



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.11.2022 Bulletin 2022/44

(21) Application number: **22169802.0**

(22) Date of filing: **25.04.2022**

(51) International Patent Classification (IPC):
F24F 1/22 (2011.01) F24F 1/24 (2011.01)
F24F 1/46 (2011.01) F24D 3/18 (2006.01)
F24F 5/00 (2006.01) F24H 4/02 (2022.01)

(52) Cooperative Patent Classification (CPC):
F24F 1/22; F24D 3/18; F24F 5/0003; F24H 4/02;
F24F 1/24; F24F 1/46

(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
 Designated Validation States:
KH MA MD TN

(30) Priority: **27.04.2021 JP 2021074709**

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

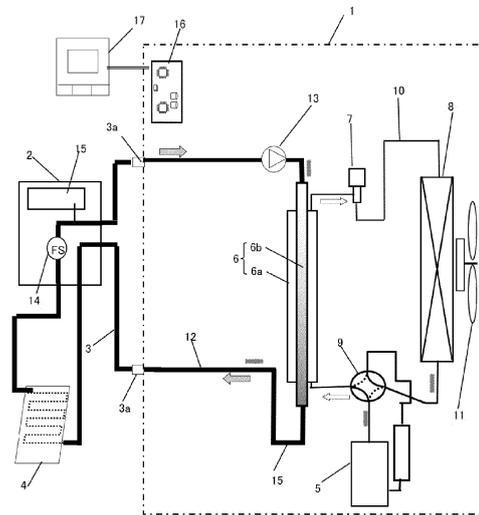
(72) Inventors:
 • **NAKATANI, Kazuhito**
Osaka-shi, Osaka, 540-6207 (JP)
 • **MORIWAKI, Shunji**
Osaka-shi, Osaka, 540-6207 (JP)
 • **YAMAOKA, Yuki**
Osaka-shi, Osaka, 540-6207 (JP)
 • **YOSHIDA, Jun**
Osaka-shi, Osaka, 540-6207 (JP)

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

(54) **HEAT MEDIUM CIRCULATION DEVICE**

(57) Combustible refrigerant having specific gravity which is greater than that of air is used as refrigerant, a control substrate 16 is accommodated in a power source box 21, the power source box 21 is placed above an air blower 11, and an interior of the power source box 21 is not in communication with an interior machine chamber 18. According to this, it is possible to ensure safety when refrigerant leaks from a heat pump type heat medium circulation device using combustible refrigerant having low GWP, and it is possible to provide a safe heat medium circulation device having long lifetime, capable of lowering temperature of the control device.

[Fig. 1]



- | | |
|------------------------------------|----------------------------------|
| 1 Outdoor unit | 8 Air refrigerant heat exchanger |
| 2 Intermediate relay device | 9 Four-way valve |
| 3 Heat medium pipe | 10 Refrigerant circuit |
| 3a Connection port | 11 Air blower |
| 4 Exterior radiator | 12 Heat medium circuit |
| 5 Compressor | 13 Circulation pump |
| 6 Water refrigerant heat exchanger | 14 Flow rate sensor |
| 6a Refrigerant pipe | 15 Expansion absorption tank |
| 6b Heat medium pipe | 16 Control substrate |
| 7 Expansion valve | 17 Remote controller |

Description

[TECHNICAL FIELD]

[0001] The present invention relates to a heat pump type heat medium circulation device using refrigerant.

[BACKGROUND TECHNIQUE]

[0002] As a heat pump type heat medium circulation device or a heat pump hot water supply system, there is known a device or a system in which an inverter for controlling a compressor or a radiator plate for radiating heat of the inverter is placed above an air blower.

[0003] According to patent document 1 for example, the radiator plate is placed in an air blowing circuit.

[0004] In patent document 2, a control device is placed above an air blower circuit.

[PRIOR ART DOCUMENTS]

[PATENT DOCUMENTS]

[0005]

[Patent Document 1] Japanese Patent Application Laid-open No.2005-083692

[Patent Document 2] Japanese Patent No.4899510

[SUMMARY OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

[0006] Currently, due to enhancement of an increased awareness concerning environment, it is required to use low GWP refrigerant especially in Europe. As the low GWP refrigerant, carbon dioxide (R744) and combustible propane (R290) are used. However, in the case of carbon dioxide, water entry temperature in the heat pump hot water supply system is high, efficiency is low. Further, in the case of the carbon dioxide, pressure is high and thus, pressure resistance is required. Therefore, cost of part becomes high. Also, in the case of the carbon dioxide, efficiency at the time of cooling operation is about 60% of R32 refrigerant. Therefore, for a heat medium circulation device which heats or cools a room by heating or cooling heat medium, propane is more suitable than carbon dioxide.

[0007] However, the propane is combustible refrigerant, and it is important to ensure safety when refrigerant leaks. Since electric potential is applied to a control substrate or a control part which controls a compressor, it is especially important to ensure safety when the refrigerant leaks.

[0008] Therefore, it is an object of the present invention to solve such a conventional problem, and to provide a safe, durable and inextensible heat medium circulation device using combustible refrigerant.

[MEANS FOR SOLVING THE PROBLEM]

[0009] A heat medium circulation device including an outdoor unit, the outdoor unit includes: a refrigerant circuit connecting a compressor, a use-side heat exchanger, a pressure reducing means and a heat source-side heat exchanger to one another to circulate refrigerant; a heat medium circuit connected to the use-side heat exchanger; an air blower for emitting air wind to exchange heat with the heat source-side heat exchanger; and a control substrate for controlling operations of the compressor, the pressure reducing means and the air blower; in which an interior of the outdoor unit is partitioned by a partition plate, one side of the partition plate is an outside air communication chamber, the other side of the partition plate is an interior machine chamber, the heat source-side heat exchanger and the air blower are placed in the outside air communication chamber, and the compressor, the use-side heat exchanger and the pressure reducing means are placed in the interior machine chamber, wherein the refrigerant is combustible refrigerant having specific gravity which is greater than that of air, the control substrate is accommodated in the power source box, the power source box is placed above the air blower, and an interior of the power source box is in communication with the interior machine chamber.

