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(54) **HYDRAULIC MODULE FOR HEATING SYSTEMS WITH A HEAT PUMP**

(57) A hydraulic module (100) for a heating device with a heat pump and at least one heating circuit and / or a domestic hot water circuit, with a closed heat transfer medium circuit. The hydraulic module (100) comprises a tank for circulating, filtering and reheating the heat transfer medium. The tank is hydraulically connectable to the heat exchanger (7) of the heat pump, to the heating circuit and / or to the domestic hot water circuit. The tank consists of an upper part (20) and a lower part (30) which are waterproof connected to each other. The hydraulic module integrates a cyclone filter for solid impurities and a magnetic separator for metal impurities in the tank.

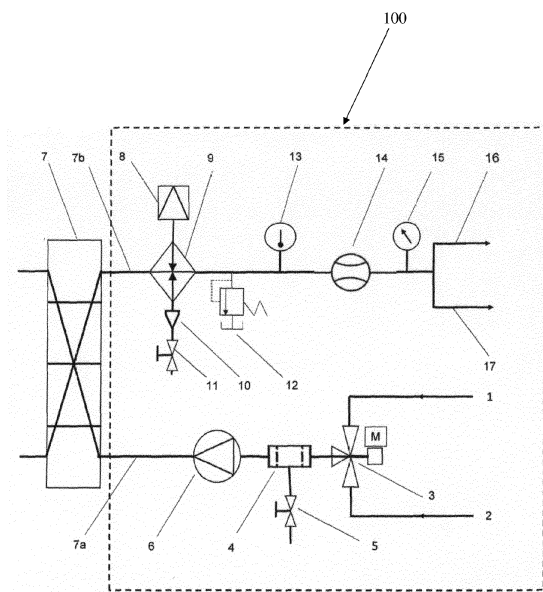


Fig.1

Description

Technical field

[0001] The invention relates to the design of a hydraulic module for heating systems with a heat transfer medium closed-circuit heat pump.

Prior art

[0002] Heat pumps use heat from the surrounding environment - from the ground, from ground water or from the air and provide heat for residential space heating and domestic hot water preparation throughout the year. They significantly reduce the cost of energy consumption, they are a substitute for fossil fuel burning and significantly help to reduce carbon dioxide emissions.

[0003] A closed circuit filled with refrigerant is the basis of a heat pump. The heat pump, or cooling circuit, has four basic parts - an evaporator, a compressor, a condenser and an expansion valve.

[0004] With an air-to-water heat pump, low-potential heat is supplied to the evaporator from the ambient air. The heat input causes the refrigerant to evaporate, the refrigerant vapour becomes a carrier of thermal energy and transfers it to the compressor. The air, the flow through the evaporator of which is provided by fans, cools down by that. The air path is the primary side of the heat pump. The compressor draws vapour from the evaporator, compresses it and pushes it into the condenser. The liquid refrigerant, which has condensed in the condenser at a higher (condensing) pressure, is injected into the evaporator by the expansion valve to evaporate again at a lower (evaporating) pressure.

[0005] The energy supplied to the condenser is transferred to the circulating heat transfer medium, which is the secondary side of the heat pump. The heat transferred from the condenser thus primarily heats the heat transfer medium.

[0006] The heat exchanger of the heat pump (condenser) can be located in the external unit of the heat pump or in the internal part of the system. The heat is further transferred by the heat transfer medium via the hydraulic module.

[0007] Hydraulic modules for heat pump heating systems must meet in particular the following criteria:

- A continuous flow of the heat transfer medium through the hydraulic module must be ensured
- Heat transfer medium distribution to the heating circuit and/or to the hot water preparation circuit must be ensured
- Measurement of the flow, pressure and temperature of the medium must be possible
- Filtration of solid particles (impurities) from the heat transfer medium must be ensured
- It must be possible to drain the heat transfer medium from the hydraulic circuit

- It must be possible to reheat the heat transfer medium in the event that the heat pump does not supply sufficient heat to the heating system, such as e.g. in winter months

- 5 • The medium used as a heat transfer medium must be protected against freezing, especially if the heat exchanger of the heat pump is located in the external unit

10 **[0008]** The hydraulic module should also be compact, its dimensions should take up as little space in the system as possible.

[0009] Conventional hydraulic modules for heat pump heating systems are assembled from individual separate components, connected by other parts, mainly pipes and connectors. Such a hydraulic module may be too large and, especially due to the requirement for reheating, together with an electric heater they take up a considerable amount of space in the heating system.

20 **[0010]** Heating equipment manufacturers strive to minimize the size of the hydraulic modules.

[0011] Document WO2018202436A1 discloses a structural unit for a hydraulic module consisting of three separately made structural connection components, which are preferably made of injection moulded plastic composite materials. The inlet structural component is used to connect the inlet of domestic and heating water to the hydraulic module, and the outlet structural component is used for the outlet of the heated domestic and heating water, and they are connected by a plate exchanger to each other. The connection sockets located on the individual structural components are used to connect other functional elements of the hydraulic module, such as valves, sensors, an expansion tank, etc. The inlet structural components are connected to the circulating pump structural component and to the plate exchanger. The location of the circulating pump structural component in the hydraulic module assembly ensures the smallest dimensions of the entire hydraulic module while meeting the hydraulic displacement requirements of the hydraulic module.

