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(54) **HEAT PUMP WITH PRE-HEATING / PRE-COOLING OF HEAT / COLD SOURCE**

(57) A heat pump has a compressor 1, a first heat exchanger 3 (evaporator), an expansion valve 2 and a second heat exchanger 5 (condenser). The first heat exchanger 3 exchanges energy with the air to be cooled and is provided with a fan 6. The second heat exchanger 5 exchanges energy with tap water and for this purpose is connected to a water pipe 15, 16. The heat pump also has a third heat exchanger 4 for preheating or pre-cooling

the tap water through the heat transfer medium to save tap water if it is hot in the summer or cold in the winter. The flow of the heat transfer medium through the third heat exchanger 4 can be controlled by a control valve 7 and the supply line 15 of the tap water can first be led through the third heat exchanger 4 by means of shut-off valves 9 and 12 before being sent to the second heat exchanger 5.

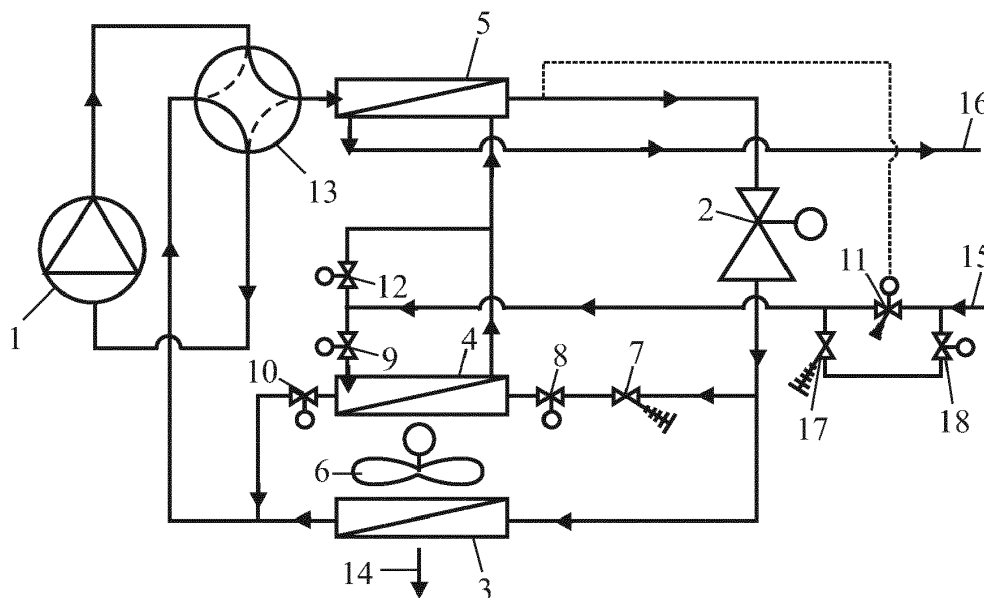


FIG. 2

Description

Technical field of the invention

[0001] The invention relates to a heat pump, wherein energy is exchanged via a heat transfer medium between a heat or cold source and a room to be heated or cooled by heating or cooling indoor air or water for heating / cooling floor and / or radiators, which heat pump is provided with a first circuit, for circulation of the heat transfer medium between the heat or cold source and the space to be heated or cooled, and a second circuit for water, said heat pump comprising:

- a compressor for compressing the heat transfer medium in the gaseous state,
- an expansion valve for reducing the pressure of the heat transfer medium in the liquid state,
- a first heat exchanger between the compressor and the expansion valve for effecting a phase transition between liquid and gas of the heat transfer medium,
- a second heat exchanger between the compressor and the expansion valve for effecting a phase transition between liquid and gas of the heat transfer medium opposite to that of the first heat exchanger,
- a third heat exchanger in which heat transfer between the water and the heat transfer medium can take place for preheating or pre-cooling the water in the second circuit, which third heat exchanger is in a bypass line which is present between the expansion valve and the compressor and which is parallel to the first heat exchanger and which third heat exchanger can be switched in the circuit of the heat transfer medium by means of a control valve present in the bypass line, and
- a fan for blowing air through the first heat exchanger, or
a heating water pipe present in the first heat exchanger,

the first circuit being formed by the compressor, the first heat exchanger, the expansion valve and the second heat exchanger and, depending on the position of the control valve, by the third heat exchanger and forming a closed circuit for the heat transfer medium.

