

Air Heater

Air Top 2000 S D (Diesel) Air Top 2000 S B (Gasoline)

Service and Repair Manual



- Improper installation or repair of Webasto heating and cooling systems can cause fire or the leakage of deadly carbon monoxide leading to serious injury or death.
- Installation and repair of Webasto heating and cooling systems requires special Webasto training, technical information, special tools and special equipment.
- NEVER attempt to install or repair a Webasto heating or cooling system unless you have successfully completed the factory training course and have the technical skills, technical information, tools and equipment required to properly complete the necessary procedures.
- ALWAYS carefully follow Webasto installation and repair instructions and heed all WARNINGS.
- Webasto rejects any liability for problems and damage caused by the system being installed by untrained personnel.

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1. Introduction

1.1 Scope and Purpose

This repair shop manual is intended to support familiarized personnel in the repair of the Air Top 2000 S.

1.1.1 Use of Air Heaters

The air heater Air Top 2000 S is used to

- heat the cabin
- defrost the windscreens.

They are not cleared for heating a transportation compartment for dangerous goods.
The heaters operate independent from the vehicle engine and are connected to the fuel tank and to the electrical system of the vehicle. Their use is possible in vehicles with water- or air-cooled engines.

1.2 Meaning of Warnings, Cautions and Notes

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

WARNING

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

CAUTION

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

NOTE

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

1.3 Additional Documentation to be used

This workshop manual contains all information and procedures necessary for the repair of the Air Top 2000 S. The use of additional documentation is normally not necessary.
Operating instructions/installation instructions and the vehicle specific installation proposal may be used as complementary information as necessary.

1.4 Safety Information and Regulations

The general safety regulations for the prevention of accidents and the relevant operating safety instructions have to be observed at all times. "General Safety Regulations" beyond the scope of these regulations are detailed in the following. The specific safety regulations applicable to this manual are highlighted in the individual chapters by Warnings, Cautions, and Notes.

1.4.1 General Safety Notes

Within the scope of the StVZO (Road Licensing Regulations of the Federal Republic of Germany) "Design General Approvals", laid down by the Federal Office for Motor Traffic, exist for the Air Top 2000 S with the following official marks of conformity:

- S 324 (Diesel)
- S 325 (Gasoline)

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

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

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

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

This validates the "Design General Approval".

The acceptance certificate must be kept with the vehicle.

The year of first operation must be permanently marked on the identification label.

The heaters are cleared for heating the passenger and driver cabins but not for heating compartments intended for the transportation of dangerous goods.

The heater must not be installed in the passenger or driver compartments of busses. Should the heater nevertheless be installed in such a compartment, the installation box must be sealed tight against the vehicle interior. There must be sufficient ventilation of the installation box from the exterior in order not to exceed a maximum temperature of 40 °C in the installation box.

At filling stations and fuel depots the heater must be switched off as there is a potential danger of explosion.

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

Due to the danger of poisoning and suffocation the heater must not be operated in enclosed areas such as garages or workshops without exhaust venting, not even if the start-up is activated by the timer or telestart device.

When removing the heater the gasket below must be replaced.

The heat exchanger of the air heater remains serviceable for a maximum of 10 years and must then be replaced with an original spare part by the manufacturer or by one of its authorized workshops. The heater must then be provided with a label marked with the sales date and with the words "Original Spare".

Should exhaust pipes be routed through rooms accommodating persons, these pipes shall also be renewed after 10 years.

Installations not legally authorized will void the air heater's "Official Marks of Conformity" and thus the vehicle's permit of operation. The same applies for repairs performed by unskilled personnel and repairs with no original spare parts.

1.5 Legal Provisions for Installation

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

Testing is performed upon presentation of the operating and installation instructions of the manufacturer.

The year of the initial operation must be durably marked on the heater identification plate by the installing person.

Heating Air System

Heating air intake openings must be arranged so that under normal operating conditions exhaust fumes of the vehicle engine or air heater are not likely to be expected.

Extracting combustion air from the vehicle interior is not permissible.

Combustion Air Line

The combustion air required must be taken from the exterior.

Within rooms accommodating persons, the combustion air lines must not have more than four disconnects and a splash-water protected exterior wall feedthrough. The disconnects must be sealed in a way not to exceed a leak rate of 200 l/h at an overpressure of 0.5 mbar. The line including feedthrough, disconnects, material and specific type must be described in the installation instructions.

The line must require tools for installation and removal, must be protected against damage, and must be shock-proof.

Exhaust Line

Heaters must be designed to discharge the exhaust to the exterior.

Exhaust pipes must be routed so that exhaust fumes are unlikely to penetrate into the vehicle's interior.

The function of any parts of the vehicle essential for its operation must not be impaired. Condensate or water penetrated must not be able to accumulate in the exhaust line.

Drain holes are permissible; these must drain the fluid to the exterior via lines sealed against the vehicle interior.

The exhaust line outlet is to be positioned to the top, to the side, or in case of exhaust venting below the vehicle floor, to the nearest possible location of the vehicle's or cockpit's side or rear end. In compartments accommodating persons, exhaust lines must not have more than one disconnect and must have a splash-water protected feedthrough in the exterior wall/floor. For water, that has penetrated into the exhaust line, the connection of a drain line with a metal-sealing joint is permissible. The drain pipe must be routed sealed through the exterior wall or the vehicle floor. The heat exchanger, the exhaust line connected, as well as the possible drain pipe must be sealed so that with an overpressure of double the overpressure of the exhaust having the maximum permissible exhaust line length - at least however at an overpressure of 0.5 bar - a total leak rate of 30 l/h is not exceeded.

The line including feedthrough, disconnects, material and specific type must be described in the installation instructions.

The line must require tools for installation and removal, must be protected against damage, and must be shock-proof.

Metal lines must be used. These may not heat to more than 110 °C should there be the possibility of contact within the room interior. Protective devices against contact may be fitted.

Should exhaust pipes be routed through rooms accommodating persons, these pipes shall be renewed after 10 years using genuine spare parts.

Combustion Air Inlet and Exhaust Outlet

During installations these ports for combustion air entry and exhaust fume exit must be of such type, that a ball with a diameter of 16 mm cannot be inserted. Electrical lines, switch gear and control gear of the heater must be located in the vehicle so that their proper function cannot be impaired under normal operating conditions.

For the routing of fuel lines and the installation of additional fuel tanks §§ 45 and 46 of the StVZO are to be adhered to.

The most important regulations are: Fuel lines are to be designed in such a way that they remain unaffected by torsional stresses in the vehicle, engine movement and the like. They must be protected against mechanical damage.

Fuel-carrying parts are to be protected against excessive heat and are to be arranged so that any dripping or evaporating fuel can neither accumulate nor be ignited by hot components or electrical equipment.

In busses, fuel lines and fuel tanks may be located neither in the passenger area nor in the driver's compartment. In these type of vehicles the fuel tanks must be located such that they do not pose a direct hazard to the exits in the event of a fire. Fuel supply must not be by means of gravity or pressurization of the fuel tank.

Installation Rules for Webasto Fuel Tanks for the Fuel Supply of Heaters in Vehicles

In busses the installation is not permitted in the passenger or driver compartment.

The fuel fill neck must in no vehicle be located within any of these compartments.

Fuel containers for gasoline fuel must not be located immediately behind the front panelling of the vehicle.

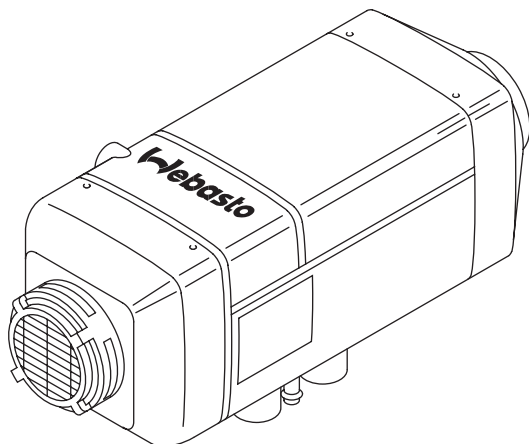
They must be separate from the engine so that even in case of an accident the inflammation of fuel is unlikely to be expected. This does not apply for towing vehicles with an open cockpit.

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

2. General Description

The air heater Air Top 2000 S operates under the evaporator principle and basically consists of:

- combustion and heating air fan
- heat exchanger
- burner insert with combustion tube
- control unit



Air Heater Air Top 2000 S

For control and monitoring a

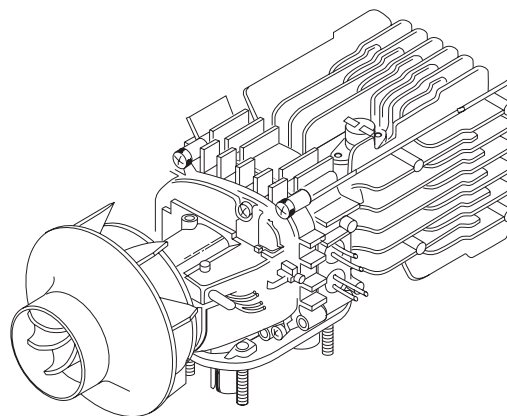
- control unit/control circuit board
- flame sensor
- glow plug
- temperature limiter
- temperature sensor

are located within the unit.

All Air Top 2000 S heaters may be controlled by means of an optional external temperature sensor.

Fuel supply is provided externally by a fuel dosing pump.

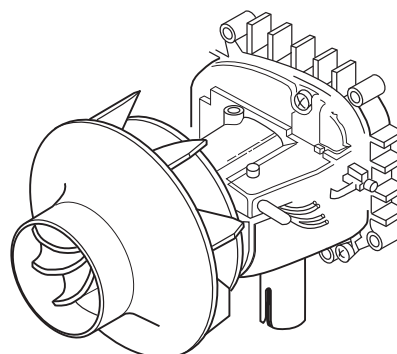
A malfunction of the Air Top 2000 S is indicated by an error code displayed on the combination or standard timer. When equipped with the standard control dial, the operating indicator flashes. In addition a heater check out may be performed using a personal computer (refer to operating instructions PC air heater diagnosis).



Air Heater Air Top 2000 S
(covers removed)

2.1 Combustion and Heating Air Fan

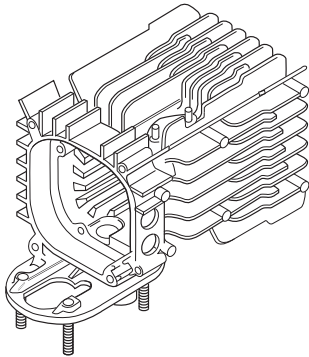
The combustion and heating air fan delivers the air required for combustion from the combustion air inlet to the burner insert. By means of the fan the heating air is also delivered to the hot air outlet.



Combustion and Heating Air Fan

2.2 Heat Exchanger

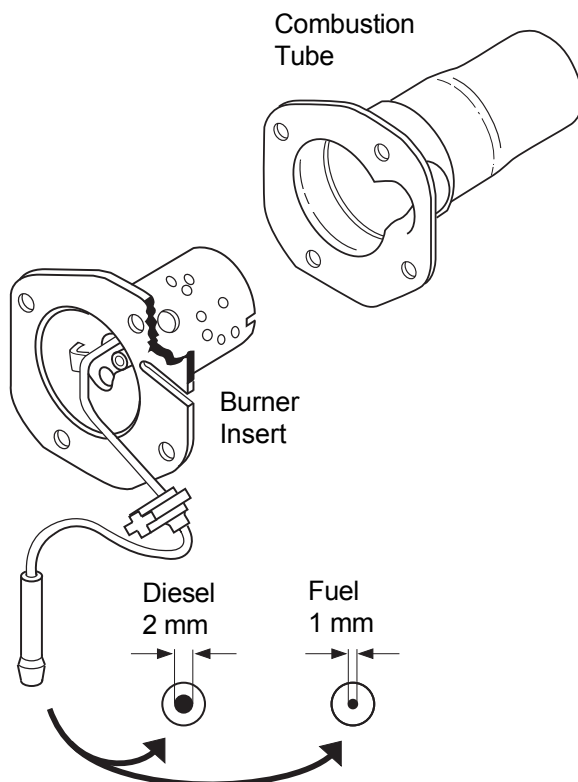
The heat exchanger dissipates the heat provided by combustion to the air delivered by the combustion and heating air fan.



Heat Exchanger

2.3 Burner Insert with Combustion Tube

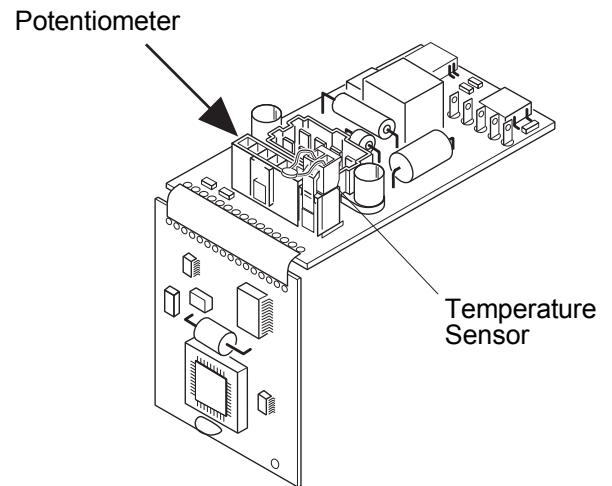
Within the burner insert fuel is distributed in the combustion tube across the burner cross-section. In the combustion tube the combustion of the fuel/air mixture takes place heating up the heat exchanger.



2.4 Control Unit / Control Circuit Board

The control unit/control circuit board is the central controlling unit for functional sequencing and monitoring of the combustion operation. A temperature sensor located on the control unit is used for temperature control. All heaters may have the temperature sensor replaced with an external temperature sensor. The combustion and heating air fan may be set by means of a potentiometer.

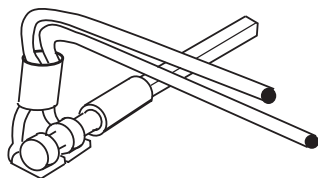
A malfunction in the Air Top 2000 S is indicated by an error code displayed on the combination or standard timer. When equipped with a standard control dial the operating indicator flashes. In addition a heater check out may be performed using a personal computer (refer to operating instructions PC air heater diagnosis).



Control Unit - Air Top 2000 S

2.5 Flame Sensor

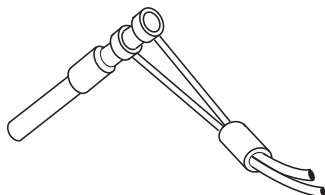
The flame sensor is a low-Ohm PTC resistor changing its resistance dependent on its heating by the flame. The signals are routed to the control unit for processing. The flame sensor monitors the flame operating condition over the complete duration of heater operation.



Flame Sensor

2.6 Glow Plug

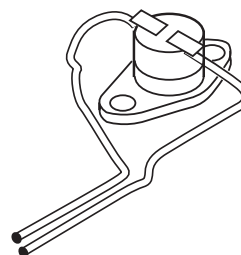
The glow plug ignites the fuel/air mixture at the start of the air heater operation. The glow plug is acting as an electrical resistor and is located in the burner insert opposed to the flame side.



