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(54) **AIR CONDITIONER**

(57) It is an object of the present invention to provide an air conditioner preventing occurrence of chattering even when a refrigerant, changed into liquid in a radiant heat exchanger, resides in the vicinity of the radiant heat exchanger and an open/close valve during a heating operation. In an air conditioner (1), a first check valve (42) is disposed between a radiant heat exchanger (14) and

an open/close valve (41). When the open/close valve (41) is closed, less liquid refrigerant exists between the open/close valve (41) and the first check valve (42). Even when the liquid refrigerant spontaneously evaporates and the internal pressure is increased, the internal pressure is not increased enough to push and open the open/close valve (41). Occurrence of chattering is thereby prevented.

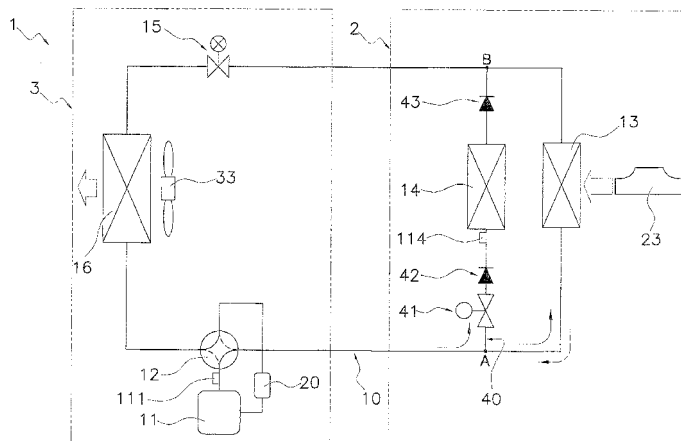


FIG. 1

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**Description****TECHNICAL FIELD**

[0001] The present invention relates to an air conditioner including a refrigerant circuit configured to execute a vapor compression refrigeration cycle.

**BACKGROUND ART**

[0002] Patent Literature 1 (Japan Laid-open Patent Application Publication No. JP-A-H07-055234) describes an exemplary air conditioner configured to execute a heating operation using a high pressure refrigerant. Specifically, the exemplary air conditioner is configured to cause the high pressure refrigerant to flow into a radiant heat exchanger. In the exemplary air conditioner described in Patent Literature 1 (Japan Laid-open Patent Application Publication No. JP-A-H07-055234), a valve is disposed on the downstream of the radiant heat exchanger for regulating the amount of the high pressure refrigerant flowing into the radiant heat exchanger during a heating operation. The valve is configured to close the flow path for preventing the high pressure refrigerant from flowing into the radiant heat exchanger when the temperature of the radiant heat exchanger is increased to the upper limit.

**SUMMARY OF THE INVENTION**

<Technical Problem>

[0003] In the aforementioned structure, however, the high pressure refrigerant is trapped in the radiant heat exchanger by means of the pressure of a compressor. Accordingly, the refrigerant, a compressor oil and etc. reside in the radiant heat exchanger. This makes it difficult to lower the temperature of the refrigerant. In other words, the temperature of the radiant heat exchanger cannot be lowered when necessary. Further, the amount of the compressor oil to be returned to the compressor is reduced. Therefore, chances will be increased that reliability of the compressor is deteriorated.

[0004] In view of the above, the applicant of the present invention produced a structure for preventing the high pressure refrigerant from being trapped in the radiant heat exchanger. Specifically in the structure, an open/close valve is disposed on the upstream of the radiant heat exchanger for blocking the flow path of the high pressure refrigerant flowing towards the radiant heat exchanger. Even in the structure, the refrigerant is changed into liquid in the radiant heat exchanger during a heating operation and resides in the vicinity of the radiant heat exchanger and the open/close valve. When the liquid refrigerant spontaneously evaporates under the condition and the internal pressure is increased, the open/close valve is pushed and repeatedly opened and closed by means of the increased internal pressure. This phenom-

enon is so-called "chattering".

[0005] It is an object of the present invention to provide an air conditioner preventing occurrence of chattering in an open/close valve even when a refrigerant is changed into liquid in a radiant heat exchanger and resides in the vicinity of the radiant heat exchanger and the open/close valve during a heating operation.

<Solution to Problem>

[0006] An air conditioner according to a first aspect of the present invention includes a refrigerant circuit configured to execute a vapor compression refrigeration cycle and is configured to execute a heating operation using at least a high pressure refrigerant. In the air conditioner, the refrigerant circuit includes a convective heat exchanger, a radiant heat exchanger, an open/close valve and a check valve. The convective heat exchanger is configured to execute heat exchange between the high pressure refrigerant flowing through the inside thereof and an air flowing towards the outside thereof. The radiant heat exchanger is configured to heat a predetermined member by means of the high pressure refrigerant flowing through the inside thereof for causing the predetermined member to emit a radiant heat. The open/close valve is disposed on the upstream of the radiant heat exchanger for blocking a flow path of the high pressure refrigerant flowing towards the radiant heat exchanger during the heating operation. The check valve is disposed between the radiant heat exchanger and the open/close valve.

[0007] According to the air conditioner of the first aspect of the present invention, the check valve is disposed between the radiant heat exchanger and the open/close valve. When the open/close valve is closed, less liquid refrigerant exists between the open/close valve and the check valve. Even when the liquid refrigerant spontaneously evaporates and the internal pressure is increased, the internal pressure is not increased enough to push and open the open/close valve. Occurrence of chattering is thereby prevented.

[0008] An air conditioner according to a second aspect of the present invention relates to the air conditioner according to the first aspect of the present invention. In the air conditioner, the open/close valve is an opening degree regulating valve having a function of blocking the flow path and a function of regulating an opening degree of the flow path.

[0009] According to the air conditioner of the second aspect of the present invention, performance of the radiant heat exchanger is increased or reduced by regulating the opening degree of the refrigerant flow path. Further, the refrigerant flow path is configured to be blocked when the performance of the radiant heat exchanger reaches a predetermined set value. Convenience and security of the air conditioner can be thereby enhanced.

[0010] An air conditioner according to a third aspect of

the present invention relates to the air conditioner according to one of the first and second aspects of the present invention. In the air conditioner, the open/close valve is configured to block the flow path when a temperature of the predetermined member reaches an upper limit of a permissive temperature.

**[0011]** According to the air conditioner of the third aspect of the present invention, the high pressure refrigerant is prevented from flowing into the radiant heat exchanger when the temperature of the predetermined member of the radiant heat exchanger reaches the upper limit of the permissive temperature thereof during execution of a heating operation using the radiant heat exchanger. Therefore, reduction in the temperature of the refrigerant is accelerated within the radiant heat exchanger. As a result, reduction in the temperature of the predetermined member is accelerated and the air conditioner can be returned to the heating operation using the radiant heat exchanger.

#### <Advantageous Effects of Invention>

**[0012]** According to the air conditioner of the first aspect of the present invention, less liquid refrigerant exists between the open/close valve and the check valve. Even when the liquid refrigerant spontaneously evaporates and the internal pressure is increased, the internal pressure is not increased enough to push and open the open/close valve. Occurrence of chattering is thereby prevented.

**[0013]** According to the air conditioner of the second aspect of the present invention, performance of the radiant heat exchanger is increased or reduced by regulating the opening degree of the refrigerant flow path. Further, the refrigerant flow path is configured to be blocked when the performance of the radiant heat exchanger reaches a predetermined set value. Convenience and security of the air conditioner can be thereby enhanced.

**[0014]** According to the air conditioner of the third aspect of the present invention, the high pressure refrigerant is prevented from flowing into the radiant heat exchanger when the temperature of the predetermined member of the radiant heat exchanger reaches the upper limit of the permissive temperature thereof during execution of a heating operation using the radiant heat exchanger. Therefore, reduction in the temperature of the refrigerant is accelerated within the radiant heat exchanger. As a result, reduction in the temperature of the predetermined member is accelerated and the air conditioner can be returned to the heating operation using the radiant heat exchanger.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0015]**

FIG. 1 is a refrigerant circuit diagram of an air con-

ditioner according to an exemplary embodiment of the present invention.

FIG. 2 is an exploded perspective view of the internal structure of an indoor unit.

FIG. 3 is a side view of a heat exchanger assembly.

FIG. 4 is a cross-sectional view of a radiant heat exchanger, illustrating an exemplary attachment structure of a panel and heat transfer tubes.

