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(54) HEAT MEDIUM CIRCULATION SYSTEM

(57) [Object] The present disclosure provides a heat medium circulation system which safely disperses leaked refrigerant to outside atmosphere and which further enhances safety.

[Solving Means] A heat medium circulation system 100 in the present disclosure includes: a refrigerant circuit 110 which is formed by annularly connecting a compressor 111, a use-side heat exchanger 112, an expander 113 and a heat source-side heat exchanger 114 to one another; a heat medium circuit 120 through which heat medium cooled or heated by the use-side heat exchanger 112 by means of refrigerant discharged from the compressor 111 circulates; and a control device 130, in which the heat medium circuit 120 is provided therein at least with a circulation device through which the heat medium circulates, a heating device 127 for electrically heating the heat medium, and a deaerating device 128 which discharges the circulating gas in the heat medium circuit 120 to outside the heat medium circuit 120. The heat medium circulation system 100 uses flammable refrigerant. The heating device 127 is placed downstream of the circulation device and on a side higher than the circulation device, and the deaerating device 128 is placed downstream of the heating device 127 and on a side higher than the heating device 127.

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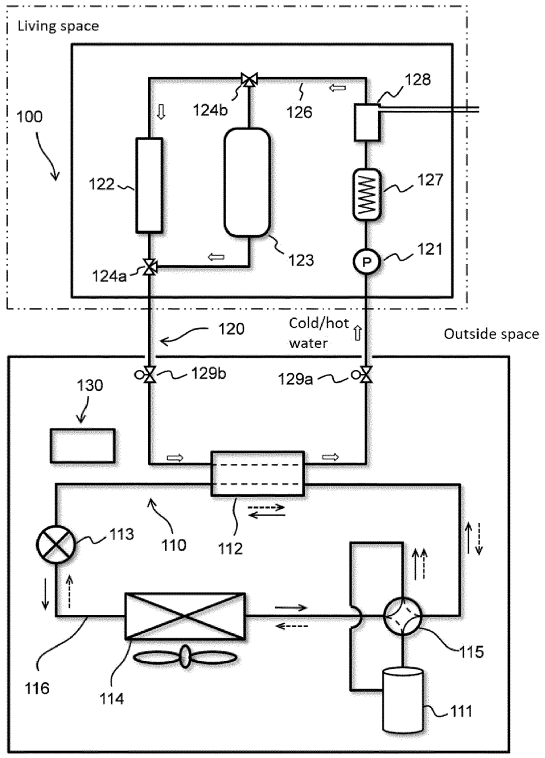
[Fig. 1]



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Description

[TECHNICAL FIELD]

[0001] The present disclosure relates to a heat medium circulation system.

[BACKGROUND TECHNIQUE]

[0002] Patent document 1 discloses a heat pump device which prevents flammable refrigerant from being ignited. According to this heat pump device, a refrigerant discharge valve in a heat medium circuit is provided outside a casing.

[PRIOR ART DOCUMENT]

[PATENT DOCUMENT]

[0003] [Patent Document 1] PCT International Publication No. WO2018/047265

[SUMMARY OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

[0004] The present disclosure provides a heat medium circulation system which safely disperses, into outside atmosphere, flammable refrigerant which leaks into a use-side heat medium circuit.

[MEANS FOR SOLVING THE PROBLEM]

[0005] A heat medium circulation system of the present disclosure includes: a refrigerant circuit which is formed by annularly connecting a compressor, a use-side heat exchanger, an expander and a heat source-side heat exchanger to one another, and which uses flammable refrigerant; a heat medium circuit through which heat medium cooled or heated by the use-side heat exchanger by means of refrigerant discharged from the compressor circulates; and a control device. The heat medium circuit is provided therein at least with a circulation device through which the heat medium in the heat medium circuit circulates, a heating device for electrically heating the heat medium, and a deaerating device which separates gas in the heat medium circuit and discharges the gas to outside. The heating device is placed downstream of the circulation device and on a side higher than the circulation device, and the deaerating device is placed downstream of the heating device and on a side higher than the heating device.

[0006] A heat medium exit of the heating device is placed on a side higher than a heating portion of the heating device. A heat medium entrance of the heating device is placed on a side lower than the heat medium exit.

[0007] The control device heats the heating portion of the heating device such that surface temperature of the heating portion becomes lower than temperature of ignition point of the flammable refrigerant.

[0008] The heat medium circulation system of the present disclosure further includes a refrigerant leakage detection sensor for detecting leakage of the flammable refrigerant into the heat medium circuit, and shut-off valves for shutting off a flow path of the heat medium which circulates in the heat medium circuit. When the control device determines that the flammable refrigerant leaks into the heat medium circuit, the control device operates the shut-off valves in its closing direction to stop flow of the heat medium.

[0009] The refrigerant leakage detection sensor is a refrigerant concentration sensor placed near an exhaust port of the deaerating device. When a detection value of the refrigerant concentration sensor becomes higher by a predetermined value or more, the control device determines that the flammable refrigerant leaks from the heat medium circuit.

[0010] The flammable refrigerant is R32, mixed refrigerant including 70% or more by weight of R32, propane or mixed refrigerant including propane.

[EFFECT OF THE INVENTION]

[0011] According to the heat medium circulation system in the present disclosure, flammable refrigerant is safely discharged into outside atmosphere. According to this, safety is further enhanced.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0012]

Fig. 1 is a block diagram of a heat medium circulation system in an embodiment of the present invention;
Fig. 2 is a pressure-enthalpy diagram (P-h diagram) of the heat medium circulation system in the embodiment;
Fig. 3 is a block diagram of a control system of the heat medium circulation system in the embodiment;
Fig. 4 is a schematic diagram of a state where refrigerant gas in a heat medium circuit in the embodiment is discharged into outside atmosphere; and
Fig. 5 is a flowchart for describing detection of leakage of refrigerant of the heat medium circulation system and control operation of shut-off valves in the embodiment.

[MODE FOR CARRYING OUT THE INVENTION]

[0013] The present disclosure has such a configuration that a heating device is placed downstream of a circulating device and at a position higher than the circulating device, and a deaerating device is placed downstream of the heating device and at a position higher than the heating device. According to this, the present disclosure

provides a heat medium circulation system which safely discharges, into outside atmosphere, refrigerant which leaks into a heat medium circuit.

