(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 693 670 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
03.04.2024 Bulletin 2024/14

(21) Application number: **20155785.7**

(22) Date of filing: **06.02.2020**

(51) International Patent Classification (IPC):
F24D 3/08 *(2006.01)* ***F24D 11/02*** *(2006.01)*
F24D 15/04 *(2006.01)* ***F24D 17/02*** *(2006.01)*
F24D 19/00 *(2006.01)* ***F24D 19/10*** *(2006.01)*
F24H 4/04 *(2006.01)* ***F24H 9/12*** *(2022.01)*
F24H 9/02 *(2006.01)* ***F24F 1/0007*** *(2019.01)*
F24F 1/32 *(2011.01)* ***F24F 13/20*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F24D 15/04; F24D 19/0097; F24H 4/04; F24H 9/02; F24H 9/13; F24D 2200/12; F24F 1/32; F24F 3/001; F24F 5/0096

(54) **HEAT PUMP SYSTEM**

WÄRMEPUMPENSYSTEM

SYSTÈME DE POMPE À CHALEUR

(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: **08.02.2019 JP 2019021111**

(43) Date of publication of application:
12.08.2020 Bulletin 2020/33

(73) Proprietor: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

(72) Inventors:
- **TERAKADO, Yuki**
  Osaka, 540-6207 (JP)
- **MIYOSHI, Dai**
  Osaka, 540-6207 (JP)

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

(56) References cited:
EP-A1- 1 906 107
EP-A1- 2 933 580
EP-A1- 3 059 509
EP-A1- 3 076 100
EP-A1- 3 260 785
EP-A1- 3 361 172
WO-A1-2018/150253
DE-U1- 20 304 068
JP-A- 2007 040 661

EP 3 693 670 B1

Description

[TECHNICAL FIELD]

[0001] The present invention relates to a heat pump system for producing hot water using a heat pump cycle.

[BACKGROUND TECHNIQUE]

[0002] Conventionally, according to a configuration of the heat pump system of this kind, a heat pump unit is placed on a ceiling surface of a hot water tank unit having a hot water tank.

[0003] The ceiling surface of the hot water tank unit is provided with two pipe-connecting portions projecting from an outer surface thereof. A casing of the heat pump unit is also provided with two pipe-connecting portions projecting from an outer surface thereof.

[0004] The hot water tank unit and the heat pump unit have such a configuration that water circulates through a hot water unit and the heat pump unit by connecting these two pipe-connecting portions to each other through two pipes.

[0005] Patent Document 2 discloses a hot water generator which comprises, inter alia, a heat pump device, a compressor, a water-refrigerant heat exchanger, a decompressor and an evaporator, a heat medium path through which heat medium heated by the water-refrigerant heat exchanger flows, a hot water tank in which heat medium or hot water heated by the heat medium is stored, and a casing in which at least the water-refrigerant heat exchanger, the heat medium path, the hot water tank, an overpressure relief valve and an air vent valve are accommodated. The casing is provided with an operating portion cover which can open and close, or can attach and detach. The overpressure relief valve and the air vent valve are placed on an inner side of the operating portion cover.

[0006] Moreover, Patent Document 3 refers to a heat source unit which includes a compressor, an electronic expansion valve, a heat-source side heat exchanger, an outdoor blower, and a controller for electric devices. A hydrothermal exchange unit accommodates water heat exchangers, water pipes, pumps and a controller. The hydrothermal exchange unit has a housing. The front, rear, upper, left and right sides of the housing are covered with panels. A bottom plate for the housing is disposed predetermined distance above the lower end of the housing. The housing accommodates the hydrothermal exchange unit, and a space below the bottom plate of the housing accommodates connectors for the water pipes and refrigerant pipes.

[PRIOR ART DOCUMENTS]

[PATENT DOCUMENTS]

[0007]

[Patent Document 1] Japanese Patent Application Laid-open No. 2011-122752
[Patent Document 2] European Patent Application Laid-open No. 2 933 580
[Patent Document 3] European Patent Application Laid-open No. 1 906 107

[SUMMARY OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

[0008] According to the conventional configuration, however, since the pipe-connecting portions project from the ceiling surface of the hot water tank unit, a connecting portion which connects a pipe to the former pipe or a product can easily be seen from a user and therefore, there is a problem that outward appearance of the product is deteriorated.

[0009] The present invention solves the conventional problem and it is an object of the invention to provide a heat pump system which enhances outward appearance by placing a connecting portion which connects a pipe to a product or at least a portion of a pipe which is connected to the connecting portion in a place where a user cannot usually keep an eye on.

[MEANS FOR SOLVING THE PROBLEM]

[0010] To solve the conventional problem, the present invention provides a heat pump system including: a heat pump unit where a compressor, a decompressor and an evaporator are placed; a hot water unit where at least a water-refrigerant heat exchanger is placed; a first refrigerant pipe through which refrigerant compressed by the compressor flows toward the water-refrigerant heat exchanger; and a second refrigerant pipe through which the refrigerant after it releases heat in the water-refrigerant heat exchanger flows toward the decompressor, in which the first refrigerant pipe and the second refrigerant pipe connect the heat pump unit and the hot water unit to each other, wherein a casing which forms the hot water unit includes a recess which is recessed in a deeper direction than standing surfaces and in a lower direction than a ceiling surface, and a first connecting portion which connects the hot water unit and the first refrigerant pipe to each other and a second connecting portion which connects the hot water unit and the second refrigerant pipe to each other are placed in the recess.

[0011] According to this, the casing which forms the hot water unit includes the recess which is recessed in the deeper direction than the standing surface and in the lower direction than the ceiling surface, and the first connecting portion which connects the hot water unit and the first refrigerant pipe to each other and the second connecting portion which connects the hot water unit and the second refrigerant pipe to each other are placed in the recess. Therefore, since the first connecting portion and the second connecting portion are located in a place

where a user cannot usually keep an eye on, it is possible to provide a heat pump system which enhances the outward appearance.

[0012] A portion of the first refrigerant pipe which is connected to the first connecting portion and a portion of the second refrigerant pipe which is connected to the second connecting portion are also placed in the recess. Therefore, since these portions are located in a place where a user cannot usually keep an eye on, it is possible to provide a heat pump system which enhances the outward appearance.

[EFFECT OF THE INVENTION]

[0013] According to the present invention, a connecting portion which connects a pipe to a produce and at least a portion of a pipe connected to the connecting portion are located in place where a user cannot usually keep an eye on. Therefore, it is possible to provide a heat pump system which enhances the outward appearance.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0014]

Fig. 1 is a circuit diagram of a heat pump system in an embodiment of the present invention;
Fig. 2 is a diagram showing a connection configuration of the heat pump system;
Fig. 3 is a perspective view of a ceiling surface of a hot water unit of the heat pump system; and
Fig. 4 is a side view of the hot water unit of the heat pump system.

[MODE FOR CARRYING OUT THE INVENTION]

[0015] A first aspect of the present invention provides a heat pump system including: a heat pump unit where a compressor, a decompressor and an evaporator are placed; a hot water unit where at least a water-refrigerant heat exchanger is placed; a first refrigerant pipe through which refrigerant compressed by the compressor flows toward the water-refrigerant heat exchanger; and a second refrigerant pipe through which the refrigerant after it releases heat in the water-refrigerant heat exchanger flows toward the decompressor, in which the first refrigerant pipe and the second refrigerant pipe connect the heat pump unit and the hot water unit to each other, wherein a casing which forms the hot water unit includes a recess which is recessed in a deeper direction than standing surfaces and in a lower direction than a ceiling surface, and a first connecting portion which connects the hot water unit and the first refrigerant pipe to each other and a second connecting portion which connects the hot water unit and the second refrigerant pipe to each other are placed in the recess.

