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(54) **HEAT PUMP APPARATUS**

(57) In a heat pump apparatus, a compressor configured to compress a refrigerant, a first heat exchanger configured to exchange heat between the refrigerant compressed by the compressor and a liquid heating medium, a decompression apparatus configured to decompress the refrigerant having passed through the first heat exchanger, a second heat exchanger configured to exchange heat between the refrigerant decompressed in the decompression apparatus and air, and a fan configured to blow air to the second heat exchanger are housed in a cabinet. The cabinet is partitioned into a fan room in which the fan is installed, and a machine room in which the compressor is installed by a partition plate which extends in a vertical direction. The second heat exchanger is installed along a rear surface of the cabinet in the fan room. The first heat exchanger is installed below the compressor in the machine room.

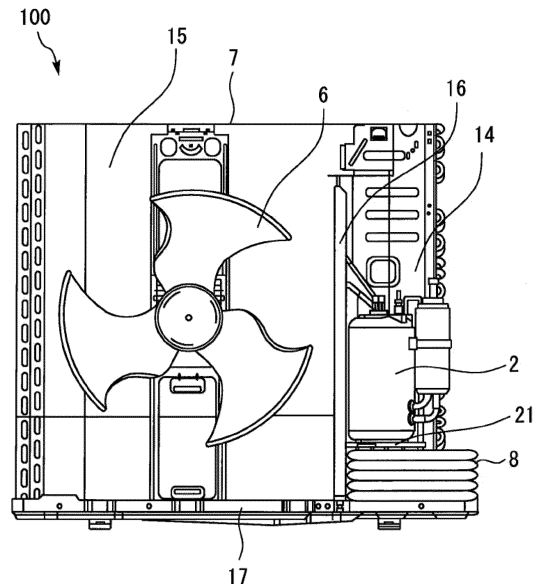


FIG. 1

Description

[Technical Field]

[0001] The present invention relates to a heat pump apparatus.

[Background Art]

[0002] A heat pump system which heats a liquid heating medium such as water by using heat absorbed from outside air is widely used. As an outdoor unit of such a heat pump system, PTL 1 discloses an outdoor unit which includes a refrigeration cycle having a compressor, an air heat exchanger, a decompression mechanism, and a water heat exchanger in a cabinet. In the outdoor unit, an internal portion of the cabinet is partitioned into a machine room in which the compressor is provided and an air path room in which an air blowing fan which blows air to the air heat exchanger is provided. In addition, a heat exchanger is disposed below the air blowing fan.

[Citation List]

[Patent Literature]

[0003] [PTL 1] Japanese Patent Application Publication No. 2012-184892

[Summary of Invention]

[Technical Problem]

[0004] The outdoor unit in PTL 1 has the following problem. The heat exchanger disposed below the air blowing fan may obstruct the path of air blown by the air blowing fan. When the air path is obstructed, heat exchange efficiency between air and a refrigerant of the air heat exchanger may decrease.

[0005] The present invention has been made in order to solve the above-described problem, and an object thereof is to provide a heat pump apparatus capable of securing an air path of a fan which blows air to a heat exchanger to increase heat exchange efficiency of the heat exchanger.

[Solution to Problem]

[0006] In a heat pump apparatus according to the present invention, a compressor configured to compress a refrigerant, a first heat exchanger configured to exchange heat between the refrigerant compressed by the compressor and a liquid heating medium, a decompression apparatus configured to decompress the refrigerant having passed through the first heat exchanger, a second heat exchanger configured to exchange heat between the refrigerant decompressed in the decompression apparatus and air, and a fan configured to blow air to the

second heat exchanger are housed in a cabinet. The cabinet is partitioned into a fan room in which the fan is installed and a machine room in which the compressor is installed by a partition plate which extends in a vertical direction. The second heat exchanger is installed along a rear surface of the cabinet in the fan room. The first heat exchanger is installed below the compressor in the machine room.

[Advantageous Effects of Invention]

[0007] According to the heat pump apparatus of the present invention, the first heat exchanger is installed below the compressor in the machine room. Accordingly, in the fan room in which the fan is installed, it is possible to prevent the air path of the fan from being obstructed by the first heat exchanger. With this, the air path of the fan which blows air to the second heat exchanger which exchanges heat between the refrigerant and air is effectively secured, and hence it becomes possible to increase the heat exchange efficiency of the second heat exchanger.

[Brief Description of Drawings]

[0008]

FIG. 1 is a front view showing the internal structure of a heat pump apparatus of Embodiment 1.

FIG. 2 is an external perspective view of the heat pump apparatus of Embodiment 1 when viewed obliquely from the front.

FIG. 3 is an external perspective view of the heat pump apparatus of Embodiment 1 when viewed obliquely from behind.

FIG. 4 is a view showing a refrigerant circuit and a water circuit of a heat pump hot water supply system which includes the heat pump apparatus of Embodiment 1.

FIG. 5 is a configuration diagram showing a principal portion of a water-refrigerant heat exchanger.

FIG. 6 is a front view showing the internal structure of a heat pump apparatus of Embodiment 2.

FIG. 7 is a front view showing the internal structure of a heat pump apparatus of Embodiment 3.

[Description of Embodiments]

[0009] Hereinbelow, embodiments will be described with reference to the drawings. Common elements in the drawings are designated by the same reference numerals, and the duplicate description thereof will be simplified or omitted. In addition, the present disclosure can include any combinations of, among configurations described in the following embodiments, configurations which can be combined.

Embodiment 1.

[0010] FIG. 1 is a front view showing the internal structure of a heat pump apparatus of Embodiment 1. FIG. 2 is an external perspective view of the heat pump apparatus of Embodiment 1 when viewed obliquely from the front. FIG. 3 is an external perspective view of the heat pump apparatus of Embodiment 1 when viewed obliquely from behind. FIG. 4 is a view showing a refrigerant circuit and a water circuit of a heat pump hot water supply system which includes the heat pump apparatus of Embodiment 1.

[0011] A heat pump apparatus 100 of the present embodiment is installed outdoors. The heat pump apparatus 100 heats a liquid heating medium. The heating medium in the present embodiment is water. The heat pump apparatus 100 heats water to generate hot water. The heating medium in the present invention may be brine other than water such as, e.g., a calcium chloride aqueous solution, an ethylene glycol aqueous solution, or alcohol.