Glow Plug

2.7 Temperature Limiter

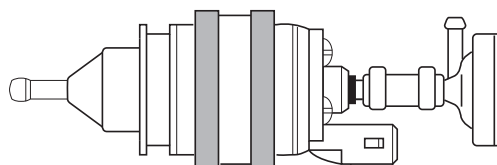
The temperature limiter protects the air heater against excessive operating temperatures. Overheat protection is activated at a temperature higher than 150 °C to interrupt the electrical circuit of the dosing pump and switch off the heater with run-down operation. After cooling down the electrical circuit is restored. The air heater may be switched on again (see 3.1.8).



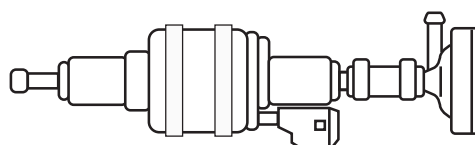
Temperature Limiter

2.8 Dosing Pump

The dosing pump is a combined supply, dosing and shut-off system for the fuel supply of the heater out of the vehicle's fuel tank.



Dosing Pump DP 2 for Gasoline and Diesel operated Heaters



Dosing Pump DP 30 for Diesel operated Heaters

3. Functional Description

3.1 Functional Description Air Top 2000 S

3.1.1 Control Element

The control element is used to switch the air heater on and off, set the desired room temperature (air intake temperature between 10 °C and 45 °C), and to unlock a failure interrupt condition.

The green LED indication is used to indicate the operating condition (LED permanently on) and an overheat condition (LED flashes).

3.1.2 Switch-On

The control element is set to the desired room temperature. When switching the air heater on, the operating indicator is illuminated and the glow plug is activated (cycled). The motor of the combustion and heating air fan starts high-speed operation for 1 second (break-away moment) and is then under slow-down control to approx. 30% (Diesel) or 50% (fuel) of full speed.

NOTE

Should the temperature of the intake air be above the selected, rated temperature, only the motor of the combustion and heating air fan will operate (control idle). Start operation will be initiated with a heating air temperature below the rated temperature.

The flame sensor function is checked. If the flame sensor at this time already signals "flame", there will be a 120 second run-down and an error lockout of the control unit. A malfunction of any other component monitored causes an error lockout without run-down.

After approx. 20 seconds (for fuel operated heaters after approx. 15 seconds) the fuel dosing pump is activated. After another 25 seconds the speed of the combustion and heating air fan is continuously increased to a higher rate and combustion begins. As soon as a flame is detected, combustion will be stabilized (see 3.1.3).

Should no normal combustion be achieved within 120 seconds (for fuel operated heaters after approx. 115 seconds), the speed of the combustion and heating air fan is increased for approx. 30 sec and there will be an automatic repeat start with the glow plug activated and fuel dosing pump deactivated (no fuel supply).

Should no proper combustion develop within 120 seconds (for fuel-operated within 115 seconds) the combustion and heating air fan speed is increased to full load for approx. 30 seconds (15 seconds for fuel-operated heaters) with the glow plug on and the dosing pump off (no fuel delivery) with a subsequent automatic restart.

Should the no-combustion-condition persist, after another 80 seconds (for fuel operated heaters after approx. 85 seconds) there will be a switch-off by error lockout (see 3.1.8) with a run-down of the combustion and heating air fan lasting 120 seconds at 2/3 of its max. speed.

2. Start (automatic restart)

Fan speed is again reduced to approx. 30% (for fuel operated heaters to approx. 50%) and fuel is delivered. During the next 20 seconds fan speed is increased to approx. 60% (for fuel-operated heaters to approx. 75%) of full speed. As soon as a flame is detected within the next 55 seconds, combustion will be stabilized. Should there be no flame condition after a total fuel delivery period of 180 seconds, fuel delivery will be stopped and the glow plug deactivated. The combustion air fan continues full load operation for another 120 seconds (run-down) and the heater enters the error lockout condition.

3.1.3 Stabilization

Diesel Operated Heaters

With the glow plug activated the operating speed of the combustion and heating air fan is increased. After another 20 seconds the speed of the combustion and heating air fan is continuously increased within 17 seconds to full load for full heat.

NOTE

This operating condition is omitted if the set temperature (control idle) has already been achieved once. The glow plug is deactivated and heating operation commences. A flame-out during speed up control causes a restart, 5 restarts an error lockout of the heater.

Fuel Operated Heaters

With the glow plug activated the operating speed of the combustion and heating air fan is continuously increased within 4 seconds to full load for full heat. This operating condition will be omitted if the start occurs after a control idle period.

The glow plug is deactivated and heating operation commences. A flame-out during speed up control causes a restart, 5 restarts an error lockout of the heater.

3.1.4 Heating Operation

During operation the combustion exhaust gasses flow through the heat exchanger charging its walls with combustion heat, which in turn is taken up by the heating air delivered by the heating air fan to be routed to the vehicle interior.

The temperature of the heating air sucked in is measured by means of a temperature sensor fitted to the air intake side of the air heater or by means of an externally located temperature sensor.

A temperature below the one set with the control element increases the heater performance up to maximum heat. In order to extend the burner idle period of Diesel operated heaters during permanent operation with a heating performance in excess of 1.1 kW, the fuel dosing pump delivery rate is reduced every 15 minutes for 20 seconds.

A heating performance less than 1.1 kW causes the fuel delivery to the dosing pump to be interrupted every 30 minutes for 4 seconds. Additionally heating operation is briefly suspended every 9 hours like in control idle. For Diesel-operated heaters this is only applicable, if at this time heating performance is less than 1.1 kW.

3.1.5 Control Operation

During control operation fan speed and dosing pump rate of delivery are subject to heating performance. The glow plug is deactivated.

3.1.6 Control Idle

After reaching the temperature set with the control element, heating performance is controlled to decrease. The speed of the combustion and heating air fan slows down and the fuel delivery rate to the dosing pump is reduced. When exceeding the air intake temperature set with the control element during minimum heating performance, the dosing pump is deactivated after 5 seconds and combustion terminates.

Fan speed remains constant for 35 seconds and is then increased to approx. 60% of full speed for cooling the heater down. the fan then continues to operate at approx. 30% of full speed until temperature is below the temperature set with the control element. If temperature falls below the one set with the control element, the heater will restart (without break away).

NOTE

New settings on the control element are executed by the control unit/heater with a time delay.

3.1.7 Switch-Off

Switching the heater off extinguishes the operation indication of the control element.

If no fuel has been delivered or if the air heater is in control idle, the air heater is deactivated immediately without run-down.

If fuel supply has commenced it will be immediately stopped at switch-off. Fan speed remains constant and then decreases within 30 seconds to approx. 60% of full speed. After this or with the flame sensor detecting "no flame", fan speed rises to maximum speed for 60 seconds and run down for 120 seconds is initiated. Run-down is at approx. 60% of full speed and is deactivated automatically.

NOTE

Re-activation of the heater during run-down is permitted. Run-down will be completed first with a subsequent re-start.

3.1.8 Switch-off upon Failure

The control unit recognizes failures of individual air heater components and malfunctions in the start sequence and in normal operation.

The air heater is deactivated and enters the error lock out mode under the following conditions:

- flame sensor open or short circuit
- temperature sensor open or short circuit
- glow plug open or short circuit
- fan motor open or short circuit or fan speed wrong
- dosing pump open or short circuit
- overheating
- low voltage below 10 Volt or high voltage above 15 Volt in excess of 20 seconds for 12 Volt heaters
- low voltage below 20 Volt or high voltage above 30 Volt in excess of 20 seconds for 24 Volt heaters

A switch-off like in "switch-off" will be performed.

In case of overheating there will be no fuel supply. After run-down the control unit is in the error lockout mode.

The operation indication outputs a flash code.

For error unlock the air heater has to be switched off momentarily (at least 2 seconds) before switching on.

4. Technical Data

As long as no threshold values are given, the following technical data are understood to include tolerances of $\pm 10\%$ usual for heaters at an ambient temperature of $+20\text{ }^{\circ}\text{C}$ and at nominal voltage and conditions.

Electrical Components:

Control unit, combustion air fan, dosing pump, timer, glow plug and control dial are for 12 or 24 Volts operation.

The components temperature limiter and flame detector are independent of voltage.

Fuel for Air Top 2000 S B (gasoline):

The fuel specified by the manufacturer must be used.

Fuel for Air Top 2000 S D (diesel/PME):

The diesel fuel specified by the vehicle manufacturer must be used.

We know of no negative influences due to additives.

If fuel is extracted from the vehicle's tank, follow the additive instructions issued by the vehicle manufacturer.

If you change to low-temperature fuel, the heater must be operated for approx. 15 minutes so that the fuel system is filled with the new fuel.

The Air Top 2000 S D heater is also licensed for use with PME (bio-diesel), which complies with ASTM D6751 and DIN EN 14214.

Air Heater	Operation	AT 2000 S B	AT 2000 S D	
Mark of conformity		~ S 325	~ S 324	
Heater type		Air heater with evaporator burner		
Heat flow	Control range	1.1 – 2.0 kW	0.9 – 2.0 kW	
Type of fuel		Gasoline	Diesel/Fuel oil (EL)	
Fuel consumption	Control range	0.1 .. 0.2 kg/h (0.16..0.27 l/h)	0.1 .. 0.21 kg/h (0.12 .. 0.24 l/h)	
Nominal voltage		12 Volt	12 Volt	24 Volt
Operation voltage		10 ... 15 Volt	10 ... 15 Volt	20 ... 30 Volt
Rated power consumption	Control range	9 ...22 W		
Permitted ambient temp.: Heater: - operation - storage Dosing pump: - operation - storage Control element: - operation - storage		-40 ° ... +40 °C -40 ° ... +85 °C -40 ° ... +20 °C -40 ° ... +85 °C -40 ° ... +75 °C -40 ° ... +85 °C		
Permitted combustion air intake temperature		-40 ... +20 °C		
Setting range for indoor temperature	Control range	+10 ... +45 °C		
Volume flow of heating air against 0.5 bar	Max.	70 m³/h		
CO ₂ in exhaust (perm. functional range)	Max.	9.5 ... 10.5	9.5 ... 12.0	
Dimensions air heater		Length 311 ± 2 mm Width 120 ± 1 mm Height 121 ± 1 mm		
Weight, heater		2.6 kg		

5. Troubleshooting

5.1 General

A malfunction of the Air Top 2000 S is indicated by an error code displayed on the combination or standard timer. When equipped with a standard control dial the operating indicator flashes. In addition a heater check out may be performed using a personal computer (refer to operating instructions PC air heater diagnosis).

CAUTION

Troubleshooting requires profound knowledge about structure and theory of operation of heater components and may only be performed by skilled personnel.

In cases of doubt refer to Sections 2 or 3 for functional interrelations.

CAUTION

Troubleshooting is normally limited to the isolation of defective components.

The following causes for trouble are not considered and should always be checked for to exclude them as cause for trouble:

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

If individual components are checked, the control unit electrical connections must be disconnected.

After any correction of a failure a functional test has to be performed in the vehicle.

5.2 General Failure Symptoms

The following table (Fig. 501) lists the possible failure symptoms.

Failure Symptom	Probable Cause	Remedy
Air heater switches off automatically	No combustion after start or repeat start	Switch off heater momentarily and switch on <u>once</u> again
	Flame extinguishes during operation	Switch off heater momentarily and switch on <u>once</u> again
	Heater overheats Operation indication flashes	Check heat air ducting for obstructions, allow heater to cool down, switch off heater momentarily and switch on <u>once</u> again
	Vehicle electrical system voltage too low	Charge battery Switch off heater momentarily and switch on <u>once</u> again
Heater expels black fumes	Combustion air and/or exhaust ducting blocked	Check combustion and exhaust ducting for obstructions

Fig. 501 General Failure Symptoms

5.3 Failure Symptoms during Operation

The following table (Fig. 502) lists the possible failure symptoms as they might occur during the functional sequence of operation.

In case of malfunction the failure is to be isolated and removed using this table. It is important to accurately identify the failure symptom.

Should the failure symptom not be contained in this table or the trouble not be detected under the specific

failure symptom listed, in emergencies, assistance by our service technicians may be requested.

NOTE

Overheating and dosing pump failure are always indicated additionally after run-down by the flashing LED of the control dial.

In all cases of trouble also a defective control unit may be the cause should all other components turn out to be serviceable.

Failure Symptom	shows afterseconds	Possible Causes
No start and no illumination of LED on control element	immediately	Wrong cabling, defective fuse
No start but LED illuminates	immediately	Fan or control unit defective or fan blocked
Very low speed with no start	immediately	Control idle operation: wrong manual control (selected temperature is below air intake temperature) or wrong integration (excessive air intake temperature)
Motor operates momentarily and then stops	1	Glow plug or flame sensor short or open circuit or control unit defective
Stoppage without run-down	5	Fan motor obstructed, binding
Run-down after	1	Flame detection erroneous
Run-down after	20	Voltage to control unit too low
Run-down after and dosing pump does not cycle	120	Cabling to dosing pump, pump itself or overheat protection defective
Run-down after	40 to 120	Intermittent disconnect of connection to dosing pump or to overheat protection
Run-down after	230	No flame: wrong fuel supply quantity, defective or slow fan, coked burner (in particular pilot flame outlet bore), combustion air/exhaust ducting obstructed or heat exchanger coked, dosing pump seized
Run-down	during combustion operation	Overheating or voltage too low or component error (flame sensor, glow plug, overheat sensor, dosing pump, burner) or no fuel supply or obstructed combustion air/exhaust ducting
Stoppage without run-down	during combustion operation	Fan motor failure or seizure
Interruption of dosing pump cycling and max. speed for 30 sec with subsequent re-start	during combustion operation	Flame-out by gas bubbles in fuel delivery or strong wind against exhaust outlet or defective no-flame detection

Fig. 502 Failure Symptoms during Operation

5.4 Error Code Output

When equipped with a combination or standard timer a malfunction will cause an error code output to the display of the timer for indication.

NOTE

When equipped with a control dial, the error code output is indicated by flashing of the operating indicator/error code indication. The number of flash pulses corresponds to the number indicated in the table below. After a quick pulse train there will always be an error code output.

Error code output on display of combination or standard timer

F	01	No start (after 2 attempts)
F	02	Flame out (at least >5)
F	03	Voltage too low or too high
F	04	Premature flame detection
F	05	Flame sensor open or short circuit
F	06	Temperature sensor open or short circuit
F	07	Dosing pump open or short circuit
F	08	Fan motor open or short circuit or wrong speed
F	09	Glow plug open or short circuit
F	10	Overheating

6. Functional Tests

6.1 General

This section describes the on-vehicle and off-vehicle testing of the air heater to check its proper operation.

WARNING

The air heater shall not be operated in enclosed areas like garages or workshops not provided with exhaust venting facilities.

6.2 Adjustments

6.2.1 Adjustment of the CO₂ Contents

6.2.1.1 General

The CO₂ contents of the exhaust is adjusted with the potentiometer on the control circuit board. The air heater is preset by the manufacturer with respect to the combustion and heating air fan fitted. After adjustment by the manufacturer the potentiometer is in center position (Fig. 601). After an inadvertent loss of this position it is sufficient to restore its original position.

The manufacturer setting may be corrected by rotating the potentiometer. A suitable tool like a small screw driver (2.5 mm tip) is to be used.

