

Coolant Heater

Thermo 90
Thermo 90 S

Workshop Manual

Table of Contents

1. Introduction

1.1 Scope and Purpose 1-1

1.2 Meaning of Warnings, Cautions and Notes 1-1

1.3 Additional Documentation to be used 1-1

1.4 General Safety Regulations and Information 1-1

 1.4.1 General Safety Notes 1-1

1.5 Corrections and Improvements 1-2

2. General Description

2.1 Combustion Air Fan 2-2

2.2 Heat Exchanger 2-2

2.3 Temperature Sensor 2-3

2.4 Temperature Limiter 2-3

2.5 Burner Insert 2-3

2.6 Glow Pin 2-3

2.7 Flame Sensor 2-3

2.8 Combustion Tube 2-3

2.9 Circulation Pump 2-3

2.10 Control Unit 2-3

2.11 Fuel Dosing Pump 2-3

3. Functional Description (Fig.3-1)

3.1 Switch-on 3-1

3.2 Heating Operation 3-1

3.3 Control Operation 3-1

3.4 Switch-off 3-1

3.5 Malfunctions 3-3

 3.5.1 Switch-off upon Failure 3-3

 3.5.2 Diagnosis after Switch-off upon Failure (Thermo 90) 3-3

 3.5.3 Diagnosis after Switch-off upon Failure (Thermo 90 S) 3-3

 3.5.4 Reading and Understanding the Flash Code 3-3

4. Technical Data (Standard Measure) 4-1

4. Technical Data (Metric Measure) 4-2

5. Troubleshooting

5.1 General 5-1

5.2 General Failure Symptoms 5-1

5.3 Failure Symptoms after Switch-off upon Failure 5-2

5.4 Storing a Fault Code in Memory 5-3

5.4.1	Reading and Removing Error Codes Stored in Memory using the PC Diagnostics Kit P.N. 92542C	5-3
5.5	Visual Inspection for Assessment of Burner Condition	5-4
5.5.1	Burner Housing	5-4
5.5.2	Rear Wall with Metal Evaporator	5-5
5.5.3	Combustion Chamber	5-5
5.5.4	Burner Assembly	5-5
6.	Functional Tests	
6.1	General	6-1
6.2	Adjustments	6-1
6.2.1	Adjustment of the CO ₂ Content	6-1
6.3	Components Testing	6-1
6.3.1	Temperature Sensor Resistance Check	6-1
6.3.2	Glow Pin Resistance Check	6-1
6.3.3	Flame Sensor Resistance Test	6-1
6.3.4	Combustion Air Fan Test	6-1
7.	Circuit Diagrams	
7.1	General	7-1
8.	Servicing	
8.1	General	8-1
8.2	Work on the Heater	8-1
8.3	Work on the Vehicle	8-1
8.4	Heater Test Run	8-1
8.5	Annual Maintenance	8-1
8.6	Visual Inspections and Installation Regulations	8-3
8.6.1	Connection to the Vehicle's Cooling System	8-3
8.6.2	Connection to the Vehicle's Fuel System	8-3
8.6.2.1	Fuel Tapping	8-4
8.6.2.2	Fuel Lines	8-5
8.6.3	Fuel Dosing Pump	8-5
8.6.3.1	Installation Location	8-5
8.6.3.2	Installation and Attachment	8-6
8.6.4	Fuel Filter	8-6
8.6.5	Combustion Air Supply	8-6
8.6.6	Exhaust Line	8-6
8.7	Removal and Installation	8-7
8.7.1	Heater, Removal and Installation	8-7
8.7.1.1	Removal	8-7

8.7.1.2	Installation	8-7
8.7.2	Replacement of Circulation Pump	8-7
8.7.3	Replacement of Temperature Limiter	8-7
8.7.4	Replacement of Temperature Sensor	8-7
8.7.5	Replacement of Combustion Air Fan	8-7
8.8	First Operation	8-7
9.	Repair	
9.1	General	9-1
9.1.1	Work on Components after Disassembly	9-1
9.1.1.1	Cleaning	9-1
9.1.1.2	Visual Inspection	9-1
9.2	Disassembly and Assembly	9-2
9.2.1	Electrical Connections (Fig. 9-1)	9-2
9.2.1.1	Disconnecting Electrical Connections (Connection X1)	9-2
9.2.1.2	Making Electrical Connections	9-2
9.2.2	Replacement of Circulation Pump	9-3
9.2.2.1	Removal	9-3
9.2.2.2	Installation	9-3
9.2.3	Replacement of Temperature Limiter	9-4
9.2.3.1	Removal	9-4
9.2.3.2	Installation	9-4
9.2.4	Replacement of Temperature Sensor	9-4
9.2.4.1	Removal	9-4
9.2.4.2	Installation	9-4
9.2.5	Replacement of Combustion Air Fan	9-6
9.2.5.1	Removal	9-6
9.2.5.2	Installation	9-6
9.2.6	Replacement of Burner, Flame Sensor and Glow Pin	9-7
9.2.6.1	Removal	9-7
9.2.6.2	Installation	9-7
9.2.7	Replacement of Burner Head	9-9
9.2.7.1	Removal	9-9
9.2.7.2	Installation	9-9
9.2.8	Replacement of Heat Exchanger	9-10
9.2.8.1	Removal	9-10
9.2.8.2	Installation	9-10

1. Introduction

1.1 Scope and Purpose

This repair shop manual is intended to support familiarized personnel in the repair of *Thermo 90* and *Thermo 90 S* coolant heaters.

The coolant heater may only be operated with the specified fuel (Diesel 1, Diesel 2, Arctic grade, Kerosene and certain military spec. fuels).

The coolant heater may only be operated within the specified operating voltage range designated by type.

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 heaters *Thermo 90* and *Thermo 90 S*.

The use of additional documentation is normally not necessary. Operating instructions/installation instructions and the vehicle specific installation guides (when available) may be used as complementary information if necessary.

1.4 General Safety Regulations and Information

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

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

The heater may only be installed in motor vehicles, or in independent heating systems, with a minimum coolant capacity of 6 litres (1.6 US Gal.).

The heater must not be installed in the passenger compartments of vehicles. Should the heater 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 60 °C (140 °F) in the installation box. Excessive temperatures may cause malfunctions.

⚠ WARNING

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

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

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

In the vicinity of the coolant heater, a temperature of 85 °C (185 °F) must not be exceeded under any circumstances (e.g. during body paint work). A violation of this temperature limit may cause permanent damage to the electronics.

When checking the coolant level, proceed in accordance with the vehicle manufacturer's instructions.

The coolant in the heating circuit of the heater must contain a minimum of 10% of a quality brand glycol based anti-freeze.

Ignoring the installation instructions and its procedures will void the warranty granted by Webasto. The same applies for repairs performed by unskilled, unauthorized personnel and repairs without using genuine Webasto spare parts. This will void the coolant heaters "Official Marks of Conformity."

Extracting combustion air from the vehicle interior is not permissible under any circumstance.

The exhaust line outlet is to be positioned below the vehicle floor, to the nearest possible location of the vehicle's or cockpit side or rear end. Exhaust pipes must be routed so that exhaust fumes will not penetrate into the vehicle's interior.

The function of any parts vital for vehicle operation must not be impaired. Condensation accumulation in the exhaust line must be directly drained. A condensation drain hole may be provided as required.

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, the following important regulations must be adhered to:

- Fuel lines are to be installed in such a way that they remain unaffected by torsional stresses created by vehicle and engine movement. They must be protected against mechanical damage. Fuel-carrying parts are to be protected against excessive heat and are to be installed 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 must not be located in the passenger area or in the driver's compartment. In these type of vehicles the fuel tanks must be located such that they do not pose a direct hazard to the exits in the event of a fire. Fuel supply must not be by means of gravity or pressurization of the fuel tank.
- Installation instructions for Webasto fuel tanks for the fuel supply of coolant heaters in vehicles:
In busses the installation is not permitted in the passenger or driver's compartment.
- The fuel filler neck must not be located in the passengers or driver's compartment of any vehicle.
- Fuel containers for gasoline fuel must not be located immediately behind the front paneling of the vehicle. They must be separate from the engine so that even in the case of accident the inflammation of fuel is unlikely to be expected.

This does not apply for towing vehicles with an open cockpit.

All fuel containers offered in the Webasto Accessories Catalog are suitable for a maximum operating pressure of 0.15 bar over-pressure.

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

- The fuel containers must either be equipped with a vent cap or be ventilated in another way (ventilation line). Only filler caps in accordance with DIN 73400 may be used.
- The operational state of the heater, i.e. an indication "on" or "off", must be clearly visible.

2. General Description

The Webasto Thermo 90 and 90 S coolant heater, in combination with the vehicle's own heating system, is used to:

- heat the cab, sleeper or interior areas of vehicles
- defog/defrost windshields
- preheat water cooled engines

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

The heater is designed around the Ferro-Tec Technology evaporator burner system and operates intermittently, controlled by the temperature sensor.

Dependent on the deviation of the current coolant temperature from the rated value of the temperature sensor, combustion performance is continuously controlled within a range from 1.8 to 7.6 kW (6,100 to 26,000 Btu/hr) for Diesel operated heaters and within 2.0 to 7.6 kW (6,800 to 26,000 Btu/hr) for gasoline operated coolant heaters. For an extremely high heating performance requirement (preheating) the maximum performance of 9.1 kW (31,000 Btu/hr) is available with

diesel operated coolant heaters for up to 2 hours after heater actuation.

The Webasto Thermo 90 and 90 S coolant heaters basically consist of:

- combustion air fan
- heat exchanger
- burner insert with combustion tube
- circulation pump

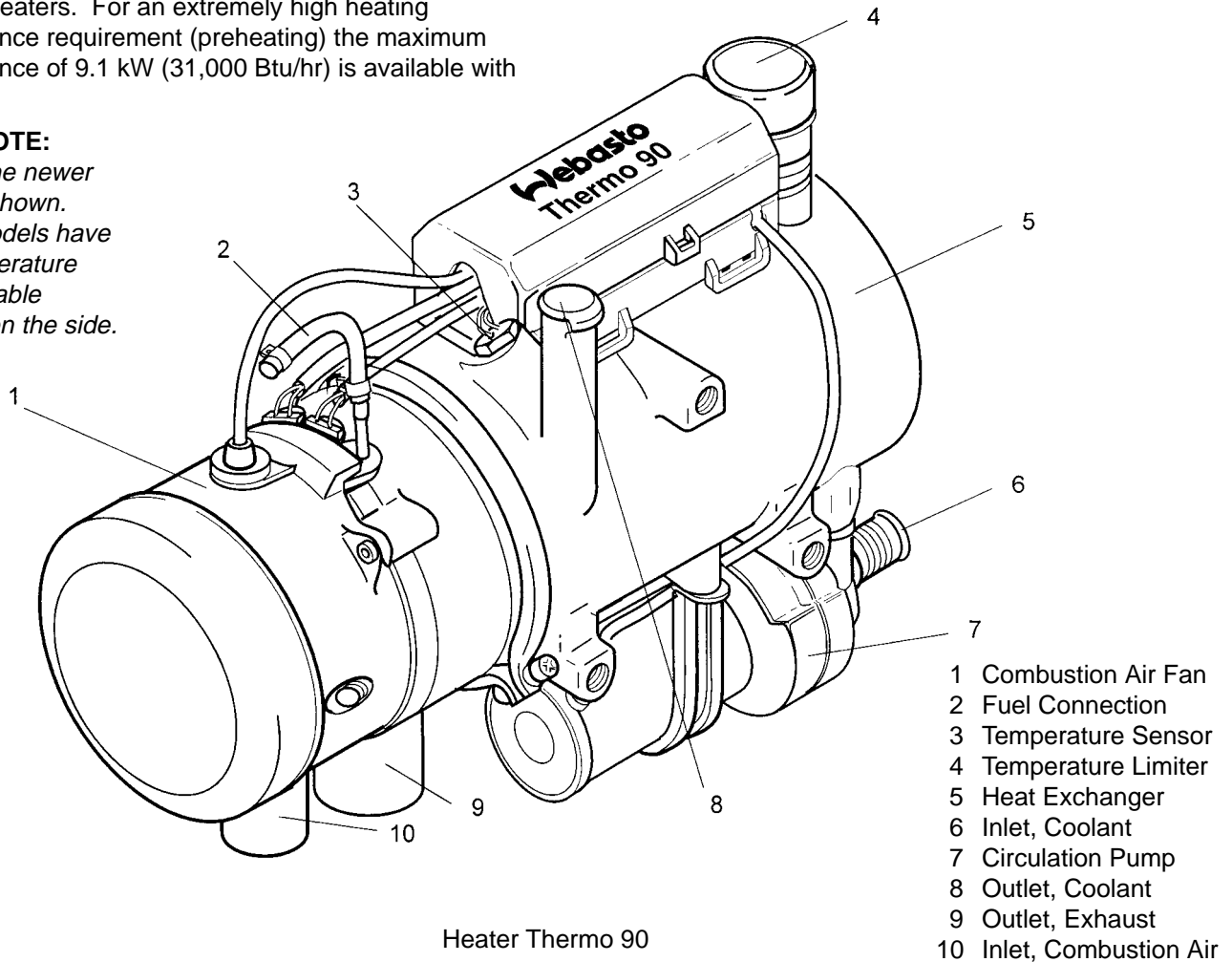
For control and monitoring, the following are located inside the heater unit:

- control unit (external)
- flame sensor
- glow pin
- temperature sensor
- temperature limiter

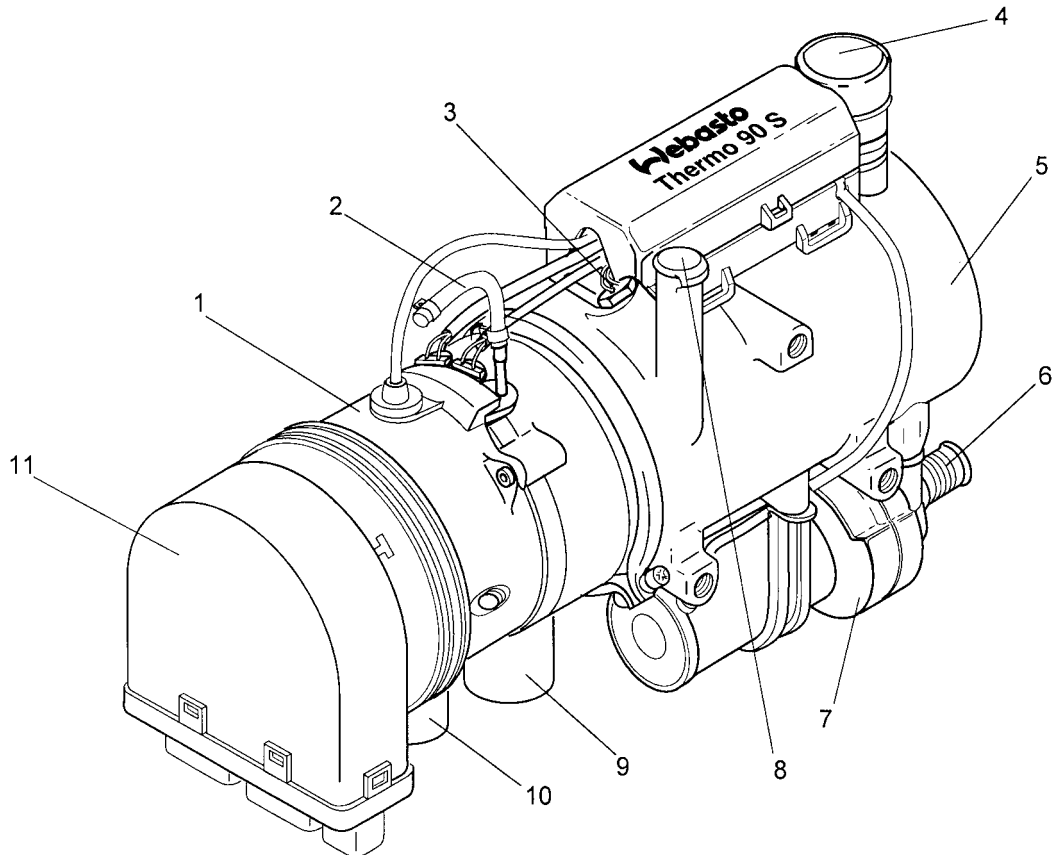
On the Thermo 90 S heater, the control unit is flanged to the combustion air fan. It is possible to remote mount the control unit using an optional mounting bracket.

NOTE:

One of the newer models shown. Older models have the temperature sensor cable located on the side.



