HEATING SYSTEMS

Thermo E+ 120
Thermo E+ 200
Thermo E+ 320

12/24V

Workshop manual

Rev. 03/2020
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Valeo

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1 Introduction

1.1 Content and purpose

This workshop manual is used during maintenance and repair of water heaters (further referred to as heaters) Thermo E+ 120, E+ 200 and E+320 in the 12V and 24V version, as well as in single-pipe and two-pipe version.

NOTE:
The Thermo E+ Installation Instructions contain an overview about the heater variants.

ATTENTION:
Work on the heater may only be performed by briefed and/or trained by Valeo personnel.

1.2 Effectivity of the workshop manual

The workshop manual applies to heaters listed on the title page of this document.
It may be subjected to modifications and amendments. The respectively currently effectife version is binding. This version can be found on the Valeo website under Service/ Downloads/Heating systems.

1.3 Meaning of highlighted content

Throughout this manual the emphasized words Warning!, Caution!, ATTENTION: and NOTE: used as follows:

Warning!	**Danger to life and health!**

This caption is used to indicate possible severe injuries or fatal accidents if instructions or procedures are carried out incorrectly or entirely disregarded.

Caution!	**Hazardous to health!**

This caption is used to indicate possible minor injuries if instructions or procedures are carried out incorrectly or entirely disregarded.

ATTENTION:

This caption points to actions which may cause material damage.

NOTE:
This caption is used to draw attention to an important feature.

1.4 Symbols

Symbol tightening torque value:
Identifies in graphics parts (eg nuts, bolts) that are to be mounted with a specific tightening torque. The torque values are shown at the symbol and are binding.

1.5 Further documentation to be used

The use of additional service literature is required. References are provided in the workshop manual at appropriate locations.
The following documents are to be used during work at the heaters:

- Operating and Service Instructions
- Installation Instructions
- Technical Information (TI)
- Spare Parts List
- Operating Instructions for the Diagnose Thermo Test, further referred to as DTT

1.6 Safety information and regulations

Basically, general accident pevention provisions and the valid industrial safety directions must be adhered to. "General Safety Regulations" which exceed the framework of these provisions are listed below. The specific safety regulations which affect the present manual are issued highlighted in the individual sections or procedures.

1.6.1 General safety regulations

Warning!	**Danger to life and health!**

Read the Thermo E+ Operating and Service Instructions before operating the heater for first time.

Familiarize yourself with the Thermo E+ Installation Instructions before you make any modifications to the existing heater installation.

NOTE:

The Thermo E+ Operating and Service Instructions contain safety instructions and regulations to be followed for safe operation of the heater.

The Thermo E+ Installation Instructions contain the statutory regulations and other safety hints and regulations for the proper installation of the heater.

1.6.2 Other safety information

1.6.2.1 Fuel systen

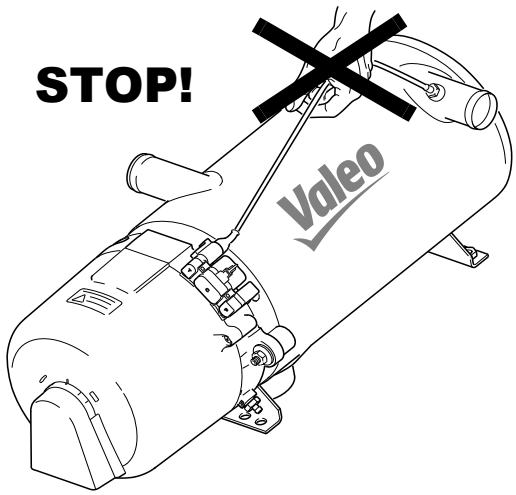
ATTENTION:

If there are signs of leakage in the fuel system (drops on the heater or under the vehicle), the cause should be analyzed and remedied before continuing operation of the heater.

1.6.2.2 Temperature sensors

ATTENTION:

The temperature sensors cable may not be mechanically stressed (pull on the cable, carry the heater at the cable etc.).



1.7 Suggestions for improvement and change

Please direct any complaints, improvement or modification suggestions regarding this manual to:

service-valeobus@valeo.com

2 Technical Data

Unless limiting values are defined, the technical data should be understood with tolerances of ±10% common for heaters at an ambient temperature of +20°C, and at nominal voltage.

Table 201 Technical Data

Heater		Thermo E+ 120	Thermo E+ 200	Thermo E+ 320
ECE Type Approval Number E1 122R 00		0539	0540	0541
Kind of construction		High pressure atomizer		
Heating flow (at ambient temperature of 20°C)	kW	12	20	32
Fuel		see para. 2.2		
Fuel consumption [1]	kg/h	1.2	2.0	3.2
Rated voltage	V =	12 / 24		
Operating voltage range	V =	10…15 / 20.5 ... 30		
Rated power consumption at 12/24 V [2]	W	45	55	110
Switching thresholds	°C	72 / 82		
Permitted temperature of sucked combustion air [3]	°C	-40…65 / 85		
Permitted ambient temperature during operation	°C	-40…85		
Permitted storage temperature	°C	-40...90		
Max. operating overpressure in coolant cycle	bar	2.0		
Capacity of the heat exchanger	l	1.4	1.8	1.8
Minimum coolant flow rate [4]	l/h	1200	2400	2700
Minimum capacity of the coolant cycle	l	10	25	
CO_2 in exhaust gas at rated voltage [5]	Vol %	10.6	9.5	10.0
Heater dimensions with splash guard, LxWxH	mm	438x249x224	593x249x224	
Weight	kg	13.5	17.3	
Diameter coolant connection	mm	25	38	
Diameter exhaust gas connection	mm	38	70	

1) at rated conditions (rated voltage, winter Diesel, 15 °C)
2) without circulating pump and heating element
3) When permanently above 65°C, a reduced service life is assumed (a combustion air intake temperature of 65°C should not be exceeded)
4) Minimum water flow at coolant temperatures above 50°C
Below 50°C a lower water flow is permitted, if the occurence of vapor bubbles due to local overheating safely can be excluded.
5) For further CO_2 values vs. voltage, see Cha. 7.

2.1 Electrical components

All components of the heater as well as the circulation pump and the timer are available in two versions which are designed for either 24 or 12 Volt nominal voltage. The voltage for the temperature sensor is regulated by the control unit.

NOTE:
Circulating pumps must be assigned to the heaters according to the nominal voltage and flow resistance in the coolant cycle.

2.2 Fuel

Suitable fuel is the diesel fuel specified by the vehicle manufacturer. Only the on the model plate of the heater specified fuel must be used.

The following table lists the by Valeo approved fuels and their specifications.

Fuel	Requirements acc.	Remarks
Summer Diesel	DIN EN 590	
Winter Diesel	DIN EN 590	
Arctic Diesel and Diesel for a strong winter climate	DIN EN 590	
Bio Diesel (FAME)*	DIN EN 14214	max. 20% see TI Fuels
Paraffinic diesel fuel from synthesis or hydro-genation (HVO)*	DIN EN 15940	only selected fuels see TI Fuels

* Further information on approved fuels contain the TIs (Technical Information) Biodiesel and Parafinic Diesel (HVO).
It can be found on the Valeo website under Service/ Technical-Updates-TI/Heating systems

In case of air temperatures below 0°C a commercially available winter Diesel fuel, at temperatures below -18°C a Diesel for arctic climate conditions must be used.

The usage of flow improvers respectively additives is permitted. There are no negative influences due to additives known.

ATTENTION:

While using the fuels, their operating limits must be considered and if necessary, suitable measures (nozzle preheating, electrical heated filter) should be applied.

If fuel is supplied from the vehicle tank, follow the vehicle manufacturer's instructions on additives.

3 Description of assemblies and components

The heaters Valeo Thermo E+ 120, E+ 200 and E+ 320 are used in conjunction with the vehicle heating system

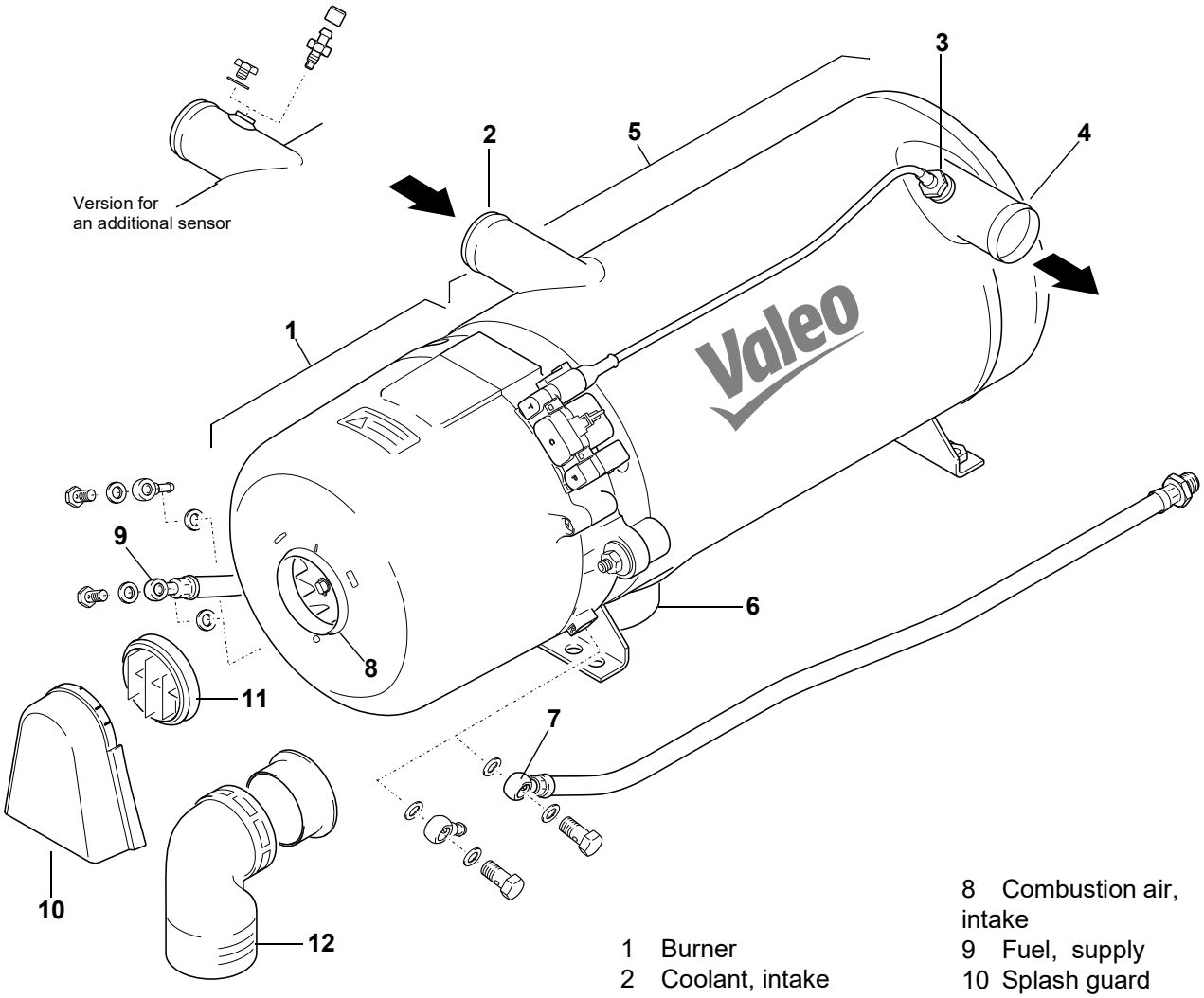
– to heat the passenger compartment
– to preheat water-cooled vehicle engines.

The heater operates independently from the vehicle engine and is connected to the cooling system, the fuel system and the electrical system of the vehicle. It is bolted down to the vehicle chassis or is secured using an additional cross beam.
Heat is generated by combustion of liquid fuels. Via the heat exchanger of the heater, the heat is dissipated to a coolant circuit. The adaptation to the changing demand of heat is reached by intermittent operation.
The control device controls on the basis of the signals of a temperature sensor the on and off switching of the burner.

The heaters of the Thermo E+ series basically consist of the main components:

– burner
– combustion chamber
– heat exchanger

External in the vehicle a circulation pump is installed or in case of a compact device directly on the heater.



1 Burner
2 Coolant, intake
3 Temperature sensors
4 Coolant, outlet
5 Heat exchanger
6 Exhaust outlet
7 Fuel, return
8 Combustion air, intake
9 Fuel, supply
10 Splash guard (grid alternative)
11 Grid
12 Intake air elbow incl. adapter (grid alternative)

Fig. 301 Heater overview

3.1 Burner

The burner consists of the components

- combustion air fan
- control device with flame guard
- fuel pump with solenoid valve
- fuel nozzle
- electronic ignition unit
- disc
- nozzle block preheater (optional)

3.1.1 Combustion air fan

The combustion air fan transports the air required for combustion from the combustion air intake to the combustion chamber.

The combustion air fan consists of the burner motor and the fan wheel. Air is drawn in through the air intake opening in the hood. This air intake opening is equipped with a splashguard, a protective grid or an intake air elbow.

To the three different heating capacity classes of the Thermo E+ series in the versions for 12V and 24V operating voltage different motors are assigned. This assignment is clearly beyond the material number. The motors must not be interchanged.

NOTE:
The positioning of the motor to the housing is safely defined by a pin and a hole (see Fig. 803).

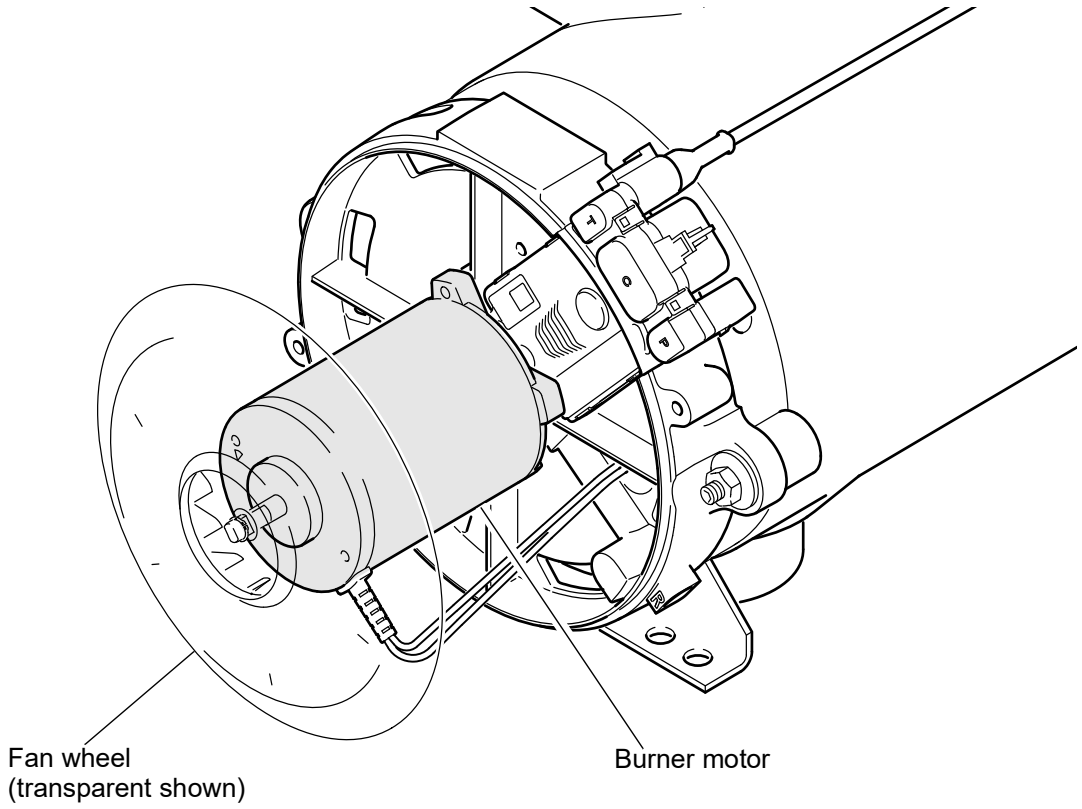
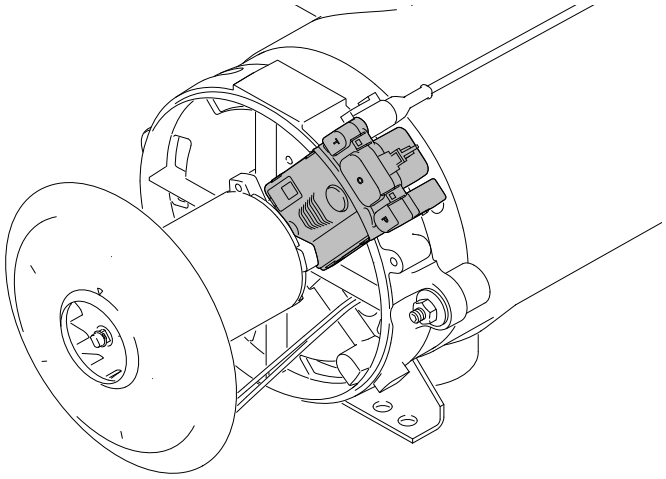


Fig. 302 Combustion air fan

3.1.2 Control device

The control device SG1590 ensures the operating sequence and burner operation monitoring.
In the control device the flameguard is integrated.



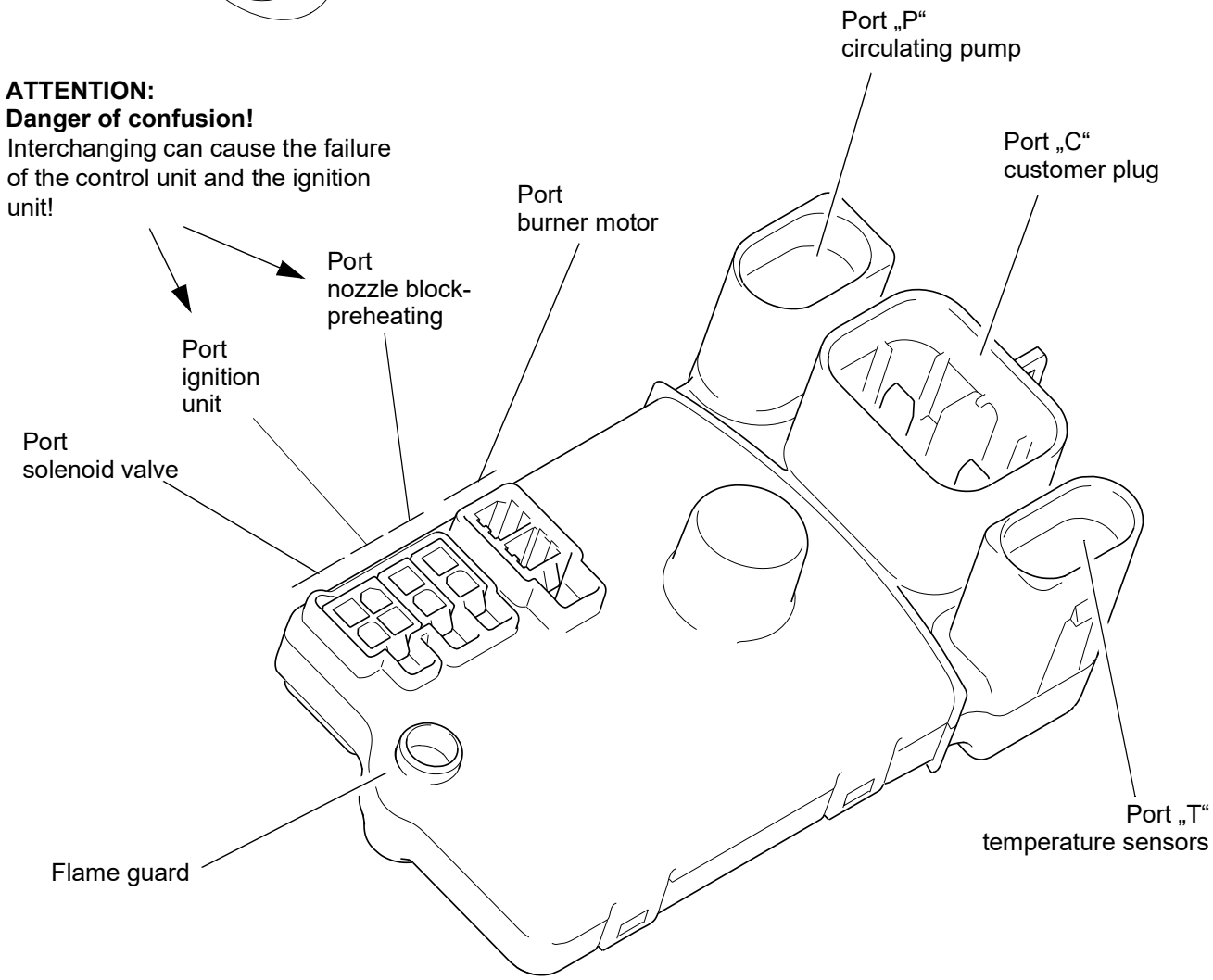


Fig. 303 Control device SG1590

3.1.2.1 Flame guard

The flameguard monitors the combustion flame condition during heater operation.
The flame guard is a photo transistor in the control device that changes its resistance depending on the flame brightness and in this way the applied to it voltage.

The light from the combustion chamber passes through the dust protection tube into the opening in the housing of the control device (see also Fig. 304) and thus to the photo transistor.
The dust protection tube is held by a spring between the control device and the disc.

