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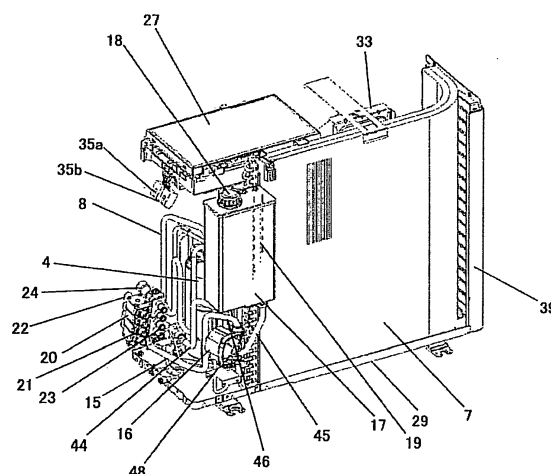
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(54) **Heat pump hydronic heater**

(57) A heat pump hydronic heater of the present invention includes a refrigerant circuit 8, a circulation pump 16 which circulates a heating medium heated by a water refrigerant heat exchanger to an external radiator, and a cistern 17 in which the heating medium is stored, and the circulation pump 16 is disposed below the cistern 17. A pipe which connects the cistern and the circulation pump to each other can be a short pipe, bending times can be reduced and thus, power of the circulation pump 16 can be reduced and as a result, power consumption can be reduced, energy can be saved and efficiency can be enhanced. Noise and vibration can be reduced, maintenance performance is excellent and the heat pump hydronic heater can be designed compact.

[Fig. 1]



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Description

[Technical Field]

[0001] The present invention relates to a heat pump hydronic heater which heats a heating medium such as water and antifreezing liquid to warm up a room.

[Background Technique]

[0002] As a conventional heat pump hydronic heater of this kind, there is one including a refrigerant circuit, a water refrigerant heat exchanger, a circulation pump and a cistern.

The refrigerant circuit is formed by annularly connecting a compressor, a water refrigerant heat exchanger, decompressing means and an evaporator to one another. The water refrigerant heat exchanger receives supply of a refrigerant from this refrigerant circuit, and heats a heating medium such as low temperature water or antifreezing liquid by heat exchange. The circulation pump conveys a heating medium such as water and antifreezing liquid heated by the water refrigerant heat exchanger. The heating medium such as heated water and antifreezing liquid is stored in the cistern. The cistern and the circulation pump are placed on a heat pump apparatus.

[0003] Figs. 10 are an upper surface interior view of a conventional heat pump hydronic heater 100 and a front interior view of essential portions of the heat pump hydronic heater 100.

The heat pump hydronic heater 100 includes a cistern 101 and a circulation pump 102. The cistern 101 replenishes a heating medium such as water and antifreezing liquid, and functions as a buffer of the heating medium such as expanded water and antifreezing liquid. The circulation pump 102 supplies hot water to an external radiator (such as floor heating system and fan convector) installed at a separated place. An entire periphery of the heat pump hydronic heater 100 is covered with an exterior frame 103. An interior of the heat pump hydronic heater 100 is vertically divided by a vertical divider 105. A heat pump apparatus 104 is disposed below the vertical divider 105, and the cistern 101 and the circulation pump 102 are disposed above the vertical divider 105.

A heating medium outward port 106 and a heating medium return port 107 are disposed above the vertical divider 105. The heating medium outward port 106 and the heating medium return port 107 include a plurality of connection ports for connecting the external radiator and pipes to each other. The plurality of connection ports provided in the heating medium outward port 106 and the heating medium return port 107 are oriented rearward. A pipe cover 108 in which a power cord or the like is accommodated is provided on a right side of the heat pump apparatus 104 (see patent document 1 for example).

[0004] Fig. 11 shows an air conditioner having hot water heating function.

According to this air conditioner having hot water heating function, a refrigerant circuit including a compressor 112 is accommodated in an outdoor casing 111. A unit box 113 is provided on a back surface of the outdoor casing 111, and a cistern 114 is accommodated in the unit box 113.

A circulation pump 115 is disposed on a side of the compressor 112 in the outdoor casing 111. A heating medium outward port 116 and a heating medium return port 117 connected to an external radiator are disposed on a lower surface of the outdoor casing 111 below the cistern 114 (see patent document 2 for example).

[Prior Art Documents]

[Patent Documents]

[0005]

[Patent Document 1] Japanese Patent Application Laid-open No.2010-144986

[Patent Document 2] Japanese Patent No.4049602

[Summary of the Invention]

[Problem to be Solved by the Invention]

[0006] According to the configuration of patent document 1, however, the cistern 101 in which water is stored and the circulation pump 102 for conveying water are located above the heat pump apparatus 100. Hence, when expanded water overflows and leaks from the cistern 101 or when water leaks from a joint portion of the pipe of the circulation pump 102, the water flows toward the heat pump apparatus 100 and enters the heat pump apparatus 100.

To prevent such a case, it is necessary to take measures including providing a weir around the cistern 101, but the measures increase the number of parts and increase the cost.

[0007] The configuration of patent document 2 using the air conditioner having hot water heating function, a basic configuration is different from the heat pump hydronic heater. According to the configuration of patent document 2, the circulation pump 115 is accommodated in the outdoor casing 111. Therefore, a distance between the circulation pump 115 and the cistern 114 becomes long, efficiency is deteriorated and a pressure loss is increased. Since the circulation pump 115 is accommodated in the outdoor casing 111 together with the compressor 112, there is fear that the circulation pump 115 and the compressor 112 resonate and produce abnormal sound. Further, since the circulation pump 115 is in the outdoor casing 111, there is a problem that it is difficult to exchange the circulation pump 115.

[0008] The present invention has been accomplished to solve the above problems, and it is an object of the invention to provide a heat pump hydronic heater which

reduces noise and enhances maintenance performance.

[Means for Solving the Problems]

[0009] To solve the conventional problems, a heat pump hydronic heater of the present invention includes: a refrigerant circuit formed by connecting a compressor, a water refrigerant heat exchanger, a decompressor and an evaporator to one another; a circulation pump which circulates a heating medium heated by the water refrigerant heat exchanger to an external radiator; and a cistern in which the heating medium is stored, characterized in that the circulation pump is disposed below the cistern.

[Effect of the Invention]

[0010] According to the present invention, it is possible to provide a heat pump hydronic heater which reduces noise and enhances maintenance performance.

[Brief Description of the Drawings]

[0011]

Fig. 1 is a rear interior perspective view of a heat pump hydronic heater according to a first embodiment of the present invention;

Fig. 2 is a front interior perspective view of the heat pump hydronic heater;

Fig. 3 is a rear interior perspective view of the heat pump hydronic heater;

Fig. 4 is a front interior perspective view of the heat pump hydronic heater;

Fig. 5(a) is a front external perspective view of the heat pump hydronic heater and Fig. 5(b) is a rear external perspective view of the heat pump hydronic heater;

Fig. 6 is an interior side view of essential portions of the heat pump hydronic heater;

Fig. 7 is a refrigerant circuit and hot water circuit diagram of the heat pump hydronic heater;

Fig. 8 is a rear outward working diagram of the heat pump hydronic heater;

Fig. 9 is a refrigerant circuit and hot water circuit diagram of the heat pump hydronic heater;

Fig. 10(a) is an upper surface interior view of a conventional heat pump hydronic heater and Fig. 10(b) is a front view of the conventional heat pump hydronic heater; and

Fig. 11(a) is a rear outward perspective view of a conventional air conditioner having hot water heating function and Fig. 11(b) is a front view of the conventional air conditioner having hot water heating function.

[Explanation of Symbols]

[0012]

- 2 external radiator
- 3 heating medium pipe
- 4 compressor
- 5 water refrigerant heat exchanger
- 7 evaporator
- 8 refrigerant circuit
- 9 blast fan
- 15 hot water circuit
- 16 circulation pump
- 17 cistern
- 21 heating medium outward port
- 23 heating medium return port
- 36 sheath body
- 47 rear sheath body
- 49 vibration-isolating rubber

[Mode for Carrying Out the Invention]

[0013] A first aspect of the invention provides a heat pump hydronic heater including: a refrigerant circuit formed by connecting a compressor, a water refrigerant heat exchanger, a decompressor and an evaporator to one another; a circulation pump which circulates a heating medium heated by the water refrigerant heat exchanger to an external radiator; and a cistern in which the heating medium is stored, characterized in that the circulation pump is disposed below the cistern.

According to this configuration, a pipe which connects the cistern and the circulation pump can be shortened, and the number of bent portions can be reduced. Hence, the power of the circulation pump can be reduced. As a result, power consumption can be reduced, energy can be saved, and efficiency can be enhanced.

When the heat pump hydronic heater is installed, a heating medium such as water and antifreezing liquid in the cistern first enters the circulation pump before the heat pump hydronic heater is operated, and air entrainment is not produced in the circulation pump, it is possible to easily distribute the heating medium such as water and antifreezing liquid to the entire pipe paths uniformly in a state where no air entrainment exists, and the constructing time can be shortened.

[0014] According to a second aspect of the invention, the heat pump hydronic heater further includes a sheath body in which the refrigerant circuit is accommodated, the sheath body includes a rear sheath body which projects outward, and the cistern and the circulation pump are accommodated in the rear sheath body.

According to this configuration, the cistern and the circulation pump are disposed on the rear sheath body which protrudes rearward of the sheath body. Hence, the circulation pump can be disposed away from the compressor which is a source of vibration and noise. Therefore, abnormal noise generated by resonance between the circulation pump and the compressor can be prevented, and it is possible to reduce the noise and vibration.