Heater Thermo 90

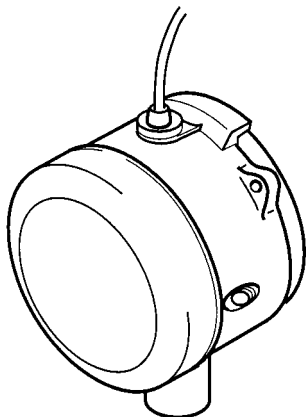


- 1 Combustion Air Fan
- 2 Fuel Connection
- 3 Temperature Sensor
- 4 Temperature Limiter
- 5 Heat Exchanger
- 6 Inlet, Coolant
- 7 Circulation Pump
- 8 Outlet, Coolant
- 9 Outlet, Exhaust
- 10 Inlet, Combustion Air
- 11 Control unit (may also be located remotely in the vehicle)

Heater Thermo 90 S

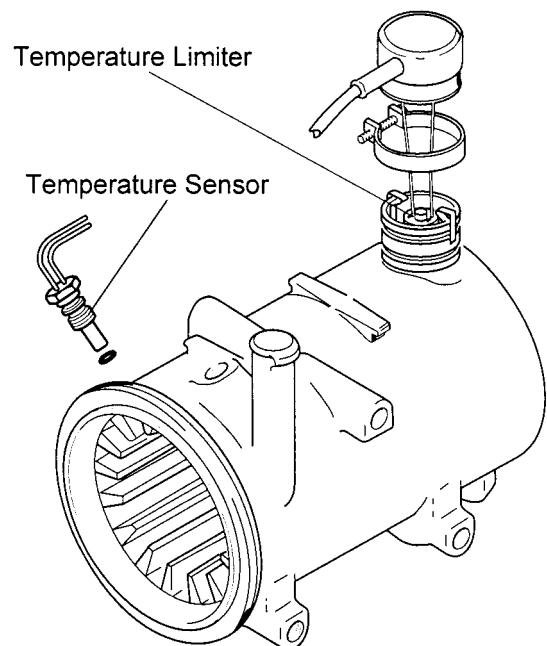
2.1 Combustion Air Fan

The combustion air fan delivers the air required for combustion from the combustion air inlet to the burner insert.



2.2 Heat Exchanger

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



2.3 Temperature Sensor

The temperature sensor senses the coolant temperature in the heat exchanger of the heater unit as electrical resistance. This signal is fed to the control unit for processing.

2.4 Temperature Limiter

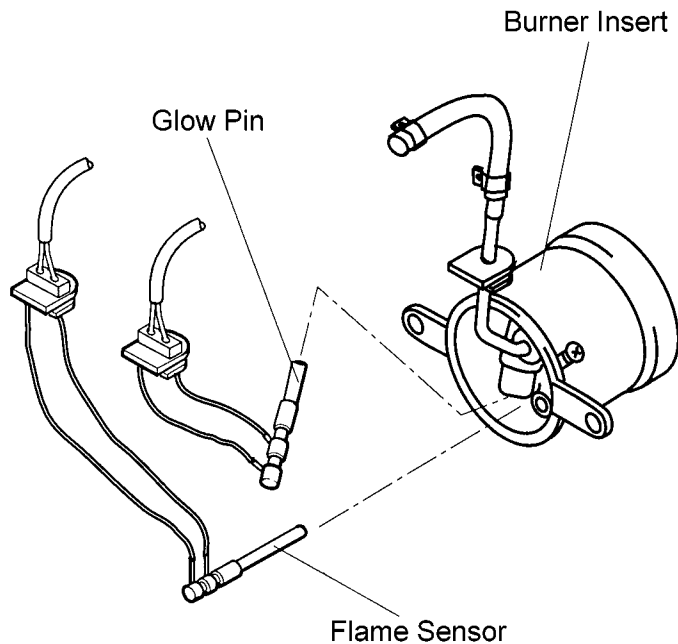
The overheat protection (bimetal) protects the heater unit from excessive operating temperatures. The overheat protection responds at a coolant temperature higher than 105 °C to switch off the heater.

2.5 Burner Insert

Within the burner insert, fuel is distributed in the combustion tube across the burner cross-section.

2.6 Glow Pin

The glow pin ignites the fuel/air mixture at the start of heater operation. The glow pin is acting as an electrical resistor and is located in the burner insert opposite the flame source.

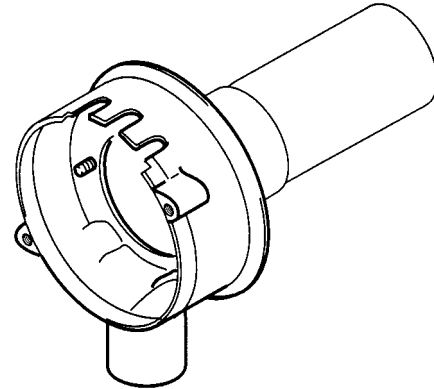


2.7 Flame Sensor

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.

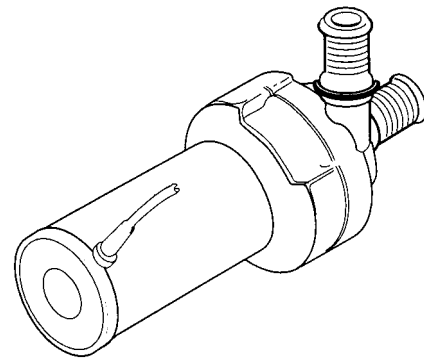
2.8 Combustion Tube

Inside the combustion tube the combustion of the fuel/air mixture takes place, heating up the heat exchanger.



2.9 Circulation Pump

The circulation pump provides for circulation of the coolant in the vehicle and heater circuits. The control unit switches the pump on for operation throughout the entire time of heater operation (also in control idle).



2.10 Control Unit

The control unit is the central controlling device for functional sequencing and monitoring of the combustion operation. It is mounted to the heat exchanger on Thermo 90 heaters and flanged to the combustion air fan on Thermo 90 S heaters.

2.11 Fuel Dosing Pump

Fuel supply to the heater and its dosing is ensured externally by a fuel dosing pump. When the heater is deactivated, it also serves as a shut-off valve. The magnetic coil of the dosing pump receives the pulses from the microprocessor of the control unit.

3. Functional Description (Fig. 3-1)

3.1 Switch-on

When operating the push button "Immediate Heating", the "Operating Indicator" on the timer illuminates

or

by activation with the switch, the "Operating Indicator" integrated in the switch illuminates.

Circulation pump, glow pin, and combustion air fan are put into operation.

3.2 Heating Operation

After approx. 50 seconds, combustion commences with the automatically controlled heating operation in full load for a maximum of 2 hours.

The vehicle's own heating blower starts to operate only after the heat carrier (coolant) has accumulated enough heat. After reaching the pre-coded rated temperature (see table Control Temperatures) heating performance, precision control will take over in stages down to the lowest part load operation.

3.3 Control Operation

If the coolant temperature rises up to the control idle threshold, the heater enters the control idle phase. The circulation pump, the vehicle's own blower, and the operating indicator remain in operation during the control idle period.

After the coolant has cooled down to the pre-coded reactivation temperature, the heater resumes operation.

Diesel Operated Coolant heaters

If the coolant heater's coolant temperature is above the rated temperature but has not yet reached the threshold for control idle, with the temperature dropping within 10 minutes back to rated temperature (after reaching it for the first time), the coolant heater reverts to the 9.1 kW (31,000 Btu/hr) heating stage. Should the rated temperature be obtained after 10 minutes, there will be an automatic reactivation to a maximum performance output of 7.6 kW (26,000 Btu/hr).

Gasoline Operated Coolant Heaters

The maximum heating performance of gasoline operated coolant heaters is always 7.6 kW (26,000 Btu/hr).

3.4 Switch-off

When switching the heater off, the operation indicator on the timer/switch extinguishes. Combustion ends and the run-down cycle is initiated. The circulation pump and combustion air fan, however, continue operation to cool down the heater (run-down) and are automatically deactivated after about 90 seconds. A reactivation of the heater during run-down is permitted.

Room temperature control by means of the vehicle's own heating blower may be provided in addition to employing a room thermostat.

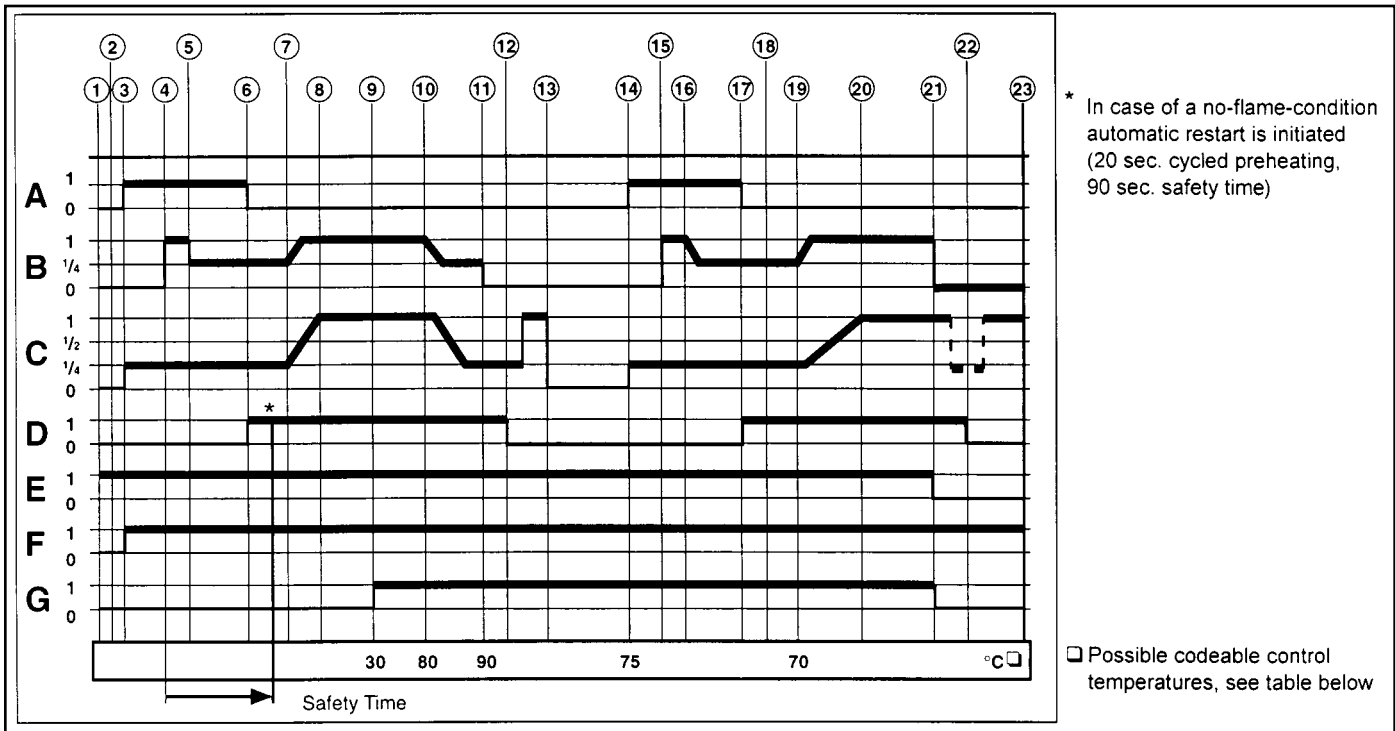


Fig. 3-1 Functional Sequence

Functional Sequence for Thermo 90/90 S

- ① Switch-on
- ② Configuration Check
- ③ Preheating 40 sec. (cycled)
- ④ Fuel Dosing Pump Priming 5 - 7 sec. (1)
- ⑤ Fuel Dosing Pump / Part Load (1/4)
- ⑥ Flame Sensor Take-over
- ⑦ Stabilization Period
- ⑧ Full Load
- ⑨ Vehicle Blower 'On' (optional)
- ⑩ Control Range
- ⑪ Control Idle
- ⑫ Flame Sensor 'cold' (0)
- ⑬ Run-down completed
- ⑭ Preheating 15 - 20 sec. (cycled)
- ⑮ Fuel Dosing Pump Priming 5 - 7 sec. (1)
- ⑯ Fuel Dosing Pump / Part Load (1/4)
- ⑰ Flame Sensor Take-over
- ⑱ Stabilization Period
- ⑲ Coolant Temperature down
- ⑳ Full Load
- ㉑ Switch-off (run-down)
- ㉒ Flame Sensor 'cold' (0)
- ㉓ Run-down completed

- A Glow Pin
- B Fuel Dosing Pump
- C Combustion Air Fan
- D Flame Sensor
- E Operation Indicator Light
- F Circulation Pump
- G Vehicle Blower (optional)

Setting of Control Temperatures - Thermo 90

Table	Rated Temp. at Sensor	Control Idle	Reactivation after Control Idle
Minus to B6	80 °C	90 °C	75 °C
B6 not used	72 °C	82 °C	67 °C
Plus to B6	65 °C	75 °C	60 °C

On the enclosure and compact kits, B6 is connected to minus (-).

Setting of Control Temperatures - Thermo 90 S

Connection of a plus (+) or minus (-) signal to the control unit (connector X12, contact 7) will enable different threshold values.

Table	Rated Temp. at Sensor	Control Idle	Reactivation after Control Idle
Plus (+)	72 °C	82 °C	67 °C
Minus (-)	80 °C	90 °C	75 °C

On the enclosure and compact kits, connector X12, contact 7 is connected to minus (-).

NOTE:

In the case of both heater models, the selected control idle temperature of the heater should be below the opening temperature of the engine thermostat.

3.5 Malfunctions

3.5.1 Switch-off upon Failure

In case of a no-flame condition, fuel is delivered for a maximum of 180 seconds.

In the event of a flame-out during operation, fuel is delivered for a maximum of 90 seconds.

Should an overheat condition exist (after response of the temperature limiter), no fuel will be delivered.

After switch-off by low voltage protection for more than 20 seconds, there will be no fuel delivery.

	Thermo 90	Thermo 90 S
12 Volt	10.5 ± 0.5 V	10.5 – 0.5 V
24 Volt	21 ± 1 V	21 – 1 V

After the correction of the fault, there will be an error lock-out. Reset by switch-off and reactivation of the heater.

In case of overheating, the temperature limiter has to be reset after the unit has cooled down.

⚠ CAUTION

To avoid damage to the component, do not attempt to reset the temperature limiter by force while hot.

3.5.2 Diagnosis after Switch-off upon Failure (Thermo 90)

When operated with switch or digital timer, the type of error lock-out condition is indicated by an operation indicator light flash code while the heater is in run-down.

After five short signals the following long flash pulses are counted:

- 1x No start (after 2 start attempts)
- 2x Flame-out during operation (repeated > 5)
- 3x Voltage too low
- 4x Premature flame detection
- 5x Flame sensor open or short circuit
- 6x Temperature sensor open or short circuit
- 7x Fuel Dosing pump open or short circuit or Temperature limiter tripped (overheating)
- 8x Fan motor open or short circuit or wrong speed of fan motor
- 9x Glow pin open or short circuit

3.5.3 Diagnosis after Switch-off upon Failure (Thermo 90 S)

When equipped with a standard timer model 1531, an error code will be indicated on the timer display:

- F 01 No start (after 2 start attempts)
- F 02 Flame-out during operation (repeated > 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 Fuel Dosing pump open or short circuit
- F 08 Fan motor open or short circuit or wrong speed of fan motor
- F 09 Glow pin open or short circuit
- F 10 Overheating
- F 11 Circulation pump open or short circuit

When operated with a switch, the type of error lock-out condition is indicated by an operation indicator light flash code while the heater is in run-down.

After five short signals the following long flash pulses are counted:

- 1x No start (after 2 start attempts)
- 2x Flame-out during operation (repeated > 5)
- 3x Voltage too low or too high
- 4x Premature flame detection
- 5x Flame sensor open or short circuit
- 6x Temperature sensor open or short circuit
- 7x Fuel Dosing pump open or short circuit
- 8x Fan motor open or short circuit or wrong speed of fan motor
- 9x Glow pin open or short circuit
- 10x Overheating
- 11x Circulation pump open or short circuit

3.5.4 Reading and Understanding the Flash Code

The five short flashes are only an indication that an error code has been registered and not to be counted. Count only the long flash pulses following the five short flashes to obtain the correct code.

Example (x = 1 Flash)
 Error code 7x would appear as this:
 xxxxx ... X ... X ... X ... X ... X ... X ... X

The sequence will repeat until the heater completes the run-down cycle and switches off after which the error code will be stored in the control unit memory. See section 5. "Troubleshooting" for further information.

4. Technical Data (Standard Measure) Electrical Components:

As long as no threshold values are given, the following technical data is understood to include tolerances of ±10% usual for heaters at an ambient temperature of +68 °F and at nominal voltage and conditions.