[0016] According to this, the casing which forms the hot water unit includes the recess which is recessed in the deeper direction than the standing surface and in the lower direction than the ceiling surface, and the first connecting portion which connects the hot water unit and the first refrigerant pipe to each other and the second connecting portion which connects the hot water unit and the second refrigerant pipe to each other are placed in the recess. Therefore, since the first connecting portion and the second connecting portion are located in a place where a user cannot usually keep an eye on, it is possible to provide a heat pump system which enhances the outward appearance.

[0017] A portion of the first refrigerant pipe which is connected to the first connecting portion and a portion of the second refrigerant pipe which is connected to the second connecting portion are also placed in the recess. Therefore, since these portions are located in a place where a user cannot usually keep an eye on, it is possible to provide a heat pump system which enhances the outward appearance.

[0018] According to a second aspect of the invention, in the first aspect, longitudinal directions of the first connecting portion and the second connecting portion are placed substantially in a horizontal direction.

[0019] According to this, operations to connect the first connecting portion and the first refrigerant pipe to each other and connect the second connecting portion and the second refrigerant pipe to each other become easy, and it is possible to enhance operation efficiency of an operation to connect the hot water unit and the refrigerant pipe to each other. Further, it is possible to reduce a height of the recess, and an interior content of the hot water unit can be increased.

[0020] According to a third aspect of the invention, in any of the first and second aspects, the recess opens toward a rear surface of the casing.

[0021] According to this, the first refrigerant pipe which is connected to the first connecting portion of the hot water unit and the second refrigerant pipe which is connected to the second connecting portion of the hot water unit can be placed behind a rear surface of the casing of the hot water unit through the opening.

[0022] Therefore, the first connecting portion and the second connecting portion which are provided in the hot water unit, as well as the first refrigerant pipe and the second refrigerant pipe which are respectively connected to the first connecting portion and the second connecting portion are also located in the place where a user cannot usually keep an eye on. Therefore, it is possible to provide the heat pump system which further enhances the outward appearance.

[0023] According to a fourth aspect of the invention, in any one of the first to third aspects, a hot water tank is placed in the hot water unit.

[0024] According to this, it is possible to provide a heat pump system capable of supplying hot water from the hot water tank.

[0025] According to a fifth aspect of the invention, in any one of the first to fourth aspects, the refrigerant is

combustible refrigerant.

[0026] According to this, the refrigerant is the combustible refrigerant having density larger than air under atmospheric pressure. The first connecting portion which connects the hot water unit and the first refrigerant pipe to each other and the second connecting portion which connects the hot water unit and the second refrigerant pipe to each other are provided on the side of the ceiling surface of the hot water unit.

[0027] Therefore, even if the combustible refrigerant leaks from the first connecting portion or the second connecting portion, the combustible refrigerant diffuses vertically downward centering around the hot water unit. At that time, since its density is also diluted, a possibility of inflammability can be lowered.

[0028] An embodiment of the present invention will be described below with reference to the drawings. The invention is not limited to the embodiment.

(Embodiment)

[0029] Fig. 1 is a circuit diagram of a heat pump system in an embodiment of the present invention. The heat pump system of the embodiment includes a heat pump unit 1 placed outdoors and a hot water unit 2 placed indoors.

[0030] The hot water unit 2 is connected to a heating terminal 19 through a heat medium pipe 20. A water supply pipe 31 for supplying water from a water pipe or the like to the hot water unit 2, and a hot water-discharging pipe 30 for supplying hot water to the hot water supply terminal 33 are connected to the hot water unit 2.

[0031] Fig. 2 is a diagram showing a connection configuration of the heat pump system of the embodiment. The heat pump unit 1 and the hot water unit 2 of the heat pump system are connected to each other through a first refrigerant pipe 8c and a second refrigerant pipe 8d.

[0032] The heat pump unit 1 and the hot water unit 2 are connected to each other through an electric wiring 18. A control signal is transmitted from a control device 21 (see Fig. 1) provided in the hot water unit 2 to the heat pump unit 1 through the electric wiring 18.

[0033] The hot water unit 2 and the heating terminal 19 (e.g., floor heating) are connected to each other through the heat medium pipe 20. The hot water-discharging pipe 30 is connected to the hot water unit 2. Hot water is supplied to the hot water supply terminal 33 through the hot water-discharging pipe 30.

[0034] The water supply pipe 31 is connected to the hot water unit 2. Water is supplied to a hot water tank 15 through the water supply pipe 31.

[0035] As shown in Fig. 1, the heat pump unit 1 includes a compressor 3 which compresses refrigerant and discharges high temperature refrigerant, a decompressor 5 which decompresses refrigerant, an evaporator 6a which exchanges heat between air and refrigerant, and a four-way valve 7 which changes a flowing path of the refrigerant.

[0036] The compressor 3, the decompressor 5, the evaporator 6a and the four-way valve 7 are connected to one another through refrigerant pipes. A solenoid expansion valve or a capillary tube is used as the decompressor 5. Further, the heat pump unit 1 is provided with a blower fan 6b for sending a wind to the evaporator 6a and facilitating heat exchange between air and refrigerant. The heat pump unit 1 is provided with a casing 2a (see Fig. 3) for covering the compressor 3, the decompressor 5, the evaporator 6a, the blower fan 6b and the four-way valve 7.

[0037] A water-refrigerant heat exchanger 4 which exchanges heat between heat medium and high temperature refrigerant to produce high temperature heat medium is placed in the hot water unit 2. The water-refrigerant heat exchanger 4 is annularly connected through the refrigerant pipe together with the compressor 3, the decompressor 5, the evaporator 6a and the four-way valve 7 and constitutes a heat pump cycle.

[0038] For example, a plate type heat exchanger can be used as the water-refrigerant heat exchanger 4. Alternatively, a double-pipe type heat exchanger having a heat medium pipe and a refrigerant pipe can also be used as the water-refrigerant heat exchanger 4. Heat medium flows through the heat medium pipe and refrigerant flows through the refrigerant pipe. The heat medium pipe is placed in the refrigerant pipe. Water or antifreezing fluid can be used as the heat medium.

[0039] The water-refrigerant heat exchanger 4 placed in the hot water unit 2 and the four-way valve 7 and the decompressor 5 placed in the heat pump unit 1 are connected to each other through the first refrigerant pipe 8c and the second refrigerant pipe 8d. Here, the heat pump unit 1 is placed outdoors and the hot water unit 2 is placed indoors.

[0040] Combustible refrigerant is used as the refrigerant which circulates through the heat pump unit 1 and the hot water unit 2. In this embodiment, the "combustible refrigerant" includes slightly flammable refrigerant in addition to the combustible refrigerant.

[0041] That is, as the refrigerant which circulates through the heat pump unit 1 and the hot water unit 2, R32 which is the slightly flammable refrigerant, mixture refrigerant including 65wt% or more of R32, or HFO based mixture refrigerant is used, but R290 may be used. These refrigerants are combustible refrigerants having density larger than air under atmospheric pressure.

[0042] The hot water tank 15 in which high temperature hot water is store is placed in the hot water unit 2. The hot water tank 15 is covered with heat insulating material such as foaming material. According to this, heat retaining property of water stored in the hot water tank 15 is enhanced.

