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

(11) EP 2 733 437 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.05.2014 Bulletin 2014/21

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

(21) Application number: **13193291.5**

(22) Date of filing: **18.11.2013**

(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
Designated Extension States:
BA ME

(30) Priority: **20.11.2012 JP 2012253968**

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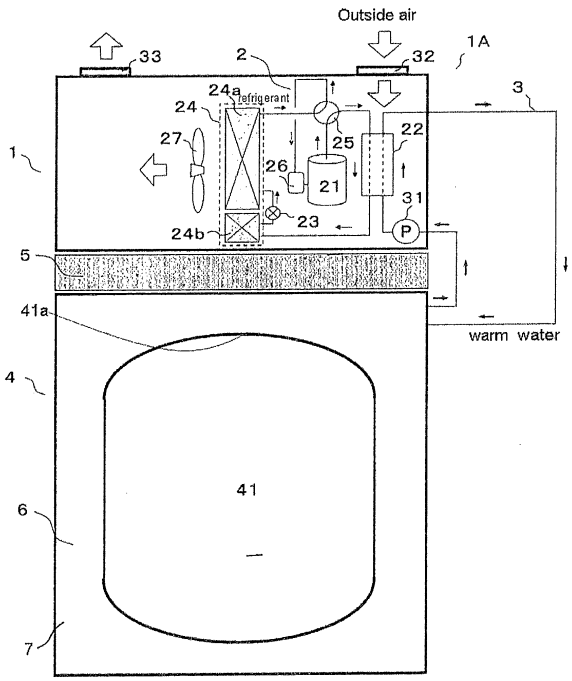
(54) Heat pump water heater

(57) A heat pump water heater comprising a refrigerant circuit 2, a heat pump unit 1 and a hot water tank 41, wherein the heat pump unit 1 is disposed above the hot water tank 41 unit, and heat resistance R1 between the hot water tank 41 and the heat pump unit 1 is greater than heat resistance R2 between the hot water tank 41 and a side of the hot water tank 41 unit. It is possible to realize a water heater in which a heat radiation amount from an upper portion of the hot water tank 41 is reduced, a heat radiation loss from the hot water tank 41 is suppressed by minimum enhancement heat insulation, and energy efficiency is high.

[Fig. 5]



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Description

[TECHNICAL FIELD]

[0001] The present invention relates to a water heater which heats water using a heat pump.

[BACKGROUND TECHNIQUE]

[0002] Conventionally, there is known a heat pump water heater which produces high temperature fluid (warm water) utilizing condensation latent heat of refrigerant by a radiator of a heat pump unit, and carries out heat storage operation for storing the produced hw in a hot water tank, and which utilizes the produced hot water for heating a room or supplying the produced hot water.

[0003] As such a heat pump water heater, there is one in which a heat pump unit is disposed on an upper portion of a hot water tank unit (see patent document 1 for example).

[0004] Figs. 6 show the heat pump water heater described in patent document 1. As shown in Fig. 6(a), the heat pump water heater includes a hot water tank unit 200 and a heat pump unit 100. The heat pump unit 100 is disposed on an upper portion of the hot water tank unit 200.

[0005] According to the heat pump unit 100, a compressor 110, a radiator 120, an expansion device (not shown) and an evaporator (air heat exchanger) 130 are annularly connected to one another through a refrigerant pipe, and a refrigerant circuit is configured. Refrigerant flows through the refrigerant pipe. The radiator 120 heat-exchanges between refrigerant which flows through the refrigerant circuit and fluid which flows through a fluid circuit 230.

[0006] A hot water tank 210, a portion of the fluid circuit 230 and a circulation pump 220 are disposed in the hot water tank unit 200. The fluid circuit 230 is configured by annularly connecting the radiator 120, the hot water tank 210 and the circulation pump 220 to one another through a fluid pipe through which heat medium such as water flows.

[0007] As shown in Fig. 6(b), a lateral width of an evaporator 130 of the heat pump unit 100 is shorter than a lateral width of the hot water tank unit 200 by a lateral width which is required for installing the compressor 110.

[0008] In the case of the heat storage operation by which hot water is stored in the hot water tank 210, low temperature fluid (water) stored in the hot water tank 210 is conveyed, by the circulation pump 220, from the hot water tank 210 to the heat pump unit 100 through the fluid circuit 230. Heat medium (warm water) is heated by the radiator 120 of the heat pump unit 100 and temperature of the heat medium becomes high. The heat medium flows out from the heat pump unit 100 through the fluid circuit 230 and then flows into the hot water tank unit 200 and is stored from the fluid circuit 230 which is connected to an upper portion of the hot water tank 210.

[0009] When it is requested to supply hot water, high temperature fluid in an upper portion of the hot water tank 210 flows out from the hot water tank 210 through a pipe (not shown), and the fluid is conveyed to a hot water supply terminal.

[0010] High temperature fluid is produced by the heat pump unit 100 using the hot water tank 210, heat is stored the hot water tank 210, and if it is requested to supply hot water, it is possible to utilize high temperature heat medium which is stored in the hot water tank 210.

[PRIOR ART DOCUMENT]

[PATENT DOCUMENT]

[0011] [Patent Document 1] Japanese Patent Application Laid-open No.2011-122752

[SUMMARY OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

[0012] According to the conventional configuration, however, the heat pump unit 100 is disposed on the upper portion of the hot water tank unit 200, and the fluid pipe which connects the heat pump unit 100 and the hot water tank unit 200 to each other is disposed on the upper portion of the hot water tank 210.

[0013] Therefore, the conventional configuration has such a problem that a heat resistance (a reciprocal of a heat passage rate) between the heat pump unit 100 including the low temperature evaporator 130 and the upper portion of the high temperature hot water tank 210 becomes small, heat is prone to move from the hot water tank 210 whose temperature becomes high to the heat pump unit 100 and as a result, a heat radiation amount from the hot water tank 210 increases and energy efficiency is lowered.

[0014] The present invention has been accomplished to solve the conventional problem, and it is an object of the invention to provide a heat pump water heater which is capable of reducing a heat radiation loss from the hot water tank by appropriately insulating heat between the heat pump unit and the hot water tank unit and which has excellent energy saving performance.