Control unit, combustion air fan motor and fuel dosing pump, glow pin, control switch and timer are either of the 12V or 24V type.
The components temperature limiter, temperature sensor and flame sensor are identical in the 12V and 24V units.

Coolant Heater	Operation	Thermo 90 / 90 S	
		Gasoline	Diesel
Type		BW 80	DW 80
Mark of conformity		- S231	- S232
Heater type		Coolant heater with Ferro-Tec Technology	
Heat output	Maximum Control range	6,800 - 26,000 Btu/hr	31,000 Btu/hr 6,100 - 26,000 Btu/hr
Type of fuel		Gasoline	Diesel #1, #2 and Arctic
Fuel consumption (US gallon)	Maximum Control range	0.06 - 0.26 gal/hr	0.28 gal/hr 0.05 - 0.24 gal/hr
Rated voltage		12 Volt	12 or 24 Volt
Operating voltage range		10 ... 15 Volt	10 ... 15 or 20 ... 30 Volt
Rated power consumption with circulation pump (without vehicle blower)	Maximum Control range	37 - 83 W	90 W 37 - 83 W
Permitted ambient temperature: Heater: -operation -storage Control unit: -operation -storage Fuel dosing pump: -operation -storage			-40° ... +230 °F -40° ... +266 °F -40° ... +167 °F -40° ... +185 °F -40° ... +68 °F -40° ... +104 °F -40° ... +185 °F
Permitted over-pressure (heat exchanger)	Maximum	29 psi.	
Heat exchanger capacity		0.04 US gal.	
Maximum combustion air intake temperature		+104 °F	
Coolant circuit minimum capacity		1.6 US gal.	
Volume flow of circulation pump against 2.0 psi.		7.25 US gal/min.	
CO2 in exhaust (permissible operating range)		10 ... 12.0 Vol.-%	
CO2-setting values at approx. +68 °F and geographical height above SL		0 ft. 10%	1640 ft. 10.6% 3280 ft. 11.3%
Dimensions of heater (Tolerance ± 0.11 in.)		Length 12.2 in. (14.0 in.) ¹⁾ Width 05.24 in. Height 08.66 in.	
Weight		10.5 lb	

¹⁾ Thermo 90 S with control unit mounted on heater

4. Technical Data (Metric Measure)

Electrical Components:

As long as no threshold values are given, the following technical data is understood to include tolerances of ±10% usual for heaters at an ambient temperature of +20 °C and at nominal voltage and conditions.

Control unit, combustion air fan motor and fuel dosing pump, glow pin, control switch and timer are either of the 12V or 24V type.
The components temperature limiter, temperature sensor and flame sensor are identical in the 12V and 24V units.

Coolant Heater	Operation	Thermo 90 / 90 S	
		Gasoline	Diesel
Type		BW 80	DW 80
Mark of conformity		- S231	- S232
Heater type		Coolant heater with Ferro-Tec Technology	
Heat output	Maximum Control range	2.0 kW - 7.6 kW	9.1 kW 1.8 kW - 7.6 kW
Type of fuel		Gasoline	Diesel #1, #2 and Arctic
Fuel consumption	Maximum Control range	0.25 l/h - 1.0 l/h	1.1 l/h 0.19 l/h - 0.9 l/h
Rated voltage		12 Volt	12 or 24 Volt
Operating voltage range		10 ... 15 Volt	10 ... 15 or 20 ... 30 Volt
Rated power consumption with circulation pump (without vehicle blower)	Maximum Control range	37 W - 83 W	90 W 37 W - 83 W
Permitted ambient temperature: Heater: -operation -storage Control unit: -operation -storage Fuel dosing pump: -operation -storage		-40° ... +110 °C -40° ... +130 °C -40° ... + 75 °C -40° ... + 85 °C -40° ... +20 °C -40° ... +40 °C -40° ... + 85 °C	
Permitted over-pressure (heat exchanger)	Maximum	2.0 bar	
Heat exchanger capacity		0.15 l	
Maximum combustion air intake temperature		+40 °C	
Coolant circuit minimum capacity		6.00 l	
Volume flow of circulation pump against 0.15 bar		1650 l/h	
CO2 in exhaust (permissible operating range)		10 ... 12.0 Vol.-%	
CO2-setting values at approx. +20 °C and geographical height above SL		0 m 10%	500 m 10.6% 1000 m 11.3%
Dimensions of heater (Tolerance ± 3 mm)		Length 310 mm (355 mm) ¹⁾ Width 133 mm Height 220 mm	
Weight		4.8 kg	

¹⁾ Thermo 90 S with control unit mounted on heater

5. Troubleshooting

5.1 General

This section describes troubleshooting procedures for the Thermo 90 and Thermo 90 S coolant heaters.

⚠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 defects are not included in the troubleshooting procedures. Before troubleshooting, check for and eliminate these defects:

- **fuel supply (plugged fuel filter or no fuel)**
- **corrosion on battery terminals**
- **blown fuses**
- **corrosion on electrical wiring and fuses**
- **corrosion on connectors**
- **loose contact on connectors**
- **wrong crimping on connectors**
- **shut-down initiated by temperature limiter**

After any correction of a failure a functional test has to be performed in the vehicle; before switching the heater off and on again.

5.2 General Failure Symptoms

The following table (Fig. 5-1) lists possible, general failure symptoms.

Failure Symptom	Probable Cause	Remedy
Heater switches off automatically	No combustion after start or repeat start	Control unit goes into error lock-out. Switch heater off and on again.
	Flame extinguishes during operation	If a no-heating condition persists contact your Webasto service agent.
	Heater overheats due to lack/loss of coolant	Replenish coolant. After cool-down of unit, push button of temperature limiter before reactivation or replace temperature limiter.
	Low voltage condition for more than 20 seconds	Check fuses, connections and charge state of battery.
	Switch-off caused by temperature limiter	After cool-down of unit, push button of temperature limiter before reactivation or replace temperature limiter.

Fig. 5-1 General Failure Symptoms

NOTE:

In many cases the probable cause of failure may be the burner. Perform a visual inspection according to 5.4.

5.3 Failure Symptoms after Switch-off upon Failure

The heater Thermo 90 S, with standard timer, outputs errors to the timer display for indication (see 3.6.3). The following table may also be used as representative reference.

NOTE:

When operated with a switch the type of failure is indicated by a flash code of the operation indicator light during heater run-down.

After five short signals the long flash pulses are counted.

Failure Symptom	Probable Cause	Remedy
No function	Electrical wiring, fuses Control unit defective	Check fuses Check battery connections + at A5 / – at A3 / + from A1 (Thermo 90) + at 12 / – at 9 / + at 3, connector X12 (Thermo 90 S) Replace control unit
1 Flash pulse (F 01) (no start)	Fuel system Combustion air/exhaust duct Burner	Check fuel level Check fuel filter Bleed fuel system Check combustion air/exhaust duct for foreign matter and clean as required Clean burner or replace as necessary
2 Flash pulses (F 02) (flame-out during operation)	Fuel supply Burner	Check fuel level Check fuel filter Bleed fuel system Clean burner or replace as necessary
3 Flash pulses (F 03) (low voltage)	Electrical power supply	Check battery (load test) Check electrical connections
4 Flashes (F 04) (flame sensor continuously hot)	Flame sensor defective	Replace flame sensor
5 Flash pulses (F 05) (flame sensor)	Wiring Flame sensor defective	Check wiring for damage, open connections or short circuit Replace flame sensor
6 Flash pulses (F 06) (temperature sensor)	Wiring Temperature sensor defective	Check wiring for damage, open connections or short circuit Replace temperature sensor
7 Flash pulses (F 07) (fuel metering pump) (temperature limiter)	Wiring Fuel metering pump defective Coolant circuit (Thermo 90 only)	Check wiring for damage, open connections or short circuit Replace fuel metering pump Check coolant level Bleed coolant circuit Reset temperature limiter

Fig. 5-2 Failure Symptoms after Switch-off upon Failure (Part 1 of 2)

Failure Symptom	Probable Cause	Remedy
8 Flash pulses (F 08) (combustion air fan)	Wiring Combustion air fan defective	Check wiring for damage, open connections or short circuit Replace replace combustion air fan
9 Flash pulses (F 09) (glow pin)	Wiring Glow pin defective	Check wiring for damage, open connections or short circuit Replace glow pin
10 Flash pulses (F 10) (temperature limiter Thermo 90 S only)	Coolant circuit Wiring	Check coolant level Bleed coolant circuit Reset temperature limiter Check wiring for damage, open connections or short circuit
11 Flash pulses (F 11) (coolant circulation pump Thermo 90 S only)	Wiring Coolant circulation pump defective	Check wiring for damage, open connections or short circuit Replace coolant circulation pump

Fig. 5-2 Failure Symptoms after Switch-off upon Failure (Part 2 of 2)

5.4 Storing a Fault Code in Memory

Once the Thermo 90 S completes the after run period (cool down) initiated by a failure event, the current flash code will be downloaded (stored) in memory.

The Thermo 90 S can store up to four error codes. Once the memory is “full”, any additional error code will replace the earliest code stored thereby continually updating the error codes stored in memory with the four most recent malfunctions.

5.4.1 Reading and Removing Error Codes Stored in Memory using the PC Diagnostics Kit P.N. 92542C

It is possible to read and remove (reset) stored error codes from the Thermo 90 and Thermo 90 S control unit memory.

This is achieved through the use of a diagnostic interface kit connected between the heater and an IBM compatible computer having the necessary software installed.

The PC Diagnostic Interface Kit comes complete with interface module and cables, software and instructions for use.

Order PC Diagnostics Kit under part number 92542C.

Several interface connection adapters are available for use with various heater models. For this reason, interface connection adapters are not included in the PC Diagnostics Kit.

Order the appropriate interface connector for the heater model(s) you will likely be working with.

For the Thermo 90, order adapter # 83661A
For the Thermo 90 S, order adapter # 92556A

In addition to working with stored fault codes, the PC Diagnostics Kit allows you to do several other functions such as reading values while the heater is in operation or testing individual components. Printing out of fault codes is also available (user supplied printer required).

For further capabilities and instructions for using the PC Diagnostics Kit, see the instruction manual included with the kit.

5.5 Visual Inspection for Assessment of Burner Condition

Burner and evaporator have specific features indicating their need for replacement or their serviceable condition. The following describes the criteria for a correct inspection.

5.5.1 Burner Housing

- The starting air bore (Fig. 5-3) must not be clogged, otherwise there will be no start.

Remedy

Carefully remove any contamination with a wire of 1.5 mm diameter. Remove glow pin first.

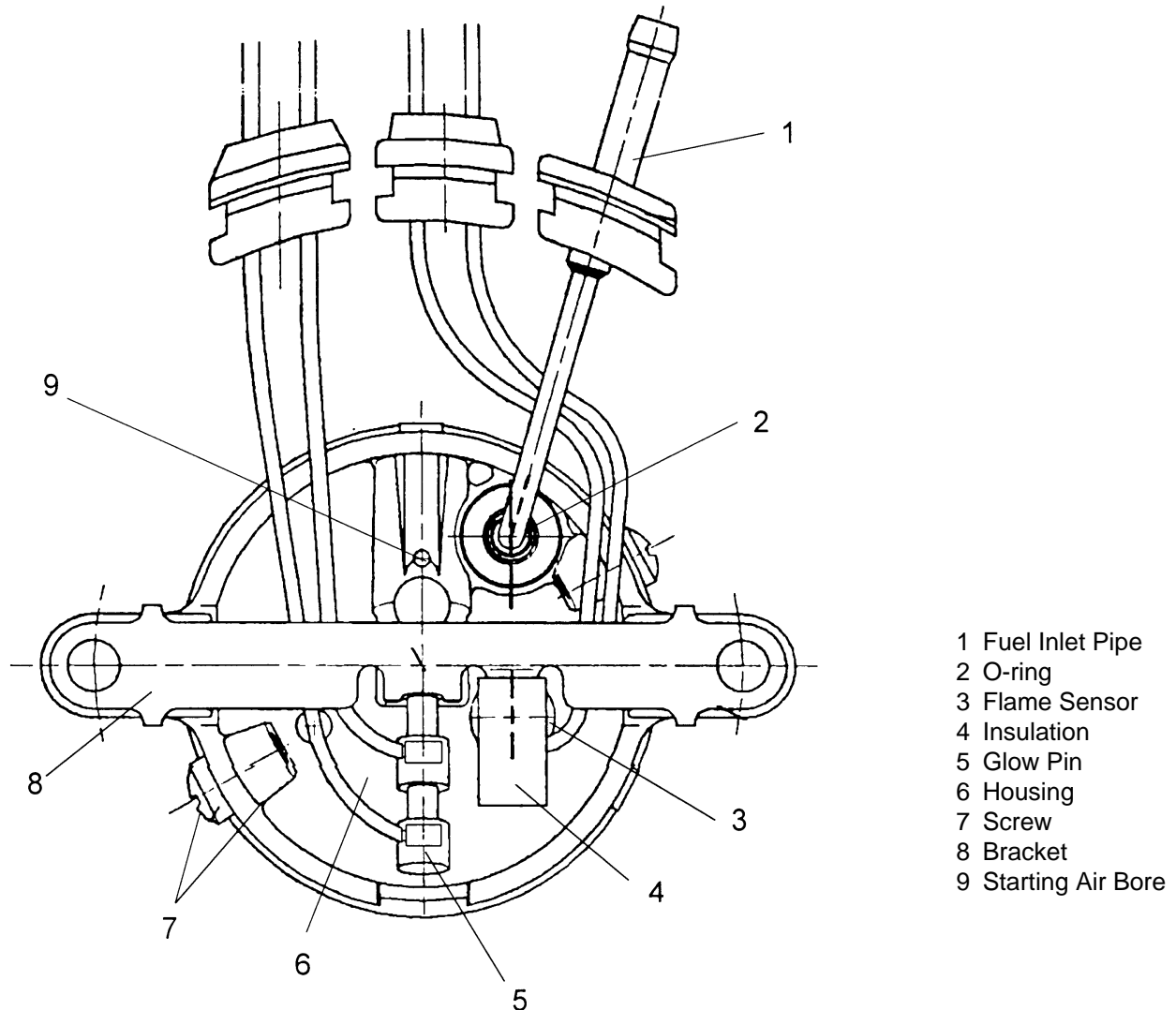


Fig. 5-3 Visual Inspection, Burner Rear Wall

5.5.2 Rear Wall with Metal Evaporator

- The pilot flame exit bore (Fig. 5-4) must not be clogged, otherwise there will be no start.

Remedy

Replace burner assembly

- Cracks, delaminations, as well as black or other discolorations of the evaporator do not cause a burner failure and are meaningless.
- Coke deposits on the evaporator surface (except for the pilot flame exit bore) are normal and must not be removed. When the load changes from full load to part load and vice versa the burner normally is self-cleaning.

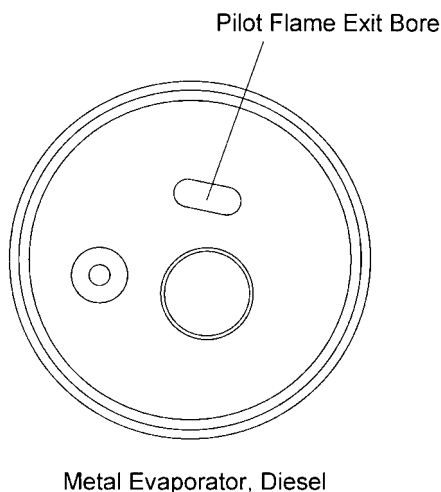
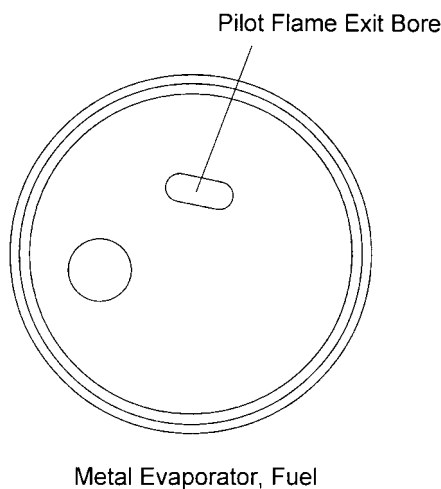


Fig. 5-4 Visual Inspection, Pilot Flame Exit Bore

5.5.3 Combustion Chamber

- The combustion chamber (Fig. 5-5) should not be damaged (e.g. dented). A combustion chamber with dents may cause insufficient combustion or coking of the heater.

