HEATING SYSTEMS

NGW 300
LGW 300

GBW 300

NGW 300 / LGW 300 model

Workshop manual

Rev. 02/2006
Id.No. 11112258A

Valeo

Table of contents

Table of figures

1 Introduction

1.1 Content and purpose

This workshop manual serves as support for trained staff in the repair of the NGW 300, LGW 300 und GBW 300 water heaters.

The heaters may only be operated with the kind of gas indicated on the model plate and and with the relevant kind of electrical connection.

1.2 Meaning of the headings in capital letters.

In this manual, the words CAUTION, ATTENTION and PLEASE NOTE have the following meaning:

CAUTION
This heading is used, if a failure to follow instructions and procedures accurately or to follow instructions and procedures at all can lead to injuries or to fatal accidents.

ATTENTION
This heading is used, if a failure to follow instructions and procedures accurately or to follow instructions and procedures at all can lead to the damaging of components.

PLEASE NOTE
This heading is used, if attention should be drawn to a specific feature.

1.3 Further documentation to be used

This workshop manual contains all the necessary information and instructions with respect to the repair of the NGW 300, LGW 300 and GBW 300 water heaters. The use of additional documentation can be required.

If necessary, installation and operating instructions can also be used.

1.4 Safety information and regulations

Basically, general accident pevention provisions and the valid industrial safety directions must be adhered to.

"General Safety Regulations" which exceed the framework of these provisions are listed below. The specific safety regulations which affect the present manual are issued in the individual sections or procedures with headings in capital letters.

1.4.1 General safety regulations

"General model approvals " with an official test stamp have been issued by the Kraftfahrt Bundesamt [Federal Bureau of Motor Vehicles and Drivers] for the NGW 300, LGW 300 and GBW 300 water heaters in the area governed by the StVZO [Road Traffic Licensing Regulation]:

~ S 291 for the NGW 300 heater

~ S 313 for the LGW 300 heater

~ S 330 for the GBW heater

and a model approval in accordance with EC Directives 72/245/EEC (EMC) with authorisation no:

e1*72/245*95/54*1260*xx

Liability claims can only be asserted, if the claimant can prove adherence to the the maintenance and safety instructions.

Failure to follow the installation instructions and the directions they contain will result in the exclusion of liability on the part of Spheros. The same shall also apply for repairs which are not conducted by experts or for those where original replacement parts are not used. This will result in the revocation of the general model approval for the heater and thus the general operating permit for the motor vehicle as well.

CAUTION

- The heater may not be operated in enclosed spaces (e.g. a garage or a workshop without an extraction system) due to the danger of contamination and suffocationr, and may not be operated with time preselection.
- Due to the risk of explosion, the heater must be switched off at petrol stations and fuelling tanks.
- Due to fire danger, the heater may not be operated in the vicinity of combustible materials such as dry grass and leaves, paper board, paper, etc.

ATTENTION
Where combustible vapours or dust can form (e.g. in proximity to fuel, coal, sawdust and grain storage areas or the like), the heater must be switched off.

The heaters must be operated only with the kind of gas indicated on the model plate.

NGW 300	with CNG (natural gas)
LGW 300	with LPG (propane)
GBW 300	depending on the design with CNG (natural gas) or LPG (propane)

The proportion of methane in the CNG (natural gas) must amount to 95 % at least. If the proportion of methane is at a still permissible 85-95 %, the CO_2value must be readjusted.

Withdrawal of gas in LPG (propane) sysrems must happen in the gas phase.

ATTENTION

The gas pressure regulator must be replaced after 4 years of operation, for safety reasons. Failure to do so can lead to leakage and thus an escape of gas, due to aging of the sealing elements.

PLEASE NOTE

Oil and condensate which have accumulated in the gas pressure regulator must be drained out in accordance with section 8.

CAUTION

As the combustion noise of the heater is barely audible, special care must be taken when working in the vicinity of the heater. In any event, the heater should be secured to prevent its being switched on unintentionally.

When there is a rather sustained period of smoke emission, unusual combustion noises or a smell of gas, the heater must be put out of operation by removal of the fuse and may only be put back into service after an inspection by staff trained by Spheros.

In the area where the heater is the temperature may not exceed 100 °C (storage temperature). If this temperature is exceeded, permanent damage can be done to the electronic system.

Checking the status of the coolant should be done in accordance with the process described in documentation provided by car manufacturers. The water in the heater's heating circuit must contain at least 20 % brand name antifreeze solution. In the event of overheating, if pure water is used, due to its lower boiling point, this can lead to a partial loss of cool water. In this case, coolant must be replenished.

Additives in the heating circuit should not adversely affect metal, plastic or rubber and should not form deposits.

The opening pressure in a car's cooling system (normally indicated on the radiator cap) must be between 0.4 and 2 bar of the maximum allowable working pressure.

1.5 Legal regulations for installation

PLEASE NOTE

These regulations are binding in the area subject to the StVZO [Road Traffic Licensing Regulation] and should also be observed in countries where there are no specific provisions.

The installation of heaters must be performed in accordance with installation instructions.

The year in which the heater was first put into operation must be identified by the installer on its model plate by striking out/removing the inapplicable years permanently.

The combustion air must not be taken from the interior of the vehicle.

The opening of the exhaust pipe should be installed to face upwards or to the side, or, if the exhaust pipe runs under the floor of the vehicle, into the vicinity of the side boundary of the driver's cab or of the vehicle. Exhaust gas pipes must be laid in such a way as to preclude the expectation of exhaust gas fumes penetrating into the interior of the vehicle. The function of parts of the vehicle which are important for its operation must not be curtailed. Accumulation of condensate in the exhaust pipe absolutely must be removed. If necessary, a condensate drain hole may be drilled.

Combustion air intake and exhaust outlet:

The openings of the combustion air intake and the exhaust outlet must be designed in such a way as to prevent a sphere with a diameter of 16 mm from passing through.

The heater's electrical lines and switching and control units must be configured so that their flawless operation cannot be restricted under normal conditions.

Installing the heater in the driver's cabin or the passsenger compartment of a bus is not permitted.

The heater is not approved for installation in motor vehicles used for the transportation of hazardous materials.

Gas pipes must be laid in compliance with the VdTÜV, TRG, ECE-R110. ECE-R67 and DVGW [German Technical and Scientific Association for Gas and Water] guidelines.

Gas pipes must be designed in such a way that torsion of the vehicle, engine vibrations and the like have no effect on their durability. They must be protected from mechanical damage.

Gas pipes in buses must not be installed in the passenger compartment or the driver's cab. Parts that convey gas must be configured so that entrances and exits are not in danger of being obstructed in the event of a fire.

A regular check of the parts which carry gas, must be carried out annually. Leaky or damaged parts must be replaced by original replacement parts.

The particular operating status of the heater (at least on or off) must be easily recogniable.

2 General description

The NGW 300, LGW 300 and GBW 300 water heaters operate in conjunction with the on-board heating system

– to heat the passenger compartment
– to defrost the window panels and
– to heat the water-cooled engines

in busses.

Water heaters operate independently of the vehicle's engine and are connected to the cooling system, the gas system and the electrical system of the vehicle.

Heater type:

NGW 300 for the CNG type of gas (natural gas)
LGW 300 for the LPG type of gas (propane)

GBW 300
NGW 300 version for the CNG type of gas (natural gas)
LGW 300 version for the LPG type of gas (propane)

The heater which is designed to work in accordance with the heat exchange principle is controlled by the regulating thermostat in intermittent operation

The heater basically consists of

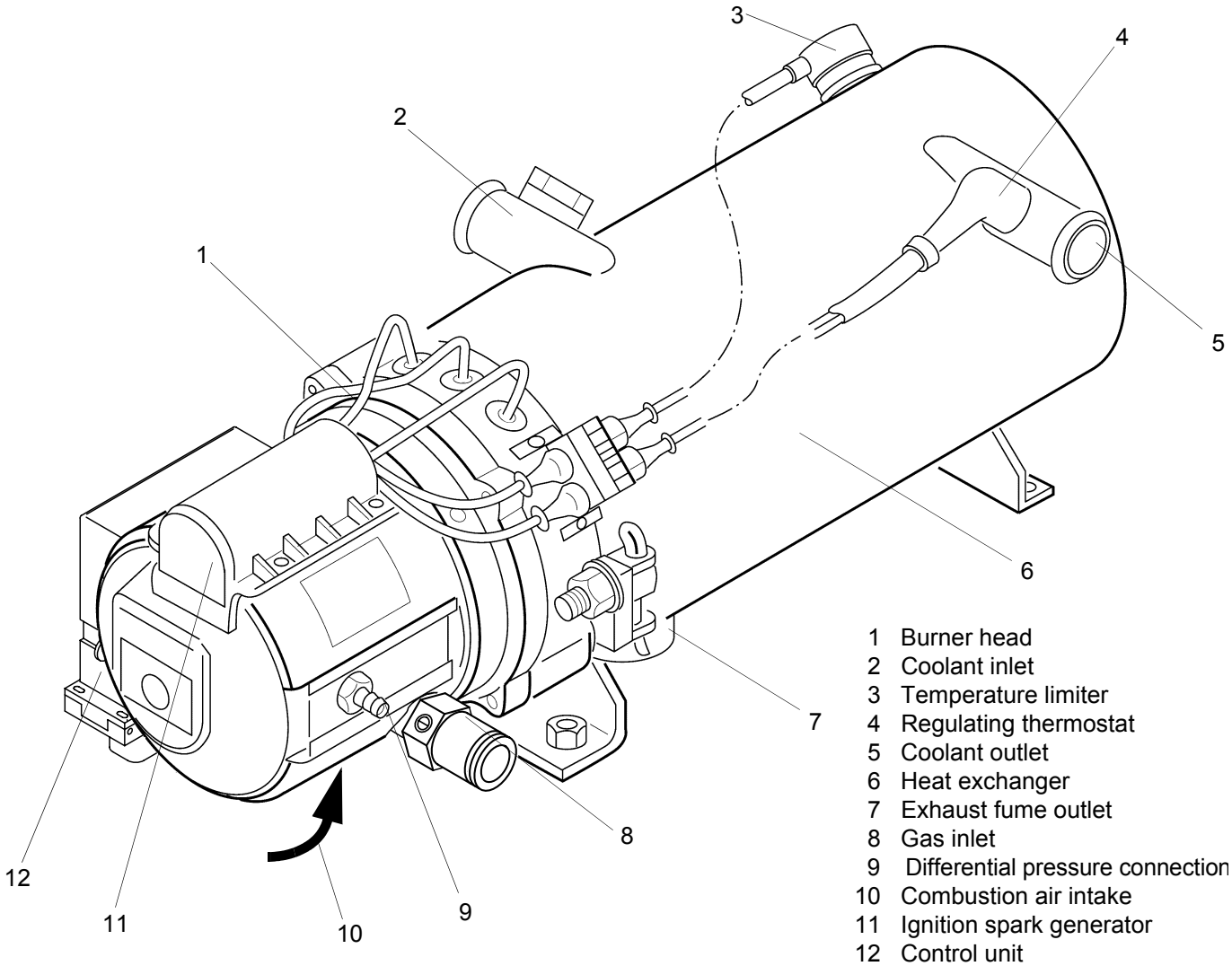
– the burner head
– the heat exchanger and
– the combustion chamber zusammen

The following components are located in the heater:

– a control unit
– a flame monitor electrode
– an ignition spark generator with ignition electrodes
– a regulating thermostat
– a temperature limiter and
– a vacuum switch

imfor control and monitoring.

In addition, a circulating pump and a gas pressure regulator for the gas are installed in the vehicle to supply the heating system as well as a thermostat valve for heating the gas pressure regulator. The NGW 300 also has a time-delayed solenoid installed in the heater's gas suction hose.



1 Burner head
2 Coolant inlet
3 Temperature limiter
4 Regulating thermostat
5 Coolant outlet
6 Heat exchanger
7 Exhaust fume outlet
8 Gas inlet
9 Differential pressure connection
10 Combustion air intake
11 Ignition spark generator
12 Control unit

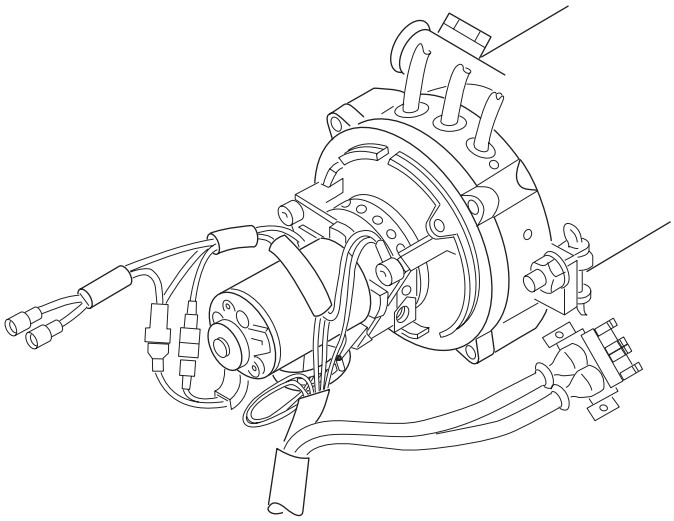
Fig. 201 NGW 300 water heater

2.1 Combustion air fan

The combustion air fan forces the air necessary for combustion from the combustion air inlet into the combustion chamber. In addition, the necessary amount of gas is aspirated from the fan by means of the gas pressure regulator.

The fan comprises an impellent and a rotor which are joined together by means of a coupling. The air is sucked in via a protective grille in the hood and mixed with gas in the mixer.

There is a special version for a combustion air intake extension which commits the combustion air to be taken in by means of this extension.



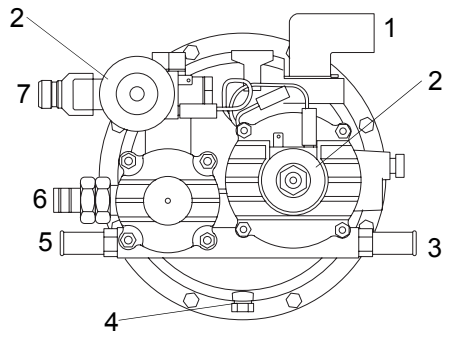
2.2 Gas pressure regulator

Gas is supplied by means of the vehicle's gas supply system, in which the gas pressure regulator is incorporated. Different types of regulators are utilised for operation with CNG (natural gas) and LPG (propane).

In CNG gas pressure regulators, the gas pressure of the system is regulated downward from a maximum of 220 bar of excess pressure in 3 steps to barely below atmospheric pressure. A safety valve protects the gas pressure regulator in the event of a pressure surge.

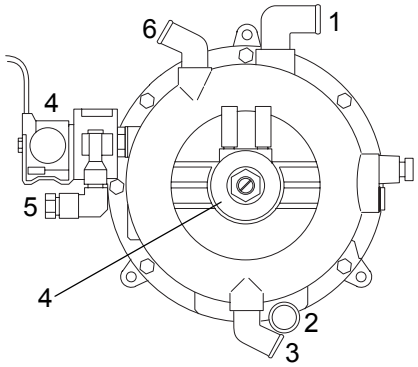
In LPG gas pressure regulators, the gas pressure of the system is regulated downward from a maximum of 30 bar of excess pressure in 2 steps to barely below atmospheric pressure.

After the solenoids have opened, the required quantity of gas is sucked out of the gas pressure regulator by the combustion air fan through the gas suction hose. The required quantity of gas is released by a diaphragm valve in the gas pressure regulator. This is dependent on the cross-section of the gas intake nozzle and the negative pressure in the gas suction pipe.



1 Gas outlet to the heater
2 Solenoid (2)
3 Water outlet
4 Drain plug (oil)
5 Water inlet
6 Safety valve
7 Gas inlet from the storage tank

CNG gas pressure regulator (NGW 300)



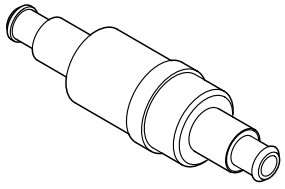
1 Gas outlet to the heater
2 Drain plug (oil)
3 Water inlet
4 Solenoid (2)
5 Gas inlet from the storage tank
6 Water outlet

LPG gas pressure regulator (LGW 300)

2.2.1 Heating the gas pressure regulator

As the expansion of the compressed gas causes considerable cooling, the gas pressure regulator must be warmed up. This is accomplished by integration into the cool water circuit. The flow rate is regulated by a thermostat valve.

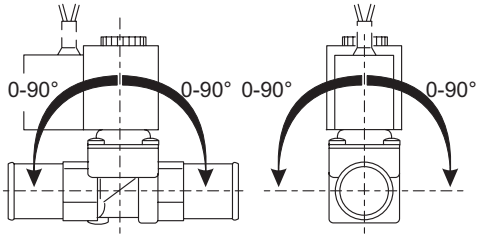
At approximately 50 °C, the thermostat valve begins to restrict the flow rate and is in the final position at approximately 60°C. Further heating and regulation of the flow rate are guaranteed by a leakage amount.



Thermostat valve

2.2.2 Delayed-action solenoid (only for the NGW 300)

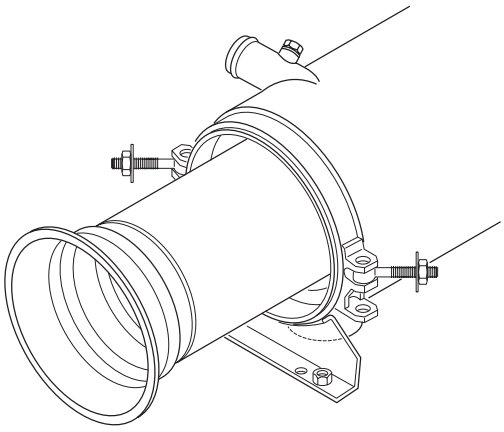
The delayed-action solenoid is necessary at gas supply pressures of 8 bar for the safe functioning of the input solenoid valve on the gas pressure regulator.
The solenoid is installed in the gas hose from the gas pressure regulator to the heater and is connected electrically in series to the solenoids in the gas pressure regulator.
After the solenoids in the gas pressure regulator are opened, the delayed-action solenoid releases the gas flow to the heater with a second's delay.
For higher gas supply pressures, the delayed-action solenoid can be installed as an additional safety element.
The delayed-action solenoid is a basic integral part of the GBW 300, version NGW.



Delayed-action solenoid

2.3 Heat exchanger

In the heat exchanger, the heat produced by combustion is transferred to the coolant circuit.

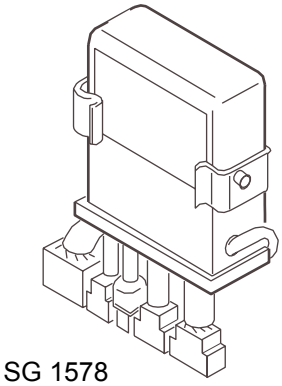


2.4 Combustion chamber

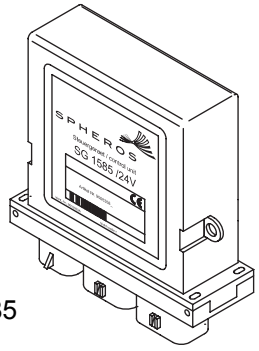
The gas-air mixture is distributed in the combustion chamber and is burned there. The heat exchanger and the coolant flowing through it are heated by this process.

2.5 Control unit

The control unit guarantees the function sequence and monitoring of the firing operation.
The SG 1578 control unit for the NGW 300 and LGW 300 heaters is no longer available and is being replaced by the modified SG 1585 control unit.
When refitting, the appropriate vehicle-specific adapter wiring harness is required.
The GBW 300 heaters are already equipped with the SG 1585 control unit.



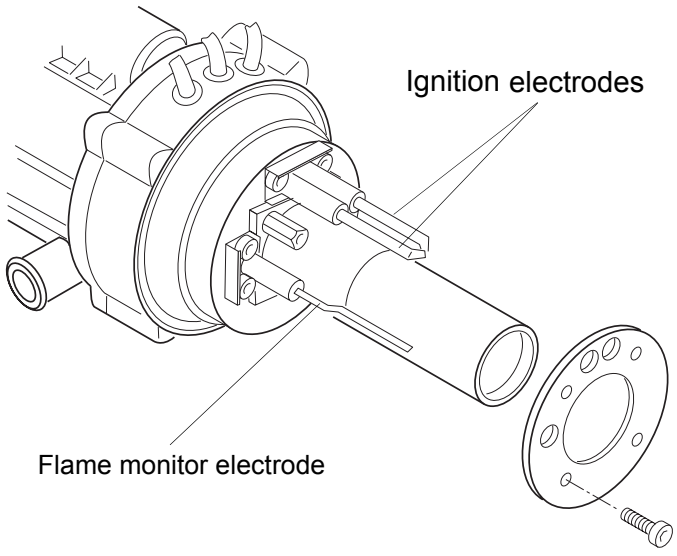
SG 1578



SG 1585

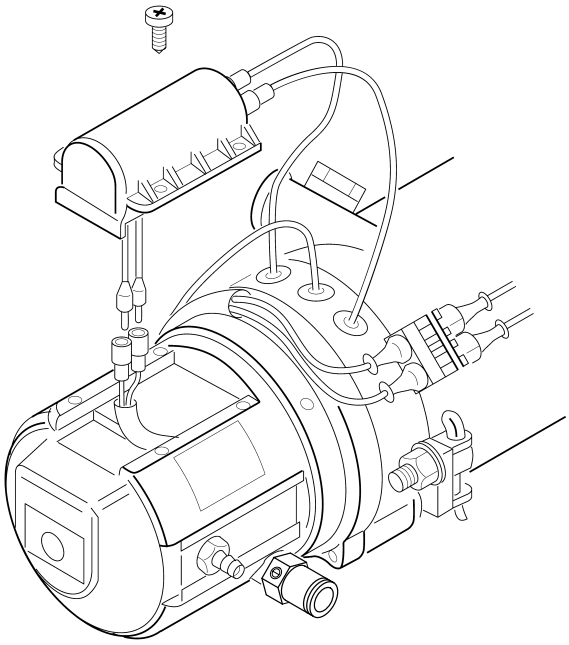
2.6 Flame monitor electrode

During the entire firing operation, the state of the flame is monitored by the flame monitor electrode. By means of ionisation of the air, depending on the temperature (flame), the signal is changed at the flame monitor electrode and processed by the control unit.



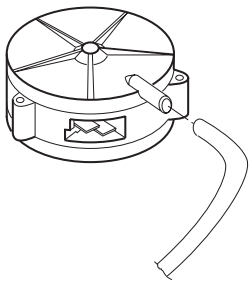
2.7 Ignition spark generator with ignition electrodes

ImIn the ignition spark generator, high voltage is produced to ignite the gas-air mixture.
Ignition occurs via a high voltage spark between the two ignition electrodes.



