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(71) Applicant: **Borgwarner Inc.**
Auburn Hills, Michigan 48326 (US)

(72) Inventors:

- **Höfle, Stefan**
76189 Karlsruhe (DE)
- **Meixus Touris, Melissa**
74339 Walheim (DE)

(74) Representative: **Twelmeier Mommer & Partner**
Patent- und Rechtsanwälte mbB
Westliche Karl-Friedrich-Straße 56-68
75172 Pforzheim (DE)

(54) FLOW HEATER AND METHOD FOR OPERATING A FLOW HEATER

(57) Disclosed is a flow heater comprising an inlet (4), an outlet (5), and an electrical interface (6, 8). The flow heater comprises a plurality of heater modules (1) that each comprise a module inlet (2) connected to the inlet (4), a module outlet (3) connected to the outlet (5), a

heating element for heating liquid flowing from the module inlet (2) to the module outlet (3), and an electrical module interface (7, 9) connected to the electrical interface (6, 8).

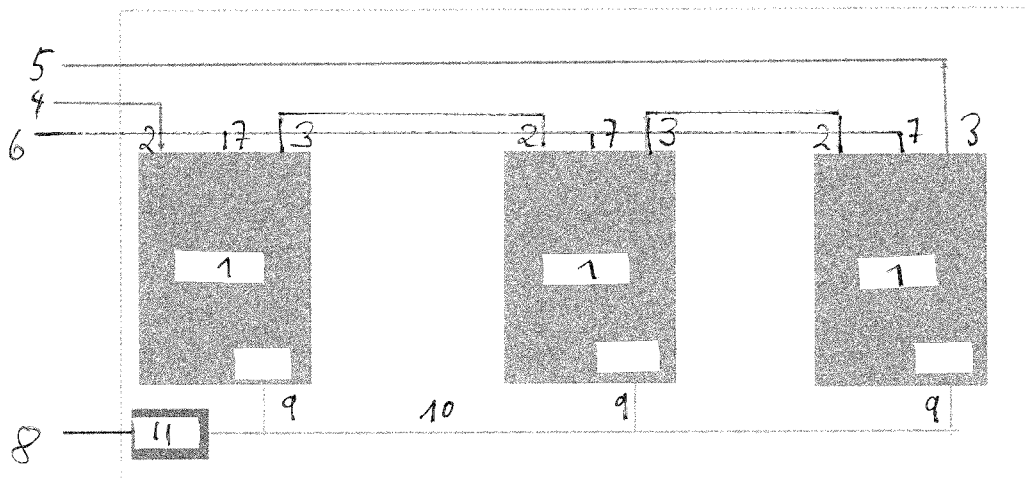


Fig. 3

Description

[0001] The invention refers to a flow heater for heating liquids in an automotive vehicle.

[0002] Flow heaters are needed in vehicles to heat various liquids, in particular water or aqueous solutions and oil. The heating power needed in commercial vehicles is usually about two to three times higher than heating power needed in passenger cars.

[0003] It is an object of the present invention to reduce development effort and capital expenditures to deliver flow heaters for use in commercial vehicles.

[0004] This object is solved by a flow heater according to claim 1 and a method for operating such a flow heater. Advantageous refinements of the invention are the matter of dependent claims.

[0005] According to the present invention, the flow heater comprises several heating modules that are connected in series or in parallel to a single inlet and a single outlet. Although the flow heater comprises several heater modules, the number of interfaces for connection to a commercial vehicle is not increased in comparison to prior art flow heaters for commercial vehicles. The heater modules can be provided with a power rating suitable for passenger vehicles and therefore produced cost-efficiently in very large numbers. The invention thereby shows how flow heaters for commercial vehicles can be produced at lower cost and still be installed fairly easily in a commercial vehicle. The present invention effectively uses several flow heaters suitable for passenger vehicles in a commercial vehicle while the interfaces to the vehicles are kept like it would be with a single flow heater of higher power.

[0006] For example, the heater modules may have a heating power of 3 kW to 6 kW, and the flow heater may comprise two to four heater modules. The heating power of the flow heater may for example be in the range of 8 kW to 14 kW.