Remedy

Replace burner assembly

- The air bores (Fig. 5-5) in the combustion chamber must not be coked. Coked air bores may cause a no-start or insufficient combustion.

Remedy

Removal of coke deposits by careful scraping.

5.5.4 Burner Assembly

- The cables of the glow pin and flame sensor must be routed as shown in Fig. 5-3.
- The screwed connection of the housing and combustion chamber must be secure (Fig 5-5).
- Housing and combustion chamber (Fig. 5-5) must be connected securely without any play (check by slight movement of fuel pipe).
- The O-ring must have a tight fit around the fuel chamber upper edge (Fig. 5-3) and must seal completely.
- The gap between housing edge and combustion chamber upper edge (Fig. 5-5) must be equal around the entire circumference.
- The insulation (4, Fig. 5-3) must be present.

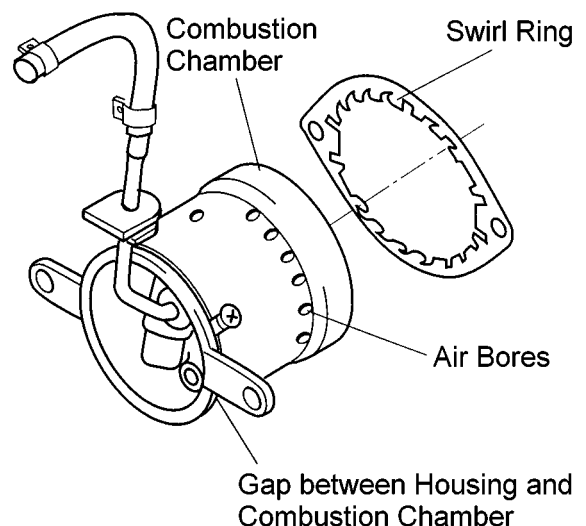


Fig. 5-5 Visual Inspection, Burner Assembly

6. Functional Tests

6.1 General

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

⚠WARNING

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

6.2 Adjustments

6.2.1 Adjustment of the CO₂ Content

A change of the combustion air volume set by the manufacturer may be performed by rotating the air set screw.

Setting Procedure

Clockwise rotation: CO₂ value decreases (prior to measurement; heater must have been in operation for at least 5 min).

Coarse setting: Rotate air set screw clockwise fully in and then back one turn.

6.3 Components Testing

6.3.1 Temperature Sensor Resistance Check

During electrical testing of the temperature sensor using a digital multi-meter, the following readings should be obtained:

Resistance at 25 °C (77 °F): 990 ... 1010 Ω
 Test current: < 1 mA

6.3.2 Glow Pin Resistance Test

During electrical testing of the glow pin using a digital multi-meter, the following readings should be obtained:

Glow pin:	12 Volt (red)	24 Volt (green)
Resistance at 25 °C:	0.324 ... 0.360	1.3 ... 1.44 Ω
(77 °F):		
Test current:	< 5 mA	< 5 mA

6.3.3 Flame Sensor Resistance Test

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

Cold Test:
 Resistance at 25 °C (77 °F): 2.6 ... 3.4 Ω
 Test current: < 5 mA

Hot test:
 Resistance at 800 - 1000 °C:
 (1472 - 1832 °F): 12 ... 15 Ω
 (ceramic rod red hot over a length of approx. 20 mm)
 Test current: < 5 mA

6.3.4 Combustion Air Fan Test

The motor speed check must be performed with the heater assembled and within the operating voltage range. During the test, check for grinding noises.

NOTE:

For the motor speed check, the fan cover must be removed. Prior to re-installation the gasket is to be replaced.

⚠CAUTION

Pay attention not to break off the locking cams, otherwise replace cover and gasket.

Speed in control range min. 1800 rpm (±9%)
 Speed in control range max. 6100 rpm (±9%)

In the event speed values are out of tolerance replace combustion air fan (see 9.2.5).

NOTE:

*On the Thermo 90 the function of the combustion air fan can be checked with the diagnostic computer or the components tester.
 On the Thermo 90 S, the check is performed by means of the PC heater diagnosis.*

7. Circuit Diagrams

7.1 General

The circuit diagrams (Fig. 7-2 and 7-4) show possible circuits of the Thermo 90 heater with:

- with standard switch and harness wiring using Deutsch connector and blower interlock wiring with Deutsch connector – North American enclosure & compact kits (see Fig. 7-2).
- with 7-Day 3-Program digital timer wiring without Deutsch connector – German version (see Fig. 7-4).

The circuit diagrams (Figs. 7-3 and 7-5) show possible circuits of the Thermo 90 S heater with:

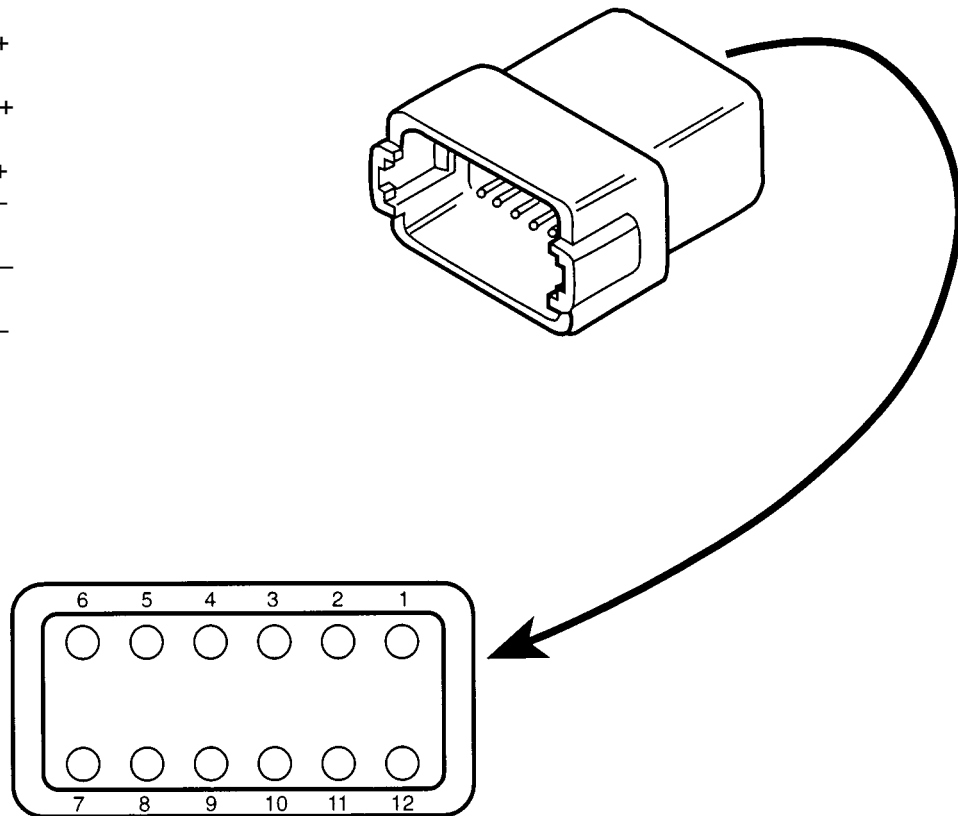
- with standard switch and harness wiring using Deutsch connector and blower interlock wiring with Deutsch connector – North American enclosure & compact kits (see Fig. 7-3).
- with 7-Day 3-Program digital timer wiring without Deutsch connector – German version (see Fig. 7-5).

Fig. 7-1 shows the pin assignment (X1) for Thermo 90 and Thermo 90 S heaters.

⚠ CAUTION

The – poles must not be looped or reversed as some components are controlled by negative polarity.

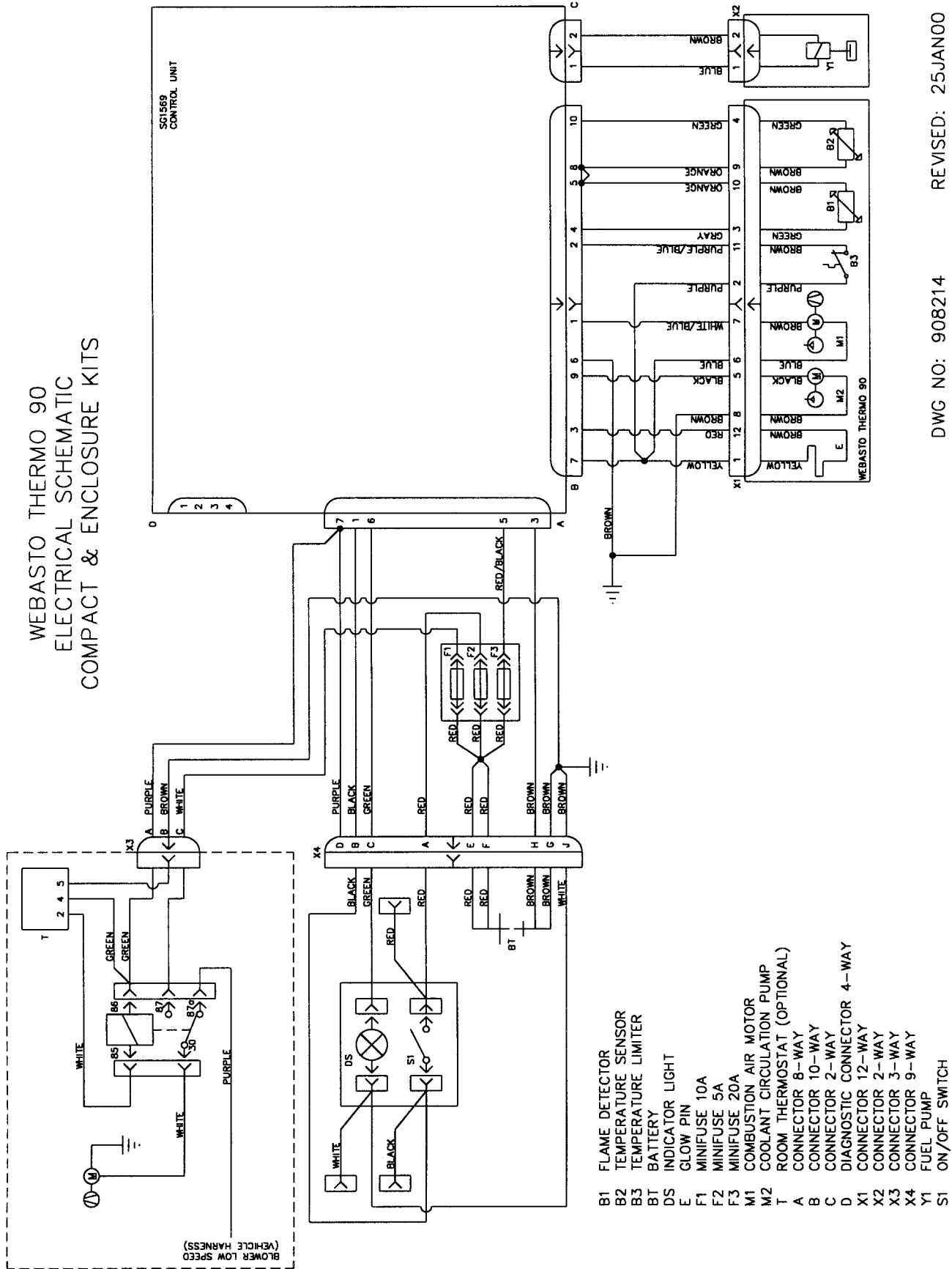
- 1 = Glow Pin +
- 2 = Temperature Limiter +
- 3 = Flame Sensor +
- 4 = Temperature Sensor +
- 5 = Circulation Pump +
- 6 = Combustion Air Fan +
- 7 = Combustion Air Fan –
- 8 = Circulation Pump –
- 9 = Temperature Sensor –
- 10 = Flame Sensor –
- 11 = Temperature Limiter –
- 12 = Glow Pin –



View from rear

Fig. 7-1 Visual Inspection, Burner Rear Wall

WEBASTO THERMO 90
ELECTRICAL SCHEMATIC
COMPACT & ENCLOSURE KITS



DWG NO: 908214 REVISED: 25JAN00

Fig. 7-2 Circuit Diagram – Thermo 90, 12 and 24 V Enclosure and Compact Kit with Deutsch Connector

WEBASTO THERMO 90 S
ELECTRICAL SCHEMATIC
B 8025-3000-0006

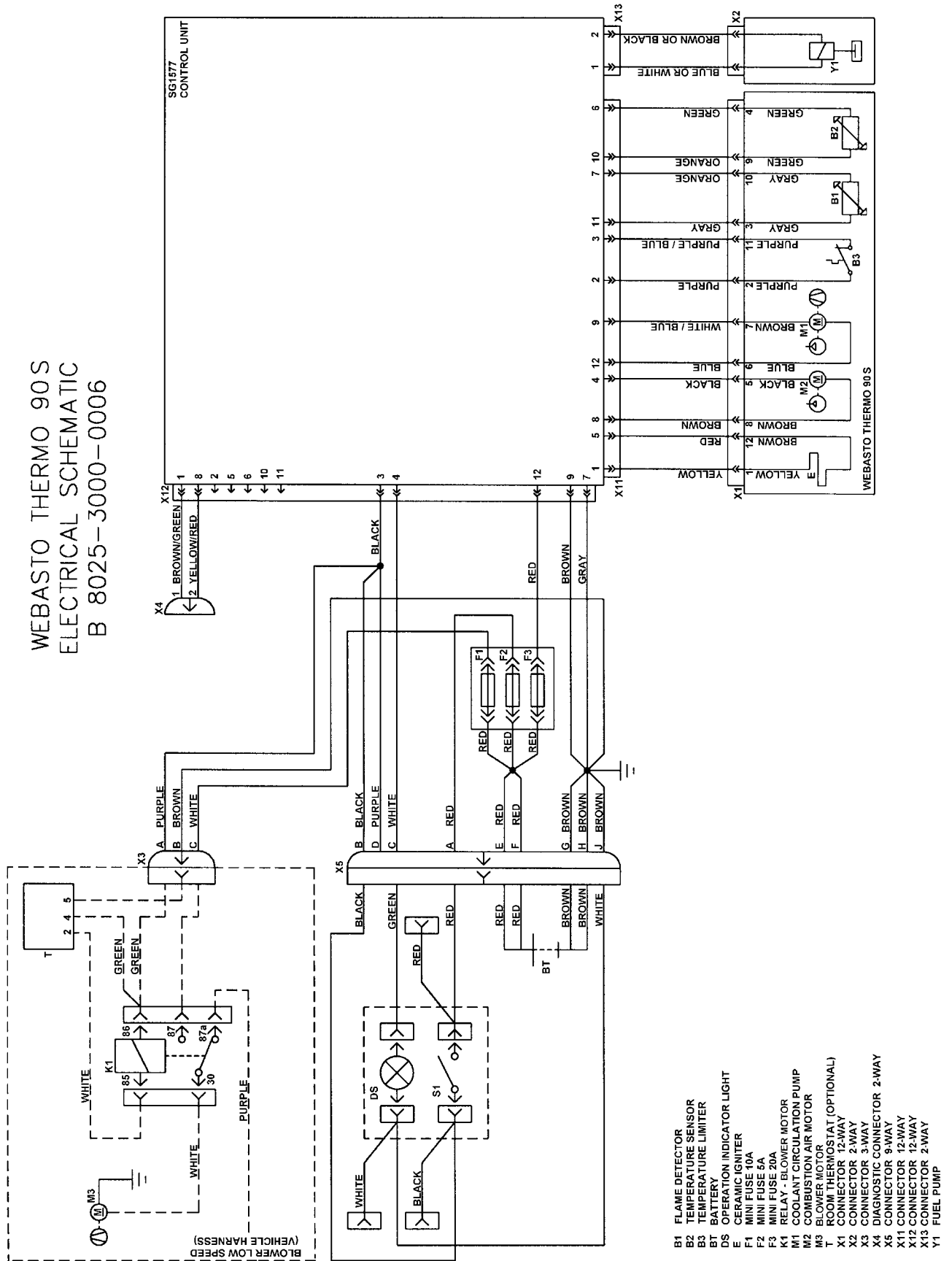
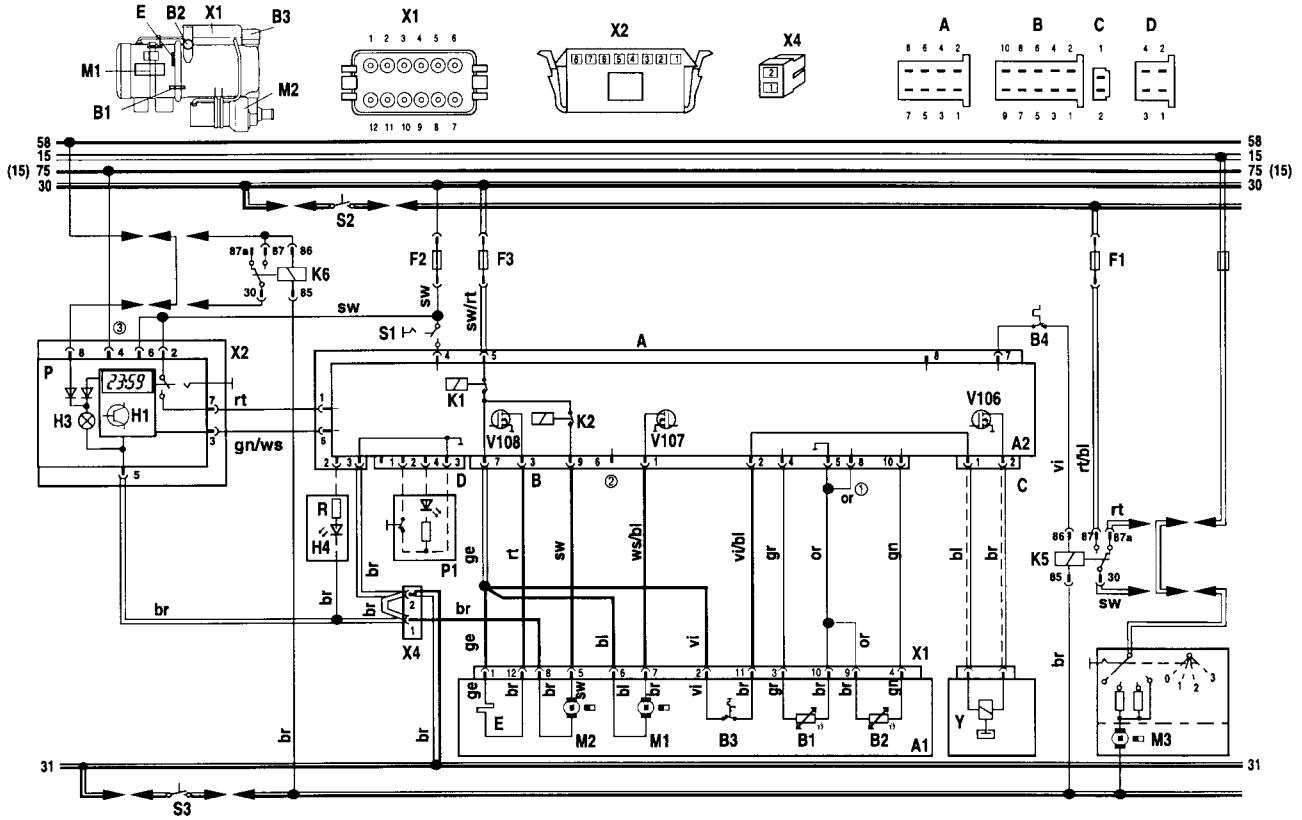