[MEANS FOR SOLVING THE PROBLEM]

[0015] To solve the problems of the conventional technique, the present invention provides a heat pump water heater comprising a refrigerant circuit which is formed by annularly connecting a compressor, a radiator, an expansion device and an evaporator to one another through a pipe and through which refrigerant circulates, a heat pump unit in which at least the evaporator of the refrigerant circuit is disposed, and a hot water tank unit including a hot water tank in which warm water produced by the radiator is stored, wherein the heat pump unit is dis-

posed above the hot water tank unit, and heat resistance R1 between the hot water tank and the heat pump unit is greater than heat resistance R2 between the hot water tank and a side of the hot water tank unit.

[0016] According to this configuration, it is possible to reduce a heat radiation amount from the hot water tank by appropriately insulating heat between the heat pump unit and the upper portion of the hot water tank unit which is heated to higher temperature.

[EFFECT OF THE INVENTION]

[0017] According to the present invention, it is possible to provide a heat pump water heater which reduces the heat radiation amount from the hot water tank in which heat is stored and which has high energy efficiency.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0018]

Fig. 1 is a schematic block diagram of a heat pump water heater in a first embodiment of the present invention;

Fig. 2 is a diagram showing a relation between outside air temperature and a heat ratio of the heat pump water heater;

Fig. 3(a) is a plan view when an evaporator of the heat pump water heater is disposed in a lateral direction, Fig. 3(b) is a plan view when the evaporator of the heat pump water heater is disposed on a diagonal line, and Fig. 3(c) is a plan view when the evaporator of the heat pump water heater is disposed in a radial direction;

Fig. 4 is a plan view showing a configuration of a heat insulation material of the heat pump water heater;

Fig. 5 is a schematic block diagram of a heat pump water heater in a second embodiment of the present invention; and

Fig. 6(a) is a schematic side view showing a configuration of a conventional heat pump water heater, and Fig. 6(b) is a schematic plan view showing a configuration of the conventional heat pump water heater.

[EXPLANATION OF SYMBOLS]

[0019]

1 heat pump unit
2 refrigerant circuit
4 hot water tank unit
5 partition
1A heat pump water heater
21 compressor
22 radiator
23 expansion valve (expansion device)
24 evaporator
24a evaporating portion
24b cooling portion
41 hot water tank

[MODE FOR CARRYING OUT THE INVENTION]

[0020] A first aspect of the invention provides a heat pump water heater comprising a refrigerant circuit which is formed by annularly connecting a compressor, a radiator, an expansion device and an evaporator to one another through a pipe and through which refrigerant circulates, a heat pump unit in which at least the evaporator of the refrigerant circuit is disposed, and a hot water tank unit including a hot water tank in which warm water produced by the radiator is stored, wherein the heat pump unit is disposed above the hot water tank unit, and heat resistance R1 between the hot water tank and the heat pump unit is greater than heat resistance R2 between the hot water tank and a side of the hot water tank unit.

[0021] According to this aspect, the heat resistance R1 between the upper portion of the hot water tank and the heat pump unit becomes greater than the heat resistance R2 between the hot water tank and the side of the hot water tank unit. Hence, heat is appropriately insulated between the upper portion of the hot water tank unit whose temperature becomes high and the heat pump unit having the evaporator whose temperature becomes low, and it is possible to reduce the heat radiation amount from the hot water tank. Therefore, it is possible to enhance the energy efficiency by the minimum heat insulation enhancement between the hot water tank and the heat pump unit.

[0022] According to a second aspect of the invention, in the first aspect, the heat resistance R1 is 1.1 to 2.8 times of the heat resistance R2.

[0023] According to this aspect, it is possible to uniform a heat flowing speed between the hot water tank and outside of the hot water tank unit throughout the year during which outside air temperature is changed. Hence, even if the outside air temperature is changed throughout the year, it is possible to reduce the heat radiation from the hot water tank and to enhance the annual energy efficiency.

[0024] According to a third aspect of the invention, in the first or second aspect,
the evaporator is disposed at a central portion of the heat pump unit with respect to a horizontal direction.

[0025] According to this aspect, an area of the evaporator where air and refrigerant which circulates through the evaporator heat-exchanges is increased. Hence, it is possible to increase a heat absorption amount in the evaporator, and to enhance the heating ability in the radiator.

[0026] According to a fourth aspect of the invention, in any one of the first to third aspects, the heat pump unit further includes a cooling portion for cooling refrigerant, and the cooling portion is disposed below the evaporator.

[0027] According to this aspect, high temperature refrigerant before it is decompressed by the expansion device flows into the cooling portion below the evaporator. Hence, the lower portion of the evaporator is heated by heat which is transmitted from the cooling portion cooled by the high temperature refrigerant. That is, since a temperature difference between the hot water tank and the lower portion of the evaporator is reduced by the cooling portion, a heat moving amount from the hot water tank to the evaporator is reduced, and an energy loss caused by heat radiation from the hot water tank is reduced.

[0028] According to a fifth aspect of the invention, in any one of the first to fourth aspects, the heat resistance R1 between the hot water tank and the heat pump unit on an inner side is greater than the heat resistance R1 on an outer side.

[0029] According to this aspect, a heat resistance in a region where heat flux is large, i.e., in a region between the high temperature hot water tank and the low temperature evaporator can be made greater. Further, as compared with a case where an expensive material having great heat resistance is used entirely, a using amount of material having great heat resistance is reduced. Therefore, it is possible to provide a heat pump water heater in which the heat resistance between the hot water tank and the heat pump unit is inexpensively increased, a heat radiation amount from the hot water tank is reduced and energy efficiency is enhanced.

[0030] Embodiments of the present invention will be described below with reference to the drawings. The invention is not limited to the embodiments.

(First Embodiment)

[0031] Fig. 1 is a schematic block diagram of a heat pump water heater in a first embodiment of the present invention.

[0032] The heat pump water heater 1A includes a heat pump unit 1, a fluid circuit 3, a hot water tank unit 4, and a partition 5 which partitions the heat pump unit 1 and the hot water tank unit 4 from each other. Expanded polypropylene as a first heat insulation material is used as the partition 5.

[0033] The heat pump unit 1 includes a refrigerant circuit 2 through which refrigerant is circulated. As the refrigerant, it is possible to use zeotropic refrigerant mixture such as R407C, pseudo azeotropic refrigerant mixture such as R410A, single refrigerant, i.e., HFC-based refrigerant such as R32, and natural refrigerant such as CO_2.

[0034] A hot water tank 41 is disposed in the hot water tank unit 4. A second heat insulation material 6 (e.g., expanded polypropylene) is disposed between a periphery of the hot water tank 41 and an exterior body 7 of the hot water tank unit 4.