[0014] An embodiment will be described in detail below with reference to the drawings. Excessively detailed description will be omitted in some cases. For example, detailed description of already well known matters, or redundant description of substantially the same configuration will be omitted in some cases. This is for preventing the following description becoming redundant more than necessary, and for making it easy for a person skilled in the art to understand.

[0015] The accompanying drawing and the following description are provided so that the person skilled in the art can sufficiently understand the present disclosure, and it is not intended that they limit the subject matter described in claims.

[0016] The embodiment of the present invention will be described below using Figs. 1 to 5.

[1-1. Configuration]

[1-1-1. Configuration of heat medium circulation system]

[0017] In Fig. 1, a heat medium circulation system 100 includes a refrigerant circuit 110, a heat medium circuit 120 and a control device 130.

[0018] The refrigerant circuit 110 is a vapor compression type refrigeration cycle. The refrigerant circuit 110 is configured by connecting a compressor 111, a use-side heat exchanger 112, an expander 113 and a heat source-side heat exchanger 114 to one another through pipe 116. The refrigerant circuit 110 uses, as refrigerant, propane which is flammable refrigerant.

[0019] The refrigerant circuit 110 is provided with a four-way valve 115 which switches between a heating operation and a cooling operation. Warm water is produced in the heating operation, and cold water is produced in the cooling operation.

[0020] The heat medium circuit 120 is configured by connecting, to one another through a heat medium pipe 126, the use-side heat exchanger 112, a conveying pump 121 which is a conveying device of heat medium, a use-side terminal 122 such as a panel of a floor heating, and a first switching valve 124a and a second switching valve 124b for selectively switching circuits of heat medium. The heat medium circuit 120 uses water or antifreeze liquid as the heat medium.

[0021] The heat medium circuit 120 is provided with a hot water tank 123 in parallel with the use-side terminal 122. The use-side terminal 122 and the hot water tank 123 are connected to each other through the heat medium pipe 126. The heat medium pipe 126 branches off from the first switching valve 124a and joins the second switching valve 124b.

[0022] The heat medium circuit 120 includes a heating device 127 downstream of the conveying pump 121. The heating device 127 includes a heater element 150 (see Fig. 4) at a position higher than an installation position of the conveying pump 121. The heat medium pipe 126 is connected to the heating device 127 such that heat medium which flows out from the conveying pump 121 flows in from a lower portion of the heating device 127 and flows out from an upper portion of the heating device 127.

[0023] A deaerating device 128 is provided downstream of a flowing direction of the heating device 127 and at the highest position (uppermost side) of the heat medium circuit 120. The deaerating device 128 can discharge gas which circulates through the heat medium circuit 120 to outside. A discharge port of the deaerating device 128 opens into outside atmosphere.

[0024] A first shut-off valve 129a which stops flow of heat medium is provided between the conveying pump 121 and the use-side heat exchanger 112 in the heat medium circuit 120. A second shut-off valve 129b is provided between the use-side heat exchanger 112 and the first switching valve 124a.

[0025] In Fig. 1, solid arrows show a flowing direction of refrigerant at the time of heating operation, and broken arrows show the flowing direction of refrigerant at the time of cooling operation.

[0026] Change of a state of refrigerant at the time of the heating operation and the cooling operation will be described using Fig. 2.

[0027] At the time of the heating operation, high pressure refrigerant (point a) discharged from the compressor 111 flows into the use-side heat exchanger 112 through the four-way valve 115, and radiates heat into the heat medium which flows through the use-side heat exchanger 112. The high pressure refrigerant (point b) after it radiates in the use-side heat exchanger 112 is decompressed and expanded by the expander 113 and thereafter, the refrigerant flows into the heat source-side heat exchanger 114. Low pressure refrigerant (point c) which flows into the heat source-side heat exchanger 114 absorbs heat from outside air and evaporates, and again returns into a suction side (point d) of the compressor 111 through the four-way valve 115.

[0028] On the other hand, at the time of the cooling operation, high pressure refrigerant (point a) discharged from the compressor 111 flows into the heat source-side heat exchanger 114 through the four-way valve 115, and radiates heat into outside air in the heat source-side heat exchanger 114. The high pressure refrigerant (point b) after it radiates heat in the heat source-side heat exchanger 114 is decompressed and expanded in the expander 113 and then, the refrigerant flows into the use-side heat exchanger 112. Low pressure refrigerant (point c) which flows into the use-side heat exchanger 112 absorbs heat from the heat medium which flows through the use-side heat exchanger 112 and evaporates, and again returns to the suction side (point d) of the compressor 111 through the four-way valve 115.

[0029] Next, change of a state of heat medium in the heat medium circuit 120 will be described. First, at the

time of the heating operation, heat medium is heated by the use-side heat exchanger 112, and the heat medium is circulated by the conveying pump 121. The heat medium radiates heat in the use-side terminal 122, and the heat medium is utilized for heating a use-side load. The heat medium which radiates heat in the use-side terminal 122 and whose temperature is lowered is again heated by the use-side heat exchanger 112.

[0030] Here, when a heating amount in the use-side heat exchanger 112 is smaller than a heat amount which can sufficiently heat the use-side load, the heater element 150 of the heating device 127 is energized, and the heat medium which flows into the heating device 127 is directly heated.

[0031] High temperature heat medium heated by the use-side heat exchanger 112 circulates through the hot water tank 123 by switching operations of the first switching valve 124a and the second switching valve 124b. The high temperature heat medium is introduced from an upper portion of the hot water tank 123 into the hot water tank 123, and lower temperature heat medium is derived from a lower portion of the hot water tank 123, and is heated by the use-side heat exchanger 112.

[0032] On the other hand, at the time of the cooling operation, heat medium is cooled by the use-side heat exchanger 112, and the heat medium is circulated by the conveying pump 121. According to this, the heat medium absorbs heat in the use-side terminal 122, and is utilized for cooling a use-side load. The heat medium which absorbs heat in the use-side terminal 122 and whose temperature rises is again cooled by the use-side heat exchanger 112.

[0033] The control device 130 is provided in a casing of the heat medium circulation system 100, and the control device 130 controls the number of rotations of the compressor 111, a throttle amount of the expander 113, the number of rotations of the conveying pump 121 and applied voltage of the heating device 127. The control device 130 switches the four-way valve 115, and switches between the first switching valve 124a and the second switching valve 124b. According to this, control is performed such that efficiency of the vapor compression type refrigeration cycle is enhanced.