[EFFECT OF THE INVENTION]

[0010] According to the present invention, the combustible refrigerant having greater specific gravity than air is used as the refrigerant, the control substrate is accommodated in the power source box, the power source box is placed above the air blower, and the interior of the power source box is not in communication with the interior machine chamber. Therefore, it is possible to prevent combustible refrigerant from entering the power source box having the control substrate. According to this, it is possible to provide a heat medium circulation device using the safe heat pump.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0011]

Fig. 1 is a pipe circuit diagram of a heat medium circulation device according to a first embodiment of the present invention;

Figs. 2 are diagrams showing configuration of an outdoor unit of the heat medium circulation device;

Figs. 3 are diagrams showing configuration the an outdoor unit of a heat medium circulation device according to a second embodiment of the invention; and

Figs. 4 are diagrams showing flow of air of a power source box in the outdoor unit.

[MODE FOR CARRYING OUT THE INVENTION]

[0012] A heat medium circulation device according to a first embodiment of the present invention, combustible refrigerant having greater specific gravity than air is used as refrigerant, a control substrate is accommodated in a power source box, the power source box is placed above an air blower, and an interior of the power source box is not in communication with an interior machine chamber.

[0013] According to the embodiment, it is possible to prevent the combustible refrigerant from entering the power source box having a control substrate. Therefore, it is possible to provide a heat medium circulation device using a safe heat pump.

[0014] In a second embodiment, in the heat medium circulation device of the first embodiment, the control substrate includes a heat radiating section, and the power source box includes a ventilation duct for introducing air into the power source box from outside of the outdoor unit, and an outlet section for discharging air in the power source box to outside of the power source box.

[0015] According to the embodiment, air existing outside of the outdoor unit can be brought into the power source box through the ventilation duct to cool the control substrate, and temperature of the control substrate can be lowered. According to this, it is possible to prevent parts from deteriorating, and to use the heat medium circulation device for a long term with consistent performance.

[0016] In a third embodiment, in the heat medium circulation device of the first or the second embodiment, the control substrate is placed in an outside air communication chamber.

[0017] According to this embodiment, since there is no control substrate above the interior machine chamber, even if combustible refrigerant leaks out from a refrigerant circuit, the combustible refrigerant does not flow toward the control substrate. According to this, it is possible to provide a safe heat medium circulation device.

[EMBODIMENTS]

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

(First Embodiment)

[0019] Fig. 1 is a pipe circuit diagram of a heat medium circulation device according to a first embodiment of the present invention.

[0020] The heat medium circulation device of the embodiment includes an outdoor unit 1, an intermediate relay device 2 and an exterior radiator 4. The heat medium circulation device heats or cools heat medium such as circulating water or antifreeze liquid. The outdoor unit 1 and the intermediate relay device 2 are connected to each other through a heat medium pipe 3. The interme-

diated relay device 2 and the exterior radiator 4 are connected to each other through the heat medium pipe 3.

[0021] Although Fig. 1 shows the panel like exterior radiator 4 such as floor heating, the exterior radiator 4 may be a domestic radiator such as a fan convector including a panel heater or an air blower 11. The exterior radiator 4 may be a hot air blower or a hot water radiator used in a factory.

[0022] The outdoor unit 1 heats or cools water, and hot water or cold water is produced. The hot water or cold water passes through the heat medium pipe 3, and is sent to the exterior radiator 4, and heats or cools a living room where the exterior radiator 4 is placed. In this manner, the exterior radiator 4 heats or cools a part or a space. The outdoor unit 1 produces hot water or cold water for heating or cooling a part or a space.

[0023] The outdoor unit 1 is provided therein with a compressor 5, a water refrigerant heat exchanger 6, an expansion valve 7, an air refrigerant heat exchanger 8 and a four-way valve 9. The compressor 5 compresses and circulates refrigerant. The water refrigerant heat exchanger 6 exchanges heat between heat medium such as water or antifreeze liquid and refrigerant which is circulated by the compressor 5. The expansion valve 7 is pressure reducing means. The four-way valve 9 switches between a heating operation and a cooling operation of heat medium.

[0024] The refrigerant circuit 10 annularly connecting, to one another, the compressor 5, the four-way valve 9, the water refrigerant heat exchanger 6, a pressure reducing means 7 and the air refrigerant heat exchanger 8, thereby forming a closed circuit, and refrigerant is circulated through the refrigerant circuit 10.

[0025] The water refrigerant heat exchanger 6 is composed of a refrigerant pipe 6a through which refrigerant flows, and a heat medium pipe 6b through which heat medium flows. The water refrigerant heat exchanger 6 is formed as a copper pipe or a stainless steel pipe having high heat conductivity. The water refrigerant heat exchanger 6 exchanges heat between refrigerant and heat medium, and heats or cools heat medium such as water or antifreeze liquid by refrigerant.

[0026] In this embodiment, the water refrigerant heat exchanger 6 corresponds to a use-side heat exchanger, and the air refrigerant heat exchanger 8 corresponds to a heat source-side heat exchanger.

[0027] The air blower 11 transfers air to the air refrigerant heat exchanger 8, and promotes heat exchanging ability of the air refrigerant heat exchanger 8.

[0028] On the other hand, heat medium is circulated through a heat medium circuit 12, and the circulating heat medium exchanges heat with refrigerant in the water refrigerant heat exchanger 6. A circulation pump 13 forcibly circulates the heat medium in the heat medium circuit 12, and the circulation pump 13 is placed at a location upstream of the water refrigerant heat exchanger 6.

[0029] The intermediate relay device 2 includes a flow rate sensor 14 provided in series with the heat medium

pipe 3, and an expansion absorption tank 15 placed in parallel to the heat medium pipe 3. The expansion absorption tank 15 is of a hermetic type.

[0030] A pair of connection ports 3a connect the heat medium pipe 3 and the heat medium circuit 12 to each other.

[0031] Control parts which control various kinds of actuators and various kinds of sensors (e.g., temperature sensor) of the outdoor unit 1 are placed in a control substrate 16. A user operates action and various kinds of setting operations in the outdoor unit 1 and the intermediate relay device 2 by a remote controller 17.

[0032] Figs. 2 show configuration of the outdoor unit of the heat medium circulation device, wherein Fig. 2(a) is a front view of an introspection, Fig. 2(b) is a side view of the introspection, and Fig. 2(c) is a top view of the introspection.

[0033] The outdoor unit 1 is composed of a bottom plate 1a and a cover 1b which form a casing, and an interior machine chamber 18 and an outside air communication chamber 19 are formed in the outdoor unit 1.

[0034] An interior of the outdoor unit 1 is partitioned by a partition plate 20, one side of the partition plate 20 is the outside air communication chamber 19, and the other side of the partition plate 20 is the interior machine chamber 18.

