(19) DANMARK

(10) **DK/EP 2215954 T3**

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: ***A 47 L 15/42 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2017-07-17**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2017-05-17**

(86) Europæisk ansøgning nr.: **09005447.9**

(86) Europæisk indleveringsdag: **2009-04-17**

(87) Den europæiske ansøgnings publiceringsdag: **2010-08-11**

(30) Prioritet: **2009-02-09 EP 09001756**

(84) Designerede stater: **AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR**

(73) Patenthaver: **V-Zug AG, Industriestrasse 66, CH-6301 Zug, Schweiz**

(72) Opfinder: **Werner, Jürg, Alte Affolternstrasse 51b, 8908 Hedingen, Schweiz**
Dober, Ernst, Spechtenstrasse 104, 6036 Dierikon, Schweiz

(74) Fuldmægtig i Danmark: **Zacco Denmark A/S, Arne Jacobsens Allé 15, 2300 København S, Danmark**

(54) Benævnelse: **Opvaskemaskine med varmepumpe**

(56) Fremdragne publikationer:
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EP-A- 1 917 899
DE-A1- 2 326 246
DE-A1- 3 048 268
DE-U1-202007 017 077
JP-A- 10 080 391

The invention relates to a dishwasher as well as to a method for operating it according to the preamble of the independent claims.

In order to improve the energy efficiency of dishwashers, it has amongst others been proposed to provide a heat exchanger, which serves to retrieve heat from the vat and to supply it to the fresh water.

Additionally, EP1864603 and JP 10-080391 propose dishwashers with heat pumps in order to improve efficiency of the device.

It is the objective of the present invention to further improve energy efficiency of a dishwasher. This objective is reached by the independent claims. According to this, a heat pump with at least a condenser and at least an evaporator is used, by means of which heat can be extracted from and/or supplied to the process water or the vat.

Preferably, the condenser or (if multiple condensers are present) at least one of the condensers respectively and/or, if multiple evaporators are present, at least one of the evaporators respectively are arranged at a wall of the vat, particularly alongside this wall, thus making it possible in a simple way, meaning without special heat exchange devices, etc., to provide a direct heat supply or a direct heat retrieval respectively. "Wall" of the vat thereby means a sidewall of the vat, its top and its bottom.

According to the claim, the process water is transported in a known way from a sump below the vat via a recirculation pipe system into spraying arms of the dishwasher. At least a condenser is arranged at the circulation pump for heating up the process water there. This embodiment has the advantage that complicated structures at the vat wall and particularly at the vat bottom, which are potentially difficult to clean and/or hinder water discharge, are obsolete. The condenser is arranged at least partially at the pump chamber of the

circulation pump, because a high flow speed is present there, such that the heat can be transferred to the process water with high efficiency.

For this, the condenser is arranged at the wall of the pump chamber. It has

at least a pipe,

- which runs in a meander-shaped way and has straight sections, which are arranged at a wall of the pump chamber arranged cylindrically around a rotation axis of the blade wheel, or

- which is arranged in a helix at the pump chamber, wherein the helix is arranged coaxially to the rotation axis of the blade wheel, or

the first condenser has a chamber which is arranged in a cylindrical way around the pump chamber.

In a further preferred embodiment the evaporator or (if multiple evaporators are present) at least one of the evaporators, respectively, is thermally coupled to the discharge area, through which water is released from the vat into the sewage after use. In this way, heat can be extracted from the discharge water.

Further preferred embodiments of the invention result from the dependent claims as well as from the now following description by means of the figures. Thereby it is shown in:

Fig. 1 a first embodiment of a dishwasher,

Fig. 2 a second embodiment of a dishwasher with a single evaporator,

Fig. 3 a third embodiment of a dishwasher with a single evaporator,

Fig. 4 a fourth embodiment of a dishwasher with a bypass valve,

Fig. 5 a fifth embodiment of a dishwasher with an additional circulation pump,

Fig. 6 a sixth embodiment of a dishwasher with a discharge water tank,

Fig. 7 a seventh embodiment of a dishwasher with a coaxial heat exchanger,

Fig. 8 a section through the discharge water tube of a further embodiment,

Fig. 9 an eighth embodiment of the dishwasher with a condenser at the circulation pump,

Fig. 10 a first embodiment of the circulation pump,

Fig. 11 a part of the pump housing of a second embodiment of the circulation pump,

Fig. 12 a third embodiment of the circulation pump and

Fig. 13 a section through the pump chamber of the circulation pump of Fig. 12.

The dishwasher shown schematically in Fig. 1 has a vat 1 for receiving the items to be washed, like i.e. dishes, crockery or the like. Furthermore, the dishwasher has, as known, spraying arms (not shown), as well as a circulation pump for circulating process water from the sump 2 into the spraying arms. The items to be washed are located in one or more racks. A control controls and commands the operations of all components. A device formed in this way is known to the skilled person.

Fresh water is supplied to the device via a fresh water valve 3 and a softener 4. Used water is pumped into a discharge pipe 6 by a discharge pump 5. These components are also basically known to the skilled person.

The device further has a heat pump comprising a compressor 7 from which a heat pump medium is pumped to one or more condensers 8, where liquefaction takes place by releasing heat. From the condenser 8 the medium travels to at least an evaporator 10a, 10b via at least an expansion valve 9a, 9b, where the medium evaporates by absorbing heat. The medium goes back to the compressor 7 from the evaporator 10a, 10b.

The term "expansion valve" comprises each type of capillary, regulators or the like, which are suitable to reduce the pressure of the medium pumped into the heat pump before the evaporator.

In the embodiment shown in Fig. 1 the condenser 8 is arranged at the bottom 12 of the vat and contacts it directly, in a heat conducting manner, such that the bottom 12 can be heated in the vicinity of the condenser 8.

Furthermore, in the embodiment shown in Fig. 1 two evaporators 10a, 10b are provided, wherein an own expansion valve 9a, 9b is attributed to each one. Furthermore, a switch 14 is provided before the expansion valves in order to supply the pumped medium optionally to the one or the other evaporator 10a or 10b respectively.

