

(19)



(11)

EP 2 530 399 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
28.09.2016 Bulletin 2016/39

(51) Int Cl.:
F24H 4/04 (2006.01) **F24H 9/02** (2006.01)
F24H 9/06 (2006.01)

(21) Application number: **12153145.3**

(22) Date of filing: **30.01.2012**

(54) **Heat pump hydronic heater**

Hydronischer Wärmepumpenheizer

Dispositif de chauffage hydronique à pompe thermique

(84) Designated Contracting States:
**AL 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 RS SE SI SK SM TR**

(30) Priority: **31.05.2011 JP 2011122003**

(43) Date of publication of application:
05.12.2012 Bulletin 2012/49

(73) Proprietor: **Panasonic Corporation
Kadoma-shi
Osaka 571-8501 (JP)**

(72) Inventors:
• **FUKUNAGA, Toshikatsu
Osaka 540-6207 (JP)**

• **AOYAMA, Shigeo
Chuo-ku, Osaka 540-6207 (JP)**
• **ISAYAMA, Yasuhiko
Chuo-ku, Osaka 540-6207 (JP)**

(74) Representative: **Eisenführ Speiser
Patentanwälte Rechtsanwälte PartGmbB
Postfach 31 02 60
80102 München (DE)**

(56) References cited:
**EP-A2- 2 116 789 WO-A1-2011/025374
DE-A1- 10 142 779 GB-A- 2 448 177**

EP 2 530 399 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

[Technical Field]

5 **[0001]** The present invention relates to a heat pump hydronic heater which heats a room with hot water produces by using a heat pump circuit.

[Background Technique]

10 **[0002]** Most of conventional heaters use fuel of a combustion system such as petroleum and gas as a heat source but in recent years, heating market using a heat pump technique is rapidly growing. Conventional air conditioners can also both cool and heat a room utilizing the heat pump technique.

15 **[0003]** However, the conventional air conditioner has a problem that it is difficult to warm feet at the time of a heating operation and to solve this problem, hydronic heaters utilizing the heat pump technique have been developed (patent document 1).

20 **[0004]** According to the hydronic heater described in patent document 1, heat is exchanged between high temperature refrigerant and water, and hot water which is heated by the heat exchange is sent to a heating terminal such as a floor heating panel, thereby heating a room.

25 **[0005]** An integral type heat pump hot water supply apparatus in which a refrigerant cycle and a hot water supply cycle are accommodated in one body unit (patent documents 2 and 3).

[Prior Art Documents]

[Patent Document]

30

[0006]

[Patent Document 1] Japanese Patent Application Laid-open No.2008-39305

[Patent Document 2] Japanese Patent Application Laid-open No.2003-404907

35 [Patent Document 3] Japanese Patent Application Laid-open No.2007-155257

[Patent Document 4] International Patent Application WO 2011 025374 A1.

[Summary of the Invention]

40 [Problem to be Solved by the Invention]

45 **[0007]** According to the heat pump hydronic heater of the patent document 1, a hot water supply heat exchanger is vertically provided in a hot water tank, and since hot water for hot water supply is produced using hot water which is to be sent to a heating terminal, a temperature of the entire hot water in the hot water tank is decreased. As a result, a temperature of hot water to be sent to the heating terminal is decreased and comfort at the heating terminal is deteriorated.

50 **[0008]** According to the heat pump hot water supply apparatuses of the patent documents 2 and 3, hot water heated in the hot water tank is supplied as hot water supply.

55 **[0009]** According to the heat pump hot water supply apparatus of this kind, when water is hard as in Europe, America and China, scale easily adheres to interiors of a hot water tank, a heat exchanger and other pipes.

60 **[0010]** Therefore, if water to be used is hard, a heat pump hydronic heater of a type in which hot water in the hot water tank is circulated and a floor heating operation or a hot water supply operation is carried out is suitable, but this heater requires an expansion tank for absorbing expansion of water in a circulation pipe which becomes a closed space.

65 **[0011]** Especially when hot water in the hot water tank is used for the floor heating operation or for a panel heater in doors, since a capacity of the closed space is also large, the expansion tank is also increased in size inevitably.

70 **[0012]** The present invention has been accomplished to solve the conventional problem, and it is an object of the invention to provide a heat pump hydronic heater in which a heat pump circuit and a hot water tank circuit are accommodated in one casing and which can absorb expansion of water in a circulation path when hot water in a hot water tank is circulated through heat a floor or supply hot water.

75 [Means for Solving the Problem]

80 **[0013]** The problem is solved by the subject-matter of claim 1. According to a heat pump hydronic heater of the invention, a heat pump circuit and a hot water tank circuit are accommodated in one casing, and a hermetic expansion

tank is connected to a hot water tank. According to the invention, it is possible to absorb expansion of water in a circulation path which configures a hot water tank circuit by providing a hermetic expansion tank in the casing, heat radiation is small as compared with a case where the heat pump circuit and the hot water tank circuit are formed as units which independent from each other, and freezing is less prone to be generated in winter.

[Effect of the Invention]

[0014] According to the invention, the heat pump circuit and the hot water tank circuit can be accommodated in separate spaces of one casing, and it is possible to absorb expansion of water in the circulation path when hot water in the hot water tank is circulated through heat a floor or supply hot water.

[Brief Description of the Drawings]

[0015]

Fig. 1 is a block diagram of a heat pump hydronic heater according to an embodiment of the present invention;
 Fig. 2 is a diagram showing a configuration of an essential portion of an interior of the heater as viewed from a front surface of a casing of the embodiment;
 Fig. 3 is a diagram showing a configuration of an essential portion of the interior of the heater as viewed from one of sides of the casing;
 Fig. 4 is a diagram showing a configuration of an essential portion of the interior of the heater as viewed from the other side of the casing; and
 Fig. 5 is a rear view of the casing.

[Mode for Carrying Out the Invention]

[0016] According to a heat pump hydronic heater of a first aspect of the invention, a hermetic expansion tank is connected to a hot water tank. According to this aspect, it is possible to absorb expansion of water in a circulation path which configures a hot water tank circuit.

[0017] According to a second aspect of the invention, in the heat pump hydronic heater of the first aspect, a longitudinally long cylindrical tank is used as the hot water tank, the evaporator is provided with a blast fan to send air, the hot water tank is disposed in one of spaces in the casing in its width direction, the evaporator and the blast fan are disposed in the other space in the casing in the width direction, and the expansion tank is disposed at a location higher than the hot water tank. According to this aspect, the heat pump circuit and the hot water tank circuit can be accommodated in the casing. By disposing the expansion tank at the location higher than the hot water tank, it is possible to increase an amount of water which can be accommodated in the expansion tank with respect to an amount of water in the hot water tank circuit.

[0018] According to a third aspect of the invention, in the heat pump hydronic heater of the second aspect, the expansion tank is disposed in a space above the hot water tank, and the expansion tank is covered with a heat insulator. According to this aspect, since high temperature water is introduced into the expansion tank, heat efficiency can be enhanced by reducing influence of air flow caused by the blast fan and preventing heat radiation by the heat insulator.

[0019] According to a fourth aspect of the invention, in the heat pump hydronic heater of the first or second aspect, the hot water tank circuit includes a hot water supply circuit, in the boiling circuit, a boiling pump is driven, thereby introducing water in the hot water tank to the water/refrigerant heat exchanger, and hot water produced by the water/refrigerant heat exchanger is returned to the hot water tank, in the hot water supply circuit, a hot water supply pump is driven, thereby introducing hot water in the hot water tank to a hot water supply heat exchanger, and the hot water which exchanged heat with respect to hot water-to-be-supplied flowing through a hot water supply pipe by the hot water supply heat exchanger is returned to the hot water tank, in the heating circuit, a heat pump is driven, thereby introducing the hot water in the hot water tank to the heating terminal, and the hot water which dissipated heat at the heating terminal is returned to the hot water tank, the casing includes an intake connection port through which the hot water-to-be-supplied is supplied to the hot water supply heat exchanger, a take-out connection port through which the hot water-to-be-supplied heated by a hot water supply heat exchanger is introduced to the hot water supply terminal, a hot water outflow port through which the hot water is supplied to the heating terminal, and a hot water inflow port through which the hot water from the heating terminal is returned to the hot water tank, the evaporator is disposed such that it is opposed to a back surface and the other side surface of the casing, one of front surface of the casing in the width direction is closed, the other front surface of the casing in the width direction is formed as an air outlet for the blast fan, and the intake connection port, the take-out connection port, the hot water outflow port and the hot water inflow port are disposed in lower portions of the back surface of the casing. According to this aspect, an interior of the one casing can be divided into a space

where air flows and heat exchange is carried out and a space where heat radiation is prevented, the four connection ports are formed in the lower portions of the back surface, the casing can be disposed along a wall surface of a building for example, a pipe which connects the casing and an interior of a room with each other can be shortened and thus, freezing can be prevented in winter.

[0020] According to a fifth aspect of the invention, in the heat pump hydronic heater of the fourth aspect, the hot water tank includes a partition plate which partitions an interior of the hot water tank into an upper space and a lower space, an upper heater disposed in the upper space, and a lower heater disposed in the lower space, in the boiling circuit, the hot water produced by the water/refrigerant heat exchanger is returned to the lower space, in the hot water supply circuit, the hot water in the upper space is introduced to the hot water supply heat exchanger, and in the heating circuit, the hot water in the lower space is introduced to the heating terminal. According to this aspect, water whose temperature is higher than a boiling temperature of the heat pump circuit can be stored in the hot water tank, and the high temperature water can be utilized as hot water-to-be-supplied.

[0021] According to a sixth aspect of the invention, in the heat pump hydronic heater of any one of the first to fifth aspects, R407C is used as the refrigerant. According to this aspect, water having higher temperature as compared with R410A can be obtained.

[0022] According to a seventh aspect of the invention, in the heat pump hydronic heater of any one of the first to sixth aspects, the back surface of the casing is opposed to a wall surface of a building, and the casing is disposed out of doors. According to this aspect, since a pipe which connects the casing and an interior of a room with each other can be shortened, freezing can be prevented in winter.

[0023] An embodiment of the invention will be explained with reference to the drawings. The invention is not limited to the embodiment.

[0024] Fig. 1 is a block diagram of a heat pump hydronic heater of the embodiment of the invention. First, a configuration a heat pump hydronic heater of the embodiment will be explained using Fig. 1. The heat pump hydronic heater of the embodiment includes a heat pump circuit and a hot water tank circuit. The heat pump circuit and the hot water tank circuit are accommodated in one casing 50, and the casing 50 is disposed out of doors.