[1-1-2. Configuration of control device]

[0034] Next, configuration of the control device 130 will be described using Fig. 3. The control device 130 is composed of a controller 131 and a user interface 132. The controller 131 is connected to a high pressure side pressure sensor 133, a discharge temperature sensor 134, a heat source-side heat exchange sensor 135, an outside air temperature sensor 136, and a water-entering temperature sensor 137, a water-going temperature sensor 138 and a gas sensor 139. The controller 131 is provided with a microcomputer and a memory. The user interface 132 stops operation of the device and inputs temperature setting of heat medium to be produced. The high pressure side pressure sensor 133 is provided in a discharge-side pipe of the compressor 111, and detects discharge-side pressure. The discharge temperature sensor 134 detects discharged refrigerant temperature. The heat source-side heat exchange sensor 135 is provided in a refrigerant pipe of the heat source-side heat exchanger 114, and detects saturation temperature of refrigerant which flows through the heat source-side heat exchanger 114. The outside air temperature sensor 136 is provided on an outer surface of the casing of the heat medium circulation system 100, and detects outside air temperature. The water-entering temperature sensor 137 detects temperature of heat medium which flows into the use-side heat exchanger 112 provided in the heat medium circuit 120. The water-going temperature sensor 138 detects temperature of heat medium which flows out from the use-side heat exchanger 112. The gas sensor 139 detects concentration of flammable gas discharged from the deaerating device 128.

[1-2. Action]

[0035] Action of the heat medium circulation system 100 having the above-described configuration will be described below.

[1-2-1. Cooling and heating operation actions]

[0036] The controller 131 carries out the heating operation or the cooling operation based on input information of the user interface 132. At the time of the operation, the controller 131 controls the compressor 111 based on a detection value of the outside air temperature sensor 136, a detection value of the water-going temperature sensor 138, and the number of rotations determined based on a water-going temperature set value of the user interface 132. Further, the controller 131 controls a throttle amount of the expander 113 while comparing with a detection value of the discharge temperature sensor 134 such that it becomes equal to a discharge temperature target value which is determined based on a detection value of the high pressure side pressure sensor 133 and a detection value of the heat source-side heat exchange sensor 135.

[0037] The controller 131 controls the number of rotations of the conveying pump 121 such that a difference between the detection value of the water-going temperature sensor 138 and a detection value of the water-entering temperature sensor 137 becomes equal to a predetermined temperature difference.

[0038] At the time of the heating operation, the controller 131 controls the applied voltage of the heater element 150 of the heating device 127 such that the detection value of the water-going temperature sensor 138 becomes equal to the water-going temperature set value.

[1-2-2. Discharging action of refrigerant and operating action when refrigerant leaks]

[0039] Operation action when refrigerant leaks into the heat medium circuit 120 will be described based on Fig. 4.

[0040] Fig. 4 schematically shows a flow of refrigerant gas mixed in heat medium in which the refrigerant gas is separated in the deaerating device 128 and discharged into outside atmosphere.

[0041] For example, when a partition wall between a flow path of refrigerant and a flow path of heat medium in the use-side heat exchanger 112 is cracked and refrigerant leaks into the heat medium circuit 120, the refrigerant gas flows into the conveying pump 121 in a state where the refrigerant gas is mixed in the heat medium, and the refrigerant gas is pressurized and circulated in the heat medium circuit 120. The refrigerant gas which flows out from the conveying pump 121 flows through the heating device 127 and then the refrigerant gas flows into the deaerating device 128. The refrigerant gas which flows into the deaerating device 128 is separated from the heat medium by reduction in flowing speed caused by enlargement of a diameter of the flow path and by buoyancy force of gas, and the refrigerant gas stays in an upper portion of the deaerating device 128. According to this, liquid level of the heat medium in the deaerating device 128 is lowered, a float valve is lowered, and the refrigerant gas which stays is discharged from the discharge port into the outside atmosphere.

[0042] The refrigerant gas discharged into the outside atmosphere is dispersed, and generation of flammable space is suppressed.

[0043] A heat medium exit 152 of the heating device 127 may be provided at a position (higher side) higher than the heater element 150 of the heating device 127. A heat medium entrance 151 of the heating device 127 may be provided at a position (lower side) lower than the heat medium exit 152.

[0044] It is preferable that the heater element 150 of the heating device 127 is heated such that surface temperature of the heater element 150 becomes lower than temperature of ignition point of refrigerant.

[0045] Next, shut-off action of refrigerant will be described. The first shut-off valve 129a and the second shut-off valve 129b are solenoid on-off valves. When the control device 130 detects that refrigerant leaks, an electromagnetic coil is energized, the first shut-off valve 129a and the second shut-off valve 129b are closed, and circulation of heat medium in the heat medium circuit 120 is stopped.

[0046] Action at this time will be described in more detail using a flowchart in Fig. 5. First, start of the heating operation or the cooling operation is instructed by user's operation of the user interface 132 (step S1). By the instruction, the control device 130 operates the compressor 111 and the conveying pump 121, controls the number of rotations, and adjusts an opening degree of the expander 113 (step S2). Next, the control device 130 makes the gas sensor 139 detect refrigerant concentration Cr in the vicinity of the discharge port of the deaerating device 128 (step S3). The control device 130 compares preset refrigerant concentration Ca and the refrigerant concentration Cr with each other, and determines whether the refrigerant concentration Cr is equal to or higher than the refrigerant concentration Ca (step S4).

[0047] When the refrigerant concentration Cr is lower than the refrigerant concentration Ca (NO in step S4), refrigerant is not discharged from the deaerating device 128, and the control device 130 determines that refrigerant does not leak into the heat medium circuit 120, and continues the operation.

[0048] When the refrigerant concentration Cr is equal to or higher than the Ca (YES in step S4), refrigerant is discharged from the deaerating device 128, and the control device 130 determines that refrigerant gas leaks into the heat medium circuit 120. The control device 130 stops the operations of the compressor 111 and the conveying pump 121 (step S5). Next, the control device 130 energizes the first shut-off valve 129a and the second shut-off valve 129b, operates the valves into closing directions, and the control device 130 stops the flow of the heat medium (step S6).

