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(54) **AIR CONDITIONER**

(57) The object of the present invention is to provide a uniform wind speed distribution at the outlet of an indoor unit in an air conditioner having a centrifugal fan. In addition, another object of the present invention is to improve heat exchange efficiency without increasing the dimensions of the indoor unit.

The indoor unit 1 of the air conditioner comprises a casing 11, a heat exchanger 30, and a turbofan 40. Among the air passageways 35 that extend from the turbofan 40 to the outlets 20 via the heat exchanger 30, air passageways 35b, 35d, which extend from the turbofan 40 to the outlet 20 and oppose the direction of the wind from the turbofan 40, are narrower than other air passageways 35a, 35c.

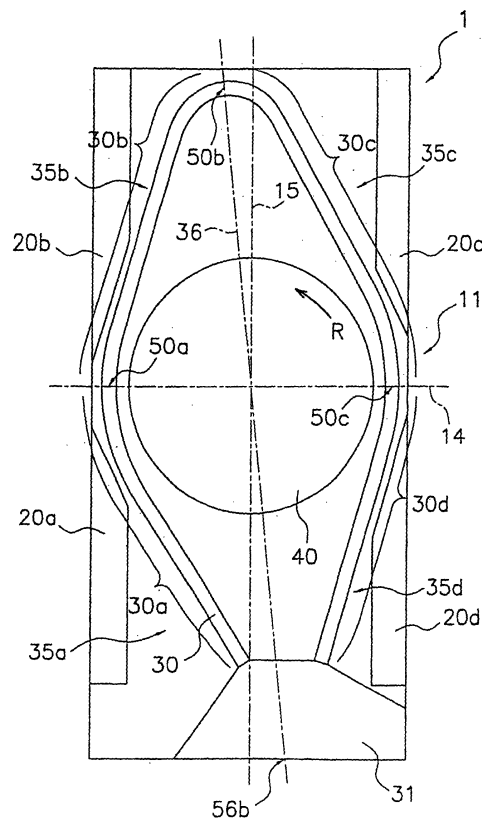


Fig. 3

EP 1 382 917 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an air conditioner, and more particularly relates to an air conditioner recessed in a ceiling.

RELATED ART

[0002] An air conditioner comprises an outdoor unit, which includes a compressor, a fan, and a heat exchanger, and which is installed outdoors; and an indoor unit, which includes a fan and a heat exchanger. Types of indoor units include a type attached to a wall, and a type recessed in a ceiling.

[0003] The indoor unit of the ceiling-recessed type principally comprises a casing having an inlet and an outlet on the bottom side, a centrifugal fan disposed between the casing, and a heat exchanger disposed between the centrifugal fan and the outlet. In such an indoor unit, the indoor air is taken in from the inlet into the casing by the centrifugal fan. Further, the air taken in is blown in the horizontal direction. Furthermore, the air delivered from the centrifugal fan is heat exchanged in the heat exchanger, which is disposed so that it surrounds the centrifugal fan. Subsequently, that air is supplied from the outlet to the indoor space.

[0004] The ventilation from the outlet of the air conditioner may become uneven because of the shape of the internal ventilation unit. In particular, because a ceiling-recessed indoor unit is disposed in the ceiling, the size of the casing is limited, and a centrifugal fan and a heat exchanger are disposed in that limited casing space. Therefore, it is difficult to prevent the ventilation from becoming uneven. Further, if the ventilation becomes uneven, it leads to the generation of ventilation noise from the part where there is a strong airflow, and also leads to a reduction in cooling and heating performance.

[0005] In addition, because the size of the heat exchanger of a ceiling-recessed indoor unit is limited for the same abovementioned reasons, there is a need to improve as much as possible the exchange of heat between the heat exchanger and the air in that limited space.

DISCLOSURE OF THE INVENTION

[0006] The object of the present invention is to provide a uniform wind speed distribution at the outlet of an indoor unit in an air conditioner having a centrifugal fan and in addition, to improve heat exchange efficiency without increasing the dimensions of the indoor unit.

[0007] The air conditioner as recited in Claim 1 comprises a casing, a centrifugal fan, and a heat exchanger. The casing has an inlet for sucking in air to the inside, and outlets for blowing out air to the outside. The centrifugal fan is disposed in the interior of the casing. The

heat exchanger is provided in the interior of the casing so that it surrounds the centrifugal fan. In addition, the heat exchanger is disposed so that, among air passageways extending from the centrifugal fan to the outlets via the heat exchanger, the air passageway that extends from the centrifugal fan to the outlet and that opposes the direction of the wind from the centrifugal fan is narrower than the other air passageway.

[0008] In the above air conditioner, driving the centrifugal fan sucks in air from the inlet into the casing, and that air is further blown out from outlets. At that time, the air passageways formed between the centrifugal fan and the outlets each have a different air resistance due to the shape of the casing and the position of the outlets, as well as the mutual positional relationships of the centrifugal fan, the heat exchanger, and the outlets. Consequently, the wind speed of the air blown out from each of the outlets varies, which leads to the generation of ventilation noise in some cases, as well as to a reduction in cooling and heating performance.

[0009] Specifically, there is a large volume of air from the outlets opposing the direction of the wind from the centrifugal fan compared with the outlets not opposing the direction of the wind from the centrifugal fan.

[0010] Furthermore, in the above air conditioner, a heat exchanger is disposed so that, among the air passageways, the air passageways extending from the centrifugal fan to the outlets opposing the direction of the wind are narrower compared with other air passageways. Consequently, the air resistance of these air passageways increases, the airflow speed is held down, and the speed distribution of the wind blown out from the outlets can be made uniform. Thereby, it is possible to control the ventilation noise as well as to maintain cooling and heating performance.

[0011] The air conditioner according to Claim 2 is the air conditioner as recited in Claim 1, wherein the casing is rectangular shaped. The heat exchanger has first, second, and third proximate parts, respectively in the reverse order of the rotational direction of the centrifugal fan, that are more proximate to the sidewalls of the casing than both sides of each of the proximate parts. The length of a first portion of the heat exchanger between the first proximate part and the second proximate part is substantially the same as the length of a second portion between the second proximate part and the third proximate part.

[0012] Because of the air resistance due to the width of the air passageways, the volume of the air blown out from the outlets becomes even, and the volume of the air that flows through the first and second portions become substantially equal. Moreover, because the lengths of the heat exchanger in the first and second portions are substantially equal, the heat exchange efficiencies are substantially identical. Thereby, the heat exchange efficiencies in the air passageways become uniform, cooling and heating efficiencies are improved, and the temperature distribution of the air from the out-

lets becomes uniform.