Especially, the circulation pump is separated from the compressor. This means that a sufficient pipe space can

be secured around the compressor, the pipe can be routed using sufficient space, and it is possible to easily reduce the noise and vibration.

[0015] According to the third aspect of the invention, the circulation pump is placed on a bottom plate of the rear sheath body.

According to this configuration, the compressor which is a vibration source is placed on the bottom plate of the sheath body, and the circulation pump is placed on a rear bottom plate of another rear sheath body. Hence, abnormal noise generated by resonance between the circulation pump and the compressor can be prevented, and it is possible to reduced the noise and vibration.

[0016] According to a fourth aspect of the invention, the circulation pump is placed on a vibration-isolating member, and the circulation pump is held by a pipe which is connected to the cistern.

According to this configuration, the flexibility of the circulation pump is enhanced, vibration can be reduced, and when it is necessary to exchange the circulation pump due to trouble of the circulation pump, if the rear sheath body is detached, the circulation pump can be seen from outside. Further, since the circulation pump is placed on the cushion rubber without fixing the circulation pump using a screw, it is possible to easily detach the circulation pump.

It is possible to easily mount a new circulation pump, and the maintenance performance of the heat pump hydronic heater can be enhanced.

[0017] According to a fifth aspect of the invention, a bottom of the rear sheath body is located above a lowermost portion of the sheath body, and a heating medium outward port and a heating medium return port which are for connecting the sheath body and the external radiator to each other through pipe are disposed on a side of the sheath body.

According to this configuration, when a heating medium pipe connected to the heating medium outward port and the heating medium return port is routed in the left direction of the outdoor unit of the heat pump hydronic heater, there is fear that the heating medium pipe closes the evaporator, but the heating medium pipe is mounted on the right side of the sheath body of the heat pump hydronic heater, and the heating medium pipe is made to pass through a space below a rear sheath plate which protrudes in a convex form rearward of the body. Hence, it is possible to prevent the heating medium pipe from being disposed at a high location, and to prevent the heating medium pipe from closing the evaporator.

That is, it is possible to prevent an amount of air passing through the evaporator from being reduced, prevent the performance from being deteriorated, and prevent power consumption from increasing, and energy of the heat pump hydronic heater can excellently be saved.

[0018] Embodiments of the present invention will be described with reference to the drawings. The invention is not limited to the embodiments.

(First Embodiment)

[0019] A heat pump hydronic heater of a first embodiment of the present invention will be described based on Figs. 1 to 8.

[0020] The first embodiment will be described using a refrigerant circuit and water circuit diagram of the heat pump hydronic heater of Fig. 7.

The heat pump hydronic heater includes an outdoor unit 1 and external radiators 2. The outdoor unit 1 heats a heating medium such as water and antifreezing liquid. The external radiators 2 are connected to the outdoor unit 1 through heating medium pipes 3. The heating medium circulates through the outdoor unit 1 and the external radiators 2. Each of the external radiators 2 is a panel external radiator such as a floor heating system, but the external radiator 2 may be a radiator such as a fan convector including a panel heater or a blast fan 9.

The heating medium heated by the outdoor unit 1 is sent to the external radiators 2 through the heating medium pipes 3, and warms up a room where the external radiator 2 is installed. In the heat pump hydronic heater, the outdoor unit 1 is a heat source thereof.

[0021] The outdoor unit 1 as the heat pump heat source is provided therein with the following parts.

The outdoor unit 1 includes a compressor 4 which compresses a refrigerant, a water refrigerant heat exchanger 5 which exchanges heat between a heating medium and a refrigerant, an expansion valve 6 which is decompressing means, and an evaporator 7. The compressor 4, the water refrigerant heat exchanger 5, the decompressing means 6 and the evaporator 7 are annularly connected to one another to configure a refrigerant circuit 8, and a refrigerant circulates through the refrigerant circuit 8.

The water refrigerant heat exchanger 5 is composed of a copper pipe having high thermal conductivity, and is of a double pipe structure including a refrigerant pipe 5a disposed outside and a water pipe 5b disposed inside. A refrigerant flows between an inner peripheral surface of the refrigerant pipe 5a and an outer peripheral surface of the water pipe 5b, and a heating medium flows in the water pipe 5b. A flowing direction of the refrigerant and a flowing direction of the heating medium are opposite from each other. The refrigerant heats the heating medium.

[0022] The blast fan 9 conveys air to the evaporator 7, and promotes the heat-exchanging ability of the evaporator 7.

A condensation temperature sensor 10 is brazed to and mounted on the water refrigerant heat exchanger 5. A compressor outlet temperature sensor 11 is provided in a compressor discharge pipe 12 of the compressor 4. An air heat exchanging outlet temperature sensor 13 is provided in an air heat exchanging outlet pipe 14 of the evaporator 7.

The outdoor unit 1 includes a hot water circuit 15. The hot water circuit 15 includes a circulation pump 16. The circulation pump 16 is disposed upstream of the water

refrigerant heat exchanger 5. The hot water circuit 15 is connected to the heating medium pipe 3, and the circulation pump 16 circulates a heating medium between the external radiator 2 and the water refrigerant heat exchanger 5.

A cistern 17 is disposed upstream of the circulation pump 16. The cistern 17 adjusts an amount of a heating medium which circulates through the water refrigerant heat exchanger 5, the hot water circuit 15, the heating medium pipe 3 and the external radiator 2. If the circulation amount becomes deficient, the cistern 17 replenishes the heating medium, and if the circulation amount increases due to expansion, the cistern 17 stores the heating medium.

The cistern 17 includes a cap 18 which opens for replenishing the heating medium, and a water level sensor 19 which detects a water level in the cistern 17.

[0023] An outward-side terminal of the hot water circuit 15 includes thermally-actuated valves 20. The plurality of external radiators 2 includes the thermally-actuated valves 20. The thermally-actuated valves 20 provided on the external radiator 2 which is used are opened, the thermally-actuated valves 20 provided in the external radiator 2 which is not used or the thermally-actuated valves 20 which are not connected to the external radiator 2 are closed, and control is performed such that hot water flows only to the required external radiator 2. An outlet side of the hot water circuit 15 includes heating medium outward ports 21, and an inlet side of the hot water circuit 15 includes heating medium return ports 23. The heating medium outward ports 21 are provided downstream of the thermally-actuated valve 20, and the heating medium pipe 3 is connected to the heating medium outward ports 21. Although the thermally-actuated valves 20 are provided at four locations in Fig. 7, the heating medium pipe 3 is connected to only two locations, and the number of external radiators 2 is also two. When all of the external radiators 2 are not used, the thermally-actuated valves 20 are closed.

An outward header pipe 22 divides the hot water circuit 15 into the plurality of circuits, and connects the plurality of thermally-actuated valves 20. When the number of thermally-actuated valves 20 is one, the thermally-actuated valve 20 is connected to the hot water circuit 15 without using the outward header pipe 22.

[0024] The heating medium return ports 23 are connected to the heating medium pipe 3. Hot water dissipates heat in the external radiator 2 and temperature thereof is lowered, and the hot water returns to the heating medium pipe 3. Then number of heating medium return ports 23 is the same as that of the thermally-actuated valves 20, and the number is four in Fig. 7.

The heating medium return ports 23 are connected to the hot water circuit 15 (return port heating medium pipe 44) through the return header 24. When the number of thermally-actuated valves 20 and the heating medium return ports 23 is one, the heating medium return ports 23 are connected to the hot water circuit 15 (return port

heating medium pipe 44) without using the return header 24.

[0025] A water refrigerant heat exchanger inlet temperature sensor 25 measures temperature of a heating medium which enters the water refrigerant heat exchanger 5. A water refrigerant heat exchanger outlet temperature sensor 26 measures temperature of a heating medium on the side of the outlet of the water refrigerant heat exchanger 5.

10 A control device 27 controls various actuators and sensors of the heat pump hydronic heater. A remote control unit 28 is used when a user operates the heat pump water heater or carries out various setting operations.

[0026] Figs. 1 to 6 show the outdoor unit shown in the refrigerant circuit and hot water circuit diagram of the heat pump hydronic heater shown in Fig. 7, wherein Figs. 1 to 4 are interior perspective view, Fig. 5 is an external perspective view and Fig. 6 is a side view of interior essential portions. The same members as those shown in Fig. 7 are designated with the same symbols.

[0027] As shown in Figs. 1 and 2, there is a bottom plate 29 at a lowermost portion of the outdoor unit 1, and the compressor 4 is placed on a right side on the bottom plate 29. The water refrigerant heat exchanger 5 is of a double pipe structure including the refrigerant pipe 5a disposed outside and the water pipe 5b. The water refrigerant heat exchanger 5 is placed on the bottom plate 29. The pipe of the double pipe structure has a spiral shape so that the heat exchanger can be made compact. The compressor discharge pipe 12 is connected to the water refrigerant heat exchanger 5. A refrigerant is compressed to a high pressure by the compressor 4 and is discharged out, and this refrigerant flows into the water refrigerant heat exchanger 5 from an uppermost front surface of the refrigerant pipe 5a.