[0012] This hydraulic unit does not meet the requirements for a hydraulic module for a heat pump system, as it does not provide reheating, which is needed, for example, in the event of increased heat demand at the outlet or to support the air/water heat pump at very low ambient temperatures. For example, a separate electric heater must be connected to the circuit for reheating.

[0013] A heat pump with a hydraulic module made of a housing having at least the first wall and the second wall, each of which are injection moulded, is published in the EP2312224B1 document. The first and second walls are made of plastic and are joined together, mainly by welding, such as vibration welding, ultrasonic welding, friction welding or laser welding. The cavity is partly formed by the walls of the hydraulic module and the fluid pipe connection is provided with a flow connection and a reverse connection. Further cavities of the compact

module are described, an additional electric heater being incorporated into one cavity at least in the preferred design.

[0014] The disadvantage of the described hydraulic module is the fact that limescale builds up, especially on the heating elements, during the heating of water, and thus solid impurities can form and accumulate in the cavity, which can be the cause of serious malfunctions in the heating system. The hydraulic module does not provide the possibility of filtering impurities.

[0015] EP3816521 A1 describes a hydraulic assembly for a heat pump for space heating and domestic hot water production, which comprises many functions, including filtering of magnetic impurities and the circulation pump body. The disadvantage of this solution is that it contains only a common filtering device and the body of the circulation pump is not sufficiently protected against magnetic impurities. The positions of the magnets should be closer to the circulating pump, but at a distance that does not affect the proper function of the electric motor. Additionally, the hydraulic assembly is too complex.

[0016] The design of an electric water heater with an integrated solid impurity and magnetic impurity separator with one common drain valve is provided in the document EP3910260 A1. This electric water heater can be used in any system with a closed circuit of a heating medium, then there is no need to incorporate an autonomous filter in the circuit. It conveniently integrates a filter for solid impurities where limescale builds up, i.e. near the heating coils. However, the location of the magnetic filter in the electric water heater is not ideal due to the greater distance from the circulating pump in the heating system.

[0017] The present invention eliminates the shortcomings of the solutions known in the state of the art and discloses a compact hydraulic module for a heat pump heating system, designed to circulate a heat transfer medium in at least one closed circuit, which provides reheating, integrates the function of a cyclonic filter for solid impurities and a magnetic separator for metallic impurities, and provides all the required functions, the components of the hydraulic module being connected via connectors and formed channels, without the use of connection tubes and extra lines.

Description of the invention

[0018] A tank for circulation, filtration and reheating of the heat transfer medium is the basic structural unit of the hydraulic module. The tank is made up of an upper part and a lower part, which are connected watertight to each other by bolts and seals or weld, and during operation the hydraulic module is placed in an upright position. Both parts of the tank are preferably made of composite materials by injection moulding. Using the mould the technology allows the integration of additional connection channels, chambers, cavities and connectors for the hydraulic module components in both parts of the tank, so the tank is also a connection point for the hydraulic

module components, thus eliminating the need for additional pipe connections.

[0019] The upper part of the tank is provided with a cover and a concentric inner wall, and the lower part of the tank is provided with a cover with a conical shape in at least one area. By means of the concentric wall, two separate circulation channels are defined in the upper part the tank - an outer circulation channel and an inner circulation channel. The heating elements of the electric heating block are arranged in the internal circulation channel for heat transfer medium reheating.

[0020] The flow through the tank of the hydraulic module is ensured by the upper part of the tank being hydraulically connected to the heat exchanger of the heat pump and the heat transfer medium being directed through the connection channel to the internal circulation channel defined by the concentric wall.

[0021] The circulation of the heat transfer medium in the hydraulic circuit is provided by a circulating pump, which is arranged in the lower part of the tank and its outlet is hydraulically connected to the heat exchanger of the heat pump and the inlet is hydraulically connected to a 3/2 - way switch valve.

[0022] The heat transfer medium is reheated by means of an electric heating block. The heated heat transfer medium is directed into an external circulation channel in the upper part of the tank, into which connection channels for the heat transfer medium outlet to the circuits of the heating system for heating and for domestic hot water preparation are integrated.

[0023] The concentric wall arrangement in the upper part of the tank helps to change the direction and velocity of the flow of the heat transfer medium as it moves through the inner circulation channel from top to bottom and the outer circulation channel from bottom to top.

[0024] The barrier formed by the concentric wall and the heating elements helps to separate solid impurities from the flow of the heat transfer medium, which are deposited by gravity in the conical area of the lower part of the tank, from where they are removed by a drain valve. Autonomous cyclone filters for solid impurities work on the same principle.

[0025] If limescale builds up on the heating elements while heating the heat transfer medium, any impurities scaled off are removed close to where they originated and are not further transferred into the heat transfer medium circuit. In addition, the design of the lower tank of the hydraulic module allows the magnetic separator to separate magnetic impurities that may enter the heat transfer medium circuit, for example from radiators, and thus protect in particular the circulating pump, but also other components of the hydraulic module from damage.

[0026] The hydraulic module includes connecting channels, chambers and connectors for a 3/2 - way valve for switching the circuits, a pressure relief valve, circulating pump, magnet, temperature sensor, drain valve for solid impurity removal and drain valve for magnetic impurity removal, bleed valve and connectors for their con-

nection as well as connectors for connecting the hydraulic module to the circuits for heating water, domestic water and heat pump heat exchanger.

