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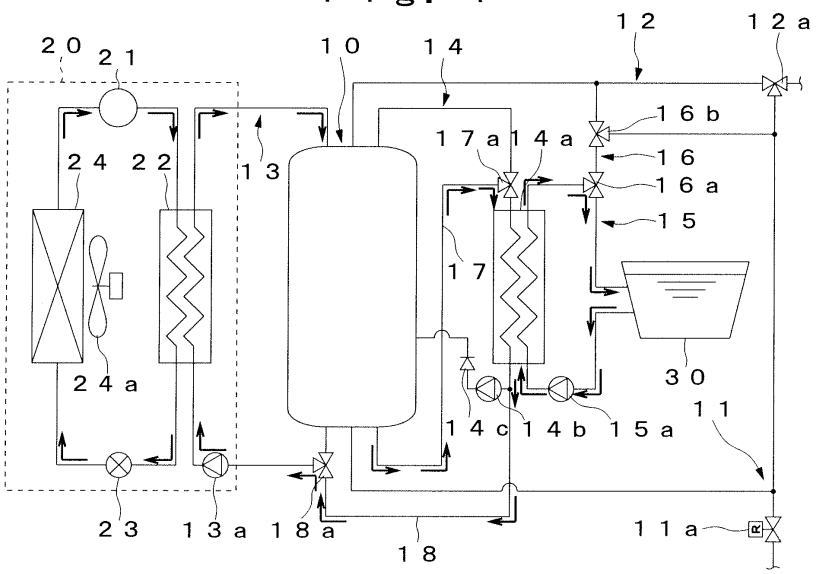
(54) HOT WATER SUPPLY DEVICE

(57) An object of the invention is, for example, to provide a hot water supply device capable of using the heat energy remained in the warm water used for the predetermined application such as the remaining hot water of a bath tub for heating the water by a simple structure.

The hot water supply device of the present invention allows the heat energy of the remaining hot water in the bath tub to be recovered by the water flowing out from the lower part of the hot water storage tank heated by a gas cooler. Hence, it is unnecessary to recover the heat energy of the remaining hot water in the bath tub by a refrigerant circulating in a refrigerant circuit of a heat pump unit, and by a simple structure of only piping for water circulation, the heat energy of the remaining hot water of the bath tub is used in heating the water.

Fig. 4



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Description

Technical field

[0001] The present invention relates to a hot water supply device for storing high-temperature water heated in a heating unit in a hot water storage tank, for example, such as a gas cooler and the like of a heat pump cycle.

Background art

[0002] Conventionally, as a hot water supply device of this type, one having a heating unit for heating water and a hot water storage tank for storing high-temperature water heated in the heating unit and supplying the high-temperature water stored in the hot water storage tank, for example, to the sink of a kitchen, the bath tub of a bathroom, and the like is known.

[0003] Further, as a method of recovering heat energy of hot water used for the prescribed application, for example, such as the remaining hot water and the like in the bath tub after bathing as heat energy for heating the water stored in the hot water storage tank, a hot water supply device is known. This device includes a refrigerant circuit connected with a gas cooler as a heating unit and a heat exchanger for heat recovery to heat-exchange a refrigerant flowing the refrigerant circuit with the remaining hot water of the bath tub, so that the heat energy of the remaining hot water of the bath tub is recovered by the refrigerant by the heat exchanger for heat collection (for example, see Patent Document 1).

[0004] Patent Document 1: Japanese Patent Application Laid-Open No.

Disclosure of the invention

Problems to be solved by the invention

[0005] However, in the hot water supply device capable of recovering the heat energy of the hot water used for the predetermined application, a heat exchanger for heat recovery is required apart from the heat exchanger for allowing the refrigerant to absorb the heat energy of the atmosphere during the normal operation, and at the same time, the piping of the refrigerant circuit becomes complicated, thereby increasing the production cost.

[0006] The present invention has been made in view of the above described problems, and an object of the invention is, for example, to provide a hot water supply device capable of recovering the heat energy remained in the hot water used for the predetermined application such as the remaining hot water of a bath tub as heat energy for heating the water by a simple structure.

Means for solving the problems

[0007] In order to achieve the above object, the present invention includes a heating unit for heating water, a hot water storage tank for storing high-temperature water heated in the heating unit, and heat recovering means for allowing water heated in the heating unit to recover heat energy remained in the warm water used for a predetermined application by heat-exchanging the warm water used for the predetermined application with water heated in the heating unit.