[0012] As shown in FIG. 1, the heat pump apparatus 100 includes a base 17 serving as a bottom plate which forms a bottom portion of a cabinet. On the base 17, when viewed from the front, a machine room 14 is formed on the right side, and a fan room 15 is formed on the left side. The machine room 14 and the fan room 15 are separated from each other by a partition plate 16 which extends in a vertical direction.

[0013] As shown in FIGS. 2 and 3, the cabinet forming an outer shell of the heat pump apparatus 100 further includes a front panel 18, a side panel 19, and a top panel 20. The front panel 18 is constituted by a front surface portion 18a which covers a front surface of the heat pump apparatus 100, and a left side surface portion 18b which covers a left side surface thereof. The side panel 19 is constituted by a rear surface portion 19a which covers part of a rear surface of the heat pump apparatus 100, and a right side surface portion 19b which covers a right side surface thereof. These constituent elements of the cabinet are formed from, e.g., sheet metal material. An exterior surface of the heat pump apparatus 100 is covered with the cabinet except an air-refrigerant heat exchanger 7 which is disposed on the side of the rear surface and will be described later. An opening for discharging air having passed through the fan room 15 is formed in the front panel 18, and a lattice 18c is attached to the opening. Note that FIG. 1 shows a state in which the individual portions of the cabinet other than the base 17 are detached. In addition, in FIG. 1, the depiction of part of constituent equipment is omitted.

[0014] As shown in FIG. 4, the heat pump apparatus 100 includes a refrigerant circuit in which a compressor 2, a water-refrigerant heat exchanger 8 serving as a first heat exchanger, an air-refrigerant heat exchanger 7 serving as a second heat exchanger, and an expansion valve 10 for decompressing a refrigerant are annularly connected via a refrigerant pipe 4. The heat pump apparatus 100 performs an operation of a refrigerant cycle, i.e., a

heat pump cycle.

[0015] As shown in FIG. 1, the compressor 2, the water-refrigerant heat exchanger 8, the expansion valve 10 (the depiction thereof is omitted), and the refrigerant pipe which connects these elements are incorporated into the machine room 14. The compressor 2 compresses low-pressure refrigerant gas. The refrigerant may also be, e.g., carbon dioxide. The water-refrigerant heat exchanger 8 exchanges heat between a high-temperature high-pressure refrigerant discharged from the compressor 2 and water. The detail of an installation structure of the water-refrigerant heat exchanger 8 will be described later.

[0016] The expansion valve 10 is an example of a decompression apparatus which decompresses a high-pressure refrigerant to change the high-pressure refrigerant into a low-pressure refrigerant. The low-pressure refrigerant subjected to the decompression is brought into a gas-liquid two-phase state. The air-refrigerant heat exchanger 7 exchanges heat between the low-pressure refrigerant and the air. In the air-refrigerant heat exchanger 7, the low-pressure refrigerant evaporates by absorbing heat of the air. The fan 6 blows air to the air-refrigerant heat exchanger 7, and heat exchange in the air-refrigerant heat exchanger 7 can be thereby accelerated. Low-pressure refrigerant gas having evaporated in the air-refrigerant heat exchanger 7 is sucked into the compressor 2.

[0017] On the other hand, in order to secure an air path, the fan room 15 has space larger than that of the machine room 14. The fan 6 is incorporated into the fan room 15. The fan 6 includes two to three propeller blades, and a motor which rotationally drives the propeller blades. The motor and the propeller blades rotate with electric power supplied from the outside. On the side of a rear surface of the fan room 15, the air-refrigerant heat exchanger 7 is installed so as to face the fan 6. The air-refrigerant heat exchanger 7 includes a large number of fins formed of aluminum thin plates, and a long refrigerant pipe which is in intimate contact with a large number of the fins formed of aluminum thin plates and is folded back several times. The air-refrigerant heat exchanger 7 has a flat outer shape which is bent into an L shape. The air-refrigerant heat exchanger 7 is installed so as to extend from the rear surface of the heat pump apparatus 100 to the left side surface thereof. An end portion on the side of a rear surface of the air-refrigerant heat exchanger 7 extends to a rear side of the machine room 14. Accordingly, the partition plate 16 has a flat outer shape which is bent into an L shape, and is installed so as to partition space from the front surface of the heat pump apparatus 100 to the end portion on the side of the rear surface of the air-refrigerant heat exchanger 7. In the air-refrigerant heat exchanger 7, heat is exchanged between the refrigerant in the refrigerant pipe and air around the fins. The amount of air flowing between and passing through the individual fins is increased and adjusted by the fan 6, and the amount of heat exchange is thereby increased and ad-

justed.

[0018] Next, a description will be given of the water circuit of the heat pump apparatus 100 and a hot water storage apparatus 33. As shown in FIG. 4, a heat pump hot water supply system 1 is constituted by the heat pump apparatus 100 and the hot water storage apparatus 33. The hot water storage apparatus 33 includes a hot water storage tank 34 having a capacity of, e.g., about several hundred liters, and a water pump 35 for sending water in the hot water storage tank 34 to the heat pump apparatus 100. The heat pump apparatus 100 and the hot water storage apparatus 33 are connected via an external pipe 36, an external pipe 37, and electrical wiring (the depiction thereof is omitted).

[0019] A lower portion of the hot water storage tank 34 is connected to an inlet of the water pump 35 via a pipe 38. The external pipe 36 connects an outlet of the water pump 35 and a water inlet valve 28 of the heat pump apparatus 100. The external pipe 37 connects a hot water outlet valve 29 of the heat pump apparatus 100 and the hot water storage apparatus 33. The external pipe 37 can communicate with an upper portion of the hot water storage tank 34 via a pipe 39 in the hot water storage apparatus 33.

