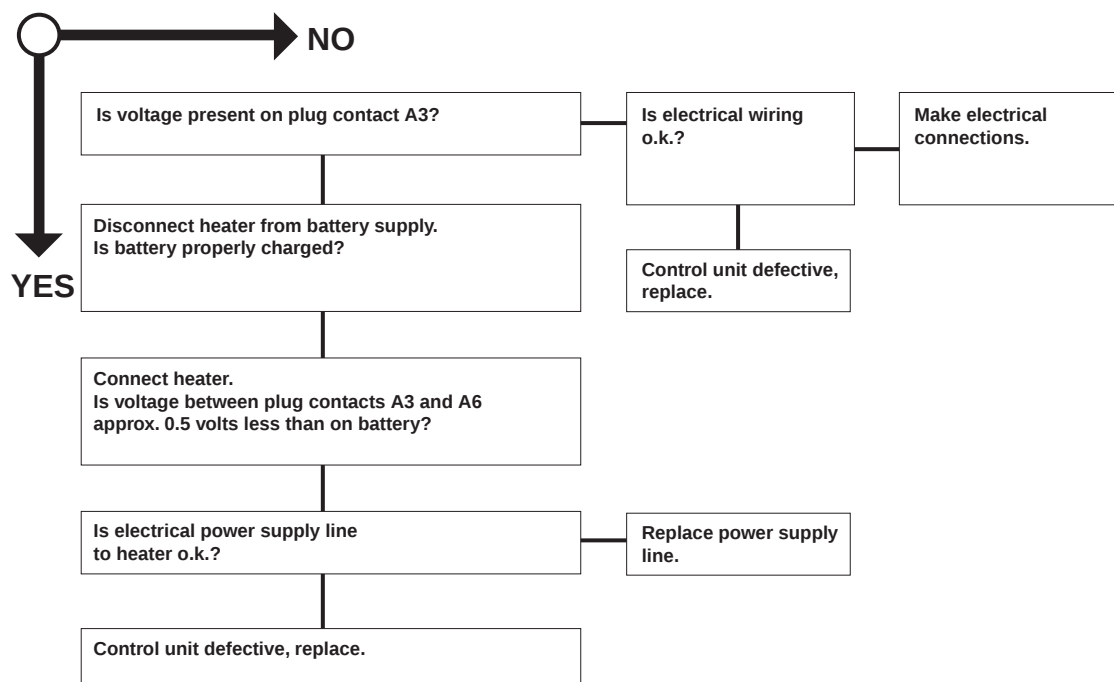
Heaters with control unit 1572D:

If the heater performs 5 consecutive attempts to start due to a malfunction, the heater enters an error lockout and

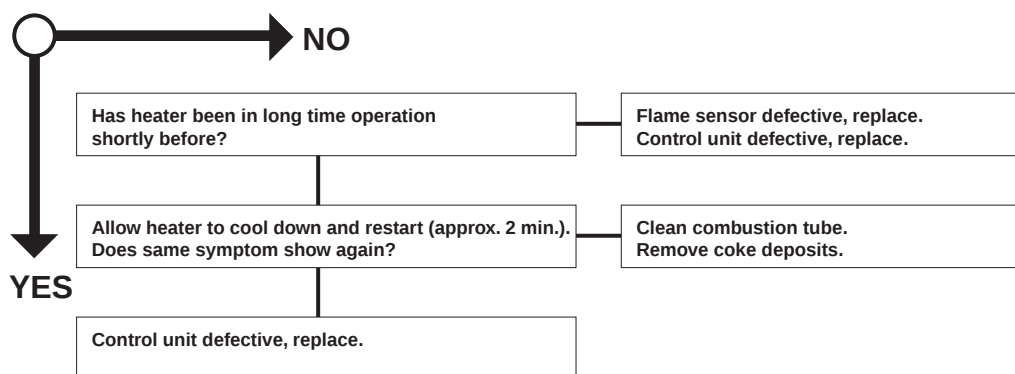
stops any further attempts to start. This error lockout is superior to the normal error lockout condition. The error lockout reset is achieved by switching the heater on and disconnection of the heater power supply during run-down.



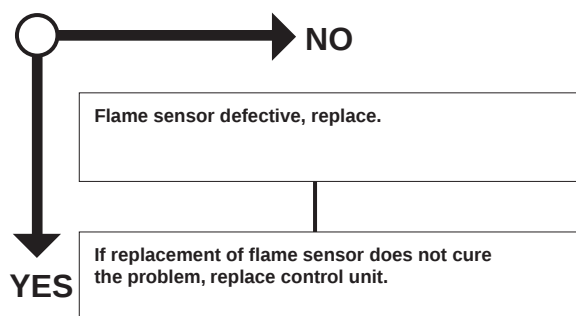
5.3.2.3 Fault Symptom "Low Voltage"



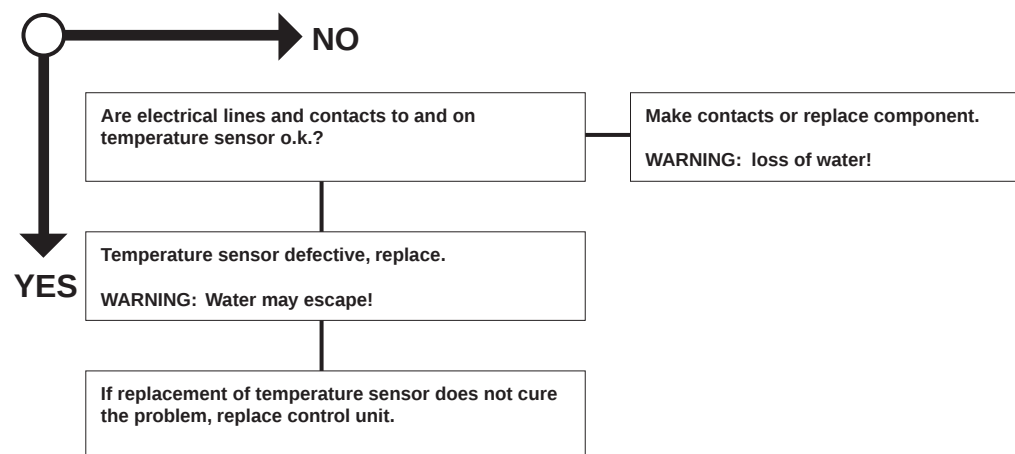
5.3.2.4 Fault Symptom "Foreign Light Detection during Run-up or Run-down"



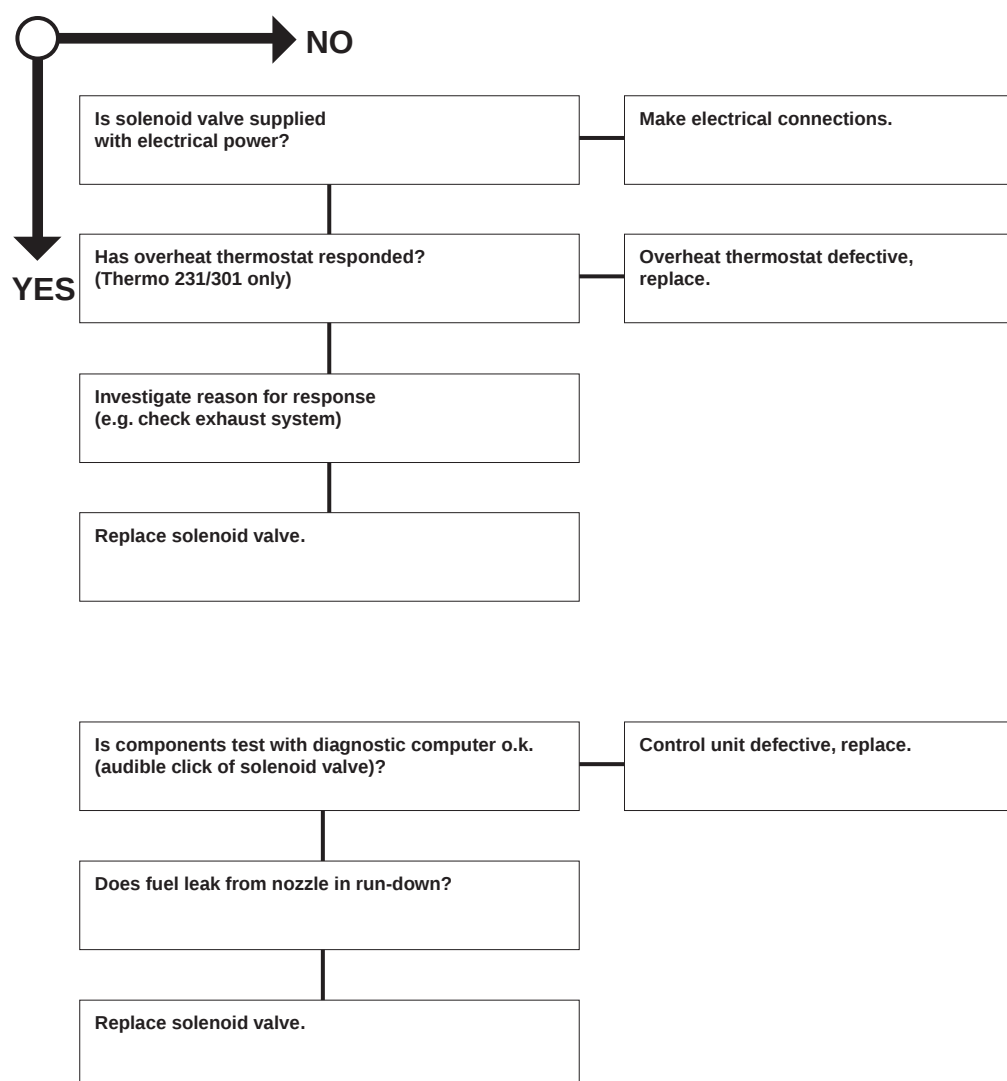
5.3.2.5 Fault Symptom "Flame Sensor Defective"



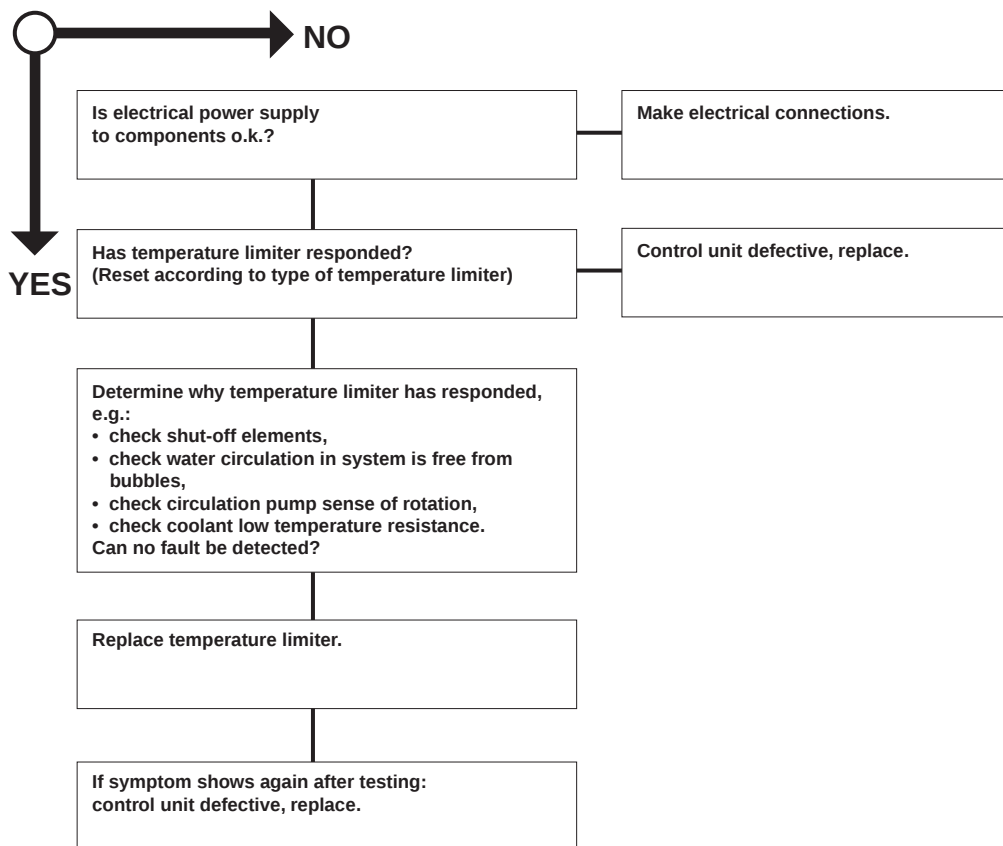
5.3.2.6 Fault Symptom "Temperature Sensor Defective"



5.3.2.7 Fault Symptom "Solenoid Valve Defective"



5.3.2.8 Fault Symptom "Temperature Limiter Defective"



6 Functional Checkouts

6.1 General

This section describes the tests and adjustments on the heater in installed and removed condition to prove its serviceability.

WARNING

The heater must not be operated in closed areas like garages or workshops with no exhaust ventilation facilities.

To prevent fires do not switch heater on with burner swung open.

6.2 Adjustments

6.2.1 Adjustment of CO₂ Contents

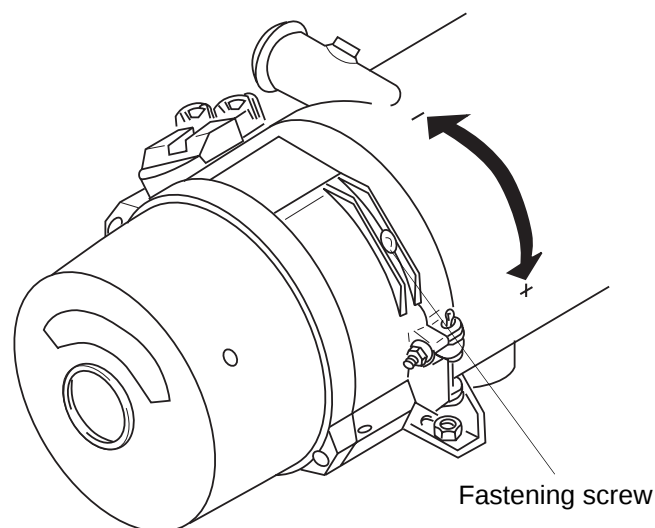
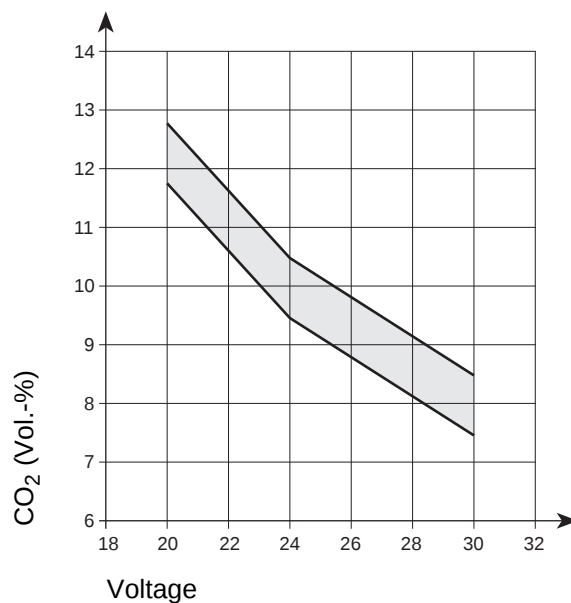
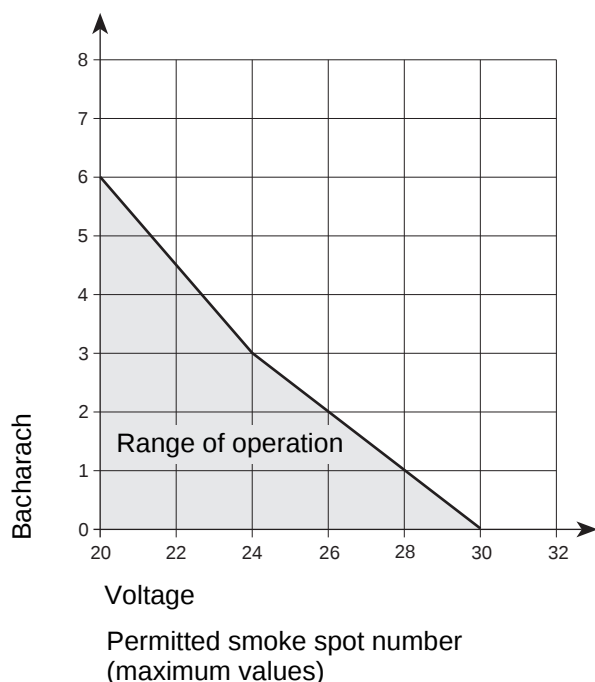
It is allowed to change the manufacturer's setting for combustion air quantity by rotation of the setting ring.

Measurement of the CO₂ value of the exhaust gas must be performed followed by an adjustment of the combustion air quantity as required in case of:

- repairs on the burner
- irregularities in combustion
- functional checkouts
- nozzle replacement

Setting procedure

- measure control unit power supply voltage
- operate heater for approximately 5 min.
- measure CO₂ contents and smoke spot number and compare with relevant diagram



- loosen fastening screw (refer to Fig.) and reposition setting ring with fastening screw until rated value is obtained.
- tighten fastening screw with 1.0 +0.5 Nm and apply screw seal varnish.

NOTE

CO₂ setting depends on fuel (viscosity) and on geodetic altitude (0.1 % per 100 m).

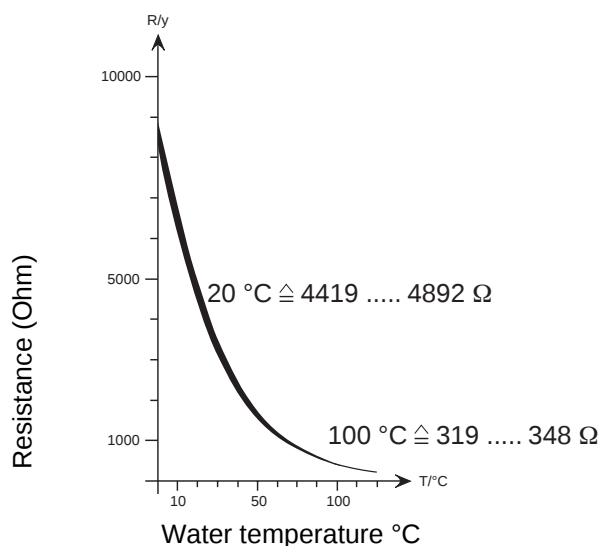
If proper setting cannot be obtained or when exceeding smoke spot number, proceed as follows:

- check burner head air side for damage and replace if required
- check fuel pump pressure and replace pump if required
- replace fuel nozzle
- measure burner motor speed

6.3 Components Testing

6.3.1 Temperature Sensor Resistance Check

When checking the temperature sensor with a digital multimeter the values of the following diagram must be obtained. Resistance checking is preferably performed at ambient temperatures between 20° C and approximately 100° C (immerse sensor in water).