[0008] As a result, the heat energy remained in the hot water used for the predetermined application is recovered by the water heated in the heating unit, and therefore, it is unnecessary to recover, for example, the heat energy remained in the hot water used for the predetermined application by a refrigerant circulating in a refrigerant circuit of a heat pump unit.

[0009] Further, in order to achieve the above object, the present invention includes a hot water storage tank for storing water for hot water supply, a heating unit for heating water, a first circulation circuit for allowing water at the lower part in the hot water storage tank to flow into the heating unit and water heated in the heating unit to return to the upper part in the hot water storage tank, a heat exchanger for heat-exchanging water in the hot water storage tank with the water used for a predetermined application, a second circulation circuit for allowing water at the upper part in the hot water storage tank to flow into the heat exchanger and water heat-exchanged in the heat exchanger to return into the hot water storage tank, a third circulation circuit for allowing water to be used for the predetermined application to circulate into the heat exchanger, and heat recovery means for allowing water at the lower part in the hot water storage tank to flow into the second circulation circuit so as to carry out heat-exchange with water used for the predetermined application circulating in the third circulation circuit, and allowing water circulating in the second circulation circuit and heat-exchanged with water used for the predetermined application to flow into the first circulation circuit to be heated in the heating unit and return to the upper part in the hot water storage tank.

[0010] As a result, the heat energy of the remaining hot water of the bath tub is recovered by the water flowing out from the lower part of the hot water storage tank in the heat exchanger, and the water having recovered the heat energy of the remaining hot water of the bath tub is heated in the heating unit and is returned to the upper part of the hot water storage tank. Hence, it is unnecessary to recover, for example, the heat energy of the remaining hot water of the bath tub by the refrigerant circulating in the refrigerant circuit of a heat pump unit, and the heat energy of the remaining hot water of the bath tub is recovered by the heat exchanger for heating the water used for the predetermined application.

Advantages of the invention

[0011] According to the present invention, for example, it is unnecessary to recover the heat energy remained in the hot water used for the predetermined application by

the refrigerant circulating in the refrigerant circuit of the heat pump unit, and the heat energy remaining in the hot water used for the predetermined application such as the remaining hot water of the bath tub can be recovered as the heat energy for heating the water stored in the hot water storage tank by a simple structure of piping for water circulation only.

[0012] These and other objects, features and advantages of the present invention will become apparent by referring to the following description and the accompanied drawings.

Brief description of the drawings

[0013]

Figure 1 is an outline block diagram of a hot water supply device showing an embodiment of the present invention.

Figure 2 is an outline block diagram of the hot water supply device showing a flow path of refrigerant and water during hot water storing operation.

Figure 3 is an outline block diagram of the hot water supply device showing the flow path of the water during reheating operation.

Figure 4 is an outline block diagram of the hot water supply device showing the flow path of the refrigerant and the water during heat-recovery hot water-storing operation.

Description of symbols

[0014]

10 HOT WATER STORAGE TANK

13 FIRST CIRCULATION CIRCUIT

13a FIRST CIRCULATION PUMP

14 SECOND CIRCULATION CIRCUIT

14a HEAT EXCHANGER

15 THIRD CIRCULATION CIRCUIT

17 PIPING

17a SECOND THREE-WAY VALVE

18 PIPING

18a THIRD THREE-WAY VALVE

20 HEAT PUMP UNIT

22 GAS COOLER

30 BATH TUB

Best mode for carrying out the invention

[0015] This hot water supply device includes a hot water storage tank 10 storing the water for hot water supply and a heat pump unit 20 heating the water stored in the hot water storage tank 10, and can use high-temperature water stored in the hot water storage tank 10, for example, as the hot water of bathing, washing, and the like, and also as a heat source reheating the hot water stored in a bath tub 30 and heating equipment.

[0016] The hot water storage tank 10 is made of a member such as stainless, and is formed in a cylindrical shape with an upper end and a lower end closed and extending upward and downward. Further, the hot water storage tank 10 is covered in the outside with a heat insulation material such as glass wool or urethane foam, thereby insulating the transfer of heat between the interior and the outside of the hot water storage tank 10.