35 A heating medium moves from the water pipe 5b located at a lower most portion to the water pipe 5b located above the former water pipe 5b and is heated. The heating medium is heated to high temperature and density thereof is lowered, and the heating medium is guided from the water pipe 5b located at the upper portion into the heating medium pipe 3, a buoyant force is added and power of the circulation pump 16 can be reduced. The hot water circuit 15 which connects the water refrigerant heat exchanger 5, the thermally-actuated valves 20 and the heating medium return ports 23 to each other passes through the front surface of the compressor 4.

[0028] The radiator heat insulator 30 shown in Fig. 4 includes a radiator upper heat insulator 30a and a radiator lower heat insulator 30b formed from heat insulator such as Styrofoam to enhance heat insulating properties of the water refrigerant heat exchanger 5. The water refrigerant heat exchanger 5 is sandwiched between the radiator upper heat insulator 30a and the radiator lower heat insulator 30b. The radiator lower heat insulator 30b is placed on the bottom plate 29 such that the radiator heat insulator 30 engages with concavity and convexity on a flat surface of the bottom plate 29.

A cover body 31 shown in Fig. 4 is disposed on an outer and upper side of the radiator heat insulator 30, and covers front, rear, left, right and upper surfaces of the radiator upper heat insulator 30a and the radiator lower heat insulator 30b. Although a configuration using a part which is different from the radiator heat insulator 30 is used as the cover body 31 is shown in the drawing, it is also possible to form the cover body 31 and the radiator heat insulator 30 as an integrally formed one part. Although portions of the radiator heat insulator 30 and the cover body 31 are cut so that the water refrigerant heat exchanger 5 can be seen in Fig. 4, the actual radiator heat insulator 30 and cover body 31 are not cut.

[0029] The evaporator 7 is bent into an L-shape to surround a rear side portion of the water refrigerant heat exchanger 5, and the evaporator 7 is placed on the bottom plate 29.

The blast fan 9 is disposed in the evaporator 7 and above the cover body 31, the blast fan 9 makes air forcibly pass through the evaporator 7, and promotes the heat exchange between the air and a refrigerant. A blast motor 32 drives the blast fan 9, and a motor stage 33 holds the blast motor 32. The motor stage 33 is fixed to an upper surface of the cover body 31.

A divider 34 isolates, from each other, a space in which the blast fan 9 and the water refrigerant heat exchanger 5 are disposed and a space in which the compressor 4 and the expansion valve 6 that is decompressing means are disposed.

The control device 27 is placed above the divider 34. A power cord connection terminal 35a and a remote control unit connection terminal 35b are provided on the right side of the control device 27.

The various parts described above are accommodated in a sheath body 36 of a heat pump hydronic heater body. As shown in an external perspective view of Figs. 5, the sheath body 36 includes a front plate 37, a right plate 38, a left plate 39 and a ceiling plate 40. The front plate 37 which covers a front side, the right plate 38 which covers a right side and a right and rear side, and the left plate 39 which covers a left side are mounted on the bottom plate 29. The ceiling plate 40 which covers an upper side is placed on the front plate 37, the right plate 38 and the left plate 39.

[0030] The plurality of thermally-actuated valves 20 protrude outside of the right plate 38 and are vertically disposed at a location on a right side of the sheath body 36 and on a right and outer side of the compressor 4. When the number of thermally-actuated valves 20 is one, the one thermally-actuated valve 20 is disposed outside of the right plate 38. A heating medium is heated by the water refrigerant heat exchanger 5 and it becomes hot water, and the thermally-actuated valve 20 sends this heating medium to the external radiator 2 through the heating medium pipe 3.

The plurality of heating medium return ports 23 likewise protrude outside of the right plate 38 on a side of the thermally-actuated valve 20 and are vertically disposed.

A heating medium dissipates heat in the external radiator 2 and temperature thereof is lowered. This heating medium is returned to the hot water circuit 15 by the heating medium return port 23.

[0031] The thermally-actuated valves 20 and the heating medium return ports 23 are mounted on a port mounting tool 41. A port mounting tool cover 42 covers the port mounting tool 41. The port mounting tool 41 and the port mounting tool cover 42 are mounted such that they protrude outside of the right plate 38. When a maintenance operation is carried out, the port mounting tool cover 42 is detached, and it is possible to touch a pipe of the hot water circuit 15.

That is, the thermally-actuated valves 20, the heating medium return ports 23, the port mounting tool 41 on which the thermally-actuated valves 20 and the heating medium return ports 23 are mounted, and the port mounting tool cover 42 are disposed at locations protruding sideways from the sheath body 36 of the heat pump hydronic heater.

The outward header pipe 22 is connected to the thermally-actuated valve 20, and the outward header pipe 22 and the water pipe 5b of the water refrigerant heat exchanger 5 are connected to each other through a thermally-actuated valve pipe 43 which is the hot water circuit 15. The water refrigerant heat exchanger outlet temperature sensor 26 is mounted on the thermally-actuated valve pipe 43.

[0032] The cistern 17 protrudes rearward of the right plate 38 existing behind the compressor 4. The return port heating medium pipe 44 is connected to a lower surface of the cistern 17. The return port heating medium pipe 44 is connected to the return header 24 which is integrally formed on the heating medium return port 23.

A heating medium dissipates heat in the external radiator 2 and temperature thereof is lowered. The heating medium is guided to the cistern 17 by the return port heating medium pipe 44.

The cistern 17 functions to absorb volume expansion of the heating medium which is heated from low temperature to high temperature and whose volume is increased. Especially when antifreezing liquid having large volume expansion ratio is used as the heating medium, a capacity of the cistern 17 is determined so that the heating medium does not overflow.

[0033] The cap 18 is provided above the cistern 17. The cap 18 is detached and a heating medium is replenished to the cistern 17. A slit is formed in a portion of the cap 18, and increased pressure in the cistern 17 is released from the slit.

When a heating medium more than prescribed amount is input to the cistern 17, expanded heating medium is made to overflow from the cap 18. Since the cistern 17 protrudes rearward from the right plate 38 located behind the compressor 4, the overflowing heating medium can be released outward.

The water level sensor 19 provided in the cistern 17 detects a water level in the cistern 17, and if the water level

is lowered, the water level sensor 19 issues a warning to a user and displays the warning on the remote control unit 28, thereby urging the user to replenish the heating medium.

The circulation pump 16 is disposed below the cistern 17. Like the cistern 17, the circulation pump 16 protrudes toward a back surface of the right plate 38 located behind the compressor 4.

[0034] A pump outward pipe 45 which is pulled out from a lower portion of the cistern 17 is connected to the circulation pump 16 disposed below the cistern 17, and a heating medium such as water and antifreezing liquid flows through the pump outward pipe 45 from an upper side to a lower side.

That is, the cistern 17, the pump outward pipe 45 and the circulation pump 16 are disposed at positions protruding toward the back surface of the right plate 38 located behind the compressor 4.

The circulation pump 16 carries out operation such that hot water forcibly circulates through the hot water circuit 15. The water refrigerant heat exchanger 5 and the pump outward pipe 46 are connected to the circulation pump 16. A water refrigerant heat exchanger inlet temperature sensor 25 which measures temperature of hot water entering the water refrigerant heat exchanger 5 is mounted on the pump outlet pipe 46.

[0035] Figs. 5 are external perspective views of the heat pump hydronic heater in a state where the sheath body 36 is mounted. The circulation pump 16 and the cistern 17 are covered with a rear sheath body 47 which protrudes in a convex form rearward of the right plate 38 of the sheath body 36 behind the compressor 4. The rear sheath body 47 prevents water from entering the circulation pump 16 and the cistern 17 from outside. The rear sheath body 47 includes a rear bottom plate 47a, a rear side plate 47b and a rear upper plate 47c.

[0036] Fig. 6 is an interior side view. The circulation pump 16 disposed below the cistern 17 is placed on a pump stage 48 fixed to the rear bottom plate 47a. The pump stage 48 is fixed to the rear bottom plate 47a (concerning rear bottom plate 47a, see Fig. 3).

A vibration-isolating rubber 49 is provided above the pump stage 48. The circulation pump 16 is placed on the vibration-isolating rubber 49. The circulation pump 16 is biased upward by the pump outward pipe 45 and the pump outlet pipe 46, a lower portion of the circulation pump 16 is merely placed on the vibration-isolating rubber 49, and is not fixed by means of a screw, and is held by a holding structure having high flexibility.

Fig. 7 is a refrigerant circuit and water circuit diagram of the heat pump hydronic heater. As shown in Fig. 7, a range surrounded by a broken line A falls within the rear sheath body 47 which is disposed behind the compressor 4.

[0037] Referring back to Fig. 5, a pipe cover 50 is provided on a right and outer side of the right plate 38, and the port mounting tool 41 and the port mounting tool cover 42 are mounted on the right plate 38 inside the pipe cover

50. The thermally-actuated valves 20 and the heating medium return ports 23 are mounted on the port mounting tool 41, thereby likewise preventing water from entering from outside.

5 The front plate 37 of the sheath body 36 is provided with a transfer port 37a which is concentric with the blast fan 9. The transfer port 37a is provided with a bell mouth 37b. The bell mouth 37b has a squeezed or narrowed shape which is concentric with the blast fan 9, and which is curved in a substantially semi-circular radially outward form from its inner peripheral.

10 If the blast fan 9 rotates, air is sucked from the evaporator 7 and is discharged out from the transfer port 37a of the front plate 37, thereby exchanging heat.

15 A transfer grille 51 has a grid-shaped opening through which wind from the blast fan 9 passes. The transfer grille 51 is provided such that it protrudes forward of the transfer port 37a of the front plate 37, and the transfer grille 51 rectifies wind, thereby reducing noise, and also functions to protect such that a hand does not touch the blast fan 9.