FIG. 5 is a chart representing the relation between temperature to be detected by a second temperature sensor and actions of an open/close valve during a heating operation.

FIG. 6 is a cross-sectional view of the radiant heat exchanger, illustrating a second attachment structure of the panel and the heat transfer tubes.

FIG. 7 is a cross-sectional view of the radiant heat exchanger, illustrating a third attachment structure of the panel and the heat transfer tubes.

FIG. 8 is a cross-sectional view of the radiant heat exchanger, illustrating a fourth attachment structure of the panel and the heat transfer tubes.

FIG. 9 is a cross-sectional view of the radiant heat exchanger, illustrating a fifth attachment structure of the panel and the heat transfer tubes.

FIG. 10 is a cross-sectional view of the radiant heat exchanger, illustrating a sixth attachment structure of the panel and the heat transfer tubes.

#### DESCRIPTION OF EMBODIMENTS

**[0016]** An exemplary embodiment of the present invention will be hereinafter explained with reference to figures. It should be noted that the following exemplary embodiment is merely a specific example of the present invention, and therefore does not intend to limit the technical scope of the present invention.

#### <Refrigerant Circuit 10 for Air Conditioner 1>

**[0017]** FIG. 1 is a refrigerant circuit diagram of an air conditioner according to the exemplary embodiment of the present invention. As illustrated in FIG. 1, the air conditioner 1 includes an indoor unit 2 mainly disposed in the indoor space and an outdoor unit 3 mainly disposed in the outdoor space. The indoor unit 2 and the outdoor unit 3 are connected through a refrigerant communication piping, and the structure forms a refrigerant circuit 10 configured to execute a vapor compression refrigeration cycle.

**[0018]** In the refrigerant circuit 10, a compressor 11, a four-way switching valve 12, a convective heat exchanger 13, an expansion valve 15, an outdoor heat exchanger 16 are sequentially connected. Further, a branch pipe 40 is disposed in parallel to the convective heat exchanger 13. An open/close valve 41, a first check valve 42, a radiant heat exchanger 14 and a second check valve 43 are series-connected to the branch pipe 40 while being sequentially aligned from the compressor 11 side. Fur-

ther, an accumulator 20 is connected to the four-way switching valve 12 and the inlet of the compressor 11.

**[0019]** The four-way switching valve 12 is configured to cause the refrigerant discharged from the compressor 11 to flow towards either the convective heat exchanger 13 or the outdoor heat exchanger 16. During a heating operation, for instance, a control unit is configured to cause the four-way switching valve 12 to select a flow path depicted with a solid line in FIG. 1 for causing the refrigerant to flow towards the convective heat exchanger 13. During a cooling operation, by contrast, the control unit is configured to cause the four-way switching valve 12 to select a flow path depicted with a dotted line in FIG. 1 for causing the refrigerant to flow towards the outdoor heat exchanger 16.

**[0020]** The convective heat exchanger 13 is a type of heat exchanger formed by a plurality of fins and a plurality of heat transfer tubes arranged perpendicularly to the fins. The convective heat exchanger 13 is configured to execute heat exchange between the refrigerant flowing through the heat transfer tubes and the air flowing against the surfaces of the fins. A fan 23 is disposed in the vicinity of the convective heat exchanger 13 for supplying air towards the surfaces of the fins.

**[0021]** The radiant heat exchanger 14 is a type of heat exchanger formed by a plate (hereinafter referred to as a panel) made of aluminum and heat transfer tubes attached to the panel. The radiant heat exchanger 14 is configured to heat the panel by means of the high pressure refrigerant flowing through the heat transfer tubes for causing the panel to emit radiant heat.

**[0022]** The expansion valve 15 is an electronic expansion valve functioning as a decompression mechanism. The expansion valve 15 is connected between the convective heat exchanger 13 and the outdoor heat exchanger 16. The expansion valve 15 is configured to narrow the refrigerant flow path for decompressing the refrigerant. The outdoor heat exchanger 16 is a type of heat exchanger formed by a plurality of fins and a plurality of heat transfer tubes arranged perpendicularly to the fins. The outdoor heat exchanger 16 is configured to execute heat exchange between the refrigerant flowing through the heat transfer tubes and the air flowing against the surfaces of the fins. Further, an outdoor fan 33 is disposed in the vicinity of the outdoor heat exchanger 16 for supplying air towards the surfaces of the fins. The accumulator 20 is configured to accumulate excessive liquid refrigerant and return only gas refrigerant to the compressor 11.

**[0023]** A discharge temperature sensor 111 is attached to a discharge pipe connecting the outlet of the compressor 11 and the four-way switching valve 12. The discharge temperature sensor 111 is configured to detect the temperature of the high pressure refrigerant to be discharged from the compressor 11.

**[0024]** The control unit is configured to control the temperature of the panel of the radiant heat exchanger 14 based on the temperature to be detected by the discharge

temperature sensor 111. However, another temperature sensor (hereinafter referred to as a second temperature sensor 114) may be attached in the vicinity of the high pressure refrigerant inlet of the radiant heat exchanger 14 when the temperature to be detected by the discharge temperature sensor 111 and the temperature of the panel are different due to pressure loss caused by a long pipe connecting the open/close valve 41 and the radiant heat exchanger 14. It should be noted that both of the discharge temperature sensor 111 and the second temperature sensor 114 are used in the present exemplary embodiment.

<Internal Structure of Indoor Unit 2>

**[0025]** FIG. 2 is an exploded perspective view of the internal structure of the indoor unit. In FIG. 2, the outer shell of the indoor unit 2 is formed by a frame 210 and a grill 240. In the frame 210, a left plate 232, a right plate 213 and a top plate 214 are respectively fixed to the left end, the right end and the top end of a rectangular opening 211. The frame 210 includes a fan compartment 210a and an electric component compartment 210b.

**[0026]** The grill 240 includes an upper blower vent 240a, a lower blower vent 240b, an opening 240c, a left suction vent 240d and a right suction vent 240e. The upper blower vent 240a is positioned on the upper part of the grill 240, whereas the lower blower vent 240b is positioned on the lower part of the grill 240. The opening 240c is formed for exposing a panel 14a to the indoor space. The left suction vent 240d is positioned on the left face of the grill 240, whereas the right suction vent 240e is positioned on the right face of the grill 240.

**[0027]** Air is inhaled through the left suction vent 240d and the right suction vent 240e in conjunction with activation of the fan 23 and passes through a filter 218 disposed on the upstream of the convective heat exchanger 13 via spaces between the heat insulated rear face of the panel 14a and suction path forming plates 115 and 116. After passing through the filter 218, the air is directed to the convective heat exchanger 13. Heat exchange is then executed for the air in the convective heat exchanger 13. The heat-exchanged air passes through a circular hole 216a of a bell mouth 216 and enters the fan 23. The air is then blown out of the fan 23, travels through the fan compartment 210a towards the upper blower vent 240a and the lower blower vent 240b, and is blown out through the upper blower vent 240a and the lower blower vent 240b.

**[0028]** The circular hole 216a of the bell mouth 216 has a diameter slightly less than the vane inner diameter of the fan 23. When passing through the circular hole 216a, the air enters between the vanes of the fan 23 and is compressed by the vanes of the fan 23. The compressed air is blown out in the outer peripheral direction of the fan 23.

**[0029]** A motor support plate 215 is disposed and fixed between the top and the bottom of the fan compartment

210a for supporting a driving motor 23a of the fan 23. The driving motor 23a is fixed to the motor support plate 215 by means of screws 23b. The bell mouth 216 then closes the fan compartment 210a. An electric component box 24 is held in the electric component compartment 210b. The electric component box 24 accommodates the control unit embedded with a CPU, a memory and etc.

**[0030]** A heat exchanger assembly 220 is an integrated structure of the convective heat exchanger 13 and the radiant heat exchanger 14. A drain pan assembly 217 is disposed below the convective heat exchanger 13. During a cooling operation, for instance, moisture contained in the air is condensed on the surface of the convective heat exchanger 13 when the air passes through the conductive heat exchanger 13. The drain pan assembly 217 receives such condensed water falling from the convective heat exchanger 13.