[0017] The heat pump unit 20 includes an electric compressor 21, a gas cooler 22 as a heating unit, an expansion valve 23, and an evaporator 24, and a refrigerant circuit is configured by sequentially connecting them by refrigerant piping made of copper, stainless or the like. Further, the refrigerant circuit uses carbon dioxide as a refrigerant by which its high pressure side becomes a supercritical state. Further, the evaporator 24 is provided with a blower 24a circulating the air that heat-exchange with the refrigerant.

[0018] Further, the hot water storage tank 10 is connected with water supply piping 11 supplying the water to the hot water storage tank 10 from water works, hot water supply piping 12 supplying high-temperature water supplying hot water to a bath, a kitchen, and the like, a first circulation circuit 13 heating low-temperature water of the hot water storage tank 10 in a gas cooler 22 to be returned to the hot water storage tank 10, and a second circulation circuit 14 reheating the warm water stored in the bath tub 30 by the high-temperature water of the hot water storage tank 10.

[0019] The water supply piping 11 is connected to the lower part of the hot water storage tank 10, and the water reduced to the predetermined pressure by a decompression valve 11a is allowed to flow into the hot water storage tank 10. Further, the water supply piping 11 is connected to the hot water supply piping 12 in addition to the hot water storage tank 10.

[0020] The hot water supply piping 12 is connected to the upper part of the hot water storage tank 10, and the high-temperature water of the upper part circulates the hot water supply piping 12 by the pressure of the water supply flowing into the hot water storage tank 10. Further, the hot water supply piping 12 is connected to the water supply piping 11 through a first mixing valve 12a, and supplies the warm water of the predetermined temperature obtained by mixing the high-temperature water circulating in the hot water supply piping 12 and the water

circulating in the water supply piping 11 to the bath room, the kitchen, and the like.

[0021] The first circulation circuit 13 has a lower part of the hot water storage tank 10, a first circulation pump 13a as a circulation pump, a gas cooler 22, and an upper part of the hot water storage tank 10 connected sequentially by piping, and by the first circulation pump 13a, the water of the lower part of the hot water storage tank 10 circulates the gas cooler 22 and flows into the upper part of the hot water storage tank 10.

[0022] A second circulation circuit 14 has the upper part of the hot water storage tank 10, a heat exchanger 14a, a second circulation pump 14b, a check valve 14c, and a generally center portion in a vertical direction of the hot water storage tank 10 connected sequentially, and by the second circulation pump 14b, the high-temperature water of the upper part of the hot water storage tank 10 circulates the heat exchanger 14a and flows into the generally center portion in the vertical direction of the hot water storage tank 10. The heat exchanger 14a heat-exchanges the high-temperature water circulating in the second circulation circuit 14 and the warm water in the bath tub 30 circulating in the third circulation circuit 15 to be described later.

[0023] The third circulation circuit 15 has the bath tub 30,a third circulation pump 15a, and the heat exchanger 14a connected sequentially, and by the third circulation pump 15a, the warm water of the bath tub 30 circulates the heat exchanger 14a and flows into the bath tub 30. Further, the third circulation circuit 15 is connected with one end side of hot water filling piping 16 supplying the hot water to the bath tub 30 through a first three-way valve 16a.

[0024] The hot water filling piping 16 has one end side connected to the third circulation circuit 15 through the first three-way valve 16a, and has the other end side connected to the water supply piping 11 and the hot water supply piping 12 through a second mixing valve 16b. That is, when the third circulation circuit 15 and the hot water filling piping 16 are communicated by the first three-way valve 16a, the water of the water supply piping 11 and the high-temperature water of the hot water supply piping 12 are mixed by the first mixing valve 16b so as to circulate in the hot water filling piping 16 and the third circulation circuit 15, and is supplied to the inside of the bath tub 30.

[0025] Further, the second circulation circuit 14 has one end side of piping 17 as a first communication pipe the other side of which is connected to the lower part of the hot water storage tank 10 connected to the flow path between the upper part of the hot water storage tank 10 and the inflow side of the heat exchanger 14a through a second three-way valve 17a as a first flow path changeover valve. That is, the water of the upper part or the water of the lower part of the hot water storage tank 10 flows into the heat exchanger 14a by the switching of the second three-way valve 17a. Further, the second circulation circuit 14 has one end side of the piping 18 as second communication piping the other side of which is connected to the flow path between the lower part of the hot water storage tank 10 of the first circulation circuit 13 and the first circulation pump 13a through a third three-way valve 18a as a second flow path changeover valve connected to the flow path between the outflow side of the heat exchanger 14a and the suction side of the second circulation plump 14b. That is, the flow path of the outflow side of the heat exchanger 14a of the second circulation circuit 14 communicates with the suction side of the first circulation pump 13a of the first circulation circuit 13 through the piping 18 by the switching of the third three-way valve 18a, and when the second circulation pump 14b stops and the first circulation pump 13a operates, the water flowing out from the heat exchanger 14a of the second circulation circuit 14 is absorbed by the first circulation pump 13a, and flows into the first circulation circuit 13.

