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(54) **AIR CONDITIONING SYSTEM**

(57) To provide an air conditioner that eliminates discomfort (drafty feeling) that is produced as a result of conditioned air directly striking the human body and ensures heating comfort. An air conditioner (1) includes an indoor heat exchanger (6) that causes heat to be radiated with respect to air from a supercritical refrigerant and a fan (53) that generates an air flow with respect to the indoor heat exchanger (6). In the indoor heat exchanger (6) during heat radiation, the refrigerant is allowed to flow such that the refrigerant moves from a downstream side of the air flow closer to an upstream side thereof, and conditioned air that has been heated by the indoor heat exchanger (6) is blown out upward inside a room and is sucked in from below. The blowout temperature of the conditioned air is 45°C to 55°C, and the blowout velocity of the conditioned air is equal to or less than 2 m/s.

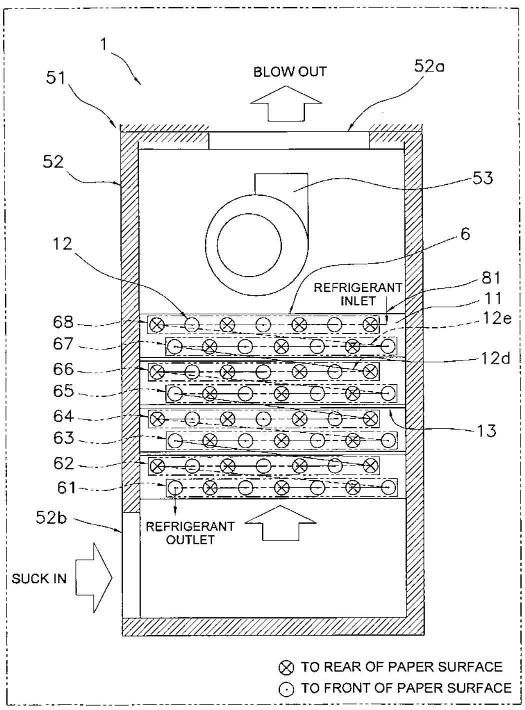

FIG. 4

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Description

TECHNICAL FIELD

[0001] The present invention relates to an air conditioner that utilizes a refrigerant whose high pressure side becomes supercritical.

BACKGROUND ART

[0002] Conventionally, in an air conditioner, in order to improve heating performance, there is employed a method (e.g., see Patent Document 1) where the cross-sectional area of heat transfer tubes on the downstream side of a refrigerant during heating operation is made smaller than the cross-sectional area of the other heat transfer tubes to quicken the flow velocity of the refrigerant and intensify heat transfer from the refrigerant by the turbulence effect.
Patent Document 1: JP-A No. 10-176867

DISCLOSURE OF THE INVENTION

PROBLEM THAT THE INVENTION IS TO SOLVE

[0003] However, in the method described in Reference Document 1, heating performance improves, but conditioned air that is blown out from the air conditioner is blown out downward from above, so discomfort (drafty feeling) that is produced as a result of the conditioned air directly striking the human body has not been eliminated. Although the drafty feeling may be eliminated if the conditioned air is blown out upward, for example, just the upper space becomes warm and heating comfort is no longer ensured.
[0004] It is an object of the present invention to provide an air conditioner that eliminates the drafty feeling and ensures heating comfort.

MEANS FOR SOLVING THE PROBLEM

[0005] An air conditioner pertaining to a first aspect of the present invention comprises: a heat exchanger that causes heat to be radiated with respect to air from a supercritical refrigerant; and a fan that generates an air flow with respect to the heat exchanger. In the heat exchanger during heat radiation, the refrigerant is allowed to flow such that the refrigerant moves from a downstream side of the air flow closer to an upstream side thereof, and conditioned air that has been heated by the heat exchanger is blown out upward inside a room.
[0006] In this air conditioner, the supercritical refrigerant that has a high heat transfer coefficient and specific heat flows so as to oppose the air flow, so the temperature of the air flow rises as the air flow proceeds from the upstream side to the downstream side. For this reason, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, heat exchange performance improves, and heating comfort is ensured. Moreover, high-temperature conditioned air is blown out upward inside the room, so the ceiling becomes heated and the inside of the room becomes heated by secondary radiation from the ceiling. For this reason, the conditioned air does not directly strike the human body, and the drafty feeling is eliminated.
[0007] An air conditioner pertaining to a second aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the air is sucked in from below.
[0008] In this air conditioner, the conditioned air that has been blown out upward pushes and circulates the air at the ceiling, and that air is sucked in from below. For this reason, the conditioned air does not directly strike the human body, and the drafty feeling is eliminated.
[0009] An air conditioner pertaining to a third aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the heat exchanger includes plural plate fins and plural heat transfer tubes. The plate fins include plural through holes in a plane disposed substantially parallel to the air flow. The heat transfer tubes are inserted into the through holes in the plate fins. Additionally, the four or more rows of the heat transfer tubes that are arranged in a direction intersecting the air flow are formed from the upstream side of the air flow toward the downstream side.
[0010] In this air conditioner, the supercritical refrigerant that has a high heat transfer coefficient and specific heat flows so as to oppose the air flow, so the temperature of the air flow rises as the air flow proceeds from the upstream side to the downstream side. For this reason, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, heat exchange performance improves, and heating comfort is ensured.
[0011] An air conditioner pertaining to a fourth aspect of the present invention comprises the air conditioner pertaining

to the third aspect of the present invention, wherein a path for allowing the refrigerant to flow from the heat transfer tubes that belong to the row on the downstream side of the air flow to the heat transfer tubes that belong to the row on the upstream side of the air flow is formed in the heat exchanger.

[0012] In this air conditioner, the refrigerant flows so as to oppose the air flow, so the temperature of the air flow rises as the air flow proceeds from the upstream side to the downstream side. For this reason, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, heat exchange performance improves, and heating comfort is ensured.

[0013] An air conditioner pertaining to a fifth aspect of the present invention comprises the air conditioner pertaining to the fourth aspect of the present invention, wherein the direction of the refrigerant flow inside the path includes, when projected onto a plane that is orthogonal to long axes of the heat transfer tubes, a direction that intersects the air flow and a direction that leads from the downstream side of the air flow to the upstream side.

[0014] In this air conditioner, the refrigerant flows so as to oppose the air flow, so the temperature of the air flow rises as the air flow proceeds from the upstream side to the downstream side. For this reason, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, heat exchange performance improves, and heating comfort is ensured.

[0015] An air conditioner pertaining to a sixth aspect of the present invention comprises the air conditioner pertaining to the fourth aspect of the present invention, wherein the path is formed by a single path.

[0016] In this air conditioner, the path distance becomes longer, and it becomes easier for the refrigerant to be cooled. For this reason, coefficient of performance (COP) improves.

[0017] An air conditioner pertaining to a seventh aspect of the present invention comprises the air conditioner pertaining to the fourth aspect of the present invention, wherein the path includes connecting tubes that interconnect the heat transfer tubes that belong to the rows that are adjacent. The connecting tubes interconnect the heat transfer tubes that are positioned on ends in mutually opposite directions of the rows that are adjacent.

[0018] In this air conditioner, the temperature difference between the rows is maintained at a constant. For this reason, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, heat exchange performance improves, and heating comfort is ensured.

[0019] An air conditioner pertaining to an eighth aspect of the present invention comprises the air conditioner pertaining to the fourth aspect of the present invention, wherein the path alternately travels, in at least one pair of the rows that are adjacent, between the heat transfer tubes that belong to the one row and the heat transfer tubes that belong to the other row.

[0020] In this air conditioner, heat conduction loss in one of the plate fins is reduced, and heat exchange performance improves.

[0021] An air conditioner pertaining to a ninth aspect of the present invention comprises the air conditioner pertaining to the third aspect of the present invention, wherein the plate fins are divided between at least one pair of the rows that are adjacent.

[0022] In this air conditioner, heat transfer on the surfaces of the plate fins is controlled and the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, so heat exchange performance improves.

[0023] An air conditioner pertaining to a tenth aspect of the present invention comprises the air conditioner pertaining to the third aspect of the present invention, wherein the plate fins are divided between all of the rows that are adjacent.

[0024] In this air conditioner, heat transfer on the surfaces of the plate fins is further controlled and the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, so heat exchange performance improves.

[0025] An air conditioner pertaining to an eleventh aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the heat exchanger is disposed in a state where it is slanted with respect to a horizontal plane.

[0026] In this air conditioner, during cooling operation, it becomes easier for drain water to move away from the heat exchanger, so a drop in air volume and a drop in evaporation pressure are prevented.

[0027] An air conditioner pertaining to a twelfth aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the fan is located on the downstream side of the air flow with respect to the heat exchanger.

[0028] In this air conditioner, uneven flow of the air flow is prevented, so a drop in heat exchange performance is prevented.

[0029] An air conditioner pertaining to a thirteenth aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the heat exchanger is divided into two, and the one heat exchanger is disposed on the upstream side of the air flow and the other heat exchanger is disposed on the downstream side of the air flow.

[0030] In this air conditioner, the degree of freedom with which the heat exchanger may be disposed increases, which is space-saving.

[0031] An air conditioner pertaining to a fourteenth aspect of the present invention comprises the air conditioner pertaining to the thirteenth aspect of the present invention, wherein the fan is disposed between the two heat exchangers.

[0032] In this air conditioner, space is effectively utilized, which is space-saving.

[0033] An air conditioner pertaining to a fifteenth aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the fan is a centrifugal fan.

[0034] In this air conditioner, uneven flow of the air flow is prevented, so a drop in heat exchange performance is prevented.

[0035] An air conditioner pertaining to a sixteenth aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the refrigerant is CO_2.

[0036] In this air conditioner, the ozone depletion potential of the refrigerant is 0, and the refrigerant does not destroy the atmospheric environment.

[0037] An air conditioner pertaining to a seventeenth aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the blowout temperature of the conditioned air is 45°C to 55°C.

[0038] In this air conditioner, the ceiling is heated and the space below is also heated by secondary radiation from the ceiling, so the drafty feeling is eliminated.

[0039] An air conditioner pertaining to an eighteenth aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the blowout velocity of the conditioned air is equal to or less than 2 m/s.

[0040] In this air conditioner, the velocity of the air that strikes the human body is controlled, so the drafty feeling is eliminated.

[0041] An air conditioner pertaining to a nineteenth aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the air conditioner performs overload time control for raising the blowout temperature of the conditioned air when the load during heating operation is higher than a rated load, and for increasing the air volume while maintaining the blowout temperature of the conditioned air at substantially the predetermined value when the blowout temperature of the conditioned air becomes equal to or greater than a predetermined value.

[0042] In this air conditioner, when the operating load is higher than the rated load, that is, even when the outside temperature is low, heating comfort is maintained.

[0043] An air conditioner pertaining to a twentieth aspect of the present invention comprises the air conditioner pertaining to the nineteenth aspect of the present invention, wherein the predetermined value is 55°C.

[0044] In this air conditioner, even when the outside temperature is low, heating comfort is maintained.

[0045] An air conditioner pertaining to a twenty-first aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein during cooling operation, control to periodically reduce the number of rotations of the fan is executed.

[0046] In this air conditioner, it becomes easier for drain water to fall, and a drop in evaporation pressure is prevented.

[0047] An air conditioner pertaining to a twenty-second aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the blowout angle of the conditioned air that is blown out upward inside the room is an angle where the conditioned air does not directly strike the human body.

[0048] In this air conditioner, the conditioned air does not directly strike the human body, and the drafty feeling is eliminated.

[0049] An air conditioner pertaining to a twenty-third aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the blowout angle of the conditioned air that is blown out upward inside the room is equal to or greater than 45° with respect to a horizontal plane.