[0043] The water-refrigerant heat exchanger 4 is placed in the hot water unit 2. The water-refrigerant heat exchanger 4 produces high temperature heat medium by heat radiation of refrigerant. A heat medium path 12a through which heat medium flows is placed in the hot

water unit 2. The heat medium path 12a includes a bypassing path 12b. The bypassing path 12b branches from a three-way valve 16 provided in the heat medium path 12a, and is connected to the heat medium path 12a located upstream of the three-way valve 16 through a heat exchanger 15a provided in the hot water tank 15.

[0044] The heat medium path 12a is connected to the heating terminal 19 through a first heating connecting portion 20a and a second heating connecting portion 20b, and constitutes a heat medium circuit 12. The heat medium path 12a connects the first heating connecting portion 20a and the second heating connecting portion 20b to each other. Heat medium from outside of the hot water unit 2 flows into the first heating connecting portion 20a, and heat medium from inside of the hot water unit 2 flows out from the second heating connecting portion 20b.

[0045] A circulation pump 9, the water-refrigerant heat exchanger 4, a heater portion 14 and the three-way valve 16 are provided in this order in the heat medium path 12a from the upstream side (on the side of the first heating connecting portion 20a) with respect to a flowing direction of the heat medium. A flow switch 10, an overpressure-releasing valve 11, an expansion tank 13, an air vent valve 17 and a pressure gage 23 are provided in the heat medium path 12a.

[0046] The flow switch 10 detects a flow of hot water. The flow switch 10 is located downstream of the circulation pump 9 and the water-refrigerant heat exchanger 4, i.e., the flow switch 10 is located at a position where heat medium after it exchanges heat by the water-refrigerant heat exchanger 4 flows. By placing the flow switch 10 downstream of the circulation pump 9 in this manner, it is possible to detect an operating state of the circulation pump 9.

[0047] In this embodiment, the flow switch 10 is provided in the heat medium pipe between the water-refrigerant heat exchanger 4 and the heater portion 14. The flow switch 10 may detect a flow rate of the heat medium which flows through the heat medium circuit 12.

[0048] In this embodiment, a DC pump is used as the circulation pump 9. When the heat pump system is installed, it is necessary to set a flow rate of the heat medium flowing through the heat medium circuit 12 in a predetermined range in accordance with a size and a heat radiation amount of the heating terminal 19 which is provided in the heat medium circuit 12.

[0049] This setting is carried out by a remote controller 22 when the heat pump system is installed. In this embodiment, a circulation amount of the heat medium caused by the circulation pump 9 can be set by selecting from seven stages by the remote controller 22.

[0050] In the heat medium circuit 12, the heater portion 14 having electric heating means (heater) is placed in a case which forms a flow path. Heat medium flows through the flow path. If the heat medium flows through the heater portion 14, the heat medium is heated to predetermined temperature by the heater.

[0051] The heater portion 14 can be used when outside temperature is low and the heating ability of the heat pump cycle is deteriorated and when the heat medium cannot be heated sufficiently only by heat radiation of the refrigerant in the water-refrigerant heat exchanger 4. The heater portion 14 can be used also when the heat pump cycle is out of order.

[0052] The heat medium path 12a is provided with the expansion tank 13 and the overpressure-releasing valve 11 which adjust pressure. By heating the heat medium by the water-refrigerant heat exchanger 4, if a volume of the heat medium in the heat medium circuit 12 expands, heat medium of the volume expanded amount is absorbed by the expansion tank 13.

[0053] If internal pressure of the heat medium circuit 12 rises to predetermined pressure or higher, heat medium in the heat medium circuit 12 can be discharged to outside of the heat medium circuit 12 by the overpressure-releasing valve 11. In this embodiment, the expansion tank 13 is provided in the heat medium pipe located downstream of the three-way valve 16. The overpressure-releasing valve 11 is mounted on the heater portion 14.

[0054] The air vent valve 17 is provided in the heat medium circuit 12 in the hot water unit 2. The air vent valve 17 has a function to automatically discharge air stored in the valve to outside. Therefore, by placing the air vent valve 17 in the heat medium circuit 12, air remaining in the heat medium circuit 12 can be discharged to outside of the heat medium circuit 12.

[0055] The air vent valve 17 is provided at the highest position in the heat medium path 12a. Since air in the heat medium circuit 12 is stored at the highest position in the heat medium circuit 12 by its buoyancy force, it is possible to easily vent air in the heat medium circuit 12 by providing the air vent valve 17 at the highest position of the heat medium circuit 12. The heat medium path 12a is provided with the pressure gage 23. According to this, it is possible to detect pressure in the heat medium circuit 12.

[0056] The hot water unit 2 is provided therein with the bypassing path 12b which constitutes a portion of the heat medium circuit 12. The bypassing path 12b branches from the three-way valve 16, and is connected to the heat medium path 12a between the first heating connecting portion 20a and the circulation pump 9 through the heat exchanger 15a provided in the hot water tank 15.

[0057] The heat medium path 12a located downstream of the heater portion 14 is provided with the three-way valve 16. The three-way valve 16 can be switched between a state to flow heat medium heated by the water-refrigerant heat exchanger 4 to the hot water tank 15 and a state to flow the heat medium to downstream of the heat medium path 12a.

[0058] According to this, if heat medium flows to the hot water tank 15, it is possible to heat water stored in the hot water tank 15 by the heat exchanger 15a. If the heat medium flows to the downstream of the heat medium path 12a, the heat medium can be made to flow to the

heating terminal 19 (e.g., radiator or floor heating panel) provided in the heat medium circuit 12 located outside of the hot water unit 2, and a heating operation can be carried out.

[0059] Among heat media which flow out from the water-refrigerant heat exchanger 4, the three-way valve 16 may be able to adjust a flow rate of heat medium flowing to the hot water tank 15 and a flow rate of heat medium flowing to the downstream of the heat medium path 12a.

[0060] Heat medium which flows through the bypassing path 12b flows in from a connection port 15b located on a relatively upper side with respect to a height direction of the hot water tank 15, and heat medium after it exchanges heat with the heat exchanger 15a flows out from a connection port 15c located on a relatively lower side with respect to the height direction of the hot water tank 15. According to this, it is possible to efficiently heat water in the hot water tank 15.

[0061] The water supply pipe 31 through which water from a water pipe flows is connected to the hot water tank 15. Water from the water pipe flows into a lower location of the hot water tank 15 through a pressure reducing valve 32 and a first hot water supplying connecting portion 30a provided in the hot water unit 2.

[0062] The hot water-discharging pipe 30 through which water in the hot water tank 15 flows out is connected to the hot water tank 15 at a location higher than the water supply pipe 31. Water (hot water) in the hot water tank 15 flows out from an upper portion of the hot water tank 15 into the hot water-discharging pipe 30.

[0063] Thereafter, the water (hot water) flows to outside of the hot water unit 2 from a second hot water supplying connecting portion 30b, and is supplied to the hot water supply terminal 33 such as a faucet and a shower. A combination tap 34 is provided on the upstream side of the hot water supply terminal 33. The combination tap 34 mixes water from the water supply pipe 31 and hot water from the hot water-discharging pipe 30 with each other.

[0064] In this embodiment, heat medium is heated by the water-refrigerant heat exchanger 4, and the heated heat medium is made to flow to the heat exchanger 15a, thereby heating water in the hot water tank 15. That is, water in the hot water tank 15 is indirectly heated through heat medium using heat of refrigerant which circulates through the heat pump cycle.