[0035] The refrigerant circuit 2 is configured by sequentially and annularly connecting a compressor 21, a radiator (condenser) 22, an expansion device 23 such as an expansion valve and a capillary tube, and an evaporator 24 to one another through a pipe. An accumulator 26 for separating gas and liquid from each other is provided between the evaporator 24 and the compressor 21. The refrigerant circuit 2 is provided with a four-way valve 25. By switching the four-way valve 25, a heat storage operation for heating the hot water tank 41 and a defrosting operation for eliminating frost generated on the evaporator 24 are carried out.

[0036] The evaporator 24 is disposed above the hot water tank unit 4 and at a substantially central portion of the heat pump unit 1 in the horizontal direction, i.e., on an extension of a top 41 a of the hot water tank 41.

[0037] A radiator 22 is a heat exchanger which exchanges heat between refrigerant and water. A portion of the refrigerant circuit 2 and a portion of the fluid circuit 3 are disposed in a radiator 22, and the radiator 22 exchanges heat between refrigerant which circulates through the refrigerant circuit 2 and heat medium such as water and brine which circulates through the fluid circuit 3. The fluid circuit 3 is configured by annularly connecting the radiator 22 of the heat pump unit 1, the hot water tank 41 of the hot water tank unit 4, and the circulation pump 31 to one another. The radiator 22 and the circulation pump 31 which configure the fluid circuit 3 are accommodated in the heat pump unit 1.

[0038] An air blower 27 is provided in the vicinity of the evaporator 24. The air blower 27 sucks air from an air suction port 32 into the heat pump unit 1. Air sucked from the air suction port 32 is discharged from an air discharge port 33.

[0039] In the heat pump water heater 1A having the above-described configuration, action and an effect of the heat storage operation for heating water in the hot water tank 41 will be described. In Fig. 1, arrows show flowing directions of refrigerant and warm water (fluid) at the time of the heat storage operation.

[0040] If the heat storage operation is requested, high pressure and high temperature gas refrigerant discharged from the compressor 21 circulates through the refrigerant circuit 2 and flows into the radiator 22. Heat medium which is sent from the hot water tank 41 under pressure by the circulation pump 31 is supplied to the radiator 22. The high temperature and high pressure gas refrigerant heats the heat medium in the radiator 22, and the refrigerant is liquefied and condensed. The liquefied and condensed high pressure liquid refrigerant flows out from the radiator 22.

[0041] The high pressure liquid refrigerant which flowed out from the radiator 22 is decompressed by the expansion device 23 and expanded and then, the refrigerant flows into the evaporator 24. Low pressure gas/liquid two phase refrigerant which flowed into the evaporator 24 absorbs heat from air and is evaporated, and becomes low pressure gas/liquid two phase refrigerant or excessively heated gas refrigerant and flows out from the evaporator 24. The low pressure refrigerant which flowed out from the evaporator 24 passes through the

four-way valve 25, gas and liquid of the refrigerant are separated from each other in the accumulator 26 and then, gas refrigerant is sucked into the compressor 21.

[0042] Heat medium which is heated in the radiator 22 becomes warm water, and flows out from the radiator 22 and flows into the hot water tank 41. According to this, heat is stored in the hot water tank 41.

[0043] Next, concrete examples of temperatures of various portions of the heat pump water heater 1A when the heat storage operation is carried out will be described below.

[0044] Temperature of environment where the heat pump water heater 1A shown in Fig. 1 is installed is defined as 20°C for example.

[0045] If the heat storage operation is carried out, high temperature water is stored in the hot water tank 41, and the evaporator 24 is brought into a low temperature (below zero) state. Here, a temperature difference dT1 (= 65 K) between temperature of the hot water tank 41 (e.g., 55°C) and temperature of the evaporator 24 (e.g., -10°C) is about two times of a temperature difference dT2 (= 35 K) between temperature of a side surface of the hot water tank 41 and temperature of a side surface of the hot water tank unit 4 (e.g., 20°C).

[0046] In this embodiment, heat resistance R1 (a reciprocal of a heat passage rate) between the upper portion of the hot water tank 41 and the heat pump unit 1 is set greater than heat resistance R2 between the hot water tank 41 and the side (exterior body 7) of the hot water tank unit 4. Here, if the heat resistance R1 is defined as about two times of the heat resistance R2, heat flux (heat moving amount per unit area) q1 (= dT1/R1) from the hot water tank 41 to the heat exchanger evaporator 24 is substantially equal to heat flux q2 (= dT2/R2) from the side surface of the hot water tank 41 and the side surface of the hot water tank unit 4.

[0047] At this time, if an area of an upper surface of the hot water tank unit 4 is defined as A1, since the area A1 is smaller than an area A2 of the side of the hot water tank unit 4, a heat moving amount Q1 (= q1×A1) between the high temperature hot water tank 41 and the low temperature evaporator 24 becomes smaller than a heat moving amount Q2 (= q2xA2) between the hot water tank 41 and the side of the hot water tank unit 4. Therefore, since the temperature is high, it is possible to reduce the heat radiation amount from the upper portion of the hot water tank 41 having the large heat flux, and to enhance the energy efficiency.

[0048] Here, if the first heat insulation material having thermal conductivity K1 and thickness L1 is used as the partition 5 and if a material 6 having thermal conductivity K2 and thickness L2 is used as the second heat insulation material between the hot water tank unit 4 and the exterior body 7 of the hot water tank unit 4, the heat resistance R1 and R2 can be expressed as L1/K1 and L2/K2, respectively. Hence, the heat resistance R1 and R2 are set to desired values by appropriately adjusting L1, R1, L2 and R2.

[0049] As the first heat insulation material of the partition 5 and the second heat insulation material 6, it is possible to use expanded resin such as expanded polystyrene in addition to the expanded polypropylene, fiber material such as glass wool and glass fiber, and a vacuum heat insulation material. By using these heat insulation materials singularly or in combination, and by forming and disposing an air layer between the heat insulation materials, the heat resistance R1 and R2 are set to desired values.

[0050] Concerning the heat resistance R1, it is also possible to adjust heat resistance of the first heat insulation material used as the partition 5 and heat resistance of the second heat insulation material 6 disposed on the upper portion of the hot water tank 41, and when a heat insulation material is disposed in the heat pump unit 1 and below the evaporator 24, it is also possible to adjust heat resistance of that heat insulation material.