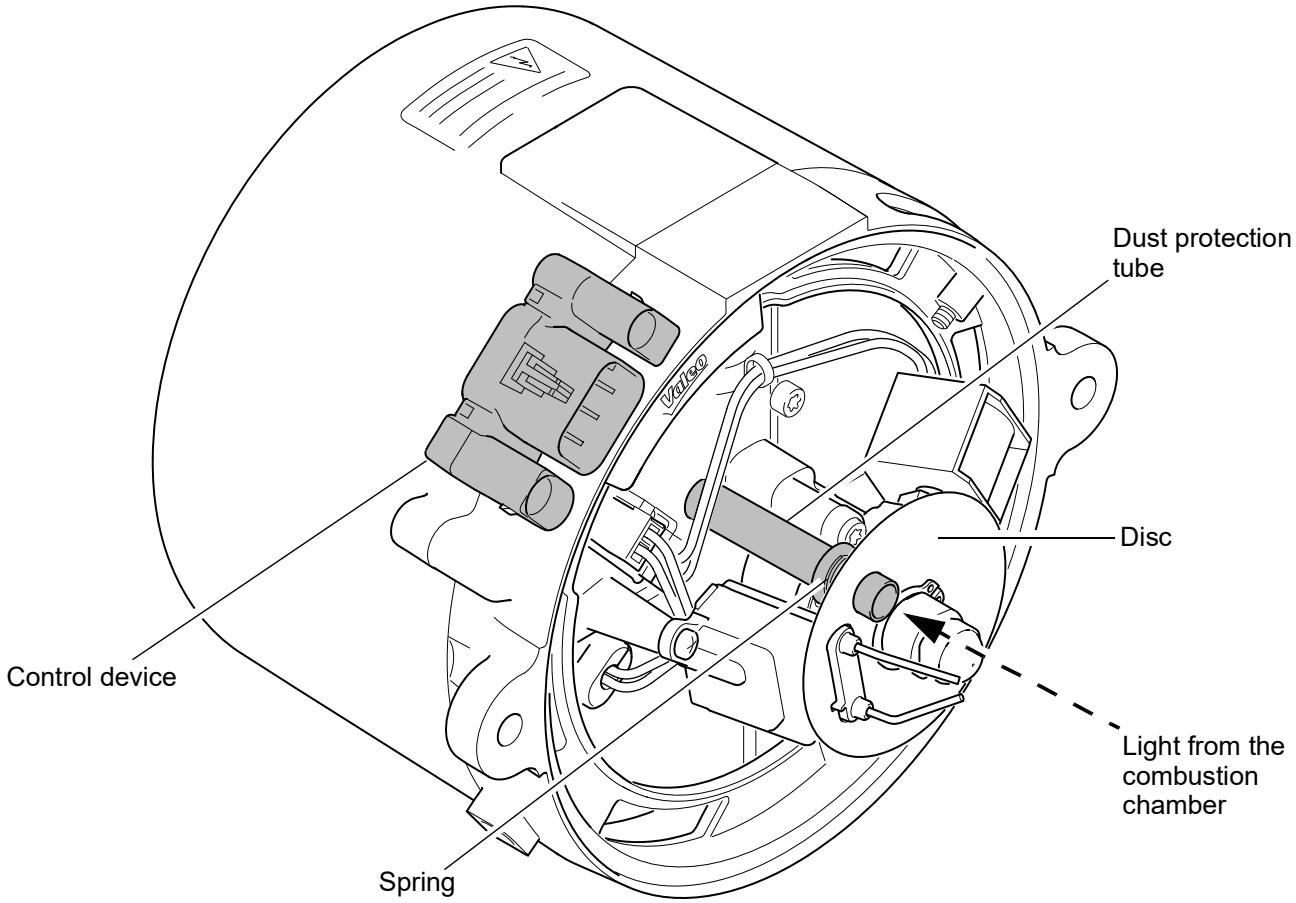


Fig. 304 Flame guard

3.1.3 Fuel pump with solenoid valve

The fuel pump is responsible for fuel supply.

The pump is driven by the burner motor via a coupling. Fuel is compressed in the fuel pump and atomized by the fuel nozzle.
The solenoid valve installed at the fuel pump opens and closes the fuel supply to the fuel nozzle.

Depending on the heating capacity class and the operating voltage, different fuel pumps are installed in the heaters.

3.1.4 Fuel nozzle

The fuel nozzle is screwed in the nozzle block of the fuel pump.
It is a high-pressure atomizing nozzle with filter element.

Each heating capacity class is a different fuel nozzle assigned..

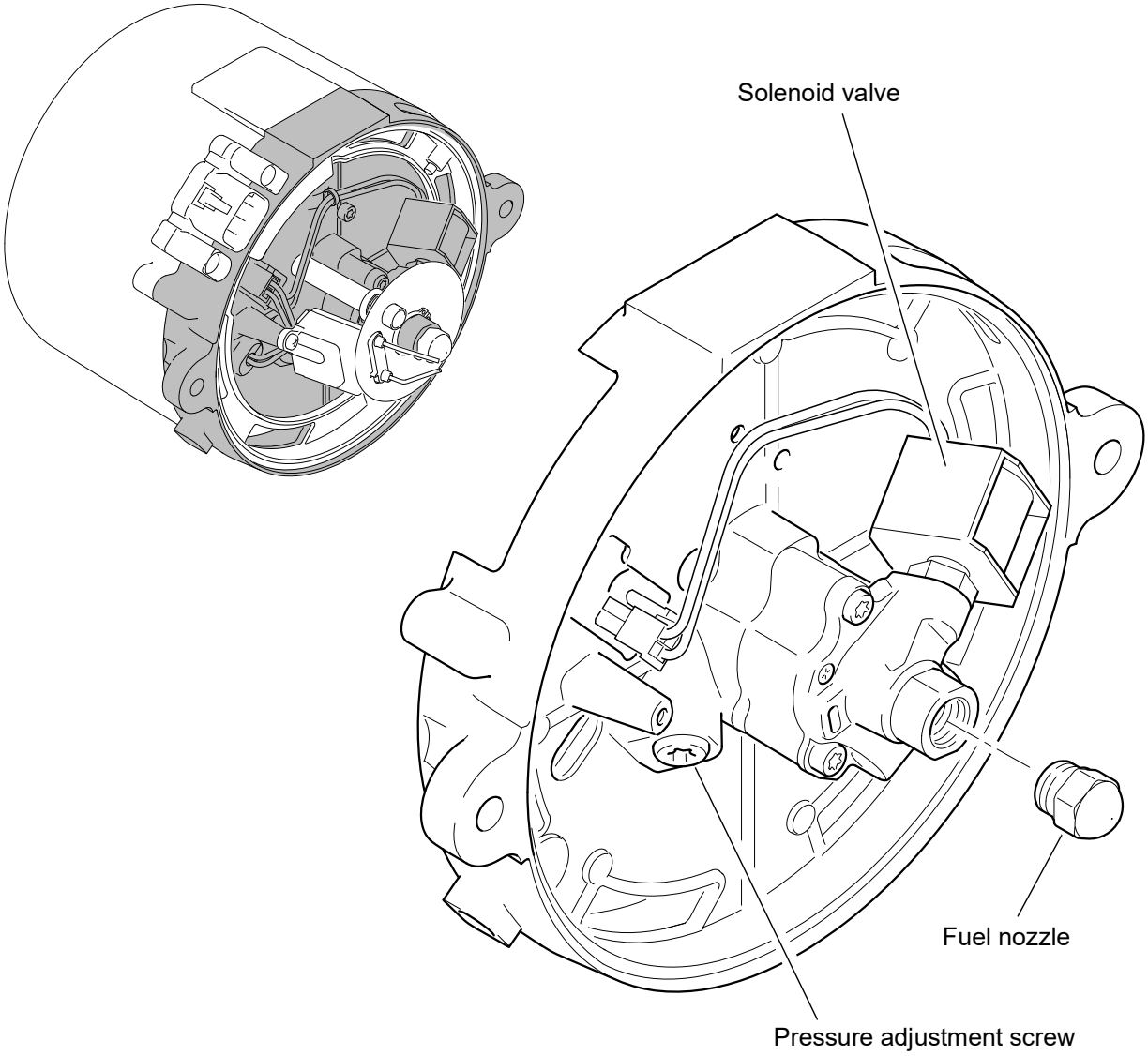


Fig. 305 Fuel pump with solenoid valve and fuel nozzle

3.1.5 Electronic ignition unit

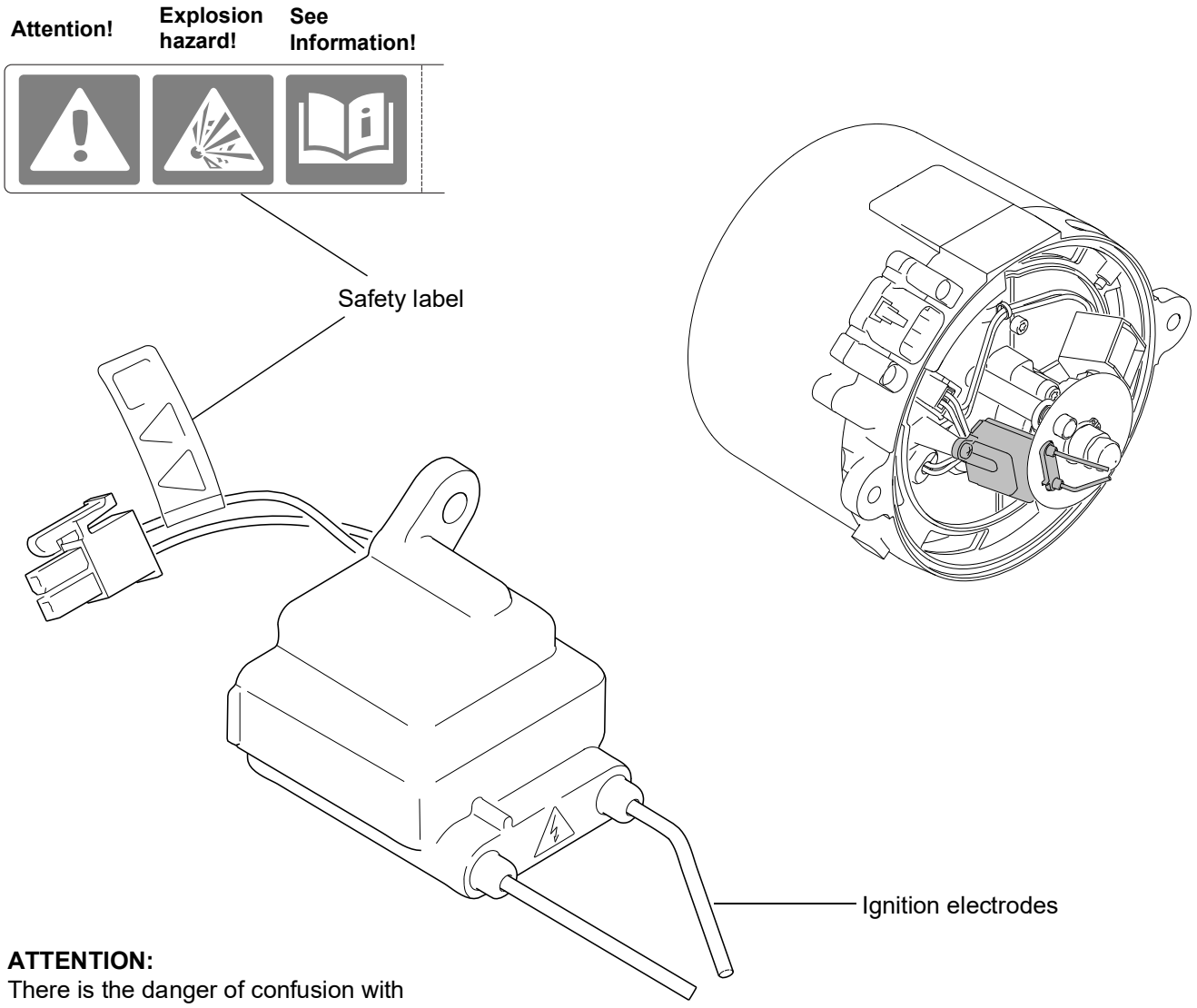
In the electronic ignition unit the high voltage required for ignition of the fuel-air mixture is induced.
For this it receives voltage pulses in a certain frequency from the control device.
Ignition is triggered by a high voltage spark, which is initiated on the ignition electrodes.

ATTENTION:
There are two different electronic ignition units. The wrong use can lead to the failure of the heater, so please pay attention to the correct use:

- use 11121236_ with the electronic control unit 11121234_ (12V) only
- use 11121237_ with the electronic control unit 11121235_ (24V) only

Warning!	**Explosion hazard!**

No voltage of any kind or duration may be applied to the ignition unit for test purposes. It may only be operated and tested together with the associated control device (component test).



ATTENTION:
There is the danger of confusion with the port of the nozzle block preheater when plug in (see Fig. 303).

Fig. 306 Electronic ignition unit

3.1.6 Nozzle block preheater

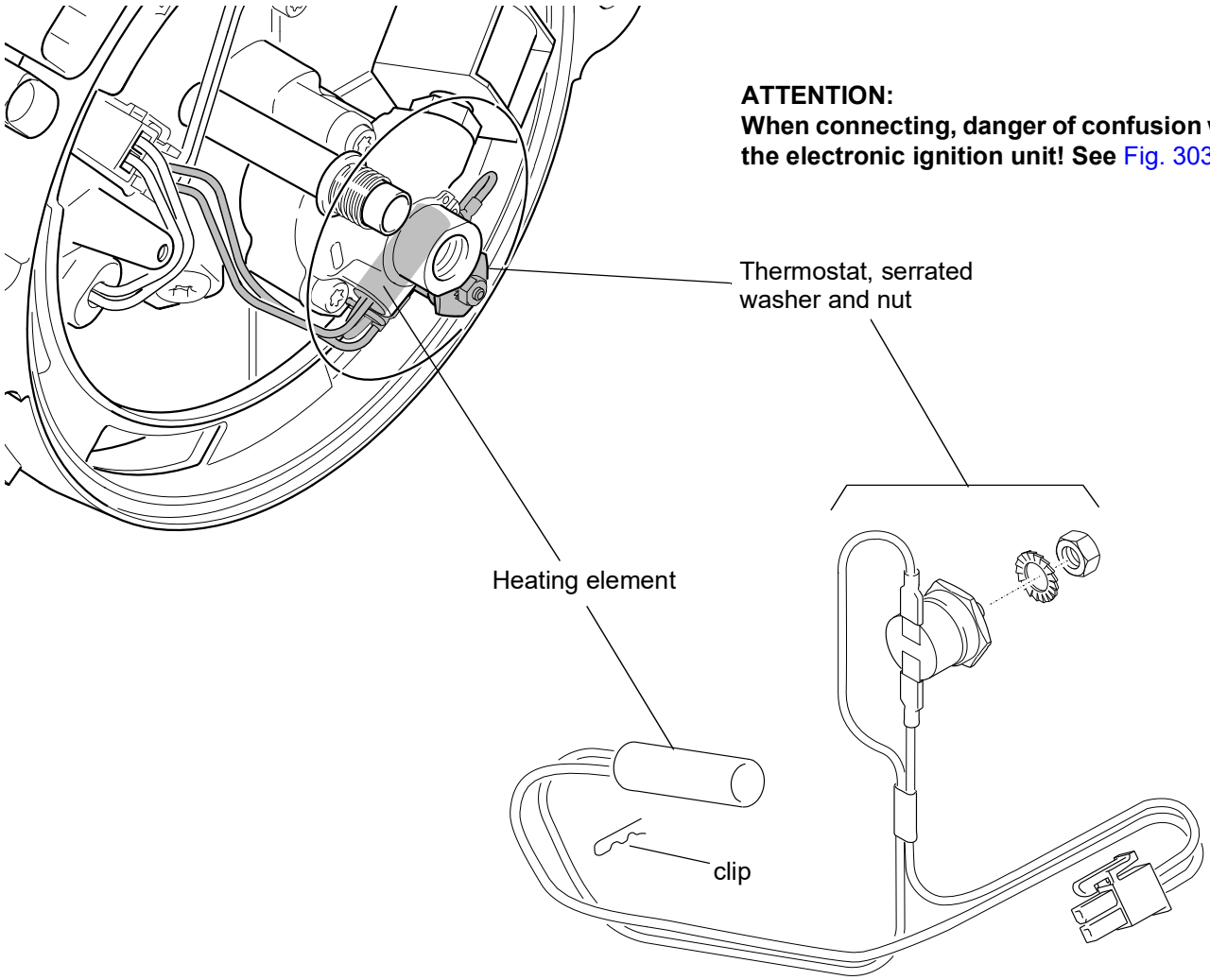
In case of very low temperatures fuel may exhibit severely modified viscosity. Due to insufficient fuel atomization functional heater malfunctions may occur.

Depending on the fuel used, these temperatures vary. When used in cold regions or if fuels different from diesel fuel are used, we recommend the use of a nozzle block preheater.
The nozzle block preheater consists of a heating element and a thermostat.
At a temperature below of 0°C the heating element heats the nozzle holder and thus, fuel and atomizer nozzle. Fuel viscosity is reduced and atomization improved.
The heating time depends on the temperature of intake air and the heat reflection from the combustion space. Above 8°C the thermostat switches off.

The use of the nozzle block preheater is optional. The retrofitting can be done without control device modification.

ATTENTION:
There are two different heating elements. The wrong use can lead to the failure of the heater, so please pay attention for ident. no. and label at the wiring harness of the nozzle block preheater:

- 11139457_ for devices with 12V, 12kW
- 11113972_ for all other variants



ATTENTION:
When connecting, danger of confusion with the electronic ignition unit! See Fig. 303**.**

Note:
In the graphic above, the disc is shown transparently and the fuel nozzle is omitted for clarity.

Fig. 307 Nozzle block preheater

3.1.7 Temperature sensors with water temperature sensor and integrated overheating protection

The water temperature sensor captures the coolant temperature at the heat exchanger outlet as electrical resistance.This signal is transmitted to the control device, where it is processed.

The overheating protection integrated into the temperature sensor is responsible for temperature limitation. As with the temperature sensor, the coolant temperature is captured at the heat exchanger outlet as electrical resistance and transmitted to the control device. Overheating protection prevents inadmissibly high heater operating temperatures.

At a temperature greater than 140°C heater deactivation and interlocking is initiated.

The cable between the plug and the temperature sensors is shorter with the Thermo E+ 120 than with the Thermo E+ 200/320.
All Thermo E+ temperature sensors have a red mark (see Fig. 308) on the cable.
They are not compatible with the other heaters manufactured by Valeo.

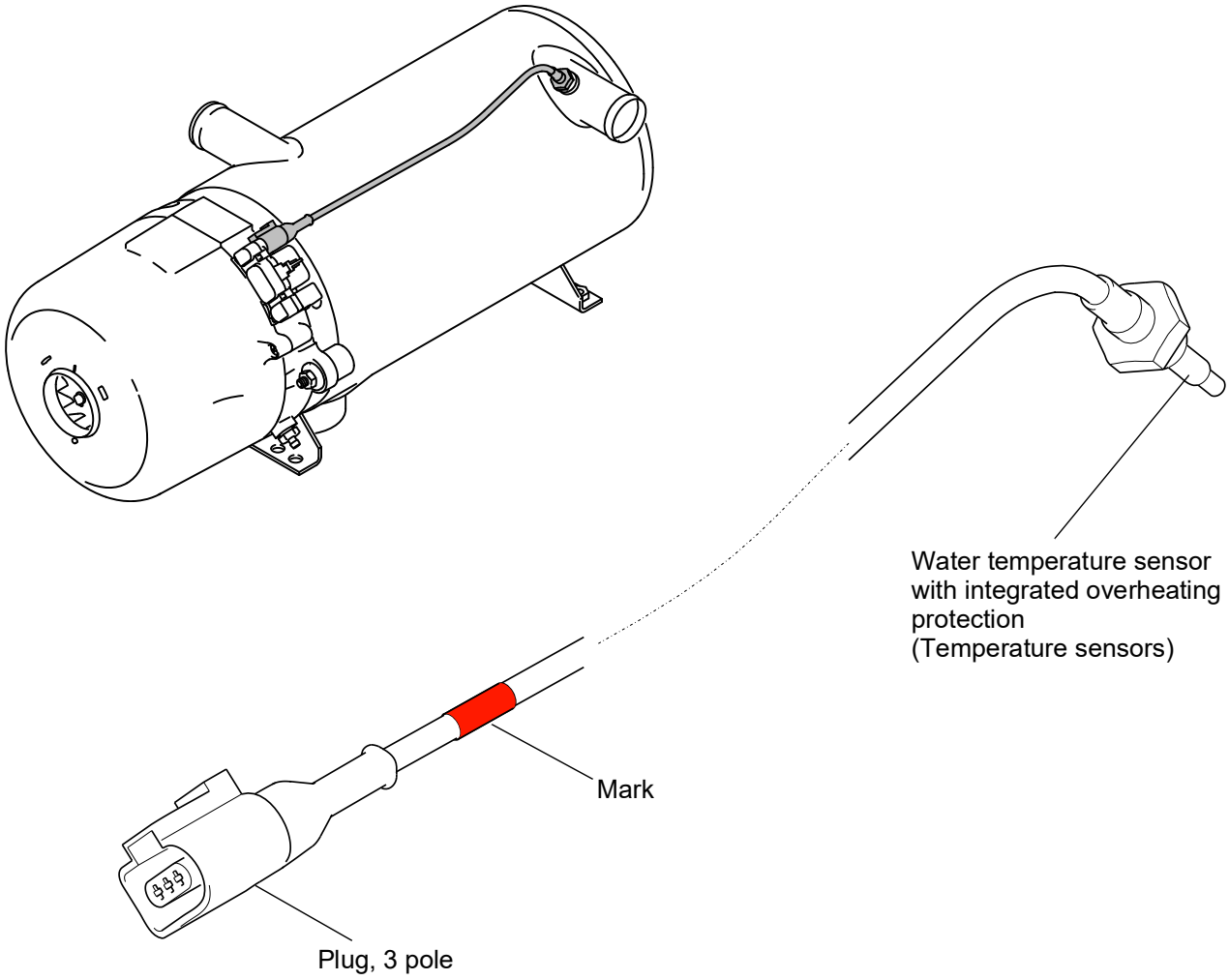


Fig. 308 Temperature sensors

3.2 Wärmeübertrager

The heat exchanger (Fig. 309) transfers the heat generated by combustion to the coolant circulation system.

