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Spheros Water heaters

Workshop Manual

**DBW 160**

**DBW 230(2020)**

**DBW 300**

**DBW 350**

Status: 07/2010

**BUTLER TECHNIK**

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## 1 Introduction

### 1.1 Contents and purpose

This workshop manual serves to support trained personnel in the repair of coolant heaters DBW 160/230/300/350.

The heater may only be operated with the specified fuel (diesel) and only with the type of electrical connection specified for the respective model.

### 1.2 Applicability of the manual

The manual is applicable for the heaters listed on the title page. The heaters mainly differ with regard to their technical data (see Section 4).

### 1.3 Meaning of the warning and safety notices

In this manual, the signal words DANGER, CAUTION and NOTE have the following meanings:

#### DANGER

This heading is used when incorrect compliance or non-compliance with instructions or procedures may result in injuries or lethal accidents.

#### CAUTION

This heading is used when incorrect compliance or non-compliance with instructions or procedures may result in damage to components.

#### NOTE

This headline is used to indicate particularly useful or special information.

### 1.4 Further documentation to be used

This workshop manual contains all information and instructions required for the repair of coolant heaters DBW 160/230/300/350.

The use of additional documentation is normally not required.

If required, the installation instructions and the operating instructions can be used in addition.

### 1.5 Safety information and regulations

As a rule, the applicable general regulations and instructions concerning accident prevention and work safety must be observed.

"General safety regulations" beyond the scope of these regulations are listed in the following.

The special safety regulations of importance for this manual are indicated in the relevant sections or process descriptions in the form of signal words (warnings, cautions, notes).

#### 1.5.1 General safety regulations

For the heaters DBW 160/230/300/350, type approvals according to EC directives 72/245/EEC (EMC) and 2001/56/EC (heater systems) have been granted, with the EC approval number:

e1\*2001/56\*0006xx

For installation, primarily the provisions of Annex VII to directive 2001/56/EC must be observed.

#### CAUTION

Non-compliance with the installation instructions and the notes contained will lead to exclusion of liability by Spheros. The same applies to repairs not carried out by experts or without the use of genuine spare parts. This will result in the invalidation of the General Build-Type Approval of the heater and hence the General Certification (German 'ABE').

**The year the heater was initially commissioned must be permanently marked on the type label by removing the relevant year.**

The heaters are approved for heating the vehicle engine and the passenger compartment. When the heater is used in vehicles not subject to the StVZO [German road-traffic licensing regulations] (e.g. ships), locally applicable regulations must be complied with.

The heater may only be installed in vehicles or in independent heating systems with a minimum coolant volume of 10 litres.

The heater may not be installed in the driver's or passenger's compartments of vehicles. If the heater is nevertheless installed in such a compartment, the installation case must be tightly sealed towards the vehicle interior. From the outside, the installation case must be sufficiently vented so that a maximum temperature of 85 °C in the installation case is not exceeded. If this temperature is exceeded, malfunctions may occur.

**DANGER**

**Because of danger of poisoning and suffocation, the heater must not, not even with a timer, be operated in enclosed rooms such as garages or workshops without exhaust-gas extraction systems.**

**Because of explosion hazard, the heater must be switched off at filling stations and filling systems.**

**CAUTION**

**Wherever flammable fumes or dust can form (e.g. near fuel, carbon, wood-dust, cereal storage sites or similar), the heater must be switched off due to explosion hazard.**

**The heater may not be operated in the vicinity of flammable materials, such as dry grass, leaves, cardboard boxes, paper etc.**

In the vicinity of the control unit, an ambient temperature of 110°C (storage temperature) must not be exceeded (e.g. when paint work is carried out on the vehicle). If the specified temperature is exceeded, permanent damage to the electronics may occur. When checking the coolant level, proceed according to the vehicle manufacturer's instructions. The coolant in the heating circuit must contain at least 10% of a brand-name anti-freeze agent.

Additives in the heating circuit may not be aggressive against metals, plastics and rubber and may not cause any deposits.

The opening pressure in the vehicle cooling system - usually indicated on the radiator cap - must range between 0.4 and 2.0 bar allowable working pressure (also applies to separate heating circuits).

**1.6 Legal requirements regarding the installation**

For installation, primarily the provisions of Annex VII to directive ECE R122 must be observed.

**NOTE:**

**The provisions of these directives are binding in the area of application of the ECE directive and should also be observed in countries without specific regulations!**

**(Excerpt from directive ECE R122, Appendix VII)**

7.1 A clearly visible operation indicator in the operator's field of vision must inform about the heater being switched on or off.

**Regulations regarding the installation in the vehicle**

**5.3.1 Area of application**

5.3.1.1 As stipulated in Section 5.3.1.2, combustion heaters must be installed according to the provisions of Section 5.3.

5.3.1.2 In class-O vehicles with heaters for liquid fuel, it is assumed that they comply with the provisions of Section 5.3.

**5.3.2 Positioning of the heater**

5.3.2.1 Parts of the vehicle body and other components in the vicinity of the heater must be protected from excessive heating and possible fuel or oil-induced soiling.

5.3.2.2 Even in the event of overheating, no fire hazard may be caused by the combustion heater. This provision is considered to be complied with if, during installation, relevant clearance to all components is maintained, sufficient ventilation is provided for or fire-resistant materials or heat shields have been used.

5.3.2.3 In class-M2 and M3 vehicles, the combustion burner may not be located in the passenger compartment. Its installation in the passenger compartment is, however, permissible when it is located in a properly sealed casing which also complies with the provisions of Section 5.3.2.2.

5.3.2.4 The label named in Appendix 7, Section 1.4 or a duplicate must be positioned to allow for easy reading when the heater is installed in the vehicle.

5.3.2.5 The heater must be installed in a location where the risk of injuring persons and damaging items carried is as small as possible.

**5.3.3 Fuel supply**

5.3.3.1 The fuel-filler neck may not be located in the passenger compartment and must be equipped with a tightly-sealing cap which prevents fuel from escaping.

5.3.3.2 In heaters for liquid fuel, where the fuel supply is separated from the vehicle's fuel supply, the type of fuel and the filler neck must be clearly marked.

5.3.3.3 On the filler neck, a note must be visible, saying that the heater must be switched off before refuelling it. A corresponding instruction must also be included in the



manufacturer's operating manual.

#### **5.3.4 Exhaust system**

5.3.4.1 The exhaust outlet must be positioned so that no exhaust fumes can get into the vehicle's interior via venting devices, hot-air inlets or window openings.

#### **5.3.5 Combustion air inlet**

5.3.5.1 The air for the heater's combustion chamber must not be drawn in from the vehicle's passenger compartment.

5.3.5.2 The air inlet must be protected and positioned in a way that it cannot be blocked by garbage or luggage.

#### **5.3.6 Heating air inlet**

5.3.6.1 The combustion air supply may consist of ambient air or circulating air and must be drawn in from a clean area which can presumably not be contaminated by exhaust gas from the engine, the combustion heater or another source in the vehicle.

5.3.6.2 The inlet opening must be protected by grilles or other suitable means.

#### **5.3.7 Heating air outlet**

5.3.7.1 Hot air pipes in the vehicle must be protected and positioned so touching them will not result in injuries or damage.

5.3.7.2 The air outlet must be protected and positioned in a way that it cannot be blocked by garbage or luggage.

#### **5.3.8 Automatic control of the heating system**

5.3.8.1 When the engine stalls, the heating system must automatically be switched off and the fuel supply interrupted within five seconds. If a manually operated control device has already been activated, the heating system can remain in operation.

#### **CAUTION:**

**Non-compliance with the installation instructions and the notes contained will lead to exclusion of liability by Spheros. The same applies to repairs not carried out by experts or without the use of original spare parts. This results in the invalidation of the heater's type approval and hence the *ECE type approval*.**

Installation instructions for separate fuel tanks with regard to the fuel supply of coolant heaters in vehicles:

- In busses, the installation in the passenger's or driver's compartment is not permissible.
- In no vehicle may the fuel-filler neck be located in the passenger's or driver's compartment.
- The fuel tanks must either be equipped with a ventilated cap or any other type of ventilation (vent line).

Only caps in compliance with DIN 73400 may be used.

## **1.7 Suggestions for improvements and modifications**

Please address any complaints, improvements or suggestions for correction of this technical manual to:

Spheros GmbH  
Friedrichshafener Straße 9 - 11  
82205 Gilching  
Phone: +49 (0) 8105 7721-201  
Fax: +49 (0) 8105 7721-199



## 2 General Description

The Spheros *DBW* 160, 230, 300 and 350 coolant heaters supplement the vehicle's heating system

- to heat the passenger compartment
- to defrost the windows, and
- to preheat liquid-cooled engines.

The coolant heater functions independently of the vehicle engine and is connected to the cooling system, fuel system and electric system.

The heater is designed for heat transfer and is controlled by a temperature sensor. It's operation is intermittent.

The heaters of the type *DBW* 160, 230, 300 and 350 comprise the following main components:

- combustion air fan
- fuel pump
- heat exchanger
- combustion chamber
- electronic ignition unit with ignition electrodes

Some heater variants are equipped with a nozzle-block preheater.

The heater is controlled by

- a control unit
- a flame sensor

integrated in the device.

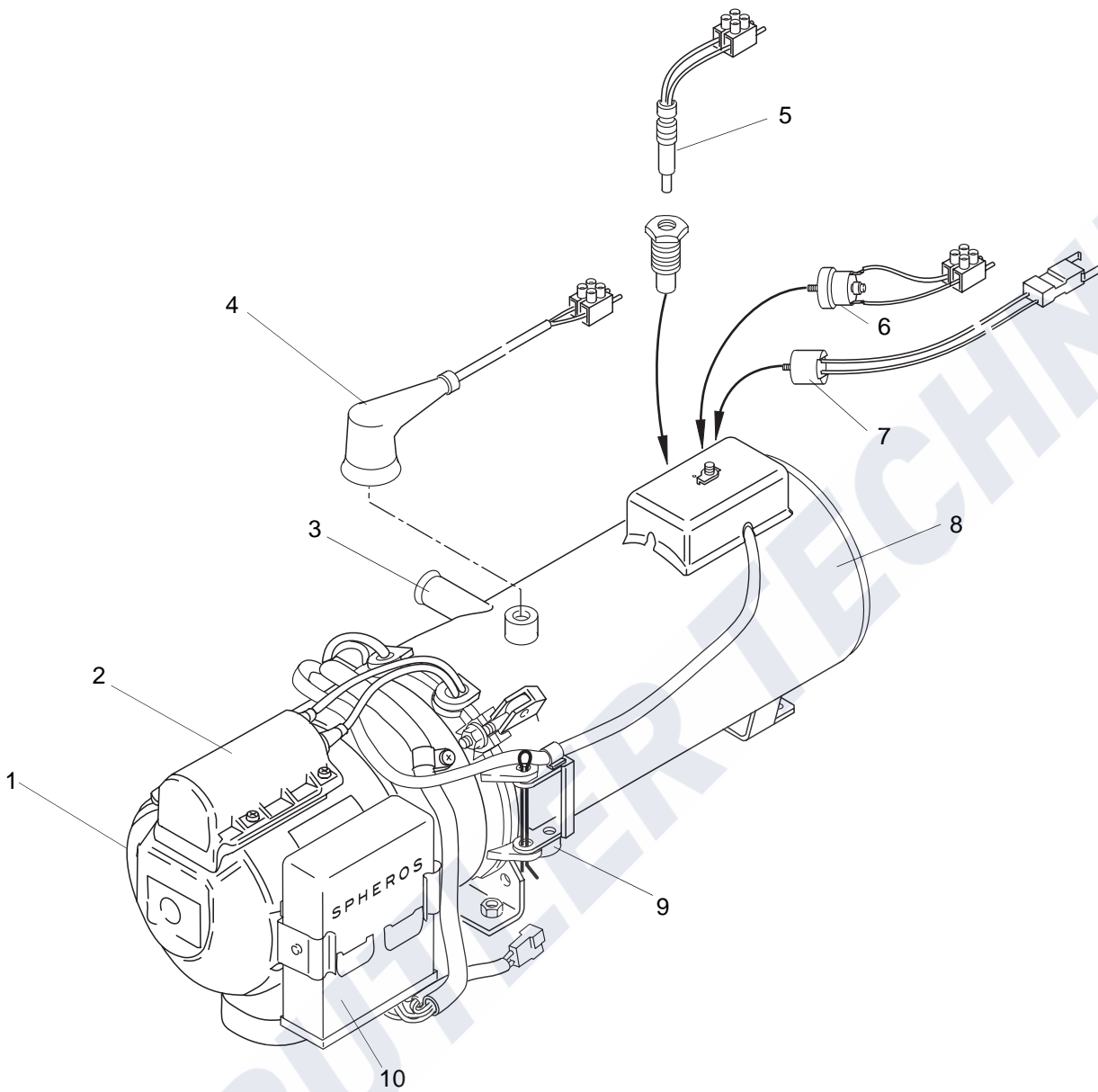
The control units are fitted laterally at the rear or on the top, depending on the heater variant.

The heater may comprise

- a temperature limiter
- a thermal fuse
- a fan thermostat

depending on variant.

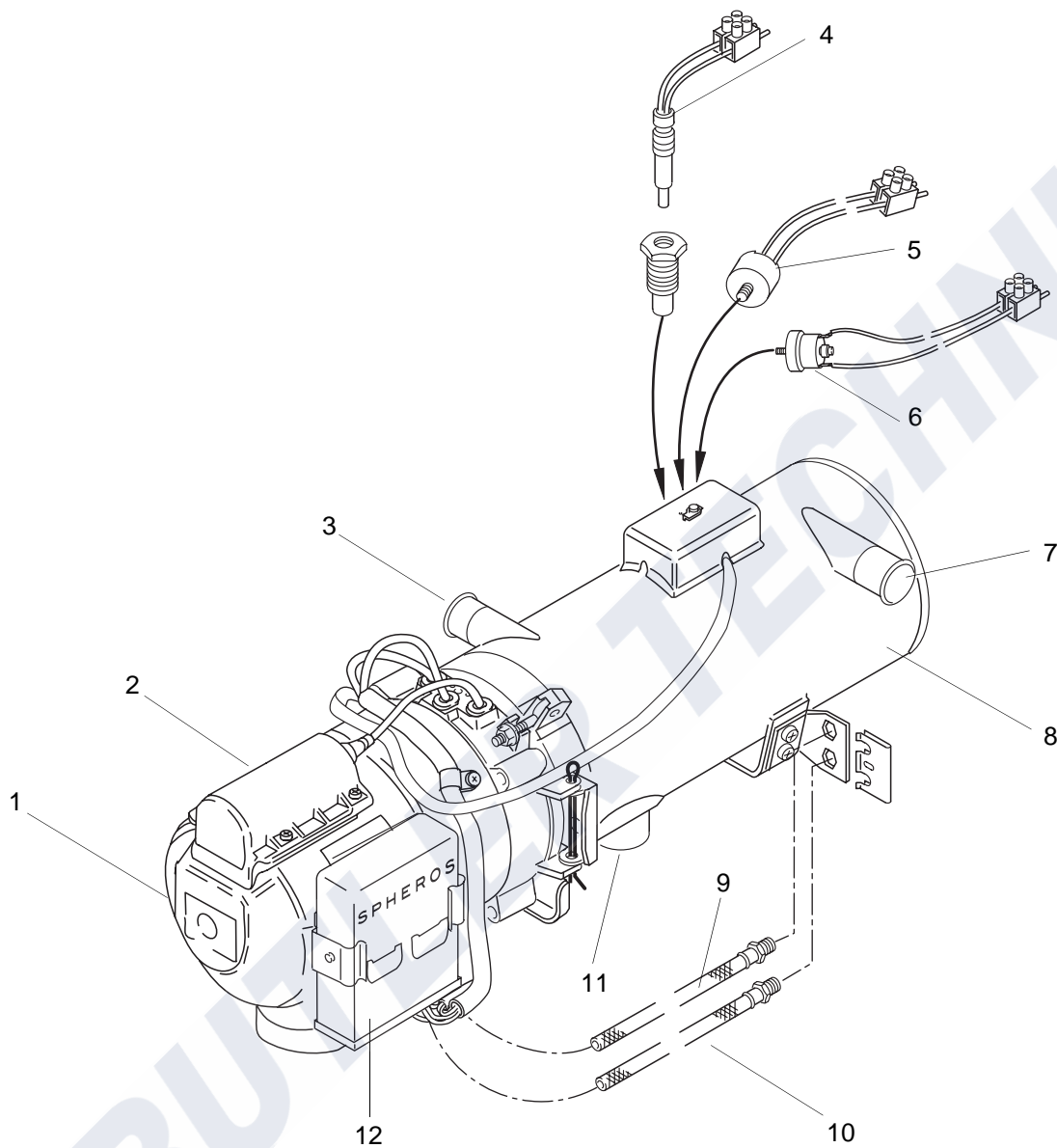
An external circulation pump is installed in the vehicle.



- 1 Burner head
- 2 Electronic ignition unit
- 3 Coolant outlet
- 4 Control thermostat
- 5 Fusible link

- 6 Temperature limiter
- 7 Fan thermostat
- 8 Heat exchanger
- 9 Exhaust outlet
- 10 Control unit

Heater DBW 160



- 1 Burner head
- 2 Electronic ignition unit
- 3 Coolant inlet
- 4 Fusible link \*
- 5 Control thermostat \*
- 6 Temperature limiter \*
- 7 Coolant outlet
- 8 Heat exchanger
- 9 Fuel return

- 10 Fuel supply
- 11 Exhaust outlet
- 12 Control unit

\* for components installed in applicable heater variants

Heater DBW 230, DBW 300 and DBW 350

## 2 General Description

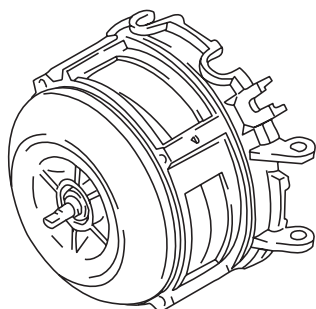
**DBW 160 / 230 (2020) / 300 / 350**

### 2.1 Combustion air fan

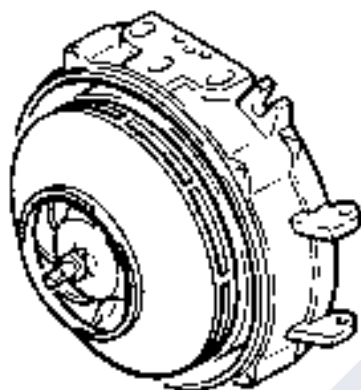
The combustion air fan supplies the air required for combustion from the air intake into the combustion chamber.

Heaters are fitted with the following fan types:

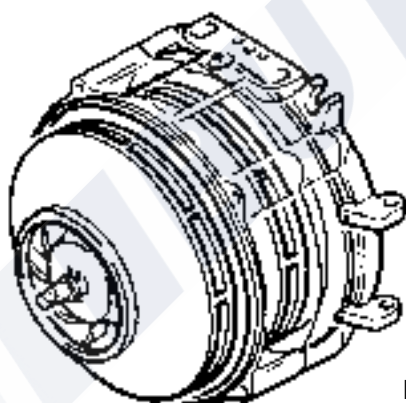
- DBW 160 – side-channel fan,
- DBW 230 / 300 – radial fan,
- DBW 350 – two-stage radial fan.



DBW 160



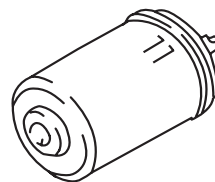
DBW 230 / 300



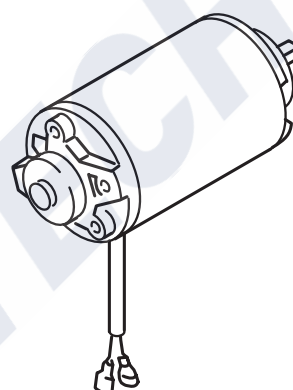
DBW 350

### 2.2 Motor

The motor drives the combustion air fan via a coupling and the fuel pump via a gearset.



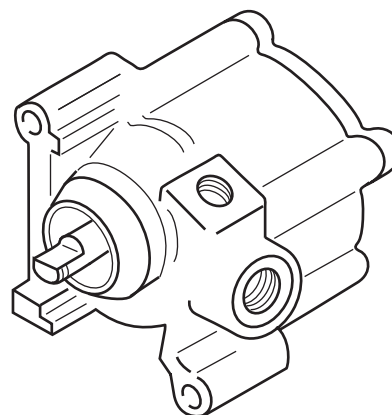
DBW 300.62



DBW 160 / 230 / 300 / 350

### 2.3 Fuel pump

The fuel pump supplies fuel for combustion. It is driven by the combustion air fan motor via a coupling. Inside the fuel pump, the fuel is pressurised to approx. 10 bar (DBW 160 11.5 bar) and is vaporised by the high-pressure atomiser. Fuel supply to the atomiser is controlled by a solenoid valve.



2.3.1 Nozzle-block preheater

The nozzle-block preheater heats the fuel flowing to the high-pressure nozzle.

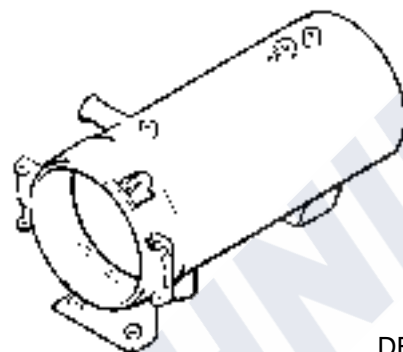
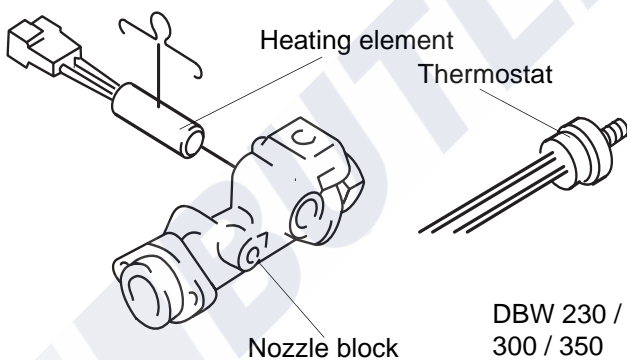
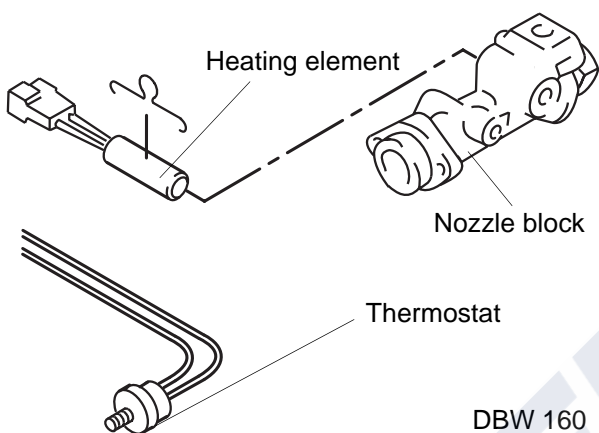
Heaters without nozzle-block preheaters may show malfunctions at extremely low temperatures. At temperatures < 0° C, the heating element in the nozzle block is actuated via a thermostat. Heating duration depends on the heat reflected in the combustion chamber, and the heater switches off when the thermostat reaches a temperature of +8° C.

Heaters without nozzle-stock preheaters can be retrofitted.

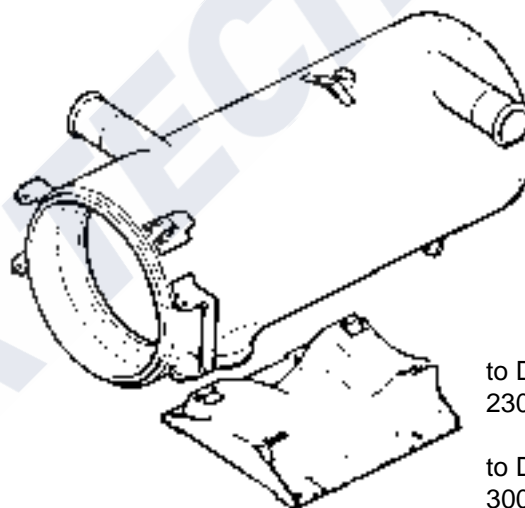
For parts required please refer to parts list.

2.4 Heat exchanger

The heat exchanger transfers the heat generated by combustion into the cooling system.