[0038] Fig. 8 is a working diagram showing that the heating medium pipe 3 is mounted on the outdoor unit 1 of the heat pump hydronic heater.

25 An outdoor unit 1 is placed on a block base 52, and the outdoor unit 1 is held such that it floats by about 100 mm. The block base 52 is generally made of concrete or resin. The heating medium pipe 3 is mounted on the heating medium outward port 21 and the heating medium return port 23. An interior of the heating medium pipe 3 is a crosslinked polyethylene pipe, and a heat insulator is provided outside of the crosslinked polyethylene pipe.

30 The heating medium pipe 3 is connected to the external radiator 2, a heating medium heated by the outdoor unit 1 is sent from the heating medium outward port 21 to the external radiator 2 through the heating medium outward pipe 3a, thereby warming up a room. The heating medium whose heat is exchanged there and whose temperature is lowered passes through a heating medium return pipe 3b, returns to the heating medium return port 23, and the heating medium is again heated in the outdoor unit 1 of the heat pump hydronic heater, and these operations are repeated.

35 The heating medium pipe 3 is rotated in a left direction of the body in Fig. 8, but in the case of the left direction also, the heating medium pipe 3 is routed straightly in some cases.

[0039] The operation of the heat pump hydronic heater will be described based on the drawings.

50 If the compressor 4 is operated, a refrigerant is compressed to a high pressure and is discharged. The refrigerant passes through the compressor discharge pipe 12, and is sent to the water refrigerant heat exchanger 5, and exchanges heat with a heating medium which is sent by the circulation pump 16 and the refrigerant dissipates heat. According to this operation, the heated heating medium is changed from a low temperature heating medium to a high temperature heating medium.

A refrigerant which flows out from the water refrigerant heat exchanger 5 is decompressed and expanded by the expansion valve 6, is sent to the evaporator 7, exchanges heat with air which is sent by the blast fan 9, and while the refrigerant passes through the evaporator 7, the refrigerant is evaporated and gasified. The gasified refrigerant is sucked into the compressor 4, is again compressed, and this process is repeated, and the low temperature heating medium which passes through the water refrigerant heat exchanger 5 is gradually heated.

[0040] Concerning the hot water circuit 15, a heating medium is heated in the water refrigerant heat exchanger 5 by operating the circulation pump 16, the heated heating medium is forcibly sent to the outward header pipe 22, the heating medium is divided into a plurality of locations (four locations in the drawing, but the heating medium is not divided in some cases), and they are sent to the thermally-actuated valves 20.

One of the thermally-actuated valves 20 through which a heating medium flows to the external radiator 2 is set by the remote control unit 28, the set thermally-actuated valve 20 is opened, and other thermally-actuated valves 20 are closed. A heating medium passes through a pipe which is provided outside of the outdoor unit 1 via the thermally-actuated valve 20 and the heating medium outward port 21, and the heating medium is guided into the external radiator 2. The heating medium dissipates heat in the external radiator 2, and warms up a room where the external radiator 2 is installed.

The heating medium which dissipates heat in the external radiator 2 and whose temperature is lowered passes through the heating medium pipe 3, and flows toward the heating medium return port 23. The heating medium passes through the heating medium return port 23 and the return header 24, passes through the return port heating medium pipe 44 and enters the cistern 17 from a lower surface of the cistern 17. A constant amount of heating medium such as water and antifreezing liquid exists in the cistern 17 such that an air layer exists above the heating medium.

[0041] Thereafter, the heating medium similarly passes through the pump outward pipe 45 from the lower surface of the cistern 17, is forcibly sucked into the circulation pump 16, and is forcibly sent to the pump outlet pipe 46 by the circulation pump 16, and the heating medium whose temperature is lowered is heated by the water refrigerant heat exchanger 5, and is again guided into the external radiator 2, and these operations are repeated, and the heating medium such as water and antifreezing liquid which dissipates heat in the external radiator 2 warms up a room.

At this time, the actuators which carry out the operation are the compressor 4, the circulation pump 16, the blast motor 32 (blast fan 9) and the expansion valve 6. Three of them, i.e., the compressor 4, the circulation pump 16 and the blast motor 32 (blast fan 9) are main noise sources and especially the compressor 4 generates the greatest noise.

[0042] Members which consume electric power are the compressor 4, the circulation pump 16, the blast fan 9 and the thermally-actuated valve 20 having the greatest power consumption. Among them, the thermally-actuated valve 20 is energized when the hot water circuit 15 opens. Therefore, power consumption varies depending upon the number of opened thermally-actuated valves 20.

At this time, if the circulation pump 16 is disposed below the cistern 17, the pump outward pipe 45 can be shortened, and power of the circulation pump 16 can be reduced. As a result, power consumption can be reduced by reducing the input, COP of the heat pump hydronic heater can be enhanced and energy can be saved.

A heating medium can be guided from the cistern 17 to the circulation pump 16 by the gravity, power of the circulation pump 16 can be reduced, power consumption can be reduced and energy can be saved. By placing the circulation pump 16 below the cistern 17, the pump outward pipe 45 can be made substantially straightly or the number of curved portions can be reduced. Therefore, there is an effect for reducing the power consumption.

[0043] Concerning the noise of the circulation pump 16 also, reduction in input means reduction of the number of rotations of the circulation pump 16 and as a result, it is possible to reduce the noise of the circulation pump 16. The cistern 17 and the circulation pump 16 are disposed on the back surface of the right plate 38 behind the compressor 4 and the sheath body 36, and the cistern 17 and the circulation pump 16 protrude rearward of the right plate 38. Therefore, the circulation pump 16 can be disposed at a location separated away from the compressor 4.

As described above, the member which generates the greatest vibration and noise is the compressor 4, the vibration thereof is transmitted to the bottom plate 29 and the sheath body 36, and this generates noise and vibration of the heat pump hydronic heater.

At this time, if the circulation pump 16 which is operated like the compressor 4 resonates with the compressor 4, the vibration and noise are further increased, but since the circulation pump 16 is disposed at the location separated away from the compressor 4, the resonance is less prone to be produced, and it is possible to reduce the noise and vibration.

At this time, the circulation pump 16 is placed on the rear bottom plate 47a of the rear sheath body 47 which protrudes rearward of the right plate 38, and the circulation pump 16 is not placed on the same location as the bottom plate 29 where the compressor 4 is placed. Therefore, resonance is not produced almost at all, and the heat pump hydronic heater having low vibration can be obtained.

[0044] The circulation pump 16 is merely placed on the vibration-isolating rubber 49 on the pump stage 48 fixed to the rear bottom plate 47a, and the circulation pump 16 is not fixed using a screw, and this holding structure has high flexibility. This fact exerts an effect that

vibration of the circulation pump 16 is reduced or vibration is prevented from being transmitted to the sheath body 36 or the like.

The circulation pump 16 and the cistern 17 are disposed in the rear sheath body 47 which protrudes rearward of the right plate 38. Since the circulation pump 16 and the cistern 17 are separated away from the compressor 4, a sufficient pipe space can be secured around the compressor 4.

The various pipes such as the compressor discharge pipe 12 are connected to the compressor 4 which is the actuator having the greatest vibration and noise, thereby configuring the refrigerant circuit 8.

Since the sufficient space is secured around the compressor 4, it is possible to route the pipe using a sufficient space, and it is possible to easily reduce the vibration and noise. Fig. 1 shows the compressor discharge pipe 12 connected to the compressor 4, the compressor discharge pipe 12 is bent into a U-shape so that vibration can be absorbed. A pipe having the same shape can be provided around the compressor 4, and it is possible to reduce the vibration and noise.

[0045] When a heating medium such as water and antifreezing liquid in the cistern 17 is reduced and the water level sensor 19 issues a warning, it is necessary to open the cap 18 and replenish the heating medium such as water and antifreezing liquid. On the other hand, since the height of the body of the heat pump hydronic heater is the same as that of the other heat pump heat source having no circulation pump 16 and cistern 17, it is possible to easily replenish the heating medium.

[0046] When the heating medium pipe 3 (heating medium outward pipe 3a, heating medium return pipe 3b) is routed in the left direction of the outdoor unit 1 of the heat pump hydronic heater, there is fear that the heating medium pipe 3 closes the evaporator 7 but as shown in a working diagram in Fig. 8, the heating medium pipe 3 is mounted rearward on the right side of the outdoor unit 1 of the heat pump hydronic heater, and the heating medium pipe 3 protruding in the convex form rearward of the body is made to pass a space below the rear sheath body 47. According to this configuration, it is possible to prevent the heating medium pipe 3 from being disposed on the upper side, and to prevent the heating medium pipe 3 from closing the evaporator 7. An amount of air which passes through the evaporator 7 is reduced, it is possible to prevent performance from being deteriorated and prevent power consumption from increasing, and the heat pump hydronic heater having excellent energy-saving technology can be obtained.

Here, the heating medium pipe 3 is routed in the left direction of the outdoor unit 1 of the heat pump hydronic heater, but when the heating medium pipe 3 is routed in the right direction, since the evaporator 7 is not closed, no problem occurs. When the heating medium pipe 3 is routed rearward also, no problem occurs. The problem in terms of performance occurs only when the heating medium pipe 3 is routed in the left direction.