2.8 Vacuum switch

The vacuum switch is mounted under the hood of the burner. It controls the negative pressure and thus the rotational speed of the combustion air blower. The signal is processed by the control unit which then activates the solenoids on the gas pressure regulator.
When there is atmospheric pressure, the vacuum switch is turned on. It is turned off by low pressure of from 2.5 ±0.5 mbar.

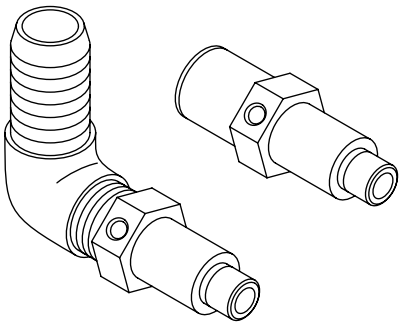


2.9 Gas inlet nozzles

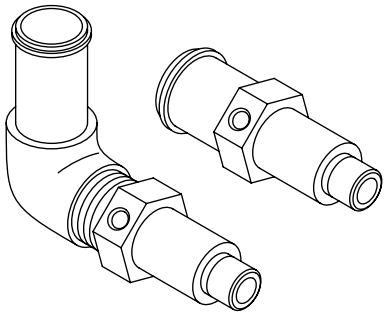
The amount of gas required for combustion is determined by the gas inlet nozzles on the burner.

The CO_2 content in the exhaust gas can be set by means of the setting screw.

Gas inlet nozzles are available in a straight form or an angular shape.



Gas inlet nozzles for NGW 300



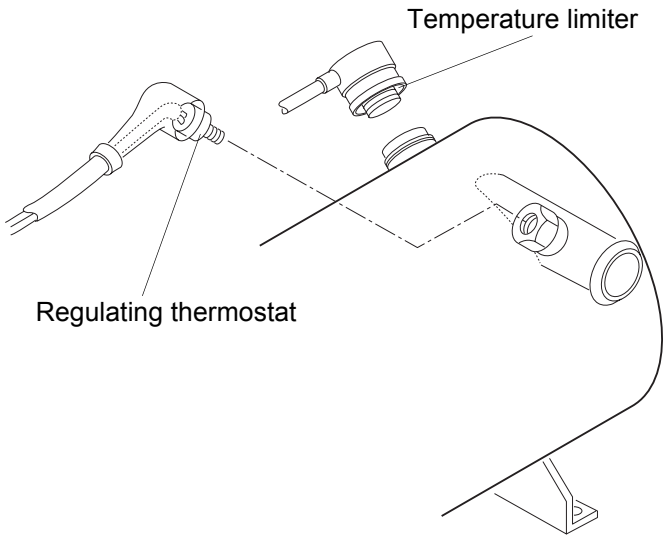
Gas inlet nozzles for LGW 300

2.10 Regulating thermostat

The regulating thermostat (bimetal) measures the coolant temperature at the water outlet of the heat exchanger. The signal is conducted to the control unit and is processed there.
The system is switched off at 75±3°C
and is switched on again at 68±5°C.

2.11 Temperature limiter

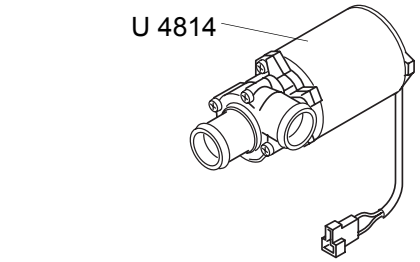
The temperature limiter (bimetal) protects the heater against incorrect high temperatures. The temperature limiter acts at a temperature above 125°C and switches off the heater.
The temperature limiter may be reset mechanically, once a temperature of 90 °C has been reached.

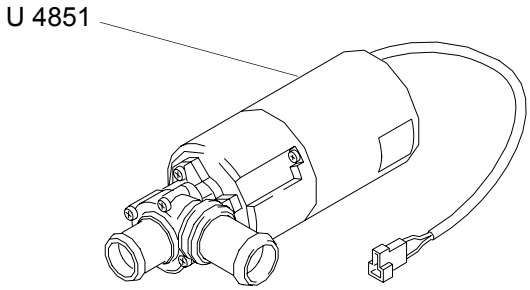


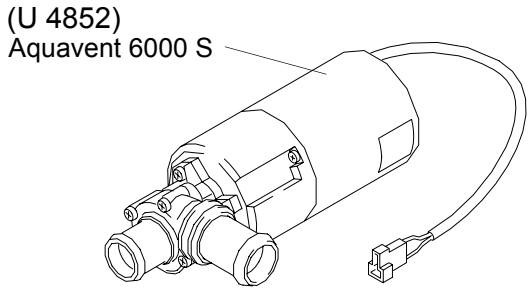
2.12 Circulating pump

The circulating pump which is located externally guarantees that the coolant is conveyed in the vehicle's or the heater's circuit.
The circulating pump is switched on by the control unit and runs throughout the entire operation of the heater.

The heater can be operated with the U4814, the U4851 or the Aquavent 6000 S (U 4852) circulating pump.







2.12.1 The U 4851 and Aquavent 6000 S (U 4852) circulating pumps

The U 4851 / Aquavent 6000 S (U 4852) circulating pump is equipped with a brushless motor.

Soft start
The motor starts slowly and protects its material from wear. It reaches its maximum speed only after approx. 5 seconds.

Protection against dry running
A dry running protection system is integrated into the motor for speeds of 3,300 rpm.

If the motor consumes less than 4 A of current in a timeframe of 1018 revolutions, it detects that it is running dry. The motor is switched off when it goes into error mode (after approx. 10 seconds of operation or approx. 15 seconds after being switched on.

For the Aquavent 6000 S circulating pump (U 4852) the permitted dry running was extended to 45 minutes.

Blocking protection
If the operating speed falls below 57 rpm, the motor is switched off by the error mode after approx. 1 second.

If the motor fails to complete a revolution in 1 second, despite having a current feed , it is switched off by the error mode.

Overload protection
Overload protection is activated after completion of the soft start. In this way, the consumption of current is restricted and the speed is regulated to 5,550 rpm. This means that the motor will not be damaged, by the hydraulic compression of the circulating pump.

Error mode
The motor is switched off by the error mode in the event of faults. After approx. 5 seconds, the motor will be switched from error mode into the power-saving sleep mode.

Sleep mode
In sleep mode, the internal users of the motor's electronic system are switched off. The consumption of current in this mode then amounts to < 2 mA.

Reactivation of the motor
The motor can be reactivated from sleep mode. This is done by disconnecting it from the power supply for approx. 2 minutes. After the voltage supply is restored, the motor will restart in soft start.

Reverse polarity protection
The motor is **not equipped with internal reverse polarity protection**. The wiring harness in conjunction with a15A fuse protect the motor against reverse polarity.

3 Description of function

Depending on how it is equipped, the heater is turned on and off by a switch, a timer or the airconditioning control unit.

An operating indicator light is available to monitor the opearting procedure.

After the heater is switched off ,there is an after-run. (see 3.3 "Switching off".

NOTE.

Below is a description of of the operation cycle with the SG 1585 control unit.

3.1 Switching on

When the heater is switched on, the operating indicator lights up. The combustion air fan and the circulating pump start.

The vacuum switch is shut off at the proper motor speed (low pressure) and the signal is transferred to the control unit and processed.

After approx. 15 seconds, the high voltage ignition spark begins. If there is a shortlived drop in voltage when the heater is switched on in the low voltage range, the lead time is extended.

One second later, the solenoids open in the gas pressure regulator (after another second, the delayed-action solenoid in the gas hose for the NGW 300 opens, if available) and the gas-air mixture is conveyed into the burner by means of the combustion air fan, where it is ignited by high voltage ignition sparks.

At the beginning of the flame monitoring, the ignition spark generator is shut down so that flame detection is not disrupted.

3.2 When the heater is in operation

Once the operating temperature has been reached, the control unit takes over the regulated operation, whereby the temperature of the heat exchanger (cooling liquid) is maintained at a virtually constant level by alternately switching it on and off.

If the temperature rises above the upper switching point of the regulating thermostat, the solenoids in the gas pressure regulator close off the gas supply and the after-run is initiated.

The flame is extinguished, but the combustion air fan and the circulating pump continue to run.

The circulating pump remains in operation during the control pause; the operating indicator lights up.

If the temperature falls to the lower switching point of the regulating thermostat, the heater will be started again and the after-run will be ended.

3.3 Switching off

When the heater is switched off, the solenoids in the gas pressure regulator are closed and combustion ends. The operating indicator light goes out and the after-run begins. The combustion air fan and the circulating pump will be switched off after approx. 125 seconds.

Switching the heater on again during the after-run is permissible. It will restart only after the after-run has ended.

3.4 Fault lock-out

Upon detection of one of the fault characteristics listed below, the heater performs a fault lock-out whereby the operating indicator light goes out. The combustion air fan and the circulating pump will be switched off after 125 seconds.

3.4.1 Faults when the heater is switched on

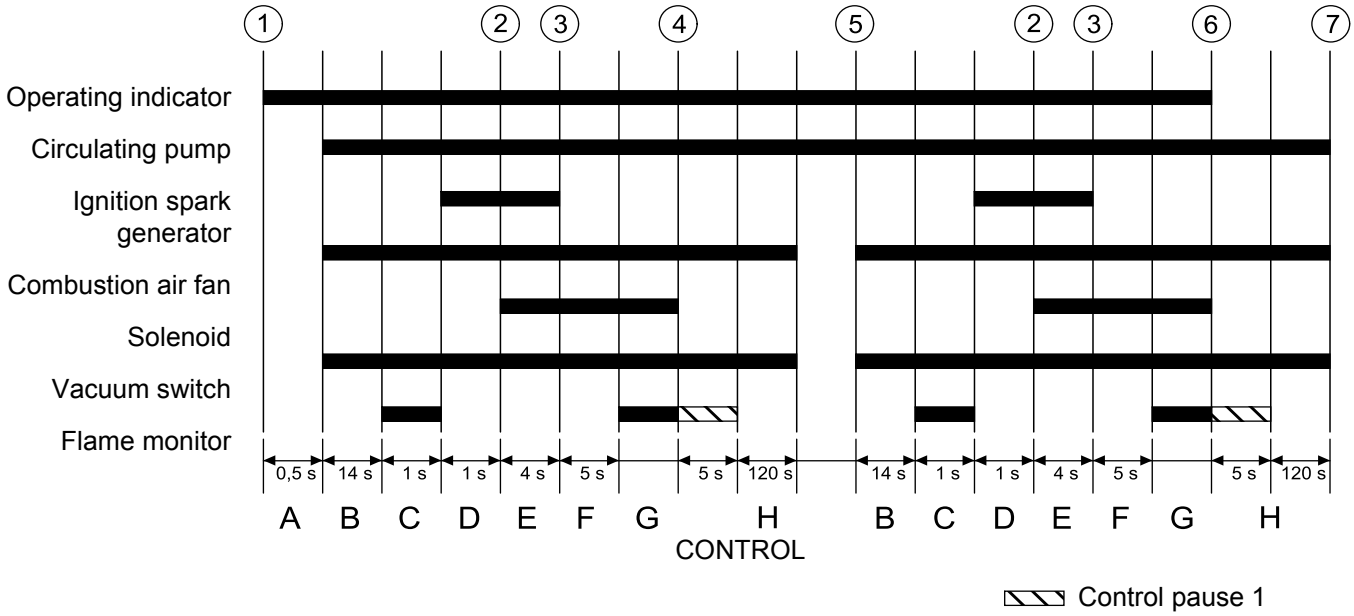
- Interruption of the temperature limiter
- Short circuit of the vacuum switch
- Short circuit of the fan motor
- Short circuit of the circulating pump (when programmed)
- Interruption of the circulating pump (when programmed)
- Short circuit /interruption of the flame monitor mode
- Short circuit of the ignition spark generator

3.4.2 Faults during the starting process

- Intrerruption of the vacuum switch
- Interruption of the temperature limiter
- Solenoid valves don’t open
- Ignition spark generator defect
- Flame monitor electrode defect
- Flame detected in the supply line
- No flame detected after approx. 25 seconds

3.4.3 Faults while the heater is in operation

- Failure to reach the low voltage threshold of < 21.5 V for a duration of 20 seconds
- Interruption of combustion for longer than 10 seconds
- Short circuit /interruption of the flame montor electrode during combustion
- Interruption of the temperature limiter during combustion
- Short circuit / interruption of the solenoid during combustion



(1) Main switch “ON”
(2) Start
(3) Formation of flames
(4) Upper switching threshold
(5) Lower switching threshold
(6) Switch off
(7) Heater off

A Temperature monitoring
B Supply
C Extraneous light monitoring
D Preliminary ignition
E Flame ignition
F Flame stabilisation
G Firing operation
H After-run (control pause 1/

Fig. 301 Operating cycle

3.4.4 Shutdown of the heater when there is low voltage

When there is low voltage of < 21.5 V, a fault lock-out and an after-run occur. The heater is in a holding pattern (control pause). If the voltage goes up again within 20 seconds to > 22.0 V, the heater starts anew.

3.4.5 Shutdown of the heater when theree is low voltage (not a fault lock-out)

If there is high voltage of more than 30 V for longer than 6 seconds, the users are shut down and the heater finds itself in a holding pattern after the after-run.

If the voltage drops again to below 30 V, the heater will switch itself on again.

3.4.6 Fault lock-out when there is a flame but the solenoids are deactivated

Upon detection of a flame when the solenoids have been deactivated by the control unit, the heater is shut down with an error.

In the error after-run , the fan motor is immediately shut down, the circulating pump will continue to run until the end of the error after-run.

– The operating indicator light blinks.

If there is a short circuit in the solenoids, with UB (terminal 30) the heater becomes locked.

The lock may be removed from the heater, only after the cause of the fault has been removed. (see 3.5).

Where there are deactivated albeit permeable solenoids, the heater will not be locked. After the cause of the fault has been eliminated, the heater can be put into operation once more by switching it on, off and on again,

3.4.7 Faults due to overheating /interruption of the temperature limiter

If the heater overheats there is a fault lock-out by means of the temperature limiter and the heater becomes locked after the error after-run.

After the system has cooled down and the cause has been eliminated and the heater has been examined for possible damage, in particular to the cabling, the temperature limiter and the regulating thermostat, the head of the temperature limiter must be reset manually.

Only then can the lock be removed from the heater.

3.5 Removing the heater lock

The heater lock must be removed as follows:

- By means of diagnosis: delete fault memory
  or
- Switch on the heater; in the error after-run, remove the heater from the power supply for 5 seconds (pull the fuse). Restore the power supply and start the heater again.

Blank page for notes

4 Technical data

As long as no limit values are indicated, the technical data refer to the customary heater tolerances of ± 10% at an ambient temperature of + 20°C and at nominal voltage.

Type of gas:
The heaters may only be operated with the kind of gas indicated on the model plate.

PLEASE NOTE
The NGW 300 version of the heaters is set for CNG-Gas with a methane content of more than 95% by volume when it leaves the factory. If the methane content is below 95% by volume (85 -95% by volume), the CO2 content in the exhaust must be reset.

Electrical components:
Control units, the motor for the combustion air blower, the circulating pump, gas pressure regulator solenoids, the delayed-action solenoid, ignition spark generators and pre-selector/timer are designed for 24 V.

Components such as the temperature limiters, regulating thermostats, ignition electrodes, flame monitor electrodes, vacuum switches and switches are not designed for a specific voltage.

PLEASE NOTE
The allocation of circulating pumps to heaters must be done in accordance with the cold water side resistors.

Heater model	**GBW 300**	
Test mark	~ S 330	
Version	NGW 300	LGW 300
Heat flow	30 kW	30 kW
Fuel	CNG (natural gas with a minimum of 95 % methane)	LPG (Propan)
Combustion gas pressure when entering the heater	- 2,5 mbar	- 2,5 mbar
Fuel consumption	3,8 m^3/h (3,15 kg/h)	(2,9 kg/h)
Nominal voltage	24 Volt	24 Volt
Operating voltage range	21 ... 30 Volt	21 ... 30 Volt
Rated power consumption without a circulating pump	110 W	100 W
Pressure regulator used	Landi Renzo, TN 1, 24V	Landi Renzo, SE 81, 24V
Pressure at the pressure regulator intake max/min	220 bar / 8 bar	30 bar / 1,5 bar
Permissible ambient temperature for the heater, control unit and pressure regulator in the engine compartment	Storage temperature -25...+ 100 °C Operating temperature-25...+85 °C	Storage temperature-20... + 100 °C Operating temperature-20...+ 85°C
Permissible ambient temperature for the heater, control unit and pressure regulator in the installation box	Storage temperature- 25 ... + 85 °C Operating temperature-25...+ 60°C	Storage temperature- 20 ... + 85 °C Operating temperature-20...+ 60°C
Permissible operating overpressure	0,4 ... 2,0 bar	0,4 ... 2,0 bar
Heat exchanger filling capacity	1,8 l	1,8 l
Minimum capacity of the circuit system	10,0 l	10,0 l
CO2 in exhaust gas at nominal voltage	8.5 ... 10.5% by volume	10 ... 12 Vol %
Thermostat regulating range	Switches off above 75 ± 3 °C Switches on above 68 ± 3 °C	Switches off above 75 ± 3 °C Switches on above 68 ± 3 °C
Heater dimensions (Tolerance ± 3 mm)	L 620 mm B 246 mm H 220 mm	L 620 mm B 246 mm H 220 mm
Weight: heater pressure regulator	20 kg 3,2 kg	20 kg 2,0 kg

Circulating pump	**U 4814**	**Aquavent 6000 S**
Supply rate	5200 (against 0,15 bar)	6000 (against 0,4 bar)
Nominal voltage	24 Volt	24 Volt
Operating voltage range	20...28 Volt	18...32 Volt
Rated power consumption	104 W	215W
Dimensions (Tolerance ± 3 mm)	L 228,5 mm B 100 mm H 105 mm	L 284 mm B 115 mm H 110 mm
Weight	2,1 kg	2,95 kg

Blank page for notes

5 Troubleshooting and elimination of faults

5.1 General information

This section describes the troubleshooting and the elimination of faults in NGW 300 / LGW 300 and GBW 300 heaters.

ATTENTION

Troubleshooting and the elimination of faults require precise knowledge about the structure and the function of the individual heater components and may only be carried out by expert staff.

If there is any doubt, you can find out how the components function in relationship to one another by reading sections 2 and 3.

ATTENTION

Normally, fault detection is limited to locating the faulty components.
The following causes of faults are not taken into consideration and should be thoroughly checked and/or a fault for this reason should be excluded:

Corrosion of connectors
A loose connection on a plug
Crimping faults on connectors
Corrosion of pipes and fuses
Corrosion of the battery poles

After the elimination of each fault, a functional test must be conducted in the vehicle.

5.2 General fault symptoms

The following table (fig. 501) lists the possible, general fault symptoms.

Fault symptom	**possible cause**
Electrical faults	
The operating indicator light does not go on and the heater fails to function.	• Inadequate voltage supply • Defective fuses • The line to the plugs of the control unit's X2 connection is interrupted
The F1 fuse is activated.	• Short circuit in the circulating pump or in the supply line to the heater • Short circuit in the supply line to the heater/ motor • A defective operating indicator light or wiring to the operating indicator light is interrupted or. shortcircuited
Faults in the water system	
The heater ceases to function correctly, because the connected heat exchangers are not delivering adequate heat.	<u>The flow rate is too low,</u> because • there is air in the heater, in the heat exchangers or in segments of the system • cocks (flow rate regulators) are restricted, dirty or closed • there are impurities in the system, e.g. in narrow places • of the inadequate delivery rate of the circulating pump (air in the pump housing), Inverted rotational direction – check the (cable colours(black + / brown –) Inadequate anti-freeze protection, The system resistance is excessive (particularly high when cold)

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

Fault symptom	possible cause
	• Circulating pump defect <u>Heat exchangers (water/air) supply has too little heat,</u> because • there is air in the heat exchangers or in the system sections • the heat exchange (internal/external) surfaces are dirty • the air intake or output is inadequate • the blower has: an inadequate delivery rate / an incorrect rotation direction / excessive resistance • the proportion of antifreeze agent is too high • the dimensions of the heat exchanger are too small
Rough estimate of the flow rate Flow rate in [l/h] = $\frac{\text{Heat supply [kW] according to model plate}}{\text{Temperature difference } \Delta t \text{ in [K] or [°C] between the water input and output, measured at the heater (e.g. with a contact thermometer)}} \times 860$	
Faults in the gas supply	
No fuel supply to the heater	• empty gas tank • bent, closed, clogged or leaky lines • frozen water inlets in the gas regulator or in the gas line • contaminated gas filters in the gas filter regulators • closed gas supply valve • solenoids don't open • defective gas pressure regulator • defective vacuum switch • defective delayed-action solenoid
Faults in combustion	• the speed of the combustion air fan is too low • defective combustion air fan • restricted combustion air supply • restricted gas supply • the methane content of the gas doesn't match requirements (min. 95% by volume) • contaminated combustion air intake grille

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

6 Function tests

6.1 General information

This section decribes the tests on heaters in both their installed and dismounted states to prove that they are operating properly.

CAUTION

Heaters should not be operated in closed spaces such as garages or workshops without an exhaust system.

Due to the danger of fire, do not switch on the heater if the burner head is dismantled.

6.2 Combustion test

6.2.1 Test of CO_2content

The CO_2content in the exhaust gas must be measured:

- as part of a function test
- if there are irregularities in combustion
- after the burner has been repaired
- after the gas pressure regulator has been replaced
- when refitting the delayed-action solenoid in the NGW 300 heater
- when retrofitting NGW 300 and LGW 300 heaters with an adjustable nozzle
- for the operation of the NGW 300 heater with CNG (natural gas) whose methane content is below 95 % by volume
- after the installation of a replacement burner

PLEASE NOTE

The CO_2values for the NGW 300 replacement burner are set at the factory for utilisation with the delayed-action solenoid.