The first evaporator 10a is thermally coupled to the vat 1, preferably by being arranged at a first side wall 15 of it. In this way, the vat 1 and particularly said side wall 15 can be cooled with the first evaporator 10a.

The second evaporator 10b is thermally coupled to a discharge area 16 of the device, wherein the term "discharge area" denotes an area through which the water is transferred from the vat 1 to the discharge pipe 6 after use. In this way, heat can be retrieved from the discharge area 16 and particularly from the water located there by means of the second evaporator 10b.

In practice the discharge area 16 consists, in the embodiment according to Fig. 1, of a discharge pipe 17 alongside or inside which the tubular second evaporator 10b is guided, wherein the discharge pipe 17 and the second evaporator 10b are thermally coupled. In order to extend the interaction period between the evaporator 10b and the discharge pipe 17 and to increase the amount of water which can be stored in the discharge area 16 to at least around the amount of the water required during a process phase, meaning at least around

3 liters, the discharge pipe 17 and the evaporator 10b are installed preferably in a meander-shaped or helical way. In order to improve the heat transfer the water flows in the discharge pipe 17 preferably in the opposite direction with respect to the medium in the second evaporator 10b.

The medium of the first evaporator 10a and of the second evaporator 10b are reunited in a combination valve or a second switch 18 before the compressor 7.

The operation of the device is as follows:

1. At the beginning of a main washing cycle fresh water is supplied via the fresh water valve 3.

2. At the same time, the heat pump is started, with the aim to supply thermal energy from the water in the discharge area 16 to the vat 1. For this, the switch 14 is adjusted in a way that the second evaporator 10b is in operation. The heat pump is switched off when the water temperature in the discharge area goes below a threshold value, i.e. 5°C. If the temperature inside the vat or in the cleaning water respectively doesn't reach a predefined value (depending on the program i.e. between 40 and 60°C) it is possible to additionally electrically heat, either simultaneously with the heating by the heat pump or after that.

3. At the end of the main washing cycle the water is discharged from the vat into the discharge area 16. There it replaces the water which was cooled down by the heat pump in step 2.

4. New fresh water is supplied for an intermediary rinsing phase via the fresh water valve 3.

5. The heat pump is actuated again in order to transfer the heat from the discharge area 16 into the vat 1. In this process, the water in the discharge area 16 is again cooled off at most to said threshold value of for example 5°C. At the same time the circulation pump which transports water from the sump 2 into the spraying arms is preferably operated at least temporarily with low

power in such a way that water flows out of the lower spraying arm without impinging on the items to be washed. In this way it is reached that the water can absorb the heat from the condenser 8 at the bottom 12 of the vat 1, without cooling down by the cold water the items to be washed. As soon as the heat from the discharge area 16 has been exchanged the items to be washed are intermediary rinsed and thereafter the intermediary rinsing phase is ended.

6. The water from the vat 1 is again pumped out and replaces the now cold water in the discharge area 16.

7. New fresh water is supplied for a gloss refining phase (clear refining phase) via the fresh water valve 3.

8. The heat pump is again operated in order to transfer the heat from the discharge area 16 into the vat 1. Again, the circulation pump which transports water from the sump 2 into the spraying arms is preferably at least temporarily operated with low power in order that the water to be circulated, however without impinging on the items to be washed. As soon as the heat from the discharge area 16 has been exchanged, the items to be washed are rinsed in a glossy way and thereafter the gloss rinsing phase is ended. The gloss rinsing water can be transferred to the discharge area 16.

9. Now the drying phase can begin. The switch 14 is switched over such that now the first evaporator 10a lies in the circuit, however not the second evaporator 10b. The heat pump is started. Thereby the bottom 12 of the vat 1 is heated by the condenser 8 while the side wall 15 is cooled by the evaporator 10a. In this way, a convection stream is generated in the vat 1 insofar as air is heated via the condenser 8 and rises. This air flows between the items to be washed and dries them. The air then contacts the side wall 15 where it is cooled down, such that water is extracted from it. The

condensed water flows down the side wall 15 and gets into the sump 2.

The convection in step 9 can be intensified by arranging the condenser 8 only in a section of the bottom area 12 which is located opposite of the first side wall 15.

It is evident from the above process course that the heat pump serves two objectives. On the one hand it is used to transfer heat from the discharge area 16 into the vat 1 or the water located there respectively. Furthermore it is used to extract water from the air in the vat 1 during the drying. For this, both evaporators 10a and 10b are alternatively used. By attributing an own expansion valve 9a or 9b respectively, to each evaporator, the expansion valves can be adapted to the parameters and desired operating temperatures of both evaporators in an optimum way. Additionally, the switch 14 can be arranged in the high pressure area in this case, where its flow resistance plays a subordinate role. It is however also conceivable to provide only a common expansion valve for both evaporators 10a, 10b.

In the above example heat is transferred in the steps 5 and 8 from the respective previous process phase in the current process phase. Depending on the number of process phases also further such steps can take place. Thereby, at the end of the respective process phase the cooled down water is replaced with used warm water in the discharge area 16.

It is also conceivable to operate the second evaporator 10b at least temporarily in the drying phase, either together (parallel) or alternating with the first evaporator, in order to still supply heat from the discharge area 16 to the vat 1.

Both functions mentioned above of the heat pump (drying process and heat transfer) may also be used in a standalone manner. According to this, Fig. 2 shows a simpler embodiment of a dishwasher in case of which only

the first evaporator 10a is present. The second evaporator 10b is omitted, thus simplifying the construction. In this case the heat pump is only used to support the drying.

Accordingly, an alternative embodiment is shown in Fig. 3, in case of which only the second evaporator 10b is present and the first evaporator 10a is omitted. Again, the construction is simplified. In this case the heat pump is used to transfer heat from a process phase to a later process phase.