A constant gap is required for the back surface of the evaporator 7 for allowing air to flow, but even if the convex rear sheath body 47 is provided, it is necessary to provide a gap rearward and thus, there is no waste. When there is a wall behind the outdoor unit 1 of the heat pump hydronic heater, if members are disposed while using the rear sheath body 47 as a guide, it is possible to secure a constant space behind the evaporator 7, and there is an effect that performance is not deteriorated.

[0047] Since the circulation pump 16 and the cistern 17 are disposed inward of the rear sheath body 47 which protrudes rearward of the right plate 38, the height of the body of the heat pump hydronic heater can be the same as that of the heat pump heat source having no cistern 17 or circulation pump 16, and the heat pump hydronic heater can be made compact.

When the heat pump hydronic heater is installed, even if the heat pump hydronic heater is installed at a lower location and an air conditioner is installed at a high location using a double-holder, the height of the installed air conditioner is not increased so much, the air conditioner can be seen from outside of the house, it is possible to prevent an exterior from being deteriorated, and it is possible to exert a merit obtained by the fact that the height is low.

[0048] At the time of installation, it is necessary that the cap 18 of the cistern 17 is opened before operation, and a heating medium such as water and antifreezing liquid is put into the cistern 17. Thereafter, it is necessary that the circulation pump 16 is operated, the heating medium such as water and antifreezing liquid is distributed from the water refrigerant heat exchanger 5 to the external radiator 2 uniformly.

At this time, since the circulation pump 16 which forcibly circulates the heating medium is disposed below the cistern 17, the heating medium such as water and antifreezing liquid put into the cistern 17 is also put into the circulation pump 16, air entrainment is not produced in the circulation pump 16, it is possible to easily distribute the heating medium such as water and antifreezing liquid to the entire pipe paths in a state where no air entrainment exists, operability of contractor who installs the heat pump hydronic heater and the external radiator 2 can be enhanced, and the constructing time can be shortened.

[0049] When it is necessary to exchange the circulation pump 16 due to trouble of the circulation pump 16, if the rear sheath body 47 is detached, the circulation pump 16 can be seen from outside. Further, since the circulation pump 16 is placed on the vibration-isolating rubber 49 without fixing the circulation pump 16 using a screw, it is possible to easily detach the circulation pump 16.

It is possible to easily mount a new circulation pump 16, and the maintenance performance of the heat pump hydronic heater can be enhanced.

[0050] The heating medium return port 23, the cistern 17, the circulation pump 16, the water refrigerant heat exchanger 5 and the heating medium outward port 21

and the hot water circuit 15 are indicated using the refrigerant circuit and the water circuit of the heat pump hydronic heater shown in Fig. 4, but the cistern 17 and the circulation pump 16 may be disposed downstream of the water refrigerant heat exchanger 5 as shown in Fig. 9.

In this case, a heating medium such as water and anti-freezing liquid after it is heated is stored in the cistern 17, and when a defrosting operation of the refrigerant circuit 8 is carried out, it is possible to use this high temperature water.

[0051] The present invention is extremely effective for maintaining the heat pump hydronic heater body as compact as possible, reducing noise and vibration, enhancing the performance, and enhancing the maintenance performance.

[Industrial Applicability]

[0052] As described above, the heat pump hydronic heater of the invention can be applied not only to a domestic hydronic heater but also to a hydronic heater for business purposes.

Claims

1. A heat pump hydronic heater comprising:

a refrigerant circuit formed by connecting a compressor, a water refrigerant heat exchanger, a decompressor and an evaporator to one another;

a circulation pump which circulates a heating medium heated by the water refrigerant heat exchanger to an external radiator; and

a cistern in which the heating medium is stored, **characterized in that** the circulation pump is disposed below the cistern.

2. The heat pump hydronic heater according to claim 1, further comprising a sheath body in which the refrigerant circuit is accommodated, **characterized in that**

the sheath body includes a rear sheath body which projects outward, and

the cistern and the circulation pump are accommodated in the rear sheath body.

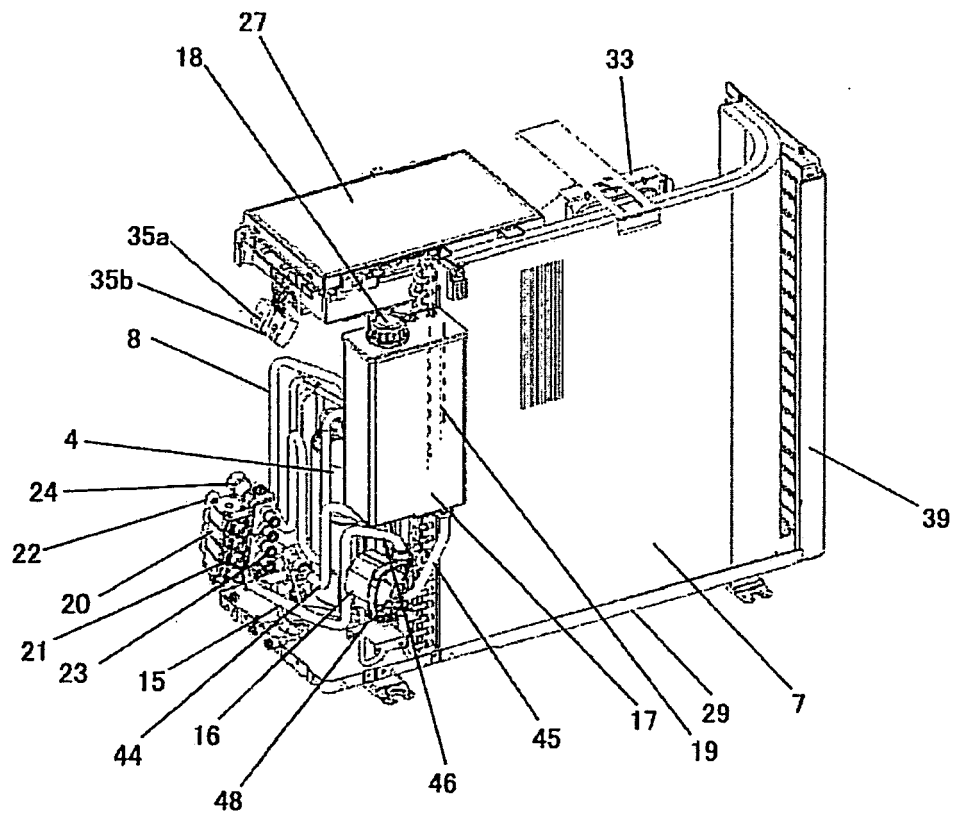
3. The heat pump hydronic heater according to claim 2, **characterized in that** the circulation pump is placed on a bottom plate of the rear sheath body.

4. The heat pump hydronic heater according to claim 2 or 3, **characterized in that** the circulation pump is placed on a vibration-isolating member, and the circulation pump is held by a pipe which is connected

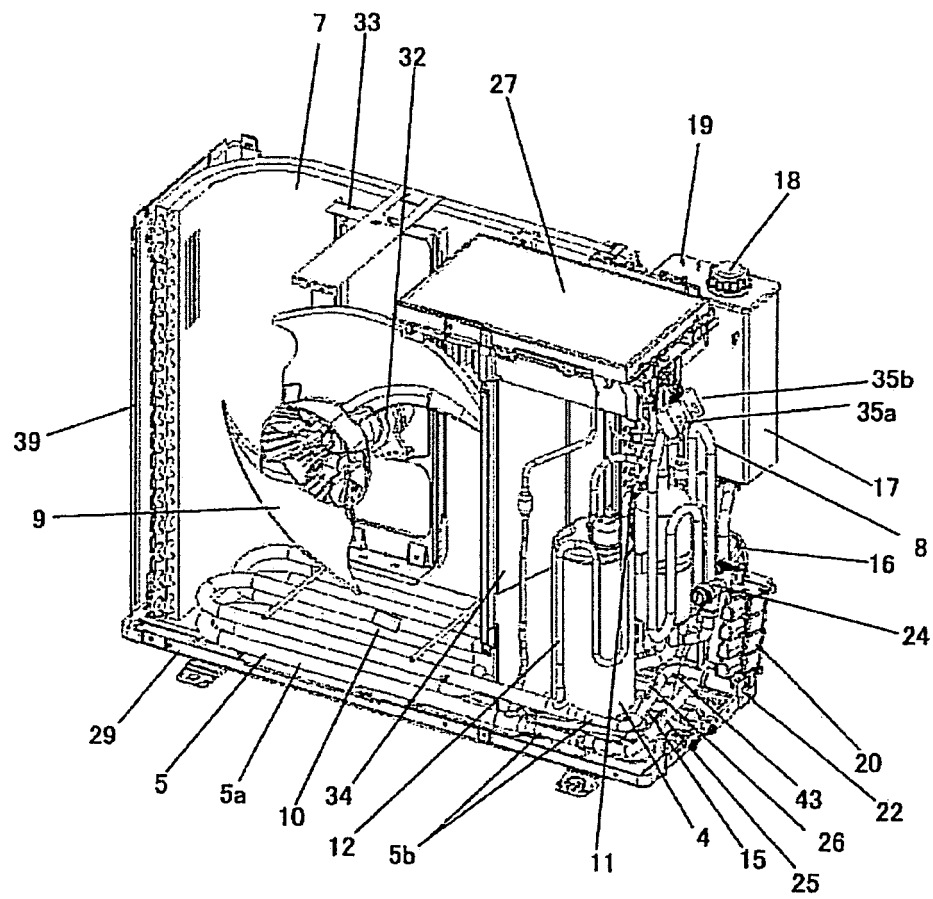
to the cistern.