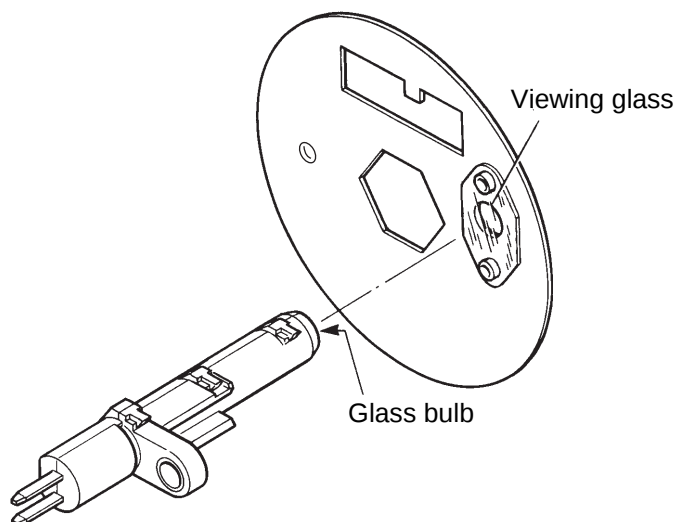
6.3.2 Flame Sensor Resistance Check

NOTE

The glass bulb of the flame sensor and the viewing glass of the window (refer to Fig.) are to be cleaned if contaminated. In case of damage or not obtaining the rated values replace flame sensor.

Check

- cover flame sensor glass bulb
- check resistance (rated value: < 20 kOhm)
- uncover flame sensor glass bulb and expose to light of strong lamp.
- check resistance (rated value: < 400 Ohm)



6.3.3 Igniter Electrodes Check

NOTE

The insulator of the igniter electrodes must show no damage. Igniter electrodes with a gap out of tolerance or not working properly must be replaced.

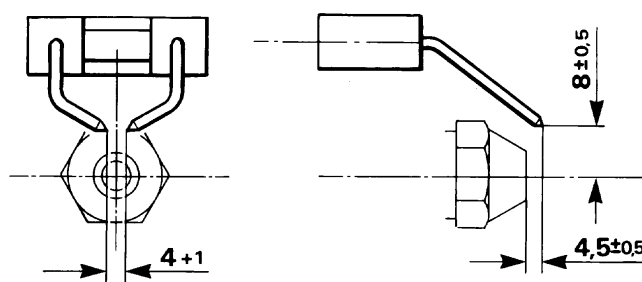
Check

- inspect insulators of igniter electrodes for damage

CAUTION

In order not to disturb the fuel atomization do not touch nozzle bore when measuring gap between electrodes.

- check gap between electrodes according to Fig. and check condition of electrodes.



6.3.4 Igniter Box Check

NOTE

The igniter box may also be tested using the PC heater diagnosis (component test).

WARNING

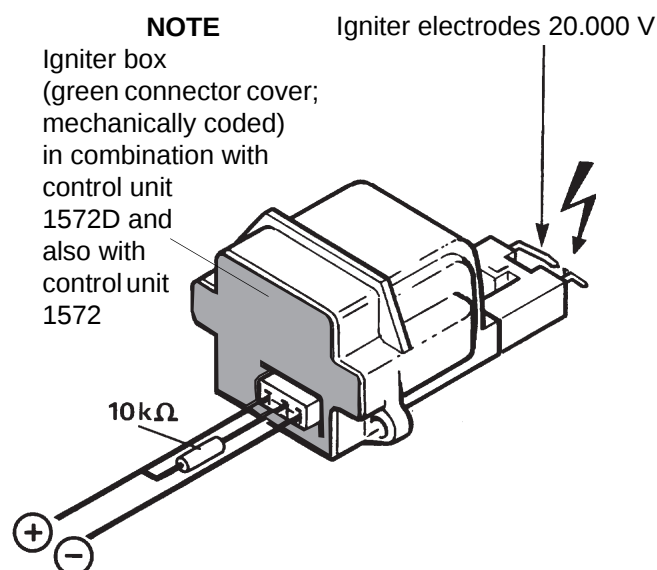
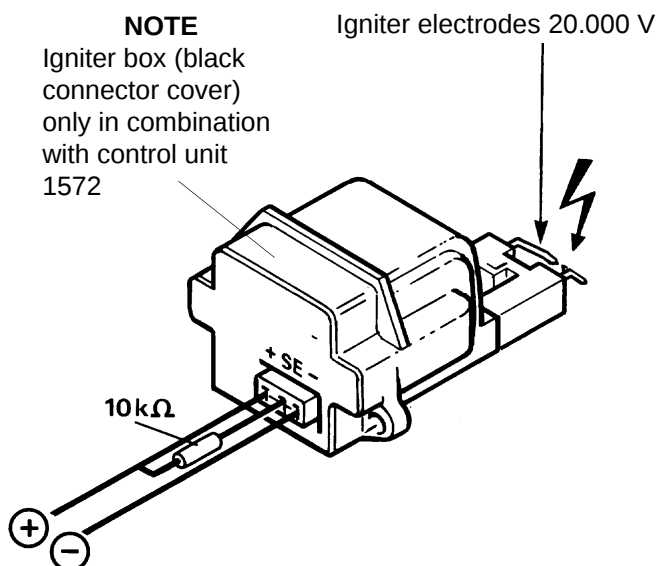
High voltage; 20.000 volts arcing across the igniter electrodes.

CAUTION

Do not apply voltage to igniter box without electrodes.

Check

- apply 24 V as shown on figure
- normal condition: spark between electrodes.



6.3.5 Fuel Pump Check

6.3.5.1 Fuel Pump Check on Heaters with Control Unit 1572

NOTE

Fuel pump testing is performed with fuel pump installed. Fuel pump pressure setting is not allowed; replace pump if required.

For fuel pump testing a tester must be locally manufactured. For this purpose a pressure gauge may be used soldered onto a used nozzle (range of indication 0 to 15 bar).

CAUTION

Remove igniter box.

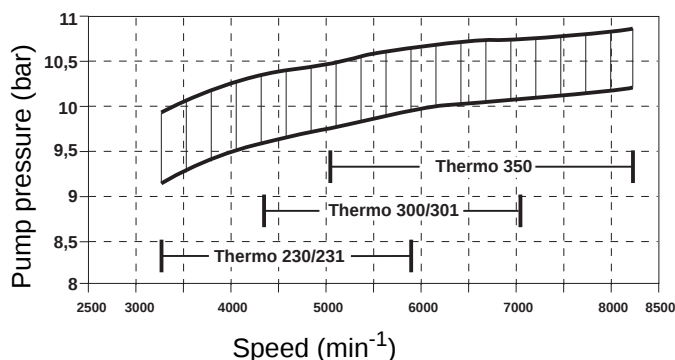
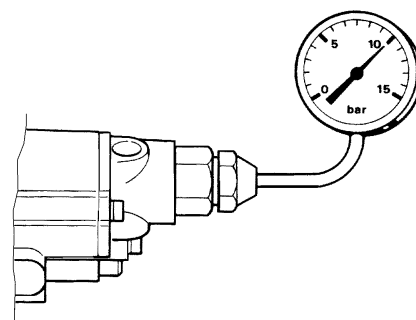
Check

- remove igniter box (refer to 9.2.7.1).
- remove nozzle.
- screw on tester.
- cover flame sensor.
- switch on heater.
- after approximately 13 sec. pump pressure is indicated (refer to diagram).
- switch off heater.
- unscrew tester.

CAUTION

Do not damage nozzle bore.

- screw in nozzle and torque with 20 Nm.
- install igniter box (refer to 9.2.7.2).



Pump pressure in relation to speed

6.3.5.2 Fuel Pump Check on Heaters with Control Unit 1572D

NOTE

A fuel pump check of heaters with control unit 1572D may only be performed after consulting Webasto.

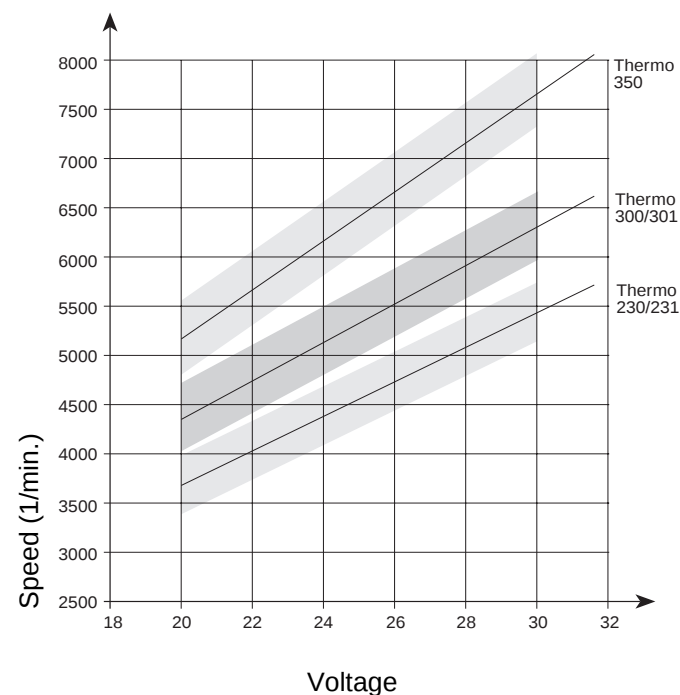
6.3.6 Fan Motor Check

NOTE

The fan motor check is performed with the burner installed. If normal conditions are not obtained the fan motor must be replaced.

Check

- check fan motor bearing condition(binding)
 - measure heater power supply voltage
 - switch on heater
 - measure speed and compare with the diagram below
- | | | |
|----------------|-----------|---------|
| Thermo 230/231 | 4400 ±350 | 24 Volt |
| Thermo 300/301 | 5200 ±420 | 24 Volt |
| Thermo 230 | 6200 ±500 | 24 Volt |



6.3.7 Solenoid Valve Check

NOTE

A solenoid valve leaking valve seat shows by rather long smoke emissions during run-down. In this case fuel keeps dripping through the fuel nozzle.

Short smoke emissions are normal caused by clearing the area between solenoid valve and nozzle bore.

Check**CAUTION**

Disconnect solenoid valve connector from control unit to avoid damage to the control unit.

- Check electrics for the following values:
 - break voltage 17.0 Volts
 - operating voltage 19.2 ... 28.8 Volts
 - power consumption at nominal voltage and 20° C 10 Watts
 - nominal current 0.42 Amps

NOTE

On heaters with control unit 1572 the solenoid valve may also be checked by means of the PC heater diagnosis (component test).

6.3.8 Nozzle Block Preheater Check

NOTE

At a temperature of < 0° C the heater cartridge in the nozzle block is activated. The heating period depends on the heat reflected within the combustion chamber. Preheating is deactivated when the thermostat ambient temperature is +8° C.

Power consumption is 130 ±13 Watts at 24 Volt.

Check

- swing burner head open or remove
- disconnect electrical connector from nozzle
- connect ohmmeter to connector
- using cooling spray cool down thermostat or bridge
- resistance (max. 4.5 Ω).

7 Circuit Diagrams

7.1 General

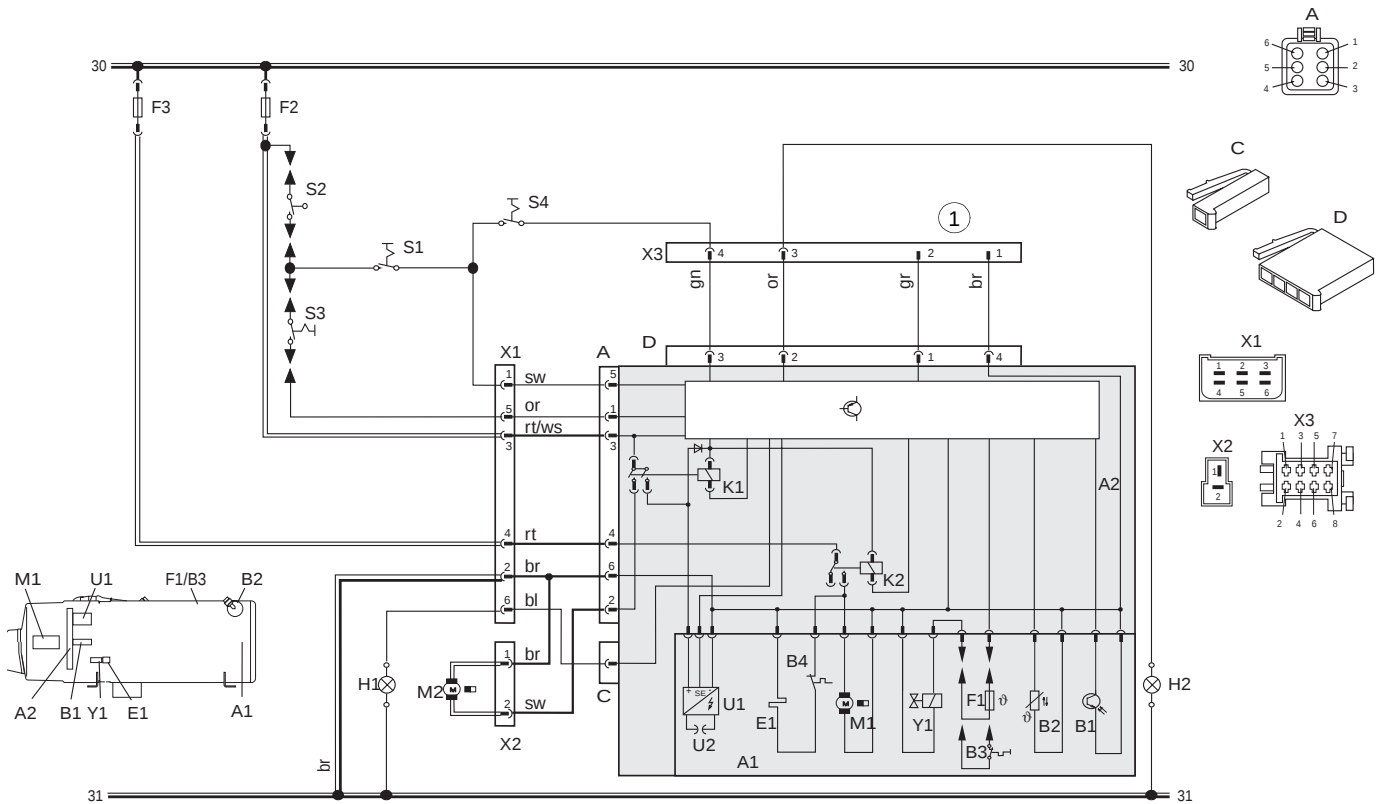
The circuit diagrams (Fig. 701 and 702) show possible heater circuits for *Thermo 230, 300* and *350* with control unit 1572 and with

- switch
- timer 1529 (triple timer)

The circuit diagrams (Fig. 703 and 704) show possible heater circuits for *Thermo 230, 231, 300, 301* and *350* with control unit 1572D and with

- switch
- standard timer 1531

The circuit diagrams (Fig. 705 through 709) show possible variants of heater circuits for *Thermo 230, 231, 300, 301* and *350* with control unit 1572D.



1 Diagnostic connector

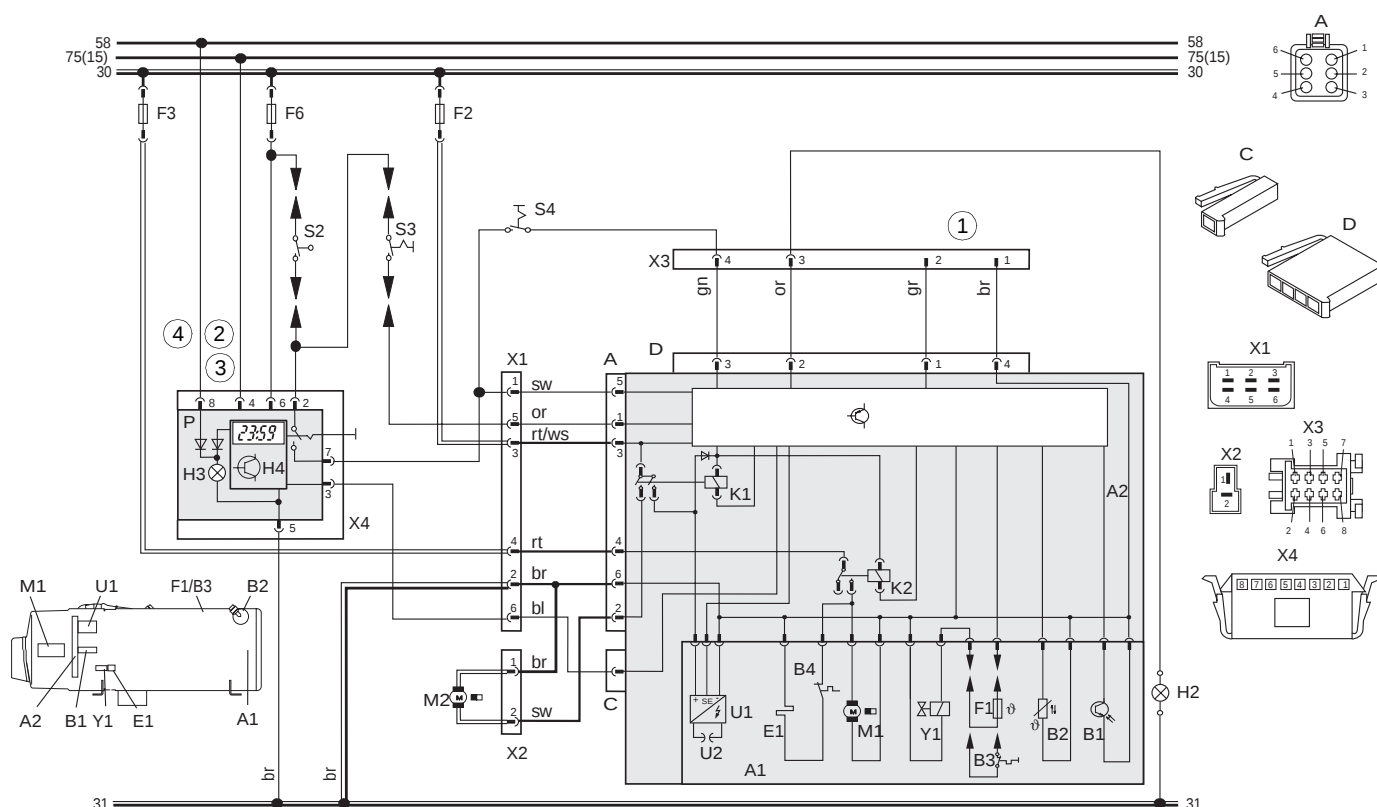
Wire gauges		
	< 7.5 m	7.5 - 15 m
	0.75 mm ²	1.5 mm ²
	1.0 mm ²	1.5 mm ²
	1.5 mm ²	2.5 mm ²
	2.5 mm ²	4.0 mm ²
	4.0 mm ²	6.0 mm ²

Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572
B1	Flame sensor	
B2	Temperature sensor	
B3	Temperature limiter	
B4	Thermostat	open at T > 8 °C
E1	Heating cartridge	for nozzle preheating
F2	Fuse 25A	flat fuse SAE J 1284
F3	Fuse 25A	flat fuse SAE J 1284
H1	Light	operation indicator light
K1	Relay (in item A2)	for circulation pump
K2	Relay (in item A2)	for combustion air fan / heating cartridge
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S2	Continuity switch	on water cock

Item	Nomenclature	Remark
S3	Switch, external trigger circulation pump	
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
X1	Plug connections, 6-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
Y1	Solenoid valve	

Fig. 701 Automatic Control Circuit with Control Unit 1572 and Switch



- ① Diagnostic connector
- ② to vehicle terminal +75 if available, otherwise terminal 15
- ③ Timer P:
with plus to connection 4 = continuous operation during immediate heating
without plus to connection 4 = heating period 1 hour
- ④ vehicle lighting terminal 58

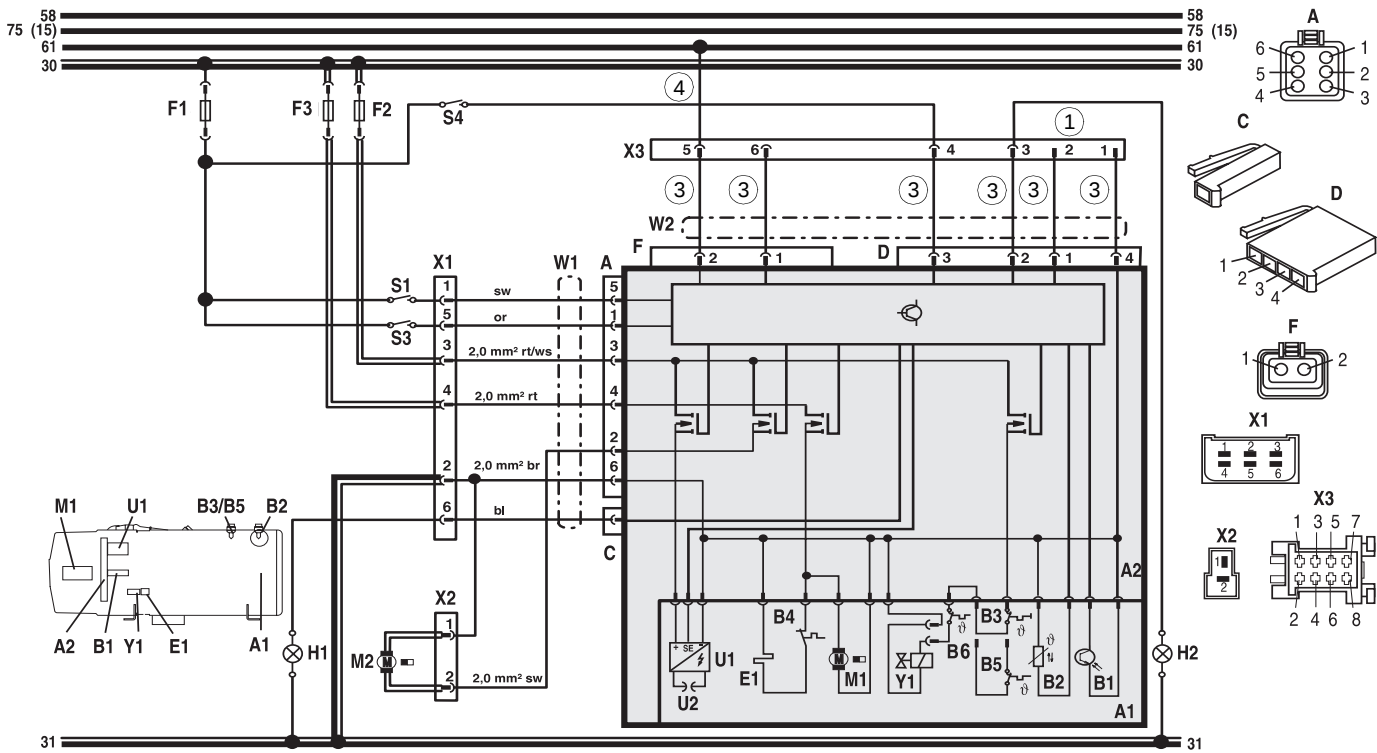
Wire gauges	
	< 7.5 m
	0.75 mm ²
	1.0 mm ²
	1.5 mm ²
	2.5 mm ²
	4.0 mm ²

Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572
B1	Flame sensor	
B2	Temperature sensor	
B3	Temperature limiter	
B4	Thermostat	opens at T > 8 °C
E1	Heating cartridge	for nozzle preheating
F2	Fuse 25A	flat fuse SAE J 1284
F3	Fuse 25A	flat fuse SAE J 1284
F6	Fuse 5A	flat fuse SAE J 1284
H3	Light in item P	symbol lighting
H4	Symbol for "Heating" in Display	symbol lighting (in item P)
K1	Relay (in item A2)	for circulation pump
K2	Relay (in item A2)	for combustion air fan / heating cartridge
M1	Motor	combustion air fan
M2	Motor	circulation pump
P	Triple timing clock (1529)	for timed operation

Item	Nomenclature	Remark
S2	Continuity switch	on water cock
S3	Switch, external trigger circulation pump	
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
X1	Plug connections, 6-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
X4	Plug connections, 8-pole	
Y1	Solenoid valve	

Fig. 702 Automatic Control Circuit with Control Unit 1572 and Timer (Triple Timer)



① Diagnostic connector

③	Pin assignment:		Pin assignment	4wire lead	Twire lead
			D1	0,75 gr	0,75 rt
			D2	0,75 or	0,75 or
			D3	0,75 gn	0,75 bl
			D4	0,75 br	2,0 br
			F1	nicht belegt	2,0 sw
			F2	nicht belegt	2,0 rt/ws

④ with connection to terminal 61 auxiliary

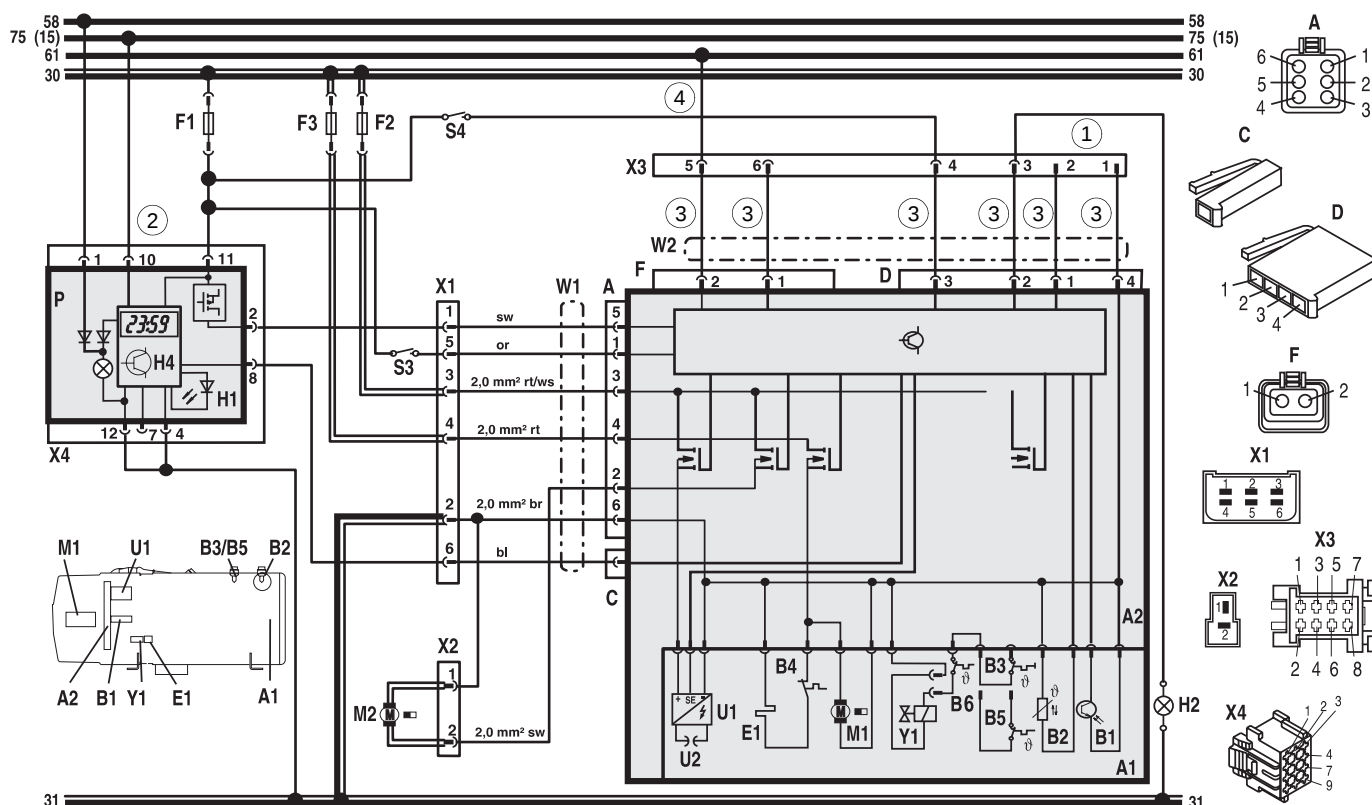
Wire gauges		
	< 7.5 m	7.5 - 15 m
	0.75 mm ²	1.5 mm ²
	1.0 mm ²	1.5 mm ²
	1.5 mm ²	2.5 mm ²
	2.5 mm ²	4.0 mm ²
	4.0 mm ²	6.0 mm ²

Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	
B4	Thermostat	for nozzle preheating
B5	Thermostat	alternative to B3
E1	Heating cartridge	for nozzle preheating
F1	Fuse 5 A	flat fuse DIN 72581 part 3
F2	Fuse 25 A	flat fuse DIN 72581 part 3
F3	Fuse 25 A	flat fuse DIN 72581 part 3
H1	Light	operation indicator light
H2	Light	flame indicator
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S3	Switch	external trigger circulation pump
S4	Switch	power save operation

Item	Nomenclature	Remark
U1	Igniter box	
U2	Igniter electrodes	
W1	Wiring harness (1)	
W2	Wiring harness (2)	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
F	Plug connections, 2-pole	
X1	Plug connections, 6-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
Y1	Solenoid valve	

Fig. 703 Automatic Control Circuit with Control Unit 1572D and Switch



① Diagnostic connector

② Timer P:
with plus to connection 10 = continuous operating during immediate heating
terminal 10 not connected = duration of heating programmable (10 min to 120 min);

③ Pin assignment:

Pin assignment	4wire lead	7wire lead
D1	0.75 gr	0.75 rt
D2	0.75 or	0.75 or
D3	0.75 gn	0.75 bl
D4	0.75 br	2.0 br
F1	not used	2.0 sw
F2	not used	2.0 rt/ws

Wire gauges		
	< 7.5 m	7.5 - 15 m
	0.75 mm ²	1.5 mm ²
	1.0 mm ²	1.5 mm ²
	1.5 mm ²	2.5 mm ²
	2.5 mm ²	4.0 mm ²
	4.0 mm ²	6.0 mm ²

④ with connection to terminal 61 auxiliary

Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

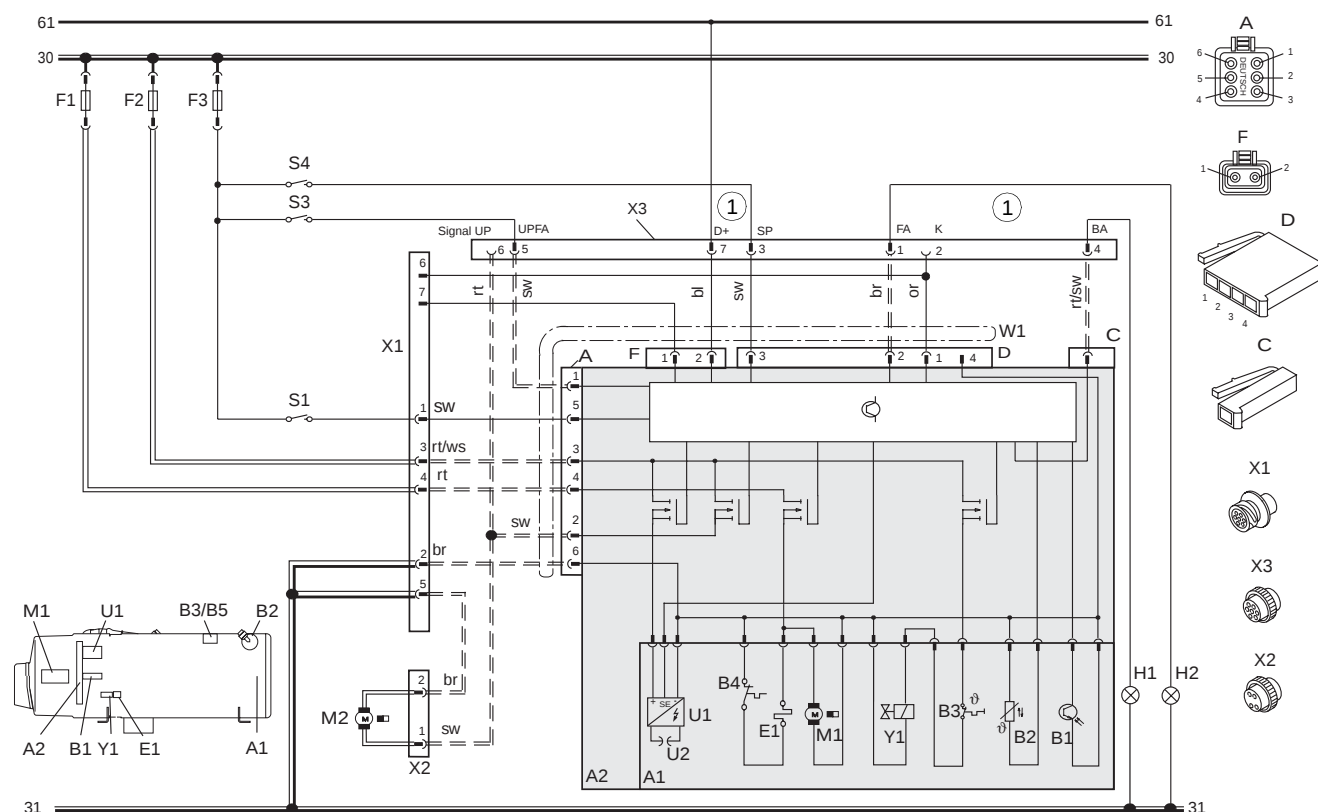
Item	Nomenclature	Remark
A1	Heater	
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	
B4	Thermostat	for nozzle preheating
B5	Thermostat	alternative to B3
E1	Heating cartridge	for nozzle preheating
F1	Fuse 5 A	flat fuse DIN 72581 part 3
F2	Fuse 25 A	flat fuse DIN 72581 part 3
F3	Fuse 25 A	flat fuse DIN 72581 part 3
H1	Light	operation indicator light
H2	Light	flame indicator
H4	Symbol for "Heating" in Display	symbol lighting (in item P)
M1	Motor	combustion air fan
M2	Motor	circulation pump
P	Standard timer (1531)	for timed operation

Item	Nomenclature	Remark
S3	Switch	external trigger circulation pump
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
W1	Wiring harness (1)	
W2	Wiring harness (2)	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
F	Plug connections, 2-pole	
X1	Plug connections, 6-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
X4	Plug connections, 12-pole	
Y1	Solenoid valve	

Fig. 704 Automatic Control Circuit with Control Unit 1572D and Standard Timer

7 Circuit Diagrams	<i>Thermo 230 / 231 / 300 / 301 / 350</i>
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Thermo 230 / 231 / 300 / 301 / 350



① Diagnostic connector

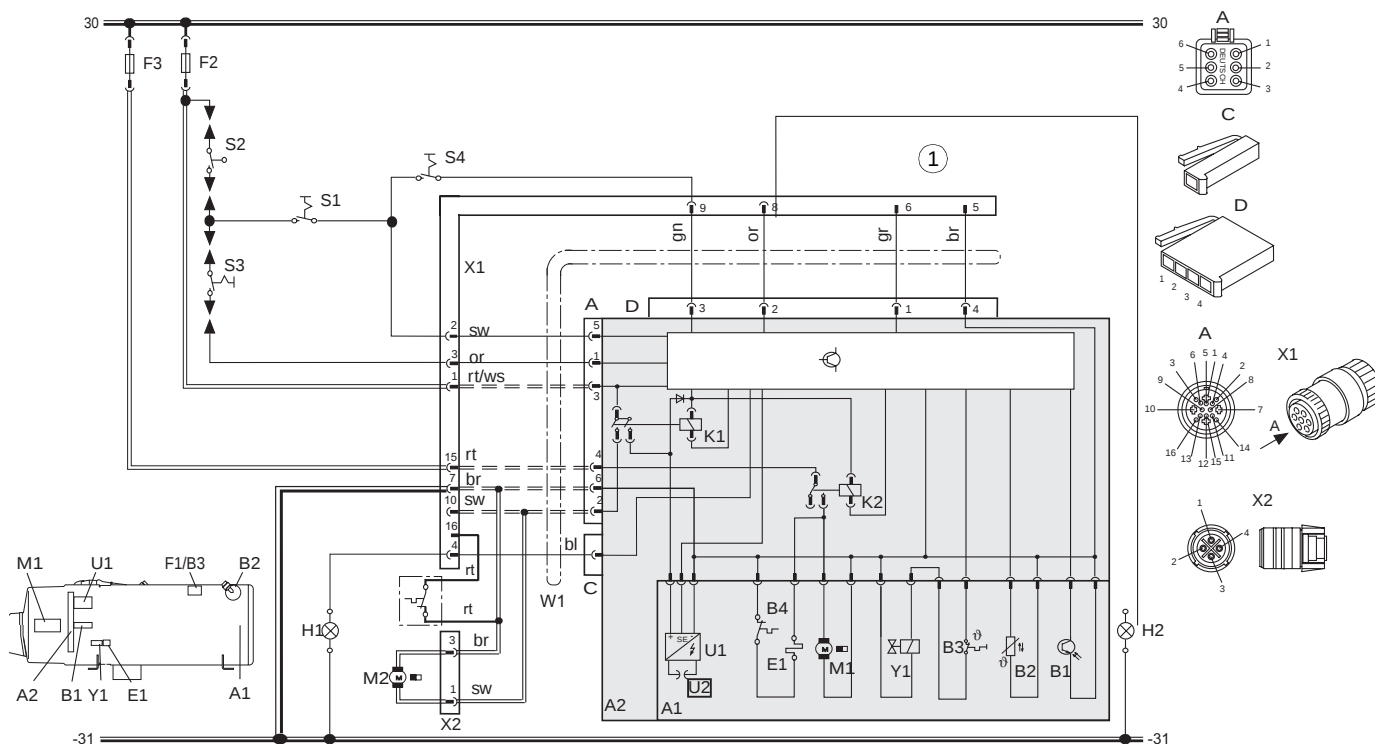
Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Wire gauges		
	< 7,5 m	7,5 - 15 m
	0,75 mm ²	1,5 mm ²
	1,0 mm ²	1,5 mm ²
	1,5 mm ²	2,5 mm ²
	2,0 mm ²	? mm ²
	2,5 mm ²	4,0 mm ²
	4,0 mm ²	6,0 mm ²