A further embodiment is shown in Fig. 4. Here, a bypass valve 20 is provided, by means of which water can be transferred from the device from the vat 1 to the discharge pipe 6 optionally by bypassing the discharge area 16. In this way it is possible to carry out a heat transfer between two process phases, even when they are separated by a third process phase. Particularly, the intermediary rinsing phase doesn't necessarily require heat, such that the process course described above can be changed with the assembly according to Fig. 4 insofar, as the heat pump is not operated in the intermediary rinsing phase, thus in step 5. At the end of the rinsing phase the water is not transferred to the discharge area 16 but directly to the discharge pipe 6 by bypassing the discharge area 16. Thus, the heat from the hot water of the main washing phase can be pumped into the vat in the subsequent rinsing phase. In this way, an unnecessary heat loss is avoided. Besides, the intermediary rinsing phase may be shortened because no heat transfer is necessary.

A further embodiment of the dishwasher is shown in Fig. 5. Here, an additional circulation pump 21 as well as a switching valve 22 is provided at the end of discharge area 16, such that water can be circulated in the discharge area 16. In this way, the heat transfer between the second evaporator 10b and the water in the discharge area 16 can be accelerated.

In the embodiment according to Fig. 6 the water in the discharge area is guided through a tank 22. The tank 22 takes over the storing function of the discharge pipe 17, however it has the advantage of a better space usage. However, in this case one should be cautious that the tank 22 is formed in such a way that in case of an inflow of new discharge water a mixing with the old water should be avoided as much as possible. Additionally, the tank 22 has to be formed such that as little dirt as possible can deposit. When a discharge pipe 17 is used, the danger of a mixing and of a deposit of dirt is basically smaller.

In the embodiment according to Fig. 7 the pipe of the second evaporator 10b and the discharge pipe 17 don't run side by side but the evaporator 10b is at least partly surrounded by the discharge pipe 17.

A preferred construction of this heat exchanger is shown in Fig. 8. As can be seen, the evaporator 10b is arranged in an elongate recess of the discharge pipe 17. Preferably, the discharge pipe is formed as a blow-moulded plastic part and elastically presses against the evaporator 10b.

A further embodiment is shown in Fig. 9, which illustrates some important further principles which are explained in the following.

Fig. 9 shows a circulation pump 25, by means of which the process water is transported from the sump 2 below the vat 1 via a recirculation pipe system 26 into the spraying arms of the dishwasher.

The first condenser 8 according to this embodiment is arranged at the circulation pump 25. However, an at least partial arrangement at the sump 2 and/or at the recirculation pipe system 26 is also conceivable. It serves to supply heat to the process water during the cleaning phase. During this phase the process water is transported through the sump 2, the pump

25 as well as the recirculation pipe system 26, such that it can be heated up there in a targeted way.

In order to also be able to use the heat pump in this case during the drying phase, a second condenser 8' may be additionally provided at a wall of the vat 1. It is in operation during the drying phase together with the first evaporator 10a in order to extract water from the process air in the way described above.

As shown in Fig. 9, the second condenser 8' is arranged at a second sidewall 15', which is arranged opposite of the first sidewall 15 with the first evaporator 10a, such that a good convection can be generated. The arrangement of the second condenser 8' at a sidewall additionally has the advantage that the second condenser doesn't heat up the water which flows away on the bottom 12 during the drying phase, but it releases its heat to the process air in a targeted way.

Preferably, the first condenser 8 and the second evaporator 10b are arranged in series, with an expansion valve 9b arranged in between, such that the cooling medium can be guided through the first condenser 8 and the second evaporator 10b during the cleaning phase, in order to transport heat from the discharge area 16 into the process water.

As can further be seen in Fig. 9, a switch may be arranged between the compressor 7 and the first and the second condenser 8 and 8', in order to supply the pumped medium optionally to the first and the second condenser 8 or 8', respectively.

As mentioned, the first condenser 8 is preferably arranged at the circulation pump 25 in the embodiment according to Fig. 9. A possible embodiment of the pump 25 with the first condenser 8 is shown in Fig. 10.

The construction of the pump corresponds approximately to the one according to DE 20 2007 017 077 U1. Particularly, the pump has a housing 28 inside which

a pump chamber 27 is arranged. A blade wheel (not visible in the figures) is located inside the pump chamber 27, which is turned about a rotation axis 30 by a motor 29. It is e.g. referred to Fig. 2 of DE 20 2007 017 077 U1 for the corresponding construction of the pump.

The pump chamber 27 has a cylindrical wall 31 which is arranged concentrically to the rotation axis 30. In the embodiment according to Fig. 10, the most part of the pipe of the first condenser 8 runs meander-shaped at the wall 31. The pipe has a plurality of straight sections 32 parallel to the rotation axis 30, which are connected to one another via U-shaped bent sections 33.

In the embodiment according to Fig. 10, the pipe of the condenser 8 extends up to the axial termination wall 35 of the pump chamber 27, which is perpendicular to the rotation axis 30, such that the heat exchange can be improved. It is however also conceivable that the pipe of the condenser is only arranged at the cylindrical wall 31 of the pump chamber 27.

The pipe of the condenser 8 may be arranged outside at the wall of the pump chamber 27, as shown in Fig. 10, or (as shown in the following in Fig. 11), at its inner side.

A further embodiment of the circulation pump 25 is shown in Fig. 11, which only shows the cylindrical wall 31 of the pump chamber 27. Here, the pipe of the condenser 8 runs in a helix along the cylindrical wall 31. The helix is arranged coaxially to the rotation axis 30.

Finally, Fig. 12 and 13 show a third embodiment of the circulation pump 25. It corresponds substantially to the one according to Fig. 10, with the difference that the condenser 8 is embodied as chamber 40 in the housing 28. The chamber 40 extends cylindrically around the pump chamber 27. The wall of the housing 28 of the pump chamber is double-walled for forming the chamber 40. The medium is inserted into the chamber 40 via a

first connecting socket 41 and is again deviated via a second connecting socket 42.