[0013] The air conditioner as recited in Claim 3 comprises a casing, a centrifugal fan, and a heat exchanger. The rectangular casing has an inlet for sucking in air to the inside, and outlets for blowing out air to the outside. The centrifugal fan is disposed in the interior of the casing. The heat exchanger is provided in the interior of the casing so that it surrounds the centrifugal fan. In addition, the heat exchanger has first, second, and third proximate parts, respectively in the reverse order of the rotational direction of the centrifugal fan, that are more proximate to the casing than both sides of each of the proximate parts. The first proximate part and the third proximate part of the heat exchanger are positioned in the vicinity of an axis, which passes through the center of the centrifugal fan and is orthogonal to opposing first and second sidewalls of the casing. A second proximate part of the heat exchanger is disposed so that it is offset on the first proximate part side of the heat exchanger with respect to an axis, which passes through the center of the centrifugal fan and is orthogonal to opposing third and fourth sidewalls of the casing. The outlets comprises first and second outlets provided respectively in the first and second sidewalls of the casing so that they interpose the first proximate part, and third and fourth outlets provided so that they interpose the third proximate part.

[0014] In the above air conditioner, driving the centrifugal fan sucks in air from the inlet into the interior of the casing, and the air is further blown out from four outlets. At this time, the air resistance in each of the air passageways formed between the centrifugal fan and the outlets varies by the shape of the casing, the position of the outlets, as well as the mutual positional relationships among the centrifugal fan, the heat exchanger, and the outlets. Consequently, the wind speed of the air blown out from each of the outlets varies, which in certain cases generates ventilation noise and leads to a decrease in cooling and heating performance.

[0015] Specifically, in the above air conditioner, the first outlet and the second outlet are disposed in a first sidewall of the casing so that they interpose a first proximate part.

[0016] Accordingly, if the downstream side of the rotational direction of the centrifugal fan is provisionally made the first outlet, and the upstream side is provisionally made the second outlet, then the wind direction of the centrifugal fan opposes the second outlet, which increases the air volume to the second outlet. Conversely, the air volume to the first outlet is smaller than the second outlet. This applies likewise for the third outlet and the fourth outlet.

[0017] Further, in the above air conditioner, the heat exchanger is arranged inclined with respect to the axis that passes through the center of the centrifugal fan and that is orthogonal to the casing sidewall. The air resistance in the air passageway extending from the centrifugal fan to the outlets is adjusted so as to make the air

volume from each of the outlets uniform.

[0018] Specifically, by offsetting the second proximate part on the first proximate part side, the air passageway formed between the first proximate part and the second proximate part is narrower than the air passageway formed between the third proximate part and the second proximate part. Because the narrowed air passageway creates an air resistance to the flow of air blown out from the centrifugal fan, the airflow that passes through the first proximate part and the second proximate part and is blown out from the second outlet is less than the other air passageways, and the speed distribution of the wind blown out from the outlets can be made uniform. Thereby, the ventilation noise can be controlled, and cooling and heating performance can also be maintained.

[0019] The air conditioner as recited in Claim 4 is the air conditioner as recited in Claim 3, wherein the length of a first portion of the heat exchanger between the first proximate part and the second proximate part is substantially the same as the length of a second portion between the second proximate part and a third proximate part.

[0020] In the claim above, the heat exchange efficiencies in the air passageways are substantially identical, the same as in Claim 2. Thereby, the heat exchange efficiencies in the air passageways are made uniform, the cooling and heating efficiencies are improved, and the temperature distribution of the air from each of the outlets is made uniform.

[0021] The air conditioner as recited in Claim 5 is the air conditioner as recited in Claim 2 or Claim 4, wherein the heat exchanger comprises a bent part that is bent in the direction of the interior of the casing in the first portion.

[0022] Because the position of the second proximate part is offset toward the first proximate part side, it is necessary to bend the second proximate part in order to make the length of the heat exchanger in the first and second portions equal. At this point, the heat exchanger in the first portion is bent in a direction toward the interior of the casing. Thereby, the lengths of the heat exchanger are equalized without the need to change the size of the casing, and the configuration is simplified.

[0023] The air conditioner as recited in Claim 6 is the air conditioner as recited in any one claim of Claim 1 to Claim 5, wherein the heat exchanger comprises heat exchanger main bodies and a connecting part that connects the heat exchanger main bodies.

[0024] Bending the heat exchanger distorts the internal structure of the heat exchanger. Consequently, there is a possibility that the process of bending the heat exchanger may create a defect. To the extent that there are a large number of bent parts, the number of bending processes increases, which increases the frequency of defects.

[0025] Because there were two or more heat exchangers in the indoor unit, the number of bending processes

esses per heat exchanger can be reduced. Thereby, the frequency of heat exchanger defects can be controlled.

[0026] In addition, if heat exchangers of the same shape is used, the number of types of heat exchangers to be manufactured is reduced, and the manufacturing labor and expenditures can thereby be reduced.

[0027] The air conditioner as recited in Claim 7 comprises a casing, a centrifugal fan, a heat exchanger, and a coolant supply unit. The casing comprises an inlet for sucking in air to the inside, and outlets for blowing out air to the outside and which are disposed rectangularly. The centrifugal fan is disposed in the interior of the casing. The heat exchanger is provided in the interior of the casing so that it surrounds the centrifugal fan, and is disposed rectangularly on the inner side of the outlets. The coolant supply unit is provided at one corner of the heat exchanger, and supplies a coolant to the heat exchanger. The heat exchanger comprises an extension part on the downstream side of the rotational direction of the centrifugal fan with respect to the coolant supply unit.

[0028] In the above air conditioner, driving the centrifugal fan sucks in air from the inlet into the interior of the casing, and the air is then further blown out from the outlets. At this time, the air resistance in the air passageways formed between the centrifugal fan and the outlets varies by the shape of the casing, the position of the outlets, the position of the coolant supply unit, as well as the mutual positional relationships among the centrifugal fan, the heat exchanger, and the outlets. Consequently, the wind speed of the air blown out from each of the outlets varies. In particular, because a coolant supply unit is supplied, the air passageway facing the outlet near the coolant supply unit is unfortunately narrowed. Consequently, the airflow on the downstream side of the rotational direction of the centrifugal fan increases, creating turbulence in the airflow. Consequently, the air delivered from the outlet in the vicinity of the coolant supply unit is blown out without being sufficiently air-conditioned.

[0029] Further, in one of the air passageways in the above air conditioner, the heat exchanger is provided with an extension part with respect to the coolant supply unit on the downstream side of the rotational direction of the centrifugal fan. Thereby, cooling and heating performance can be maintained because the conditioning of the air blown out from the outlets can be made uniform.