The heat exchanger of the Thermo E+ 120 is shorter than that of the Thermo E+ 200/320.

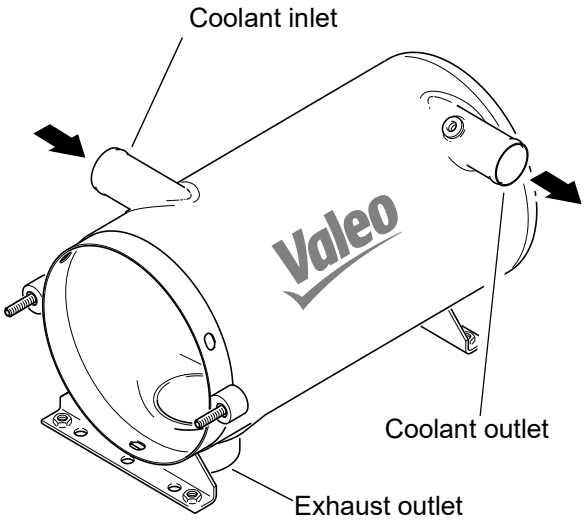


Fig. 309 Heat exchanger (exemplary)

3.3 Combustion chamber

The combustion chamber (Fig. 310) is used for generation and combustion of the fuel air mixture. The generated hot exhaust gas heats the coolant flowing through the heat exchanger.

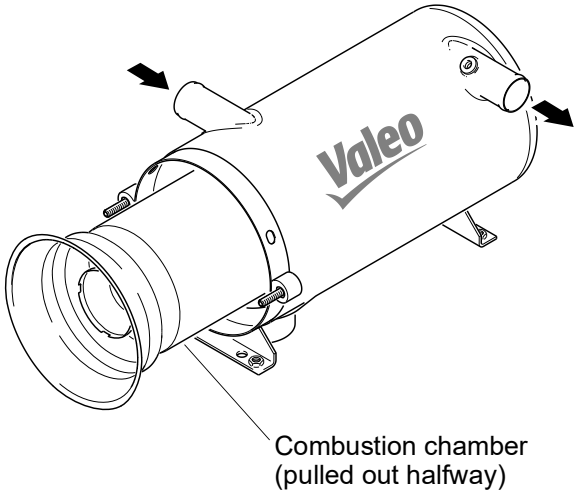


Fig. 310 Combustion chamber

In the heaters are used different combustion chambers depending on the heating capacity class. They differ in length and the swirl plates (see figure below).
The combustion chamber of the Thermo E + 120 has additional a thermal insulation. The combustion chambers are provided with an embossing of the identifier of the respective associated heater

ATTENTION:

The operation of the heater with a combustion chamber of another heating capacity class is prohibited.

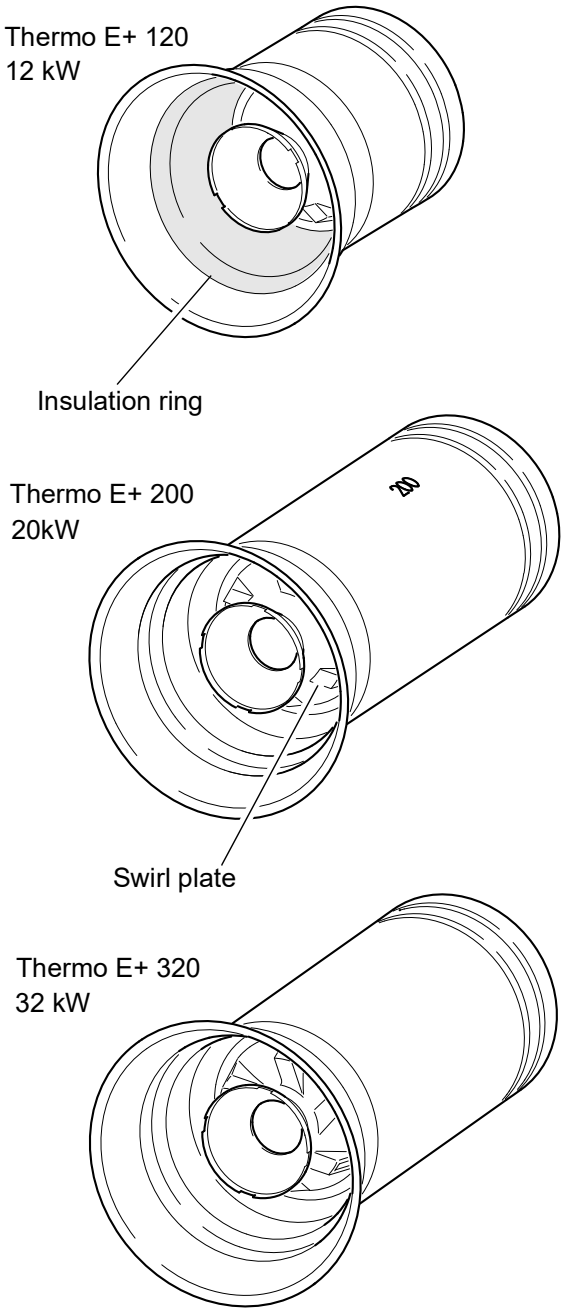


Fig. 311 Combustion chambers of the heating capacity classes

3.4 Circulating pump

The externally arranged circulating pump ensures coolant transport within the vehicle and/or heater circulation system.
Depending on the application, the circulating pump is switched on via the control device or directly via the vehicle electrical system and operated during the entire heater operation duration.
An external control (UPFA - circulation pumps external control) of the circulation pumps independent of the heater operation is possible.

Further information on the installation and operation of the circulating pump is contained in the Thermo E+ Installation Instructions.

All service information regarding your Valeo circulating pump(s) can be found on the Valeo website under Pumps.

3.5 Heated fuel filter

The integrated filter heating is switched on at a fuel temperature of ≤ 0.5 ± 2.5 °C and off at ≥ 5.5 ± 2.5 °C by a temperature switch.When the heater is operated at low temperatures, depending on fuel used a heated fuel filter must be installed. See Technical Updates (TI) on the Valeo-website).

4 Heater functions

4.1 General heater functionality description

The heater principle is based on a high-pressure atomizer burner and is monitored by an integrated control unit.

The burner motor powers the fan and the fuel pump. The fuel pump is coupled to the motor using a plastic coupling. The fan produces the required combustion air, the combustion air volume is impacted by the burner motor speed.

The first CO_2 adjustment was made at Valeo.
For adaption to different applications (extension of combustion air intake or exhaust line) and after any maintenance and repair the CO_2 content is to be readjusted in a workshop.

The fuel pressure is generated in the fuel pump and reduced to the required pressure using a pressure limiting valve.
A solenoid valve releases the fuel via the atomizer nozzle for combustion in the combustion chamber.

As an option, the fuel pump can be equipped with a nozzle block preheater.
The nozzle block preheater heats the nozzle holder with the atomizer nozzle at temperatures below 0°C and thus the fuel. The fuel air mixture is ignited in the combustion chamber via a high-voltage ignition spark.

The flame is monitored by an optical flame detector integrated into the control device.

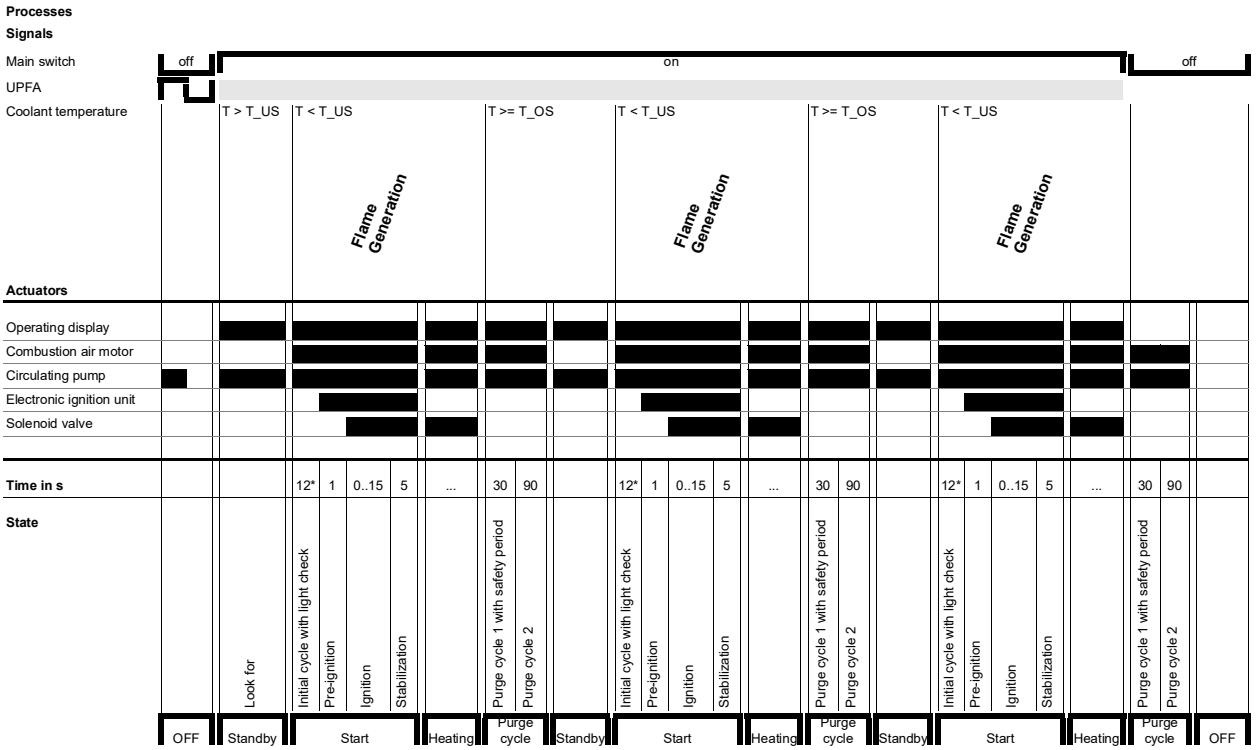
Depending on the equipment, the heater is switched on and off using a
- digital timer
- switch
- or climate control.

During heating operation the burner is automatically switched on and off. For control a temperature sensor is installed in the coolant outlet of the heat exchanger.
The heater is switched on, when the temperature falls short of a lower temperature threshold (72°C), and is switched off, if the upper temperature threshold (82°C) is reached.
A distinction between parking heating and auxiliary heating mode does not exists.

For overheating protection of the heater the switching thresholds are modified by the control unit, if specified temperature gradients are exceeded (gradient evaluation).

An operation indicator is available for monitoring the operation status of the heater. The operation indicator is also used to output error messages via flash code.

4.2 Operational heater sequence



*) The initial cycle state can be extended by up to 258 s (total initial cycle time up to 270 s) at low coolant temperatures due to preheating.

Abb. 401 Operational sequence

4.2.1 Switching on and start

When switched on, the operating display is illuminated, the control unit starts controlled operation and checks the coolant temperature.

If the coolant temperature is below the lower temperature threshold, the initial cycle starts.
Combustion air fan and circulating pump are switched on.

After approximately 12 seconds (initial cycle time) the high-voltage spark is ignited. Approx. 1 second later the solenoid valve of the fuel pump is opened.
The fuel injected via the atomizer nozzle and mixed with the air of the combustion air fan, is ignited by the ignition spark and burned in the combustion chamber.
The flame is monitored by a flame detector integrated into the control unit.
Approximately 5 seconds after a flame is detected, the control unit switches the electronic ignition unit off. Until then the flame is stabilized.

With optional nozzle block preheater:
The heating element is in the control device in parallel connected with the motor output and is activated by the thermostat at temperatures below 0°C.

4.2.2 Heating operation

After the flame is stabilized, the heater is in controlled operation.

Once the upper switching threshold is exceeded, heating operation is finished and purge cycle initiated.
The solenoid valve is closed, the flame expires, however the combustion air fan and circulating pump continue running.
The purge cycle ends approx. after 120 seconds. The combustion air fan is switched off.
The heater is in a controlled break. The operation indicator is illuminated.

Once the temperature falls short of the lower switching threshold, the heater restarts burner operation. It runs through the same sequence as the switching-on sequence.

4.2.2.1 Gradient evaluation

In case of low coolant flow or poor coolant circuit venting the temperature may quickly increase during heating operation.
The control unit recognizes the quick temperature increase and automatically sets the upper switching threshold to a lower value.
The quicker the temperature increases, the lower the switching threshold for starting the controlled break is set.

In addition, the burner is also switched back on again after the controlled break at a lower switching threshold.

This prevents residual heat triggering the overheating protection.

If the temperature rise (temperature gradient) is again within permissible limits, the thresholds are reset to normal values immediately (lower threshold 72°C, upper threshold 82°C).

4.2.2.2 Minimum combustion period

NOTE:
Frequent burning time under 120 seconds may result in soot build and increased smoke formation.

A minimum burner combustion period of 120 second is targeted.
For ambient and operating conditions this target is not always achieved.
In order to achieve the minimum combustion period, the lower switching threshold is variably adjusted by the control device.
This process is also called hysteresis adaptation and is applied during each heating operation.

If the combustion period falls short of the minimum combustion period of 120 seconds, the lower switching value is lowered by 1K for the following combustion process. The upper switching threshold remains as is.

This can be repeated until the minimum combustion period is reached or the lower switching threshold is reduced by 5K.
A further lowering is not possible.
Following a combustion process, where the required minimum combustion period was reached, the lower switching threshold is raised in steps of 1 K, max. up to the initial level.

4.2.3 Switching off

Switching the heater off ends the combustion process.
The operation indicator goes off and the purge cycle is initiated.
The solenoid valve closes, the flame expires, the combustion air fan and circulating pump continue running.
The purge cycle ends approx. after 120 seconds. The combustion air fan is switched off.

If a malfunction occurs during purge cycle (e.g. flame detection), the purge cycle may be shorter than 120 seconds.

During purge cycle it is permitted to switch the heater back on. The burner will restart after a purge cycle time of 30 seconds and subsequent initial cycle time.

4.3 Diagnosis interface and DTT Diagnosis

The heaters of the Thermo E + series are diagnosable.
The DTT diagnosis can be used to check the heater in the vehicle using a PC.

For information about connecting your heater to the DTT diagnosis and how to use it, refer to the DTT Operating instructions included with the device.
The operating instructions are also available for Download from the Internet on the Valeo website.

4.4 Fault lock-out and heater lock-out

A distinction is made between fault lock-out and heater lock-out.
The lock-outs protect the heater and the surrounding vehicle assemblies against sequence errors after a failure or a malfunction of individual heater components.
In a heater lock-out safety-related components are affected by the failure or malfunction. It may only be released by Valeo trained personnel after eliminating the cause.
Each fault lock-out and heater lock-out is stored in the control device.

4.4.1 Fault lock-out

If one of the malfunctions listed below occurs, the heater will initiate a fault shut-down, followed by a fault lock-out.

Depending on the error timing, no purge cycle or a 120 seconds purge cycle will be executed.
Flash impulses are outputted via the operation indicator.
In case of several sequential fault lock-outs a heater lock-out is initiated (see 4.4.2).

4.4.1.1 Malfunctions during switching-on and start procedure

NOTE:
If malfunctions occur during switching-on or during the start process prior to ignition, the heater will be switched off without purge cycle.

The heater is in fault lock-out.The motor stops immediately or does not start.

Malfunction causes:
- Short circuit and/or interruption of electrical components:
  - burner motor (stops immediately)
  - Electronic ignition unit
  - Optional nozzle block preheater
- Interruption of circulating pump operation
- Flame or extraneous light detection by the flame detector prior to ignition of the high-voltage ignition spark.
- No start: No flame detection within 15 seconds after opening the solenoid valve.
- Temperature sensor delivers unacceptable temperature values.
- Heater operation outside the permissible temperature range.
- Voltage falls short of the low voltage threshold of approx. 20.5 (10*) Volt at motor start or within a duration of 20 seconds after a heating request.
- Voltage exceeding the high voltage threshold of approx. 30 (15*) Volt at motor start or within a duration of 6 seconds (purge cycle only, no fault lock-out).
- Plug of the electronic ignition unit is inserted wrong
- Control device malfunction

4.4.1.2 Malfunctions during heater operation

NOTE:
In case of malfunctions during heater operation, first a 120 seconds purge cycle will be performed. Then the heater is switched into the fault lock-out.

Malfunction causes:
- Short circuit of the circulating pump.
- Short circuit or interruption of other electrical components (motor, solenoid valve, electronic ignition unit, nozzle block preheater).
- Water temperature greater than the upper switching threshold.
- Temperature sensor delivers unacceptable temperature values.
- Heater operation outside the permissible temperature range.
- Flame interruption (combustion interruption for longer than 15 seconds).
- Voltage falls short of the low voltage threshold of approx. 20.5 (10*) Volt at motor start or within a duration of 20 seconds after a heating request.
- Voltage exceeding the high voltage threshold of approx. 30 (15*) Volt at motor start or within a duration of 6 seconds (purge cycle only, no fault lock-out).
- Control device malfunction.

4.4.1.3 Malfunctions during purge cycle

Malfunction causes:
- Short circuit or interruption of the burner motor (stops immediately)
- Interruption of circulating pump operation
- Heater operation outside the permissible temperature range.
- Voltage falling short of the low voltage threshold of approx. 20.5 (10*) V at motor start or within a duration of 20 seconds after a heating request.
- Voltage exceeding the high voltage threshold of approx. 30 (15*) V at motor start or within a duration of 6 seconds (purge cycle is applied, but no fault lock-out).
- Control device malfunction.

* at 12V rated voltage

4.4.1.4 Fault lock-out release and error clearance

The fault lock-out is released when the heater is switched off.
After that it will be immediately ready for operation.
The detected error is stored in the error memory and can be read using DTT diagnosis.
It is possible to delete the stored error using the DTT diagnosis

4.4.2 Heater lock-out

The heater lock-out overrides the standard fault lock-out.

If the heater lock-out is active, neither start nor purge cycle are executed after switching the heater back on.
Prior to restarting the heater troubleshooting must be performed by personnel trained by Valeo in order to identify the root cause.
After that the heater interlock can be released (see 4.4.2.1).

Here it is differentiated between interlocks caused by overheating and interlocks caused by other errors.

NOTE:
If malfunctions occur during switching-on or during the start process prior to ignition, the heater will be switched off without purge cycle.
The heater is in the heater lock-out state.
The burner motor stops immediately or does not start.
Besides that a purge cycle between 30 seconds and 120 seconds is performed depending on error type and timing.
Subsequently the heater status is switched to heater lock-out.

Heater lock-out causes:
- Short circuit and/or interruption of electrical components:
  - Solenoid valve
  - Flame detector
  - Overheating protection
  - Water temperature sensor
- Flame not expired within 30 seconds after purge cycle started (Burner motor stops)
- Overheating protection triggered
- Control device error or programming error
- Repeated malfunctions
- Repeated flame interruptions

4.4.2.1 Heater lock-out release

To release, the switched on heater must be disconnected from the vehicle electrical system as follows.

Release a heater lock-out without DTT diagnosis:

NOTE:
Disconnect the power supply for release, by pulling the plug C is not permissible.

1. Remedy the cause of the heater lock-out.
2. Disconnect the power supply (**Observe** 5.2 **!**) for at least 10s.
3. Reconnect power supply.
4. Switch the locked-out heater off and then on again.
5. Repeat steps 2. and 3.
6. Heater is ready for service and starts, if necessary turn it off.

NOTE:
If the main switch remains in the on position when disconnecting the power supply, the heater automatically starts after connecting it to the vehicle electrical system.
The heater can be switched off during initial cycle.

Release the heater lock-out using the DTT diagnosis:
1. Connect the heater with the DTT diagnosis and read out the error memory.
2. Remedy the cause of the heater lock-out.
3. Disconnect the power supply (observe 5.2 !) for at least 10s.
4. Reconnect the heater to the vehicle electrical system.
5. Using the DTT diagnosis, delete the error/error memory.

4.5 Error output

If the heater is equipped with the standard timer, an error output is displayed on the pre-selection timer after a malfunction occurs, otherwise via flash code at the operation indicator.

5 Troubleshooting

5.1 General

Warning!	Danger to life and health!

The safety instructions and regulations of Chapter 1 (see 1.6) must be observed.