5. The heat pump hydronic heater according to any one of claims 2 to 4, **characterized in that** a bottom of the rear sheath body is located above a lowermost portion of the sheath body, and a heating medium outward port and a heating medium return port which are for connecting the sheath body and the external radiator to each other through pipe are disposed on a side of the sheath body.

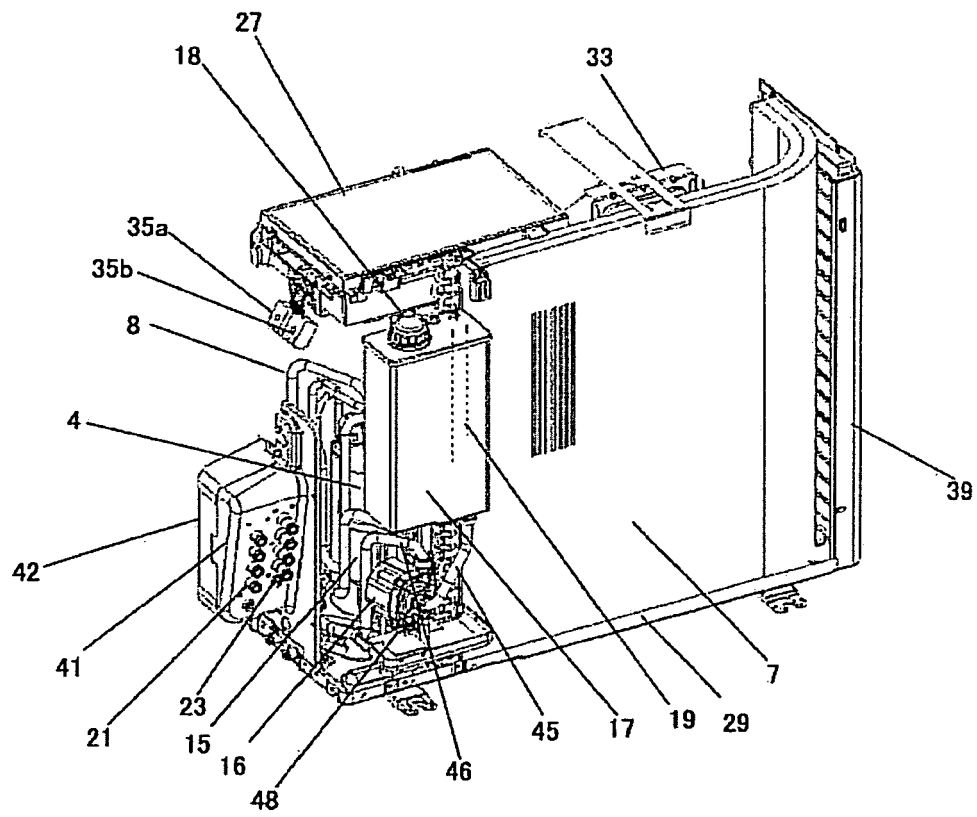
[Fig. 1]



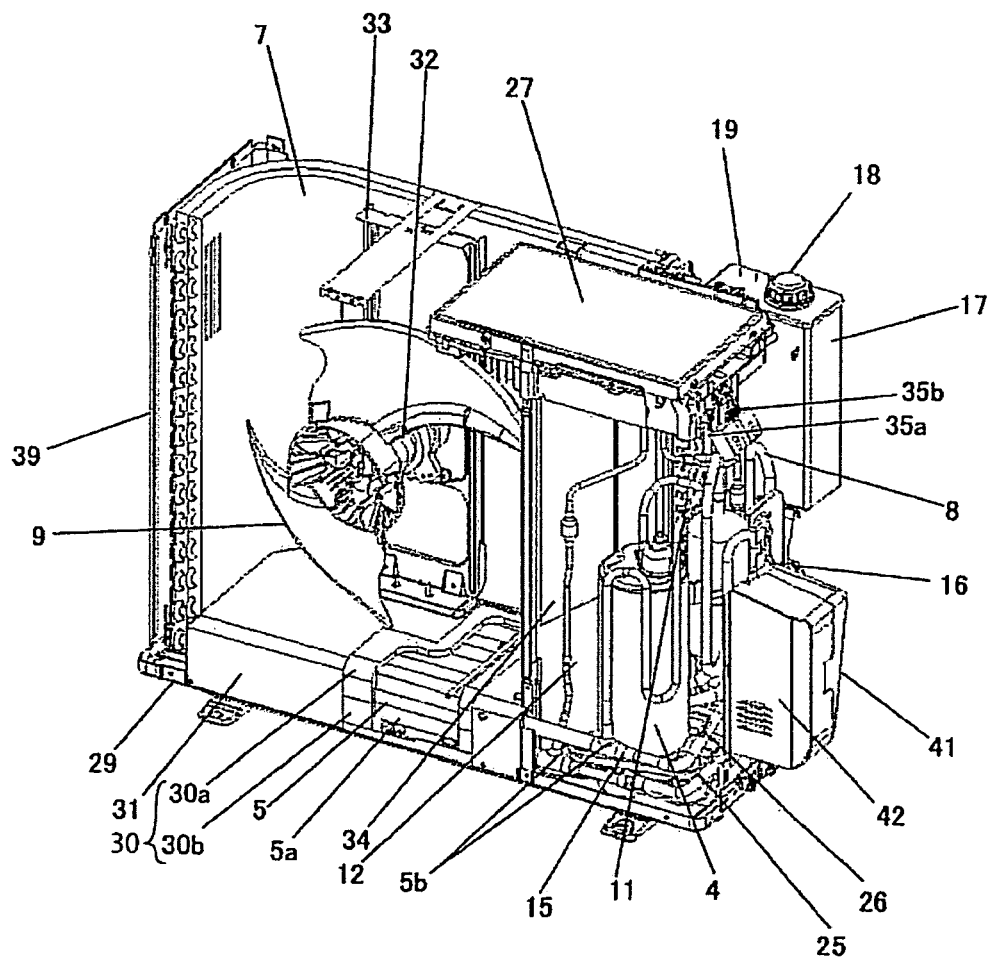
[Fig. 2]



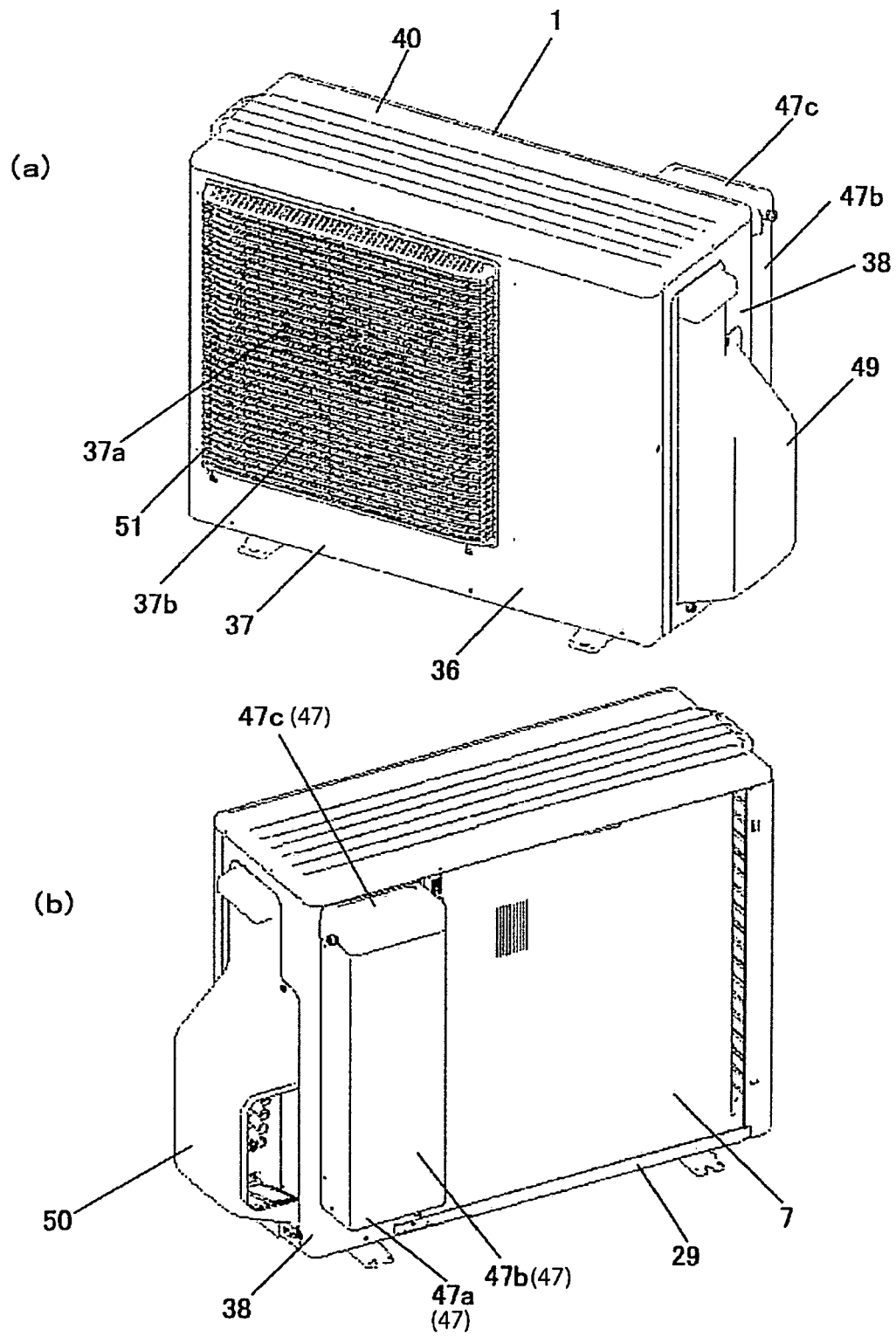
[Fig. 3]