CAUTION

Set potentiometer slowly; observe end positions.

Adjustment may be performed at any electrical system voltage.

Clockwise rotation increases the fan speed and decreases the CO₂ contents. Counterclockwise rotation decreases the fan speed and increases the CO₂ contents.

If the setting range is not sufficient (e.g. after replacement of the combustion and heating air fan) the manufacturer's setting may be cancelled according to the procedure described in the following.

6.2.1.2 New Basic Setting

CAUTION

The manufacturer's setting cannot be restored.

1. Withdraw cover from upper shell according to 9.2.1.
2. Switch on air heater.
3. Rotate potentiometer two times and with no interrupt through its complete setting range (e.g. max. - min. - max.).
4. Adjust desired CO₂ contents (Fig. 601).
5. Switch off air heater.
6. Install cover and secure.

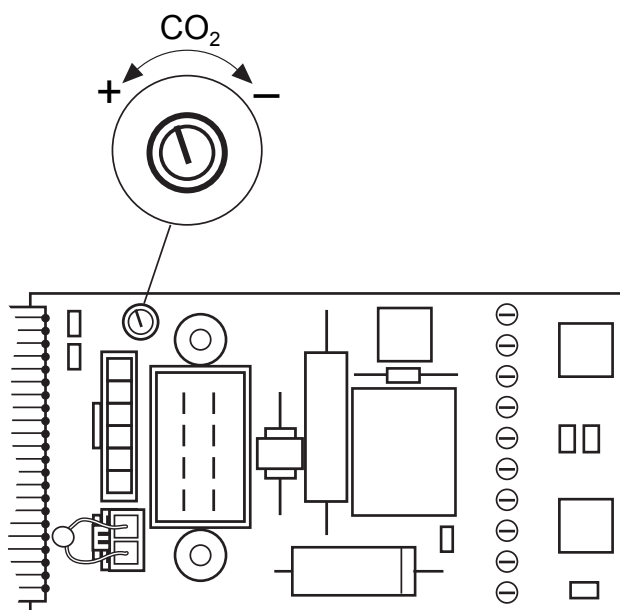


Fig. 601 Adjustment of CO₂ Contents

6.3 Components Testing**CAUTION**

During electrical testing always ensure that the control unit and the component under test are electrically disconnected from each other.

6.3.1 Glow Plug Resistance Test

During electrical testing of the glow plug using a digital multimeter, the following readings should be obtained:

Glow plug	12 Volt (red)	24 Volt (green)
Resistance at 25 °C:	0.324 ... 0.360 Ω	1.3 ... 1.44 Ω
Test current:	< 5 mA	< 5 mA

6.3.2 Flame Sensor Resistance Test

During electrical testing of the flame sensor using a digital multimeter, the following readings should be obtained:

Cold test:

Resistance at 25 °C:	2.6 ... 3.4 Ω
Test current:	< 5 mA

Hot test:

Resistance at 800 - 1000 °C:	12 ... 15 Ω
(ceramic rod red hot over a length of approx. 20 mm)	
Test current:	< 5 mA

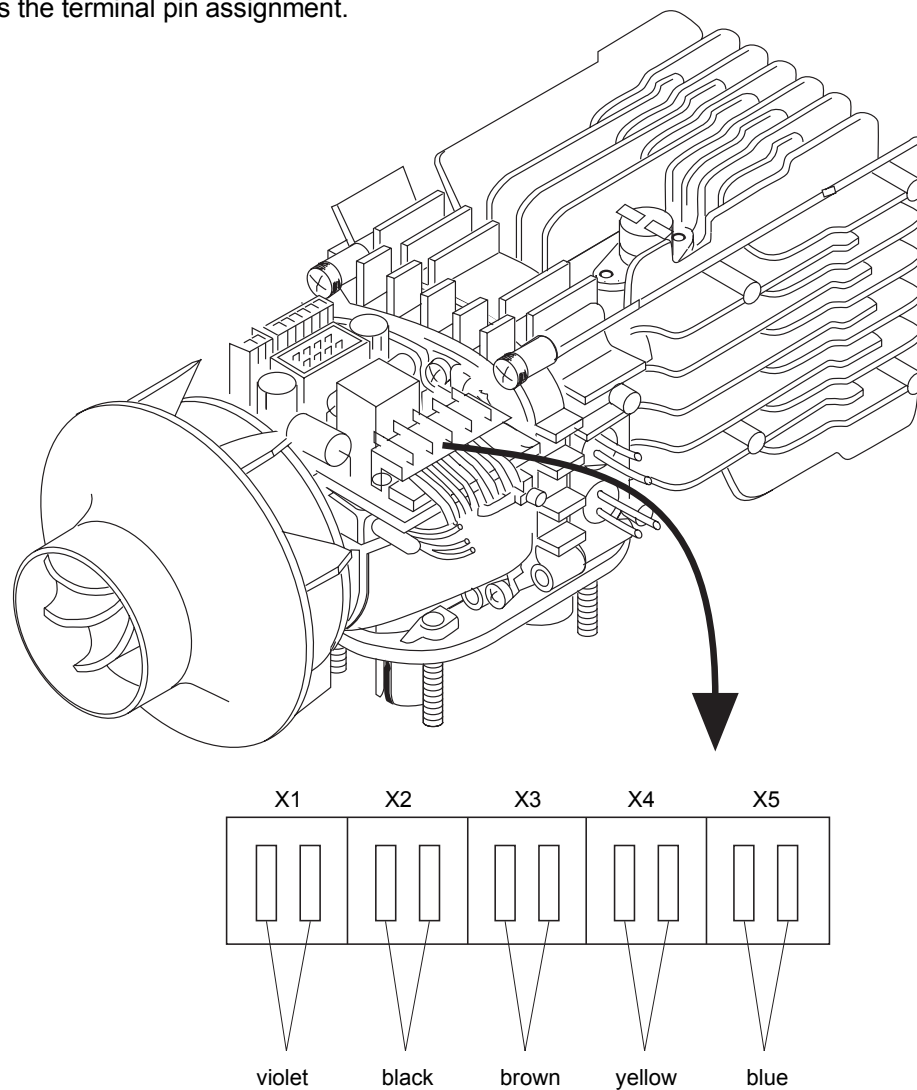
7. Circuit Diagrams

7.1 General

The air heater Air Top 2000 S may be operated using the control dial (rated value transmitter/switch) or with the control dial and a combination or standard timer. The circuit diagrams (Figs. 702 to 704) show the possible circuits 12 or 24 Volt with

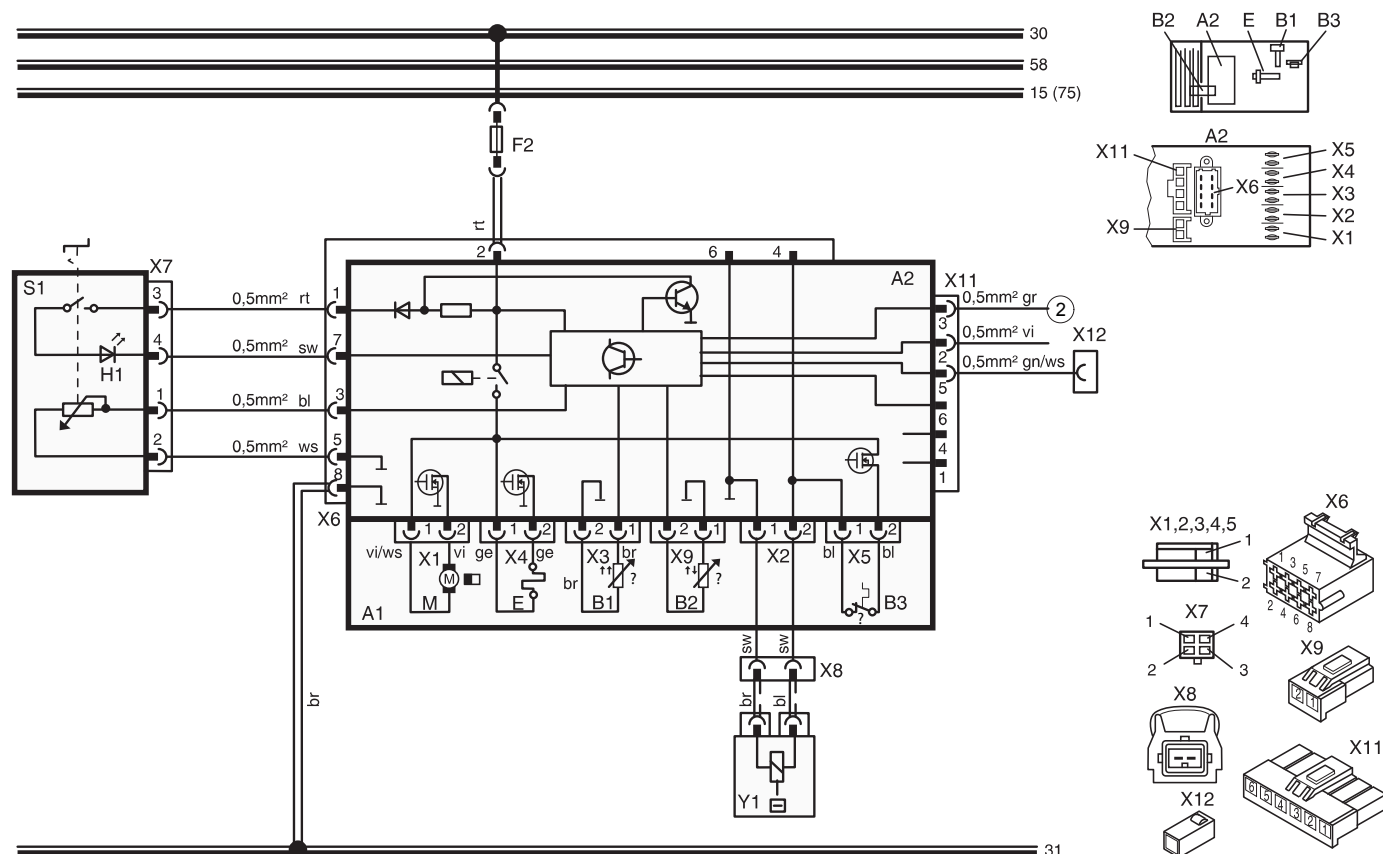
- control element
- combination timer
- control element and standard timer

Fig. 701 shows the terminal pin assignment.



- X1 = Connection, Combustion and Heating Air Fan
- X2 = Connection, Dosing Pump
- X3 = Connection, Flame Sensor
- X4 = Connection, Glow Plug
- X5 = Connection, Temperature Limiter

Fig. 701 Terminal Pin Assignment, Air Top 2000 S



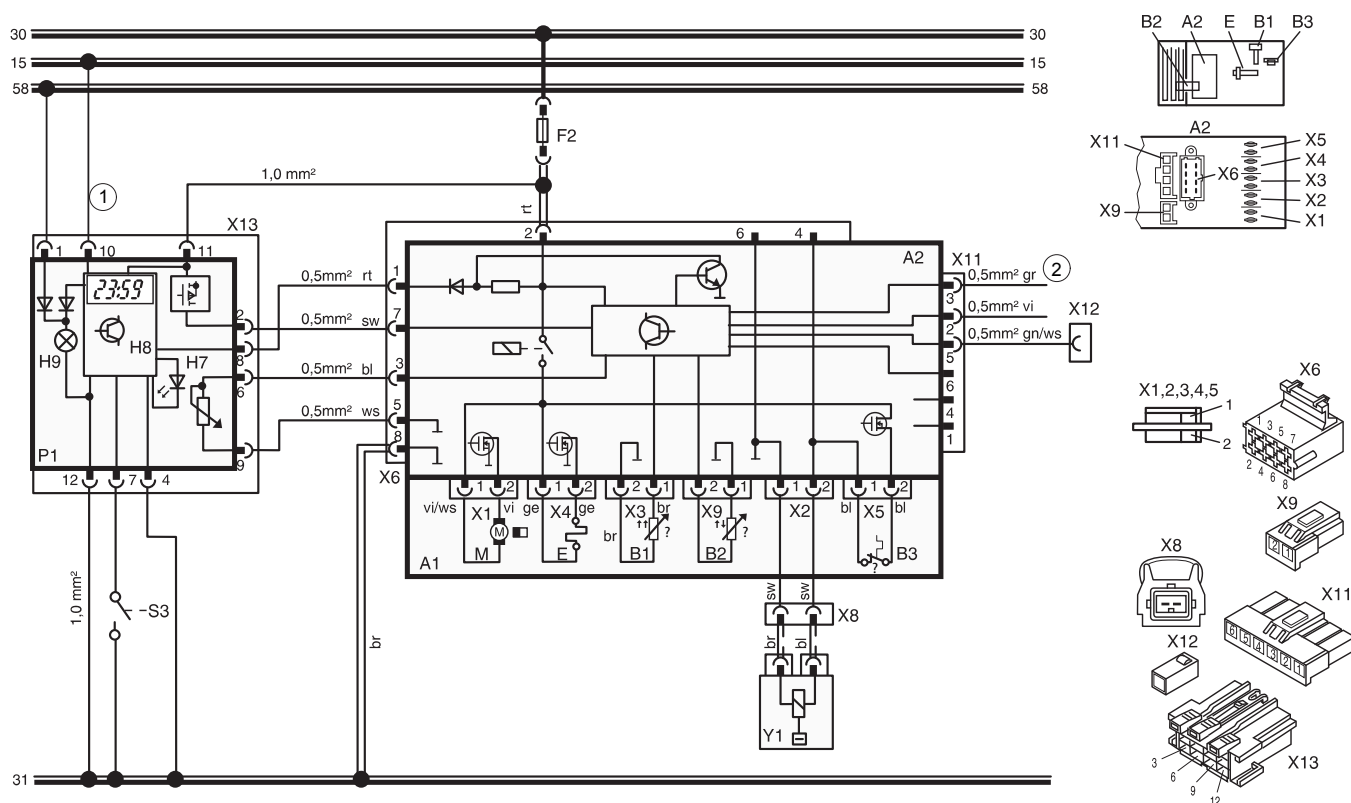
Item	Nomenclature	Remark
A1	Air Heater	Air Top 2000 S
A2	Control Unit	
B1	Flame Sensor	
B2	Temperature Sensor	
B3	Temperature Limiter	
E	Glow Plug	
F2	Fuse 24V 10A/12V 15A	Flat Fuse SAE J 1284
H1	LED green (in item S1)	Operation indication
M	Motor	
S1	Control Element	Rated Value Setting Switch
X1-X5	Connection 2-pole	of item A2
X6	Connection 8-pole	of item A2
X7	Connection 4-pole	of item S
X8	Connection 2-pole	
X9	Connection 2-pole	of item A2
X11	Connection 6-pole	of item A2
X12	Connection 1-pole	Diagnosis (K-wire)
Y1	Dosing Pump	

Wire Gauges		
	< 7.5 m	7.5 - 15 m
—	0.75 mm ²	1.5 mm ²
==	1.0 mm ²	1.5 mm ²
===	1.5 mm ²	2.5 mm ²
====	2.5 mm ²	4.0 mm ²
=====	4.0 mm ²	6.0 mm ²