The CO_2-content must be in the following range:

The NGW 300 heater and the GBW 300 heater in the NGW 300 version	8.5 to 10.5 % by volume
The LGW 300 heater and the GBW 300 heater in the LGW 300 version	10.0 to 12.0 % by volume

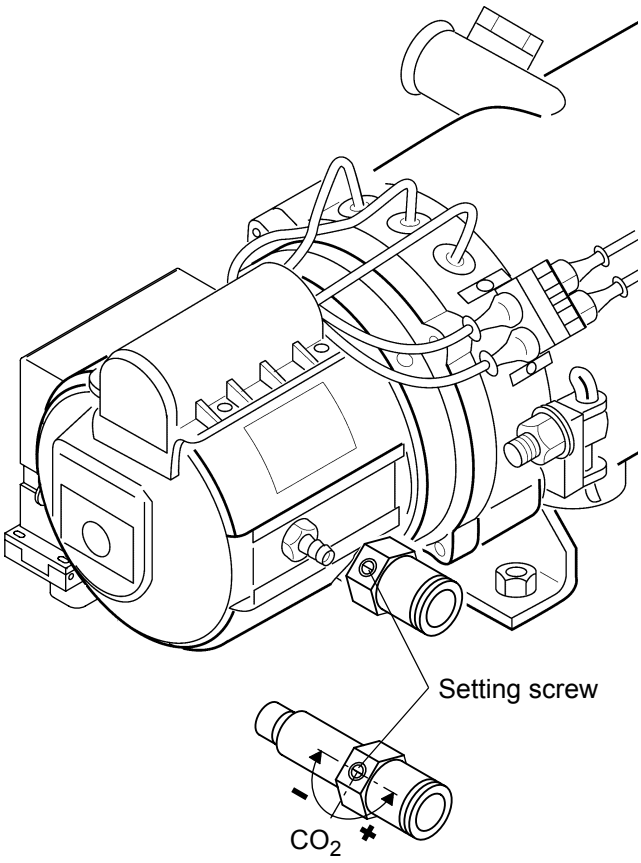
PLEASE NOTE

In heaters that have not yet been equipped with a gas intake nozzle, no adjustment of the CO_2-setting is possible.
These heaters should be retrofitted with the adjustable gas inlet nozzle, in order to set the CO_2value correctly.

For heaters which are already equipped with the adjustable gas inlet nozzle the CO_2content can be set at the setting screw (Fig.. 601).

The following tool is needed for this:

- NGW 300 — a 6 mm Allen key
- LGW 300 — a 4 mm Allen key



PLEASE NOTE

When setting the CO_2, turn the setting screw carefully, as even a slight turn will have a strong effect on the CO_2-value.

Fig. 601 Setting the CO_2-content

6.3 Tests of individual components

6.3.1 Test of the regulating thermostat

PLEASE NOTE

The regulating thermostat must be firmly screwed in (by hand) and the protective cap must be mounted. The cables must not be damaged.

Test

During the test with a digital multimeter the the flow rate of the regulating thermostat should be checked.

Switching temperature:

– opens at 75 ± 3 °C
– closes at 68 ± 5 °C

At room temperature the contact is closed. When it heats to above the upper switching point, it is opened.

6.3.2 Temperature limiter test

ATTENTION

The retaining spring must be in the temperature limiter's slot and must be locked in place on both sides of the housing. Union. The cables must not be damaged and must not be located above the release button.

Test

During the test with a digital multimeter the the flow rate of the regulating thermostat should be checked.

Switching temperature:

– opens at 125 °C +8 /-4 °C

When it cools down, the temperature limiter remains open until approx. 5 °C. Once it reaches a temperature below 90 °C, it can be reset by pressing the button.

6.3.3 Test of the ignition electrodes

PLEASE NOTE

The insulating material of the ignition electrodes must not show any sign of damage or cracks. Ignition electrodes with an electrode clearance outside of the tolerance or ignition electrodes which are not working flawlessly must be replaced

Test

– Examine the insulation material of the ignition electrodes for damage.
– Check the electrode clearance in accordance with figure. 602 and the condition of the ignition electrodes.

6.3.4 Test of the flame monitor electrode

PLEASE NOTE

The insulating material of the ignition electrodes must not show any sign of damage or cracks. If a flame monitor electrode is not working perfectly, it should be replaced.

Test

– Examine the insulating material of the flame monitor electrode for damage.
– Check the electrode clearance in accordance with fig. 602 and the status of the flame monitor electrode.

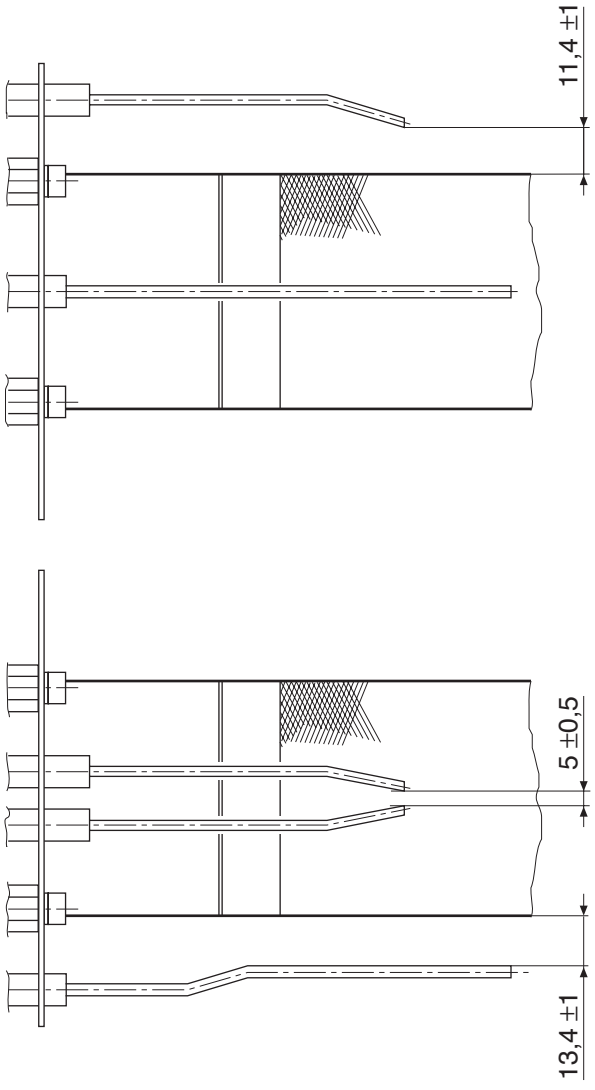


Fig. 602 Testing the electrode clearances

6.3.5 Testing the ignition spark generator

CAUTION

High voltage! On the ignition electrodes, a voltage of approx. 8,000 V arcs over.

ATTENTION

Do not supply voltage to the ignition spark generator without ignition electrodes.

PLEASE NOTE

Damaged sleeves or sleeves which were not pushed up far enough to seal the ignition electrodes will lead to arc-over here when there is moisture (condensation) present

Test

– Use direct current voltage of 24 V (positive on the black line; negative on the brown line).
– Target status: ignition sparks on the ignition electrodes jump over.

6.3.6 Test of the burner motor

PLEASE NOTE

Testing of the combustion air motor is conducted when it is installed. If the target values are not achieved, the motor is replaced.

Test

– Examine the motor for the quality of its bearings (sluggishness)
– Measure the rpm
  Target rpm at 24 V: 5800 ± 580 min^{-1}

6.3.7 Vacuum switch test

Test

– Check plug contacts for corrosion and to make sure that they are firmly attached.
– Examine the general condition of the hose to the gas mixer and check for damage.
– Examine the vacuum switch's housing for cracks or other damage.
– Examination of the switching function
  Target values:
  The vacuum switch is open without low pressure.
  The vacuum switch must be shut when the low pressure is 2.5 ± 0.5 mbar.

6.3.8 Gas pressure regulator test

ATTENTION

The gas pressure regulator must not be disassembled.

PLEASE NOTE

Testing is done when the heater is installed.

6.3.8.1 General test

– Testing plug contacts for corrosion and to make sure that they are firmly attached.
– Was the gas pressure regulator replaced after 4 years of operation?
– When the heater is switched off, no gas may escape through the outlet to the heater or when solenoids are open.
– The supply line connection must be checked for impermeability

6.3.8.2 Test of the intake valve on the gas pressure regulator

During the firing operation, disconnect the plug connection to the inlet valve, The enrichment valve and the delayed-action solenoid in the gas intake pipe (in the NGW 300) must still be controlled Combustion must stop immediately.
If combustion doesn't stop immediately, the gas pressure regulator must be replaced.

6.3.8.3 Examination of the functioning of the enrichment valve on the gas pressure regulator

During the firing operation and under **hot running** conditions, disconnect the plug connection to the enrichment valve. The CO_2-content of the exhaust gas must drop considerably (1,5 - 3 %).
If the CO_2doesn't change, the gas pressure regulator must be replaced.

6.3.8.4 Testing the safety valve on the gas pressure regulator

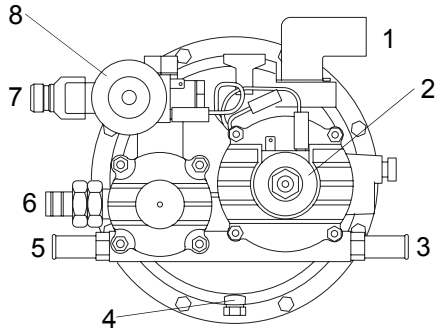
If the intake valve is open (applicable to CNG gas pressure regulators, only), no gas must escape at the safety valve's hose connection.
If gas escapes, the gas pressure regulator must be replaced.

6.3.8.5 Checking for accumulations of oil and condensation in the gas pressure regulator

Possible accumulations of oil and condensate must be drained by unscrewing the drain plug on the gas pressure regulator. If larger amounts have accumulated, testing must be done to establish whether the quarterly draining interval was adhered to. If the result is positive, the interval must be shortened.
In the event that solid particulate matter is found in the oil/condensate, the gas pressure regulator must be replaced. After the test, the drain plug for the CNG (NGW 300) gas pressure regulator must be screwed in with a tightening torque of 8 ±1 Nm. The drain plug for the LPG (LGW 300) gas pressure regulator must be handscrewed.

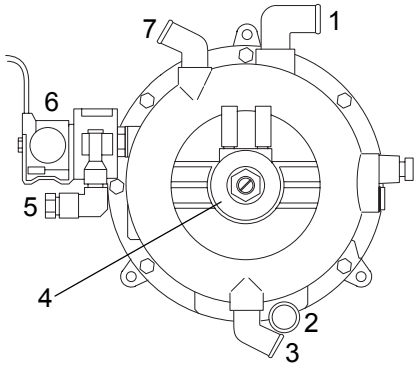
PLEASE NOTE

- For installed gas pressure regulator equipment with an overhead drain plug, the oil/condensate can be drained by means of the gas outlet of the gas pressure regulator (1, fig. 603 u. 604). To accomplish this, dismount the gas hose from the gas pressure regulator and drain the oil/condensate out of the gas pressure regulator and the gas hose.
- If the gas pressure regulator's connection port is not accessible, then the oil/condensate can be drained by dismounting the gas hose at the heater or via the gas hose at the inlet of the delayed-action solenoid. Therefore, the gas hose must be directed downwards.
- Finally, reconnect the gas hose and secure with hose clamps.



1 Gas outlet to the heater
2 Enrichment valve
3 Water outlet
4 Drain plug (oil)
5 Water inlet
6 Safety valve
7 Gas inlet from the storage tank
8 Intake valve

Fig. 603 CNG (NGW 300) Gas pressure regulator test



1 Gas outlet to the heater
2 Drain plug (oil)
3 Water inlet
4 Enrichment valve
5 Gas inlet from the storage tank
6 Intake valve
7 Water outlet

Fig. 604 LPG (LGW 300) Gas pressure regulator test

6.3.9 Test of the delayed-action solenoid in the gas intake pipe

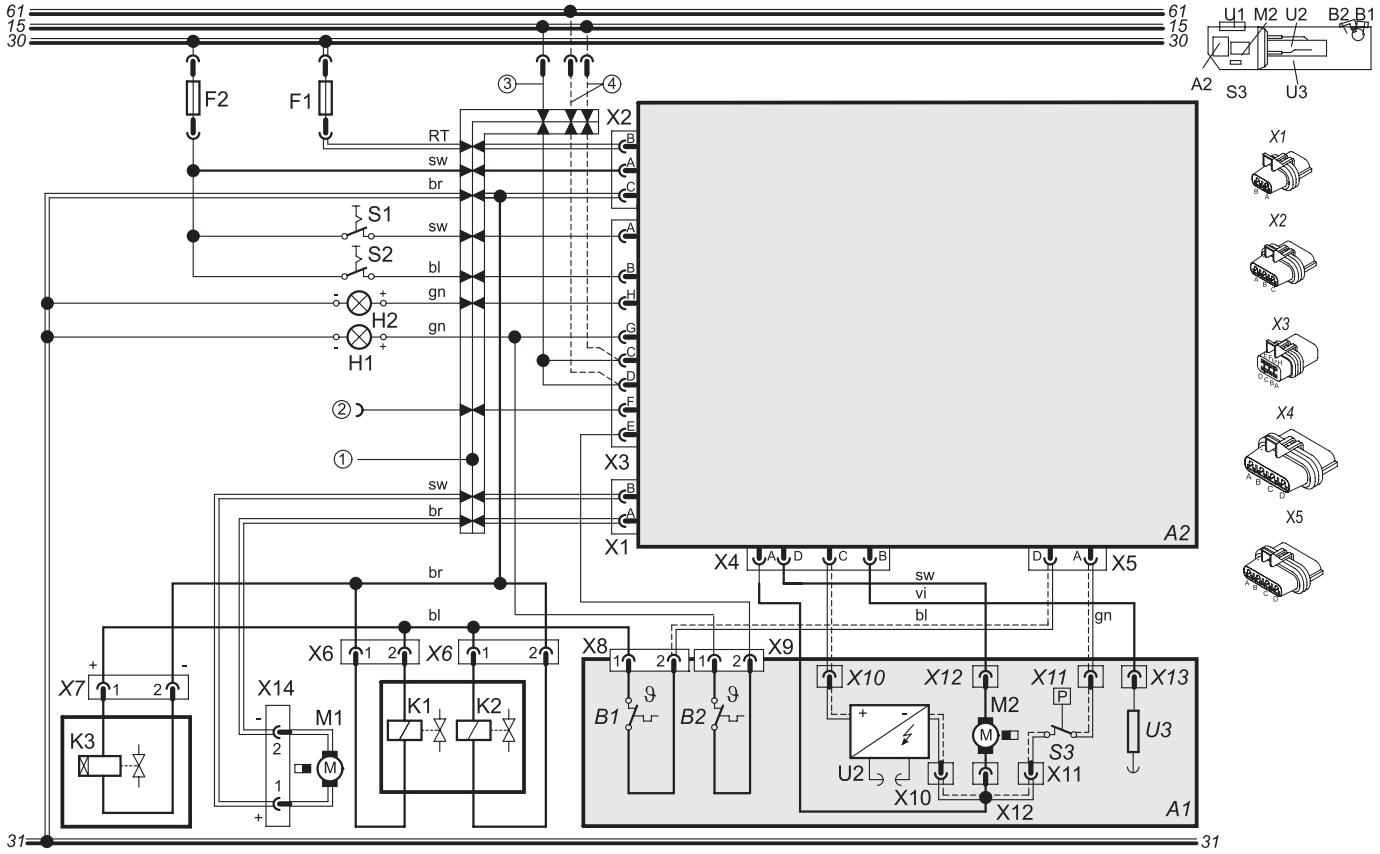
Test

– Use 24 V direct current voltage.
Target state:
the solenoid must open after a delay of 1 second.
If the time is exceeded or undershot by
0.5 seconds, the delayed–action solenoid must be replaced.

7 Wiring diagrams

7.1 General information

Figures. 701 to 709 show the system wiring diagrams of the heaters with switches and/or timers and vehicle-specific circuits.



① Interface for vehicle plug connection,(customised)

② W-Bus diagnosis

③ Not required for the USA/Canada

④ USA/Kanada

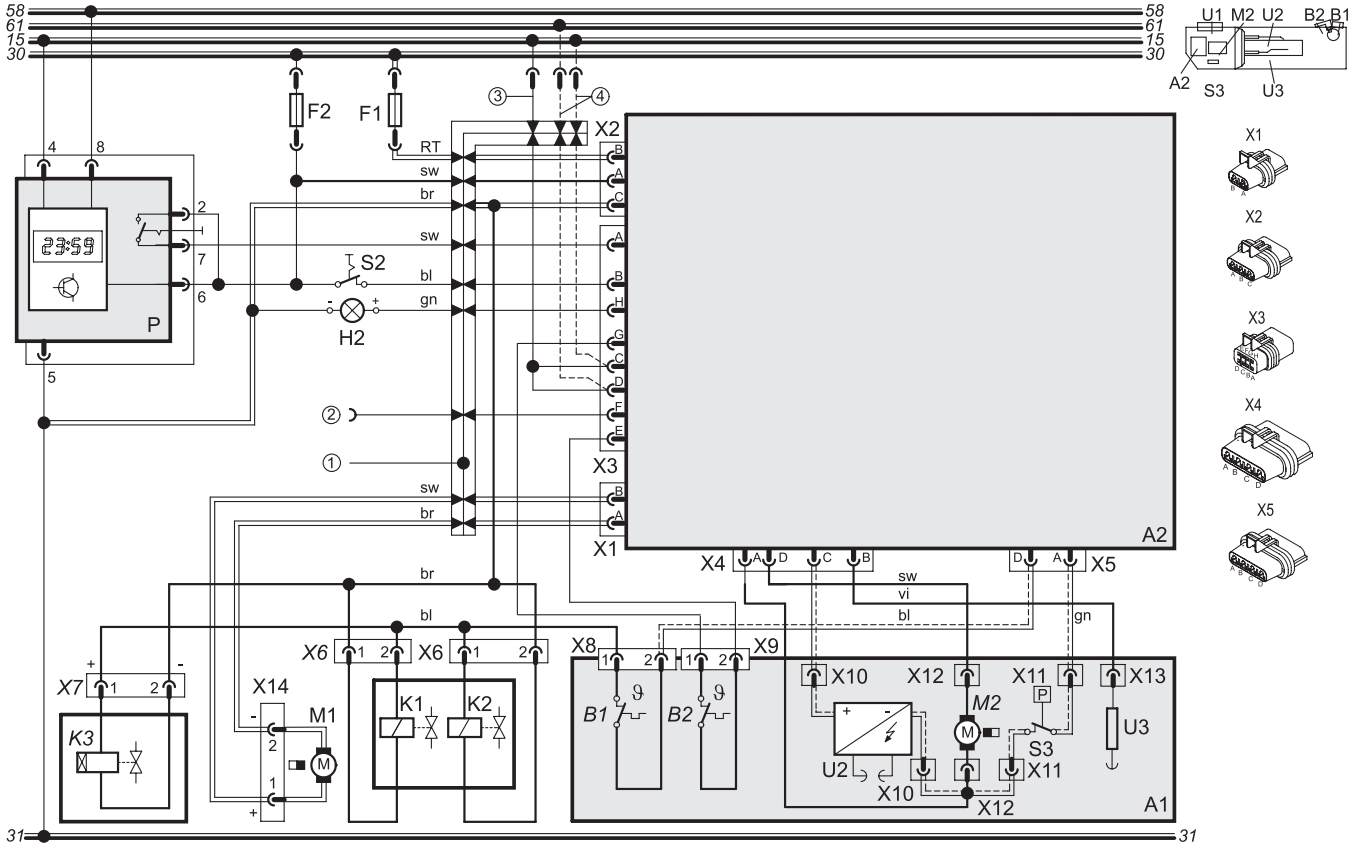
Cable colours	
bl	blue
br	brown
ye	yellow
gn	green
gr	grey
or	orange
rd	red
bk	black
vi	violet
wh	white

Cable cross sections		
	< 7,5 m	7,5 - 15 m
———	0,75 mm²	1,5 mm²
— — —	1,0 mm²	1,5 mm²
———	1,5 mm²	2,5 mm²
———	2,5 mm²	4,0 mm²
———	4,0 mm²	6,0 mm²

Item	Designation	Comment
A1	Heater	NGW 300 / LGW 300
A2	Conrol unit	
B1	Temperature limiter	
B2	Regulating thermostat	
F1	25 A fuse	DIN 72581
F2	5 A fuse	DIN 72581
H1	Lights	Operating indicator
H2	Lights	Flame indicator
K1	Solenoid	High pressure
K2	Solenoid	Low pressure
K3	Solenoid (1 sec.delayed action)	only for the NGW
M1	Motor	Circulating pump
M2	Motor	Combustion air fan
S1	ON/OFF switch	Heater
S2	ON/OFF switch	Remote-controlled circulating pump
S3	Vacuum switch	

Item	Designation	Comment
U2	Ignition electrode	
U3	Flame monitor electrode	
X1	2-pin plug connection	A2 control unit
X2	4-pin plug connection	A2 control unit
X3	8-pin plug connection	A2 control unit
X4	4-pin plug connection	A2 control unit
X5	4-pin plug connection	A2 control unit
X6	2-pin plug connection	Pressure regulator
X7	2-pin plug connection	Delayed-action solenoid
X8	2-pin plug connection	Temperature limiter
X9	2-pin plug connection	Regulating thermostat
X10	1-pin plug connection	Ignition spark generator
X11	1-pin plug connection	Vacuum switch
X12	1-pin plug connection	Combustion air fan
X13	1-pin plug connection	Flame semsor
X14	2-pin plug connection	Circulating pump

Fig. 701 Basic wiring for the NGW 300 / LGW 300 / GBW 300 with a switch



① Interface for vehicle plug connection (customised)