Fig. 7-3 Circuit Diagram – Thermo 90 S, 12 and 24 V Enclosure and Compact Kit with Deutsch Connector

Thermo 90 Basic Kit Wiring (German)



- ① For gasoline heaters remove this connection
- ② Temperature coding (temperature at water outlet): see table page 3-2
- ③ Timer P:
with plus at connection 4 = permanent operation in immediate heating
without plus at connection 4 = heating period 1 hour

	< 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

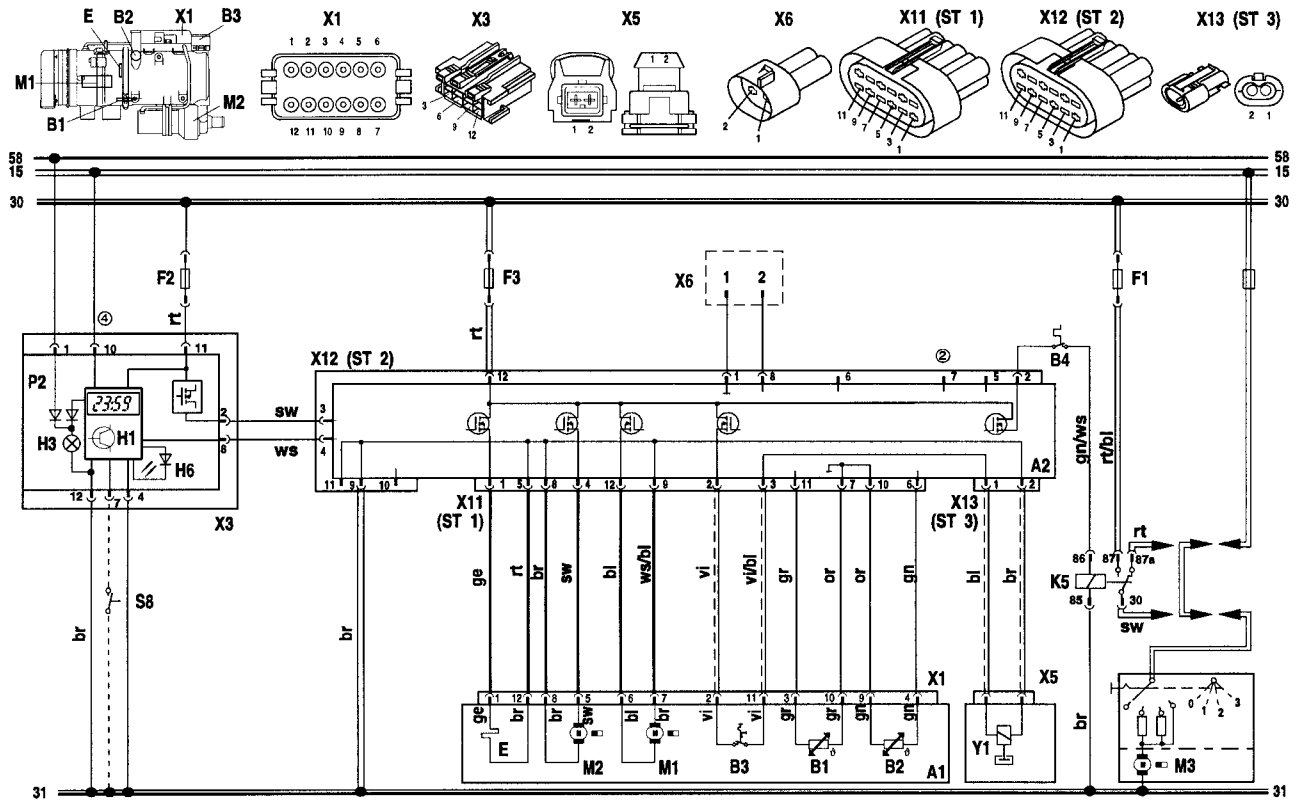
bl	blue
br	brown
ge	yellow
gn	green
gr	grey
or	orange
rt	red
sw	black
vi	violet
ws	white

Item	Nomenclature	Remark
A1	Heater	Thermo 90
A2	Control Unit	SG 1569
B1	Flame Sensor	
B2	Temperature Sensor	
B3	Temperature Limiter	
B4	Room Thermostat	
E	Glow Plug	
F1	Fuse 20A	Fiat Fuse SAE J 1284
F2	Fuse 5A	Fiat Fuse SAE J 1284
F3	Fuse 20A	Fiat Fuse SAE J 1284
H1	Symbol for "Heating" in Display	Operation Indication (in item P)
H3	Light	Symbol illumination (in item P)
H4	LED max. 20 mA	Flame indication
K1	Relay (in item A2)	Master relay
K2	Relay (in item A2)	For circulation pump
K5	Relay	For vehicle blower
K6	Relay	Only required for battery switch in minus
M1	Motor	Combustion air fan
M2	Motor	Circulation pump

Item	Nomenclature	Remark
M3	Motor	Vehicle blower
P1	Test Unit	For diagnosis
P	Timer	For pre-timed operation
R	Resistor	Resistor for H4
S1	Switch for Circulation Pump	For separate switch-on
S2	Switch	Battery switch in plus
S3	Switch	Battery switch in minus
V106	Transistor	in item A2
V107	Transistor	in item A2
V108	Transistor	in item A2
X1	Connection 12-pole	on item A1
X2	Connection 8-pole	on item P
X4	Connection 2-pole	
Y	Dosing pump	

Fig. 7-4 Circuit Diagram – Thermo 90, 12 and 24 V German Version with 7-Day 3-Program digital timer

Thermo 90 S Basic Kit Wiring (German)



- ② Temperature coding (temperature at water outlet): see table page 3-2
- ④ Timer P2:
with plus at connection 10 = permanent operation in instant heating
without plus at connection 10 = heating period programmable (10 min to 120 min); basic setting 120 min

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

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

Item	Nomenclature	Remark
A1	Heater	Thermo 90/Thermo 90 S
A2	Control Unit	
B1	Flame Sensor	
B2	Temperature Sensor	
B3	Temperature Limiter	
B4	Room Thermostat	
E	Glow Plug	
F1	Fuse 20A	Flat Fuse SAE J 1284
F2	Fuse 5A	Flat Fuse SAE J 1284
F3	Fuse 20A	Flat Fuse SAE J 1284
H1	Symbol for "Heating" in Display	Operation Indication (in item P1 or P2)
H3	Light	Symbol illumination (in item P1 or P2)
H6	LED red (in item P2)	Illumination instant heat switch, standby indication, on indication
K5	Relay	For vehicle blower
M1	Motor	Combustion air fan
M2	Motor	Circulation pump
M3	Motor	Vehicle blower
P2	Standard timer (1531)	for pre-timed operation

Item	Nomenclature	Remark
S8	Switch button	Instant heat switch remote control
X1	Connection 12-pole	on item A1
X3	Connection 12-pole	on item P2
X5	Connection 2-pole	
X6	Connection 2-pole	Diagnosis
X11	Connection 12-pole	on item A2 (ST 1)
X12	Connection 12-pole	on item A2 (ST 2)
X13	Connection 2-pole	on item A2 (ST 3)
Y1	Dosing pump	

Fig. 7-4 Circuit Diagram – Thermo 90 S, 12 and 24 V German Version with 7-Day 3-Program digital timer

8. Servicing

8.1 General

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

8.2 Work on the Heater

Prior to performing any work, it is mandatory to disconnect the vehicle battery main lead. As long as the heater is in operation or in run-down, the battery main supply must not be disconnected due to the danger of overheating and resulting in a response of the overheat protection. When performing extensive repairs on the heater, a complete removal is advisable. After work on the heating circuit, a coolant mixture consisting of water and anti-freeze must be replenished in accordance with manufacturer instructions followed by a careful bleeding of the heating circuit.

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 heater, a temperature of 130 °C (266 °F) must not be exceeded under any circumstances (e.g. during body paint work).

8.4 Heater Test Run

⚠WARNING

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

8.5 Annual Maintenance

Before or after each heating season the following maintenance procedures should be performed to maintain the heater's functional reliability:

Heater and Enclosure

- Clean heater exterior and interior of enclosure of any accumulated debris and dust with compressed air or water. Do not force water into electrical connections or into heater.

Electrical System

- Examine electrical connections for corrosion at connections and for security.
- Examine battery condition and clean terminals.
- Load test batteries and replace as necessary.

Combustion Air and Exhaust System

- Check exhaust and combustion air tubes for damage and for foreign matter and contamination. Repair or replace damaged items as necessary.

Fuel System

- Replace fuel filter P.N. 487171 if equipped.
- Examine fuel lines and fuel filter for leakage and damage. Repair or replace damaged items as necessary.

Coolant System

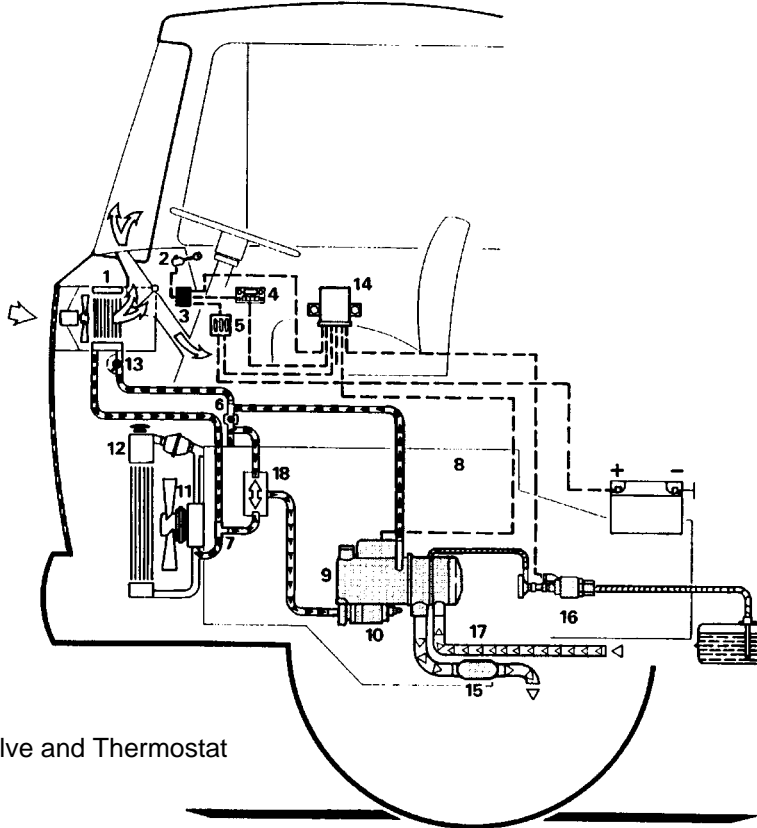
- Examine coolant circuit and circulation pump for leakage and damage.
- Examine hoses for abrasions and cracks.
- Check coolant level and anti-freeze strength. Refer to vehicle manufacturer's recommendations pertaining to coolant system maintenance.

Operational Test

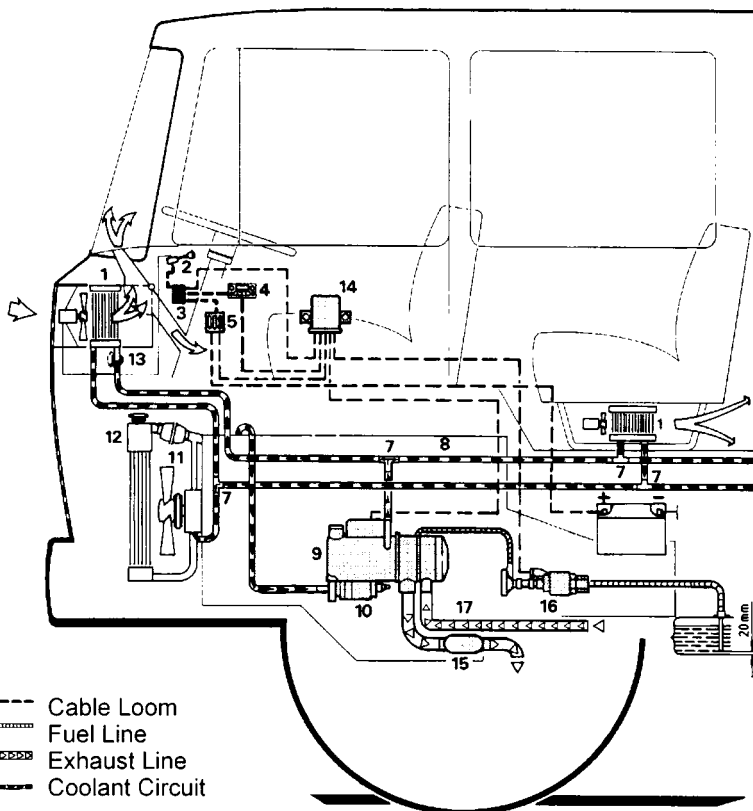
- Operate the Webasto heater for 15 minutes or more.
- Check coolant and fuel connections for leakage. Re-tighten clamps as necessary.
- Check sleeper blower operation by turning on the thermostat. Allow the fan to cycle on and off to ensure proper functioning.

NOTE:

The manufacturer mounts the control unit of Thermo 90 S heater to the combustion air fan.



With Check Valve and Thermostat



- 1 Heat Exchanger, Vehicle Heating System
- 2 Blower Switch, Vehicle Heating System
- 3 Relay for Vehicle System
- 4 Timer
- 5 Fuse Box in Vehicle
- 6 Check Valve with Drain Hole
- 7 T-Junction
- 8 Vehicle Engine
- 9 Heater Unit
- 10 Circulation Pump
- 11 Engine Coolant Pump
- 12 Radiator
- 13 Regulating Valve
- 14 Control Unit
- 15 Exhaust Muffler
- 16 Fuel Dosing Pump
- 17 Combustion Air Intake Line
- 18 Thermostat

- Cable Loom
- Fuel Line
- ▨ Exhaust Line
- Coolant Circuit

Without Check Valve

Fig. 8-1 Examples for Heater Installation

8.6 Visual Inspections and Installation Regulations

8.6.1 Connection to the Vehicle's Cooling System

In thermostat circuits only thermostats opening at < 65 °C (149 °F) are to be used.