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

② Connection X11/2 and X11/3 for TRS function only

Fig. 702 Circuit Diagram Automatic Control Air Top 2000 S, 12V/24V with Control Dial



Item	Nomenclature	Remark
A1	Air Heater	Air Top 2000 S
A2	Control Unit	
B1	Flame Sensor	
B2	Temperature Sensor	
B3	Temperature Limiter	
E	Glow Plug	
F2	Fuse 24V 10A/12V 15A	Flat Fuse SAE J 1284
H7	LED red (in item P)	Instant heat switch illumination, standby indication, operating indicator light
H8	Heating symbol in display (in item P)	Operating indicator light, overheat indication
H9	Light (in item P)	Symbol illumination
M	Motor	
P1	Combination Timer (1531)	
S3	Switch	Instant heating remote control
X1-X5	Connection 2-pole	of item A2
X6	Connection 8-pole	of item A2
X8	Connection 2-pole	
X9	Connection 2-pole	of item A2
X11	Connection 6-pole	of item A2
X12	Connection 1-pole	Diagnosis (K-wire)
X13	Connection 12-pole	of item P
Y1	Dosing Pump	

Wire Gauges

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

Wire Colours

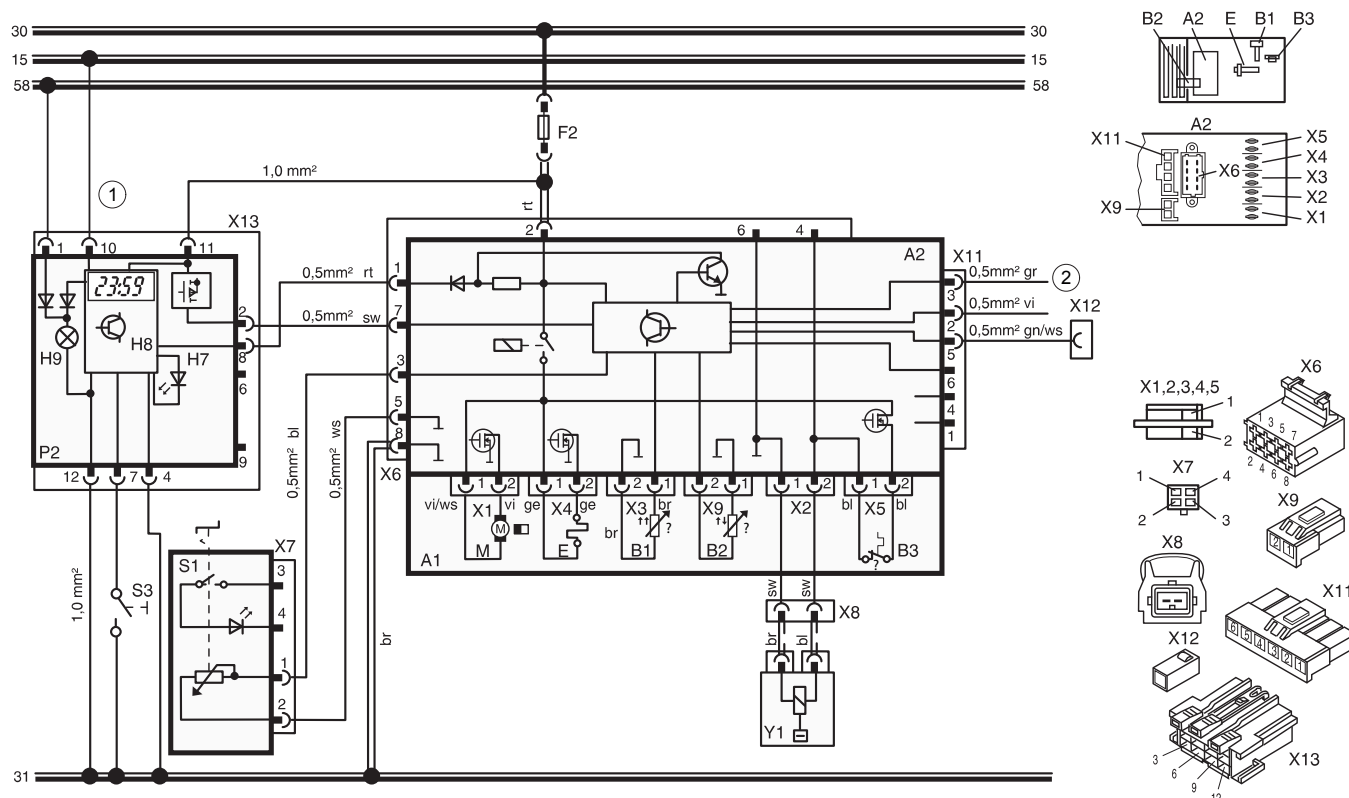
bl	blue
br	brown
ge	yellow
gn	green
gr	grey
or	orange
rt	red
sw	black
vi	violet
ws	white

- ① with plus from terminal (15/75) to connection 10: permanent operation during instant heating as long as ignition on

without plus to connection 10: heating time programmable as required (10 min to 120 min), default setting 120 min.

- ② Connection X11/2 and X11/3 for TRS function only

Fig. 703 Circuit Diagram Automatic Control Air Top 2000 S, 12V/24V with Combination Timer



Item	Nomenclature	Remark
A1	Air Heater	Air Top 2000 S
A2	Control Unit	
B1	Flame Sensor	
B2	Temperature Sensor	
B3	Temperature Limiter	
E	Glow Plug	
F2	Fuse 24V 10A/12V 15A	Flat Fuse SAE J 1284
H7	LED red (in item P)	Instant heat switch illumination, standby indication, operating indicator light
H8	Heating symbol in display (in item P)	Operating indicator light, overheat indication
H9	Light (in item P)	Symbol illumination
M	Motor	
P2	Standard timer	
S1	Control Element	Rated Value Setting Switch
S3	Switch	Instant heating remote control
X1-X5	Connection 2-pole	of item A2
X6	Connection 8-pole	of item A2
X7	Connection 4-pole	of item S1
X8	Connection 2-pole	
X11	Connection 6-pole	of item A2
X12	Connection 1-pole	Diagnosis (K-wire)
X13	Connection 12-pole	of item P
Y1	Dosing Pump	

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

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

① with plus from terminal (15/75) to connection 10:
permanent operation during instant heating as long as ignition on

without plus to connection 10:
heating time programmable as required (10 min to 120 min), default setting 120 min.

② Connection X11/2 and X11/3 for TRS function only

Fig. 704 Circuit Diagram Automatic Control Air Top 2000 S,
12V/24V with Control Dial and Standard Timer

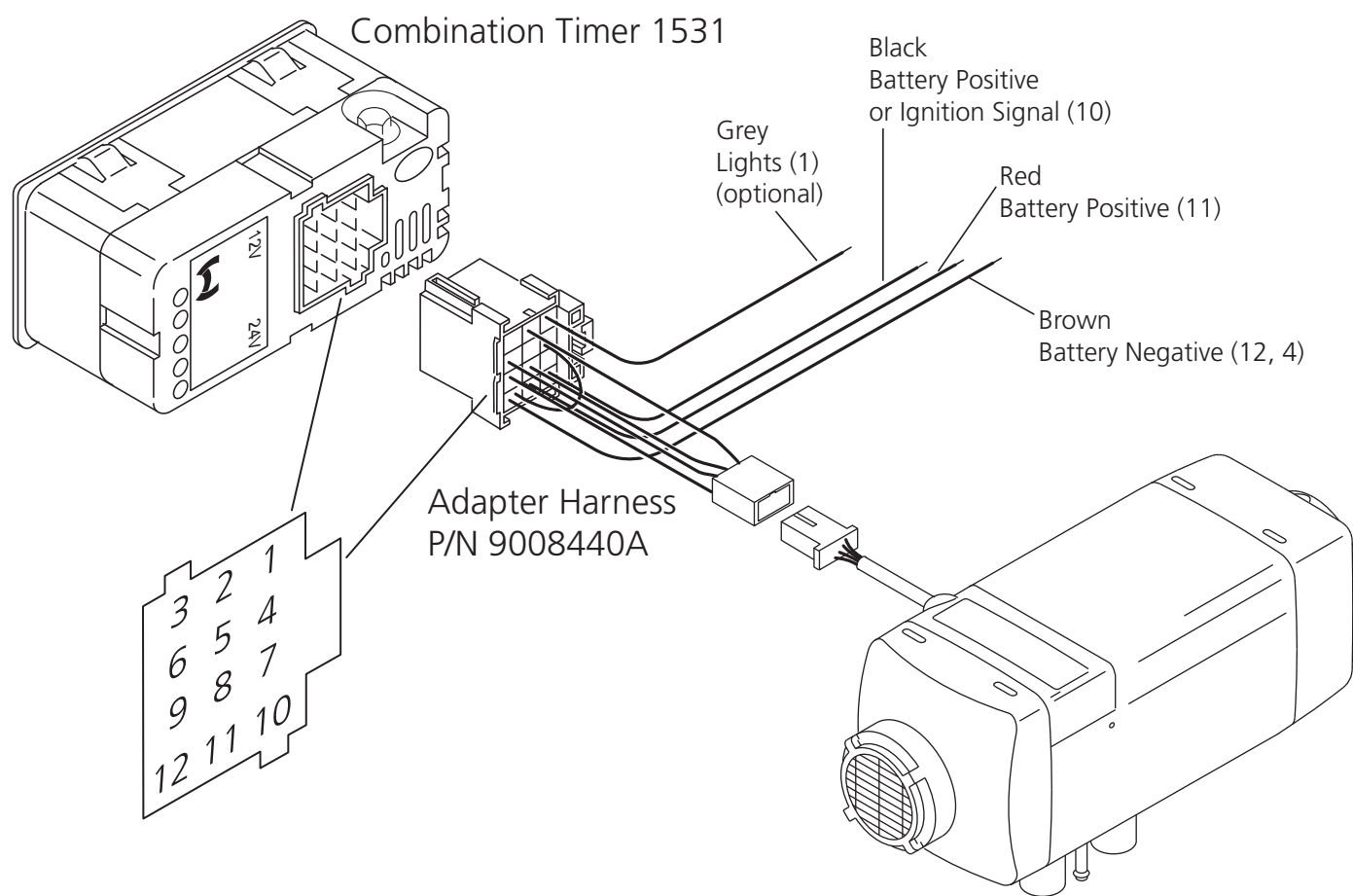


Fig. 705 Connection Diagram, Air Top 2000 S with Combination Timer

8. Servicing

8.1 General

This section describes the servicing procedures that may be performed with the air heater installed.

8.2 Work on the Air Heater

Prior to performing any work it is mandatory to disconnect the vehicle battery main lead. As long as the air heater is in operation or in run-down, the battery main supply must not be disconnected due to the danger of overheating resulting in a response of the overheat protection.

When performing extensive repairs on the heater a complete removal is advisable. When performing repairs requiring a relocation of the installation position, the relevant installation instructions and the vehicle-specific installation proposal have to be observed.

8.3 Work on the Vehicle

CAUTION

In the vicinity of the air heater a temperature of 85 °C must not be exceeded under any circumstances (e.g. during body paint work).

8.4 Air Heater Test Run

WARNING

The air heater must not be operated, not even with timer, in enclosed areas like garages or workshops not equipped with an exhaust venting facility.

CAUTION

Operation of the heater without the control unit cover is not permitted and causes overheating.

8.5 Servicing

NOTE

In order to avoid the seizure of mechanical components, the air heater should be operated every 4 weeks for at least 20 minutes.

The air heater does not require maintenance. It should however be checked by Webasto-trained skilled personnel on regular intervals, the latest before the heating season begins (point of time, when the heater is more frequently in use due to weather conditions).

For reasons of the air heater's functional reliability perform the following servicing:

- check heating air inlet and outlet for foreign matter and contamination. (Contaminated or clogged heating air ducts may lead to overheating and thus response of the temperature limiter).
- Clean air heater exterior (prevent the ingress of water).
- Examine electrical connections for corrosion of contacts and for security.
- Check combustion air and exhaust ducts for damage and obstructions.
- Check fuel lines and fuel filter for leakage.
- Replace fuel filter if installed.

8.6 Visual Inspections and Installation Regulations

8.6.1 Heating Air System

CAUTION

The integration of the air heater into the vehicle's own air system is not permitted due to the system's high pressure and temperature.

Fitted in the air heater on the heating air intake side is a temperature sensor, which operates the heater in the relevant range of performance in conjunction with the control dial dependent on the air intake temperature and position of the rated value transmitter. Heating performance is selected so that after quickly reaching the preselected indoor temperature it is maintained at this value. Air Top 2000 S heaters may be operated with an external temperature sensor (see 9.1.2).

Minimum inside diameter of the heating air duct is 55 mm. Standard diameter is 60 mm.

NOTE

For heating air ducting only materials may be used which are temperature-proof to at least 130 °C.

Maximum loss of pressure between suction and delivery side of the heating air duct 1.0 mbar (10 mm water column).

When exceeding this value the temperature limiter is very likely to respond. The heating air hose is to be secured at its joints.

8.6.2 Fuel Supply

The fuel is taken from the vehicle fuel tank or from a separate fuel tank. The values for maximum pressure at the fuel extraction point are shown in Fig. 801.

Permissible fuel inflow height H	At maximum pressure in fuel line
0.00 m (0.00 in.)	0.20 bar (2.9 PSI)
1.00 m (39.4 in.)	0.11 bar (1.6 PSI)
2.00 m (78.7 in.)	0.03 bar (0.44 PSI)
Maximum fuel intake height S	At maximum negative pressure in fuel tank
0.00 m (0.00 in.)	-0.10 bar (-1.45 PSI)
0.50 m (19.7 in.)	-0.06 bar (-0.87 PSI)
1.00 m (39.4 in.)	-0.02 bar (-0.29 PSI)

8.6.2.1 Fuel Tapping

Vehicles with a Diesel Engine

The fuel must be taken from the vehicle fuel tank or from a separate tank (Figs. 802, 803 and 804). This separate fuel pickup precludes any effect of pressure.

Vehicles with an Injection Engine

When installing the heater in a vehicle with fuel injection systems, it is important to establish whether the fuel pump is located inside or outside the tank.

If the fuel pump is located inside the tank, fuel can only be extracted from the return line using a Webasto fuel tee fitting in which case it must be ensured that the return line continues almost to the bottom of the tank. If this is not the case, a Webasto fuel standpipe (see Figs. 802, 803 and 804) may be used.

If the fuel pump is installed outside the tank, the fuel connection may also be made between the tank and fuel pump, again using only the Webasto fuel tee fitting.

Vehicles with a Carburetor Engine

The fuel may only be extracted on cars using a special Webasto fuel tee fitting as close to the tank as possible.

The connection may be made in either the supply or return line, in which case the return line must lead almost to the base of the tank. If this is not the case, the return line may be extended.

The fuel tee must be fitted in such a way that any air or gas bubbles are automatically discharged towards the tank.

The fuel tee should not be located near the engine, as gas bubbles may form in the lines on account of heat radiated from the engine. This may cause problems during combustion.