② W-Bus diagnosis

③ Not required in the USA/Canada

④ USA/Canada

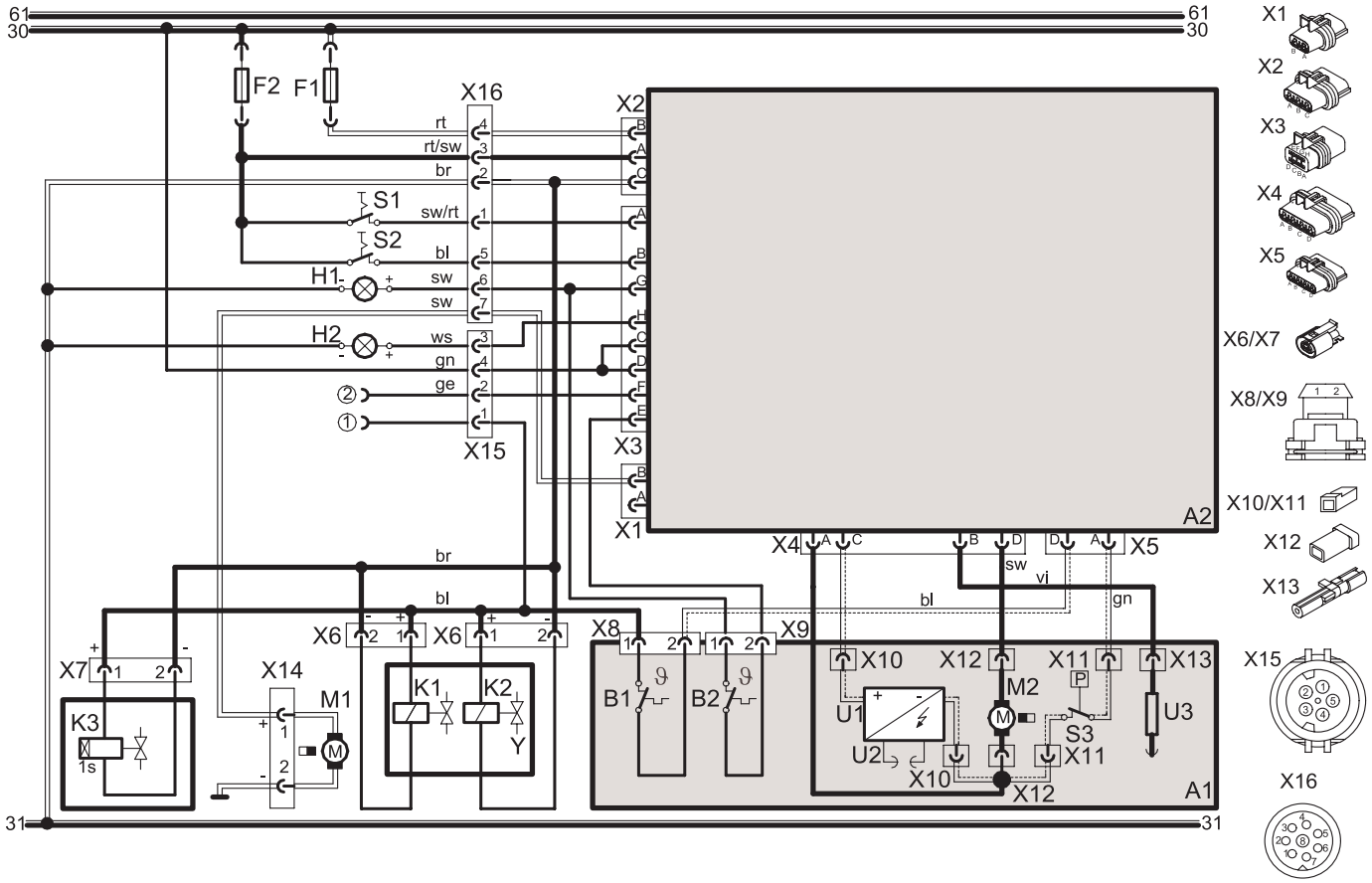
Cable cross sections		
	< 7,5 m	7,5 - 15 m
	0,75 mm²	1,5 mm²
	1,0 mm²	1,5 mm²
	1,5 mm²	2,5 mm²
	2,5 mm²	4,0 mm²
	4,0 mm²	6,0 mm²

Cable colours	
bl	blue
br	brown
ye	yellow
gn	green
gr	grey
or	orange
rd	red
bk	black
vi	violet
wh	white

Item	Designation	Comment
A1	Heater	NGW 300 / LGW 300
A2	Conrol unit	
B1	Temperature limiter	
B2	Regulating thermostat	
F1	25 A fuse	DIN 72581
F2	5 A fuse	DIN 72581
H2	Lights	Flame indicator
K1	Solenoid	High pressure
K2	Solenoid	Low pressure
K3	Solenoid (1 sec.delayed action)	only for the NGW
M1	Motor	Circulating pump
M2	Motor	Combustion air fan
P	Timer	
S2	ON/OFF switch	Remote-controlled circulating pump
S3	Vacuum switch	

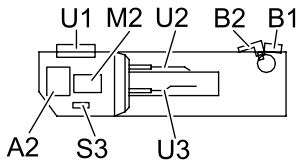
Item	Designation	Comment
U2	Ignition electrode	
U3	Flame monitor electrode	
X1	2-pin plug connection	A2 control unit
X2	4-pin plug connection	A2 control unit
X3	8-pin plug connection	A2 control unit
X4	4-pin plug connection	A2 control unit
X5	4-pin plug connection	A2 control unit
X6	2-pin plug connection	Pressure regulator
X7	2-pin plug connection	Delayed-action solenoid
X8	2-pin plug connection	Temperature limiter
X9	2-pin plug connection	Regulating thermostat
X10	1-pin plug connection	Ignition spark generator
X11	1-pin plug connection	Vacuum switch
X12	1-pin plug connection	Combustion air fan
X13	1-pin plug connection	Flame semsor

Abb. 702 Basic wiring for the NGW 300 / LGW 300 / GBW 300 with a timer



① Reglator control outlet

② W-Bus diagnosis



Line colours	
bl	blue
br	brown
ye	yellow

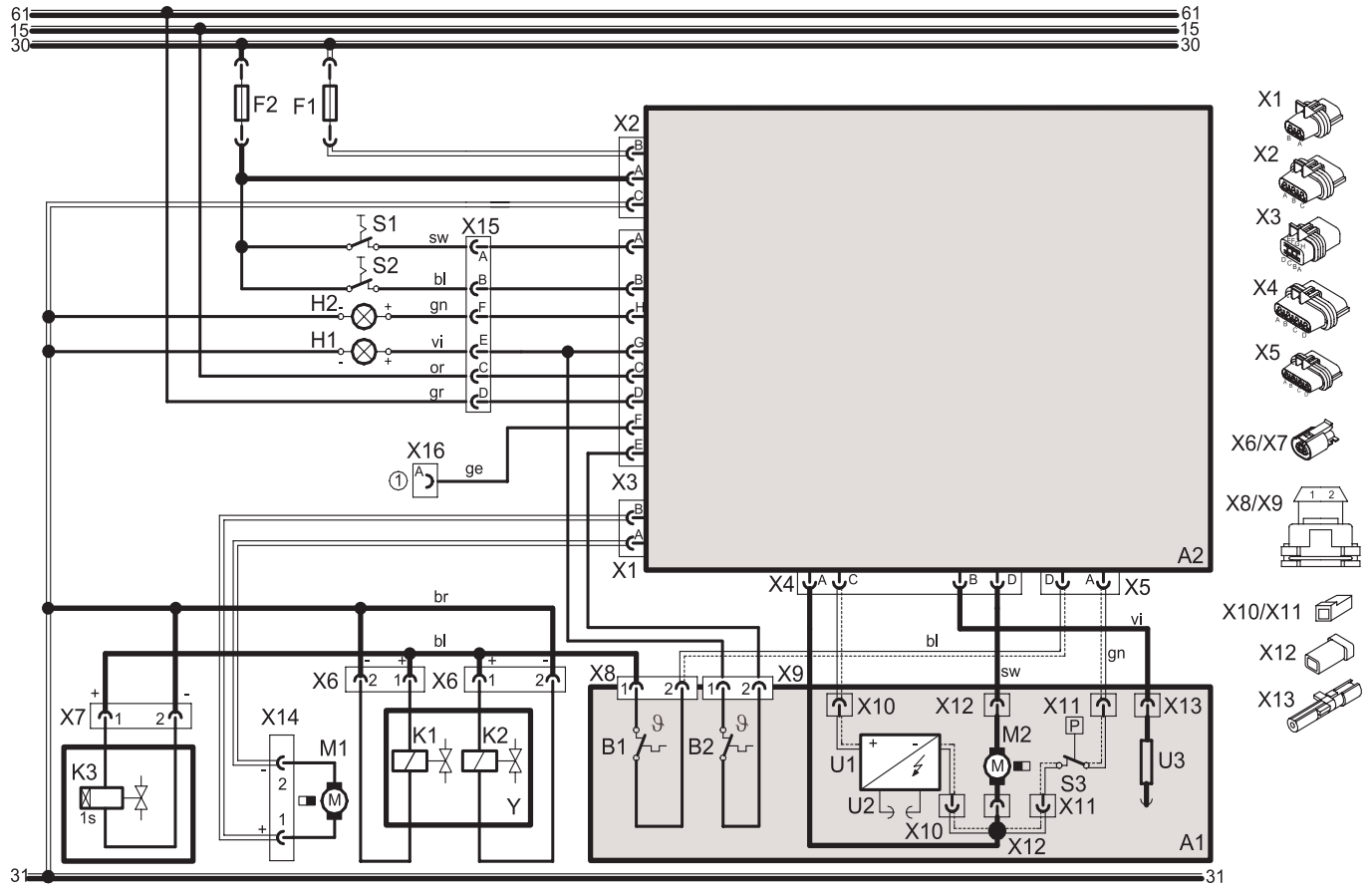
Cable cross sections		
	< 7,5 m	7,5 - 15 m
	0,75 mm²	1,5 mm²
	1,0 mm²	1,5 mm²
	1,5 mm²	2,5 mm²
	2,5 mm²	4,0 mm²
	4,0 mm²	6,0 mm²

Cable colours	
bl	blue
br	brown
ye	yellow
gn	green
gr	grey
or	orange
rd	red
bk	black
vi	violet
wh	white

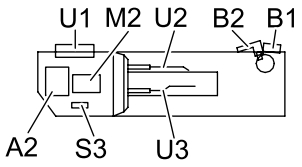
Item	Designation	Comment
A1	Heater	GBW 300
A2	Conrol unit	
B1	Temperature limiter	
B2	Regulating thermostat	
F1	25 A fuse	DIN 72581
F2	5 A fuse	DIN 72581
H1	Lights	Operating indicator
H2	Lights	Flame indicator
K1	Solenoid	High pressure
K2	Solenoid	Low pressure
K3	Solenoid (1 sec.delayed action)	only for the NGW
M1	Motor	Circulating pump
M2	Motor	Combustion air fan
S1	ON/OFF switch	Heater
S2	ON/OFF switch	Remote-controlled circulating pump
S3	Vacuum switch	
U1	Ignition spark generator	

Item	Designation	Comment
U2	Ignition electrode	
U3	Flame monitor electrode	
X1	2-pin plug connection	A2 control unit
X2	4-pin plug connection	A2 control unit
X3	8-pin plug connection	A2 control unit
X4	4-pin plug connection	A2 control unit
X5	4-pin plug connection	A2 control unit
X6	2-pin plug connection	Pressure regulator
X7	2-pin plug connection	Delayed-action solenoid
X8	2-pin plug connection	Temperature limiter
X9	2-pin plug connection	Regulating thermostat
X10	1-pin plug connection	Ignition spark generator
X11	1-pin plug connection	Vacuum switch
X12	1-pin plug connection	Combustion air fan
X13	1-pin plug connection	Flame sensor
X14	2-pin plug connection	Circulating pump
X15	5-pin plug connection	Vehicle interface
X16	8-pin plug connection	Vehicle interface
Y	Pressure regulator	

Fig. 703 System wiring for the GBW 300 - MAN



① W-Bus diagnosis



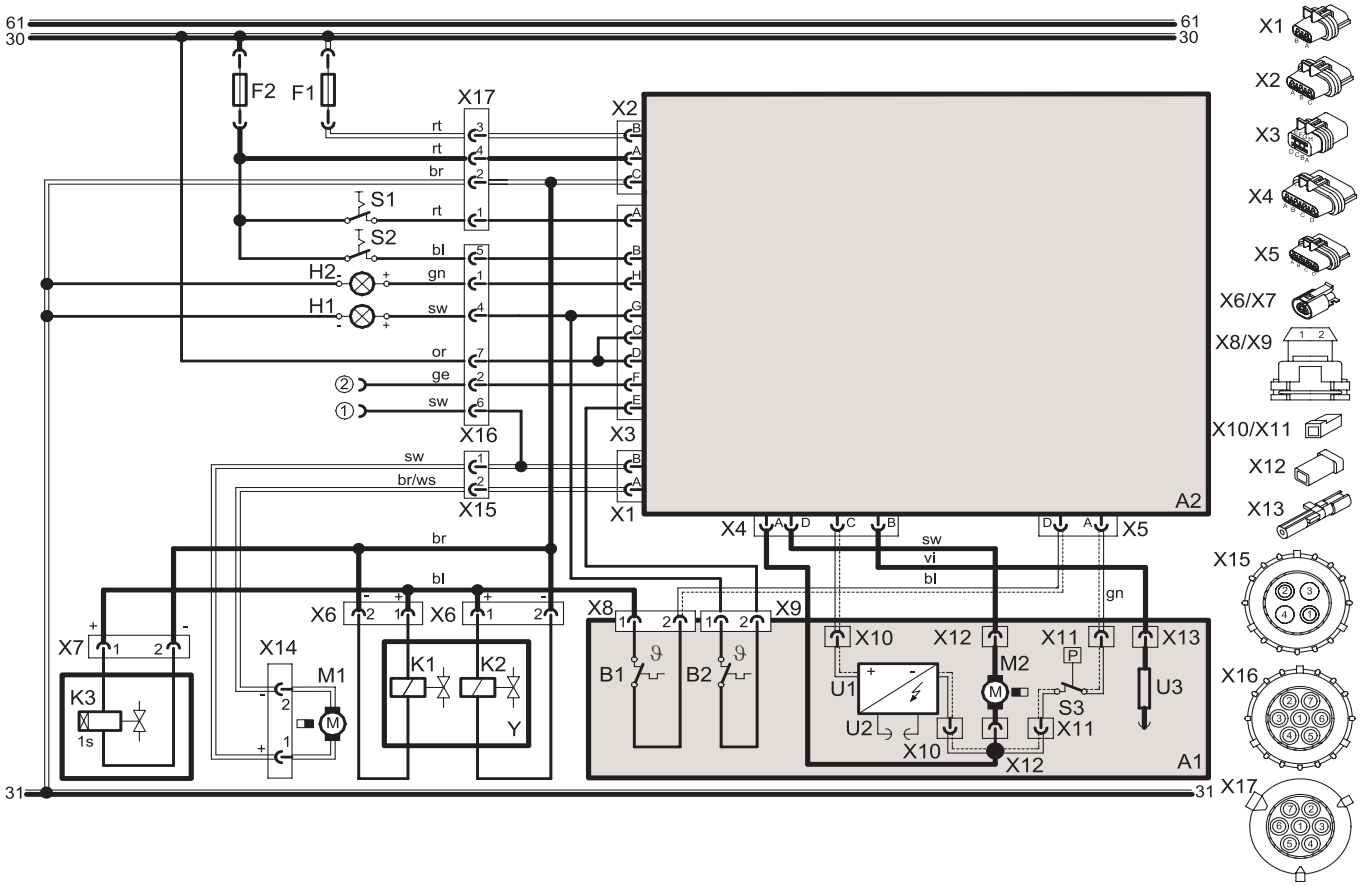
Cable cross sections		
	< 7,5 m	7,5 - 15 m
	0,75 mm²	1,5 mm²
	1,0 mm²	1,5 mm²
	1,5 mm²	2,5 mm²
	2,5 mm²	4,0 mm²
	4,0 mm²	6,0 mm²

Cable colours	
bl	blue
br	brown
ye	yellow
gn	green
gr	grey
or	orange
rd	red
bk	black
vi	violet
wh	white

Item	Designation	Comment
A1	Heater	GBW 300
A2	Control unit	
B1	Temperature limiter	
B2	Regulating thermostat	
F1	25 A fuse	DIN 72581
F2	5 A fuse	DIN 72581
H1	Lights	Operating indicator
H2	Lights	Flame indicator
K1	Solenoid	High pressure
K2	Solenoid	Low pressure
K3	Solenoid (1 sec.delayed action)	only for the NGW
M1	Motor	Circulating pump
M2	Motor	Combustion air fan
S1	ON/OFF switch	Heater
S2	ON/OFF switch	Remote-controlled circulating pump
S3	Vacuum switch	
U1	Ignition spark generator	

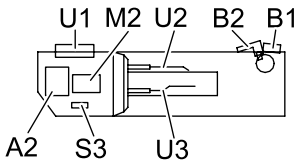
Item	Designation	Comment
U2	Ignition electrode	
U3	Flame monitor electrode	
X1	2-pin plug connection	A2 control unit
X2	4-pin plug connection	A2 control unit
X3	8-pin plug connection	A2 control unit
X4	4-pin plug connection	A2 control unit
X5	4-pin plug connection	A2 control unit
X6	2-pin plug connection	Pressure regulator
X7	2-pin plug connection	Delayed-action solenoid
X8	2-pin plug connection	Temperature limiter
X9	2-pin plug connection	Regulating thermostat
X10	1-pin plug connection	Ignition spark generator
X11	1-pin plug connection	Vacuum switch
X12	1-pin plug connection	Combustion air fan
X13	1-pin plug connection	Flame sensor
X14	2-pin plug connection	Circulating pump
X15	6-pin plug connection	Vehicle interface
X16	3-pin plug connection	Vehicle interface
Y	Pressure regulator	

Fig. 704 System wiring for the GBW 300 - USA



① UP control signal

② W-Bus diagnosis



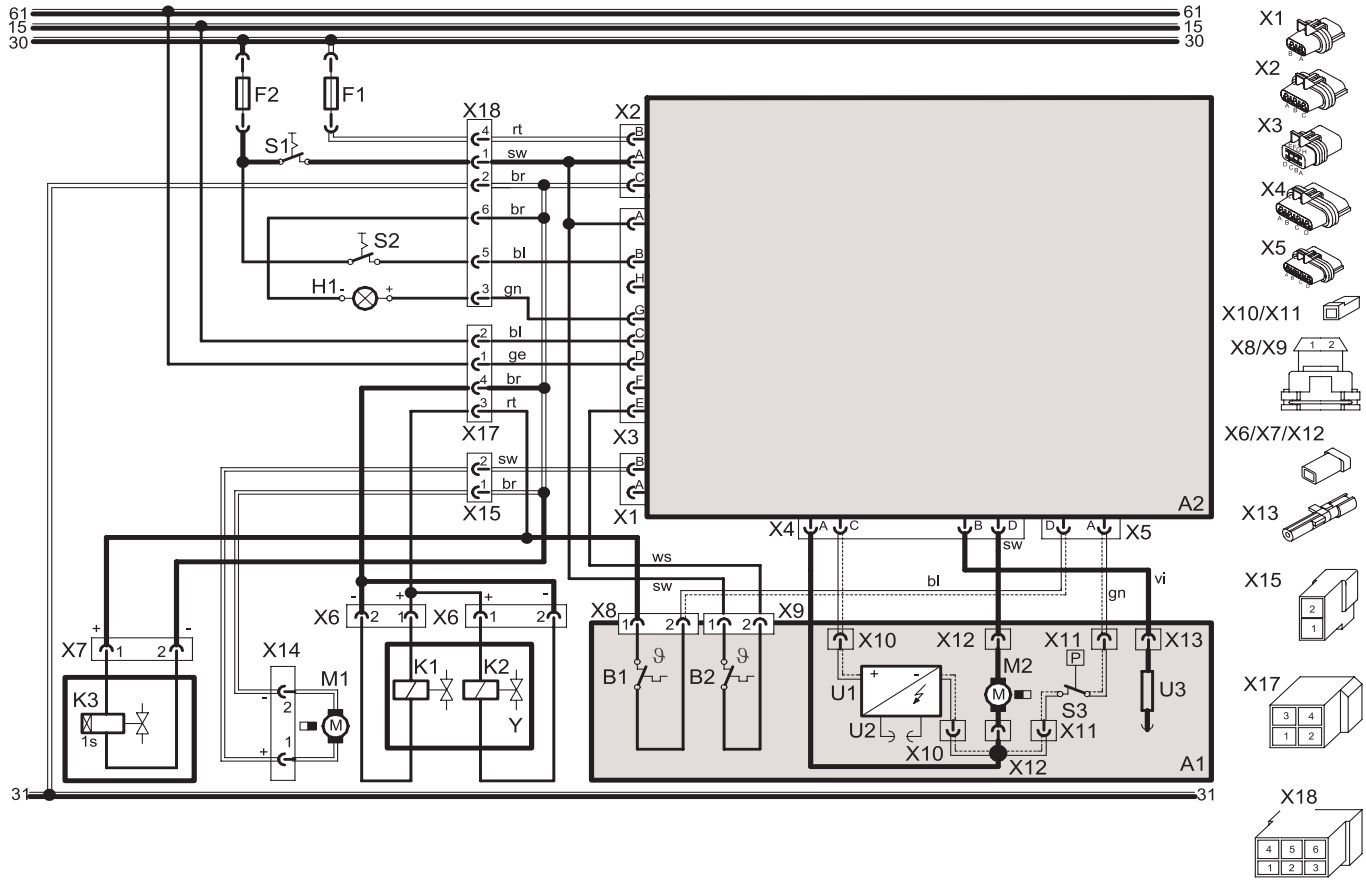
Cable cross sections		
	< 7,5 m	7,5 - 15 m
	0,75 mm²	1,5 mm²
	1,0 mm²	1,5 mm²
	1,5 mm²	2,5 mm²
	2,5 mm²	4,0 mm²
	4,0 mm²	6,0 mm²

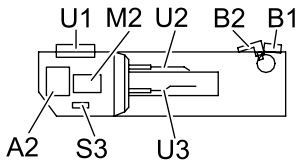
Cable colours	
bl	blue
br	brown
ye	yellow
gn	green
gr	grey
or	orange
rd	red
bk	black
vi	violet
wh	white

Item	Designation	Comment
A1	Heater	GBW 300
A2	Control unit	
B1	Temperature limiter	
B2	Regulating thermostat	
F1	25 A fuse	DIN 72581
F2	5 A fuse	DIN 72581
H1	Lights	Operating indicator
H2	Lights	Flame indicator
K1	Solenoid	High pressure
K2	Solenoid	Low pressure
K3	Solenoid (1 sec.delayed action)	only for the NGW
M1	Motor	Operating indicator
M2	Motor	Circulating pump
S1	ON/OFF switch	Combustion air fan
S2	ON/OFF switch	Remote-controlled circulating pump
S3	Vacuum switch	
U1	Ignition spark generator	
U2	Ignition electrode	

Item	Designation	Comment
U3	Flame monitor electrode	
X1	2-pin plug connection	A2 control unit
X2	4-pin plug connection	A2 control unit
X3	8-pin plug connection	A2 control unit
X4	4-pin plug connection	A2 control unit
X5	4-pin plug connection	A2 control unit
X6	2-pin plug connection	Pressure regulator
X7	2-pin plug connection	Solenoid (delayed-action)
X8	2-pin plug connection	Temperature limiter
X9	2-pin plug connection	Regulating thermostat
X10	1-pin plug connection	Ignition spark generator
X11	1-pin plug connection	Vacum switchr
X12	1-pin plug connection	Combustion air fan
X13	1-pin plug connection	Flame sensor
X14	2-pin plug connection	Circulating pump
X15	4-pin plug connection	Vehicle interface
X16	7-pin plug connection	Vehicle interface
X17	7-pin plug connection	Vehicle interface
Y	Pressure regulator	