[0065] That is, according to this embodiment, water which flows through the water supply pipe 31 is heated by heat medium storing in the hot water tank 15 while the water flows through the heat exchanger 15a, the water flows out from the hot water-discharging pipe 30 and is supplied to the hot water supply terminal 33. According to this, if the high temperature heat medium is stored in the hot water tank 15, it is possible to heat water by the heat exchanger 15a and to supply the water to the hot water supply terminal 33 when the hot water supply terminal 33 becomes necessary hot water.

[0066] The first heating connecting portion 20a and the second heating connecting portion 20b provided in the hot water unit 2 are connected to the heating terminal 19 such as the radiator and the flor heating panel by the heat medium pipe 20. According to this, the heat medium path 12a constitutes the heat medium circuit 12. The first heating connecting portion 20a and the second heating connecting portion 20b can be attached to and detached from the heat medium pipe 20.

[0067] Next, operation of the heat pump system in this embodiment will be described below.

[0068] The heat pump system in this embodiment can execute at least a heating operation to supply heat medium to the heating terminal 19 provided in the heat medium circuit 12 and to heat a room, a hot water-storing operation to store high temperature heat medium or hot water in the hot water tank 15, and a defrosting operation to melt frost adhering to the evaporator 6a.

[0069] These operations are started when a user instructs to start the operation by the remote controller 22 or when the control device 21 of the heat pump system determines that it is necessary to execute the operation due to time slot or temperature around the heat pump system.

[0070] When the user instructs to start the heating operation by the operation of the remote controller 22, or when the control device 21 determines that the heating operation is necessary due to temperature and the like in the room, the control device 21 starts the heating operation.

[0071] In the heating operation, the control device 21 drives the compressor 3 of the heat pump cycle and the circulation pump 9 provided in the heat medium circuit 12. When the decompressor 5 is a solenoid expansion valve, the control device 21 adjusts an opening of the valve.

[0072] In the heating operation, the control device 21 switches the three-way valve 16 to the downstream of the heat medium circuit 12. According to this, refrigerant circulates through the heat pump cycle. Further, heat medium circulates through the heat medium circuit 12 and flows through the heating terminal 19.

[0073] If the compressor 3 is driven, refrigerant circulates through the heat pump cycle. The refrigerant is compressed by the compressor 3 and is brought into a high temperature and high pressure state. The high temperature and high pressure refrigerant flows into the water-refrigerant heat exchanger 4 through the four-way valve 7, and releases heat to the heat medium.

[0074] The refrigerant which flows out from the water-refrigerant heat exchanger 4 is decompressed by the decompressor 5. The refrigerant which flows out from the decompressor 5 exchanges heat with air sent by the blower fan 6b in the evaporator 6a, and the refrigerant evaporates. Thereafter, the refrigerant which flows out from the evaporator 6a flows into the compressor 3 through the four-way valve 7, and is again compressed. The refrigerant circulates through the heat pump cycle in this manner.

[0075] Heat medium circulates through the heat medium circuit 12 by driving a circulation pump 6. The heat medium which circulates through the heat medium circuit 12 is heated to high temperature by heat of the refrigerant in the water-refrigerant heat exchanger 4. Here, the three-way valve 16 is set such that heat medium flows to the downstream of the heat medium circuit 12.

[0076] Hence, heat medium which flows out from the water-refrigerant heat exchanger 4 and flows through the heater portion 14 flows out into the heat medium circuit 12 located outside of the hot water unit 2 through the three-way valve 16 and the first heating connecting portion 20a, and the heat medium flows into a heating terminal 19 (e.g., floor heating). The heat medium releases heat in the heating terminal 19 and thereafter, the heat medium flows from the first heating connecting portion 20a into the heat medium path 12a again. The heat medium circulates through the heat medium circuit 12 in this manner.

[0077] The control device 21 controls the heat pump cycle and the circulation pump 9 such that temperature of heat medium which is supplied to the heating terminal 19 becomes equal to predetermined temperature. For example, the control device 21 can control the decompressor 5 and the number of rotations of the compressor 3 such that temperature (discharging temperature of hot water) of heat medium which flows out from the water-refrigerant heat exchanger 4 becomes equal to target temperature, and the control device 21 can control the number of rotations of the circulation pump 9 such that temperature (entering temperature of water) of heat medium which flows into the water-refrigerant heat exchanger 4 becomes equal to predetermined temperature.

[0078] That is, in the heat pump cycle, control to bring temperature (discharging temperature of hot water) of refrigerant which is discharged from the compressor 3 into predetermined temperature is executed, and the circulation pump 9 controls the entering temperature of water to adjust temperature (entering temperature of water) of heat medium which flows into the water-refrigerant heat exchanger 4. When heat medium cannot be heated sufficiently only by the heat pump cycle, the control device 21 heats the heat medium using the heater portion 14.

[0079] When a user instructs to start the hot water-storing operation by the operation of the remote controller 22, or when the control device 21 determines that the hot water-storing operation is necessary due to time slot or temperature of water in the hot water tank 15, the control device 21 starts the hot water-storing operation.

[0080] In the hot water-storing operation, the control device 21 drives the compressor 3 of the heat pump cycle and the circulation pump 9 provided in the heat medium circuit 12. When the decompressor 5 is a solenoid expansion valve, the control device 21 adjusts an opening of the valve.

[0081] In the hot water-storing operation, the control device 21 switches the three-way valve 16 to the bypassing path 12b. According to this, refrigerant circulates through the heat pump cycle and heat medium flows through the heat exchanger 15a. The user can adjust, by the remote controller 22, temperature of heat medium which is supplied to the heat exchanger 15a.

[0082] Heat medium which flows into the bypassing path 12b and flows through the heat exchanger 15a releases heat to water stored in the hot water tank 15 and heats the water. According to this, high temperature water is stored in the hot water tank 15.

[0083] In a hot water supplying operation, heated water flows out into the hot water-discharging pipe 30, flows out to outside of the hot water unit 2 through the second hot water supplying connecting portion 30b, and the water is supplied to the hot water supply terminal 33. That is, the hot water supplying operation is carried out using the high temperature water stored in the hot water tank 15.

[0084] In the hot water-storing operation, the control device 21 controls the heat pump cycle and the circulation pump 9 such that temperature of heat medium which is supplied to the heat exchanger 15a becomes equal to predetermined temperature.

[0085] For example, the control device 21 can control the decompressor 5 and the number of rotations of the compressor 3 such that temperature (discharging temperature of hot water) of heat medium which flows out from the water-refrigerant heat exchanger 4 becomes equal to target temperature, and can control the number of rotations of the circulation pump 9 such that temperature (entering temperature of water) of heat medium which flows into the water-refrigerant heat exchanger 4 becomes equal to predetermined temperature.

[0086] When heat medium cannot be heated sufficiently only by the heat pump cycle, the control device 21 heats the heat medium using the heater portion 14.

[0087] When outside air temperature becomes equal to or lower than predetermined temperature or when temperature of refrigerant which flows through the evaporator 6a becomes equal to or lower than predetermined temperature, the control device 21 determines that frost adheres to the evaporator 6a, and the defrosting operation for removing the frost is executed.

[0088] In the defrosting operation, the control device 21 switches a circulation direction of refrigerant by the four-way valve 7. According to this, the refrigerant flows through the compressor 3, the four-way valve 7, the evaporator 6a, the decompressor 5, the water-refrigerant heat exchanger 4, the four-way valve 7 and the compressor 3 in this order. As a result, high temperature and high pressure refrigerant flows into the evaporator 6a, and the defrosting operation is carried out.