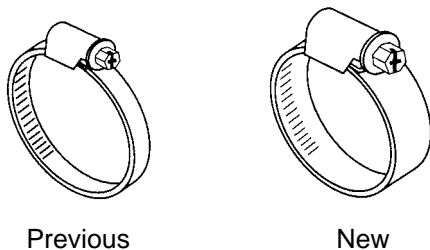
The installation of the heater should be in a location as low as possible to ensure static priming of the heater and circulation pump. This applies in particular for the circulation pump, which is not self-priming.

The heater is to be connected to the cooling system according to Fig. 8-1. The amount of coolant in the cooling system must be at least 6 litres (1.6 US gal.).

The coolant hoses used must meet the minimum requirements of DIN 73411. The hoses must be routed without kinking, and for proper priming where possible, in an upwards direction. Hose connections must be secured with hose clamps to prevent slippage.

NOTE:

Hose clamps must be torqued to 1.5 Nm (clamps previously in use) or to 5.0 Nm (new, wide clamps).



8.6.2 Connection to the Vehicle's Fuel System

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

Fuel lines must be of the type as described in section 8.6.2.2 of this manual.

The fuel system limitations are illustrated in Fig. 8-2.

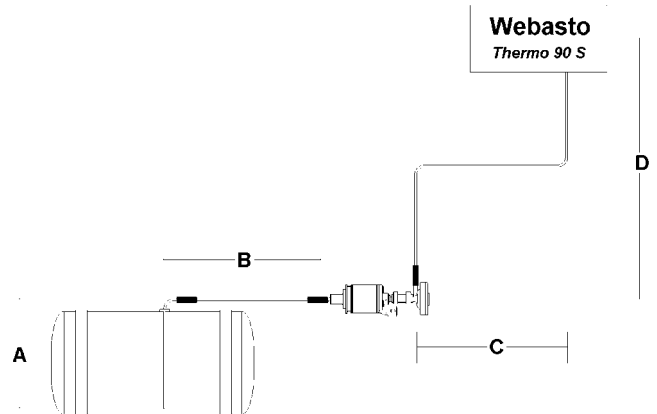


Fig. 8-2 Fuel Supply

- Maximum suction height (A) = 1 m (3' 3")
- Maximum suction length (A + B) = 2 m (6' 6")
- Maximum delivery length (C + D) = 6 m (19' 6")
- Maximum delivery height (D) = 3 m (9' 9")

Prior to first operation of the heater or after replacement of the coolant, bleed the cooling circuit.

Heater and lines have to be installed so that a static priming is guaranteed.

Insufficient priming during heating operation may cause failure due to overheating.

Proper priming is indicated by a circulation pump almost noiseless in operation. Insufficient priming during heating operation may cause the resettable temperature limiter to trip.

8.6.2.1 Fuel Tapping

Fuel tapping must be from the fuel reservoir or from a separate tank (Fig. 8-3). This separate fuel tapping avoids an influence on the pressure.

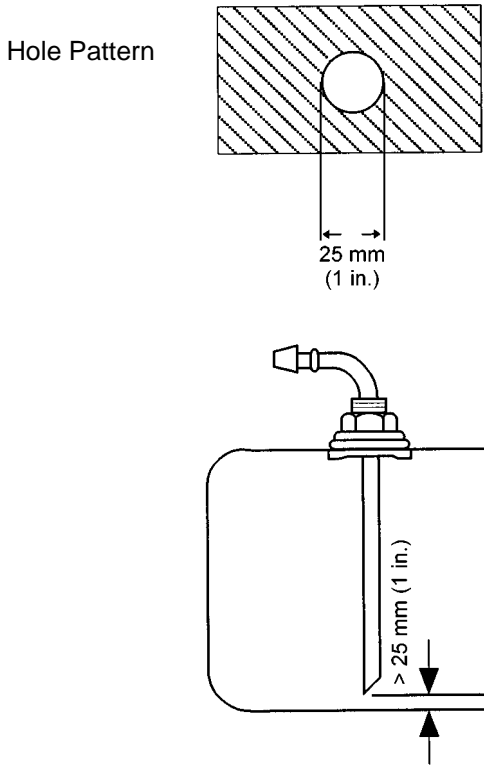


Fig. 8-3 Webasto Fuel Tank Tap*

* Use fuel tap only on metal fuel tanks

Vehicles with Gasoline Engines

In combination with carburetor equipped or fuel injected gasoline engines with a return line, the heater's fuel system integration must be in the return line.

Carburetor equipped gasoline engines without a return line must have the heater integrated in the fuel supply between the vehicle's fuel tank and fuel pump.

NOTE:

A fuel supply line can normally be identified by an installed fuel filter.

If an exhalation vessel is installed in the vehicle's fuel system, fuel tapping must be upstream of the exhalation vessel.

For fuel tapping from the supply or return line only the specific Webasto fuel tap "T", e.g. Ident. No. 470910 for 8 mm ID. may be used. The fuel tap must be mounted so that the air or gas bubbles can escape towards the fuel tank. Air or gas bubbles may build up in the vehicle fuel line in case of a leak in the vehicle's carburetor or fuel pump or when environmental temperatures are higher than the fuel evaporation temperature.

The fuel tap should not be located in the engine compartment because the radiation of engine heat may cause gas bubbles to build up in the fuel lines causing malfunctions in the combustion operation.

When installing the heater in vehicles with fuel injection systems, the fuel pumps location within or outside the fuel tank must be investigated first.

If the fuel pump is fitted inside the fuel tank, the fuel may be tapped only from the return line ensuring that the return line is routed almost to the tank floor. If this is not the case the fuel line may be lengthened.

In case of a fuel pump mounted externally to the tank, the fuel tap can be located between the fuel tank and the fuel pump.

8.6.2.2 Fuel lines

Fuel lines may only be steel, copper, or plastic lines made of unhardened, light and temperature stabilized PA 11 or Pa 12 (e.g. Mecanyl RWTL) according to DIN 73378.

As in most cases, if 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 (5/32 in.), air or gas bubbles accumulate resulting in malfunctions should the lines be descending or having sags.

The diameters specified above (2 mm) ensure a non-accumulation of air bubbles.

A descending line routing from the fuel 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 loosening with hose clamps.

Connection of 2 Pipes with Hose

The proper connection of fuel lines with hoses is shown in Fig. 8-4.

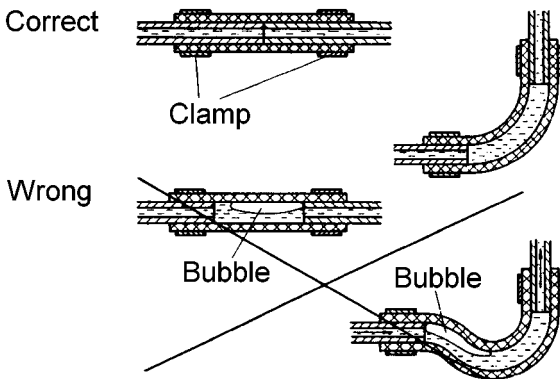
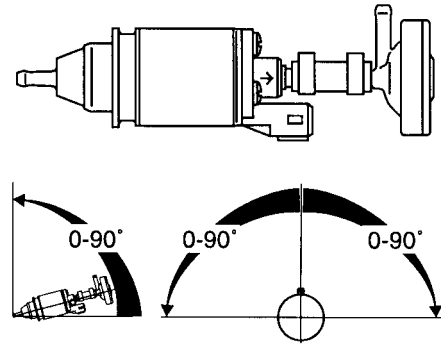


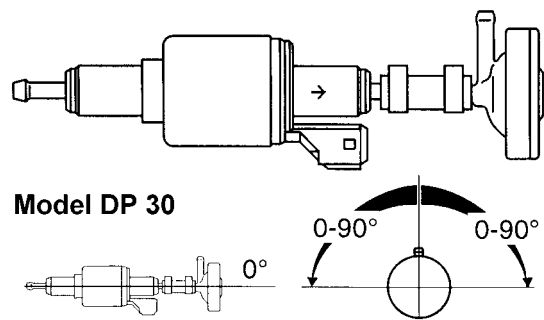
Fig. 8-4 Pipe/Hose Connection

8.6.3 Fuel Dosing Pump

The fuel dosing pump is a combined delivery, dosing, and shut-off system and is subject to certain installation criteria (see Figs. 8-2 and 8-5).



Thermo 90 / 90S 12 Volt - Gasoline



Model DP 30

Thermo 90 / 90S 12 Volt and 24 Volt - Diesel
Installation Position Horizontal Only!

Fig. 8-5 Fuel Dosing Pump, Installation Location and Attachment

8.6.3.1 Installation Location

It is advantageous to mount the fuel dosing pump in a cool location as near as possible to the fuel tank. The ambient temperature must never exceed +20 °C (68 °F) for gasoline and +40 °C (104 °F) for Diesel installations at any time while in operation. The maximum pressure at the tapping location must be below 1.5 bar (21.75 psi.).

Fuel 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 fuel dosing pump is to be attached with anti-vibration mounts. The installation location is limited according to Fig. 8-5 to ensure sufficient self-bleeding capability. Due to the danger of corrosion, the plug connection between fuel dosing pump and fuel dosing pump cable loom may only be fitted with Webasto original spare parts.

8.6.4 Fuel Filter

If there is the probability of contaminated fuel, only the Webasto filter, part number 487171, may be used. The use of fuel filters not designed for Webasto heater fuel systems may cause a vapor lock or interfere with the proper delivery of fuel.

The fuel filter can be installed anywhere between the vertical and horizontal positions, but must be installed in the direction of flow.

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, impact of snow, or intake of splash water is possible.

The combustion air intake line (inner diameter at least 30 mm or 1 3/16 in.) may have a length from 0.5 m to 5 m (18 in. to 16 ft.) with several bends totaling no more than 360°. Smallest bending radius is 45 mm (1 3/4 in.).

The combustion air inlet must not be located above the exhaust outlet.

NOTE:

The combustion air intake line is to be routed in a downward direction. If this is not possible, a water drain hole (4 mm or 5/32 in. dia.) must be provided at the lowest point.

If the heater is located near the fuel tank in a common installation compartment, combustion air must be taken in from, and the exhaust routed to, the exterior. The feed-through openings must be splash waterproof.

If the heater is located in a closed installation box, a vent port of at least 6 cm² (2 3/8 in²) is required. If the temperature in the installation box exceeds the permitted ambient temperature of the heater (see Technical Data), the vent port must be enlarged.

8.6.6 Exhaust Line

The exhaust line (inner diameter 38 mm or 1.5 in.) may have a length from 0.5 m to 5 m (18 in. to 16 ft.) and be routed with several bends totaling no more than 360°. Smallest bending radius is 85 mm (3 3/8 in.).

The exhaust muffler is mandatory and to be mounted near the heater.

In order to ensure the angle of $90^\circ \pm 10^\circ$, an attachment is required no further than 150 mm (6 in.) away measured from the exhaust pipe end.

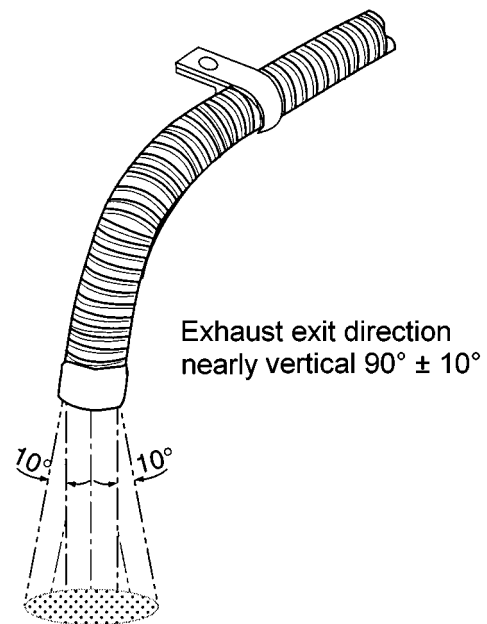


Fig. 8-6 Exhaust Outlet, Direction of Flow

The exhaust pipe outlet opening must not point in the direction of motion (see Fig. 8-6).

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

Rigid exhaust-line pipes can be made of unalloyed or alloyed steel, but must have a minimum wall thickness of 1.0 mm (1/32 in.). Flexible exhaust pipes must be made only of alloyed steel. The exhaust pipe is secured to the air heater with a clamp. For further requirements, consult Webasto Thermosystems.

8.7 Removal and Installation

⚠CAUTION

It is permissible to service the heater in the installed position only if sufficient space is available for removal and disassembly of the various components of the heater. Should there not be sufficient space or there exists a possibility of damage to the components of the heater during disassembly, the heater must be removed from the installed position.

8.7.1 Heater, Removal and Installation

8.7.1.1 Removal

1. Disconnect battery terminal leads.

NOTE:

On the Thermo 90 S heater, with control unit flanged to combustion air fan, only connectors X12 and X13 require disconnection from control unit.

2. Remove top cover.
3. Disconnect plug of cable loom from heater.
4. Disconnect fuel inlet on heater.
5. Loosen hose clamps and disconnect coolant hoses from heater.
6. Disconnect combustion air intake and exhaust outlet tubes at heater.
7. Remove three nuts and washers from heater mount.
8. Remove heater.

8.7.1.2 Installation

1. Locate heater in installation position and secure with three nuts and washers.
2. Reconnect coolant hoses and secure with hose clamps. Torque tighten clamps to 5 Nm.
3. Reconnect fuel line to heater.
4. Reconnect combustion air inlet and exhaust outlet tubes at heater.

NOTE:

On the Thermo 90 S heater, with control unit flanged to combustion air fan, reconnect connectors X12 and X13 to control unit.

5. Connect plug of cable loom to heater.
6. Plug on top cover and arrest.
7. Reconnect battery terminal leads.
8. Bleed fuel supply system.
9. Bleed coolant circuit.

8.7.2 Replacement of Circulation Pump

NOTE:

The procedure for replacement of the circulation pump is identical with the heater removed or installed. Replacement is to be performed in accordance with instructions described in section 9.2.2.

8.7.3 Replacement of Temperature Limiter

NOTE:

The procedure for replacement of the temperature limiter is identical with the heater removed or installed. Replacement is to be performed in accordance with instructions described in section 9.2.3.

8.7.4 Replacement of Temperature Sensor

NOTE:

The procedure for replacement of the temperature sensor is identical with the heater removed or installed. Replacement is to be performed in accordance with instructions described in section 9.2.4.

8.7.5 Replacement of Combustion Air Fan

NOTE:

The procedure for replacement of the combustion air fan is identical with the heater removed or installed. Replacement is to be performed in accordance with instructions described in section 9.2.5.

8.8 First Operation

After installation of the heater, the fuel supply system and the cooling circuit must be thoroughly bled, observing the vehicle manufacturer's instructions. During the test run of the heater, all connections are to be checked for leakage and tightness. Should the heater assume an error lock-out condition during operation, perform troubleshooting (see Section 5).

9. Repair

9.1 General

This section describes the repairs that may be performed on the heater Thermo 90 Thermo 90 S when removed. Any further disassembly will void the warranty.

For re-assembly only Webasto-authorized spare parts kits are to be used.

9.1.1 Work on Components after Disassembly

⚠ CAUTION

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

9.1.1.1 Cleaning

- All disassembled components must be cleaned.

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 necessary.

9.2 Disassembly and Assembly

9.2.1 Electrical Connections (Fig. 9-1)

9.2.1.1 Disconnecting Electrical Connections (Connection X1)

NOTE:

All electrical connections are joined in the connector. Prior to removal of a component, the relevant electrical connections first have to be disconnected.

On the Thermo 90 S heater with flanged combustion air fan, connector X1 on heater and connection X12 on control unit must be disconnected and reconnected after making electrical connections.

1. Remove top cover from heater.
2. Using removal tool (hook end) withdraw lock wedge from connector.
3. Using removal tool (screw driver end) press down relevant locking tab and while keeping tab depressed withdraw cables from connector.

9.2.1.2 Making Electrical Connections

1. Slide cable into relevant contact pocket until locked.
2. Using removal tool (screw driver end) insert lock wedge in connector and press in until locked.
3. Fit top cover.

NOTE:

One of the newer models Thermo 90 shown. Older models have the cable of the temperature limiter located on the side.

Heater Thermo 90 S may have the control unit located on the combustion air fan.