Additionally to the first condenser 8, a resistive heating may be provided at the circulation pump 25 and/or at the recirculation pipe system 26, i.e. a heating which generates heat by guiding an electric current through a resistance. Such a heating allows e.g. to heat up the water faster or to a higher temperature than it would be possible only with the condenser 8. In the embodiment according to Fig. 10 and 12, this heating is shown by the reference number 36 and is laid in a sleeve shape around a suction pipe 37, through which the water is sucked into the circulation pump 25.

Patentkrav

1. Opvaskemaskine med et kar (1) til optagelse af emner, der skal vaskes, hvor den omfatter en varmepumpe, hvor varmepumpen omfatter mindst en kondensator (8) og mindst en fordamper (10a, 10b), der er anbragt på en sådan måde, at der kan udtages og/eller tilføres varme til procesvandet eller karret (1), hvor opvaskemaskinen endvidere omfatter en cirkulationspumpe (25) til at transportere procesvand fra en sump (2) under karret (1) via et recirkulationsledningssystem (26) til sprøjtearme af opvaskemaskinen, hvor cirkulationspumpen (25) omfatter et pumpekammer (27), hvori der er anbragt et vingehjul til transport af procesvandet,
kendetegnet ved, at mindst en første kondensator (8) er anbragt på cirkulationspumpens (25) pumpekammer (27), og
at den første kondensator (8) omfatter mindst en rørledning,
- der strækker sig meanderformet og omfatter lige afsnit (32), som er anbragt på en væg (31) af pumpekammeret (27), der er anbragt cylinderformet omkring en rotationsakse (30) af vingehjulet, eller
- der er anbragt i en spiral på pumpekammeret (27), hvor spiralen er anbragt koaksialt i forhold til vingehjulets rotationsakse (30), eller
at den første kondensator (8) omfatter et kammer (40), der er anbragt cylinderformet omkring pumpekammeret (27).

2. Opvaskemaskine ifølge krav 1, hvor den første kondensator (8) omfatter mindst en rørledning, der strækker sig meanderformet og omfatter lige afsnit (32), der er anbragt på en væg (31) af pumpekammeret (27), der er anbragt cylinderformet omkring en rotationsakse (30) af vingehjulet, og hvor rørledningen strækker sig ind i en endevæg (35) af pumpekammeret (27), der står vinkelret på rotationsaksen (30).

3. Opvaskemaskine ifølge et af de foregående krav, hvor der på cirkulationspumpen (25) og/eller på recirkulationsledningssystemet (26) udover den første kondensator (8) er anbragt en resistiv varmeindretning (36).

4. Opvaskemaskine ifølge et af de foregående krav, hvor der endvidere er anbragt en anden kondensator (8') på en væg af karret (1), især på en side-

væg (15') af karret (1).

5. Opvaskemaskine ifølge krav 4, hvor varmepumpen omfatter en kompressor (7), og hvor der mellem kompressoren (7) og den første og anden kondensator (8, 8') er anbragt et skiftespor (14') til valgfrit at tilføre et pumpet medium til den første og den anden kondensator (8, 8').

6. Opvaskemaskine ifølge et af de foregående krav, hvor fordamperen (10b) eller mindst en af fordamperne (10a 10b) er koblet termisk med et afløbsområde (16), hvor opvaskemaskinen er udformet til at afgive vand fra karret (1) efter anvendelse gennem afløbsområdet (16), og især hvor opvaskemaskinen omfatter en første fordamper (10a), der er koblet termisk med karret (1) og omfatter en anden fordamper (10b), der er koblet termisk med afløbsområdet (16).

7. Opvaskemaskine ifølge krav 6, hvor afløbsområdet (16) omfatter et afløbsrør (17), på eller i hvilket den anden fordamper (10b) er ført langs, og især hvor afløbsrøret (17) og den anden fordamper (10b) er lagt meanderformet eller spiralformet.

8. Opvaskemaskine ifølge et af de foregående krav, hvor mindst en af kondensatorerne og/eller fordamperen (10a) eller mindst en af fordamperne (10a, 10b) er anbragt ved en væg af karret (1) og især strækker sig langs denne væg.

9. Fremgangsmåde til drift af opvaskemaskinen ifølge et af de foregående krav, hvor varme udtages fra og/eller tilføres til procesvandet eller karret (1) med varmepumpen, hvor varmen tilføres til procesvandet, idet den første kondensator (8), der er anbragt på cirkulationspumpen (25), opvarmes.

10. Fremgangsmåde ifølge krav 9, hvor, i en tørrefase, varme tilføres til et første vægområde, især en sidevægs (15') vægområde, af karret (1), og varme udtages fra et andet vægområde, især af en sidevæg (15), ved hjælp af varmepumpen, og der således genereres en konvektionsstrøm i karret (1).

11. Fremgangsmåde ifølge et af kravene 9 eller 10, hvor servicen vaskes i mindst en første og en anden procesfase, hvor procesvand på karret (1) i slutningen af den første procesfase ledes til et afløbsområde, og frisk vand i begyndelsen af den anden procesfase føres til karret (1), hvor varme udtages af procesvandet i afløbsområdet ved hjælp af varmepumpen i den anden procesfase og tilføres til procesvandet i karret (1), og især hvor procesvandet i slutningen af den anden procesfase føres fra karret (1) til afløbsområdet og dér erstatter procesvandet fra den første procesfase.