**[0031]** It should be noted that a blower vent assembly 250 is attached to the upper blower vent 240a. The blower vent assembly 250 includes a louver for changing an air blowing-out direction. Further, a left frame bar 241, a right frame bar 242 and an upper frame bar 243 are respectively attached to the left edge, the right edge, and the upper edge of the opening 240c of the grill 240.

**[0032]** FIG. 3 is a side view of the heat exchanger assembly. In the heat exchanger assembly 220 of FIG. 3, the convective heat exchanger 13 and the radiant heat exchanger 14 are fixed to each other by means of attachment plates 221. Each attachment plate 221 is a sheet-metal member extended from a frame 14c of the radiant heat exchanger 14 in an opposite direction to the panel 14a. Each attachment plate 221 includes through holes 221a.

**[0033]** The convective heat exchanger 13 includes a pair of tube plates 13c in the vicinity of the both ends of each heat transfer tube 13b. Each tube plate 13c includes screw holes to be matched with the through holes 221a of the attachment plates 221. The convective heat exchanger 13 and the attachment plates 221 are fixed by means of screws via the through holes 221a.

**[0034]** FIG. 4 is a cross-sectional view of the radiant heat exchanger for illustrating an exemplary attachment structure of the panel and the heat transfer tubes. In FIG. 4, attachment brackets 14e are opposed to the panel 14a while heat transfer tubes 14b are interposed therebetween. Specifically, the attachment brackets 14e are fixed to bracket receivers 14d having preliminarily fixed to the panel 14a by means of attachment screws 14f. Each bracket receiver 14d includes a screw hole 14da that one of the attachment screws 14f is screwed. Each attachment bracket 14e includes a flat plate portion 14ea, a bulged portion 14eb and flanged portions 14ec. The flat plate portion 14ea is closely attached to the rear face, opposite to the radiant face, of the panel 14a. The bulged portion 14eb is bulged from the flat plate portion 14ea for forming a U-shaped groove that one of the heat transfer tubes 14b is fitted. The flanged portions 14ec, bulged from the both ends of the flat plate portion 14ea, are fixed

to the bracket receivers 14d. Each flanged portion 14ec includes a through hole 14ed to be matched with the screw hole 14a of each bracket receiver 14d.

**[0035]** The heat transfer tubes 14b are firstly disposed on the rear face of the panel 14a. Subsequently, the attachment brackets 14e are respectively disposed while the through holes 14ed thereof are faced to the screw holes 14a of the bracket receivers 14d. Under the condition, the flanged portions 14ec of the attachment brackets 14e are respectively fixed to the bracket receivers 14d by means of the attachment screws 14f. Consequently, the attachment brackets 14e and the heat transfer tubes 14b are pressed onto the panel 14a. Heat can be thereby reliably transferred from the attachment brackets 14e and the heat transfer tubes 14b to the panel 14a.

<Actions of Air Conditioner 1>

**[0036]** The air conditioner 1 is configured to cause the four-way switching valve 12 to change the refrigerant flow path for switching between a cooling operation and a heating operation. First, an exemplary case will be explained that the refrigerant circuit functions as a circuit for a heating operation.

(Heating Operation)

**[0037]** During a heating operation, the flow path depicted with the solid line in FIG. 1 is selected in the four-way switching valve 12. Accordingly, the high pressure gas refrigerant, discharged from the compressor 11, branches into and flows through the branch pipe 40 and the convective heat exchanger 13. The branch point of the refrigerant flow is hereinafter referred to as a point A. The gas refrigerant, flowing into the branch pipe 40 at the point A, sequentially flows through the open/close valve 41, the first check valve 42, the radiant heat exchanger 14 and the second check valve 43, and then joins the refrigerant flowing from the convective heat exchanger 13. The confluence of the refrigerant flows is hereinafter referred to as a point B.

**[0038]** The attachment brackets 14e and the heat transfer tubes 14b are closely attached to the panel 14a (see FIG. 4). The heat of the gas refrigerant is thereby transferred to the panel 14a through the heat transfer tubes 14b. Accordingly, the panel 14a increases its temperature. The panel 14a with increased temperature herein emits radiant heat. Therefore, air and objects, positioned ahead the panel 14a, are heated by the radiant heat. In the radiant heat exchanger 14, the gas refrigerant is partially condensed by means of heat exchange with the panel 14a. Therefore, the liquid refrigerant and the gas refrigerant herein coexist in the radiant heat exchanger 14.

**[0039]** The gas refrigerant, flowing into the convective heat exchanger 13 at the point A, is condensed as a result of heat exchange with the air flowing against the outside

of the convective heat exchanger 13. On the other hand, the air increases its temperature in the convective heat exchanger 13 and is blown out to the indoor space for heating the indoor space.

**[0040]** Further, the liquid refrigerant, flowing out of the convective heat exchanger 13, joins the refrigerant flowing out of the radiant heat exchanger 14 at the point B. The joined refrigerant subsequently flows towards the outdoor heat exchanger 16. On the way to the outdoor heat exchanger 16, the joined refrigerant is decompressed in the expansion valve 15. The decompressed refrigerant then flows into the outdoor heat exchanger 16. In the outdoor heat exchanger 16, the refrigerant evaporates and changes into the gas refrigerant as a result of heat exchange with the air flowing against the outside of the outdoor heat exchanger 16.

**[0041]** After flowing out of the outdoor heat exchanger 16, the gas refrigerant is returned to the compressor 11 via the four-way switching valve 12 and the accumulator 20. The air conditioner 1 is thus configured to execute a heating operation using the radiant heat exchanger 14 and the convective heat exchanger 13.

**[0042]** FIG. 5 is a chart representing the relation between temperature to be detected by the second temperature sensor and actions of the open/close valve during a heating operation. In FIG. 5, the open/close valve 41 is configured to switch the flow path from an opened state to a closed state when the temperature detected by the second temperature sensor 114 exceeds a predetermined temperature (herein set as 70 degrees Celsius). In other words, the open/close valve 41 is configured to switch a state of the refrigerant flowing into the radiant heat exchanger 14 to a state of the refrigerant flowing into only the convective heat exchanger 13 without flowing into the radiant heat exchanger 14.

**[0043]** When a preliminarily set switching period of time T1 elapses, the open/close valve 41 is configured to switch the flow path back to the opened state from the closed state. Accordingly, the air conditioner 1 is returned to the heating operation using the radiant heat exchanger 14.

**[0044]** During a heating operation only using the convective heat exchanger 13, the liquid refrigerant and the gas refrigerant remain residing between the open/close valve 41 and the point B. When the liquid refrigerant spontaneously evaporates under the condition, the internal pressure is increased between the open/close valve 41 and the point B. In the present exemplary embodiment, however, the first check valve 42 is disposed between the radiant heat exchanger 14 and the open/close valve 41. Even when the liquid refrigerant spontaneously evaporates and the internal pressure is increased, the pressure within the radiant heat exchanger 14 does not affect the open/close valve 41. Further, less liquid refrigerant exists between the open/close valve 41 and the first check valve 42. Even when the liquid refrigerant existing therein spontaneously evaporates and the internal pressure is increased, the internal pressure is not increased

enough to push and open the open/close valve 41. Therefore, occurrence of chattering is herein prevented.

**[0045]** When the panel 14a of the radiant heat exchanger 14 sufficiently reduces its temperature during a heating operation only using the convective heat exchanger 13, the branch pipe 40 is opened by the open/close valve 41 and the heating operation is again executed by the radiant heat exchanger 14 and the convective heat exchanger 13.

(Cooling Operation)

**[0046]** Next, an exemplary case will be explained that the refrigerant circuit functions as a circuit for a cooling operation. During a cooling operation, the flow path depicted with the dotted line in FIG. 1 is selected in the four-way switching valve 12. Accordingly, the high pressure gas refrigerant, discharged from the compressor 11, flows towards the outdoor heat exchanger 16. The gas refrigerant is condensed as a result of heat exchange with the air flowing against the outside of the outdoor heat exchanger 16. The liquid refrigerant, flowing out of the outdoor heat exchanger 16, flows towards the convective heat exchanger 13. On the way to the convective heat exchanger 13, the liquid refrigerant is decompressed in the expansion valve 15. The decompressed refrigerant then flows into the convective heat exchanger 13. It should be noted that the liquid and gas refrigerant is blocked from flowing into the branch pipe 40 at the point B by the second check valve 43 before flowing into the convective heat exchanger 13.