[0089] When temperature of heat medium which flows into the water-refrigerant heat exchanger 4 is lower than the predetermined temperature, the control device 21 actuates the heater portion 14 and heats the heat medium, and circulates the heated heat medium through the heat medium circuit 12.

[0090] According to this, it is possible to prevent heat medium in the heat medium circuit 12 from being frozen. When the defrosting operation is carried out while the heating operation or the hot water-storing operation is being executed, it is possible to suppress temperature of heat medium supplied to the heating terminal 19 or the heat exchanger 15a from lowering, and usability is enhanced.

[0091] Next, a connecting configuration between the heat pump unit 1 and the hot water unit 2 through the first refrigerant pipe 8c and the second refrigerant pipe 8d in the heat pump system will be described.

[0092] Fig. 3 is a perspective view of a ceiling surface of the hot water unit of the heat pump system of the embodiment, and Fig. 4 is a side view of the hot water unit of the heat pump system of the embodiment.

[0093] In Fig. 3, the heat pump system includes the first refrigerant pipe 8c through which combustible refrigerant compressed by the compressor 3 of the heat pump unit 1 flows toward the water-refrigerant heat exchanger 4 of the hot water unit 2, and the second refrigerant pipe 8d through which combustible refrigerant releases heat by heating heat medium in the water-refrigerant heat exchanger 4 flows toward the decompressor 5 of the heat pump unit 1.

[0094] The first refrigerant pipe 8c and the second refrigerant pipe 8d connect the heat pump unit 1 and the hot water unit 2 respectively.

[0095] The casing 2a which forms the hot water unit 2 includes a recess 2b which is recessed in a deeper direction than any of standing surfaces composed of a front surface 2aFRONT, a side surface 2aSIDE and a rear surface 2aREAR of the casing 2a, and in a lower direction than a ceiling surface 2aTOP.

[0096] As shown in Fig. 3, an upper portion of the recess 2b is opened, the recess 2b is formed from three standing walls 2c and a bottom surface 2d located lower than the ceiling surface 2aTOP. The recess 2b includes an opening 2e with respect to the standing surface side of the casing 2a. An entire first connecting portion 8a which connects heat exchanger hot water unit 2 and the first refrigerant pipe 8c to each other and an entire second connecting portion 8b which connects the hot water unit 2 and the second refrigerant pipe 8d to each other are placed in the recess 2b. The upper portion of the recess 2b in the embodiment is opened, but the recess 2b may be provided with a pipe cover or the like.

[0097] According to this, since the entire first connecting portion 8a and the entire second connecting portion 8b are located at places where a user cannot usually keep an eye on, it is possible to provide a heat pump system having enhanced outward appearance.

[0098] In addition, a portion of the first refrigerant pipe 8c and a portion of the second refrigerant pipe 8d which are respectively connected to the first connecting portion 8a and the second connecting portion 8b are also placed in the recess 2b, and the first refrigerant pipe 8c and the second refrigerant pipe 8d are located at places where a user cannot usually keep an eye on. Therefore, it is possible to provide a heat pump system having the enhanced outward appearance.

[0099] Longitudinal directions of the first connecting portion 8a and the second connecting portion 8b are placed substantially in the horizontal direction. The expression "substantially in the horizontal direction" includes "slightly inclined".

[0100] At that time, root portions of the first connecting portion 8a and the second connecting portion 8b are placed at the standing wall 2c which is opposed to the opening 2e of the recess 2b. A connected portion between the first connecting portion 8a and the second connecting portion 8b is placed facing the opening 2e of the recess 2b. In this case also, the entire first connecting portion 8a and the entire second connecting portion 8b are placed in the recess 2b.

[0101] According to this, it becomes easy to connect the first connecting portion 8a and the first refrigerant pipe 8c to each other and connect the second connecting portion 8b and the second refrigerant pipe 8d to each other, and operation efficiency of the operation to connect the hot water unit 2 and the refrigerant pipe to each other can be enhanced. A height of the recess 2b can be lowered, and the interior content of the hot water unit 2 can be increased.

[0102] Of course, since the entire first connecting portion 8a and the entire second connecting portion 8b are placed in the recess 2b, and the portion of the first refrigerant pipe 8c and the portion of the second refrigerant pipe 8d which are respectively connected to the first connecting portion 8a and the second connecting portion 8b are also placed in the recess 2b, and these elements are located at places where a user cannot usually keep an eye on. Therefore, it is possible to provide a heat pump system having enhanced outward appearance.

[0103] Among the standing surfaces composed of the front surface 2aFRONT, the side surface 2aSIDE and the rear surface 2aREAR of the casing 2a, it is preferable that the recess 2b has the opening 2e facing the rear surface 2aREAR of the casing 2a.

[0104] This is because that if the recess 2b has the opening 2e facing the rear surface 2aREAR of the casing 2a, the first refrigerant pipe 8c connected to the first connecting portion 8a of the hot water unit 2 and the second refrigerant pipe 8d connected to the second connecting portion 8b of the hot water unit 2 can be placed behind the rear surface of the casing 2a of the hot water unit 2 through the opening 2e of the recess 2b.

[0105] According to this, the entire first connecting portion 8a and the entire second connecting portion 8b are placed in the recess 2b, and the portion of the first refrigerant pipe 8c and the portion of the second refrigerant pipe 8d which are respectively connected to the first connecting portion 8a and the second connecting portion 8b are also placed in the recess 2b and thereafter, the first refrigerant pipe 8c and the second refrigerant pipe 8d facing the heat pump unit 1 can be placed behind the

rear surface of the casing 2a of the hot water unit 2 through the opening 2e of the recess 2b.

[0106] That is, in the hot water unit 2 placed indoors such that its rear surface side usually faces the wall side, even if a user sees the hot water unit 2 from front, the first connecting portion 8a, the second connecting portion 8b, the first refrigerant pipe 8c and the second refrigerant pipe 8d are located at places where a user cannot keep an eye on. Therefore, it is possible to provide a heat pump system having the enhanced outward appearance.

[0107] In this embodiment, the refrigerant is the combustible refrigerant having density larger than air under atmospheric pressure, and the first connecting portion 8a which connects the hot water unit 2 and the first refrigerant pipe 8c to each other and the second connecting portion 8b which connects the hot water unit 2 and the second refrigerant pipe 8d to each other are provided on the side of the ceiling surface of the casing 2a of the hot water unit 2.

[0108] Hence, even if combustible refrigerant leaks from the first connecting portion 8a or the second connecting portion 8b, the combustible refrigerant diffuses vertically downward centering around the hot water unit 2 and the density thereof is diluted at that time. Therefore, a possibility of inflammability can be lowered.

[INDUSTRIAL APPLICABILITY]

[0109] According to the present invention, as described above, the connecting portion which connects a pipe to a product and at least a portion of a pipe which is connected to the connecting portion are located at places where a user cannot usually keep an eye on. Therefore, it is possible to provide a heat pump system having enhanced outward appearance and thus, the invention can be applied to a hot water supplying system, a hot water heater and the like.