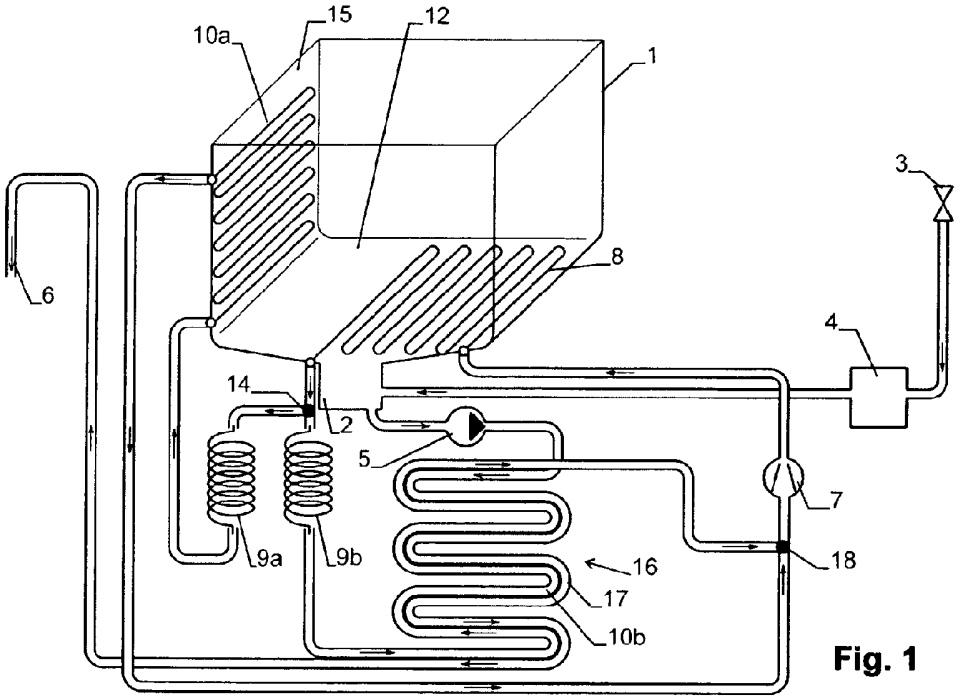
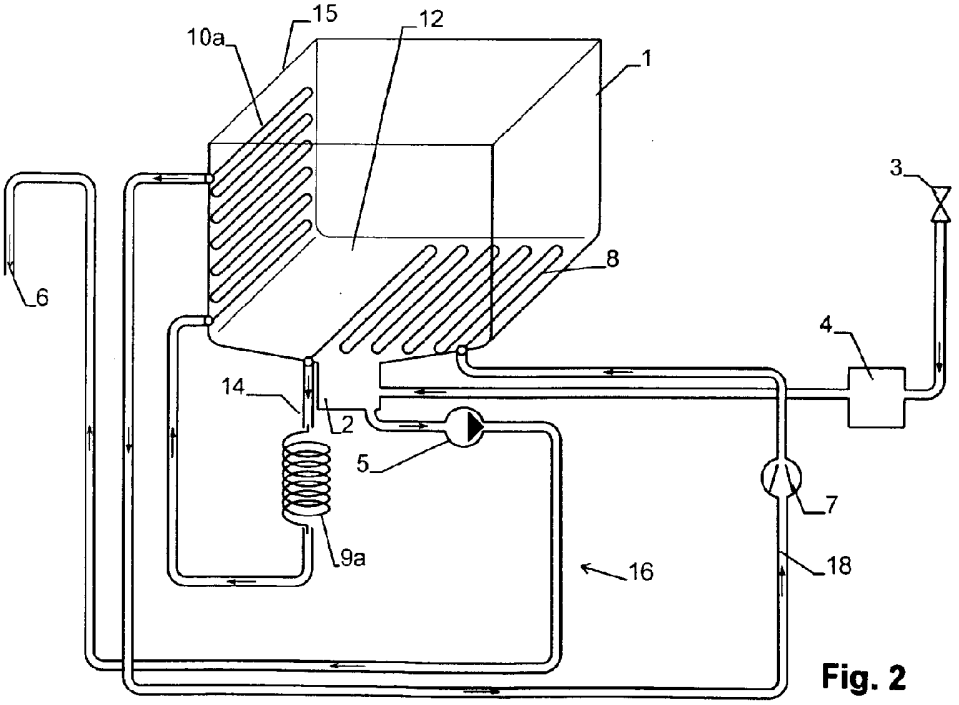

15
12
10a
1
3
8
6
4
14
2
5
7
9a
9b
16
18
17
10b

Fig. 1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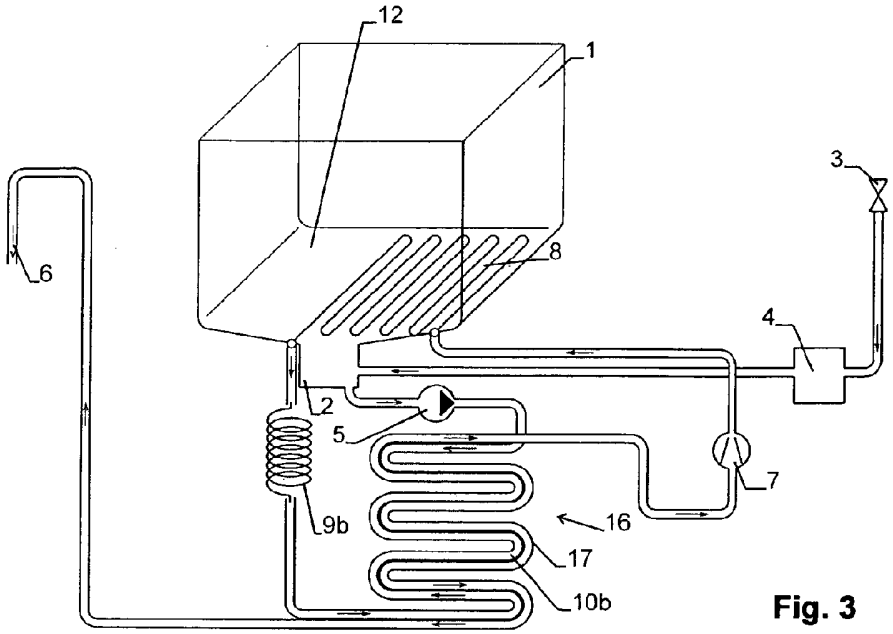
1
3
8
6
4
14
2
5
7
9a
16
18