[0025] The heat pump circuit includes a compressor 1 which compresses a refrigerant and discharge a high temperature refrigerant, a water/refrigerant heat exchanger 2 which exchanges heat between water and high temperature refrigerant to produce hot water, a decompressor 3 which decompresses a refrigerant, an evaporator 4a which exchanges heat between air and a refrigerant, and a four-way valve 5 which changes flow paths of a refrigerant. The compressor 1, the water/refrigerant heat exchanger 2, the decompressor 3, the evaporator 4a and the four-way valve 5 are annularly connected to one another through a refrigerant pipe 6, thereby forming a heat pump circuit. To form the heat pump circuit, there is provided a blast fan 4b which blows air to the evaporator 4a to facilitate the heat exchange between air and a refrigerant. As the water/refrigerant heat exchanger 2, it is possible to use a plate type heat exchanger and a double pipe type heat exchanger. In the heat pump circuit, R410A is used as a refrigerant, but chlorofluorocarbons-based refrigerant of R407C is more suitable.

[0026] The hot water tank circuit includes a hot water tank 7 in which hot/cold water is stored. A partition plate 8 is disposed in the hot water tank 7 at a substantially intermediate portion thereof in a height direction of the hot water tank 7. In the hot water tank 7, an upper space which is higher than the partition plate 8 is a hot water supply-hot water section 7a, and a lower space which is lower than the partition plate 8 is a heating hot water section 7b. By partitioning the interior of the hot water tank 7 into the upper space and the lower space, hot water in the hot water supply-hot water section 7a can be used for heat exchange when hot water is supplied, and hot water in the heating hot water section 7b can be used for circulating to the heating terminal when a room is heated.

[0027] A water outlet 10 is provided in a lower portion of the hot water tank 7. A water pipe through which low temperature water is sent from the water outlet 10 to the water/refrigerant heat exchanger 2 is provided with a boiling pump 9. By driving the boiling pump 9, low temperature water is sent from the water outlet 10 to the water/refrigerant heat exchanger 2, the water/refrigerant heat exchanger 2 absorbs heat from the refrigerant and hot water is produced.

[0028] Hot water produced by the water/refrigerant heat exchanger 2 is returned to a hot water inlet 11 provided in an upper portion of the heating hot water section 7b. In this embodiment, the hot water tank 7, the water outlet 10, the boiling pump 9, the water/refrigerant heat exchanger 2 and the hot water inlet 11 are connected to one another through a water pipe, thereby forming a boiling circuit. An AC pump having a constant circulation flow rate is used as the boiling pump 9.

[0029] The partition plate 8 has a plurality of openings, when hot water heated by the heat pump circuit returns to the heating hot water section 7b, the hot water flows into the hot water supply-hot water section 7a through the openings.

[0030] A periphery of the partition plate 8 and an inner wall of the hot water tank 7 are welded to each other through a plurality of welding points, and gaps are provided between the periphery of the partition plate 8 and the hot water tank 7 other than the welding points. Hot water which returned from the hot water inlet 11 flows into the hot water supply-hot water section 7a through the gaps formed between the periphery of the partition plate 8 and the hot water tank 7.

[0031] Stainless steel is used for the hot water tank 7 and the partition plate 8 in view of corrosion resistance.

[0032] A temperature sensor 12a which detects an inflow-water temperature is provided at a water-side inlet of the water/refrigerant heat exchanger 2, and a temperature sensor 12b which detects an outflow-water temperature is provided at a water-side outlet of the water/refrigerant heat exchanger 2. A flow switch 13 is provided for detecting that hot/cold water flows through the boiling circuit.

[0033] The boiling pump 9, the flow switch 13 and an over pressure relief valve 14 are provided in upstream and downstream pipes of the water/refrigerant heat exchanger 2. The flow switch 13 detects flow of hot/cold water. The flow switch 13 is disposed downstream of the boiling pump 9. Since the flow switch 13 is disposed downstream of the boiling pump 9, it is possible to detect that the boiling pump 9 is not normally operated.

[0034] The over pressure relief valve 14 which adjusts a pressure in the boiling circuit is provided above the boiling pump 9. If an abnormal condition is encountered in the boiling circuit and an internal pressure rises and becomes higher than a set pressure of the over pressure relief valve 14, expanded hot/cold water can be discharged from the over pressure relief valve 14.

[0035] An upper heater 15a is disposed in the hot water supply-hot water section 7a, and a lower heater 15b is disposed in the heating hot water section 7b. The upper heater 15a is used for heating hot water in the hot water supply-hot water section 7a, and the lower heater 15b is used for heating hot water in the heating hot water section 7b.

[0036] Temperature sensors 16a, 16b, 16c and 16d are disposed on a side wall of the hot water tank 7 for detecting a temperature of hot/cold water in the hot water tank 7. The temperature sensor 16a is disposed above the upper heater 15a, and the temperature sensor 16b is disposed at substantially the same height as the upper heater 15a. The temperature sensor 16c is disposed at a location lower than the partition plate 8 and higher than the lower heater 15b, and the temperature sensor 16d is disposed at substantially the same height as the lower heater 15b.

[0037] The hot water tank circuit is provided with a hot water supply heat exchanger 18 which produces hot water to be sent to a hot water supply terminal 17. High temperature water in the hot water tank 7 is sent to a primary-side flow path of the hot water supply heat exchanger 18, and low temperature water is sent from a water supply source to a secondary-side flow path of the hot water supply heat exchanger 18.

[0038] A hot water supply pump 19 is provided in a water pipe through which high temperature water in the hot water tank 7 is sent to the hot water supply heat exchanger 18. A hot water-outflow port 20 is provided in an upper portion of the hot water supply-hot water section 7a of the hot water tank 7, and a water-inflow port 21 is provided in a lower portion of the heating hot water section 7b of the hot water tank 7. By driving the hot water supply pump 19, high temperature water is sent from the hot water-outflow port 20 to a primary-side flow path of the hot water supply heat exchanger 18.

[0039] Hot water after heat is exchanged by the hot water supply heat exchanger 18 is returned from the water-inflow port 21 into the hot water tank 7. In this embodiment, the hot water tank 7, the hot water-outflow port 20, the hot water supply heat exchanger 18, the hot water supply pump 19 and the water-inflow port 21 are connected to one another through the water pipe to form a hot water supply circuit. An AC pump whose circulation flow rate is constant is used as the hot water supply pump 19.

[0040] A water pipe between the hot water supply pump 19 and the water-inflow port 21 is provided with a check valve 23 and a flow rate adjusting valve 22 which adjusts a circulation flow rate of hot/cold water in the boiling circuit. The check valve 23 is provided to prevent convection of hot/cold water in the hot water supply circuit. When the hot water supply pump 19 is not driven, the check valve 23 prevents high temperature water in an upper portion of the hot water tank 7 from entering a lower portion of the hot water tank 7 through the hot water supply heat exchanger 18. If the high temperature water flows into the lower portion of the hot water tank 7, a temperature of hot water which is sent to the water/refrigerant heat exchanger 2 becomes high and boiling efficiency is deteriorated.

[0041] Hence, in this embodiment, by providing the check valve 23, only when a flow rate becomes equal to a predetermined load or higher, hot/cold water is circulated through the hot water supply circuit in a normal direction. In the embodiment, only when a load of 20 g is applied in the normal direction of the check valve 23, hot/cold water flows in the normal direction. The value of the load is not limited to 20 g.

[0042] An over pressure relief valve 24 which adjusts a pressure in the hot water supply circuit is provided in a water pipe extending from the hot water-outflow port 20 to the hot water supply heat exchanger 18. If the pressure in the hot water supply circuit becomes higher than a set pressure of the over pressure relief valve 24, hot/cold water is discharged from the over pressure relief valve 24. The hot water tank 7 is provided at its lower portion with a water plug 25, and hot/cold water in the hot water tank 7 can be discharged outside.

[0043] A water line extending from the water supply source is connected to a water supply pipe 26 through an intake connection port 51. The water supply pipe 26 is connected to a bottom of the hot water tank 7 and a secondary-side flow path of the hot water supply heat exchanger 18 through a three-way valve 27.

[0044] When the hot water tank circuit is installed, the three-way valve 27 is switched to a flow path which is connected to the hot water tank 7, the tank 7 is filled with water, and after the hot water tank 7 becomes full of water, the three-way valve 27 is switched to a flow path which is connected to the hot water supply heat exchanger 18. After water is supplied to the hot water tank 7, if the three-way valve 27 is switched to the flow path connected to the hot water supply heat exchanger 18 in this manner, a water circuit including the hot water tank 7 is closed, new water does not enter, and even

if a user is living in an area of hard water having a high mineral content, scale is deposited only from water which is put into the hot water tank 7 for the first time.

[0045] A water pipe between the three-way valve 27 and the hot water supply heat exchanger 18 is provided with an over pressure relief valve 29. A water supply pressure is applied from the water supply source directly to the hot water supply heat exchanger 18. Hence, when the water supply pressure is high, if water is supplied from the water supply source directly to the hot water supply heat exchanger 18, there is a possibility that the hot water supply heat exchanger 18 is destroyed and breaks down. Hence, the over pressure relief valve 29 is provided and when hot/cold water of more than given water supply pressure enters, water is discharged outside through the over pressure relief valve 29 to prevent the hot water supply heat exchanger 18 from breaking down.

[0046] If a temperature of low temperature water supplied from the water supply source rises in the hot water supply heat exchanger 18, the low temperature water is supplied to the hot water supply terminal 17 through a hot water supply pipe 30. The hot water supply terminal 17 is connected to the hot water supply pipe 30 through a take-out connection port 52. The hot water supply pipe 30 includes a temperature sensor 31 and an auxiliary temperature sensor 32 which are hot water supply temperature detecting means for detecting a temperature of hot/cold water. The hot water supply pipe 30 also includes flow rate sensor 33 which is flow rate detecting means for detecting a flow rate.

[0047] The heat pump hydronic heater includes a heating terminal 34 for heating a room and it is possible to heat the room by circulating hot water in the hot water tank 7 through the heating terminal 34. The heating terminal 34 is connected to the hot water tank 7 through a hot water outflow port 53 and a hot water inflow port 54. The heating pump 35 sends hot water from the heating hot water section 7b of the hot water tank 7 to the heating terminal 34 through the hot water outflow port 53, and the hot water is returned from the heating terminal

[0048] 34 to the heating hot water section 7b of the hot water tank 7 through the hot water inflow port 54. Hot water sent to the heating terminal 34 is taken out from a hot water take-out port 36 provided in the vicinity of the hot water inlet 11, and hot water in the heating hot water section 7b is supplied to the heating terminal 34. Hot water after it is heat-exchanged in the heating terminal 34 is returned to the bottom of the hot water tank 7. An AC pump having a constant circulation flow rate is used as the heating pump 35.