[0026] In the hot water storage device thus configured as above, when the ordinary hot water storage operation is performed, the first circulation pump 13a and a compressor 21 are operated. At this time, the third three-way valve 18a is set in the flow path that communicates the lower part of the hot water storage tank 10 and the suction side of the first circulation pump 13a. As a result, as shown in FIG. 2, the refrigerant discharged from the compressor 21 circulates the gas cooler 22 and, after that, flows into the evaporator 24 through the expansion valve 23, and the refrigerant flowed out from the evaporator 24 is absorbed by the compressor 21. Further, the water of the lower part of the hot water storage tank 10 is circulated in the first circulation circuit 13 by the first circulation pump 13a, and is heated by carrying out heat-exchange in the gas cooler 22, and is stored in the upper part of the hot water storage tank 10. When the high-temperature water in the hot water storage tank 10 reaches the predetermined amount, the first circulation pump 14a and the compressor 21 are stopped.

[0027] The high-temperature water of the upper part of the hot water storage tank 10 circulates in the hot water supply piping 12, and is mixed with the water circulating in the water supply piping 11 by the first mixing valve 12a, and is supplied as the warm water of the predetermined temperature from a shower of the bath room and a water faucet of the kitchen. Further, with the water filling piping 16 and the third circulation circuit 15 communicated with each other by the first three-way valve 16a, the high-temperature water of the upper part of the hot water storage tank 10 is mixed with the water circulating in the water supply piping 11 by the second mixing valve 16b, and is supplied to the bath tub 30 as the warm water of the predetermined temperature through the third circulation circuit 15. When the high-temperature water of the hot water storage tank 10 is consumed, the water of the water supply piping 11 flows into the hot water storage tank 10, and therefore, the inside of the hot water storage tank 10 is always held in a high water level.

[0028] Further, when a reheating operation for heating

the warm water in the bath tub 30 is performed, the second circulation pump 14b and the third circulation pump 15a are operated. At this time, the first three-way valve 16a is set in the flow path that communicates the heat exchanger 14a and the bath tub 30. Further, the second three-way valve 17a is set in the flow patch that communicates the upper part of the hot water storage tank 10 and the inflow side of the heat exchanger 14a. Further, the third three-way valve 18a is set in the flow path that communicates the lower part of the hot water storage tank 10 and the suction side of the first circulation pump 13a. As a result, as shown in FIG. 3, in the heat exchanger 14a, the high-temperature water circulating in the second circulation circuit 14 and the warm water in the bath tub 30 circulating in the third circulation circuit 15 carry out heat-exchange, so that the warm water in the bath tub 30 is heated. The high-temperature water circulating in the second circulation circuit 14 is cooled by carrying out heat-exchange in the heat exchanger 14a, and is returned to the generally center portion in the vertical direction of the hot water storage tank 10.

[0029] Further, when a heat-recovery hot water-storing operation for storing the high-temperature water in the hot water storage tank 10 and recovering the heat energy of the remaining hot water in the bath tub 30 is performed, the second circulation pump 14b is stopped, and the first circulation pump 13a and the third circulation pump 15a are operated. At this time, the first three-way valve 16a is set in the flow path that communicates the heat exchanger 14a and the bath tub 30. Further, the second three-way valve 17a is set in the flow path that communicates the piping 17 and the inflow side of the heat exchanger 14a. Further, the third three-way valve 18a is set in the flow path that communicates the piping 18 and the suction side of the first circulation pump 13a. As a result, as shown in FIG. 4, the water of the lower part of the hot water storage tank 10 is circulated in the piping 17 by the first circulation pump 13a and flows into the heat exchanger 14a, and heat-exchanges with the remaining hot water of the bath tub 30 circulating in the third circulation circuit 15 in the heat exchanger 14a so as to be heated. The water heated by carrying out heat-exchange with the remaining hot water of the bath tub 30 circulates the piping 18 and is heated in the gas cooler 22, and is stored in the upper part of the hot water storage tank 10.