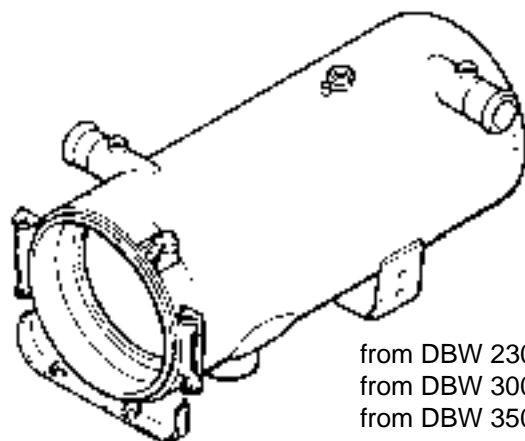


DBW 160



to DBW 230(2020).32

to DBW 300.15



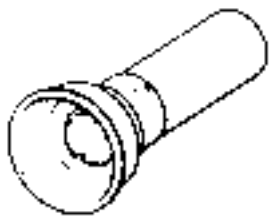
from DBW 230(2020).33  
from DBW 300.15  
from DBW 350.01

## 2 General Description

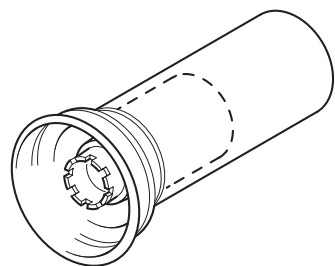
**DBW 160 / 230 (2020) / 300 / 350**

### 2.5 Combustion chamber

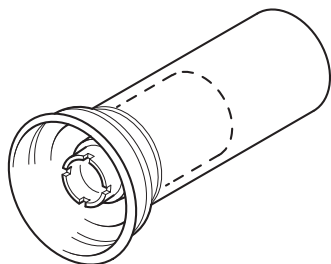
The fuel/air mixture is distributed in the combustion chamber where it is burned, thus heating the heat exchanger.



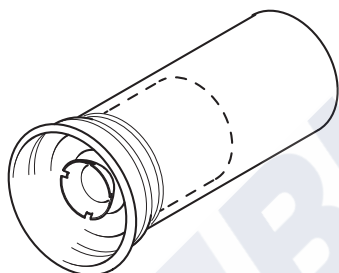
DBW 160



to  
DBW 230(2020).32



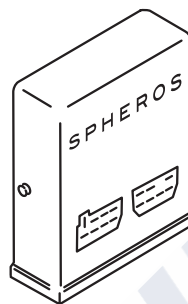
to  
DBW 300.15



from  
DBW 230(2020).33  
DBW 300.16  
DBW 300.62 without flame pipe  
DBW 350.01

### 2.6 Control unit

The control unit is the core control element ensuring the system function and the monitoring of the combustion.

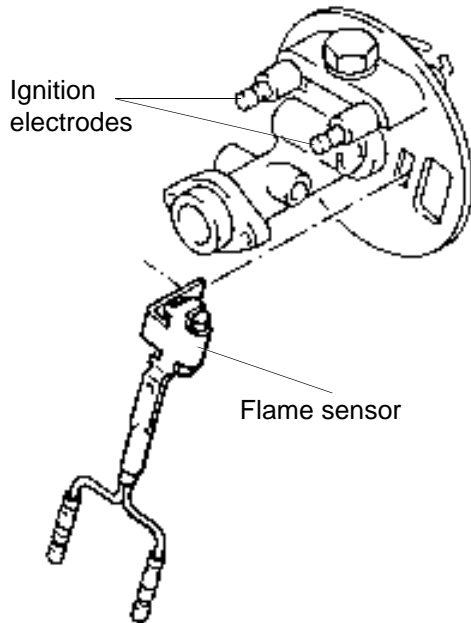


Control unit 1553



**2.7 Flame sensor**

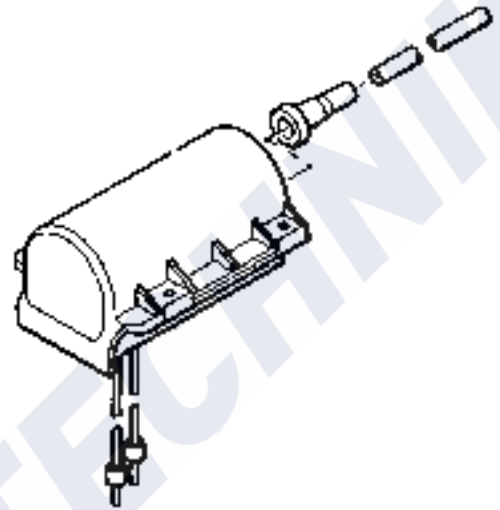
The flame sensor monitors the flame during the entire combustion process. The flame sensor acts as a photoelectric resistor detecting the absence of a flame or as a photoelectric transistor detecting the presence of a flame and responding to its luminous intensity. Its signals are received and processed by the control unit.



Flame sensor for control unit 1553

**2.8 Electronic ignition unit with ignition electrodes**

The electronic ignition unit creates the high voltage required to ignite the fuel/air mixture. Ignition is then realised by high-voltage spark-over between the two ignition electrodes.



## 2 General Description

## DBW 160 / 230 (2020) / 300 / 350

### 2.9 Temperature limiter / Thermal fuse

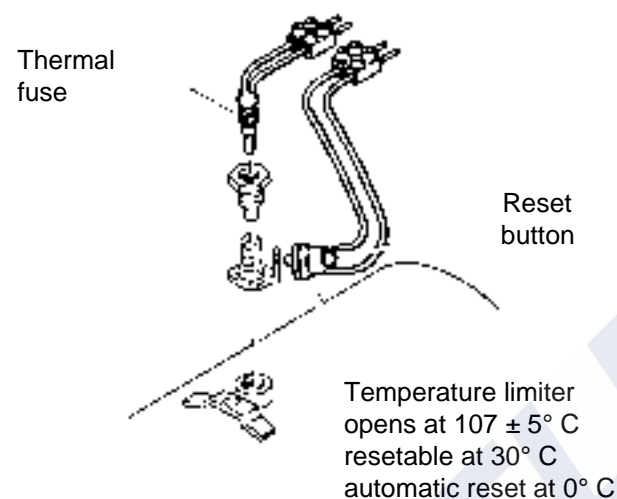
#### Temperature limiter

The temperature limiter (bi-metal) protects the heater against excessive operating temperatures. The temperature limiter trips when a temperature of  $107^{\circ}\text{C}$  or  $117^{\circ}\text{C}$  is exceeded, turning off the heater. The temperature limiter is resettable or self-resetting.

#### Thermal fuse

The thermal fuse protects the heater against excessive operating temperatures. It comprises a fusible link that trips at excessive temperatures, turning off the heater.

Heaters can be retrofitted with temperature limiters replacing the thermal fuses.



### 2.10 Control thermostat

#### Control thermostat at heater

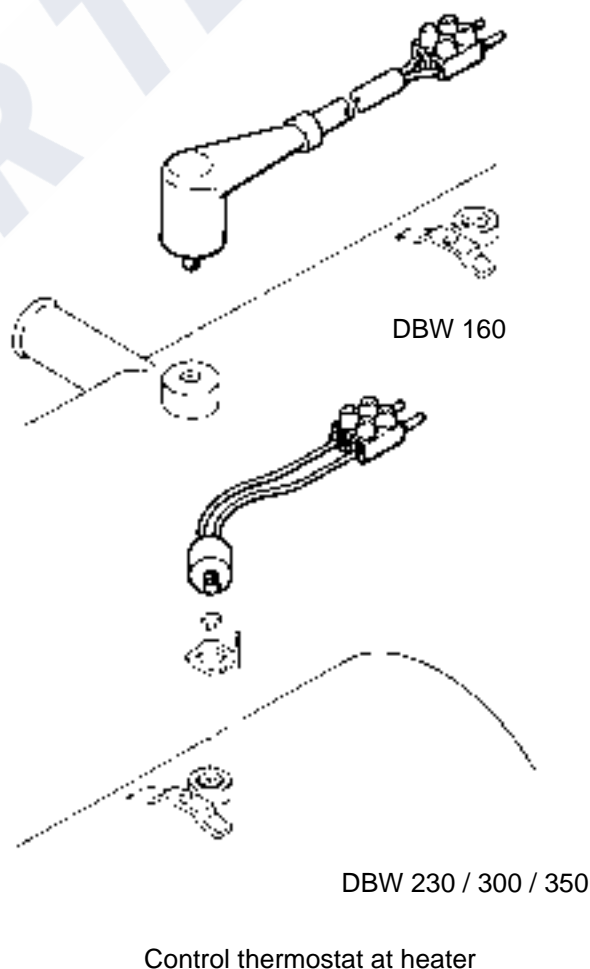
After reaching operating temperature, closed-loop operation is performed by the control thermostat. The coolant is maintained at a constant temperature by turning the heater on and off. The thermostat closes at  $63 \pm 5^{\circ}\text{C}$  and opens at  $70 \pm 3^{\circ}\text{C}$ .

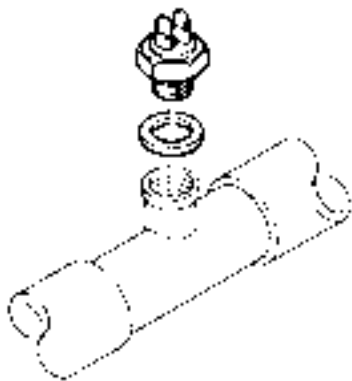
#### External control thermostat

Closed-loop operation can also be executed by an external control thermostat.

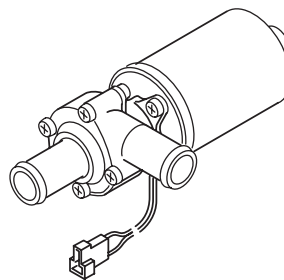
After reaching operating temperature, closed-loop operation is performed by the control thermostat. The coolant is maintained at a constant temperature by turning the heater on and off. The thermostat closes at  $71 \pm 2^{\circ}\text{C}$  and opens at  $78 \pm 2^{\circ}\text{C}$ ; alternatively at  $62 \pm 2^{\circ}\text{C}$  and  $70 \pm 2^{\circ}\text{C}$ .

Heaters with energy-conservation function (temperature conservation) may be fitted with a thermostat closing at  $35 \pm 2^{\circ}\text{C}$  and opening at  $42 \pm 2^{\circ}\text{C}$ .





External control thermostat

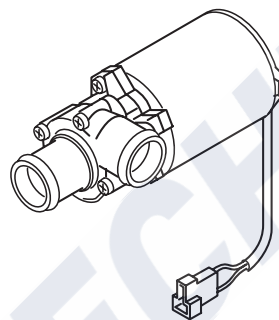


U 4810

Recommended for heater DBW 160

### 2.11 Fan thermostat

The fan thermostat turns the vehicle heater's fan on and off at coolant temperatures between 30° C and 40° C. The thermostat closes at  $40 \pm 3^\circ \text{C}$  and opens at  $30 \pm 5^\circ \text{C}$ .

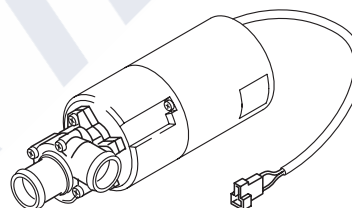


U 4814

Recommended for heater DBW 230, 300 and 350

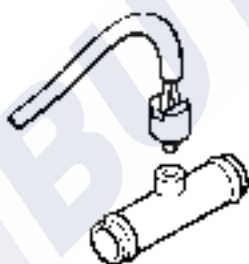


Fan thermostat at heater

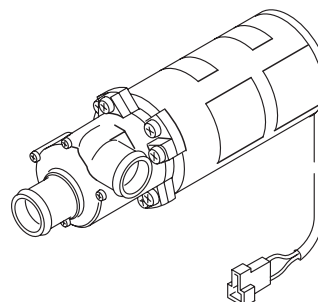


U 4851

Recommended for heater DBW 230, 300 and 350



– Fan thermostat in coolant system

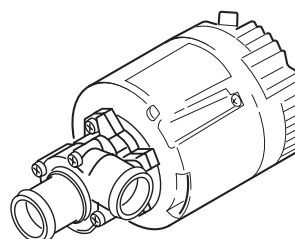


U 4854

Recommended for heater DBW 230, 300 and 350

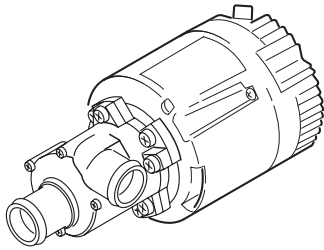
### 2.12 Circulation pump

The external circulation pump circulates the coolant in the cooling system of the vehicle and in the heater. The pump is activated by the control unit and runs throughout the entire operating period of the heater. Heaters are compatible with pumps of the type U 4810 (DBW 160 only), U 4814, U 4851, U 4854, U 4855 or U 4856.

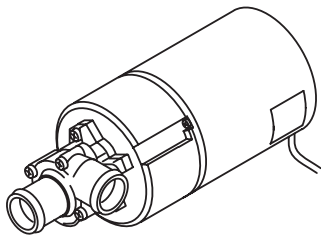


U 4855 (replaces U 4851)

Recommended for heater DBW 230, 300 and 350



U 4856  
(replaces  
U 4852)  
Recommended  
for heater DBW  
230, 300 and 350



U 4852  
  
Recommended  
for heater DBW  
230, 300 and 350

## 3 Function Description

### 3.1 General

The heaters are equipped with burners using high-pressure atomisers and run in intermittent operation. They are thermostatically controlled (control unit 1553).

### 3.2 Operation

The heater is switched on and off at the

- switch (On/Off) or
- by the timer.

Its operating mode is shown by an operation indicator integrated in the timer or by a separate indicator light.

Heaters can be fitted with optional nozzle-block pre-heaters and heater elements for operation at extremely low temperatures.

Operation (see Fig. 301)

#### 3.2.1 Switch on

When the system is switched on, the operation indicator lights up. Combustion air fan, fuel pump and circulation pump start. After approx. 15 seconds, the solenoid valve opens and fuel is injected into the combustion chamber via the atomiser. At the same time, a high-voltage ignition spark is generated. When the flame sensor detects a flame, it outputs a signal to the control unit which switches the electronic ignition unit off.

If no flame is detected, please refer to 3.2.4.

#### 3.2.2 Heating operation

After reaching operating temperature, closed-loop operation is performed by the control thermostat.

Coolant temperature is then maintained at a constant level by switching the heater on and off. When the temperature exceeds the upper switch point, the solenoid valve shuts off the fuel supply, causing the flame to extinguish. The combustion air fan then runs on for approx. 150 seconds, switching off automatically. The circulation pump keeps on running during the burner's off-periods, and the operation indicator remains on. When the temperature falls below the lower switch point, the heater is restarted.

#### 3.2.3 Switch off

When the heater is switched off, combustion is stopped. The operation indicator is turned off, and the purge cycle begins. Combustion air fan and circulation pump are switched off after approx. 150 seconds.

The heater cannot be restarted during purge cycle.

#### 3.2.4 Malfunction cut-out

##### Heaters with control unit 1553

A malfunction cut-out occurs

- if no combustion is detected within approx. 30 seconds after the heater is switched on,
- if the fuel supply is interrupted for more than 10 seconds during heating operation,
- if thermal fuse or temperature limiter detect overheating of the heater. The thermal fuse must always be replaced by a fuse of the identical type (observe colour code). Reset the button of the temperature limiter (once the heater has cooled down to below 60° C).
- if undervoltage is detected approx. 10 – 25 seconds after the temperature falls below the switch point.

Once the cause of the malfunction has been eliminated, the heater can be unlocked by switching it off and back on.

### 3 Function Description *DBW 160 / 230 (2020) / 300 / 350*

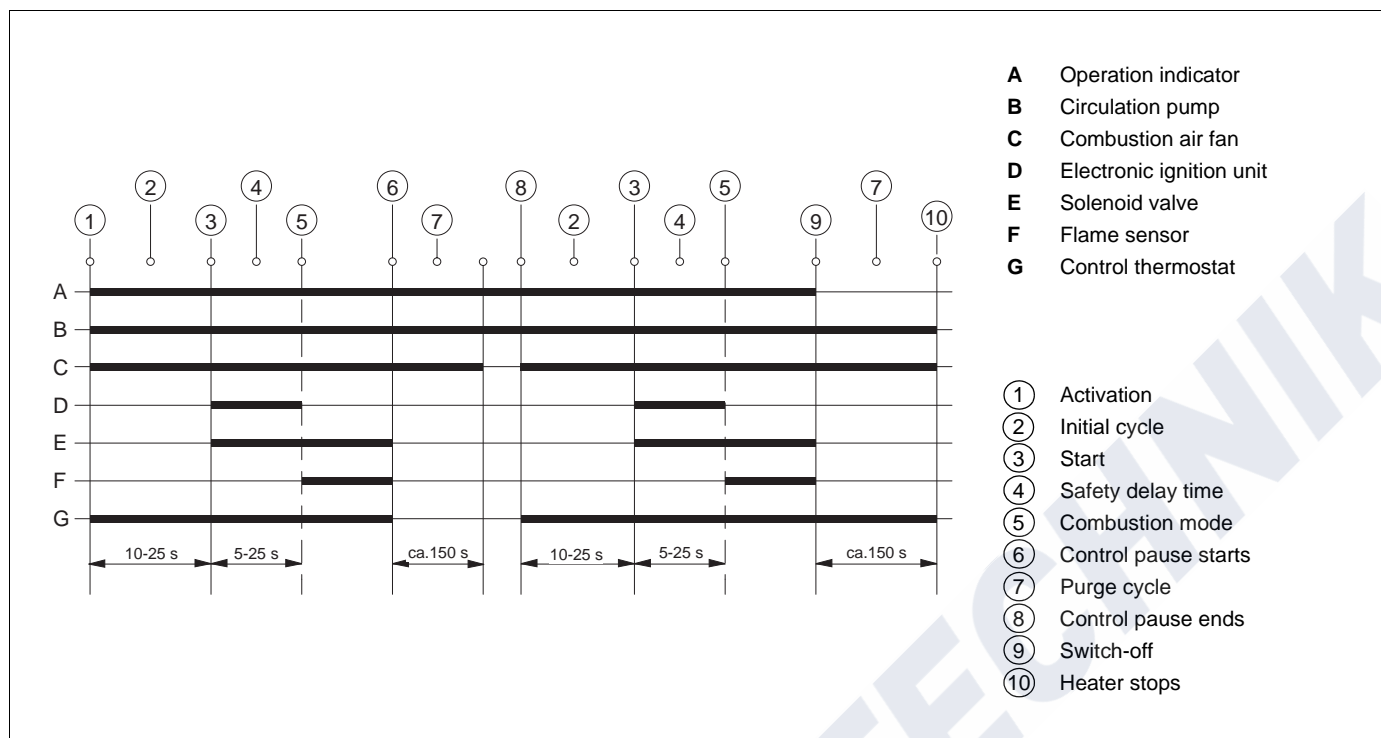


Fig. 301 Function sequence (control unit 1553)

## 4 Technical data

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

### Electrical components

Control unit, motors for combustion air fan and circulation pump, solenoid valve, electronic ignition unit, heating element, nozzle-block preheater and timer are designed for 24 volts. The components temperature limiter, flame sensor, temperature sensor and switch are voltage-independent.

#### NOTE

Combinations of circulation pumps and heaters must be selected in accordance with coolant flow resistance

### Fuel

Only the type of fuel indicated on the heater's type label may be used.

Commercially available diesel fuels in accordance with DIN EN 590 (diesel fuel) may be used.

According to the diesel-fuel standard DIN EN 590, up to 5% of biodiesel additive is also permissible.

At temperatures below  $0^\circ\text{C}$ , a commercially available winter diesel fuel should be used.

The use of flow improvers or additives is permissible. Adverse effects are not known.

#### CAUTION:

**For fuel taken from the vehicle tank, the vehicle manufacturer's specifications regarding additives apply.**

Heater		DBW 160	DBW 230	DBW 300	DBW 350
ECE approval number according to R10 (EMC)		025038			
ECE approval number according to R122 (heating systems)		000204	000205	000206	000207
Build type		High-pressure atomiser			
Heat flow	kW (kcal/h)	16 (13 800)	23.3 (20 000)	30 (26 000)	35 (30 000)
Fuel		Diesel fuel as per DIN 51601			
Fuel consumption	kg/h	1.9	2.5	3.3	3.7
Nominal voltage	V –	12 or 24			24
Nominal-voltage range	V –	10...14 / 21...28			21...28
Nominal power consumption (without circulation pump)	W	100 (12V) 90 (24V)	110 (12V) 110 (24V)	100 (12V) 130 (24V) .62: 100 (24V)	170 (24V)
Permissible ambient temperature during operation (heater, control unit, circulation pump)	$^\circ\text{C}$	-40... + 60			
Permissible storage temperature (heater, control unit, circulation pump)	$^\circ\text{C}$	-40... + 85			
Permissible operating pressure	bar	0.4...2.0			
Heat-exchanger filling capacity	l	1.1	2.4		
Minimum amount of coolant in circuit	l	10.00 l			
CO <sub>2</sub> in exhaust gas at nominal voltage	Vol %	10.5 $\pm$ 0.5			
CO in exhaust gas	Vol %	max. 0.2			
Bacharach smoke number	Vol %	< 4.0			
Heater dimensions (tolerance $\pm 3$ mm)	mm	length 584 width 205 height 228	length 681 to .32 length 680 to .50 width 230 to .32 width 240 to .50 height 279 to .32 height 269 to .50	length 681 to .15 length 680 to .30 width 230 to .15 width 240 to .30 height 279 to .15 height 269 to .30	length 725 width 240 height 279 to .10 height 269 from .11
Weight	kg	14.5	24 from .33: 22	24 from .33: 22	23

## 4 Technical Data

**DBW 160 / 230 (2020) / 300 / 350**

Circulation-pump type	Volume flow	Nominal voltage	Operating voltage range	Nominal power consumption	Dimensions	Weight
	l/h	V –	V –	W	length width height	kg
<b>U 4810</b>	1600 (at approx. 0.15 bar)	12 or 24	10 ...14 / 20 ...28	25	173 94 77	0.8
<b>U 4814</b>	5000 (at approx. 0.2 bar)	12 or 24	10 ...14 / 20 ...28	104	228 100 105	2.1
<b>U 4851</b>	6000 (at approx. 0.4 bar)	24	20 ...28	209	279 115 110	2.7
<b>U 4852</b>	6000 (at approx. 0.4 bar)	24	20 ...28	209	284 115 110	2.95
<b>U 4854</b>	5200 (at approx. 0.15 bar)	24	20 ...28	104	221 100 105	2.1
<b>U 4855</b>	6000 (at approx. 0.4 bar)	24	20 ...28	210	225 110 115	2.4
<b>U 4856</b>	6000 (at approx. 0.4 bar)	24	20 ...28	210	229 110 115	2.5



## 5 Troubleshooting

### 5.1 General

**CAUTION**

The analysis and resolution of faults requires intimate knowledge of the design and function of the heater's components and may be performed by qualified personnel only.

When in doubt about the functional relationships, please refer to sections 2 and 3.

**CAUTION**

Fault identification is usually limited to the identification of defective components. The following fault causes have not been considered and should always be checked to eliminate these faults as causes for malfunctions:

- Corrosion on connector**
- Loose contact at connector**
- Crimping faults at connector**
- Corrosion at wiring and fuses**
- Corrosion at battery poles**

A function check in the vehicle must be performed each time a fault has been resolved.

### 5.2 General fault symptoms

The following table (Fig. 501) shows general fault symptoms.