[0049] A hermetic expansion tank 37 is connected to the hot water tank 7. An interior of the expansion tank 37 is separated into a water chamber and an air chamber by a diaphragm, and capacities of the water chamber and the air chamber are changed by the diaphragm. Therefore, the expansion tank 37 can absorb expansion of water in the circulation path which configures the hot water tank circuit. The expansion tank 37 may be connected to a pipe extending from the heating pump 35 to the hot water outflow port 53 or a pipe extending from the hot water inflow port 54 to the hot water tank 7, but it is preferable that the expansion tank 37 is connected to an upper portion of the hot water tank 7.

[0050] An operation of the heat pump hydronic heater having the above-described configuration will be explained below.

[0051] First, a boiling operation will be explained. First, a boiling temperature T_h of hot/cold water in the water/refrigerant heat exchanger 2 is set. If the boiling operation is started, the boiling pump 9 is driven and hot water in the hot water tank 7 is supplied to the water/refrigerant heat exchanger 2. The boiling operation carried out by the heat pump circuit is continued until a temperature detected by the temperature sensor 12b exceeds the boiling temperature T_h . When hot water in the hot water tank 7 is to be boiled by the heat pump circuit, the four-way valve 5 is switched such that high temperature refrigerant discharged from the compressor 1 flows into the water/refrigerant heat exchanger 2.

[0052] As a result, high temperature refrigerant discharged from the compressor 1 flows into the water/refrigerant heat exchanger 2, thereby dissipating heat to hot/cold water and high temperature water can be produced. In the water/refrigerant heat exchanger 2, water and a refrigerant flow in a counterflowing manner so that the heat exchanging efficiency is enhanced.

[0053] If a temperature of hot/cold water coming from the water/refrigerant heat exchanger 2 detected by the temperature sensor 12b approaches the boiling temperature T_h , the revolution number of the compressor 1 is reduced to lower the ability. If the temperature detected by the temperature sensor 12b becomes higher than the boiling temperature T_h by a predetermined temperature T_a (e.g., 2°C), the operation of the compressor 1 is stopped and the boiling operation is completed. The hot water tank 7 is full of hot/cold water of the boiling temperature T_h .

[0054] High temperature water produced by the water/refrigerant heat exchanger 2 is returned to the heating hot water section 7b, and the hot water supply-hot water section 7a is also full of hot/cold water of the boiling temperature T_h through the gaps between the periphery of the partition plate 8 and the hot water tank 7. At that time, an inflow-water temperature T_i detected by the temperature sensor 12a when the operation of the compressor 1 is stopped is stored.

[0055] Also after the boiling operation carried out by the heat pump circuit is completed, the boiling pump 9 is driven and hot water in the hot water tank 7 is circulated through the water/refrigerant heat exchanger 2. This is because that it is necessary to detect a temperature of hot water in the hot water tank 7 by the temperature sensor 12a and the temperature sensor 12b even while the boiling operation is stopped, and the boiling operation carried out by the heat pump circuit must be restarted immediately when the temperature of heat exchanger in the hot water tank 7 is lowered.

[0056] The boiling pump 9 is driven even while the hot water supply operation is stopped, hot water in the hot water tank 7 is always detected by the temperature sensor 12a, and when a temperature detected by the temperature sensor

12b becomes lower than the inflow-water temperature T_i stored when the operation of the compressor 1 is stopped by a predetermined temperature T_b (e.g., 5°C), the operation of the compressor 1 is restarted, and the boiling operation is started.

[0057] If the boiling temperature T_h is set to 55°C for example, the operation of the compressor 1 is stopped when a temperature detected by the temperature sensor 12b exceeds 57°C (=55°C+2°C). If the temperature detected by the temperature sensor 12a when the operation of the compressor 1 is stopped is 53°C, the fact that the inflow-water temperature T_i is 53°C is stored. The boiling pump 9 is driven even after the operation of the compressor 1 is stopped, and when a temperature detected by the temperature sensor 12b becomes lower than the inflow-water temperature T_i by a predetermined temperature T_b (e.g., 5°C), the operation of the compressor 1 is restarted. The predetermined temperatures T_a and T_b shown in the embodiment are one example, and the invention is not limited to the embodiment.

[0058] In the hot water tank circuit, a boiling temperature T_u of the upper heater 15a, a boiling temperature T_{bo} of the lower heater 15b and a hot water supply temperature T_k to the hot water supply terminal 17 can be set.

[0059] In the embodiment, by setting the boiling temperature T_u of the upper heater 15a to a temperature higher than the boiling temperature T_h , hot water in the hot water supply-hot water section 7a can be boiled to the boiling temperature T_u . If the boiling temperature T_h is set to 55°C and the boiling temperature T_u is set to 75°C for example, the boiling operation is carried out such that water is boiled to the boiling temperature T_h (55°C) by the water/refrigerant heat exchanger 2 and it is boiled to 75°C by the upper heater 15a.

[0060] Since it is possible to set different boiling temperatures in the upper space and the lower space between the partition plate 8, water can be boiled to an optimal temperature in accordance with respective terminals, and usability can be enhanced.

[0061] Next, a boiling operation carried out by the upper heater 15a will be explained. When the operation of the upper heater 15a is to be started, output of the upper heater 15a is turned ON when a temperature detected by a temperature sensor 16a provided at a location higher than the upper heater 15a becomes lower than the boiling temperature T_u by a predetermined temperature T_c (e.g., 5°C). Hot water in the hot water supply-hot water section 7a is heated by the upper heater 15a, and the output of the upper heater 15a is turned OFF when a temperature detected by a temperature sensor 16b provided at the same location as the upper heater 15a becomes higher than the boiling temperature T_u by a predetermined temperature T_d (e.g., 2°C).

[0062] As described above, the temperature sensor which determines when the upper heater 15a is turned ON and the temperature sensor which determines when the upper heater 15a is turned OFF are made different from each other so that the upper heater 15a is not frequently switched between ON and OFF, and the durability of the upper heater 15a is enhanced. The predetermined temperatures T_c and T_d shown in the embodiment are one example, and the invention is not limited to the embodiment.

[0063] Next, a boiling operation carried out by the lower heater 15b will be explained. The lower heater 15b is turned ON when the boiling operation can not be carried out by a heat pump unit A, thereby preventing a temperature of hot water in the heating hot water section 7b from decreasing.

[0064] If the heating operation is continued for example, frost forms on the evaporator 4a and a defrosting operation must be carried out. In such a case, a refrigerant flow path is switched by the four-way valve 5, thereby flowing high temperature refrigerant coming from the compressor 1 into the evaporator 4a, and the defrosting operation is carried out at a temperature of the refrigerant.

[0065] However, when the defrosting operation is carried out, the refrigerant can not dissipate heat by the water/refrigerant heat exchanger 2, hot water can not be produced by the water/refrigerant heat exchanger 2. As a result, a temperature of hot water in the heating hot water section 7b is decreased and this decreases a temperature of hot water to be supplied to the heating terminal 34. To prevent this, the lower heater 15b is turned ON, thereby preventing the temperature of hot water in the heating hot water section 7b from decreasing and comfort at the heating terminal 34 can be maintained. Not only during the defrosting operation but also when the heat pump unit A breaks down, it is possible to heat hot water in the heating hot water section 7b by the lower heater 15b.

[0066] In this embodiment, control is performed such that only when a temperature detected by the temperature sensor 16d is lower than a boiling temperature T_{bo} by the predetermined temperature T_e (e.g., 10°C), the lower heater 15b is turned ON.

[0067] As a result, when the boiling temperature T_{bo} is set equal to the boiling temperature T_h , water is boiled to the boiling temperature T_h by the heat pump circuit in the heating hot water section 7b, and the lower heater 15b is not turned ON unless a temperature detected by the temperature sensor 16d is lower than the boiling temperature T_{bo} by the predetermined temperature T_e .

[0068] When the defrosting operation of the evaporator 4a is carried out or when ability of the heat pump circuit is not exerted, the lower heater 15b can be turned ON only when the temperature detected by the temperature sensor 16d is lower than the boiling temperature T_{bo} by the predetermined temperature T_e , and extremely efficient boiling operation can be carried out.

[0069] When the boiling operation is carried out by the lower heater 15b, if the lower heater 15b is to be stopped, the

boiling operation is carried out such that the lower heater 15b is turned ON when the temperature detected by the temperature sensor 16d is higher than the boiling temperature T_{bo} by a predetermined temperature T_f (e.g., 2°C).

[0070] As described above, both the boiling operation carried out by the heat pump circuit and boiling operation carried out by the lower heater 15b in combination are used in combination, even in a state where the boiling operation is not carried out by the heat pump unit A due to defrosting operation of the evaporator 4a, hot water in the heating hot water section 7b is maintained at the boiling temperature T_{bo} , the hot water can stably be sent to the heating terminal 34, and comfort is not deteriorated. The predetermined temperatures T_e and T_f shown in the embodiment are one example, and the invention is not limited to the embodiment.

[0071] Next, a heating operation will be explained. If the heating operation is started, the heating pump 35 is driven and hot water in the heating hot water section 7b is supplied to the heating terminal 34. Hot water which dissipated heat in the heating terminal 34 is returned to the lower portion in the hot water tank 7. At that time, since AC pump is used as the heating pump 35, hot/cold water of a given flow rate is circulated at the time of the heating operation.

[0072] Next, a hot water supply operation will be explained. A hot water supply set temperature T_k is set. If hot/cold water comes from the hot water supply terminal 17 and the flow rate sensor 33 detects that a flow rate becomes a predetermined flow rate or higher, the hot water supply pump 19 is driven and high temperature water in the hot water supply-hot water section 7a is sent to the hot water supply heat exchanger 18.

[0073] An opening degree of the flow rate adjusting valve 22 is adjusted in accordance with a temperature deviation between the temperature T_1 detected by the temperature sensor 31 and the hot water supply set temperature T_k , and feedback control is performed such that the temperature T_1 detected by the temperature sensor 31 becomes equal to the hot water supply set temperature T_k . Hot water after it dissipated heat in the hot water supply heat exchanger 18 is returned to the lower portion of the heating hot water section 7b.

[0074] A temperature layer is created in the heating hot water section 7b and this layer has such properties that that a higher location has a higher temperature. Therefore, even if hot water after it dissipated heat in the hot water supply heat exchanger 18 is returned to the lower portion of the heating hot water section 7b, influence on a temperature of hot water to be sent to the heating terminal 34 is small.

[0075] Since high temperature water in the hot water supply-hot water section 7a is used as hot water to be sent to the hot water supply heat exchanger 18, and high temperature water in the heating hot water section 7b is used as hot water to be sent to the heating terminal 34, it is possible to suppress influence of hot water supply operation received by the hot water to be sent to the heating terminal 34.