Brief description of the drawings

[0027] The invention is described with reference to, but not limited to, the following figures:

Fig. 1 shows the hydraulic schematic of the hydraulic module according to the presented invention

Fig. 2 is the 3D illustration of an example of the implementation of the hydraulic module according to the presented invention, with valves and sensors connected Fig. 3 shows the hydraulic module from Fig. 2 in exploded view

Fig. 4 shows the cross-section of the hydraulic module with the three-way valve shown

Fig. 5 shows the cross-section of the hydraulic module with the circulating pump body, cyclone filter and magnetic impurity separator shown.

Preferred embodiments of the invention

[0028] A hydraulic module 100, for heating systems with a heat pump and with at least one heating water circuit and/or a domestic hot water preparation circuit, with a closed circuit of a heat transfer medium, comprises a tank for providing circulation, filtration and reheating of the heat transfer medium, the tank being hydraulically connectable to the heat exchanger 7 of the heat pump, to the heating circuit and/or to the domestic hot water preparation circuit.

[0029] The tank is made up of an upper part 20 and a lower part 30, which are connected watertight to each other by bolts and seals, during operation the hydraulic module is placed in an upright position (the upper part 20 is located above the lower part 30).

[0030] The watertight joint between the parts 20 and 30 can also be made as welded in another embodiment.

[0031] The upper part 20 of the tank is closed by a flange 50 on the top.

[0032] The upper part 20 of the tank comprises a concentric wall 40 defining an internal circulation channel 70, wherein an external circulation channel 80 is defined between the tank wall and the concentric wall 40.

[0033] The lower part of the tank 30 comprises a conical area 60 for trapping the solid impurities separated from the flow of the heat transfer medium.

[0034] The concentric wall 40 is designed to separate solid impurities from the flow of the heat transfer medium. The impurities conducted by the heat medium stream impinge on the concentric wall 40, decelerate, separate from the stream and settle in the conical area 60 of the tank.

[0035] A body 6 of the circulating pump for circulating the heat transfer medium is formed in the lower part 30 of the tank.

[0036] A connector for a drain valve 11 for removing settled impurities from the conical area 60 is arranged in the lower part 30 of the tank.

[0037] An integrated cyclonic filter 10 for removing solid impurities from the closed circuit of a heat transfer medium thus comprises the concentric wall 40, the conical area 60, and the attached drain valve 11.

[0038] The two parts 20, 30 of the tank are made of composite plastic by injection moulding; the concentric wall 40 in the upper part 20 of the tank, the circulating pump body 6 in the lower part 30 of the tank, the conical area 60 in the lower part 30 of the tank, circulation channels 70, 80 defined by the concentric wall 40 and the outer wall of the upper part 20 of the tank, interconnecting channels inside the tank, and connectors on the outer walls of both parts 20, 30 of the tank are provided by injection molding together with the tank walls.

[0039] An electric heating block 9 for heat transfer medium reheating is mounted on the flange to the upper part 20 of the tank by a flange 50 and is arranged in the internal circulation channel 70.

[0040] A bleed valve 8 is attachable to the flange 50 via a connector, which is positioned uppermost within the hydraulic module 100 during operation.

[0041] The upper part 20 of the tank is provided with a connector 7b for the inlet of the heat transfer medium from the heat exchanger 7 of the heat pump to the hydraulic module 100 (the heat exchanger 7 is not a part of the hydraulic module 100).

[0042] Through the connector 7b, the heat transfer medium enters the internal circulation channel 70, in which the filtering and reheating functions are provided.

[0043] The heat transfer medium circulates by the circulating pump. The hydraulic connections of the circulating pump and the body 6 of the circulating pump are arranged in the lower part 30 of the tank and are made by injection moulding.

[0044] A channel 35 for a 3/2 - way switch valve 3 connecting and a channel 90 for connecting the outlet of the 3/2 - way valve 3 with an inlet to the body 6 of the circulating pump are formed in the lower part 30 of the tank.

The 3/2 - way switch valve 3 is controlled by an electric actuator (preferably by a stepper motor) during operation.

[0045] The circulating pump body 6 is hydraulically connected via a connector 7a to the heat exchanger 7 of the heat pump. To ensure the operation of the circulating pump, the circulating pump body 6 is connected to the actuator 6a via an adapter 6b.

[0046] In the lower part 30 of the tank, the connections between the 3/2 - way valve 3 and the connector 1 for the inlet of the heat transfer medium from the heating circuit and the connector 2 for the inlet of the heat transfer medium from the domestic hot water preparation circuit are moulded.

[0047] During the heating system operation, the heat

extracted from the heat pump is used to heat the heating circuit or the domestic hot water preparation circuit by the hydraulic module. By means of the 3/2 - way valve 3, either the circuit of a heat transfer medium fed via the connector 1 or the circuit of a heat transfer medium fed via the connector 2 is connected to the inlet of the circulating pump body 6.

[0048] In the lower part 30 of the tank, a chamber 36 for inserting the magnet 4 and a cavity 6c connected to the connector for connecting the drain valve 5 are arranged.

[0049] Any metallic impurities released into the closed hydraulic circuit (for example from radiators) passing through the channel 90 are attracted by the magnet 4 and trapped in the cavity 6c.

[0050] A connector for the drain valve 5 is arranged in the lower part 30 of the tank for the final removal of metallic impurities from the closed circuit of the heat transfer medium. After the magnet 4 is ejected from the chamber, the metallic impurities are released from the cavity 6c by gravity and removed from the circuit via the drain valve 5.