[1-3. Effect and the like]

[0049] As described above, in the embodiment, the heat medium circulation system 100 includes the refrigerant circuit 110, the heat medium circuit 120, the conveying pump 121, the heating device 127 and the deaerating device 128. The refrigerant circuit 110 is a vapor compression type refrigeration cycle formed by annularly connecting the compressor 111, the use-side heat exchanger 112, the expander 113 and the heat source-side heat exchanger 114 to one another. Liquid heat medium which heats and cools the use-side load circulates through the heat medium circuit 120. The conveying pump 121 is for circulating heat medium in the heat medium circuit 120. The heating device 127 electrically heats the heat medium. The deaerating device 128 selectively discharges gas in the heat medium circuit 120 to outside atmosphere outside the heat medium circuit 120.

[0050] The heating device 127 is placed downstream of the conveying pump 121 and on a side higher than the circulation device 121, and the deaerating device 128 is placed downstream of the heating device 127 and on a side higher than the heating device 127.

[0051] According to this, since the conveying pump 121 is located upstream of the heating device 127 and on a side lower than the heating device 127, it is possible to suppress the staying of flammable gas which is caused when dissolved air or leaked refrigerant in the heat medium which is precipitated by heating in the heating device 127 flows into the conveying pump 121, air biting is generated and the pump is stopped.

[0052] Since the deaerating device 128 is located

downstream of the heating device 127 and on a side higher than the heating device 127, precipitated gas does not stay in the heating device 127, the gas is derived into the deaerating device 128 and the gas can be discharged outside.

[0053] Hence, even when flammable refrigerant leaks from the use-side heat exchanger 112 into the heat medium circuit 120, it is possible to reliably discharge the flammable refrigerant into outside atmosphere. According to this, safety is further enhanced.

[0054] As in the present embodiment, the heat medium exit 152 of the heating device 127 may be placed on the side higher than the heater element 150 of the heating device 127, and the heat medium entrance 151 of the heating device 127 may be placed on the side lower than the heat medium exit 152.

[0055] According to this, since heat medium flows toward the upper side of the heating device 127, when flammable refrigerant leaks from the use-side heat exchanger 112 into the heat medium circuit 120, the flammable refrigerant and air are prevented from staying in an upper portion of a container of the heating device 127. Even when the flammable refrigerant and air stay, they stay only up to a position higher than the heater element 150.

[0056] Hence, the staying flammable gas does not directly come into contact with a surface of a heater. According to this, safety is further enhanced.

[0057] The heater element 150 of the heating device 127 may be heated such that its surface temperature becomes lower than temperature of ignition point of flammable refrigerant which is charged into the refrigerant circuit 110 as in this embodiment.

[0058] According to this, even if flammable refrigerant leaks from the use-side heat exchanger 112 into the heat medium circuit 120, the safety is further enhanced.

[0059] When the control device 130 determines that flammable refrigerant leaks into the heat medium circuit 120, the control device 130 may control to close the first shut-off valve 129a and the second shut-off valve 129b as in the embodiment.

[0060] According to this, since the first shut-off valve 129a and the second shut-off valve 129b are closed, circulation of heat medium in which refrigerant gas is mixed is more swiftly stopped, and flammable refrigerant is prevented from moving toward the use-side terminal 122. Hence, safety is further enhanced.

[0061] When a gas concentration detection value of the gas sensor 139 placed in the vicinity of an exhaust port of the deaerating device 128 becomes higher than preset gas concentration, the control device 130 may determine that flammable refrigerant leaks into the heat medium circuit 120 as in the embodiment.

[0062] According to this, it is reliably possible to determine that flammable refrigerant leaks. Therefore, safety is further enhanced.

[0063] The flammable refrigerant may be R32, mixed refrigerant including 70% or more by weight of R32, propane or mixed refrigerant including propane.

[0064] According to this, even when global warming potential (GWP) is low and refrigerant leaks, it is possible to suppress the adverse environmental impact. Hence, environmental performance is enhanced.

(Other embodiments)

[0065] The embodiment has been described as an example of a technique disclosed in the present application. However, the technique in the present disclosure is not limited to this, and the technique can also be applied to embodiments which are subjected to change, replacement, addition or omission. Constituent elements described in the above embodiment can be combined as new embodiments.

[0066] Other embodiments will be described below.

[0067] In the embodiment, a cooling/heating hot water supply system was described as one example of the heat medium circulation system 100. It is only necessary that the heat medium circulation system 100 can cool or heat liquid. Therefore, the heat medium circulation system 100 is not limited to the cooling/heating hot water supply system. However, if the cooling/heating hot water supply system is used as the heat medium circulation system 100, it can meet annual heat demand of residential houses. Further, a cool water/hot water chiller may be used as the heat medium circulation system 100. If the cool water/hot water chiller is used as the heat medium circulation system 100, since it can meet a cooling/heating heat load used in a factory, energy saving performance in the factory can be enhanced.

[0068] In this embodiment, an air purge valve using a float valve was described as one example of the deaerating device 128. It is only necessary that in the deaerating device 128, when gas is mixed in heat medium, the gas is discharged from the heat medium circuit 120. Therefore, the deaerating device 128 is not limited to the air purge valve. However, if the air purge valve is used as the deaerating device 128, since the air purge valve can be used for removing air in the heat medium circuit 120 when heat medium is charged in installation construction, it is possible to reduce cost. When pressure of the heat medium circuit 120 rises, a pressure relief valve which discharges heat medium and refrigerant gas at the same time may be used as the deaerating device 128. If the pressure relief valve is used as the deaerating device 128, it is possible to suppress the pressure rise when refrigerant leaks into the heat medium circuit 120, and there is effect that damage of a pipe can be suppressed and reliability is enhanced.

[0069] In the embodiment, the gas sensor 139 was described as one example of a refrigerant leakage detection sensor. It is only necessary that the leakage detection sensor can determine that refrigerant leaks from the refrigerant circuit 110 into the heat medium circuit 120. Therefore, the leakage detection sensor is not limited to the gas sensor 139, i.e., a refrigerant concentration sensor. However, if the refrigerant concentration sensor is

used as the refrigerant leakage detection sensor, it is possible to realize with a simple configuration. As the refrigerant leakage detection sensor, a valve-opening action of a refrigerant discharge device may be detected by a microswitch or a hall IC. If the valve-opening action of the refrigerant discharge device is detected, since its structure is simple, there is effect that the device can be made small and light in weight.