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	
B4	Thermostat	for nozzle preheating
E1	Heating cartridge	for nozzle preheating
F1	Fuse 25 A	flat fuse DIN 72581 part 3
F2	Fuse 25 A	flat fuse DIN 72581 part 3
F3	Fuse 5 A	flat fuse DIN 72581 part 3
H1	Light	operation indicator light
H2	Light	flame indicator
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S3	Switch	external trigger circulation pump
S4	Switch	power save operation
U1	Igniter box	

[illegible]

Fig. 705 System Circuit Daimler Chrysler Citaro, Ident.-Nr. 67131



① Diagnostic connector

Fuse acc. to SAE J 1284 / DIN 72581			
	DW 230	DW 300	DW 350
F2	25A / 16A	25A / 16A	25A / 16A
F3	25A / 16A	25A / 16A	25A / 16A

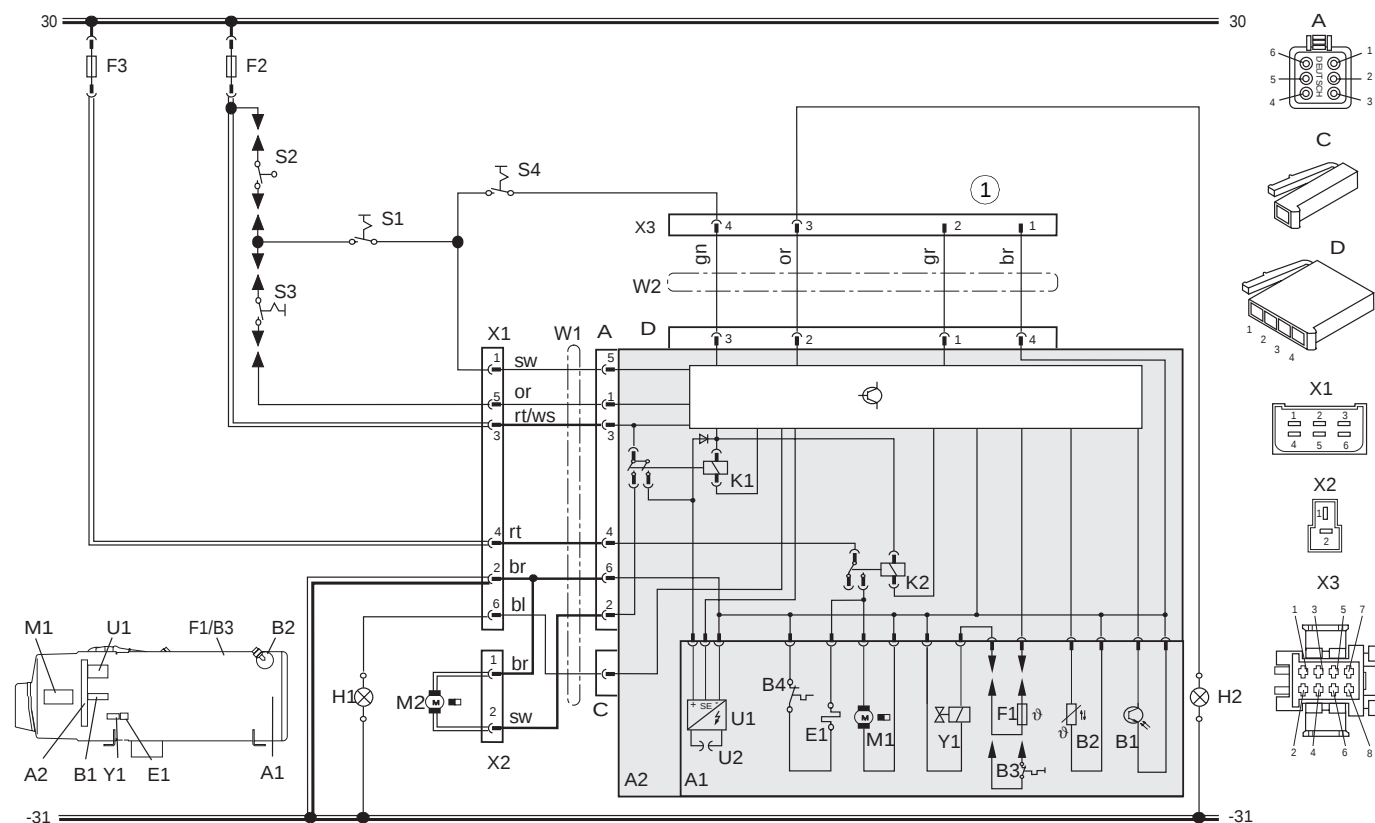
Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Wire gauges		
	< 7,5 m	7,5 - 15 m
—	0,75 mm ²	1,5 mm ²
==	1,0 mm ²	1,5 mm ²
===	1,5 mm ²	2,5 mm ²
====	2,0 mm ²	? mm ²
=====	2,5 mm ²	4,0 mm ²
=====	4,0 mm ²	6,0 mm ²

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	alternative to F1
B4	Thermostat	for nozzle preheating
B5	Fire sensor	Van Hool
E1	Heating cartridge	
F2	Fuse	see table
F3	Fuse	see table
H1	Light	operation indicator light
H2	Light	flame indicator
K1	Relay (in item A2)	for circulation pump motor
K2	Relay (in item A2)	for combustion air fan
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S2	Continuity switch	on water cock

Item	Nomenclature	Remark
S3	Switch, external trigger circulation pump	required, if S2 not installed
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
W1	Wiring harness	Van Hool
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
X1	Plug connections, 16-pole	
X2	Plug connections, 4-pole	
Y1	Solenoid valve	

Fig. 706 System Circuit Van Hool, Ident.-Nr. 89401



① Diagnostic connector

Fuse acc. to SAE J 1284 / DIN 72581			
	DW 230	DW 300	DW 350
F2	25A / 16A	25A / 16A	25A / 16A
F3	25A / 16A	25A / 16A	25A / 16A

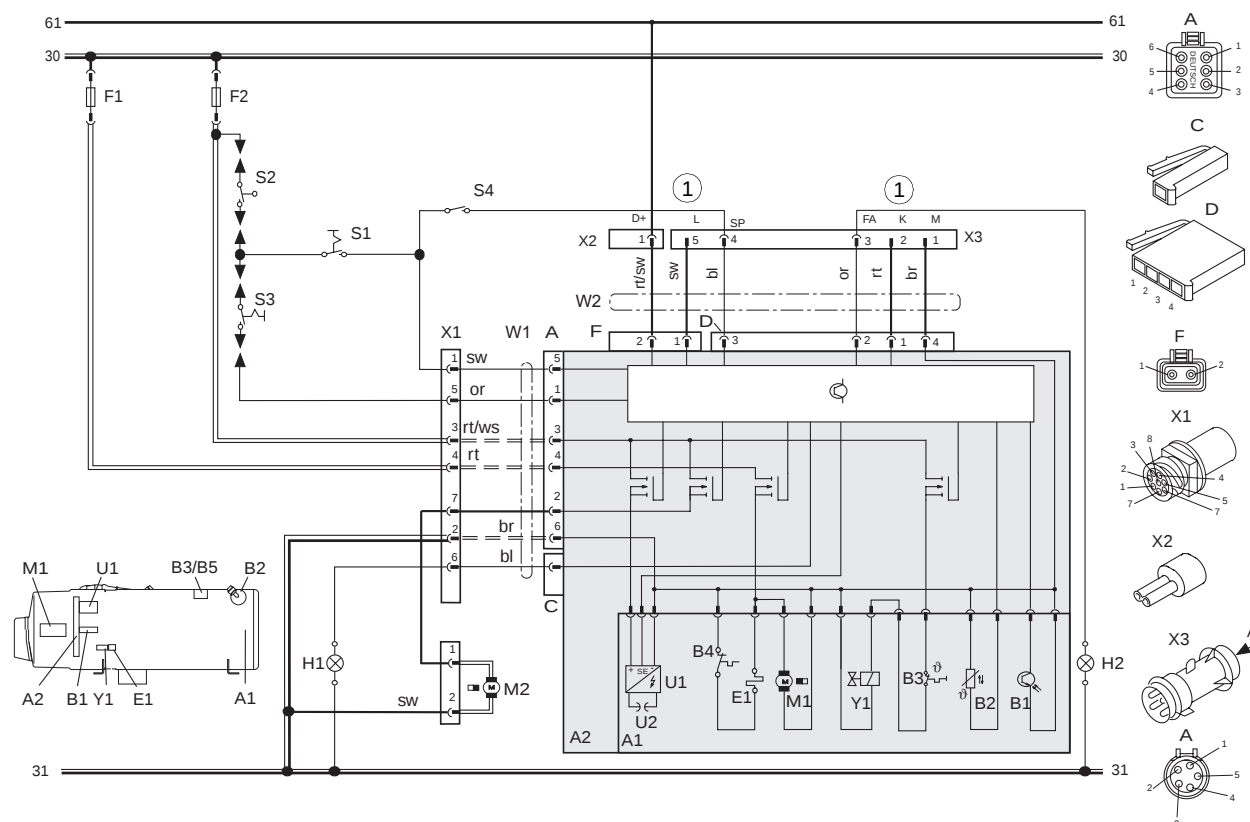
Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Wire gauges		
	< 7,5 m	7,5 - 15 m
—	0,75 mm ²	1,5 mm ²
==	1,0 mm ²	1,5 mm ²
===	1,5 mm ²	2,5 mm ²
====	2,0 mm ²	? mm ²
=====	2,5 mm ²	4,0 mm ²
————	4,0 mm ²	6,0 mm ²

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	alternative to F1
B4	Thermostat	for nozzle preheating
E1	Heating cartridge	for nozzle preheating
F2	Fuse	see table
F3	Fuse	see table
H1	Light	operation indicator light
H2	Light	flame indicator
K1	Relay	for circulation pump motor
K2	Relay	for combustion air fan
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S2	Continuity switch	on water cock

Item	Nomenclature	Remark
S3	Switch, external trigger circulation pump	required, if S2 not installed
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
W1	Wiring harness (1)	
W2	Wiring harness (2)	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
X1	Plug connections, 6-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
Y1	Solenoid valve	

Fig. 707 System Circuit O405 / O407 / O408, Ident.-Nr. 91292



① Diagnostic connector

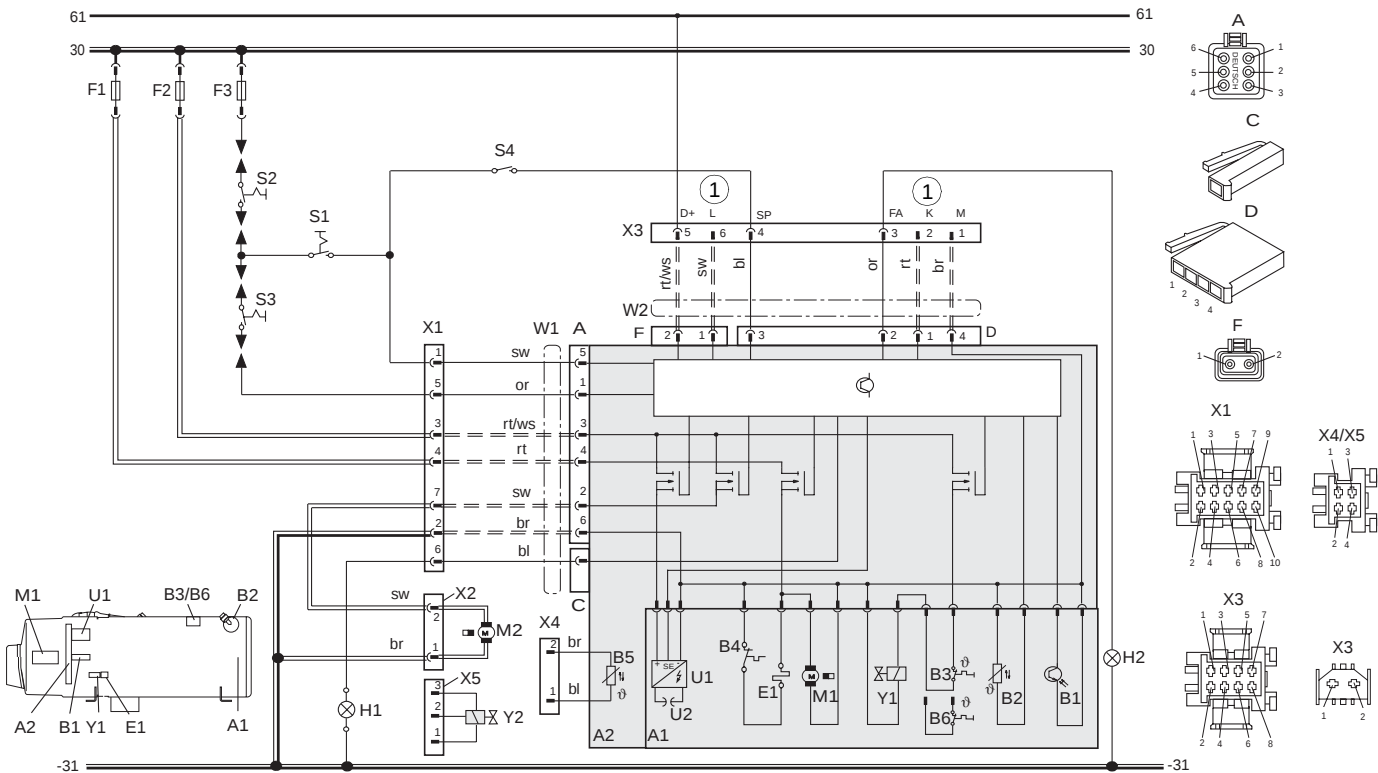
Wire gauges		
	< 7,5 m	7,5 - 15 m
	0,75 mm ²	1,5 mm ²
	1,0 mm ²	1,5 mm ²
	1,5 mm ²	2,5 mm ²
	2,0 mm ²	? mm ²
	2,5 mm ²	4,0 mm ²
	4,0 mm ²	6,0 mm ²

Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	
B4	Thermostat	for nozzle preheating
E1	Heating cartridge	for nozzle preheating
F2	Fuse 25 A	flat fuse DIN 72581 part 3
F3	Fuse 25 A	flat fuse DIN 72581 part 3
H1	Light	operation indicator light
H2	Light	flame indicator
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S2	Continuity switch	on water cock
S3	Switch, external trigger circulation pump	required, if S2 not installed
S4	Switch	power save operation

Item	Nomenclature	Remark
U1	Igniter box	
U2	Igniter electrodes	
W1	Wiring harness (1)	
W2	Wiring harness (2)	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
F	Plug connections, 2-pole	
X1	Plug connections, 6-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
Y1	Solenoid valve	

Fig. 708 System Circuit MAN, Ident.-Nr. 89404



1 Diagnostic connector

Wire gauges	
	< 7,5 m
	7,5 - 15 m
	0,75 mm ²
	1,0 mm ²
	1,5 mm ²
	2,0 mm ²
	2,5 mm ²
	4,0 mm ²

Wire colors	
bl	blue
br	brown
ge	yellow
gn	green
gr	gray
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	not grounded
A2	Control unit	SG 1572D
B1	Flame sensor	observe polarity
B2	Temperature sensor	polarity optional
B3	Temperature limiter	
B4	Thermostat	for nozzle preheating
B5	Temperature sensor extern	observe polarity
B6	Thermostat	alternative to B3
E1	Heating cartridge	for nozzle preheating
F1	Fuse 25 A	flat fuse DIN 72581 part 3
F2	Fuse 25 A	flat fuse DIN 72581 part 3
F3	Fuse 5 A	flat fuse DIN 72581 part 3
H1	Light	operation indicator light
H2	Light	flame indicator
M1	Motor	combustion air fan
M2	Motor	circulation pump
S1	Switch	on / off
S2	Continuity switch	on water cock

Pos.	Nomenclature	Remark
S3	Switch, external trigger circulation pump	required, if S2 not installed
S4	Switch	power save operation
U1	Igniter box	
U2	Igniter electrodes	
W1	Wiring harness (1)	
W2	Wiring harness (2)	
A	Plug connections, 6-pole	
C	Plug connections, 1-pole	
D	Plug connections, 4-pole	
F	Plug connections, 2-pole	
X1	Plug connections, 10-pole	
X2	Plug connections, 2-pole	
X3	Plug connections, 8-pole	
X4	Plug connections, 4-pole	
X5	Plug connections, 4-pole	
Y1	Solenoid valve	
Y2	Shut-off valve with filter	

Fig. 709 System Circuit SETRA, Ident.-Nr. 90972

8 Servicing

8.1 General

This section describes the servicing procedures allowed on the heater when installed.

8.2 Heater Servicing

As long as the heater is in operation or in run-down the battery main power supply must not be disconnected to prevent the heater from overheating by response of the overheat protection.

When performing long time repairs on the heater its removal is appropriate.

After working on the heating circuit replenish with a coolant mix prepared with water and anti-freeze and bleed circuit afterwards according to manufacturer's instructions.

8.3 Vehicle Servicing

CAUTION

In the vicinity of the heater a temperature of 110 °C must under no circumstances be exceeded (e.g. during paint work on the vehicle).

8.4 Heater Test Run

The heater must not be operated, not even with the timer, in enclosed areas like garages or workshops not equipped with exhaust ventilation facilities.

8.5 Maintenance

To ensure functional reliability of the heater the following maintenance must be performed:

- check combustion air inlet and exhaust outlet for contamination and clean as required.
- outside the heating season the heater should be operated with the vehicle engine cold approximately every four weeks for 10 minutes setting the heating system to "warm". This avoids difficulties in the start-up.
- after replacing the coolant of the vehicle engine ensure proper bleeding of the heater and circulation pump after bleeding the vehicle cooling system. Replenish coolant to manufacturer's instructions if on low level.

- at least once a year, in case of contaminated fuel more often, the fuel filter or filter cartridge as well as the filter screen of the fuel pump must be replaced to avoid malfunctions.
- in case of leakage the fuel pump must be replaced immediately, otherwise every 5 years.
- the heater should be checked in regular intervals by a Webasto service agent, the latest before the beginning of the heating season (refer to Annex A "Scheduled Maintenance").