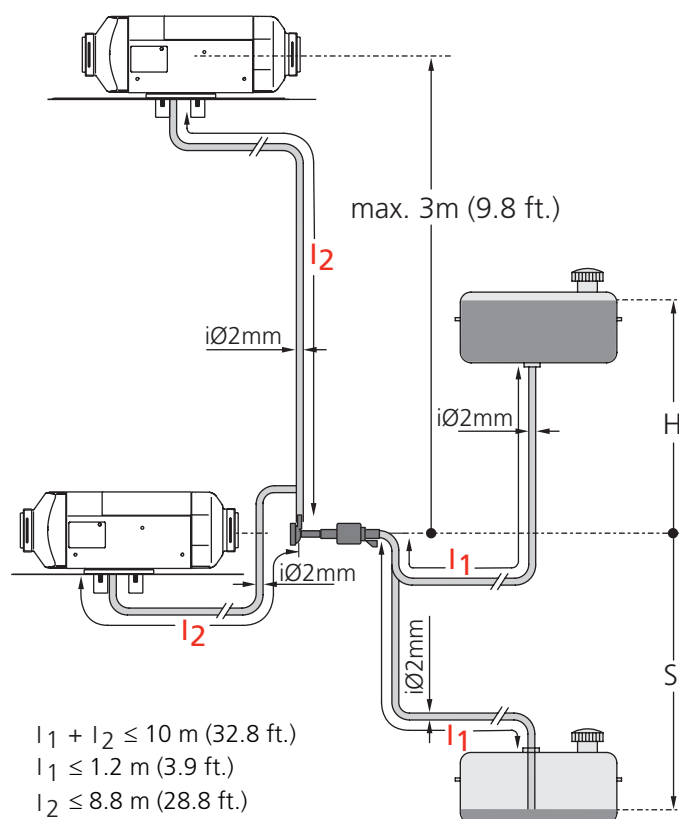


Fig. 801 Fuel Supply

Hole Pattern

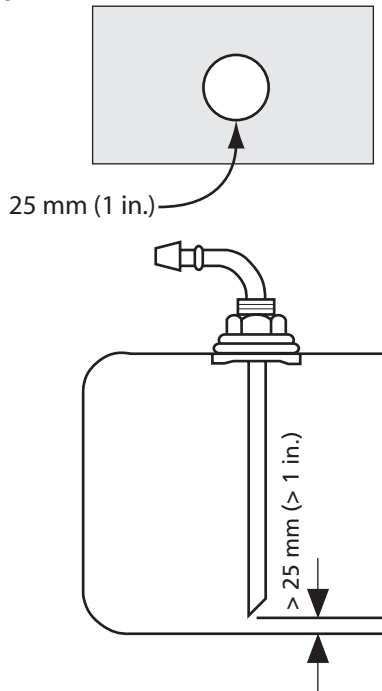


Fig. 802 Webasto Fuel Tank Tap

* Use fuel tank tap only on metal fuel tanks

Fuel Tank Tap

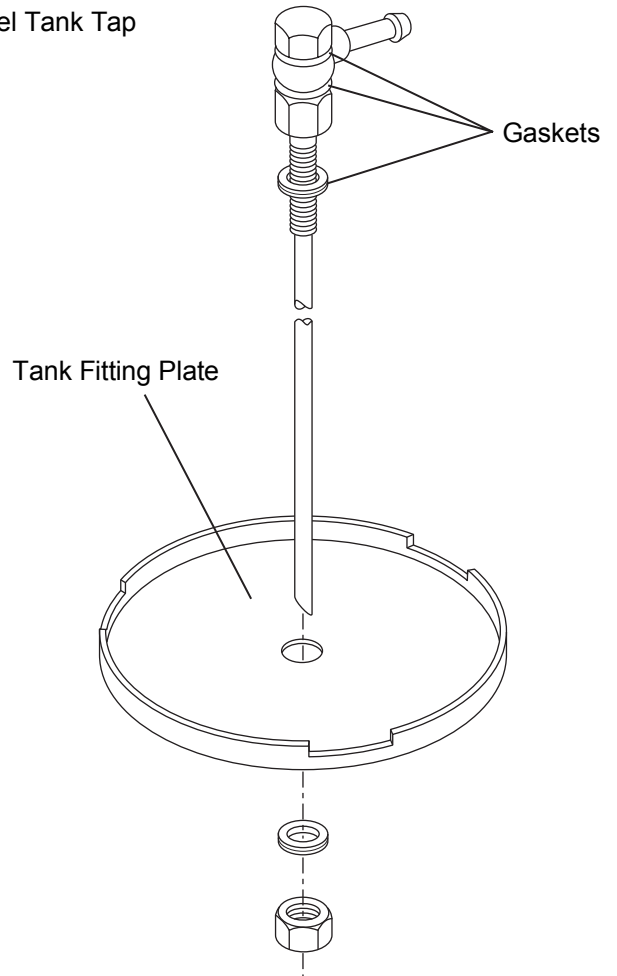


Fig. 804 Fuel Tapping from Plastic Tank (tapping via fitting plate)

NOTE

The fitting plate must be made of sheet metal!

Plastic Tank

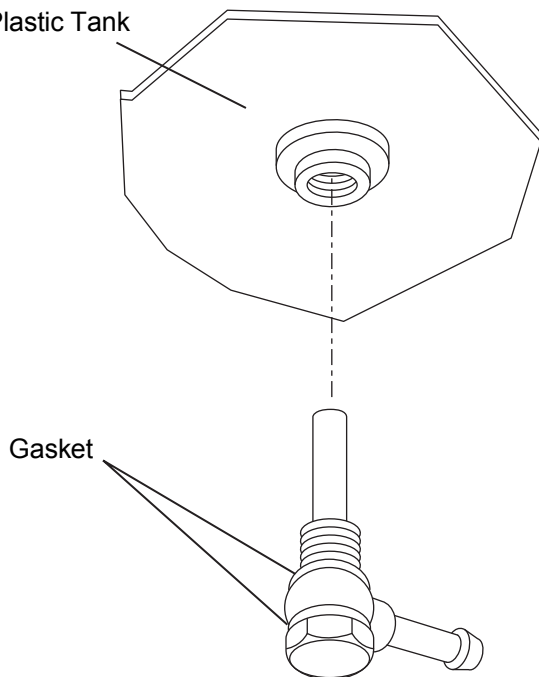


Fig. 803 Fuel Tapping from Plastic Tank (tapping via fuel drain plug)

8.6.2.2 Fuel Lines

Fuel lines may only be steel, copper, or plastic lines made of unhardened, light and temperature stabilised PA 11 or PA 12 (e.g. Mecanyl RWTL) according to DIN 73378. As in most cases a permanently rising fuel line routing cannot be ensured, the inner diameter must not exceed a certain value. Starting from an inside diameter of 4 mm, air or gas bubbles accumulate resulting in malfunctions should the lines be descending or have sags. The diameters specified in Fig. 801 will ensure that bubbles do not form.

A descending line routing from the dosing pump to the heater should be avoided.

Loose fuel lines must be secured in order to avoid sagging. The installation must ensure protection against stone impacts and **undue temperatures** (exhaust line). The fuel line joints are to be secured against slipping with hose clamps.

Connection of 2 Pipes with Hose

The proper connection of fuel lines with hoses is shown in Fig. 805.

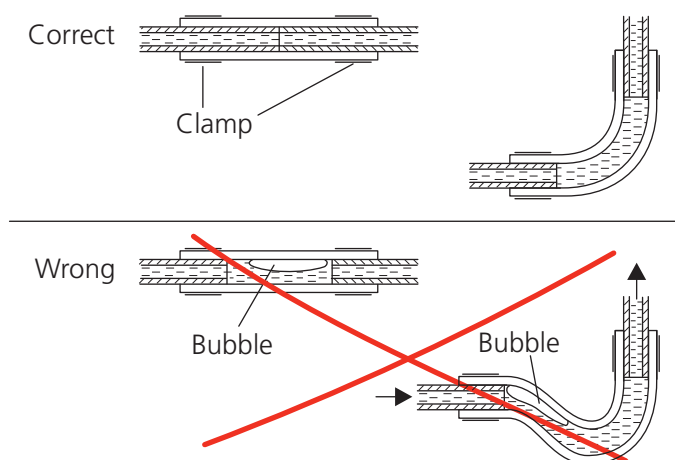
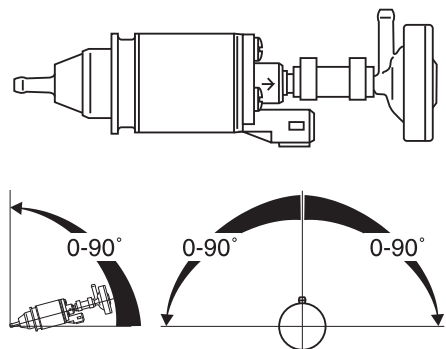


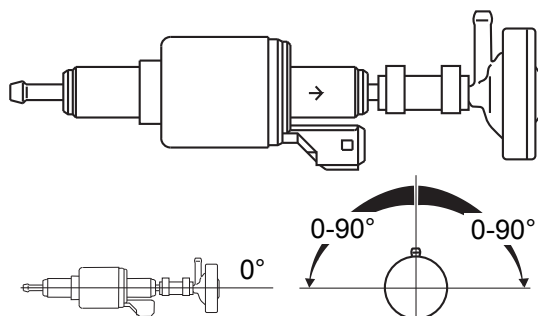
Fig. 805 Pipe/Hose Connection

8.6.3 Dosing Pump

The dosing pump is a combined delivery, dosing, and shut-off system and is subject to certain installation criteria (see Figs. 801 and 806).



AT 2000 S. 12 Volt and 24 Volt - Gasoline and Diesel



AT 2000 S D. 12 Volt and 24 Volt - Diesel DP 30
Installation Position only Horizontal

Fig. 806 Dosing Pump, Installation Position and Attachment

8.6.3.1 Installation Location

It is advantageous to mount the dosing pump in a cool location. The ambient temperature must never exceed +20 °C during operation.

Dosing pump and fuel lines must not be installed in locations exposed to heat radiated by hot vehicle components. A heat shield is to be provided as required.

8.6.3.2 Installation and Attachment

The dosing pump is to be attached with anti-vibration mounts. The installation location is limited according to Fig. 806 to ensure sufficient self-venting capability. Due to the danger of corrosion the plug connection between dosing pump and dosing pump cable loom may only use Webasto original parts.

8.6.4 Fuel Filter

Only a Webasto filter, P/N 50487171A, is allowed to be used if the fuel is expected to be contaminated. Install vertically if possible, however at most horizontally (check flow direction).

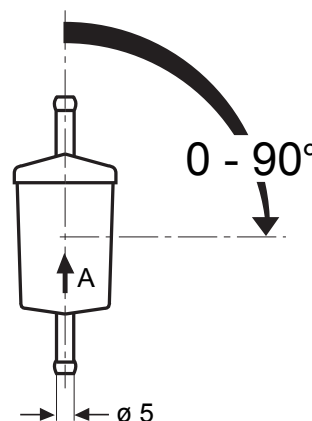


Fig. 807 Fuel Filter

8.6.5 Combustion Air Supply

Combustion air must under no circumstances be extracted from rooms with persons. The combustion air inlet must not point towards the forward direction of motion. It must be located so that no clogging by contamination is to be expected.

NOTE

For fuel operated heaters the combustion air tap must be located in a possibly cool and splash water proof position using a combustion air line.

If the air heater is located in a closed installation box, combustion air must be taken in from and the exhaust routed to the exterior. The feedthroughs must not allow exhaust fumes to enter the vehicle interior.

If a contaminated combustion air supply is expected, a combustion air filter (Ident No. 21963A) can be fitted (Air Top 2000 S D only).

8.6.6 Exhaust Line

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

The exhaust muffler is preferably mounted near the air heater. The direction of flow is optional.

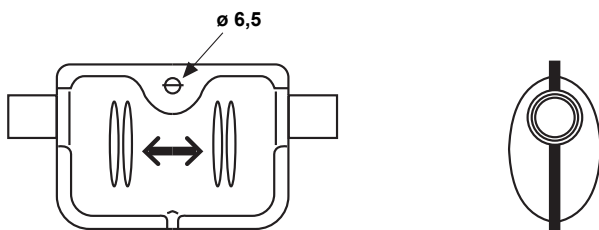


Fig. 808 Exhaust Muffler, Direction of Flow

Operation of the air heater is also permitted without muffler.

8.6.7 Combustion Air Intake and Exhaust Lines

In order to avoid damage to the dosing pump cable, no exhaust line may be used for the elongation of the combustion air intake line.

Length of the combustion air intake and exhaust line:
 with muffler: max. 2.0 m
 without muffler: max. 5.0 m

Both lines must be routed away from the heater in a descending attitude. If this is not possible, a condensate drain hole $\varnothing 4$ mm must be provided at the lowest point.

Inner diameter of lines:

Combustion air line: 22 mm
 Exhaust line: 22 mm

NOTE

When exceeding an exhaust line length of 2 m, insulated exhaust lines have to be used (below minimum dew point).

Smallest bending radius: 50 mm

In order to ensure the angle of $90^\circ \pm 10^\circ$, an attachment is required not further than 150 mm away measured from the exhaust pipe end.

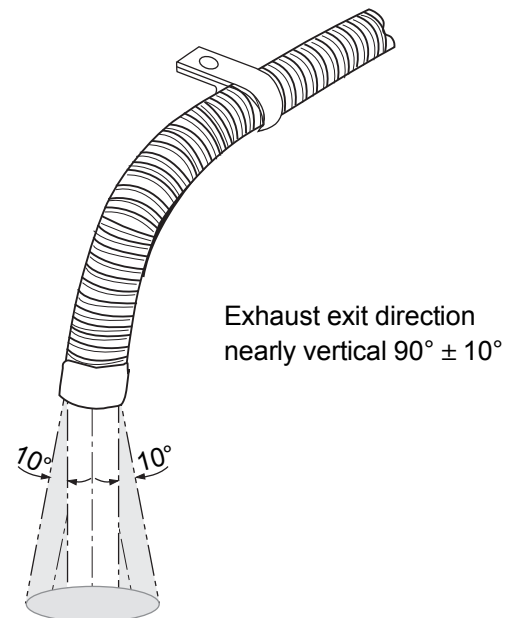


Fig. 809 Exhaust Pipe Outlet, Installation Position

WARNING

Any exhaust exit direction other than the one shown in Fig. 809 may cause fires.

Sum of bends:

Combustion air line: max. 270°
 Exhaust: max. 270°

8.6.8 Electrical Connections

8.6.8.1 Connection Air Heater, Control Dial

Electrical connection is according to Circuit Diagram Automatic Control (see Section 7).

For connection of the cable loom the cover (see 9.2.1.1) of the air heater has to be removed for connecting the cable loom plug(s) to the control unit. Avoid touching the control unit strip conductors.

Prior to first operation of the air heater the cover must be fitted to avoid the loss of heated air (air heater overheating).

The cable feedthrough may be from left or right.

8.6.8.2 Connection of Power Supply

Ideally from the vehicle's central electrical system.

An additional blade terminal fuse holder is to be fitted to protect the heater and harness (supplied with the heater). The fuse holder should be installed as close as is practical to the power source e.g. in the vehicle battery enclosure.

The fuse holder is constructed of weather resistant components.