Fault symptom	Possible cause
<p><b>Faults in the electric system</b></p> <p>Activation light does not light up, heater does not operate.</p> <p>Fuse F2 blows.</p> <p>Fuse F3 blows.</p> <p>Heater functions correctly, but operation indicator does not light up.</p>	<ul style="list-style-type: none"> <li>• No voltage supply,</li> <li>• fuses,</li> <li>• Supply line to contacts of connector A of control unit.</li> </ul> <p>Short-circuit in circulation pump or heater supply line.</p> <p>Short-circuit in supply line to heater/motor/ nozzle-block preheater (if installed)</p> <p>Operation indicator is defective or wiring to operation indicator is interrupted or short-circuited.</p>
<p><b>Faults in coolant system</b></p> <p>Heater shuts down as the connected heat exchangers do not dissipate sufficient heat.</p>	<p>Flow rate insufficient because of</p> <ul style="list-style-type: none"> <li>• air or gas in heater, heat exchangers or system sections.</li> <li>• Valves (flow controllers): restricted flow, soiled, closed.</li> <li>• System contamination, e.g. filter or tight spots.</li> <li>• Insufficient feed from circulation pump (air or gas in pump housing), reversed sense of rotation – check wiring colours (black + / brown –)</li> <li>• Insufficient anti-freeze protection,</li> </ul>

Fig. 501 General fault symptoms (page 1 of 2)

Fault symptom	Possible cause
	<ul style="list-style-type: none"> <li>• Excessive system resistance (especially when cold).</li> <li>• Circulation pump defective</li> </ul> <p><u>Heat exchangers (coolant/air) do not dissipate sufficient heat because</u></p> <ul style="list-style-type: none"> <li>• of air or gas in the heat exchangers or in system sections.</li> <li>• Soiled thermal transfer surfaces (inside/outside).</li> <li>• Insufficient air intake or air output.</li> <li>• Fan: insufficient flow / reversed sense of rotation / excessive resistance.</li> <li>• Anti-freeze concentration too high.</li> <li>• Heat exchanger insufficiently dimensioned.</li> </ul>
<p><b>Estimation of flow rate</b></p> <p>Flow rate in [l/h] =</p> $\frac{\text{Heat flow [kW] acc. to type plate}}{\text{Temperature difference } \Delta t \text{ in [K] or [° C] measured between coolant inlet and outlet at heater (e.g. with contact thermometer)}} \times 860$	
<p><b>Fault in fuel supply</b></p> <p>No fuel supply to heater.</p>	<ul style="list-style-type: none"> <li>• Fuel tank empty.</li> <li>• Kinked, blocked, clogged or leaking lines.</li> <li>• Paraffin wax separation or frozen water in fuel filter or lines.</li> <li>• Tank vent plugged.</li> <li>• Fuel lines reversed.</li> <li>• Fuel filter soiled.</li> </ul>
<p><b>Faults in combustion process</b></p> <p>CO<sub>2</sub> cannot be adjusted to target value. Unsmooth combustion.</p>	<ul style="list-style-type: none"> <li>• Air bubbles in suction line (leak in suction line).</li> <li>• Fuel filter soiled or leaking.</li> <li>• Fuel supply system leaks (suction height, vacuum in tank); observe installation instructions.</li> <li>• Fuel pump defective (pump pressure).</li> <li>• Return line flow restricted.</li> <li>• Pump strainer soiled.</li> <li>• Atomiser defective.</li> <li>• Combustion air and exhaust line flow restricted, lines clogged.</li> <li>• Burner motor speed too slow.</li> </ul>

Fig. 501 General fault symptoms (page 2 of 2)

5.3 Troubleshooting – Quick diagnostic

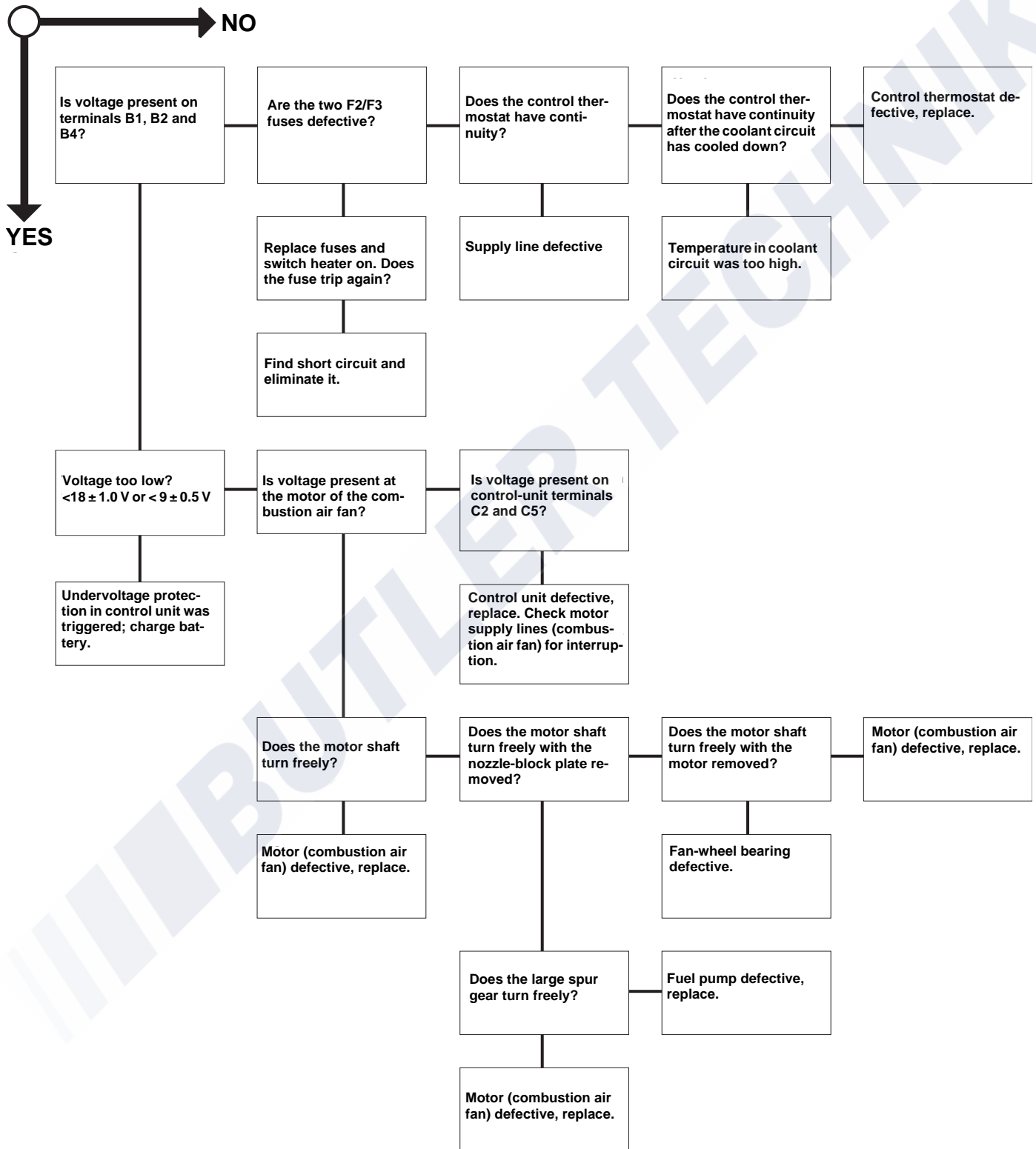
Heater types:

- all heaters

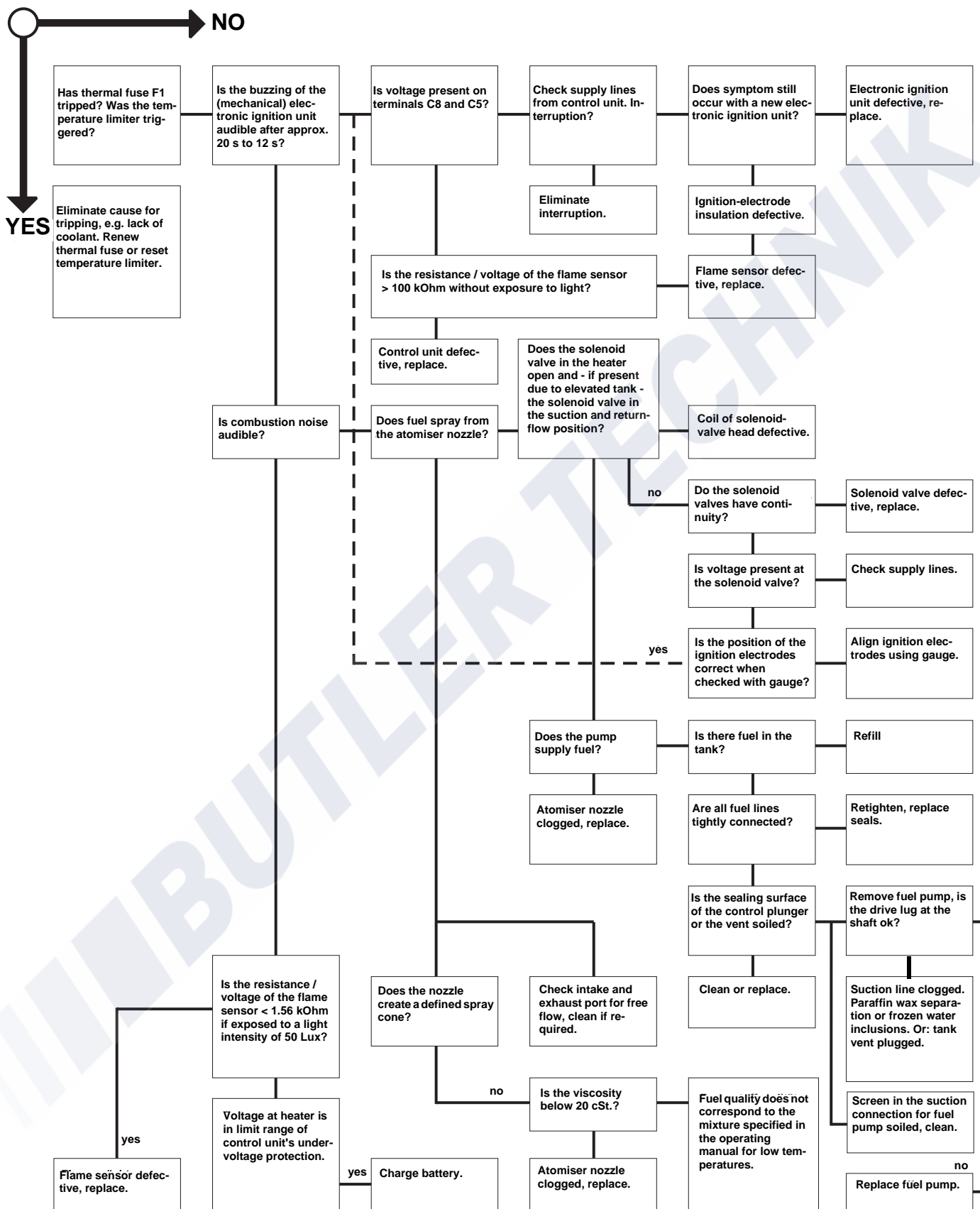
Fault symptom	Check, repair, if required, replace																		
	Power supply	Fuses	Electr. lines and connections	Switches	Thermal fuse and/or temperature limiter	Control thermost.	Flame sensor	Control unit	Ignition electrodes	Electronic ignition unit; ignition cable	Drive (motor)	Fuel supply	Fuel pump	Fuel solenoid valve	Atomiser nozzle	Circulation pump	Combustion air duct	Exhaust duct	
After activation – no function	●	●	●	●			●												
Function indicator – extinguishes after approx. 25 s					●	●	●	●	●	●	●	●	●	●					
Combustion air fan – does not run	●	●	●		●		●			●									
Combustion air fan – no run-up	●						●												
Combustion air fan – no run-down							●												
Circulation pump – does not run	●	●	●				●			●									
Ignition spark – not present		●	●				●	●	●										
Combustion – does not start					●		●	●	●		●	●	●	●					
Combustion – stops after approx. 25 s	●		●				●	●											
Combustion – cannot be stopped				●			●						●						
Combustion causes light-coloured smoke											●	●		●					
Combustion causes dark smoke	●		●							●	●					●	●		
Heater overheats			●		●	●	●								●			●	

5.4 Fault symptoms

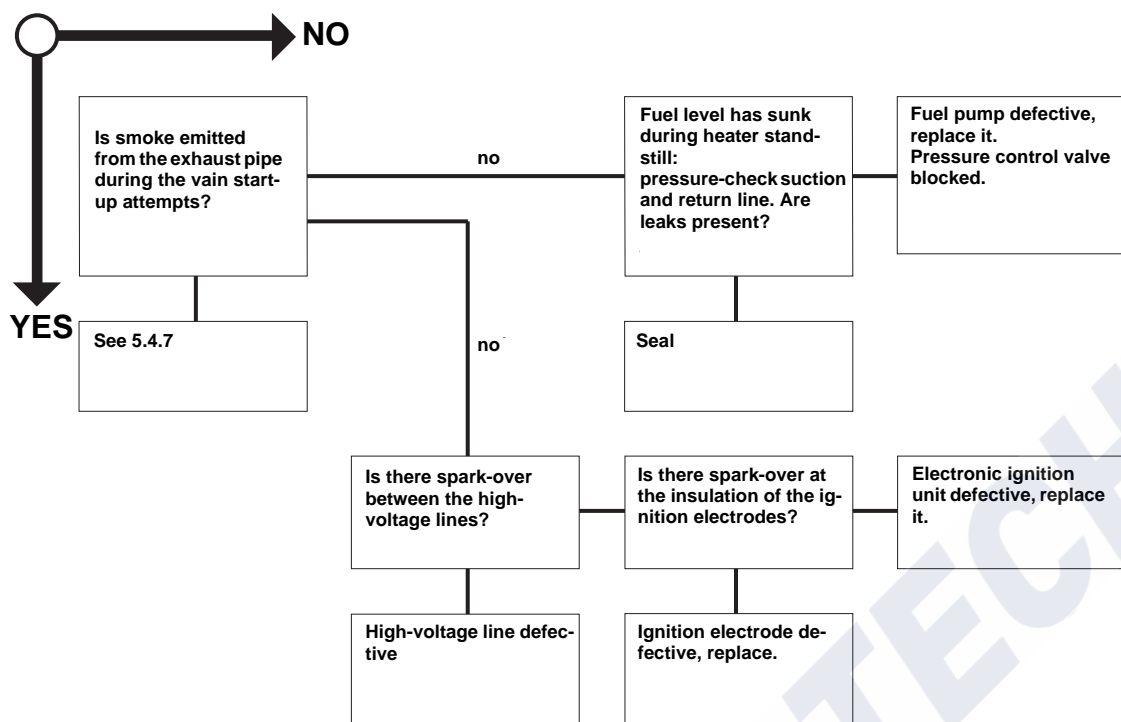
5.4.1 Heater does not start when being switched on



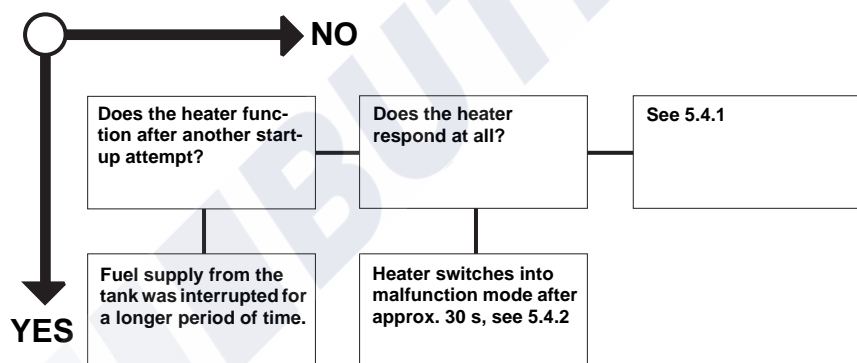
5.4.2 Heater repeatedly switches into malfunction mode approx. 30 s after being switched on



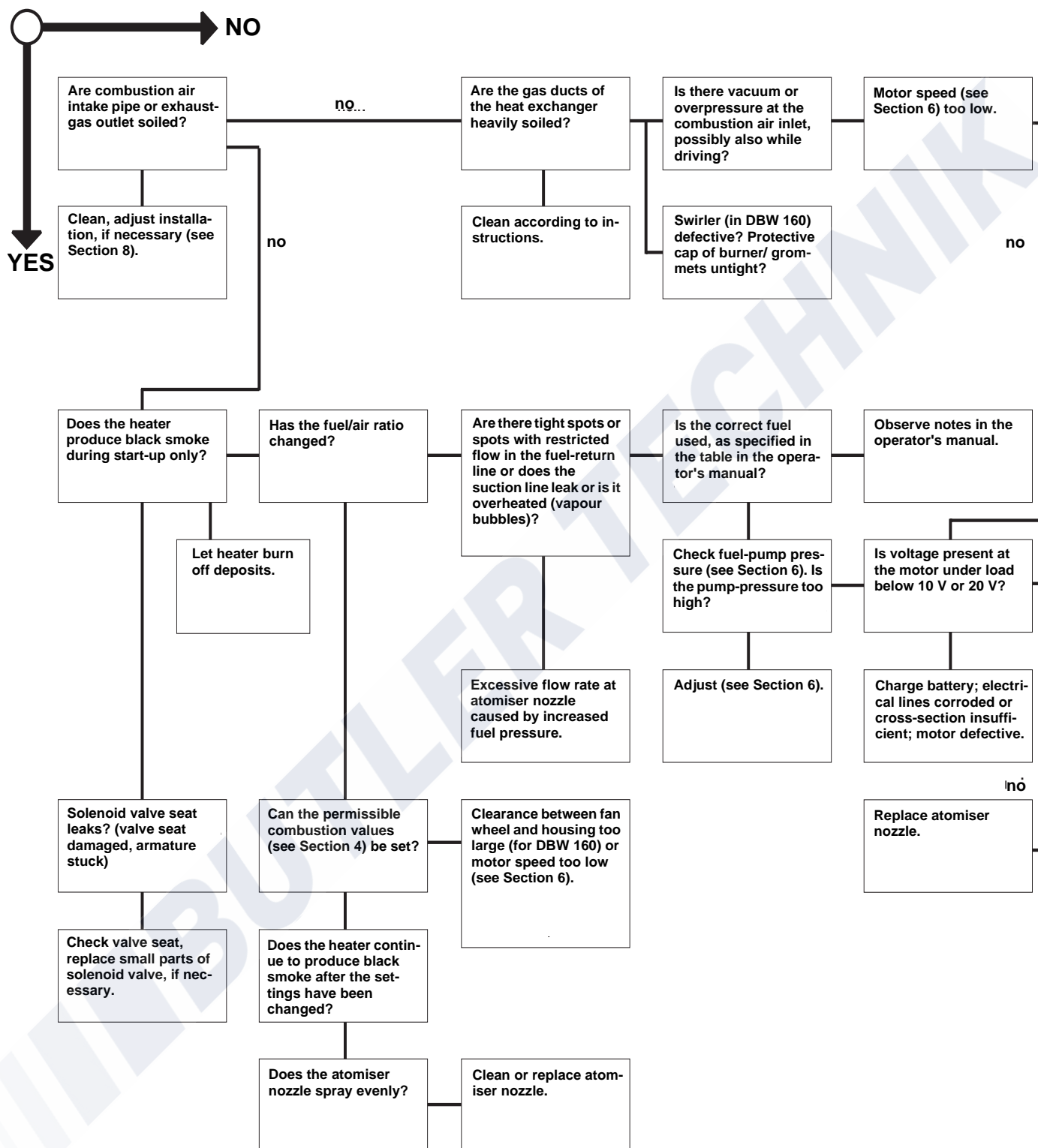
5.4.3 Heater requires several attempts to start



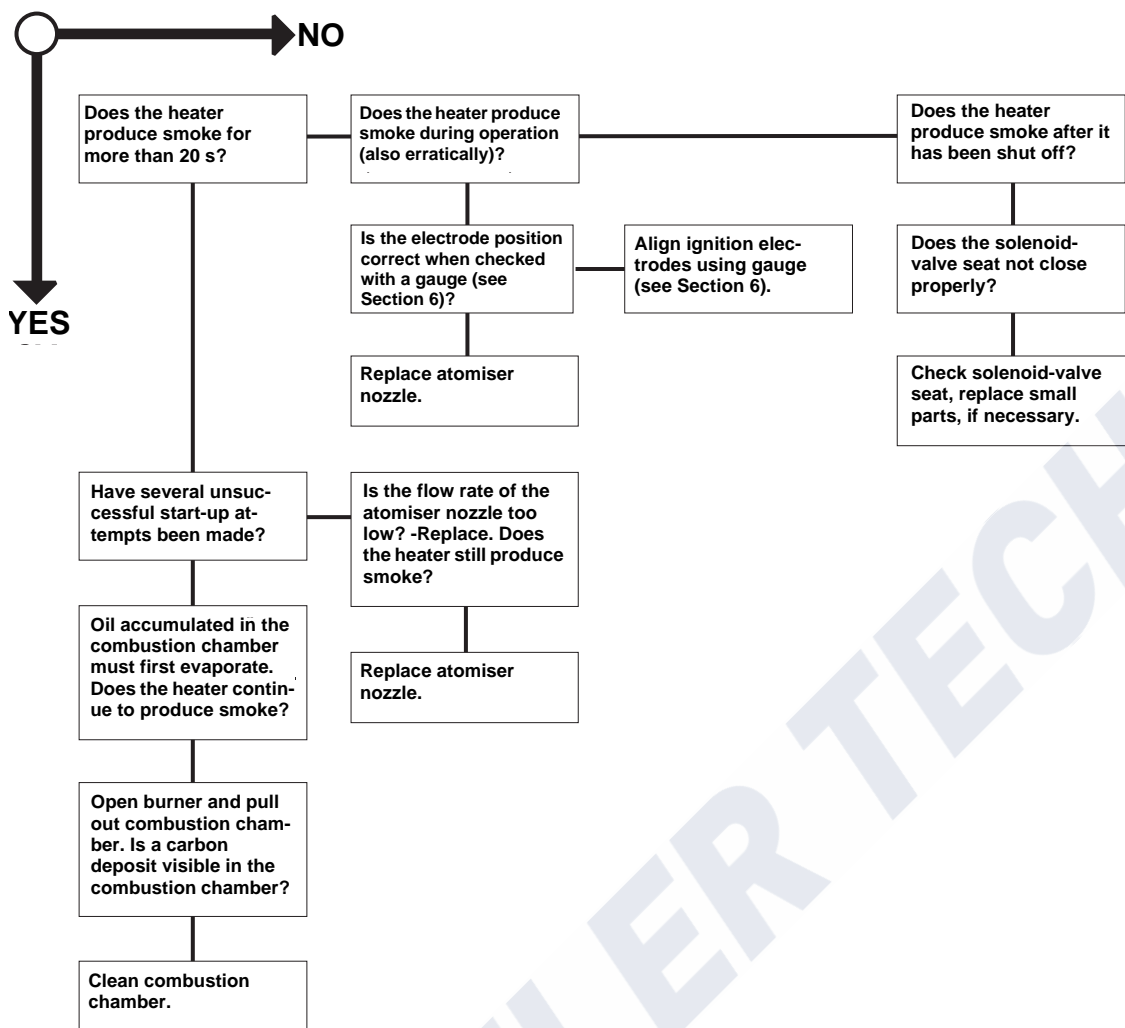
5.4.4 Heater turns off by itself during operation



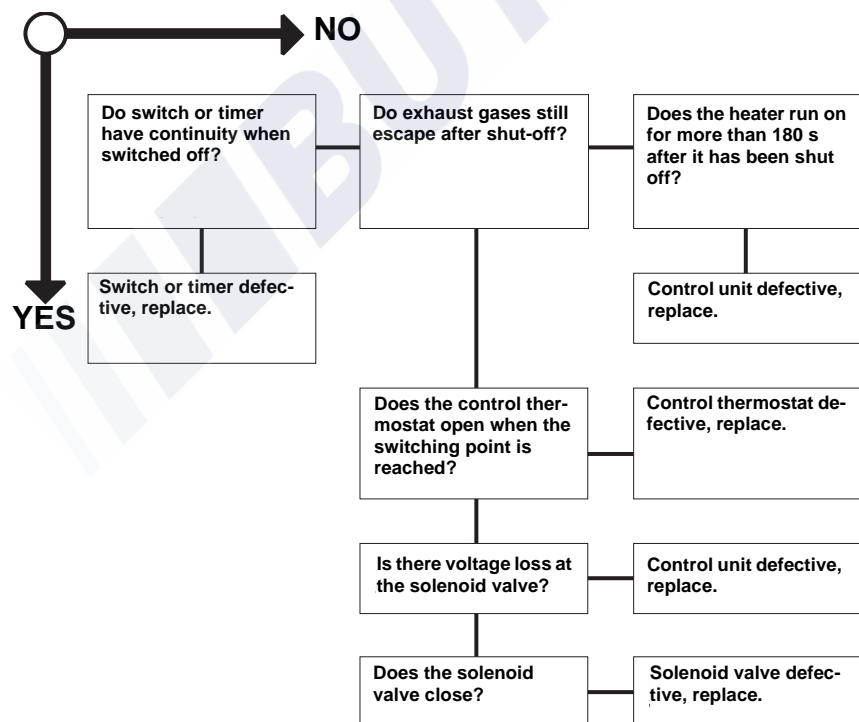
5.4.5 Heater creates black smoke



5.4.6 Heater creates white smoke



5.4.7 Heater cannot be switched off





## 6 Function Checks

### 6.1 General

This section describes the checks and settings to be performed on the installed and removed heater to verify its fitness for operation.