[EXPLANATION OF SYMBOLS]

[0110]

1	heat pump unit
2	hot water unit
2a	casing
2aTOP	ceiling surface
2aFRONT	front surface (standing surface)
2aSIDE	side surface (standing surface)
2aREAR	rear surface (standing surface)
2b	recess
2c	standing walls
2d	bottom surface
2e	opening
3	compressor
4	water-refrigerant heat exchanger
5	decompressor
6a	evaporator
7	four-way valve
8a	first connecting portion
8b	second connecting portion
8c	first refrigerant pipe
8d	second refrigerant pipe
11	overpressure-releasing valve
12	heat medium circuit
12a	heat medium path
12b	bypassing path
15	hot water tank
15a	heat exchanger
17	air vent valve
19	heating terminal
20	heat medium pipe
20a	first heating connecting portion
20b	second heating connecting portion
21	control device
22	remote controller
23	pressure gage
30a	first hot water supplying connecting portion
30b	second hot water supplying connecting portion

Claims

1. A heat pump system comprising:

a heat pump unit (1) where a compressor (3), a decompressor (5) and an evaporator (6a) are placed;
a hot water unit (2) where at least a water-refrigerant heat exchanger (4) is placed;
a first refrigerant pipe (8c) through which refrigerant compressed by the compressor (3) flows toward the water-refrigerant heat exchanger (4);
a second refrigerant pipe (8d) through which the refrigerant after it releases heat in the water-refrigerant heat exchanger (4) flows toward the decompressor (5), in which the first refrigerant pipe (8c) and the second refrigerant pipe (8d) connect the heat pump unit (1) and the hot water unit (2) to each other; and
a casing (2a) which forms the hot water unit (2), **characterized in that** the casing (2a) includes a recess (2b) which is recessed in a deeper direction than standing surfaces (2aFRONT, 2aSIDE, 2aREAR) and in a lower direction than a ceiling surface (2aTOP), and
a first connecting portion (8a) which connects the hot water unit (2) and the first refrigerant pipe (8c) to each other and a second connecting portion (8b) which connects the hot water unit (2) and the second refrigerant pipe (8d) to each other are placed in the recess (2b).

2. The heat pump system according to claim 1, wherein longitudinal directions of the first connecting portion (8a) and the second connecting portion (8b) are

placed substantially in a horizontal direction.

3. The heat pump system according to claim 1 or 2, wherein the recess (2b) opens toward a rear surface (2aREAR) of the casing (2a).

4. The heat pump system according to any one of claims 1 to 3, wherein a hot water tank (15) is placed in the hot water unit (2).

5. The heat pump system according to any one of claims 1 to 4, wherein the refrigerant is combustible refrigerant.

Patentansprüche

1. Wärmepumpensystem, umfassend:

eine Wärmepumpeneinheit (1), in der ein Verdichter (3), ein Dekompressor (5) und ein Verdampfer (6a) platziert sind;
eine Warmwassereinheit (2), in der mindestens ein Wasser-Kältemittel-Wärmetauscher (4) platziert ist;
ein erstes Kältemittelrohr (8c) durch das vom Verdichter (3) verdichtetes Kältemittel zum Wasser-Kältemittel-Wärmetauscher (4) strömt;
ein zweites Kältemittelrohr (8d), durch das das Kältemittel, nachdem es im Wasser-Kältemittel-Wärmetauscher (4) Wärme abgegeben hat, zum Dekompressor (5) strömt, in dem das erste Kältemittelrohr (8c) und das zweite Kältemittelrohr (8d) die Wärmepumpeneinheit (1) und die Warmwassereinheit (2) miteinander verbinden; und
ein Gehäuse (2a), das die Warmwassereinheit (2) bildet,
dadurch gekennzeichnet, dass das Gehäuse (2a) eine Einbuchtung (2b) umfasst, die in einer tieferen Richtung als stehende Flächen (2aFRONT, 2aSIDE, 2aREAR) und in einer niedrigeren Richtung als eine Deckenfläche (2aTOP) vertieft ist, und
ein erster Verbindungsabschnitt (8a), der die Warmwassereinheit (2) und das erste Kältemittelrohr (8c) miteinander verbindet, und ein zweiter Verbindungsabschnitt (8b), der die Warmwassereinheit (2) und das zweite Kältemittelrohr (8d) miteinander verbindet, in der Einbuchtung (2b) platziert sind.

2. Wärmepumpensystem nach Anspruch 1, wobei Längsrichtungen des ersten Verbindungsabschnitts (8a) und des zweiten Verbindungsabschnitts (8b) im Wesentlichen in einer horizontalen Richtung liegen.

3. Wärmepumpensystem nach Anspruch 1 oder 2, wobei sich die Einbuchtung (2b) zu einer rückseitigen Fläche (2aREAR) des Gehäuses (2a) hin öffnet.

4. Wärmepumpensystem nach einem der Ansprüche 1 bis 3, wobei ein Warmwasserbehälter (15) in der Warmwassereinheit (2) platziert ist.

5. Wärmepumpensystem nach einem der Ansprüche 1 bis 4, wobei das Kältemittel ein brennbares Kältemittel ist.

Revendications

1. Système de pompe à chaleur comprenant :

une unité de pompe à chaleur (1) dans laquelle sont placés un compresseur (3), un décompresseur (5) et un évaporateur (6a) ;
une unité à eau chaude (2) dans laquelle est placé au moins un échangeur de chaleur eau-fluide frigorigène (4) ;
un premier tuyau (8c) à fluide frigorigène à travers lequel le fluide frigorigène comprimé par le compresseur (3) s'écoule vers l'échangeur de chaleur eau-fluide frigorigène (4) ;
un second tuyau (8d) à fluide frigorigène à travers lequel le fluide frigorigène après sa libération de chaleur dans l'échangeur de chaleur eau-fluide frigorigène (4) s'écoule vers le décompresseur (5), le premier tuyau (8c) à fluide frigorigène et le second tuyau (8d) à fluide frigorigène reliant l'unité de pompe à chaleur (1) et l'unité à eau chaude (2) l'une à l'autre ; et
un boîtier (2a) qui forme l'unité à eau chaude (2),
caractérisé en ce que le boîtier (2a) comprend un évidement (2b) qui est évidé dans un sens plus profond que les surfaces verticales (2aFRONT, 2aSIDE, 2aREAR) et dans un sens plus bas qu'une surface de plafond (2aTOP) et une première partie de liaison (8a), qui relie l'unité à eau chaude (2) et le premier tuyau (8c) à fluide frigorigène l'un à l'autre, et une seconde partie de liaison (8b), qui relie l'unité à eau chaude (2) et le second tuyau (8d) à fluide frigorigène l'un à l'autre, sont placées dans l'évidement (2b).