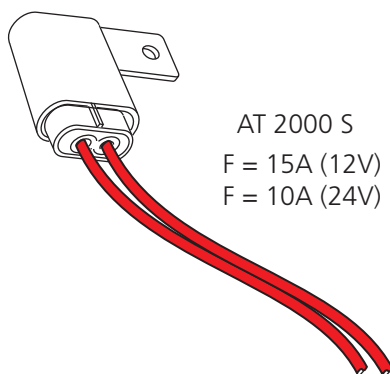


Fig. 810 Weather Resistant Fuse Holder

8.6.8.3 Connection Control Dial

The cable loom is prefabricated to connect to the control dial (rated value transmitter).

For plug disconnection pull on terminal plug only (Fig. 812).

By pulling on the cable loom the terminal plug is secured (self-locking).

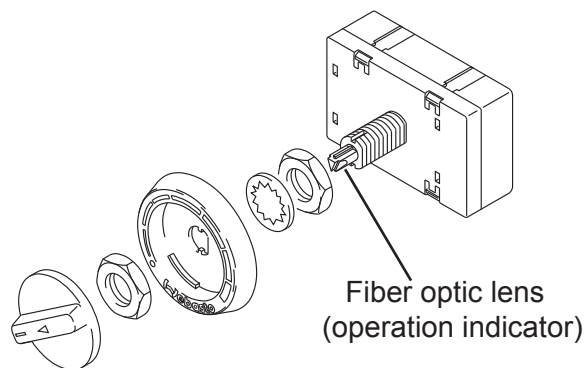


Fig. 811 Control Dial

NOTE

The fiber optic lens must be in contact with the rotary knob.

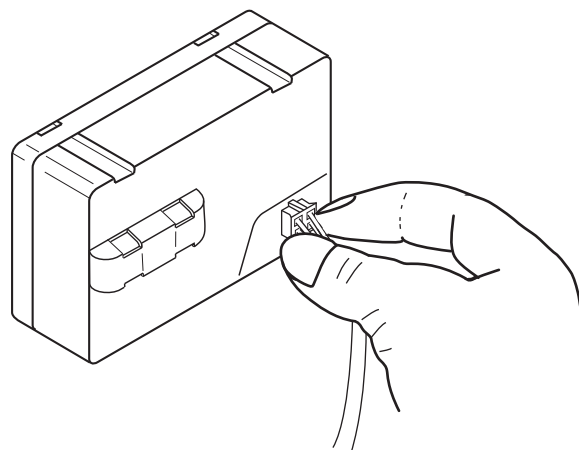
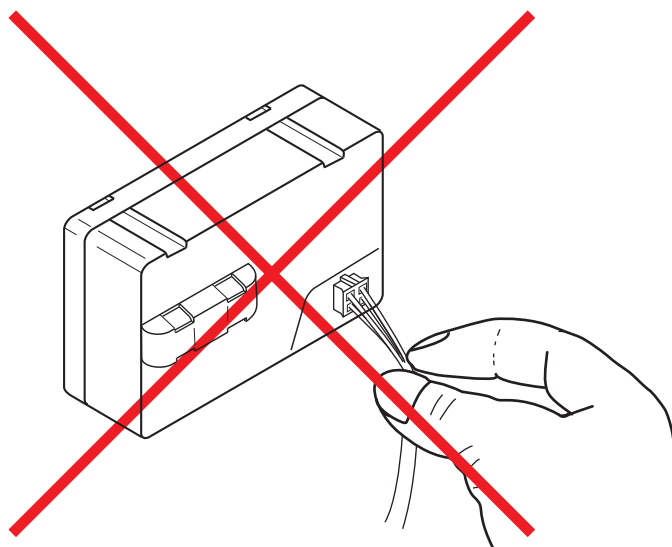


Fig. 812 Pulling the Plug

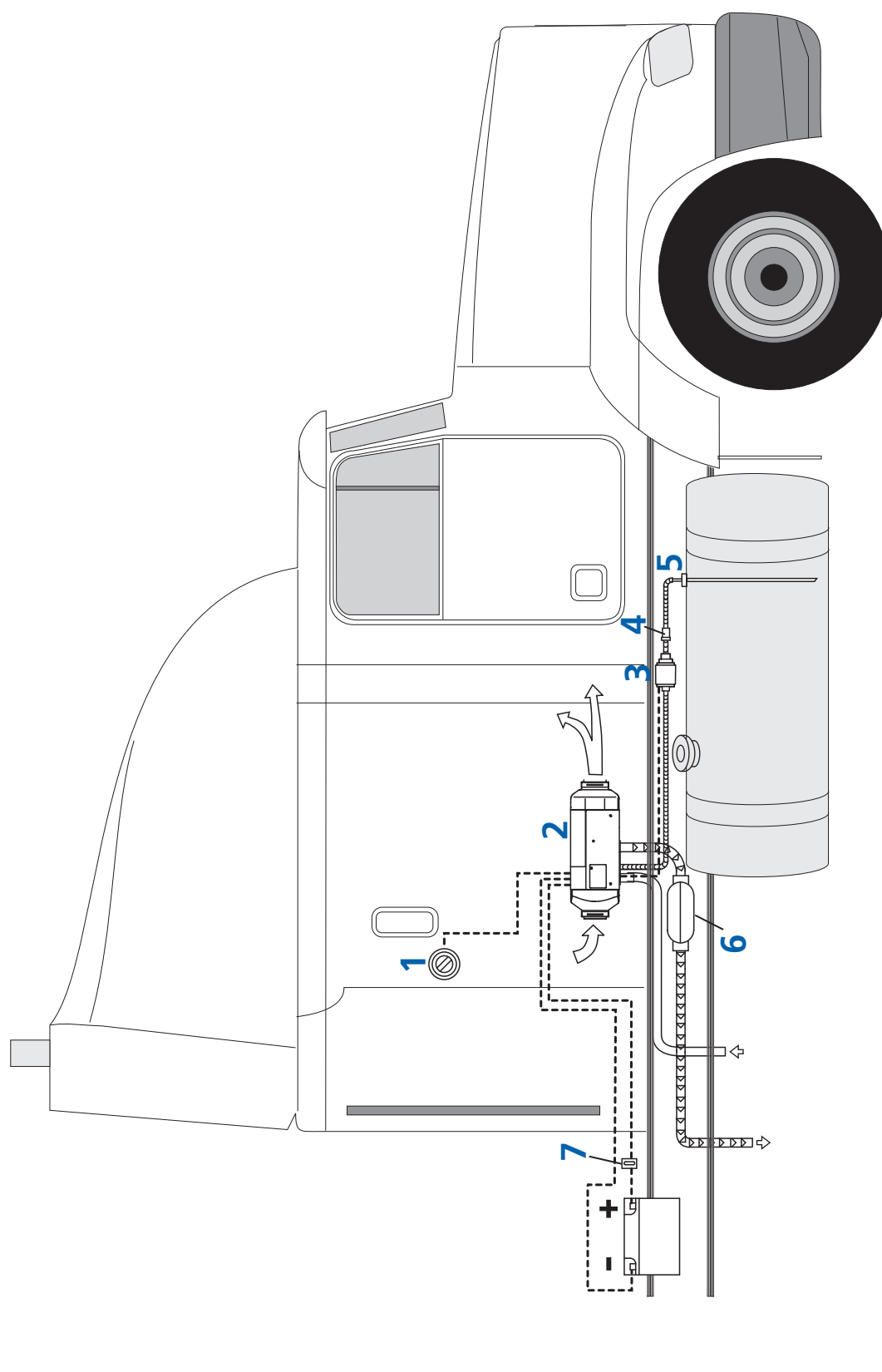


Fig. 813 Example of an Installation

8.7 Removal and Installation**CAUTION**

When the heater is installed it must not be dismantled.

8.7.1 Air Heater, Removal and Installation**8.7.1.1 Removal**

1. Disconnect battery terminal leads.
2. Withdraw cover from upper housing shell according to 9.2.1.
3. Disconnect the wire harness plug from control unit.
4. Disconnect interior air ducts if present.
5. Disconnect cable to dosing pump at cable disconnect.
6. Disconnect fuel inlet on air heater.
7. Disconnect connections of combustion air intake and exhaust outlet on air heater.
8. Remove four nuts and lock washers on air heater.
9. Remove air heater and discard gasket.

8.7.1.2 Installation

1. Locate air heater with **new** gasket in installation position and secure with four nuts and lock washers (use original Webasto nuts only).
2. Tighten nuts with 6 + 1 Nm.
3. Secure connection for fuel inlet on air heater.
4. Secure connections for combustion air inlet and exhaust outlet on air heater.
5. Route cable to dosing pump and connect to dosing pump.
6. Connect wire harness to control unit.
7. Install cover and secure.
8. Reconnect battery terminal leads.
9. Install interior ducting if present.
10. Bleed fuel supply system (see 8.8).

8.8 Start-Up

After you have installed the heater, bleed the fuel supply system carefully.

NOTE

As a result of the low fuel consumption the heater must be switched on several times to fill the fuel line.

Conduct a trial of the heater to check all the connections for leaks and to ensure that they are secure. If the heater suffers a fault during operation, the fault must be located and remedied.

9. Repair

9.1 General

This section describes the repairs that may be performed on the air heater Air Top 2000 S after it has been removed from the vehicle.
Any further disassembly will void the warranty.
For reassembly, only components of the proper spare parts and kits are to be used.

9.1.1 Work on Components after Disassembly

CAUTION

All gaskets located between disassembled components as well as the exhaust outlet seal must always be replaced and discarded.

9.1.1.1 Cleaning

- All components disassembled must be cleaned with cleaning spirit and subsequently dried with pressurized air.
- All sealing compound must be carefully removed from components using a suitable tool.

9.1.1.2 Visual Inspection

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

9.1.2 Incorporation of Modifications

NOTE

The continuous design improvement of the heaters is intended to optimise their serviceability avoiding failures or malfunctions.

In general equipment in service may be retrofitted with available modification kits. In the following that modification which may be incorporated easily during maintenance:

- installation of an external temperature sensor for optimising temperature control of the Air Top 2000 S (see 9.1.2.1).

9.1.2.1 Installation of an External Temperature Sensor

General

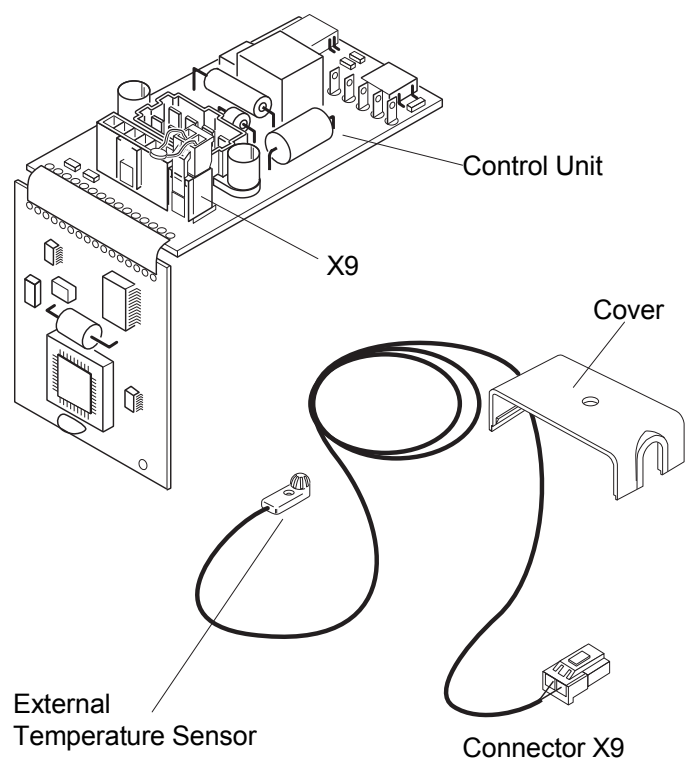
The heater can control the required temperature perfectly if its temperature sensor is exposed to the air of the main area of the vehicle. In certain circumstances, this is not always possible using the temperature sensor integrated in the control unit due to the installation circumstances (addition of fresh air). In this case proper temperature control can be ensured using an external temperature sensor fitted in the appropriate area.

Procedure

1. Select adequate installation location for external temperature sensor.

IMPORTANT

- Temperature sensor should not be in the direct line of heated air flow or located in the vicinity of heating sources (e.g. vehicle's own heater).
 - The sensor is to be installed at medium height in the vehicle interior on surfaces that are as vertical as possible.
 - The installation location should not be exposed to direct sun light.
 - Do not mount temperature sensor behind curtains or the like.
2. Mount external temperature sensor and route cable to control unit.
 3. Connect connector X9 and install cover.
 4. Perform test run and check control behaviour.



9.2 Disassembly and Assembly

9.2.1 Removal of Housing Components/Covers

9.2.1.1 Cover for Electrical Connection

Dependent on the type of installation the cable loom exits the air heater either on the left or right. The cover (1, Fig. 901) may be levered off using a blunt blade in the areas marked (X).

9.2.1.2 Grates for Heating Air Inlet and Outlet

The grates (5, Fig. 901) can be released from the covers by twisting and pulling off forwards.

9.2.1.3 Covers for Heating Air Inlet and Outlet

Both covers (3 and 6, Fig. 901) can be released and removed by pressing the four detents on top and bottom using a suitable tool.

9.2.1.4 Upper Housing Shell

NOTE

The covers for the heating air inlet and outlet must be removed.

The upper shell (2, Fig. 901) can be raised by pulling up.

9.2.1.5 Lower Housing Shell

By gently pulling the lower shell (4, Fig. 901) on both sides in the areas (Y), you can release the fixing and the shell can be taken off the motor casing.