[0035] The air refrigerant heat exchanger 8 and the air blower 11 are placed in the outside air communication chamber 19. The compressor 5, the water refrigerant heat exchanger 6, the pressure reducing means 7, the circulation pump 13 and the four-way valve 9 are placed in the interior machine chamber 18.

[0036] The bottom plate 1a is provided at the lowermost portion of the outdoor unit 1, and the compressor 5 is placed in the interior machine chamber 18 located on the right side of the bottom plate 1a.

[0037] The water refrigerant heat exchanger 6 is a plate type heat exchanger, and the water refrigerant heat exchanger 6 is placed at a position on the right rear side of the bottom plate 1a. The pair of connection ports 3a connected to the water refrigerant heat exchanger 6 extends toward the outside from the casing on the rear side of the casing. The heat medium pipe 3 is connected to the connection ports 3a.

[0038] Although Figs. 2 show the plate type heat exchanger, the heat exchanger may be of a double pipe configuration only if heat can be exchanged between refrigerant and heat medium.

[0039] The expansion valve 7 which is the pressure reducing means and the four-way valve 9 which switches between the heating operation and the cooling operation of the heat medium are placed in the vicinity of the compressor 5. The expansion valve 7 and the four-way valve 9 constitute the refrigerant circuit 10 together with the compressor 5.

[0040] The air refrigerant heat exchanger 8 is placed on the left rear side of the bottom plate 1a. The air refrigerant heat exchanger 8 is connected to the expansion

valve 7 and the four-way valve 9 through a pipe which extends from the rightmost portion of the air refrigerant heat exchanger 8.

[0041] The air blower 11 which transfers air is placed at a position opposed to the air refrigerant heat exchanger 8. The air blower 11 promotes heat exchanging ability of the air refrigerant heat exchanger 8.

[0042] The circulation pump 13 is placed below the water refrigerant heat exchanger 6, and forcibly circulates heat medium in the heat medium circuit 12. The circulation pump 13 is connected to the water refrigerant heat exchanger 6 and the connection ports 3a.

[0043] The circulation pump 13 circulates heat medium in the heat medium circuit 12. The circulation pump 13 may be provided in the intermediate relay device 2.

[0044] The interior machine chamber 18 and the outside air communication chamber 19 are partitioned by the partition plate 20. The partition plate 20 is provided between a front side of the casing and the air refrigerant heat exchanger 8 located behind the casing.

[0045] The control substrate 16 is placed above the partition plate 20, and the control substrate 16 is provided in the power source box 21 which is placed above the outside air communication chamber 19.

[0046] The control substrate 16 includes an IPM (intelligent power module) 16a, a radiating fin 16b and an electrolytic capacitor 16c. The IPM 16a drives the compressor 5 by an inverter. The radiating fin 16b cools the IPM 16a. The electrolytic capacitor 16c drives the inverter efficiently. The IPM 16a and the electrolytic capacitor 16c are ones of heat radiating sections. The radiating fin 16b projects downwardly from the power source box 21, and is cooled by the air blower 11.

[0047] The power source box 21 is formed into a substantially hexahedron box body from a power source box lower portion 21a and a power source box lid 21b. According to the power source box 21, after the control substrate 16 is set on the power source box lower portion 21a, the power source box lid 21b covers the control substrate 16. The control substrate 16 is covered with the power source box 21.

[0048] Lead wires of the various kinds of actuators and sensors are connected to the control substrate 16. By these lead wires, lead wire-passing holes of the power source box 21 are sealed such that outside air does not flow into the power source box 21 or almost no outside air flows into the power source box 21.

[0049] A portion of the power source box 21 is located slightly above the interior machine chamber 18, but the power source box 21 is completely partitioned from the interior machine chamber 18. The control substrate 16 is placed above the outside air communication chamber 19.

[0050] Refrigerant used in the refrigerant circuit 10 is combustible refrigerant having specific gravity greater than air, and the refrigerant is propane (R290) for example.

[0051] Action of the heat medium circulation device will

be described based on the drawings.

[0052] In Fig. 1, the four-way valve 9 is in a state where hot water is produced, a hot water producing operation will be described first.

[0053] If the compressor 5 is operated, refrigerant is compressed to high pressure by the compressor 5, and the refrigerant is discharged. The refrigerant passes through the four-way valve 9 and is sent to the water refrigerant heat exchanger 6. The refrigerant exchanges heat with low temperature water which passes through the heat medium circuit 12 by power of the circulation pump 13 in the water refrigerant heat exchanger 6, and the refrigerant radiates heat. According to this, the low temperature water is heated and becomes high temperature water, and the high temperature water is sent from the heat medium pipe 3 to the exterior radiator 4 through the intermediate relay device 2. According to this, the living room is heated.

[0054] The refrigerant which flows out from the water refrigerant heat exchanger 6 is decompressed and expanded by the expansion valve 7, the refrigerant is sent to the air refrigerant heat exchanger 8 which is the evaporator, the refrigerant exchanges heat with air sent by the air blower 11, and while the refrigerant passes through the air refrigerant heat exchanger 8, the refrigerant is evaporated and gasified.

[0055] The gasified refrigerant passes through the four-way valve 9, the refrigerant is sucked into the compressor 5, and is again compressed.

[0056] At this time, propane (R290) is used as the refrigerant. The propane is natural refrigerant, GWP (global warming potential) is extremely low, as low as 3, and the propane does not become a subject to regulation in the future also.

[0057] The propane is used for air conditioners. The propane is largely different from R32 (GWP: 675) which becomes a subject to regulation of chlorofluorocarbon in the future, and the propane is environmentally friendly refrigerant.

[0058] Further, unlike carbon dioxide gas (GWP: 1) having low GWP and extremely low cooling performance, heating performance and cooling performance of the propane are the same as those of chlorofluorocarbon-based refrigerant. Hence, a possibility that the propane becomes future mainstream is high.

[0059] However, the propane is combustible refrigerant.

[0060] There is a possibility that the propane refrigerant leaks out in the refrigerant circuit 10, and the propane refrigerant is liable to leak when a part in the refrigerant circuit 10 cracks.

[0061] The control substrate 16 has many parts to which electric potential is applied, and it is important to ensure safety.