[0076] When the flow rate sensor 33 does not detect a flow of hot/cold water, if it is detected that a hot water temperature T_1 detected by the temperature sensor 31 is higher than a hot water supply abnormal temperature T_j (e.g., 65°C) or higher, it is determined that an abnormal condition is encountered, the operation of the hot water supply pump 19 is stopped, the opening degree of the flow rate adjusting valve 22 is fully closed to reliably prevent high temperature water in the hot water tank 7 from being sent to the hot water supply heat exchanger 18. This can prevent high temperature water in the hot water tank 7 from being used uselessly, and prevent the hot water tank 7 from drying up. The predetermined temperature T_j shown in the embodiment is one example, and the invention is not limited to the embodiment.

[0077] The heat pump hydronic heater of the embodiment is provided with the auxiliary temperature sensor 32. This prevents high temperature water from coming from the hot water supply terminal 17. Next, detection of abnormal condition carried out by the auxiliary temperature sensor 32 at the time of the hot water supply operation will be explained.

[0078] First, when the hot water supply operation is being carried out, a temperature of hot water supplied to the hot water supply terminal 17 in the auxiliary temperature sensor 32 is detected, a temperature deviation between a temperature T_1 detected by the temperature sensor 31 and a temperature T_2 detected by the auxiliary temperature sensor 32 is detected.

[0079] If it is detected that the temperature T_2 is higher than the temperature T_1 by a predetermined temperature T_g (e.g., 8°C), there is a possibility that the temperature sensor 31 is erroneously operated and high temperature water is supplied to the hot water supply terminal 17. Therefore, the operation of the hot water supply pump 19 is stopped and the opening degree of the flow rate adjusting valve 22 is fully closed. As a result, high temperature water does not come out from the hot water supply terminal 17 and safety can be secured. The predetermined temperature T_g shown in the embodiment is one example, and the invention is not limited to the embodiment.

[0080] Next, control of the flow rate adjusting valve 22 at the time of the hot water supply operation will be explained.

[0081] First, if hot/cold water is supplied from the hot water supply terminal 17, the flow rate sensor 33 detects that a flow rate becomes higher than a predetermined flow rate. If the flow rate sensor 33 detects that the flow rate becomes higher than the predetermined flow rate, operation of the hot water supply pump 19 is started.

[0082] If predetermined time α (e.g., 8 seconds) is elapsed after the operation of the hot water supply pump 19 is started, operation of the flow rate adjusting valve 22 is started and the opening degree of the flow rate adjusting valve 22 is adjusted such that the temperature T_1 detected by the temperature sensor 31 becomes equal to the hot water supply set temperature T_k . The opening degree of the flow rate adjusting valve 22 is maintained at a predetermined opening degree during the predetermined time α .

[0083] By delaying the time to start the operation of the flow rate adjusting valve 22 by the predetermined time α after the operation of the hot water supply pump 19 is started, it is possible to prevent a temperature of hot/cold water supplied to the hot water supply terminal 17 from hunting.

[0084] If the hot water supply operation is not carried out for a long time after the last time hot water supply operation is completed, the hot water supply heat exchanger 18 is cooled. Therefore, a flow rate of hot water sent from the hot water tank 7 to the hot water supply heat exchanger 18 is maintained constant until a temperature of the hot water supply heat exchanger 18 is stabilized after the hot water supply operation is started, thereby preventing the temperature of hot water supplied to the hot water supply terminal 17 from hunting.

[0085] Next, an opening degree of the flow rate adjusting valve 22 during the hot water supply operation will be explained. The flow rate adjusting valve 22 during a normal hot water supply operation is controlled based on the temperature T1 detected by the temperature sensor 31. By setting the hot water supply set temperature Tk, the opening degree of the flow rate adjusting valve 22 is adjusted such that a temperature detected by the temperature sensor 31 becomes equal to the hot water supply set temperature Tk.

[0086] However, if a flow rate of hot/cold water sent from the water supply source to the hot water supply heat exchanger 18 is changed by operating the hot water supply terminal 17, a balance between high temperature water sent from the hot water tank 7 to the hot water supply heat exchanger 18 and low temperature water sent from the water supply source to the hot water supply heat exchanger 18 is lost, and hunting of a temperature of hot/cold water supplied to the hot water supply terminal 17 occurs.

[0087] Hence, in the embodiment, the opening degree of the flow rate adjusting valve 22 is determined in accordance with variation in the flow rate of hot/cold water detected by the flow rate sensor 33.

[0088] First, if hot/cold water comes out from the hot water supply terminal 17, the opening degree of the flow rate adjusting valve 22 is adjusted such that the temperature T1 detected by the temperature sensor 31 becomes equal to the hot water supply set temperature Tk. Then, the hot water supply terminal 17 is operated and if a flow rate detected by the flow rate sensor 33 is varied, a heat balance at the hot water supply heat exchanger 18 is lost.

[0089] Hence, several seconds are required until the temperature T1 detected by the temperature sensor 31 is varied after the flow rate of hot/cold water supplied to the hot water supply terminal 17 is varied, and if the opening degree of the flow rate adjusting valve 22 is controlled based on the temperature T1 detected by the temperature sensor 31, vertical hunting of the temperature of hot/cold water supplied to the hot water supply terminal 17 occurs.

[0090] Hence, in this embodiment, a flow rate Qa before predetermined time La is always stored, and a current flow rate Qo and the flow rate Qa before the predetermined time La are compared with each other. As a result of comparison between the flow rates, if the flow rate is increased more than a flow rate Qd, the opening degree of the flow rate adjusting valve 22 is driven to a target opening degree Pt irrespective of a value of the temperature T1 detected by the temperature sensor 31.

[0091] The target opening degree Pt is determined in accordance with the current flow rate Qo, the flow rate Qa before the predetermined time La and a current opening Pn of the flow rate adjusting valve 22. At that time, a fact that the current flow rate Qo is increased greater than the flow rate Qa before the predetermined time La means that an amount of hot/cold water to be supplied to the hot water supply terminal 17 is increased and thus, it is necessary to further supply high temperature water from the hot water tank 7 to the hot water supply heat exchanger 18. Therefore, the target opening degree Pt is increased more than the current opening Pn.

[0092] Next, the current flow rate Qo and the flow rate Qa before the predetermined time La are compared with each other, and if the flow rate is reduced more than the flow rate Qd, the opening degree of the flow rate adjusting valve 22 is driven to the target opening degree Pt irrespective of a value of the temperature T1 detected by the temperature sensor 31.

[0093] The target opening degree Pt is determined in accordance with the current flow rate Qo, the flow rate Qa before the predetermined time La and the current opening Pn of the flow rate adjusting valve 22. At that time, a fact that the current flow rate Qo is reduced larger than the flow rate Qa before the predetermined time La means that the amount of hot/cold water to be supplied to the hot water supply terminal 17 is reduced and thus, it is necessary to reduce the high temperature water to be supplied from the hot water tank 7 to the hot water supply heat exchanger 18. Therefore, the target opening degree Pt is closed more than the current opening Pn.

[0094] As described above, when a flow rate of hot/cold water to be supplied to the hot water supply terminal 17 is largely varied, the opening degree of the flow rate adjusting valve 22 is controlled to the target opening degree Pt irrespective of a value of the temperature T1 detected by the temperature sensor 31. According to this, it is possible to prevent a temperature of hot/cold water to be supplied to the hot water supply terminal 17 from hunting.

[0095] Even if the opening degree is varied from the current opening Pn to the target opening degree Pt, the temperature T1 detected by the temperature sensor 31 is largely overshoot in some cases. Hence, in this embodiment, when the temperature T1 detected by the temperature sensor 31 is higher than the hot water supply set temperature Tk by a predetermined temperature Ty (e.g., 3°C) or more, the opening degree of the flow rate adjusting valve 22 is reduced by a predetermined opening degree D.

[0096] This predetermined opening degree D is made different between a case where the current flow rate Q_0 detected by the flow rate sensor 33 is large and a case where the current flow rate Q_0 detected by the flow rate sensor 33 is small. That is, it is determined whether the current flow rate Q_0 is greater than a predetermined flow rate Q_b (e.g., 5L/min), and if the current flow rate Q_0 is greater than the predetermined flow rate Q_b , the opening degree of the flow rate adjusting valve 22 is reduced by a predetermined opening degree D_a , and if the current flow rate Q_0 is smaller than the predetermined flow rate Q_b , the opening degree of the flow rate adjusting valve 22 is further reduced by a predetermined opening degree D_b . At that time, there is a relation that the predetermined opening degree D_a is larger than the predetermined opening degree D_b ($D_a > D_b$).

[0097] A variation amount of a flow rate when the opening degree of the flow rate adjusting valve 22 is small and a variation amount of a flow rate when the opening degree of the flow rate adjusting valve 22 is large are different from each other. For example, a point M_a of a certain opening degree P_a which is a large flow rate is to be reduced by a flow rate Q_x , it is necessary to reduce the opening degree to a point M_b which is an opening degree P_b , but if attempt is made to reduce a point M_c of an opening degree P_c which is a small flow rate by the flow rate Q_x , it is only necessary to reduce the opening degree to a point M_d which is the opening degree P_d . That is, it can be found that as the flow rate is greater, the flow rate is not reduced unless the opening degree is reduced largely. Hence, in this embodiment, the predetermined opening degree D_a is set larger than the predetermined opening degree D_b ($D_a > D_b$), and as the current flow rate Q_0 is greater, the opening degree is reduced largely.

[0098] Since the flow rate adjusting valve 22 has such properties that as the opening degree is smaller, the flow rate is varied largely. Hence, control is performed such that a driving speed when the opening degree of the flow rate adjusting valve 22 is reduced by the predetermined opening degree D_a is faster than a driving speed when the opening degree of the flow rate adjusting valve 22 is reduced by the predetermined opening degree D_b .

[0099] As described above, the variation opening of the flow rate adjusting valve 22 is controlled in accordance with two kinds of predetermined opening degrees D_a and D_b depending upon whether the current flow rate Q_0 is greater than the predetermined flow rate Q_b or not, and the driving speed of the flow rate adjusting valve 22 is controlled in the different manner when the current flow rate Q_0 is large and when the current flow rate Q_0 is small. According to this, it is possible to perform control suitable for properties of the flow rate adjusting valve 22, and it is possible to further shorten the overshooting time. The predetermined temperature T_y , the predetermined flow rate Q_b , and the predetermined opening degrees D_a and D_b are one example, and the invention is not limited to the embodiment.

[0100] Next, an opening degree of the flow rate adjusting valve 22 when the hot water supply operation is stopped will be explained. First, since the heat exchanger hot water supply heat exchanger 18 keeps heat within predetermined time β (e.g., 10 minutes) after the hot water supply operation, the opening degree of the flow rate adjusting valve 22 at the time of completion of the hot water supply operation is maintained, and hot/cold water is supplied to the hot water supply terminal 17 at the same temperature as that at the time of the last time hot water supply operation when hot/cold water is again supplied from the hot water supply terminal 17.