[0030] The air conditioner as recited in Claim 8 is the air conditioner as recited in Claim 7, wherein the extension part is bent in the direction of the interior of the casing.

[0031] Herein, the extension part of the heat exchanger with respect to the coolant supply unit on the downstream side of the rotational direction of the centrifugal fan is a bent part that is bent in the direction toward the interior of the casing. Thereby, the length of the heat exchanger can be extended without changing the size or

the casing.

BRIEF EXPLANATION OF DRAWINGS

[0032]

FIG. 1 is an exterior perspective view of the indoor unit of the air conditioner according to the first and second embodiments.

FIG. 2 is vertical cross-sectional view of the indoor unit of the air conditioner according to the first embodiment.

FIG. 3 is a horizontal cross-sectional view of the indoor unit of the air conditioner according to the first embodiment.

FIG. 4 is a horizontal cross-sectional view of the indoor unit of the air conditioner according to the second embodiment.

FIG. 5 is a horizontal cross-sectional view of the indoor unit of the air conditioner according to the third embodiment.

PREFERRED EMBODIMENTS

FIRST EMBODIMENT

[0033] FIG. 1 shows an exterior perspective view of the indoor unit 1 of the air conditioner according to the first embodiment of the present invention. FIG. 2 is a vertical cross-sectional view and FIG. 3 is a horizontal cross-sectional view of the indoor unit at a surface that includes the centrifugal fan.

CONSTITUTION

[0034] An indoor unit 1 is a ceiling-recessed type, and comprises a casing 11 that is recessed in a ceiling. In addition, a turbofan 40 (centrifugal fan) and a heat exchanger 30 are provided in the casing 11. The indoor unit 1 takes in air placed in the indoor space, air conditions the air, and supplies that air to the indoor space after it has been air-conditioned by the heat exchanger.

[0035] The casing 11 is a case that holds members of the indoor unit 1 therein. The casing 11 has an outline shape of a rectangular parallelepiped, and has a bottom plate 12 on the bottom thereof. An outlet 20 is formed on the outer side of the long side of the bottom plate 12, and an inlet 21 is provided on the inner side of the outlet 20. The outlet 20 is a ventilation port for supplying air that has been air-conditioned by the indoor unit 1 to the indoor space, and the inlet 21 is a ventilation port for taking in air from the indoor space to the indoor unit 1. Furthermore, on one of a pair of long sides of the casing 11, the outlet 20 has a first outlet 20a provided on the downstream side (from the center of the long side) of the rotational direction of the turbofan 40; and a second outlet 20b provided on the upstream side of the rotational direction. Further, on the other long side, the outlet 20

has a third outlet 20c provided at a position opposing the second outlet 20b on the downstream side (from the center of the long side) of the rotational direction of turbofan 40; and a fourth outlet 20d provided at a position opposing the first outlet 20a on the upstream side of the rotational direction.

[0036] The turbofan 40 is positioned substantially at the center of the casing 11. The turbofan 40 is provided with vanes at the periphery. By rotating in the direction of the arrow R in FIG. 3, pushes out the air in the interior of the turbofan 40 in the rotational direction, producing an airflow in the interior of the indoor unit 1.

[0037] The heat exchanger 30 is a member that exchanges heat with the ventilating air. Further, the heat exchanger 30 is formed in a substantially rhombic shape so that it surrounds the turbofan 40, and has first, second, and third proximate parts 50a, 50b, and 50c that are proximate to the inner wall of the casing 11 more than both sides of each of the proximate parts 50a, 50b, 50c, respectively. The first proximate part 50a is positioned in the vicinity of an axis 14, which passes through the center of the turbofan 40 and is orthogonal to the long side of the casing 11, and is interposed between the first outlet 20a and the second outlet 20b. The third proximate part 50c is positioned on the opposite side opposing the first proximate part 50a, and is interposed between the third outlet 20c and the fourth outlet 20d. In addition, the second proximate part 50b is positioned on an axis 36, which is inclined toward the second outlet 20b side (the first proximate part 50a side) by just a predetermined angle from an axis 15, which passes through the center of the turbofan 40 and is orthogonal to the short side of the casing 11. In addition, the heat exchanger 30 is connected to a coolant supply unit 31 at the end part of the heat exchanger 30. Further, the coolant supply unit 31 is disposed on the fourth outlet 20d side displaced with respect to the axis 15.

[0038] By disposing the heat exchanger 30 as described above, an air passageway is formed from the turbofan 40 to each of the outlets. Namely, a first air passageway 35a, which extends from the turbofan 40 to the first outlet 20a, is formed between the coolant supply unit 31 and the first proximate part 50a. A second air passageway 35b, which extends from the turbofan 40 to the second outlet 20b, is formed between the first proximate part 50a and the second proximate part 50b. A third air passageway 35c, which extends from the turbofan 40 to the third outlet 20c, is formed between the second proximate part 50b and the third proximate part 50c. A fourth air passageway 35d, which extends from the turbofan 40 to the fourth outlet 20d, is formed between the third proximate part 50c and the coolant supply unit 31.

[0039] In addition, portions 30a - 30d of the heat exchanger 30 are disposed corresponding to the air passageways 35a - 35d, respectively. In other words, among the portions of the heat exchanger 30, the first portion 30a is disposed in the first air passageway 35a

between the coolant supply unit 31 and the first proximate part 50a, and the second portion 30b is disposed in the second air passageway 35b between the first proximate part 50a and the second proximate part 50b. In addition, among the portions of the heat exchanger 30, the third portion 30c is disposed in the third air passageway 35c between the second proximate part 50b and the third proximate part 50c, and the fourth portion 30d is disposed in the fourth air passageway 35d between the third proximate part 50c and the coolant supply unit 31.

[0040] Further, by disposing the heat exchanger 30 inclined as discussed above, the first portion 30a and third portion 30c are shorter than the second portion 30b and fourth the portion 30d.

OPERATION

[0041] The following explains the operation of the indoor unit 1.

[0042] The interior of the indoor unit 1 is ventilated by the rotation of the turbofan 40. Air is taken into the interior of the indoor unit 1 from the inlet 21, which faces the indoor space. The air taken in is then delivered by the turbofan 40 to the surroundings thereof. The air that has been pushed out is heat exchanged by the heat exchanger 30, which is arranged at the circumference of the turbofan 40, and is then supplied from the outlets 20a - 20d to the indoor space.

[0043] The following discusses the wind speed (airflow) of the air passageways 35a - 35d for the case in which the turbofan 40 has rotated.

[0044] First, let us consider the second outlet 20b and the third outlet 20c side of the axis 14.