[0007] In a method for operating a flow heater the heating power of each heater module may be set individually. This means that the various heater modules of the flow heater may be operated with different heating powers. If the various heater modules are connected in series, the temperature of liquid to be heated rises from the first heater module to the last. The heating power of the heater modules may decrease from the first heater module to the last in order to achieve the most efficient heat transfer.

[0008] In a further embodiment, each heating module may be provided with temperature sensors that are used by a control unit of the flow heater to monitor operation of the various heater modules. The control unit may communicate with a vehicle control unit and provide operating parameters to the vehicle control unit. For example, the control unit may diagnose an operating condition of the various heater modules and store that condition in a memory. The operating condition may then be considered in setting the heating power of the various modules

and, especially if a fault condition of a module was detected, reported to the vehicle control unit.

[0009] Further details and advantages of the invention are explained by means of examples of embodiments, with reference to the accompanying drawings. Equal and corresponding parts of various embodiments are provided with the same reference numbers in all figures.

Fig. 1 shows schematically a circuit diagram of a flow heater;

Fig. 2 shows schematically another circuit diagram of a flow heater;

Fig. 3 shows schematically another circuit diagram of a flow heater;

Fig. 4 a heater module of a flow heater; and

Fig. 5 a flow heater comprising three flow heaters.

[0010] Fig. 1 shows schematically a circuit diagram of a flow heater comprising three heater modules 1 which each have a module inlet 2 and a module outlet 3. The module inlets 2 are connected in parallel to an inlet 4 of the flow heater and the module outlets 3 are connected in parallel to an outlet 5 of the flow heater. In operation, liquid to be heated flows from the inlet 4 of the flow heater in parallel through the heater modules 1 and then to the outlet 5 of the flow heater.

[0011] The module inlets 2 and the module outlets 3 may comprise a spigot, e.g. as shown in fig.1. It is also possible to connect a module outlet 3 directly to a module inlet 2. For example, a heater module 1 may have a module inlet 2 on an upper side and a module outlet on a lower side such that stacking modules on top of each other connects the module inlet of a heater module to the module outlet of the heater module above. A seal, e.g. on O-ring, may be used between a module outlet and a module inlet.

[0012] The flow heater has an electrical interface 6 for connection to a source of heating current, e.g., a high voltage source. The electrical interface 6 is connected in parallel to electrical module interfaces 7 to provide heating power to the heating modules 1. The flow heater also has another electrical interface 8 for connection to a control unit of a vehicle. In the embodiment shown, the electrical control interface 8 of the flow heater is connected only to one electrical module interface 9 of one of the heater modules 1. This heater module 1 is connected via an internal bus 10 to the other heater modules 1 and controls them according to commands received via the electrical interface 8 of the flow heater. A master-slave architecture may be used for control of the heater modules, wherein the heater module connected to the electrical control interface 8 of the vehicle acts as a master that controls the other heater module as slaves via the internal bus 10.

[0013] Fig. 2 shows schematically a circuit diagram of another flow heater comprising three heater modules 1. This embodiment differs from the embodiment of fig. 1 discussed above only in that liquid to be heated flows from the inlet 4 of the flow heater in series through the heater modules 1 and then to the outlet 5 of the flow heater.

[0014] A parallel connection of the heater modules 1 as shown in fig. 1 results in a lower pressure loss compared to a serial connection of the heater modules 1 as shown in fig. 2. This is advantageous in some applications, but larger fluid flows are needed for a parallel connection to prevent overheating.

[0015] Fig. 3 shows schematically a circuit diagram of another flow heater comprising three heater modules 1. This embodiment differs from the embodiment of fig. 2 only in how the heater modules 1 are controlled. The electric control interface 8 of the flow heater is connected to a control unit 11 which controls all heater modules 1 via the internal bus 10. All heater modules 1 have an electronic module interface 9 that is connected to the internal bus 10 and via the internal bus 10 to the control unit 11. The control unit 11 is arranged between the electrical control interface 8 and the internal bus 10.

[0016] The control unit 11 may be able to set the heating power of each heater module 1 individually. If the various heater modules are connected in series, the temperature of liquid to be heated rises from the first heater module to the last. The heating power of the heater modules may decrease from the first heater module to the last in order to achieve the most efficient heat transfer.