[0020] The hot water storage apparatus 33 further includes a mixing valve 40. To the mixing valve 40, a hot water supply pipe 41 which branches off from the pipe 39, a water supply pipe 42 through which water supplied from a water source such as a water supply passes, and a hot water supply pipe 43 through which hot water supplied to a user side passes are connected. The mixing valve 40 adjusts the temperature of supplied hot water by adjusting a mixing ratio of hot water which flows in from the hot water supply pipe 41, i.e., high-temperature water and water which flows in from the water supply pipe 42, i.e., low-temperature water. Hot water obtained by the mixing by the mixing valve 40 is sent to terminals on the user side such as, e.g., a bathtub, a shower, a faucet, and a dishwasher through the hot water supply pipe 43. A water supply pipe 44 which branches off from the water supply pipe 42 is connected to the lower portion of the hot water storage tank 34. Water which flows in from the water supply pipe 44 is stored on a lower side in the hot water storage tank 34.

[0021] Next, a description will be given of the operation of the heat pump apparatus 100 in heat accumulating operation. The heat accumulating operation is operation in which hot water is accumulated in the hot water storage tank 34 by sending hot water heated in the heat pump apparatus 100 to the hot water storage apparatus 33. The heat accumulating operation is as follows. The compressor 2, the fan 6, and the water pump 35 are operated. The rotation speed of the motor of the compressor 2 can change in a range of about several tens of rps (Hz) to about several hundred of rps (Hz). With this, it is possible to adjust and control heating power by changing the flow rate of the refrigerant.

[0022] It is possible to adjust and control the amount

of heat exchange between the refrigerant and air in the air-refrigerant heat exchanger 7 by changing the rotation speed of the motor of the fan 6 to the rotation speed of about several hundred rpm to about several thousand rpm to change the flow rate of air passing through the air-refrigerant heat exchanger 7. Air is sucked from the rear of the air-refrigerant heat exchanger 7 installed at the rear side of the fan 6, passes through the air-refrigerant heat exchanger 7, passes through the fan room 15, and is discharged toward the front of the front panel 18 on a side opposite to the air-refrigerant heat exchanger 7.

[0023] The expansion valve 10 adjusts the degree of the flow path resistance of the refrigerant. With this, it is possible to adjust and control the pressure of each of the high-pressure refrigerant on the upstream side of the expansion valve 10 and the low-pressure refrigerant on the downstream side thereof. The rotation speed of the compressor 2, the rotation speed of the fan 6, and the degree of the flow path resistance of the expansion valve 10 are controlled in accordance with an installation environment and use conditions of the heat pump apparatus 100.

[0024] The low-pressure refrigerant is sucked into the compressor 2 through piping. The low-pressure refrigerant is compressed in the compressor 2 to become the high-temperature high-pressure refrigerant. The high-temperature high-pressure refrigerant is discharged from the compressor 2 to the refrigerant pipe. The high-temperature high-pressure refrigerant flows into a refrigerant inlet portion of the water-refrigerant heat exchanger 8 through the piping. The high-temperature high-pressure refrigerant exchanges heat with water in the water-refrigerant heat exchanger 8 to heat water and generate hot water. The refrigerant is reduced in enthalpy and temperature while the refrigerant passes through the water-refrigerant heat exchanger 8. The high-pressure refrigerant reduced in temperature flows into an inlet portion of the expansion valve 10 from a refrigerant outlet portion of the water-refrigerant heat exchanger 8 through the refrigerant pipe. The high-pressure refrigerant is reduced in temperature by being decompressed in the expansion valve 10 to become a low-temperature low-pressure refrigerant. The low-temperature low-pressure refrigerant flows into an inlet portion of the air-refrigerant heat exchanger 7 from an outlet portion of the expansion valve 10 through the refrigerant pipe. The low-temperature low-pressure refrigerant exchanges heat with air in the air-refrigerant heat exchanger 7, is increased in enthalpy, flows into the refrigerant pipe from an outlet portion of the air-refrigerant heat exchanger 7, and is sucked into the compressor 2. Thus, the refrigerant circulates and the heat pump cycle is performed.

[0025] At the same time, by driving the water pump 35, water in the lower portion in the hot water storage tank 34 is caused to flow into a water inlet portion of the water-refrigerant heat exchanger 8 through the pipe 38, the external pipe 36, the water inlet valve 28, and an internal pipe 30. The water exchanges heat with the refrigerant in the water-refrigerant heat exchanger 8 and is heated,

and hot water is thereby generated. The hot water flows into the upper portion of the hot water storage tank 34 through an internal pipe 31, the hot water outlet valve 29, the external pipe 37, and the pipe 39. By performing the heat accumulating operation described above, hot water having high temperature is gradually accumulated from the upper portion toward the lower portion in the hot water storage tank 34.

[0026] Note that hot water heated in the heat pump apparatus 100 may be directly supplied to the user side without being stored in the hot water storage tank 34. In addition, the heating medium heated in the heat pump apparatus 100 may be used for indoor heating or the like.

[0027] Next, a description will be given of the structure and arrangement of the water-refrigerant heat exchanger 8 provided in the heat pump apparatus 100 of Embodiment 1. The water-refrigerant heat exchanger 8 performs heat exchange between water serving as the heating medium which circulates in the water circuit and the refrigerant which circulates in the refrigerant circuit. FIG. 5 is a configuration diagram showing a principal portion of the water-refrigerant heat exchanger. The water-refrigerant heat exchanger 8 includes heating medium piping 82 and refrigerant piping 84. Water serving as the heating medium flows through the heating medium piping 82. A high-temperature refrigerant sent from the compressor 2 flows through the refrigerant piping 84. In the heating medium piping 82, one or a plurality of continuous spiral grooves 86 are formed in an outer peripheral surface of the piping. The number of spiral grooves is not particularly limited. In an example of the water-refrigerant heat exchanger 8 shown in FIG. 5, two spiral grooves 86 are formed in the heating medium piping 82.

[0028] The refrigerant piping 84 branches at some midpoint such that a plurality of flow paths arranged in parallel are formed. In the example of the water-refrigerant heat exchanger 8 shown in FIG. 5, the refrigerant piping 84 branches into first refrigerant piping 841 and second refrigerant piping 842. The first refrigerant piping 841 and the second refrigerant piping 842 are fitted in a state in which the first refrigerant piping 841 and the second refrigerant piping 842 are spirally wound along the two spiral grooves 86 formed in the heating medium piping 82.