**[0047]** In the convective heat exchanger 13, the liquid refrigerant evaporates and changes into the gas refrigerant as a result of heat exchange with the air flowing against the outside of the convective heat exchanger 13. On the other hand, the air reduces its temperature in the convective heat exchanger 13 and is blown out to the indoor space for cooling the indoor space. The gas refrigerant flows out of the convective heat exchanger 13 and flows towards the four-way switching valve 12 via the point A. The gas refrigerant is then returned to the compressor 11 via the four-way switching valve 12 and the accumulator 20.

<Features>

**[0048]** According to the air conditioner 1, as described above, the branch pipe 40 is configured to be closed by the open/close valve 41 for blocking the high pressure refrigerant from flowing into the radiant heat exchanger 14 when the temperature of the panel 14a of the radiant heat exchanger 14 reaches the upper limit of its permissive temperature during a heating operation using the radiant heat exchanger 14. As a result, reduction in the temperature of the refrigerant is accelerated within the radiant heat exchanger 14 and reduction in the temperature of the panel 14a is also accelerated. Therefore, the air conditioner 1 can be returned to the heating operation

using the radiant heat exchanger 14.

**[0049]** Further, the first check valve 42 is disposed between the radiant heat exchanger 14 and the open/close valve 41. Therefore, less liquid refrigerant exists between the open/close valve 41 and the first check valve 42 when the open/close valve 41 is closed. Even when the liquid refrigerant spontaneously evaporates and the internal pressure is increased, the internal pressure is not increased enough to push and open the open/close valve 41. Therefore, occurrence of chattering is prevented.

<Modification>

**[0050]** In the aforementioned exemplary embodiment, the open/close valve 41 is employed for closing and opening the branch pipe 40. However, an opening degree regulating valve may be used instead of the open/close valve 41. The opening degree regulating valve herein has a function of blocking the flow path of the branch pipe 40 and a function of regulating the opening degree of the flow path of the branch pipe 40.

**[0051]** With the opening degree regulating valve, the temperature of the panel 14a of the radiant heat exchanger 14 is increased or reduced by regulating the opening degree of the flow path. Further, the flow path of the refrigerant is configured to be blocked when the temperature of the panel 14a reaches its upper limit. Therefore, the opening degree regulating valve can enhance convenience and safety of the air conditioner 1.

<Other Modifications>

**[0052]** The attachment structure of the panel 14a and the heat transfer tubes 14b in the radiant heat exchanger 14 is not limited to that illustrated in FIG. 4. Other attachment structures will be hereinafter explained with reference to FIGS. 6 to 10. It should be noted that the face, opposite to the radiant face, of the panel 14a will be hereinafter referred to as a rear face for the sake of easy explanation.

**[0053]** FIG. 6 is a cross-sectional view of the radiant heat exchanger for illustrating a second attachment structure of the panel and the heat transfer tubes. In FIG. 6, each of attachment panels 141 includes a flat plate portion 141a and bulged portions 141b. The flat plate portion 141a is joined to the rear face of the panel 14a, whereas the bulged portions 141b are bulged from the that plate portion 141a. Each bulged portion 141b is bulged higher than the diameter of each heat transfer tube 14b. Each bulged portion 141b includes a U-shaped groove 141c that one of the heat transfer tubes 14b is fitted. Each heat transfer tube 14b is fitted into corresponding one of the U-shaped grooves 141c and then the edges of the opening of the U-shaped groove 141c are pressed and swaged onto the outer peripheral surface of each heat transfer tube 14b.

**[0054]** FIG. 7 is a cross-sectional view of the radiant heat exchanger for illustrating a third attachment struc-

ture of the panel and the heat transfer tubes. In FIG. 7, the panel 14a and the heat transfer tubes 14b are jointed by means of brazing. In this case, a filler material 140 is filled with corners (i.e., clearances) produced in contact portions between the panel 14a and the heat transfer tubes 14b. Therefore, heat can be efficiently transferred from the heat transfer tubes 14b to the panel 14a.

**[0055]** FIG. 8 is a cross-sectional view of the radiant heat exchanger for illustrating a fourth attachment structure of the panel and the heat transfer tubes. In FIG. 8, each of first attachment brackets 341 includes a flat plate portion 341a and a bulged portion 341b. The flat plate portion 341a is joined to the rear face of the panel 14a, whereas the bulged portion 341b is bulged from the flat plate portion 341a. The flat plate portion 341a is closely joined to the rear face of the panel 14a by means of either spot welding or brazing. The bulged portion 341b is bulged at a height roughly the same as the diameter of each heat transfer tube 14b. The bulged portion 341b includes a U-shaped groove 341c that one of the heat transfer tubes 14b is fitted. Further, the bulged portion 341b includes screw holes 341d on the both sides of the U-shaped groove 341c.

**[0056]** Each of second attachment brackets 342 includes through holes 342a to be matched with the screw holes 341d of corresponding one of the first attachment brackets 341. The second attachment brackets 342 are respectively fixed to the first attachment brackets 341 by means of screws 343 for covering the heat transfer tubes 14b respectively fitted into the U-shaped grooves 341c. The respective heat transfer tubes 14b are herein slightly protruded from the U-shaped grooves 341c. Therefore, the heat transfer tubes 14b are respectively pressed and closely fitted to the U-shaped grooves 341c when the second attachment brackets 342 are respectively fixed to the first attachment brackets 341 by means of screws.

**[0057]** FIG. 9 is a cross-sectional view of the radiant heat exchanger for illustrating a fifth attachment structure of the panel and the heat transfer tubes. In FIG. 9, each of presser brackets 441 includes a flat plate portion 441a and a U-shaped groove 441b. The flat plate portion 441a is joined to the rear face of the panel 14a. The U-shaped groove 441b is opposed to the rear face of the panel 14a while one of the heat transfer tubes 14b is interposed therebetween. Specifically, the heat transfer tubes 14b are disposed on the rear face of the panel 14a and are then respectively covered with the U-shaped grooves 441b of the presser brackets 441. Under the condition, the flat plate portions 441a of the presser brackets 441 and the rear face of the panel 14a are joined by means of either spot welding or brazing.

**[0058]** FIG. 10 is a cross-sectional view of the radiant heat exchanger for illustrating a sixth attachment structure of the panel and the heat transfer tubes. In FIG. 10, the panel 14a includes bulged portions 541 on the rear face thereof. The bulged portions 541 are arranged in the positions where the heat transfer tubes 14b are disposed. Each bulged portion 541 includes a U-shaped

groove 541a that one of the heat transfer tubes 14b is fitted. The U-shaped groove 541a has a predetermined depth for allowing the outer peripheral surface of each heat transfer tube 14b to be slightly protruded therefrom when fitted therein. Further, each bulged portion 541 includes screw holes 541b on the both sides of the U-shaped groove 541a.

**[0059]** Each of presser brackets 542 includes through holes 542a to be matched with the screw holes 541b of corresponding one of the bulged portions 541. The presser brackets 542 are respectively fixed to the bulged portions 541 by means of screws 543 for covering the outer peripheral surfaces of the heat transfer tubes 14b respectively slightly protruded from the bulged portions 541.

#### INDUSTRIAL APPLICABILITY

**[0060]** As described above, the present invention is useful for a heating machine using a radiant heat exchanger.

#### REFERENCE SIGNS LIST

##### [0061]

1	Air conditioner	25
10	Refrigerant circuit	
13	Convective heat exchanger	
14	Radiant heat exchanger	
41	Open/close valve	30
42	First check valve	

#### CITATION LIST

##### PATENT LITERATURE

**[0062]** PTL 1: Japan Laid-open Patent Application Publication No. JP-A-H07-055234

#### Claims

1. An air conditioner (1) including a refrigerant circuit (10) configured to execute a vapor compression refrigeration cycle, the air conditioner (1) configured to execute a heating operation using at least a high pressure refrigerant, wherein the refrigerant circuit (10) includes:
  - a convective heat exchanger (13) configured to execute heat exchange between the high pressure refrigerant flowing through the inside thereof and an air flowing towards the outside thereof;
  - a radiant heat exchanger (14) configured to heat a predetermined member by means of the high pressure refrigerant flowing through the inside thereof for causing the predetermined member to emit a radiant heat;

an open/close valve (41) disposed on the upstream of the radiant heat exchanger (14) for blocking a flow path of the high pressure refrigerant flowing towards the radiant heat exchanger (14) during the heating operation; and a check valve (42) disposed between the radiant heat exchanger (14) and the open/close valve (41).