[0051] If the heat resistance R1 above the hot water tank 41 is set excessively large as compared with the heat resistance R2 on the side of the hot water tank 41, an amount of heat stored in the hot water tank 41 is transmitted to the side of the hot water tank 41 having low heat resistance and the heat is dissipated. Therefore, it is not possible to effectively reduce the heat radiation amount as the entire hot water tank unit 4. Hence, it is necessary to appropriately adjust a relation between the heat resistance R1 above the hot water tank 41 and the heat resistance R2 on the side of the hot water tank 41 to uniform the heat flux around the hot water tank 41.

[0052] Outside air temperature at a location where the heat pump water heater 1A is installed, environmental temperature thereof, and temperature of hot water stored in the hot water tank 41 are changed throughout the year. Therefore, it is necessary to set the relation between the heat resistance R1 and the heat resistance R2 to uniform the heat flux around the hot water tank 41 so that annual change in temperature can be accommodated. A method thereof will be described below.

[0053] The outside air temperature at a location where the heat pump water heater 1A is installed, environmental temperature thereof, and temperature of hot water stored in the hot water tank 41 are changed throughout the year. Therefore, temperature differences dT1 and dT2 are also changed. Here, if heat flux q1 = q2, dT1/dT2 = R1/R2 is also changed if the outside air temperature is changed.

[0054] Here, temperature in a room where the heat pump water heater 1A is installed is defined as 20°C in accordance with European Norm EN16147, temperature of hot water which is heated by the radiator 22 and stored in the hot water tank 41 is defined as 50°C to 90°C on the assumption that heat medium is heated using HFC refrigerant and on the assumption that heat medium is heated using CO2 refrigerant, and a difference ΔT between temperature of the evaporator 24 and outside air temperature is defined as 5 K to 15 K. According to this, a relation between heat resistance ratio R1/R2 and outside air temperature becomes as shown in Fig. 2.

[0055] When heat flux q1 = q2, R1/R2 = dT1/dT2 is in a range of 1.1 to 2.8 with respect to change in outside air temperature in a range of outside air temperature of -20°C to 20°C which is based on assumption of extremely low outside air temperature in a cold weather region.

[0056] That is, when R1/R2 = 1.1 to 2.8, heat flux q1 from the hot water tank 41 to the evaporator 24 becomes equal to heat flux q2 from the hot water tank 41 to the hot water tank unit 4, and heat flux around the hot water tank 41 is uniformed.

[0057] Therefore, when R1/R2 = 1.1 to 2.8, since it is possible to uniform heat flux throughout the year during which outside air temperature is changed, even if outside air temperature is changed throughout the year, it is possible to reduce the heat radiation amount from the upper portion of the hot water tank 41.

[0058] When the evaporator 24 is disposed above the hot water tank unit 4 and at a substantially central portion of the heat pump unit 1 with respect to the horizontal direction, if the hot water tank unit 4 is formed into a rectangular parallelepiped shape, the evaporator 24 can be formed such that its length is equal to a lateral width of the hot water tank unit 4 or is equal to a length of a diagonal line of the hot water tank unit 4 as shown in Figs. 3(a) and 3(b), and if the hot water tank unit 4 is formed into a columnar shape, the evaporator 24 can be formed such that its length is equal to a length of a diameter of the hot water tank unit 4 as shown in Fig. 3(c). Hence, an area where air and refrigerant which circulates through the evaporator 24 are heat-exchanged can be increased. As a result, a heat absorption amount in the evaporator 24 can be increased and the heating ability in the radiator 22 can be enhanced.

[0059] As shown in Fig. 4, the heat resistance R1 of the partition 5 is higher in its inner side than its outer side which is on sides of the heat pump unit 1 and the hot water tank unit 4. More specifically, heat resistance of a region S1 of the partition 5 located below the evaporator 24, i.e., heat resistance of the region S1 where the evaporator 24 is located is set greater than heat resistance of other regions S2, i.e., heat resistance of the regions S2 where the evaporator 24 is not located. According to this, the region S1 where a top 41 a of the hot water tank 41 whose temperature becomes high and the low temperature evaporator 24 are located can be made as the region S1 where having the great heat resistance, and regions around the region S1 can be made as the regions S2 having small heat resistance.

[0060] According to this, as compared with a case where a material having great heat resistance is used for the entire partition 5, a using amount of material having great heat resistance is reduced, and it is possible to inexpensively reduce the heat radiation amount from the hot water tank 41.

[0061] As described above, in this embodiment, the heat pump water heater includes the partition 5 which partitions the heat pump unit 1 and the hot water tank unit 4 from each other, and the heat resistance R1 between the upper portion of the hot water tank 41 and the heat pump unit 1 is made greater than the heat resistance R2 between the hot water tank 41 and the side of the hot water tank unit 4. According to this, the following effects can be obtained.

[0062] That is, the heat resistance R1 in a location above the hot water tank 41 having a great heat radiation amount is made greater than the heat resistance R2 of the side of the hot water tank 41, and heat flux around the hot water tank 41 is uniformed. According to this, it is possible to reduce the heat radiation loss only by enhancing the heat insulation of the upper portion of the hot water tank 41, and to enhance the energy efficiency.

[0063] The heat resistance R1 is set 1.1 to 2.8 times of the heat resistance R2. According to this, it is possible to uniform heat flux around the hot water tank 41 throughout the year during which outside air temperature is changed. Even if outside air temperature is changed, it is possible to reduce the heat radiation amount from the hot water tank 41 and to enhance the annual energy efficiency.

[0064] The evaporator 24 is disposed above the hot water tank unit 4 and at the substantially central portion of the hot water tank unit 4 with respect to the horizontal direction. According to this, the area where air and refrigerant which circulates through the evaporator 24 are heat-exchanged can be increased. As a result, the heat absorption amount in the evaporator 24 can be increased and the heating ability in the radiator 22 can be enhanced.

[0065] The heat resistance R1 of the partition 5 at its central portion is made greater than the heat resistance R1 of the peripheral portion of the partition 5. According to this, the region S1 having the great heat resistance is limited to a region between the high temperature hot water tank 41 and the low temperature evaporator 24. Hence, as compared with a case where a material having great heat resistance is used for the entire partition 5, a using amount of material having great heat resistance is reduced, and it is possible to inexpensively reduce the heat radiation amount from the hot water tank 41.