[0101] However, after the predetermined time β after the hot water supply operation is completed, there is a possibility that the temperature of the hot water supply heat exchanger 18 is decreased or hot water in the hot water tank 7 is boiled. Therefore, there is a possibility that hunting of a temperature of hot/cold water supplied from the hot water supply heat exchanger 18 occurs when hot/cold water is supplied from the hot water supply terminal 17 next time, and high temperature hot/cold water is supplied to the hot water supply terminal 17.

[0102] An opening degree of the flow rate adjusting valve 22 after the hot water supply operation is completed will be explained.

[0103] It is determined whether an opening degree of the flow rate adjusting valve 22 when the hot water supply operation is completed after the predetermined time β after the hot water supply operation is completed is greater than a predetermined opening degree K_a . If the opening degree of the flow rate adjusting valve 22 is greater than the predetermined opening degree K_a , since there is a possibility that high temperature water is sent to the hot water supply terminal when the hot water supply operation is carried out next time, the opening degree of the flow rate adjusting valve 22 is driven to the predetermined opening degree K_a .

[0104] When the opening degree of the flow rate adjusting valve 22 is driven to the predetermined opening degree K_a , the opening degree is driven to the predetermined opening degree K_a after the flow rate adjusting valve 22 is fully closed and an original position is checked. By checking the original position, it is possible to keep the flow rate adjusting valve 22 with a precise opening degree, and it is possible to prevent high temperature water from being supplied to the hot water supply terminal 17 when the hot water supply operation is carried out next time.

[0105] If the opening degree of the flow rate adjusting valve 22 when the hot water supply operation is completed is smaller than the predetermined opening degree K_a , there is no possibility that high temperature water is sent to the hot water supply terminal when the hot water supply operation is carried out next time. Therefore, the opening degree of the flow rate adjusting valve 22 at the time of completion of the hot water supply operation is kept as it is to prepare for the next hot water supply operation.

[0106] As described above, by adjusting the opening degree of the flow rate adjusting valve 22 when the hot water

supply operation is not carried out, it is possible to prevent high temperature water from being sent to the hot water supply terminal 17 when the hot water supply operation is carried out next time. The predetermined opening degree K_a is set to such a value that a temperature of hot/cold water to be supplied does not exceed a predetermined temperature irrespective of a flow rate of hot/cold water supplied from the hot water supply terminal 17, and the predetermined opening degree K_a can appropriately be changed in accordance with a system of a user. The predetermined time α and the predetermined time β are one example, and the invention is not limited to the embodiment.

[0107] Next, a casing of the heat pump hydronic heater of the embodiment will be explained.

[0108] Fig. 2 is a diagram showing a configuration of an essential portion of an interior of the heater as viewed from a front surface of the casing of the embodiment. Fig. 3 is a diagram showing a configuration of an essential portion of the interior of the heater as viewed from one of sides of the casing. Fig. 4 is a diagram showing a configuration of an essential portion of the interior of the heater as viewed from the other side of the casing. Fig. 5 is a rear view of the casing.

[0109] A longitudinally long cylindrical tank is used as the hot water tank 7.

[0110] The hot water tank 7 is disposed in one of spaces in the casing 50 in its width direction, and the evaporator 4a, the blast fans 4b, the compressor 1, the water/refrigerant heat exchanger 2, the boiling pump 9, the hot water supply pump 19 and the heating pump 35 are disposed in the other space in the casing 50 in its width direction. It is preferable that two blast fans 4b are provided in the height direction. The compressor 1, the water/refrigerant heat exchanger 2, the boiling pump 9, the hot water supply pump 19 and the heating pump 35 are disposed at lower locations in the other space in the casing 50 in the width direction, and the evaporator 4a and the blast fans 4b are disposed at upper locations in the other space in the casing 50 in the width direction.

[0111] The expansion tank 37 is disposed at a location higher than the hot water tank 7. By disposing the expansion tank 37 at the location higher than the hot water tank 7, it is possible to increase an amount of water which can be accommodated in the expansion tank 37 with respect to an amount of water in the hot water tank circuit. It is preferable that the expansion tank 37 is disposed in a space above the hot water tank 7. The expansion tank 37 is covered with a heat insulator 38. Since high temperature water is introduced into the expansion tank 37, heat efficiency can be enhanced by reducing influence of air flow caused by the blast fan 4b and preventing heat radiation by the heat insulator 38.

[0112] The evaporator 4a is disposed such that it is opposed to a back surface and the other side surface of the casing 50.

[0113] One of front surfaces of the casing 50 in its width direction is closed, and the other front surface of the casing 50 in the width direction is formed as an air outlet for the blast fans 4b.

[0114] The intake connection port 51, the take-out connection port 52, the hot water outflow port 53 and the hot water inflow port 54 are disposed at lower locations of the back surface of the casing 50.

[0115] In this embodiment, by driving the boiling pump 9, water in the hot water tank 7 is introduced directly into the water/refrigerant heat exchanger 2, hot water produced by the water/refrigerant heat exchanger 2 is returned to the hot water tank 7, thereby heating hot/cold water in the hot water tank 7, hot/cold water in the hot water tank 7 is introduced directly into the heating terminal 34 by driving the heating pump 35, hot water which dissipated heat at the heating terminal 34 is returned into the hot water tank 7. Alternatively, hot water produced by the water/refrigerant heat exchanger 2 may be introduced directly into the heating terminal 34, or water in the hot water tank 7 may be heated by hot water produced by the water/refrigerant heat exchanger 2.

[0116] According to the embodiment, the interior of the one casing 50 can be divided the space where air flows and heat exchange is carried out and the space where heat radiation is prevented. Since the intake connection port 51, the take-out connection port 52, the hot water outflow port 53 and the hot water inflow port 54 are disposed at the lower locations of the back surface, the casing 50 can be disposed along a wall surface of a building, a length of a pipe which connects the casing 50 and an interior of a room to each other can be shortened and thus, it is possible to prevent freezing in winter.

[Industrial Applicability]

[0117] The present invention provides a heat pump hydronic heater suitable for hard water and cold area.

[Explanation of Symbols]

[0118]

1	compressor
2	water/refrigerant heat exchanger
3	decompressor
4a	evaporator
4b	blast fan
5	four-way valve

	6	refrigerant pipe
	7	hot water tank
	8	partition plate
	9	boiling pump
5	10	water outlet
	11	hot water port
	12a, b	temperature sensor
	13	flow switch
	14	over pressure relief valve
10	15a	upper heater
	15b	lower heater
	16a, 16b, 16c, 16d	temperature sensor
	17	hot water supply terminal
	18	hot water supply heat exchanger
15	19	hot water supply pump
	20	hot water-outflow port
	21	water-inflow port
	22	flow rate adjusting valve
	23	check valve
20	24	over pressure relief valve
	25	waste plug
	26	water supply pipe
	27	three-way valve
	28	over pressure relief valve
25	29	over pressure relief valve
	30	hot water supply pipe
	31	temperature sensor
	32	auxiliary temperature sensor
	33	flow rate sensor
30	34	heating terminal
	35	heating pump
	36	hot water take-out port
	37	expansion tank
	50	casing
35	51	intake connection port
	52	take-out connection port
	53	hot water outflow port
	54	hot water inflow port

40

Claims

1. A heat pump hydronic heater comprising a heat pump circuit and a hot water tank circuit, in which the heat pump circuit includes a compressor (1) which compresses a refrigerant and discharges a high temperature refrigerant, a water/refrigerant heat exchanger (2) which exchanges heat between water and a high temperature refrigerant to produce hot water, a decompressor (3) which decompresses a refrigerant, and an evaporator (4a) which exchanges heat between air and a refrigerant, the hot water tank circuit includes a boiling circuit and a heating circuit, in the boiling circuit, hot/cold water in a hot water tank (7) is heated by the water/refrigerant heat exchanger (2), in the heating circuit, the hot water produced by the water/refrigerant heat exchanger (2) is introduced directly into a heating terminal (34) or introduced to the heating terminal (34) through the hot water tank (7), and the hot water is made to dissipate heat by the heating terminal (34), and the heat pump circuit and the hot water tank circuit are accommodated in one casing (50), wherein a longitudinally long cylindrical tank is used as the hot water tank (7), wherein the evaporator (4a) is provided with a blast fan (4b) to send air, and wherein the hot water tank (7) is disposed in one of spaces in the casing (50) in its width direction, **characterized in that** a hermetic expansion tank (37) is connected to the hot water tank (7) wherein the evaporator (4a) and the blast fan (4b) are disposed in the other space in the casing (50) in the width

direction, and

wherein the expansion tank (37) is disposed at a location higher than the hot water tank (7).

2. The heat pump hydronic heater according to claim 1, wherein
the expansion tank (37) is disposed in a space above the hot water tank (7), and the expansion tank (37) is covered with a heat insulator.
3. The heat pump hydronic heater according to claim 1 or 2, wherein
the hot water tank circuit includes a hot water supply circuit,
in the boiling circuit, a boiling pump (9) is driven, thereby introducing water in the hot water tank (7) to the water/refrigerant heat exchanger (2), and hot water produced by the water/refrigerant heat exchanger (2) is returned to the hot water tank (7),
in the hot water supply circuit, a hot water supply pump (19) is driven, thereby introducing hot water in the hot water tank (7) to a hot water supply heat exchanger (18), and the hot water which exchanged heat with respect to hot water-to-be-supplied flowing through a hot water supply pipe (30) by the hot water supply heat exchanger (18) is returned to the hot water tank (7),
in the heating circuit, a heating pump (35) is driven, thereby introducing the hot water in the hot water tank (7) to the heating terminal (34), and the hot water which dissipated heat at the heating terminal (34) is returned to the hot water tank (7),
the casing (50) includes an intake connection port (51) through which the hot water-to-be-supplied is supplied to the hot water supply heat exchanger (18),
a take-out connection port (52) through which the hot water-to-be-supplied heated by a hot water supply heat exchanger (18) is introduced to a hot water supply terminal (17),
a hot water outflow port (53) through which the hot water is supplied to the heating terminal (34), and
a hot water inflow port (54) through which the hot water from the heating terminal (34) is returned to the hot water tank (7),
the evaporator (4a) is disposed such that it is opposed to a back surface and the other side surface of the casing (50), one of front surface of the casing (50) in the width direction is closed,
an other front surface of the casing (50) in the width direction is formed as an air outlet for the blast fan (4b), and
the intake connection port (51), the take-out connection port (52), the hot water outflow port (53) and the hot water inflow port (54) are disposed in lower portions of the back surface of the casing (50).
4. The heat pump hydronic heater according to claim 3, wherein
the hot water tank (7) includes a partition plate (8) which partitions an interior of the hot water tank (7) into an upper space and a lower space,
an upper heater (15a) disposed in the upper space, and
a lower heater (15b) disposed in the lower space,
in the boiling circuit, the hot water produced by the water/refrigerant heat exchanger (2) is returned to the lower space,
in the hot water supply circuit, the hot water in the upper space is introduced to the hot water supply heat exchanger (18), and
in the heating circuit, the hot water in the lower space is introduced to the heating terminal (34).
5. The heat pump hydronic heater according to any one of claims 1 to 4, wherein R407C is used as the refrigerant.
6. The heat pump hydronic heater according to any one of claims 1 to 5, wherein the back surface of the casing (50) is adapted to be attached to a wall surface of a building, and the casing (50) is disposed out of doors.