2. The air conditioner (1) recited in claim 1, wherein the open/close valve (41) is an opening degree regulating valve having a function of blocking the flow path and a function of regulating an opening degree of the flow path.
3. The air conditioner (1) recited in one of claims 1 and 2, wherein the open/close valve (41) is configured to block the flow path when a temperature of the predetermined member reaches an upper limit of a permissive temperature.

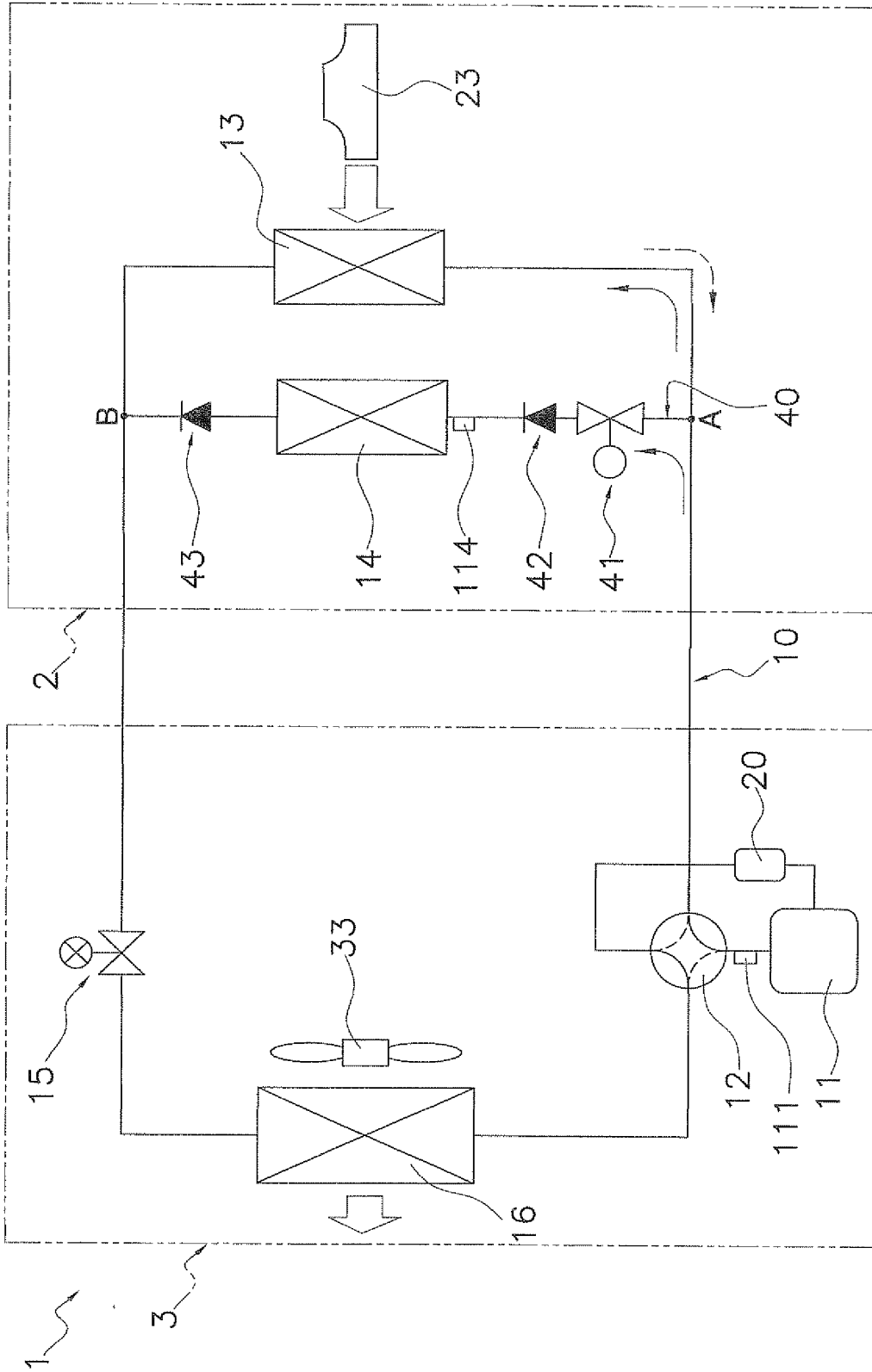


FIG. 1

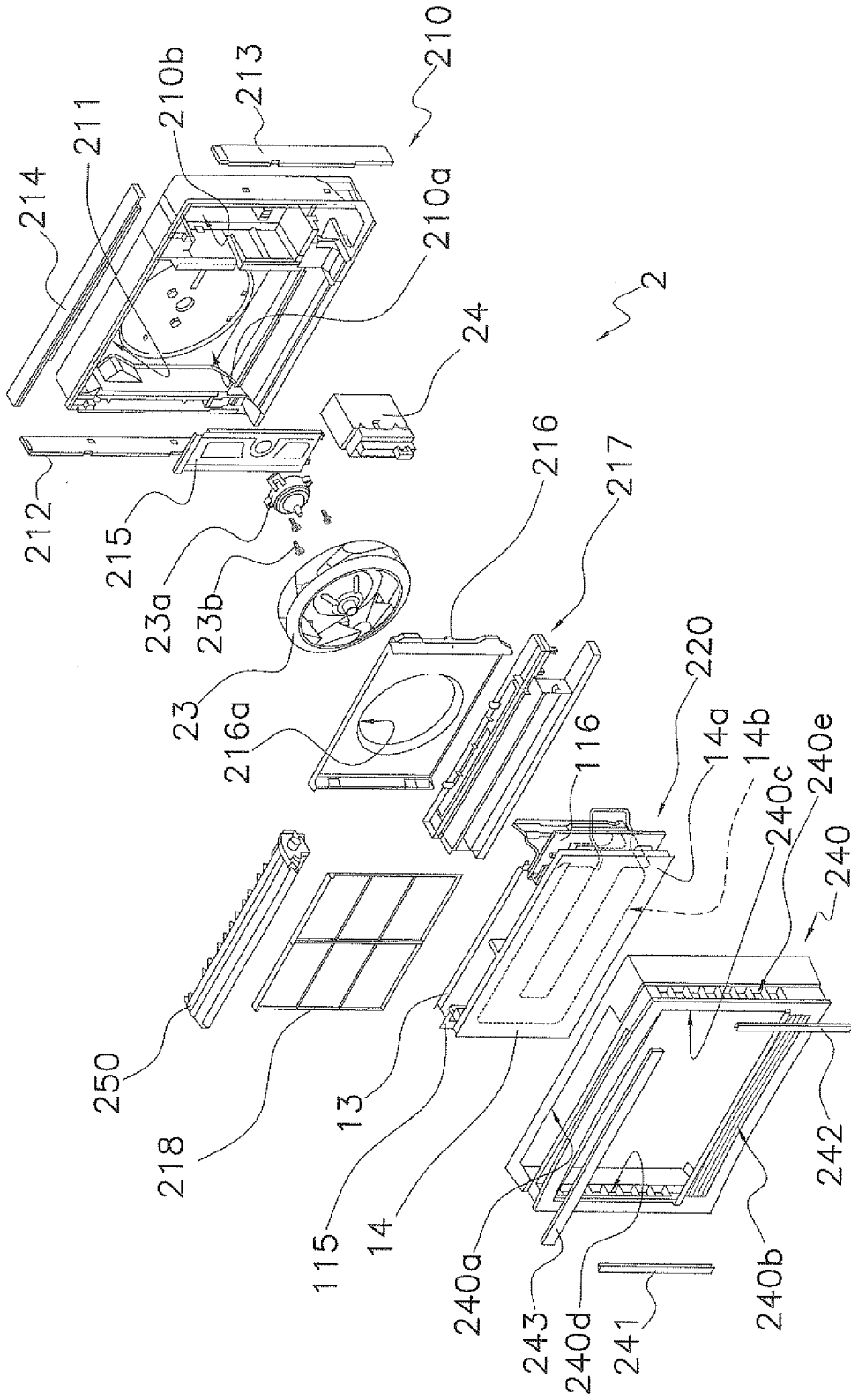


FIG. 2

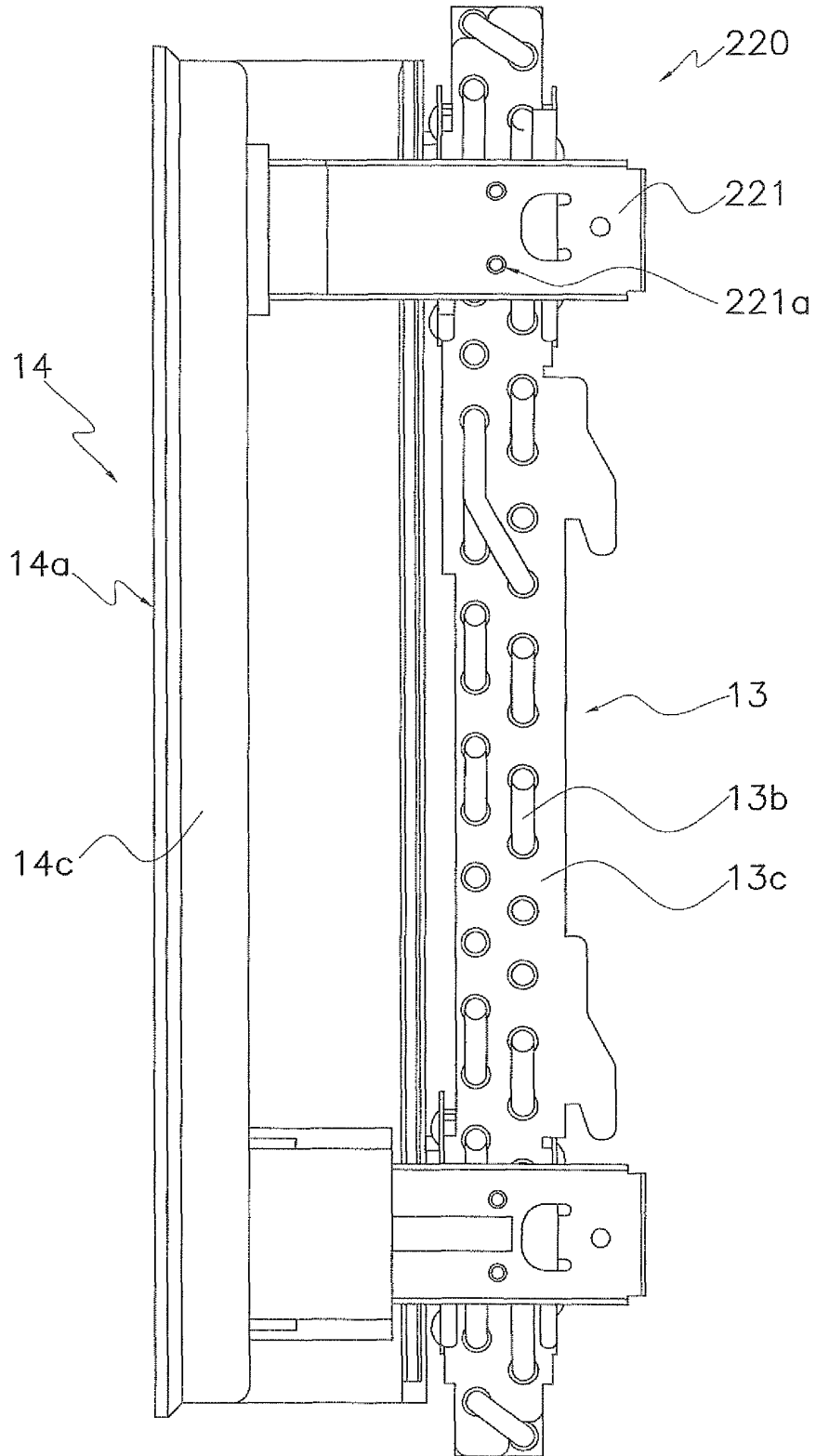


FIG. 3

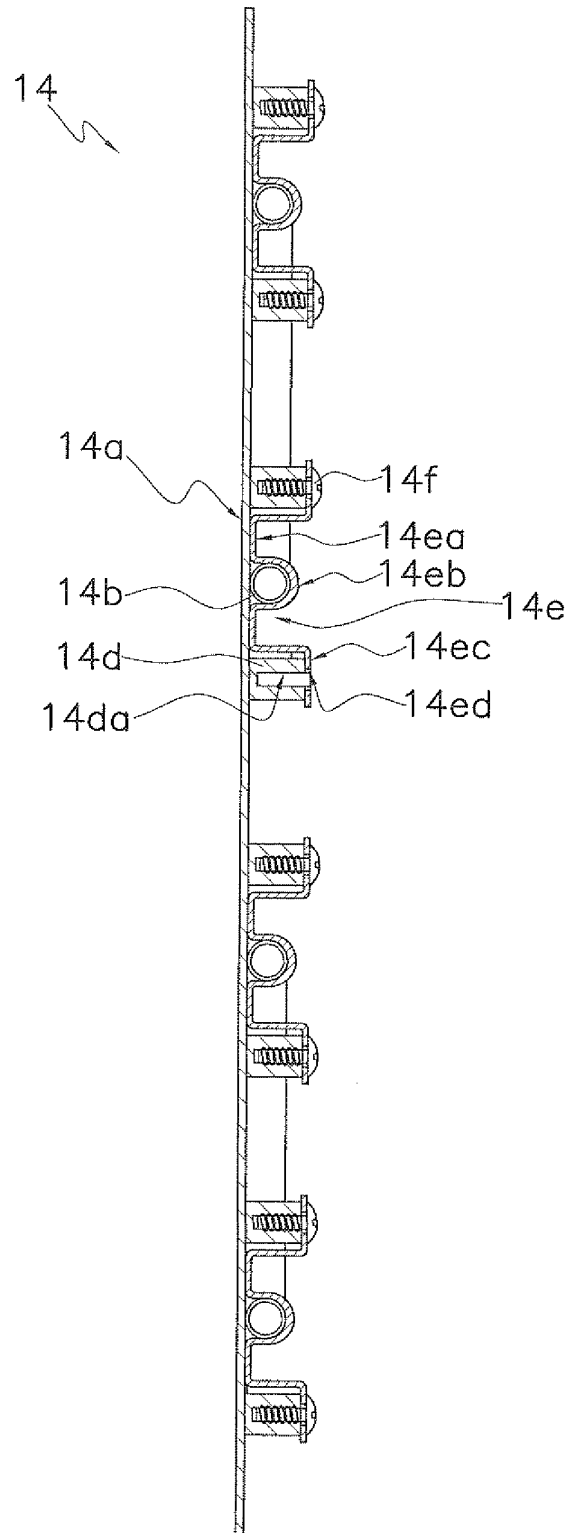


FIG. 4

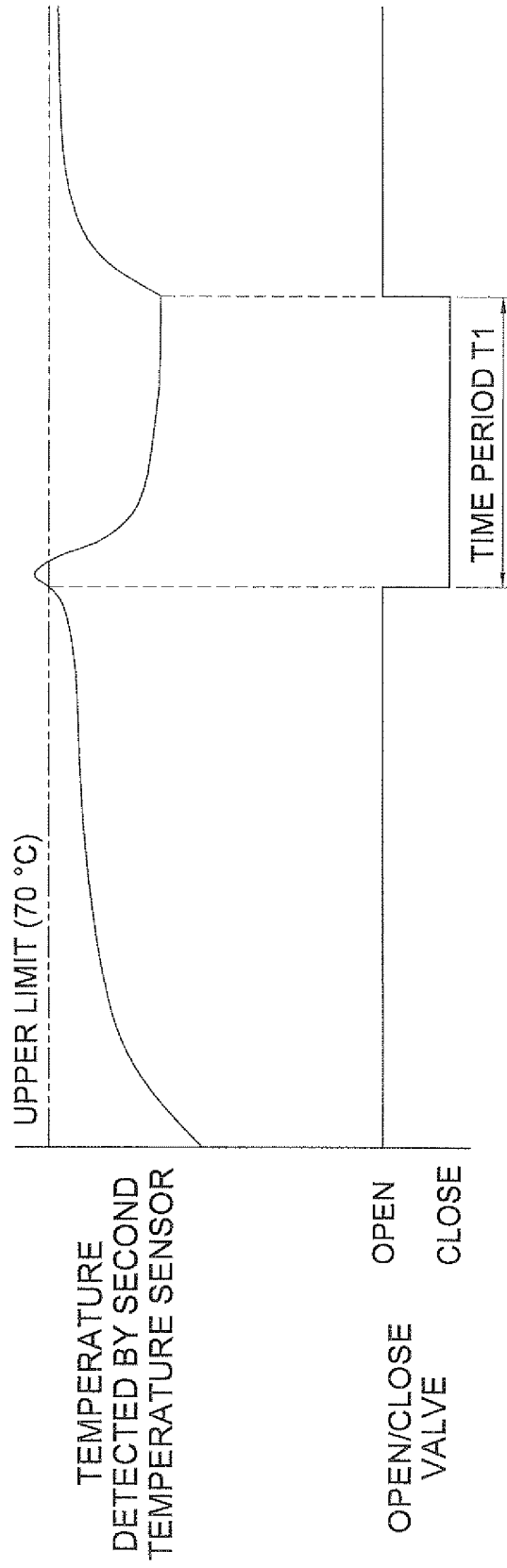


FIG. 5

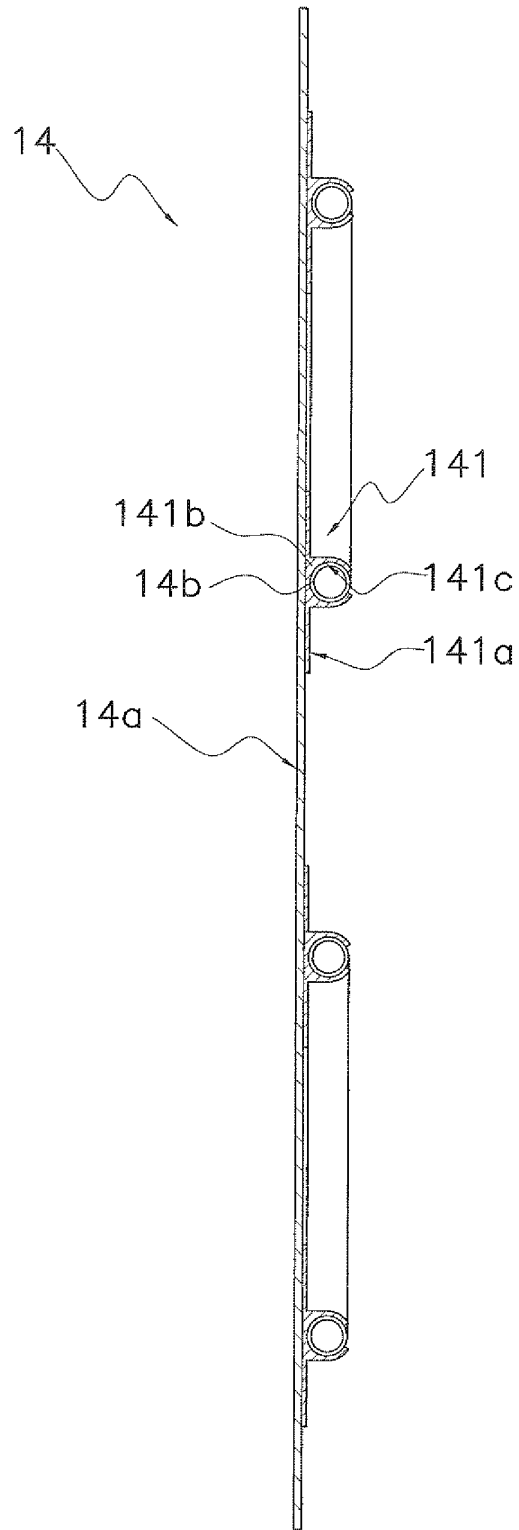


FIG. 6

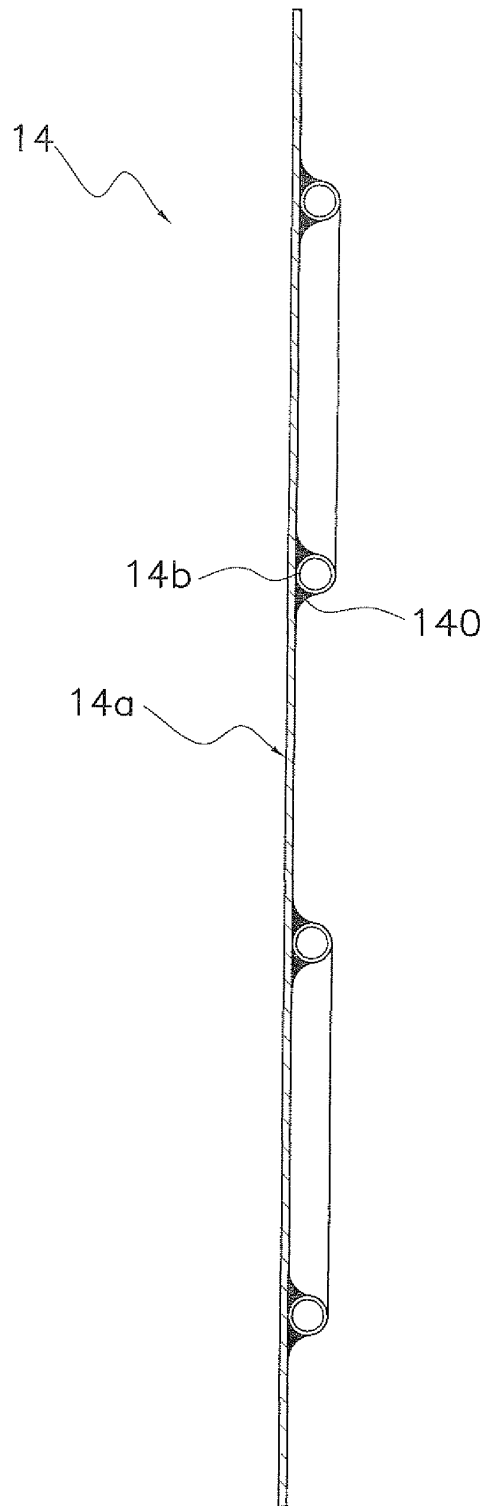