[0066] Although air flows in from the air suction port 32 of the upper portion of the heat pump unit 1 in the embodiment, the air may flow in from a side of the heat pump unit 1. In the embodiment, the compressor 21, the radiator (condenser) 22, the expansion device 23 such as an expansion valve and a capillary tube and the evaporator 24 are sequentially and annularly connected to one another through the pipe to configure the refrigerant circuit 2, and the refrigerant circuit 2 is accommodated in the heat pump unit 1. Alternatively, the radiator (condenser) 22 may be configured by winding a refrigerant pipe around an outer periphery of the hot water tank 41, the radiator (condenser) 22 may be provided in the hot water tank 41, and the radiator (condenser) 22 may not be accommodated in the heat pump unit 1. According to this also, the effects of the present invention are exerted. Therefore, it is not absolutely necessary that the radiator (condenser) 22 is accommodated in the heat pump unit 1.

(Second Embodiment)

[0067] Fig. 5 is a schematic block diagram of a heat pump water heater in a second embodiment of the present invention. In the second embodiment, the same symbols are allocated to the same function members as those in the first embodiment, and detailed description thereof will be omitted.

[0068] In a heat pump water heater 1A of the second embodiment, an evaporator 24 of a heat pump unit 1 is a fin tube heat exchanger, and the evaporator 24 includes an evaporating portion 24a and a cooling portion 24b which cools refrigerant. Here, the cooling portion 24b is disposed below the evaporator 24.

[0069] Action and an effect of the heat pump water heater 1A having the above-described configuration will be described below.

[0070] If a heat storage operation is requested, high pressure and high temperature refrigerant discharged from a compressor 21 circulates through a refrigerant circuit 2 and flows into a radiator 22, and the refrigerant dissipates heat. Liquefied and condensed high pressure liquid refrigerant flows out from the radiator 22 and flows into the cooling portion 24b. The refrigerant heat-exchanges with air in the cooling portion 24b and is cooled. The refrigerant flows out from the cooling portion 24b and is decompressed and expanded by an expansion device 23 and then, the refrigerant flows into the evaporating portion 24a, and the refrigerant heat-exchanges with air and is evaporated. Low pressure refrigerant which flows out from the evaporator 24 passes through a four-way valve 25, gas and liquid of the refrigerant are separated from each other by an accumulator 26, gas phase refrigerant is sucked into the compressor 21 and is compressed, and the refrigerant again flows into the radiator 22.

[0071] Here, refrigerant before it is decompressed by the expansion device 23 has relatively high temperature as compared with outside air, and this refrigerant flows into the cooling portion 24b disposed below the evaporator 24.

[0072] As a result, a lower portion of the evaporator 24 is heated by relatively high temperature refrigerant which flows out from the radiator 22, and the refrigerant dissipates heat to air in the cooling portion 24b and is cooled.

[0073] According to this, temperature of the lower portion of the evaporator 24 rises, a temperature difference between the upper portion of the high temperature hot water tank 41 and a portion of the evaporator 24, especially the evaporating portion 24a whose temperature becomes low is reduced. Since refrigerant can be brought into an excessively cooled state by the cooling portion 24b, it is possible to increase an enthalpy difference in the evaporator.

[0074] Hence, a heat moving amount from the hot water tank 41 to the evaporator 24 is reduced, it is possible to reduce a heat radiation loss from the hot water tank 41, and to enhance the energy efficiency while making best use of the evaporator 24.

[INDUSTRIAL APPLICABILITY]

[0075] The present invention is especially useful for a heat pump water heater which heats fluid by a heat pump unit and which supplies the fluid and utilizes the fluid for heating a room.

Claims

1. A heat pump water heater comprising
a refrigerant circuit which is formed by annularly connecting a compressor, a radiator, an expansion device and an evaporator to one another through a pipe and through which refrigerant circulates,
a heat pump unit in which at least the evaporator of the refrigerant circuit is disposed, and
a hot water tank unit including a hot water tank in which warm water produced by the radiator is stored, wherein
the heat pump unit is disposed above the hot water tank unit, and
heat resistance R1 between the hot water tank and the heat pump unit is greater than heat resistance R2 between the hot water tank and a side of the hot water tank unit.

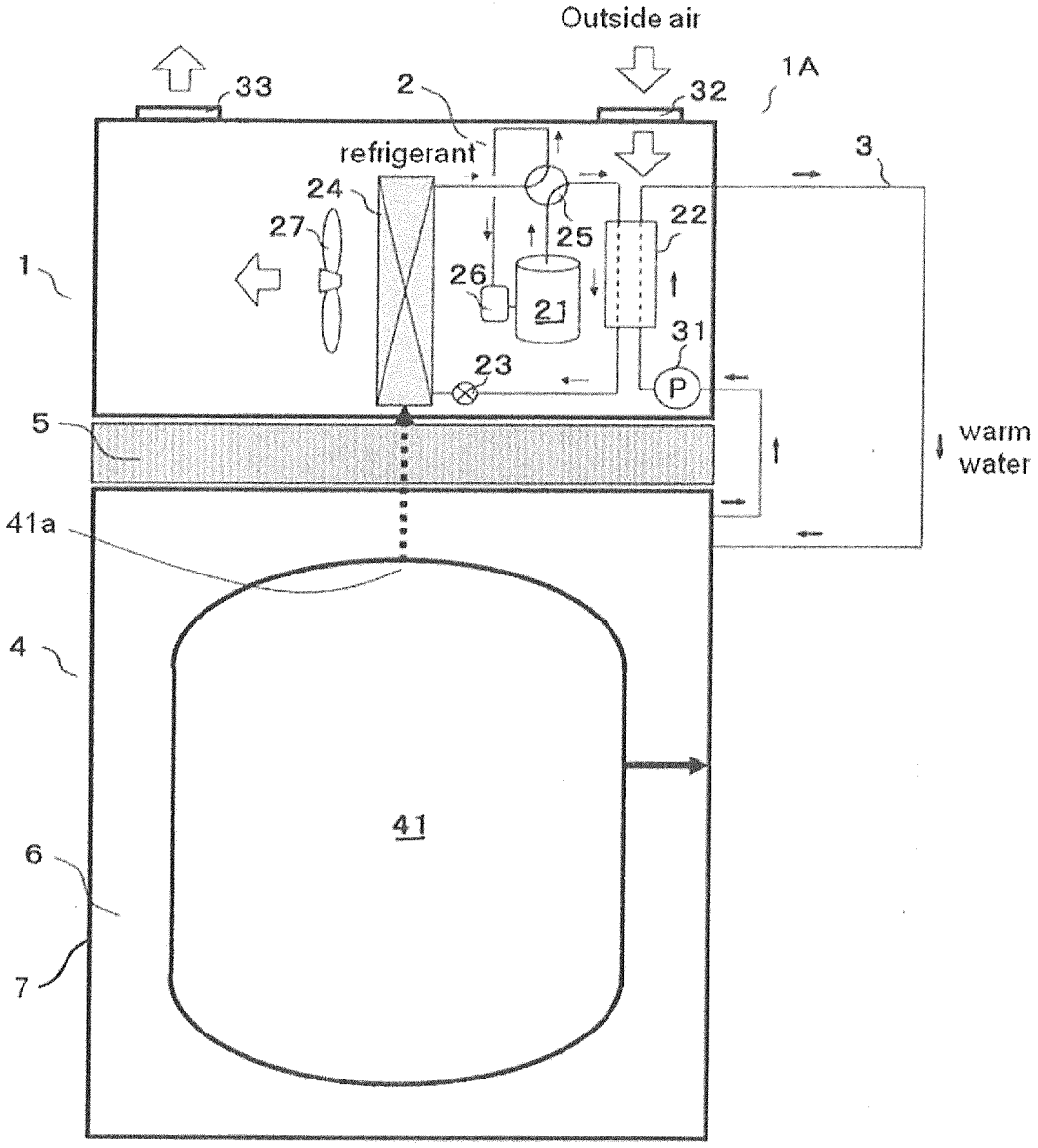
2. The heat pump water heater according to claim 1, wherein the heat resistance R1 is 1.1 to 2.8 times of the heat resistance R2.