#### WARNING

The heater must never be operated in enclosed rooms such as garages or workshops without exhaust-gas extraction systems.

Risk of fire! Do not switch on the heater with the burner swung away from its operating position.

### 6.2 Settings

#### 6.2.1 Adjusting CO<sub>2</sub> contents

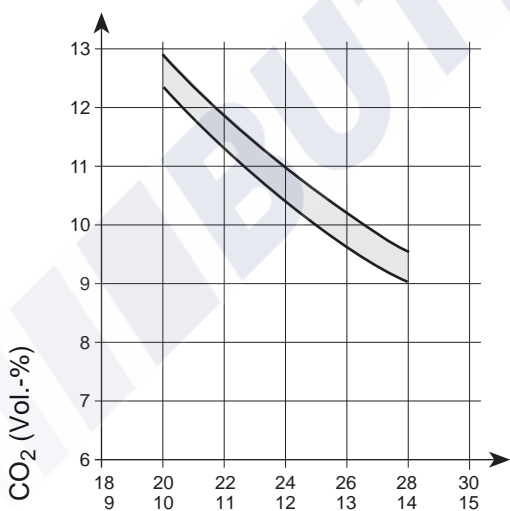
The combustion air quantity set at the factory may be changed by turning the adjustment ring.

The CO<sub>2</sub> content of the exhaust must be measured and the combustion air quantity must be adjusted, if required:

- after repair of the burner
- in case of irregular combustion
- during function checks
- after atomiser replacement

#### Adjustment procedure

- Measure input voltage at heater
- Run heater for approx. 5 min.
- Measure CO<sub>2</sub> and smoke spot number and compare with applicable diagram.



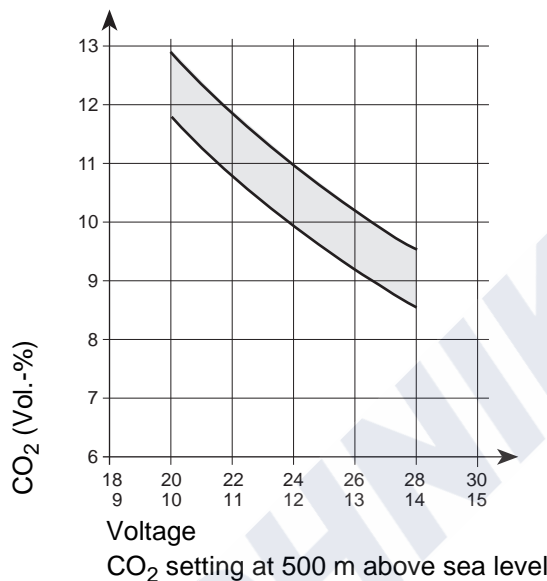
Voltage  
CO<sub>2</sub> setting at 500 m above sea level

DBW 160 (atomiser: 0.3 gph)

DBW 230(2020) (≥ .33)

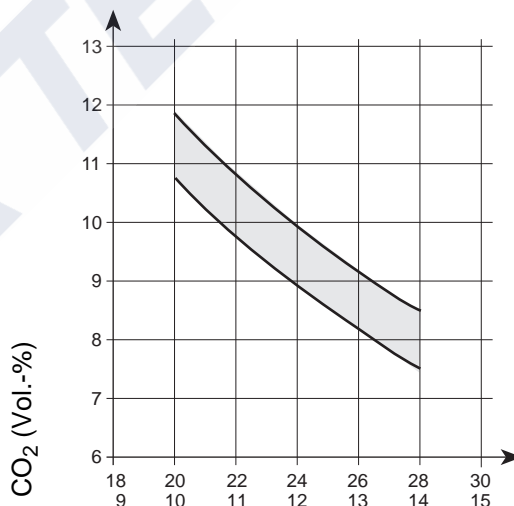
DBW 300 / DBW 350

Fuel-pump pressure 10 bar



CO<sub>2</sub> setting at 500 m above sea level

DBW 160 (atomiser: 0.4 gph)  
Fuel-pump pressure 11.5 bar (0.4 gph)  
Fuel-pump pressure 10 bar (0.3 gph)



Voltage  
CO<sub>2</sub> setting at 500 m above sea level

DBW 230(2020) (≤ .32)

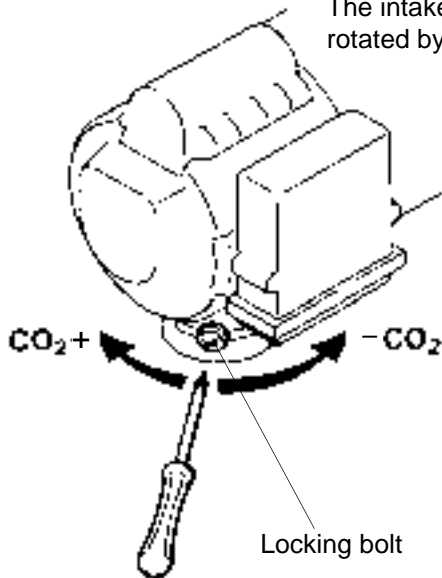
DBW 300 (≤ .15)

Fuel-pump pressure 10 bar

## 6 Function Checks *DBW 160 / 230 (2020) / 300 / 350*

### NOTE

The intake duct may be rotated by 180°.



- Release locking bolt (see Fig.) and move the adjustment ring with the locking bolt until the target value is achieved.
- Torque locking bolt to 1.0 +0.5 Nm and secure it with locking compound.

### NOTE

The CO<sub>2</sub> setting depends on the fuel (viscosity) and the height above sea level (0.1% per 100 m).

If the CO<sub>2</sub> value cannot be adjusted to target value proceed as follows:

- Check air intake side of burner head for damage and replace, if required
- Check fuel pump pressure and replace pump, if required
- Replace atomiser
- Measure burner motor speed.
- Check wiring conduit grommets for correct installation.

## 6.3 Checks of individual components

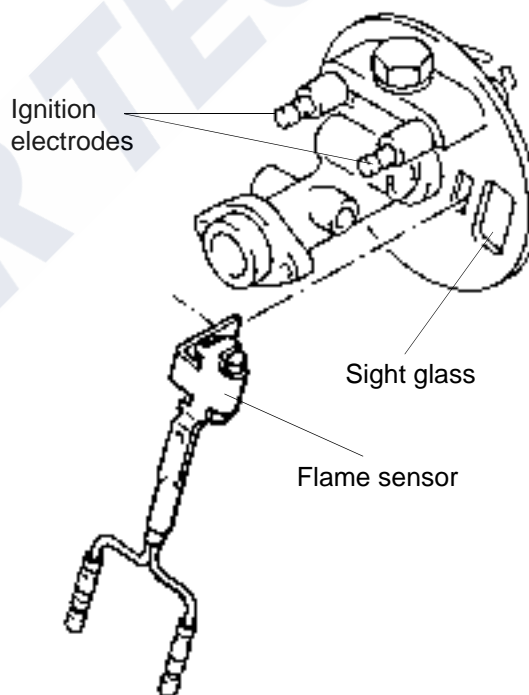
### 6.3.1 Check of flame sensor resistance

#### NOTE

The glass body of the flame sensor and the sight glass (see Fig.) must be cleaned if soiled. In case of damage or if the target value is not reached, the flame sensor must be replaced.

#### 6.3.1.1 Check of flame sensor at control unit 1553

- Connect ohmmeter to flame sensor
- Black out the flame sensor. Push on a piece of black insulating hose and pinch its ends
- After approx. 20 seconds the resistance must increase to > 100 k-Ohm
- Expose the flame sensor to the light of a match lit approx. 1 cm away. The resistance must drop to approx. 300 Ohm.



### 6.3.2 Check and adjustment of ignition electrodes

#### NOTE

- The ignition electrodes' insulation bodies may not show any signs of damage. Ignition electrodes with an electrode gap outside the tolerance range or incorrectly functioning ignition electrodes must be adjusted or replaced.
- Ignition electrode gaps can be adjusted using the gauge. The gauge's front edge must contact the atomiser with the tips of the ignition electrodes resting in the two notches.

#### Check

- Check the ignition electrodes' insulation bodies for signs of damage.

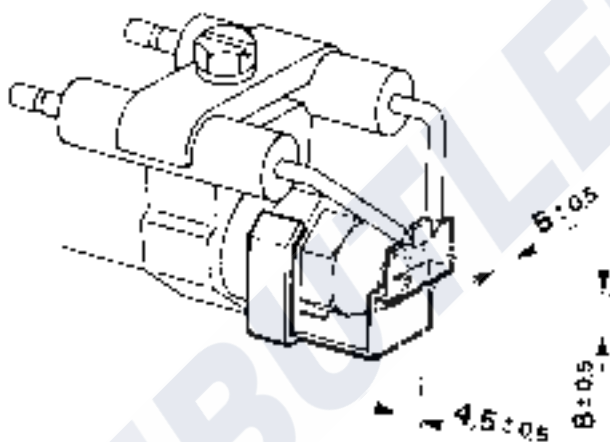
#### CAUTION

In order not to disturb fuel atomisation, the atomizer bore must not be touched while measuring the electrode gap.

- Check electrode gap using the gauge as shown in the fig. and check the condition of the electrodes.

#### Adjustment

- Adjust gap by bending electrodes and verify using the gauge as shown.



### 6.3.3 Check of electronic ignition unit

#### WARNING

High voltage; the spark generated at the ignition electrodes has a voltage of approx. 8,000 volts.

#### CAUTION

Never apply voltage to the electronic ignition unit without the ignition electrodes being installed.

#### Check

#### NOTE

Connect the positive pole of a DC power supply to the black line and the negative pole to the brown line.

- Apply a DC voltage of 12 or 24 volts.
- Target condition: Spark-over between ignition electrodes.

### 6.3.4 Check of fuel pump

#### NOTE

The fuel pump is checked when installed. Pump-pressure adjustment is permissible.

Testing requires a testing device. Testing devices (0 to 15 bar display range) are available from Spheros main dealers.

#### CAUTION

The electronic ignition unit must be removed.

#### Check

- Remove electronic ignition unit (see 9.2.7.1).
- Remove atomiser.
- Install testing device.
- Cover flame sensor.
- Turn on heater.
- Pump pressure is indicated after approx. 15 seconds (see diagram).
- Turn off heater.
- Remove testing device.

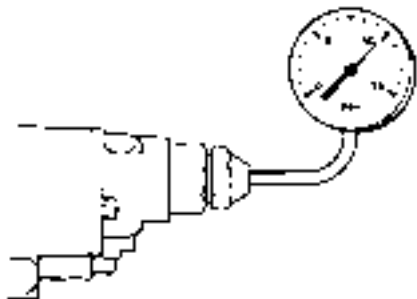
#### CAUTION

Do not damage atomiser bore.

- Screw in atomiser nozzle and tighten to 20 Nm.

## 6 Function Checks *DBW 160 / 230 (2020) / 300 / 350*

- Install electronic ignition unit (see 9.2.7.2).



### 6.3.5 Check of burner motor

#### NOTE

The combustion air fan is checked when installed. The fan motor must be replaced if the target conditions are not achieved.

#### Check

- Check bearings of burner motor (must be freely running).
- Measure input voltage at heater
- Turn on heater.
- Measure speed (at nominal voltage, the speeds must be within the specified ranges).

DBW 160	.....4050 – 4950
DBW 230	.....5220 – 6380
DBW 300	.....5220 – 6380
DBW 350	.....5040 – 6160

### 6.3.6 Check of solenoid valve

#### NOTE

Longer periods of smoke emission during run-down is an indication of a leaking solenoid valve seat. In this case fuel trickles from the atomiser.

A short period of smoke emission is normal. This is caused by the fuel draining from the space between solenoid valve and atomiser bore.

#### Check

#### CAUTION

Disconnect the connector of the solenoid valve at the control unit.

Failure to follow this instruction may result in damage of the control unit.

- Check electric function of **12-volt devices** using the following data:
  - Opening voltage 8.5 volts
  - Operating voltage 9.6 ... 14.4 volts
  - Power consumption at nominal voltage and 20° C 10 watts
  - nominal current 0.83 ampere
- Check electric function of **24-volt devices** using the following data:
  - Opening voltage 17.0 volts

- Operating voltage 19.2 ... 28.8 volts
- Power consumption at nominal voltage and 20° C 10 watts
- nominal current 0.42 ampere

### 6.3.7 Check of nozzle-block preheater

#### NOTE

At temperatures of < 0° C the thermostat activates the heater element inside the nozzle block. The heating duration depends on the reflection heat in the combustion chamber and is switched off at +8° C at the thermostat. The power consumption is 130 ±13 watts at 12 volts or 24 volts.

#### Check

- Swing away or remove the burner head.
- Disconnect connector from nozzle block.
- Connect ohmmeter to connector.
- Chill thermostat using freeze spray or bridge it.
- Resistance (max. 4.5 Ω).

BUTLER TECHNIK

**BUTLER TECHNIK**

## **7 Wiring diagrams**

### **7.1 General information**

The wiring diagrams and application examples (Fig. 701 to 704) show possible circuits for the heaters *DBW 160, 230 (2020), 300* and *350*.



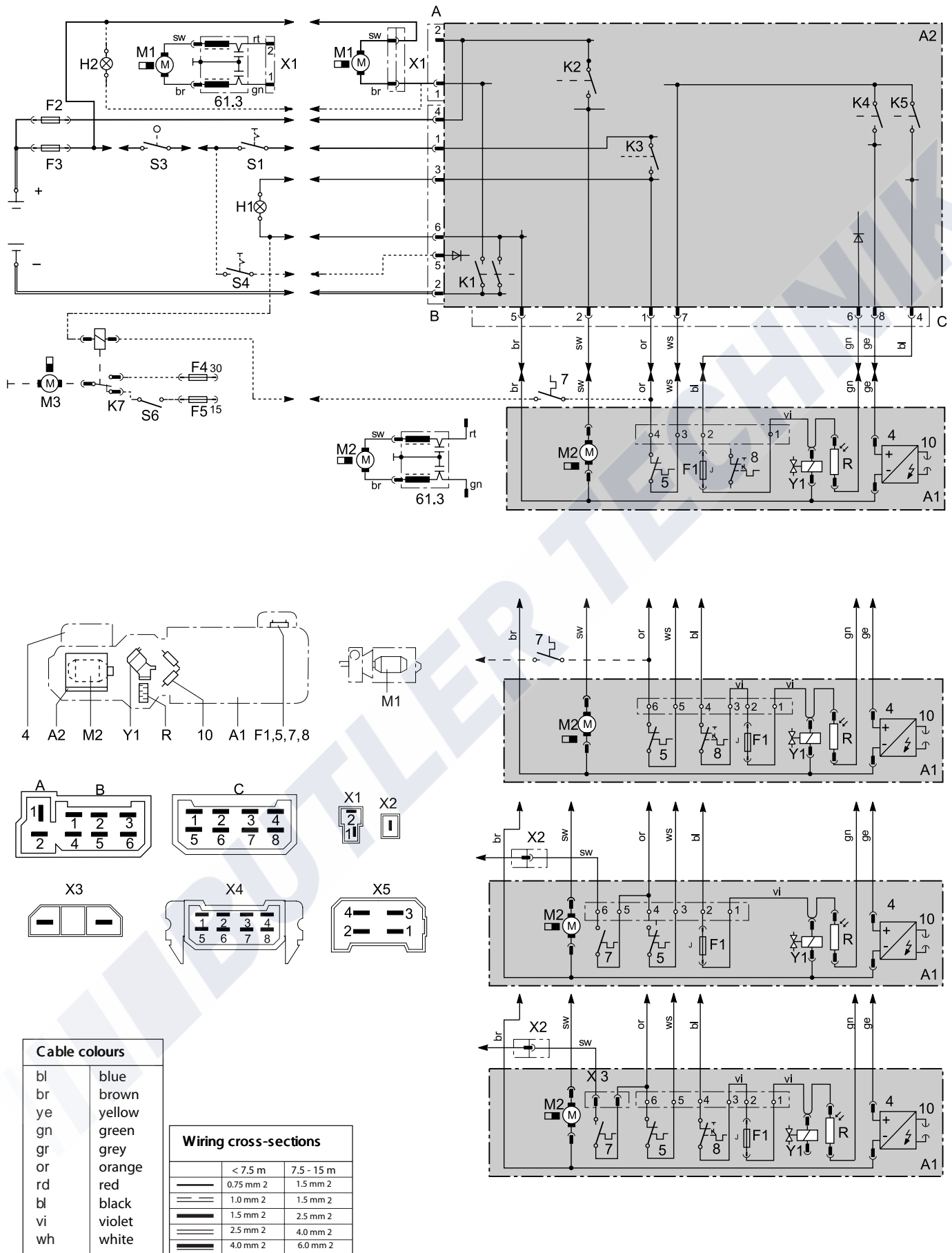


Fig. 701 (page 1 of 2) Automatic wiring diagram, DBW 160 with control unit 1553 and switch, system variants and pin allocation



Pos.	Designation	Comment	A	B	C	D
A1	Heater			●		
A2	Control unit	CU 1553	●			
4	Electronic ignition unit		●			
5	Thermostat	Control thermostat (internal)	●			
7	Thermostat	Fan thermostat	○	○	○	
8	Thermostat	Temperature-limiter thermostat	●			
10	Ignition electrodes		●			
61.3	Interference-suppression kit (2 x)	Interference suppression			○	
A	Connector	Control unit, 2-pin	●			
B	Connector	Control unit, 6-pin	●			
B5	Thermostat	Nozzle-block preheater	○			
C	Connector	Control unit, 8-pin	●			
F1	Thermal fuse	reversible polarity	●			
F2	8 A fuse	Automotive fuse as per DIN 72581		○		
F3	8 A fuse	Automotive fuse as per DIN 72581		○		
F4	Fuse	Automotive fuse as per DIN 72581		○		
F5	Fuse	Automotive fuse as per DIN 72581				●
F6	Fuse	Automotive fuse as per DIN 72581		○		
H1	Light, green	Operation indicator		●		
H2	Light, for circulation pump	If actuated via S4			○	
K1	Relay	Circulation pump; negative terminal for heater				
K2	Relay	Heater motor				
K3	Relay	Light; control-thermostat operation				
K4	Relay	Electronic ignition unit				

Pos.	Designation	Comment	A	B	C	D
K5	Relay	Solenoid valve; flame sensor				
K6	Relay	Nozzle-block preheater	○			
K7	Relay	Vehicle-heater fan			○	
M1	Motor	Circulation pump		●		
M2	Motor	Combustion air fan	●			
M3	Motor	Vehicle fan				●
R	Flame sensor	Photoelectric resistor, reversible polarity	●			
R1	Motor resistor	Power resistor	○			
S1	Switch	for heater ON - OFF		●		
S3	Switch on shut-off valve	Contact open when shut-off valve closed			○	
S4	Switch	for ON - OFF, with separate connection of circulation pump			○	
S6	Switch	Vehicle fan				●
X1	Connector	2-pin		○		
X2	Connector	1-pin		○		
X3	Connector	2-pin		○		
X5	Connector	4-pin		○		
Y1	Solenoid valve	reversible polarity	●			
<p>A installed in heater                      B unmounted supply parts                      C only if required                      D included in vehicle equipment                      ● fixed allocation                      ○ possible depending on the scope of delivery or design type</p>						

Fig. 701 (page 2 of 2) Automatic wiring diagram, DBW 160 with control unit 1553 and switch, system variants and pin allocation

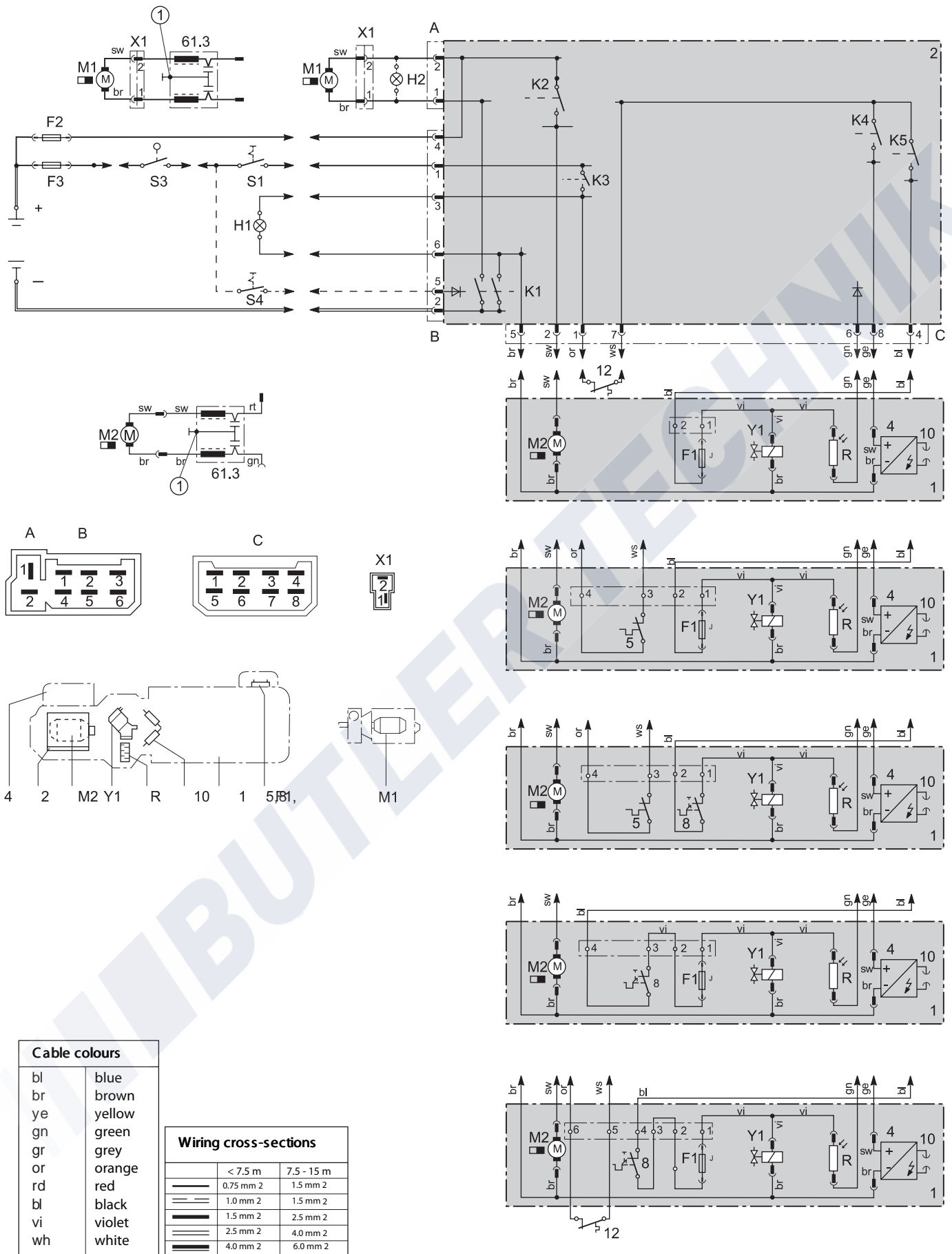


Fig. 702 (page 1 of 2) Automatic wiring diagram, DBW 230/300 with control unit 1553, 24 volts

Pos.	Designation	Comment	A	B	C	D
1	Heater	floating		●		
2	Control unit	CU 1553	●			
4	Electronic ignition unit		●			
5	Thermostat	Control thermostat (internal)	○			
8	Thermostat	Temperature-limiter thermostat	●			
10	Ignition electrodes		●			
12	Thermostat	Control thermostat (external)			○	
61.3	Interference-suppression kit (2 x)	Interference suppression			○	
F1	Thermal fuse	reversible polarity	●			
F2	8 A fuse	Automotive fuse as per DIN 72581		○		
F3	8 A fuse	Automotive fuse as per DIN 72581		○		
H1	Light, green	Operation indicator		●		
H2	Light, for circulation pump	If actuated via S4			○	
K1	Relay	Circulation pump; negative terminal for heater				
K2	Relay	Heater motor				
K3	Relay	Light; control-thermostat operation				
K4	Relay	Electronic ignition unit				
K5	Relay	Solenoid valve; flame sensor				
M1	Motor	Circulation pump		●		
M2	Motor	Heater motor	●			
R	Flame sensor	Photoelectric resistor, reversible polarity	●			
S1	Switch	for heater ON - OFF		●		
S3	Switch on shut-off valve	Contact open when shut-off valve closed			○	
S4	Switch	for ON - OFF, with separate connection of circulation pump			○	
X1	Connector	2-pin		○		
Y1	Solenoid valve	reversible polarity	●			
A installed in heater B unmounted supply parts C only if required D included in vehicle equipment ● fixed allocation ○ possible depending on the scope of delivery or design type  Ensure good ground connection!						