[0062] In this regard, the control substrate 16 is placed in the power source box 21 whose six surfaces are covered. This power source box 21 is placed not above the interior machine chamber 18 where the refrigerant circuit

10 such as the compressor 5 is placed, but is placed above the outside air communication chamber 19 through which outside air passes. According to this, it is possible to prevent refrigerant from flowing into the power source box 21.

[0063] Especially, the specific gravity of the propane is 1.56 which is heavier than that of air, and when the propane leaks, it stays in a lower portion of the outdoor unit 1, and this configuration is more advantageous than a configuration where it is placed above the outdoor unit 1.

[0064] However, when the refrigerant circuit 10 cracks during operation, there is a possibility that the propane refrigerant furiously spouts out, the propane refrigerant reaches an upper portion of the outdoor unit 1. In this regard, since the control substrate 16 is placed in the power source box 21 whose six surfaces are covered, it is possible to prevent combustible refrigerant from flowing into the power source box 21.

[0065] According to this, even if combustible refrigerant is used, it is possible to provide a heat medium circulation device using a safe heat pump.

[0066] The control substrate 16 is placed above the outdoor unit 1, and the control substrate 16 is covered with the power source box 21. According to this, it is possible to realize a heat medium circulation device with relatively simple configuration, and it is possible to enhance safety inexpensively.

[0067] Although the heat medium heating operation to produce hot water is described, the heat medium cooling operation is also possible to switching the four-way valve 9 to change the flowing direction of refrigerant. Behavior when refrigerant leaks at this time is the same, and it is possible to ensure safety.

(Second Embodiment)

[0068] Figs. 3 are diagrams showing configuration the an outdoor unit of a heat medium circulation device according to a second embodiment of the invention, wherein Fig. 3(a) is a front view of an introspection, Fig. 3(b) is a side view of the introspection, and Fig. 3(c) is a top view of the introspection. The same symbols are allocated to the same functional members as those of the first embodiment, description thereof will be omitted, and portions which are different from those of the first embodiment will mainly be described.

[0069] The control substrate 16 is placed above a partition plate 20, and provided in a power source box 21 placed above an outside air communication chamber 19.

[0070] The control substrate 16 includes an IPM (intelligent power module) 16a, a radiating fin 16b and an electrolytic capacitor 16c. The IPM 16a drives the compressor 5 by an inverter. The radiating fin 16b cools the IPM 16a. The electrolytic capacitor 16c drives the inverter efficiently. The IPM 16a is one of heat radiating section. The radiating fin 16b projects downwardly from the power source box 21, and is cooled by the air blower 11.

[0071] The power source box 21 is formed into a substantially hexahedron box body from a power source box lower portion 21a and a power source box lid 21b. According to the power source box 21, after the control substrate 16 is set on the power source box lower portion 21a, the power source box lid 21b covers the control substrate 16. The control substrate 16 is covered with the power source box 21.

[0072] Lead wires of the various kinds of actuators and sensors are connected to the control substrate 16. BY these lead wires, lead wire-passing holes of the power source box 21 are sealed such that outside air does not flow into the power source box 21 or almost no outside air flows into the power source box 21.

[0073] A ventilation duct 22 is provided in the power source box 21 on the side of an interior machine chamber 18. The ventilation duct 22 is fixed to the power source box 21. A power source box opening inlet 21c is provided in the power source box 21 which is opposed to the ventilation duct 22.

[0074] The ventilation duct 22 is connected to a right plate 23 of the outdoor unit 1. A right plate opening inlet 23a is provided in the power source box 21 which is opposed to the ventilation duct 22 of the right plate 23.

[0075] A power source box opening outlet 21d is provided in a front surface of the power source box 21 which is opposed to the outside air communication chamber 19.

[0076] The operation for producing hot water will be described here also.

[0077] If the remote controller 17 is operated and the heat medium circulation device is operated, the compressor 5 is driven, refrigerant which is compressed to high pressure by the compressor 5 and is discharged passes through the four-way valve 9, and refrigerant is sent to the water refrigerant heat exchanger 6, and the refrigerant exchanges heat with low temperature water which passes through the heat medium circuit 12 by power of the circulation pump 13, and the refrigerant radiates heat. According to this, the low temperature water is heated and becomes high temperature water, the water passes through the heat medium pipe 3 and is sent to the intermediate relay device 2, and sent to the exterior radiator 4 from the intermediate relay device 2, and the living room is heated.

[0078] Refrigerant which flows out from the water refrigerant heat exchanger 6 is decompressed and expanded by the expansion valve 7, the refrigerant is sent to the air refrigerant heat exchanger 8 which is an evaporator, the refrigerant exchanges heat with air sent by the air blower 11, and while the refrigerant passes through the air refrigerant heat exchanger 8, the refrigerant is evaporated and gasified.

[0079] This gasified refrigerant passes through the four-way valve 9, the refrigerant is sucked by the compressor 5 and is again compressed.

[0080] At this time, temperatures of the IPM 16a and the electrolytic capacitor 16c rise. The radiating fin 16b projects downward from the power source box 21, and

the radiating fin 16b is cooled by the air blower 11.

However, such a cooling operation is insufficient in some cases. Especially, the low temperature water producing operation is carried out in a state where outside air temperature is high, and the water refrigerant heat exchanger 6 becomes a condenser. Hence, the air refrigerant heat exchanger 8 is brought into a high temperature state, and even if the air refrigerant heat exchanger 8 is cooled by the air blower 11, the radiating fin 16b cannot be cooled sufficiently in some cases.

[0081] Especially, since the control substrate 16 is covered with the power source box 21, heat generated in the control substrate 16 does not escape, and there is a tendency that the power source box 21 is brought into high temperature.

[0082] Generally, endurance of a capacitor used in an inverter depends on temperature, and temperature induces an effect on its lifetimes. Generally, Arrhenius rule is established between temperature and lifetime. If temperature rises by 10°C, evaporation speed of electrolytic solution used in the capacitor becomes two times and the lifetime becomes 1/2 and thus, this is also called "10°C two times rule".

[0083] A general electrolytic capacitor is specified in "105°C - 2,000 hours" in many cases. However, in the case of 2,000 hours, if operation is carried out for ten hours a day and this is continued for 150 days, the lifetime of the capacitor becomes one year and four months, and this is shorter than two years.