[0029] The water-refrigerant heat exchanger 8 of Embodiment 1 configured in the above manner has a configuration in which the refrigerant piping 84 is caused to branch into a plurality of the refrigerant pipings and the refrigerant pipings are fitted in the spiral grooves of the heating medium piping 82, and hence it is possible to increase a contact heat transfer area between the refrigerant piping 84 and the heating medium piping 82. In addition, it is also possible to prevent adjacent refrigerant pipings from coming into contact with each other, and hence it is possible to prevent leakage of heat. Further, it is possible to change the contact heat transfer area between the refrigerant piping 84 and the heating medium piping 82 by changing the number of branching of

the refrigerant piping 84, and hence it becomes possible to easily optimize flow path design.

[0030] The water-refrigerant heat exchanger 8 is formed into a hollow cylindrical shape by spirally stacking the heating medium piping 82 around which the refrigerant piping 84 is wound. As shown in FIG. 1, the water-refrigerant heat exchanger 8 is installed on the base 17 in a lower portion of the machine room 14. In the hollow of the water-refrigerant heat exchanger 8, a column 21 is provided to stand upward from the base 17. The compressor 2 is supported on the column 21. According to such an arrangement of the machine room 14, the water-refrigerant heat exchanger 8 is disposed below the compressor 2.

[0031] According to the present embodiment, the following effect is obtained by providing the water-refrigerant heat exchanger 8 in the machine room 14. The air path of the fan room 15 is not obstructed by the water-refrigerant heat exchanger 8. With this, the air path of the fan 6 which blows air to the air-refrigerant heat exchanger 7 is effectively secured, and hence it becomes possible to increase heat exchange efficiency of the air-refrigerant heat exchanger 7. With this, it is possible to increase thermal efficiency of the heat pump cycle.

Embodiment 2.

[0032] Next, a heat pump apparatus of Embodiment 2 will be described. FIG. 6 is a front view showing the internal structure of the heat pump apparatus of Embodiment 2. A heat pump apparatus 200 shown in FIG. 6 has a structure common to the heat pump apparatus 100 of Embodiment 1 except that a sound absorbing material 22 is provided. The sound absorbing material 22 is disposed so as to integrally cover the water-refrigerant heat exchanger 8 and the compressor 2. The sound absorbing material 22 is formed of a material having fine voids. The sound absorbing material 22 may include at least one of, e.g., felt, glass wool, and rock wool. The above sound absorbing material 22 has a heat insulation function in addition to the function of absorbing sound.

[0033] As described above, the water-refrigerant heat exchanger 8 is disposed below the compressor 2. Accordingly, it is possible to configure the sound absorbing material 22, which is usually disposed around the compressor 2, such that the sound absorbing material 22 covers the compressor 2 together with the water-refrigerant heat exchanger 8. According to such a configuration, it is possible to suppress a reduction in the temperature of the water-refrigerant heat exchanger 8. With this, it is possible to increase the heat exchange efficiency in the water-refrigerant heat exchanger 8, and hence it becomes possible to increase the efficiency of the heat accumulating operation.

[0034] In addition, according to the heat pump apparatus 200 of Embodiment 2, the heat pump apparatus 200 has a structure in which the compressor 2 and the water-refrigerant heat exchanger 8 are covered with the

single sound absorbing material 22, and hence working efficiency during manufacture is improved. Further, it is not necessary to combine and use a plurality of the sound absorbing materials, and hence the structure contributes to a reduction in manufacturing cost.

Embodiment 3.

[0035] Next, a heat pump apparatus of Embodiment 3 will be described. FIG. 7 is a front view showing the internal structure of the heat pump apparatus of Embodiment 3. A heat pump apparatus 300 shown in FIG. 7 has a structure common to the heat pump apparatus 100 of Embodiment 1 except that a sheet metal member 24 is newly provided, and except the installation structure of the compressor 2.

[0036] The sheet metal member 24 is installed on the base 17 so as to cover the entire water-refrigerant heat exchanger 8. The compressor 2 is installed on an upper surface of the sheet metal member 24. As long as the sheet metal member 24 is configured to be capable of housing the water-refrigerant heat exchanger 8 inside the sheet metal member 24, and have a strength which allows the sheet metal member 24 to support the compressor 2, the shape of the sheet metal member 24 is not limited. As the shape of the sheet metal member 24, it is possible to use, e.g., a box-like shape.

[0037] According to the heat pump apparatus 300 having such a configuration, it is not necessary to install a column for installing the compressor 2 in a hollow portion of the water-refrigerant heat exchanger 8, and hence it becomes possible to use a configuration in which the water-refrigerant heat exchanger 8 can be slid in a front surface direction and be detached. With this, it becomes possible to improve the maintainability of the heat pump apparatus 100.

[Reference Signs List]

[0038]

1	Heat pump hot water supply system
2	Compressor
4	Refrigerant pipe
6	Fan
7	Air-refrigerant heat exchanger (second heat exchanger)
8	Water-refrigerant heat exchanger (first heat exchanger)
10	Expansion valve (decompression apparatus)
14	Machine room
15	Fan room
16	Partition plate
17	Base (bottom plate)
18	Front panel
18a	Front surface portion
18b	Left side surface portion

18c	Lattice
19	Side panel
19a	Rear surface portion
19b	Right side surface portion
20	Top panel
21	Column
22	Sound absorbing material
24	Sheet metal member
28	Water inlet valve
29	Hot water outlet valve
30	Internal pipe
31	Internal pipe
33	Hot water storage apparatus
34	Hot water storage tank
35	Water pump
36	External pipe
37	External pipe
38	Pipe
39	Pipe
40	Mixing valve
41	Hot water supply pipe
42	Water supply pipe
43	Hot water supply pipe
44	Water supply pipe
82	Heating medium piping
84	Refrigerant piping
841	First refrigerant piping
842	Second refrigerant piping
86	Spiral groove
100, 200, 300	Heat pump apparatus

Claims

1. A heat pump apparatus in which a compressor configured to compress a refrigerant, a first heat exchanger configured to exchange heat between the refrigerant compressed by the compressor and a liquid heating medium, a decompression apparatus configured to decompress the refrigerant having passed through the first heat exchanger, a second heat exchanger configured to exchange heat between the refrigerant decompressed in the decompression apparatus and air, and a fan configured to blow air to the second heat exchanger are housed in a cabinet, wherein the cabinet is partitioned into a fan room in which the fan is installed and a machine room in which the compressor is installed by a partition plate which extends in a vertical direction, the second heat exchanger is installed along a rear surface of the cabinet in the fan room, and the first heat exchanger is installed below the compressor in the machine room.
2. The heat pump apparatus according to claim 1, wherein the first heat exchanger includes:

heating medium piping in which a spiral groove is formed in an outer peripheral surface; and refrigerant piping which is spirally wound along the spiral groove.