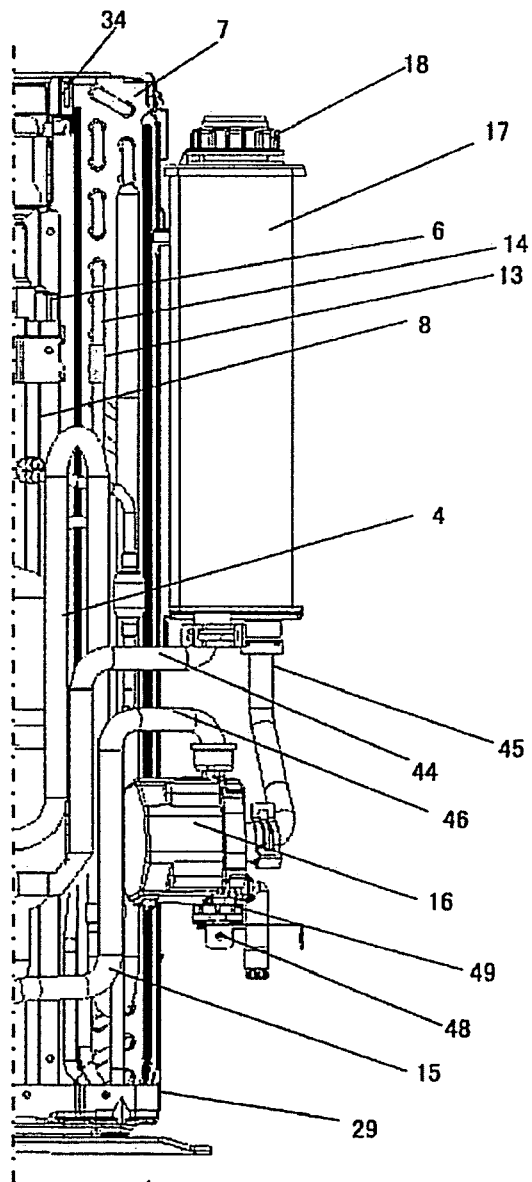
[Fig. 4]



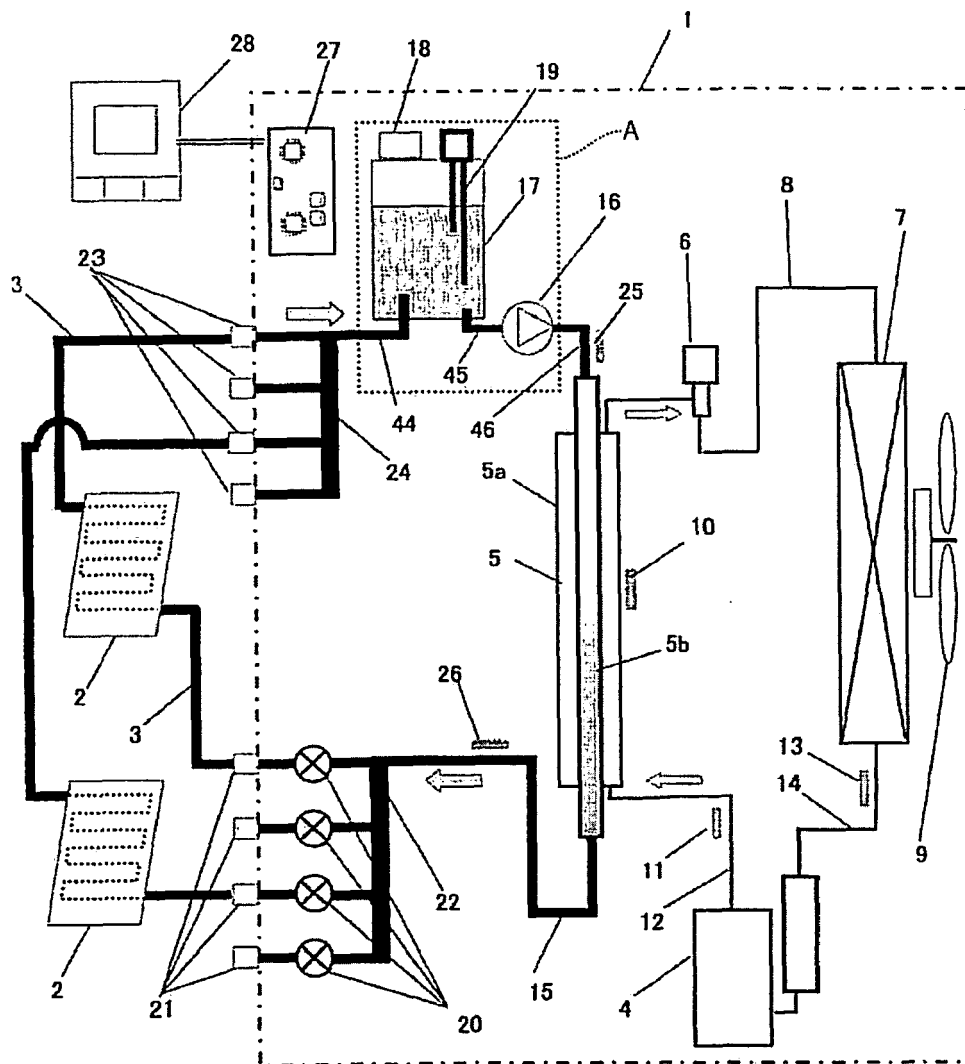
[Fig. 5]



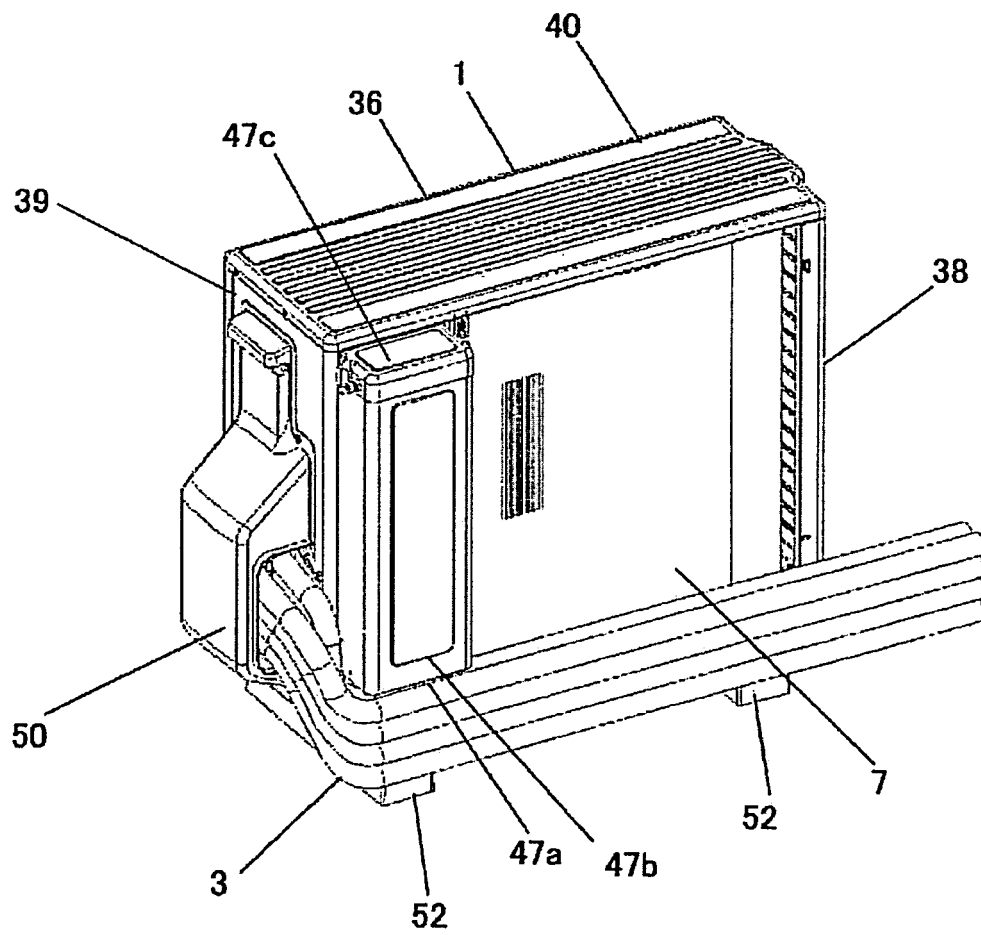
[Fig. 6]