[0030] In this manner, according to the hot water supply device of the present embodiment, since the heat energy of the remaining hot water in the bath tub 30 is recovered by the water flowing out from the lower part of the hot water storage tank 10 heated by the gas cooler 22, it is unnecessary to recover the heat energy of the remaining hot water in the bath tub 30 by the refrigerant circulating in the refrigerant circuit of the heat pump unit 20, and the heat energy of the remaining hot water in the bath tub 30 is used in heating the water by the simple structure of only piping for circulating the water.

[0031] Further, the water of the lower part in the hot water storage tank 10 is caused to flow into the second circulation circuit 14, and is heat-exchanged with the remaining hot water in the bath tub 30 circulating in the third circulation circuit in the heat exchanger 14a, and the water heat-exchanged with the remaining hot water in the bath tub 30 and circulating in the second circulation circuit 14 is allowed to flow into the first circulation circuit 13 so as to be heated in the gas cooler 22 and return to the upper part in the hot water storage tank 10. Therefore, the heat energy of the remaining hot water in the bath tub 30 can be recovered by the heat exchanger 14a reheating without requiring the heat exchanger for heat recovery separately, and by reducing the number of parts, the reduction of the production cost can be achieved.

[0032] Further, the heat energy of the remaining hot water in the bath tub 30 can be recovered from the piping 17 allowing the lower part in the hot water storage tank 10 to communicate with the inflow side of the heat exchanger 14a of the second circulation circuit 14, the second three-way valve 17a switching the flow path of the inflow side of the heat exchanger 14a of the second circulation circuit 14 to the second circulation circuit 14 side or the piping 17 side, the piping 18 allowing the outflow side of the heat exchanger 14a of the second circulation circuit 14 to communicate with the inflow side of the gas cooler 22 of the first circulation circuit 13, the third three-way valve 18a switching the flow path of the outflow side of the heat exchanger 14a of the second circulation circuit 14 to the second circulation circuit 14 side or the piping 18 side, and the first circulation pump 13a. Hence, by the simple configuration, the recovery of the heat energy of the remaining hot water can be performed, and the reduction of the production cost can be achieved.

[0033] While the above described embodiment has shown one recovering the heat energy of the remaining hot water of the bath tub 30 by the water flowing out from the lower part of the hot water storage tank 10 heated by the gas cooler 22, for example, the heat energy of the warm water serving as the heat source of a floor heating system, an air-conditioning system, and the like may be recovered by the water flowing out from the lower part of the hot water storage tank 10 heated by the gas cooler 22.

[0034] The preferred mode described in the present specification is exemplary and is not restrictive. The scope of the invention is shown by the accompanying claims, and all the modifications included in the meaning of those claims are encompassed in the present invention.

Claims

1. A hot water supply device, comprising:

a heating unit (22) for heating water;
a hot water storage tank (10) for storing high-temperature water heated in the heating unit (22); and

heat recovering means for allowing water heated in the heating unit (22) to recover heat energy remained in the warm water used for a predetermined application by heat-exchanging the warm water used for a predetermined application with water heated in the heating unit (22).

2. A hot water supply device, comprising:

a hot water storage tank (10) for storing water for hot water supply;
a heating unit (22) for heating water;
a first circulation circuit (13) for allowing water at the lower part in the hot water storage tank (10) to flow into the heating unit (22) and water heated in the heating unit (22) to return to the upper part in the hot water storage tank (10);
a heat exchanger (14a) for heat-exchanging water in the hot water storage tank (10) with water used for a predetermined application;
a second circulation circuit (14) for allowing water at the upper part in the hot water storage tank (10) to flow into the heat exchanger (14a) and water heat-exchanged in the heat exchanger (14a)to return into the hot water storage tank (10);
a third circulation circuit (15) for allowing water to be used for the predetermined application to circulate into the heat exchanger (14a); and
heat recovery means for allowing water at the lower part in the hot water storage tank (10) to flow into the second circulation circuit (14) so as to carry out heat-exchange with water used for the predetermined application circulating in the third circulation circuit(15), and allowing water circulating in the second circulation circuit (14) and heat-exchanged with water used for the predetermined application to flow into the first circulation circuit (13) to be heated in the heating unit (22) and return to the upper part in the hot water storage tank (10).