[0051] The location of the chamber 36 for inserting the magnet 4 in the lower part 30 of the tank, the dimensions and the strength of the magnet 4 are designed so that the magnetic field of the magnet 4 cannot adversely affect the operation of the electric motor-controlled 3/2 - way valve or the operation of the electric motor-controlled circulating pump.

[0052] Thus, the magnetic separator comprises a magnet 4 inserted into the chamber 36, a cavity 6c and an attached drain valve 5.

[0053] The integration of the magnetic separator of impurities in the hydraulic module 100 according to the present invention is highly advantageous, since the arrangement of the magnetic separator in close proximity to the inlet of the heat transfer medium into the circulating pump body 6 prevents damage to the circulating pump effectively.

[0054] The hydraulic module 100 according to the model provides hydraulic connections for all of the components shown in the schematic of Fig. 1.

[0055] A connector 16 for the outlet of the heat transfer medium to the heating circuit, a connector 17 for the outlet of the heat transfer medium to the domestic hot water preparation circuit, a connector for a pressure relief valve 12, a connector for a temperature sensor 13, a connector for a flow sensor 14 and a connector for a pressure sensor 15 are arranged on the upper part 20 of the tank, all of the above connectors being hydraulically connected to the external circulation channel 80.

[0056] The heat transfer medium is preferably water or water containing antifreeze agent, preferably glycol.

[0057] The hydraulic module is made of plastic by injection moulding, preferably of composite materials, in particular of PA66, PPA-GF40, PA66-GF30, PA66-GF35, PA66-GF40 or PP-GF40.

Industrial applicability

[0058] The invention is a new design of a compact hydraulic module for a closed circuit of a heat transfer medium. The integrated cyclonic filter and magnetic separator for the effective removal of solid non-metallic and metallic impurities from the heat transfer medium circuit are effectively arranged where the impurities originate (in the heating block area) or where there is a risk of damage (at the inlet to the circulating pump). The connections of the heat transfer medium to the circulating pump and to the 3/2 - way switch valve are also integrated and all valves and sensors of the hydraulic module are easily connectable via connectors, eliminating the need for additional pipe connections.

List of the reference marks

[0059]

100	hydraulic module
1	connector for a heating circuit medium inlet
2	connector for a domestic hot water preparation circuit medium inlet
3	3/2 - way valve with an electric actuator
4	magnet
5	drain valve for the magnetic separator
6	circulating pump body
6a	circulating pump actuator
6b	adapter
6c	cavity
7	heat exchanger of the heat pump
7a	connector for the heat transfer medium outlet from the hydraulic module to the heat exchanger of the heat pump
7b	connector for the heat transfer medium inlet from the heat exchanger of the heat pump to the hydraulic module
8	bleed valve
9	electric heating block
10	cyclonic filter for solid impurities
11	drain valve for the cyclonic filter for solid impurities
12	pressure relief valve
13	temperature sensor
14	flow sensor
15	pressure sensor
16	connector for the heating circuit outlet
17	connector for the domestic hot water preparation circuit outlet
20	upper part of the hydraulic module tank
30	lower part of the hydraulic module tank
35	channel for the 3/2 - way valve connection
36	chamber for the magnet
40	concentric wall
50	flange
60	conical area
70	internal circulation channel
80	external circulation channel

90 channel

Claims

1. A hydraulic module (100), for heating systems with a heat pump and with at least one heating water circuit and/or a domestic hot water preparation circuit, with a closed circuit of a heat transfer medium, comprising

a tank for providing circulation, filtration and reheating of the heat transfer medium, the tank being hydraulically connectable to the heat exchanger (7) of the heat pump, to the heating water circuit and/or to the domestic hot water preparation circuit,

the tank consists of an upper part (20) and a lower part (30), connected watertight to each other, the upper part (20) of the tank being closed by a flange (50),

characterized in that

the upper part (20) of the tank comprises a concentric wall (40) defining an internal circulation channel (70), the concentric wall (40) being designed to separate solid impurities from the stream of the heat transfer medium,

an external circulation channel (80) is defined between the tank wall and the concentric wall (40),

the lower part of the tank (30) comprises a conical area (60) for trapping the solid impurities, the body (6) of the circulating pump for circulating the heat transfer medium is formed in the lower part (30) of the tank,

a channel (35) for connecting a 3/2 - way switch valve (3) and a channel (90) for connecting the outlet of the 3/2 - way valve (3) with an inlet to the body (6) of the circulating pump are formed in the lower part (30) of the tank,

a chamber (36) for inserting a magnet (4) for separating metallic impurities is arranged in the lower part (30) of the tank.

2. The hydraulic module (100) according to claim 1, **characterized in that** an electric heating block (9) for heat transfer medium reheating is mounted on the flange (50) and is arranged in the internal circulation channel (70) of the upper part (20) of the tank.
3. The hydraulic module (100) according to claim 1, **characterized in that** it is provided with a cyclonic filter for removing solid impurities from the closed circuit of a heat transfer medium, where the cyclonic filter comprises the concentric wall (40), the conical area (60) and an attached drain valve (11).

4. The hydraulic module (100) according to claim 1, **characterized in that** a cavity (6c) for trapping metallic impurities attracted by a magnet (4) is arranged in the lower part (30) of the tank, the cavity (6c) being hydraulically connected to the channel (90) for connecting the 3/2-way valve (3) and to the circulating pump body (6) and being hydraulically connected to the connector for connecting a drain valve (5).