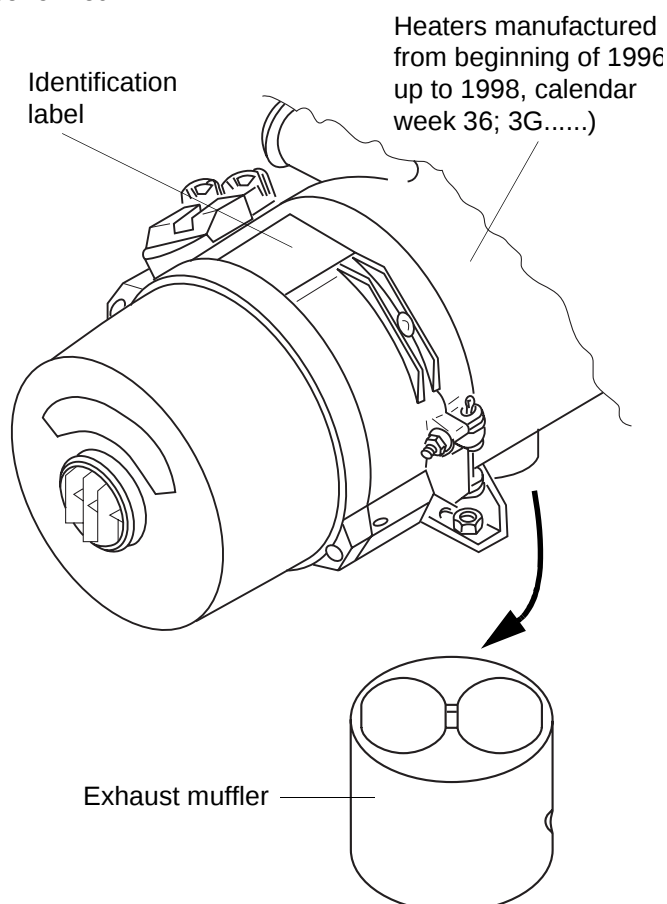
8.5.1 Inspection and Attachment of the Exhaust Muffler (only heaters from year of production 1996 and up to production date 1996, calendar week 36; 3G.....)

NOTE

If the exhaust muffler is already secured with a sheet metal screw, the following procedure need not be performed.

General

The exhaust muffler of heaters manufactured from the beginning of 1996 up to a manufacturing date of 1998 (calendar week 36; 3G.....) (for year or date of production refer to identification label) the exhaust muffler may get loose or lost under certain circumstances. Therefore an inspection for proper attachment of the muffler should be performed.



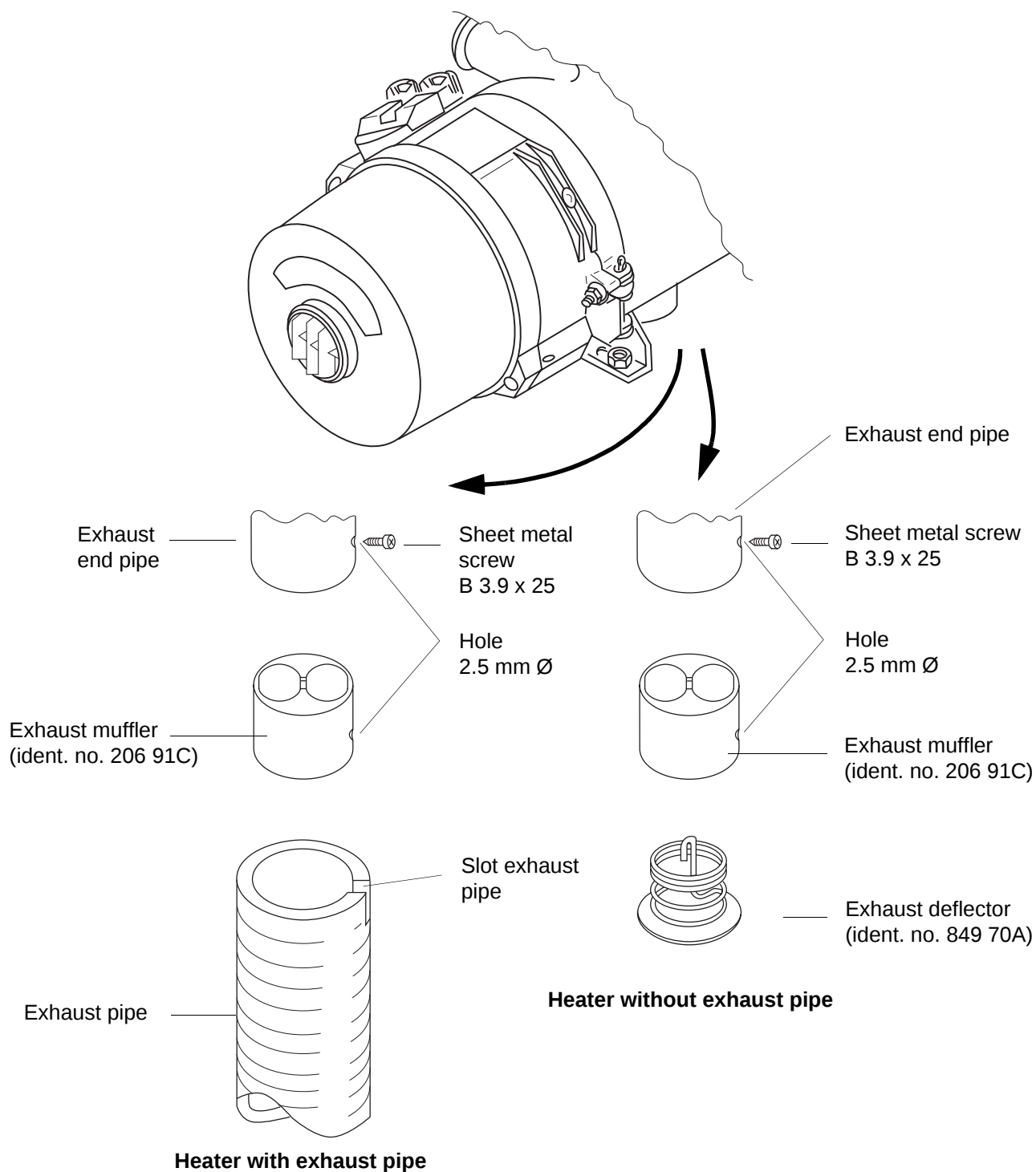
Inspection and Attachment

NOTE

The exhaust muffler must always be secured with a sheet metal screw. Drill a hole with a diameter of 2.5 mm into the exhaust end pipe and muffler and arrest muffler with a sheet metal screw B 3.9 x 25 (see figure).

1. Check exhaust end pipe for presence of muffler. For checking remove exhaust end pipe as required.
2. If muffler is found in exhaust end pipe fasten as described in NOTE. Slot or drill exhaust end pipe and refit.

3. If no muffler is found in exhaust end pipe check if muffler is upstream in exhaust pipe. If muffler is dislocated in the exhaust pipe, arrest muffler as described in NOTE. Slot or drill exhaust pipe and refit.
4. If the exhaust muffler has been lost it may be ordered free of charge from Webasto (ident. no. 206 91C). Fasten muffler according to NOTE. Slot or drill exhaust pipe and refit.
5. If heater is operated without exhaust pipe, fasten muffler according to NOTE. An exhaust deflector (ident. no. 849 70A) must be additionally fitted.



8.5.2 Burner Head Opening and Closing or Removal and Installation

WARNING

The igniter box operates with high voltage. Prior to opening the burner head the connectors of the cable harness in the vehicle have to be disconnected to prevent lethal injuries.

After closing burner head, reconnect connectors in the vehicle.

NOTE

Maintenance on the heater is easy. By swinging the burner head open the following components become accessible:

- fuel pump and fuel nozzle
- solenoid valve
- igniter box
- igniter electrodes
- flame sensor
- combustion chamber
- nozzle block preheater (if installed)

In order to obtain a convenient burner head opening angle it is required to disconnect the electrical connection(s) to the temperature limiter and temperature sensor.

Opening or removal

1. Disconnect electrical connections to temperature limiter and temperature sensor.
2. Loosen nuts (3, Fig. 801) enough to release hinge bolts (2).
3. Swing hinge bolts (2) out.
4. Swing burner head (4) open.
5. Remove cotter pin (1) as required to remove burner head.

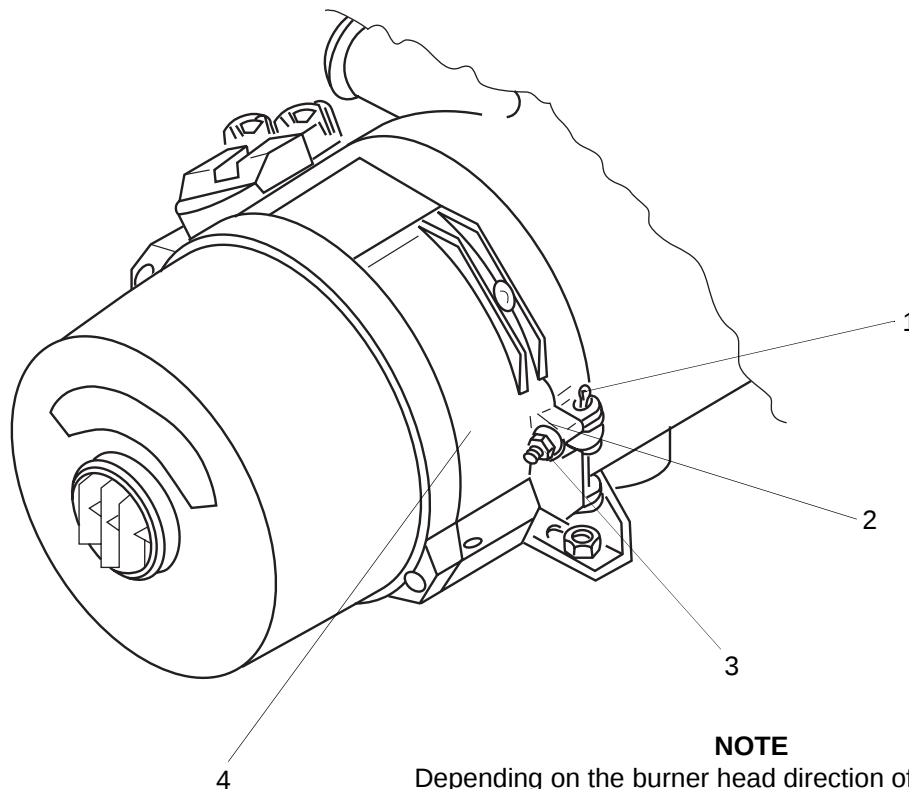
Closing or installation

1. As required fasten burner head (4, Fig. 801) in position using cotter pin (1).
2. Swing burner head (4) closed and locate for assembly.
3. Swing hinge bolts (2) into lock position and secure with nuts (3).
4. Torque nuts (3) with 7.5 Nm + 1 Nm.
5. Reconnect electrical connections to the temperature limiter and temperature sensor.

NOTE

When making electrical connections observe wiring color codes.

- 1 Cotter pin
- 2 Screw (2)
- 3 Nut (2)
- 4 Burner head



NOTE

Depending on the burner head direction of swing the cotter pin may be located on the opposite side.

Fig. 801 Swinging Burner Head open

8.6 Visual Inspections and Regulations for Installation

8.6.1 Connection to Vehicle Cooling System

The installation of the heater should be in a location as low as possible to ensure self-venting of the heater and circulation pump. This applies in particular for the circulation pump because it is not self-sucking.

The heater is to be connected to the vehicle cooling system according to Fig. 802. The cooling system coolant capacity must be at least 10 liters.

The vehicle cooling system or the separate heating circuit must use only pressure relief valves with an opening pressure of at least 0.4 bar and of max. 2.0 bar.

It is a basic requirement to use the coolant hoses supplied by Webasto, otherwise the hoses must at least meet the specifications of DIN 73411. The hoses have to be installed free of kinks and for proper venting in an inclination. Hose connections must be secured against slippage with hose clamps.

NOTE

Hose clamps must be torqued with 1.5 Nm.

Prior to the heater's first operation or after replacement of the coolant, attention must be paid to carefully bleed the cooling system. Heater and lines must be installed so that static venting is guaranteed.

Improper venting may cause malfunctions by overheating in equipment operation.

Proper venting may be identified by a circulation pump almost noiseless in operation.

When using a circulation pump U 4851 or U 4852 the circulation pump automatically switches off approx. 15 seconds after switch-on should coolant be missing or the pump wheel be seized. After 2 minutes the pump may be reactivated.

In combination with control unit 1572D (Thermo label colored) and with programmed circulation pump check the heater also switches off when coolant is missing.

8.6.2 Connection to Vehicle Fuel System

Fuel is tapped from the fuel reservoir of the vehicle or from a separate fuel tank.

8.6.2.1 Fuel Lines

In order to avoid air from being captured in fuel lines, they should only be installed with an incline. The fuel line joints are to be secured against slipping with hose clamps should no screwed mechanical unions be in use.

Should fuel hoses be installed always use the hoses supplied or offered by Webasto. If other hoses are used they must at least meet the specifications of DIN 73379. Fuel hoses must not be kinked or twisted and must be secured with clamps every 25 cm.

For routing fuel also fuel lines may be used consisting of materials standard in the manufacturing of vehicles, e.g. steel, copper or plastic lines made of unhardened, light and temperature stabilized PA11 or PA12 (e.g. Mecanyl RWTL) according to DIN 73378 observing the applicable jointing instructions.

CAUTION

Heaters cleared or modified for the consumption of PME (Bio Diesel) (observe identification label) and where PME is used, it must be ensured that the fuel lines are PME resistant.

Basic rules for the routing of fuel lines are:

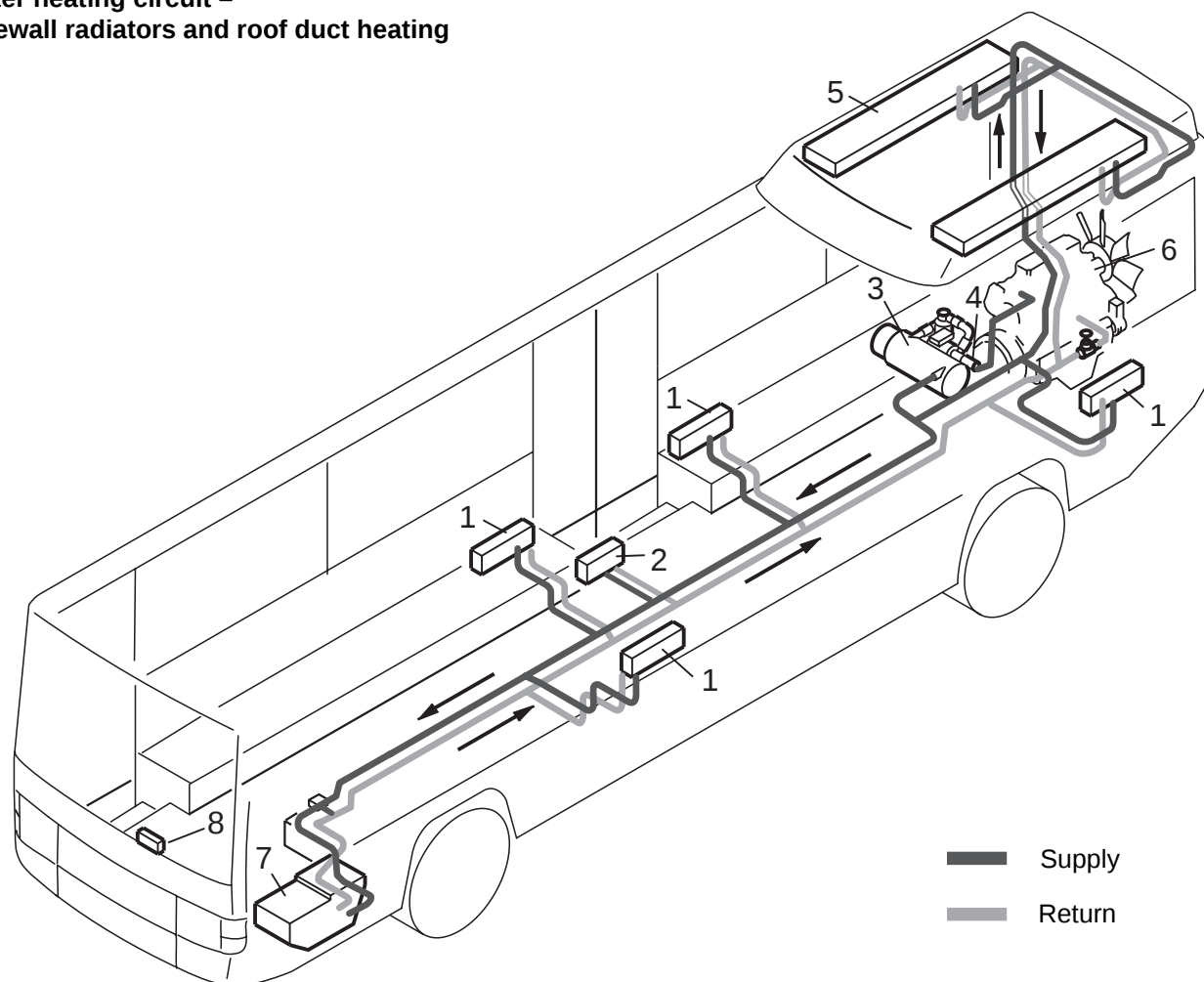
- Protect against undue temperatures.

WARNING

In overheat condition the heater outer shell may reach Diesel fuel inflammation temperature!

- Protect lines from stone strike.
- **Dripping or evaporating fuel may neither accumulate nor ignite on hot components or electrical equipment.**

**Water heating circuit –
Sidewall radiators and roof duct heating**



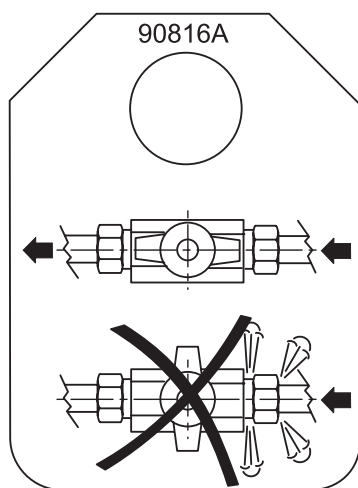
- 1 Sidewall radiator with fan
- 2 Heat exchanger, entrance
- 3 Heater unit
- 4 Circulation pump
- 5 Heat exchanger, roof
- 6 Vehicle engine
- 7 Cockpit heating
- 8 Control element

Fig. 802 Example of a Heater Installation in a Passenger Bus

When installing a shut-off device in the return line a clearly visible information label must be provided.

CAUTION

Operation with the return line shut off causes damage to the fuel pump. Fuel may escape. Danger of fire.



Information label

Loose fuel lines must be secured in order to avoid sagging.

The installation of an additional fuel pump is not allowed.

Fuel lines permissible dimensions:

- inner diameter for suction and return line: 6 mm (other diameters upon request).
- max. permissible length for each suction and return line: 10 m
- Max. permissible suction height: 2 m (installation of a bottom valve is recommended for max. suction height)
- Max. permissible priming pressure: 0.3 bar for suction and return line.