[0017] Moreover, each heater module 1 may be provided with a temperature sensor that is used by the control 11 unit of the flow heater to monitor operation of the various heater modules 1. The control unit 11 may communicate with a vehicle control unit via electrical interface 8 and provide operating parameters to the vehicle control unit. For example, the control unit 4 may diagnose an operating condition of the various heater modules and store that condition in a memory. The operating condition may then be considered in setting the heating power of the various modules and, especially if a fault condition of a module was detected, reported to the vehicle control unit.

[0018] Fig. 4 shows an embodiment of a heater module 1. The heater module 1 comprises a module inlet 2 for liquid to be heated, a module outlet 3, a heating element, e.g. an electrical heating resistor, for heating liquid flowing from the module inlet 2 to the module outlet 3, an electrical module interface 7 for heating current and another electrical module interface 9 for receiving control signals. The electrical module interface 9 might therefore also be called an electrical module control interface. The electrical interfaces 7, 9 may be provided as electrical plug connectors.

[0019] Fig. 5 shows a flow heater comprising three heater modules 1 stacked on top of each other. The flow heater has an inlet 4 for liquid to be heated, an outlet 5 for

heated liquid, an electrical interface 6 for connection to a source of heating current, e.g., a vehicle battery, and electrical control interface 8 for connection to a control unit of a vehicle. The electrical interfaces 6, 8 may be provided as electrical plug connectors.

[0020] The inlet 4 is connected in parallel to the module inlets 2 of the heater modules 1 and the outlet 5 is connected in parallel to the module outlets 3. The electrical interface 6 is connected to the electrical module interfaces 7 as shown in figures 1 to 3. The electrical control interface 8 may be connected to electrical control interfaces of the heater modules 1 as shown in fig. 1, fig. 2 or fig. 3.

[0021] The flow heater comprises a frame 12 that carries the inlet 4, the outlet 5, connecting spigots that are connecting the inlet 4 and the outlet 5 to the module inlets 2 and the module outlets 3, respectively. The frame 12 also carries the electrical plug connectors defining the electrical interfaces 6, 8. In addition, the frame 12 may carry a control unit 11 as explained with reference to fig. 3 and an internal bus 10 connected to electrical module interfaces 9 of the heater modules. The frame 12 may comprise a plate that cover a front face of the heater modules 3 and on which the electrical connectors are arranged.

[0022] The heater modules 1 are held by the frame 12. The frame 12 mechanically connects the heater modules 1 and thereby combines the heater modules 1 into a device that can be handled conveniently when it is mounted in a commercial vehicle.

List of reference signs

[0023]

1	heater module
2	module inlet
3	module outlet
4	inlet
5	outlet
6	electrical interface
7	electrical module interface
8	electrical interface
9	electrical module interfaces
10	internal bus
11	control unit
12	frame

Claims

1. Flow heater comprising

an inlet (4), an outlet (5), and an electrical interface (6, 8), **characterized by**
a plurality of heater modules (1) that each comprise
a module inlet (2) connected to the inlet (4),
a module outlet (3) connected to the outlet (5),