[0070] In the embodiment, the configuration in which the heater element 150 is incorporated in the container is described as one example of the heating device 127. It is only necessary that the heater element 150 of the heating device 127 is configured such that heat medium which flows into the heating device 127 is heated. Therefore, the installation position of the heater element 150 is not limited to the interior of the container of the heating device 127. However, if the heater element 150 is placed in the container, since the heat medium can directly be heated, heat exchanging efficiency can be enhanced. The heater element 150 of the heating device 127 may be placed on an outer surface of the container of the heating device 127. If the heater element 150 is placed on the outer surface of the container of the heating device 127, when refrigerant leaks into the heat medium circuit 120, refrigerant gas does not come into direct contact with the surface of the heater element 150.

[0071] In the embodiment, the circuit which is placed between the conveying pump 121 and the use-side heat exchanger 112, or between the use-side heat exchanger 112 and the switching valves 124a and 124b as is described one example of the installation positions of the shut-off valves 129a and 129b. The shut-off valves 129a and 129b may be placed at positions where refrigerant does not flow into living spaces when refrigerant leaks into the heat medium circuit 120. Therefore, the installation positions of the shut-off valves 129a and 129b are not limited to the positions between the conveying pump 121 and the use-side heat exchanger 112 or between the use-side heat exchanger 112 and the switching valves 124a and 124b. However, if the shut-off valves 129a and 129b are placed downstream of the discharge device, leaked refrigerant existing in the heat medium circuit 120 between the shut-off valves 129a and 129b can be discharged unto atmosphere even after the shut-off valves 129a and 129b are shut off. Therefore, safety is enhanced.

[INDUSTRIAL APPLICABILITY]

[0072] The present disclosure can be applied to a heat medium circulation system where flammable refrigerant may leak into a heat medium circuit. More specifically, the present disclosure can be applied to a hot water supply heater, a professional-use chiller and the like.

[EXPLANATION OF SYMBOLS]

[0073]

100	heat medium circulation system
110	refrigerant circuit
111	compressor
112	use-side heat exchanger
113	expander
114	heat source-side heat exchanger
115	four-way valve
116	pipe
120	heat medium circuit
121	conveying pump (conveying device)
122	use-side terminal
123	hot water tank
124a	first switching valve
124b	second switching valve
126	heat medium pipe
127	heating device
128	deaerating device
129a	first shut-off valve
129b	second shut-off valve
130	control device
131	controller
132	user interface
133	high pressure side pressure sensor
134	discharge temperature sensor
135	heat source-side heat exchange sensor
136	outside air temperature sensor
137	water-entering temperature sensor
138	water-going temperature sensor
139	gas sensor
150	heater element
151	heat medium entrance
152	heat medium exit

Claims

1. A heat medium circulation system (100) comprising:

a refrigerant circuit (110) which is formed by annularly connecting a compressor (111), a use-side heat exchanger (112), an expander (113) and a heat source-side heat exchanger (114) to one another, and which uses flammable refrigerant;

a heat medium circuit (120) through which heat medium cooled or heated by the use-side heat exchanger (112) by means of refrigerant discharged from the compressor (111) circulates; and

a control device (130), in which

the heat medium circuit (120) is provided therein at least with a circulation device (121) through which the heat medium in the heat medium circuit (120) circulates, a heating device (127) for electrically heating the heat medium, and a deaerating device (128) which separates gas in the heat medium circuit (120) and discharges the gas to outside, wherein

the heating device (127) is placed downstream of the circulation device (121) and on a side higher than the circulation device (121), and the deaerating device (128) is placed downstream of the heating device (127) and on a side higher than the heating device (127).

2. The heat medium circulation system (100) according to claim 1, wherein a heat medium exit (152) of the heating device (127) is placed on a side higher than a heating portion of the heating device (127), and a heat medium entrance (151) of the heating device (127) is placed on a side lower than the heat medium exit (152).

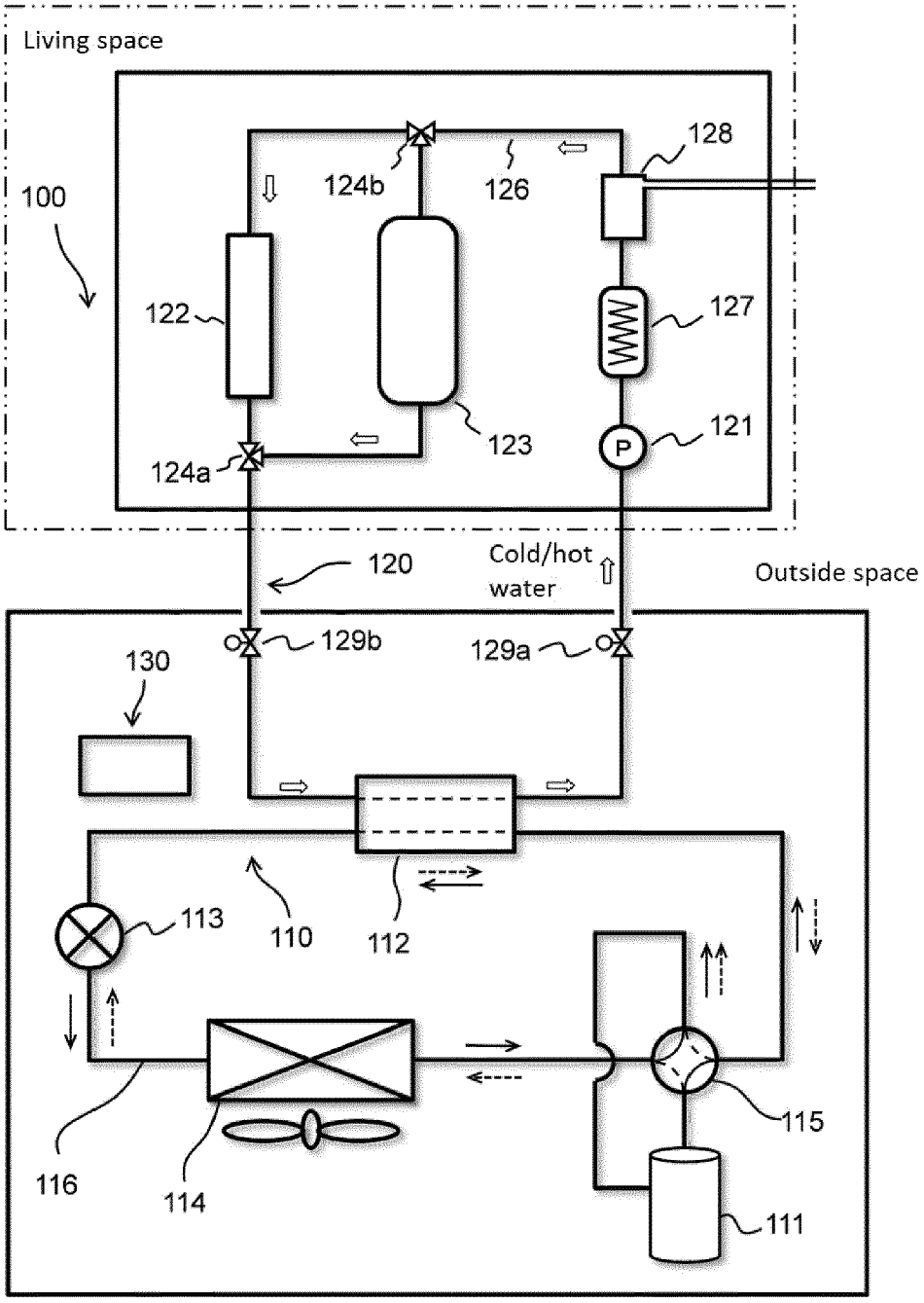
3. The heat medium circulation system (100) according to claim 2, wherein the control device (130) heats the heating portion of the heating device (127) such that surface temperature of the heating portion becomes lower than temperature of ignition point of the flammable refrigerant.