Fig. 702 (page 2 of 2) Automatic wiring diagram, DBW 230/300 with control unit 1553, 24 volts

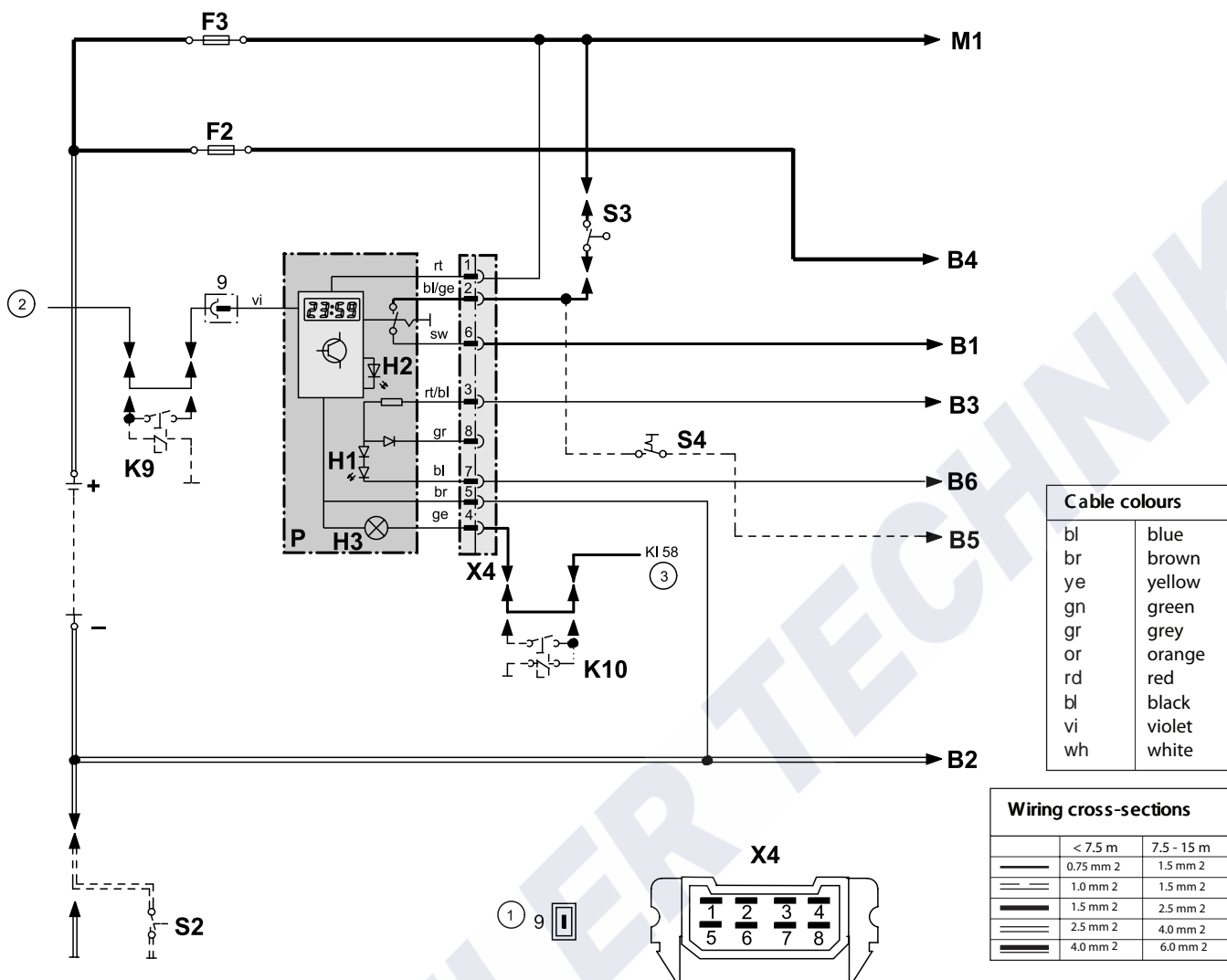


Pos.	Designation	Comment	A	B	C	D
A1	Heater	floating				
A2	Control unit	CU 1553	●			
B1	Flame sensor	Photoelectric resistor, reversible polarity	●			
B2	Thermostat	Temperature limiter	●			
B3	Thermostat	Control thermostat	○	○		
F1	Thermal fuse	reversible polarity	●			
F2	8 A fuse	Automotive fuse as per DIN 72581		○		
F3	16 A fuse	Automotive fuse as per DIN 72581		○		
F4	8 A fuse	Automotive fuse as per DIN 72581		○		
G	Battery					●
H1	Light, green	Operation indicator		●		
K1	Relay (in pos. A2)	for disconnection of negative terminal				
K2	Relay (in pos. A2)	for K7 relay				
K3	Relay (in pos. A2)	for closed-loop operation				
K4	Relay (in pos. A2)	for electronic ignition unit				
K5	Relay (in pos. A2)	for solenoid valve				
K6	Relay (in pos. A1)	for circulation pump				
K7	Relay (in pos. A1)	for burner motor				
M1	Motor	Heater	●			
M2	Motor	Circulation pump		●		
S1	Switch	for heater ON - OFF		●		
S2	Switch	separate switch for circulation pump			○	
U 1	Electronic ignition unit		●			
U2	Ignition electrodes		●			
W1	Wiring harness		●			
X1	Connector	2-pin, at position of W1				
X2	Connector	2-pin, at position of W1				
X3	Connector	2-pin, at position of W2				
Y1	Solenoid valve	reversible polarity	●			

A	installed in heater
B	unmounted supply parts
C	only if required
D	included in vehicle equipment
●	fixed allocation
○	possible depending on the scope of delivery or design type

Fig. 703 (page 2 of 2) Automatic wiring diagram, DBW 300/350 with control unit 1553, 24 volts



NOTE: Application example in connection with wiring diagram, fig. 701 or 702.

Pos.	Designation	Comment	A	B	C	D
H1	LED, green	Op. indicator (in pos. P)				
H2	Light-emitting diode, yellow	Readiness indicator (in pos. P)				
H3	Lights	Symbol illumination (in pos. P)				
K9	Relay	only required if battery switch is connected to negative terminal				
K10	Relay					
P	Timer (digital)	for timer operation		●		
S2	Switch	Battery switch				○
S3	Switch on shut-off valve	Contact open, when shut-off valve closed			○	
S4	Switch (ON - OFF)	Separate connection of circul. pump, ON - OFF			○	

Pos.	Designation	Comment	A	B	C	D
X4	Connector	8-pin (for pos. P)				
A	installed in heater					
B	unmounted supply parts					
C	only if required					
D	included in vehicle equipment					
●	fixed allocation					
○	possible depending on the scope of delivery or design type					
①	Timer P: when plus terminal is connected to connection 9 = continuous operation during immediate heating when plus terminal is not connected to connection 9 = 1-hour heating period					
②						
③	to vehicle terminal 75, if available – otherwise terminal 15					
	Vehicle illumination (terminal 58)					

Fig. 704 Application example for DBW 160/230/300, 12 and 24 volts, operation with timer and battery switch

BUTLER TECHNIK

BUTLER TECHNIK



## 8 Service and Maintenance

### 8.1 General

This section describes permissible service work on installed heater systems.

### 8.2 Heater servicing

As long as the heater is in operation or in run-down mode, the battery main power supply must not be disconnected to prevent the heater from overheating and, as a result, the overheat protection from being triggered.

When extensive repair work is carried out, it is advisable to remove the heater.

When work on the heating circuit has been carried out, a coolant mixture consisting of water and anti-freeze agent must be refilled according to the manufacturer's instructions and the heating circuit must be bled.

### 8.3 Vehicle servicing

#### CAUTION

In the vicinity of the heater, a temperature of 85° C must by no means be exceeded (e.g. when paint work is carried out on the vehicle).

### 8.4 Heater test run

The heater must not, not even with a timer, be operated in enclosed rooms such as garages or workshops without exhaust-gas extraction systems.

### 8.5 Maintenance work

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

- The openings of the combustion air intake line and the exhaust outlet must be checked for soiling and cleaned.
- Outside the heating period, the heater must be operated with a cold vehicle engine every 4 weeks for 10 minutes, with the heating temperature set to "warm". This helps to prevent difficulties during start-up.
- When replacing the coolant for the vehicle engine, take care to bleed the heater and the circulation pump properly after the vehicle cooling system has been bled. Refill coolant as specified by the vehicle manufacturer.
- At least once a year, with heavily contaminated fuel more often, the fuel filter or the filter insert must be replaced to prevent malfunctions.
- When leakage occurs, the fuel pump and the fuel lines must be replaced immediately, otherwise every 5 years.
- The heater should be checked by a Spheros service workshop at regular intervals, at the latest at the beginning of a heating period.

### 8.5.1 Swinging the burner head open and closed

#### DANGER

The electronic ignition unit is operated at high voltage. Danger! Ensure that the wiring harness connectors are disconnected from the control unit before swinging open the burner head. Reconnect the connectors once the burner head is swung closed again.

#### NOTE

The heater is maintenance-friendly. Swinging the burner head <sup>1)</sup> open grants access to the following components:

- Fuel pump and atomiser nozzle
- Solenoid valve
- Electronic ignition unit
- Ignition electrodes
- Flame sensor
- Combustion chamber
- Nozzle-block preheater (if installed)
- In DBW 160, ensure correct fit of the cable grommets

To achieve the required opening angle, the electrical con-

nections may have to be disconnected.

#### Swinging the burner head open

1. Disconnect electrical connections, if necessary.
2. Loosen nuts (3, Fig. 801) until bolts (1) can be swung out.
3. Swing bolts (1) out.
4. Swing burner head (4) open.

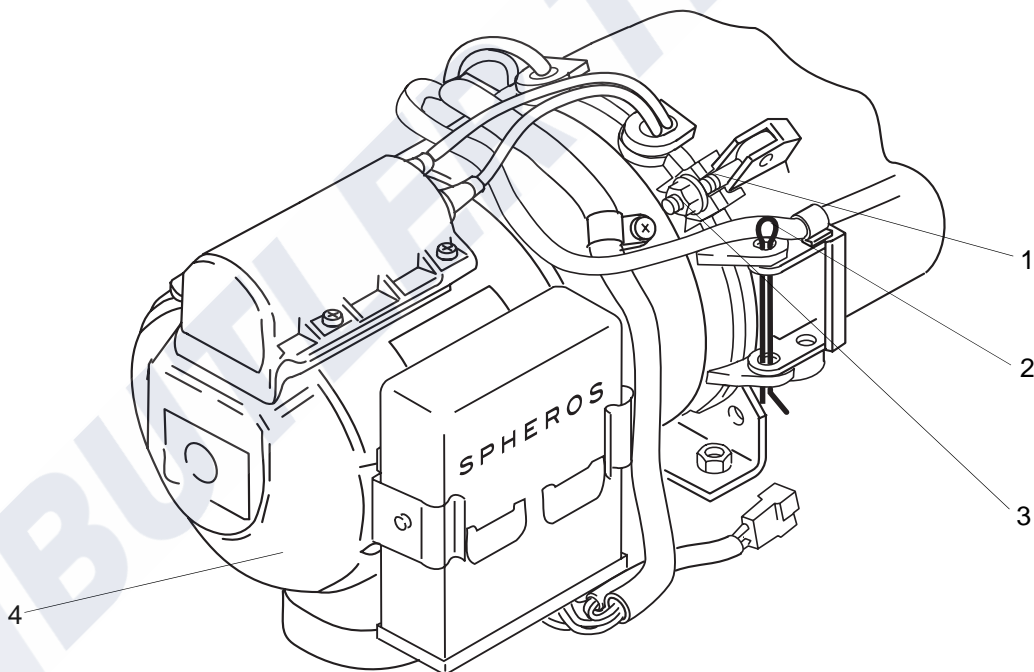
#### Swinging the burner head closed

1. Swing burner head (4, Fig. 801) closed and bring into assembly position.
2. Swing bolts (1) closed and initially hand-tighten with nuts (3) to prevent stress.
3. Torque nuts (3)
  - in DBW 160 to 5.0 Nm + 1 Nm,
  - in DBW 230(2020) / 300 / 350 to 8.0 Nm +/- 10%.
4. Connect electrical connections, if necessary.

#### NOTE

Observe wiring colour codes when reconnecting the electrical connections

- 1 bolt (2)
- 2 split pin
- 3 nut (2)
- 4 burner head



#### NOTE

- Depending on the swing direction of the burner head<sup>1)</sup>, the split pin can be located on the other side.
- The illustration shows the burner head of the DBW 160 series heaters.

<sup>1)</sup> not possible with design type DBW 300.62

Fig. 801 Swinging the burner head open and closed

## 8.6 Visual inspections / installation instructions

### 8.6.1 Connection to the vehicle's cooling system

The heater must be connected to the vehicle's cooling system as illustrated in Fig. 802. The minimum amount of coolant required in the circuit is 10 litres.

As a rule, the coolant hoses supplied by Spheros must be used. Otherwise, hoses in compliance with DIN 73411 or better must be used. The hoses must be routed without any kinks and - to ensure proper bleeding of the heater - in an upward pitch, if possible. Hose connections must be secured with clamps against slipping off.

NOTE:

The tightening torques of the hose clamps used must be observed.

In the vehicle's cooling system or a separate heating circuit, only pressure-relief valves with an opening pressure of min. 0.4 bar and max. 2.0 bar may be used.

Prior to initial start-up of the heater or after replacement of the coolant, proper bleeding of the cooling system must be ensured. Heater and lines must be installed to ensure static bleeding of the system.

Proper bleeding can be identified by almost noise-free operation of the circulation pump. Poor bleeding may result in the tripping of the resettable temperature limiter or the thermal fuse while the heater is in operation.

When circulation pump U 4855 / Aquavent 6000C is used, a low coolant level or a blocked pump impeller will cause the circulation pump to be shut off automatically approx. 15 seconds after activation. The circulation pump can be restarted after approx. 2 minutes.

When circulation pump U 4856 / Aquavent 6000SC is used, a low coolant level or a blocked pump impeller will cause the circulation pump to be shut off automatically approx. 45 seconds after activation. The circulation pump can be restarted after approx. 2 minutes.

### 8.6.2 Connection to the vehicle's fuel system

Fuel is taken from the vehicle's fuel tank or a separate fuel tank.

#### 8.6.2.1 Fuel lines

To prevent trapped air, fuel lines must be routed in an upward pitch, if possible. Connections within the fuel lines must be secured by hose clamps unless mechanical threaded joints are used.

If fuel hoses are used, only the hoses supplied or offered by Spheros must be used. Any other fuel hose must comply with DIN 73379 as a minimum. Fuel hoses must neither be kinked nor twisted and must be fastened with clamps at intervals of approx. 25 cm.

Materials commonly used in vehicle construction may also be used as fuel lines, taking into account the respective joining techniques.

As a rule, the following points must be observed when routing fuel lines:

- Lines must be protected against heat

#### DANGER

When the system overheats, the outer shell of the heater can reach the ignition temperature of diesel fuel!

- Lines must be protected against stone chipping
- **Dripping or evaporating fuel may neither collect nor be ignited by hot components or electrical equipment.**

It is not permissible to install a shut-off device in the return line!

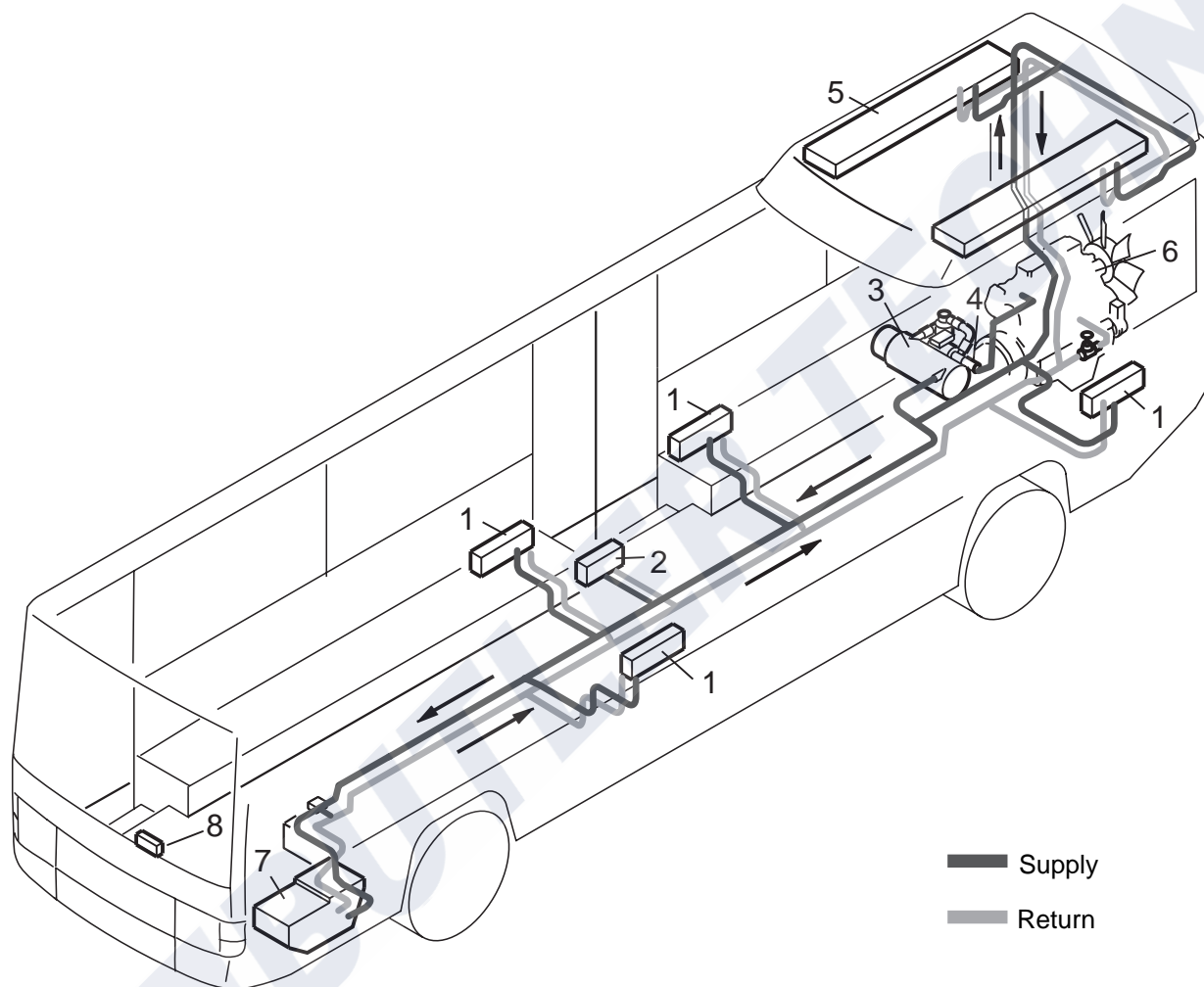
#### CAUTION

Operating the heater with closed return line will result in damage to the fuel pump. Fuel may escape. Fire hazard.

Freely suspended lines must be secured to prevent them from sagging.

It is not permissible to install an additional fuel pump. See Section 1, Page 102. for legal requirements.

Coolant heating circuit –  
Wall heater and roof-duct heating system



- 1 Wall heater with fan
- 2 Heat exchanger at entry point
- 3 Heater
- 4 Circulation pump
- 5 Heat exchanger in roof area
- 6 Vehicle engine
- 7 Heater in driver area
- 8 Control element

Fig. 802 Example of heater installation in a bus

Permissible fuel-line dimensions:

- Inside diameter for suction and return lines: 6 mm (other diameters upon request).
- Max. permissible line length per suction and return line: 10 m
- Max. permissible suction height: 2 m
- Max. permissible supply pressure: 0.3 bar.

### 8.6.2.2 Fuel filter

Fuel filters supplied or approved by Spheros must be installed (observe flow direction). To avoid malfunctions, the filter or filter insert must be replaced before the beginning of each heating period.

### 8.6.3 Combustion air supply

Combustion air may by no means be extracted from spaces in which persons are present. The combustion air intake opening may not point in the direction of travel. It must be positioned in a location where it cannot become clogged with soil or snow and draw in splash water. The combustion air inlet must not be positioned above the exhaust-gas outlet.

When the heater is installed in a joint installation space near the vehicle's fuel tank, combustion air must be drawn in from outside the vehicle and the exhaust gas must be routed to the outside. Lead-through openings must be protected against splash.

If the heater is placed in an enclosed installation case, a ventilation opening is required:

DBW 160 / 230 / 300	30 cm <sup>2</sup>
DBW 350	35 cm <sup>2</sup>

If the temperature in the installation case exceeds the permissible ambient temperature of the heater (see technical data), the ventilation opening must be enlarged after prior consultation with Spheros.

### 8.6.4 Exhaust pipe

The exhaust-pipe end may not point in the direction of travel.

The exhaust-pipe end must be positioned in a location where it cannot become clogged with soil or snow.

Only rigid pipes made of unalloyed or alloyed steel with a minimum wall thickness of 1.0 mm or flexible pipes of alloyed steel must be used as exhaust pipes. The exhaust pipe must be fastened to the heater e.g. by means of a clamp. See legal requirements for further specifications.

Permissible exhaust-pipe dimensions:

- Inner diameter:

DBW 160:	38 mm
DBW 230 to .32 / DBW 300 to .15:	80 mm
DBW 230 from .33 / DBW 300 from .16:	70 mm
DBW 350	70 mm

- Max. permissible line length: 5 m without combustion air intake extension
- Total length of combustion air intake and exhaust pipe max. 5 m
- Max. permissible bending: 270°

#### NOTE

If the exhaust pipe is routed near temperature-sensitive components it must be insulated!

Alternatively, an exhaust-gas bypass approved by Spheros must be installed.

## 8.7 Removal and installation

### CAUTION

When the heater is installed, only the following disassembly or removal processes are permitted, provided there is sufficient space for removal:

- Replacing the temperature limiter
- Replacing the fan or control thermostat
- Replacing the thermal fuse
- Replacing the fusible link
- Replacing the burner head
- Replacing the electronic ignition unit
- Replacing the flame sensor
- Replacing the combustion chamber

### 8.7.1 Heater, removal and installation

#### 8.7.1.1 Removal

1. Disconnect wiring-harness connector from control unit.
2. Remove clamp at exhaust-gas outlet.
3. Remove fuel supply and return line and fuel lines and close with blanking plugs.  
Close shut-off valves, if present.
4. Loosen hose clamps at the coolant hoses, pull off hoses and close with blanking plugs.
5. Remove relevant fasteners (bolts, nuts, washers) at the support.
6. Remove heater.

#### 8.7.1.2 Installation

1. Place heater in installation position and fasten with relevant bolts, washers and nuts.
2. Secure line at exhaust-gas outlet with clamp.
3. Slide on coolant hoses and secure with hose clamps.  
Open shut-off valves.
4. Slide on fuel supply and return lines and secure.
5. Connect wiring-harness connector to control unit.
6. Bleed fuel-supply system.
7. Bleed coolant circuit.

### 8.7.2 Replacing the temperature limiter

#### NOTE

The procedure for replacing the temperature limiter is the same for installed or uninstalled heaters.  
For replacement process, see 9.2.1.

### 8.7.3 Replacing the control thermostat

#### NOTE

The procedure for replacing the control thermostat is the same for installed or uninstalled heaters.  
For replacement process, see 9.2.2.

### 8.7.4 Replacing the fan thermostat

#### NOTE

The procedure for replacing the fan thermostat is the same for installed or uninstalled heaters.  
For replacement process, see 9.2.3.

### 8.7.5 Replacing the thermal fuse

#### NOTE

The procedure for replacing the thermal fuse is the same for installed or uninstalled heaters.  
For replacement process, see 9.2.4.

### 8.7.6- Replacing the burner head

#### NOTE

The procedure for replacing the burner head is the same for installed or uninstalled heaters.  
For replacement process, see 9.2.6.

#### DANGER

The electronic ignition unit is operated at high voltage. Danger! Ensure that the wiring harness connectors are disconnected from the control unit before replacing the burner head.

### 8.7.7 Replacing the electronic ignition unit

#### NOTE

The procedure for replacing the electronic ignition unit is the same for installed or uninstalled heaters.  
For replacement process, see 9.2.10.