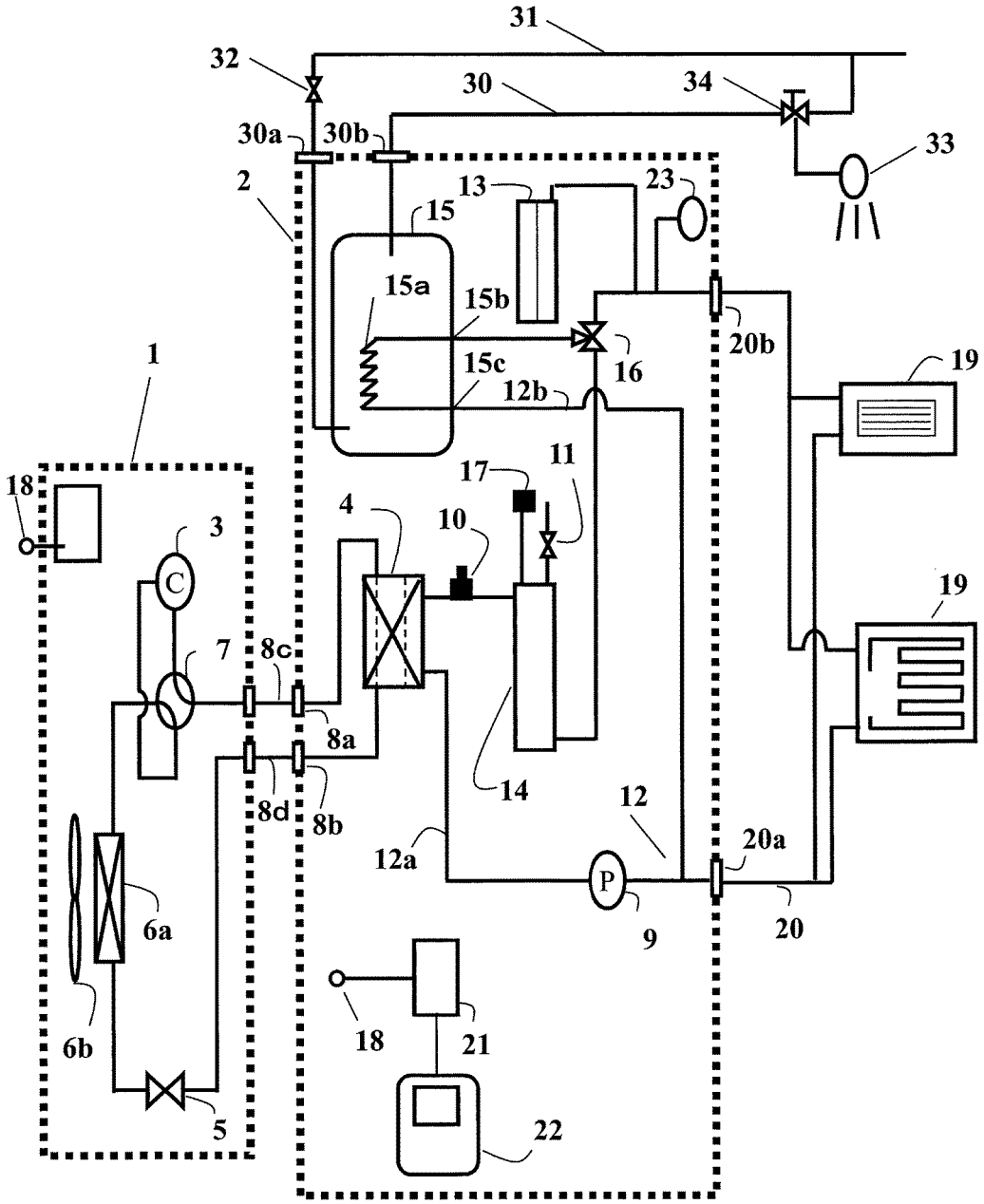
2. Système de pompe à chaleur selon la revendication 1, les directions longitudinales de la première partie de liaison (8a) et de la seconde partie de liaison (8b) étant placées sensiblement dans une direction horizontale.

3. Système de pompe à chaleur selon la revendication 1 ou 2, l'évidement (2b) s'ouvrant vers une surface arrière (2aREAR) du boîtier (2a).

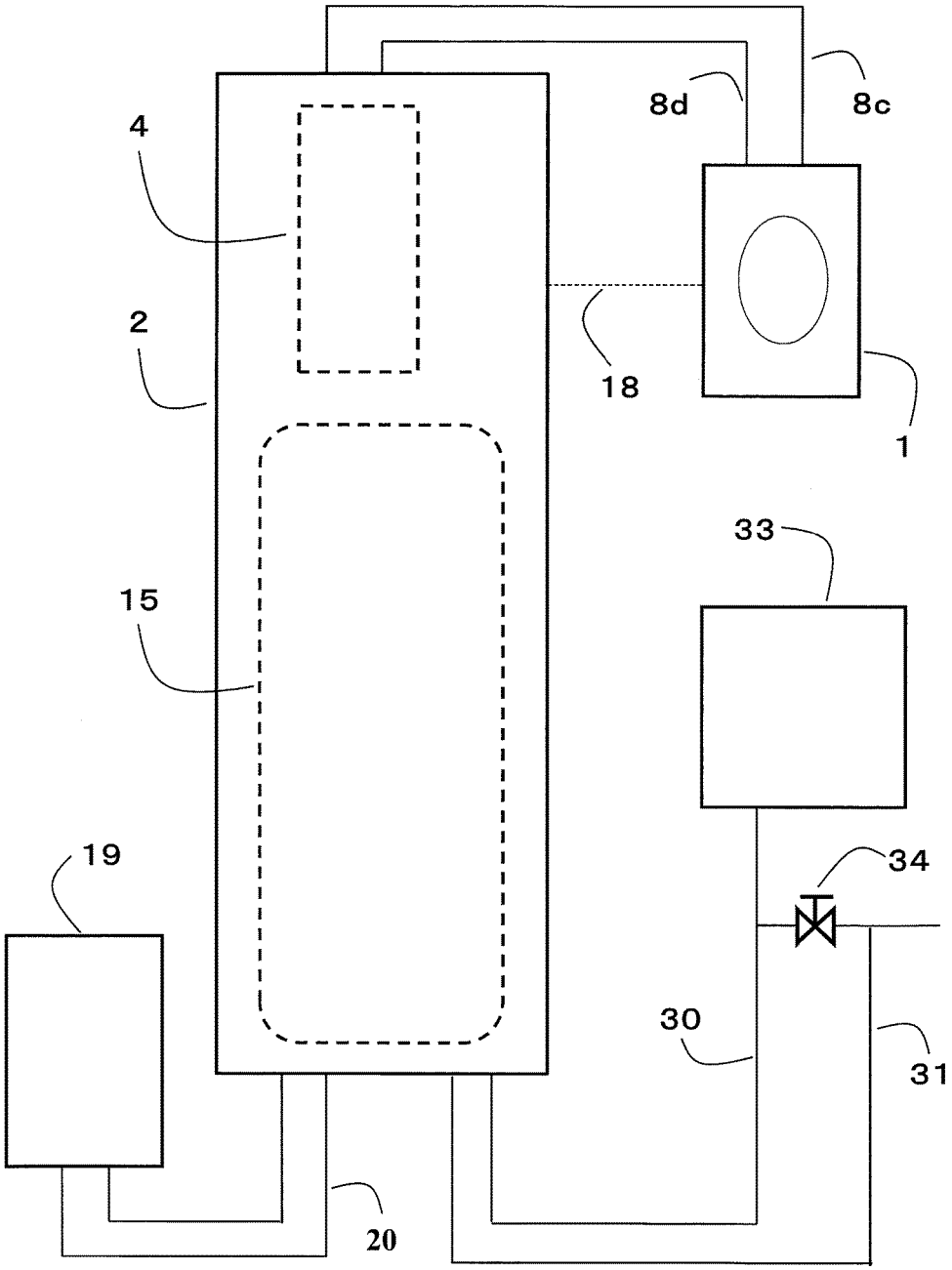
4. Système de pompe à chaleur selon l'une quelconque des revendications 1 à 3, un réservoir à eau chaude (15) étant placé dans l'unité à eau chaude (2).

5. Système de pompe à chaleur selon l'une quelconque des revendications 1 à 4, le fluide frigorigène étant un fluide frigorigène combustible.