Patentansprüche

1. Wärmepumpenhydronikheizvorrichtung umfassend einen Wärmepumpenkreislauf und einen Warmwassertankkreislauf, in dem
der Wärmepumpenkreislauf einen Kompressor (1) umfasst, der ein Kühlmittel komprimiert und ein Hochtemperaturkühlmittel ausgibt, ein Wasser/Kühlmittelwärmetauscher (2), der Wärme zwischen Wasser und einem Hochtemperaturkühlmittel austauscht, um Warmwasser zu produzieren, einen Dekompressor (3), der ein Kühlmittel dekomprimiert, und einen Verdampfer (4a), der Wärme zwischen Luft und einem Kühlmittel austauscht,
der Warmwassertankkreislauf einen Siedekreislauf und einen Heizkreislauf umfasst,
wobei in dem Siedekreislauf warmes/kaltes Wasser in einem Warmwassertank (7) durch den Wasser/Kühlmittel-

wärmetauscher (2) erhitzt wird,

wobei in dem Heizkreislauf das warme Wasser, welches durch den Wasser/Kühlmittelwärmetauscher (2) produziert wurde, direkt in eine Heizungsendvorrichtung (34) eingeführt oder durch den Warmwassertank (7) in die Heizungs-
 5 endvorrichtung (34) eingeführt wird, und das warme Wasser dazu gebracht wird, durch die Heizungsendvorrichtung (34) Wärme abzugeben, und

der Wärmepumpenkreislauf und der Warmwassertankkreislauf in einem Gehäuse (50) untergebracht sind, wobei ein longitudinal langer zylindrischer Tank als der Warmwassertank (7) benutzt wird,

wobei der Verdampfer (4a) mit einem Luftgebläse (4b) zum Überbringen von Luft ausgestattet ist, und

wobei der Warmwassertank (7) in einem der Räume in dem Gehäuse (50) in seiner Breitenrichtung angeordnet ist,
 10 **dadurch gekennzeichnet, dass** ein hermetischer Expansionstank (37) mit dem Warmwassertank (7) verbunden ist, wobei der Verdampfer (4a) und das Luftgebläse (4b) in dem anderen Raum in dem Gehäuse (50) in der Breitenrichtung angeordnet sind, und

wobei der Expansionstank (37) an einer höheren Stelle als der Warmwassertank (7) angeordnet ist.

- 15 2. Wärmepumpenhydronikheizvorrichtung nach Anspruch 1, wobei der Expansionstank (37) in einem Raum oberhalb des Warmwassertanks (7) angeordnet ist, und der Expansionstank (37) mit einem Wärmeisolator bedeckt ist.

3. Wärmepumpenhydronikheizvorrichtung nach Anspruch 1 oder 2, wobei der Warmwassertankkreislauf einen Warmwasserversorgungskreislauf beinhaltet,

20 wobei in dem Siedekreislauf eine Siedepumpe (9) betrieben wird, wodurch Wasser aus dem Warmwassertank (7) in den Wasser/Kühlmittelwärmetauscher (2) eingebracht wird, und Warmwasser, das durch den Wasser/Kühlmittelwärmetauscher (2) produziert wurde, in den Warmwassertank (7) zurückgeführt wird,

wobei in dem Warmwasserversorgungskreislauf eine Warmwasserversorgungspumpe (19) betrieben wird, wodurch Warmwasser aus dem Warmwassertank (7) in einen Warmwasserversorgungs-Wärmetauscher (18) eingebracht
 25 wird, und das Warmwasser, das Wärme im Hinblick auf bereitzustellendes Warmwasser, das durch ein Warmwasserversorgungsrohr (30) fließt, durch den Warmwasserversorgungs-Wärmetauscher (18) ausgetauscht hat, an den Warmwassertank (7) zurückgeführt wird,

wobei in dem Heizkreislauf eine Heizungspumpe (35) betrieben wird, wodurch das Warmwasser aus dem Warmwassertank (7) in die Heizungsendvorrichtung (34) eingeführt wird, und das Warmwasser, welches Wärme an die
 30 Heizungsendvorrichtung (34) abgegeben hat, in den Warmwassertank (7) zurückgeführt wird,

wobei das Gehäuse (50) einen Zulaufverbindungsanschluss (51) umfasst, durch den das bereitzustellende Warmwasser an den Warmwasserversorgungswärmetauscher (18) bereitgestellt wird,

einen Entnahmeverbindungsanschluss (52) umfasst, durch den das bereitzustellende Warmwasser, welches von einem Warmwasserversorgungswärmetauscher (18) erwärmt wurde, in eine Warmwasserversorgungsendvorrichtung (17) eingeführt wird,
 35 einen Warmwasserausflussanschluss (53) umfasst, durch den das Warmwasser an die Heizungsendvorrichtung (34) geliefert wird, und einen Warmwassereinlaufanschluss (54) umfasst, durch den das Warmwasser von der Heizungsendvorrichtung (34) an den Warmwassertank (7) zurückgeführt wird,

wobei der Verdampfer (4a) so angeordnet ist, dass er gegenüber einer rückwärtigen Fläche und der anderen
 40 Seitenfläche des Gehäuses (50) angeordnet ist,

eine der Frontseiten des Gehäuses (50) in der Breitenrichtung geschlossen ist,
 eine andere Frontseite des Gehäuses (50) in der Breitenrichtung als ein Luftauslass für das Luftgebläse (4b) ausgebildet ist, und

der Zulaufverbindungsanschluss (51), der Entnahmeverbindungsanschluss (52), der Warmwasserauslaufanschluss (53) und der Warmwassereinlaufanschluss (54) in niedrigeren Teilen der rückwärtigen Fläche des Gehäuses (50)
 45 angeordnet sind.

4. Wärmepumpenhydronikheizvorrichtung nach Anspruch 3, wobei der Warmwassertank (7) eine Unterteilungsplatte (8) umfasst, die einen Innenraum des Warmwassertanks (7) in
 50 einen oberen Raum und einen unteren Raum unterteilt,

eine obere Heizvorrichtung (15a) in dem oberen Raum angeordnet ist, und eine untere Heizvorrichtung (15b) in dem unteren Raum angeordnet ist, in dem Siedekreislauf das Warmwasser, welches durch den Wasser/Kühlmittelwärmetauscher (2) produziert wurde, zu dem unteren Raum zurückgeführt wird,

in dem Warmwasserversorgungskreislauf das Warmwasser des oberen Raumes in den Warmwasserversorgungswärmetauscher (18) eingeführt wird, und
 55 in dem Heizkreislauf das Warmwasser aus dem unteren Raum in die Heizungsendvorrichtung (34) eingeleitet wird.

5. Wärmepumpenhydronikheizvorrichtung nach einem der Ansprüche 1 bis 4,

wobei R407C als Kühlmittel benutzt wird.

6. Wärmepumpenhydronikheizvorrichtung nach einem der Ansprüche 1 bis 5,
wobei die rückwärtige Fläche des Gehäuses (50) ausgebildet ist, an eine Wandfläche eines Gebäudes angebracht zu werden, und das Gehäuse (50) im Freien angebracht ist.

Revendications

1. Appareil de chauffage hydronique à pompe à chaleur comprenant un circuit de pompe à chaleur et un circuit de réservoir d'eau chaude, dans lequel
le circuit de pompe à chaleur comprend un compresseur (1) qui comprime un réfrigérant et fournit un réfrigérant à haute température, un échangeur de chaleur eau/réfrigérant (2) qui échange de la chaleur entre de l'eau et un réfrigérant à haute température pour produire de l'eau chaude, un décompresseur (3) qui décomprime un réfrigérant, et un évaporateur (4a) qui échange de la chaleur entre de l'air et un réfrigérant,
le circuit de réservoir d'eau chaude comprend un circuit d'ébullition et un circuit de chauffage, dans ledit circuit d'ébullition, de l'eau chaude/froide dans un réservoir d'eau chaude (7) est chauffée par ledit échangeur de chaleur eau/réfrigérant (2), dans ledit circuit de chauffage, l'eau chaude produite par l'échangeur de chaleur eau/réfrigérant (2) est introduite directement dans un terminal de chauffage (34) ou est introduite à travers le réservoir d'eau chaude (7) dans le terminal de chauffage (34), et l'eau chaude est amenée à dissiper de la chaleur par le terminal de chauffage (34), et
le circuit de pompe à chaleur et le circuit de réservoir d'eau chaude sont logés à l'intérieur d'un boîtier (50), dans lequel un réservoir cylindrique longitudinalement long est utilisé en tant que réservoir d'eau chaude (7), dans lequel ledit évaporateur (4a) est muni d'un ventilateur d'air (4b) destiné à envoyer de l'air, et dans lequel le réservoir d'eau chaude (7) est disposé dans l'un des espaces dans ledit boîtier (50) dans sa direction de largeur,
caractérisé par le fait qu'un réservoir hermétique d'expansion (37) est relié au réservoir d'eau chaude (7), dans lequel ledit évaporateur (4a) et ledit ventilateur d'air (4b) sont disposés dans l'autre espace dans le boîtier (50) dans la direction de largeur, et dans lequel ledit réservoir d'expansion (37) est disposé sur un emplacement plus haut que le réservoir d'eau chaude (7).
2. Appareil de chauffage hydronique à pompe à chaleur selon la revendication 1, dans lequel le réservoir d'expansion (37) est disposé dans un espace situé au-dessus du réservoir d'eau chaude (7), et ledit réservoir d'expansion (37) est couvert d'un isolant thermique.
3. Appareil de chauffage hydronique à pompe à chaleur selon la revendication 1 ou 2, dans lequel ledit circuit de réservoir d'eau chaude comprend un circuit d'alimentation en eau chaude, dans ledit circuit d'ébullition est opérée une pompe d'ébullition (9) ce par quoi de l'eau est introduite depuis le réservoir d'eau chaude (7) dans ledit échangeur de chaleur eau/réfrigérant (2), et de l'eau chaude produite par l'échangeur de chaleur eau/réfrigérant (2) est renvoyé vers le réservoir d'eau chaude (7), dans le circuit d'alimentation en eau chaude est opérée une pompe d'alimentation en eau chaude (19) ce par quoi de l'eau chaude est introduite depuis le réservoir d'eau chaude (7) dans un échangeur de chaleur d'alimentation en eau chaude (18), et l'eau chaude qui a échangé de la chaleur par rapport à de l'eau chaude à fournir qui circule à travers un tuyau d'alimentation en eau chaude (30), par l'échangeur de chaleur d'alimentation en eau chaude (18), est renvoyée vers le réservoir d'eau chaude (7), dans le circuit de chauffage est opérée une pompe de chauffage (35) ce par quoi l'eau chaude est introduite depuis le réservoir d'eau chaude (7) dans le terminal de chauffage (34), et l'eau chaude qui a cédé de la chaleur au terminal de chauffage (34) est renvoyée vers le réservoir d'eau chaude (7), le boîtier (50) comporte un raccord de connexion d'amenée (51) à travers lequel l'eau chaude à fournir est fournie à l'échangeur de chaleur d'alimentation en eau chaude (18), un raccord de connexion de prise (52) à travers lequel l'eau chaude à fournir chauffée par un échangeur de chaleur d'alimentation en eau chaude (18) est introduite dans un terminal d'alimentation en eau chaude (17), un raccord d'écoulement d'eau chaude (53) à travers lequel l'eau chaude est fournie au terminal de chauffage (34), et un raccord d'entrée d'eau chaude (54) à travers lequel l'eau chaude est renvoyée depuis le terminal de chauffage (34) vers le réservoir d'eau chaude (7), ledit évaporateur (4a) est disposé de telle façon qu'il est opposé à une surface arrière et l'autre surface latérale du boîtier (50),