This section describes troubleshooting and error correction for Thermo E+ 120, E+ 200 and E+ 320 heaters.

In case of doubt functional connections can be obtained in chapters 3 and 4.

Error detection is usually limited to localizing the faulty component.
The following malfunction causes are not taken into account and should basically always be verified and/or a malfunction due to these reasons should be excluded:

- Corrosion on plugs
- Loose plug connections
- Crimp failures on plugs and/or pins
- Corrosion on cable and fuses
- Corrosion on battery terminals
- Cable insulation damage
- Damage to contacts due to frequent plugging in and out.

ATTENTION:
Prior to replacing a fuse, troubleshooting needs to be performed. The heater must be disconnected from the vehicle electrical system (see 5.2).
A properly dimensioned fuse must be inserted (see chapter 6 wiring diagrams).

After each error correction a functional test must be performed in the vehicle.

5.2 Disconnecting the heater from the vehicle electrical system

Some troubleshooting procedures require to disconnect the heater from the vehicle electrical system.

ATTENTION:
The disconnection from the vehicle electrical system must not be carried out via the plug on the heater (under voltage).

This can be done for example by pulling the fuse F1 (see wirings in Cha. 6).

5.3 General error symptoms

The following table lists possible, general error symptoms.

Table 501 General error symptoms

Error symptom	Possible cause
Error in the electronics	
Operation indicator does not light and the heater does not function.	• Lamp/LED of the operation indicator is defective • No supply voltage. • Fuses triggered / interrupted • cable to contact A of the connector C of the control device
Fuse F1 triggered.	Short circuit or overload of lines, heater components or the circulation pump. Check wires and connectors and components and replace if necessary.
Fuse F2 triggered.	Short circuit in the supply line of the main switch or, if used, in the preselection timer
Heater is functional, however the operation indicator does not light.	Operating indicator defective or cables to the operation indicator interrupted or shorted.

Table 501 General error symptoms

Error symptom	Possible cause
Error in the water system Circulating pump does not operate (Aquavent 6000S and Aquavent 6000SC only).	• Error mode activated. In case of malfunctions the motor is switched off via the error mode. **Reactivation of the circulating pump motor** For this purpose disconnect the power supply for > 2 min (**Observe** 5.2 **!**). After the power supply is reconnected the motor performs a soft start.
Heater stops as the connected heat exchangers in the vehicle provide insufficient heat.	<u>Flow rate too small, because</u> • Air in the heater, heat exchanger or in system sections. • Taps/valves (flow controllers) throttled, contaminated, closed. • Contaminations in the system, e.g. filters or at bottlenecks • Circulating pump delivery rate insufficient (air in pump housing) • Insufficient frost protection (antifreeze or incorrect mixing ratio) • System resistance too high (especially high in the cold). • Circulating pump defective <u>Heat exchanger provides not enough heat, because</u> • Air in the heat exchangers and/or system sections. • Contaminated heat exchangers, soot • Insufficient air entry or air exit. • Fan: Insufficient delivery rate / incorrect direction of rotation / resistance too high. • Antifreeze content too high.

Approximate flow rate determination:

$$\text{Flow rate in [l/h]} = \frac{\text{Heat flow [kW] according to type plate}}{\text{Temperature difference } \Delta t \text{ in [K] or [°C] measured on the heater between water inlet and water outlet (e.g. using contact thermometer)}} \times 860$$

Table 501 General error symptoms

Error symptom	Possible cause
Error in the fuel supply No fuel delivery to the heater.	• Fuel tank empty. • Bent, closed, clogged or leaking lines. • Paraffin deposits or frozen water entrapments in fuel filter or lines • Venting opening in tank clogged • Fuel lines mixed up • Fuel filter contaminated • Fuel pump, fuel filter and fuel lines not bleeded (in particular single-pipe operation)
Error in the combustion CO_2 value cannot be adjusted to nominal value. Irregular combustion	• Air bubbles in fuel supply line (leaking fuel supply line or resistance / negative pressure in the suction line too high). • Fuel filter contaminated or leaking • Paraffin deposits or frozen water entrapments in fuel filter or lines • Fuel integration leaking (suction lift, low pressure in tank), observe installation instruction • Fuel pump defective (pump pressure) • O-ring seal on fuel pump ineffective (leaking or O-ring is absent • Fuel nozzle defective or non-proper fuel nozzle • Combustion air and exhaust lines throttled or closed • Application air / exhaust does not match to the environmantal altitude (geodesic altitude) • Burner motor speed too low • Coupling defective • Fuel return partially or completely closed

5.4 Malfunction code output via flash code

The error cause is outputted as a flash code via the operating display.

After five short signals the long flash signals are counted.
The number of long flash impulses corresponds to the respective flash code. Flash codes and their respective error meaning are presented in Table 502.

Table 502 Flash code

No. of impulses	Error	Error description
0	Control device error	Control device error
1	No start within safety period	No start within safety period
2	Flame interruption	Flame interruption in burner operation, repeated start unsuccessful
3	Low Voltage / high voltage	High voltage (> 30V [15V]), at least 6 seconds)
		Low Voltage (< 20.5V [10V]), at least 20 seconds)
4	Extraneous light in initial or purge cycle	Extraneous light (flame detector "Bright" in purge cycle 2)
		Extraneous light (flame detector "Bright" prior to ignition)
5	Flame detector defective	Flame detector short circuit
		Flame detector interruption
6	Temperature sensor / overheat protection defective	Temperature sensor short circuit
		Temperature sensor interruption
		Temperature sensor / overheat protection non-plausible
		Overheat protection short circuit
		Overheat protection interruption
7	Solenoid valve defective	Solenoid valve short circuit
		Solenoid valve interruption
8	Combustion air fan motor / nozzle block preheater defective	Combustion air fan motor short circuit
		nozzle block pre-heater short circuit or the wrong one installed
9	Circulating pump defective	Circulating pump short circuit
10	Overheat protection triggered	Overheating T>140°C
11	Electronic ignition unit defective	Electronic ignition unit short circuit
		Electronic ignition unit interruption
12	Heater lock-out	Flame interruption counter threshold exceeded
		Heater lock-out - release required
		Malfunction counter threshold exceeded

5.5 Error symptoms during functional tests with malfunction code output

5.5.1 Error symptom "No start within safety period"

If due to a malfunction the heater unsuccessfully attempted to start eight times in a row, it will be interlocked.
No further start attempts will be tried.
The heater lock-out overrides the standard fault lock-out.

The procedure for releasing the heater interlock can be found in point 4.4.2.1.

The "No start within safety period" error symptom does not always indicate that no ignition took place.
This symptom occurs as well, if the heater fails to enter heating operation (heating or auxiliary heating state) after successful ignition, e.g. in case the fuel supply is interrupted.

5.5.2 Error symptom "Flame interruption"

If due to a malfunction flame interruption occurs during heating operation five times in a row, the heater will be locked-out.
No further start attempts will be tried.
The heater interlock overrides the standard fault lock-out.

NOTE:
After above mentioned error symptoms occur, troubleshooting according to Table 503 is recommended.
In principle, the correct supply of electrical energy, signals, fuel and air, respective the discharge of fuel and exhaust gas must be checked.

The procedure for a heater lock-out release is outlined in point 4.4.2.1.

Table 503 Error symptom "No start within safety period“ and “Flame interruption“

Medium	Kind of check / error symptom	Possible cause	Fault elemination
Electrical energy and signals	When the heater is switched on, the burner motor does not start.	Fault lock-out, heater lock-out	Fault lock-out release, heater lock-out release
		Faulty power supply to the heater	Connect electrical connections or replace damaged parts
		Faulty or damaged power supply to the burner motor of the heater	Check / repair power supply to burner motor
		Burner motor defective	Check / replace burner motor
Combustion air	Insufficient combustion air mass	– Combustion air intake opening or line, fan wheel or exhaust pipe not completely free or not properly secured – Fan wheel not properly secured – Air loss at the burner or heat exchanger	– Clean and securely mount the combustion air intake opening and line and the exhaust pipe – Properly secure the fan wheel – Check screw connections on burner and check all parts for damage
	Insufficient fresh air as combustion air	Polluted air, aspiration of exhaust fumes	Aspirate clean air, prevent aspiration of exhaust fumes

Continued on next page

Table 503 Error symptom "No start within safety period“ and “Flame interruption“

Medium	Kind of check / error symptom	Possible cause	Fault elemination
Fuel	Fuel is not supplied or not bubble-free (return and / or supply line)	Fuel filter contaminated, clogged or leaking	Check fuel filter and filter head for damage, is it soiled, clogged or leaking?
		The fuel line is leaking on the suction side or a line is completely or partially closed (e.g., taps, kinks, valves)	Re-tighten screw connections; if necessary, replace or open lines, observe installation instructions (e.g. bending radii of fuel lines)
		Fuel lines or the fuel filter are empty / not pre-filled	Fill the fuel lines and the fuel filter (bleeding procedure)
		The fuel used is not suitable for the operating temperature	Use fuel suitable for the operating temperature
		Prescribed nozzle block pre-heater and / or heated fuel filter are / is not in operation / not installed	Install prescribed nozzle block pre-heater and / or heated fuel filter and check that they are working properly (see TI BioDiesel and TI Paraff. fuels)
		Leaks due to missing or damaged seals in the fuel system, including fuel pump	Check fuel system for leaks and repair if necessary, including fuel pump
		Clutch malfunction	Check coupling and replace if necessary (check cause!)
		The shaft of the fuel pump does not rotate	Replace fuel pump
	Fuel is not atomized properly	Atomizer nozzle not free from deposits / damaged or not screwed in correctly	Replace atomizer nozzle, (DO NOT clean! pay attention to annual change interval)
		The fuel used is not suitable for the operating temperature	Use fuel suitable for the operating temperature
		Prescribed nozzle block pre-heater and / or heated fuel filter are / is not in operation / not installed	Install prescribed nozzle block pre-heater and / or heated fuel filter and check that they are working properly (see TI BioDiesel and TI Paraff. fuels)
		Incorrect pump pressure	Check / correct pump pressure; if necessary, replace fuel pump
		Solenoid valve malfunction	Check solenoid valve for function and correct assignment of voltage variant and replace if necessary

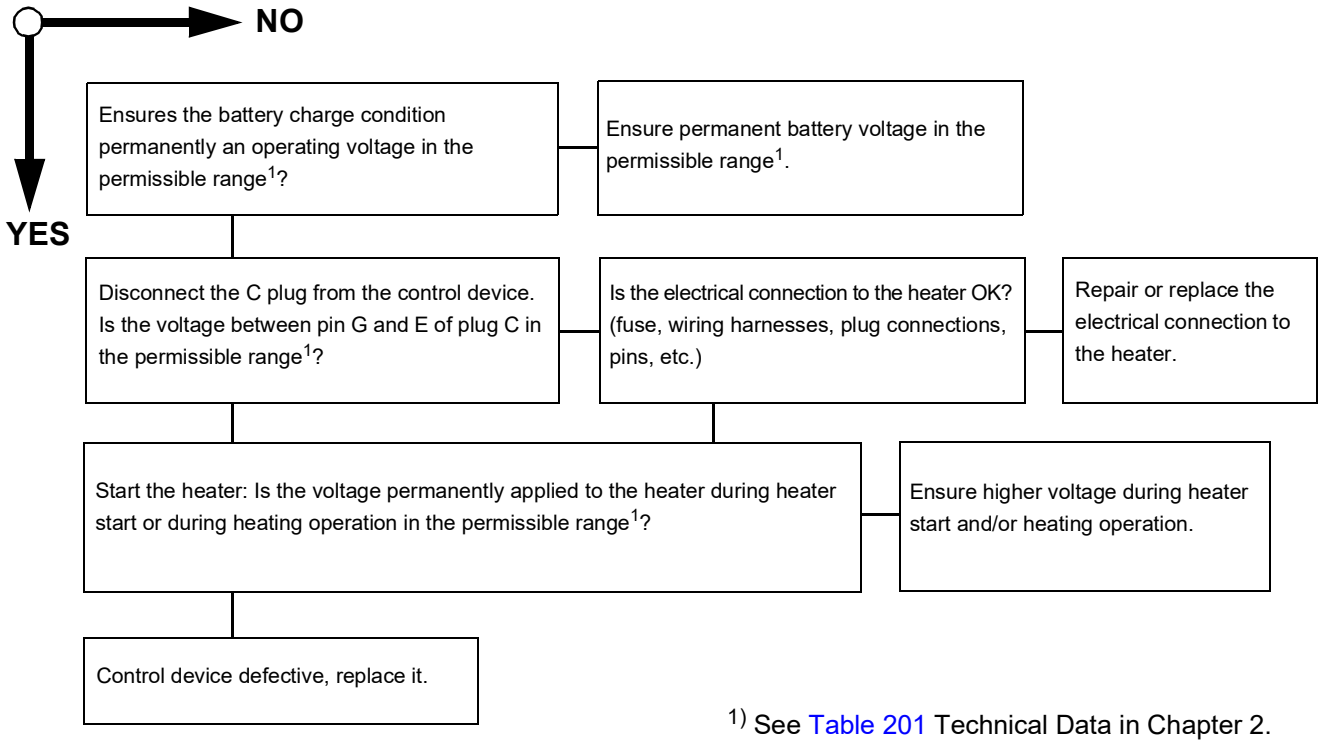
Continued on next page

Table 503 Error symptom "No start within safety period“ and “Flame interruption“

Medium	Kind of check / error symptom	Possible cause	Fault elemination
Ignition spark	Electronic ignition unit is not heard during start attempt	Electronic ignition unit defective	Check electronic ignition unit acc. to workshop manual
	Spark cannot jump properly	The gap between the ignition electrodes is not correct or electrodes are dirty	Clean electrodes; check the gap between ignition electrodes if not o.k. - replace electronic ignition unit
Flame	Although a combustion / heater start is heard, but the flame is not detected (Diagnosis)	The view of the flame guard on the flame is not ensured	Ensure the view of the flame guard on the flame, clean or install the components correctly, if necessary replace control unit
		Flame guard malfunction	Check flame guard (see workshop manual)
		The fuel used is not approved / released	Use approved / released fuels (see TI BioDiesel and TI Paraff. fuels)
		Control unit malfunction	Replace control unit

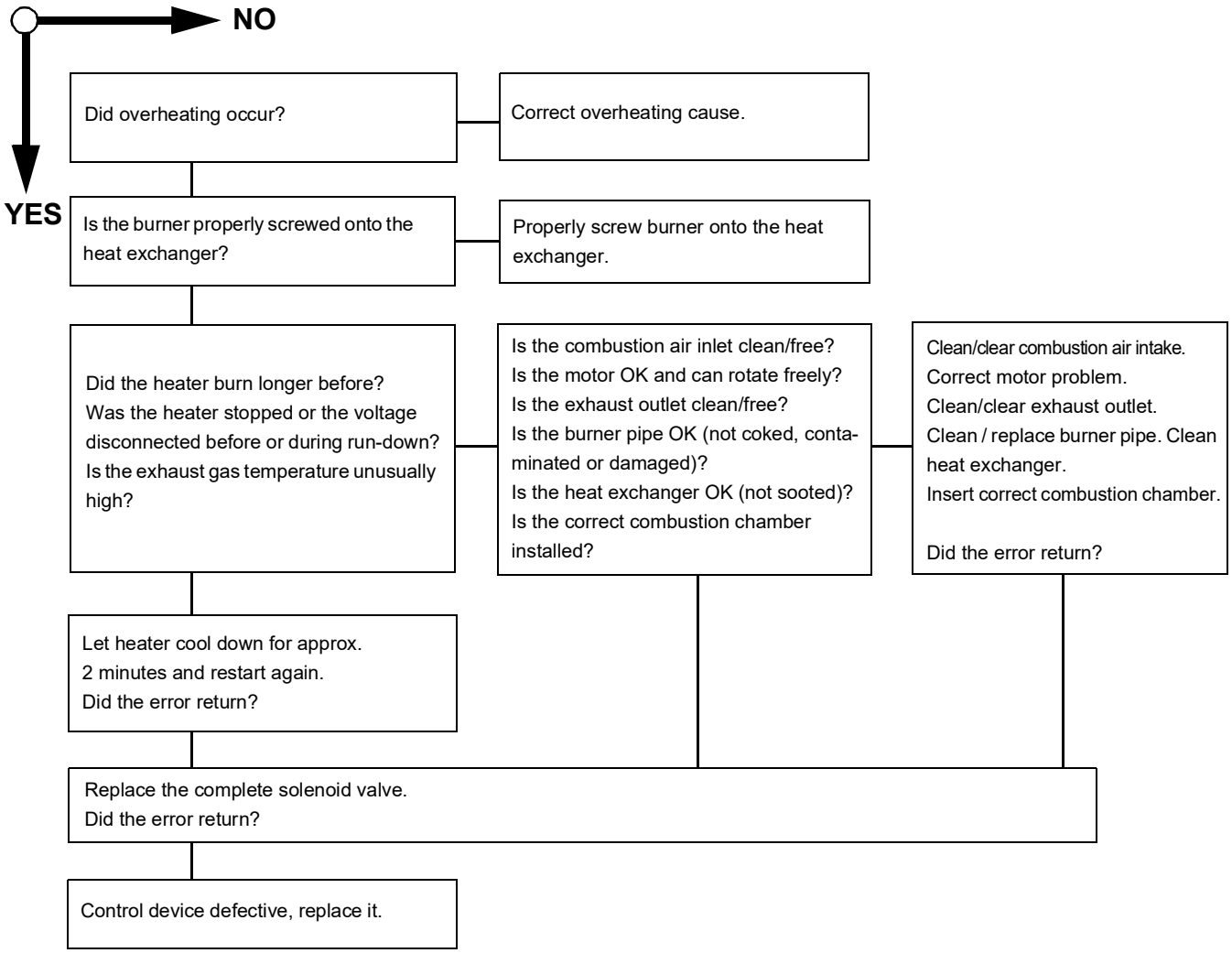
5.5.3 Error symptom "Low voltage"

A value is stored in the control unit as smallest "permissible low voltage".
It must be noted that the voltage may be lowered during heater start, and that the "low voltage" threshold may be violated.
Among others this depends on the vehicle electrical system, the temperature of optional components, such as the nozzle block preheating, circulating pumps or heatable filters.



[1)] See Table 201 Technical Data in Chapter 2.

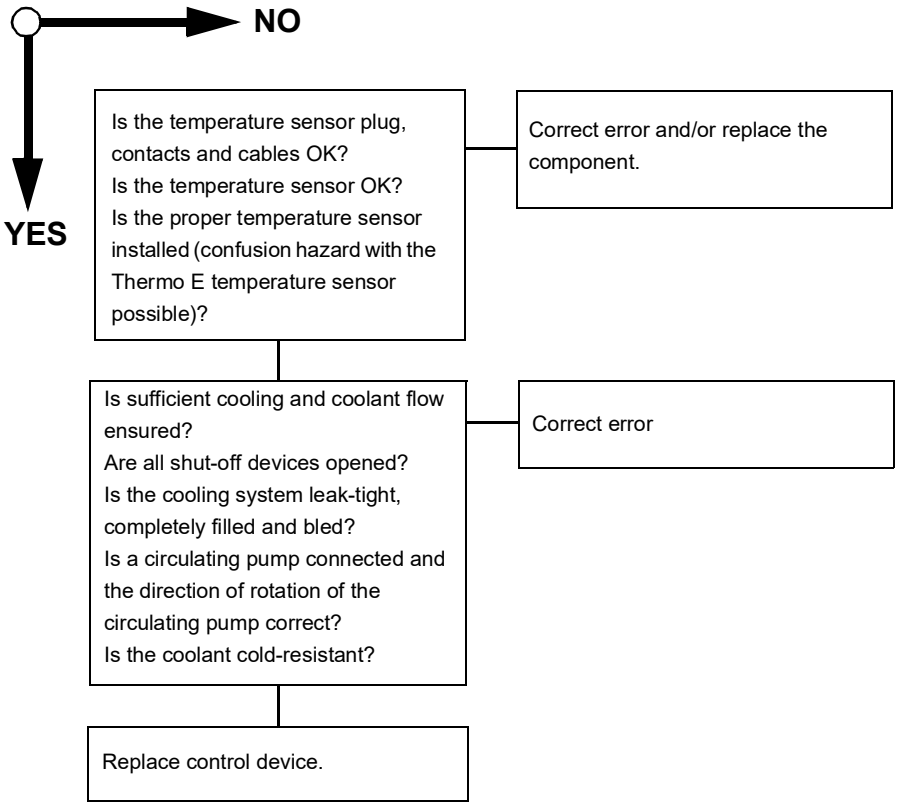
5.5.4 Error symptom "Extraneous light detected prior to ignition or during purge cycle"



5.5.5 Error symptom "Flame guard defective"

The flameguard cannot be replaced. If necessary the control device is to be replaced.

5.5.6 Error symptoms "Temperature sensor / overheating protection defective" and "Overheating"



5.6 Individual component tests

Individual components can basically be tested using visual inspection, manual electrical testing or test by means of the DTT diagnosis.
The following section provides information on the scope of tests and how to carry out the individual component tests.

NOTE:
Prior to disconnecting the temperature sensor plug connection, disconnect the heater from the vehicle electrical system (**Observe** 5.2 **!**).

5.6.1 General visual inspection

- Inspect components for damages (cracks, deformation, leaks, discolourations, etc.) and replace as needed.
- Inspect plugs and cables for corrosion, contact and crimp errors and repair as needed.
- Check plug contacts for corrosion and tight fit. Repair as needed.