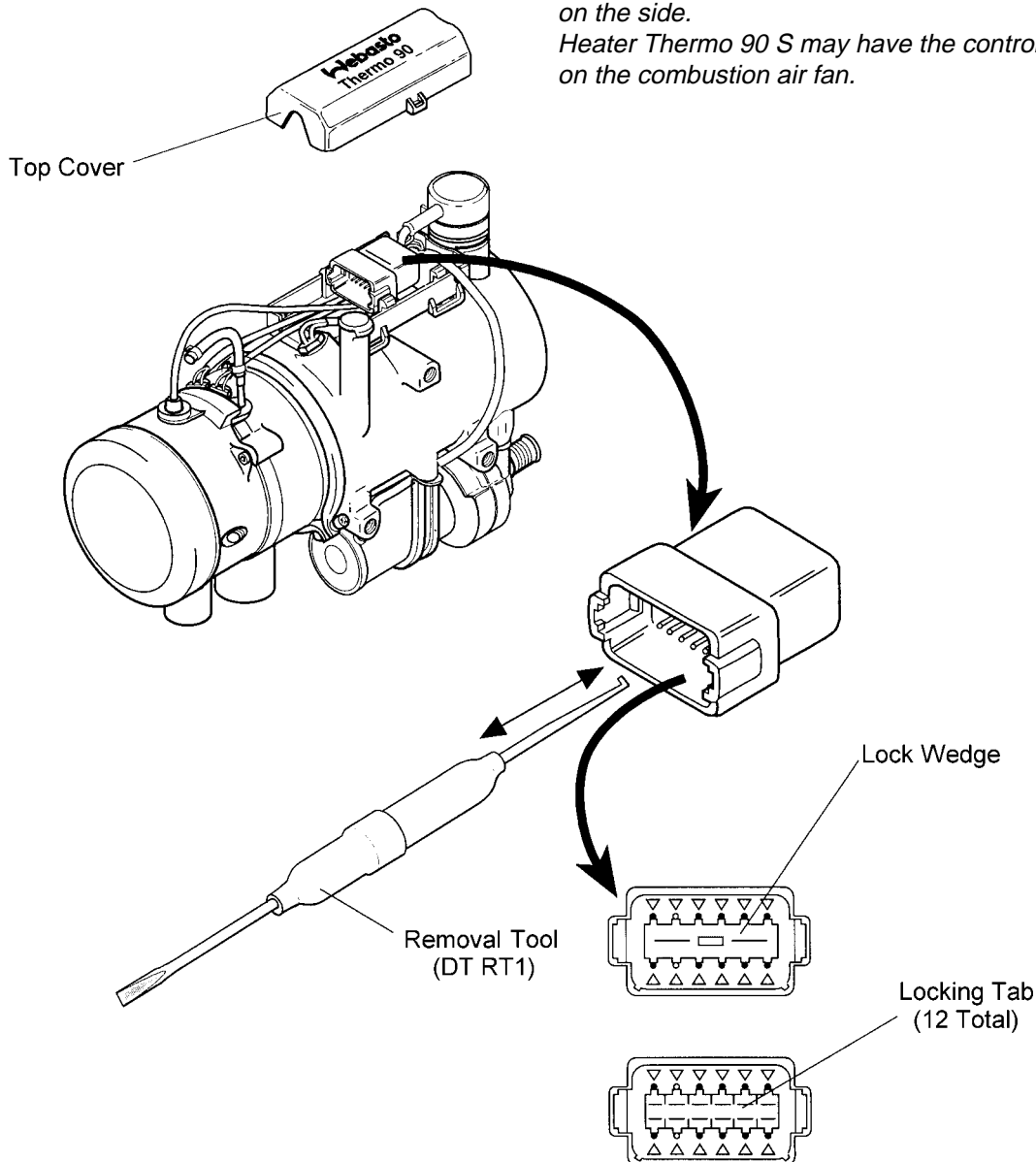


Fig. 9-1 Electrical Connections

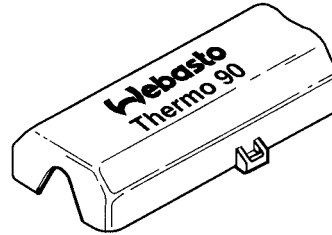
9.2.2 Replacement of Circulation Pump

9.2.2.1 Removal

1. Remove heater (see 8.7.1.1).
2. Disconnect electrical connections (see 9.2.1.1).
3. Remove screws (4, Fig. 9-2).
4. Remove clamp (3) and circulation pump (2).
5. Perform procedures on components after disassembly (see 9.1.1).

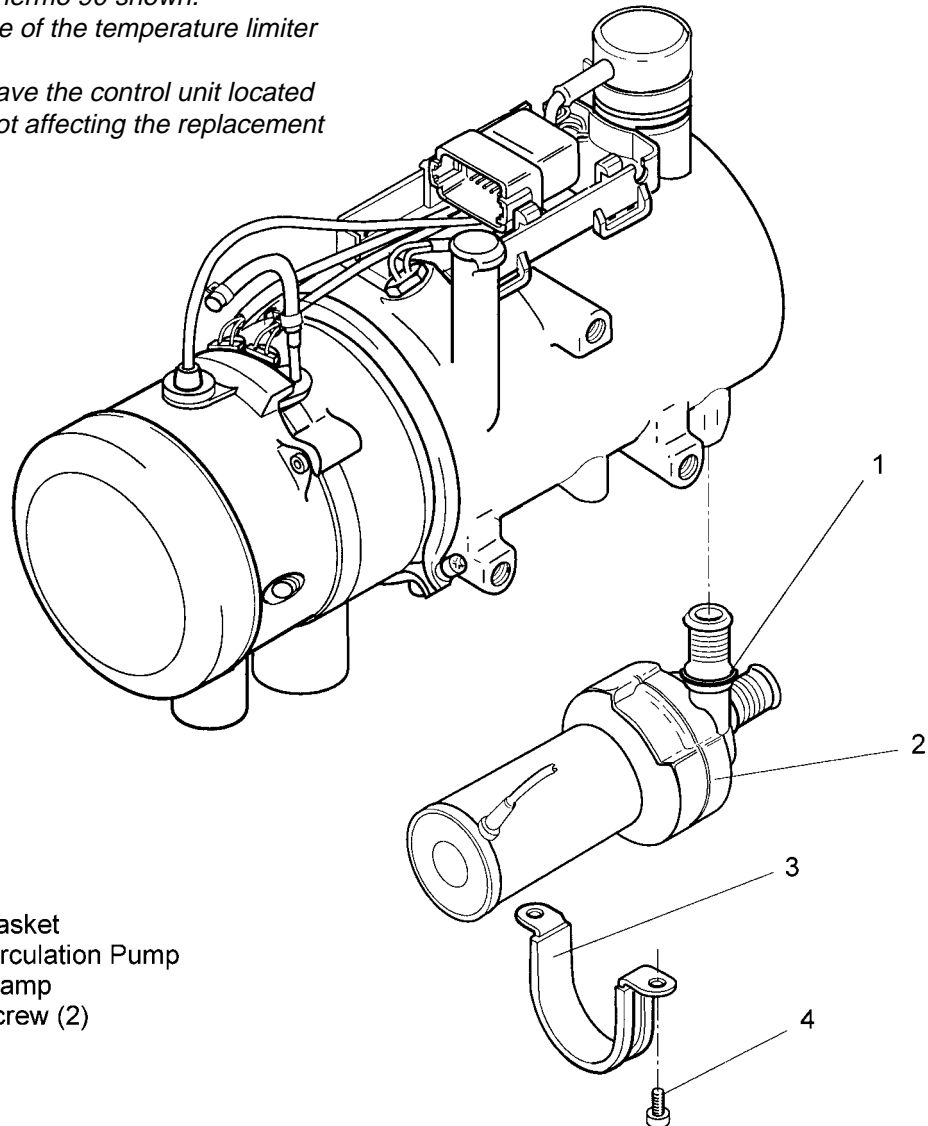
9.2.2.2 Installation

1. Apply acid free grease (Vaseline) to gasket (1, Fig. 9-2)
2. Bring circulation pump (2) in assembly position and secure using clamp (3) and screws (4).
3. Torque screws (4) to 3 Nm + 10%.
4. Make electrical connections (see 9.2.1.2).
5. Install heater (see 8.7.1.2).



NOTE:

*One of the newer models Thermo 90 shown.
Older models have the cable of the temperature limiter located on the side.
Heater Thermo 90 S may have the control unit located on the combustion air fan not affecting the replacement of the circulation pump.*



- 1 Gasket
- 2 Circulation Pump
- 3 Clamp
- 4 Screw (2)

Fig. 9-2 Replacement of Circulation Pump

9.2.3 Replacement of Temperature Limiter

9.2.3.1 Removal

NOTE:

Perform the following procedure only when the temperature limiter needs replacement. A functional check has to be performed when the temperature limiter is installed.

1. Remove heater (see 8.7.1.1).
2. Disconnect electrical connections (see 9.2.1.1).
3. Remove clamp (2, Fig. 9-3) and withdraw protective cap (1).
4. Using screw driver, lever off retaining clip and remove temperature limiter (3).
5. Perform procedures on components after disassembly (see 9.1.1).

NOTE:

Whenever the temperature limiter is removed, it must be renewed.

9.2.3.2 Installation

⚠CAUTION

Wrong installation will cause melting of the heat exchanger.

1. Insert the temperature limiter (3, Fig. 9-3) into the heat exchanger (4) and press down retaining clip.

NOTE:

Make sure the retaining clip is heard to click fully in place. Only then will the temperature limiter be in the proper installation position.

If clip does not audibly engage:

- *clean seat of the temperature limiter on the heat exchanger*
 - *clean groove on heat exchanger*
 - *insure that the locking cams are present on both sides of the spring. Renew temperature limiter if necessary.*
2. Fit protective cap (1) and secure with clamp (2).
 3. Torque tighten hose clamp with 1 Nm \pm 10%.
 4. Make electrical connections (see 9.2.1.2).
 5. Install heater (see 8.7.1.2).

9.2.4 Replacement of Temperature Sensor

9.2.4.1 Removal

1. Remove heater (see 8.7.1.1).
2. Disconnect electrical connections (see 9.2.1.1).

⚠WARNING

Escaping hot coolant may cause burns.

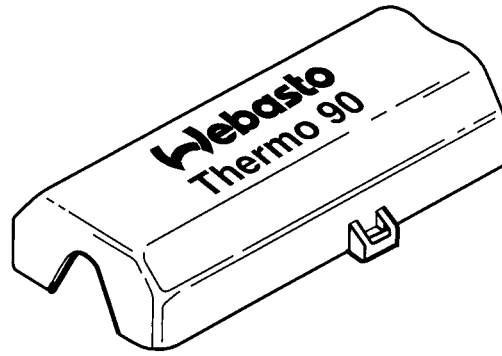
3. Unscrew temperature sensor (6, Fig. 9-3) and remove together with O-ring (5).
4. Perform procedures on components after disassembly (see 9.1.1).

9.2.4.2 Installation

1. Apply acid free grease (Vaseline) to O-ring (5, Fig. 9-4).
2. Screw temperature sensor (6) with O-ring (5) into heat exchanger (4) and torque tighten to 1.5 Nm \pm 10%.
3. Make electrical connections (see 9.2.1.2).
4. Install heater (see 8.7.1.2).

NOTE:

One of the newer models Thermo 90 shown.
 Older models have the cable of the temperature limiter located on the side.
 Heater Thermo 90 S may have the control unit located on the combustion air fan not affecting the replacement of the temperature limiter and temperature sensor.



- 1 Protective Cap
- 2 Clamp
- 3 Temperature Limiter
- 4 Heat Exchanger
- 5 O-Ring
- 6 Temperature Sensor

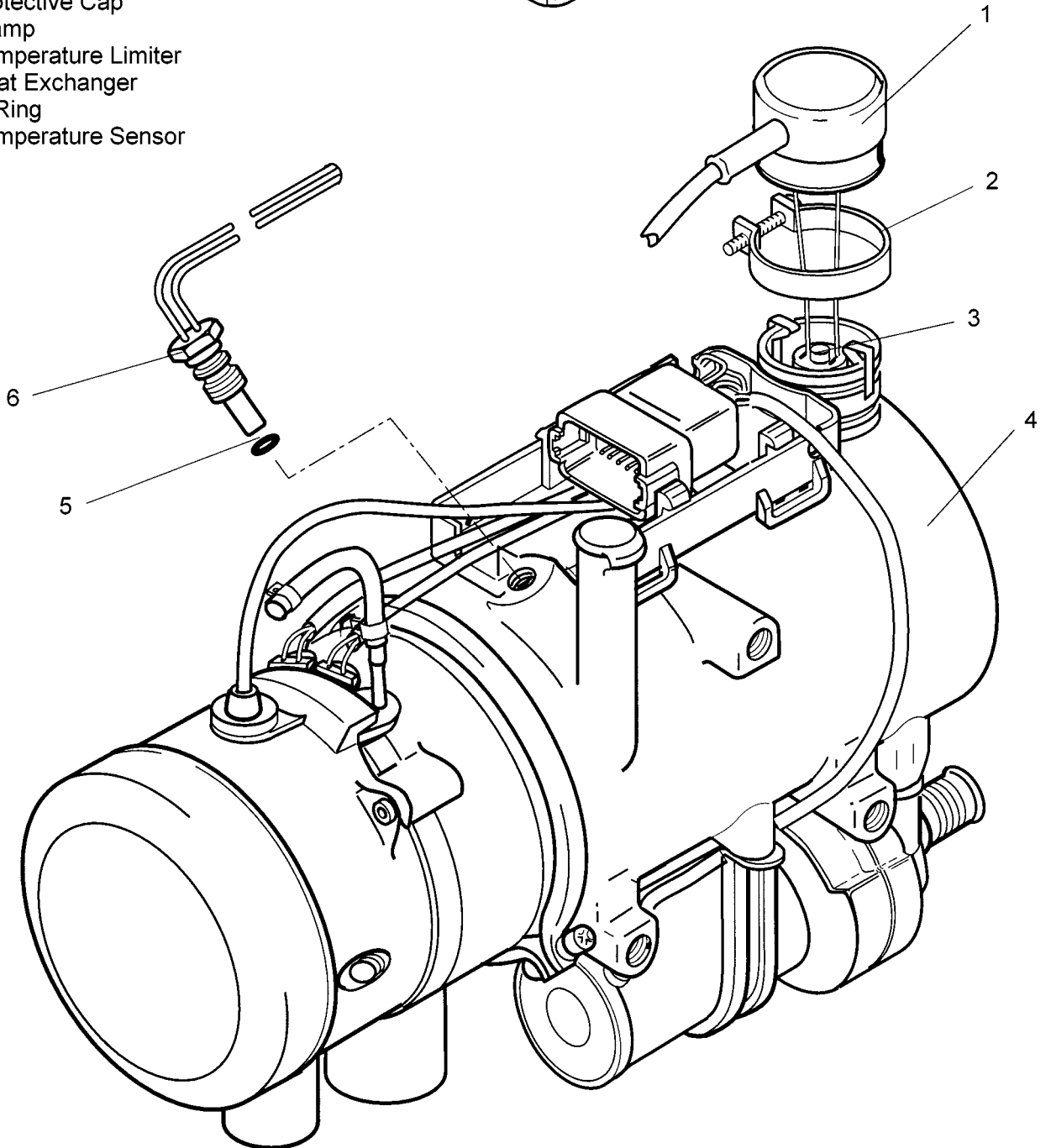


Fig. 9-3 Replacement of Temperature Limiter and Temperature Sensor

9.2.5 Replacement of Combustion Air Fan

9.2.5.2 Installation

9.2.5.1 Removal

1. Remove heater (see 8.7.1.1).
2. Disconnect electrical connections (see 9.2.1.1).
3. Remove screws (2, Fig. 9-4).
4. Pull combustion air fan (1) from burner head (4) and remove together with profiled packing ring (3).

NOTE:

On heater Thermo 90 S with flanged control unit remove control unit as required.

5. Perform procedures on components after disassembly (see 9.1.1).

NOTE:

Locate packing ring (3, Fig. 9-4) properly; do not squeeze.

1. Bring combustion air fan (1) with new profiled packing ring (3) in assembly position and secure with screws (2).
2. Torque tighten screws (2) with 3 Nm ± 10%.

NOTE:

On heater Thermo 90 S with flanged control unit install control unit as required.