[0050] In this air conditioner, the conditioned air does not directly strike the human body, the drafty feeling is eliminated, and the air does not stay in the space in the center of the room.

[0051] An air conditioner pertaining to a twenty-fourth aspect of the present invention comprises the air conditioner pertaining to the first aspect of the present invention, wherein the blowout angle of the conditioned air that is blown out upward inside the room is within the range of 60° to 80° with respect to a horizontal plane.

[0052] In this air conditioner, the conditioned air does not directly strike the human body, and the drafty feeling is eliminated. Moreover, a situation where the wall on the side where the air conditioner is installed becomes dirtied by the conditioned air that has been blown out is controlled.

EFFECTS OF THE INVENTION

[0053] In the air conditioner pertaining to the first aspect of the present invention, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, heat exchange performance improves, and heating comfort is ensured. Moreover, the conditioned air does not directly strike the human body, and the drafty feeling is eliminated.

[0054] In the air conditioner pertaining to the second aspect of the present invention, the conditioned air that has been blown out upward pushes and circulates the air at the ceiling, and that air is sucked in from below. For this reason, the conditioned air does not directly strike the human body, and the drafty feeling is eliminated.

[0055] In the air conditioners pertaining to the third through the fifth aspects of the present invention, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, heat exchange performance improves, and heating comfort is ensured.

[0056] In the air conditioner pertaining to the sixth aspect of the present invention, the path distance becomes longer and it becomes easier for the refrigerant to be cooled. For this reason, coefficient of performance (COP) improves.

[0057] In the air conditioner pertaining to the seventh aspect of the present invention, the temperature difference between the rows is maintained at a constant. For this reason, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, heat exchange performance improves, and heating comfort is ensured.

[0058] In the air conditioner pertaining to the eighth aspect of the present invention, heat conduction loss in one of the plate fins is reduced, and heat exchange performance improves.

[0059] In the air conditioners pertaining to the ninth and tenth aspects of the present inventions, heat transfer of the surfaces of the plate fins is controlled and the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, so heat exchange performance improves.

[0060] In the air conditioner pertaining to the eleventh aspect of the present invention, during cooling operation, it becomes easier for drain water to move away from the heat exchanger, so a drop in air volume and a drop in evaporation pressure are prevented.

[0061] In the air conditioner pertaining to the twelfth aspect of the present invention, uneven flow of the air flow is prevented, so a drop in heat exchange performance is prevented.

[0062] In the air conditioners pertaining to the thirteenth and fourteenth aspects of the present inventions, the degree of freedom with which the heat exchanger may be disposed increases, which is space-saving.

[0063] In the air conditioner pertaining to the fifteenth aspect of the present invention, uneven flow of the air flow is prevented, so a drop in heat exchange performance is prevented.

[0064] In the air conditioner pertaining to the sixteenth aspect of the present invention, the ozone depletion potential of the refrigerant is 0, and the refrigerant does not destroy the atmospheric environment.

[0065] In the air conditioner pertaining to the seventeenth aspect of the present invention, the ceiling is heated and the space below is also heated by secondary radiation from the ceiling, so the drafty feeling is eliminated.

[0066] In the air conditioner pertaining to the eighteenth aspect of the present invention, the velocity of the air that strikes the human body is controlled, so the drafty feeling is eliminated.

[0067] In the air conditioners pertaining to the nineteenth and twentieth aspects of the present inventions, even when the outside temperature is low, heating comfort is maintained.

[0068] In the air conditioner pertaining to the twenty-first aspect of the present invention, it becomes easier for drain water to fall, and a drop in evaporation pressure is prevented.

[0069] In the air conditioner pertaining to the twenty-second aspect of the present invention, the conditioned air does not directly strike the human body, and the drafty feeling is eliminated.

[0070] In the air conditioner pertaining to the twenty-third aspect of the present invention, the conditioned air does not directly strike the human body, the drafty feeling is eliminated, and the air does not stay in the space in the center of the room.

[0071] In the air conditioner pertaining to the twenty-fourth aspect of the present invention, the conditioned air does not directly strike the human body, and the drafty feeling is eliminated. Moreover, a situation where the wall on the side where the air conditioner is installed becomes dirtied by the conditioned air that has been blown out is controlled.

BRIEF DESCRIPTION OF THE DRAWINGS

[0072]

FIG. 1 is a refrigeration circuit of an air conditioner that utilizes CO_2 refrigerant.

FIG. 2 (a) is a pressure-enthalpy state diagram of CO_2 refrigerant. (b) is a temperature-entropy state diagram of CO_2 refrigerant.

FIG. 3 is a perspective view of an indoor heat exchanger of an air conditioner pertaining to an embodiment of the present invention.

FIG. 4 is a vertical cross-sectional view of the air conditioner.

FIG. 5 is a cross-sectional view of a room where the air conditioner is installed.
FIG. 6 is a vertical cross-sectional view of an air conditioner pertaining to a first modification of the embodiment of the present invention.
FIG. 7 is a vertical cross-sectional view of an air conditioner pertaining to a second modification of the embodiment.
FIG. 8 is a vertical cross-sectional view of an air conditioner pertaining to a third modification of the embodiment.
FIG. 9 is a vertical cross-sectional view of an air conditioner pertaining to a fourth modification of the embodiment.
FIG. 10 is a vertical cross-sectional view of an air conditioner pertaining to a fifth modification of the embodiment.
FIG. 11 is a vertical cross-sectional view of an air conditioner pertaining to a sixth modification of the embodiment.
FIG. 12 is a vertical cross-sectional view of an air conditioner pertaining to a seventh modification of the embodiment.

DESCRIPTION OF THE REFERENCE NUMERALS

[0073]

1, 101, 201, 301, 401, 501, 601, 701	Air Conditioners
6, 106, 206, 306, 406, 506, 606, 706	Heat Exchangers
11	Plate Fins
12	Heat Transfer Tubes
12d, 12e	Connecting Tubes
53, 753	Fans
61 to 68	Rows
81, 181, 281, 381, 481, 581, 681, 781	Paths

BEST MODE FOR CARRYING OUT THE INVENTION

<Refrigeration Circuit of Air Conditioner>

[0074] FIG. 1 is a refrigeration circuit of an air conditioner that utilizes CO_2 refrigerant. An air conditioner 1 includes a refrigeration circuit where a compressor 2, a four-way switch valve 3, an outdoor heat exchanger 4, an expansion valve 5 and an indoor heat exchanger 6 are interconnected by refrigerant pipes 7a and 7b. In FIG 1, the arrows indicated by the solid line and the dotted line represent flow directions of the refrigerant, and the air conditioner 1 can switch between heating operation and cooling operation by switching the flow direction of the refrigerant with the four-way switch valve 3.

[0075] During cooling operation, the outdoor heat exchanger 4 becomes a gas cooler and the indoor heat exchanger 6 becomes an evaporator. During heating operation, the outdoor heat exchanger 4 becomes an evaporator and the indoor heat exchanger 6 becomes a gas cooler. The outdoor heat exchanger 4 and the indoor heat exchanger 6 comprise plate fins 11 (see FIG. 3) and heat transfer tubes 12 (see FIG. 3), and the refrigerant inside the heat transfer tubes 12 performs heat exchange via an air flow and the plate fins 11.

[0076] In FIG. 1, point A is a suction side of the compressor 2 during heating operation, and point B is a discharge side of the compressor 2 during heat operation. Point C is a refrigerant outlet side of the indoor heat exchanger 6 during heating operation, and point D is a refrigerant inlet side of the outdoor heat exchanger 4 during heating operation.

[0077] FIG. 2(a) is a pressure-enthalpy state diagram of the CO_2 refrigerant, with the vertical axis representing pressure P and the horizontal axis representing enthalpy h. Tk is an isotherm that passes through a critical point K, and Tx is an isotherm of temperature Tx. Tx is greater than Tk, and on the right side of isotherm Tk, the CO_2 refrigerant will not become liquefied or enter a two-phase state. The region that is equal to or greater than critical pressure Pk on the right side of isotherm Tk is called a supercritical state, and the air conditioner 1 of the present embodiment is operated in a refrigeration cycle that includes a supercritical state. A, B, C and D in FIG. 2(a) represent states of the refrigerant that correspond to the points of A, B, C and D in FIG. 1.

[0078] FIG. 2(b) is a temperature-entropy state diagram of the CO_2 refrigerant, with the vertical axis representing temperature T and the horizontal axis representing entropy"s". A, B, C and D in FIG. 2(b) represent states of the refrigerant that correspond to points A, B, C and D in FIG. 1. The temperature of the refrigerant drops after it leaves point B, which is the discharge side of the compressor 2, until it reaches point C, which is the refrigerant outlet of the indoor heat exchanger 6. For this reason, the temperature of the surface of the indoor heat exchanger 6 has a temperature distribution where the temperature on the upstream side of the refrigerant is high and the temperature on the downstream side is low. Consequently, when the air flow passes from the downstream side of the refrigerant to the upstream side of the refrigerant, the temperature difference between the air and the indoor heat exchanger 6 stabilizes more, and the heat exchange amount between the air and the indoor heat exchanger 6 increases more.

<Structure of Indoor Heat Exchanger>

[0079] FIG. 3 is a perspective view of the indoor heat exchanger of the air conditioner pertaining to the embodiment of the present invention. The indoor heat exchanger 6 is a cross-fm type heat exchanger. The plate fins 11 are flat plates that are made of thin aluminium, and plural through holes 11a are formed in one plate fin 11. The heat transfer tubes 12 comprise straight tubes 12a that are inserted into the through holes 11a in the plate fins 11 and U-shaped tubes 12b that interconnect end portions of the straight tubes 12a that are adjacent. It will be noted that, in the heat transfer tubes 12 of the present embodiment, the straight tubes 12a and the U-shaped tubes 12b are integrally formed, and U-shaped tubes (not shown) on the back side of FIG. 3 are connected to the end portions of the straight tubes 12a by welding or the like after the straight tubes 12a have been inserted into the through holes 11 a in the plate fins 11.

[0080] Eight rows 61 to 68 of the heat transfer tubes 12 that are arranged in a direction intersecting the air flow are disposed from upstream of the air flow toward downstream of the air flow. The refrigerant flows from the heat transfer tubes 12 that belong to the row 68 on the downstream side of the air flow to the heat transfer tubes 12 that belong to the row 61 on the upstream side of the air flow. This refrigeration circulation path is called a path 81 (see FIG. 4); because of this path 81, the air flow and the refrigerant flow oppose each other, and the heat exchange amount increases in comparison to a configuration where the air flow and the refrigerant flow do not oppose each other. However, by experiment, in a heat exchanger where there are three or fewer rows of the heat transfer tubes, there is no great difference in effect regardless of whether the air flow and the refrigerant flow oppose each other or do not oppose each other.

[0081] It will be noted that the arrows indicated by the dotted lines inside the heat transfer tubes 12 in FIG. 3 are the aforementioned path 81 (see FIG. 4) through which the refrigerant flows, and connecting tubes 12d and connecting tubes 12e (see FIG. 4) interconnect the heat transfer tubes 12 that are positioned on ends in mutually opposite directions of the rows 61 to 68 that are adjacent.

[0082] The plate fins 11 are divided between the row 61 and the row 62. This is implemented also between the row 63 and the row 64, between the row 65 and the row 66, and between the row 67 and the row 68. Thus, the heat on the surfaces of the plate fins 11 becomes unable to cross and move over divided portions 13.

[0083] Heat transfer to the heat transfer tubes 12 from the refrigerant flowing inside the heat transfer tubes 12 is more active when the refrigerant flow is turbulent rather than laminar. In the present embodiment, the tube outer diameter of the heat transfer tubes 12 is set to be equal or less than 4 mm; thus, the flow of the refrigerant inside the heat transfer tubes 12 becomes turbulent.