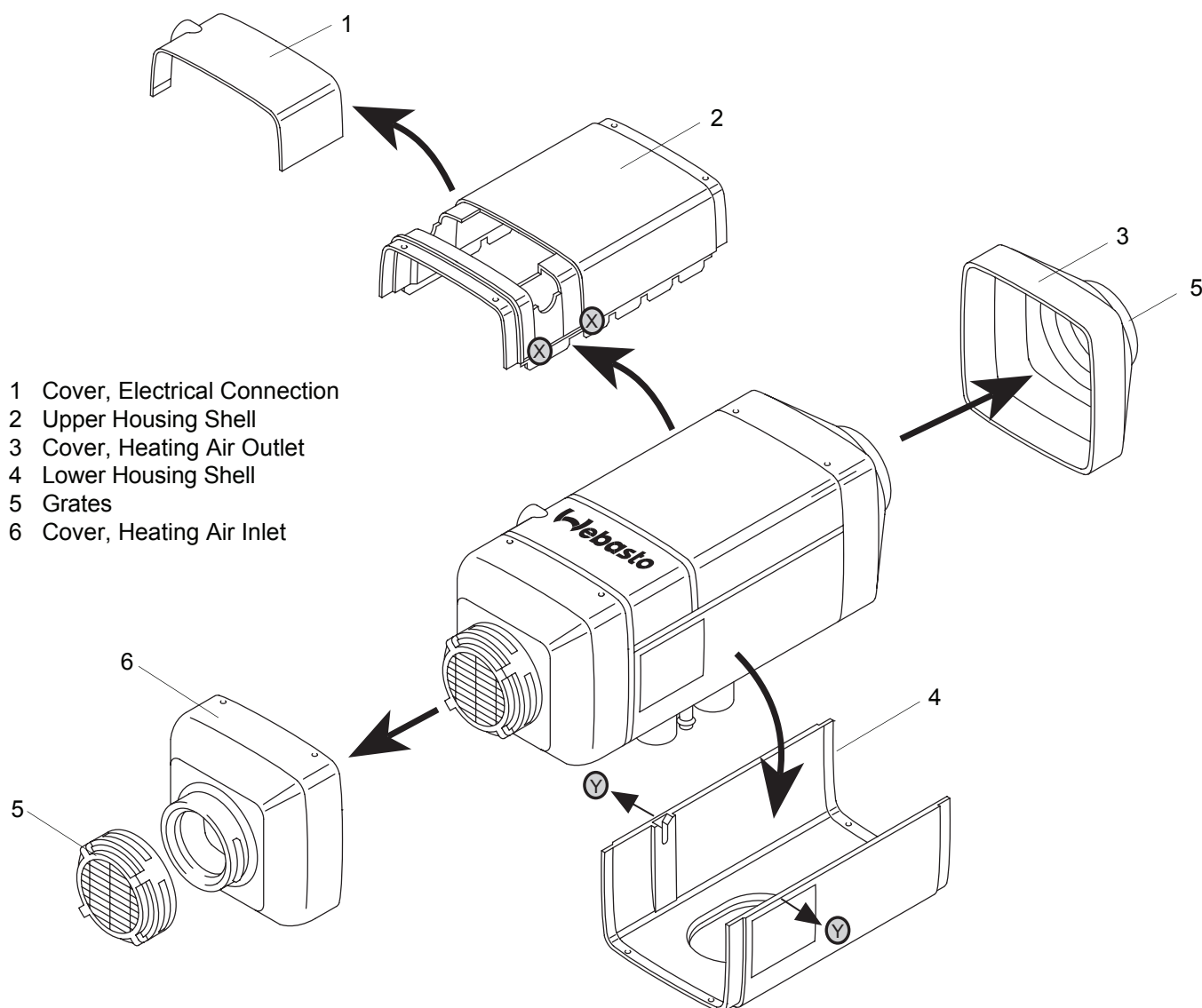


Fig. 901 Removal of Housing Components/Covers

9.2.2 Replacement of Control Unit**9.2.2.1 Removal**

During removal avoid the build-up of static charge (i.e. do not touch strip conductors).

1. Remove heater from vehicle (see 8.7.1.1).
2. Remove covers for heating air inlet and outlet (6 and 3, Fig. 901) according to 9.2.1.3.
3. Remove upper housing shell according to 9.2.1.4.
4. Disconnect terminal connections (1, Fig. 902).
5. Remove screws (3) and remove control unit (2) with bracket (6).
6. Remove screw (7) to separate control unit (2) from bracket (6) if necessary.
7. Perform work on components after disassembly (see 9.1.1).

9.2.2.2 Installation**NOTE**

During installation avoid the build-up of static charge (i.e. do not touch strip conductors).

1. Place control unit (2, Fig. 902) in position on bracket (6) and secure with screw (7).
2. Place control unit (2) with bracket (6) in installation position and secure with screws (3).
Torque screws to 0.7 ± 0.07 Nm.
3. Connect plug connections to terminal (Fig. 701).
4. Install upper housing shell and fix in position.
5. Slide on covers for heating air inlet and outlet and fix in position.
6. Install heater (see 8.7.1.2).
7. Check CO₂ setting and if necessary, adjust (see 6.2)

9.2.3 Replacement of Temperature Limiter**9.2.3.1 Removal**

1. Remove heater from vehicle (see 8.7.1.1).
2. Remove covers for heating air inlet and outlet (6 and 3, Fig. 901) according to 9.2.1.3.
3. Remove upper housing shell according to 9.2.1.4.
4. Disconnect plug connection (blue) from terminal.
5. Remove screws (4, Fig. 902).
6. Remove temperature limiter (5).
7. Perform work on components after disassembly (see 9.1.1).

9.2.3.2 Installation

1. Place temperature limiter (5, Fig. 902) into installation position and secure with screws (4).
Ensure limiter is properly seated.
2. Torque screws to 1.5 ± 0.15 Nm.
3. Connect plug connections (blue) to terminal.
4. Install on upper housing shell and fix in position.
5. Slide on covers for heating air inlet and outlet and fix in position.
6. Install heater (see 8.7.1.2).

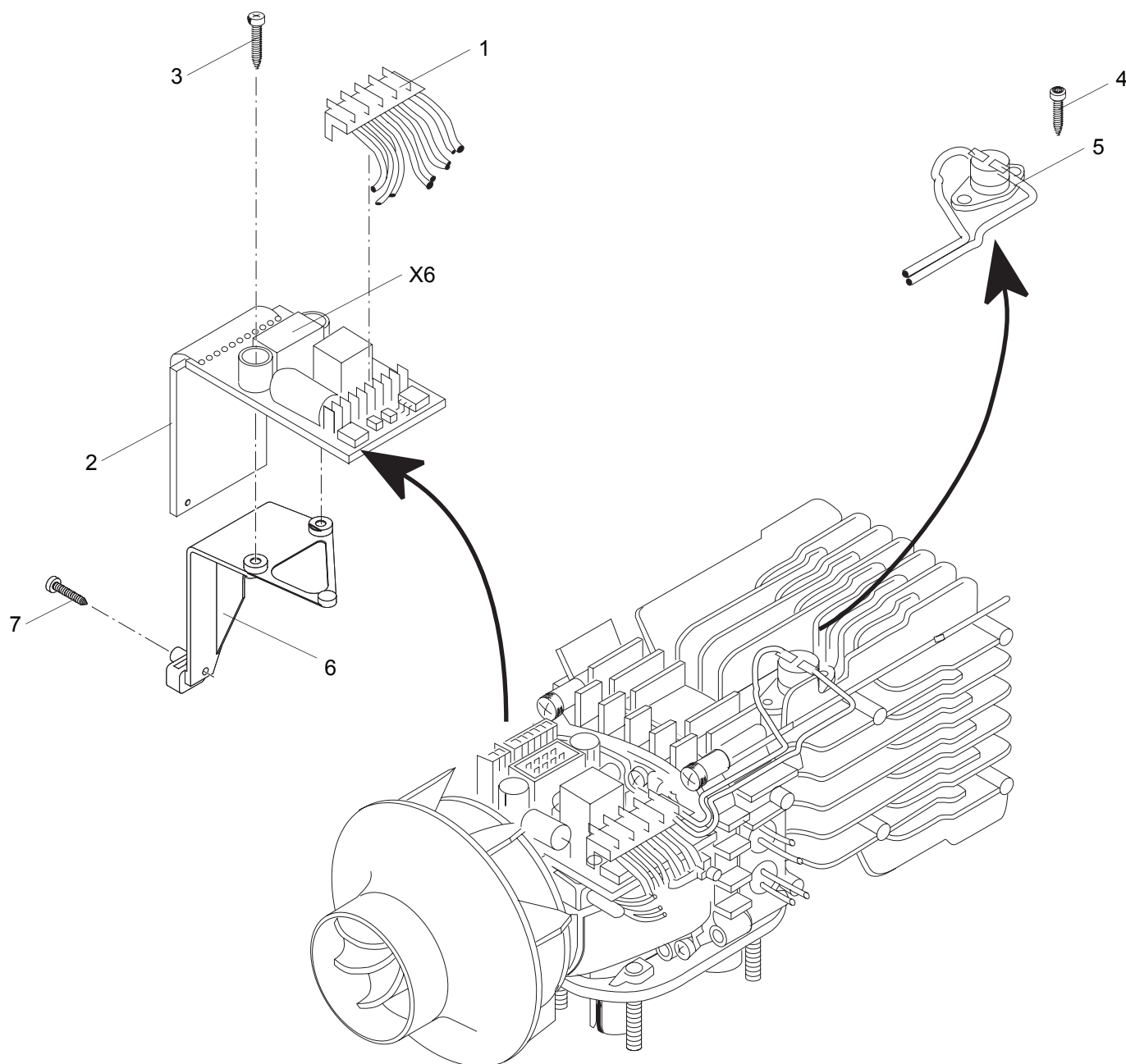


Fig. 902 Replacement of Control Unit and Temperature Limiter

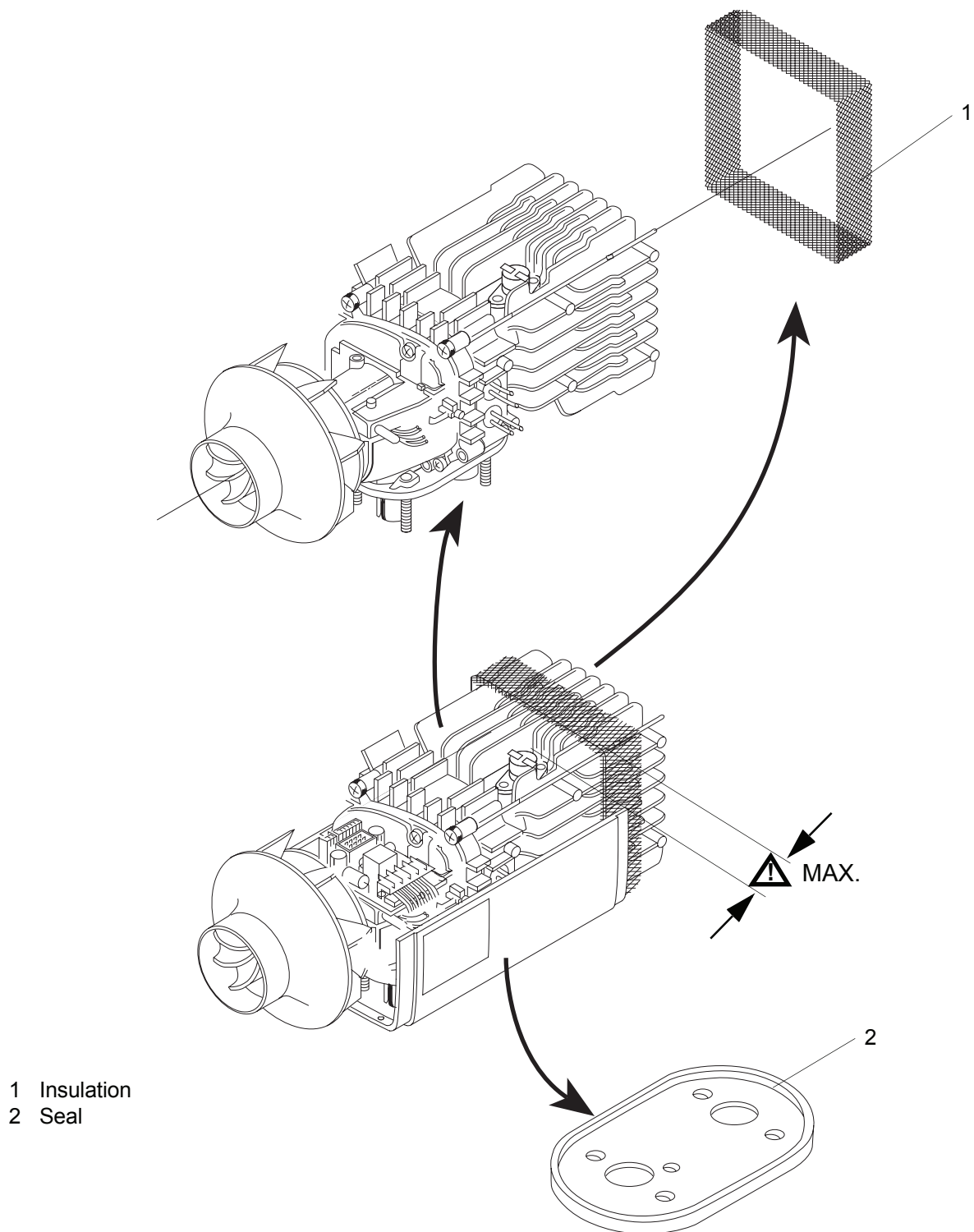


Fig. 903 Replacement of Combustion Air Fan (Disassembly)

9.2.4 Replacement of Combustion Air Fan

9.2.4.1 Removal

1. Remove air heater (see 8.7.1.1).
2. Remove control unit (see 9.2.2.1).
3. Remove seal (2 Fig. 903) from lower housing shell and discard.
4. Remove air heater from lower housing shell.
5. Remove insulation (1, Fig. 903)
6. Remove screws (1, Fig. 904).
7. Withdraw combustion air fan (3) and remove gasket (2).
8. Perform work on components after disassembly (see 9.1.1).

9.2.4.2 Installation

1. Ensure that sealing surfaces on combustion air fan and on heat exchanger are not damaged.
2. Place new gasket (2, Fig. 904) onto flange of combustion air fan (3).
3. Place combustion air fan into assembly position and mount using screws (1). Torque screws (1) to 6 Nm.

CAUTION

To ensure the proper function of the heater and to prevent malfunctions of the temperature sensor, the following must be observed when installing the wire insulating mesh:

- The wire insulating mesh must be installed as shown in Fig. 903 to prevent unwanted contact with the temperature sensor terminals.

- Loose wire strands of the mesh must be cut off to prevent contact with the temperature sensor.
 - Ensure a secure fit between the heat exchanger, insulating mesh, and the upper housing.
 - An overly worn, damaged or flattened insulating mesh must be replaced with a new mesh.
4. Place wire insulating mesh into position on the heat exchanger (1, Fig. 903).
 5. While slightly spreading the lower housing shell, place over heat exchanger until guide slots engage with pins on fan housing.
 6. Fit new seal (2, Fig. 903) on heater mount base.
 7. Install control unit (see 9.2.2.2).
 8. Install upper housing shell, air inlet and air outlet.
 9. Install air heater (see 8.7.1.2).
 10. Check CO₂ setting and adjust as required (see 6.2).