#### DANGER

The electronic ignition unit is operated at high voltage. Danger! Ensure that the wiring harness connectors are disconnected from the control unit before replacing the electronic ignition unit.

### 8.7.8 Replacing the flame sensor

#### NOTE

The procedure for replacing the flame sensor is the same for installed or uninstalled heaters.  
For replacement process, see 9.2.11.

#### DANGER

The electronic ignition unit is operated at high voltage. Danger! Ensure that the wiring harness connectors are disconnected from the control unit before replacing the flame sensor.



### **8.7.9 Replacing the combustion chamber**

**NOTE**

The procedure for replacing the combustion chamber is the same for installed or uninstalled heaters.  
For replacement process, see 9.2.15.

**DANGER**

The heater is operated with high voltage. Danger! Ensure that the wiring harness connectors are disconnected from the control unit before replacing the combustion chamber.



**8.8 Start-up**

After installation of the heater, the coolant circuit and the fuel-supply system must be carefully bled. The vehicle manufacturer's instructions must be observed during the procedure. During the test run, all coolant and fuel connections must be checked for sealing tightness and firm fit. Should the heater switch into malfunction mode during operation, troubleshooting must be performed (see Section 5).

**8.8.1 Bleeding the coolant circuit**

**NOTE**

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

Set the vehicle heating system to "warm" and refill coolant which must consist of a mixture of water and at least 10 % anti-freeze agent (on glycol basis) (corrosion protection). The use of pure water will not provide any corrosion protection and, due to the lower boiling point of water, may result in a partial loss of coolant in the event of overheating, requiring coolant to be refilled. Only coolant additives may be used that are not aggressive against metals, plastics and rubber and that do not cause any deposits.

Run the vehicle engine at high idle until the cooler thermostat is open. Shut off vehicle engine and check coolant level, refill coolant, if required.

Switch on the heater and the vehicle's heater fan while the vehicle engine is shut off. After a certain cooling period, the heater must automatically start and then shut itself down again. If no restart occurs, the temperature limiter on the heater was tripped because the heater has not been bled properly. Reset temperature limiter (by pushing the button on the temperature limiter) and repeat complete bleeding procedure.

**NOTE**

The heater can be equipped with an automatically resetting temperature limiter. In this case manual reset is not applicable.

**8.8.2 Bleeding the fuel-supply system**

When the heater is switched on, the fuel pump draws in fuel, filling the heater's entire fuel supply system.

If no combustion occurs after the first start-up, the heater must be switched off and switched on again.



## **9 Repair**

### **9.1 General**

This section describes permissible repair work on uninstalled heater systems. Any further disassembly will void the warranty.

For re-assembly, only spare parts from the corresponding spare-parts kits must be used.

#### **DANGER**

The electronic ignition unit is operated at high voltage.

The following components may also be replaced when the heater is installed, provided sufficient space is available.

- Temperature limiter
- Fan or control thermostat
- Thermal fuse
- Burner head
- Electronic ignition unit
- Flame sensor
- Combustion chamber.

Danger! Ensure that the wiring harness connectors are disconnected from the control unit before replacing a component.

## 9 Repair

## DBW 160 / 230 (2020) / 300 / 350

### 9.1.1 Measures on components in disassembled condition

#### CAUTION

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

#### 9.1.1.1 General visual inspection

- Check all components for damage (cracks, deformation, wear etc.) and replace if required.
- Check connectors and lines for corrosion, loose contacts, crimping faults etc. and repair if required.
- Check connectors for corrosion and contacts for firm fit, replace if required.

#### 9.1.1.2 Visual inspection of the combustion chamber

#### NOTE

DBW 300.62 is not provided with a flame pipe

- Check swirler for firm fit.
- Check combustion chamber for scaling and remove carbon deposits, if necessary.
- Check weld seam for cracks.

#### NOTE

Cracks on the weld seam of up to approx. 80 mm in longitudinal direction are permissible.

#### 9.1.1.3 Visual inspection of the heat exchanger

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

#### NOTE

Deposits must be removed with water jet and brush.

- Check heat exchanger for external damage, deformations etc.

#### NOTE

Heavy deformations may affect the coolant flow.

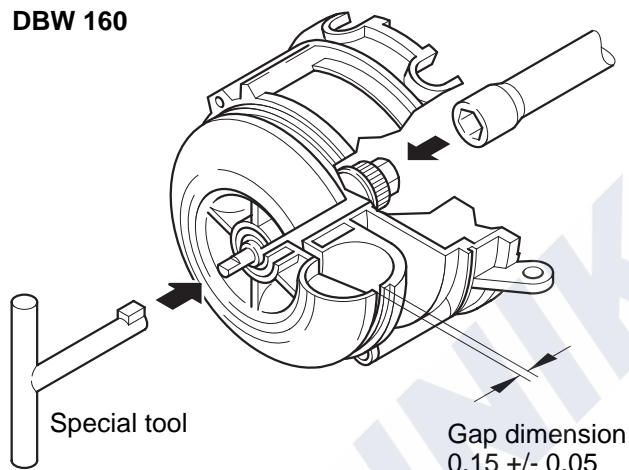
#### 9.1.1.4 Visual inspection of the combustion air fan

- Check combustion air fan for soiling and cracks.
- Check cover plate for firm fit.
- Check slide lock for firm fit.

Only DBW 160:

- Set gap dimension between fan wheel and fan housing (can be measured with a feeler gauge) at the narrowest point to 0.15 +/- 0.05 mm. For suitable tool, see spare-parts lists and accessories catalogue.

#### DBW 160



Only DBW 230/300/350:

Check hub of the combustion air fan for cracks, check shroud (rear panel) for strength.

### 9.1.2 Carrying out modifications

#### NOTE

A continuous further development of the heaters serves to optimise their performance with the aim of preventing failures or malfunctions.

Heaters already in use may usually be upgraded. Corresponding modification kits are available for this purpose.

The following modifications can be carried out as part of repair work:

- Installation of the nozzle-block preheaters for DBW 160 / 230 / 300 / 350 with control unit 1553 (see 9.1.2.1).

**9.1.2.1 Installation of the nozzle-block preheater**

**General**

The nozzle-block preheater serves to heat the fuel flowing to the atomiser nozzle. At extremely low temperatures, malfunctions may occur in the above mentioned heaters if they are not equipped with nozzle-block preheaters.

At a temperature of  $< 0^{\circ} \text{C}$ , the heating element in the nozzle block is actuated via a thermostat. The heating duration depends on the heat reflected in the combustion chamber and the heater switches off when the temperature at the thermostat is  $+8^{\circ} \text{C}$ .

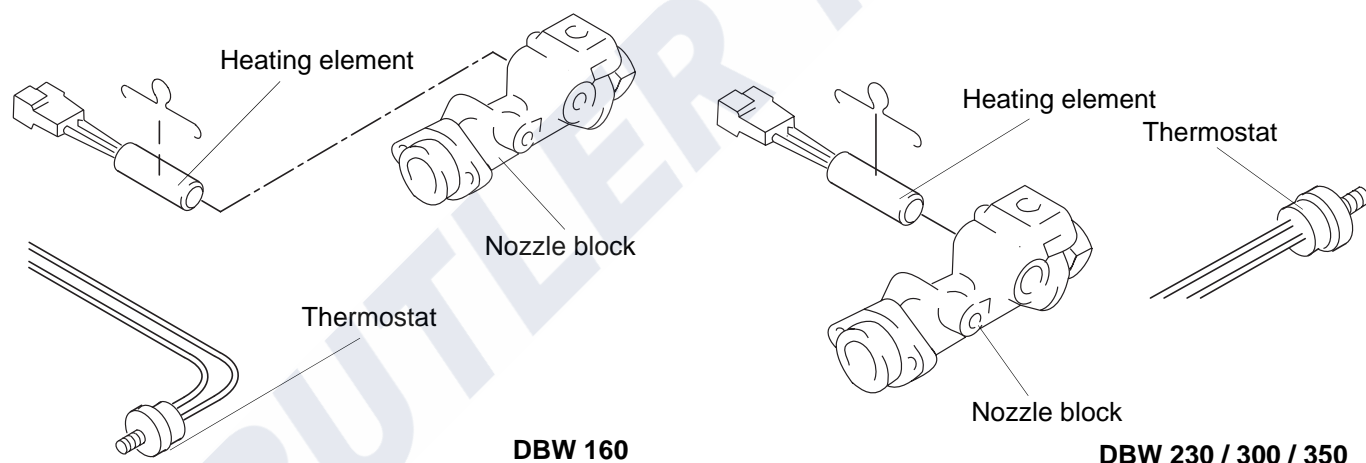
If no nozzle-block preheater is installed in the heater, it can be retrofitted according to the following procedure.

The following spare-parts kits for the heaters listed above are available for retrofits:

- 12 V heaters with control unit 1553, order no. 968 89A
- 24 V heaters with control unit 1553, order no. 989 71A

The spare-parts kit includes the following parts:

- 1 heating element
- 1 retaining clamp
- 1 relay
- 1 thermostat
- 1 wiring harness
- 1 tab
- 1 disk
- 1 nut
- 1 serrated lock washer
- 1 connector housing, 4-pin
- 1 connector housing, 2-pin
- 4 female disconnects



**DBW 160**

**DBW 230 / 300 / 350**

Implementation with DBW 160

**NOTE**

With DBW 160 heaters, the disk and the nut in the retrofit kit are not required.

1. Swing burner head open as explained in 8.5.1.
2. Remove ignition electrodes as explained in 9.2.12.1.
3. Remove circlip and pull disk with flame sensor off nozzle block.
4. Fasten thermostat (5) to the nozzle-block plate by means of the tab (7) and bolt (6).
5. Insert heating element (3) into the nozzle block (4) and fasten with retaining clamp (2).
6. Fasten relay (11) to the protective cap of the burner head (12) using a screw (9) and serrated lock washer (10).

**NOTE**

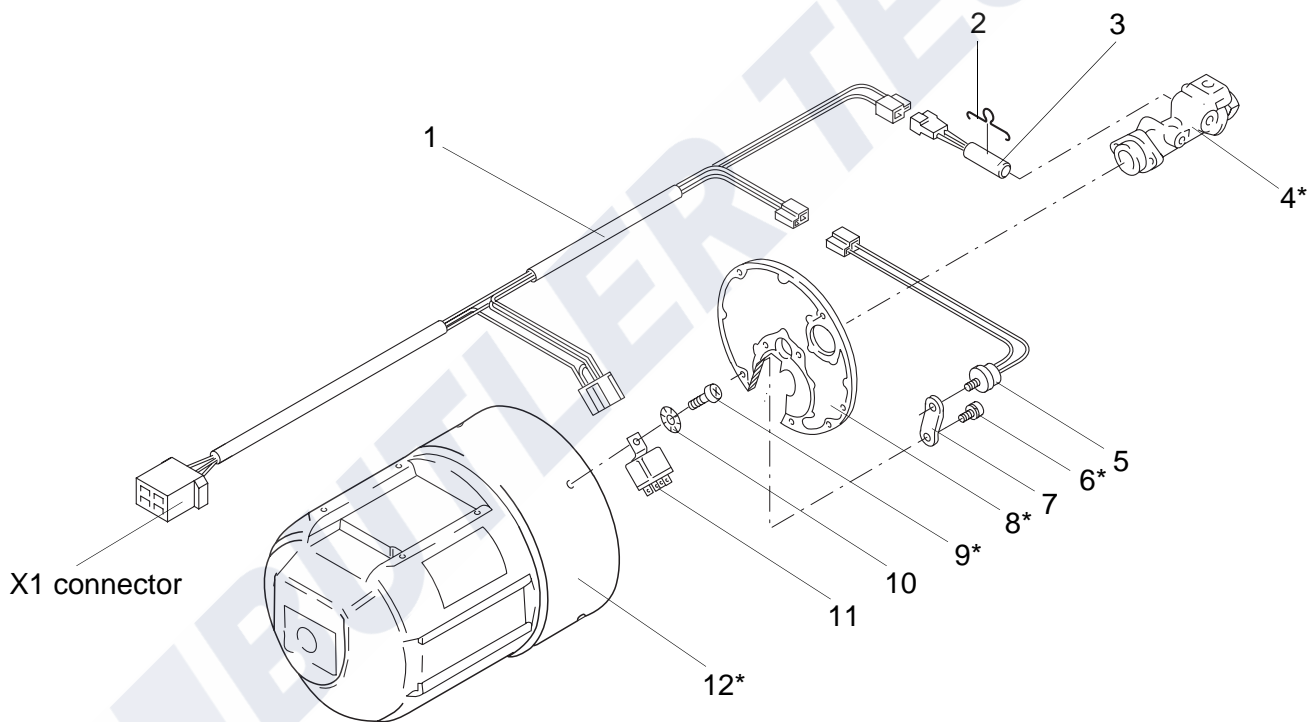
The polarity in the following work step is not important.

7. Snap female disconnects into the 2-pin connector housing to connect the heating element.

**NOTE**

Route wiring harness (1) behind the solenoid valve and route to outside via a rubber grommet with 2-pin connector housing.

8. Establish electrical connections between wiring harness (1), heating element (3), thermostat (5) and relay (11).
9. Place disk with flame sensor on nozzle block and secure with circlip.
10. Install ignition electrodes as explained in 9.2.12.2.
11. Swing burner head closed as explained in 8.5.1.
12. Establish electrical connections as shown (page 904).



- |                   |                                    |
|-------------------|------------------------------------|
| 1 wiring harness  | 7 tab                              |
| 2 retaining clamp | 8 nozzle-block plate *             |
| 3 heating element | 9 screw *                          |
| 4 nozzle block *  | 10 serrated lock washer            |
| 5 thermostat      | 11 relay                           |
| 6 bolt *          | 12 protective cap of burner head * |

\* not included in spare-parts kit

Retrofitting DBW 160

Implementation with DBW 230/300/350

**NOTE**

- With DBW 230 / 300 heaters, the tab in the retrofit kit is not required.
1. Swing burner head open as explained in 8.5.1.
  2. Remove ignition electrodes as explained in 9.2.12.1.
  3. Unscrew flame sensor from disk as explained in 9.2.11.1.
  4. Remove circlip and pull current disk with flame sensor off nozzle block and discard.
  5. Insert heating element (3) into the nozzle block (8) and fasten with retaining clamp (2).
  6. Place disk (4) on nozzle block and secure with circlip.
  7. Fasten thermostat (7) to disk (4) by means of serrated lock washer (5) and nut (6).
  8. Install flame sensor as explained in 9.2.13.2.
  9. Fasten relay (11) to the protective cap of the burner head (12) using a screw (9) and serrated lock washer (10).

**NOTE**

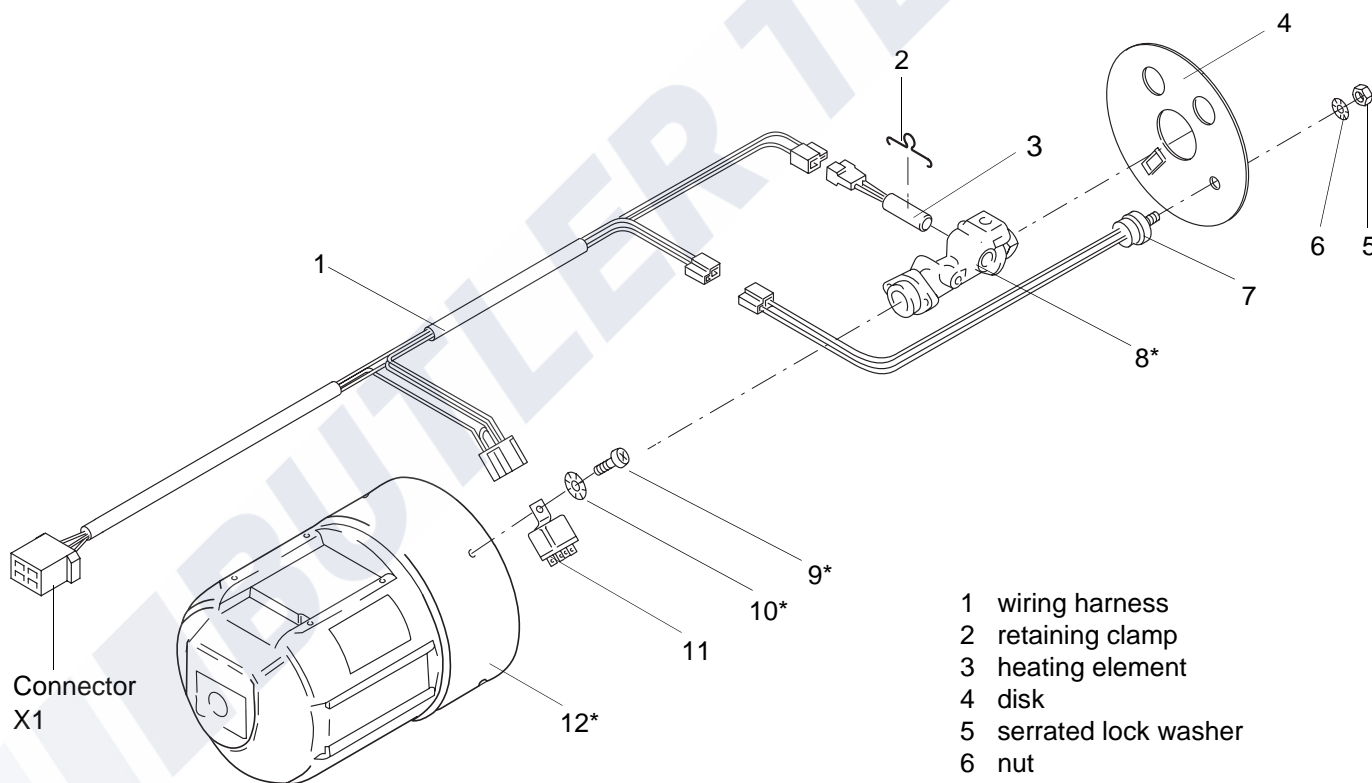
The polarity in the following work step is not important.

10. Make female disconnects for connection of heating element snap into the 2-pin connector housing.

**NOTE**

Route wiring harness (1) behind the solenoid valve and route to outside via a rubber grommet with 2-pin connector housing.

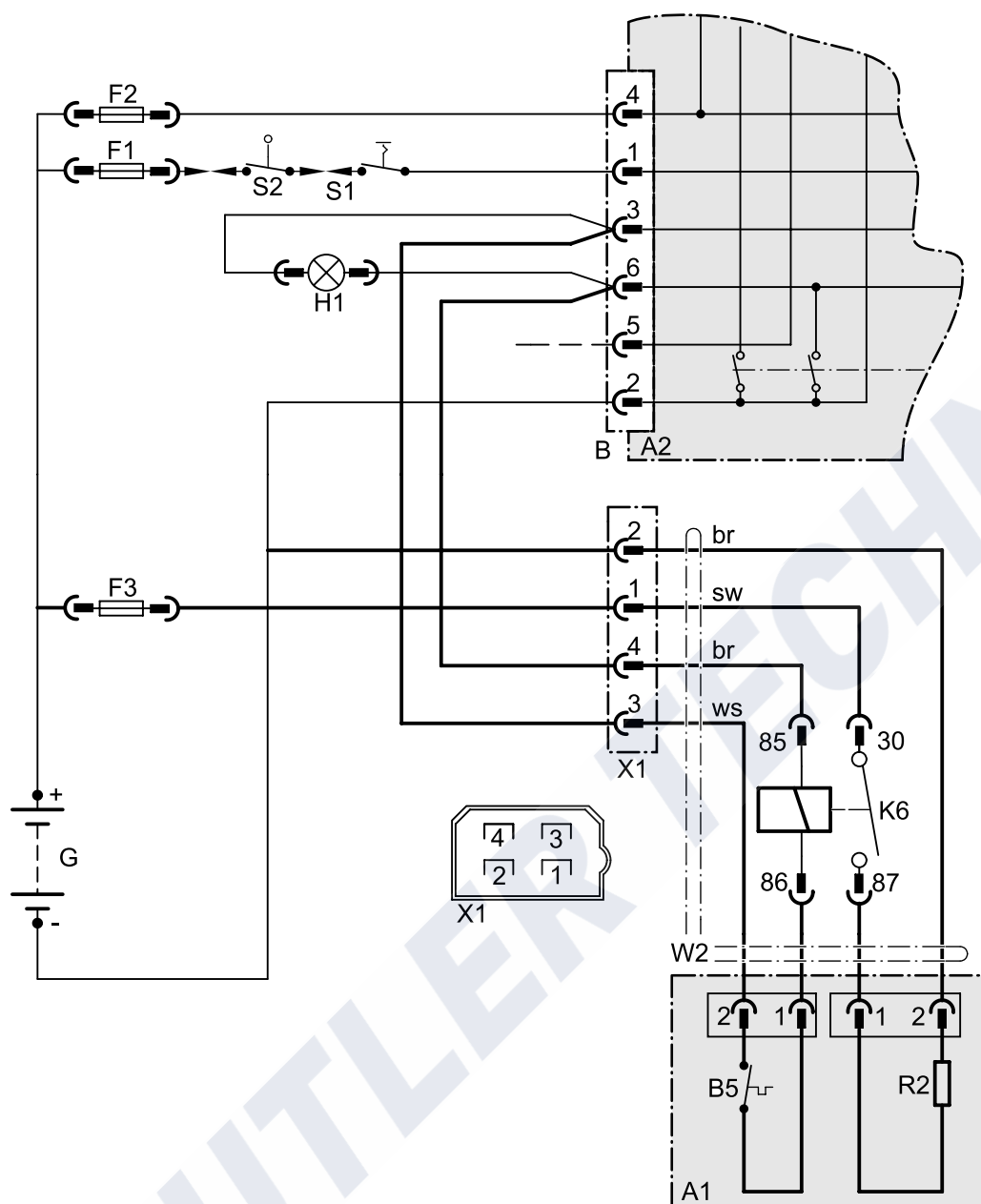
11. Establish electrical connections between wiring harness (1), heating element (3), thermostat (7) and relay (11).
12. Install ignition electrodes as explained in 9.2.12.2.
13. Swing burner head closed as explained in 8.5.1.
14. Establish electrical connections as shown (page 905).



- 1 wiring harness
- 2 retaining clamp
- 3 heating element
- 4 disk
- 5 serrated lock washer
- 6 nut
- 7 thermostat
- 8 nozzle block \*
- 9 screw \*
- 10 serrated lock washer \*
- 11 relay
- 12 protective cap of burner head \*

\* not part of scope of supply of spare-parts kit

Retrofitting DBW 230 / 300 / 350



Pos.	Designation	Comment
A1	Heater	
A2	Control unit	CU 1553
B	Connector, 6-pin	
B5	Thermostat	for nozzle-block preheating
F1	Fuse	Flat fuse as per DIN 72581
F2	Fuse	Flat fuse as per DIN 72581
F3	16 A (12 V); 8 A (24 V) fuse	Flat fuse as per DIN 72581
G	Battery	
H1	Light	Operating indicator
K6	Relay	for nozzle-block preheating
R2	Heating element	for nozzle-block preheating
S1	Switch	On / Off
S2	Switch	at shut-off valve
W2	Wiring harness	
X1	Connector, 4-pin	

Electrical connection

## **9.2 Disassembly and assembly**

### **9.2.1 Replacing the temperature limiter**

#### **9.2.1.1 Removal**

1. If required, Remove nut (4, Fig. 901) and take off protective cap (3).
2. Disconnect electrical connection to temperature limiter (8).
3. Unscrew temperature limiter (8) from angular bracket (5) or unscrew and remove hexagon head plug (6).
4. Carry out measures on components in disassembled state (see 9.1.1).

#### **9.2.1.2 Installation**

1. Screw temperature limiter (8, Fig. 901) by hand into the angular bracket (5) or into the hexagon head plug (6).
2. Establish electrical connection.
3. If required, attach protective cap (3) and secure with nut (4).

### **9.2.2 Replacing the control thermostat**

#### **9.2.2.1 Removal**

1. Remove nut (4, Fig. 901) and take off protective cap (3).
2. Disconnect electrical connection to control thermostat (1) at connecting block (2).
3. Unscrew control thermostat (1) from angular bracket (5) or heat exchanger (10) and remove.
4. Carry out measures on components in disassembled condition (see 9.1.1).