<Configuration of Air Conditioner>

[0084] FIG. 4 is a vertical cross-sectional view of an indoor unit of the air conditioner pertaining to the embodiment of the present invention. An indoor unit 51 includes a casing 52 inside of which the indoor heat exchanger 6 is installed. A fan 53 that generates an air flow is disposed above the indoor heat exchanger 6, and an air blowout opening 52a is disposed above the fan 53. An air suction opening 52b is disposed below the indoor heat exchanger 6. It will be noted that the fan 53 that is used in the present embodiment is a sirocco fan.

[0085] The line that interconnects the centers of the heat transfer tubes 12 represents the path 81 through which the refrigerant flows during heating operation, with the solid lines representing the U-shaped tubes 12b that are on the front side of the drawing and with the dotted lines representing the U-shaped tubes (not shown) and the connecting tubes (not shown) that are on the opposite side. During heating operation, the refrigerant flows from above to below inside the path 81 in the indoor heat exchanger 6, and the air flow flows from below the indoor heat exchanger 6 to above. For this reason, the air flow performs heat exchange with the higher temperature refrigerant as it approaches the air blowout opening 52a, and the temperature of the air flow rises, so the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process.

[0086] It will be noted that, in the air conditioner 1 of the type where the air flow flows from below the indoor heat exchanger 6 to above, the air flow hinders the falling of drain water during cooling operation, so the potential for drain water to collect between the plate fins 11 of the indoor heat exchanger 6 is high. When drain water collects between the plate fins 11, heat exchange is hindered and evaporation pressure during cooling operation drops. Consequently, in the present embodiment, during cooling operation, when the evaporation pressure in the indoor heat exchanger 6 falls below a predetermined pressure, control to reduce (including stop) the number of rotations of the fan 53 is executed. Thus, it becomes easier for drain water to fall, and a drop in evaporation pressure is prevented beforehand.

<Room where Air Conditioner is Installed>

[0087] FIG. 5 is a cross-sectional view of a room where the indoor unit of the air conditioner pertaining to the embodiment of the present invention is installed. As for the size of the room, the width is 5 m, the height from the floor to the ceiling is 2.4 m, and the depth is 4 m.

[0088] The indoor unit 51 of the air conditioner 1 is installed next to a wall inside the room. During heating operation, the indoor unit 51 blows out conditioned air with a temperature of 45 to 55°C toward the ceiling and heats the ceiling. Radiation heat is radiated toward the floor from the ceiling that has been heated, and this radiation heat heats the lower space inside the room.

[0089] The conditioned air that reaches the ceiling is pushed against the flow of the conditioned air that is next blown out, falls along the side wall on the opposite side of the side where the indoor unit 51 is installed, flows along the floor toward the indoor unit 51, and is sucked into the air suction opening (not shown). It will be noted that when the blowout velocity of the conditioned air that is blown out from the indoor unit 51 is too fast, this creates discomfort (drafty feeling) as a result of the convection of the conditioned air becoming turbulent and the conditioned air directly striking the human body. In the present embodiment, the blowout velocity of the conditioned air is set to be equal to or less than 2 m/s in order to ensure that a drafty feeling is not produced.

[0090] Further, the air conditioner 1 performs overload time control to maintain heating comfort when the load during heating operation becomes higher than a rated load. For example, when the outside temperature is low, the air conditioner 1 raises the blowout temperature of the conditioned air, and when the blowout temperature of the conditioned air becomes equal to or greater than 55°C, the air conditioner 1 increases the air volume while maintaining the blowout temperature of the conditioned air at substantially 55°C. Thus, the air conditioner 1 prevents a drop in heating capability when the outside temperature is low, and maintains heating comfort.

[0091] It will be noted that the blowout angle of the conditioned air that is blown out upward inside the room is an angle where the conditioned air does not directly strike the human body and is equal to or greater than 45° with respect to a horizontal plane. By experimental verification, it is best for the blowout angle of the conditioned air to be in the range of 60° to 80° with respect to a horizontal plane, the drafty feeling is eliminated, and the air does not stay in the space in the center of the room. Moreover, a situation where the wall on the side where the air conditioner is installed becomes dirtied by the conditioned air that has been blown out is also controlled.

<Characteristics>

(1)

[0092] This air conditioner 1 includes the indoor heat exchanger 6 that causes heat to be radiated with respect to air from a supercritical refrigerant and the fan 53 that generates an air flow with respect to the indoor heat exchanger 6. In the indoor heat exchanger 6 during heat radiation, the refrigerant is allowed to flow such that the refrigerant moves from a downstream side of the air flow closer to an upstream side thereof, and conditioned air that has been heated by the indoor heat exchanger 6 is blown out upward inside the room and is sucked in from below. The blowout temperature of the conditioned air is 45°C to 55°C, and the blowout velocity of the conditioned air is equal to or less than 2 m/s.

[0093] In this air conditioner 1, the supercritical refrigerant that has a high transfer coefficient and specific heat flows so as to oppose the air flow, so the temperature of the air flow rises as the air flow proceeds from the upstream side to the downstream side. For this reason, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, heat exchange performance improves, and heating comfort is ensured. Moreover, the high-temperature conditioned air is blown out upward inside the room, so the ceiling becomes heated and the inside of the room is heated by the radiation heat from the ceiling. For this reason, the conditioned air does not directly strike the human body, and the drafty feeling is eliminated.

[0094] Further, the fan 53 is a centrifugal fan, so uneven flow of the air flow is prevented, and a drop in heat exchange performance is prevented. Further, the refrigerant is CO_2, whose ozone depletion potential is 0, so the refrigerant does not destroy the atmospheric environment.

(2)

[0095] In this air conditioner 1, the indoor heat exchanger 6 includes the plural plate fins 11 and the plural heat transfer tubes 12. The plate fins 11 include the plural through holes 11a in a plane arranged substantially parallel to the air flow. The heat transfer tubes 12 are inserted into the through holes 11a in the plate fins 11. Additionally, four or more rows of the heat transfer tubes 12 that are arranged in a direction intersecting the air flow are formed from the upstream side of the air flow toward the downstream side.

[0096] In this air conditioner 1, the supercritical refrigerant that has a high transfer coefficient and specific heat flows so as to oppose the air flow, so the temperature of the air flow rises as the air flow proceeds from the upstream side to the downstream side. For this reason, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, heat exchange performance improves, and heating comfort is ensured.

(3)

[0097] In this air conditioner 1, the path 81 for allowing the refrigerant to flow from the heat transfer tubes 12 that belong to the row 68 on the downstream side of the air flow to the heat transfer tubes 12 that belong to the row 61 on the upstream side of the air flow is formed in the indoor heat exchanger 6. Additionally, the direction of the refrigerant flow inside the path 81 includes, when projected onto a plane that is orthogonal to long axes of the heat transfer tubes 12, a direction that intersects the air flow and a direction that leads from the downstream side of the air flow to the upstream side. Additionally, the path 81 includes the connecting tubes 12d and 12e that interconnect the heat transfer tubes 12 that belong to the rows 61 to 68 that are adjacent, and the connecting tubes 12d and 12e interconnect the heat transfer tubes 12 that are positioned on ends in mutually opposite directions of the rows 61 to 68 that are adjacent. The refrigerant flows so as to oppose the air flow, and the temperature of the air flow rises as the air flow proceeds from the upstream side to the downstream side. For this reason, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, heat exchange performance improves, and heating comfort is ensured. Further, the path 81 is formed by a single path, so the distance becomes longer, and it becomes easier for the refrigerant to be cooled. For this reason, coefficient of performance (COP) improves.

(4)

[0098] In this air conditioner 1, during cooling operation, control to periodically reduce (including stop) the number of rotations of the fan 53 is performed. For this reason, it becomes easier for drain water to fall, and a drop in evaporation pressure is prevented.

<First Modification>

[0099] FIG. 6 is a vertical cross-sectional view of an air conditioner pertaining to a first modification of the embodiment of the present invention. In a heat exchanger 106 of an air conditioner 101, a path 181 leads from the heat transfer tube 12 on the right end of the row 68 when seen from the front, passes through the heat transfer tube 12 on the left end of the row 68 when seen from the front, and moves to the heat transfer tube 12 on the left end of the row 67 when seen from the front that is one row below the row 68. From there, the path 181 leads to the heat transfer tube 12 on the right end of the row 67 when seen from the front and moves to the heat transfer tube 12 on the right end of the row 66 when seen from the front that is one row below the row 67. The path 181 subsequently reaches, by the same manner of progression, the heat transfer tube 12 on the right end of the row 61 when seen from the front.

[0100] The path 181 is economical because it is formed so as to interconnect, by simple U-shaped tubes, the heat transfer tubes 12 of the rows 61 to 68 that are adjacent. Consequently, the function of the above-described embodiment can be realized at a lower cost.

<Second Modification>

[0101] FIG. 7 is a vertical cross-sectional view of an air conditioner pertaining to a second modification of the embodiment of the present invention. In an indoor heat exchanger 206 of an air conditioner 201, a path 281 leads from the heat transfer tube 12 on the right end of the row 67 when seen from the front to the heat transfer tube 12 on the right end of the row 68 when seen from the front, and next the path 281 moves to the heat transfer tube 12 that is second from the right end of the row 67 when seen from the front. The path 281 subsequently reaches, by the same manner of progression, the heat transfer tube 12 on the right end of the row 61 when seen from the front. That is, the path 281 alternately travels between the heat transfer tubes 12 that belong to one row of rows that are adjacent and the heat transfer tubes 12 that belong to the other row. By employing the path 281, heat conduction loss in one of the plate fins 11 is reduced, and heat exchange performance improves.

<Third Modification>

[0102] FIG. 8 is a vertical cross-sectional view of an air conditioner pertaining to a third modification of the embodiment of the present invention. In an indoor heat exchanger 306 of an air conditioner 301, in a path 381, two small-scale paths that simulate the path 81 of the above-described embodiment are connected in parallel. For this reason, the opposing components where the refrigerant flows so as to oppose the air flow increase, and heat exchange performance improves.

<Fourth Modification>

[0103] FIG. 9 is a vertical cross-sectional view of an air conditioner pertaining to a fourth modification of the embodiment of the present invention. In an indoor heat exchanger 406 of an air conditioner 401, the routing of a path 481 is the same as that of the path 81 of the above-described embodiment, but the plate fins 11 are divided between all of the rows 61 to 68 that are adjacent. For this reason, heat transfer of the surfaces of the plate fins 11 is further controlled, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, and heat exchange performance improves.

<Fifth Modification>

[0104] FIG. 10 is a vertical cross-sectional view of an air conditioner pertaining to a fifth modification of the embodiment of the present invention. In an indoor heat exchanger 506 of an air conditioner 501, the routing of a path 581 is the same as that of the path 81 of the above-described embodiment, but the indoor heat exchanger 506 is disposed in a state where the orientation of the indoor heat exchanger 506 is slanted with respect to a horizontal plane. For this reason, during cooling operation, it becomes easier for drain water to move away from the indoor heat exchanger 506, and a drop in air volume and a drop in evaporation pressure are prevented.

<Sixth Modification>

[0105] FIG. 11 is a vertical cross-sectional view of an air conditioner pertaining to a sixth modification of the present invention. In an indoor heat exchanger 606 of an air conditioner 601, a path 681 is the same as the path 581 of the fifth modification, the indoor heat exchanger 606 is disposed in a state where the orientation of the indoor heat exchanger 606 is slanted with respect to a horizontal plane, and the plate fins 11 are divided between all of the rows 61 to 68 that are adjacent. For this reason, during cooling operation, it becomes easier for drain water to move away from the heat exchanger, and a drop in air volume and a drop in evaporation pressure are prevented. Further, during heating, heat transfer on the surfaces of the plate fins 11 is controlled, the temperature difference between the refrigerant temperature and the air temperature is appropriately maintained through the entire heat radiation process, and heat exchange performance improves.