[0002] A heat pump absorbs heat at a low temperature, which is released again at a high temperature. This is usually accomplished by allowing a liquid (heat transfer medium) to evaporate at a low temperature and to allow the vapor to condense at a high temperature. The boiling point must therefore be lowered in the first case and / or increased in the second case. The boiling point can be increased by increasing the pressure with a compressor and lowered by lowering the pressure in an expansion valve. The whole of evaporating, compressing, condensing and expanding forms a closed circuit for the circulating heat transfer medium. Energy is supplied to the heat pump (to the compressor) and heat is transferred from

the evaporator to the condenser. A heat pump is a closed cycle of a liquid with a low boiling point, for example Freon, which evaporates in the evaporator and condenses again into liquid in the condenser. The expansion valve allows the liquid to relax to a lower pressure at the evaporating temperature. This causes the liquid to boil and absorb heat from the room to be cooled. Because the heat transfer medium is colder than the environment, heat is supplied to it. The heat from the room is transferred to the heat transfer medium which evaporates completely. In the compressor, the gaseous heat transfer medium is compressed to a higher pressure and temperature and fed to the condenser. The gas releases the extracted heat to the tap water and condenses back to liquid. The compressor is the driving force in the entire process by moving the heat transfer medium. By moving the heat transfer medium in the opposite direction, heating can also be carried out with a heat pump, whereby heat is extracted from the tap water and released into the room air.

Background of the invention

[0003] A heat pump according to the preamble of claim 1 is known from US2014/0000308A. The second circuit connected to this known heat pump is a hot water circuit for heating a room by means of radiators and the first circuit extracts heat from the ambient air (by the first heat exchanger) and transfers this heat to the water in the hot water circuit (using the second heat exchanger). To keep the COP high, the water in the hot water circuit must be pre-cooled under certain circumstances. This is done in the third heat exchanger.

[0004] For heat pumps that are connected to the open water supply network and use tap water as heat or cold source, the temperature of the water in the drinking tap water supply is high on summer days. This means that a lot of tap water is required to be able to release the absorbed heat. In the winter, the temperature of the water in the tap water pipe is low, which means that also a large quantity of tap water is needed from which sufficient heat can be extracted for heating the air. In autumn and spring the temperature of the water in the drinking tap water pipe is good for heating or cooling, but the need for this is then the lowest.

Summary of the invention

[0005] It is an object of the invention to provide a heat pump of the type described in the preamble wherein in the summer and winter less tap water is required for cooling or heating. To this end, the heat pump according to the invention is characterized in that the second circuit forms part of the heat or cold source and is provided with two connections for connection to an open water supply circuit. The drinking water pipe is preferably used for this.

[0006] To prevent that the pre-heating / pre-cooling of the tap water has a negative effect on heating / cooling

the air, extra energy is supplied by the compressor during pre-heating / pre-cooling.

[0007] The advantages of the heat pump according to the invention over a heat pump in which tap water is used as heat / cold source but where no third heat exchanger is present are:

- at low outside temperature, a high efficiency during heating is obtained by increasing the tap water temperature in relation to the outside air,
- at high outside temperature, a high efficiency during cooling is obtained by reducing the tap water temperature in relation to the outside air,
- low water consumption by topping up (heating / cooling) of the tap water temperature.

[0008] An embodiment of the heat pump according to the invention is characterized in that a control valve is in the water supply line with which during cooling the amount of tap water through the second heat exchanger is controlled, which control valve is controlled by the pressure of the heat transfer medium at the second heat exchanger, and that a bypass line is present parallel to the control valve, in which bypass line a further control valve is present with which the amount of tap water is controlled by the second heat exchanger during heating. During heating, the second heat exchanger acts as an evaporator and the pressure of the heat transfer medium at the location of the second heat exchanger is such low that the control valve is completely closed. Therefore, during heating, the amount of tap water can be controlled by the further control valve in the bypass line.