5.6.2 Heat exchanger visual inspection

For heat exchanger description, see 3.2.

- Inspect heat exchanger interior for damage, corrosion, sooting and deposits.
- Inspect heat exchanger for outer damage, corrosion, moisture, deformations, deposits, discolourations, etc.

ATTENTION:

Soot and deposits in the heat exchanger must be removed, as they impact the heat transfer to the coolant. The exhaust gas temperature can rise sharply and components in the burner can be damaged by heat.
Severe outer deformations may impact coolant flow.

5.6.2.1 Visual inspection of exhaust outlet and exhaust line

Inspect exhaust outlet and possibly available exhaust line for conditions, tight fit, contamination and deposits.
Use only exhaust gas applications according to Installation instruction.

5.6.3 Combustion chamber visual inspection

For combustion chamber description, see 3.3.

- Remove combustion chamber (see 8.11).
- Inspect swirl plate and combustion chamber head for damage and tight fit.
- Check combustion chamber for scalings and coke deposits and remove as needed.
- Inspect combustion chamber for deformation and moisture.
- Inspect combustion chamber for cracks.

NOTE:
Cracks in longitudinal direction at the end of the welding seam shorter than 80 mm (E+ 200/320) and 20mm (E+ 120) are permissible.

Combustion chamber Thermo E+ 120 only:
- The insulation of the combustion chamber must be checked for condition, damage and correct seating. It must not be soaked with fuel.
- After the inspection is completed, reinstall the combustion chamber (see 8.13).

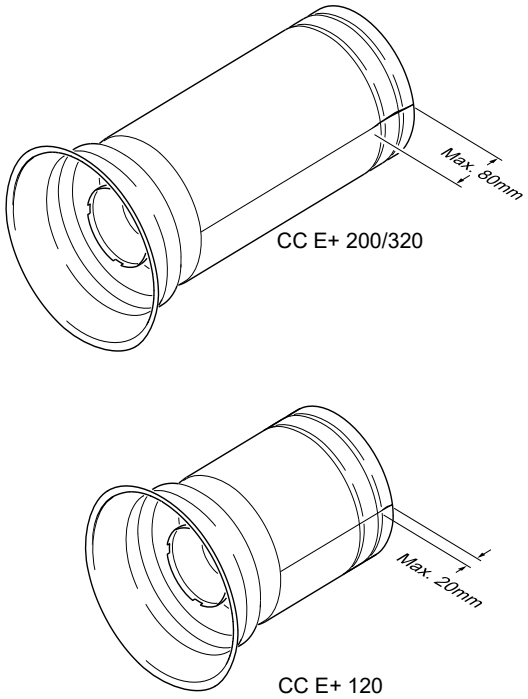


Fig.501

5.6.4 Resistance check of the temperature sensor with integrated overheating protection

Caution!	**Risk of scalds!**

Observe the risk of injuries due to increased coolant temperature.
Prior to removing the temperature sensor, the over-pressure in the cooling system must be released (e.g. by opening the cooler lid). Possibly let the heater before cool down and have collecting container ready for discharged coolant.

Inspection

- Inspect temperature sensor, plug and cable for damage and proper fit.
- Remove temperature sensor (see 8.3).
- Perform the electrical test using a measuring device suitable for resistance measurements.
- The water temperature sensor and the overheating protection should indicate values according to the charts (Fig.503 and Fig.504). Preferably the resistance should be measured at an approx. consistent temperature of 20°C and approx. 100°C (immerse sensor up to the copper gasket ring into boiling water). Prior to reading the value, the sensor should be exposed to the temperature for approx. 20 seconds. A measurement tolerance of +/- 5°C under workshop conditions is permitted.
- Install temperature sensor (see 8.3).

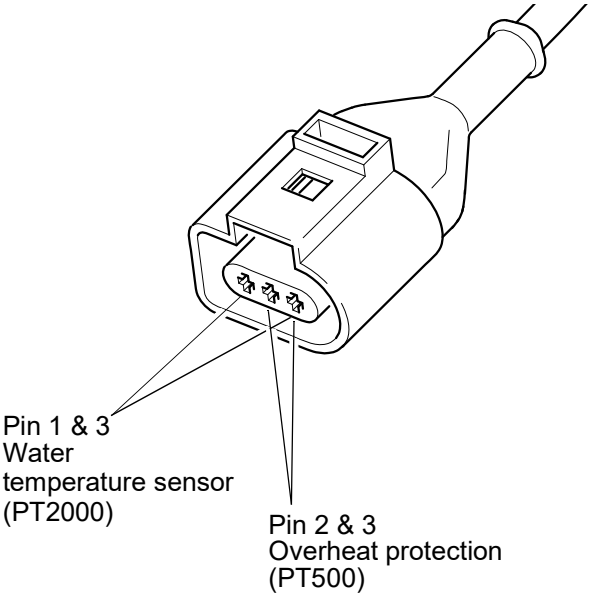


Fig.502

Resistance vs. temperature charts

Diagramm Widerstand über Temperatur

Water temperature sensor (Pin 1 and 3)

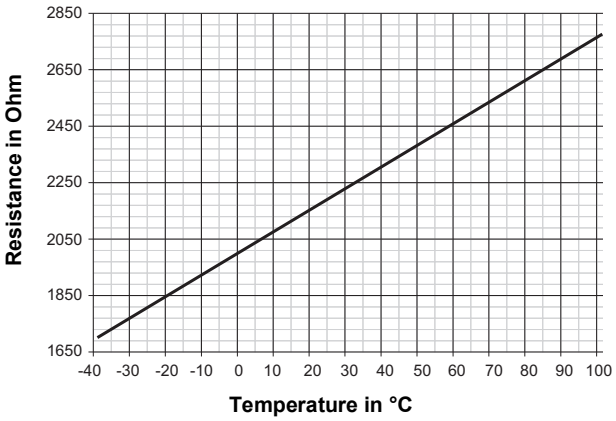


Fig.503

Overheating protection (Pin 2 and 3)

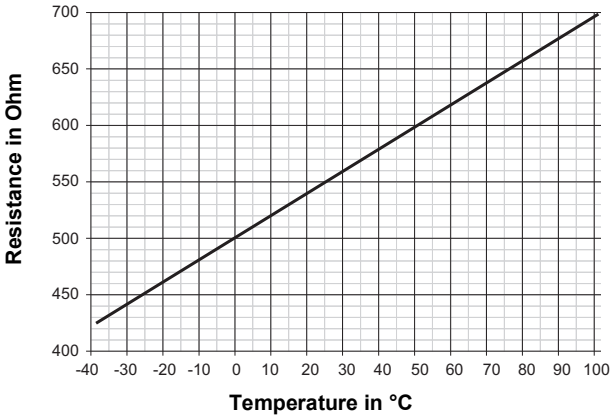


Fig.504

5.6.5 Fan, hood and combustion air intake line visual inspection

- Inspect a possibly available combustion air intake line for contamination, condition and deposits.
- Remove hood (see 8.4).
- Inspect fan channels for contamination and deposits.
- Inspect fan and motor shaft mount for cracks, stress marks and deformations.
- Check circlip for proper fit.
- Inspect hood inside and outside for damage and dirt deposits.
- Install hood (see 8.4).

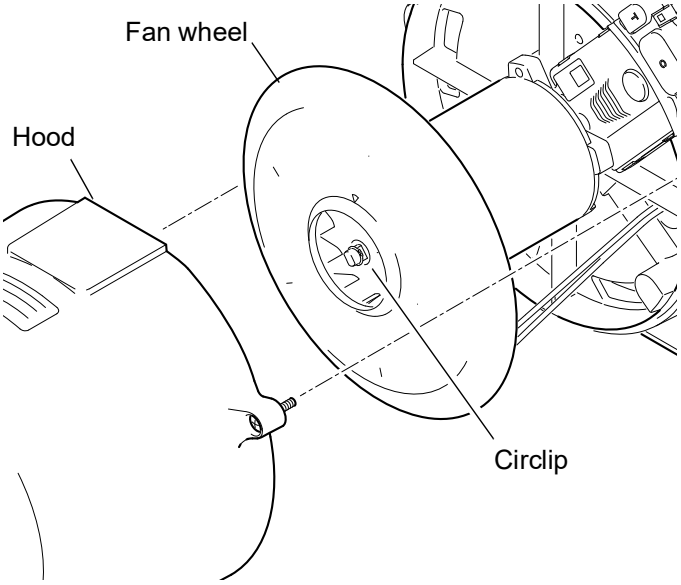


Fig.505

5.6.6 Burner motor inspection

For burner motor description, see 3.1.1.

Inspection without use of DTT diagnosis

Measure optical the motor speed with an external measuring device. For that:

- Affix a reflector onto the fan wheel.
- Apply 24V (12V) DC.
- Measure the motor speed during initial cycle, ignition, heating operation or purge cycle.
- Compare the measurement result with the nominal speed shown on the motor label. Deviations of 10% are permitted.
- If the speed is not as required:
  - Remove hood (see 8.4).
  - Check whether the proper motor is installed (heating capacity class, operating voltage of the heater).
  - If required replace burner motor (see 8.5).
- Reinstall burner (see 8.2).

Inspection using the DTT diagnosis

- Disconnect the heater from the vehicle electrical system (**Observe** 5.2 !).
- Inspect the motor for bearing conditions (stiffness).
- Connect the DTT diagnosis to the heater using the adapter wiring harness (ref. to Operating Instructions for the DTT diagnosis).
- Reconnect the heater with the vehicle electrical system.
- Start DTT diagnosis, establish connection to the heater and open the Component Test menu.
- In the Component Test menu, select the motor and proceed according to the DTT diagnosis instructions. Enter run time and start the component test.
- Measure optical the speed with an external measuring device. For that:
- Affix a reflector onto the fan wheel.
- Compare the measurement result with the nominal speed shown on the motor label. Deviations of 10% are permitted.
- If the speed is not as required:
  - Remove hood (see 8.4).
  - Check whether the proper motor is installed (heating capacity class, operating voltage of the heater).
  - If required replace burner motor (see 8.5).
- After test completion, terminate DTT diagnosis as needed.
- Disconnect the heater from the vehicle electrical system (**Observe** 5.2).
- Remove the DTT diagnosis adapter wiring harness as required.
- Reconnect the heater to the vehicle electrical system.

5.6.7 Electronic ignition unit inspection

For electronic ignition unit description, see 3.1.5.

Warning!	Explosion hazard!

No voltage of any kind or duration may be applied to the ignition unit for test purposes. It may only be operated and tested together with the associated control device (component test of the DTT).

The function of the electronic ignition unit can only be checked with the DTT diagnosis using the Component test.

Warning!	Risc of electric shock!

High voltage: The voltage received by the ignition electrode is >13,000 Volt.During operation or testing of the electronic ignition unit, the ignition electrode may not be contacted by persons or items.

Inspection using the DTT diagnosis

- Remove burner (see 8.2).
- Inspect housing and ignition electrodes of the electronic ignition unit for damage.
- Connect the DTT diagnosis to the heater using the adapter wiring harness (ref. to Operating Instructions for the DTT diagnosis).
- Reconnect the heater with the vehicle electrical system.
- Start DTT diagnosis, establish connection to the heater and open the Component Test menu.
- In the Component Test menu, select the electronic ignition unit and proceed according to the DTT diagnosis instructions. Enter run time and start the component test.
- Nominal condition:
  Ignition sparks jump over at the ignition electrodes.

  NOTES:
  – How can it be determined whether the control device or the electronic ignition unit (EIU) is defective?
  If a resistance greater than 1 Ohm (primary winding) is measured at the connector of the EIU, a defect can be assumed (12 and 24V versions). The EIU must be replaced. It is recommended to replace it pairwise with the control device.
  – For the error message "EIU interruption ..." or "EIU short circuit ..." it is recommended to replace the EIU pairwise with the control unit.
  – The EIU electrodes must not be in contact with adjacent assemblies. During the component test, the spark may only originate between the electrodes and not jump over to adjacent components.
  – The error message: "EIU short circuit or no induction" may be the result of insufficient power supply or defects in the electrical integration of the heater.
  – During the component test with the DTT, short-term misfires are permissible in static air (without fan). In the heater, the continuous sparking is supported and ensured by the air flow.
- After test completion, terminate DTT diagnosis as needed.
- Disconnect the heater from the vehicle electrical system (**Observe** 5.2 !).

Warning!	Danger of severe burn injuries!

Inadvertent operation of the removed burner can cause severe burn injuries. If the burner and heat exchanger are separated, do not connect the temperature sensor to the control unit.

- Remove the DTT diagnosis adapter wiring harness as required.
- Reinstall burner (see 8.2).

5.6.7.1 Ignition electrodes inspection

For ignition electrodes description, see 3.1.5.

Inspection

- Remove burner (see 8.2)

ATTENTION:

Do not touch the nozzle opening during the test!

When readjusting the ignition electrodes, make sure that no torque is introduced into the interior of the ignition spark generator.
To do this, hold the electrode to be adjusted at the housing outlet with a pair of pliers and carefully bend it with another pair of pliers.

- Check clear distance of the electrode tip to the fuel nozzle (see Fig.506) and adjust if necessary.
- Check the clear distance between the electrodes (see Fig.506) and adjust if necessary.

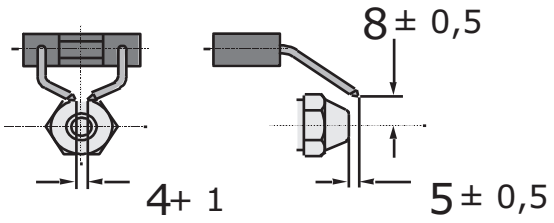


Fig.506

You can use the gauge 310646Z to check / adjust the ignition electrodes.

5.6.8 Flame guard inspection

For flame guard description, see 3.1.2.

Visual inspection

- Check correct arrangement of dust protection tube and spring between control device and disc.
  The dust protection tube must rest on the opening of the flame guard in the burner housing and engage into the burner housing.

The electronic part of the flame guard is permanently integrated into the control device and cannot be replaced.

The functional test is done using the DTT diagnosis.
If damaged or if the target value is not reached the control device is to be replaced as required.

Inspection

- Remove burner (see 8.2).
- Connect the DTT diagnosis to the heater using the adapter wiring harness (ref. to Operating Instructions for the DTT diagnosis).
- Reconnect the heater with the vehicle electrical system.
- Start DTT diagnosis and establish connection to the heater.
- Cover the opening of the dust protection tube.
  Check the flame guard voltage displayed on a PC by the DTT diagnosis (target value: U = 4.01V ... > 5.0V).
- Remove the cover from the opening of the dust protection tube and illuminate it from close distance using a bright lamp.
  Check the flame guard voltage displayed on a PC by the DTT diagnosis (target value: U = 0.13V ... 2.5V).
-
- After test completion, terminate DTT diagnosis as needed.
- Disconnect the heater from the vehicle electrical system (**Observe** 5.2 !).
- Remove the DTT diagnosis adapter wiring harness as required.
- Reinstall burner (see 8.2).

5.6.9 Fuel pump inspection

For fuel pump description, see 3.1.3.

NOTE:
The replacement interval of the fuel pump depends on the fuel used and must be observed, see Maintenance Schedule Thermo E +.

ATTENTION:

The pump pressure of the fuel pump is adjusted to a defined value in the factory.
It is permitted to readjust the pump pressure.
The disassembly of the fuel pump is not permitted.

The fuel pump pressure can be checked while the burner head is removed, using the Component Test menu of DTT diagnosis.

NOTE:
A pressure test gauge with a display range from 0 to 15 bar as well as a bleeding feature is required (Fig.508).

The pump pressure can be checked as follows:

Check without DTT diagnosis
- Remove burner (see 8.2).
- Clamp the burner in the workshop (not in the vehicle).
- Unplug motor and solenoid valve connectors from the control device.
- Ensure fuel supply.
- Remove fuel nozzle (see 8.10).
- Instead of the nozzle screw the pressure test gauge into the nozzle block (20 Nm ±2).

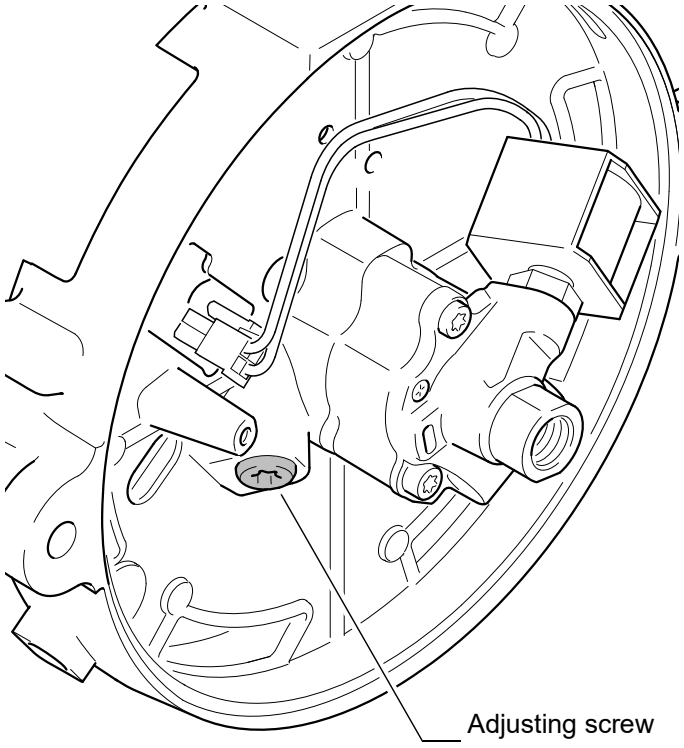
NOTE:
Excert counter pressure at the key face of the nozzle block of the fuel pump using a suitable tool.

- Connect to motor and solenoid valve 24V or 12V, pin assignment, see Fig. 603.
  Observe the direction of rotation of the motor (arrow on the fan wheel)!
- Open the bleed port at the pressure test gauge until fuel escapes bubble-free, collect it e.g. with a cloth.Close the bleed port and read the present pressure at the gauge.
- Compare the actual pressure with the target pressure in Table 504.

If the specified pressure cannot be reached, it can be readjusted. For that rotate the adjusting screw (see Fig.507) max. one revolution. If the prescribed pressure despite readjustement not be achieved or occur leaks, the fuel pump must be replaced.

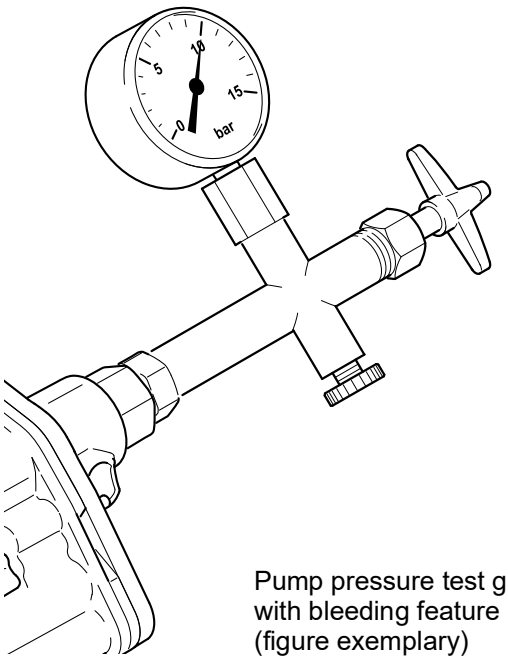
- Dismantling in reverse order.

ATTENTION:
Plug the temperature sensor screwed into the heat exchanger into the control device again.



NOTE:
In this figure the fuel pump is shown removed from heater for clarity.

Fig.507 Fuel pump



Pump pressure test gauge with bleeding feature (figure exemplary)

Fig.508

Inspection using the DTT diagnosis

- Remove burner (see 8.2).
- Connect the DTT diagnosis to the heater using the adapter wiring harness (ref. to Operating Instructions for the DTT diagnosis).
- Connect a temperature sensor **for the duration of the test only** to the control device.

Warning!	**Danger of severe burn injuries!**

Inadvertent operation of the removed burner can cause severe burn injuries.

- Reconnect the heater with the vehicle electrical system.
- Start DTT diagnosis, establish connection to the heater and open the Component Test menu.
- In the Component Test menu, select the fuel pump pressure test and start it.
- Proceed according to the DTT diagnosis instructions.

If the specified pressure (see Table 504) cannot be reached, it can be readjusted. For that rotate the adjusting screw (see Fig.507) max. one revolution.
If the prescribed pressure despite readjustement not be achieved or occur leaks, the fuel pump must be replaced.

- After test completion proceed according to the DTT diagnosis instructions and terminate DTT diagnosis as required.
- Disconnect the heater from the vehicle electrical system (**Observe** 5.2 !).
- Unplug external temperature sensor from control device.
- Remove the DTT diagnosis adapter wiring harness as required.
- Reinstall burner (see 8.2).

Table 504 Fuel pump pressure

Heater version	Operating voltage	
	24V	12V
Thermo E+ 120	9 +0.5 bar	9 +0.5 bar
Thermo E+ 200	9 +0.5 bar	9 +0.5 bar
Thermo E+ 320	9 +0.5 bar	9 +0.5 bar

5.6.10 Solenoid valve inspection

Caution!	**Risk of burns!**

The coil of the solenoid valve can heat up in switched-on condition..