Fig. 705 System wiring for the GBW 300 (standard and DC)





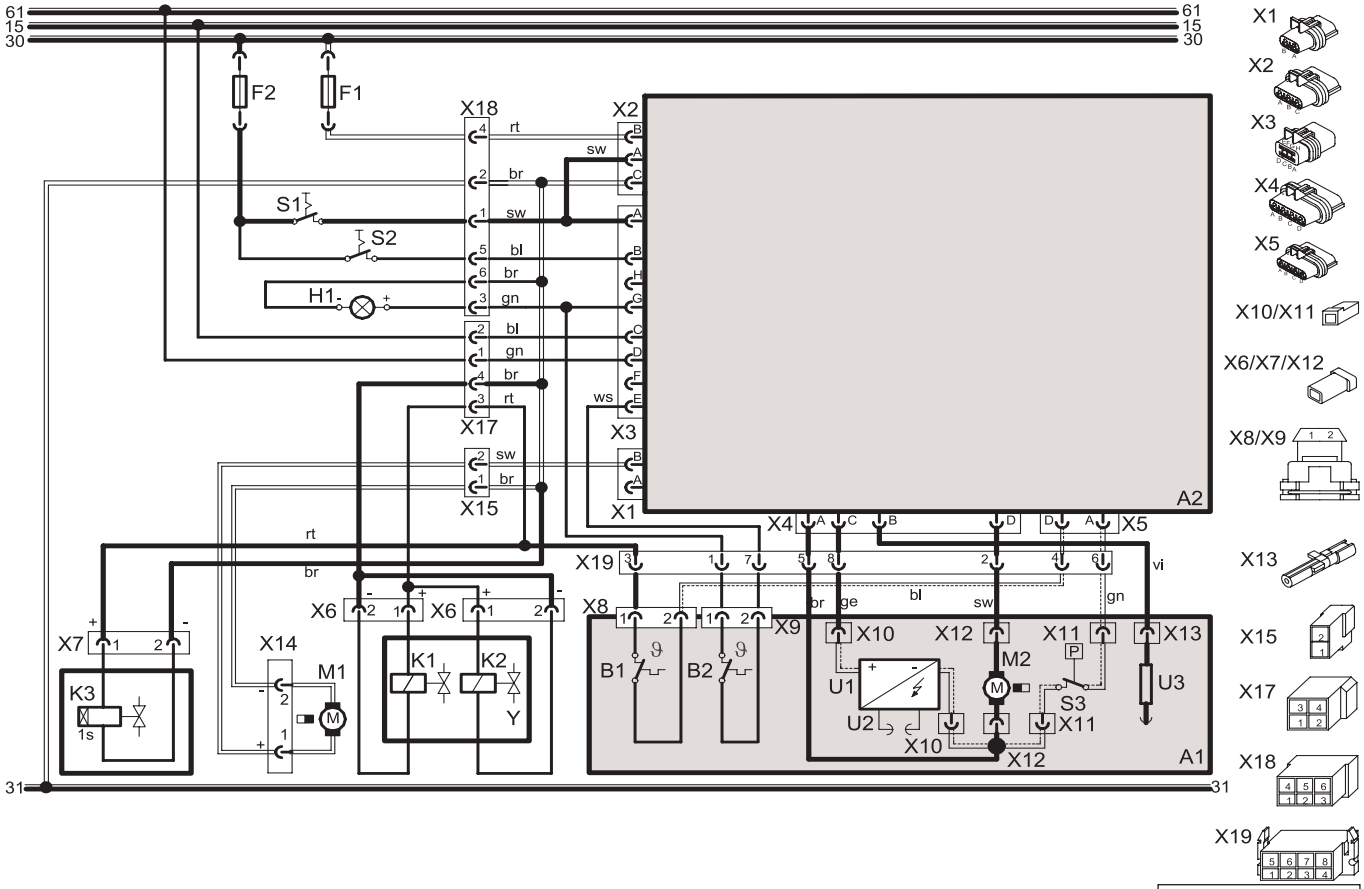
Cable cross sections		
	< 7,5 m	7,5 - 15 m
	0,75 mm²	1,5 mm²
	1,0 mm²	1,5 mm²
	1,5 mm²	2,5 mm²
	2,5 mm²	4,0 mm²
	4,0 mm²	6,0 mm²

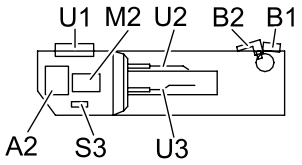
Cable colours	
bl	blue
br	brown
ye	yellow
gn	green
gr	grey
or	orange
rd	red
bk	black
vi	violet
wh	white

Item	Designation	Comment
A1	Heater	NGW 300
A2	Control unit	
B1	Temperature limiter	
B2	Regulating thermostat	
F1	25 A fuse	DIN 72581
F2	5 A fuse	DIN 72581
H1	Lights	Operating indicator
K1	Solenoid	High pressure
K2	Solenoid	Low pressure
K3	Solenoid (1 sec.delayed action)	only for the NGW
M1	Motor	Circulating pump
M2	Motor	Combustion air fan
S1	ON/OFF switch	Heater
S2	ON/OFF switch	Remote-controlled circulating pump
S3	Vacuum switch	
U1	Ignition spark generator	
U2	Ignition electrode	

Item	Designation	Comment
U3	Flame monitor electrode	
X1	2-pin plug connection	A2 control unit
X2	4-pin plug connection	A2 control unit
X3	8-pin plug connection	A2 control unit
X4	4-pin plug connection	A2 control unit
X5	4-pin plug connection	A2 control unit
X6	2-pin plug connection	Pressure regulator
X7	2-pin plug connection	Solenoid (delayed-action)
X8	2-pin plug connection	Temperature limiter
X9	2-pin plug connection	Regulating thermostat
X10	1-pin plug connection	Ignition spark generator
X11	1-pin plug connection	Vacum switch
X12	1-pin plug connection	Combustion air fan
X13	1-pin plug connection	Flame sensor
X14	2-pin plug connection	Circulating pump
X15	2-pin plug connection	Vehicle interface
X17	4-pin plug connection	Vehicle interface
X18	6-pin plug connection	Vehicle interface
Y	Pressure regulator	

Fig. 706 System wiring for the NGW IVECO





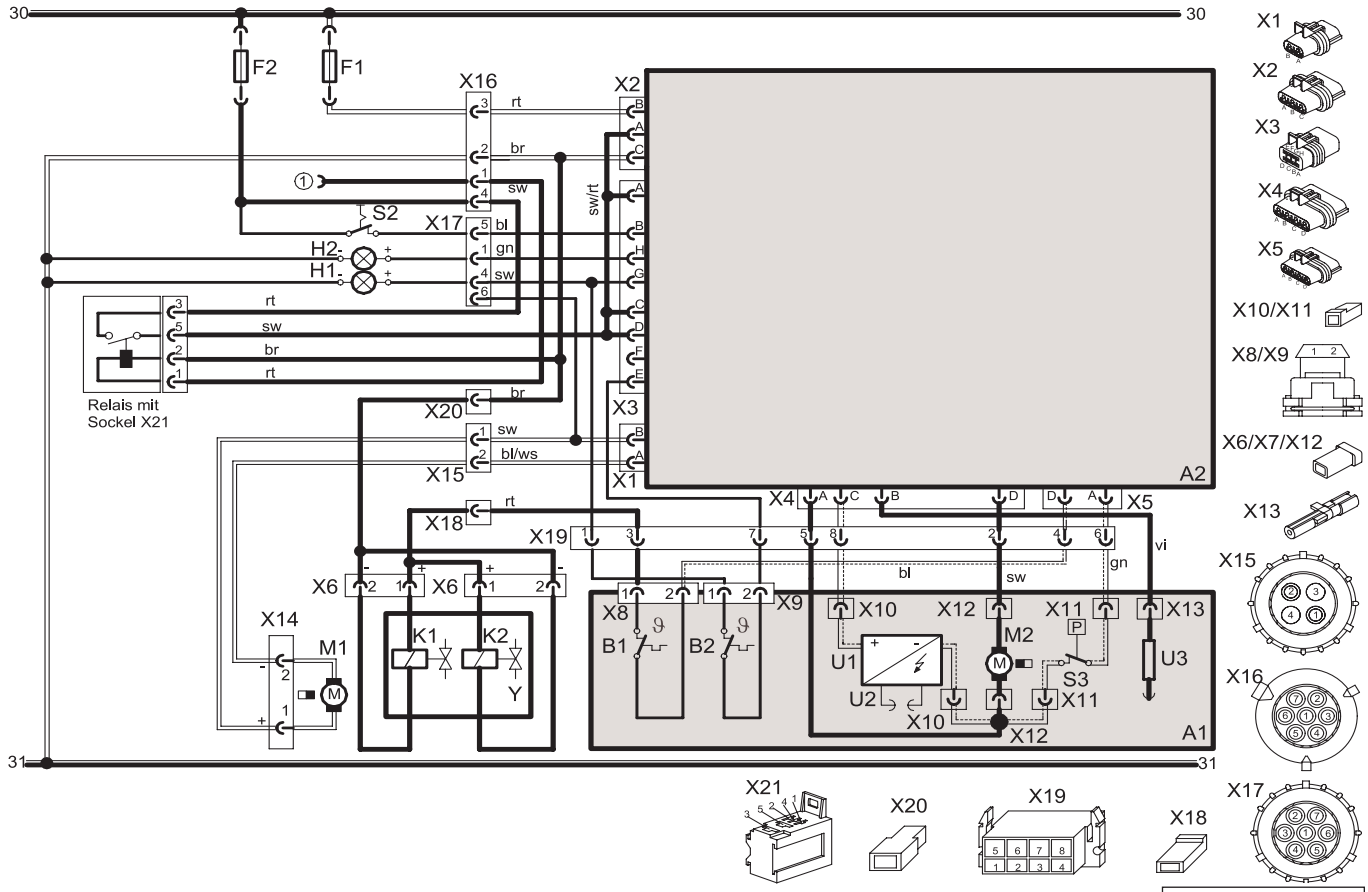
Cable cross sections		
	< 7,5 m	7,5 - 15 m
	0,75 mm²	1,5 mm²
	1,0 mm²	1,5 mm²
	1,5 mm²	2,5 mm²
	2,5 mm²	4,0 mm²
	4,0 mm²	6,0 mm²

Cable colours	
bl	blue
br	brown
ye	yellow
gn	green
gr	grey
or	orange
rd	red
bk	black
vi	violet
wh	white

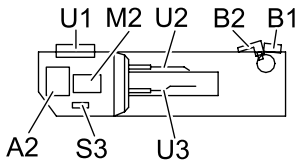
Item	Designation	Comment
A1	Heater	NGW 300 / LGW 300
A2	Control unit	
B1	Temperature limiter	
B2	Regulating thermostat	
F1	25 A fuse	DIN 72581
F2	5 A fuse	DIN 72581
H1	Lights	Operating indicator
K1	Solenoid	High pressure
K2	Solenoid	Low pressure
K3	Solenoid (1 sec.delayed action)	only for the NGW
M1	Motor	Circulating pump
M2	Motor	Combustion air fan
S1	ON/OFF switch	Heater
S2	ON/OFF switch	Remote-controlled circulating pump
S3	Vacuum switch	
U1	Ignition spark generator	
U2	Ignition electrode	
U3	Ignition spark generator	

Item	Designation	Comment
X1	2-pin plug connection	A2 control unit
X2	4-pin plug connection	A2 control unit
X3	8-pin plug connection	A2 control unit
X4	4-pin plug connection	A2 control unit
X5	4-pin plug connection	A2 control unit
X6	2-pin plug connection	Pressure regulator
X7	2-pin plug connection	Solenoid (delayed-action)
X8	2-pin plug connection	Temperature limiter
X9	2-pin plug connection	Regulating thermostat
X10	1-pin plug connection	Ignition spark generator
X11	1-pin plug connection	Vacum switch
X12	1-pin plug connection	Combustion air fan
X13	1-pin plug connection	Flame sensor
X14	2-pin plug connection	Circulating pump
X15	2-pin plug connection	Vehicle interface
X17	4-pin plug connection	Vehicle interface
X18	6-pin plug connection	Vehicle interface
X19	8-pin plug connection	Heater

Fig. 707 System wiring for the LGW / NGW 300 Standard



① Air condition control device timer "Heater On"



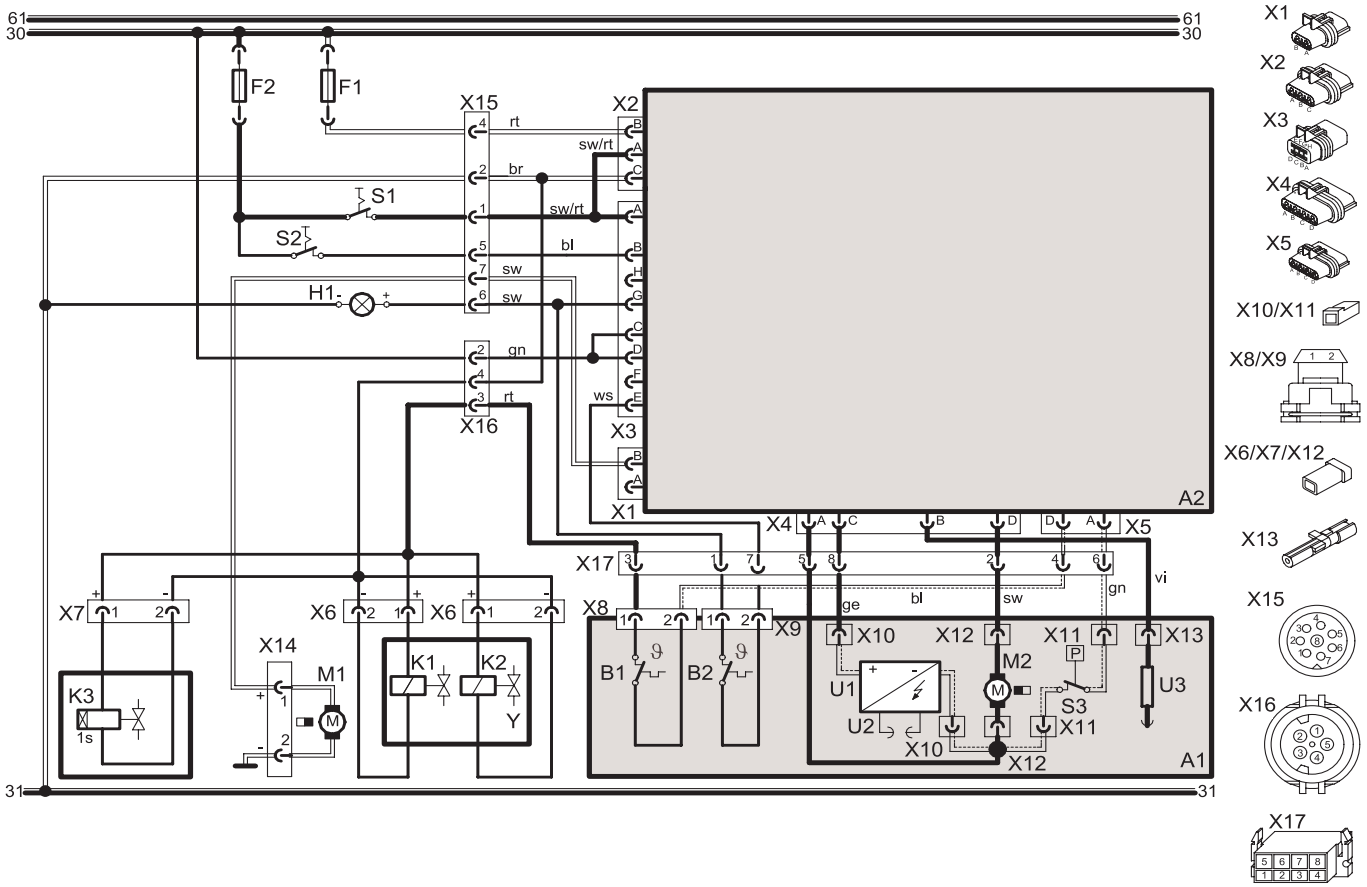
Cable cross sections		
	< 7,5 m	7,5 - 15 m
	0,75 mm²	1,5 mm²
	1,0 mm²	1,5 mm²
	1,5 mm²	2,5 mm²
	2,5 mm²	4,0 mm²
	4,0 mm²	6,0 mm²

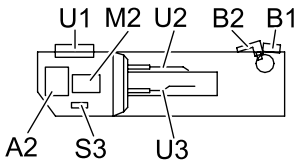
Cable colours	
bl	blue
br	brown
ye	yellow
gn	green
gr	grey
or	orange
rd	red
bk	black
vi	violet
wh	white

Item	Designation	Comment
A1	Heater	NGW 300 / LGW 300
A2	Control unit	
B1	Temperature limiter	
B2	Regulating thermostat	
F1	25 A fuse	DIN 72581
F2	5 A fuse	DIN 72581
H1	Lights	Operating indicator
H2	Lights	Flame indicator
K1	Solenoid	High pressure
K2	Solenoid	Low pressure
M1	Motor	Circulating pump
M2	Motor	Combustion air fan
S2	ON/OFF switch	Remote-controlled circulating pump
S3	Vacum switch	
U1	Ignition spark generator	
U2	Ignition spark generator	
U3	Flame monitor electrode	
X1	2-pin plug connection	A2 control unit
X2	4-pin plug connection	A2 control unit

Item	Designation	Comment
X3	8-pin plug connection	A2 control unit
X4	4-pin plug connection	A2 control unit
X5	4-pin plug connection	A2 control unit
X6	2-pin plug connection	Pressure regulator
X8	2-pin plug connection	Temperature limiter
X9	2-pin plug connection	Regulating thermostat
X10	1-pin plug connection	Ignition spark generator
X11	1-pin plug connection	Vacum switch
X12	1-pin plug connection	Combustion air fan
X13	1-pin plug connection	Flame sensor
X14	2-pin plug connection	Circulating pump
X15	4-pin plug connection	Vehicle interface
X16	7-pin plug connection	Vehicle interface
X17	7-pin plug connection	Vehicle interface
X18	1-pin plug connection	Vehicle interface
X19	8-pin plug connection	Heater Device
X20	1-pin plug connection	Vehicle interface
X21	5-pin plug connection	with SPST relay
Y	Preessure regulator	

Fig. 708 System wiring for the NGW 300 EvoBus Citaro





Cable cross sections		
	< 7,5 m	7,5 - 15 m
	0,75 mm²	1,5 mm²
	1,0 mm²	1,5 mm²
	1,5 mm²	2,5 mm²
	2,5 mm²	4,0 mm²
	4,0 mm²	6,0 mm²

Cable colours	
bl	blue
br	brown
ye	yellow
gn	green
gr	grey
or	orange
rd	red
bk	black
vi	violet
wh	white

Item	Designation	Comment
A1	Heater	NGW 300 / LGW 300
A2	Control unit	
B1	Temperature limiter	
B2	Regulating thermostat	
F1	25 A fuse	DIN 72581
F2	5 A fuse	DIN 72581
H1	Lights	Operating indicator
K1	Solenoid	High pressure
K2	Solenoid	Low pressure
K3	Solenoid (1 sec. delayed action)	only for the NGW
M1	Motor	Circulating pump
M2	Motor	Combustion air fan
S1	ON/OFF switch	Heater
S2	ON/OFF switch	Remote control circulating pump
S3	Vacuum switch	
U1	Ignition spark generator	
U2	Ignition electrode	

Item	Designation	Comment
U3	Flame monitor electrode	
X1	2-pin plug connector	A2 control unit
X2	4-pin plug connector	A2 control unit
X3	8-pin plug connector	A2 control unit
X4	4-pin plug connector	A2 control unit
X5	4-pin plug connector	A2 control unit
X6	2-pin plug connector	Pressure regulator
X7	2-pin plug connector	Delayed action solenoid
X8	2-pin plug connector	Temperature limiter
X9	2-pin plug connector	Regulating thermostat
X10	1-pin plug connector	Ignition spark generator
X11	1-pin plug connector	Vacuum switch
X12	1-pin plug connector	Combustion air fan
X13	1-pin plug connector	Flame sensor
X14	2-pin plug connector	Circulating pump
X15	8-pin plug connector	Vehicle interface
X16	5-pin plug connector	Vehicle interface
X17	8-pin plug connector	Heater
Y	Pressure regulator	

Fig. 709 System wiring for the NGW 300 MAN

8 Servicing work

8.1 General information

This section describes the workwhich is permitted to be performed on heaters when they are installed.

Work may only be performed on the heaters by staff who have been trained by Spheros.

Work on the gas supply line and and on the gas pressure regulator may only be performed by staff who are officially entitled to do so.

Heaters must be protected against being wwitched on unintentionally.

8.2 Working on heaters

The main battery supply must not be interrupted due to the danger of the heater's overheating and a related activation of overheatingprotection, if the heater is in operation or in the after-run.

When comprehensive repair work is being carried out on the heater,it is advisable to dismantle it.

After work has been carried out on the heat circuit, a coolant mixture of waterand antifreeze must be replenished in accordance with the vehicle manufacturer's instructions and the heating circuit must be ventilated.

8.3 Working on the vehicle

ATTENTION

In the area of the heater,a temperature of 100 °C must never be exceeded (e.g. when painting the vehicle).

8.4 A trial run of the heater

The heater may not be operated in enclosed spaces such as garages or workshops without an extraction system and may not be operated with time preselection.

8.5 Maintenance work

To ensure that the heater functions safely, the following maintenance work must be carried out:

– The opening of the combustion air intake grille and the exhaust opening must be checked for dirt accumulation and must be cleaned.
– Outside of the heating season, the heater should be operated when the vehicle's engine is cold, approx. every 4 weeks for 10 minutes, set at "warm" and using the slowest fan level. In that way, starting problems at the beginning of the heating season will be avoided.
– Every three months accumulated oil and condensate must be drained in accordance with 6.3.8.5 at the gas pressure regulator's oil drain plug.

PLEASE NOTE

If no oil/condensate accumulation is visible, the draining interval can be lengthened.
However, for purposes of verification, the draining procedure must be carried out at least once annually.

– The gas presure regulator must be replaced every 4 years for safety reasons (ageing of the seals).

ATTENTION

If solid particulate matter is found in the oil/condensate, the gas pressure regulator must be replaced.

– When renewing the coolant for the vehicle's engine, care must be taken to bleed the the heater, after the vehcle's cooling system has been bled. Turn on the circulating pump (if there is a separate switch) or turn on the heater for approx. 5 seconds and operate the circulating pump in the after-run. This procedure may have to be repeated. Insufficient coolant must be replenished in accordance with the manufacturer's instructions.