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3. The heat pump apparatus according to claim 2, wherein the first heat exchanger is formed into a hollow cylindrical shape obtained by spirally stacking the heating medium piping, and the compressor is supported on a column which is installed in a hollow of the first heat exchanger. 10
4. The heat pump apparatus according to any one of claims 1 to 3, further comprising a sound absorbing material integrally covering the compressor and the first heat exchanger. 15
5. The heat pump apparatus according to claim 1 or 2, further comprising a sheet metal member covering at least an upper surface of the first heat exchanger, wherein the compressor is supported by the sheet metal member. 20
6. The heat pump apparatus according to any one of claims 1 to 5, wherein CO₂ is used as the refrigerant, and water is used as the heating medium. 25

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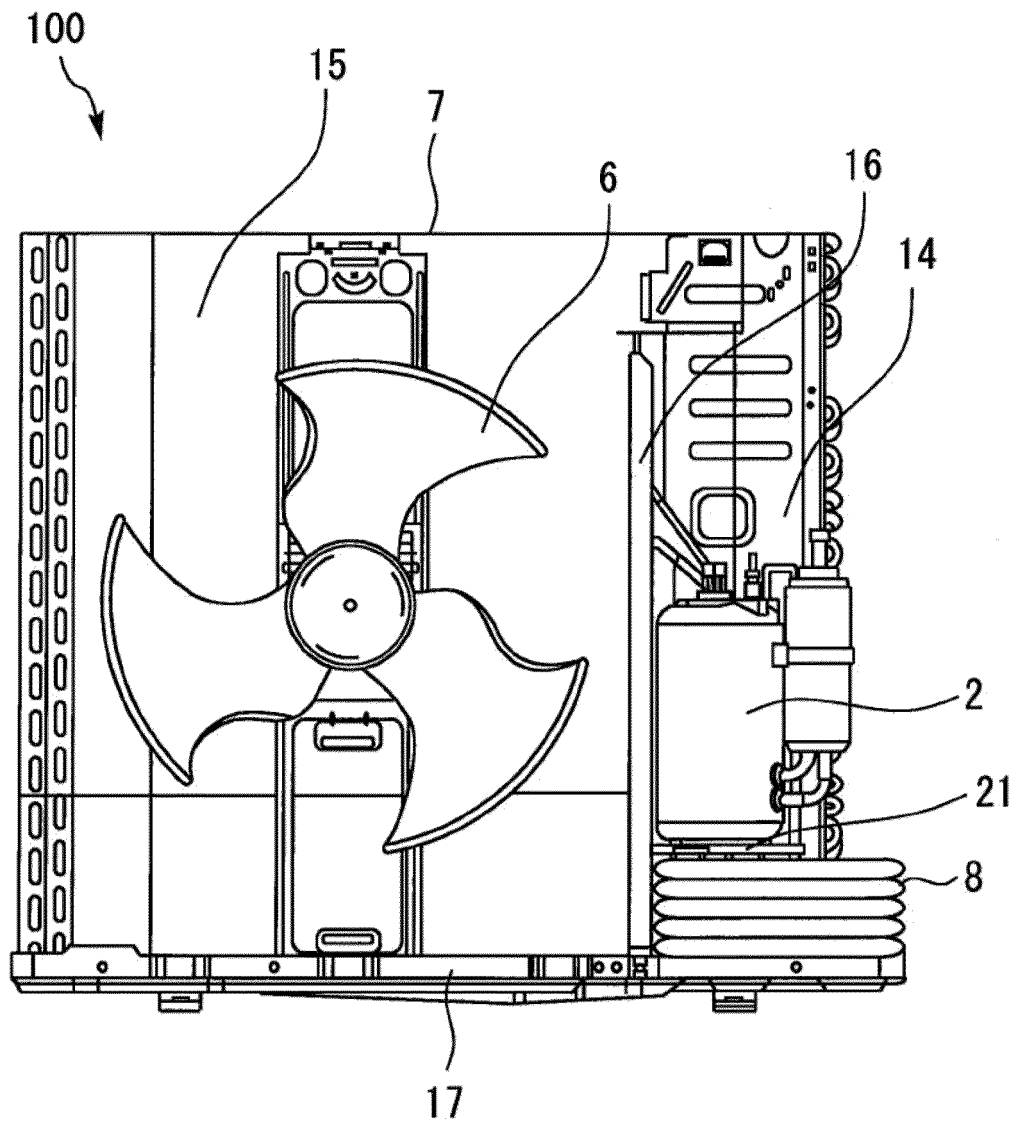