The solenoid valve must only be completely replaced.In case of replacement or assembly a new gasket ring must be used.

NOTE:
Due to system characteristics draining the space between solenoid valve and nozzle bore may cause fuel dripping from the atomizer nozzle for a short period of time.

A leaking valve seat of the solenoid valve can be indicated by smoke development in the heater during the purge cycle. Fuel drips from the atomizer nozzle. A not closing solenoid valve can lead to a heater shut-down during purge cycle and a heater lock-out.

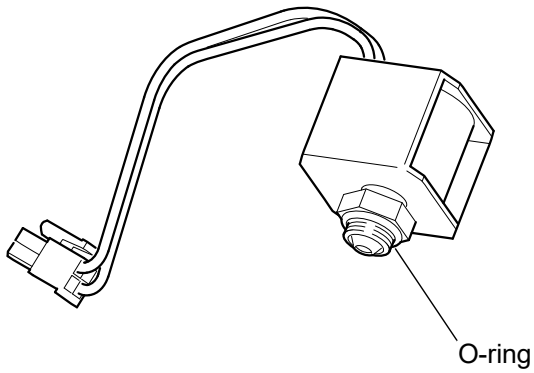


Fig.509 Solenoid valve

It is possible to manually test the electrical functionality of the solenoid valve, and using the Component Test menu of the DTT diagnosis.

Inspection using the DTT diagnosis

- Remove burner (see 8.2).
- Connect the DTT diagnosis to the heater using the adapter wiring harness (ref. to Operating Instructions for the DTT diagnosis).

- Reconnect the heater with the vehicle electrical system.
- Start DTT diagnosis, establish connection to the heater and open the Component Test menu.
- In the Component Test menu, select the solenoid valve and start the test.
- The solenoid valve must audibly open.
- After test completion, terminate DTT diagnosis as needed.
- Disconnect the heater from the vehicle electrical system (**Observe** 5.2 !).
- Remove the DTT diagnosis adapter wiring harness as required.
- Reinstall burner (see 8.2).

The electrical function of the solenoid valve may be also checked manually.

Manual check:
- Remove burner (see 8.2).
- Unplug the solenoid valve connector from the control device.
- Check electrical function by applying DC voltage:

	24V	12V
Opening voltage [V]	ab 17.0	8.5
Power consumption at 20°C [W]	9	9
Nominal current [A]	0.37	0.75

The solenoid valve must audibly open when the DC voltage is applied.

- Reconnect the solenoid valve connector to the control device.
- Reinstall burner (see 8.2).

5.6.11 Nozzle block preheater inspection

For nozzle block preheating description, see 3.1.6.

ATTENTION:
There are 2 versions of the nozzle block preheater heating element (see 3.1.6).

Caution!	**Risk of burns!**

The heating element of the nozzle block preheater can heat up during inspection.
Do not pull heating element out of the nozzle holder during inspection.

NOTE:
At a temperature below 0°C ±4°C the thermostat switches the heating element on. The heating duration depends on the temperature of the intake air and the heat reflection from the combustion space. Above 8°C ±3°C the thermostat switches off.

Inspection using the DTT diagnosis

- Remove burner (see 8.2).
- Connect the DTT diagnosis to the heater using the adapter wiring harness (ref. to Operating Instructions for the DTT diagnosis).
- Reconnect the heater with the vehicle electrical system.
- Start DTT diagnosis, establish connection to the heater and open the Component Test menu.
- In the menu Component Test select the BM/NPH and proceed according to the instructions of the DTT diagnosis.
  Enter runtime and then start the component test.
  In order to heat up the heating element, a temperature below 0°C ±4°C must be applied to the thermostat.
  Caution: At the same time the burner motor is started too.

Nominal condition: The heating element warms up.

- After test completion, terminate DTT diagnosis as needed.

Warning!	**Danger of severe burn injuries!**

Inadvertent operation of the removed burner can cause severe burn injuries. If the burner and heat exchanger are separated, do not connect the temperature sensor to the control unit.

- Disconnect the heater from the vehicle electrical system (**Observe** 5.2 !).
- Remove the DTT diagnosis adapter wiring harness as required.
- Reinstall burner (see 8.2).

Manual inspection

- Remove burner (see 8.2).
- Unplug the nozzle block preheater connector from the control device.
- Remove the nozzle block preheater as required.
- Measure the resistance with an ohmmeter on the wires that come directly from the heating element (one measuring tip on the plug, another measuring tip on the thermostat - contact to the heating element).

  Limits:
  12V Version: 1..3 Ohm
  24V Version: 5..8 Ohm
- Install the nozzle block preheater as required.
- Reconnect the nozzle block preheater to the control device.

  ATTENTION:

  When connecting, danger of confusion with the electronic ignition unit (see Fig. 303)!
- Reinstall burner (see 8.2).

6 Wiring diagrams

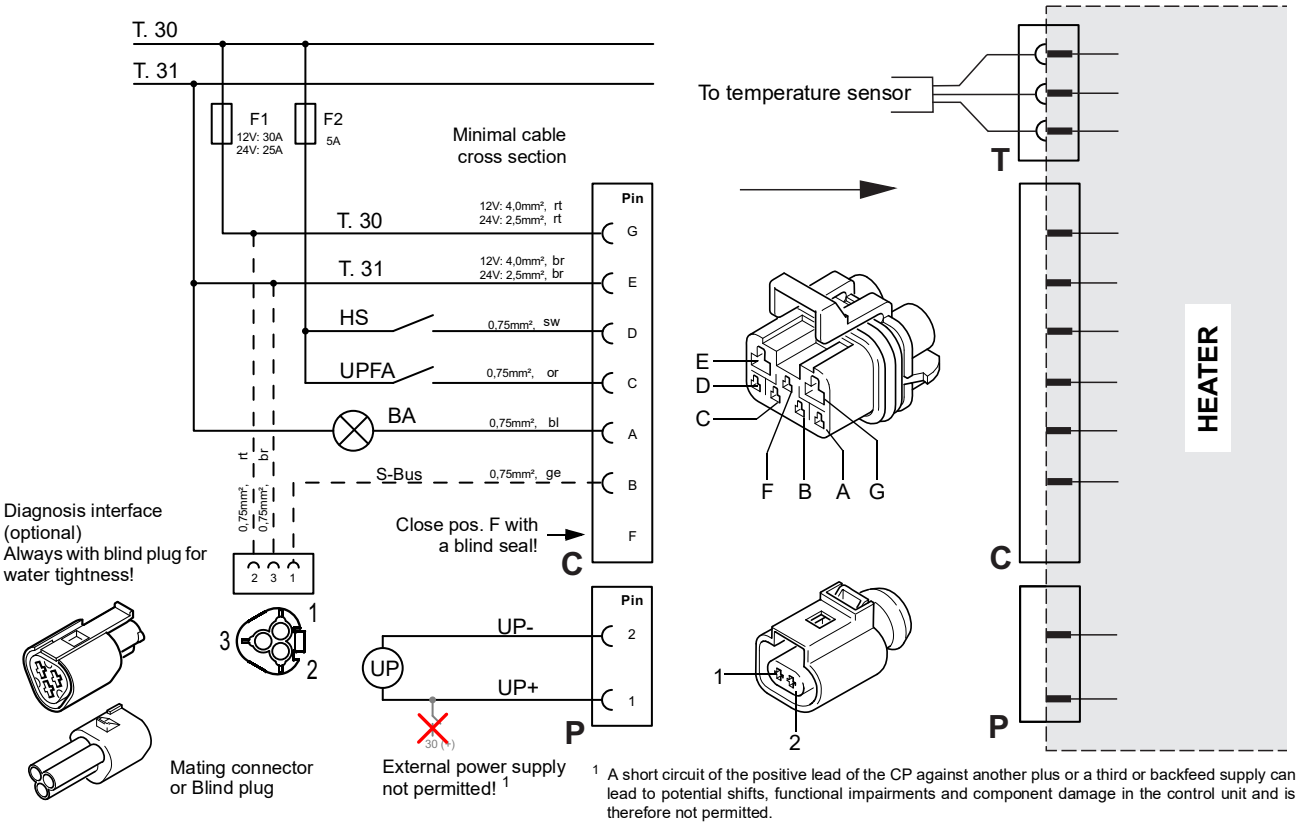
6.1 General

The following figures show the connection options of the heater to the vehicle electrical system.

ATTENTION:

The repair or replacement of cables and / or plugs must be carried out in accordance with the instructions in the Thermo E + Installation instructions.

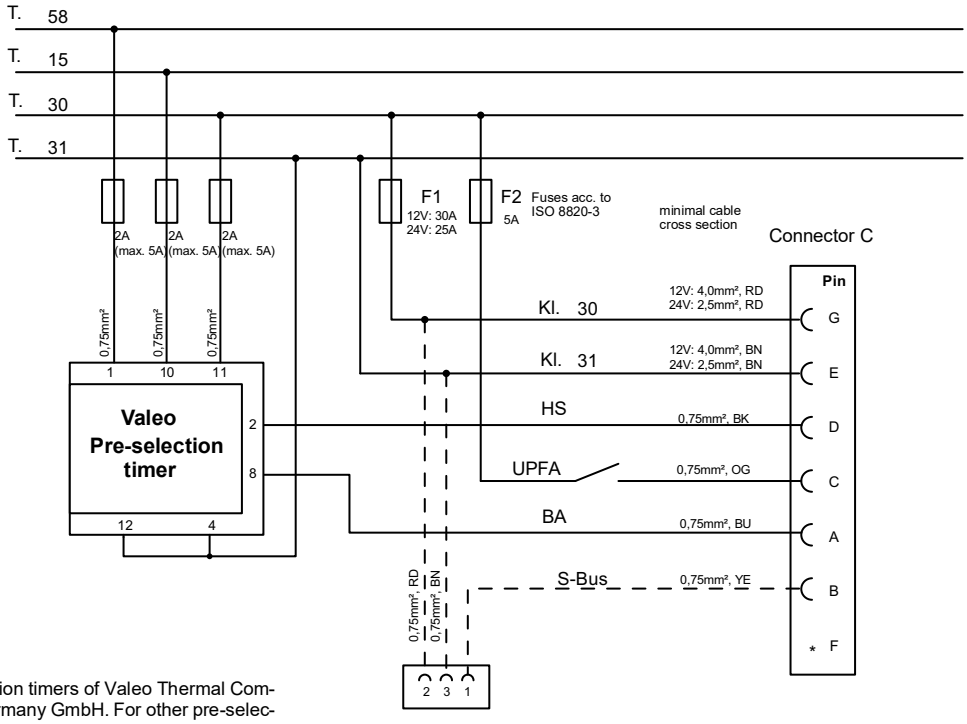
It contains all the necessary information about the required cable assembly including the connectors.



1 A short circuit of the positive lead of the CP against another plus or a third or backfeed supply can lead to potential shifts, functional impairments and component damage in the control unit and is therefore not permitted.

ATTENTION: Further information on cable assembly in the Thermo E + installation instructions!

Fig. 601 Hook-up plan for heaters Thermo E+ with switch, legend see page 603

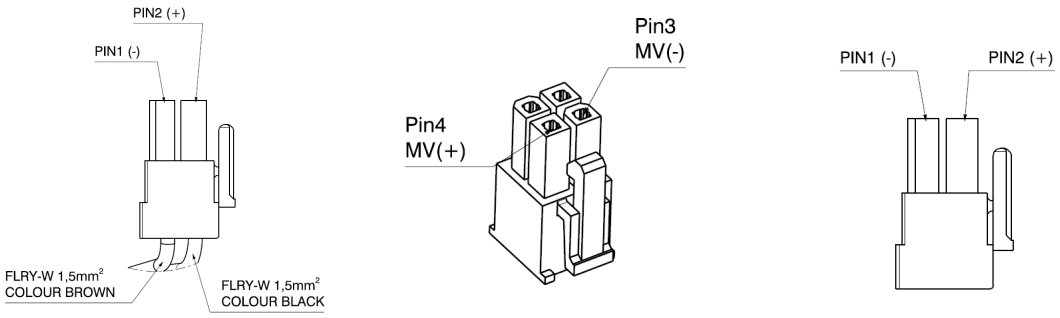


NOTE:
Applies to pre-selection timers of Valeo Thermal Commercial Vehicles Germany GmbH. For other pre-selection timers, the pinning may differ.

Fig. 602 Pin assignment of connector C if pre-selection timer 1531 is used, legend see page 603

Item	Description
F1	Car flat-type fuse 30A at 12V / 25A at 24V acc. to DIN 72581 part 3 or ISO 8820-3
F2	Car flat-type fuse 5A acc. to DIN 72581 part 3 or ISO 8820-3
BA	Operation indicator max. 5 W
UP	Circulating pump
HS	Main switch
UPFA	Circulating pump external control
T	Connector/connection of temperature sensors
C	Connector/connection to vehicle
P	Connector/connection circulating pump

Legend for hook-up diagram



Motor | Solenoid Valve | Nozzle Block Preheater

ATTENTION:
There are 2 versions of the nozzle block preheater heating element (see 3.1.6).

Fig. 603 Connector pin assignment

7 Servicing

7.1 General

Warning!	Danger to life and health!

The safety information and regulations in Chapter 1 (see 1.6) must be adhered.

7.1.1 Heater servicing

For risk of overheating, the battery main current may not be disconnected, while the heater is operating or in purge cycle.
Make sure that the circulating pump is running while the heater is switched on for tests/inspections.

7.2 Servicing

In order to ensure long-term functional reliability, the following maintenance activities should be performed on the heater.

7.2.1 Periodic heater maintenance

Scope and intervals of the periodic maintenance of the heater can be found in Anhang A of this Workshop Manual.

7.2.2 CO_2 Measurement and setting

CO_2 Measurement

The exhaust should not be measured directly at the exhaust outlet of the heat exchanger, as this may cause inaccuracies.
Exhaust fumes should be sampled from the exhaust pipe in a distance of 350 mm after the heat exchanger. At this place also the measurement of the exhaust gas temperature should be performed. If no exhaust pipe is connected for this measurement a flexible hose of approx. 500 mm length (see accessories catalog) can be installed. Increased exhaust temperature may indicate a sooted heat exchanger (see 5.6.2) or a non-switched filter heating.

1. After a combustion period of approx. 3 min. measure the CO_2 content in the exhaust and compare it with the target value in Fig. 702.
2. Determine smoke number as needed. Target value according to Bacharach: ≤ 4. (at romm temperature).

A factory set combustion air amount change is permitted an can be achieved by rotation of the adjustment ring. The measurement of the CO_2 content in the exhaust gas and the adjustment of the combustion air amount is to be performed:

- after repairs at the burner
- in case of combustion irregularities
- in the course of a functional inspection
- after fuel nozzle replacement
- for application adaption
- for permanent operation at large altitudes

CO_2 Setting

1. Measure or read from diagnosis the heater input voltage.
2. Operate the heater approx. 3 min.
3. Measure the CO_2 content and compare readings with the appropriate diagram (see Fig. 702).
4. Loosen the fixation screw (see Fig. 701) and rotate the adjustment ring with the fixation screw until the target value is reached.

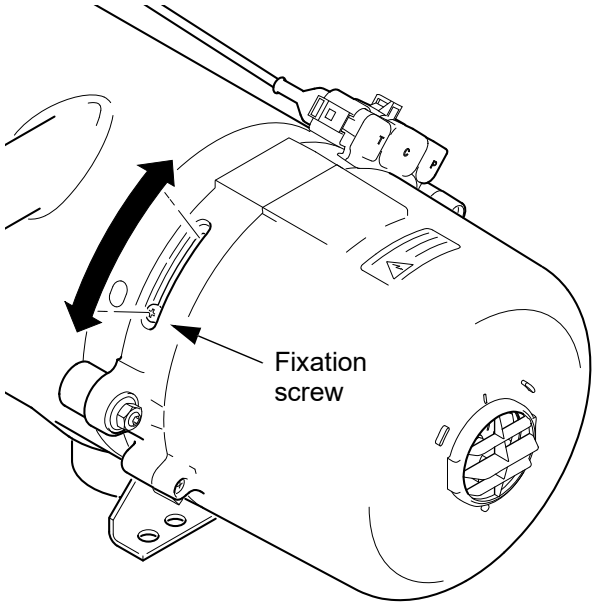


Fig. 701 Fixation screw for CO_2 setting

5. Torque fixation screw to 2.0 + 0.5 Nm and apply lokking compound.

NOTE:
The CO_2 setting depends on the fuel (viscosity) and the geodesic altitude (Delta 0.17 … 0.13 Vol-% per 100 m).

If the CO_2 value cannot be adjusted to target value proceed as follows:

- Inspect burner head on the air side for damage and replace damaged parts as needed.
- Inspect suction / exhaust gas applications for damages (reduced cross-section).
- Check heat exchanger for sooting.
- Inspect heat exchanger exhaust gas outlet.
- Inspect combustion chamber.
- Check disc.
  - Present?
  - Correct disk with respect to thermostat hole?
  - Bent?)
- Measure the burner motor speed and compare with the values in table in 5.6.6, replace if necessary.
- Check the fuel filter for contamination and replace if required.
  - clogged?
  - clouding (flocculation of paraffin)?
  - different fuels used
    (filled different fuels, different cold resistance or incompatibility)
- Replace fuel nozzle.
- Use other applications, particularly for combustion air supply.
- Verify fuel pump pressure according to 5.6.9 and readjust or replace fuel pump if required.

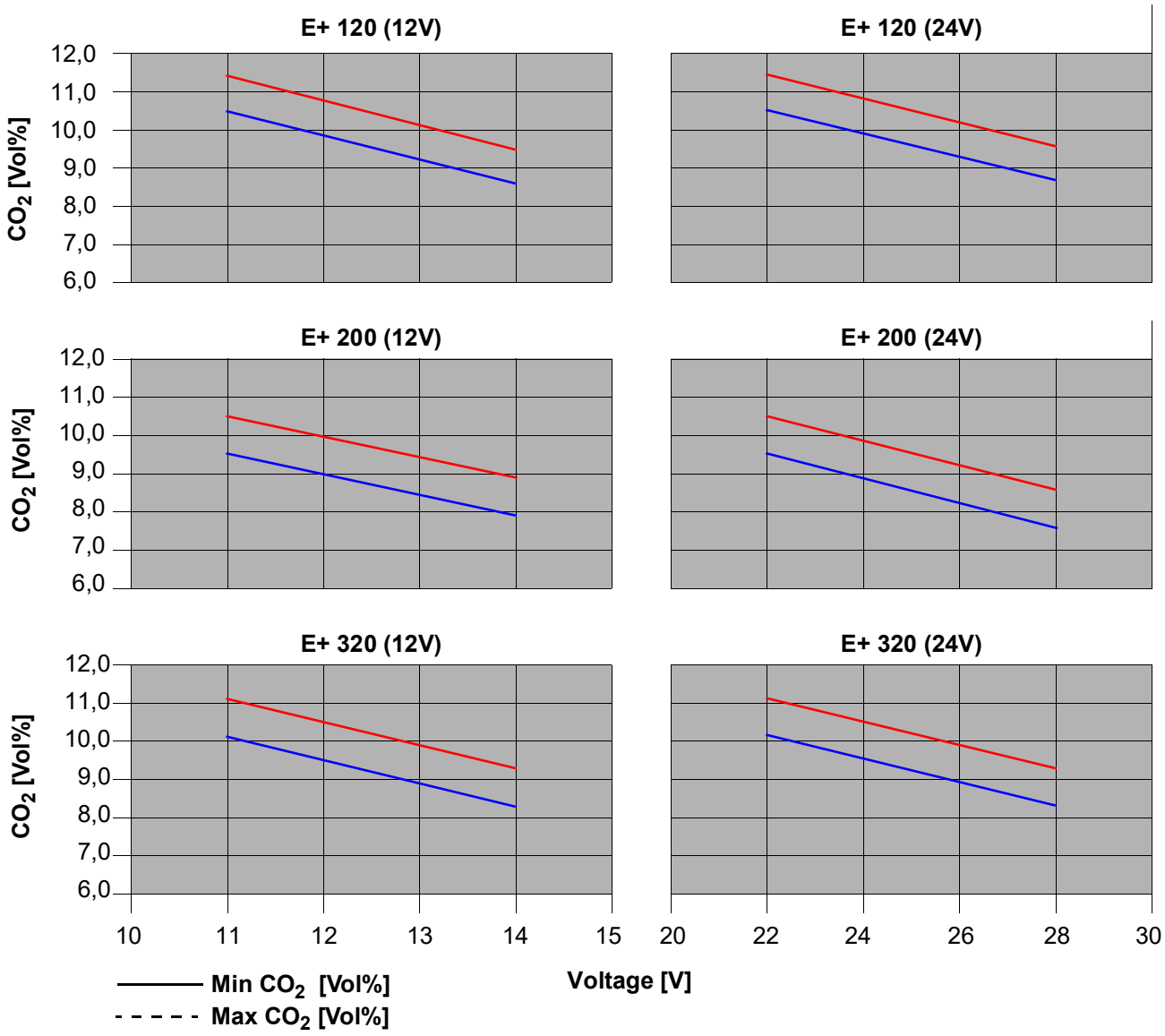


Fig. 702 CO_2 Content

8 Burner, components and heater removal and installation

8.1 General

Warning!	Danger to life and health!

The safety hints and regulations in Chapter 1 (see 1.6) must be adhered.

ATTENTION:
Prior to disassembling components the heater must be disconnected from the vehicle electrical system (Observe 5.2 !).