PLEASE NOTE

The U 4851 and Aquavent 6000 S circulating pumps have a dry running protection which deactivates the motor in a dry run after approx.10 seconds in operating mode or approx. 15 seconds after being switched on. The Aquavent 6000 S shuts down only after 45 minutes, when it is in a dry run.
The system is reactivated by disconnecting it from the power supply for approx. 2 minutes.

– At the beginning of the heating season, at the latest, the heater and the gas pressure egulator must be tested by a professional.

8.5.1 Disassembling and mounting the burner head

CAUTION

The ignition spark generator is operated at high voltage. Before disassembly, the wiring harness plugs in the vehicle must be disconnected. Otherwise, there is a danger of death. If the burner head is mounted again, reconnect the plugin the vehicle

ATTENTION

- Basically, it is necessary to disconnect not only the electrical connection to the temperature limiter and the regulating thermostat, but also the electrical connection from the vehicle to the control unit, and to loosen the reference pressure line connectors and the gas supply hose on the burner side. Otherwise,there is a risk of damage to the burner and/or the electrodes during the repair.
- Pull out the burner head carefully from the heat exchanger and slide it in order to prevent its being damaged.

PLEASE NOTE

When the burner head is dismounted, the following components become accessible:

– Ignition electrodes
– Flame monitor electrode
– Fuel pipe
– Combustion chamber

8.5.1.1 Disassembly

1. Disconnect the electrical line from the control unit to the vehicle.
2. Disconnect the electrical lines to the temperature limiter and the regulating thermostat (1, fig. 801).
3. Loosen the gas supply hose (6) and the reference pressure line (7), if they are connected.
4. Loosen both nuts (4) so far that it is possible to remove the screws (3) by swiveling.
5. Remove the screws (3) by swiveling.
6. Carefully dismount the burner head (5).

8.5.1.2 Mounting

ATTENTION

During the following procedure, please ensure that the ignition electrodes and the flame monitor electrode are not twisted.

1. Slide the burner head (5, fig. 801) carefully (5, fig. 801) into the reassembly position.
2. Swivel in the screws (3).
3. Tighten both nuts (4) with 7.5 Nm.
4. Attach the gas supply hose (6) and, if applicable, the reference pressure line (7).
5. Re-establish electrical connections (1) to the temperature limiter and the regulating thermostat.

PLEASE NOTE

Ensure that the temperature limiter's and the regulating thermostat's electrical connections are wired, using the proper colours.

6. Re-establish the electrical connection to the vehicle's wiring harness.

1 Electrical connections
2 Split pin (2)
3 Screw
4 Nut (2)
5 Burner head
6 Gas connection
7 Reference pressure

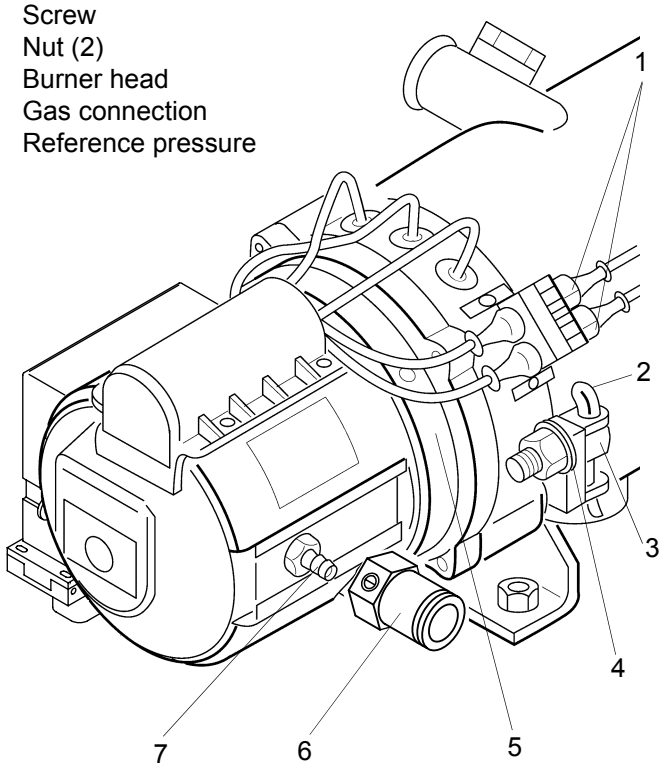


Fig. 801 Dismantling and mounting the burner head

8.6 Visual inspections and. installation regulations

8.6.1 Connection to the vehicle's cooling system

The heater must be installed in as low a position as possible, so that the heater and the circulating pump are sure to be bled automatically. This is particularly applicable, as the circulating ump is not self-priming.

As shown in fig. 802, the heater must be connected to the vehicle's cooling system. The amount of coolant present in the circuit must amount to 10 l at least.

In the vehicle's cooling system, only only high pressure valves with an opening pressure of at least 0.4 bar and max. 2.0 bar are used.

Basically, the coolant hoses provided by Spheros must be used. If this is not the case, the hoses must conform to the DIN 73411 standard, at least. Hoses are to be installed free of kinks (for flawless bleeding) and going upwards, if possible. Hose connections must be secured with hose clamps to prevent them from slipping.

PLEASE NOTE

The hose clamps must be tightened with the required torque.

Care must be taken to bleed the cooling system before the heater is used for the first time or after renewal of the coolant. The heater and lines should be installed in such a way as to guarantee static bleeding.

Inadequate bleeding can lead to a breakdown while the heater is in operation, due to overheating.

Flawless ventilation is detectable, if the pump is working virtually silently.

8.6.2 Connection to the vehicle's gas system

For the NGW 300 version, gas must be withdrawn from the tank or from the immediate vicinity of the tank. Withdrawing gas from the filler line and at places where oil and condensate can accumulate is not permissible. Extraction must be performed in such a way that the least amount of oil and condensate possible can enter the supply line to the heating system's gas pressure regulator, (outlet at the top).

For the LGW 300 version, the gas must be withdrawn in its gas phase in the tank.

Only the original Spheros hose may be used for the gasline on the low pressure side between the gas pressure regulator and the heater.

When installing the hose, icare must be taken to ensure that there is a sufficient distance (min. 25 mm) from the outer casing of the heater and/or it must be shielded to protect it from from the heat.

The hose must not be kinked or twisted.

8.6.3 Combustion air supply

Combustion air is taken in via the inlet grille in the burner hood.

Care must be taken not to suck in any exhaust gas.

If the heater is installed in an enclosed installation box, a ventilation opening of at least 100 cm^2 is required.

The combustion air intake line can be extended with a special version of the heater. The permissible dimensions of the combustion air intake line are as follows for this version:

– Internal diameter: 60 mm
– Maximum permissible line length: 3 m without an exhaust extension
– Maximum permissible bend: 450°

Under no circumstances may the combustion air be taken from spaces which accommodate people. The combustion air intake opening must not point in the direction n which the bus is traveling. It must be positioned so that it cannot become clogged with dirt or snow and cannot suck in splashing water.

The combustion air intake opening must be designed in such a way thata sphere with a diameter of 16 mm cannot fit into it. However, the inlet cross-section may not be restricted.

If the combustion air intake line cannot be installed so that it slopesdownwards, then a water drain hole with a diameter of 4 mm is to be made at its lowest point.

8.6.4 Exhaust gas line

The exhaust pipe opening may not point in the direction in which the bus is traveling.

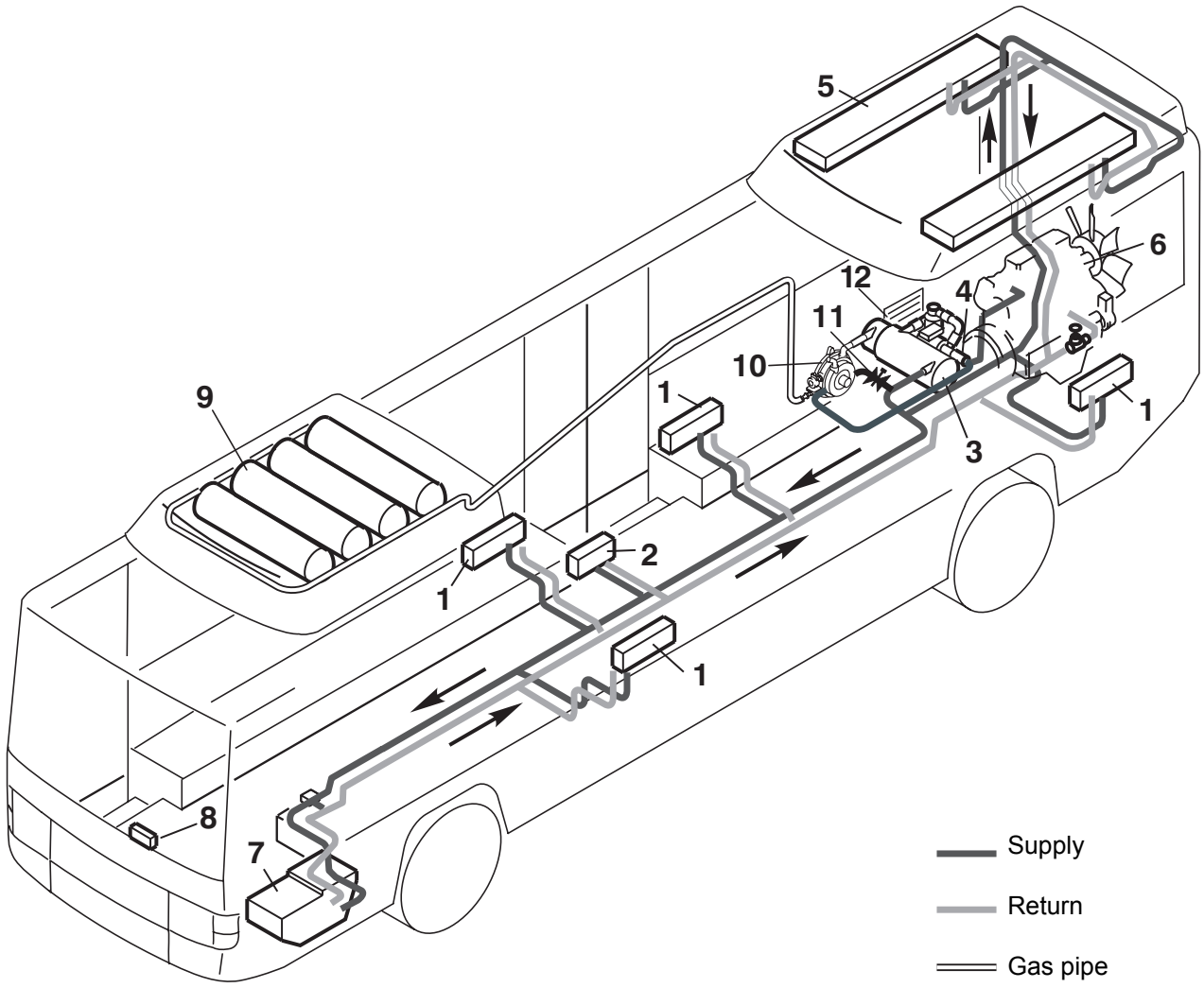
The exhaust pipe opening must be positioned so that it cannot become clogged with dirt or mud.

Rigid pipes of unalloyed or alloyed steel with a minimum wall thicknessof 1.0 mm or flexible piping of alloyed steel only must be used as exhaust lines. The exhaust pipe is secured to the heater using a clamping collar.

Permissible dimensions:

– Internal diameter: 70 mm
– Maximum permissible line length: 3 m
– Maximum permissible bend: 270°

An exhaust extension is only possible if the combustion air intake line has not been extended.



Water heating circuit – wall-mounted heater and roof duct heating

1 Wall-mounted heater with fan
2 Heat exchanger access
3 Heater
4 Circulating pump
5 Roof heat exchanger
6 Vehicle engine
7 Driver cab heating
8 Control element
9 Gas tanks
10 Gas pressure regulator
11 Thermostat valve
12 Air vent slots (at the highest point for the NGW 300 and at the lowest point for the LGW 300)

Fig. 802 Installation example for a bus heater

8.7 Disassembly and installation

ATTENTION

In its installed state, only the following disassembly and dismantling procedures are permissible, provided that thereis adequate room available for disassembly:

– Replacing the temperature limiter
– Replacing the regulating thermostat
– Replacing the control unit
– Replacing the gas pressure regulator

8.7.1 Dismantling and installation of the heater

8.7.1.1 Disassembly

1. Disconnect the wire harness plug connection to the vehicle and to the circulating pump.
2 If present, loosen the gripping clamp at the exhaust outlet.
3. Dismount the suction line for the gas delivery at the burner head and seal with blind plugs.
4. Remove the reference pressure line at the burner head, if present.
5. Drain pressure from the coolant circuit.
6. Close the water cock, if present.
7. Loosen the hose clamps on the coolant hoses. Remove the hoses and seal with blind plugs.
8. Remove 4 screws and flat washers or 4 screws and nuts from the heater bracket.
9. Remove the heater.

8.7.1.2 Installation

1. Bring the heater into the installation position and attach with 4 screws and flat washers or 4 screws and nuts (tightening torque of 15 +5 Nm).
2 If there is an exhaust line, secure it with a gripping clamp at the exhaust outlet.
3. Mount the coolant hoses and secure with hose clamps.
4. Open the water cocks, if present.
5. Mount the suction line for the gas deliveryand the reference pressure line.
6. Connect the wire harness plugs to the vehicle and at the circulating pump.
7. Replenish the coolant and bleed the coolant circuit.

ATTENTION

Due to the rise in pressure, operating the heater when the water cocks are closed will cause the connecting hoses to burst and the heat exchanger to be damaged.

8.7.2 Replacing the temperature limiter

PLEASE NOTE

The same procedure is followed when replacing the temperature limiter whether the heater is installed or not.

The replacement must be carried out in accordance with 9.2.1.

8.7.3 Replacing the regulating thermostat

PLEASE NOTE

The same procedure is followed when replacing the regulating thermostat, whether the heater is installed or not.

The replacement must be done in accordance with 9.2.2.

8.7.4 Replacing the SG 1585 control unit

PLEASE NOTE

The same procedure is followed when replacing the control unit whether the heater is installed or not.

The replacement must be done in accordance with 9.2.3.

8.7.5 Dismantling and installation of the gas pressure regulator

Replacing the gas pressure regulator must be done in accordance with 9.2.1.1.

8.8 Start-up

After the heater is installed, the coolant circuit must be carefully bled. When this is being done, the motor vehicle manufacturer's instructions must be followed.

It must be ensured that all water cocks are opened.

During the trial run, all coolant and gas connections should be tested for leaks and to make sure that they are firmly attached. If the heater breaks down while it is being operated, then troubleshooting should be performed (see Section 5).

PLEASE NOTE

When the heater is started for the first time after installation, it is to be expected that there will be some problems with the burner or the gas pressure regulator at the beginning, as the air which is present initially in the gas line leads to a lean gas-air mixture during the first seconds of operation.

8.8.1 Bleeding the coolant circuit

Set the vehicle's own heating equipment to "warm" and fill up with coolant which must consist of a mixture of water and at least 20 % (glycol-based) anti-freeze. If pure water is used, there is no protection against corrosion and, because of the lower boiling point of the water, this can lead to a partial loss of coolant, in the event of overheating. If this happens, the coolant must be replenished.

Additives in the coolant must not have an adverse effect on metals, plastic, or rubber nor must they lead to the formation of deposits.

Then, allow the vehicle to run at a higher speed, until the cooler thermostat opens. Shut down the vehicle's engine and examine the state of the coolant. If necessary, replenish the coolant.

To bleed the heating circuit, either
– switch on the circulating pump (if there is a separate switching system) or
– turn the heater on for a short time (max. 5 seconds) and operate the circulating pump in the add-run.

PLEASE NOTE

The U 4851 and Aquavent 6000 (U 4852) circulating pumps have dry run protection.
In the case of the U 4851 circulating pump, when it is in a dry run, the motor will shut down after approx. 10 seconds in operating mode or approx. 15 seconds after being switched on.
In the case of the Aquavent 6000 (U 4852) circulating pump, the dry run was extended to 5 minutes.
The pump is reactivated by disconnecting it from the power supply for approx. 2 minutes.

Insufficient coolant must be replenished.

Switch on the heater and the vehicle's own heating fan, if the engine is shut down. After a certain cooling period, the heater must turn itself on automatically and abregeln.

If, after that, it is not switched back on, the temperature limitr has been activated because the heater had not yet been perfectly bled.

The heater is now locked.

After the system has cooled down and the heater has been checked for possible damage, in particular to the temperature limiter's wiring and the regulating thermostat, the temperature limiter button must be reset manually.

The heater lock must be removed in accordance with 3.5.

9 Repair

9.1 General information

This section describes the permissible repair work when the heater is disassembled. If there is any further disassembly, any claim to a guarantee is extinguished. Only Spheros replacement parts must be used for reassembly.

CAUTION

The ignition spark generator is operated with high voltage.

The following components must also be replaced when the heater is in its installed state, if there is enough space available:

- Temperature limiter
- Regulating thermostat
- Control unit
- Burner head

Before replacement, the heater must be switched off via the main switch and the wiring harness connector in the vehicle must be disconnected. Otherwise, there is a danger of death.

9.1.1 Measures for components when the system is disassembled

ATTENTION

All sealing elements between the disassembled components must be fundamentally eliminated and renewed. Before reassembly, the sealing surfaces must be cleaned and sealant residue must be removed.

9.1.1.1 General visual inspection

- Examine all components or damage (cracks, deformation, wear etc.) and replace, if necessary.
- Examine plugs and lines for corrosion, loose connections, crimping faults etc. and repair, if necessary.
- Examine plugs for corrosion and connectors to make sure that they are firmly attached and repair, if necessary

9.1.1.2 Visual inspection of the combustion chamber

- Examine the combustion chamber for scaling and repair, if necessary.
- Examine the welded seam for cracks and repair, if necessary.

PLEASE NOTE

Cracks in the welded seam of up to 80 mm in the longitudinal direction at the end of the combustion chamber are permissible.

9.1.1.3 Visual inspection of the heat exchanger

- Examine the exhaust gas routing in the heat exchanger for damage and corrosion and repair, if necessary.
- Examine the exhaust gas muffler in the exhaust connector to make sure it is securely attached and for thermal deformation and repair, if necessary.

PLEASE NOTE

Severe thermal deformations of the exhaust gas muffler affects combustion.

- Check the heat exchanger for external damage and deformations etc. and repair, if necessary.

PLEASE NOTE

Severe deformations can compromise the coolant flow.

9.1.2 Implementation of modifications

PLEASE NOTE

Constant further development of the heaters means that their performance is being optimised with the goal of avoiding acciidents or malfunctions.

As a rule, heaters which are already in the field can be retrofitted. There are appropriate modification kits available for this purpose.

Below are modifications which can be carried out in the context of repair work.

- Installation of the SG 1585 control unit as a replacement for the SG 1578 control unit for the NGW 300 and LGW 300 (see 9.1.2.1)
- Installation of the U 4851 or Aquavent 6000 S circulating pump as a replacement for the U 4814 or U 4816 circulating pump (see 9.1.2.2)

9.1.2.1 Installation of the SG 1585 control unit as a replacement for the SG 1578 control unit

General information

The SG 1578 control unit for the NGW 300 and LGW 300 heaters is no longer available and was replaced by the SG 1585 control unit.

The conversion kits consist of the SG 1585 control unit and he vehicle-specific adapter wiring harness.

Conversion to the SG 1585 control must be carried out in accordance with the following procedures.

ATTENTION

- Replacement of the control unit must be done in an unenergised state. Ignition must be switched off.
- The sequence of procedures must be followed absolutely so that no fault entries are made in the control unit and conditionally upon that, as the case my be, locking the heater is avoided.
  (Fault entries are caused at the control unit by open inlets and outlets among other things
- A lock on the heater can only be removed by staff who have been trained by Spheros.

Implementation

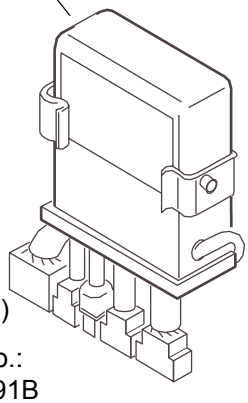
1. Ensure that the heating system is switched off. Where necessary, switch off the heating system by activating the main switch, the timer or the airconditioning system and wait until it stops running.
2. Disconnect the vehicle's and the control unit's plugs from the voltage supply.
3. Where necessary, disconnect the connectors between the vehicle and the control unit and control lines.
4. Disconnect the connector to the circulating pump.
5. If required, disconnect the connector from the control unit to the gas pressure regulator.
6. Disconnect the connector plug between the control unit and the heater.
7. Remove the control unit and retaining spring.
8. Attach the adapter wiring harness to the new control unit.
9. Slide the new control unit with a connector to the heater downwards into the guiding groove of the burner's protective hood until it snaps in place in the locking groove.
10. Attach the connector plug between the adapter wiring harness and the heater.
11. Attach the connector plug between the adapter wiring harness and the gas pressure regulator/solenoid.
12. Attach the connector plug between the adapter wiring harness and the circulating pump.
13. Where necesary, attach the connector plug between the vehicle (control line) and the adapter wiring harness.
14. Attach the connector plug between the vehicle's voltage supply and the adapter wiring harness.