[0045] Because of the rotational direction of the turbofan 40, and the arrangement of each of the outlets 20b, 20c, the second outlet 20b opposes the direction of the wind from the turbofan 40, and the wind speed of the air from the turbofan 40 increases if there is no heat exchanger 30. However, the third outlet 20c is arranged at a position along the direction of the wind from the turbofan 40, and does not oppose the direction of the wind from the turbofan 40. In other words, the third outlet 20c is disposed at a position at which the wind speed of the air from the turbofan 40 is slower if there is no heat exchanger 30. This is the same for the first outlet 20a and the fourth outlet 20d side of the axis 14. Namely, because of the rotational direction of the turbofan 40, and the arrangement of the outlets 20a, 20d, the wind speed of the air to the fourth outlet 20d is faster compared with the first air passageway 35a if there is no heat exchanger 30.

[0046] However, in the present embodiment as described above, the substantially rhombically formed heat exchanger 30 is disposed inclined with respect to the axis 15, and the widths (lengths) of the portions of the heat exchanger 30 in the air passageways 35a - 35d to the outlets 20a - 20d are not equal. In other words,

the widths of the second and fourth portions 30b, 30d are narrower than the widths of the first and third portions 30a, 30c.

[0047] Accordingly, the air resistance when passing through the second and fourth portions 30b, 30d is greater than when passing through the first and third portions 30a, 30c. As a result, the volume of air (wind speed) that passes through each of the air passageways 35a - 35d and that is blown out from the air outlets 20a - 20d, respectively, are made uniform.

SECOND EMBODIMENT

CONSTITUTION

[0048] FIG. 4 is a horizontal cross-sectional view of the indoor unit 2 of the air conditioner according to the second embodiment of the present invention.

[0049] In the first embodiment, the air resistance of each air passageway varies due to the offset arrangement of the heat exchanger, and the present embodiment aims to make the air volume from the outlets uniform. In the present embodiment, the length (i.e., the heat exchange surface area) of each portion of the heat exchanger, wherein each portion is disposed in an air passageway, differs. Accordingly, although the air volume from each outlet has been made uniform, there is a risk that the temperature distribution will become uneven.

[0050] Therefore, it is an object of the second embodiment to make the temperature distribution of the air blown out from each outlet uniform. Accordingly, the second embodiment differs from the first embodiment only in the constitution of the heat exchanger; other constitutional aspects are the same.

[0051] A heat exchanger main body 32 is a member that exchanges heat with the air that is ventilated, and is disposed so that it surrounds the turbofan 40, the same as mentioned earlier. The heat exchanger 32 comprises a first main body 321, which is disposed on the first and second outlets 20a, 20b side of the axis 15, which passes through the center of the turbofan 40 and is orthogonal to the short side of the casing 11; and a second main body 322, which is disposed on the third and fourth outlets 20c, 20d side, i.e., on the reverse side.

[0052] Further, the first main body 321 and the second main body 322 are connected by a connecting member 55 at one end in the direction along the axis 15, and are connected by a coolant supply unit 33 at the other end. Furthermore, the coolant supply unit 33 is disposed so that it is shifted toward the fourth outlet 20d side of the axis 15.

[0053] In addition, the heat exchanger 32 has first, second, and third proximate parts 53a, 53b and 53c that are more proximate to the inner wall of the casing 11 than both sides of each of the proximate parts 53a, 53b, 53c. The first proximate part 53a is positioned in the vicinity of the axis 14, and is interposed between the first

outlet 20a and the second outlet 20b. The third proximate part 53c is positioned on the reverse side of and opposing the first proximate part 53a, and is interposed between the third outlet 20c and the fourth outlet 20d. In addition, the second proximate part 53b is positioned in the vicinity of the axis 37, which is inclined toward the second outlet 20b side of the axis 15 by a predetermined angle.

[0054] Disposing the heat exchanger 30 as described above forms an air passageway that extends from the turbofan 40 to each of the outlets. Namely, the first air passageway 35a, which extends from the turbofan 40 to the first outlet 20a, is formed between the coolant supply unit 33 and the first proximate part 53a. The second air passageway 35b, which extends from the turbofan 40 to the second outlet 20b, is formed between the first proximate part 53a and the second proximate part 53b. The third air passageway 35c, which extends from the turbofan 40 to the third outlet 20c, is formed between the second proximate part 53b and the third proximate part 53c. The fourth air passageway 35d, which extends from the turbofan 40 to the fourth outlet 20d, is formed between the third proximate part 53c and the coolant supply unit 33.

[0055] Further, among the portions of the first main body 321 of the heat exchanger 32, a first portion 32a is disposed in the first air passageway 35a. Among the portions of the first main body 321, a second portion 32b is disposed in the second air passageway 35b. Furthermore, among the portions of the second main body 322 of the heat exchanger 32, a third portion 32c is disposed in the third air passageway 35c. Among the portions of the second main body 322, a fourth portion 32d is disposed in the fourth air passageway 35d.

[0056] A bent part 54 is formed in the first and third portions 32a, 32c of the heat exchanger 32, such that the bent part 54 bulges toward the outer side of the casing 11, and a bent part 52 is formed in the second and fourth portions 32b, 32d such that the bent part 52 bulges toward the inner side of the casing 11. Thereby, the lengths of the heat exchanger in the four portions 32a-32d are substantially equal, and the heat exchange surface of each area is accordingly substantially equal.

OPERATION

[0057] The basic operation of the indoor unit 2 is the same as the operation of the first embodiment.

[0058] As explained in the first embodiment, examining the second outlet 20b and the third outlet 20c side of the axis 14 shows that the wind speed of the air to the second outlet 20b is faster compared with the wind speed of the air to the third outlet 20c if there is no heat exchanger. In addition, if we likewise examine the first outlet 20a and the fourth outlet 20d side of the axis 14, the wind speed of the air to the fourth outlet 20d is faster compared with the wind speed of the air to the first outlet 20a.

[0059] In the same manner as the first embodiment, the second proximate part 53b in the present embodiment is disposed inclined with respect to the axis 15, and the flow of air (wind speed) that blows out from each of the outlets 20a - 20d is uniform. Further, bending the heat exchanger 32 makes the heat exchange surface area in each portion substantially equal, and makes the heat exchange efficiency in each of the air passageways 35a - 35d uniform. Thereby, the cooling and heating efficiency can be improved compared with a conventional air conditioner. In addition, the temperature distribution of the air blown out from each of the outlets 20a - 20d can be made uniform.

[0060] In particular, because the bent part 52 is formed in the heat exchanger 32, thus ensuring a heat exchange surface area, the heat exchange surface area can be enlarged without increasing the size of the indoor unit 2.