Sealing elements between disassembled components must be principally renewed.
This does not apply to the temperature sensor gasket ring, as it is permanently attached.
Screws with coated threads must be renewed.

Before installing components always check whether the correct version is available with regard to the voltage for which the heater is designed or the heating capacity class.

NOTE:
If components are disassembled to a degree not covered in this workshop manual, any warranty claim shall be voided.
Only genuine Valeo spare parts should be used.

Symbol tightening torque:
Features in graphics parts (e.g. nuts, bolts) that are to be mounted with a specific tightening torque. The values for the tightening torque are at the symbol and are binding.

8.2 Burner removal and installation

Burner removal

1. Disconnect the heater from the vehicle electrical system (**Observe** 5.2 !).
2. Disconnect the plug for the power supply/control (C).
3. Disconnect the plug for the circulating pump (P).
4. Disconnect the temperature sensor plug (T).
5. If necessary, disconnect the combustion air intake line from the heater.

NOTE:

Make sure that any fuel leaking during the following work step is immediately bound and professionally disposed of.

6. Pull off fuel lines (4, Fig. 801) from the banjo or loosen them by removing the banjo bolt and close with blind plugs.
7. Unscrew combination nuts (2).
8. Remove burner (1).

NOTE:

Do not bent any lines when placing the burner down.

Back to
8.7. - Disc and dust protection tube removal
8.9. - Solenoid valve removal
8.13 - Combustion chamber removal
8.15 - Heater removal

Burner installation

1. Bring burner (1, Fig. 801) n assembly position and ensure center alignment and correct fit. Cables must not be crushed, pinched or kinked.
2. Place combination nuts (2) and alternately tighten them slightly.
3. Tighten combination nuts (2).

ACHTUNG:

The two combination nuts M8, connecting the burner and the heat exchanger, must be tightened to torque, see Fig. 801, each and additional are to be secured using thread lock.

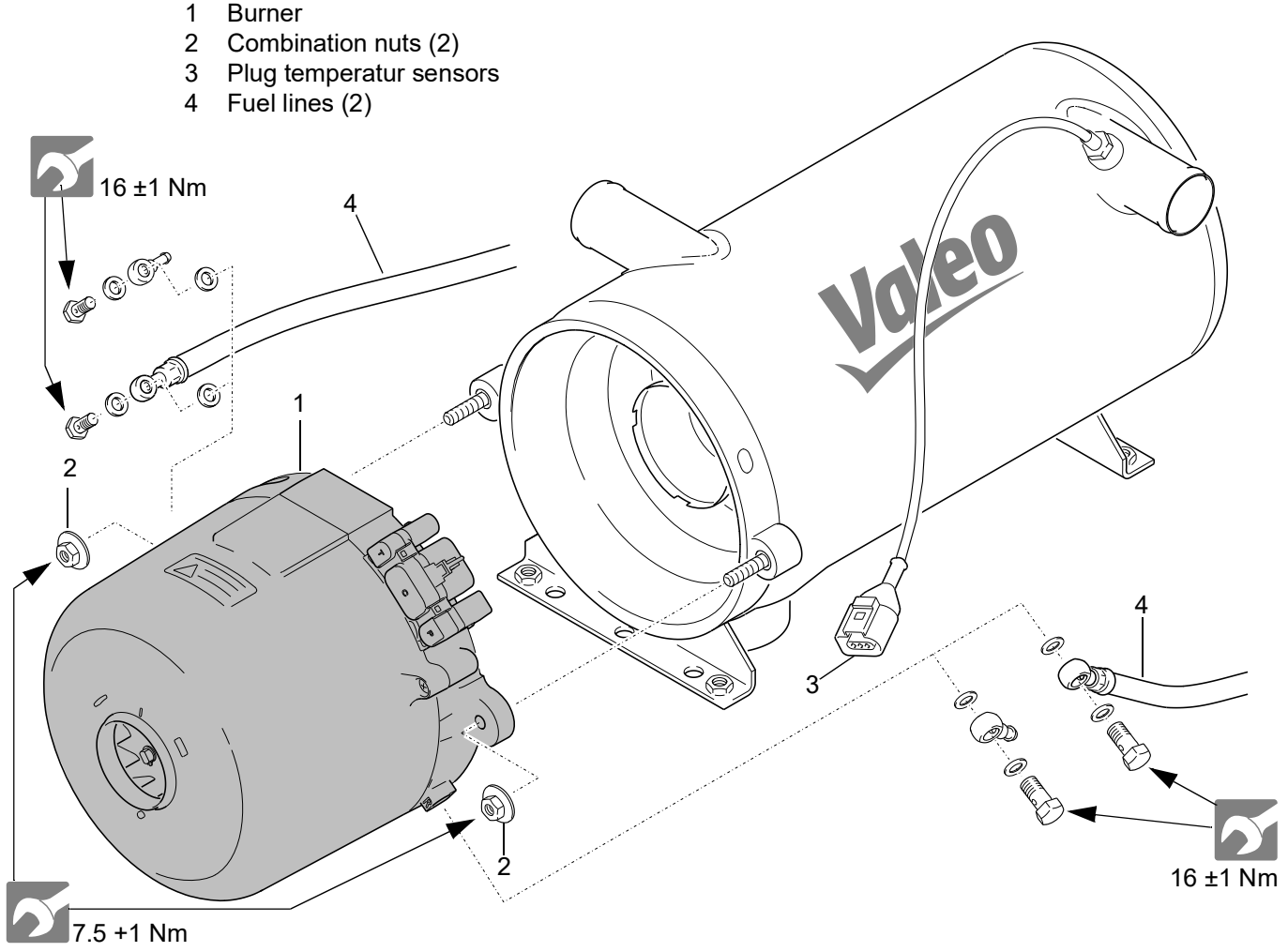


Fig. 801 Burner removal and installation

4. If applicable, bolt fuel lines down using a banjo bolt and new gaskets, or slide on fuel lines and secure with hose clamps.
5. If applicable, secure the combustion air intake line to the heater.
6. Connect the temperature sensor plug (T).
7. Connect the plug for the circulating pump (P).
8. Connect the plug for power supply/control (C).
9. Connect the heater with the vehicle electrical system.
10. Bleed the fuel supply system (see 8.16.1).

Back to:
8.15 - Heater installation

8.3 Removal and installation of the temperature sensors

Caution!	**Risc of scalds!**

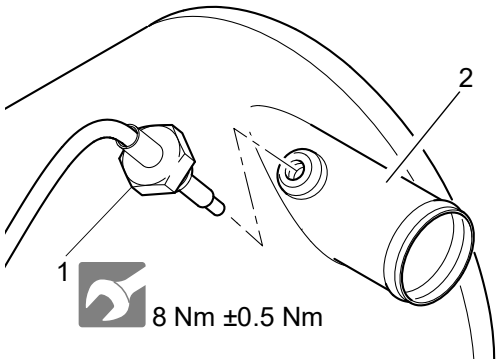
Observe the risk of injuries due to increased coolant-temperature.
Prior to removing the temperature sensors, the over-pressure in the cooling system must be released (e.g. by opening the cooler lid). Possibly let the heater before cool down and have collecting container ready for discharged coolant.

Removal
1. Disconnect the heater from the vehicle electrical system (**Observe** 5.2 !).
2. Disconnect the temperature sensor plug (3, Fig. 801).

ATTENTION:
The temperature sensors are positioned directly in the coolant circuit. To prevent coolant from escaping as far as possible, the coolant hoses are to be closed with pinch-off pliers.

3. Unscrew and remove the temperature sensors (1, Fig. 802). Collect the escaping coolant.

Installation
1. Manually screw the temperature sensors (1, Fig. 802) into the coolant outlet (2).
2. Tighten the temperature sensors (1).
3. Connect the temperature sensor plug (3,Fig. 801).
4. Connect the heater to the vehicle electrical system.



1 Temperature sensors
2 Coolant outlet

Fig. 802 Removal and Installation of the temperature sensors

8.4 Hood removal and installation

Removing the hood provides access to the following components for maintenance, inspection and repair purposes:

- Fan
- Burner motor
- Control device
- Coupling

Removal
1. Loosen screws (2, Fig. 804).
2. Remove hood (1).

Back to:
8.5 - Burner motor removal
8.6 - Control device removal

Installation
1. Place hood (1, Fig. 804) in assembly position. Ensure center alignment and proper fit.
2. Turn in the screws (2) and tighten them.

Back to:
8.5 - Burner motor installation
8.6 - Control device removal and installation

8.5 Burner motor removal and installation

Removal

1. Remove disc with dust protection tube (see 8.7).
2. Remove hood (see 8.4).
3. Unplug the burner motor connector (7, Fig. 804) from control device.
4. Remove grommet
5. Remove fan wheel (4). For that remove the shaft circlip (3) using suitable pliers.

ATTENTION:

Do not overstretch the shaft circlip.

6. Remove the three cylinder screws (6)
7. Remove the burner motor (5).
8. Pull coupling part (8) off the motor shaft.

Back to:
8.12 - Fuel pump removal and installation.

Installation

1. Slide the coupling part (8, Fig. 804) onto the motor shaft.
2. Position motor (5) onto the fuel pump (9).

NOTE:

The coupling part on the motor shaft must engage in the coupling part of the fuel pump.
When positioning the motor, the stud on the fuel pump housing must be in the hole provided for it in the motor flange, see Fig. 803).

3. Secure motor (5, Fig. 804) using three cylinder screws (6). Tighten cylinder screws.
4. Install fan wheel (4). Install shaft circlip with suitable pliers.

ATTENTION:

Do not use an overstretched shaft circlip! Ensure secure engagement of the circlip in the groove!

5. Feed the burner motor connector (7) with cable through the opening in the fuel pump housing (9) and install grommet.
6. Plug the burner motor connector (7) into the control device.
7. Install hood (see 8.4).
8. Install disc with dust protection tube (see 8.7).

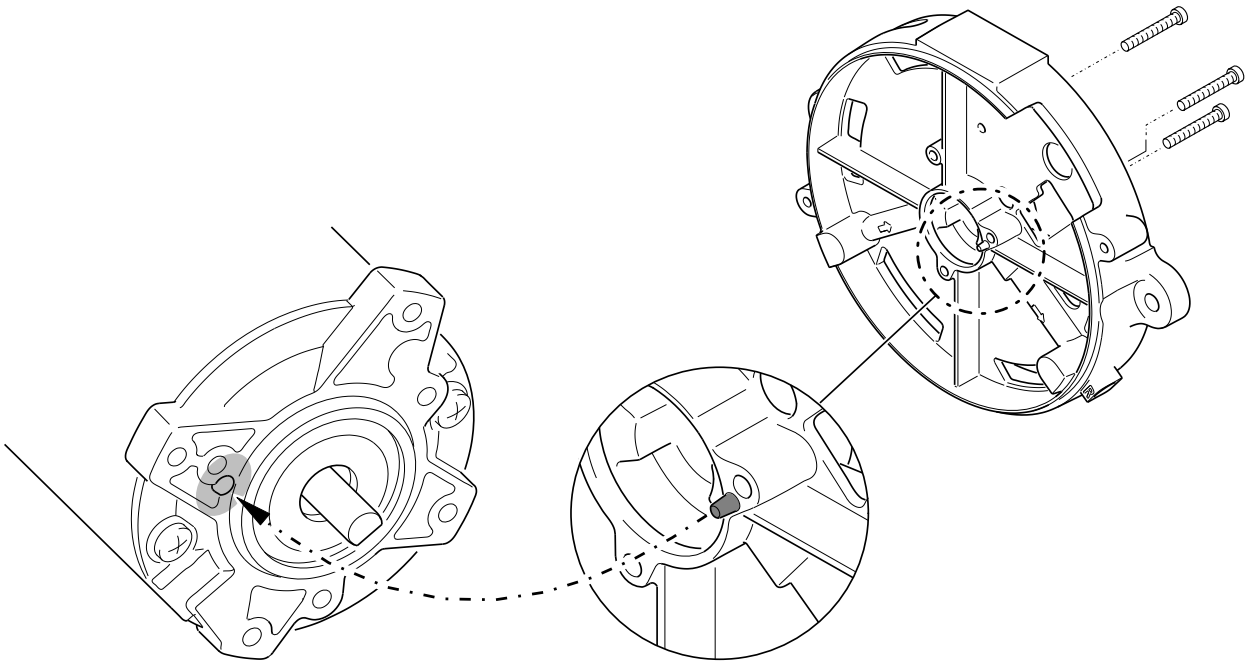


Fig. 803 Burner motor positioning

1 Hood
2 Screws, hood (2)
3 Shaft circlip
4 Fan wheel
5 Burner motor
6 Screws, motor (3)
7 Motor connector
8 Coupling (two-part)
9 Fuel pump
10 Control device

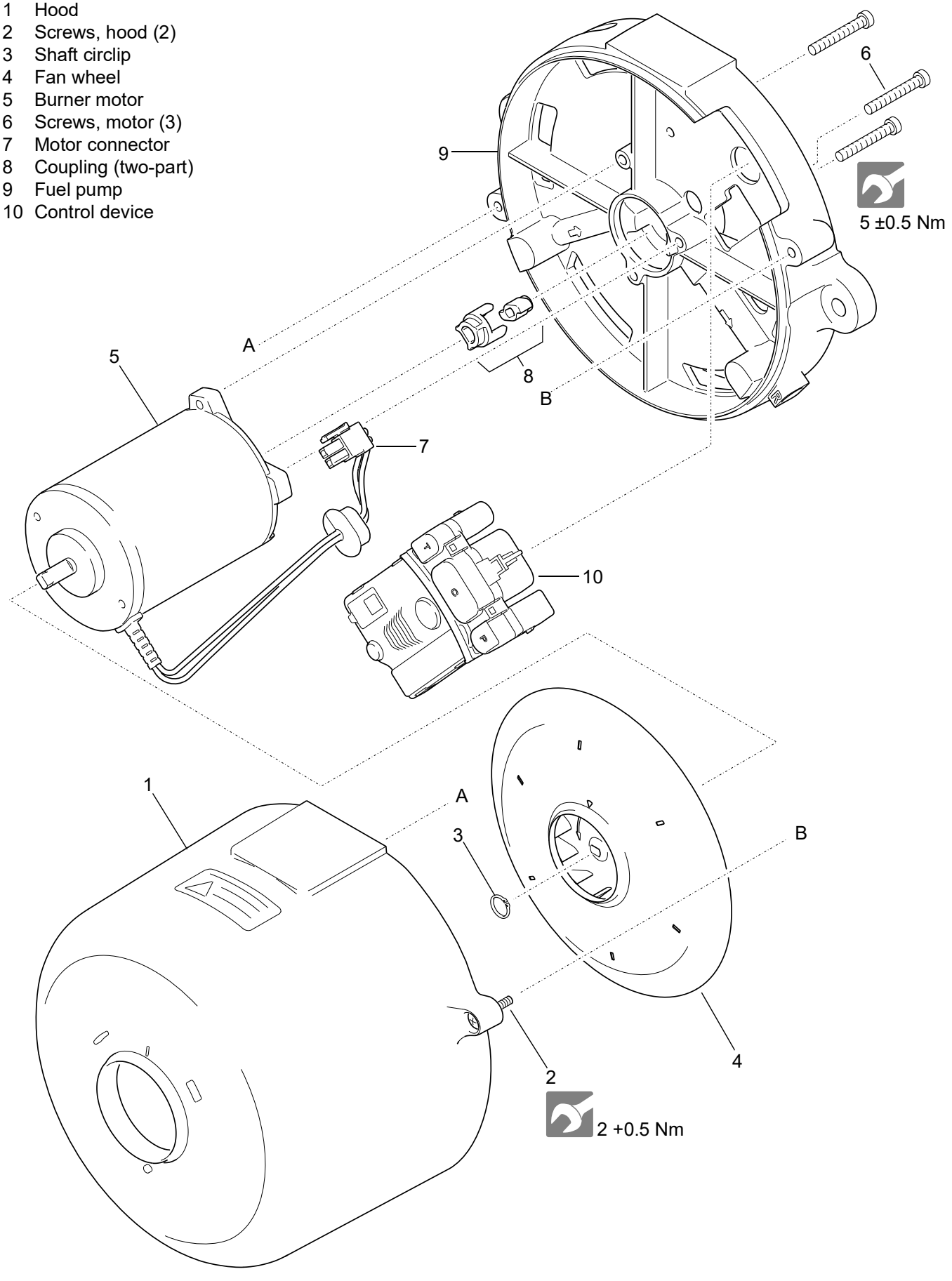


Fig. 804 Component removal and installation (1)

8.6 Control device removal and installation

Removal

1. Remove disc with dust protection tube (see 8.7).
2. Remove hood (see 8.4).
3. Unplug all internal connectors (motor, nozzle block preheating if installed, electronic ignition unit, solenoid valve) from control device (10, Fig. 804).
4. Loosen burner motor (5) cylinder screws (6) in such a way, that the control device (10) can be removed.
5. Remove control device (10).

Installation

1. Position control device (10, Fig. 804) to the fuel pump.
2. Screw the burner motor cylinder screws (6) in and tighten them.
3. Reconnect all internal connectors (motor, nozzle block preheating if installed, electronic ignition unit, solenoid valve) to the control device (10).

ATTENTION:

There are 2 versions of the nozzle block preheater heating element (see 3.1.6).
Do not confuse the connections of the electronic ignition unit and the nozzle block preheating!

4. Install hood (see 8.4).
5. Install disc with dust protection tube (see 8.7).

8.7 Disc with dust protection tube removal and installation

Removal

1. Remove burner (see 8.2) and clamp it.
2. If necessary screw the thermostat of the nozzle block preheating (6, Fig. 805) off.
3. Remove the circlip (2) from nozzle block using a suitable tool.
4. Remove disc (5), spring (10) and dust protection tube (11).

Back to:
8.5 - Burner motor removal
8.6 - Control device removal
8.8 - Electronic ignition unit removal
8.11 - Nozzle block preheating removal

Installation

1. If required install the thermostat of the nozzle block preheating (6, Fig. 805) using a serrated washer (3) and a nut (4).
2. Pre-assemble disc (5), dust protection tube (11) and spring (10).
3. Place disc (5) via fuel nozzle (1) and electronic ignition unit (7) onto the nozzle block. The lower end of the dust protection tube (11) is thereby pushed onto the lens of the flame guard in the control device (10, Fig. 804). Hold disc in position.
4. Install circlip (2, Fig. 805) using a suitable tool onto the nozzle block.

ATTENTION:

Do not bend disc!

Do not use an overstretched shaft circlip! Ensure secure engagement of the circlip in the groove!

There are 2 versions of the nozzle block preheater heating element (see 3.1.6).

5. Install burner (see 8.2).

8.8 Electronic ignition unit removal and installation

Removal

1. Remove disc with dust protection tube (see 8.7).
2. Unplug the connector of the electronic ignition unit (7, Fig. 805) from control device.
3. Remove screw (8) and electronic ignition unit (7).

Back to:
8.10 - Fuel nozzle removal

Installation

1. Position electronic ignition unit (7, Fig. 805) in installation position and secure using the screw (8).

ATTENTION:

Correctly insert the spark plug hook into the designated recess on the cover of the fuel pump.

2. Plug the connector of the electronic ignition unit (7) into the control device.
3. Install disc with dust protection tube (see 8.7).

8.9 Solenoid valve removal and installation

Removal

1. Remove burner (see 8.2).
2. Open the cable clamp which secures the cables of the solenoid valve.
3. Unplug the connector of the solenoid valve (14, Fig. 805) from control device.
4. Remove screw (18) and remove solenoid valve coil (15) with washer (17).
5. Unscrew sleeve with hexagon (16) from the nozzle block and remove along with the gasket ring (19).

Installation

1. Put new gasket ring (19, Fig. 805) onto the sleeve with hexagon (16) and screw sleeve with hexagon into the nozzle and tighten.
2. Put the solenoid valve coil (15) onto the sleeve and secure using washer (17) and screw (18). Tighten screw.
3. Plug the connector of the solenoid valve (14, Fig. 805) into the control device.
4. Fix the cables of the solenoid valve using the cable clamp.
5. Install burner (see 8.2).

8.10 Fuel nozzle removal and installation

Removal

1. Remove electronic ignition unit (see 8.8).

NOTE:
We recommend to use nozzle wrench item no. 66971_ for nozzle disassembly and assembly.

2. Screw off fuel nozzle (1, Fig. 805).
   If no nozzle wrench is used, excert counter pressure at the key face of the nozzle block of the fuel pump (9) using a suitable tool.

Installation

1. Screw in fuel nozzle (1, Fig. 805) and tighten it.
   If no nozzle wrench is used, excert counter pressure at the key face of the nozzle block of the fuel pump (9) using a suitable tool.

2. Install electronic ignition unit (see 8.8).

8.11 Nozzle block preheating removal and installation (optional)

Removal

1. Remove disc with dust protection tube (see 8.7).

2. Unplug the connector of the nozzle block preheating (6, Fig. 805) from control device (10, Fig. 805) .

3. Remove retaining clip (20, Fig. 805).

4. Withdraw heating element of the nozzle block preheating (6, Fig. 805) from out the nozzle block and remove from heater.

Installation

1. Place the heating element of the nozzle block preheating (6, Fig. 805) into the nozzle block and secure with retaining clip (20).

ATTENTION:
There are 2 versions of the nozzle block preheater heating element (see 3.1.6).