- a heating element for heating liquid flowing from the module inlet (2) to the module outlet (3), and an electrical module interface (7, 9) connected to the electrical interface (6, 8).
2. Flow heater according to claim 1, **characterized in that** the module inlets (2) of the heater modules (1) are connected in parallel to the inlet (4). 5
 3. Flow heater according to claim 1, **characterized in that** module heaters (1) are connected in series such that liquid to heated flows through the heater modules (1) one after the other. 10
 4. Flow heater according to any one of the preceding claims, **characterized in that** the heater modules (1) are stacked on top of each other. 15
 5. Flow heater according to any one of the preceding claims, **characterized by** a frame (12) that carries the electrical interface (7, 9), the inlet (4), the outlet (5), connecting spigots that are connecting the inlet (4) to the module inlets (2) and the outlet (5) to the module outlets (3), respectively. 20
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 6. Flow heater according to claim 5, **characterized in that** the heater modules (1) are held by the frame (12).
 7. Flow heater according to any one of the preceding claims, **characterized by** an internal bus (10) connecting the module electrical interfaces (9). 30
 8. Flow heater according to claim 5 and 7, **characterized in that** the internal bus (10) is provided on the frame (12). 35
 9. Flow heater according to claim 7 or 8, **characterized by** a control unit (11) connected to the electrical interface (8) and to the internal bus (10). 40
 10. Flow heater according to claim 8 and 9, **characterized in that** the control unit (11) is provided on the frame (12). 45
 11. Flow heater according to claim 7 or 8, **characterized in that** one of heater modules (1) comprises a control unit that controls the other heater modules (1) via the internal bus (10). 50
 12. Flow heater according to any one of the preceding claims, **characterized in that** the electrical interface (6, 8) comprises a first plug connector for connecting to a source of heating current and a second plug connector for connecting to a vehicle control unit. 55
 13. Flow heater according to any one of the preceding claims, **characterized in that** the heating element is an electrical resistor.
 14. Method for operating a flow heater according to any one of the preceding claims, wherein the heating power of each heater module (1) is set individually.
 15. Method according to claim 9 and 14, wherein the control unit (11) of the flow heater communicates with a vehicle control unit and provides operating parameters of the flow heater to the vehicle control unit.