THIRD EMBODIMENT

CONSTITUTION

[0061] FIG. 5 is a horizontal cross-sectional view of the indoor unit 3 of the air conditioner according to the third embodiment of the present invention.

[0062] The cross-section of a casing 13 is square-shaped, and is beveled at the four corners. Further, an outlet 22 and an inlet (not shown) are disposed along each of the four sides of the periphery of the bottom plate. The turbofan 40 is disposed at the center part of the casing 13.

[0063] A heat exchanger 34 is disposed in a substantially square shape so that it surrounds the turbofan 40 on the inner side of the outlet 22, and both ends are connected to a coolant supply unit 38, which is disposed at one corner of the casing 13. Further, because the heat exchanger 34 is disposed along each side of a square shape, it has a bent part 56 at positions corresponding to each corner. In addition, among the four linear parts of the heat exchanger 34 there is a bent part 52, which is bent so that it bulges with respect to the coolant supply unit 38 toward the interior of the casing 13 on the downstream side of the rotational direction of the turbofan 40.

OPERATION

[0064] The basic operation of the indoor unit 3 is the same as the operation of the first embodiment.

[0065] In the present embodiment, the same as in the abovementioned embodiment, an air passageway is formed in the pathways extending from the turbofan 40 to each of the outlets 22. However, among the four air passageways, the air in the air passageway on the downstream side of the rotational direction of the turbofan 40 proximate to the coolant supply unit 38 is guided to the wall of the coolant supply unit 38, and the like, and the flow of air therein is greater than in other air

passageways.

[0066] Further, among the air passageways of the heat exchanger in the present embodiment, the bent part 52 is provided in a portion positioned in the air passageway through which much air flows, and the bent part 52 has a large heat exchange surface area. Thereby, cooling and heating performance are improved because the heat exchange efficiency is improved, and because the air blown out from each of the outlets 22 is air-conditioned substantially uniformly.

INDUSTRIAL FIELD OF APPLICATION

[0067] The use of the present invention enables the speed distribution of the wind blown out from the outlets to be made uniform. Thereby, the ventilation noise can be controlled, and cooling and heating performance can be maintained.

Claims

1. An air conditioner (1), comprising:

a casing (11) having an inlet (21) for sucking in air to the inside, and outlets (20) for blowing out air to the outside;
a centrifugal fan (40), disposed in the interior of said casing (11); and
a heat exchanger (30) provided in the interior of said casing (11) so that it surrounds said centrifugal fan (40);

wherein,

said heat exchanger (30) is disposed so that, among air passageways (35b, 35c) extending from said centrifugal fan (40) to said outlets (20) via said heat exchanger (30), the air passageway (35b) that extends from said centrifugal fan to said outlet (20) and that opposes the direction of the wind from said centrifugal fan is narrower than said other air passageway (35c).

2. The air conditioner (2) as recited in Claim 1, wherein said casing (11) is rectangular shaped;

said heat exchanger (32) has first, second, and third proximate parts (53a, 53b, 53c), respectively in the reverse order of the rotational direction (R) of said centrifugal fan, that are more proximate to the sidewalls of said casing (11) than both sides of each of said proximate parts (53a, 53b, 53c); and
the length of a first portion (32b) of said heat exchanger (32) between said first proximate part (53a) and said second proximate part (53b) is substantially the same as the length of a second portion (32c) between said second proximate part (53b) and said third proximate part (53c).

3. An air conditioner (1), comprising:

a rectangular casing (11) having an inlet (21) for sucking in air to the inside, and outlets (20) for blowing out air to the outside;
 a centrifugal fan (40) disposed in the interior of said casing (11); and
 a heat exchanger (30) provided in the interior of said casing (11) so that it surrounds said centrifugal fan (40);

wherein,

said heat exchanger (30) has first, second, and third proximate parts (50a, 50b, 50c), respectively in the reverse order of the rotational direction (R) of said centrifugal fan (40), that are more proximate to said casing (11) than both sides of each of said proximate

parts (50a, 50b, 50c);

said first proximate part (50a) and said third proximate part (50c) of said heat exchanger (30) are positioned in the vicinity of an axis (14), which passes through the center of said centrifugal fan (40) and is orthogonal to opposing first and second sidewalls of said casing (11), and said second proximate part (50b) of said heat exchanger (30, 32) is disposed so that it is offset on the first proximate part (50a) side of said heat exchanger (30) with respect to an axis (15), which passes through the center of said centrifugal fan (40) and is orthogonal to opposing third and fourth sidewalls of said casing (11); and said outlets (20) comprises first and second outlets (20a, 20b) provided respectively in said first and second sidewalls of said casing (11) so that they interpose said first proximate part (50a); and third and fourth outlets (20c, 20d) provided so that they interpose said third proximate part (50c).

4. The air conditioner (2) as recited in Claim 3, wherein

the length of a first portion (32b) of said heat exchanger (32) between said first proximate part (53a) and said second proximate part (53b) is substantially the same as the length of a second portion (32c) between said second proximate part (53b) and a third proximate part (53c).

5. The air conditioner (2) as recited in Claim 2 or Claim 4, wherein

said heat exchanger (32) comprises a bent part (52) that is bent in the direction of the interior of said casing (11) in said first portion (32b).

6. The air conditioner (2) as recited in any one claim of Claim 1 to Claim 5, wherein

said heat exchanger (32) comprises heat exchanger main bodies (321, 322), and a connecting part (55) that connects said heat exchanger main bodies (321, 322).

7. An air conditioner (3), comprising:

a casing (13) comprising an inlet (21) for sucking in air to the inside, and outlets (22) for blowing out air to the outside and which are disposed rectangularly;
 a centrifugal fan (40) disposed in the interior of said casing (13);
 a heat exchanger (34) provided in the interior of said casing (13) so that it surrounds said centrifugal fan (40), and is disposed rectangularly on the inner side of said outlets (22); and
 a coolant supply unit (38) provided at one corner of said rectangular heat exchanger (34), and that supplies a coolant to said heat exchanger (34);

wherein,

said heat exchanger (34) comprises an extension part (52) on the downstream side of the rotational direction (R) of said centrifugal fan (40) with respect to said coolant supply unit (38).

8. The air conditioner (3) as recited in Claim 7, wherein said extension part (52) is bent in the direction of the interior of said casing (11).