3. The heat pump water heater according to claim 1 or 2, wherein the evaporator is disposed at a central portion of the heat pump unit with respect to a horizontal direction.

4. The heat pump water heater according to any one of claims 1 to 3, wherein the heat pump unit further includes a cooling portion for cooling refrigerant, and the cooling portion is disposed below the evaporator.

5. The heat pump water heater according to any one of claims 1 to 4, wherein the heat resistance R1 between the hot water tank and the heat pump unit on an inner side is greater than the heat resistance R1 on an outer side.

[Fig. 1]

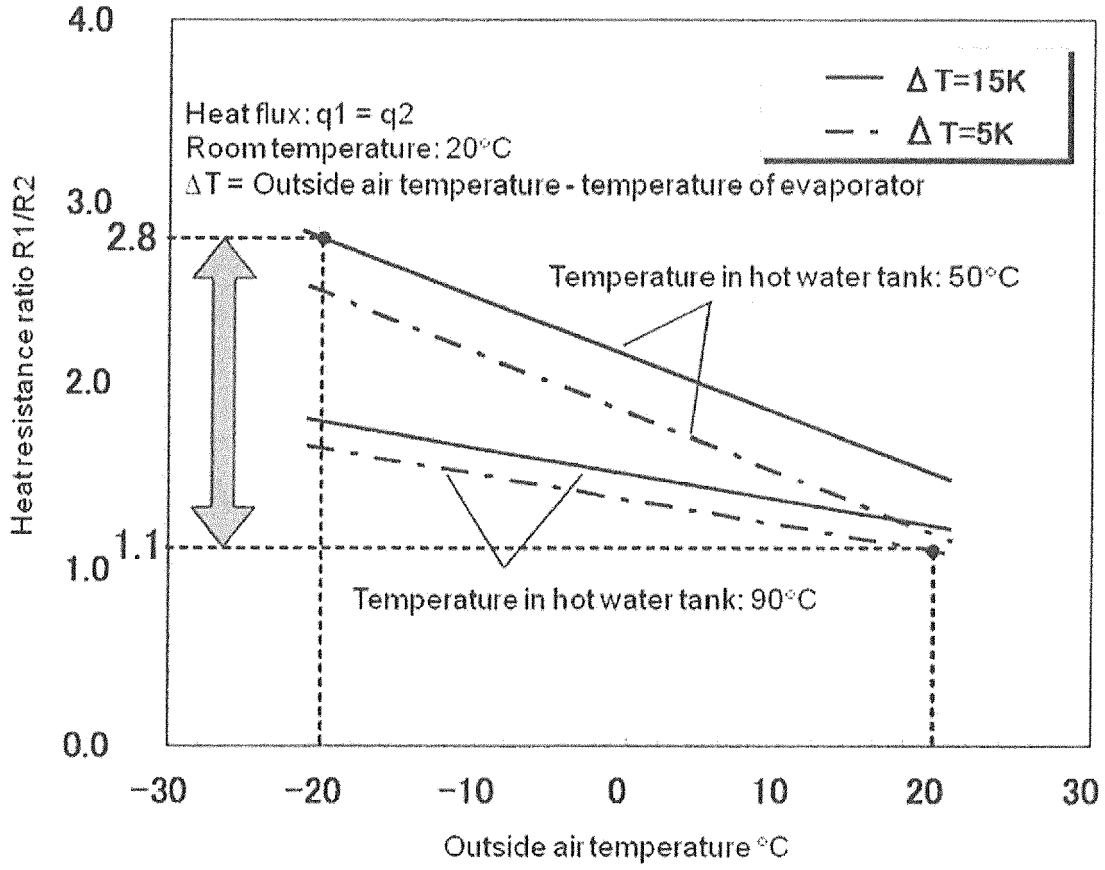


1A	Heat pump water heater
1	Heat pump unit
4	Hot water tank unit
5	Partition
24	Evaporator
41	Hot water tank