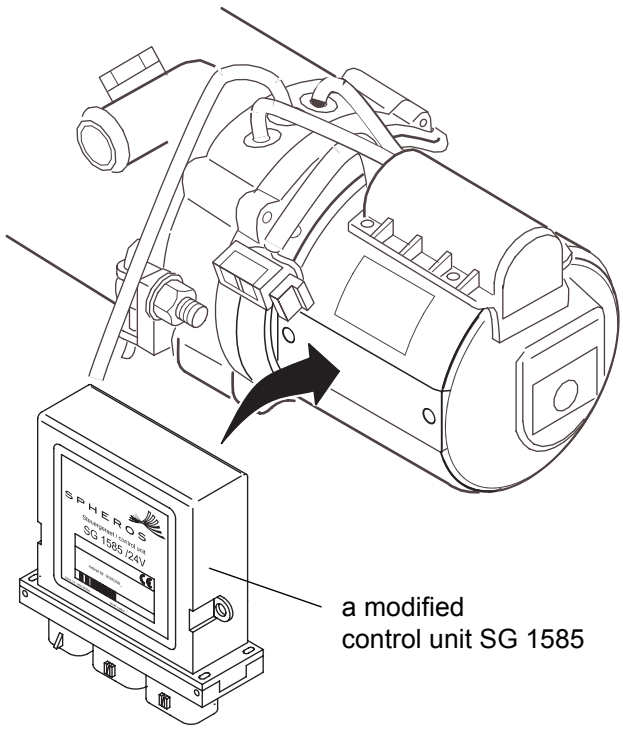
PLEASE NOTE

- Now, the heating system can be activated by turning on the main switch, the timer or the airconditioning system.
- After all work has been completed, a trial run must be carried out (start-up, firing operation, control pause and after-run).

the former
SG 1578 control unit

PLEASE NOTE
Conversion bags for MAN include the SG 1585 (ID no. 9007655) without circulation pump monitoring.





a modified
control unit SG 1585

Available conversion kits
(control unit with adapter wiring harness)

SG 1585 conversion bag for:	Order no.:
Standard (AMP plug)	90 058 91B
EvoBus	90 058 92B
MAN (AMP-plug)	90 077 74B
MAN (Schlemmer plug)	90 058 95B

Fig. 901 Replacement of the SG 1578 control unit by the 1585 control unit

9.1.2.2 Installation of the U 4851 or Aquavent 6000 S circulating pump as a replacement for the U 4814 and U 4816 circulation pumps

General information

The U 4814 and U 4816 circulating pumps can be replaced immediately by the U 4851 or Aquavent 6000 S circulating pumps, if necessary. The U 4851, Aquavent 6000 S and U 4816 circulating pumps are compatible.

When the U 4816 is replaced, the mounting parts (racks and hose clamps) can be reused. Adjustment of the water connections is not necessary. The same applies to compact devices.

When replacing the U 4814 circulating pump, the following instructions must be followed:

- The available rack and hose clamp must be removed and cast aside. The pump must be installed with a new rack and hose clamp.
- When mounting the circulating pump close to a wall, the new rack must be mounted in such a way that the gap between it and the wall amounts to approx. 60 mm (reference line: centre of the circulating pump). When necessary, the rack must be attached to the separated rack in a staggered formation.
- The hose connections must be adjusted.
- the circulating pump is installed in a compact unit,
- it is only possible to replace it with difficulty and its
- operability must be checked separately.

Implementation - U 4851 circulating pump

ATTENTION

When installing the U 4851 circulating pump, the following directions must be followed without fail. Failure to do so will exclude warranty claims.

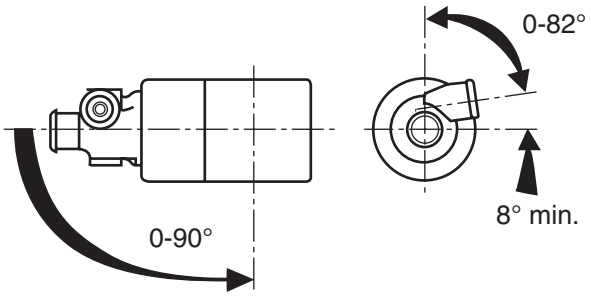
PLEASE NOTE

- The circulating pump does not ventilate itself. Due to this lack of automatic ventilation,the pump must be installed at the lowest point of the water circuit in compliance with the permissible installation position (see figure).
- No solenoids or other shut-off valves which could be closed during the operation of the pump, must be installed on the water infeed side of the circulating pump.
- No solenoids or other shut-off valves which could be closed during the operation of the pump, must be installed on the water infeed side of the circulating pump. The same applies to filters which can get clogged.

Before the circulating pump is put into operation the vehicle's cooling system and the pump body must be ventilated

ATTENTION

Improper ventilation or a dry run of the circulating pump leads to damage to the floating ring seal. Flawless ventilation is detectable, if the pump is working virtually silently.



Permissible installation position

U 4851

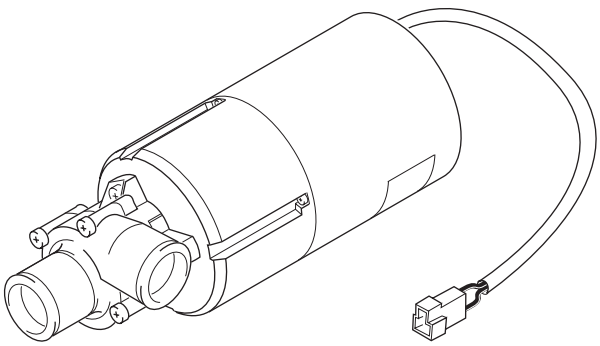


Fig. 902 U 4851 circulating pump

Implementation: Aquavent 6000 S circulating pump

ATTENTION

When installing the Aquavent 6000 S circulating pump, the following directions must be followed without fail. Failure to so will exclude warranty claims.

HINWEIS

- In contrast to the U 4851 circulating pump, the Aquavent 6000 S must be integrated into the vertical installation position in such a way that the pump head is above the motor.
- The circulating pump is not self-priming. Due to this lack of automatic ventilation,the pump must be installed at the lowest point of the water circuit in compliance with the permissible installation position (see fig. 903).
- The hoses must be laid without kinks and going upwards. Hose connections must be secured with hose clamps to prevent them from slipping.
- No solenoids or other shut-off valves which could be closed during the operation of the pump, must be installed on the water infeed side of the circulating pump. The same applies to filters which can get clogged.
- Before the circulating pump is put into operation the vehicle's cooling system and the pump body must be ventilated.
- InThere are no consumable parts installed in the circulating pump. It is also possible to replace the motor without dismantling the pump head.

ATTENTION

A dry run of the circulating pump of up to 45 mins. Is permissible. Flawless ventilation is detectable, if the pump is working virtually silently.

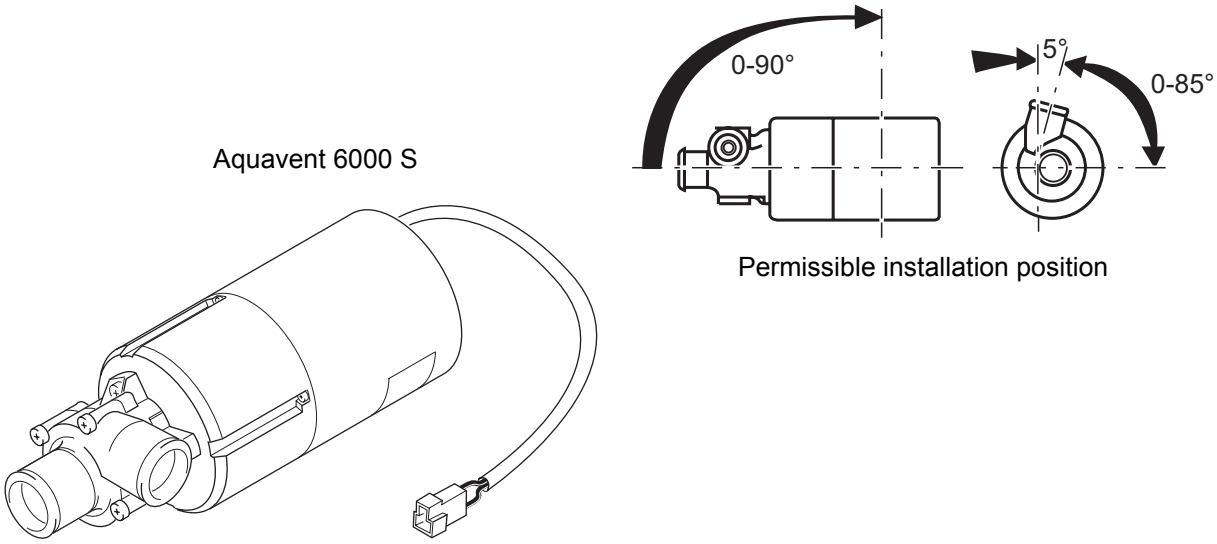


Fig. 903 Aquavent 6000 S circulating pump

9.2 Disassembly and reassembly

9.2.1 Replacement of the temperature limiter

General information

Before the temperature limiter is replaced, the heater must be switched off, so that fault entries in the control unit and thus locking of the heater is avoided.

9.2.1.1 Disassembly

1. Disconnect the electricity supply to the temperature limiter.
2. Remove the rubber cap. Lift off the retaining springs with a screwdriver and remove the temperature limiter (1, fig. 904).
3. Implement the measures for components when the system is disassembled (see 9.1.1).

9.2.1.2 Installation

1. Push the rubber cap of the temperature limiter back (1, fig. 904) so far that the temperature limiter can be brought into its installation position.
2. Insert the temperature limiter (1) in the connector (2) and press the retaining spring in.

ATTENTION

The retaining spring must be located in the slot of the casing, and must be felt and heard locking onto the union of the adapter connector. Only then does the temperature limiter have a proper connection with the heat exchanger jacket.

PLEASE NOTE

The rubber cap must be fitted in such a way that its cable sleeve runs in the direction of the heater's centre line. After the rubber cap has been fitted, the cable in the sleeve must be adjusted without tension.

3. Put the rubber cap on.
   The connecting cables may not be guided via the reset button.
4. Create an electrical connection. While doing so, be careful to ensure that the electrical wires are the proper colours.

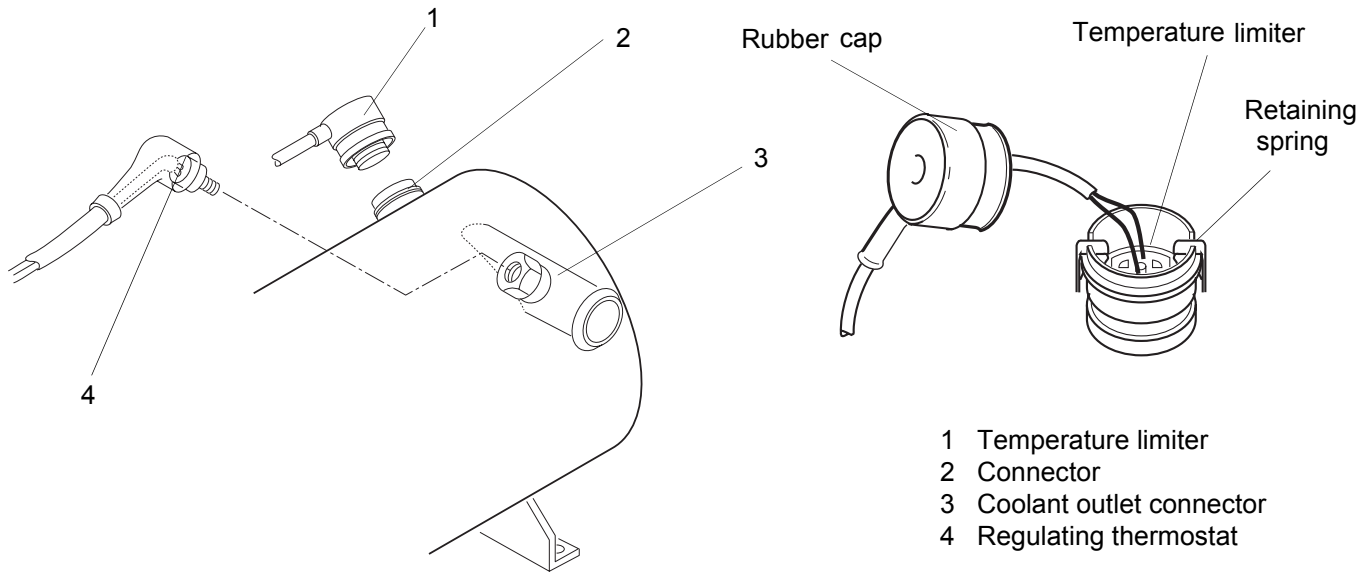
9.2.2 Replacement of the regulating thermostat

9.2.2.1 Disassembly

1. Disconnect the electricity supply to the regulating thermostat.
2. Unscrew and remove the regulating thermostat (4, fig. 904).
3. Implement the measures for components when the system is disassembled (see 9.1.1).

9.2.2.2 Installation

1. Screw the regulating thermostat (4, fig. 904) by hand into the screw plug coolant outlet adapter (3).
2. Slide the protective cap on.
3. Create an electrical connection. While doing so, be careful to ensure that the electrical wires are the proper colours.



1 Temperature limiter
2 Connector
3 Coolant outlet connector
4 Regulating thermostat

Fig. 904 Changing the temperature limiter and the regulating thermostat

9.2.3 Replacing the SG 1585 control unit

ATTENTION

Replacement of the control unit must be done in an unenergised state.

Ignition must be switched off The sequence of procedures must be followed absolutely so that no fault entries are made in the control unit and conditionally upon that, as the case my be, locking the heater is avoided.

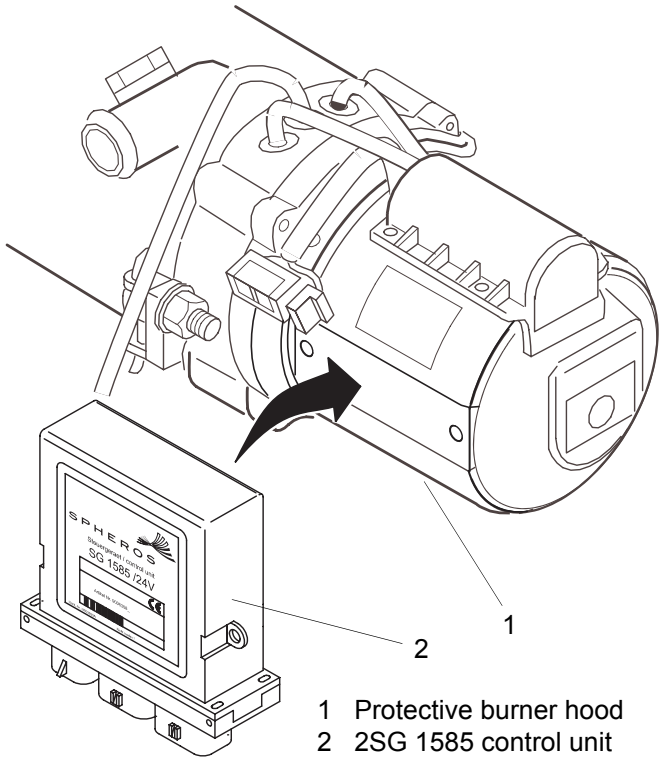
(Fault entries are caused at the control unit by open inlets and outlets among other things.)

9.2.3.1 Dismantling

1. Ensure that the heating system is switched off. Where necessary, switch off the heating system by activating the main switch, the timer or the airconditioning system and wait until it stops running.
2. Disconnect all electrical lines to the control unit (2, fig. 905).
3. Pull the control unit out of the guide slot of the burner's protective hood (1) and remove it.
4. Implement the measures for components when the system is disassembled (see 9.1.1).

9.2.3.2 Extension

1. Slide the control unit (2, fig. 905) with a plug downwards into the guiding slot of the burner's protective cap (1) ntil it snaps into place in the locking groove.
2. Re-establish all electrical connections to the control unit (2).



1 Protective burner hood
2 2SG 1585 control unit

Fig. 905 Replacing the SG 1585 control unit

9.2.4 Replacing the ignition spark generator

PLEASE NOTE

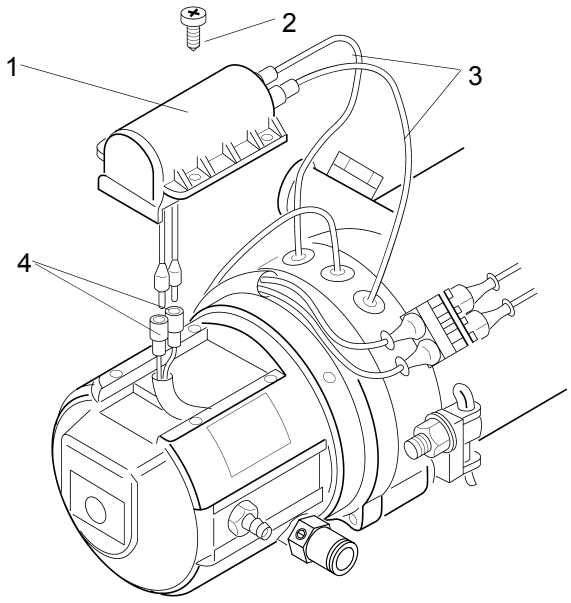
The ignition spark generator must be replaced complete with electrical connections to the ignition electrodes.

9.2.4.1 Dismantling

1. 1.Dismount the burner head (see 8.5.1.1).
2. Dismount the ignition electrodes (see 9.2.5.1) and remove the rubber sleeves from the electrical connections to the ignition spark generator.
3. Pull the electrical connections (3, fig. 906) with the rubber sleeves out of the casing.
4. Remove the fillister head screws (2).
5. Take the ignition spark generator (1) off the hood.
6. Disconnect the electrical lines (4).
7. Remove the ignition spark generator (1).
8. Implement the measures for components when the system is disassembled (see 9.1.1).

9.2.4.2 Extension

1. Guide electrical connections (3, fig. 906) through the casing and press the rubber sleeves until they are flush with the casing.
2. Establish electrical connections (4) to the ignition spark generator.(1).
3. Bring the ignition spark generator (1) into the assembly position and attach with fillister head screws (2).
4. Slide the rubber sleeves on the electrical connections onto the ignition spark generator and install the ignition electrodes (see 9.2.5.2).
5. Mount the burner head (see 8.5.1.2).



1 Ignition spark generator
2 Fillister head screw (4)
3 Electrical connection, ignition electrodes (2)
4 Electrical connection, ignition spark generator (2)

Fig. 906 Replacing the ignition spark generator

9.2.5 Replacing ignition electrodes

9.2.5.1 Disassembly

1. Dismount the burner head (see 8.5.1.1).

ATTENTION

During the following procedure, please ensure that the ignition electrodes and the flame monitor electrode are not twisted.

2. 2.Remove the cylinder screws (6, fig. 907) and dismount the heat shield (5).
3. Remove the cylinder screws (4) and pull out the ignition electrodes (3) approx.2 cm.
4. Remove electrical cionnections from the ignition electrodes (3).
5. Remove the ignition electrodes (3) and the gasket (2).
6. Implement the measures for components when the system is disassembled (see 9.1.1).

9.2.5.2 Installation

1. Position the ignition electrodes (3, fig. 907) with a new gasket (2) at the installation space, create electrical connections to the ignition electrodes (3) and push the rubber sleeves up.

PLEASE NOTE

The rubber sleeves must be pushed up agains the gasket. Otherwise there is a risk of spark-over von due to moisture.

2. Attach the ignition electrodes (3) with cylinder screws (4). Tighten the screws with 5.5 Nm.

ATTENTION

ImDuring the following procedure, please ensure that the ignition electrodes and the flame monitor electrode are not twisted.

3. Attach the heat shield (5) with cylinder screws (6).Tighten the screws with 5.5 Nm.
4. Check the spacing of the ignition electrodes (see 6.3.3).
5. Check the spacing of the flame monitor electrode (see 6.3.4).
6. Mount the burner head (see 8.5.1.2).

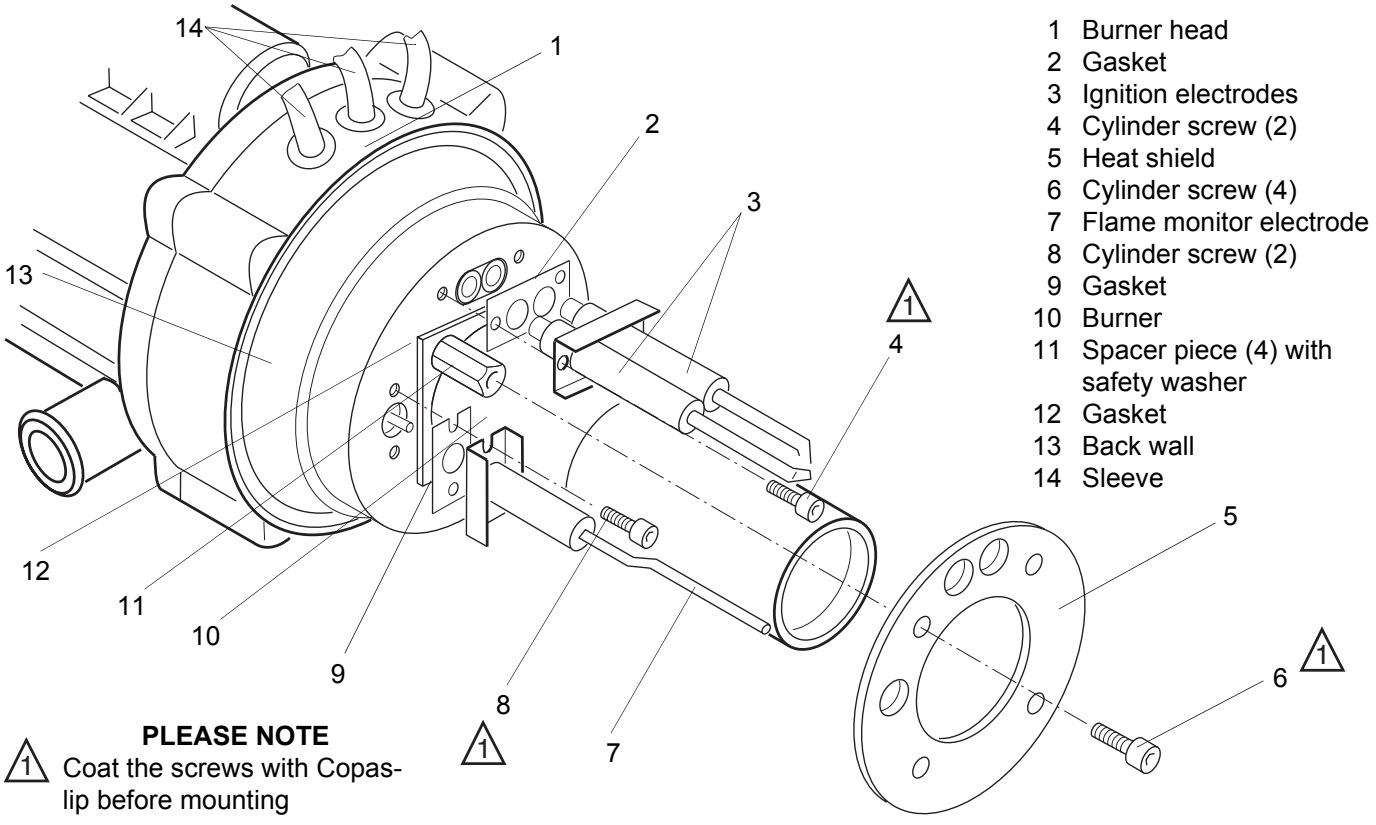


Fig. 907 Replacing the ignition electrodes, the flame monitor electrode and the burner

9.2.6 Replacing the flame monitor electrode

9.2.6.1 Disassembly

1. Dismantle the burner head (see 8.5.1.1).

ATTENTION

During the following procedure, please ensure that the ignition electrodes and the flame monitor electrode are not twisted.