<Seventh Modification>

[0106] FIG. 12 is a vertical cross-sectional view of an air conditioner pertaining to a seventh modification of the embodiment of the present invention. An indoor heat exchanger 706 of an air conditioner 701 is divided into two, with one heat exchanger 706a being disposed on the upstream side of the air flow and the other heat exchanger 706b being disposed on the downstream side of the air flow. The routing of a path 781 is similar to that of the path 81 of the above-described embodiment.

[0107] The heat exchanger 706a includes five rows 61 to 65 and realizes supercooling of the refrigerant. The heat exchanger 706b includes three rows 66 to 68, its surface temperature is higher than that of the heat exchanger 706a, and the heat exchanger 706b realizes high-temperature blowout of the conditioned air. The rows 61 to 65 are vertically disposed (vertical direction when seen from the front), so the height of the air suction opening 52b is set to be large in the heat exchanger 706a. For this reason, pressure loss is reduced.

[0108] Further, a fan 753 is disposed between the two heat exchangers 706a and 706b. For this reason, the degree of freedom with which the indoor heat exchanger 706 may be disposed increases, and space is effectively utilized. Consequently, this is space-saving.

INDUSTRIAL APPLICABILITY

[0109] As described above, the present invention can eliminate the drafty feeling and ensure heating comfort, so the present invention is useful for air conditioners in living rooms and offices.

Claims

1. An air conditioner (1, 101, 201, 301, 401, 501, 601, 701) comprising:

a heat exchanger (6, 106, 206, 306, 406, 506, 606, 706) that causes heat to be radiated with respect to air from a supercritical refrigerant; and
a fan (53, 753) that generates an air flow with respect to the heat exchanger,
wherein
in the heat exchanger during heat radiation, the refrigerant is allowed to flow such that the refrigerant moves

from a downstream side of the air flow closer to an upstream side thereof, and
conditioned air that has been heated by the heat exchanger is blown out upward inside a room.

2. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 1, wherein the air is sucked in from below.

3. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 1, wherein the heat exchanger (6, 106, 206, 306, 406, 506, 606, 706) includes plural plate fins (11) that include plural through holes (11a) in a plane disposed substantially parallel to the air flow and plural heat transfer tubes (12) that are inserted into the through holes (11a) in the plate fins (11), and
four or more rows (61 to 68) of the heat transfer tubes (12) that are arranged in a direction intersecting the air flow are formed from the upstream side of the air flow toward the downstream side.

4. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 3, wherein a path (81, 181, 281, 381, 481, 581, 681, 781) for allowing the refrigerant to flow from the heat transfer tubes (12) that belong to the row (68) on the downstream side of the air flow to the heat transfer tubes (12) that belong to the row (61) on the upstream side of the air flow is formed in the heat exchanger (6, 106, 206, 306, 406, 506, 606, 706).

5. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 4, wherein the direction of the refrigerant flow inside the path (81, 181, 281, 381, 481, 581, 681, 781) includes, when projected onto a plane that is orthogonal to long axes of the heat transfer tubes (12), a direction that intersects the air flow and a direction that leads from the downstream side of the air flow to the upstream side.

6. The air conditioner (1, 101, 201, 401, 501, 601, 701) according to claim 4, wherein the path (81, 181, 281, 481, 581, 681, 781) is formed by a single path.

7. The air conditioner (1, 401, 501, 601, 701) according to claim 4, wherein
the path (81, 481, 581, 681, 781) includes connecting tubes (12d, 12e) that interconnect the heat transfer tubes (12) that belong to the rows (61 to 68) that are adjacent, and
the connecting tubes (12d, 12e) interconnect the heat transfer tubes (12) that are positioned on ends in mutually opposite directions of the rows (61 to 68) that are adjacent.

8. The air conditioner (201) according to claim 4, wherein the path (281) alternately travels, in at least one pair of the rows (61, 62) that are adjacent, between the heat transfer tubes (12) that belong to the one row (62) and the heat transfer tubes (12) that belong to the other row (61).

9. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 3, wherein the plate fins (11) are divided between at least one pair of the rows (61, 62) that are adjacent.

10. The air conditioner (401, 601, 701) according to claim 3, wherein the plate fins (11) are divided between all of the rows (61 to 68) that are adjacent.

11. The air conditioner (501, 601) according to claim 1, wherein the heat exchanger (506, 606) is disposed in a state where it is slanted with respect to a horizontal plane.

12. The air conditioner (1, 101, 201, 301, 401, 501, 601) according to claim 1, wherein the fan (53) is located on the downstream side of the air flow with respect to the heat exchanger (6, 106, 206, 306, 406, 506, 606).

13. The air conditioner (701) according to claim 1, wherein
the heat exchanger (706) is divided into two, and
the one heat exchanger (706a) is disposed on the upstream side of the air flow and the other heat exchanger (706b) is disposed on the downstream side of the air flow.

14. The air conditioner (701) according to claim 13, wherein the fan (753) is disposed between the two heat exchangers (706a, 706b).

15. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 1, wherein the fan (53, 753) is a centrifugal fan.

16. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 1, wherein the refrigerant is CO_2.

17. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 1, wherein the blowout temperature of the conditioned air is 45°C to 55°C.

18. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 1, wherein the blowout velocity of the conditioned air is equal to or less than 2 m/s.

19. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 1, wherein the air conditioner performs overload time control for raising the blowout temperature of the conditioned air when the load during heating operation is higher than a rated load, and for increasing the air volume while maintaining the blowout temperature of the conditioned air at substantially the predetermined value when the blowout temperature of the conditioned air becomes equal to or greater than a predetermined value.

20. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 19,
wherein the predetermined value is 55°C.

21. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 1, wherein during cooling operation, under a predetermined condition control to reduce the number of rotations of the fan (53, 753) is executed.

22. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 1, wherein the blowout angle of the conditioned air that is blown out upward inside the room is an angle where the conditioned air does not directly strike the human body.

23. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 1, wherein the blowout angle of the conditioned air that is blown out upward inside the room is equal to or greater than 45° with respect to a horizontal plane.

24. The air conditioner (1, 101, 201, 301, 401, 501, 601, 701) according to claim 1, wherein the blowout angle of the conditioned air that is blown out upward inside the room is within the range of 60° to 80° with respect to a horizontal plane.

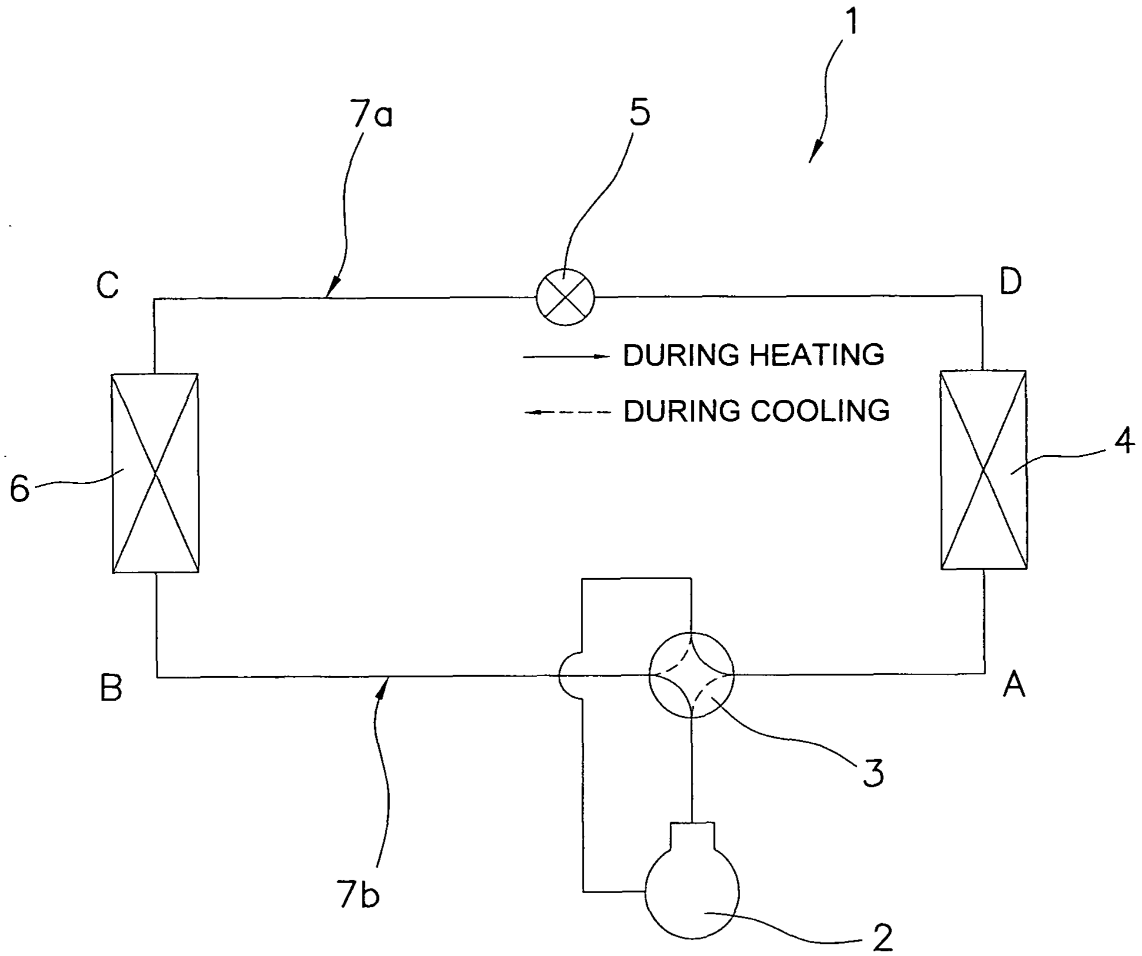
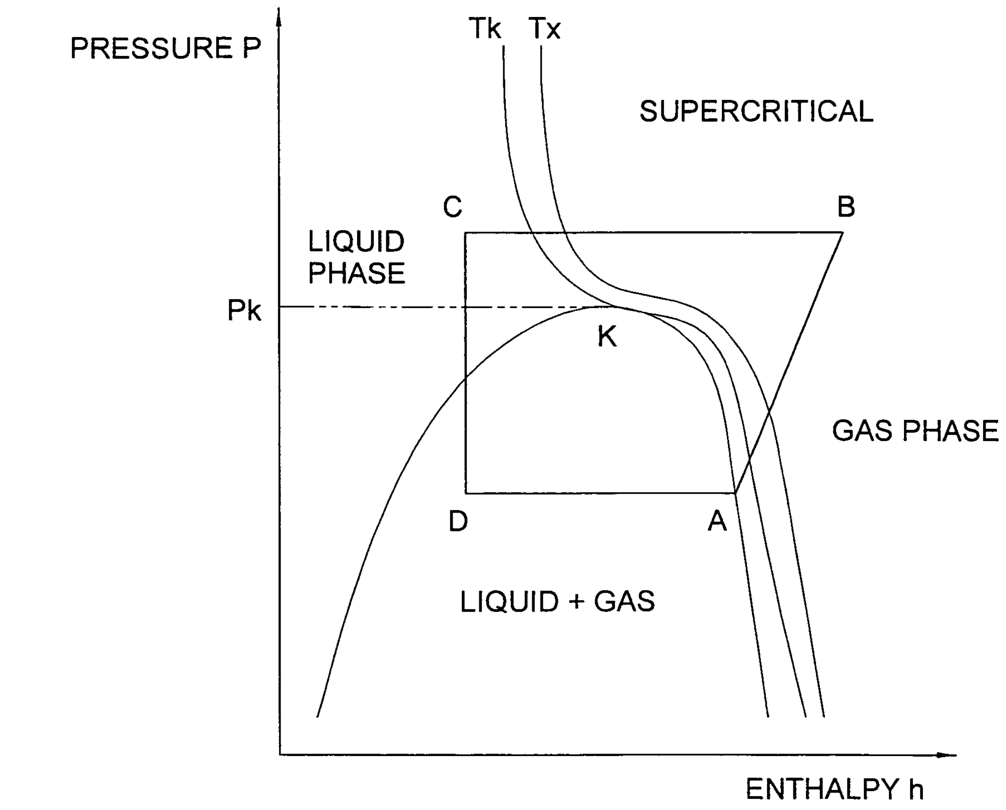