l'une des surfaces avant du boîtier (50) dans la direction de largeur est fermée,
une autre surface avant du boîtier (50) dans la direction de largeur est formée comme une sortie d'air pour le ventilateur d'air (4b), et
ledit raccord de connexion d'amenée (51), ledit raccord de connexion de prise (52), ledit raccord d'écoulement d'eau chaude (53) et ledit raccord d'entrée d'eau chaude (54) sont disposés dans des parties plus basses de la surface arrière du boîtier (50).

4. Appareil de chauffage hydronique à pompe à chaleur selon la revendication 3, dans lequel le réservoir d'eau chaude (7) comprend une plaque de division (8) qui divise un intérieur du réservoir d'eau chaude (7) en un espace supérieur et en un espace inférieur, un dispositif de chauffage supérieur (15a) est disposé dans l'espace supérieur, et un dispositif de chauffage inférieur (15b) est disposé dans l'espace inférieur, dans le circuit d'ébullition, l'eau chaude produite par l'échangeur de chaleur eau/réfrigérant (2) est renvoyée vers l'espace inférieur, dans le circuit d'alimentation en eau chaude, l'eau chaude de l'espace supérieur est introduite dans l'échangeur de chaleur d'alimentation en eau chaude (18), et, dans le circuit de chauffage, l'eau chaude de l'espace inférieur est introduite dans le terminal de chauffage (34).
5. Appareil de chauffage hydronique à pompe à chaleur selon l'une quelconque des revendications 1 à 4, dans lequel on utilise le R407C en tant que réfrigérant.
6. Appareil de chauffage hydronique à pompe à chaleur selon l'une quelconque des revendications 1 à 5, dans lequel la surface arrière du boîtier (50) est adaptée pour être montée sur une surface de paroi d'un bâtiment et ledit boîtier (50) est disposé en plein air.