Fig. 2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8
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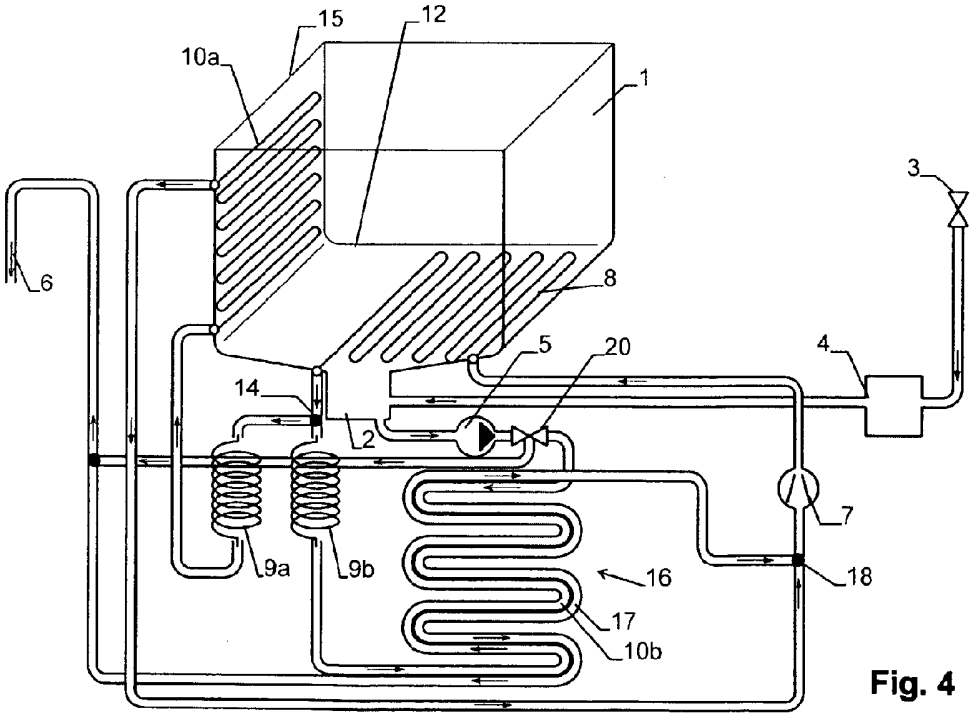
5
7
9b
16
17
10b

Fig. 3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12
10a
1
3
6
8
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20
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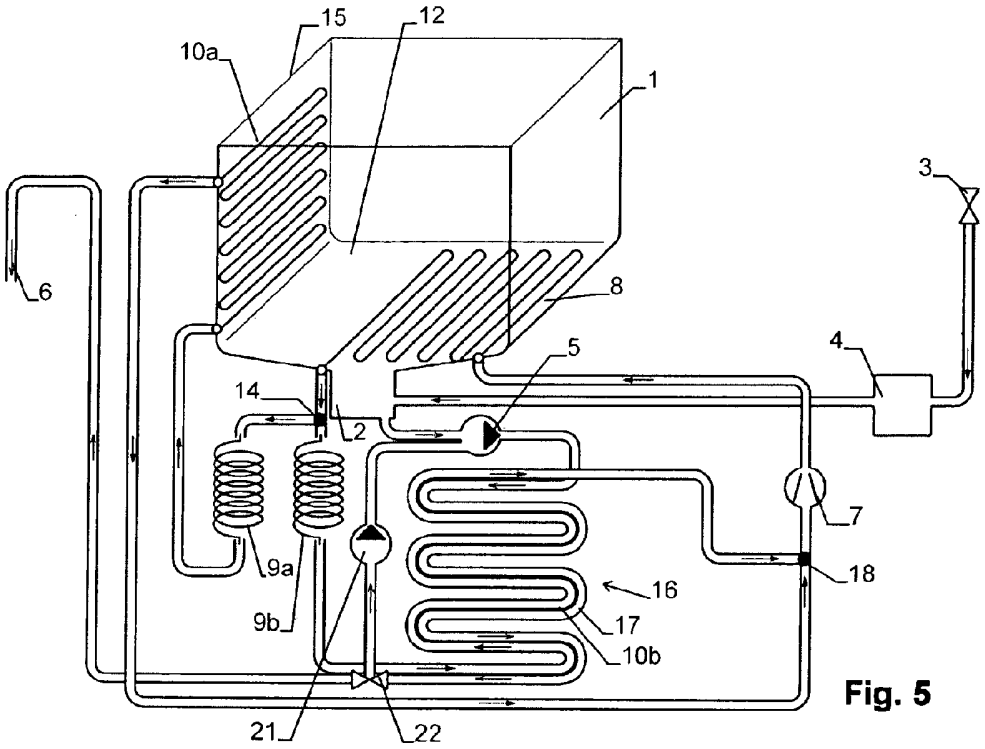
14
2
7
9a
9b
16
18
17
10b