FIG. 1


PRESSURE P
Tk
Tx
SUPERCRITICAL
C
B
LIQUID PHASE
Pk
K
GAS PHASE
D
A
LIQUID + GAS
ENTHALPY h

(a)

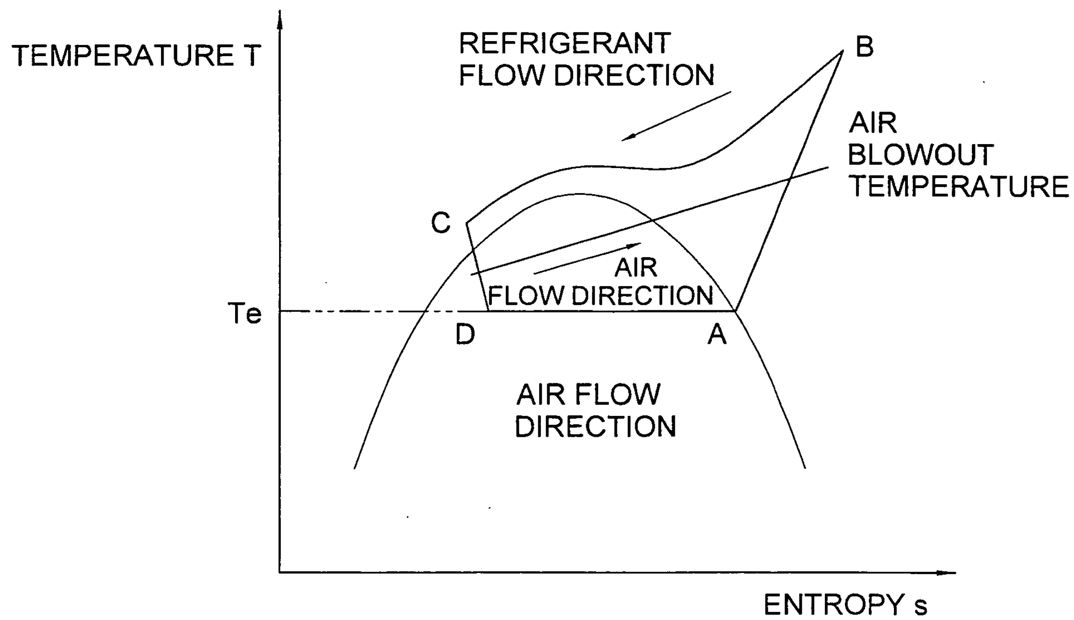

TEMPERATURE T
REFRIGERANT FLOW DIRECTION
B
AIR BLOWOUT TEMPERATURE
C
AIR FLOW DIRECTION
Te
D
A
AIR FLOW DIRECTION
ENTROPY s

FIG. 2

(b)

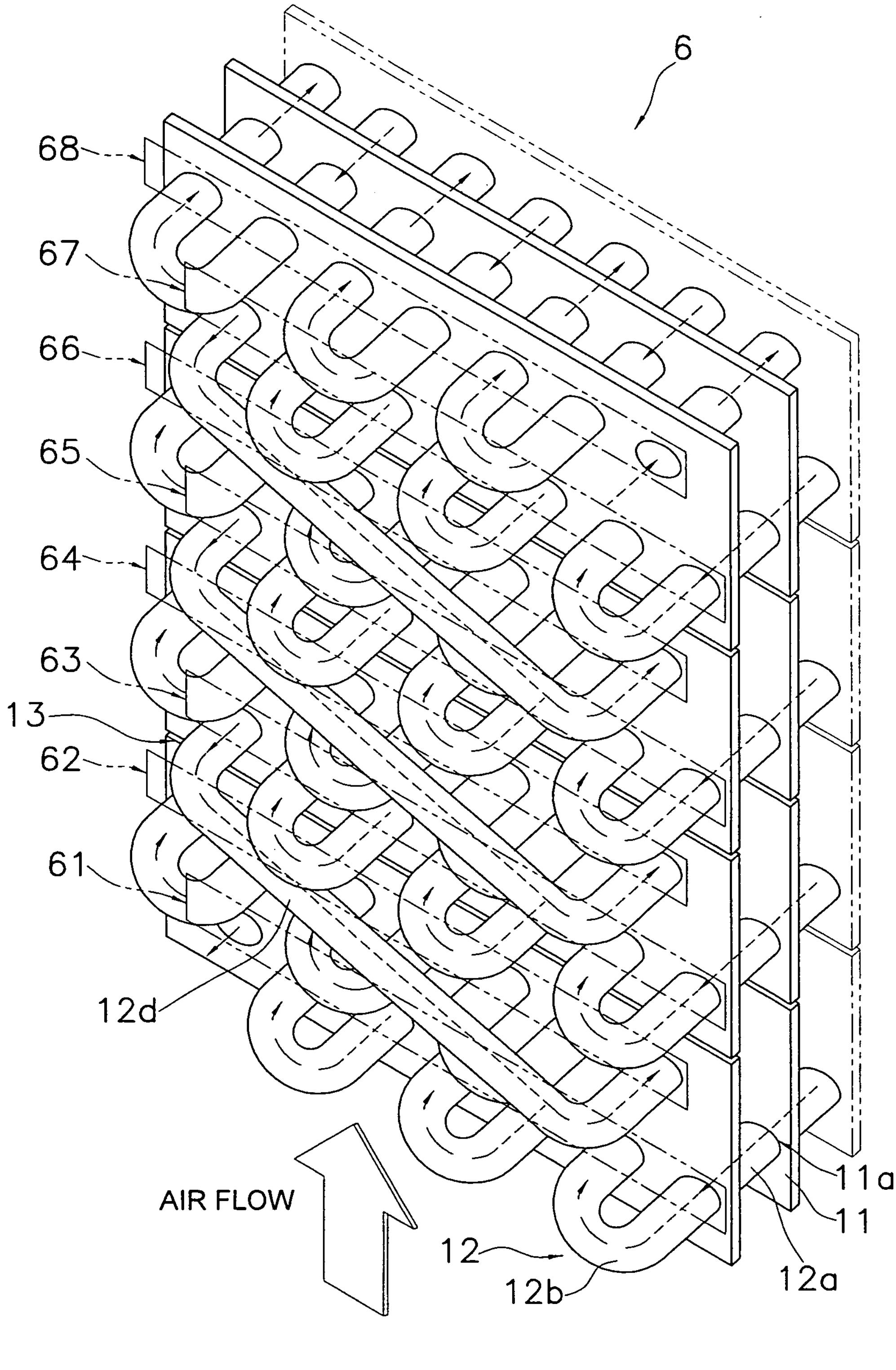


FIG. 3

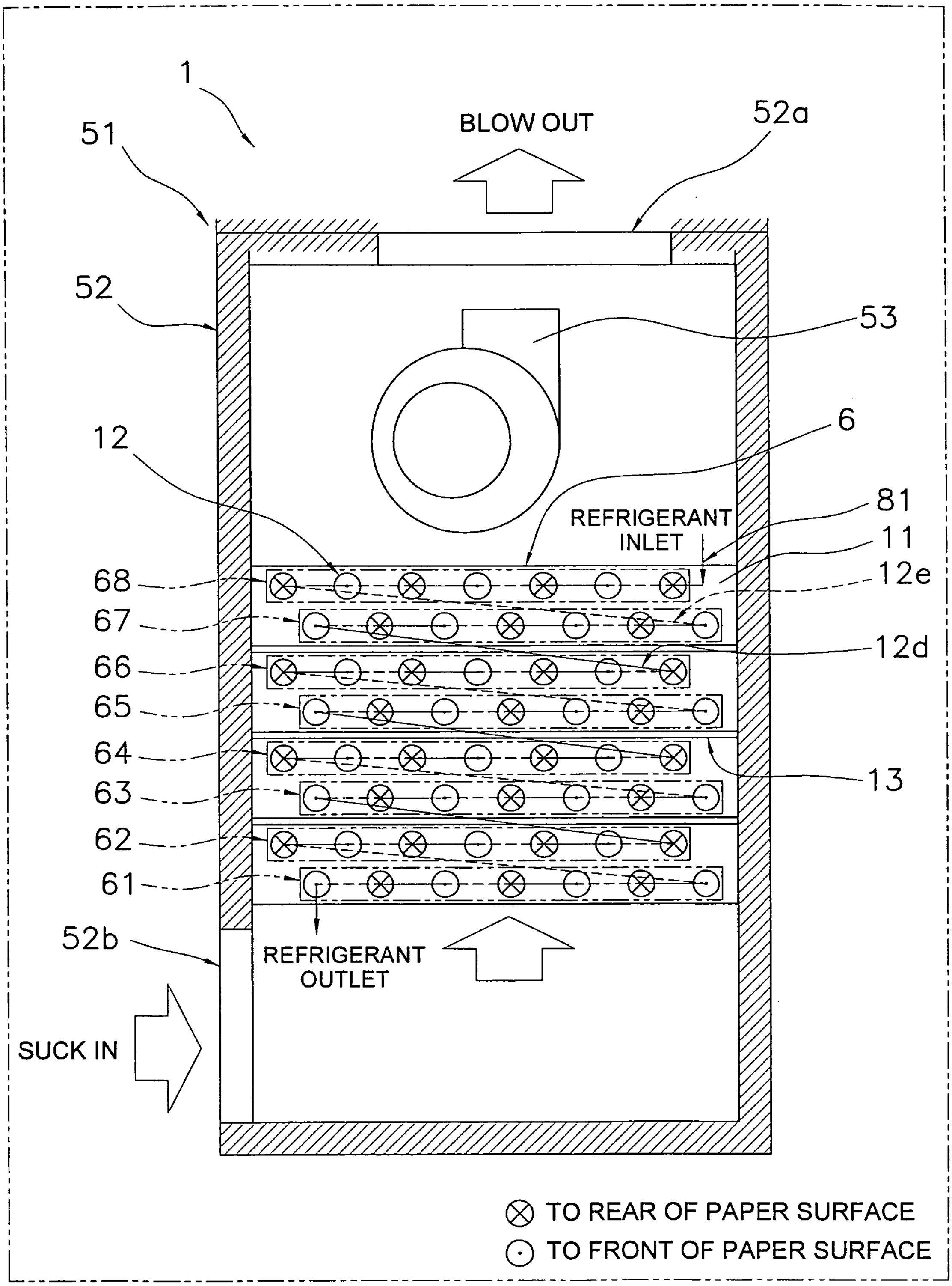

1
51
BLOW OUT
52a
52
53
12
6
REFRIGERANT INLET
81
11
12e
68
67
12d
66
65
64
13
63
62
61
52b
REFRIGERANT OUTLET
SUCK IN
TO REAR OF PAPER SURFACE
TO FRONT OF PAPER SURFACE