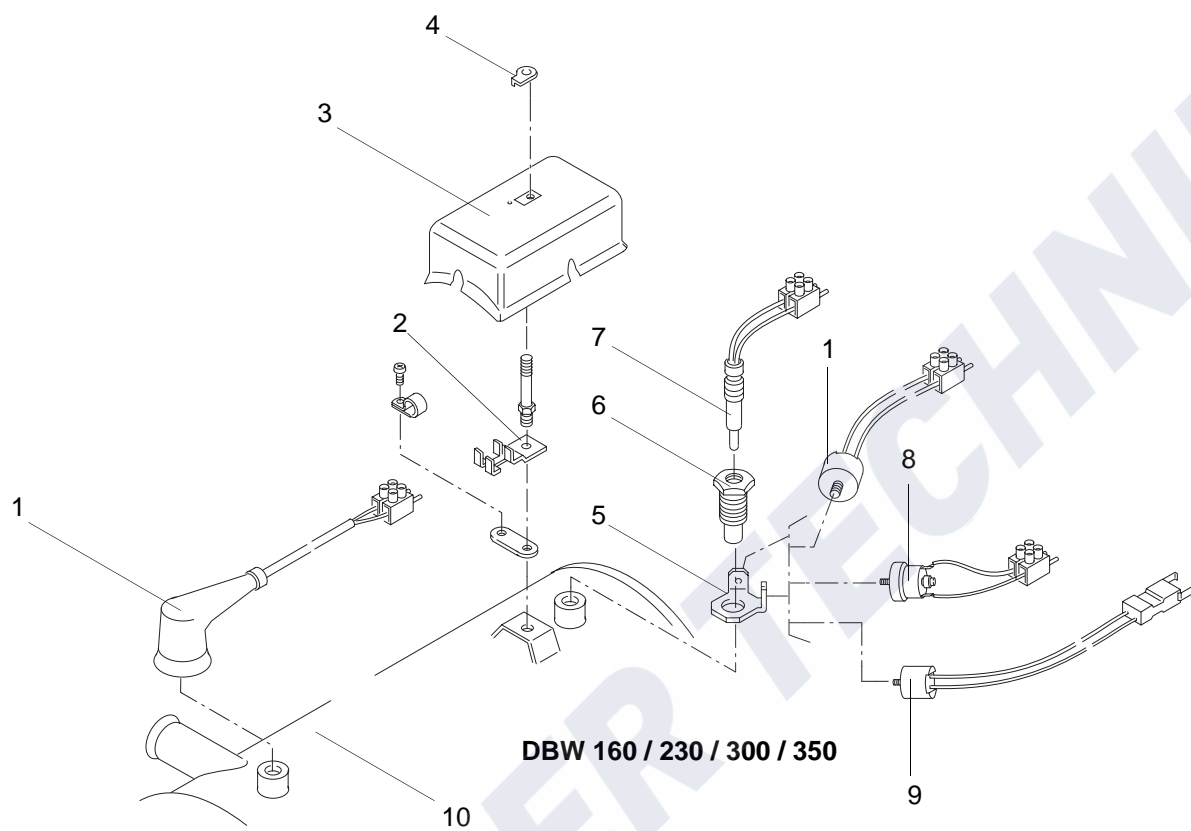
#### **9.2.2.2 Installation**

1. Screw control thermostat (1, Fig. 901) manually into angular bracket (5) or heat exchanger (10).

#### **NOTE**

Tighten control thermostat hand-tight when installing it into the heat exchanger.

2. Establish electrical connection.
3. Attach protective cap (3) and secure with nut (4).



- 1 control thermostat
- 2 connecting block
- 3 protective cap
- 4 nut
- 5 angular bracket
- 6 hexagon head plug
- 7 thermal fuse
- 8 temperature limiter
- 9 fan thermostat
- 10 heat exchanger

Fig. 901 Replacement of temperature limiter, control thermostat, fan thermostat and thermal fuse



### 9.2.3 Replacing the fan thermostat

#### 9.2.3.1 Removal

1. Remove nut (4, Fig. 901) and take off protective cap (3).
2. Disconnect electrical connection to fan thermostat (9).
3. Unscrew fan thermostat from angular bracket (5) and remove.
4. Carry out measures on components in disassembled state (see 9.1.1).

#### 9.2.3.2 Installation

1. Screw fan thermostat (9, Fig. 901) manually into angular bracket (5).
2. Establish electrical connection.
3. Attach protective cap (3) and secure with nut (4).

### 9.2.4 Replacing the thermal fuse

#### 9.2.4.1 Removal

1. Remove nut (4, Fig. 901) and take off protective cap (3).
2. Disconnect electrical connection to thermal fuse (7) at connecting block (2).
3. Unscrew thermal fuse by hand from hexagon head plug (6) and remove.
4. Carry out measures on components in disassembled state (see 9.1.1).

#### 9.2.4.2 Installation

1. Screw thermal fuse (7, Fig. 901) by hand into hexagon head plug (6).
2. Establish electrical connection.
3. Attach protective cap (3) and secure with nut (4).

### 9.2.5 Replacing the control unit

#### 9.2.5.1 Removal

1. Disconnect connector from control unit (1 or 3, Fig. 902).
2. With control unit 1553, spread retaining clamp (2), if required, and pull control unit out.
3. Carry out measures on components in disassembled condition (see 9.1.1).

#### 9.2.5.2 Installation

1. Insert control unit 1553 (1) with retaining clamp (2) into guide rails at the side of the protective cap (4) and slide in until it makes contact.
2. Plug connector into control unit.

### 9.2.6 Replacing the burner head

#### 9.2.6.1 Removal

#### NOTE

Before disconnecting the connectors or connections between the wiring harness and the measurement and control sensors, the pin allocations should be marked or noted down.

DBW 300.62 without split pin.

1. Disconnect connections to the measurement and control sensors on the heat exchanger and loosen wiring harness.
2. If required, dismantle fuel lines.
3. Loosen nuts (2, Fig. 903) until bolts can be swung out.
4. Swing bolts (3) out, pull out split pin (1) and remove.
5. Remove burner head (4).
6. Carry out measures on components in disassembled condition (see 9.1.1).

#### 9.2.6.2 Installation

1. Locate burner head (4, Fig. 903), swing bolts(3) in and tighten nuts (2) by hand.
2. Insert split pin (1) in accordance with the intended swing direction and secure.
3. Swing bolts (1) in and tighten hand-tight with nut (3) to prevent stress.
3. Torque nuts (3)
  - in DBW 160 to 5.0 Nm + 1 Nm,
  - in DBW 230 / 300 / 350 to 8.0 Nm +/- 10%.
4. If required, connect fuel lines.
5. Establish electrical connections.

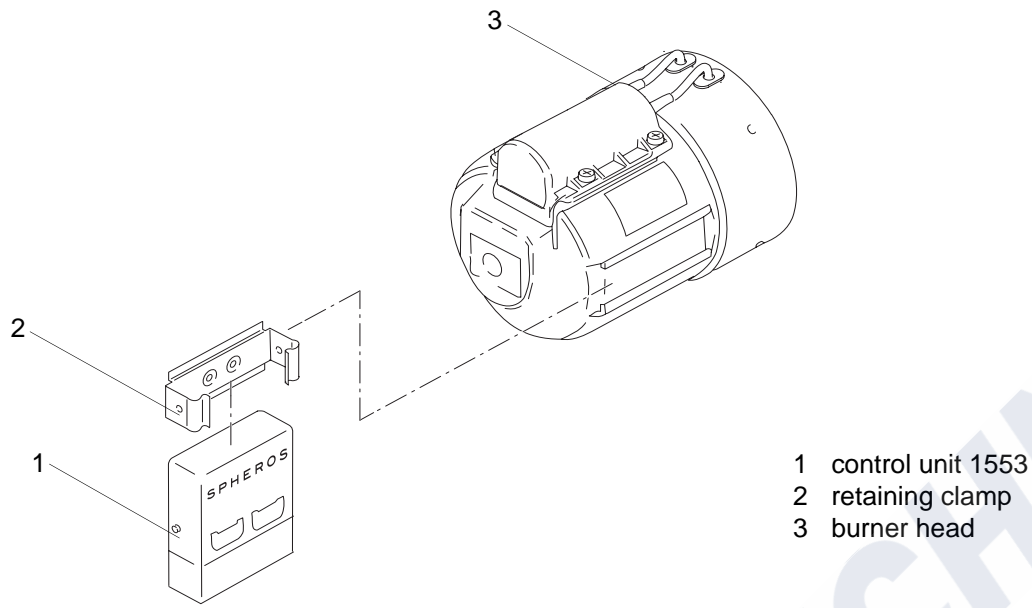
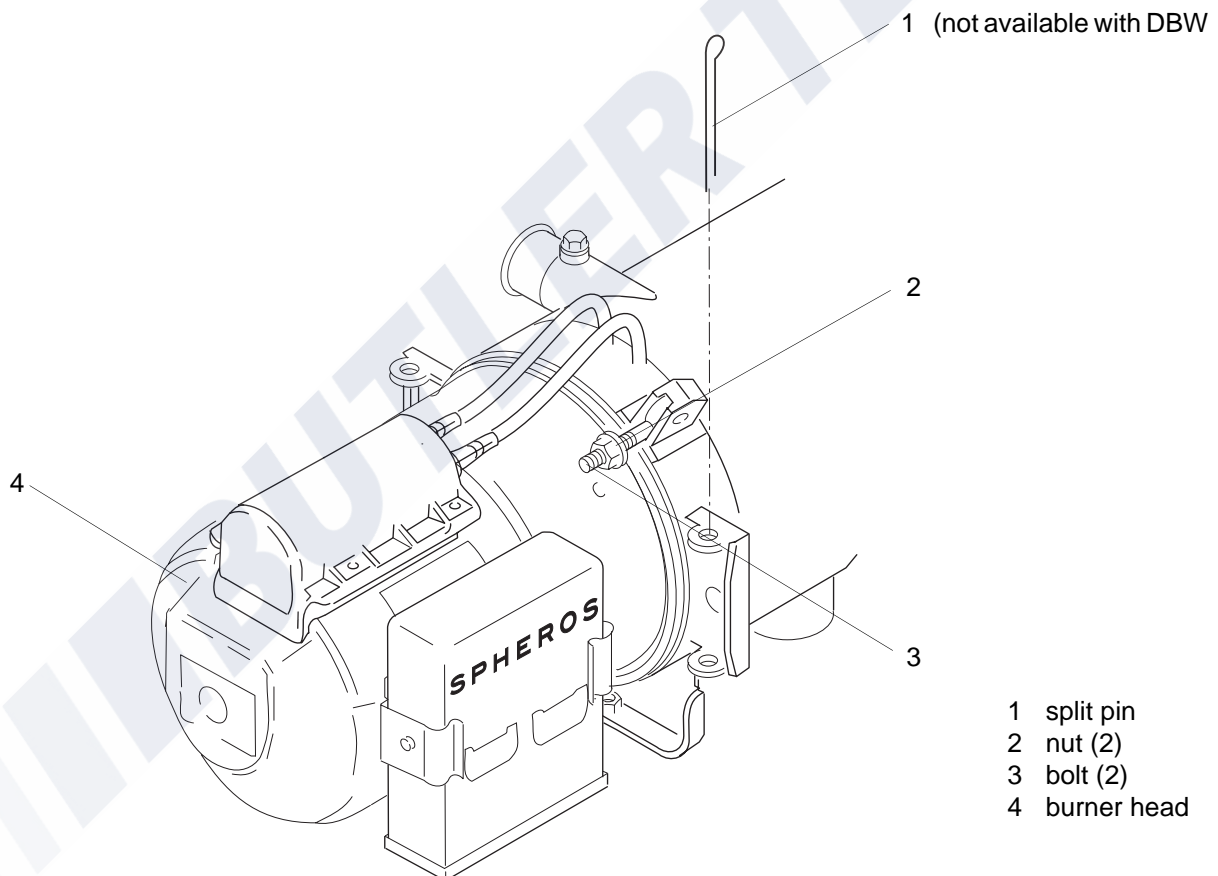


Fig. 902 Replacement of the control unit



**NOTE**

- Depending on the swing direction of the burner head, the split pin can be located on the other side.
- The illustration shows the burner head of the DBW 160 series heaters.

Fig. 903 Replacement of the burner head

### 9.2.7 Replacing the motor

#### 9.2.7.1 Removal

1. Remove bolts (15, Fig. 904) on protective cap (3) pull protective cap off to the front.
2. Disconnect electrical connections to motor (14).
3. Unscrew bolts (9) and remove motor (14) with flange (13).
4. Pull coupling (12) off motor shaft and remove.
5. Remove bolts (11) with serrated lock washers (10), lift off motor (14) and remove.
6. Carry out measures on components in disassembled condition (see 9.1.1).

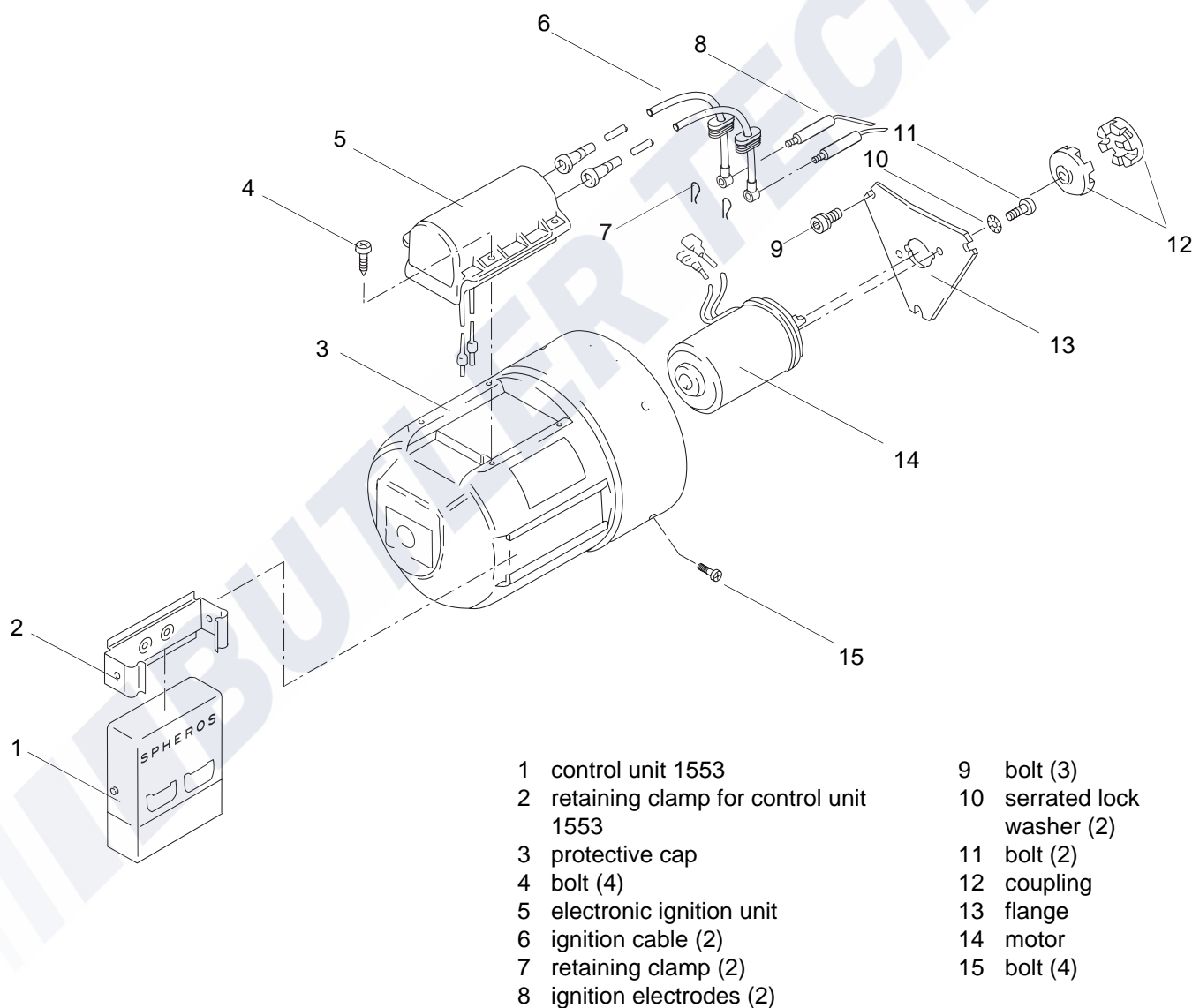
#### 9.2.7.2 Installation

1. Locate motor (14, Fig. 904) and fasten to flange (13) by means of serrated lock washers (10) and bolts (11).
2. Torque bolts to 5 Nm + 1 Nm.
3. Fit coupling (12) onto motor shaft.
4. Fasten flange (13) with bolts (9).
5. Torque bolts to 5 Nm + 1 Nm.
6. Establish electrical connections to motor, observing wiring colour codes.

**NOTE**

With DBW 300.62, observe correct polarity („—“  $\triangle$  brown line)

7. Slide on protective cap (3) and fasten with bolts (15).



**NOTE**

The illustration shows the motor of the DBW 160 series heaters.

Fig. 904 Replacement of the motor

### 9.2.8 Replacing the high-pressure nozzle

#### 9.2.8.1 Removal

1. Swing burner head open (see 8.5.1).
2. Unscrew high-pressure nozzle (11, Fig. 905) and remove.
3. Carry out measures on components in disassembled condition (see 9.1.1).

#### 9.2.8.2 Installation

1. Screw in high-pressure nozzle (11, Fig. 905) and torque to 20 Nm.
2. Swing burner head closed (see 8.5.1).

### 9.2.9 Replacing the nozzle-block preheater

#### 9.2.9.1 Removal

1. Swing burner head open (see 8.5.1).
2. Pull off retaining clamp (3, Fig. 905) and remove.
3. Disconnect electrical connection.
4. Pull out heating element (2) from side of nozzle block (15) and remove.
5. Carry out measures on components in disassembled condition (see 9.1.1).

#### 9.2.9.2 Installation

1. Establish electrical connection.
2. Slide heating element (2, Fig. 905) into nozzle block (15) and secure with retaining clamp (3).
3. Swing burner head closed (see 8.5.1).

### 9.2.10 Replacing the electronic ignition unit

#### 9.2.10.1 Removal

1. Swing burner head open (see 8.5.1).
2. Pry connector off electrodes.
5. Unscrew screw (5) from electronic ignition unit (6) and remove electronic ignition unit.
6. Disconnect electrical connections.
7. Carry out measures on components in disassembled condition (see 9.1.1).

#### 9.2.10.2 Installation

1. Establish electrical connections.
2. Locate electronic ignition unit (6, Fig. 904) and fasten with screws (5).
3. Torque screws to 0.8 Nm.
4. Route ignition cable (4) through grommets into electronic ignition unit (6).
5. Slide ignition cable onto ignition electrodes (9) and secure with retaining clamps (8).
6. Swing burner head closed (see 8.5.1).

### 9.2.11 Replacing the flame sensor

#### 9.2.11.1 Removal

1. Swing burner head open (see 8.5.1).
2. Disconnect electrical connection of flame sensor (10/10a, Fig. 905).
3. Remove bolt (14) and flame sensor (10).
4. Carry out measures on components in disassembled state (see 9.1.1).

#### 9.2.11.2 Installation

1. Locate flame sensor (10, Fig. 905) and fasten with bolt (14).
2. Torque bolt to 1.3 Nm.
3. Establish electrical connection.
4. Swing burner head closed (see 8.5.1).

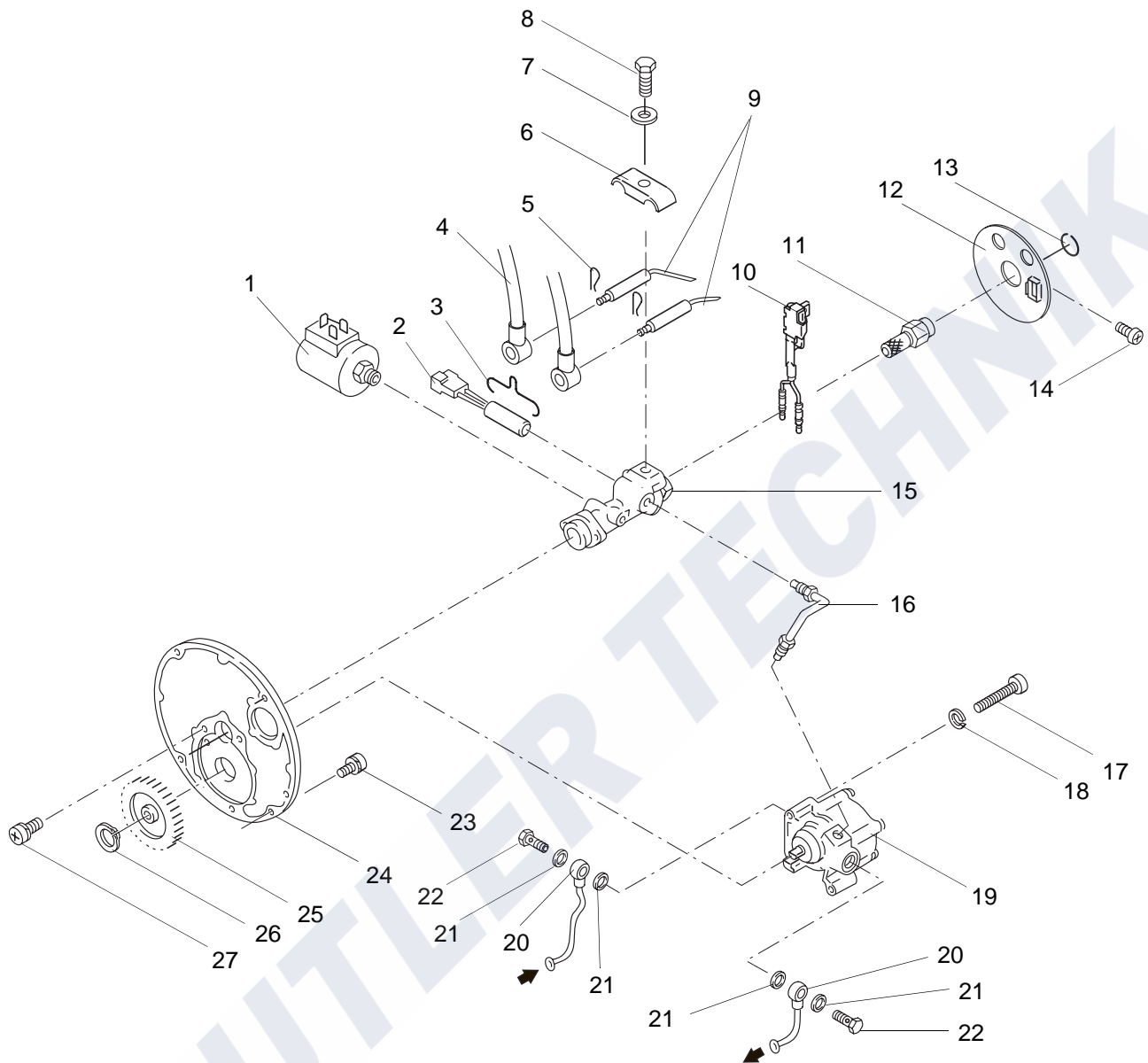
### 9.2.12 Replacing the ignition electrodes

#### 9.2.12.1 Removal

1. Swing burner head open (see 8.5.1).
2. Remove bolt (8, Fig. 905).
3. Take off washer (7) and clamp (6) and remove.
4. If required, remove circlip (13) and take off and remove disk (12).
5. If required, slide back insulation on ignition cable.
6. Pry retaining clamps (5) off ignition electrodes (9) and remove.
7. Lift off ignition electrodes (9) and remove.
8. Carry out measures on components in disassembled condition (see 9.1.1).

#### 9.2.12.2 Installation

1. Mount disk (12, Fig. 905) and secure with circlip (13), if required.
2. Insert ignition electrodes (9) through disk (12), align them and fasten with clamp (6), washer (7) and bolt (8).
3. Torque bolt (8) to 1.7 Nm.
4. Slide ignition cable (4) on and secure with retaining clamps (5).
5. If required, slide insulation on ignition electrodes.
6. Swing burner head closed (see 8.5.1).



- |                          |                         |                         |
|--------------------------|-------------------------|-------------------------|
| 1 solenoid valve         | 11 high-pressure nozzle | 21 washer (4)           |
| 2 heating element        | 12 disk                 | 22 banjo bolt (2)       |
| 3 retaining clamp        | 13 circlip              | 23 bolt (4)             |
| 4 ignition cable (2)     | 14 bolt                 | 24 nozzle-block plate * |
| 5 retaining clamp (2)    | 15 nozzle block         | 25 spur gear            |
| 6 clamp                  | 16 pressure line        | 26 circlip              |
| 7 washer                 | 17 bolt (2)             | 27 bolt (2)             |
| 8 bolt                   | 18 washer (2)           |                         |
| 9 ignition electrode (2) | 19 fuel pump            |                         |
| 10 flame sensor          | 20 fuel line (2)        |                         |

Fig. 905 Replacement of nozzle block, nozzle-block preheater, high-pressure nozzle and flame sensor.