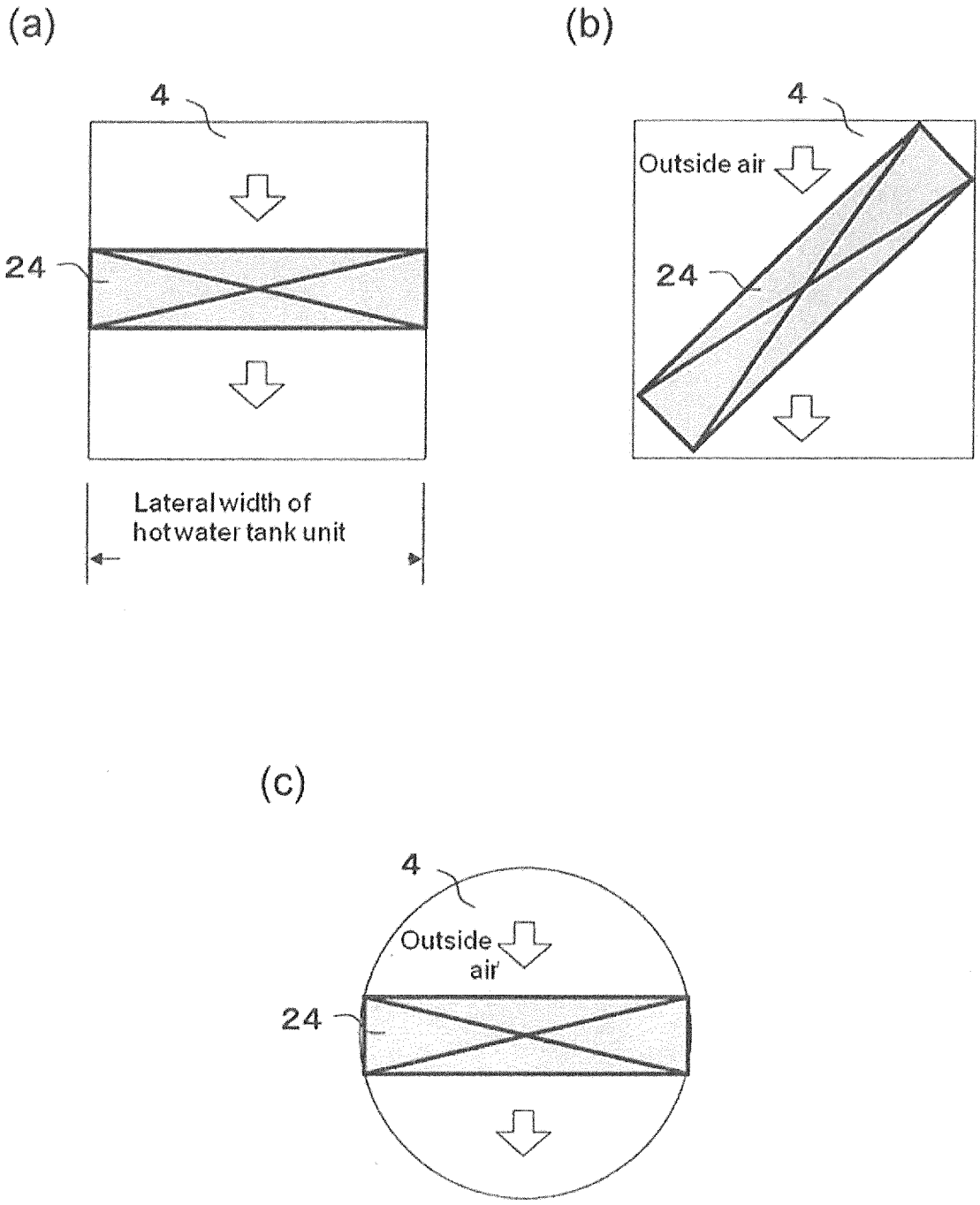
Heat movement to evaporator

Heat movement to side surface of hot water tank unit

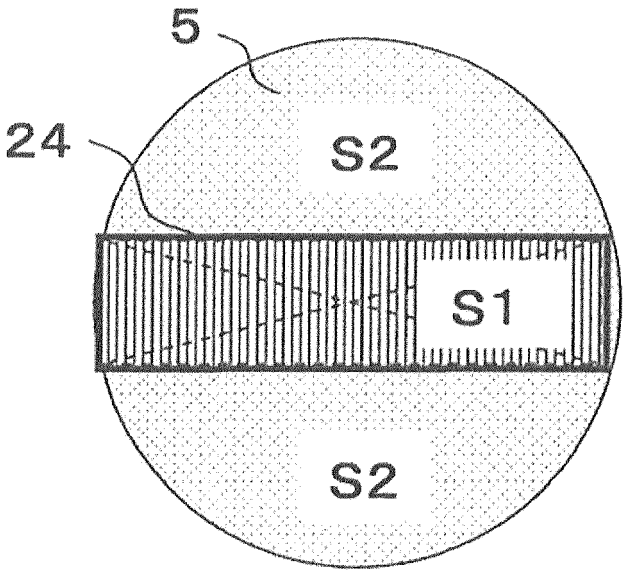
[Fig. 2]


4.0
3.0
2.8
2.0
1.1
1.0
0.0
Heat resistance ratio R1/R2
Heat flux: q1 = q2
Room temperature: 20°C
ΔT = Outside air temperature - temperature of evaporator
ΔT=15K
ΔT=5K
Temperature in hot water tank: 50°C
Temperature in hot water tank: 90°C
−30
−20
−10
0
10
20
30
Outside air temperature °C

[Fig. 3]