5. The hydraulic module (100) according to claim 4, **characterized in that** it is provided with a magnetic separator for removing metallic impurities from the closed circuit of a heat transfer medium, where the magnetic separator comprises the magnet (4) inserted into a chamber (35), a cavity (6c), and the attached drain valve (5).

6. The hydraulic module (100) according to claim 1, **characterized in that** a connector (16) for connecting the outlet of the heat transfer medium to the heating circuit, a connector (17) for connecting the outlet of the heat transfer medium to the domestic hot water preparation circuit, a connector for a pressure relief valve (12), a connector for a temperature sensor (13), a connector for a flow sensor (14) and a connector for a pressure sensor (15) are arranged on the upper part (20) of the tank, the connectors being hydraulically connected to the external circulation channel (80).

7. The hydraulic module (100) according to claim 1, **characterized in that** the upper part (20) of the tank is provided with a connector (7b) for the inlet of the heat transfer medium from the heat exchanger (7) of the heat pump to the hydraulic module, the connector (7b) being hydraulically connected to the internal circulation channel (70).

8. The hydraulic module (100) according to claim 1, **characterized in that** the lower part (30) of the tank is provided with a connector (7a) for the outlet of the heat transfer medium from the circulating pump body (6) to the heat exchanger (7) of the heat pump.

9. The hydraulic module (100) according to claim 1, **characterized in that** the lower part (30) of the tank is provided with a connector (1) for the inlet of the heat transfer medium from the heating circuit and with a connector (2) for the inlet of the heat transfer medium from the domestic hot water preparation circuit.

10. The hydraulic module (100) according to any one of the claims 1 to 9, **characterized in that**

the upper part (20) of the tank with concentric wall (40) and the lower part (30) of the tank with a circulating pump body (6) are made of plastic by injection moulding and are connected watertight by bolts and seals or weld.

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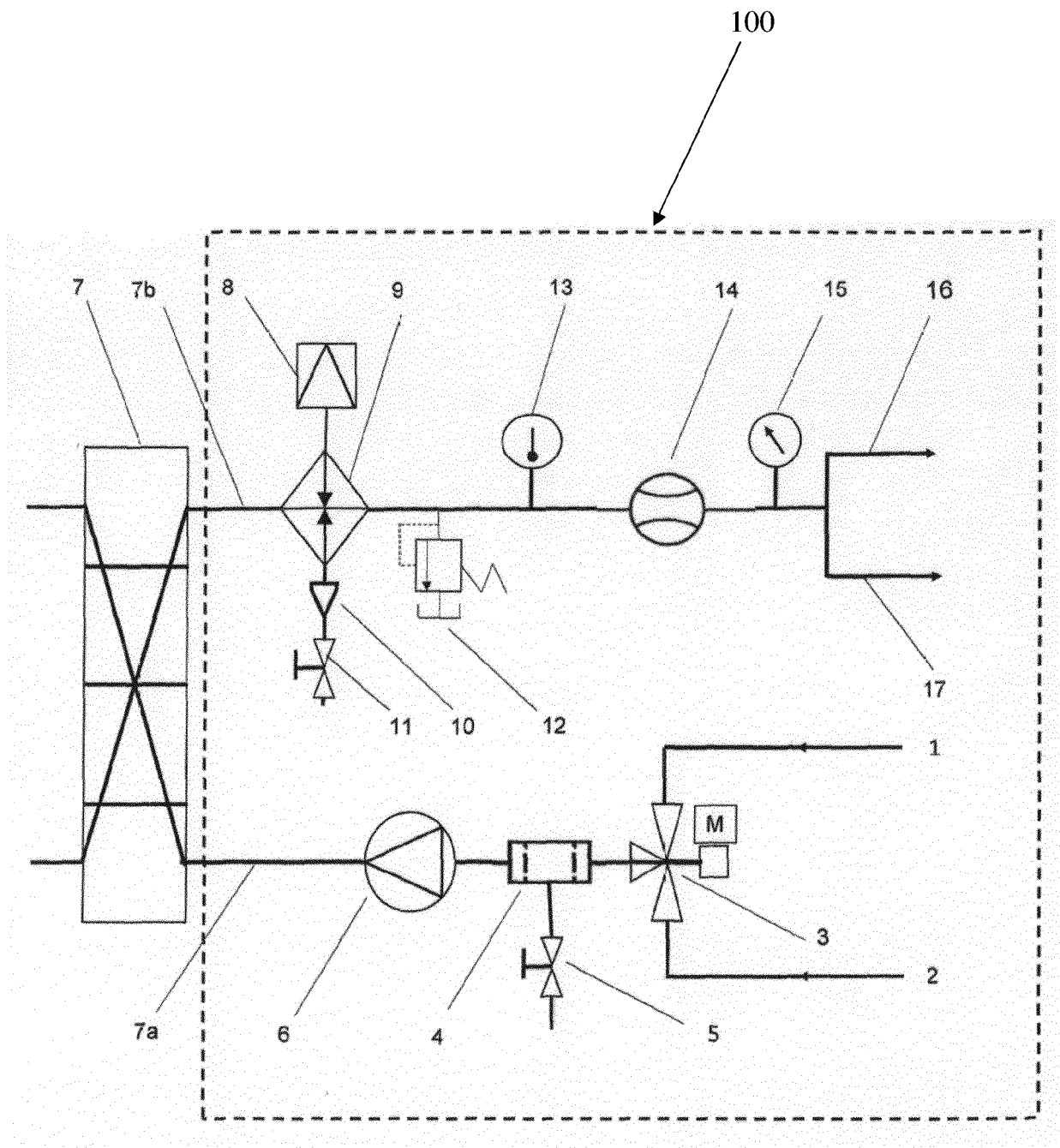