[0009] The invention also relates to a method for heating or cooling a room with the aid of a heat pump according to the invention, wherein heat is extracted from water in the second circuit or heat is released from water in the second circuit using the second heat exchanger, wherein if the water in the second circuit is warmer or colder than a set limit value corresponding to a COP which is defined as a lower limit, the water is pre-cooled or pre-heated using the third heat exchanger, and wherein heat is extracted or released from the room using the first heat exchanger.

Brief description of the drawings

[0010] The invention will be further elucidated below on the basis of drawings. These drawings show an embodiment of the heat pump according to the present invention. In the drawings:

Figure 1 is a pipe and component diagram of the heat pump according to the invention with the liquid / gas flows indicated during cooling,

Figure 2 is the diagram with the liquid / gas flows indicated during cooling with pre-cooling of the tap water,

Figure 3 is the diagram with the liquid / gas flows

indicated during heating, and

Figure 4 is the diagram with the liquid / gas flows indicated during heating with pre-heating the tap water.

Detailed description of the drawings

[0011] Figure 1 shows the heat pump according to the invention schematically. In the heat pump, energy is exchanged via a heat transfer medium between a heat or cold source formed by water in the drinking water pipe and indoor air 14 to be heated or cooled. Here, Freon is taken as heat transfer medium, but other known liquids could also be taken for this. The heat pump has a compressor 1 for compressing the heat transfer medium in the gaseous state and an expansion valve 2 for lowering the pressure of the heat transfer medium in the liquid state. Between the compressor and the expansion valve there are two heat exchangers 3 and 5 for effecting a phase transition between liquid and gas (condensing or evaporating) of the heat transfer medium. During operation, one heat exchanger effects a phase transition from liquid to gas (evaporation) and the other heat exchanger from gas to liquid (condensing). A first of the heat exchangers 3 exchanges energy with the air to be heated / cooled and is for this purpose provided with a fan 6 for blowing inside air through the first heat exchanger. The second heat exchanger 5 exchanges energy with the tap water and for this purpose is connected to a water supply line 15 and a water discharge line 16. The compressor, the first heat exchanger, the expansion valve and the second heat exchanger form a closed circuit for the heat transfer medium.

[0012] In the water supply line there is a control valve 11 with which, during the condensation of the heat transfer medium, the amount of tap water going through the second heat exchanger 5 is controlled. This control valve is pressure-controlled and is controlled by the pressure of the heat transfer medium at the location of the second heat exchanger 5. A bypass line with a further control valve 17 and a shut-off valve 18 is parallel to the control valve 11. During the evaporation of the heat transfer medium, the amount of water through the second heat exchanger 5 is controlled by the further control valve 17 by opening shut-off valve 18.

[0013] The heat pump further has a third heat exchanger 4 for pre-heating or pre-cooling the tap water by the heat transfer medium. This third heat exchanger 4 is present in the heat transfer medium circuit via a bypass line between the expansion valve 2 and the compressor 1 and parallel to the first heat exchanger 3 and can be connected in series with the second heat exchanger 5 in the tap water circuit. The flow of the heat transfer medium through the third heat exchanger 4 can be controlled by a control valve 7 which is present in a bypass line over the first heat exchanger 3. The supply line 15 of the tap water can be led directly via a first branch to the second heat exchanger 5 or via a second branch first through

the third heat exchanger 4 and then to the second heat exchanger 5. To this end, there are shut-off valves 9 and 12 in both branches. Depending on whether they are opened or closed, the tap water can be controlled.

[0014] To prevent freezing of the heat transfer medium during the pre-cooling of the tap water, the temperature of the medium is measured in the bypass line and if the temperature is too low, the valves 8 and 10 in the bypass line are closed, thereby preventing the medium from entering the third heat exchanger to freeze.