[0084] On the other hand, in atmosphere of 85°C which is lower than the former case by 20°C, lifetime of the electrolytic capacitor becomes 8,000 hours which is four times of the former case. Further, if the temperature can be 75°C which is lower by 10°C, the lifetime of the electrolytic capacitor becomes 16,000 hours. If the lifetime is 16,000 hours, even if the electrolytic capacitor is used for ten hours a day and the electrolytic capacitor is operated for 150 days in the course of the year, and the electrolytic capacitor can be operated without any problem more than 10 years.

[0085] This is one example, but other control parts have the same tendency. It is extremely important to lower the temperature of the control substrate 16 in terms of reliability and quality.

[0086] On the other hand, it is possible to generate flow 24 of air. Air is sucked into the air blower 11 which is surely operated at the time of operation, the air passes through the right plate opening inlet 23a of the right plate 23 and through the ventilation duct 22. Then, the air passes through the power source box opening inlet 21c of the power source box 21 and the control substrate 16, and through the power source box opening outlet 21d.

[0087] Figs. 4 shows this flow 24 of air.

[0088] This flow 24 of air can cool the control substrate 16, and temperature of the control substrate 16 can be lowered. According to this, the heat medium circulation device can have high reliability for a long term.

[0089] Further, at this time, even if combustible refrigerant

erant leaks out from the refrigerant circuit 10, the six surfaces of the power source box 21 are covered and in the ventilation duct 22 located in the interior machine chamber 18, there is no opening which faces the interior machine chamber 18. Hence, the right plate opening inlet 23a and the power source box opening outlet 21d having the openings are in communication only with outside of the outdoor unit 1. Hence, they do not come into contact with combustible refrigerant.

[0090] Hence, even if combustible refrigerant is used, safety is not deteriorated, and it is possible to provide a safe heat medium circulation device.

[INDUSTRIAL APPLICABILITY]

[0091] As described above, the present invention is applied to a heat medium circulation device which heats or cools heat medium in a refrigerant circuit, and the invention is suitable for domestic or institutional-use air conditioners.

[EXPLANATION OF SYMBOLS]

[0092]

1	outdoor unit
1a	bottom plate
1b	cover
2	intermediate relay device
3	heat medium pipe
3a	connection ports
4	exterior radiator
5	compressor
6	water refrigerant heat exchanger (use-side heat exchanger)
6a	refrigerant pipe
6b	heat medium pipe
7	expansion valve (pressure reducing means)
8	air refrigerant heat exchanger (heat source-side heat exchanger)
9	four-way valve
10	refrigerant circuit
11	air blower
12	heat medium circuit
13	circulation pump
14	flow rate sensor
15	expansion absorption tank
16	control substrate
16a	IPM(heat radiating section)
16b	radiating fin
16c	electrolytic capacitor(heat radiating section)
17	remote controller
18	interior machine chamber
19	outside air communication chamber
20	partition plate
21	power source box
21a	power source box lower portion
21b	power source box lid

21c	power source box opening inlet
21d	power source box opening outlet
22	ventilation duct
23	right plate
5	23a right plate opening inlet
24	flow of air

Claims

1. A heat medium circulation device including an outdoor unit (1), the outdoor unit (1) includes:
 - 10 a refrigerant circuit (10) connecting a compressor (5), a use-side heat exchanger (6), a pressure reducing means (7) and a heat source-side heat exchanger (8) to one another to circulate refrigerant;
 - 20 a heat medium circuit (12) connected to the use-side heat exchanger (6);
 - an air blower (11) for emitting air wind to exchange heat with the heat source-side heat exchanger (8); and
 - 25 a control substrate (16) for controlling operations of the compressor (5), the pressure reducing means (7) and the air blower (11); in which an interior of the outdoor unit (1) is partitioned by a partition plate (20),
 - 30 one side of the partition plate (20) is an outside air communication chamber (19), an other side of the partition plate (20) is an interior machine chamber (18), the heat source-side heat exchanger (8) and the air blower (11) are placed in the outside air communication chamber (19), and
 - 35 the compressor (5), the use-side heat exchanger (6) and the pressure reducing means (7) are placed in the interior machine chamber (18), wherein
 - 40 the refrigerant is combustible refrigerant having specific gravity which is greater than that of air, the control substrate (16) is accommodated in a power source box (21),
 - 45 the power source box (21) is placed above the air blower (11), and
 - an interior of the power source box (21) is not in communication with the interior machine chamber (18).
2. The heat medium circulation device according to claim 1, wherein the control substrate (16) includes heat radiating sections (16a, 16c), the power source box (21) includes a ventilation duct (22) for taking the air into the power source box (21) from outside of the outdoor unit (1), and an outlet through which the air in the power source box (21) is discharged to outside of the power source box (21).

3. The heat medium circulation device according to claim 1 or 2, wherein the control substrate (16) is placed in the outside air communication chamber (19).