3. The hot water supply device according to claim 2, wherein the heat recovery means comprises:

a first communication pipe (17) for communicating the lower part in the hot water storage tank (10) with the inflow side of the heat exchanger (14a) of the second circulation circuit (14);
a first flow path changeover valve (17a) for switching the flow path of the inflow side of the heat exchanger (14a) of the second circulation circuit (14) to the second circulation circuit (14) side or the first communication pipe (17) side;
a second communication pipe (18) for communicating the outflow side of the heat exchanger (14a) of the second circulation circuit (14) with the inflow side of a heating unit (22) of the first circulation circuit (13);
a second flow path changeover valve (18a) for switching the flow path of the outflow side of the heat exchanger (14a) of the second circulation circuit (14) to the second circulation circuit (14) side or the second communication pipe (18) side; and
a circulation pump (13a) connected to the first circulation circuit (13).

4. The hot water supply device according to claim 1, 2, or 3, wherein:

the water used for the predetermined application is the remaining hot water stored in a bath tub (30).

5. The hot water supply device according to claim 1, 2, or 3, wherein:

the water used for the predetermined application is the warm water used for the heating operation of a floor heating system and an air-conditioning system.

Fig. 1

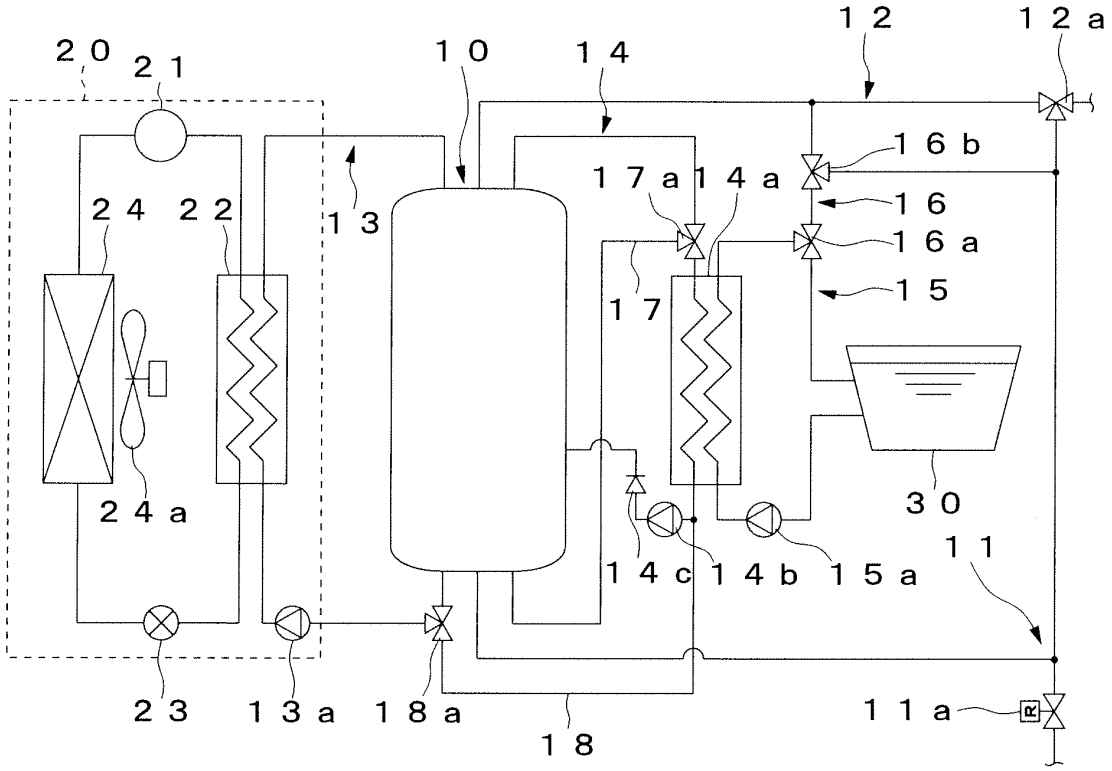
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Fig. 2