[0015] With the heat pump the indoor air 14 can be cooled as well as heated. For this purpose, the flow direction of the heat transfer medium can be reversed by switching a four-way valve 13. Figures 1 and 2 show the situation during cooling the indoor air 14, wherein the first heat exchanger 3 acts as an evaporator and the second heat exchanger 5 acts as a condenser. In this situation, the third heat exchanger 4 also functions as an evaporator. Figure 1 shows the situation without pre-cooling the tap water. In this situation, valve 12 is open and valve 9 is closed. The tap water flows directly via the supply pipe 15 to the second heat exchanger 5. Figure 2 shows the situation in which the tap water is pre-cooled. In this situation, valve 12 is closed and valve 9 is open. The tap water then flows via the supply line 15 first through the third heat exchanger and then to the second heat exchanger 5. The heat transfer medium reduced in temperature by expansion herein cools the tap water that flows to the second heat exchanger. This happens in the summer when the tap water is relatively warm (for example 25 °C), which would otherwise require a lot of tap water to allow the heat transfer medium to condense. To prevent that the cooling capacity for cooling the indoor air 14 has a negative effect on pre-cooling the tap water, the compressor is allowed to work harder. The water saving achieved in this way more than outweighs the costs for the extra energy that the compressor requires.

[0016] Figures 3 and 4 show the situation during the heating of the indoor air 14, wherein the first heat exchanger 3 acts as a condenser and the second heat exchanger 5 acts as an evaporator. In this situation, the third heat exchanger 4 also functions as a condenser. Figure 3 shows the situation without pre-heating the tap water. In this situation, valve 12 is open and valve 9 is closed. The tap water flows directly via the supply line 15 to the second heat exchanger 5. Figure 4 shows the situation in which the tap water is pre-heated. In this situation, valve 12 is closed and valve 9 is open. The tap water flows through the supply pipe 15 first through the third heat exchanger and then to the second heat exchanger 5. This happens in the winter if the tap water is relatively cold (for example 16 °C), which would otherwise require a large quantity of tap water to evaporate the heat transfer medium. This is also done to ensure that the heat transfer medium leaving the evaporator is above the freezing temperature. To prevent that the heating capacity for heating the indoor air 14 has negative effect on preheating the tap water, the compressor is also

allowed to work harder in this situation.

[0017] Although in the foregoing the invention has been elucidated with reference to the drawings, it should be noticed that the invention is by no means limited to the embodiment shown in the drawings. The invention also extends to all embodiments deviating from the embodiment shown in the drawings within the scope defined by the claims. In this way, water for floor heating (floor cooling) or radiators can be heated or cooled instead of air. In that case the fan is replaced by a water pipe that is located in the circuit of the pipes through the floor and / or the radiators.

[0018] It is also possible to include a fourth heat exchanger in the heat pump parallel with the third heat exchanger, one of these two heat exchangers then being used exclusively for pre-heating the tap water and the other heat exchanger exclusively for pre-cooling the tap water.

Claims

1. A heat pump, wherein energy is exchanged via a heat transfer medium between a heat or cold source and a room to be heated or cooled by heating or cooling indoor air (14) or water for heating / cooling floor and / or radiators, which heat pump is provided with a first circuit, for circulation of the heat transfer medium between the heat or cold source and the space to be heated or cooled, and a second circuit (15) for water, said heat pump comprising:

- a compressor (1) for compressing the heat transfer medium in the gaseous state,
- an expansion valve (2) for reducing the pressure of the heat transfer medium in the liquid state,
- a first heat exchanger (3) between the compressor and the expansion valve for effecting a phase transition between liquid and gas of the heat transfer medium,
- a second heat exchanger (5) between the compressor and the expansion valve for effecting a phase transition between liquid and gas of the heat transfer medium opposite to that of the first heat exchanger,
- a third heat exchanger (4) in which heat transfer between the water and the heat transfer medium can take place for preheating or pre-cooling the water in the second circuit, which third heat exchanger is in a bypass line which is present between the expansion valve (2) and the compressor (1) and which is parallel to the first heat exchanger (3) and which third heat exchanger can be switched in the circuit of the heat transfer medium by means of a control valve (7) present in the bypass line, and
- a fan (6) for blowing air through the first heat

exchanger, or
a heating water pipe present in the first heat exchanger,

the first circuit being formed by the compressor, the first heat exchanger, the expansion valve and the second heat exchanger and, depending on the position of the control valve (7), by the third heat exchanger and forming a closed circuit for the heat transfer medium,
characterized in that the second circuit forms part of the heat or cold source and is provided with two connections for connection to an open water supply circuit.