5

10

15

20

25

30

35

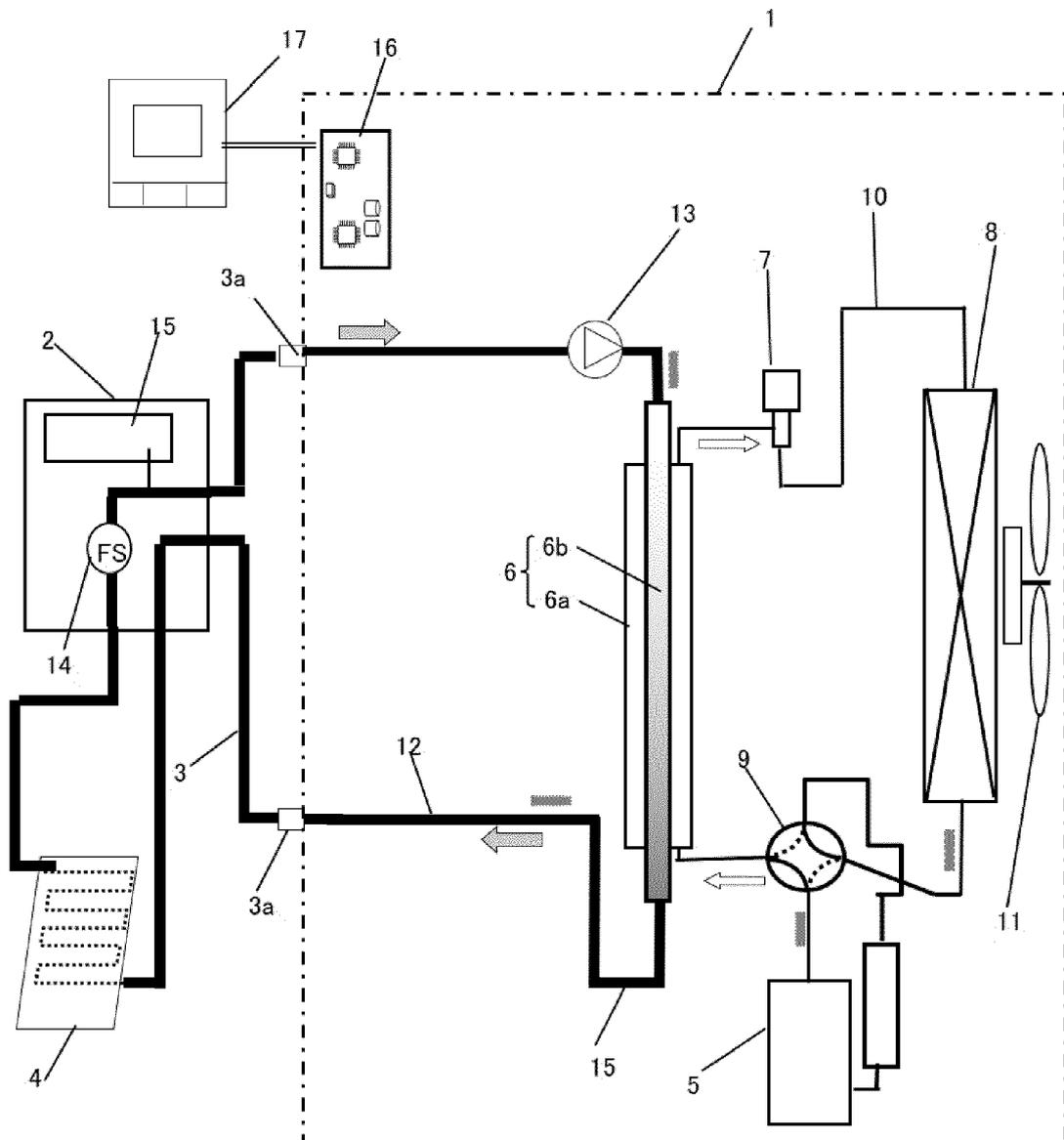
40

45

50

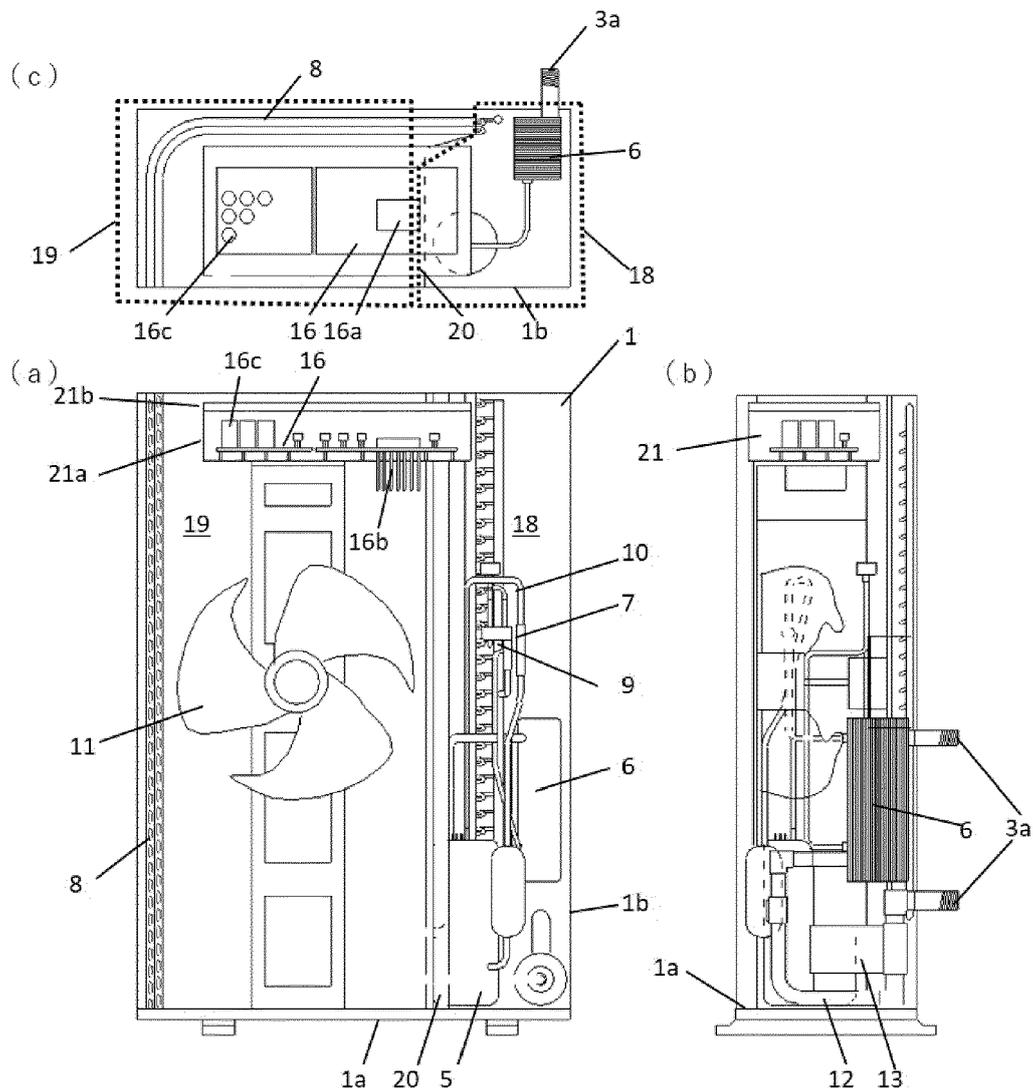
55

[Fig. 1]