4. The heat medium circulation system (100) according to any one of claims 1 to 3, further comprising a refrigerant leakage detection sensor for detecting leakage of the flammable refrigerant into the heat medium circuit (120), and shut-off valves (129a, 129b) for shutting off a flow path of the heat medium which circulates in the heat medium circuit (120), wherein when the control device (130) determines that the flammable refrigerant leaks into the heat medium circuit (120), the control device (130) operate the shut-off valves (129a, 129b) in its closing direction to stop flow of the heat medium.

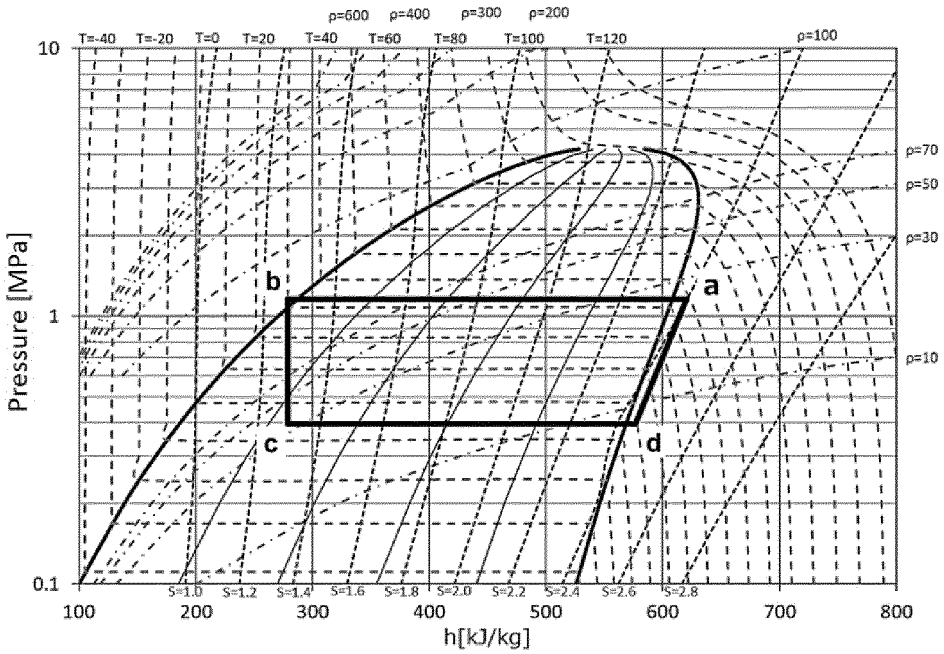
5. The heat medium circulation system (100) according to claim 4, wherein the refrigerant leakage detection sensor is a refrigerant concentration sensor placed near an exhaust port of the deaerating device (128), and
when a detection value of the refrigerant concentration sensor becomes higher by a predetermined value or more, the control device (130) determines that the flammable refrigerant leaks from the heat medium circuit (120).

6. The heat medium circulation system (100) according to any one of claims 1 to 5, wherein the flammable refrigerant is R32, mixed refrigerant including 70% or more by weight of R32, propane or mixed refrigerant including propane.

