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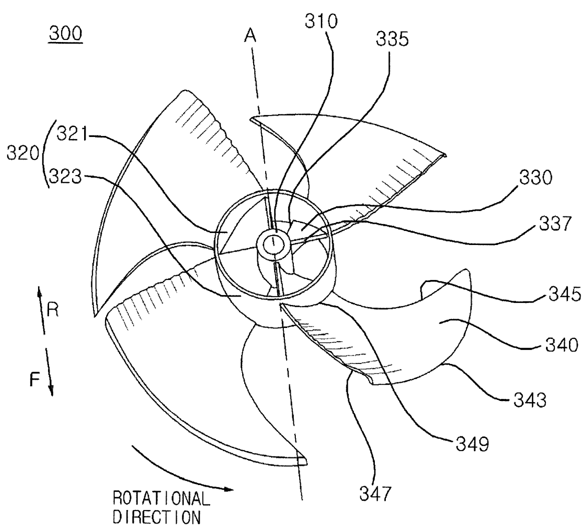
(54) BLOWER FAN

(57) A blower fan includes a hub (310) fixed to a rotary shaft, a main rib (320) disposed to surround the hub while being spaced apart from an outer circumference of the hub, a plurality of auxiliary ribs (330) connecting the hub and the main rib, and a plurality of blades (340) connected to an outer circumference of the main rib so as to generate an air stream during rotation of the blower fan, wherein the plurality of auxiliary ribs is arranged around the hub so as to generate an air stream during the rotation of the blower fan in the same direction with the plurality of blades. An air conditioner having the blower fan is also disclosed.

FIG. 6



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Description

[0001] This application claims the priority benefit of Korean Patent Application No. 2014-0059947, filed on May 19, 2014 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

[0002] The present invention relates to a blower fan and an air conditioner having the same.

[0003] In general, an air conditioner is an apparatus that cools or heats a room using a refrigeration cycle including a compressor, an outdoor heat exchanger, an expansion valve, and an indoor heat exchanger. That is, the air conditioner may be configured as a cooler that cools a room or as a heater that heats a room. In addition, the air conditioner may be configured as a heater and cooler that cools and heats a room.

[0004] The air conditioner may be mainly classified as a window type air conditioner or a separate type (or split type) air conditioner. The window type air conditioner and the separate type air conditioner are identical in function to each other except that the window type air conditioner, having an integrated cooling and heat dissipation function, is directly installed in an opening formed through the wall of a house or in a window of the house, whereas the separate type air conditioner includes an indoor unit, including an indoor heat exchanger, installed indoors, an outdoor unit, including a compressor and an outdoor heat exchanger, installed outdoors, and a refrigerant pipe connected between the indoor unit and the outdoor unit.

[0005] The outdoor heat exchanger of the outdoor unit or the indoor unit performs heat exchange between outdoor air and a refrigerant. The outdoor unit or the indoor unit includes a blower fan to blow the outdoor air for smooth heat exchange between the outdoor air and the refrigerant.

[0006] A conventional blower fan is configured to have a structure in which a main plate of the blower fan extends along the outer circumference of a hub such that the main plate protrude outward perpendicularly from a rotary shaft of the blower fan to surround the outer circumference of the hub.

[0007] When blades are rotated, an air stream is generated from the front F to the rear R of the blower fan in an axial direction of the blower fan by the blades.

[0008] At this time, a space defined between the main plate and the hub is closed such that the air stream cannot pass through the space. As a result, the air stream generated by rotation of the blades forms an eddy on the main plate at the rear R in an axial direction of the blower fan.

[0009] It is an object of the present invention to provide a blower fan exhibiting a high flow rate and low noise and an air conditioner having the same.

[0010] It will be appreciated by those skilled in the art that the present invention pertains that objects of the present invention are not limited to the above object of the present invention and other unmentioned objects of the present invention will be more clearly understood from the following description.

[0011] In accordance with an aspect of the present invention, the above and other objects can be accomplished by the provision of a blower fan including a hub fixed to a rotary shaft, a main rib disposed to surround the hub while being spaced apart from an outer circumference of the hub, a plurality of auxiliary ribs connecting the hub and the main rib, and a plurality of blades connected to an outer circumference of the main rib so as to generate an air stream during rotation of the blower fan, wherein the plurality of auxiliary ribs is arranged around the hub so as to generate an air stream during the rotation of the blower fan in the same direction with the plurality of blades.