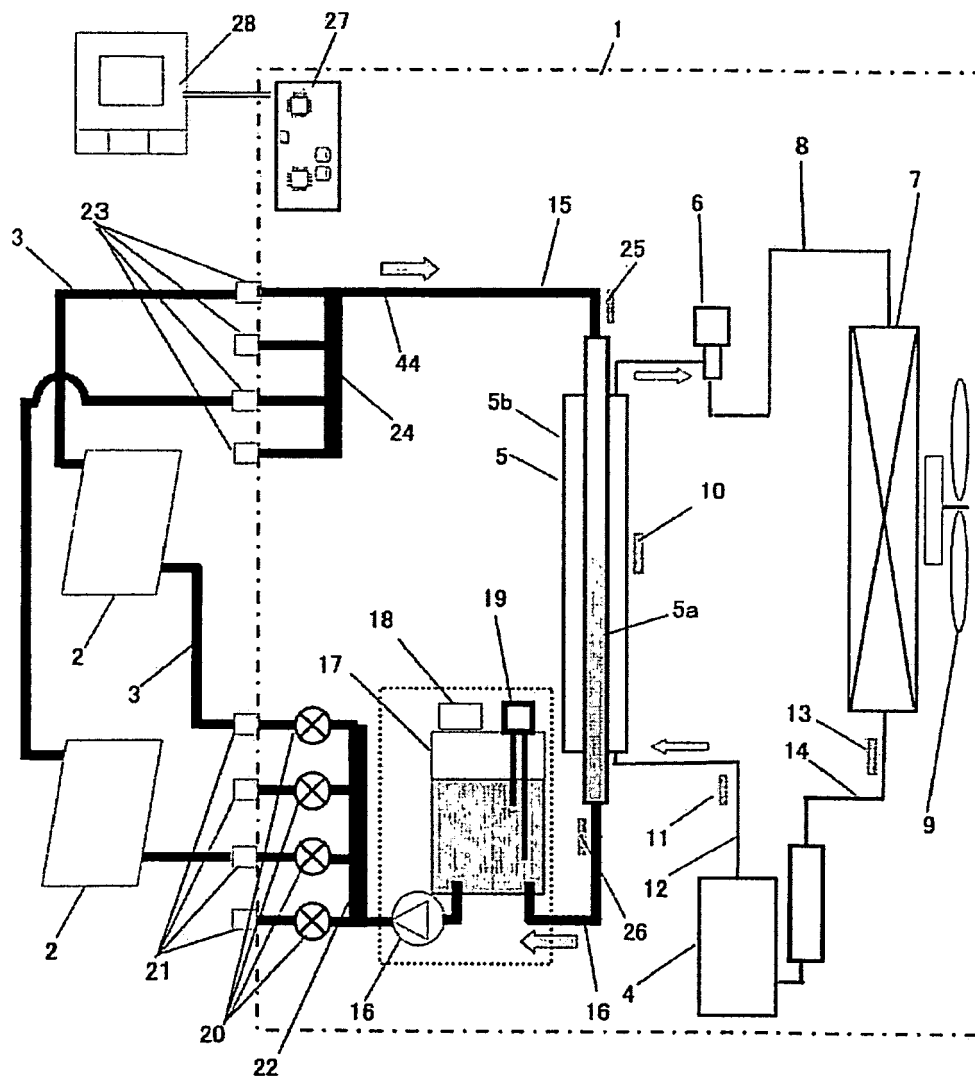
[Fig. 7]



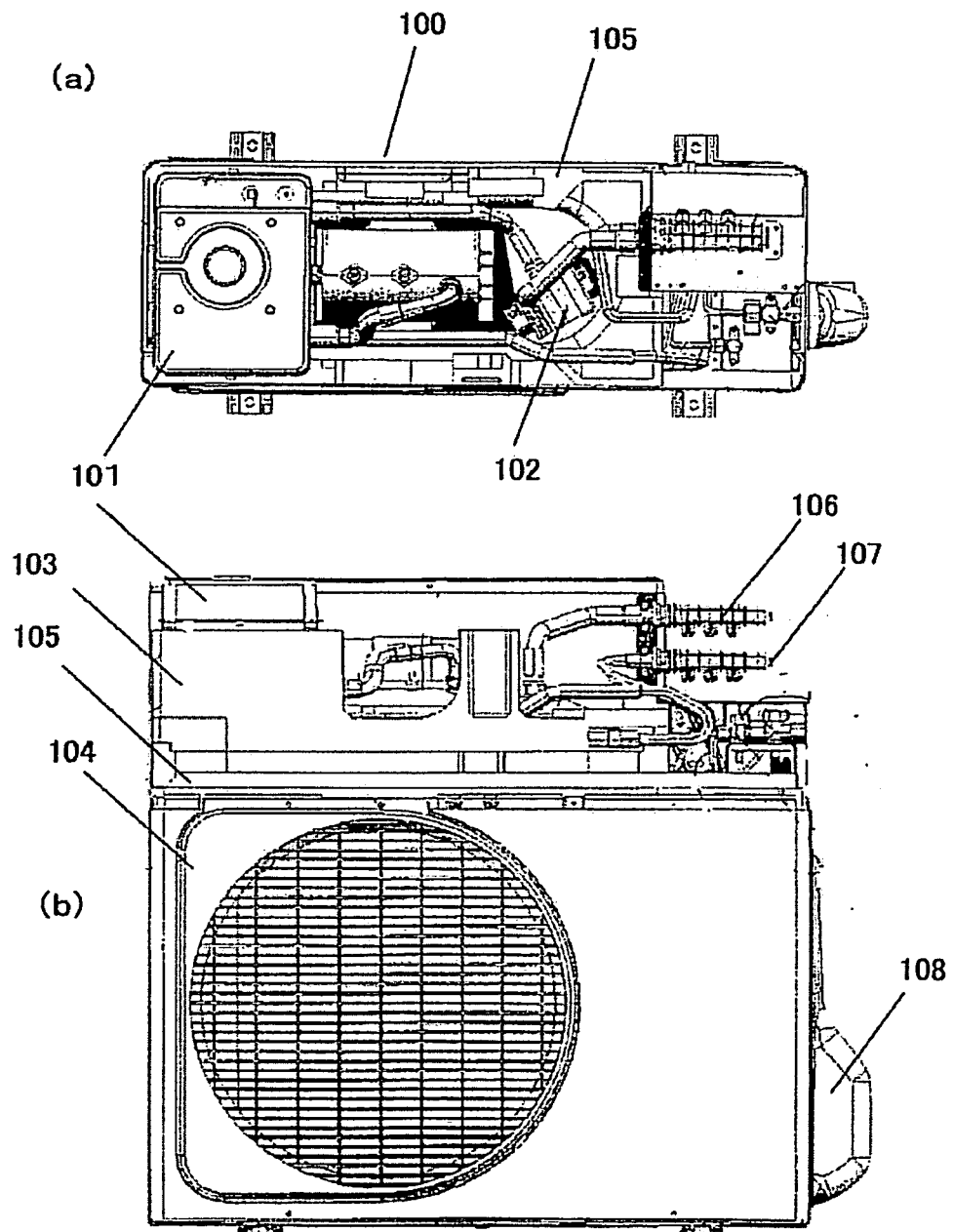
[Fig. 8]



[Fig. 9]

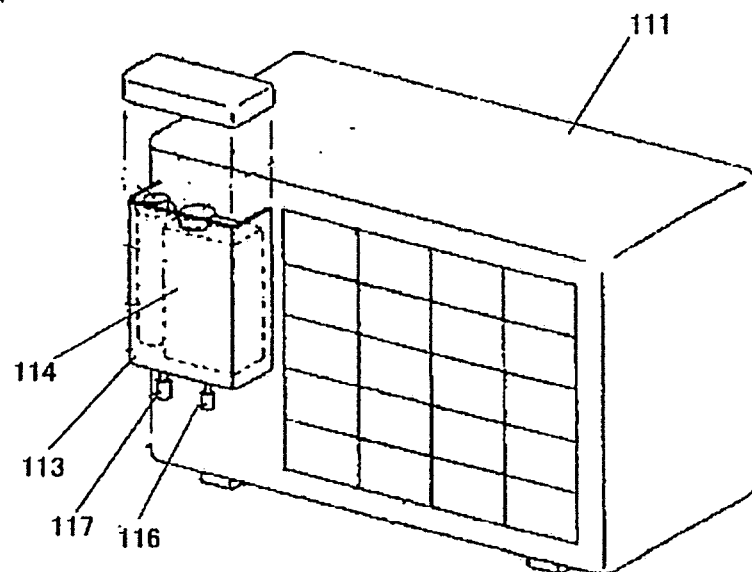


[Fig. 10]

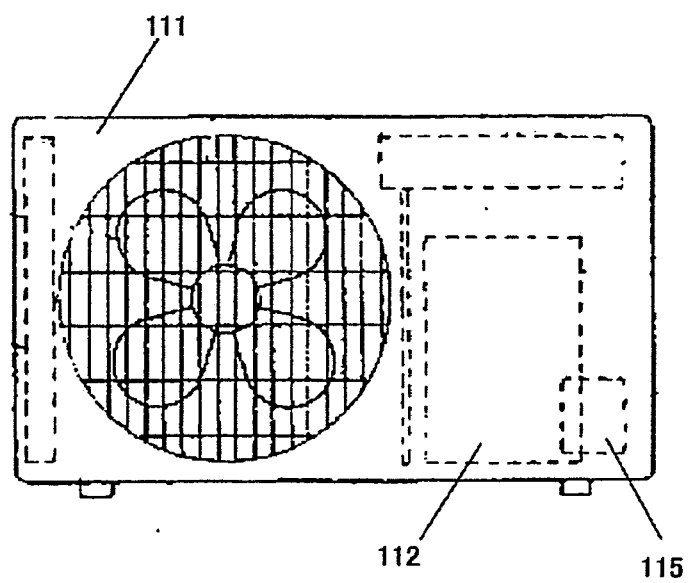


[Fig. 11]

(a)



(b)



REFERENCES CITED IN THE DESCRIPTION

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