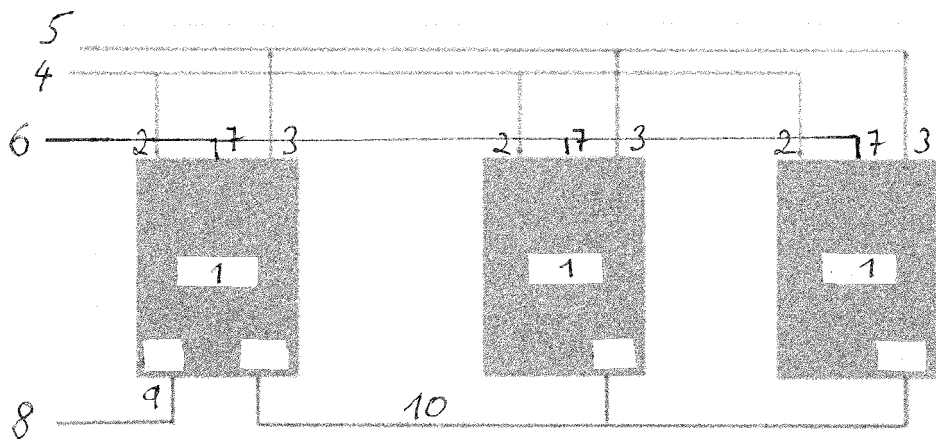


Fig. 1

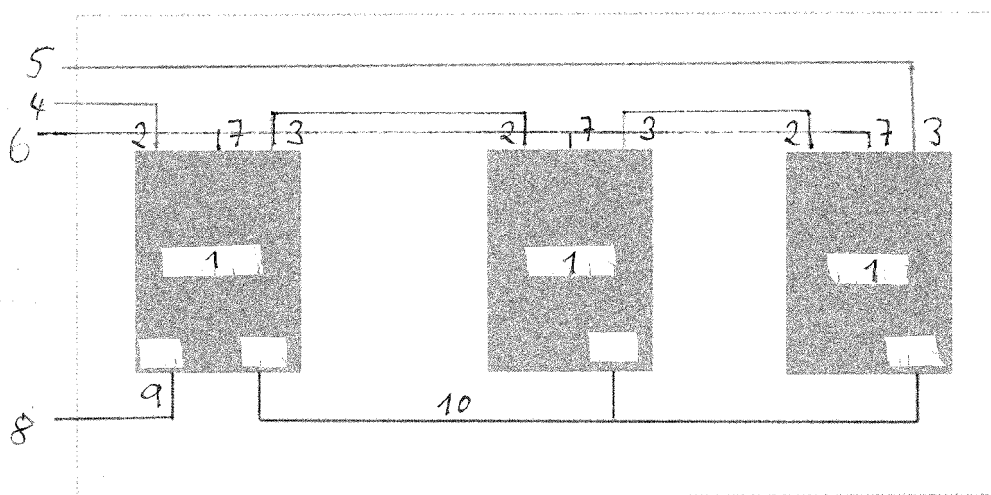


Fig. 2

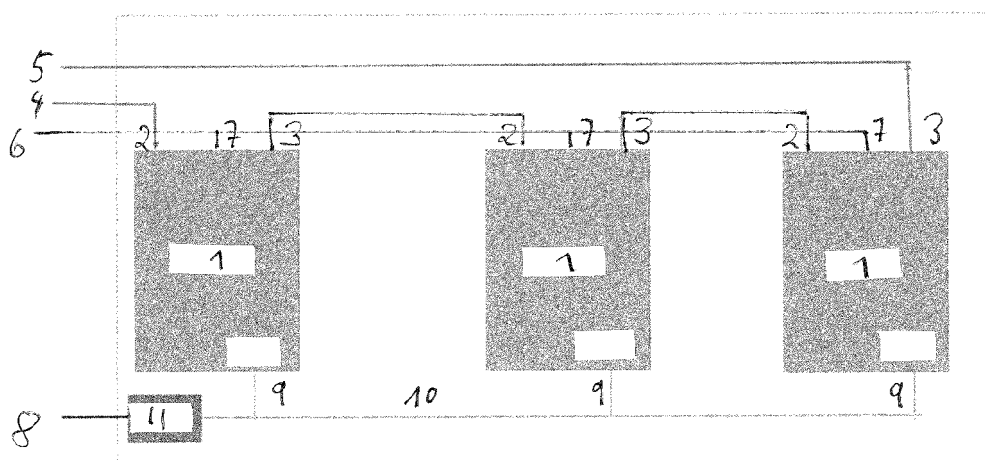


Fig. 3

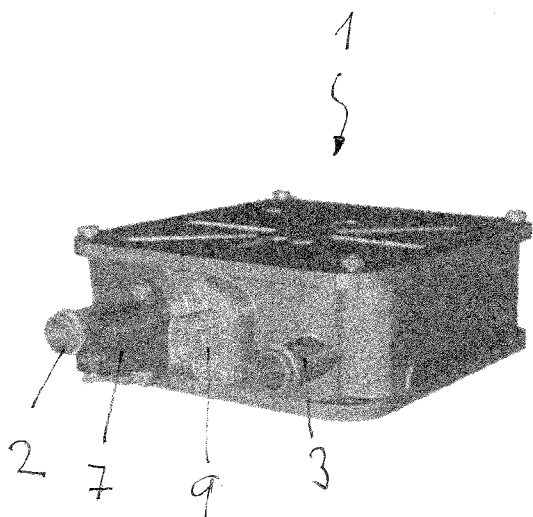


Fig. 4

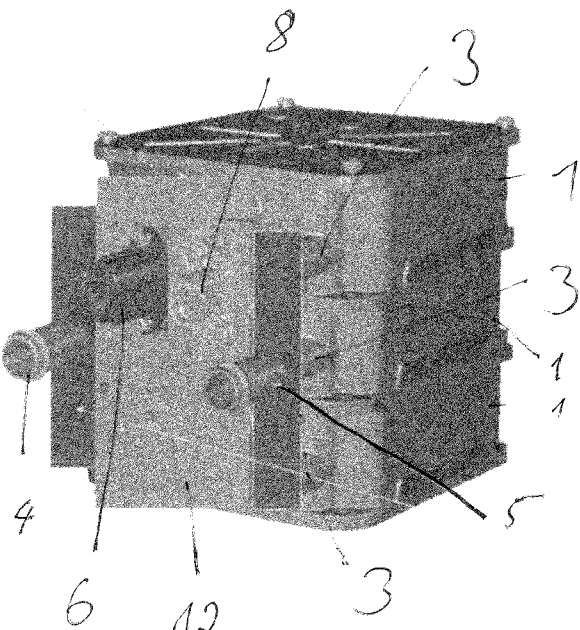


Fig. 5



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Application Number

EP 23 19 3678

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			F24H B60H H05B
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		25 January 2024	García Moncayo, O
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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