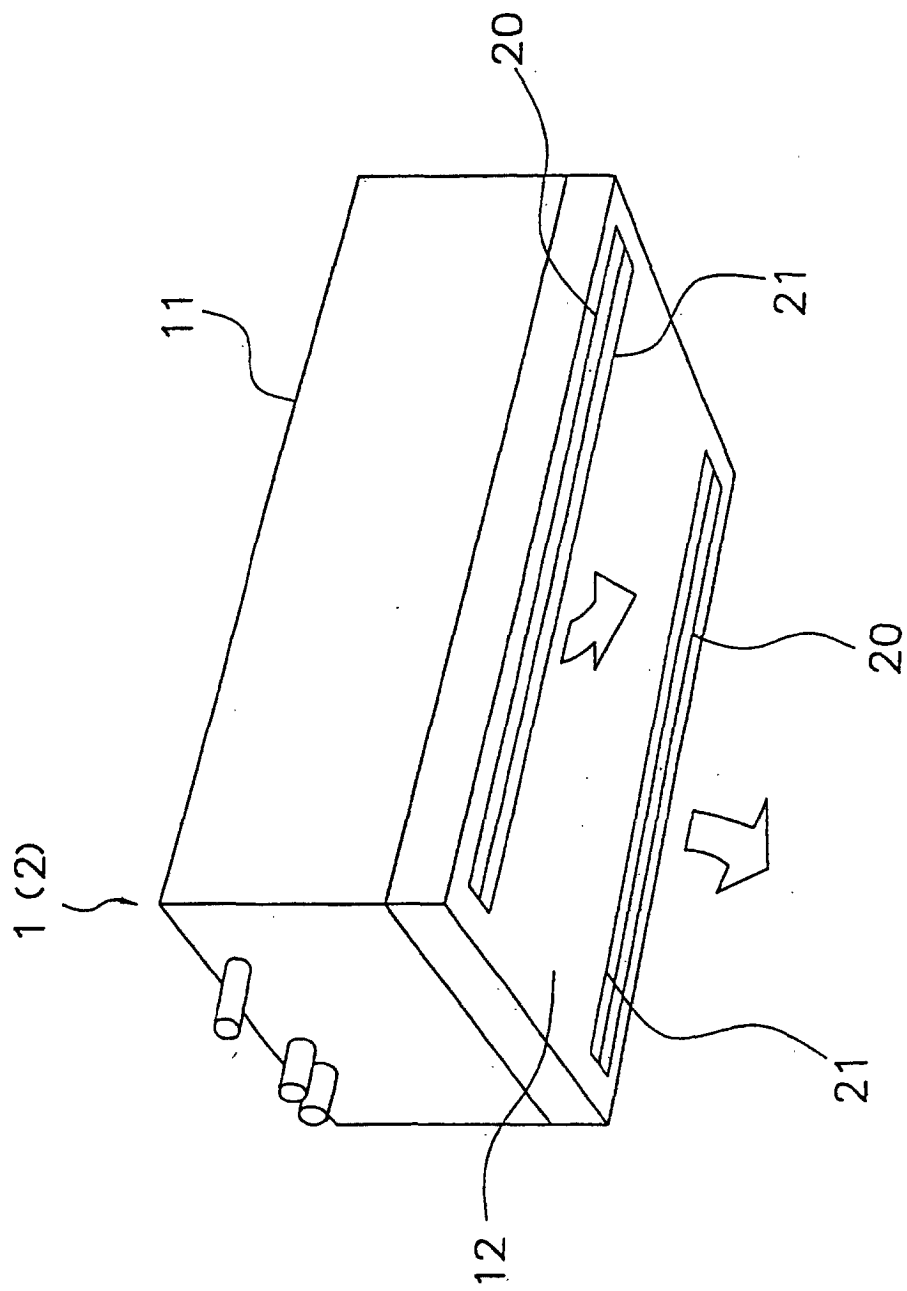


Fig. 1

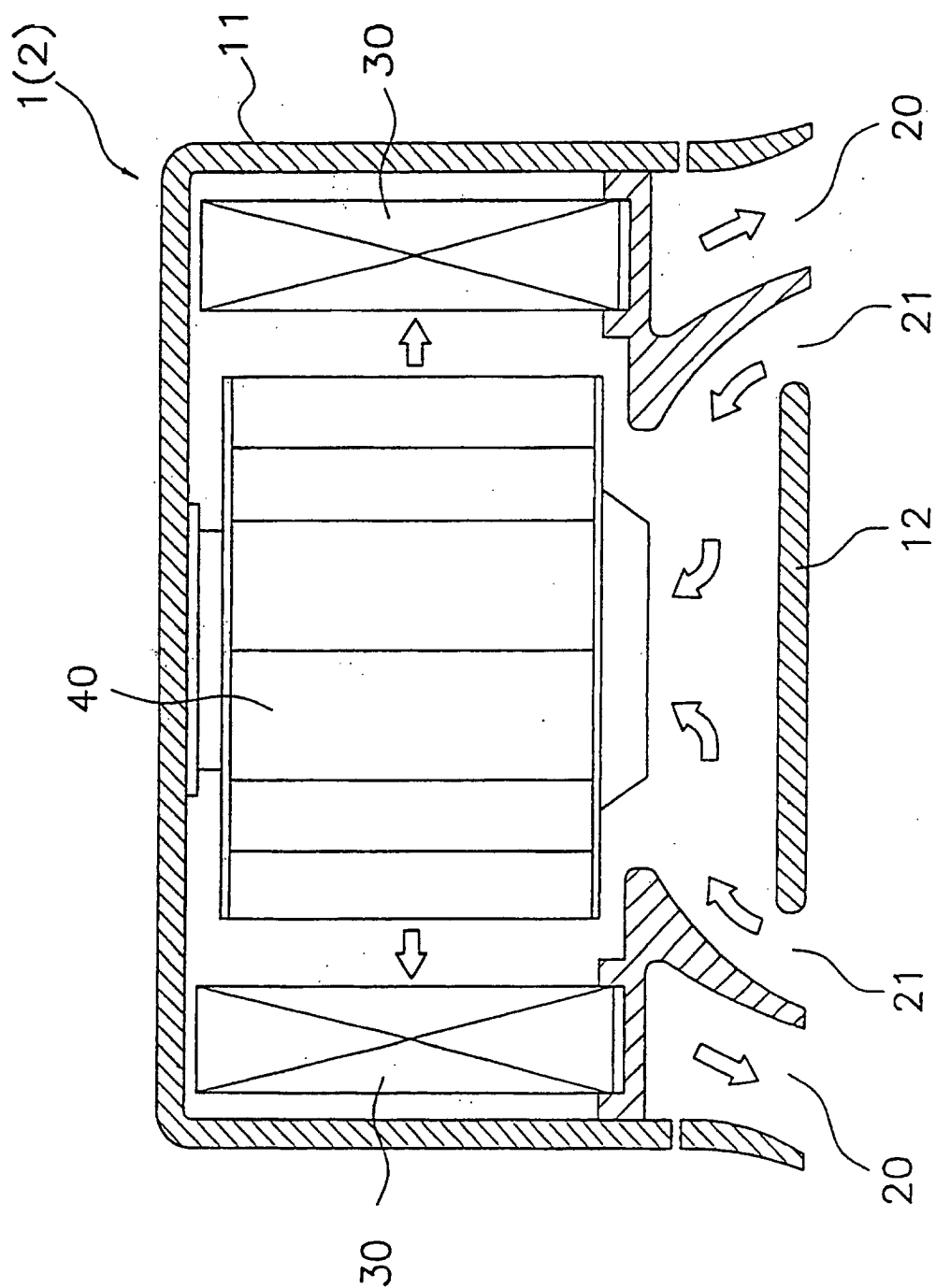


Fig. 2

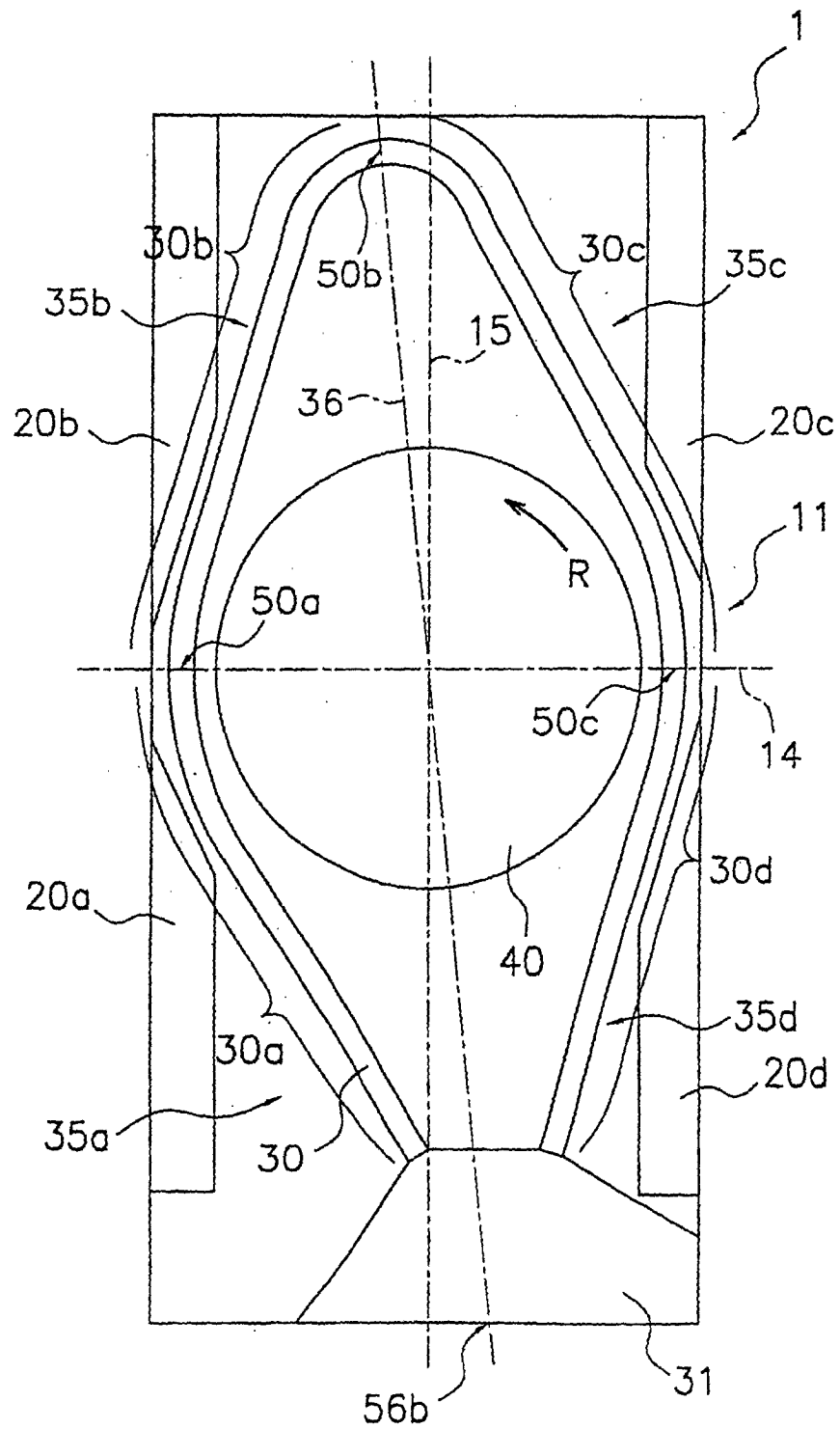


Fig. 3

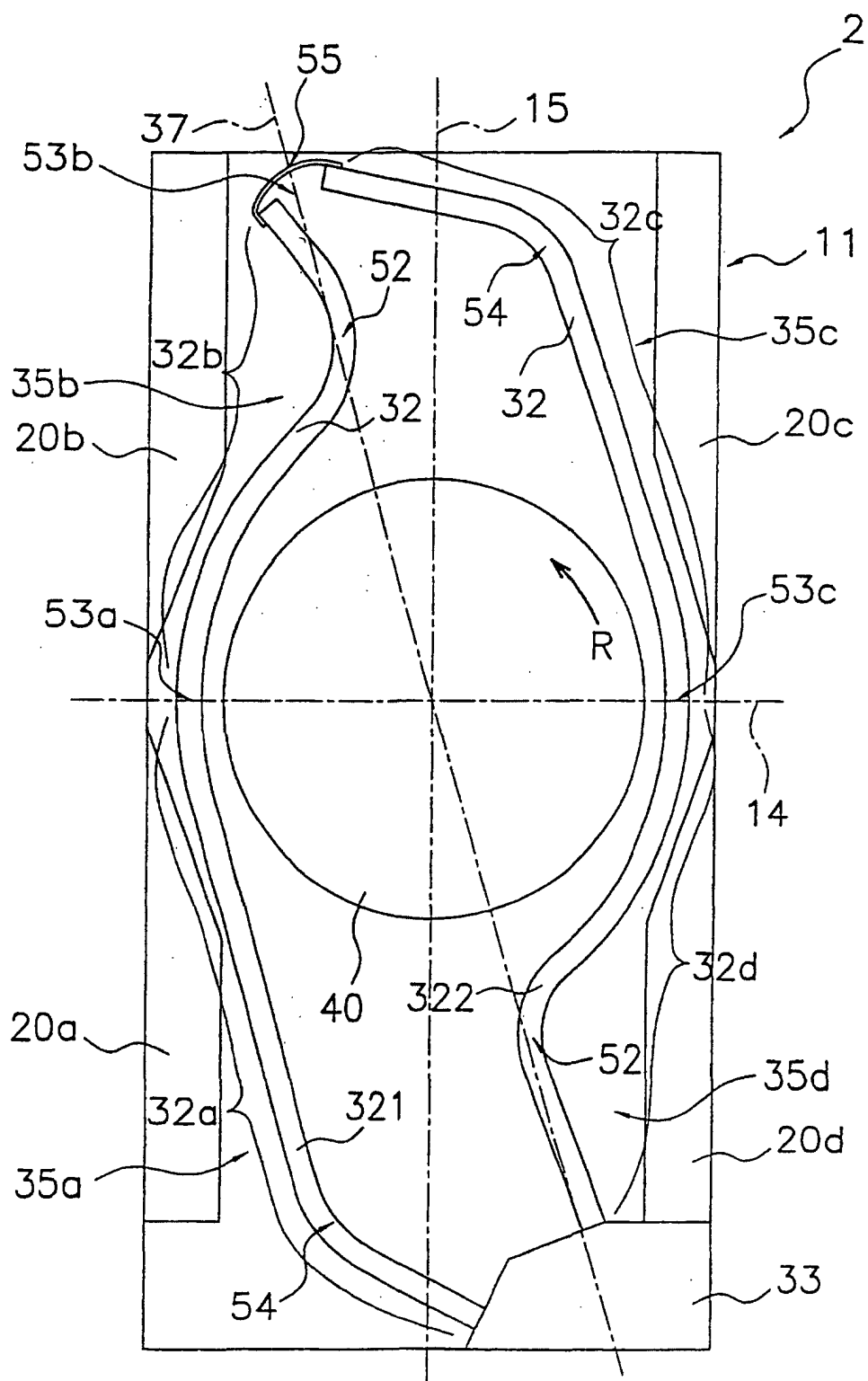


Fig. 4

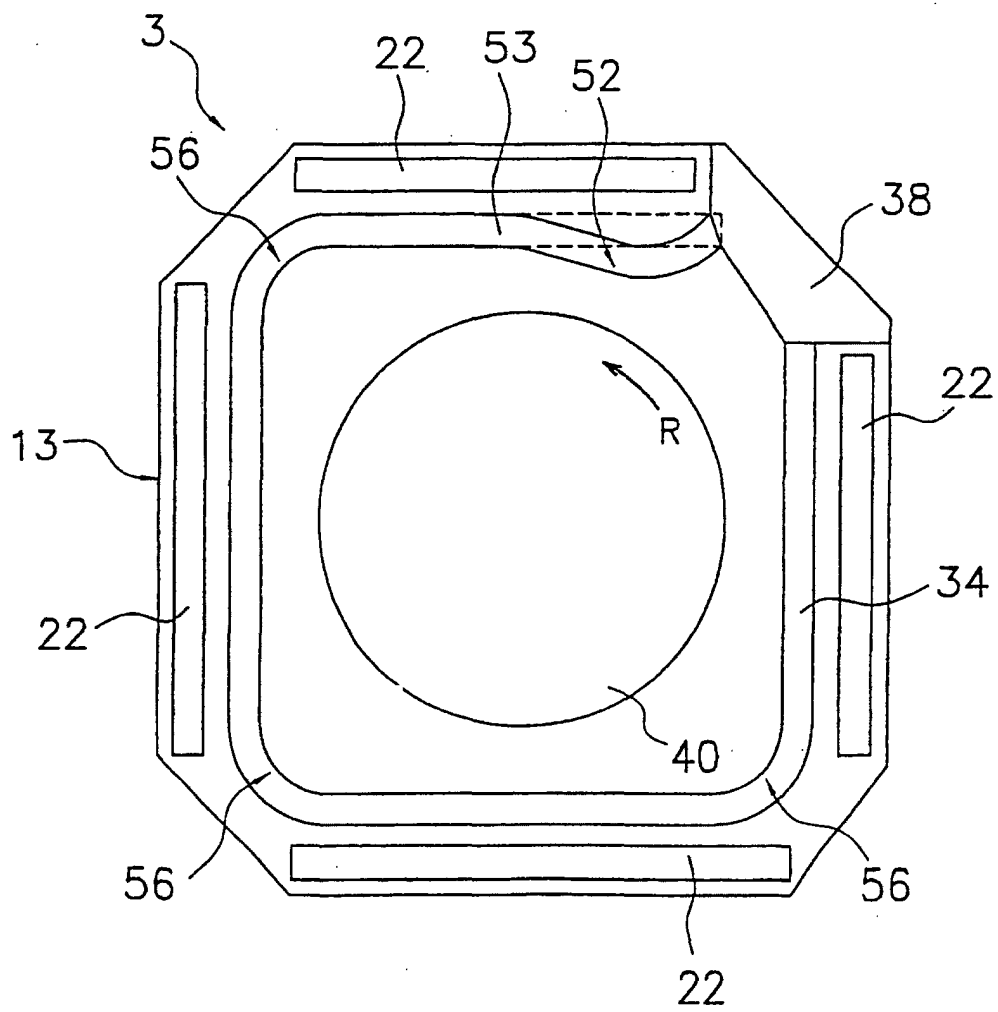


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP02/02224

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ F24F1/00 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int.Cl ⁷ F24F1/00 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2002 Kokai Jitsuyo Shinan Koho 1971-2002 Jitsuyo Shinan Toroku Koho 1996-2002 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 9-133374 A (Mitsubishi Electric Corp.),	1
Y	20 May, 1997 (20.05.97),	2, 6
A	Full text; all drawings (Family: none)	3-5, 7, 8
Y	JP 9-229467 A (Matsushita Refrigeration Co.),	6
A	05 September, 1997 (05.09.97), Full text; all drawings (Family: none)	1-5, 7, 8
A	JP 2000-220859 A (Hitachi, Ltd.), 08 August, 2000 (08.08.00), Full text; all drawings (Family: none)	1-8
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search 30 May, 2002 (30.05.02)		Date of mailing of the international search report 11 June, 2002 (11.06.02)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP02/02224

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 62-162830 A (Matsushita Electric Industrial Co., Ltd.), 18 July, 1987 (18.07.87), Full text; all drawings (Family: none)	1-8
A	JP 5-5536 A (Daikin Industries, Ltd.), 14 January, 1993 (14.01.93), Full text; all drawings (Family: none)	1-8
A	JP 2000-121089 A (Hitachi, Ltd.), 28 April, 2000 (28.04.00), Full text; all drawings (Family: none)	1-8

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