FIG. 4

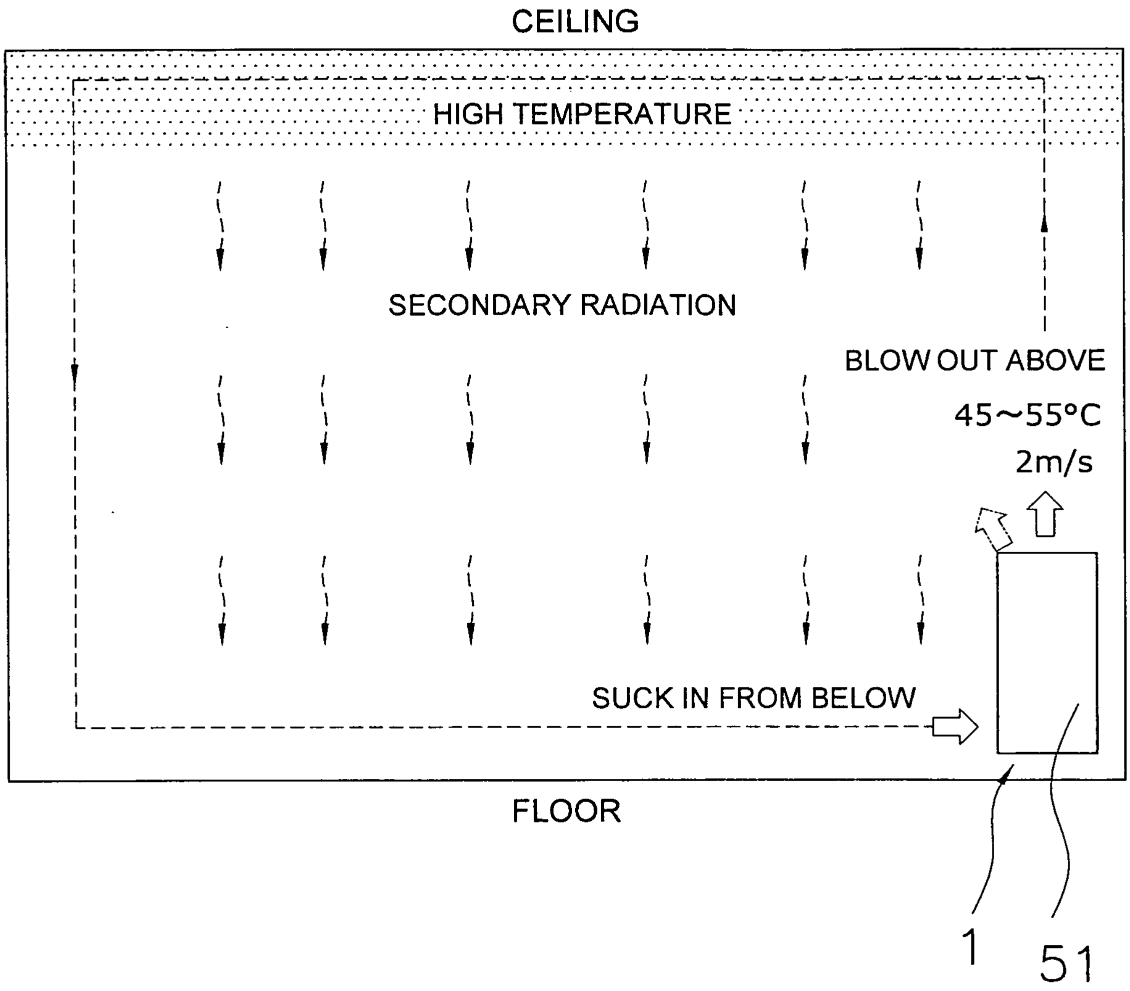

CEILING
HIGH TEMPERATURE
SECONDARY RADIATION
BLOW OUT ABOVE
45~55°C
2m/s
SUCK IN FROM BELOW
FLOOR
1
51

FIG. 5

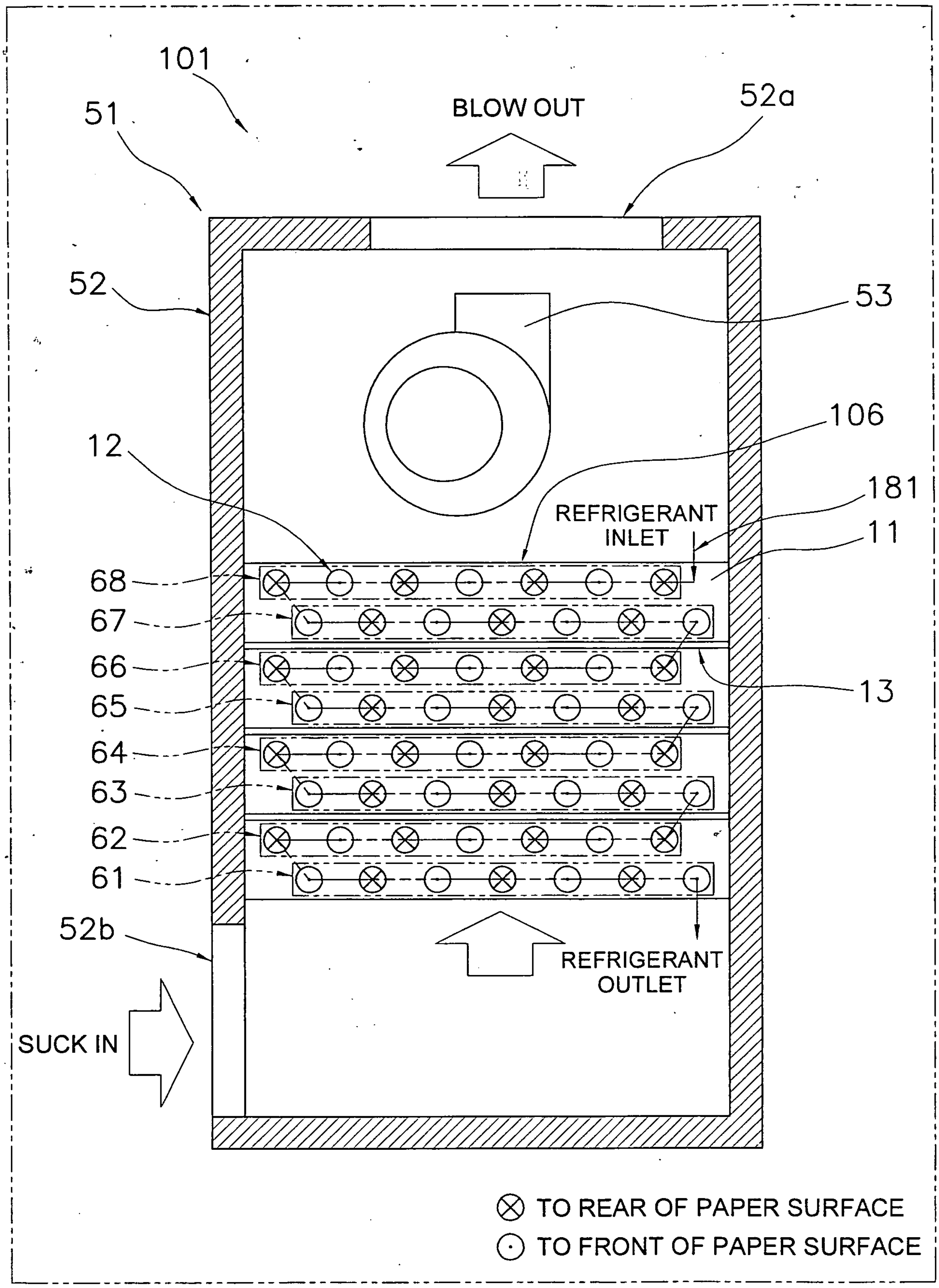

101
51
BLOW OUT
52a
52
53
106
12
REFRIGERANT INLET
181
11
68
67
66
65
64
63
62
61
13
52b
REFRIGERANT OUTLET
SUCK IN
TO REAR OF PAPER SURFACE
TO FRONT OF PAPER SURFACE

FIG. 6

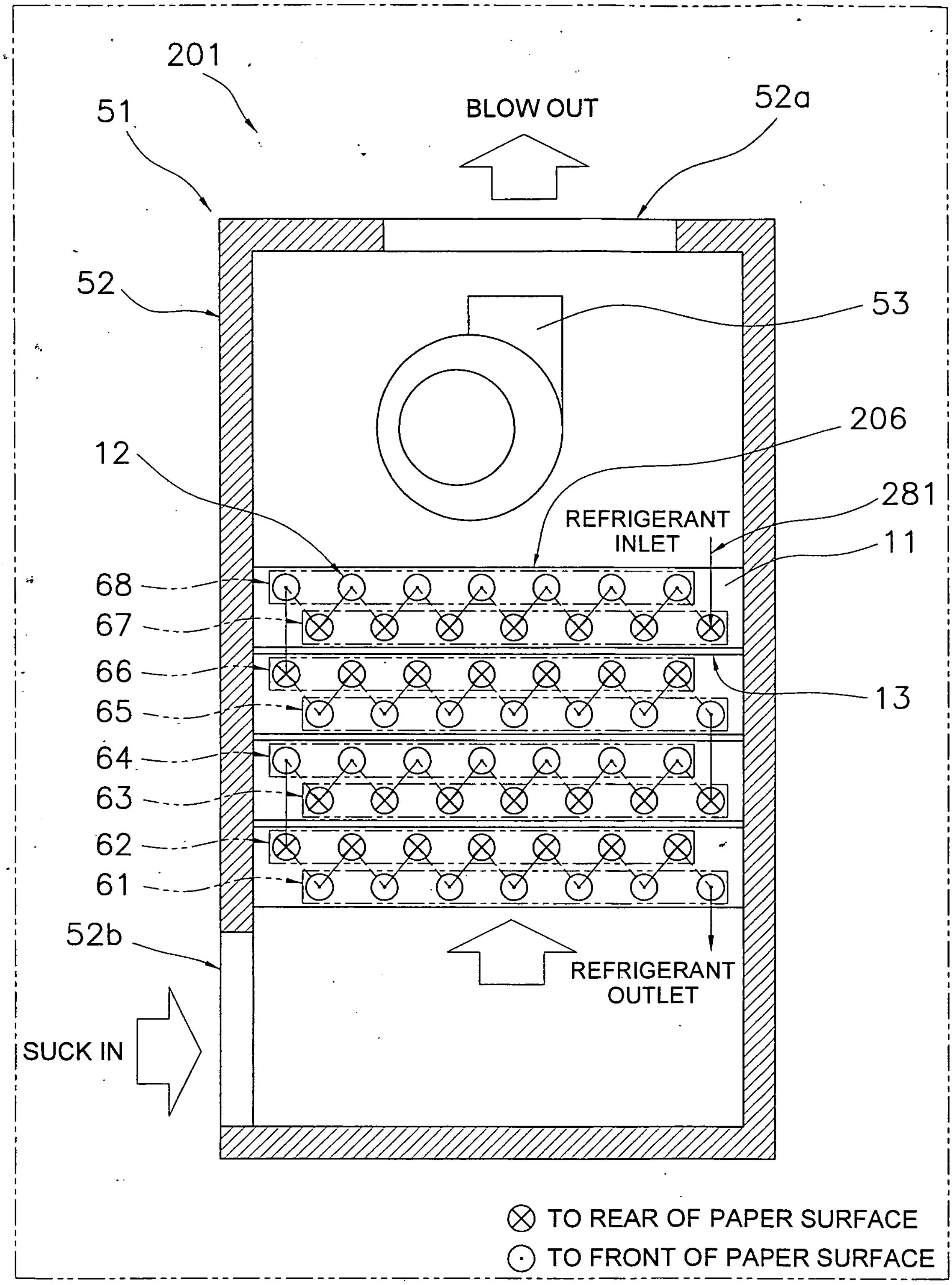

201
51
BLOW OUT
52a
52
53
206
12
281
REFRIGERANT INLET
11
68
67
66
13
65
64
63
62
61
52b
REFRIGERANT OUTLET
SUCK IN
⊗ TO REAR OF PAPER SURFACE
⊙ TO FRONT OF PAPER SURFACE