8.6.2.2 Fuel Filter

A fuel filter or PME special filter supplied as deliverable item or cleared for use by Webasto is to be fitted. Installation position possibly vertical with horizontal direction of flow. To avoid operating malfunctions replace filter or filter cartridge once a year or more often if fuel is contaminated.

8.6.3 Combustion Air Supply

CAUTION

Observe official regulations concerning the installation (see 1.6).

Combustion air must under no circumstances be extracted from rooms with persons. The combustion air

inlet must not point towards the forward direction of motion.

It must be located so that no clogging by contamination, impact of snow, or intake of splash water is to be expected.

The combustion air intake and exhaust outlet is to be located so that no air pressure difference builds up in any operating condition of the vehicle.

Permissible dimensions of combustion air intake line:

- inner diameter: 55 mm
- max. length: 5 m
- max. bend: 270°

The combustion air inlet must be located so that no exhaust fumes can enter.

NOTE

If the combustion air intake line cannot be routed upwards, a water drain hole Ø 4 mm is to be provided at the lowest point.

If the heater is located near the fuel tank in a common installation compartment, combustion air must be taken in from and the exhaust routed to the exterior. The feedthroughs must be sealed against splash water.

If the heater is located in a closed installation box, a vent port is required:

<i>Thermo 230, 231, 300 and 301</i>	30 cm ²
<i>Thermo 350</i>	35 cm ²

If the temperature in the installation box exceeds the permitted ambient temperature of the heater (see Technical Data), the vent port must be enlarged consulting Webasto.

8.6.4 Exhaust Line

CAUTION

Observe official regulations concerning the installation (see 1.6).

The exhaust pipe outlet opening must not point in the direction of motion.

The exhaust pipe outlet opening must be located so as not to expect clogging by snow or mud.

The combustion air intake and exhaust outlet is to be located so that no air pressure difference builds up in any operating condition of the vehicle.

Rigid pipes made of unalloyed or alloyed steel with a minimum wall thickness of 1.0 mm have to be used as exhaust line or flexible pipes made of alloyed steel only. The exhaust pipe is secured to the air heater e.g. with a clamp.

Permissible exhaust line dimensions:

- inner diameter: 70 mm
- max. length: 5 m
- max. bend: 270°

As an alternative an exhaust deflector must be installed cleared by Webasto.

8.7 Removal and Installation

CAUTION

In installed condition only the following disassembly or removal procedures are permitted should enough space for removal allow such action:

- replacement of temperature limiter
- replacement of temperature sensor
- replacement of combustion air fan
- replacement of burner
- replacement of igniter box
- replacement of flame sensor
- replacement of combustion chamber

8.7.1 Heater, Removal and Installation

8.7.1.1 Removal

1. Disconnect connectors of cable harness in vehicle and of circulation pump.
2. Disconnect combustion air intake on heater if required.
3. Loosen clamp on exhaust outlet.
4. Loosen fuel supply and return line connections and fit dummy plugs.
Close water cocks as applicable.
5. Loosen hose clamps on coolant hoses, disconnect hoses and fit dummy plugs.
6. Remove 3 screws and washers or 4 screws and washers.
7. Remove heater.

8.7.1.2 Installation

1. Locate heater for installation and secure with 3 screws and washers or 4 screws and washers.
2. Secure line on exhaust outlet using clamp.
3. Slide on coolant hoses and fasten with hose clamps.
Torque clamps with 1.5 Nm. Open water cocks.
4. Connect fuel supply and return lines and tighten connections or screw tight with banjo bolt and new gaskets.

5. Secure combustion air inlet line on heater as applicable.
6. Connect electrical connectors of cable harness in vehicle and to circulation pump.
7. Bleed fuel supply system.
8. Bleed coolant circuit.

8.7.2 Temperature Limiter, Replacement

NOTE

The replacement procedure for the temperature limiter is identical with the heater installed or removed.
Perform replacement in accordance with 9.2.1.

8.7.3 Temperature Sensor, Replacement

NOTE

The replacement procedure for the temperature sensor is identical with the heater installed or removed.
Perform replacement in accordance with 9.2.2.

WARNING

Prior to replacement of temperature sensor in installed condition relieve overpressure in cooling system by opening the cooling circuit sealing element.
If required also allow heater to cool down and have collector vessel ready to collect escaping coolant.

8.7.4 Burner, Replacement

NOTE

The replacement procedure for the burner is identical with the heater installed or removed.
Perform replacement in accordance with 9.2.3.

WARNING

The igniter box operates on high voltage. Prior to replacement of burner disconnect electrical connectors of cable harness in vehicle to avoid lethal accidents.

8.7.5 Igniter Box, Replacement

NOTE

The replacement procedure for the igniter box is identical with the heater installed or removed.
Perform replacement in accordance with 9.2.7.

WARNING

The igniter box operates on high voltage. Prior to replacement of igniter box disconnect electrical connectors of cable harness in vehicle to avoid lethal accidents.

8.7.6 Flame Sensor, Replacement**NOTE**

The replacement procedure for the flame sensor is identical with the heater installed or removed.
Perform replacement in accordance with 9.2.8.

WARNING

The igniter box operates on high voltage. Prior to replacement of flame sensor disconnect electrical connectors of cable harness in vehicle to avoid lethal accidents.

8.7.7 Combustion Chamber, Replacement**NOTE**

The replacement procedure for the combustion chamber is identical with the heater installed or removed.
Perform replacement in accordance with 9.2.10.

WARNING

The heater operates on high voltage. Prior to replacement of combustion chamber disconnect electrical connectors of cable harness in vehicle to avoid lethal accidents.

8.8 First Operation

After heater installation the coolant circuit and the fuel supply system must be thoroughly bled observing the vehicle manufacturer's instructions. During test runs all coolant and fuel line connections have to be checked for security and no leakage. Should the heater in operation enter a fault condition, perform troubleshooting (refer to Section 5).

NOTE

Heaters with control unit 1572D:
If the heater performs 8 subsequent attempts to start due to a malfunction, the heater enters an error lockout and stops any further attempts to start. This error lockout is superior to the normal error lockout condition.
The error lockout reset is achieved by switching the heater on and disconnection of the heater power supply within 120 sec. during run-down.

8.8.1 Water Circuit, Bleeding**NOTE**

Bleeding must always be performed in accordance with manufacturer's instructions. For bleeding the circulation pump must not be switched on.

Set vehicle own heating system to "warm" and replenish coolant which must consist of at least 20 % anti-freeze (on glycol base) (protection against corrosion). When using pure water there will be no protection against corrosion and due to the lower boiling point of the water when overheating loss of cooling water may result requiring continuous replenishment. Additives in the coolant must not affect metals, plastics or rubber and leave no deposits.

Then operate engine at increased idle until radiator thermostat opens. Shut down engine, check coolant level and replenish as required.

Switch on heater and vehicle heating fan with engine shut down. After a certain cool-down period the heater must automatically switch on and control to off. In case of no restart attempt the temperature limiter on the heater has responded because the heater has not been bled properly. Reset temperature limiter (push button on temperature limiter) and repeat complete bleeding procedure.

NOTE

The heater may be equipped with an automatically resetting temperature limiter. The manual reset is not necessary.

8.8.2 Fuel Supply System, Bleeding

When switching the heater on the fuel pump sucks fuel to prime the complete fuel supply system.

Should no combustion be achieved with the first start attempt, switch the heater off and on again.

9 Repair

9.1 General

This section describes the repairs that may be performed on the heaters *Thermo 230, 231, 300, 301* and *350* when removed. Any further disassembly will void the warranty. For re-assembly only components of the proper spare part kits are to be used.

WARNING

The igniter box operates on high voltage. The following components may also be replaced with the heater installed unless restricted space prevents access:

- temperature limiter
- temperature sensor
- combustion air fan
- burner
- igniter box
- flame sensor
- combustion chamber

Prior to replacement disconnect connectors of cable harness in vehicle to avoid lethal accidents.

Before replacing the temperature sensor also release pressure from cooling system by opening sealing element.

If required also allow heater to cool down.

9.1.1 Work on Components after Disassembly**CAUTION**

All gaskets located between disassembled components must always be replaced and discarded.

9.1.1.1 Visual Inspection, General

- Examine all components for damages (cracks, deformation, wear, etc.) and replace as necessary.
- Examine connectors and wiring for corrosion, loose contacts, wrong crimping, etc. and repair as necessary.
- Check terminals for corrosion and contacts for security. Repair as required.

9.1.1.2 Combustion Chamber, Visual Inspection

- Check swirl ring for security.
- Inspect combustion chamber for oxidizing and coke deposits and remove as required.
- Check welding seem for cracks.

NOTE

Longitudinal cracks up to 80 mm are allowed.

9.1.1.3 Heat Exchanger, Visual Inspection

- Inspect exhaust ducting in heat exchanger for sooting, deposits, damage and corrosion.

NOTE

Deposits are to be removed with water jet and brush.

- Inspect heat exchanger for exterior damage, deformation, etc.

NOTE

Heavy deformation may cause restricted flow of coolant.

CAUTION

When replacing the combustion chamber on heaters installed vertically, remove deposits in heat exchanger using a suitable tool.

9.1.1.4 Combustion Air Fan Wheel, Visual Inspection

- Check fan wheel for contamination and cracks.
- Check cover plate for security.
- Check slide lock for proper seating.

9.1.2 Incorporation of Modifications**NOTE**

Continuous enhancement of heater design is for optimizing performance and avoiding failures and malfunctions. Normally equipment in use may be retrofitted using available modification kits

The following modifications may be incorporated during repair procedures:

- installation of control unit 1572D as substitute for control unit 1572 (see 9.1.2.1)
- installation of circulation pump U 4851 or U 4852 as substitute for circulation pump U 4814 or U 4816 (see 9.1.2.2)

9.1.2.1 Installation of Control Unit 1572D as Substitute for Control Unit 1572

General

Due to the progress in the development of processors control unit 1572 can no longer be supplied. The retrofit of control unit 1572D is performed according to the following procedure:

The modification kit consists of:

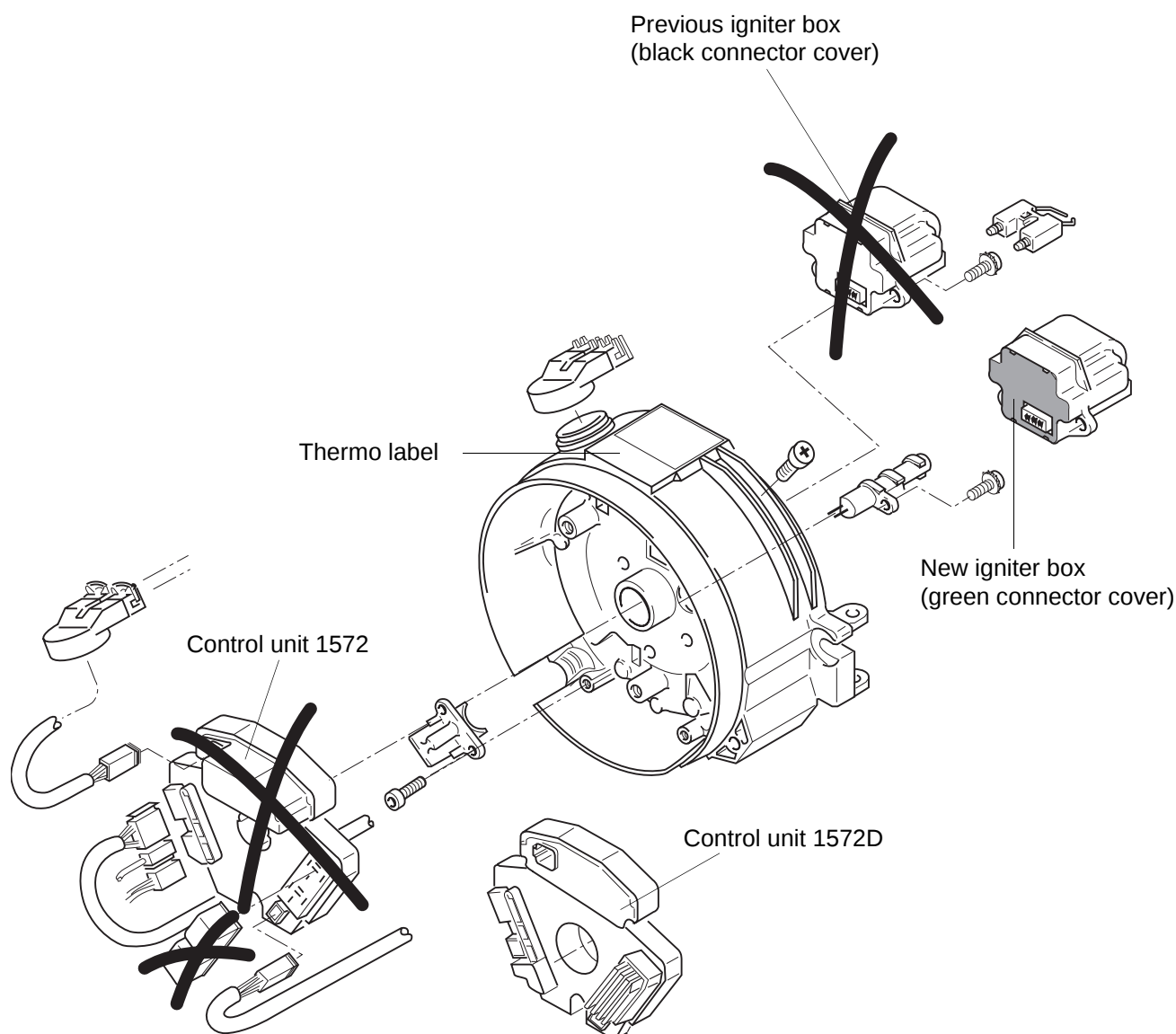
- control unit 1572D
- igniter box
- thermo identification label

Procedure

CAUTION

Control unit 1572D may only be used in combination with the igniter box delivered (green connector cover). The electrical connector is coded.

1. Remove control unit according to 9.2.5.1 and discard.
2. Remove igniter box according to 9.2.7.1 and discard.
3. Install new igniter box according to 9.2.7.2.
4. Install new control unit according to 9.2.5.2.
5. Apply new thermo label onto existing label to indicate retrofit.



9.1.2.2 Installation of Circulation Pump U 4851 or U 4852 as Substitute for Circulation Pump U 4814 or U 4816

General

Immediately from now on the circulation pumps U 4814 and U 4816 may be substituted by circulation pump U 4851 or U 4852 as required. The circulation pumps U 4851, U 4852 and U 4816 are compatible.

When exchanging circulation pump U 4816 the attachment parts (mount and hose clamp) may be re-used. An adaptation of the water connection is not necessary. The same applies for compact units.

When exchanging circulation pump U 4814 observe the following:

- The existing mount and hose clamp must be removed and discarded. Installation must be performed using a new mount and hose clamp.
- When mounting the circulation pump near to a wall the new mount must be attached so that there is a clearance of 60 mm to the wall (reference line: circulation pump centerline). If required the new mount must be relocated in relation to the old mount.
- Hose connections must be adapted.
- If the circulation pump is mounted into a compact unit, the exchange procedure is difficult and must be checked if practicable.
- The modification cannot be performed when water stations Starliner and Cityliner and involved.

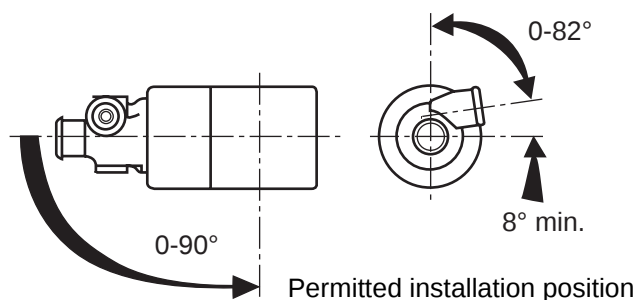
Procedure, circulation pump U 4851

CAUTION

When installing circulation pump U 4851 the following information must be strictly observed to avoid loss of warranty.

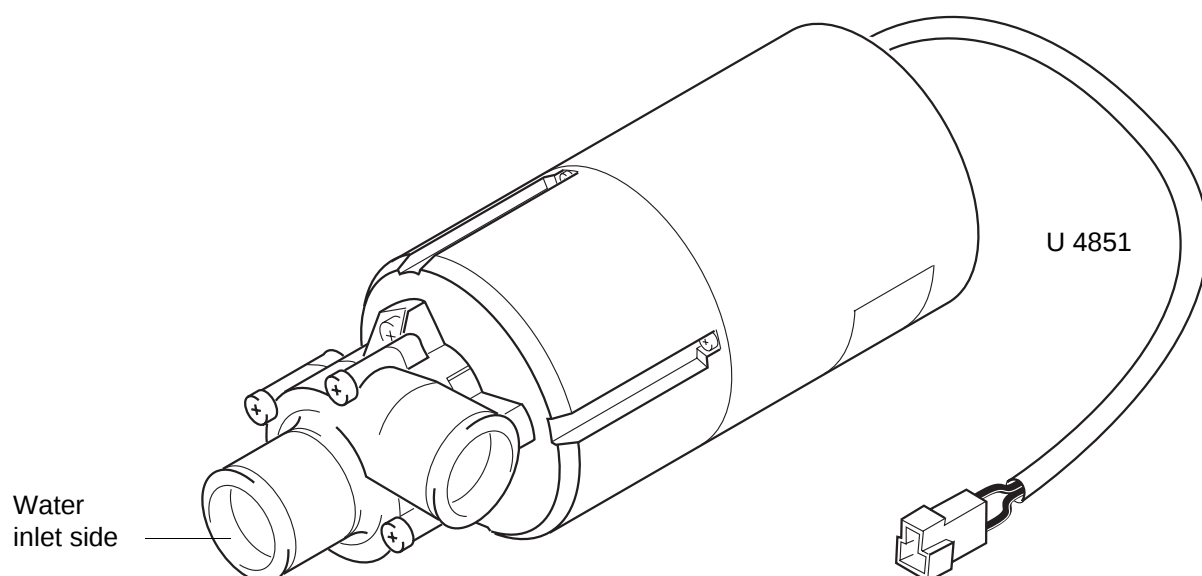
NOTE

- The circulation pump is not self-venting. Therefore the pump has to be installed at the lowest point of the water circuit observing the permitted pump orientation (see Fig.).
- The hoses must be installed routed upwards free of kinks. Hose connections must be secured against slippage with hose clamps. The hose clamps must be torqued to 1.5 Nm.
- On the water inlet side of the pump no solenoid valves or other shut-off devices must be installed allowing closure during pump operation. The same applies for filters which may clog.
- Prior to first operation of the circulation pump the vehicle cooling system and the pump body must be bled.



CAUTION

Improper bleeding or a dry run of the pump causes damage to the slip ring gasket. Proper venting is indicated by the pump operating almost noiseless.