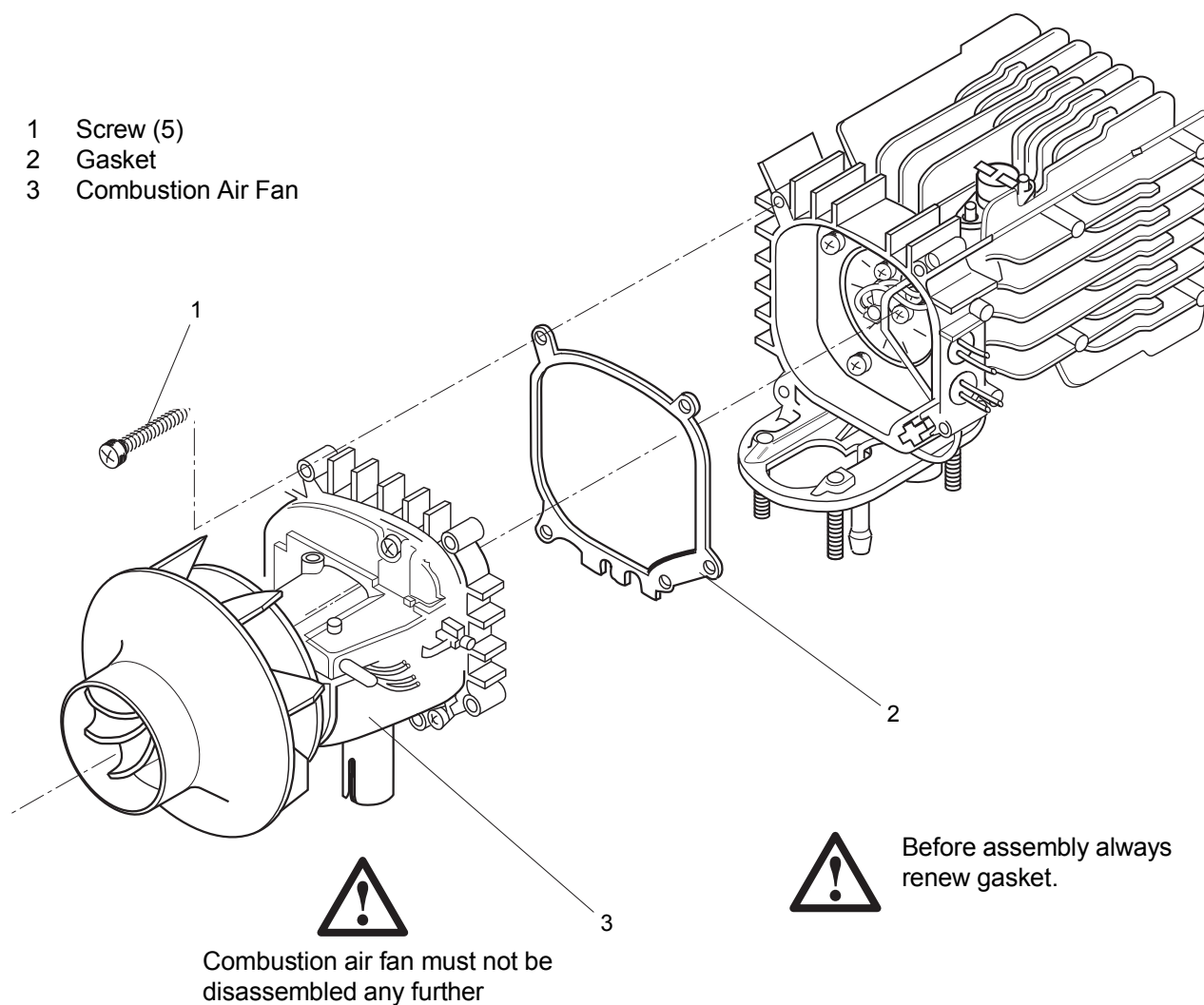


Fig. 904 Replacement of Combustion Air Fan (Assembly)

9.2.5 Replacement of Flame Sensor

9.2.5.1 Removal

1. Remove air heater (see 8.7.1.1).
2. Remove control unit (see 9.2.2.1).
3. Remove combustion air fan (see 9.2.4.1).
4. Remove screws (3, Fig. 905) and spoiler (2) for cable protection.
5. Push out cable grommet (10) towards inside.
6. Carefully bend up locking tab (4) and withdraw flame sensor (1) from burner insert (5).
7. Remove flame sensor.
8. Perform work on components after disassembly (see 9.1.1).

9.2.5.2 Installation

CAUTION

Route cable of flame sensor below fuel pipe.

1. Pass flame sensor (1, Fig. 905) below fuel pipe, feed connector through opening and push in cable grommet (10).
2. Feed cable with protection sleeve through locking tab and insert flame sensor (1) into burner insert (5).
3. Squeeze locking tab (4).
4. Secure burner insert (5) with four screws (3) and fit spoiler (2) for cable protection.
5. Pull cable of flame sensor tight.
6. Torque all 4 screws (3) to 6 ± 0.6 Nm.
7. Mount combustion air fan (see 9.2.4.2).
8. Install control unit (see 9.2.2.2).
9. Install air heater (see 8.7.1.2).

9.2.6 Replacement of Glow Plug

9.2.6.1 Removal

1. Remove air heater (see 8.7.1.1).
2. Remove control unit (see 9.2.2.1).
3. Remove combustion air fan (see 9.2.4.1).
4. Push out cable grommets (9 and 10, Fig. 905) towards inside.
5. Remove four screws (3) and spoiler (2).
6. Tilt and withdraw burner insert (5) carefully.

NOTE

Ensure that burner insert (5) has separated from burner tube (6).

CAUTION

The glow plug has to be pulled out with utmost care and must under no circumstances be twisted (danger of breaking). After a long period of combustion operation the glow plug may be caked by fuel deposits. In this case allow penetrating oil to react long enough to free glow plug for removal.

7. Loosen screw (13) and remove glow plug (11) from burner insert.
8. Perform work on components after disassembly (see 9.1.1).

9.2.6.2 Installation

1. Insert new gasket (7, Fig. 905) into heat exchanger and place combustion tube (6) in assembly position.
2. Ensure that starting air bore is not clogged. If required clean with wire (approx. 1 mm $\varnothing$) (see Detail A).

CAUTION

During glow plug installation observe twist lock (see Detail B). That means that the glow has to be inserted so that the contacts point towards the heat exchanger. Otherwise there will be the danger of a short circuit.

3. Feed glow plug (11) into burner insert (5) and arrange cable protective sleeve in slot of burner insert.

CAUTION

When performing the following step ensure that glow plug is inserted in burner insert fully against stop.

4. Secure glow plug (11) with screw (13). Torque screw (13) to 0.5 Nm.
5. Locate burner insert (5) in heat exchanger (8) observing that cable of flame sensor is positioned below fuel pipe.
6. Feed connectors of glow plug and flame sensor through openings and push in cable grommets (9 and 10).

CAUTION

When performing the following step ensure that there is a tight fit between grommet (12) and heat exchanger (8).

7. Secure burner insert (5) using screws (3) and attach spoiler (2). Torque screws (3) to 4 Nm.
8. Mount combustion air fan (see 9.2.4.2).
9. Install control unit (see 9.2.2.2).
10. Install air heater (see 8.7.1.2).

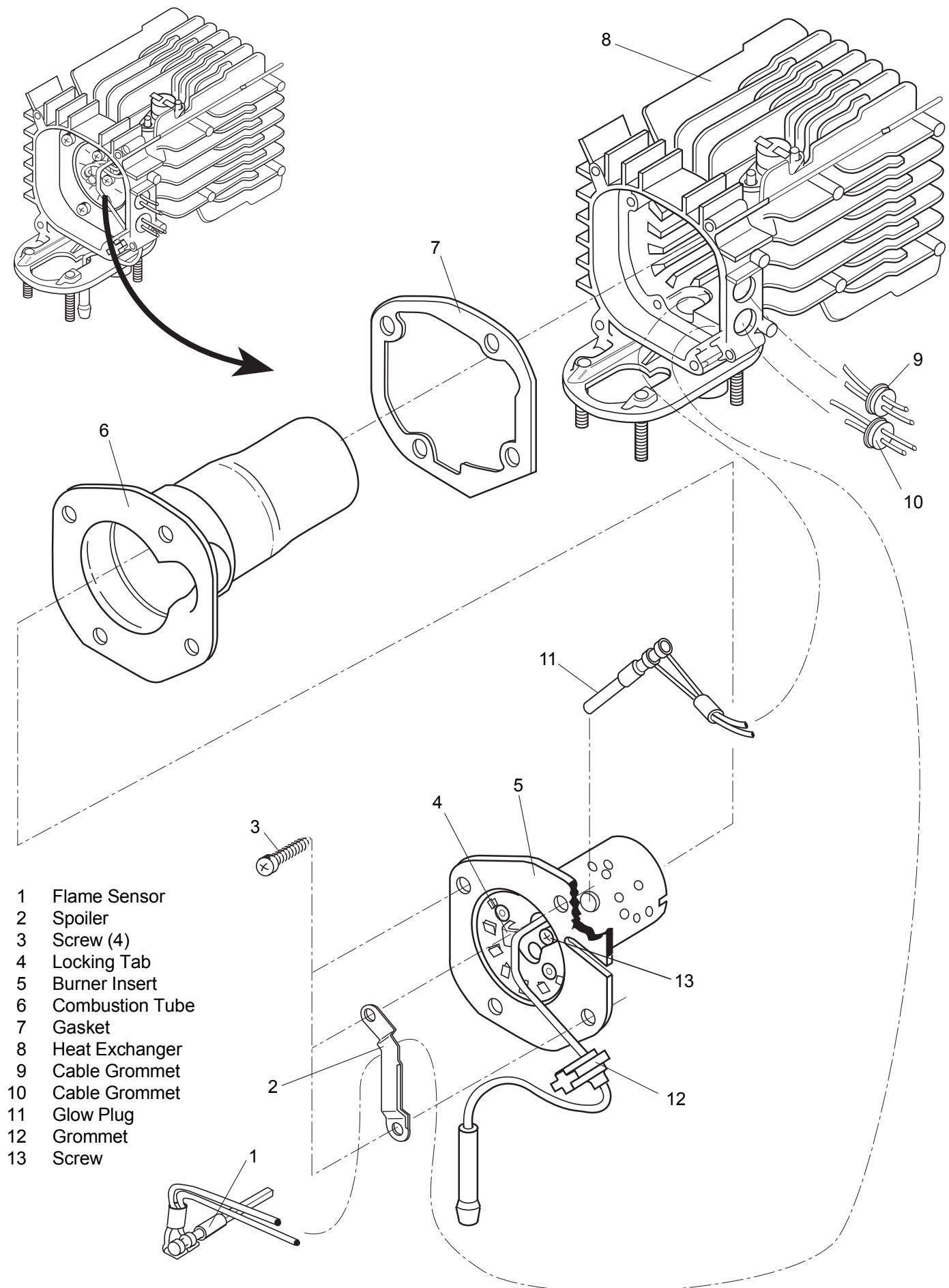


Fig. 905 Disassembly of Heat Exchanger (Sheet 1 of 2)

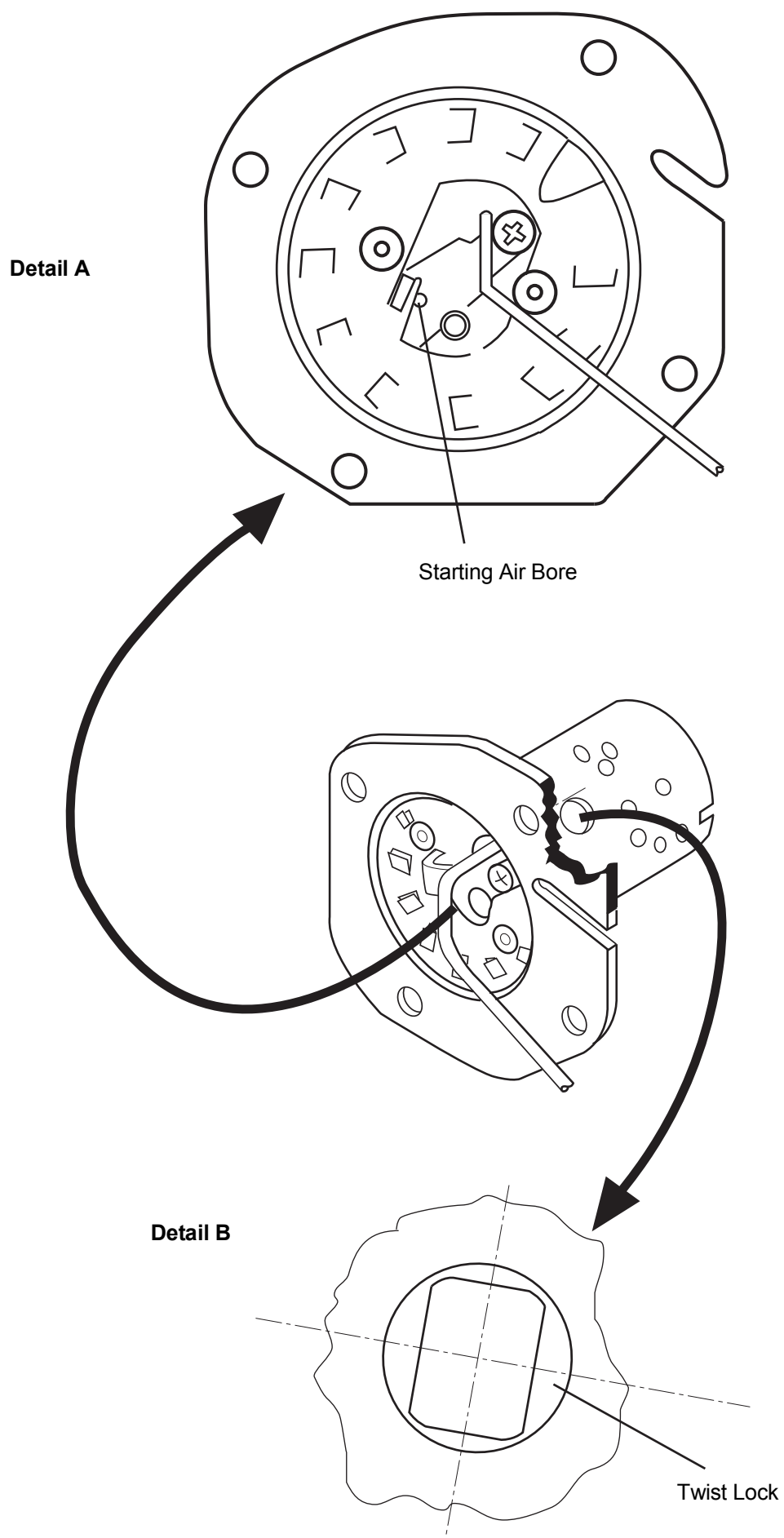


Fig. 906 Disassembly of Heat Exchanger (Sheet 2 of 2)

9.2.7 Replacement of Burner Insert, Combustion Tube, and Heat Exchanger

CAUTION

If the heat exchanger is going to be replaced, the temperature limiter must also be replaced.

9.2.7.1 Removal

1. Remove air heater (see 8.7.1.1).
2. Remove control unit (see 9.2.2.1).
3. Remove combustion air fan (see 9.2.4.1).
4. Remove flame sensor (see 9.2.5.1).
5. Remove glow plug (see 9.2.6.1).

CAUTION

When performing the following step ensure that fuel connection is not bent.

6. Remove burner insert (5, Fig. 905).
7. Withdraw combustion tube (6) from heat exchanger (8) and remove gasket.
8. Perform work on components after disassembly (see 9.1.1).

9.2.7.2 Installation

1. In case a new heat exchanger is fitted, secure temperature limiter (5, Fig. 902) with screws (4).
Torque screws to 1.5 ± 0.15 Nm.
2. Fit new gasket (7, Fig. 905).
3. Bring combustion tube (6) in assembly position.

NOTE

The burner insert will be secured when installing flame sensor and glow plug.

CAUTION

When performing the following step ensure that the fuel connection is not bent.

4. Install glow plug (see 9.2.6.2).
5. Install flame sensor (see 9.2.5.2).
6. Mount combustion air fan (see 9.2.4.2).
7. Install control unit (see 9.2.2.2).
8. Install air heater (see 8.7.1.2).

10. Packaging/Storage and Shipping

10.1 General

When it is necessary to ship the heater and its components to a Webasto repair center for inspection or repair, they are to be cleaned and packaged so that they are protected against damage during handling, transportation, and storage.

In storage an ambient temperature of +85 °C and -40 °C must not be exceeded.



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