Fig.1

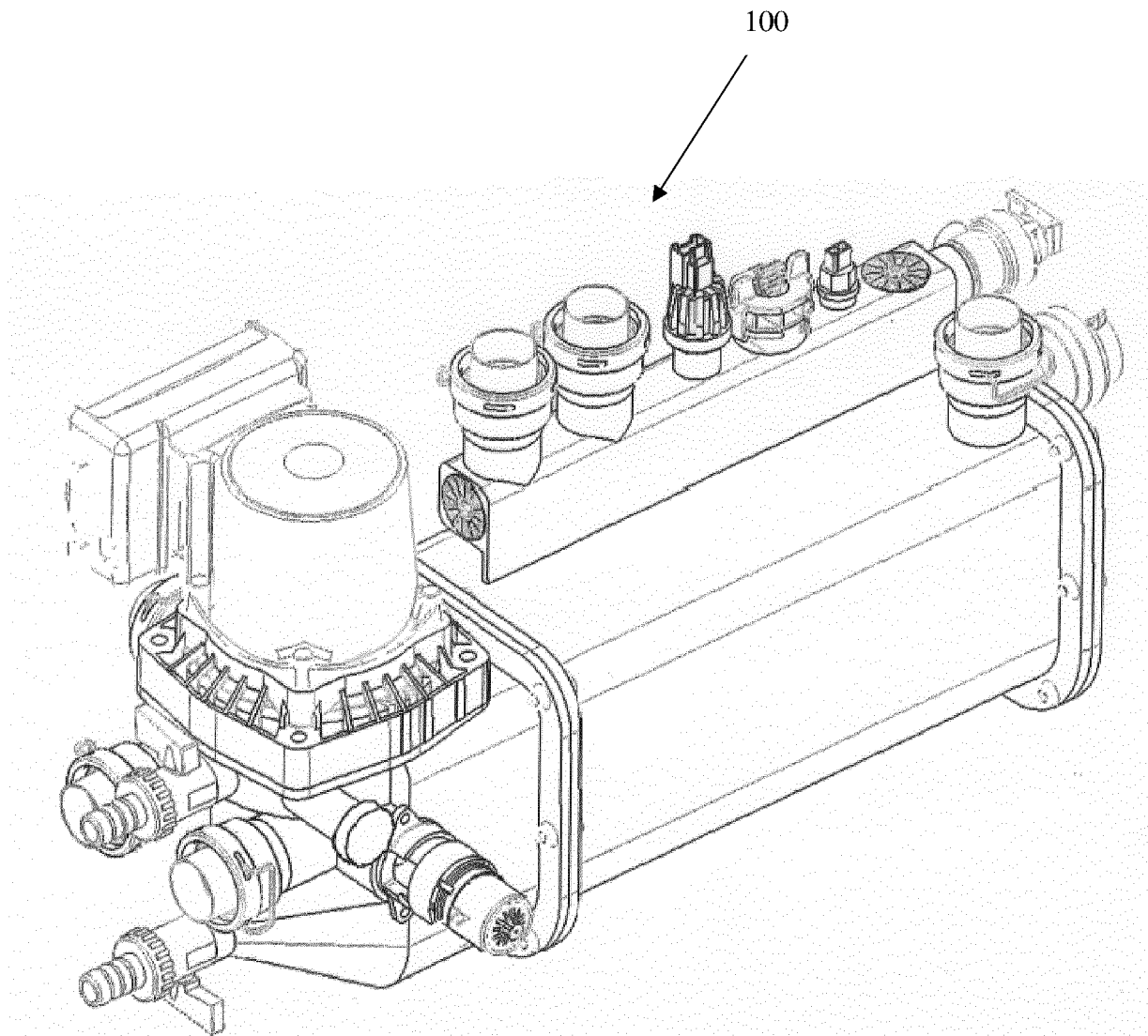


Fig.2

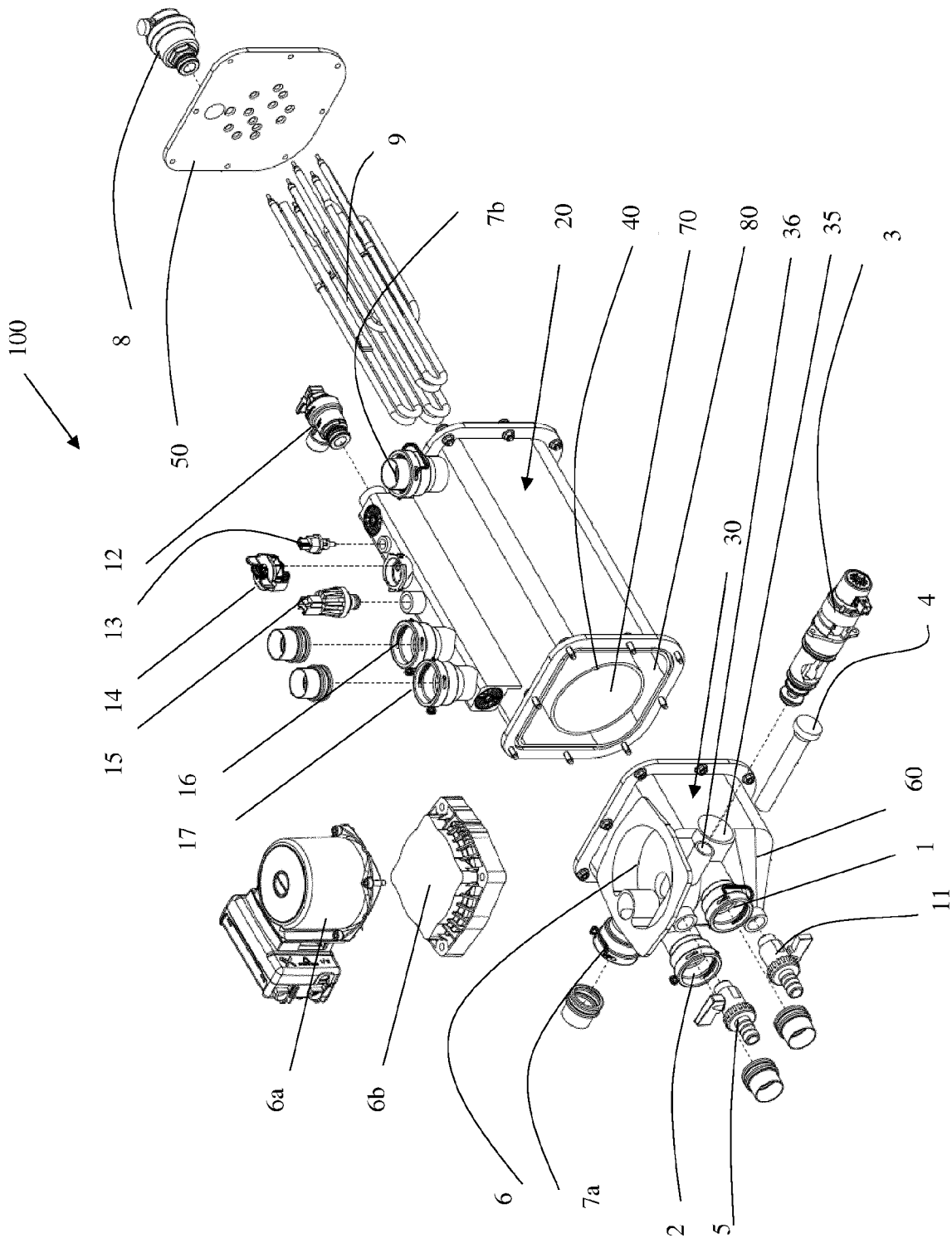


Fig.3

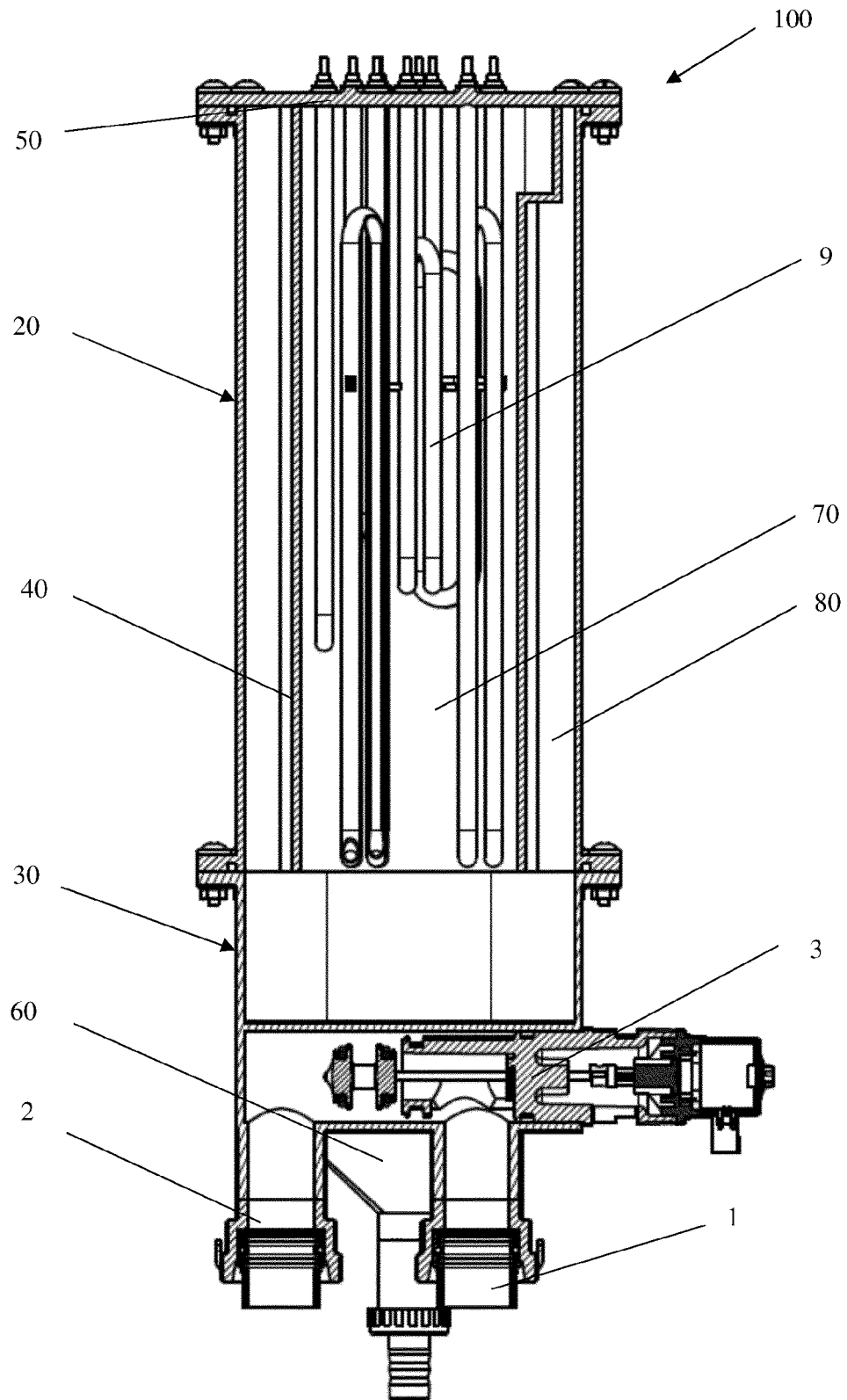


Fig.4

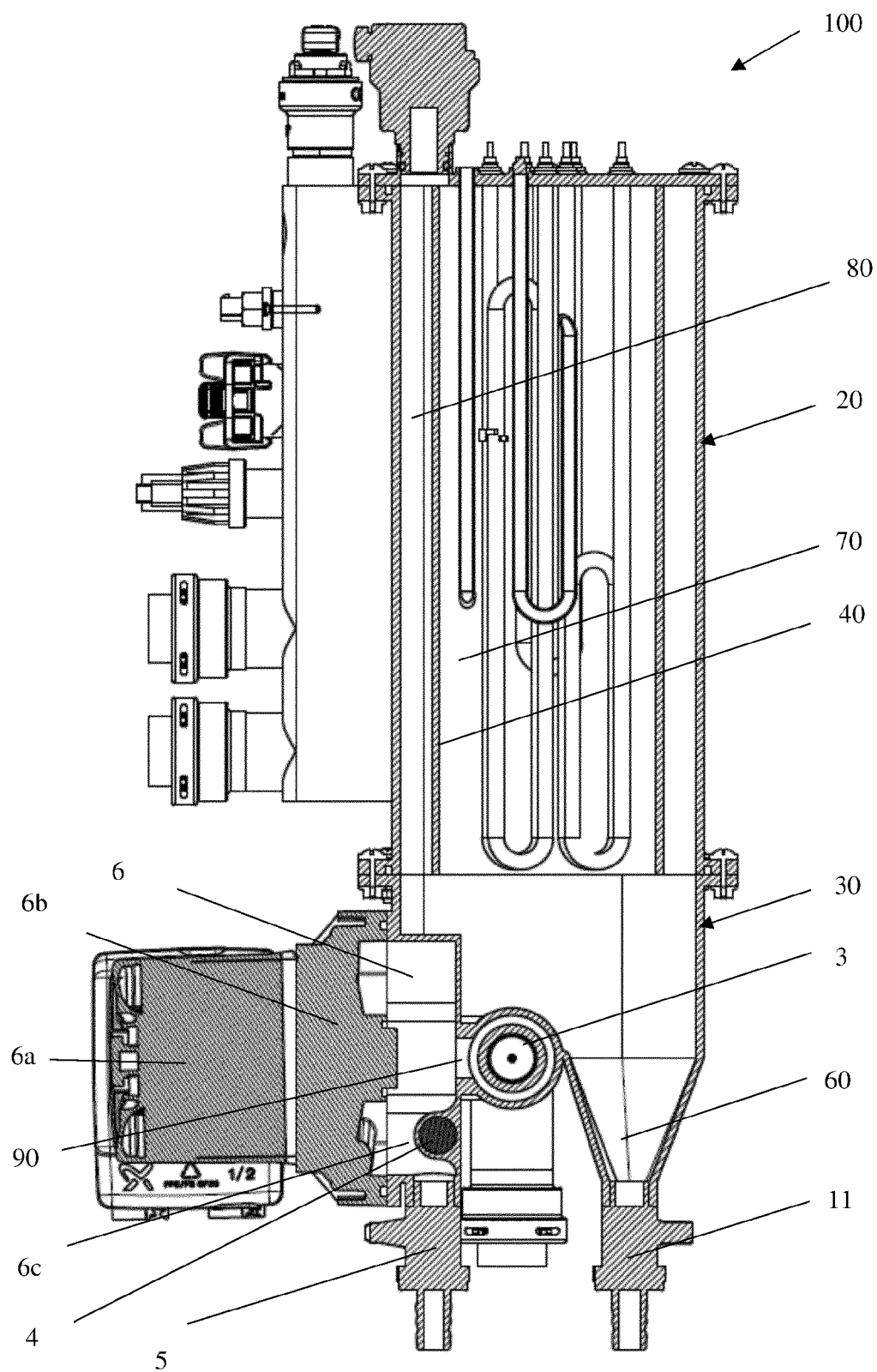


Fig. 5



EUROPEAN SEARCH REPORT

Application Number

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 25 October 2022	Examiner Ast, Gabor
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	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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5 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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