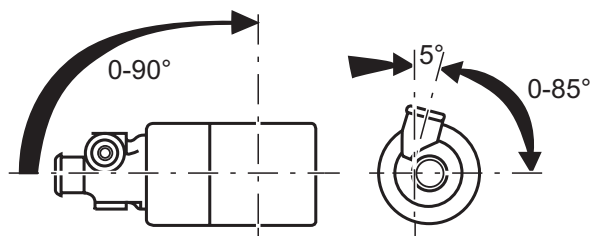
Procedure, circulation pump U 4852**CAUTION**

When installing circulation pump U 4852 the following information must be strictly observed to avoid loss of warranty.

NOTE

- Different to pump U 8451, U 8452 is to be installed in a vertical position, so that the pump head is located above the motor.
- The circulation pump is not self-venting. Therefore the pump has to be installed at the lowest point of the water circuit observing the permitted pump orientation (see Fig.).
- The hoses must be installed routed upwards free of kinks. Hose connections must be secured against slippage with hose clamps. The hose clamps must be torqued to 1.5 Nm.
- On the water inlet side of the pump no solenoid valves or other shut-off devices must be installed allowing closure during pump operation. The same applies for filters which may clog.

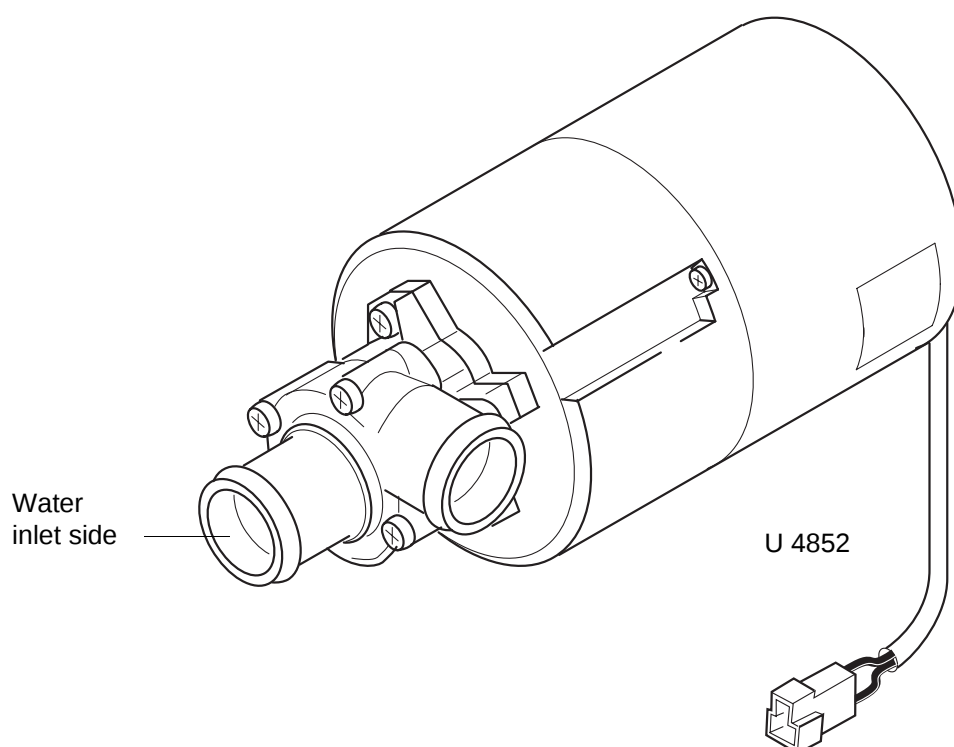
- Prior to first operation of the circulation pump the vehicle cooling system and the pump body must be bled.
- The circulation pump includes no parts subject to wear. A motor replacement in some cases is also possible without removal of the pump head.



Permitted installation position

CAUTION

A dry run of the circulation pump is permitted up to 15 minutes. Proper bleeding may be verified by almost noiseless operation of the pump.



9.2 Disassembly and Assembly

9.2.1 Temperature Limiter, Replacement

9.2.1.1 Removal

1. Disconnect electrical connection to temperature limiter.
2. Withdraw rubber cap. Using screw driver lever off retaining spring and remove temperature limiter (1, Fig. 901).

9.2.1.2 Installation

1. Slide rubber cap of temperature limiter (1, Fig. 901) back until temperature limiter can be located for installation.
2. Position temperature limiter (1) in connector (3) and push in retaining clip.

NOTE

Make sure to feel retaining spring engage in groove to ensure proper installation position of the temperature limiter.

3. Fit rubber cap.
Connection cables must not be routed over reset button.

NOTE

Observe electrical wiring color coding when making connections to temperature limiter.

4. Make electrical connections.

9.2.2 Temperature Sensor, Replacement

9.2.2.1 Removal

1. Disconnect electrical connection to temperature sensor.

WARNING

Prior to replacement of temperature sensor in installed condition relief overpressure in cooling system by opening the cooling circuit sealing element.

If required also allow heater to cool down and have collector vessel ready to collect escaping coolant.

2. Unscrew temperature sensor (2, Fig. 901) and remove.

9.2.2.2 Installation

1. Manually screw temperature sensor (2, Fig. 901) into coolant outlet (4).
2. Torque temperature sensor to 20 Nm +5 Nm.
3. Restore electrical connections.

NOTE

Observe electrical wiring color coding when making connections to temperature sensor.

9.2.3 Burner, Replacement

9.2.3.1 Removal

1. Disconnect electrical connections on burner and loosen fuel lines.
2. Loosen nuts (6, Fig. 901) until hinge bolts are free.
3. Swing hinge bolts (7) open and remove cotter pin (5).
4. Remove burner (8).
5. Perform procedures on components after disassembly (refer to 9.1.1).

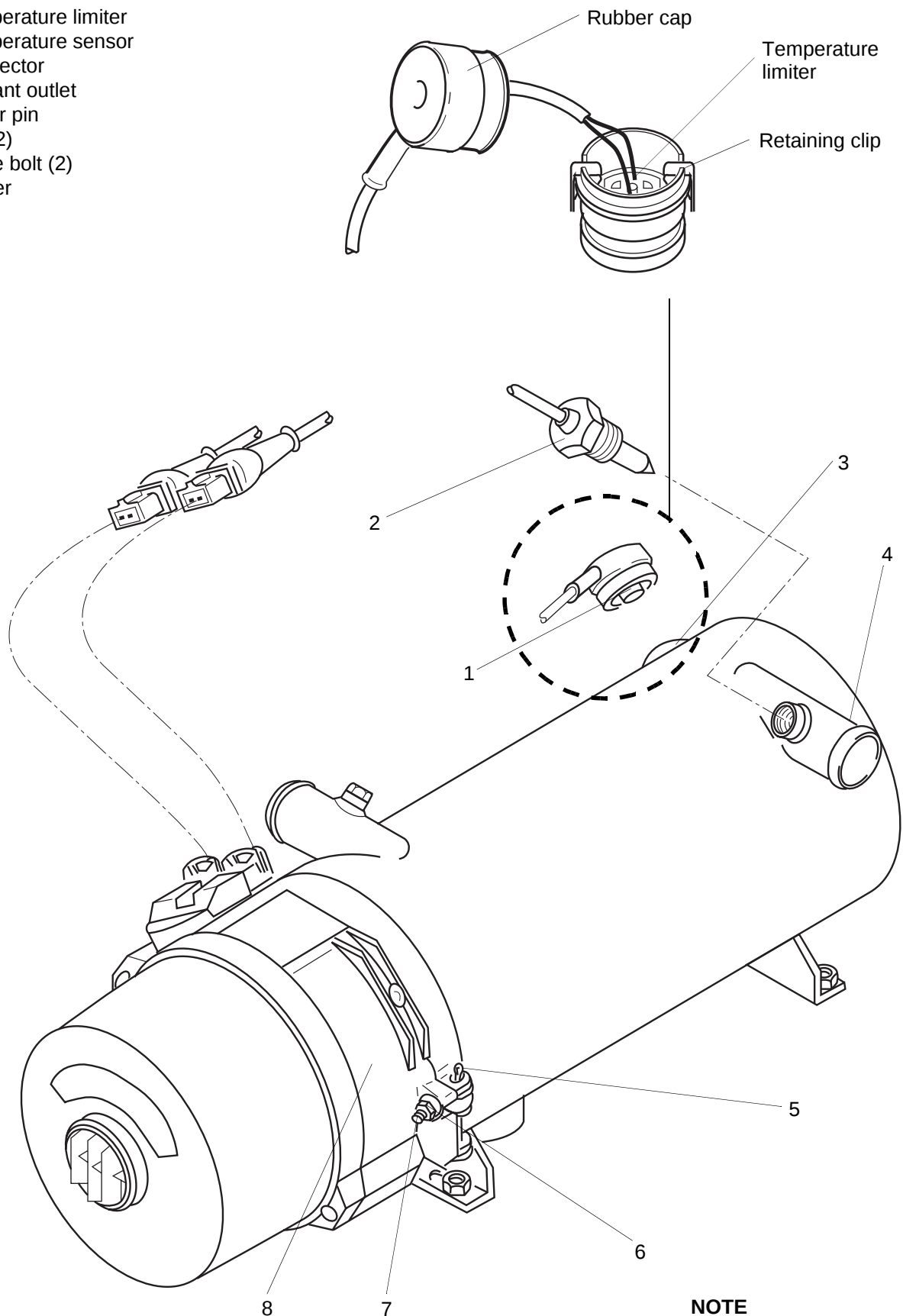
9.2.3.2 Installation

1. Position burner (8, Fig. 901) for installation, swing hinge bolts closed and secure temporarily using screws (6).
2. Insert cotter pin (5) according to the intended opening swing direction.
3. Tighten nuts (6) with 7.5 Nm + 1 Nm.
4. Connect fuel lines.
5. Restore electrical connections.

NOTE

Observe electrical wiring color coding when making connections to temperature limiter and temperature sensor.

- 1 Temperature limiter
- 2 Temperature sensor
- 3 Connector
- 4 Coolant outlet
- 5 Cotter pin
- 6 Nut (2)
- 7 Hinge bolt (2)
- 8 Burner



NOTE

Cotter pin (5) may be fitted on other side as required for burner head to swing open in opposite direction.

Fig. 901 Temperature Limiter, Temperature Sensor and Burner, Replacement

9.2.4 Combustion Air Fan, Replacement

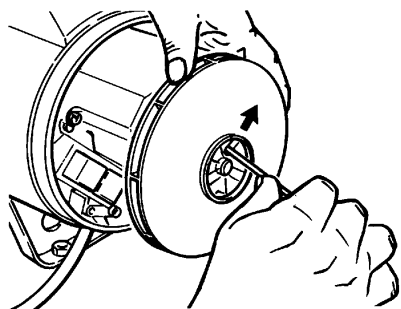
NOTE

For replacement of the combustion air fan the burner may be left installed.

In removed condition ensure that igniter electrodes are not bent and nozzle is not damaged.

9.2.4.1 Removal

1. Loosen screws (3, Fig. 902) and withdraw cap (2) from burner.
2. Using suitable tool (e.g. mandrel 3 mm) open slide lock (5) until fan wheel can be pulled off.
3. Disconnect electrical connector (9).
4. Remove screws (6) with lock washers and withdraw fan motor (7).
5. Perform procedures on components after disassembly (refer to 9.1.1).



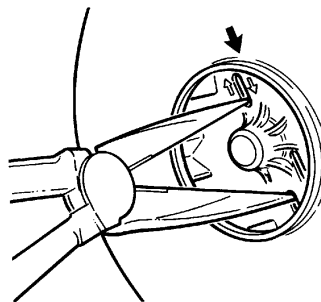
Opening slide lock

9.2.4.2 Installation

NOTE

Fan motor (7, Fig. 902) to be aligned with control unit (recess in mounting flange) and with clutch (by rotating drive shaft).

1. Align fan motor (7) and position for installation.
2. Attach fan motor using screws (6) and lock washers.
3. Tighten screws with 5 Nm + 1 Nm.
4. Connect electrical connector (9).
5. Bring slide lock (5) on fan wheel in installation position.
6. Slide fan wheel onto drive shaft and using suitable tool (e.g. mandrel 3 mm or pliers) close slide lock until fan wheel is locked.
7. Locate cap (2) and secure with screws (3).
8. Tighten screws with 2 Nm.



Closing slide lock

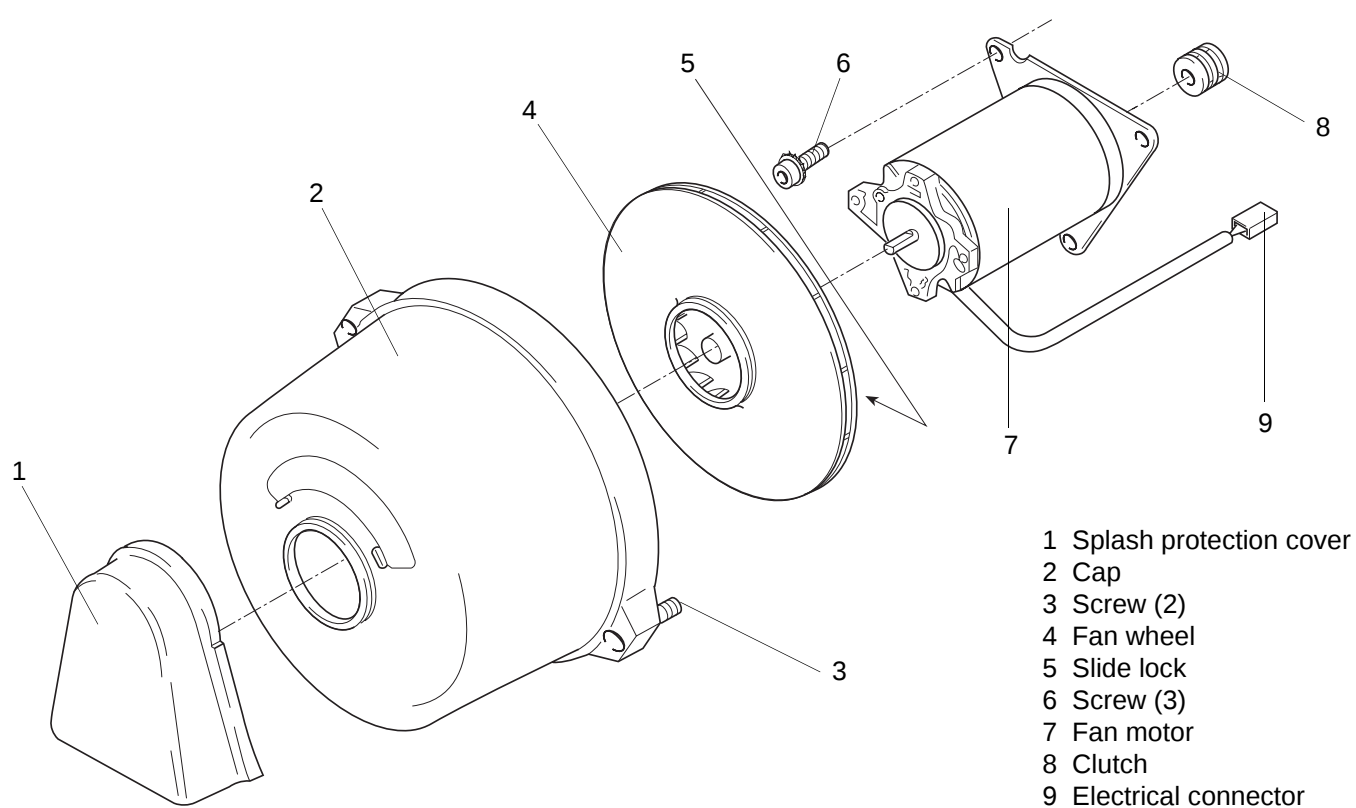


Fig. 902 Combustion Air Fan, Replacement

9.2.5 Control Unit, Replacement

NOTE

For replacement of the control unit the burner head may be left installed and must only be swung open for disconnection of electrical connector (8, Fig. 903). In removed condition ensure that igniter electrodes are not bent and nozzle is not damaged. If a control unit 1572 is substituted with a control unit 1572D, perform procedure according to 9.1.2.1.

9.2.5.1 Removal

1. Disconnect all electrical connections from control unit (23, Fig. 903).
2. Remove flame sensor (refer to 9.2.8.1).
3. Remove combustion air fan (refer to 9.2.4.1).
4. Swing burner head open (refer to 8.5.1) and disconnect electrical connector (8).
5. Carefully withdraw control unit (23) in axial direction from burner head (17) and remove.
6. Perform procedures on components after disassembly (refer to 9.1.1).

9.2.5.2 Installation

1. Carefully push control unit (23, Fig. 903) in axial direction against stop into burner head (17).
2. Install combustion air fan (refer to 9.2.4.2).
3. Make all electrical connections on control unit (23).
4. Install flame sensor (refer to 9.2.8.2).
5. Connect electrical connector (8).

9.2.6 Fuel Pump, Replacement

9.2.6.1 Removal

1. Remove burner (refer to 9.2.3.1).
2. Using screwdriver lever off igniter electrodes (1, Fig. 904) from igniter box (2) and remove.
3. Remove disk (6, Fig. 903) with heating cartridge (if installed).
4. Disconnect electrical connector (8).

NOTE

During the following step ensure that escaping fuel is immediately neutralized and properly disposed of.

5. Remove screws (9) with lock washers.
6. Withdraw fuel pump (10) together with solenoid valve (7) and remove.
7. Remove and discard O-rings (12) and filter screen (11).
8. Remove solenoid valve (7) from fuel pump (10) as required.
9. Perform procedures on components after disassembly (refer to 9.1.1).

9.2.6.2 Installation

1. Install solenoid valve (7, Fig. 903) on fuel pump (10) if required.
2. Fit new O-ring (12) and filter screen (11) on fuel pump (10).
3. Position fuel pump (10) for installation and secure with screws (9) and lock washers.
4. Tighten screws with 5 Nm + 1 Nm.
5. Connect electrical connector (8).
6. Plug on disk (6) and mount heating cartridge.
7. Plug on igniter electrodes (1, Fig. 904).
8. Install burner (refer to 9.2.3.2).

9.2.7 High Pressure Nozzle, Replacement

9.2.7.1 Removal

1. Remove burner (refer to 9.2.3.1).
2. Using screwdriver lever off igniter electrodes (1, Fig. 904) from igniter box (2) and remove.
3. Remove disk (6, Fig. 903) with heating cartridge (if installed).
4. Disconnect electrical connector (8).
5. Unscrew high pressure nozzle (4).

9.2.7.2 Installation

1. Screw in high pressure nozzle (4, Fig. 903) and tighten with 20 Nm.
2. Connect electrical connector (8).
3. Plug on disk (6) and mount heating cartridge.
4. Plug on igniter electrodes (1, Fig. 904).
5. Install burner (refer to 9.2.3.2).