FIG. 7

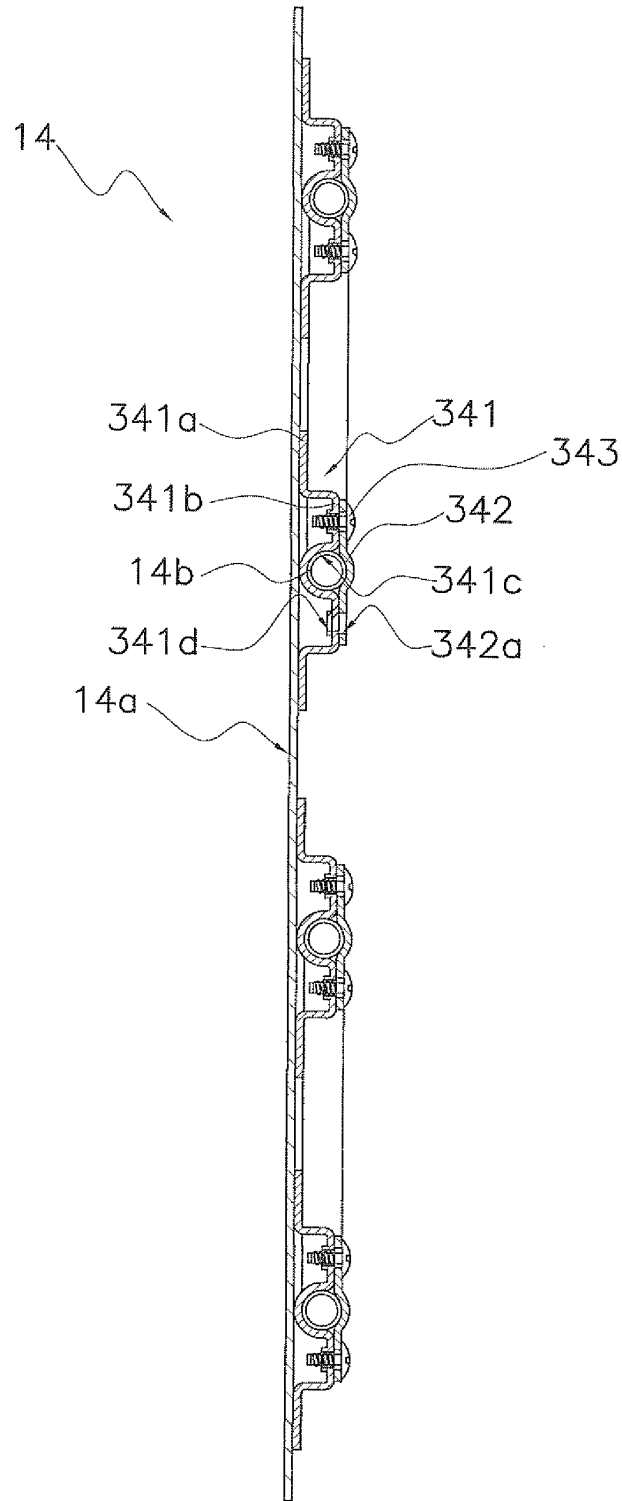


FIG. 8

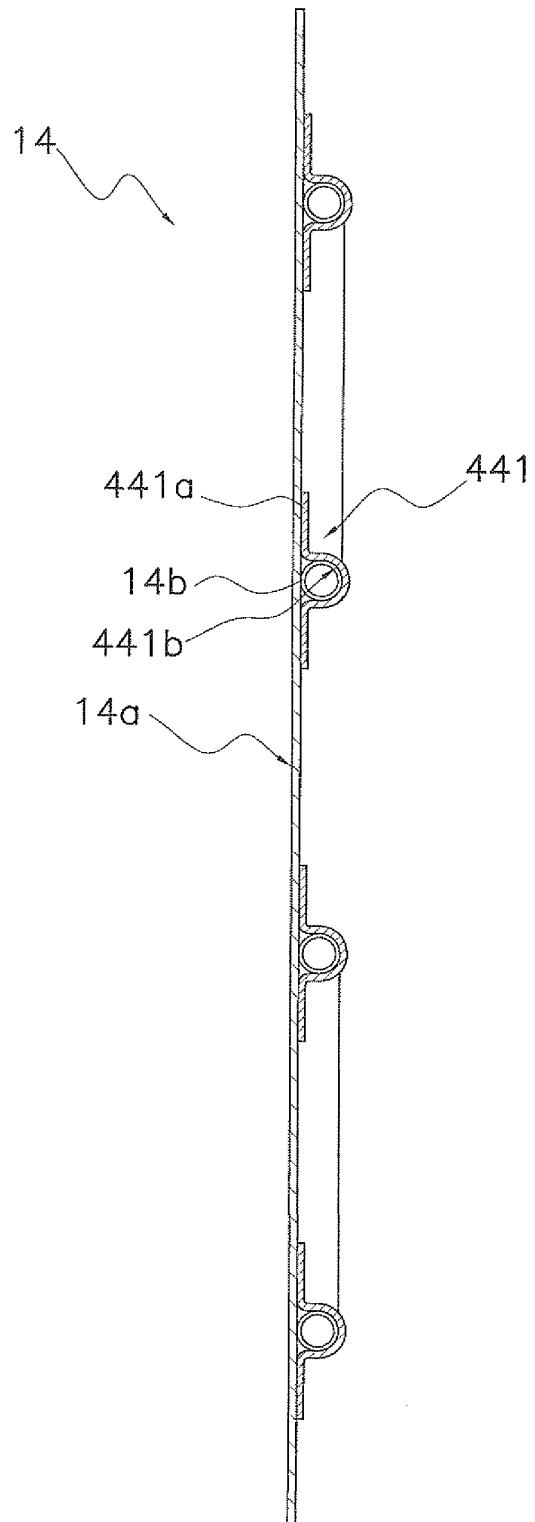


FIG. 9

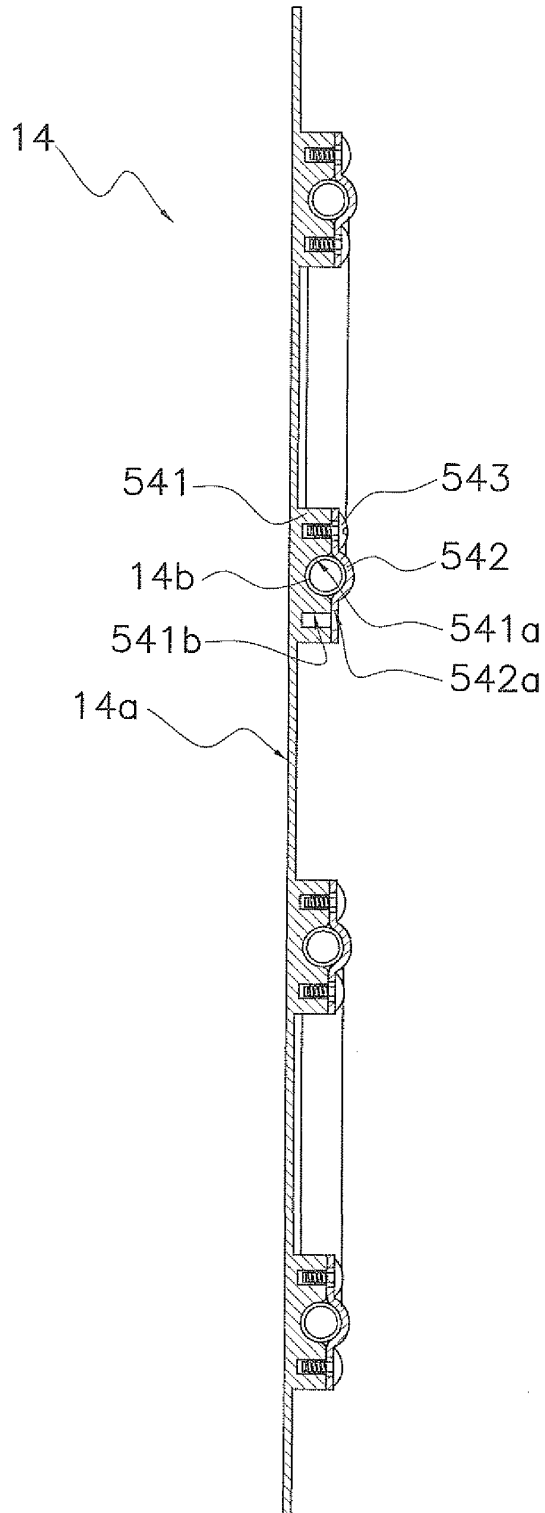


FIG. 10

**EP 2 410 250 A1**

**INTERNATIONAL SEARCH REPORT**

International application No. PCT/JP2010/001812
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<b>A. CLASSIFICATION OF SUBJECT MATTER</b> <i>F24F1/00(2006.01) i, F24F11/02(2006.01) i, F24F13/30(2006.01) i, F25B6/02(2006.01) i, F25B41/04(2006.01) i</i>  According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) F24F1/00, F24F11/02, F24F13/30, F25B6/02, F25B41/04  Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2010 Kokai Jitsuyo Shinan Koho 1971-2010 Toroku Jitsuyo Shinan Koho 1994-2010  Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2007-178058 A (Daikin Industries, Ltd.), 12 July 2007 (12.07.2007), entire text; all drawings (Family: none)	1-3
A	JP 6-307727 A (Matsushita Electric Industrial Co., Ltd.), 01 November 1994 (01.11.1994), entire text; all drawings (Family: none)	1-3
A	JP 4-369327 A (Sharp Corp.), 22 December 1992 (22.12.1992), entire text; all drawings (Family: none)	1-3
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> 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 "E" earlier application or patent but published on or after the international filing date "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) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "I" 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 26 April, 2010 (26.04.10)		Date of mailing of the international search report 11 May, 2010 (11.05.10)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/001812

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 5-33968 A (Sharp Corp.), 09 February 1993 (09.02.1993), entire text; all drawings (Family: none)	1-3
A	JP 4-48140 A (Toshiba Corp.), 18 February 1992 (18.02.1992), entire text; all drawings (Family: none)	1-3
A	JP 2005-16919 A (Daikin Industries, Ltd.), 20 January 2005 (20.01.2005), entire text; all drawings (Family: none)	1-3
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 74386/1990 (Laid-open No. 32434/1992) (Mitsubishi Heavy Industries, Ltd.), 17 March 1992 (17.03.1992), entire text; all drawings (Family: none)	1-3

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**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP H07055234 A [0002] [0062]