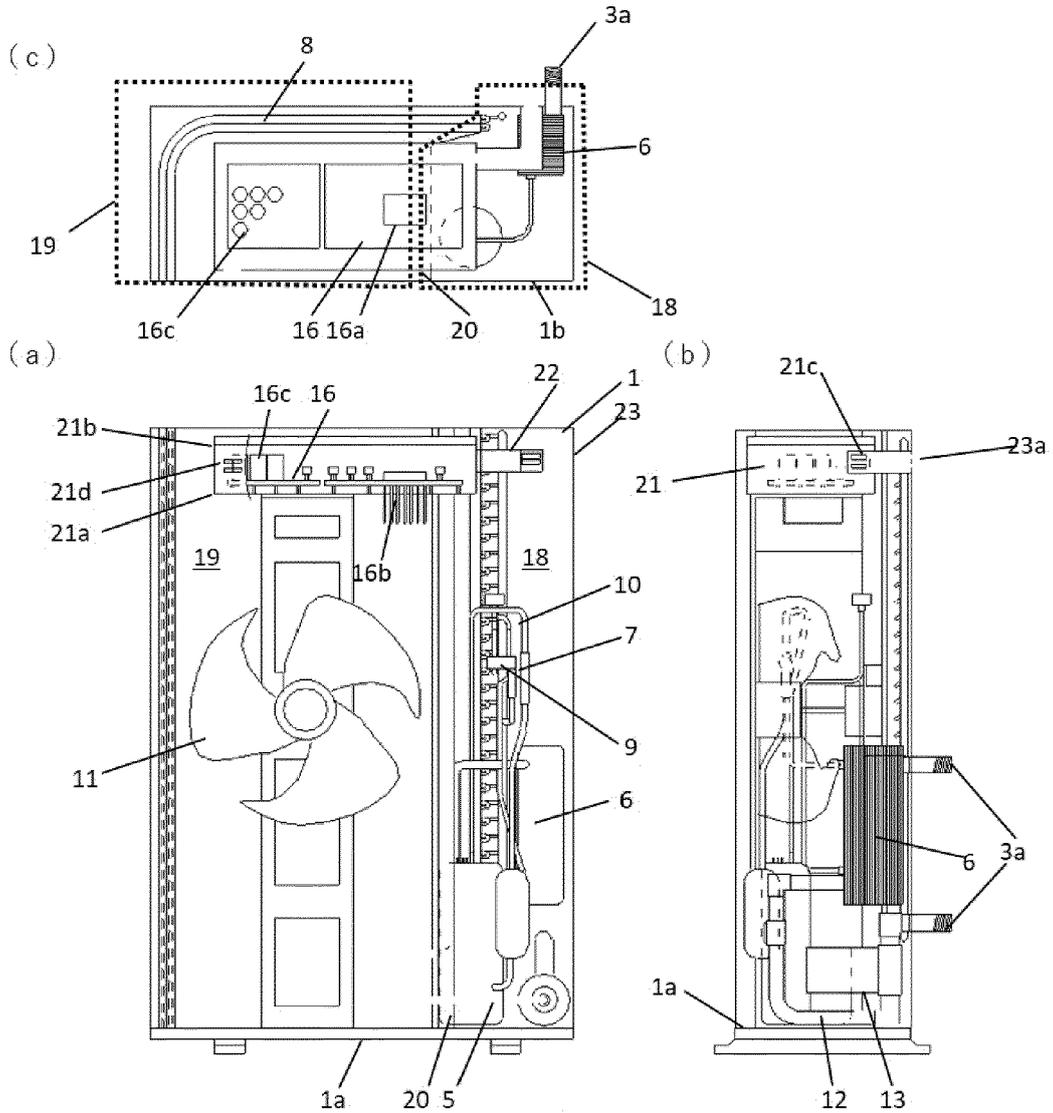
- | | | | |
|----|----------------------------------|----|--------------------------------|
| 1 | Outdoor unit | 8 | Air refrigerant heat exchanger |
| 2 | Intermediate relay device | 9 | Four-way valve |
| 3 | Heat medium pipe | 10 | Refrigerant circuit |
| 3a | Connection port | 11 | Air blower |
| 4 | Exterior radiator | 12 | Heat medium circuit |
| 5 | Compressor | 13 | Circulation pump |
| 6 | Water refrigerant heat exchanger | 14 | Flow rate sensor |
| 6a | Refrigerant pipe | 15 | Expansion absorption tank |
| 6b | Heat medium pipe | 16 | Control substrate |
| 7 | Expansion valve | 17 | Remote controller |

[Fig. 2]



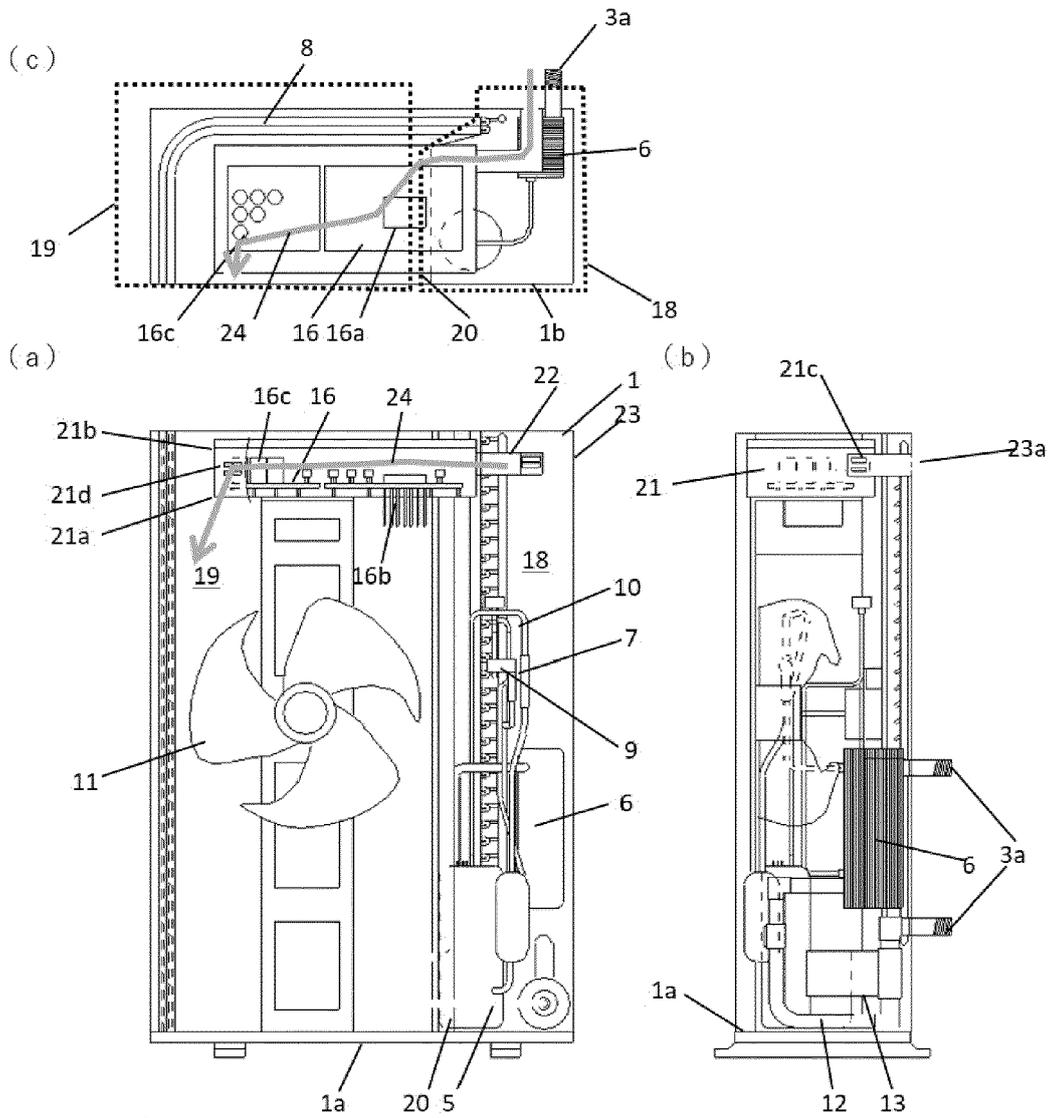
- | | | | |
|----|----------------------------------|-----|-----------------------------------|
| 1 | Outdoor unit | 13 | Circulation pump |
| 1a | Bottom plate | 16 | Control substrate |
| 1b | Cover | 16a | IPM |
| 3a | Connection port | 16b | Radiating fin |
| 5 | Compressor | 16c | Electrolytic capacitor |
| 6 | Water refrigerant heat exchanger | 18 | Interior machine chamber |
| 7 | Expansion valve | 19 | Outside air communication chamber |
| 8 | Air refrigerant heat exchanger | 20 | Partition plate |
| 9 | Four-way valve | 21 | Power source box |
| 10 | Refrigerant circuit | 21a | Power source box lower portion |
| 11 | Air blower | 21b | Power source box lid |
| 12 | Heat medium circuit | | |