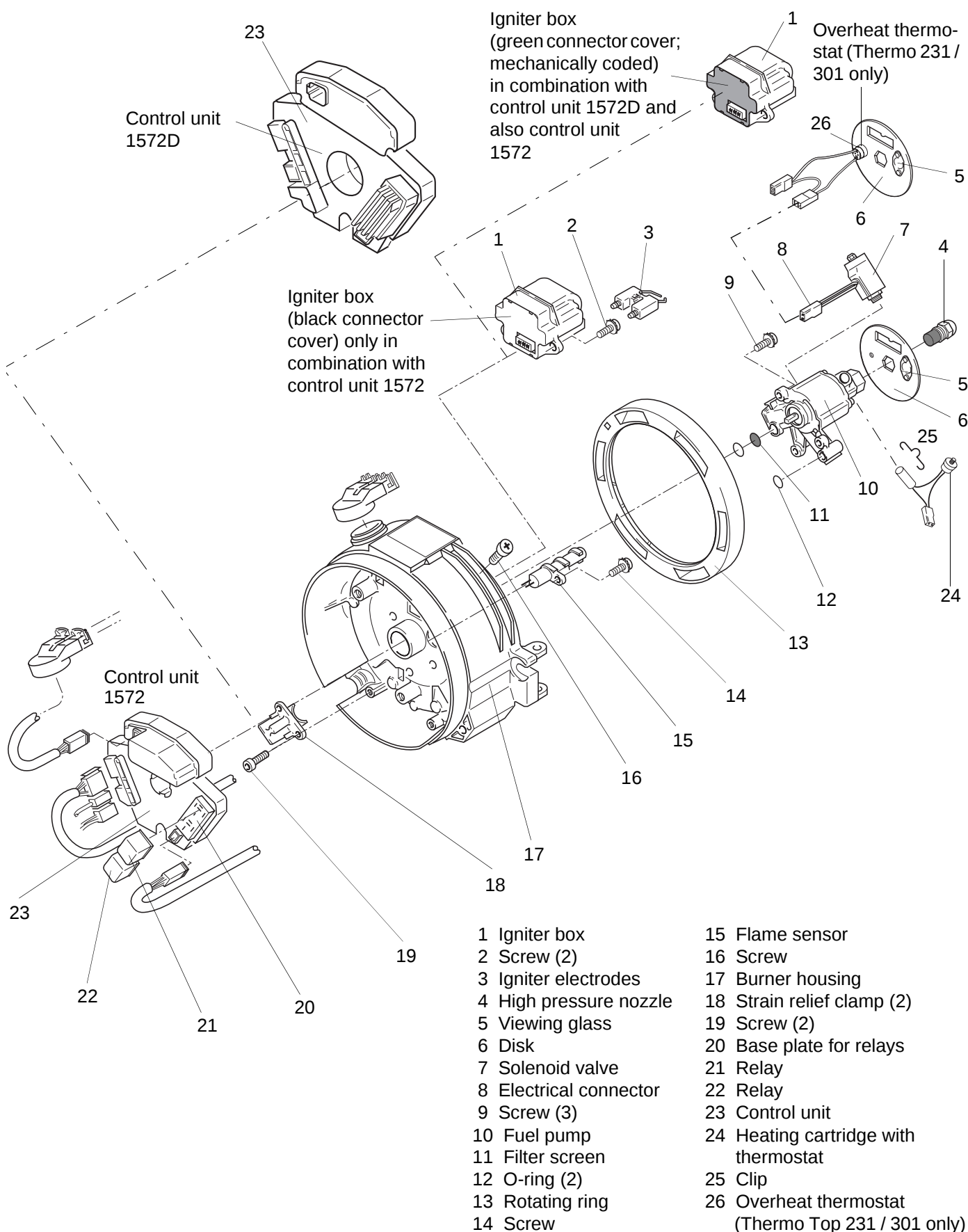


Fig. 903 Control Unit and Fuel Pump, Replacement

9.2.8 Igniter Box, Replacement

9.2.8.1 Removal

1. Remove burner if required (refer to 9.2.3.1).
2. Using screw driver lever off igniter electrodes (Fig. 904) from igniter box and remove.
3. Remove disk (6).
4. Remove screws (2) with lock washers.
5. Withdraw igniter box (1) and remove.
6. Perform procedures on components after disassembly (refer to 9.1.1).

9.2.8.2 Installation

1. Locate igniter box (1, Fig. 904) for installation, plug on making correct electrical connections and secure with screws (2) and lock washers.
2. Tighten screws (2) with 5 Nm + 1 Nm.
3. Plug on disk (6) and align.
4. Plug on igniter electrodes (3).
5. Install burner (refer to 9.2.3.2).

9.2.9 Flame Sensor, Replacement

9.2.9.1 Removal

1. Remove burner if required (refer to 9.2.3.1).
2. If required lever off igniter electrodes (Fig. 904) from igniter box using screw driver and remove.
3. Remove disk (6).
4. Remove screw (14) and lock washer.
5. Withdraw flame sensor (15) and remove.
6. Perform procedures on components after disassembly (refer to 9.1.1).

9.2.9.2 Installation

1. Position flame sensor (15, Fig. 904) for installation, plug on to make correct electrical connections and secure with screw (14) and lock washer.
2. Tighten screw (14) with 5 Nm + 1 Nm.
3. Plug on disk (6) and align.
4. Plug on igniter electrodes (3).
5. Install burner (refer to 9.2.3.2).

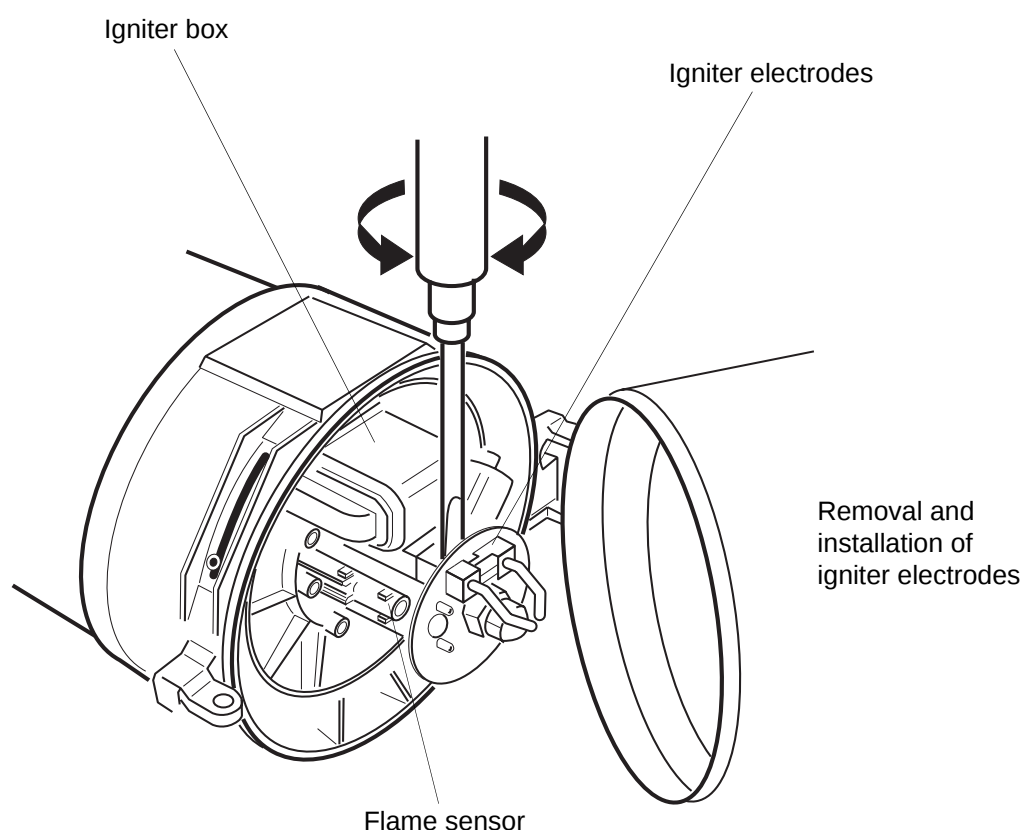


Fig. 904 Igniter Box and Flame Sensor, Replacement (Sheet 1 of 2)

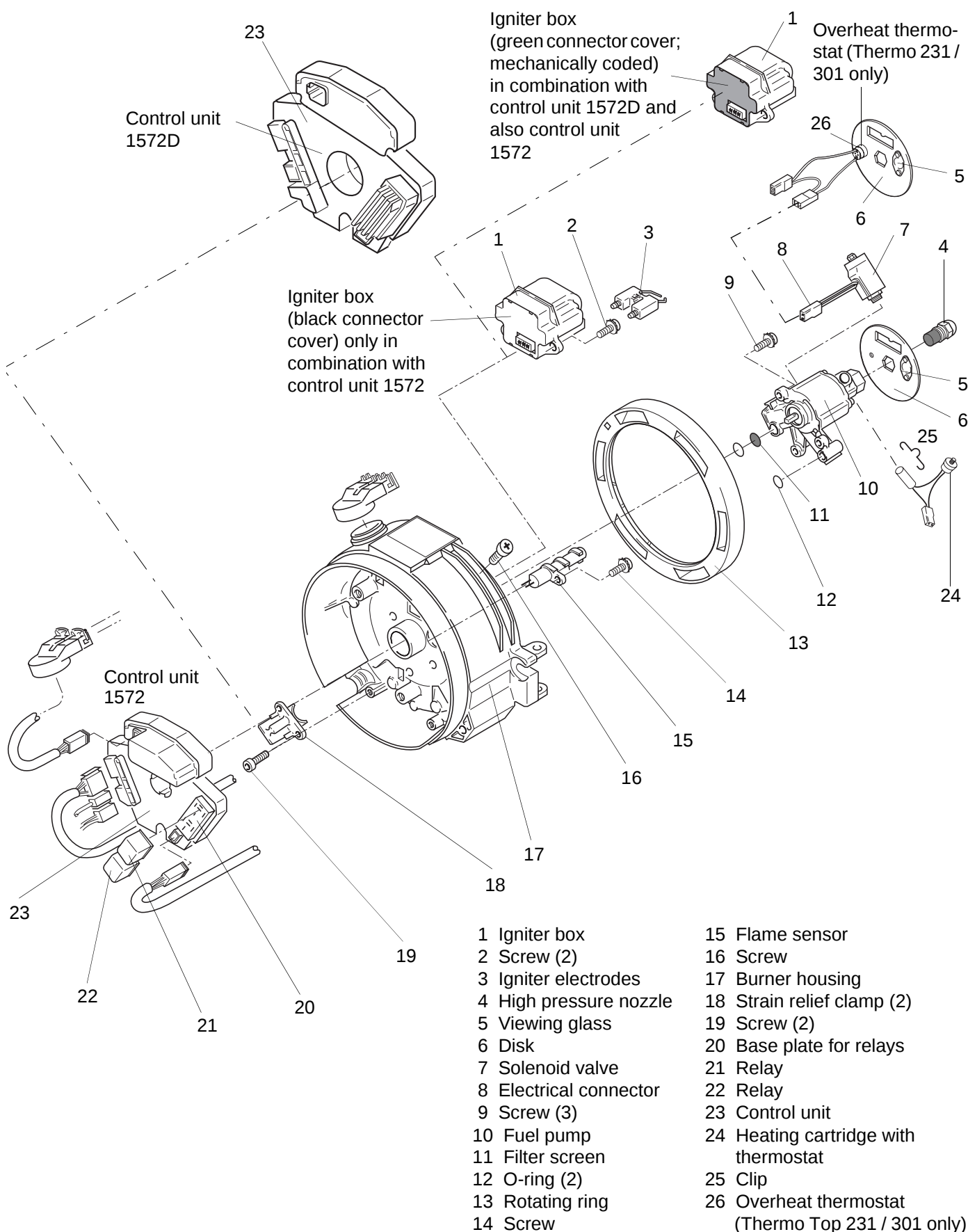


Fig. 904 Igniter Box and Flame Sensor, Replacement (Sheet 2 of 2)

9.2.10 Heat Exchanger, Replacement**9.2.10.1 Removal**

1. Remove temperature limiter (refer to 9.2.1.1).
2. Remove temperature sensor (refer to 9.2.2.1).
3. Remove burner (refer to 9.2.3.1).
4. Withdraw combustion chamber (1, Fig. 905) from heat exchanger (2).
5. Remove heat exchanger (2).
6. Perform procedures on components after disassembly (refer to 9.1.1).

9.2.10.2 Installation

1. Slide combustion chamber (1, Fig. 905) fully into heat exchanger (2) against stop.
2. Install burner (refer to 9.2.3.2).
3. Install temperature limiter (refer to 9.2.1.2).
4. Install temperature sensor (refer to 9.2.2.2).

9.2.11 Combustion Chamber, Replacement**9.2.11.1 Removal**

1. Disconnect electrical connections to temperature limiter and temperature sensor.
2. Swing burner open (refer to 8.5.1).
3. Withdraw combustion chamber (1, Fig. 905) from heat exchanger (2) and remove.
4. Perform procedures on components after disassembly (refer to 9.1.1).

9.2.11.2 Installation

1. Slide combustion chamber (1, Fig. 905) fully into heat exchanger (2) against stop.
2. Swing burner closed (refer to 8.5.1).

NOTE

Observe electrical wiring color coding when making connections.

3. Make electrical connections to temperature limiter and to temperature sensor.

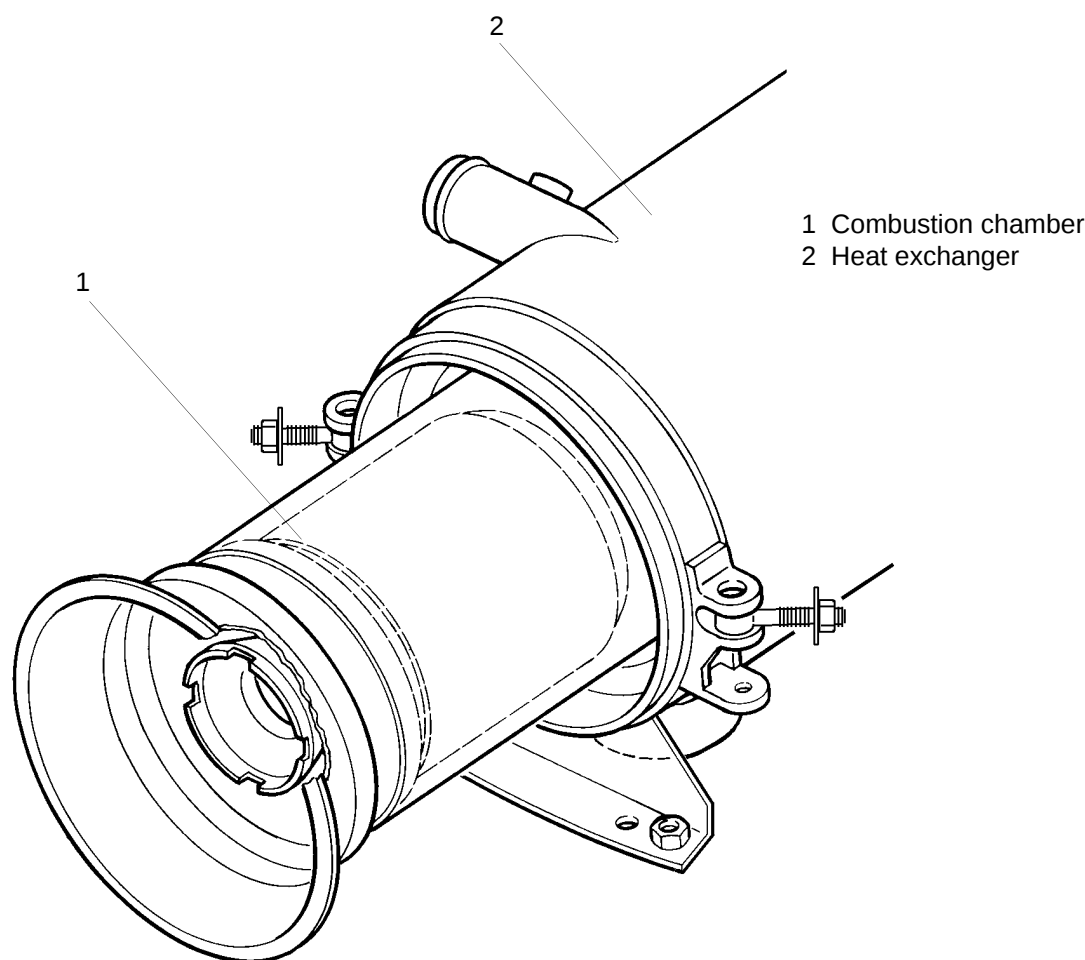


Fig. 905 Heat Exchanger and Combustion Chamber, Replacement

10 Packaging, Storage and Shipping

10.1 General

The heater or its components shipped to Webasto Thermosysteme GmbH for testing or repair must be cleaned and packaged so that they are protected against damage during handling, shipping and storage.

CAUTION

When shipping a complete heater assembly it must be drained completely. No coolant is allowed to escape when packaging or shipping.

Dummy plugs must be fitted to the coolant inlet and outlet as well as to the fuel lines.

In storage the ambient temperatures specified in Section 4 must not be exceeded.

Annex A

Scheduled Maintenance

Heater, Scheduled Maintenance

The heater should be checked in regular intervals at least at the beginning of the heating season (point of time when weather conditions cause increased use of heater).

Check / Maintenance	Important Notes	Check Result		Measured Values, Maintenance / Repair performed
		o.k.	not o.k.	
1. Electrical connections a) Disconnect electrical connectors to cable harness, inspect for oxidation, spray and reconnect after performing step 5. b) Inspect fuses for oxidation and/or check transition resistances.	Use suitable contact spray, e.g. special contact spray (order no. 101322).	☐	☐	
2. Heat exchanger a) Inspect paint for dark stains of burn (local overheating). b) Check for signs of leakage. c) Clean heater exterior and interior.	If necessary investigate reason for overheating (e.g. water circuit). Check temperature limiter.	☐ ☐ ☐	☐ ☐ ☐	
3. Fuel system a) Check fuel lines and connections for leaks. b) Replace fuel filter cartridge with gasket. c) If existing, open fuel shut-off cocks. d) Fuel pump. e) Replace fuel filter screen with gaskets in pump.	Check for tight connections in fuel supply and return! Retighten joints and hose clamps. Replace pump every 5 years.	☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐	
4. Burner head a) Check combustion air inlet for contamination. Swing burner head open: b) Check housing interior for accumulation of fuel caused by leaks. c) Clean viewing glass of flame sensor. d) Check igniter electrodes for condition. e) Replace nozzle.	Replace bent electrodes. When coked reduce replacement interval for fuel filter.	☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐	
5. Exhaust system a) Check exhaust line for contamination and clean as required. b) Remove combustion chamber from heat exchanger, inspect both components for damage and contamination and clean or replace as required. c) Insert combustion chamber and mount burner head. Check for secure connection to heat exchanger. d) Restore electrical connections.		☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	
6. Water system a) If installed, clean water filter. b) If installed, open water shut-off cocks.		☐ ☐	☐ ☐	
7. Functional checks a) If installed, open shut-off cock in return line. b) Check heater function. c) Check for smoke emissions in run-down; replace nozzle if required.	after at least 10 min. of heating operation.	☐ ☐ ☐	☐ ☐ ☐	