Fig. 4


15
12
10a
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14
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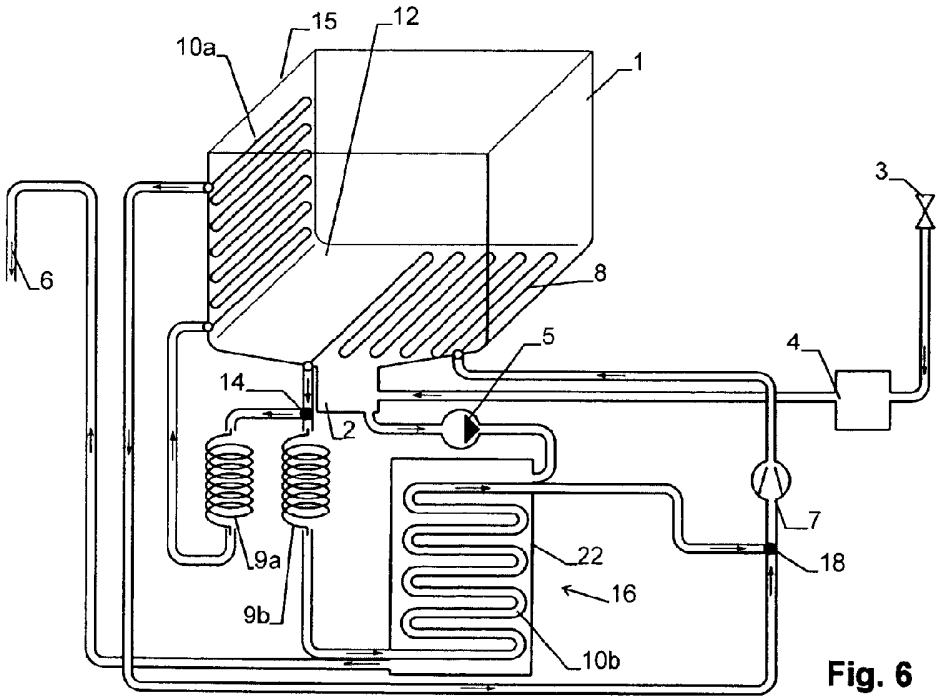
7
9a
18
16
9b
17
10b
21
22

Fig. 5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9a
22
18
16
9b
10b

Fig. 6

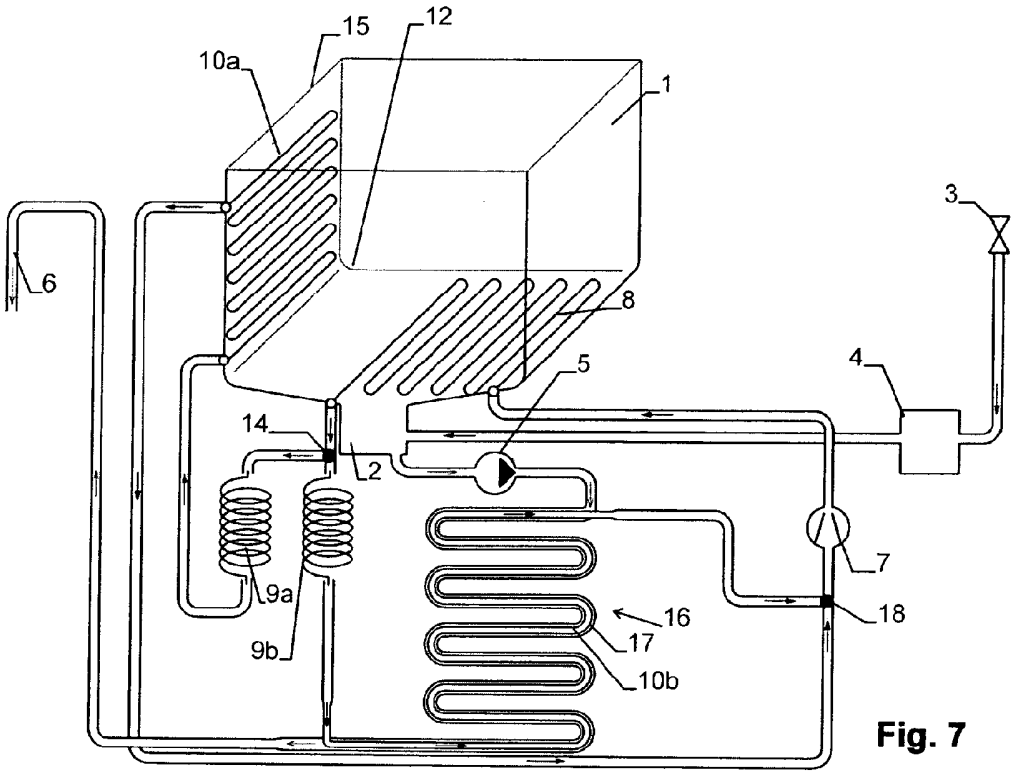

Fig. 7

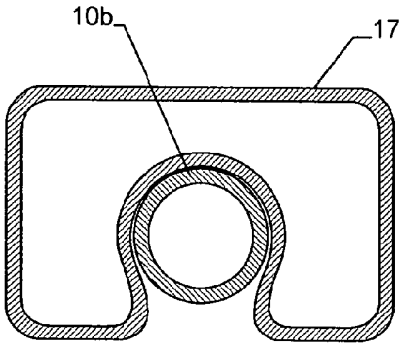

Fig. 8

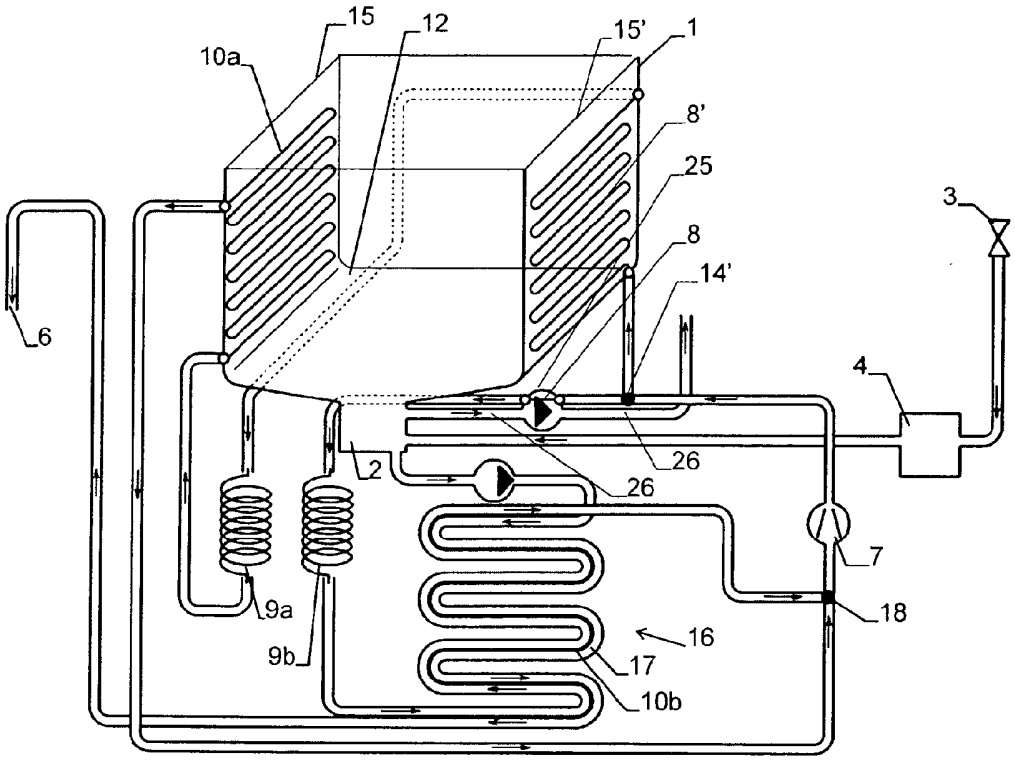
15
12
15'
1
10a
8'
25
3
8
14'
6
4
26
26
2
7
18
9a
16
9b
17
10b