2. Remove the cylinder screws (6, fig.. 907) and dismount the heat shield (5).
3. Disconnect the flame monitor electrode's plug connection at the control unit and pull back the nozzle (14) approx. 8 cm.
4. Remove the screws (8) and detach the flame monitor electrode with the connecting line (7) approx. 7 cm.
5. Remove the shrinking hose and disconnect the connecting line / flame monitor electrode plug.
6. Implement the measures for components when the system is disassembled (see 9.1.1).

9.2.6.2 Installation

1. Attach a new gasket (9, fig. 907) to the flame monitor electrode¬ (7).
2. Slide the shrinkable hose (from the replacement part bag) onto the flame monitor connection line and create a connection.
3. Slide the shrinkable hose over the flame monitor electrode's insulator (7) as far as it will go and shrink it so that it fits well all around and creates a seal.
4. Attach the flame monitor electrode (7) with cylinder screws (8). Tighten the screws with 5,5 Nm.
5. Attach the heat shield (5) with screws (6). Tighten the screws with 5,5 Nm.

ATTENTION

Make sure that the ignition electrodes and the flame monitor electrode are not twisted.

6. Check the spacing of the ignition electrodes (see 6.3.3).
7. Check the spacing of the flame monitor electrode (see 6.3.4).
8. Lock the sleeve (14) in place in the fan casing.
9. Mount the burner head (see 8.5.1.2).

9.2.7 Replacing the burner

9.2.7.1 Disassembly

1. Dismantle the burner head (see 8.5.1.1).

ATTENTION

During the following procedure, please ensure that the ignition electrodes and the flame monitor electrode are not twisted.

2. Remove the cylinder screws (6, fig.. 907) and dismount the heat shield (5).
3. Unscrew and remove spacers (11) and safety washers.
4. Remove the burner(10) with the gasket (12).
5. Implement the measures for components when the system is disassembled (see 9.1.1).

9.2.7.2 Installation

1. Bring the burner (10, fig. 907) and a new gasket (12) into the installation position and attach with spacers (11) and safety washers. Tighten the spacers with 5.5 Nm.

ATTENTION

During the following procedure, please ensure that the ignition electrodes and the flame monitor electrode are not twisted.

2. Attach the heat shield (5) with cylinder screws (6). Tighten the screws with 5.5 Nm anziehen.
3. Mount the burner head (see 8.5.1.2).

9.2.8 Disassembly and reassembly of the burner head

9.2.8.1 Disassembly

1. Dismantle the burner head (see 8.5.1.1).
2. Dismantle the conrol unit (see 9.2.3.1).
3. Dismantle the ignition spark generator (see 9.2.4.1).
4. Disassemble the igntion electrodes (see 9.2.5.1).
5. Dismount the flame monitor electrode (see 9.2.6.1).
6. Dismount the burner (see 9.2.7.1) and remove the back wall (23, fig. 908) with the gasket (24).
7. Screw off the gas nozzle.
8. 4Remove 4 fillister screws and serrated washers and dismantle the hood.
9. Remove 2 fillister screws and serrated washers and loosen the bracket (2) for the wiring harness connector.
10. Remove the hose line to the vacuum pump (3) at the gas mixer.
11. Disconnect the vacuum switch (3) from the electricity supply.
12. Remove 2 screws, nuts and the vacuum switch (3).
13. Remove the cylinder screws (5) and dismount the motor (4) with the flange (6) and the gas mixer (1).

14. Detach the coupling (9) and remove.
15. Remove the gasket (11).
16. Remove the screws (8) and lock washers (7).
17. Dismount and remove the motor (4) and gas mixer (1) from the flange (6).
18. Remove the cylinder screws (27) and lock washers (28).
19. Remove the snap ring (12) and washer (13) on the motor bracket (16).
20. With an appropriate dismantling tool, remove the motor bracket (16) from the fan casing (25).
21. Remove the nut (21), the spacer tube (20) and the bearing (19).
22. Dismount the rotor (8) and remove.
23. Press the shaft (14) and the bearing (15) out of the motor bracket (16).
24. Remove the pin (22) from the shaft (14).
25. Remove the bearing (15) from the shaft (14).
26. ORemove the O ring (26) and remove the snap ring (17).
27. Implement the measures for components, when the system is disassembled (see 9.1.1).

9.2.8.2 Reassembly

1. Press the bearing (15, fig. 908) onto the shaft (14) until they form a bond.

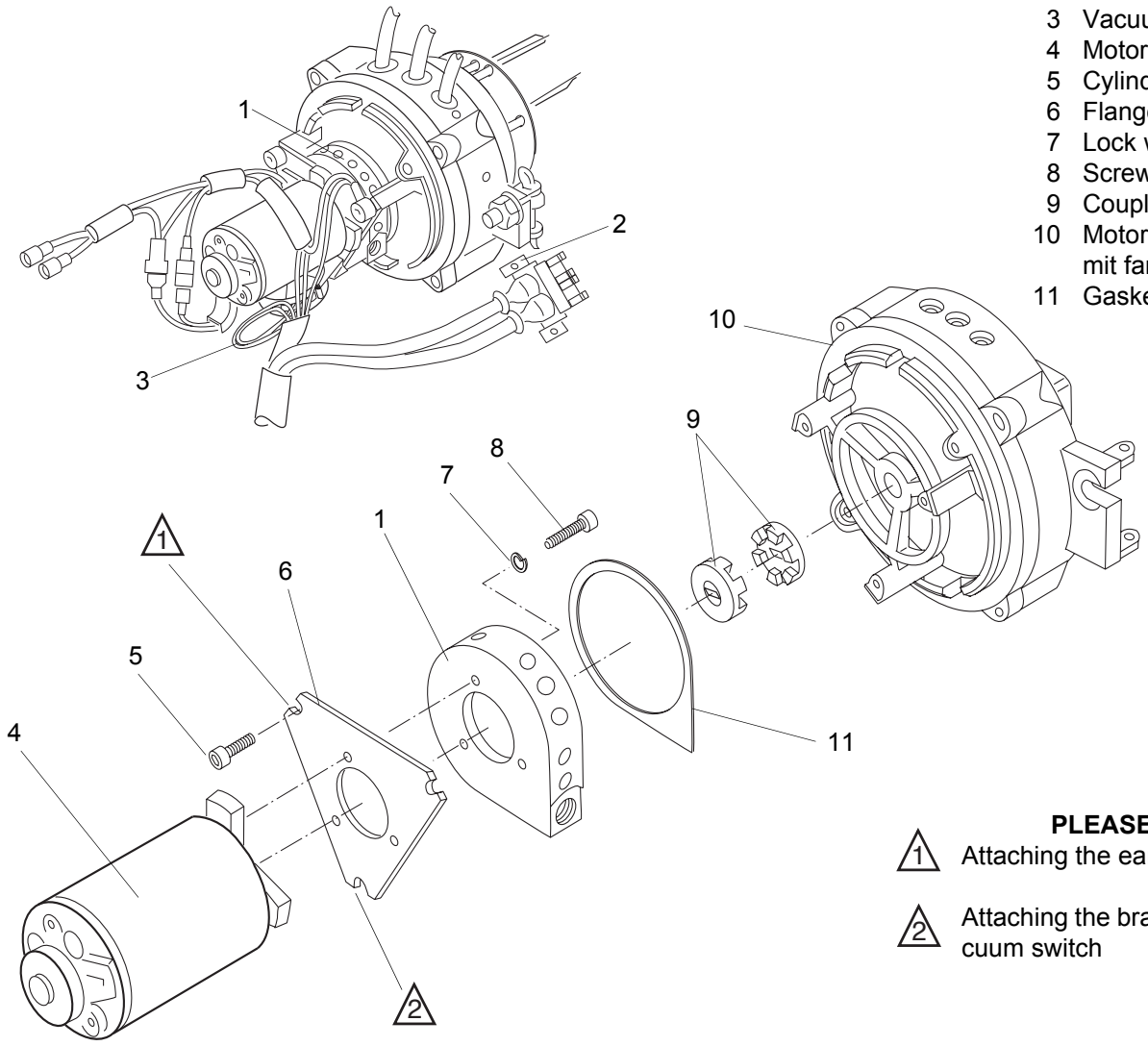
PLEASE NOTE

Insert the pin (22) until it sticks out equally on both sides of the shaft (14).

2. Insert the pin (22) into the shaft (14.
3. Insert the snap ring (17) into the motor bracket (16).
4. Press the shaft (14) with the bearing (15) into the motor bracket (16).
5. Insert the washer (13) and snap ring (12) into the motor bracket (16).
6. Slide the rotor (18), the bearing(19) and the spacer tube (20) onto the shaft (14) and attach with screws (21).
7. Tighten the nuts with 5.5 Nm.
8. Insert a new O Ring (26) into the fan casing (25).

PLEASE NOTE

The hood is not illustrated.



1 Gas mixer
2 Bracket
3 Vacuum switch
4 Motor
5 Cylinder screw (3)
6 Flange
7 Lock washer (3)
8 Screw (3)
9 Coupling
10 Motor bracket with mit fan casing
11 Gasket

PLEASE NOTE

1 Attaching the earth cable

2 Attaching the bracket for the vacuum switch

Fig. 908 Burner head disassembly and reassembly (page 1 of 2)

9. Coat the sealing surfaces between the motor bracket (16) and the fan casing (25) with a sealant (e.g. Loctite 396003).
10. Join the motor bracket (16) and the fan casing (25) and attach with cylinder screws (27) and lock washers (28).
11. Tighten the screws (27) with 5.5 Nm.
12. Place the motor (4), the flange (6) and the gas mixer (1) in the correct reassembly position and attach with screws (8) and lock washers (7).
13. Tighten the screws (8) with 5.5 Nm.
14. Put on a gasket (11).
15. Mount the coupling (9) on the shaft (14) and the motor shaft.

PLEASE NOTE

In addition, the bracket for the vacuum switch (3) and an earth cable (brown) are attached with the screws (5) (see fig. 908, page 1 of 2). The cables are to be laid between the flange (6) and the partition walls of the motor bracket.

16. Bring the motor (4) with a flange (6) and a gas mixer (1) into the reassembly position and attach the screws (5).
17. Tighten the screws (5) with 5.5 Nm.
18. Attach the vacuum switch (3) to the bracket with two screws and nuts.
19. Mount the hose line from the vacuum switch (3) to the gas mixer (1).
20. Re-establish the vacuum switch's (3) electrical connections (3).
21. Attach the bracket (2) for the wiring harness connector to the fan casing with 2 fillister screws and serrated washers.
22. Guide the cable to the ignition spark generator through the opening in the hood, position the wiring harness in the slot in the motor bracket and attach the hood with 4 fillister screws and serrated washers.
23. Screw on the gas nozzle and tighten with 5.5 Nm.
24. Bring the back wall (23) with a new gasket (24) into the reassembly position and install the burner (see 9.2.7.2).
25. Mount the ignition spark generator (see 9.2.4.2).
26. Install ignition electrodes (see 9.2.5.2).
27. Install the flame monitor electrode (see 9.2.6.2).
28. Mount the control unit (see 9.2.3.2).
29. Mount the burner head (see 8.5.1.2).

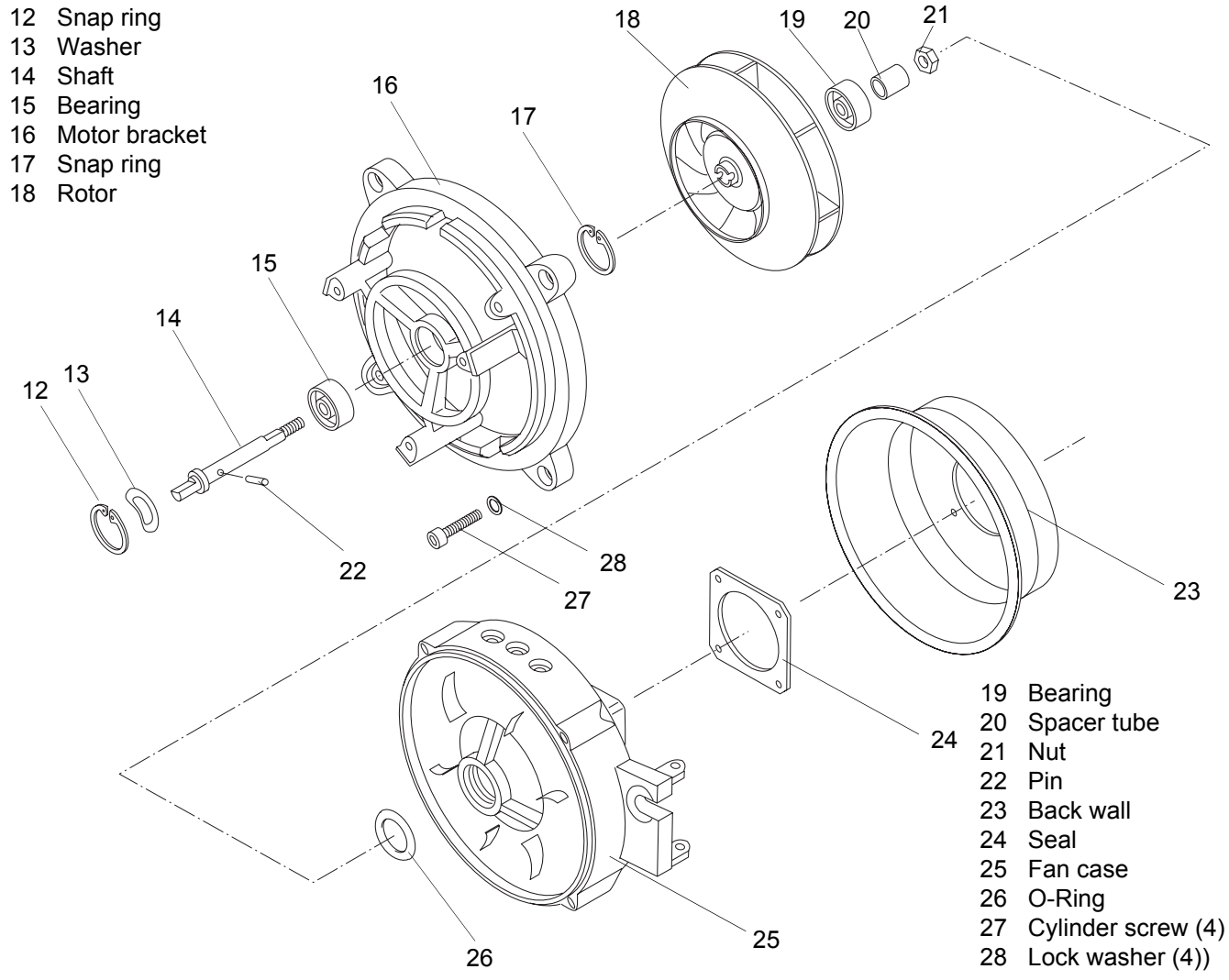


Fig. 908 Burner head, disassembly and reassembly (page 2 of 2)

9.2.9 Replacing the heat exchanger

9.2.9.1 Dismantling

1. Dismount the heater (see 8.7.1.1).
2. Dismount the burner head (see 8.5.1.1).
3. Dismantle the temperature limiter (see 9.2.1.1).
4. Dismantle the regulating thermostat (see 9.2.2.1).
5. Pull the combustion chamber (1, fig. 909) out of the heat exchanger (2).
6. Remove the heat exchanger (2).
7. Implement the measures for components, when the system is disassembled (see 9.1.1).

9.2.9.2 Extension

1. Push the combustion chamber (1, fig. 909) into the heat exchanger (2).
2. Install the temperature limiter (see 9.2.1.2).
3. Install the temperature regulator (see 9.2.2.2).
4. Mount the burner head (see 8.5.1.2).
5. Install the heater (see 8.7.1.2).

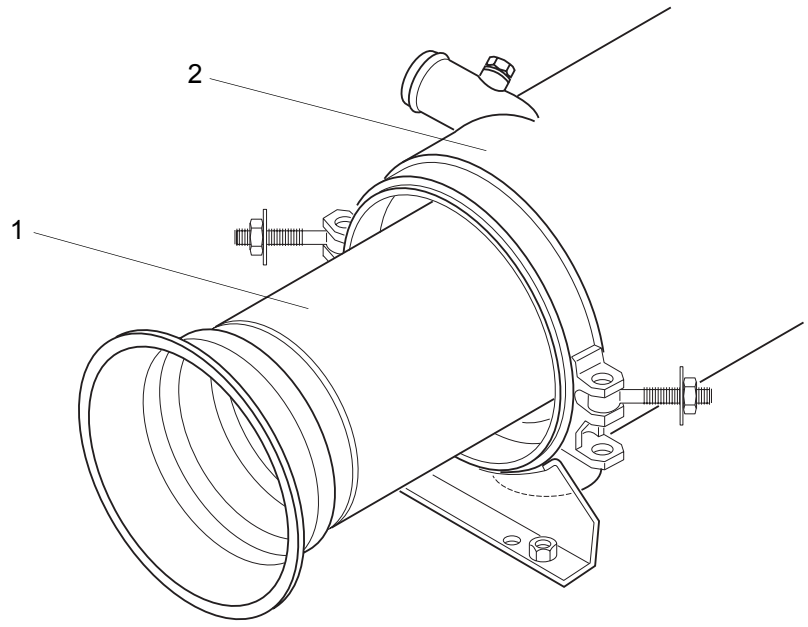
9.2.10 Replacing the combustion chamber

9.2.10.1 Disassembly

1. Dismount the burner head (see 8.5.1.1).
2. Pull the combustion chamber out of the heat exchanger (2) and remove.
3. Implement the measures for components when the heater is disassembled (see 9.1.1).

9.2.10.2 installation

1. Push the combustion chamber (1, fig. 909) into the heat exchanger (2).
2. Mount the burner head (see 8.5.1.2).



1 Combustion chamber
2 Heat exchanger

Fig. 909 Replacing the heat exchanger and the combustion chamber

9.2.11 Replacing the gas pressure regulator

CAUTION

Before dismantling the gas press regulator, it must be ensured that the gas supply line is closed from the storage tank to the gas pressure regulator.

9.2.11.1 Disassembly

1. Disconnect the coolant hoses with pliers.
2. Loosen the hose clamps on the coolant hoses and remove the hoses.
3. Loosen and remove the gas intake and outlet lines.
4. Loosen and remove the reference pressure line.
5. Remove the hose from the safety valve (only for the NGW 300).
6. Disconnect the plugs.
7. Loosen the nuts on the attachment screws and remove the gas pressure regulator together with the washers and spring ashers.

9.2.11.2 Installation

PLEASE NOTE

Replacement gas pressure regulators for the NGW 300 in compliance with ECE-R 110:

Starting in March 2004, replacement gas pressure regulators will only be supplied in the version which is in compliance with ECE-R 110.
Order no. 9008612B (standard), 9009636A (IVECO)

When replacing, please pay attention to the following:

- The differential pressure line (length: min. 100 mm, max. 500 mm) is still only connected to the gas pressure regulator.
- The connection at the heater remains free.
- The differential pressure line must run down, so that no water can penetrate it.
- The free end must be positioned in such a way that the hose opening cannot become clogged by dirt, snow or the like.
- Influencing of the pressure ratios by the air flow from the engine fan and the headwind must be avoided.
- The line must be mounted in the vehicle (e.g with clamps).

ATTENTION

Before installing new gas pressure regulators, the enclosed connector (1, fig. 910) for the reference pressure line must be screwed into the casing cover, aligned in the direction of the connection and secured with the counter nut (2) (torque value 10 ± 1 Nm). While doing this, please adhere to the screw-in depth indicated in fig. 910.

1. Bring the gas pressure regulator into the installation position with the attachment screws ,together with washers and spring washers and attach with nuts.
2. Tighten the nuts with 5.5 Nm.
3. Mount the coolant hoses and attach with hose clamps.
4. Mount the reference pressure line and secure with hose clamps.
5. Attach the hose to the safety valve and secure with hose clamps (only for the NGW 300).
6. Mount the gas intake line.

ATTENTION

After the gas pressure regulator is installed, the gas intake line must be checked by authorised personnel for impermeability.

7. Attach the gas intake hose and secure with hose clamps.
8. Connect the electrical plugs again.
9. Examine the CO2 value and adjust, if necessary.

9.2.12 Replacing the delayed-action solenoid in the gas intake line

9.2.12.1 Disassembly

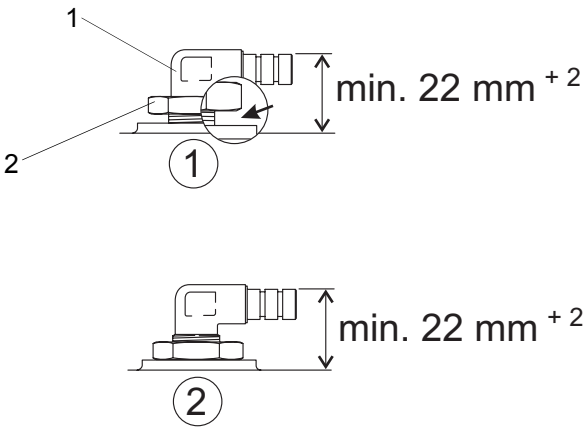
1. Disconnect the delayed-action solenoid from the electricity supply.
2. Loosen the gas hose on both sides and remove.
3. Unscrew the delayed-action solenoid and remove it from the bracket.

9.2.12.2 Installation

PLEASE NOTE

When installing, please pay attention to the flow direction..

1. Bring the delayed-action solenoid into the installation position and attach it to the bracket with 2 screws.
2. Mount the gas hose on both sides and secure with hose clamps.
3. Reconnect the delayed-action solenoid to the electricity supply.



1 Connector
2 Counter nut

Fig. 910 Connector

10 Packaging/Storage/Shipping

10.1 General information

The heater or its components, which are shipped to Spheros GmbH for checking or repair, must be cleaned and packed in such a way that they are protected from damage during handling, trasnportation and storage. A description of the defect must be enclosed.

ATTENTION

If an entire heater is being sent back, it must be completely emptied. When packaging or shipping the appliance, care must be taken to ensure that no coolant can leak out. The coolant inlets and outlets must be closed with blind plugs. The ambient temperatures listed in paragraph 4 must not be exceeded during storage.

Blank page for notes

memos

Valeo Thermal Commercial Vehicles Germany GmbH
Postfach 1371 - 82198 Gilching - Germany - Tel. +49 (0)8105 7721-0 - Fax +49 (0)8105 7721-889
www.valeo-thermalbus.com - service-valeobus@valeo.com