FIG. 1

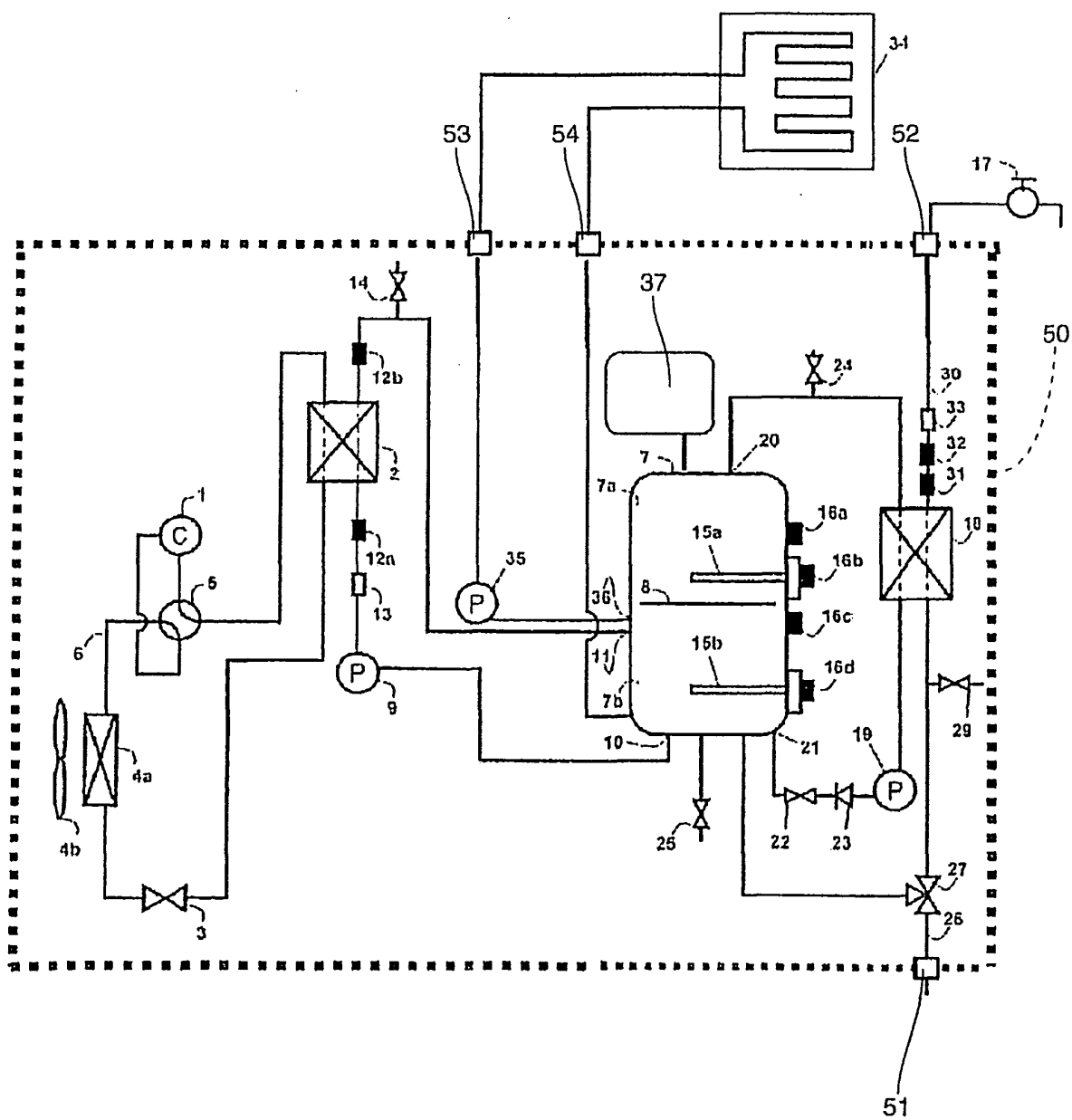


FIG. 2

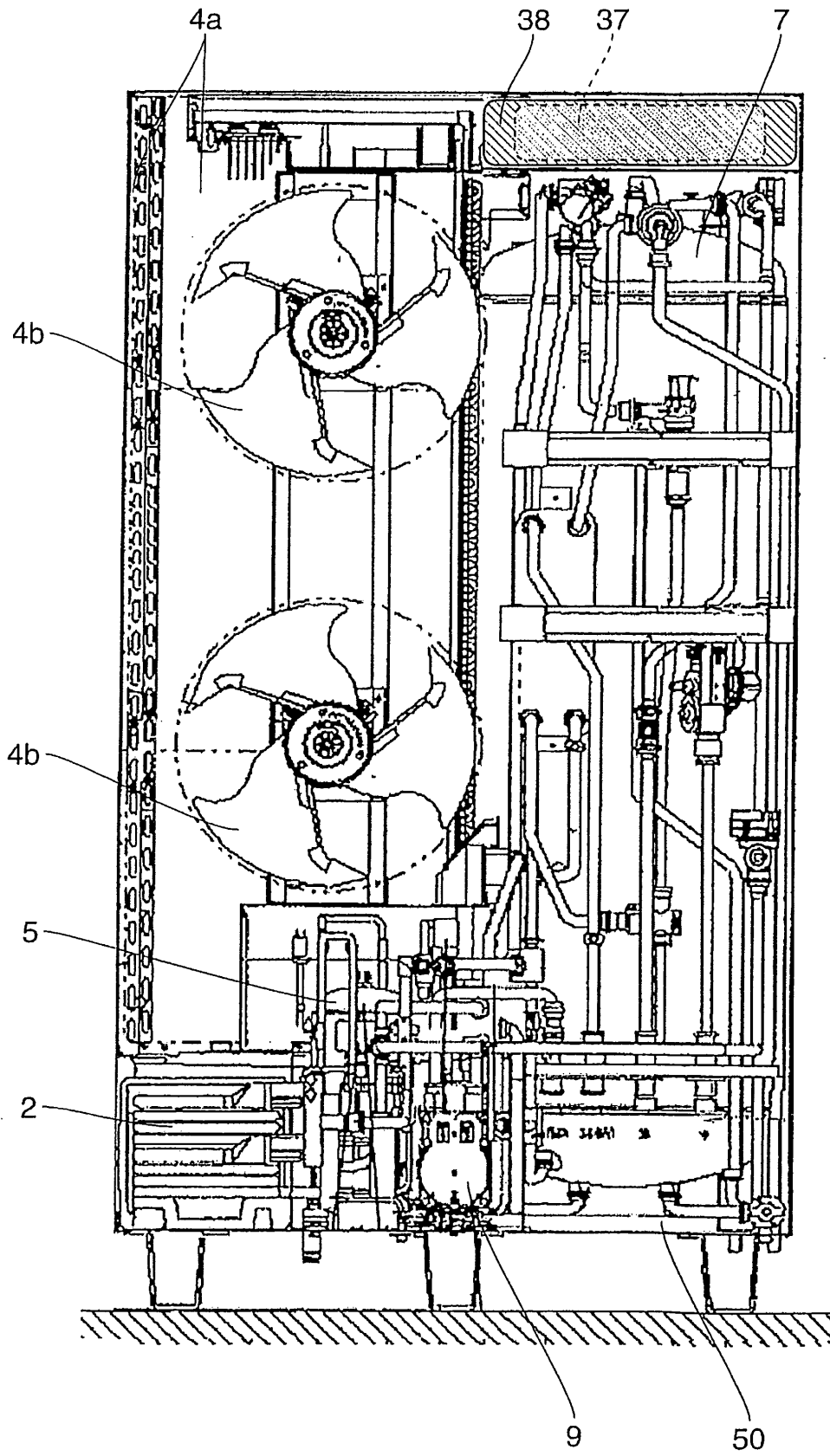


FIG. 3

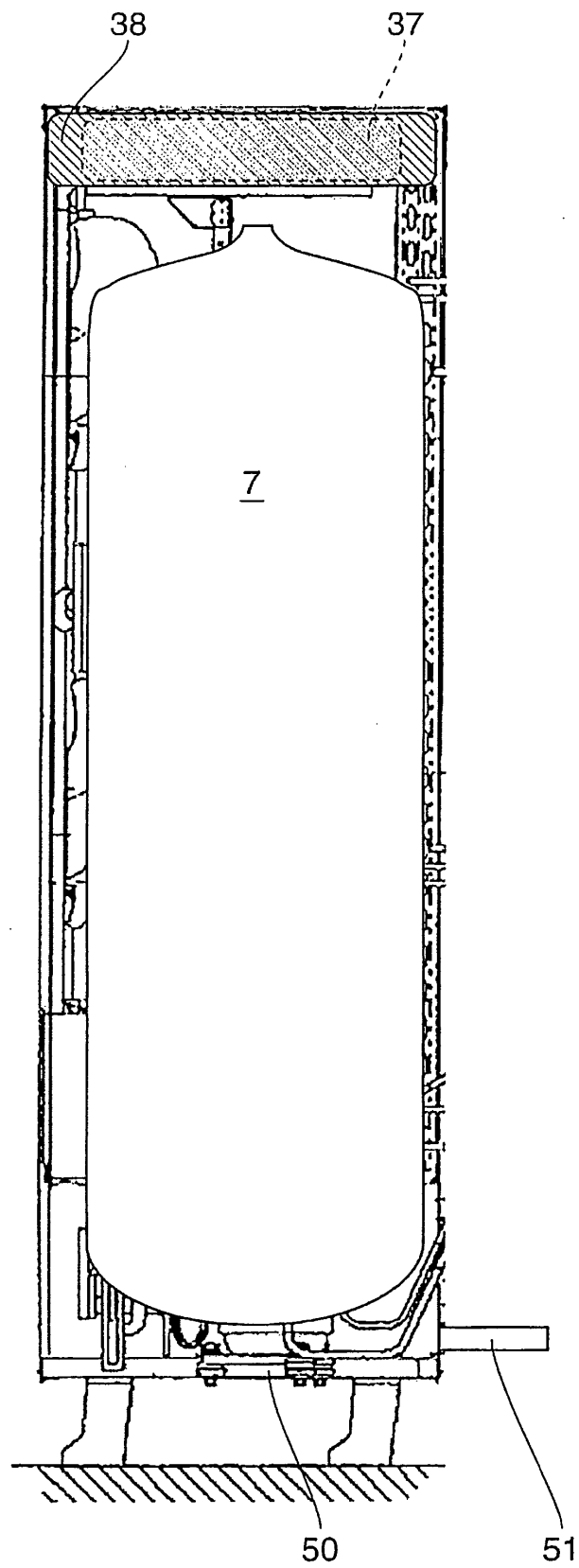


FIG. 4

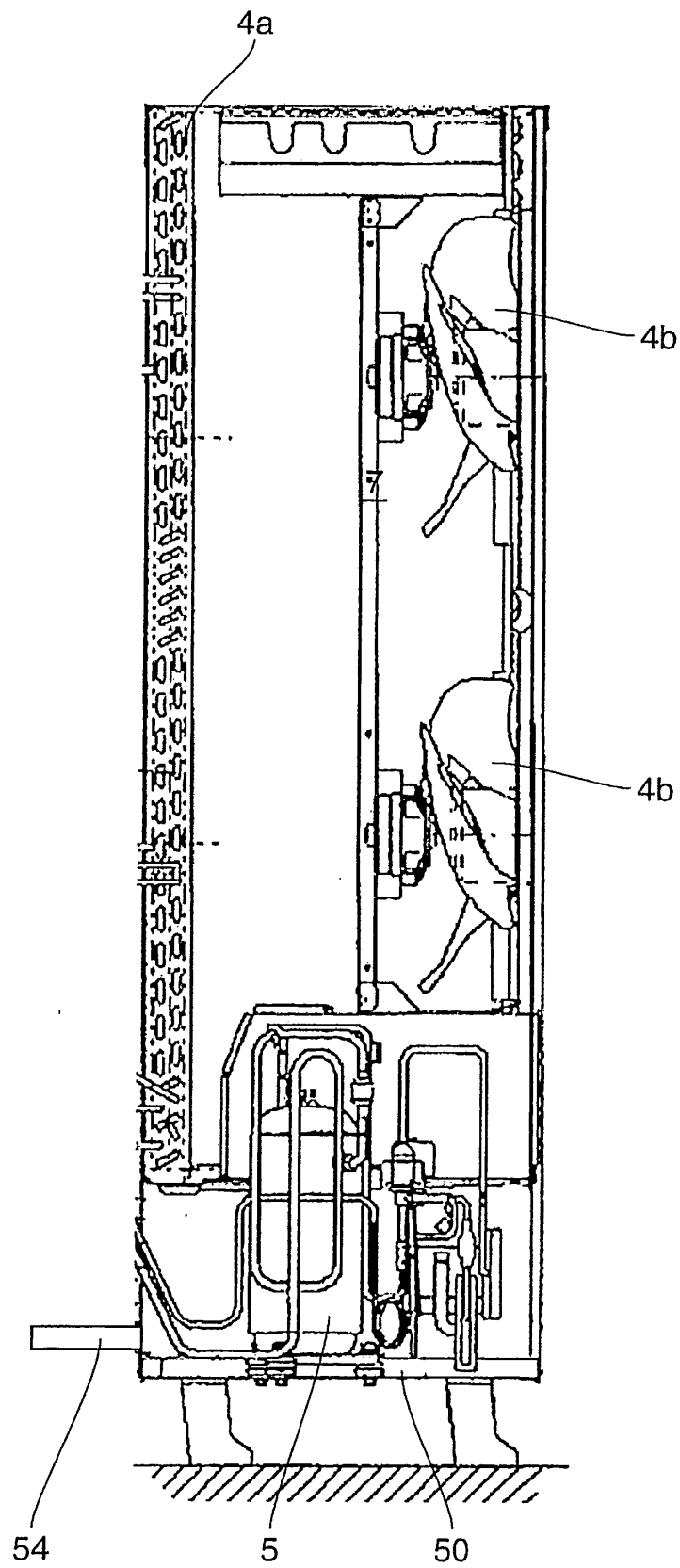
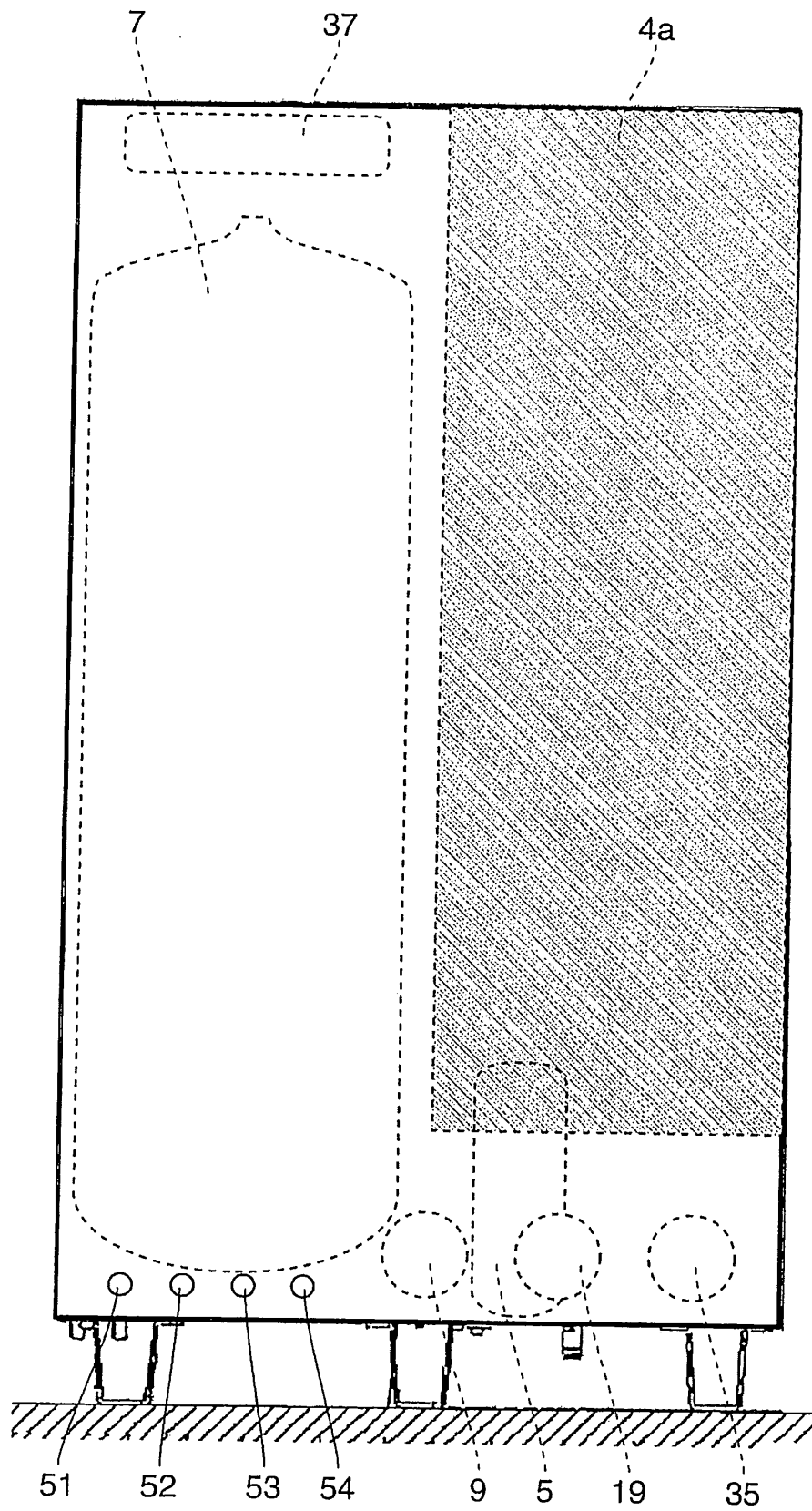


FIG. 5



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2008039305 A [0006]
- JP 2003404907 A [0006]
- JP 2007155257 A [0006]
- WO 2011025374 A1 [0006]