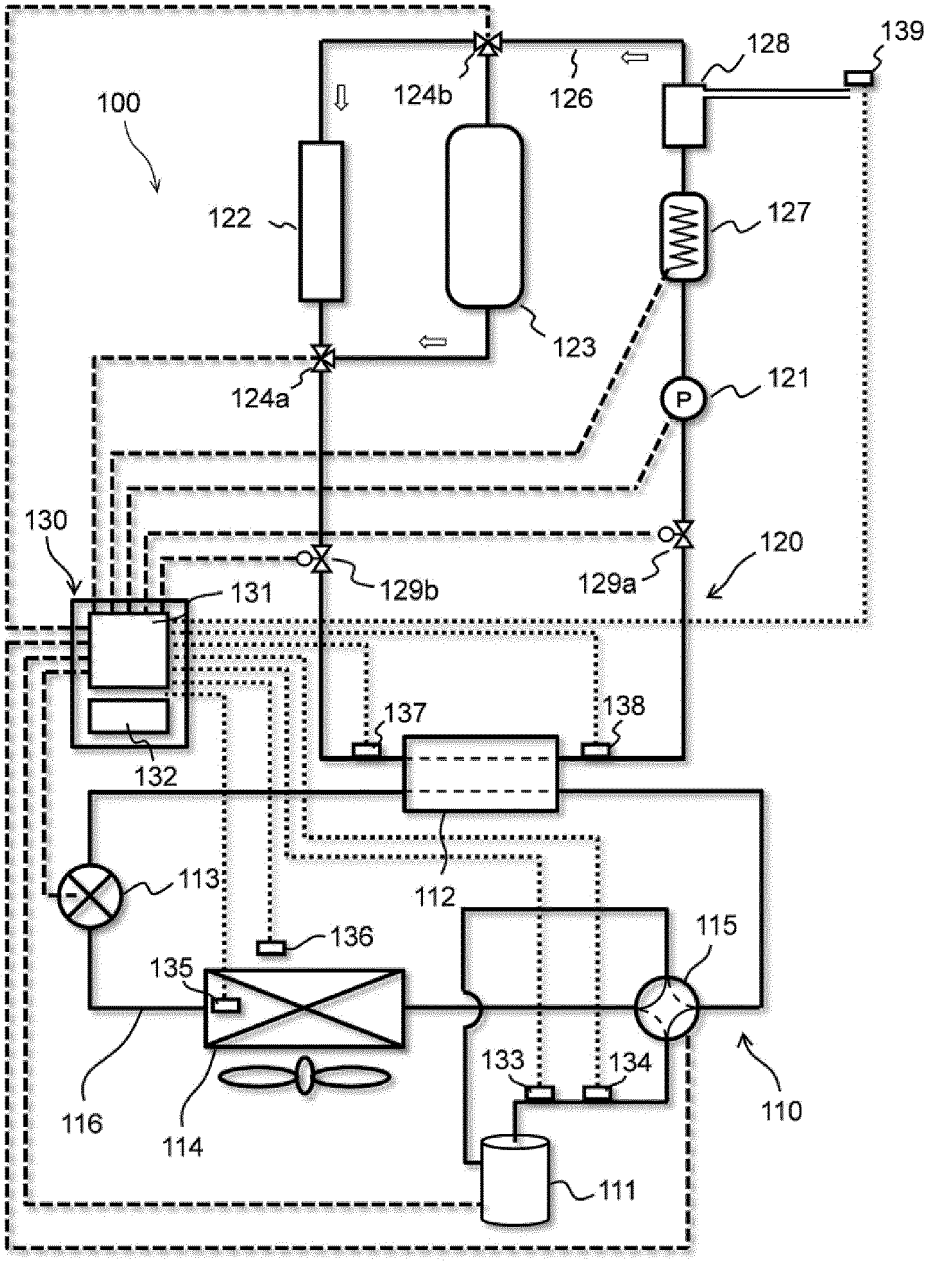
[Fig. 1]


Living space
100
122
124b
126
128
127
123
121
124a
P
120
Cold/hot water
Outside space
129b
129a
130
113
110
112
116
114
115
111

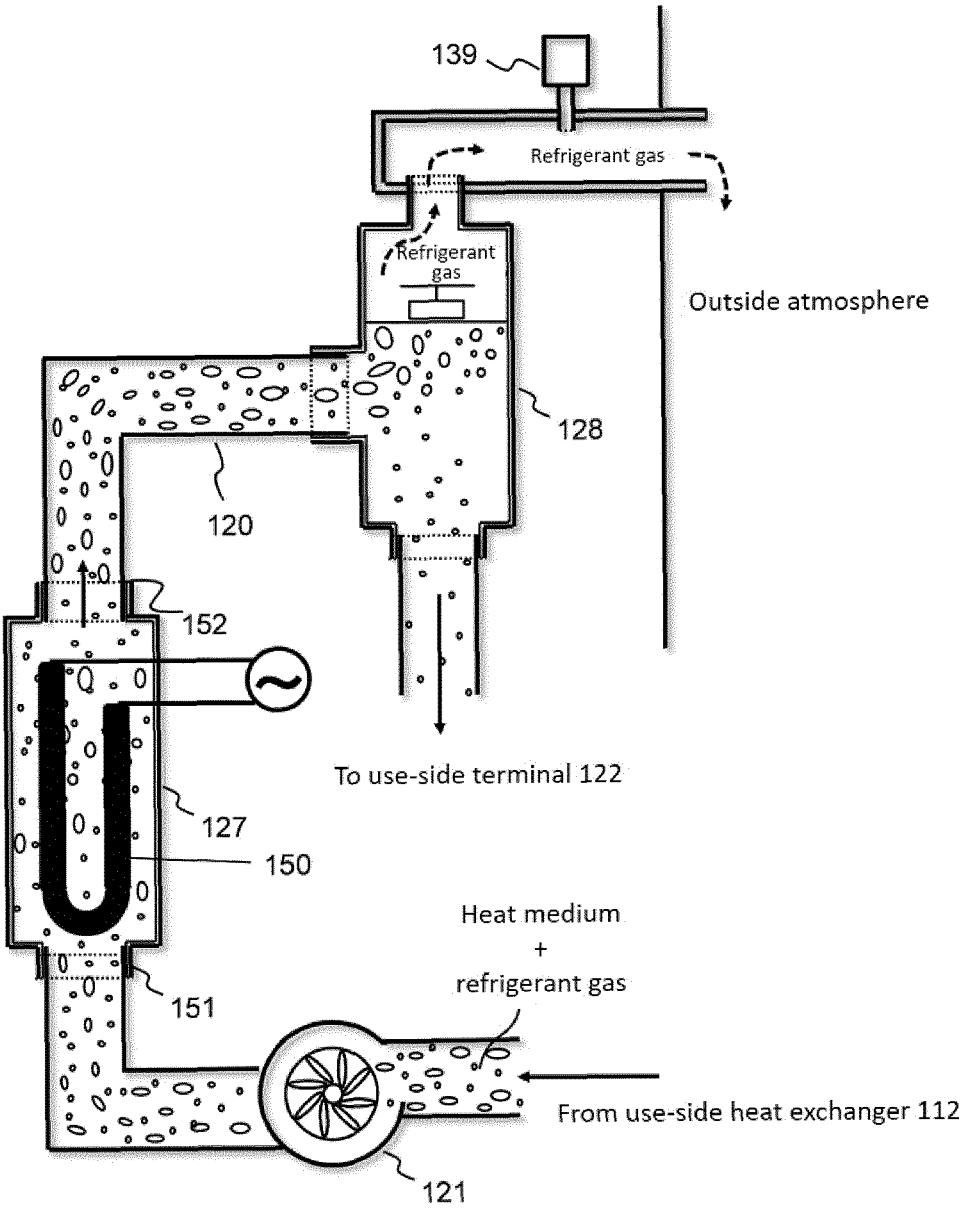
[Fig. 2]