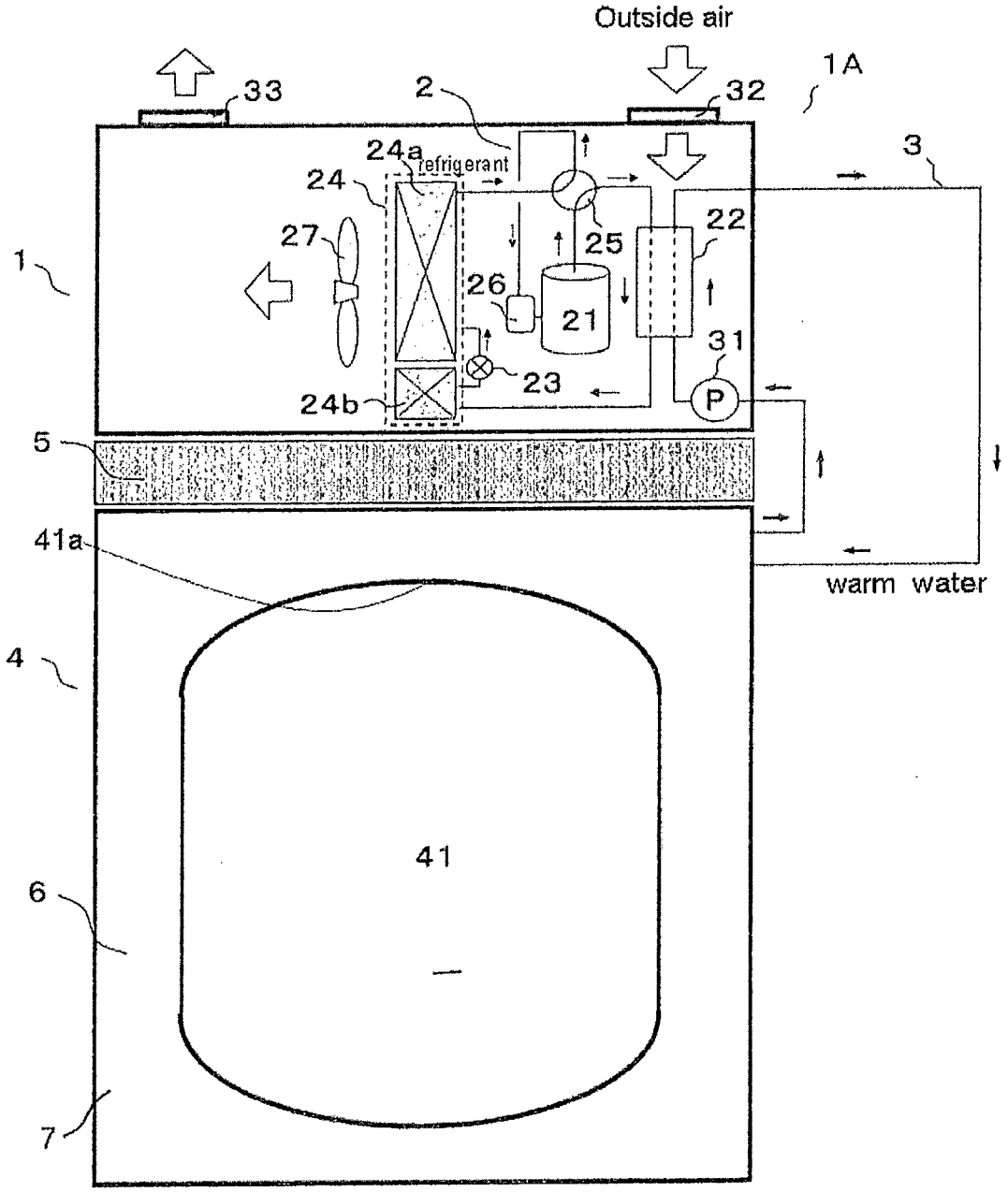

(a)
4
24
Lateral width of hot water tank unit
(b)
4
Outside air
24
(c)
4
Outside air
24

[Fig. 4]

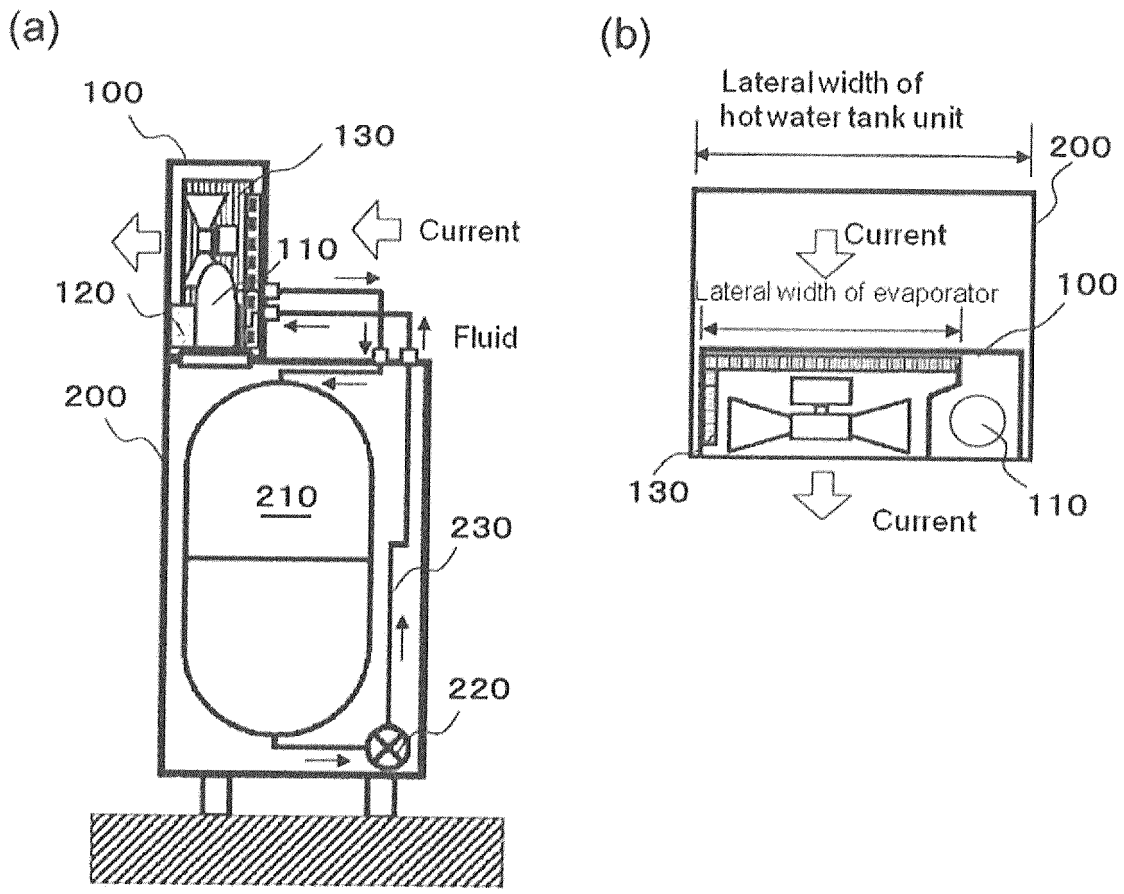


S1: region having large heat resistance
S2: region having small heat resistance

[Fig. 5]


Outside air
1A
33
2
32
3
24a
refrigerant
24
27
25
22
1
26
21
31
23
24b
P
5
41a
warm water
4
41
6
7

[Fig. 6]


(a)
100
130
Current
110
120
Fluid
200
210
230
220
(b)
Lateral width of
hot water tank unit
200
Current
Lateral width of evaporator
100
130
110
Current

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EUROPEAN SEARCH REPORT

Application Number
EP 13 19 3291

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Y	* pages 8-13 * * figures 1, 2 *	4	
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Place of search	Date of completion of the search	Examiner
Munich	25 March 2014	Schwaiger, Bernd

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1

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