3. Make electrical connections (see 9.2.1.2).
4. Install heater (see 8.7.1.2).

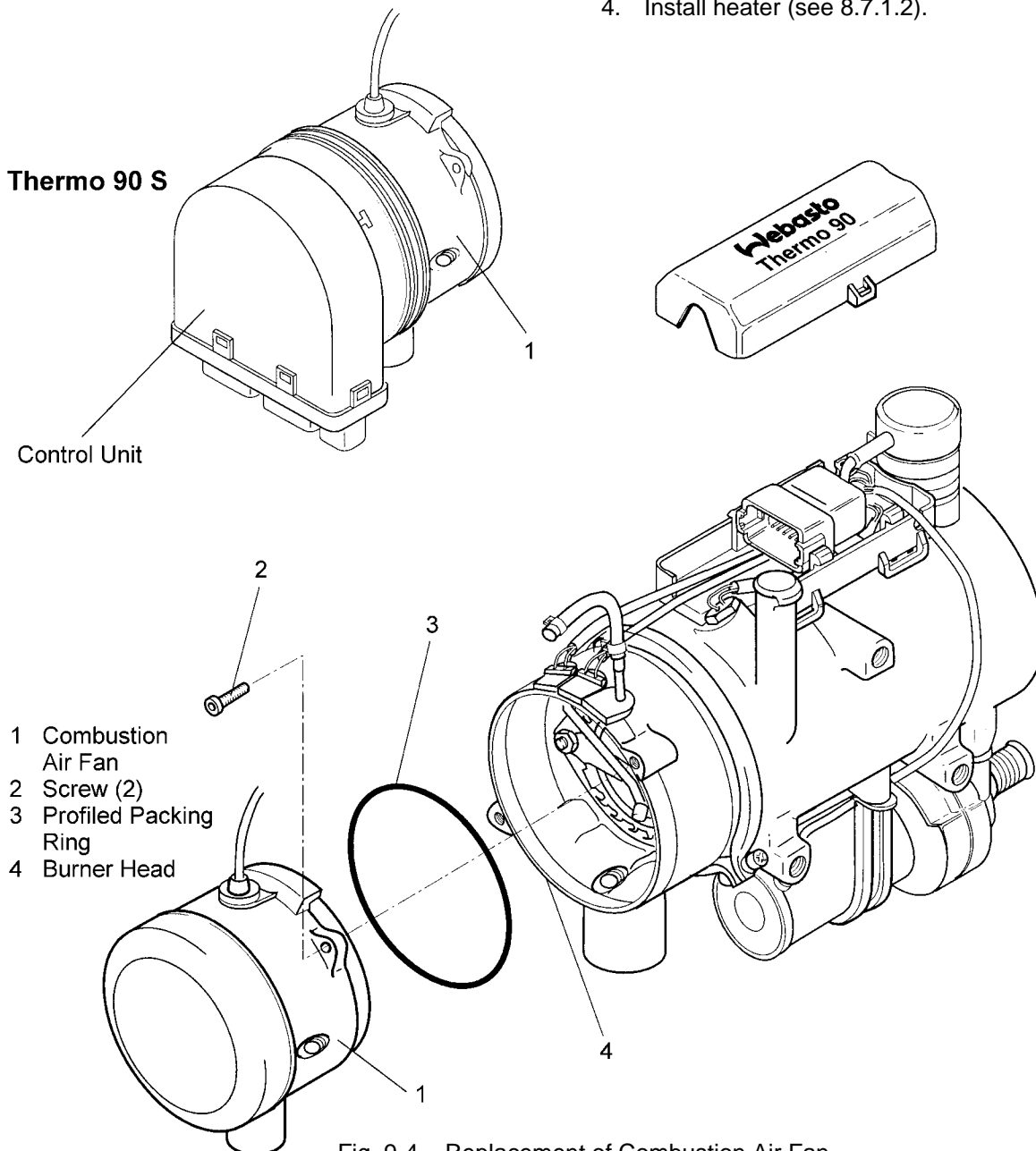


Fig. 9-4 Replacement of Combustion Air Fan

9.2.6 Replacement of Burner, Flame Sensor and Glow Pin

9.2.6.1 Removal

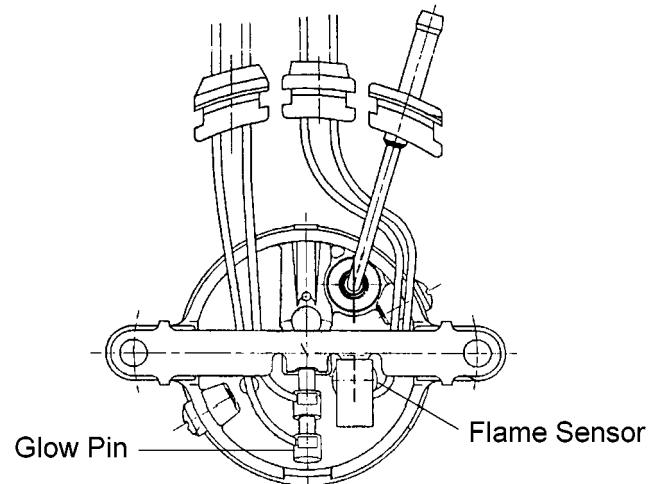
1. Remove heater (see 8.7.1.1).
2. Remove combustion air fan (see 9.2.5.1).
3. Remove screw (5, Fig. 9-5) and washer (4).
4. Remove nuts (10) and withdraw bracket.
5. Withdraw grommets (11 and 12) from slots in housing of combustion tube (3).
6. Withdraw grommet (13) and burner (1) from burner (1) and remove.
7. Pull flame sensor (7) and glow pin (6) out of burner (1) and remove.
8. Perform burner visual inspection for assessment of condition (see 9.1.1).
9. Perform procedures on components after disassembly (see 9.1.1).

9.2.6.2 Installation

1. Locate swirl ring (2, Fig. 9-5) on burner (1).
2. Carefully and fully insert flame sensor (7) and glow pin (6) into burner against stops and slide grommets (11 and 12) down slots in housing of combustion tube (3).
3. Position burner (1) and grommet (13) in burner head (3).

⚠ CAUTION

When performing the following step, ensure that cables of flame sensor (7) and glow pin (6) are routed as shown in figure.



4. Slide insulation (9) onto bracket and locate bracket (8) in assembly position.

NOTE:

Route cables of flame sensor and glow pin as shown in figure above.

5. Secure bracket (8) using nuts (10). Torque nuts to $3 \text{ Nm} \pm 10\%$.
6. Secure fuel line with screw (5) and washer (4). Torque screw to $3 \text{ Nm} \pm 10\%$
7. Mount combustion air fan (see 9.2.4.2).
8. Make electrical connections (see 9.2.1.2).
9. Install heater (see 8.7.1.2).

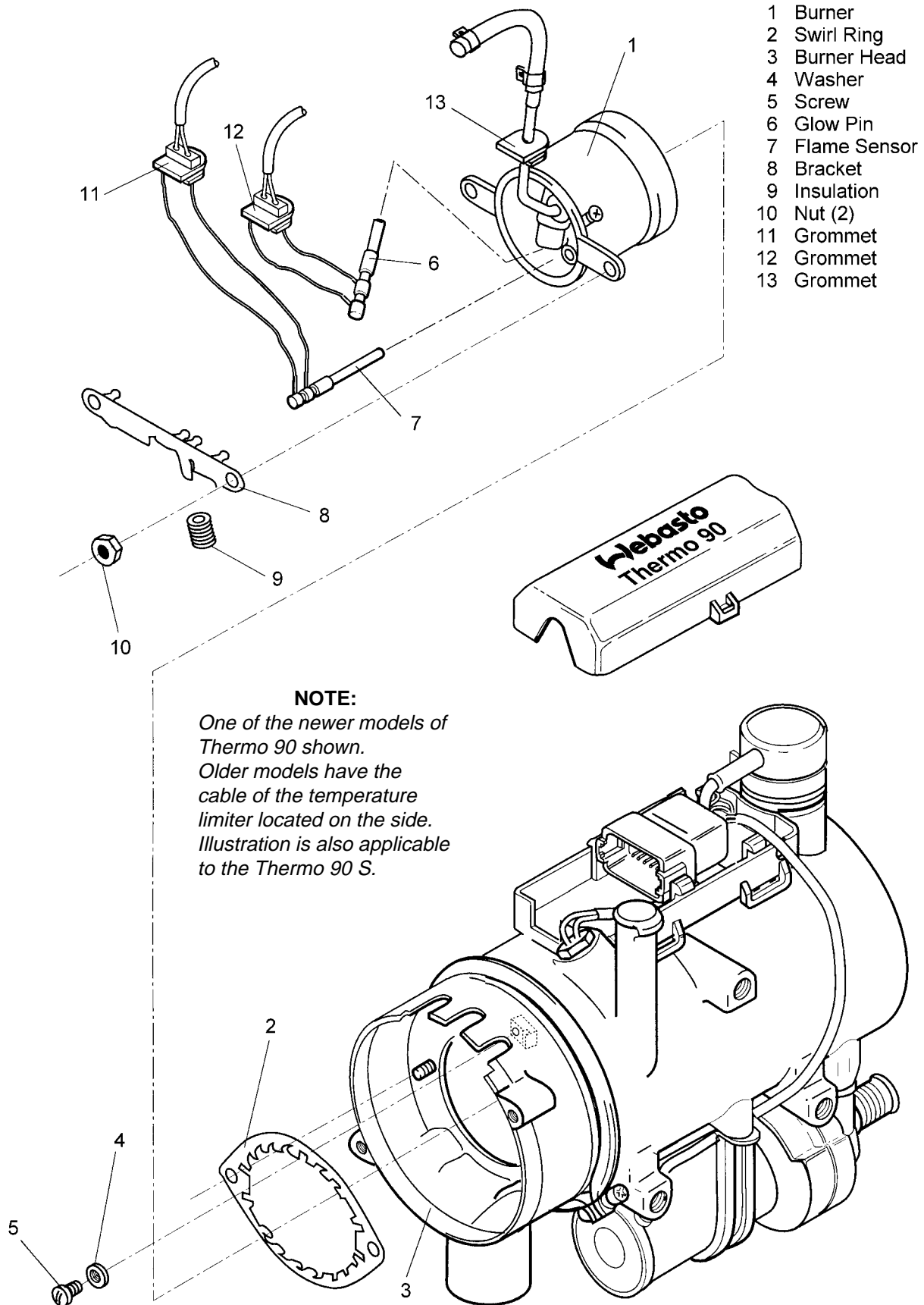


Fig. 9-5 Replacement of Burner, Flame Sensor, and Glow Pin

9.2.7 Replacement of Burner Head

9.2.7.1 Removal

1. Remove heater (see 8.7.1.1).
2. Remove combustion air fan (see 9.2.5.1).
3. Remove burner, flame sensor and glow pin (see 9.2.5.1).
4. Remove attachment screw of V-clamp (2, Fig. 9-6) and pull off clamp.
5. Withdraw burner head (1) from heat exchanger (3) and remove.
6. Perform procedures on components after disassembly (see 9.1.1).

NOTE:

Carefully inspect the gasket located at the joint between the alloy burner head and stainless steel burner tube especially at the area of the exhaust outlet. Any deterioration of this gasket will require the replacement of the burner head/tube assembly.

9.2.7.2 Installation

NOTE:

Burner head and exhaust outlet pipe can still be aligned during installation in vehicle.

1. Insert burner head (1, Fig. 9-6) into heat exchanger (3), align as necessary and secure with V-clamp (2).
2. Torque attachment screw of V-clamp to 3 Nm ± 10% as required.
3. Install burner, flame sensor, and glow pin (see 9.2.6.2).
4. Install combustion air fan (see 9.2.5.2).
5. Install heater (see 8.7.1.2).

NOTE:

One of the newer models of Thermo 90 shown. Older models have the cable of the temperature limiter located on the side. Illustration is also applicable to the Thermo 90 S.

- 1 Burner Head
- 2 V- Clamp
- 3 Heat Exchanger

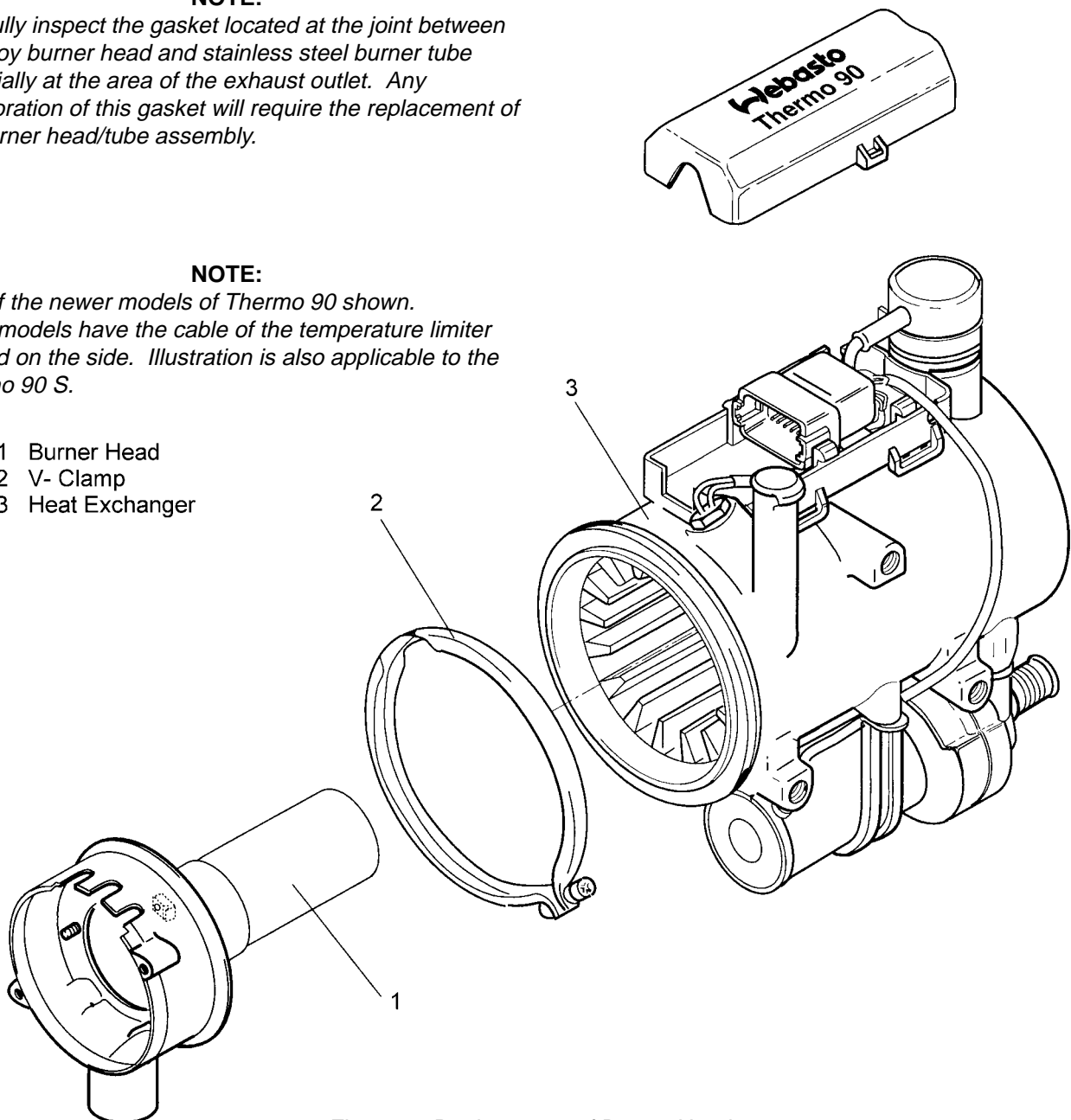


Fig. 9-6 Replacement of Burner Head

9.2.8 Replacement of Heat Exchanger**9.2.8.1 Removal**

1. Remove heater (see 8.7.1.1).
2. Remove circulation pump (see 9.2.2.1).
3. Remove temperature limiter (see 9.2.3.1).
4. Remove temperature sensor (see 9.2.4.1).
5. Remove combustion air fan (see 9.2.5.1).
6. Remove burner, flame sensor, and glow pin (see 9.2.6.1).
7. Remove burner head (see 9.2.7.1).
8. Remove connector and connector housing.
9. Perform procedures on components after disassembly (see 9.1.1).

9.2.8.2 Installation

1. Clip connector housing onto heat exchanger and engage connector in connector housing.
2. Install burner head (see 9.2.7.2).
3. Install burner, flame sensor, and glow pin (see 9.2.6.2).
4. Install combustion air fan (see 9.2.5.2).
5. Install temperature sensor (see 9.2.4.2).
6. Install temperature limiter (see 9.2.3.2).
7. Install circulation pump (see 9.2.2.2).
8. Install heater (see 8.7.1.2).

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