[Fig. 3]



- | | | | |
|----|----------------------------------|-----|-----------------------------------|
| 1 | Outdoor unit | 16a | IPM |
| 1a | Bottom plate | 16b | Radiating fin |
| 3a | Connection port | 16c | Electrolytic capacitor |
| 5 | Compressor | 18 | Interior machine chamber |
| 6 | Water refrigerant heat exchanger | 19 | Outside air communication chamber |
| 7 | Expansion valve | 20 | Partition plate |
| 8 | Air refrigerant heat exchanger | 21 | Power source box |
| 9 | Four-way valve | 21a | Power source box lower portion |
| 10 | Refrigerant circuit | 21b | Power source box lid |
| 11 | Air blower | 21c | Power source box opening inlet |
| 12 | Heat medium circuit | 21d | Power source box opening outlet |
| 13 | Circulation pump | 23 | Right plate |
| 16 | Control substrate | 23a | Right plate opening inlet |

[Fig. 4]



- | | | | |
|----|----------------------------------|-----|-----------------------------------|
| 1 | Outdoor unit | 16a | IPM |
| 1a | Bottom plate | 16b | Radiating fin |
| 3a | Connection port | 16c | Electrolytic capacitor |
| 5 | Compressor | 18 | Interior machine chamber |
| 6 | Water refrigerant heat exchanger | 19 | Outside air communication chamber |
| 7 | Expansion valve | 20 | Partition plate |
| 8 | Air refrigerant heat exchanger | 21 | Power source box |
| 9 | Four-way valve | 21a | Power source box lower portion |
| 10 | Refrigerant circuit | 21b | Power source box lid |
| 11 | Air blower | 21c | Power source box opening inlet |
| 12 | Heat medium circuit | 21d | Power source box opening outlet |
| 13 | Circulation pump | 23 | Right plate |
| 16 | Control substrate | 23a | Right plate opening inlet |
| | | 24 | Flow of air |



EUROPEAN SEARCH REPORT

Application Number

EP 22 16 9802

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2007 212025 A (MATSUSHITA ELECTRIC IND CO LTD) 23 August 2007 (2007-08-23)	1	INV. F24F1/22 F24F1/24 F24F1/46 F24D3/18 F24F5/00 F24H4/02
Y	* the whole document *	2	
A	CN 203 571 911 U (MIDEA GROUP CO LTD) 30 April 2014 (2014-04-30) * paragraphs [0024] - [26.38.39]; figure 1.2 *	1	
A	CN 202 993 409 U (GUANGDONG MIDEA ELECTRICAL APPLIANCE CO LTD) 12 June 2013 (2013-06-12) * paragraphs [0029] - [0033]; figure 1.2 *	1	
Y	EP 3 327 362 A1 (MITSUBISHI ELECTRIC CORP [JP]) 30 May 2018 (2018-05-30) * paragraph [0014]; figures 1-3 *	2	
A	EP 1 684 023 A1 (DAIKIN IND LTD [JP]) 26 July 2006 (2006-07-26) * paragraphs [0052] - [0059]; figures 3-6 *	3	
			TECHNICAL FIELDS SEARCHED (IPC) F24F F24D F24H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 9 September 2022	Examiner Blot, Pierre-Edouard
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03:82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 22 16 9802

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-09-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2007212025 A	23-08-2007	JP 4899510 B2 JP 2007212025 A	21-03-2012 23-08-2007
CN 203571911 U	30-04-2014	NONE	
CN 202993409 U	12-06-2013	NONE	
EP 3327362 A1	30-05-2018	CN 207778627 U EP 3327362 A1 JP 6632733 B2 JP WO2018061071 A1 WO 2018061071 A1	28-08-2018 30-05-2018 22-01-2020 25-04-2019 05-04-2018
EP 1684023 A1	26-07-2006	AU 2004280422 A1 CN 1864036 A EP 1684023 A1 JP 3698152 B2 JP 2005114244 A KR 20060060049 A US 2007006610 A1 WO 2005036064 A1	21-04-2005 15-11-2006 26-07-2006 21-09-2005 28-04-2005 02-06-2006 11-01-2007 21-04-2005

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 2005083692 A [0005]
- JP 4899510 B [0005]