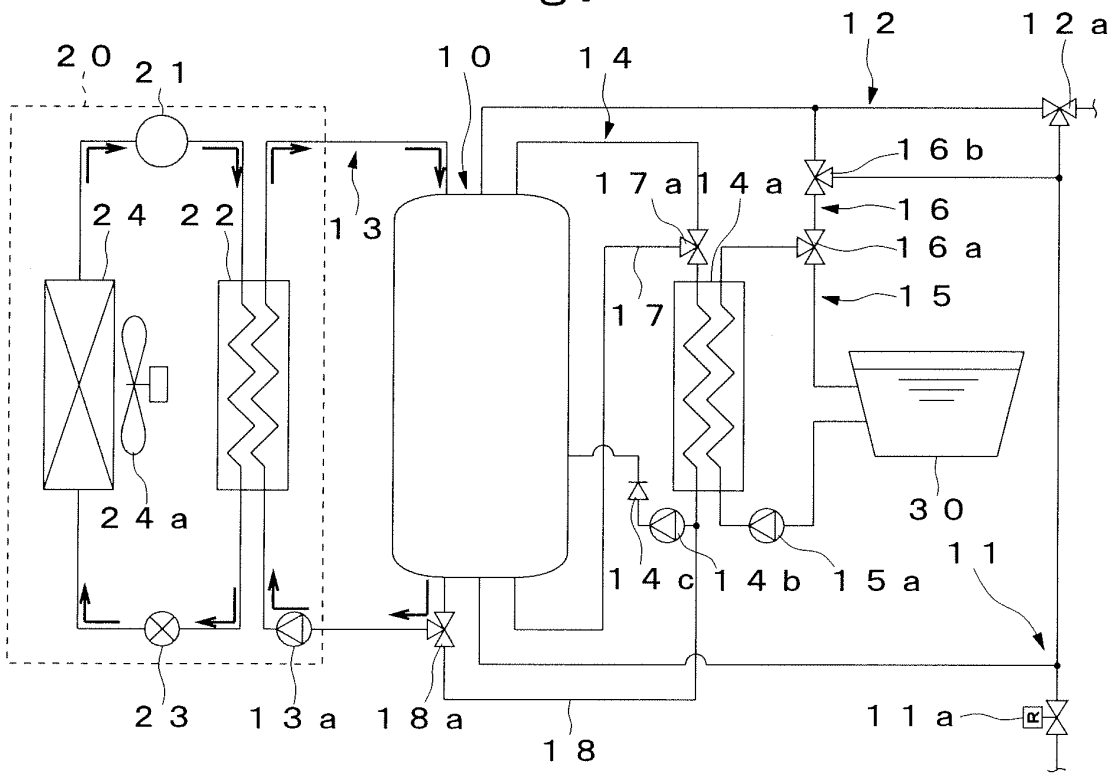
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Fig. 3