2. Heat pump according to claim 1, **characterized in that** a control valve (11) is in the water supply line with which during cooling the amount of tap water through the second heat exchanger (5) is controlled, which control valve is controlled by the pressure of the heat transfer medium at the second heat exchanger, and that a bypass line is present parallel to the control valve (11), in which bypass line a further control valve (17) is present with which the amount of tap water is controlled by the second heat exchanger (5) during heating.
3. A method for heating or cooling a room using a heat pump according to any one of the preceding claims, wherein heat is extracted from water in the second circuit or heat is released from water in the second circuit using the second heat exchanger, wherein if the water in the second circuit is warmer or colder than a set limit value corresponding to a COP which is defined as a lower limit, the water is pre-cooled or pre-heated using the third heat exchanger, and wherein heat is extracted or released from the room using the first heat exchanger.

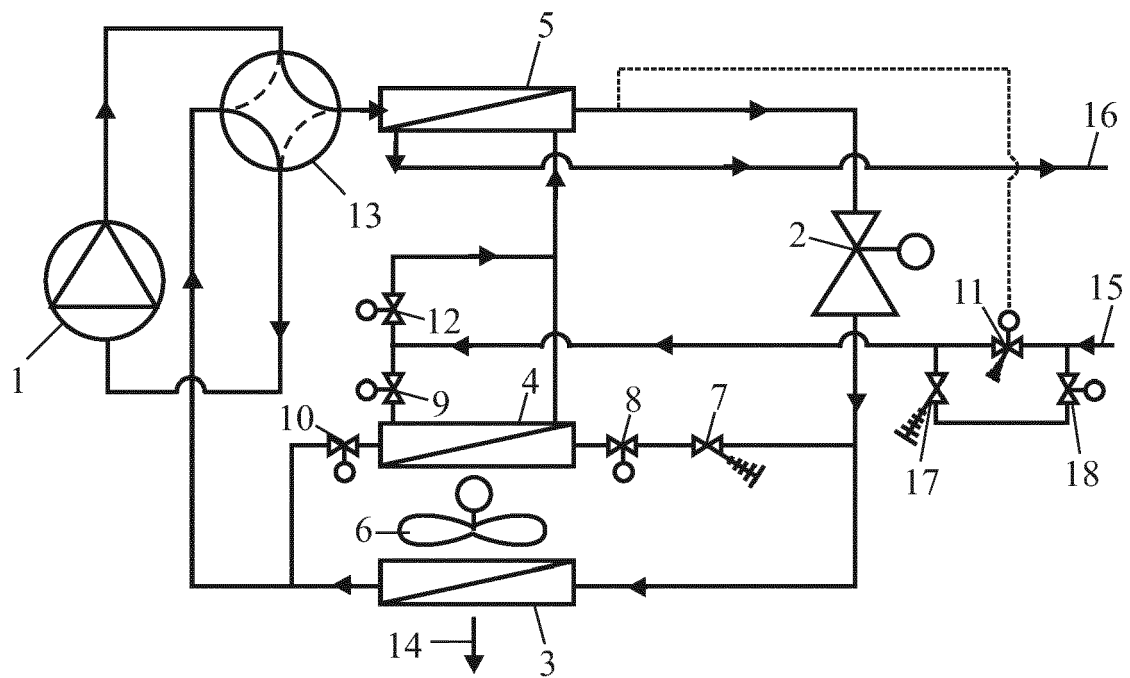


FIG. 1

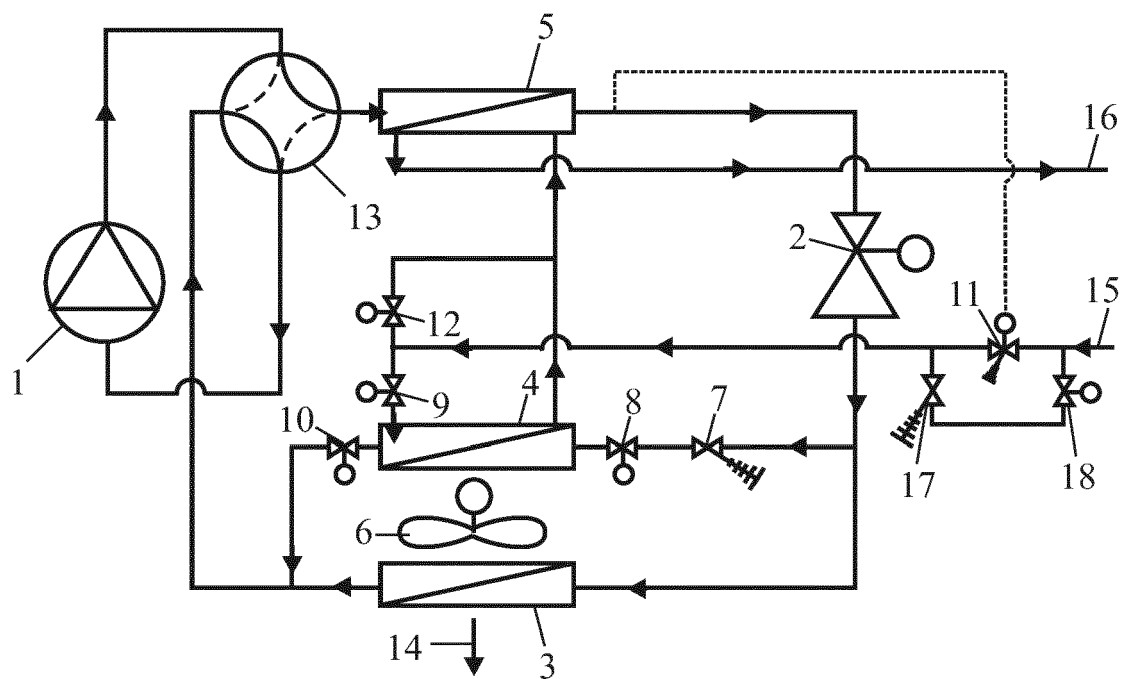