FIG. 1

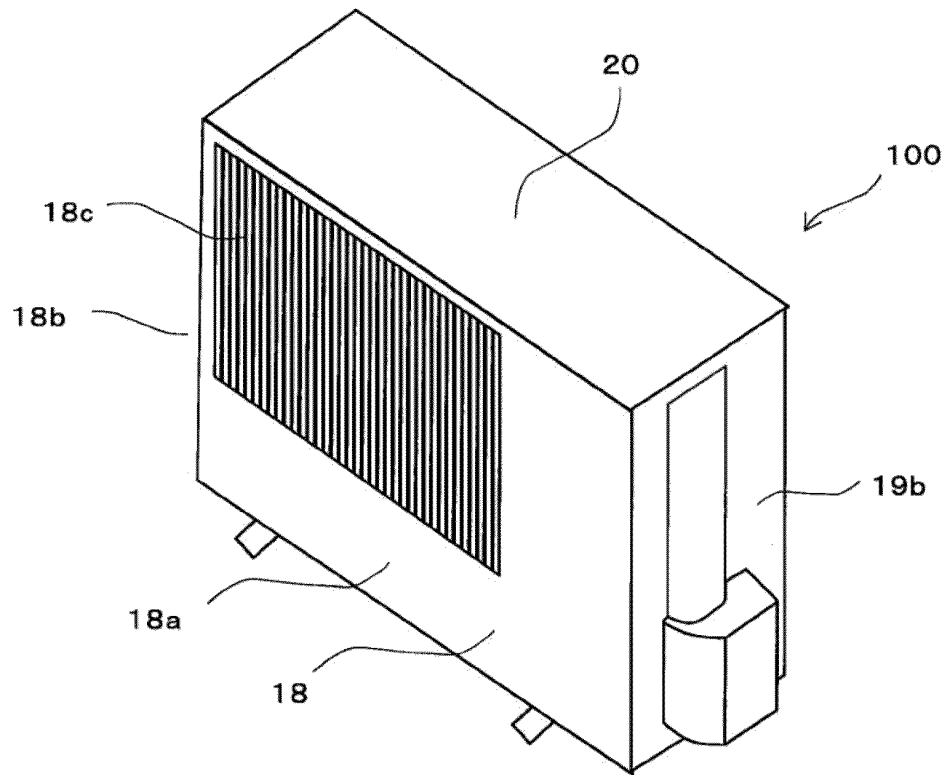


FIG. 2

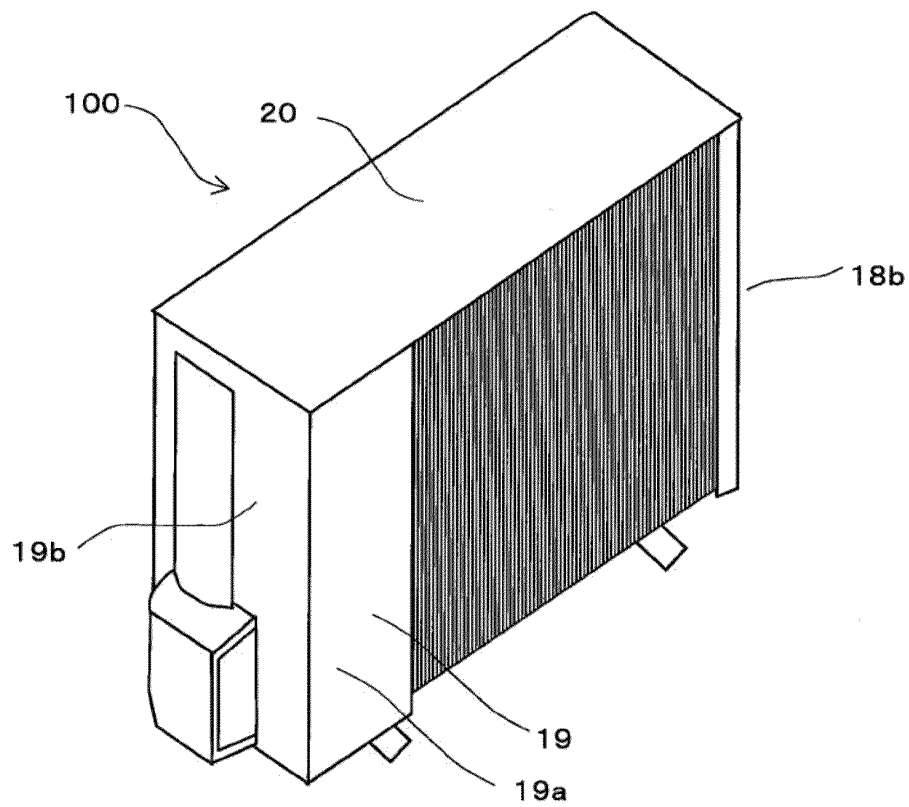


FIG. 3

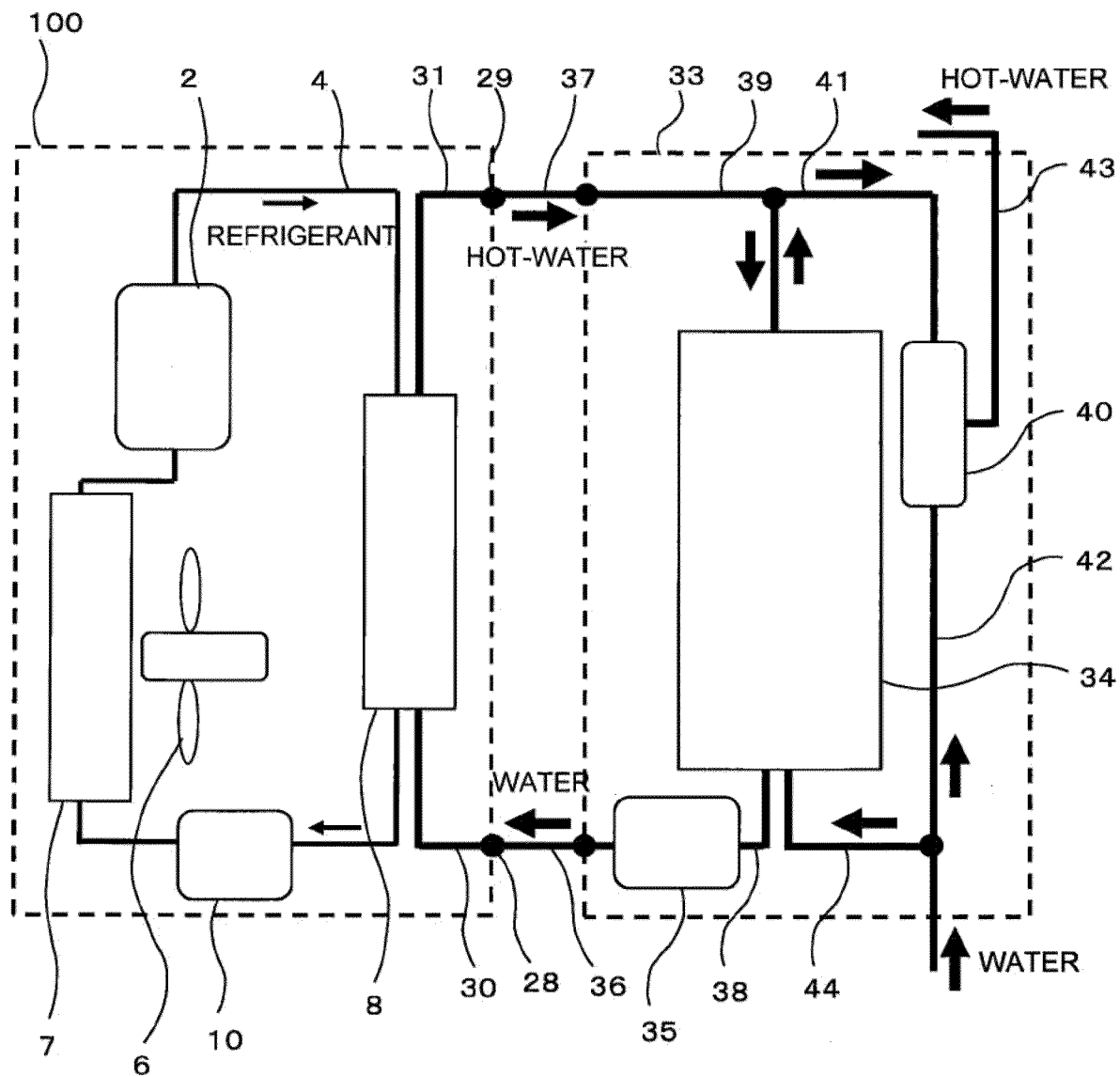


FIG. 4

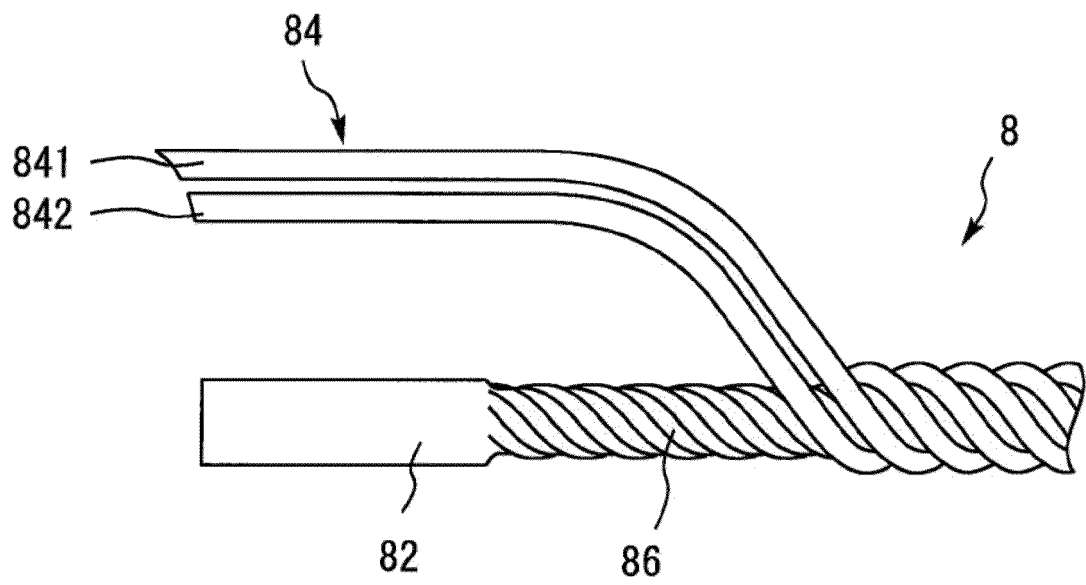


FIG. 5

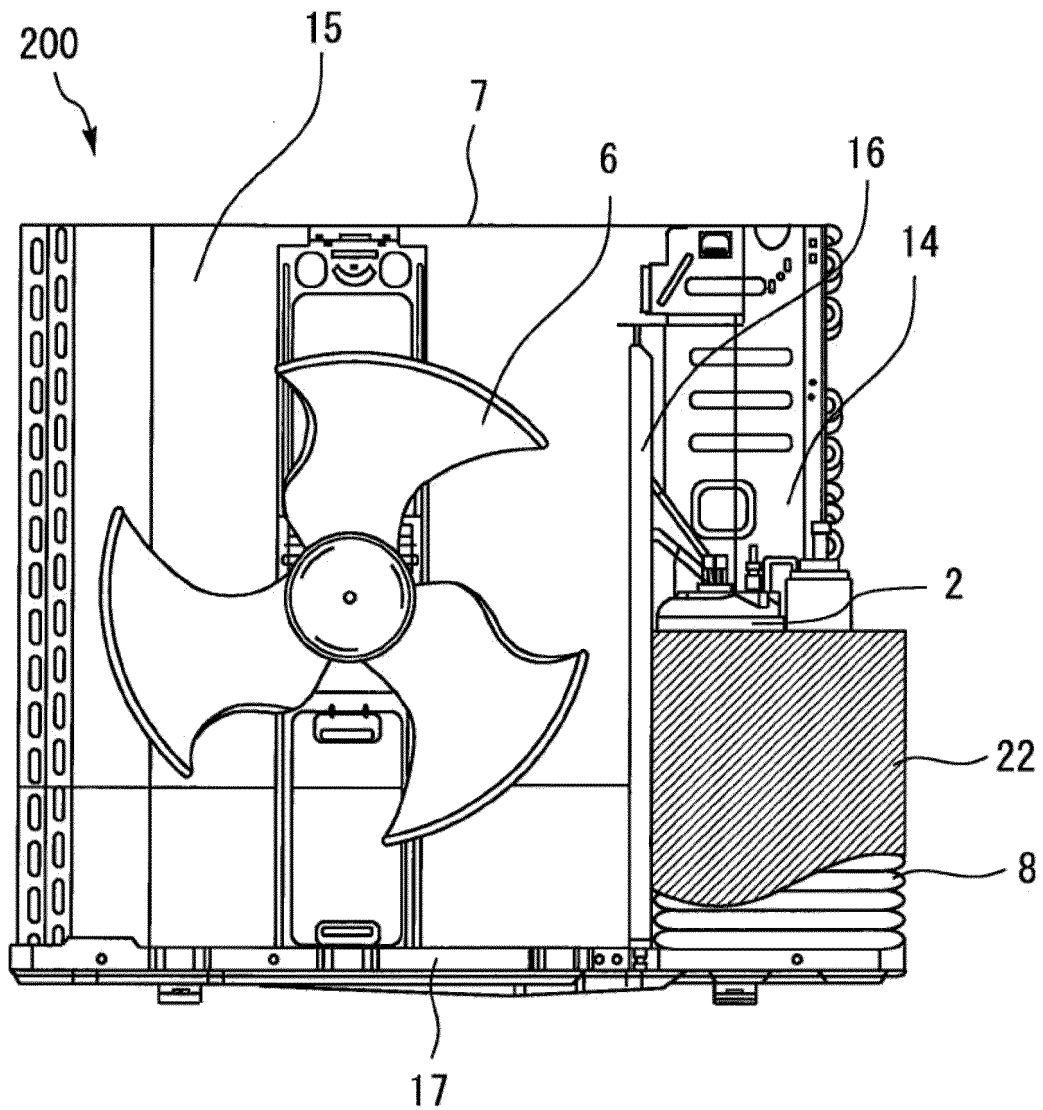


FIG. 6

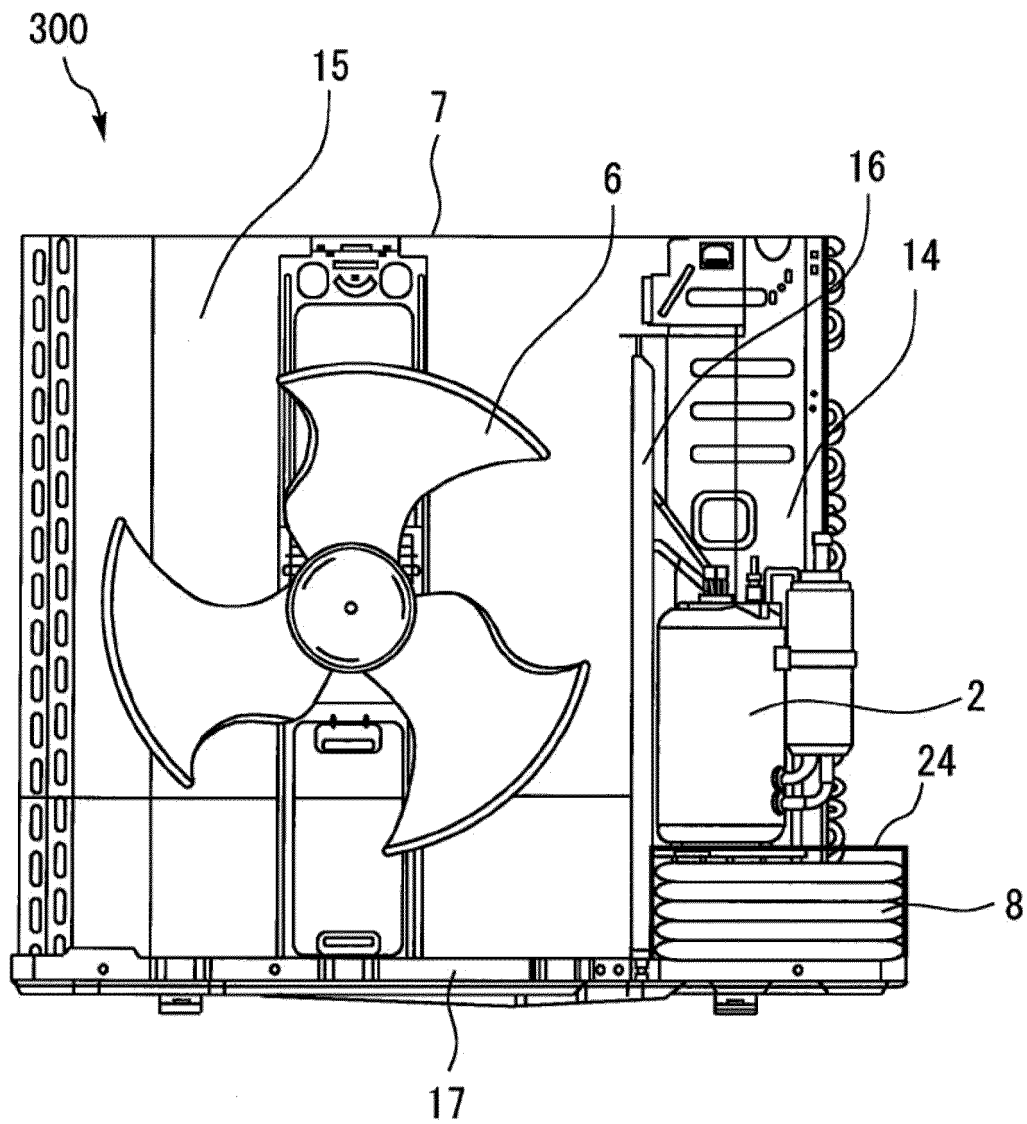


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/007312

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F25B30/02 (2006.01) i, F25B1/00 (2006.01) i, F25B31/00 (2006.01) i,
F25B39/04 (2006.01) i, F28D7/02 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. F25B30/02, F25B1/00, F25B31/00, F25B39/04, F28D7/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2012-184892 A (MITSUBISHI ELECTRIC CORPORATION)	1
Y	27 September 2012, paragraphs [0011]-[0013], [0027], fig. 2, 3 (Family: none)	2-6
Y	JP 2005-345006 A (KANSAI ELECTRIC POWER CO.) 15 December 2005, paragraph [0022], fig. 4 (Family: none)	2-6



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
07.05.2018

Date of mailing of the international search report
15.05.2018

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 38330/1990 (Laid-open No. 129833/1991) (MITSUBISHI ELECTRIC CORPORATION) 26 December 1991, fig. 1-5 (Family: none)	3-4, 6
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