Fig. 9

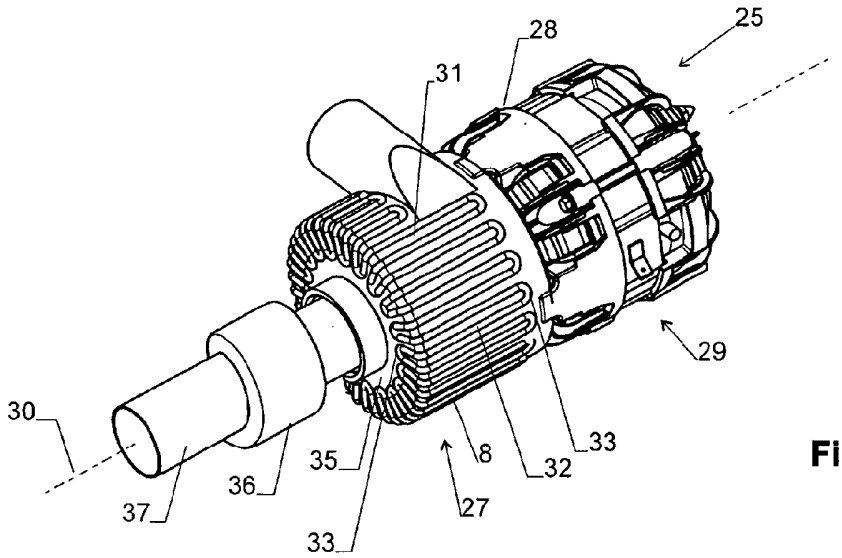
25
28
31
29
30
35
8
33
32
36
27
37
33

Fig. 10

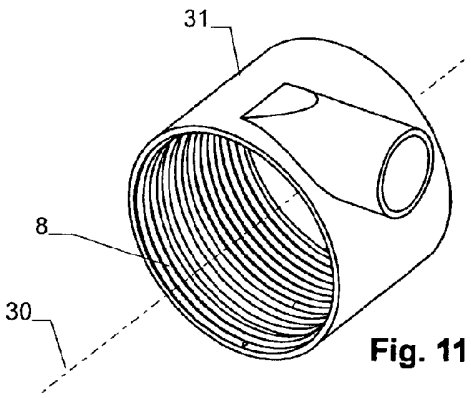

Fig. 11

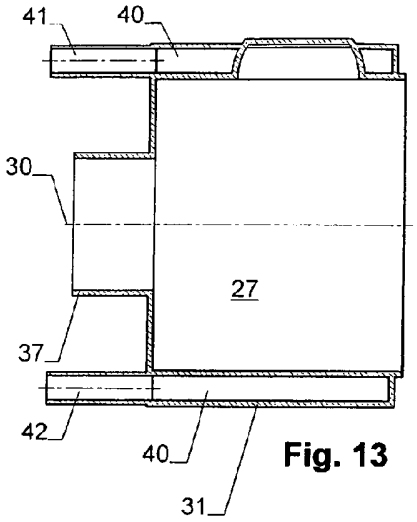

Fig. 13

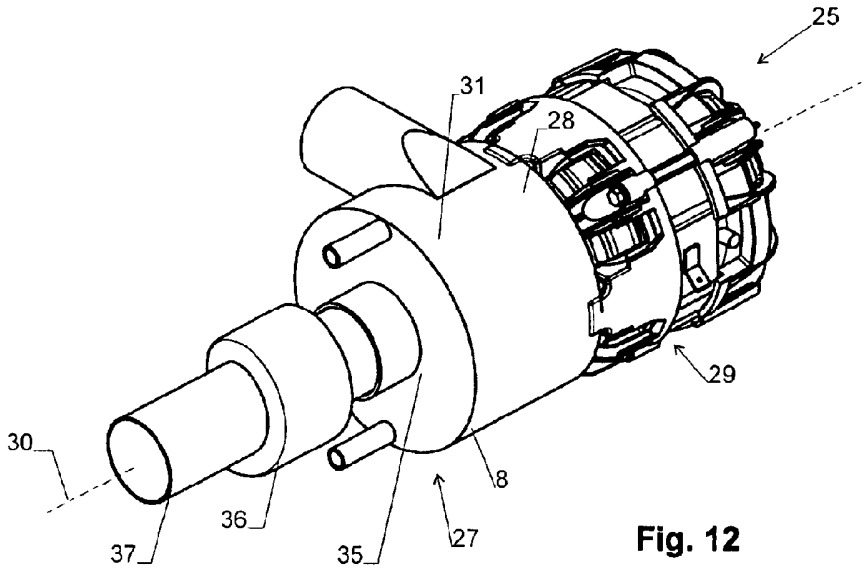

Fig. 12