FIG. 7

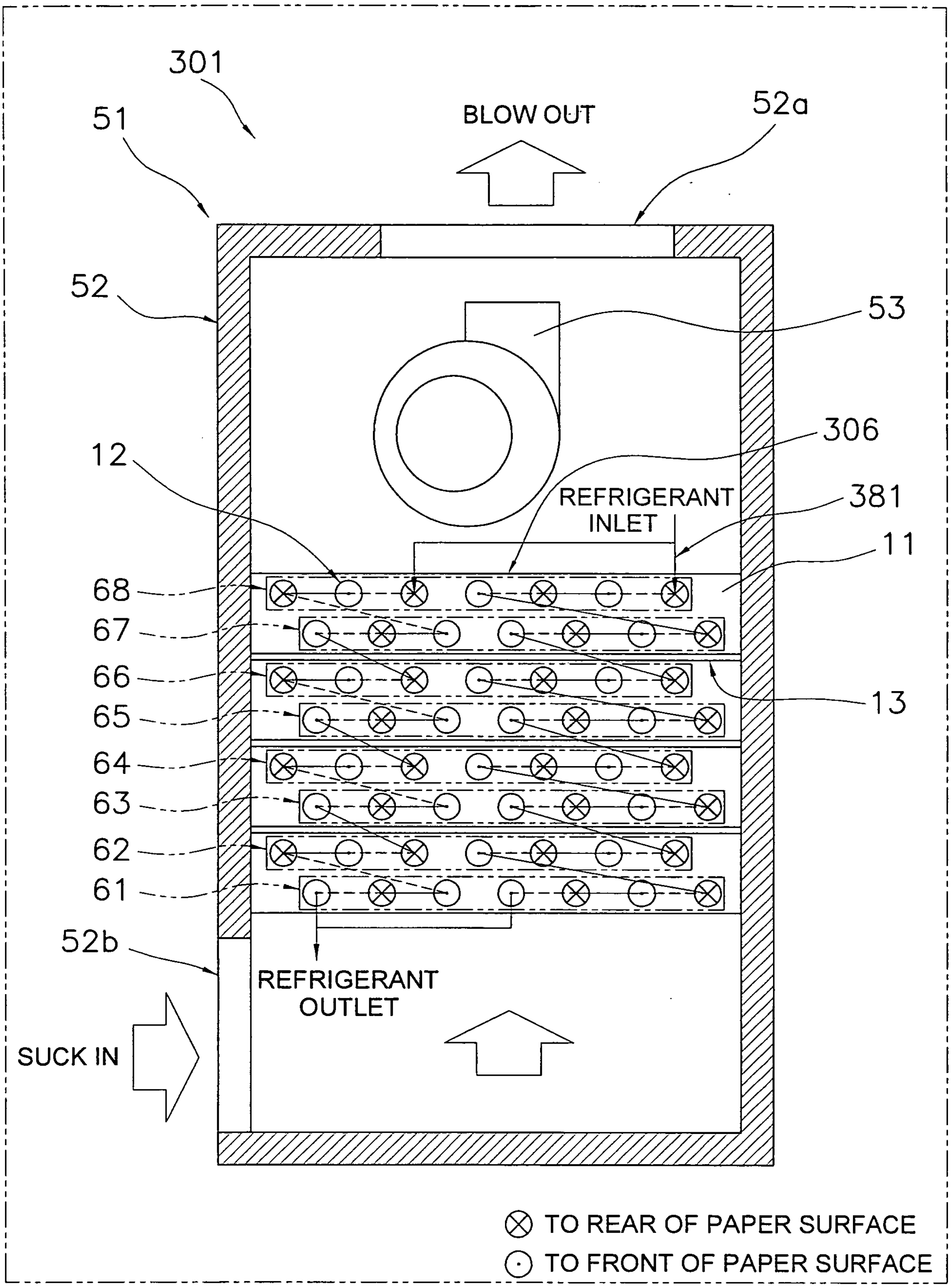

301
51
BLOW OUT
52a
52
53
306
12
REFRIGERANT INLET
381
11
68
67
66
13
65
64
63
62
61
52b
REFRIGERANT OUTLET
SUCK IN
TO REAR OF PAPER SURFACE
TO FRONT OF PAPER SURFACE

FIG. 8

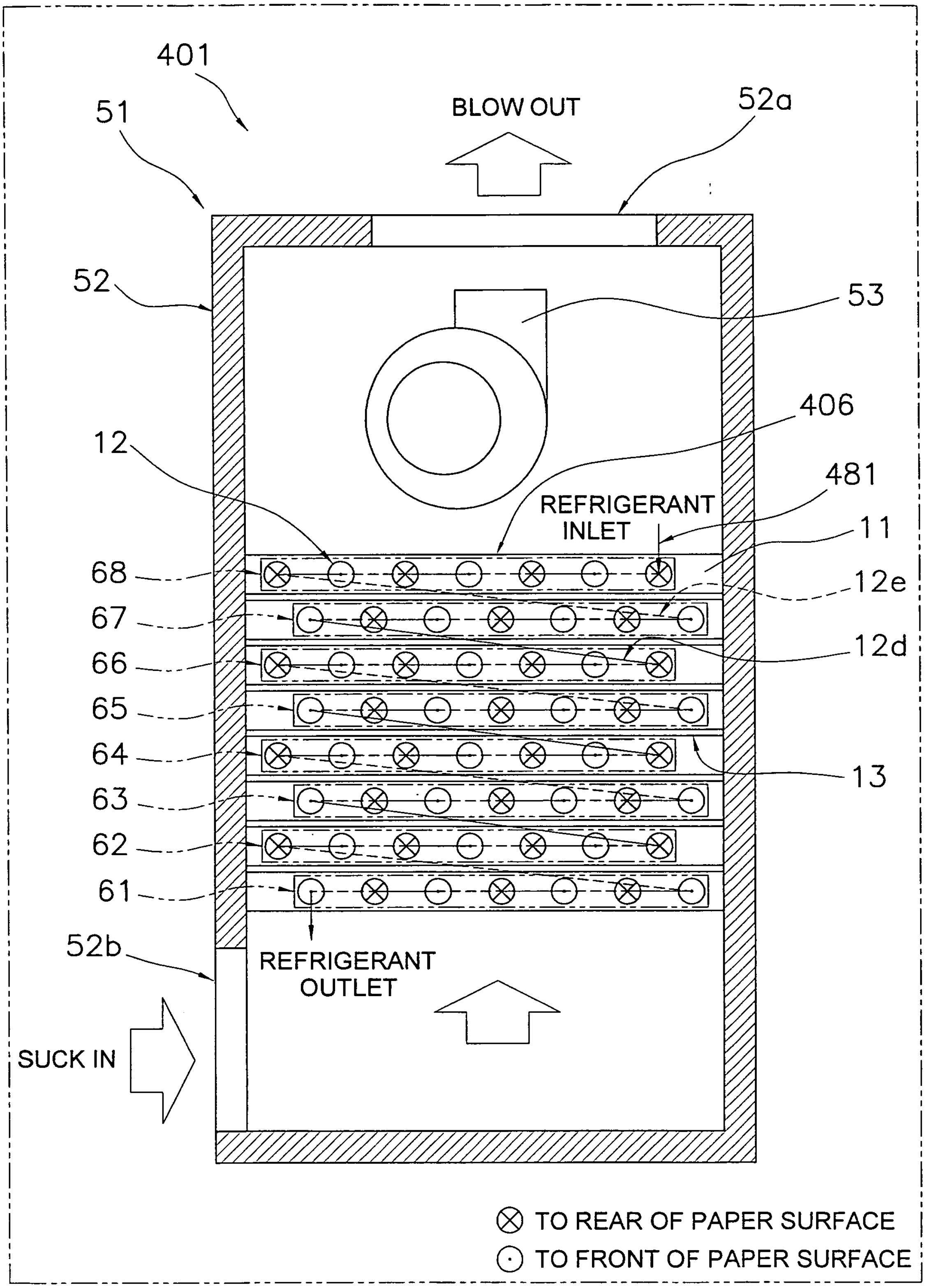

401
51
BLOW OUT
52a
52
53
406
12
481
REFRIGERANT
INLET
11
68
12e
67
12d
66
65
64
13
63
62
61
52b
REFRIGERANT
OUTLET
SUCK IN
TO REAR OF PAPER SURFACE
TO FRONT OF PAPER SURFACE

FIG. 9

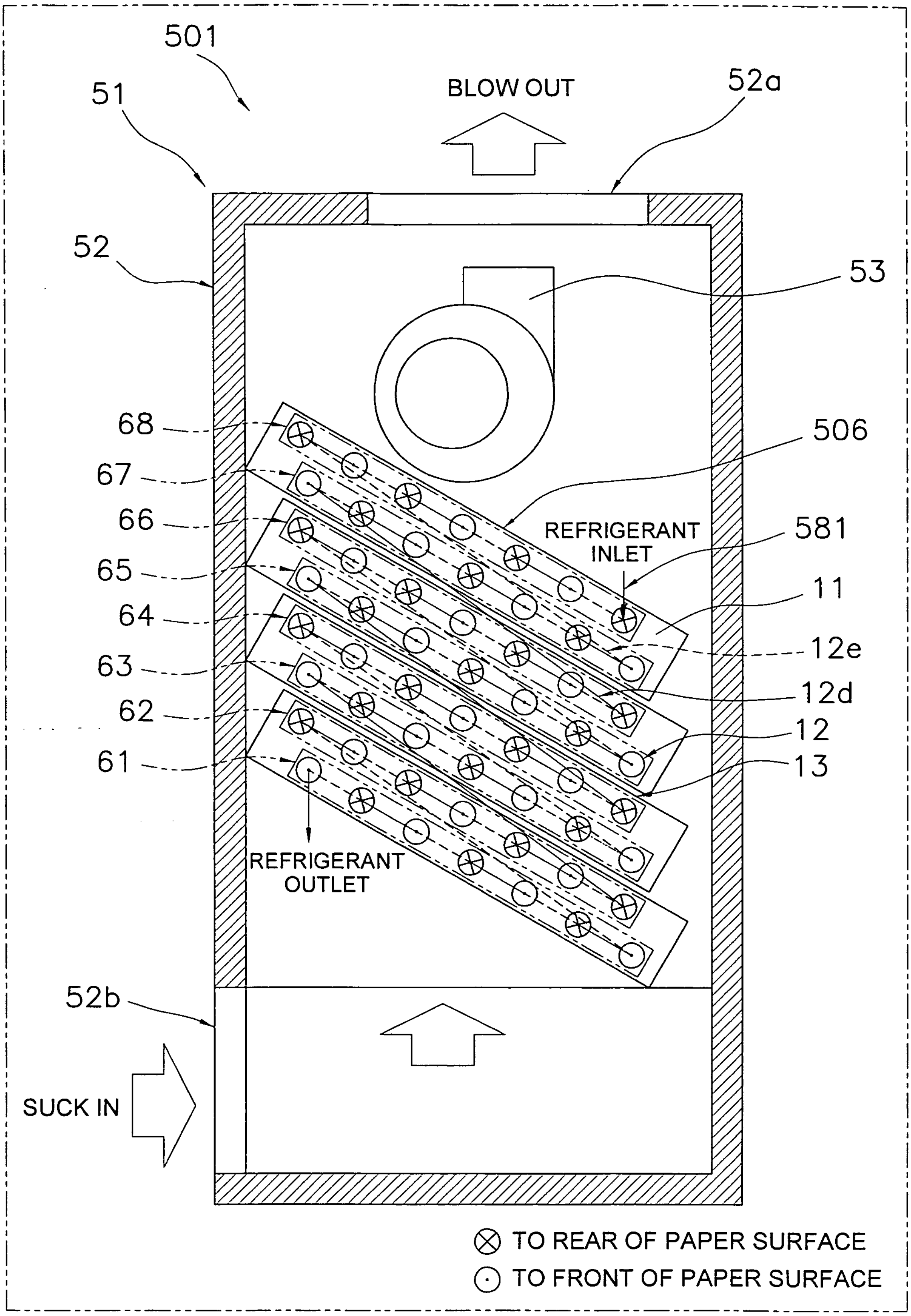

501
51
BLOW OUT
52a
52
53
68
67
66
65
64
63
62
61
506
REFRIGERANT INLET
581
11
12e
12d
12
13
REFRIGERANT OUTLET
52b
SUCK IN
⊗ TO REAR OF PAPER SURFACE
⊙ TO FRONT OF PAPER SURFACE