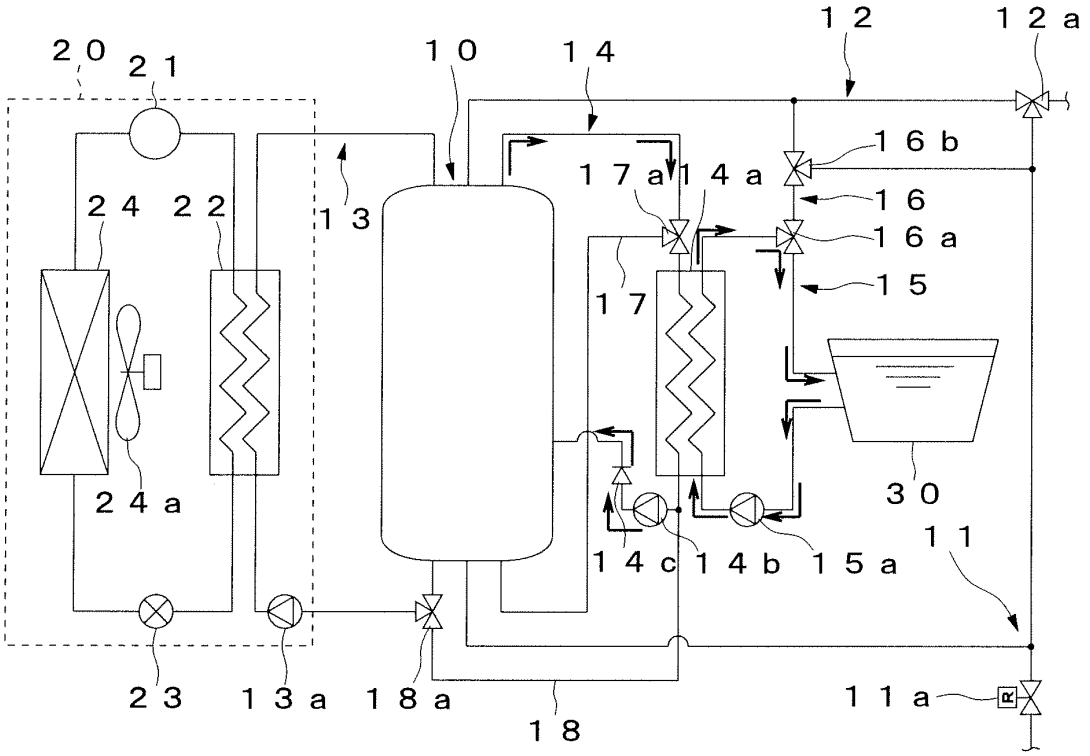
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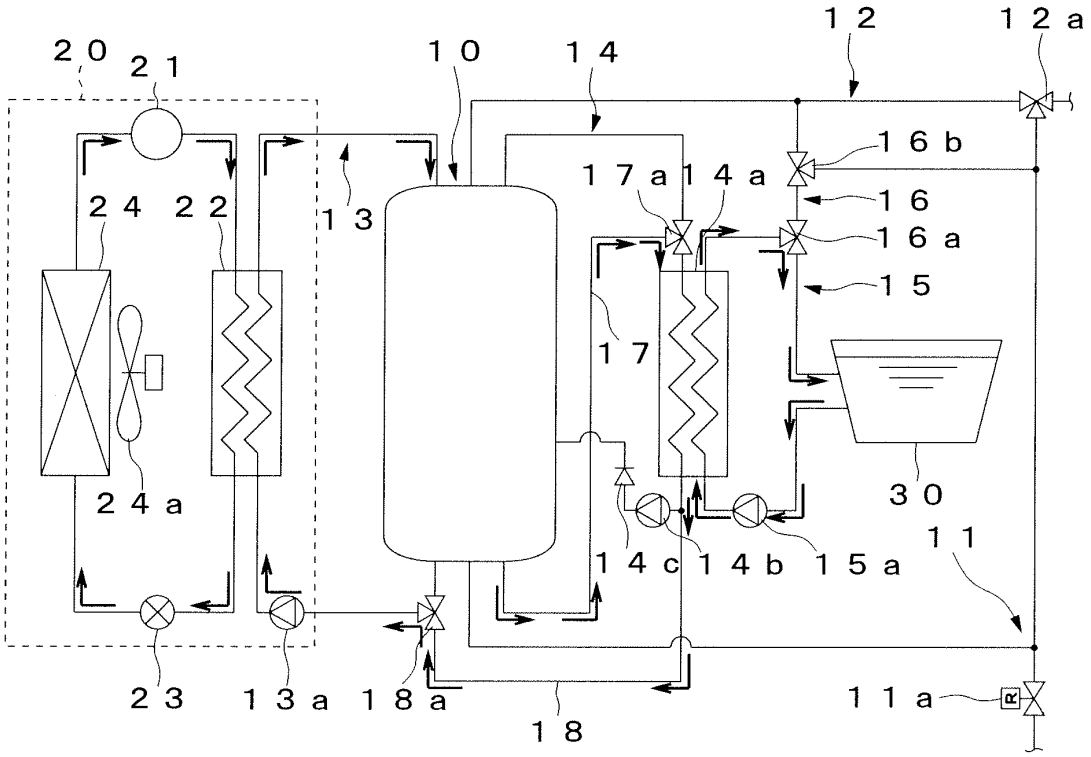
Fig. 4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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/059307

A. CLASSIFICATION OF SUBJECT MATTER
F24H1/00(2006.01)i, *F24D17/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24H1/00, F24D17/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 10-318604 A (Matsushita Electric Industrial Co., Ltd.), 04 December, 1998 (04.12.98), Par. Nos. [0019] to [0020]; Fig. 1 (Family: none)	1,4 2,5
X Y	JP 9-72612 A (Matsushita Electric Industrial Co., Ltd.), 18 March, 1997 (18.03.97), Par. Nos. [0017] to [0018]; Fig. 2 (Family: none)	1,2 4,5
Y	JP 2001-59626 A (Noritz Corp.), 06 March, 2001 (06.03.01), Par. Nos. [0004] to [0008], [0018]; Fig. 4 (Family: none)	5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
27 June, 2007 (27.06.07)	10 July, 2007 (10.07.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)