FIG. 2

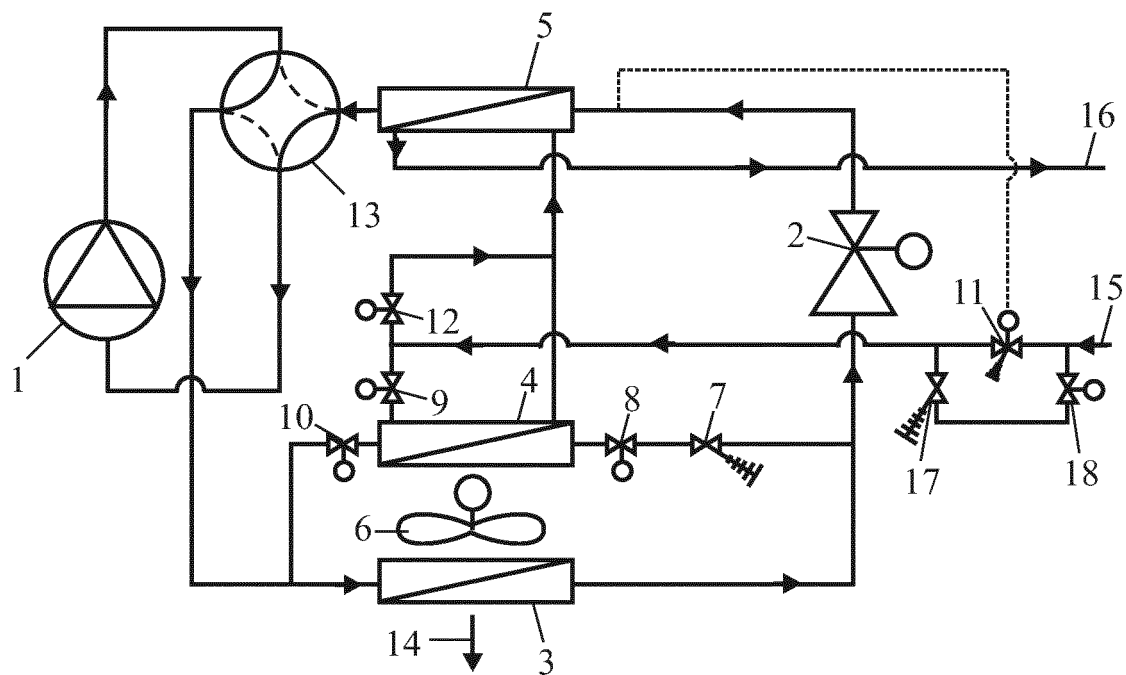


FIG. 3

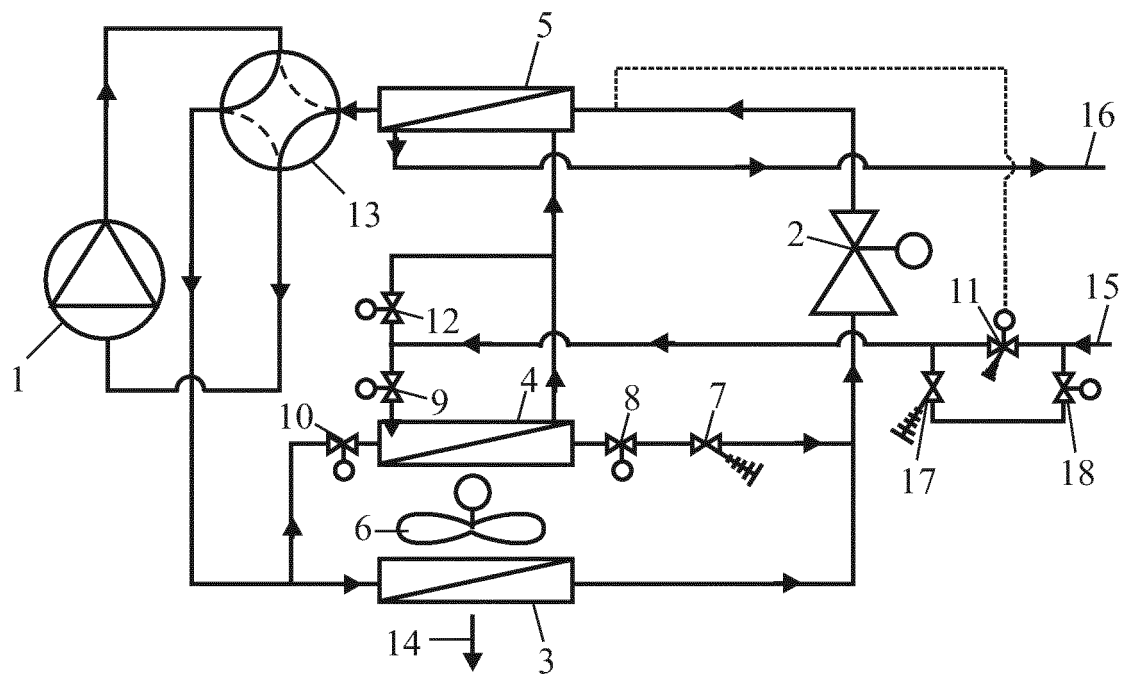


FIG. 4



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Application Number
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
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Place of search		Date of completion of the search	Examiner
Munich		17 January 2020	Weisser, Meinrad
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			

EPO FORM 1503 03/82 (P04C01)

**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.
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