**9.2.13 Replacing the fuel pump****9.2.13.1 Removal**

1. Swing burner head open (see 8.5.1).
2. Remove ignition electrodes (see 9.2.12.1).
3. Remove banjo bolts (22, Fig. 905) and washers (21), take off fuel lines (20) and remove.
4. Loosen bolt-connections on pressure line (16), take off pressure line and remove.
5. Remove bolts (23) and lift off nozzle-block plate (24).
6. Remove circlip (26) and take off spur gear (25) and remove.
7. Remove bolts (17) and washers (18), take off fuel pump (19) and remove.
8. Carry out measures on components in disassembled condition (see 9.1.1).

**9.2.13.2 Installation**

1. Locate fuel pump (19, Fig. 905) and fasten with bolts (17) and washers (18).
2. Torque bolts to 3.0 Nm.
3. Mount spur gear (25) and secure with circlip (26).
4. Insert nozzle-block plate (24) and fasten with bolts (23).
5. Torque bolts to 5.5 Nm.
6. Locate pressure line (16) and torque bolt-connections to  $6 \pm 0.6$  Nm.
7. Locate fuel lines (20) and fasten with banjo bolts (22) and washers (21).
8. Torque banjo bolts to  $15 \pm 1.5$  Nm.
9. Install ignition electrodes (see 9.2.12.2).
10. Swing burner head closed (see 8.5.1).

**9.2.14 Replacing the solenoid valve****9.2.14.1 Removal**

1. Swing burner head open (see 8.5.1).
2. Remove ignition electrodes (see 9.2.12.1).
3. Remove nozzle-block preheater (see 9.2.9.1).
4. Remove bolts (23, Fig. 905) and lift off nozzle-block plate (24).
5. Disconnect electrical connections on solenoid valve.
6. Remove nut (1, Fig. 907), take off solenoid-valve head (3) and washer (2) and remove.
7. If required, unscrew solenoid-valve body (4), remove sealing ring (5), pin (6), spring (7) and stud (8).
8. Carry out measures on components in disassembled condition (see 9.1.1).

**9.2.14.2 Installation**

1. Place sealing ring (5, Fig. 907) on solenoid-valve body (4).
2. Insert spring (7) and pin (6) into stud (8).
3. Insert stud with spring and pin into solenoid-valve body (4).
4. Screw solenoid-valve body (4) into nozzle block (9).
5. Torque bolt to 11.5 Nm.
6. Place solenoid-valve head (3) on solenoid-valve body and fasten with washer (2) and nut (1).
7. Torque nut to 2 Nm.
8. Fasten nozzle-block plate (24, Fig. 905) with bolts (23).
9. Torque bolts to 5.5 Nm.
10. Install nozzle-block preheater (see 9.2.9.2).
11. Install ignition electrodes (see 9.2.12.2).
12. Establish electrical connections to solenoid valve.
13. Swing burner head closed (see 8.5.1).

**9.2.15 Replacing the combustion chamber****9.2.15.1 Removal**

1. Swing burner head open (see 8.5.1).
2. Pull combustion chamber (1, Fig. 908) out of the heat exchanger (2) and remove.
3. Carry out measures on components in disassembled condition (see 9.1.1).

**9.2.15.2 Installation**

1. Slide combustion chamber (1, Fig. 908) into heat exchanger (2) until it makes contact.
2. Swing burner head closed (see 8.5.1).

**9.2.16 Thermostat of the nozzle-block preheater****9.2.16.1 Removal**

1. Swing burner open (see 8.5.1).
2. Disconnect electrical connection.
3. Unscrew thermostat (4, Fig. 906) from nozzle-block plate (7) or unscrew disk (1) and remove with bolt (5), tab (6) or nut (3) and serrated lock washer (2).
4. Carry out measures on components in disassembled state (see 9.1.1).

**9.2.16.2 Installation**

1. Locate thermostat (4, Fig. 906) and fasten with tab (6) and bolt (5) to nozzle-block plate (7) or with nut (3) and serrated lock washer (2) to disk (1).
2. Establish electrical connection.
3. Swing burner closed (see 8.5.1).



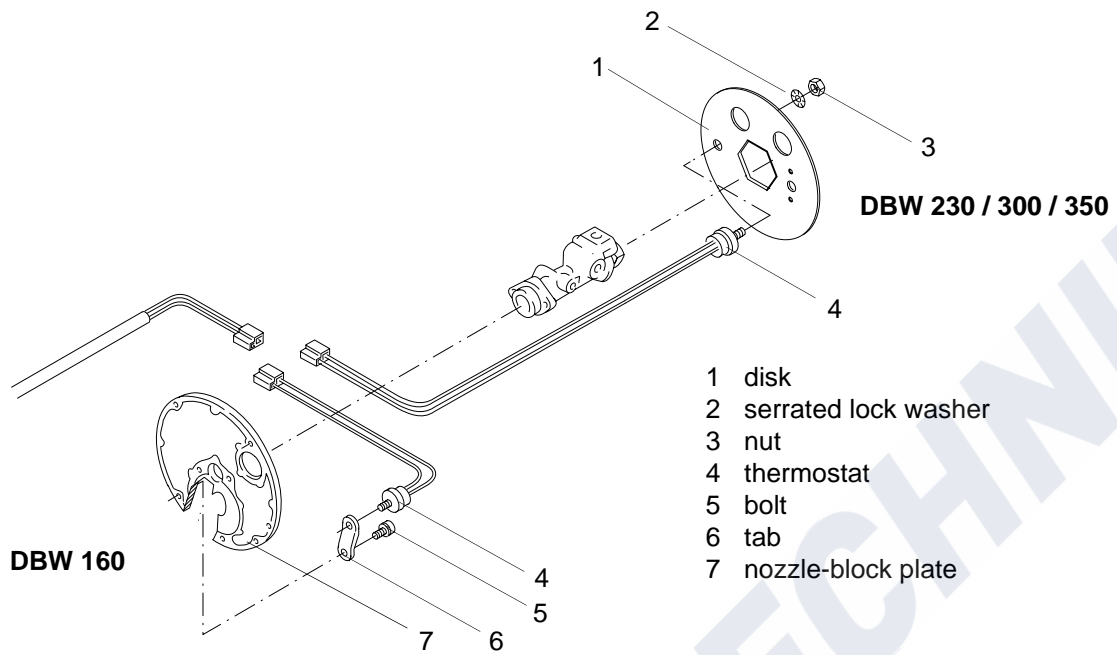


Fig. 906 Replacement of the thermostat of the nozzle-block preheater

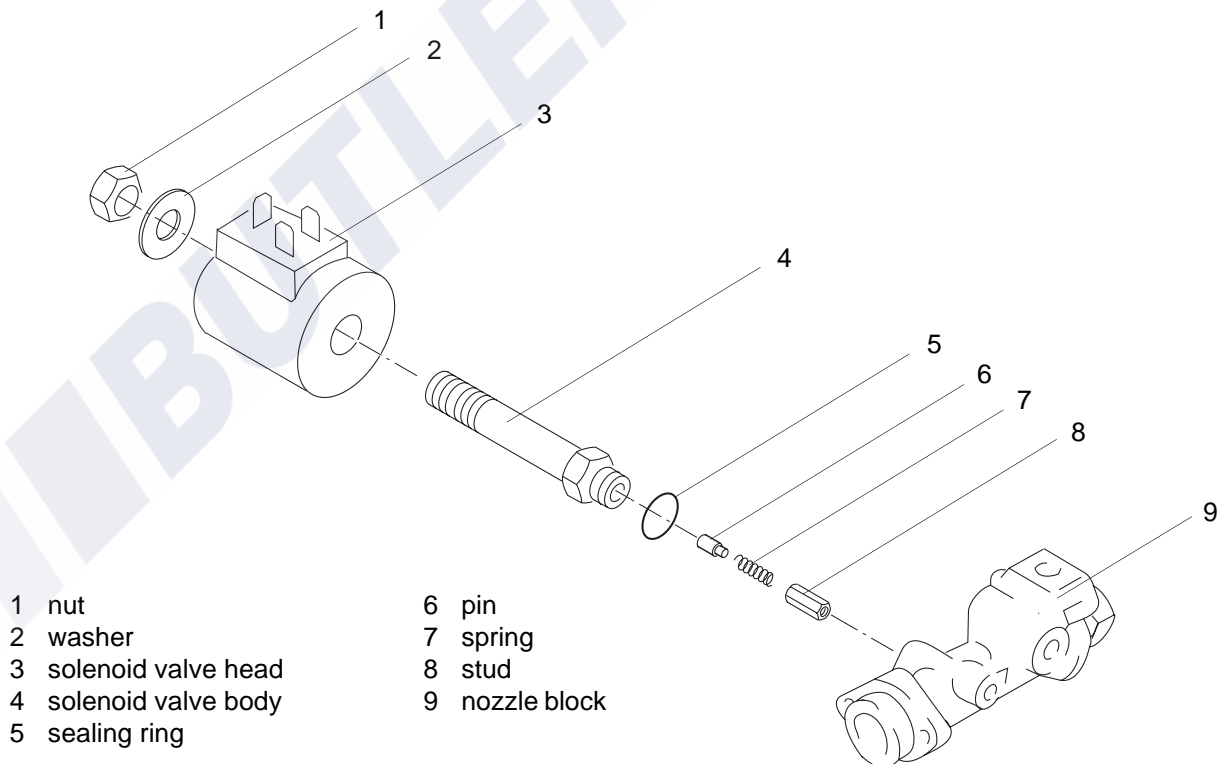


Fig. 907 Replacement of the solenoid valve

## 9.2.17 Replacing the heat exchanger

## 9.2.19.1 Removal

1. If required, remove nut (6, Fig. 908) on cover (5), lift off cover and remove.
2. Remove temperature limiter (see 9.2.1.1).
3. If required, remove thermal fuse (see 9.2.4.1).
4. If required, remove control thermostat (see 9.2.2.1).
5. If required, remove fan thermostat (see 9.2.3.1).
6. Remove bolt (4), lift off bracket (3) with electrical connections and remove.
7. Remove hexagon head plug (7) and lift off together with angular bracket (8) and remove.
8. Remove burner head (see 9.2.6.1).
9. Pull combustion chamber (1) out of the heat exchanger (2) and remove.
10. Remove heat exchanger (2).
11. Carry out measures on components in disassembled condition (see 9.1.1).

## 9.2.19.2 Installation

1. Slide combustion chamber (1, Fig. 908) into heat exchanger (2) until it makes contact.
2. Attach burner head (see 9.2.6.2).
3. Locate angular bracket (8) and screw in hexagon head plug (7).
4. Tighten hexagon head plug hand-tight.
5. Locate bracket (3) with electrical connections and fasten with bolt (4).
6. Tighten bolt hand-tight.
7. Install temperature limiter (see 9.2.1.2).
8. If required, install thermal fuse (see 9.2.4.2).
9. If required, install control thermostat (see 9.2.2.2).
10. If required, install fan thermostat (see 9.2.3.2).
11. If required, attach cover (5) and fasten with nut (6).

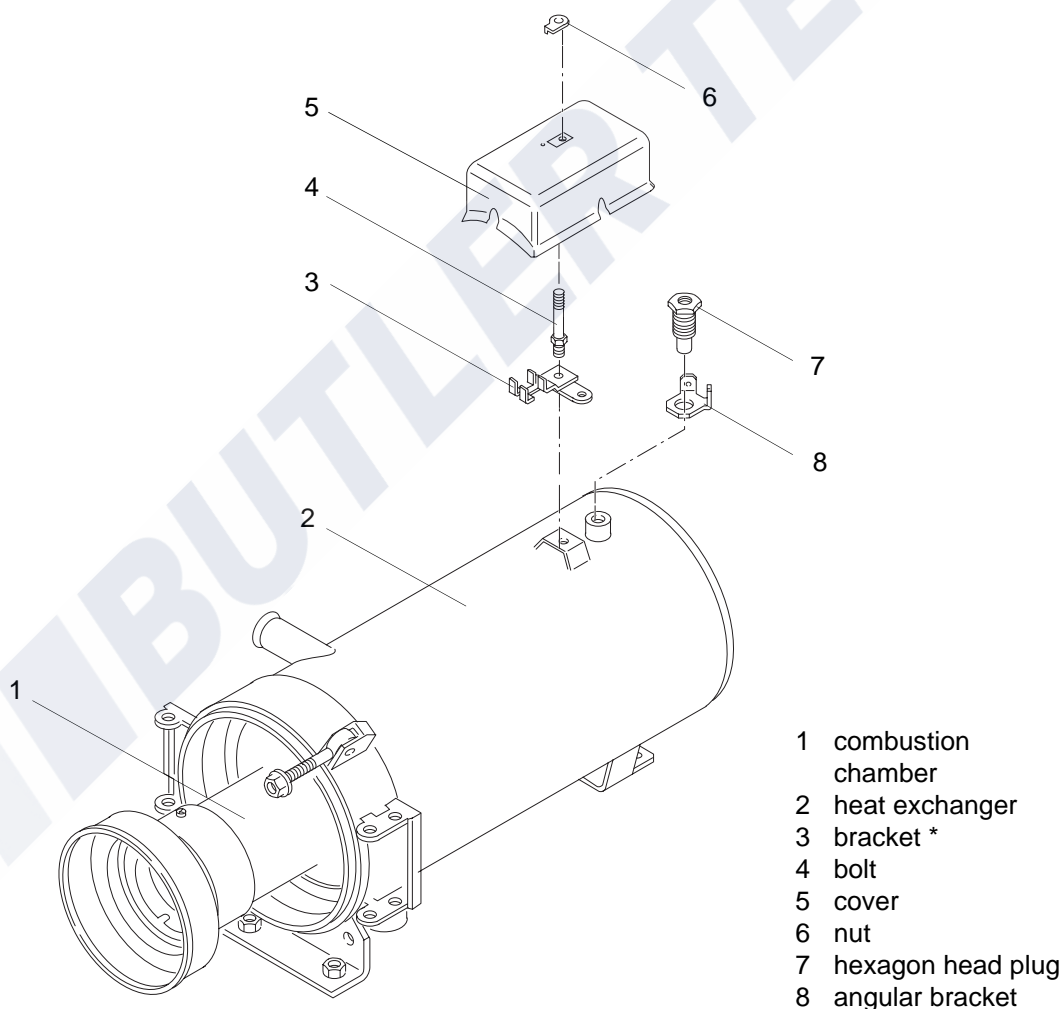


Fig. 908 Replacement of the combustion chamber and the heat exchanger



### **9.2.18 Replacing the nozzle block**

#### **9.2.18.1 Removal**

1. Swing burner head open (see 8.5.1).
2. Remove ignition electrodes (see 9.2.12.1).
3. Remove high-pressure nozzle (see 9.2.8.1).
4. If required, Remove nozzle-block preheater (see 9.2.9.1).
5. Remove solenoid valve (see 9.2.14.1).
6. Loosen bolt-connections on pressure line (16, Fig. 905) and take off pressure line and remove.
7. Remove bolts (23) and lift off nozzle-block plate (24).
8. Remove bolts (27), lift off nozzle block (15) and remove.
9. Carry out measures on components in disassembled condition (see 9.1.1).

#### **9.2.18.2 Installation**

1. Locate nozzle block (15, Fig. 905) and fasten with bolts (27).
2. Torque bolts to 5.5 Nm.
3. Locate nozzle-block plate (24) and fasten with bolts (23).
4. Torque bolts to 5.5 Nm.
5. Locate pressure line (16) and torque bolt-connections to  $6 \pm 0.6$  Nm.
6. Install solenoid valve (see 9.2.14.2).
7. If required, Install nozzle-block preheater (see 9.2.9.2).
8. Install high-pressure nozzle (see 9.2.8.2).
9. Install ignition electrodes (see 9.2.12.2).
10. Swing burner head closed (see 8.5.1).

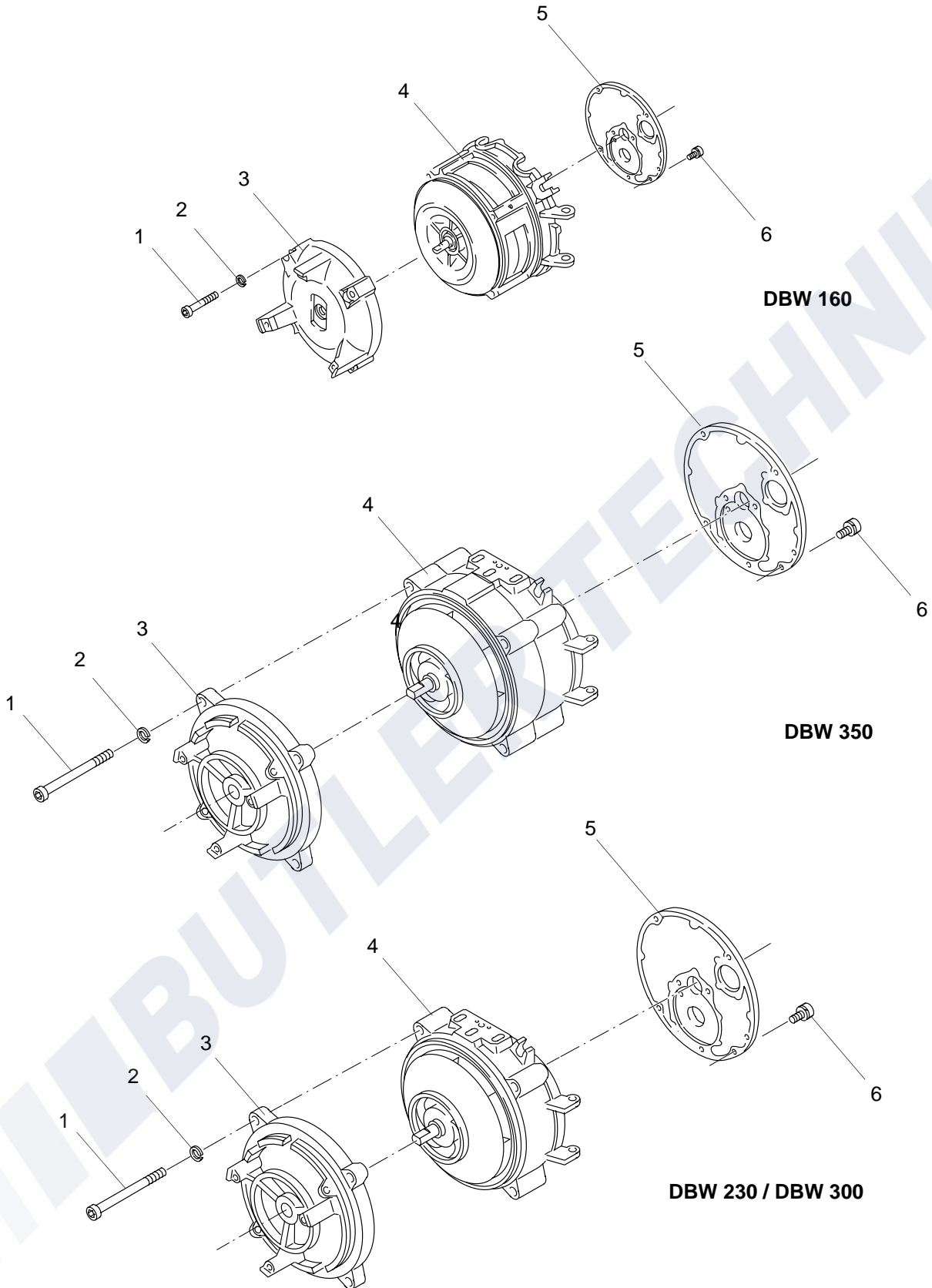
### **9.2.19 Replacing the combustion air fan**

#### **9.2.19.1 Removal**

1. Remove burner head (see 9.2.6.1).
2. Remove motor (see 9.2.7.1).
3. Remove bolts (6, Fig. 909 from the nozzle-block plate (5).
4. Remove bolts (1) and washers (2).
5. Pull engine mount (3) off the shaft.
6. Remove combustion air fan (4).
7. Carry out measures on components in disassembled state (see 9.1.1).

#### **9.2.19.2 Installation**

1. Only DBW 160:  
check gap dimension on impeller (see 9.1.1.4)
2. Locate combustion air fan (4, Fig. 909) and fasten with bolts (6) to the nozzle-block plate (5).
3. Torque bolts (6) to 5.5 Nm.
4. Fit engine mount (3) onto shaft and fasten with bolts (1) and washers (2).
5. Torque nuts (1)  
- in DBW 160 to 5.5 Nm + 1 Nm,  
- in DBW 230 / 300 / 350 to 8.0 Nm +/- 10%.
6. Install engine (see 9.2.7.2).
7. Install burner head (see 9.2.6.2).



- 1 bolt (3)
- 2 washer (3)
- 3 engine mount

- 4 Combustion air fan
- 5 nozzle-block plate
- 6 bolt (4)

Fig. 909 Replacement of the combustion air fan

**BUTLER TECHNIK**

**BUTLER TECHNIK**

## **10 Packaging, Storage and Shipping**

### **10.1 General**

Heaters or components to be sent to Spheros GmbH for testing or repair must be cleaned and packaged in such a way that they will not be damaged during handling, transport and storage.

#### **CAUTION**

Heaters sent in as complete units must be fully drained. Units and components must be packaged and shipped in such a way that leakage of fuel and coolant is reliably prevented.

Coolant supply and return flanges and fuel lines must be sealed with blanking plugs.

During storage, the ambient temperatures stated in section 4 must not be exceeded.



**Appendix A**

**Regular maintenance**

**BUTLER TECHNIK**

## A Appendix

**DBW 160 / 230 (2020) / 300 / 350**

### Regular maintenance of heater

The heater should be checked at regular intervals, but no later than at the beginning of the heating period when the heater is used again regularly due to declining ambient temperatures.

The maintenance intervals stated below apply to busses and coaches subject to normal operating conditions and requirements. Intervals may be shortened or extended for heaters used in other vehicles or applications. In such cases please contact your Spheros partner.

Check / maintenance work	Important notes	Result		Measured values, Maintenance work performed
		OK	not OK	
<b>1. Electrical connections</b> a) Disconnect electrical connections to wiring harness, check for oxidation, spray and reconnect after performing point 5. b) Check fuses for oxidation and excessive contact resistance.	Use suitable contact spray, e.g. special contact spray (order no. 101322).	<input type="checkbox"/>	<input type="checkbox"/>	
<b>2. Heat exchanger</b> a) Check for dark discolouration of paint (local overheating). b) Check for leakage. c) Clean outside and inside of heater.	Identify cause of any overheating (e.g. coolant circuit); check temperature limiter.	<input type="checkbox"/>	<input type="checkbox"/>	
<b>3. Fuel system</b> a) Check fuel lines and connections for leakage. b) Replace fuel-filter element with seal. c) Open fuel shut-off valves, if present.  d) Fuel pump and fuel lines. e) Replace fuel strainer with seals in pump.	Ensure that fuel supply and return connections do not leak! Tighten threaded joints and hose clamps.  Replace pump and lines every 5 years.	<input type="checkbox"/>	<input type="checkbox"/>	
<b>4. Burner head</b> a) Check combustion air intake opening for free flow. Swing burner head open: b) Check housing interior for fuel accumulation caused by leakage. c) Clean sight glass of flame sensor. d) Check condition of igniter electrodes. e) Replace atomiser nozzle.	Replace bent electrodes.  In case of carbon deposit Reduce change interval of fuel filter.	<input type="checkbox"/>	<input type="checkbox"/>	
<b>5. Exhaust system</b> a) Check exhaust line for free flow, clean if required. b) Remove combustion chamber from heat exchanger, check both parts for damage and soiling, clean or replace if required. c) Insert combustion chamber and install burner head. Ensure secure connection to heat exchanger. d) Reconnect electrical connections.		<input type="checkbox"/>	<input type="checkbox"/>	
<b>6. Coolant system</b> a) Clean coolant filter element, if present. b) Open coolant shut-off valves, if present.		<input type="checkbox"/>	<input type="checkbox"/>	
<b>7. Function check</b> a) Open shut-off valve in return line, if present. b) Check function of heater. c) Check for smoke during run-on period; change nozzle, if required.	after a min. heating period of 10 min.	<input type="checkbox"/>	<input type="checkbox"/>	