ρ=600
ρ=400
ρ=300
ρ=200
T=-40
T=-20
T=0
T=20
T=40
T=60
T=80
T=100
T=120
ρ=100
ρ=70
ρ=50
ρ=30
ρ=10
10
1
0.1
Pressure [MPa]
a
b
c
d
S=1.0
S=1.2
S=1.4
S=1.6
S=1.8
S=2.0
S=2.2
S=2.4
S=2.6
S=2.8
100
200
300
400
500
600
700
800
h[kJ/kg]

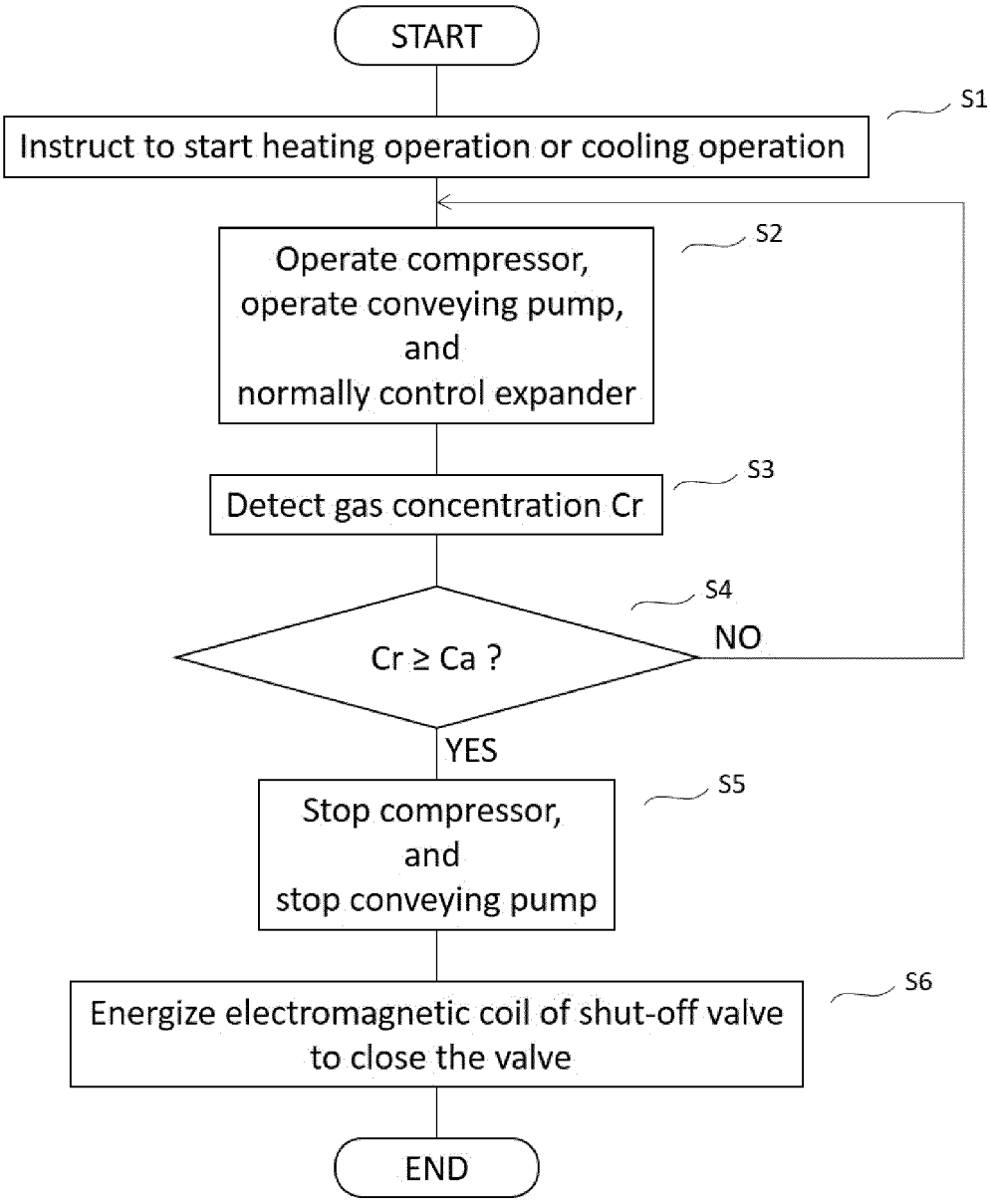
[Fig. 3]


100
122
124b
126
128
139
127
123
124a
121
P
130
129b
129a
120
131
132
137
138
113
112
136
115
135
116
114
133
134
110
111

[Fig. 4]


139
Refrigerant gas
Refrigerant gas
Outside atmosphere
128
120
152
To use-side terminal 122
127
150
Heat medium
+
refrigerant gas
151
From use-side heat exchanger 112
121

[Fig. 5]


START
S1
Instruct to start heating operation or cooling operation
S2
Operate compressor, operate conveying pump, and normally control expander
S3
Detect gas concentration Cr
S4
Cr ≥ Ca ?
NO
YES
S5
Stop compressor, and stop conveying pump
S6
Energize electromagnetic coil of shut-off valve to close the valve
END

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EUROPEAN SEARCH REPORT

Application Number
EP 21 19 2497

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	WO 2018/167861 A1 (MITSUBISHI ELECTRIC CORP) 20 September 2018 (2018-09-20) * paragraphs [0010], [0019] - [0024], [0039] - [0042]; figure 1 *	1-6	INV. F25B13/00 F24H4/02 F24H1/00
A	WO 2019/239556 A1 (MITSUBISHI ELECTRIC CORP) 19 December 2019 (2019-12-19) * paragraphs [0008] - [0056]; figures 1-4 *	1-6	
A	JP 2020 204411 A (PANASONIC IP MAN CORP) 24 December 2020 (2020-12-24) * paragraphs [0049] - [0129]; figures 1, 3, 5 *	1-6	

TECHNICAL FIELDS SEARCHED (IPC)

F25B
F24H
F24F
F24D

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 February 2022	Amous, Moez

CATEGORY OF CITED DOCUMENTS

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07-02-2022

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