2. Plug the connector of the nozzle block preheating (6) into the control device (10, Fig. 805).
3. Install disc with dust protection tube (see 8.7).

8.12 Fuel pump removal and installation

NOTE:
Make sure that any fuel leaking is immediately collected, bound and professionally disposed of.

Removal

1. Remove the burner motor (see 8.5).
2. Unplug all internal connectors (nozzle block preheating if installed, electronic ignition unit, solenoid valve) from control device (10, Fig. 804).
3. Remove control device (10).
4. Remove screw (8, Fig. 805) of the electronic ignition unit (7) and remove electronic ignition unit.
5. Remove coupling part (8, Fig. 804) off the shaft of the fuel pump (9).
6. Remove fixation screw (13, Fig. 805) of adjustment ring (12) and remove adjustment ring from fuel pump (9).
7. Screw fuel nozzle (1) off (refer to notes in 8.10).
8. If required remove retaining clip (20) of the nozzle block preheating (6) and remove nozzle block preheating from fuel pump.
9. If required remove the solenoid valve (14) from the fuel pump (see 8.9).

ATTENTION:

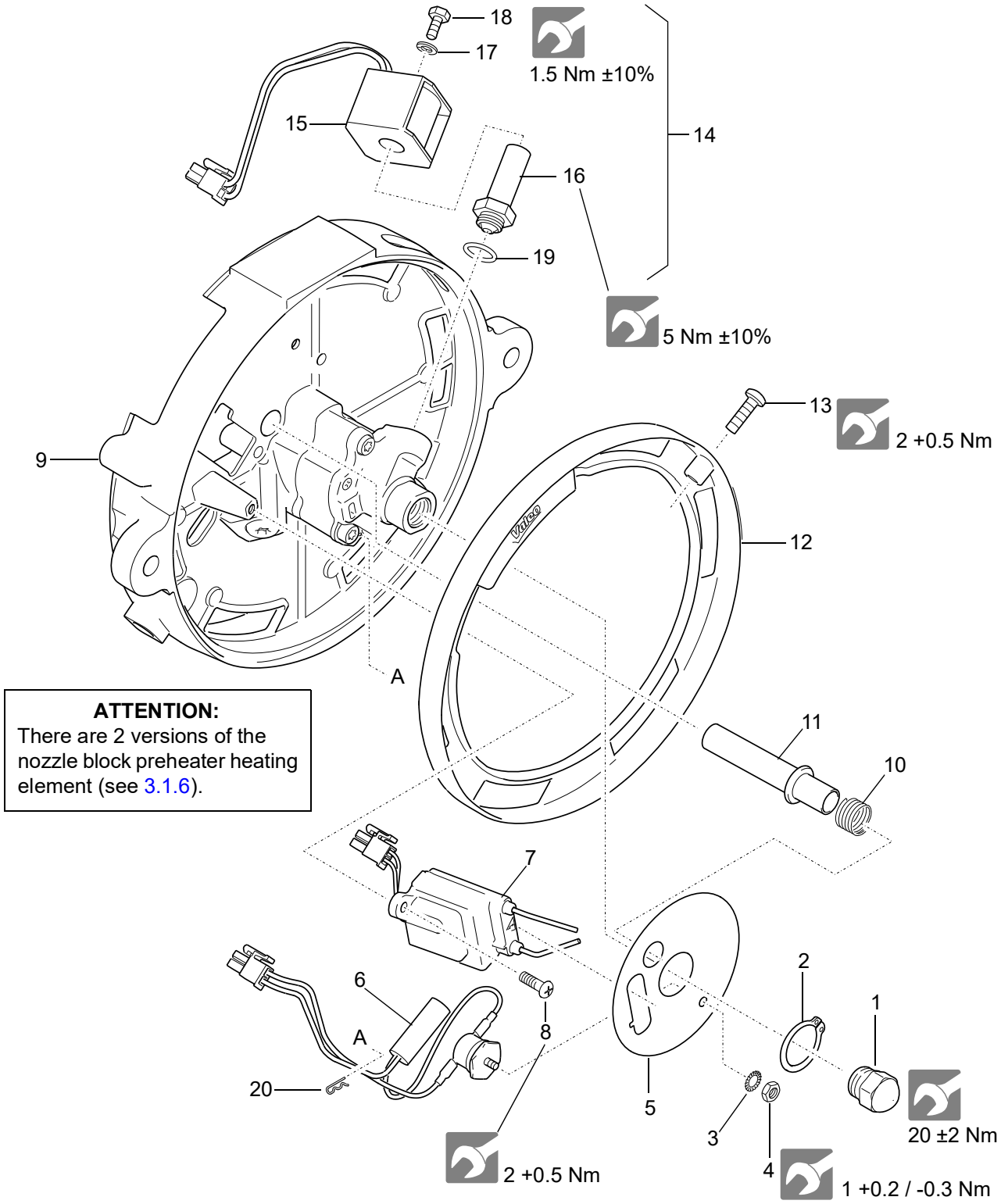
The disassembly of the fuel pump is not permitted and will result in the loss of any warranty claims.

Installation

1. Install solenoid valve (14, Fig. 805) onto the fuel pump (9) as necessary (see 8.9).
2. Install heating element of the nozzle block preheating (6) into the fuel pump and secure with retaining clip (20) as necessary.

ATTENTION:
There are 2 versions of the nozzle block preheater heating element (see 3.1.6).

3. Screw fuel nozzle (1) in (consider notes in 8.10).
4. Place adjustment ring (12) into the fuel pump and secure with fixation screw (13).
5. Slide the coupling part (8, Fig. 804) onto the shaft of the fuel pump (9).
6. Position electronic ignition unit (7, Fig. 805) in installation position and secure still rotatable using the screw (8).



1 Fuel nozzle
2 Circlip
3 Serrated washer
4 Nut
5 Disc
6 Nozzle block preheating (opt.)
7 Electronic ignition unit
8 Screw
9 Fuel pump
10 Spring
11 Dust protection tube
12 Adjustment ring
13 Screw
14 Solenoid valve assy
15 Solenoid valve coill
16 Sleeve with hexagon
17 Spring washer
18 Screw
19 Gasket ring
20 Heating element retaining clip nozzle block preheating (opt.)

Fig. 805 Component removal and installation (2)

7. Position control device (10, Fig. 804) onto the fuel pump (9).
8. Plug all internal connectors (nozzle block preheating if installed, electronic ignition unit, solenoid valve) into the control device (10).
9. Install burner motor (see 8.5).
   In process of that, after installing the circlip (2, Fig. 805), tighten the screw (8) of the electronic ignition unit (7).

8.13 Combustion chamber removal and installation

Removal

1. Remove burner (see 8.2).
2. Pull the combustion chamber (1, Fig. 806) out of the heat exchanger (2) herausziehen.

Installation

ATTENTION:
When replacing the combustion chamber, ensure that the new combustion chamber corresponds to the heating capacity class of your heating appliance.

1. Slide combustion chamber (1, Fig. 806) fully into the heat exchanger (2) against stop. Pay attention to
   a) the welding seam position, and
   b) the position of cut-outs in the combustion chamber head.

1 Combustion chamber
2 Heat exchanger
3 Exhaust outlet
4 Stand
5 Coolant inlet
6 Coolant outlet
7 Coolant hose (2x)
8 Hose clamp (2x)

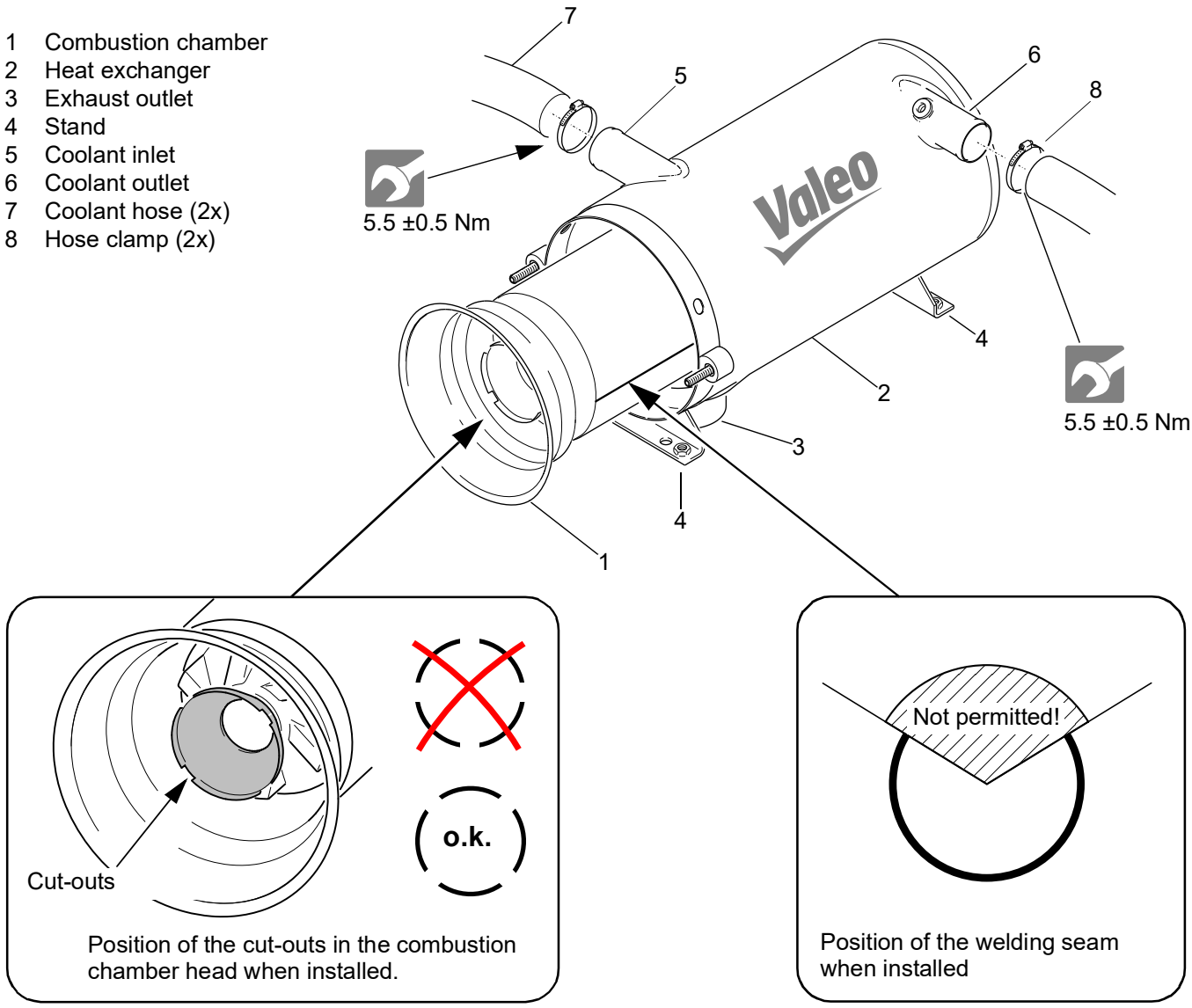


Fig. 806 Combustion chamber removal and installation

NOTE:

– The combustion chamber should be inserted into the heat exchanger in such a way that its welding seam is positioned between 2 and 10 o clock (not upwards!) (Fig. 806). A position change during maintenance is permissible and affects the expected service life of the combustion chamber positively.
– Position the cut-outs in the combustion chamber head as shown in Fig. 806. Dripping from nozzle fuel is so collected in a reservoir between disc and burner head and will be burned at the next burner operation instead to soil the heater.

2. Install burner (see 8.2).

8.14 Heat exchanger removal and installation

Caution!	**Risk of burns!**

The combustion chamber and heat exchanger can bevery hot. If necessary, let them cool down.

Removal

1. Disconnect the heater from the vehicle electrical system (**Observe** 5.2 !).
2. Unplug connector of the temperature sensors (3, Fig. 801).
3. Remove combination nuts (2) and separate burner (1) from the heat exchanger.
4. If necessary, loosen the exhaust line clamp on the exhaust outlet (3, Fig. 806).
5. If existing, close water taps.

Caution!	**Risk of scalds!**

Risk of injuries if coolant temperature is increased.

6. Loosen hose clamps on the coolant hoses, pull coolant hoses from the coolant inlet (5) and the coolant outlet (6) and seal with blank plugs.
7. Remove screws and washers of the heat exchanger stand (4).
8. Pull combustion chamber (1) out of the heat exchanger (2).
9. If necessary remove temperature sensors (see 8.3).
10. Remove heat exchanger from vehicle.

Installation

1. Position the combustion chamber (1) correctly into the heat exchanger (2) (see Fig. 806).
2. If necessary install the temperature sensors (see 8.3).
3. Bring heat exchanger (2) into installation position and mount stand (4) using screws, nuts and washers to the vehicle according to the mounting points used.
4. If necessary, secure the exhaust line using a clamp to the exhaust outlet (3).
5. Fit coolant hoses (7) onto the coolant inlet (5) and the coolant outlet (6) and secure with hose clamps (8).
6. f available, open water taps.
7. Bring burner (1, Fig. 801) in assembly position and ensure center alignment and correct fit.
8. Place nuts (2) and alternately tighten them slightly.
9. Tighten nuts (2). For tightening torque, refer to Fig. 801).
10. Connect the heater with the vehicle electrical system.
11. Bleed coolant ciruit (see 8.16.2).

ATTENTION:

The two combination nuts M8, connecting the burner head and the heat exchanger, must be tightened to torque, see Fig. 801, each and additional are to be secured using thread lock.

8.15 Heater removal and installation

ATTENTION:

The fuel supply system must be subsequently bleeded (see 8.16.1).

The coolant circuit must be subsequently bleeded (see 8.16.2).

Removal

1. Remove burner (see 8.2)
2. Remove heat exchanger (see 8.14).

Installation

1. Install heat exchanger (see 8.14)
2. Install burner (see 8.2)
3. Bleed coolant circuit (see 8.16.2).
4. Bleed fuel system (see 8.16.1.).

8.16 Start-up after burner head or heater installation

The fuel system must be bleeded after burner installation.
The coolant circuit and the fuel system must be bleeded after heater installation.
In this process the vehicle manufacturer specifications must be observed.
Coolant and fuel connections must be checked for leak-tightness and tight fit during the test run.
If a malfunction occurs during heater operation, troubles-hooting must be performed (see chapter 5).

8.16.1 Bleeding the fuel system

The whole fuel supply system including the fuel filter must completely filled with fuel before initial start-up.
Bleeding is particularly important for the operation of heaters in a single-pipe system. The bleeding procedure is described in the documentation for the single-pipe kit.

Valeo recommends the usage ofa separate bleeding unit. Follow the appropriate instructions provided by the vehicle manufacturer. Verify the fuel supplied to the heater is bubble-free.

ATTENTION:
The fuel pump must not be used to fill / bleed the fuel system!

ATTENTION:
In the event no fuel comes to the fuel pump during initial start-up (dry running), there is a risk that the fuel pump will be damaged!

8.16.2 Bleeding of the coolant circuit

NOTE:
The coolant circuit must be principally bleeded according to the manufacturer specification.

Caution!	**Risk of scalds!**

Risk of scalds if coolant temperature is increased.

The Aquavent 5000 (U4814) and Aquavent 6000S (U4855) circulating pumps may only be switched on for bleeding, after dry operation can be excluded.
The Aquavent 5000S (U4854) and Aquavent 6000SC (U4856) circulating pumps may even in dry operation be switched on for bleeding.

Adjust the vehicle heating system to "warm" and refill coolant.
As soon as it is confirmed that the vehicle engine is filled with coolant, run vehicle engine with increased idle speed. Once the cooler thermostat opens, switch the vehicle engine off and check the coolant level. Refill coolant as needed.
While the vehicle engine is switched off, switch on the heater with the circulating pump and the vehicle heating fan. After the engine motor cooled down, the heater must automatically start and stop as soon as the upper swit-ching threshold is reached.

If the heater does not start automatically, it must be veri-fied, whether the heater overheating protection is trigge-red and the heater is in fault-lockout state.

Release the heater (see 4.4.2) and repeat the bleeding process.

9 Modifications and retrofits

For further optimization the heaters are continuously improved. Units in the field can usually be upgraded or retrofitted. For this purpose respective modification kits will be available. Information can be found on the Valeo homepage under Service.

10 Packing/storage/shipping

10.1 General

The heater or its components, which are sent to Valeo for inspection or repair, must be cleaned and packaged to ensure that handling, transport and storage will not damage them.

ATTENTION:
If a complete heater is sent back, it must be completely drained. While packaging and/or shipping it must be ensured that no fuel or coolant can leak.

Coolant inlet and outlet fittings as well as the fuel lines must be plugged and sealed using blank plugs.

The temperatures described in section 2 may not be exceeded during storage.

Periodic heater maintenance

The heater should be inspected in periodic time intervals, latest at the beginning of the heating period (time of increased heater usage due to present weather conditions). In principle the regulations of the vehicle manufacturers as well as the relevant regulations of the German Federal Railway Authority (EBA) and its technical service must be adhered. If there no such regulations, Valeo prescribes the here shown maintenance intervals for common applications. For the execution of the work, the corresponding workshop manual is to be used.
If heaters should be used in other vehicles and/or applications, the maintenance intervals may be shortened or extended. In such cases please contact your dedicated Valeo partner for further information.

Address of the operator	Date of maintenance
	Vehicle data

Heater data

Type of heater: Ident. no.: Serial no.:	Operating/ control device data acc. to diagnosis STT (Spheros Thermo Test)	Date of commision

Fuel ☐ Diesel fuel ☐ Biodiesel ☐ Heating oil EL

Check / Maintenance	Important notes	Check result OK	Check result not OK	Measured values, accomplished repairs
1. Electrical connections a) Examine electrical plug connections and the wiring harness for visible damages, replace as required.		☐	☐	
2. Heat exchanger a) Check for external damage, discoloration caused by overheating and leaks. b) Clean the heat exchanger inside and outside, remove soot and debris.	Determine overheating cause as needed (e.g. water circulation system), check overheat protection.	☐ ☐	☐ ☐	
3. Fuel system a) Inspect fuel lines and connections for leakage. b) Replace fuel filter insert with gasket. resp. replaceable filter.	Ensure connections to fuel flow and return lines are sealed tight! If biodiesel is used a semi annual filter change is prescribed by the manufacturer. Re-tighten screw connections and hose clamps.	☐ ☐	☐ ☐	

Check / Maintenance	Important notes	Check result OK	Check result not OK	Measured values, accomplished repairs
c) Fuel pump / fuel hoses **Note:** Observe technical information if biodiesel or FAME is used!	Replace the fuel pump every 5, the fuel hoses every 6 years, if biodiesel is used this interval is shortened	☐	☐	
d) Replace fuel screen with gasket in the pump.	**Technical Information Biodiesel / FAME see www.valeo-thermalbus.com**	☐	☐	
4. Burner head				
a) Inspect combustion air intake opening for clear passage.		☐	☐	
b) Inspect hood for damage.	Replace damaged parts.	☐	☐	
c) Clean flame detector inspection glass (in the disk).		☐	☐	
d) Inspect condition of the ignition electrodes, if required adjust or replace them.		☐	☐	
e) Replace atomiser nozzle.		☐	☐	
f) Check solenoid valve for leaks.	Activate combustion air motor using the diagnostic tool (STT), solenoid valve must be tight	☐	☐	
5. Exhaust system				
a) Inspect exhaust line for clear passage or damage, clean or replace it as needed.		☐	☐	
b) Remove combustion chamber from heat exchanger, inspect for damage and contamination, clean and replace as needed.		☐	☐	
c) Insert combustion chamber and mount burner head. Ensure proper fit and tight connection to the heat exchanger.		☐	☐	
d) Combined nuts (M8) for burner head attachment, tightening torque 7.5 +1 Nm, secure them.	Secure them with locking compound	☐	☐	
e) Measurements		☐	☐	
Target values and procedures are outlined in the workshop manual	Limits acc. to Regulation ECE-R 122			
Ambient temperature (° C) Exhaust temperature (° C)	see technical data heater	☐	☐	
CO_2 (Vol.-%) at 24V				
Thermo	10 ±0.5	☐	☐	
Thermo E 200	9.5 ±0.5	☐	☐	
Thermo E 300	10.0 ±0.5	☐	☐	
Thermo S	9.5 +1.5	☐	☐	
Thermo plus 230	9.0 +1.5	☐	☐	
Thermo plus 300/350	9.5 +1.5	☐	☐	
Thermo E+	9.0 + 1.5	☐	☐	
CO_2 (ppm) at 19V				
Rail versions	≤1000	☐	☐	
Smoke spot number acc. to Bacharach (all devices)	≤ 4	☐	☐	
Fuel pump pressure according to Workshop Manual				
Thermo, Thermo S	10 bar	☐	☐	
Thermo E 200, Thermo plus	8 +1 bar	☐	☐	
Thermo E 320	9 +1 bar	☐	☐	
Thermo E+	9 +0.5 bar	☐	☐	

6. Water system a) If available, inspect, clean as needed or replace water filter insert.		☐	☐	
7. Functional check a) If available, open shut-off valve of the fuel return line and water line. b) Check fault memory, clear it as needed using the diagnostic tool (STT). c) Check heater functionality. **Attention:** During the maintenance, check all screw connections for tightness (for corresponding torque values see Workshop Manual).	after at least 10 min heater operation	☐ ☐ ☐	☐ ☐ ☐	

memos

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