FIG. 10

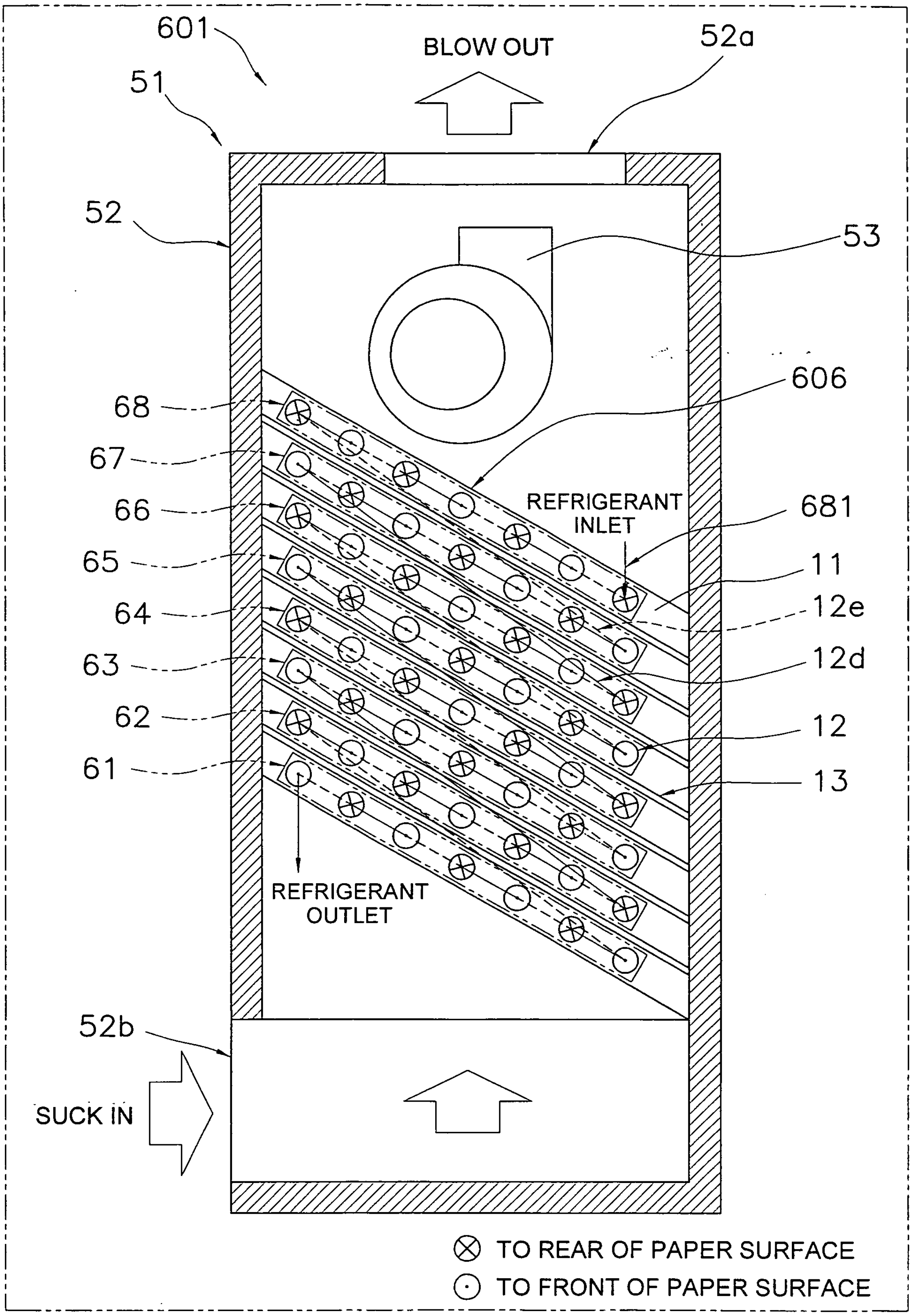

601
BLOW OUT
52a
51
52
53
606
68
67
66
65
64
63
62
61
REFRIGERANT INLET
681
11
12e
12d
12
13
REFRIGERANT OUTLET
52b
SUCK IN
TO REAR OF PAPER SURFACE
TO FRONT OF PAPER SURFACE

FIG. 11

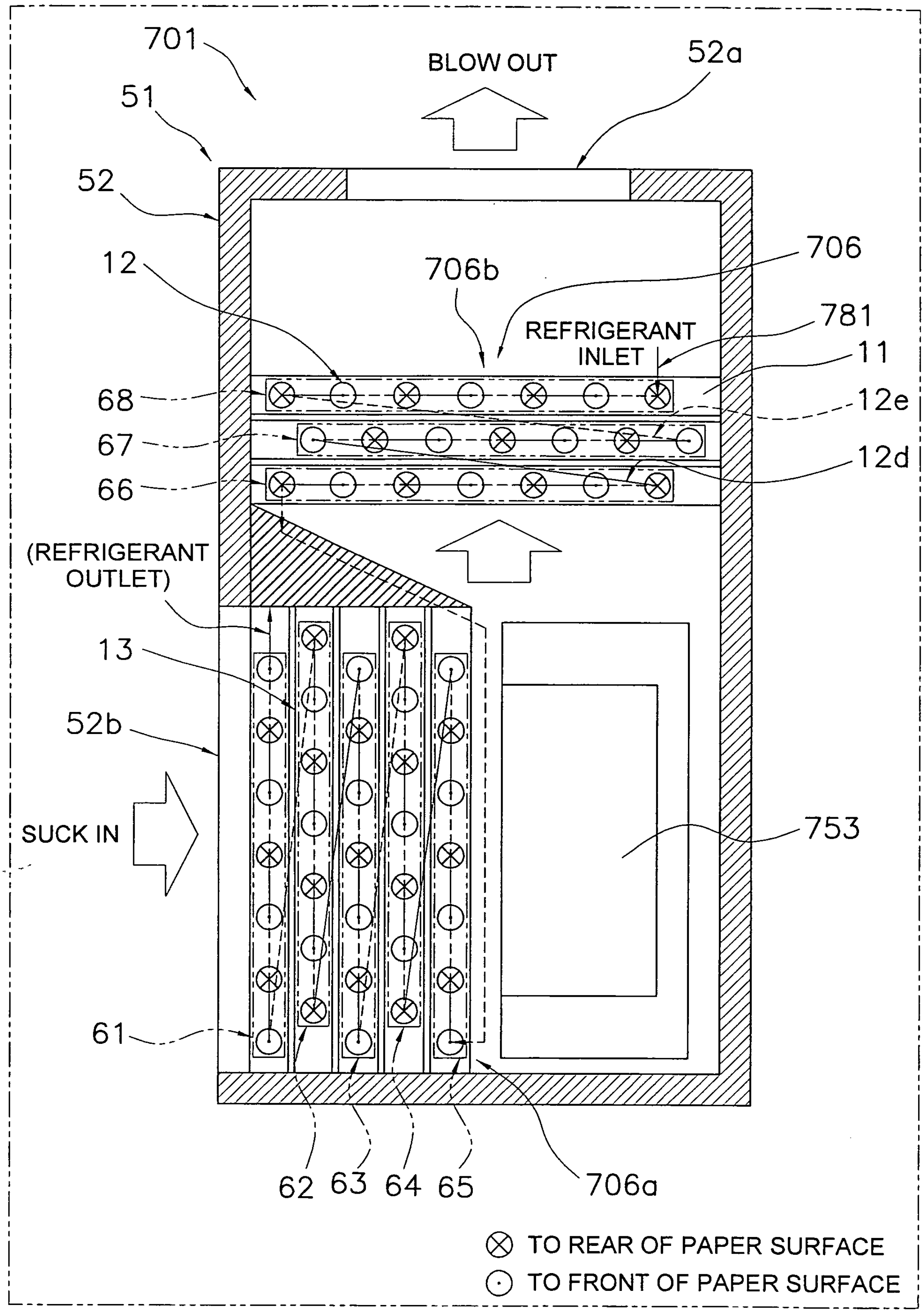

701
BLOW OUT
52a
51
52
706
12
706b
781
REFRIGERANT INLET
11
68
12e
67
12d
66
(REFRIGERANT OUTLET)
13
52b
SUCK IN
753
61
62
63
64
65
706a
TO REAR OF PAPER SURFACE
TO FRONT OF PAPER SURFACE

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/060861

A. CLASSIFICATION OF SUBJECT MATTER
F24F1/00(2006.01)i, *F24F11/02*(2006.01)i, *F24F13/30*(2006.01)i, *F25B1/00*(2006.01)i, *F28D1/053*(2006.01)i, *F28F1/32*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F24F1/00, F24F11/02, F24F13/30, F25B1/00, F28D1/053, F28F1/32

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	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2005-156093 A (Daikin Industries, Ltd.), 16 June, 2005 (16.06.05), Par. Nos. [0046], [0056] to [0059], [0066], [0074], [0076]; Fig. 2 (Family: none)	1,2,12, 16-18,20-24 3-11,13-15, 19
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 29313/1985(Laid-open No. 145217/1686) (Nishida Tekko Kabushiki Kaisha), 08 September, 1986 (08.09.86), Page 4, line 6 to page 5, line 4; Fig. 2 (Family: none)	3-10,15

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"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
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 August, 2007 (27.08.07)	04 September, 2007 (04.09.07)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/060861

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 57-157973 A (Matsushita Seiko Co., Ltd.), 29 September, 1982 (29.09.82), Figs. 1 to 3, 5 (Family: none)	7,8
Y	JP 10-274490 A (Kimura Koki Kabushiki Kaisha), 13 October, 1998 (13.10.98), Par. No. [0008]; Fig. 2 (Family: none)	9,10
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 164601/1981(Laid-open No. 71577/1983) (Matsushita Seiko Co., Ltd.), 14 May, 1983 (14.05.83), Figs. 1 to 3 (Family: none)	11
Y	JP 2001-99438 A (Kimura Koki Kabushiki Kaisha), 13 April, 2001 (13.04.01), Figs. 1, 2 (Family: none)	13,14
Y	JP 62-69055 A (Hitachi, Ltd.), 30 March, 1987 (30.03.87), Page 2, lower left column, lines 1 to 7; Fig. 3 (Family: none)	7

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 10176867 A **[0002]**