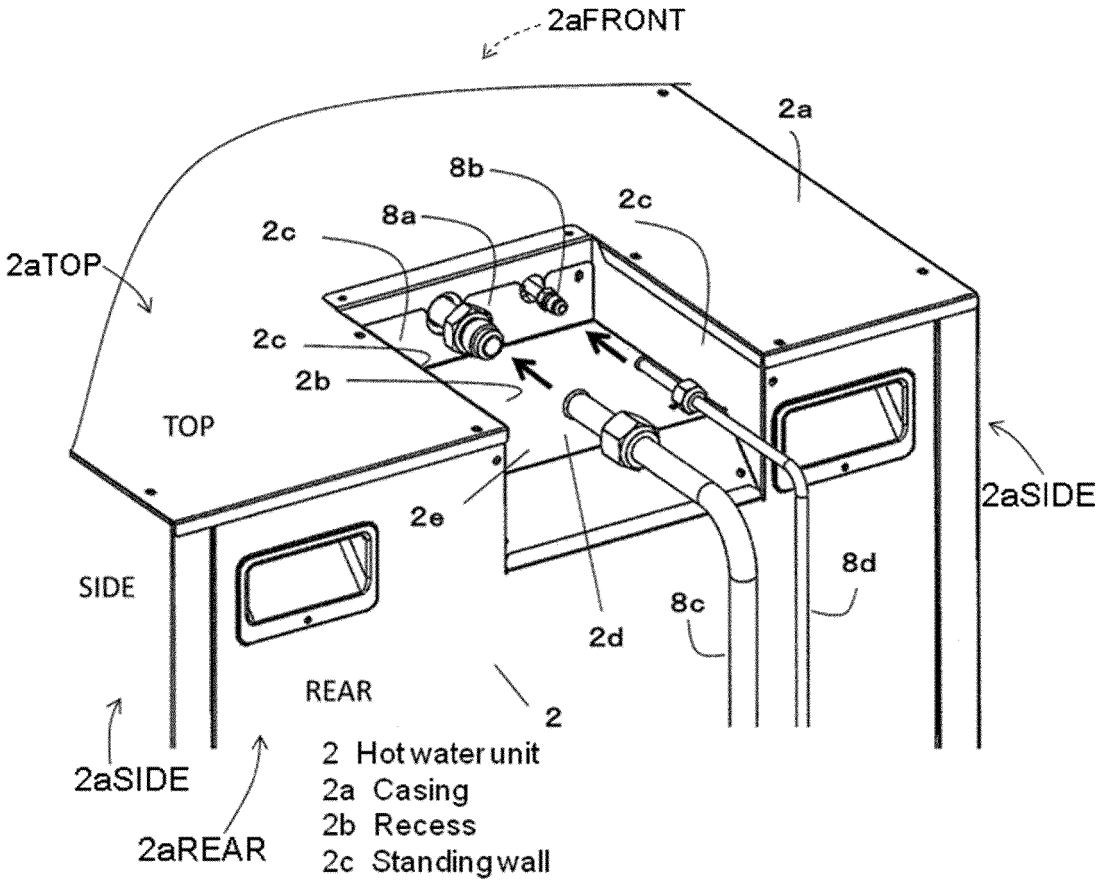
[Fig. 1]


31
32
30
34
30a
30b
33
2
13
23
15
15a
15b
16
20b
19
1
15c
12b
18
17
11
4
10
3
C
19
7
8c
8a
14
8d
8b
12
12a
20a
P
6a
9
20
6b
18
21
5
22

[Fig. 2]

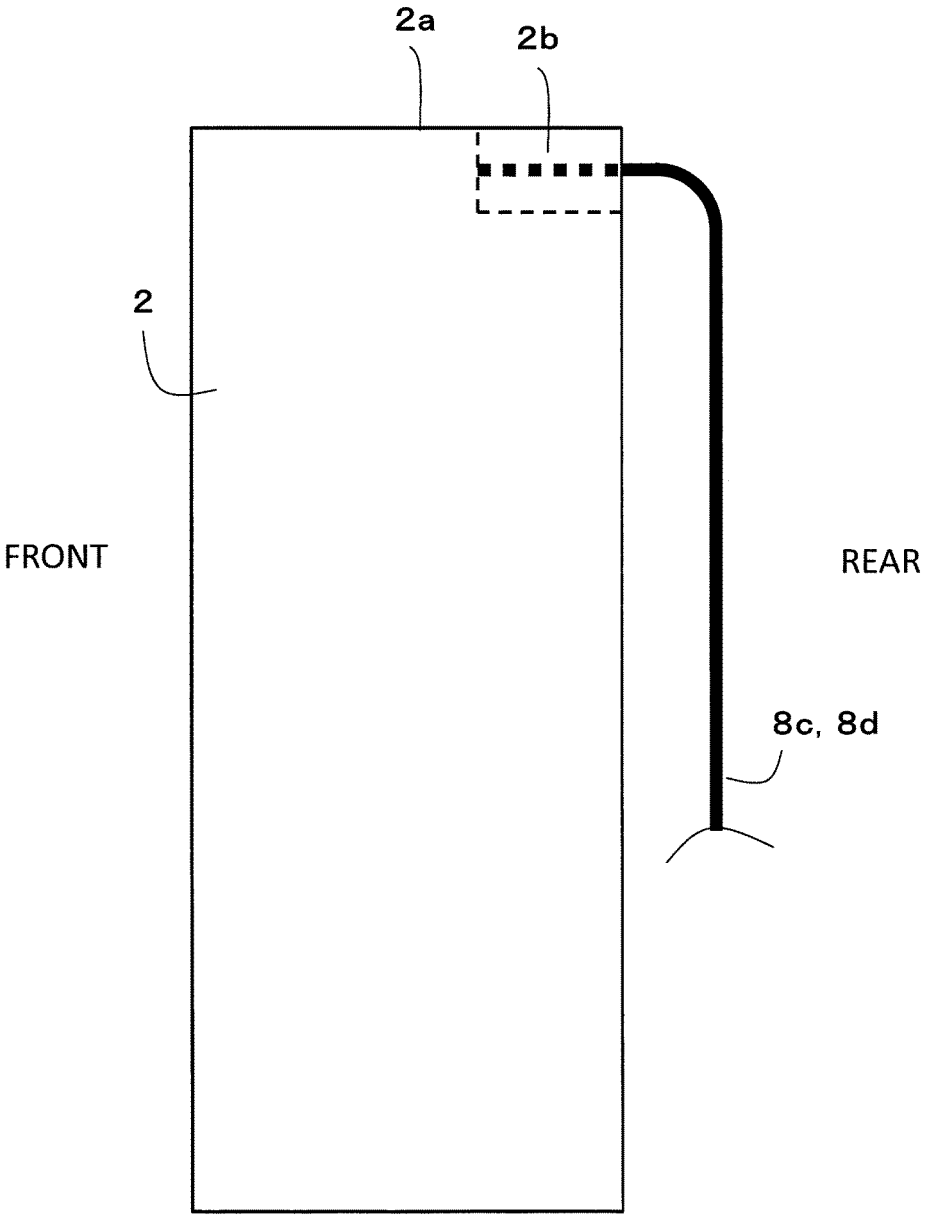


[Fig. 3]



2 Hot water unit
2a Casing
2b Recess
2c Standing wall
2d Bottom surface
2e Opening
8a First connecting portion
8b Second connecting portion
8c First refrigerant pipe
8d Second refrigerant pipe
2aTop Ceiling surface
2aFRONT Front surface (standing surface)
2aSIDE Side surface (standing surface)
2aREAR Rear surface (standing surface)

[Fig. 4]



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 2011122752 A **[0007]**
- EP 2933580 A **[0007]**
- EP 1906107 A **[0007]**