[0012] An inner edge of the plurality of auxiliary ribs is connected to the outer circumference of the hub and an outer edge of the plurality of auxiliary ribs is connected to an inner circumference of the main rib, and the plurality of auxiliary ribs is on a plane perpendicular to the rotary shaft such that the plurality of auxiliary ribs is disposed about the rotary shaft in a radial manner.

[0013] The plurality of auxiliary ribs may be shaped, from its front tip in the rotational direction of the blower fan to its rear end, to be curved toward a rear of the blower fan.

[0014] The plurality of auxiliary ribs may include an auxiliary rib front edge defining a front outline of the auxiliary rib in the rotational direction of the blades and an auxiliary rib rear edge defining a rear outline of the auxiliary rib in the rotational direction of the blades, and wherein the auxiliary rib front edge is positioned forward than the auxiliary rib rear edge in the axial direction of the blower fan.

[0015] The number of the plurality of auxiliary ribs corresponds to that of the plurality of blades.

[0016] The auxiliary rib rear edge may have a waveform shape.

[0017] The main rib may be on a plane perpendicular to the rotary shaft, having a cylindrical shape with the rotary shaft as its axis.

[0018] A radius of the main rib may be 20 % to 30 % a radius of rotation of the plurality of blades.

[0019] Each blade may include a blade front edge defining a front outline of the blade in the rotational direction of the blade; and a blade rear edge defining a rear outline of the blade in the rotational direction of the blade, and wherein the blade front edge is positioned forward than the blade rear edge in the axial direction of the blower fan.

[0020] The blade rear edge may have a waveform shape.

[0021] The inner edge of each blade may be connected to the outer circumference of the main rib, and a connection of the auxiliary rib rear edge to the main rib and a connection of the blade rear edge to the main rib alternate along the circumference of the main rib.

[0022] A connection of the auxiliary rib rear edge to the main rib and a connection of the blade rear edge to the main rib correspond to each other on an inner and outer surface of the main rib.

[0023] Each blade may be on a plane perpendicular to the rotary shaft such that the blade is shaped, from its front tip in the rotational direction of the blower fan to its rear end, to be curved toward the rear of the blower fan.

[0024] The plurality of auxiliary ribs is arranged apart from each other.

[0025] The blower fan according to any of preceding claims, wherein a thickness of the plurality of auxiliary ribs increases gradually from the main rib to the hub.

[0026] In accordance with another aspect of the present invention, there is provided an air conditioner including a case defining an external appearance thereof, a compressor to compress a refrigerant, a heat exchange disposed in the case to perform heat exchange between air and the refrigerant, and a blower fan to blow the air, wherein the blower fan includes a hub fixed to a rotary shaft, a main rib disposed to surround the hub while being spaced apart from an outer circumference of the hub, an auxiliary rib connected between the hub and the main rib, and a plurality of blades coupled to an outer circumference of the main rib to generate an air stream during rotation thereof, and the auxiliary rib is disposed about the hub in a radial manner such that the auxiliary rib is rotated by the hub to generate an air stream.

[0027] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a view schematically showing construction of an air conditioner according to an embodiment of the present invention;
FIG. 2 is a view showing an outdoor unit of an air conditioner according to an embodiment of the present invention;
FIG. 3 is an exploded perspective view showing the outdoor unit of the air conditioner shown in FIG. 2;
FIG. 4 is a perspective view showing a blower apparatus according to an embodiment of the present invention;
FIG. 5 is a sectional view showing the blower apparatus according to the embodiment of the present invention;
FIG. 6 is a perspective view showing a blower fan according to an embodiment of the present invention;
FIG. 7 is a plan view of the blower fan shown in FIG. 6;
FIG. 8 is a side view of the blower fan shown in FIG. 6;
FIG. 9A is a view illustrating the flow of air generated by a conventional blower fan;
FIG. 9B is view illustrating the flow of air generated by the blower fan according to the embodiment of the present invention; and
FIG. 10 is a plan view showing a blower fan according to another embodiment of the present invention.

[0028] Advantages and features of the present invention and a method of achieving the same will be more clearly understood from embodiments described below with reference to the accompanying drawings. However, the present invention is not limited to the following embodiments but may be implemented in various different forms. The embodiments are provided merely to complete disclosure of the present invention and to fully provide a person having ordinary skill in the art to which the present invention pertains with the category of the invention. The invention is defined only by the category of the claims. Wherever possible, the same reference numbers will be used throughout the specification to refer to the same or like elements.

[0029] Hereinafter, reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings.

[0030] FIG. 1 is a view schematically showing construction of an air conditioner according to an embodiment of the present invention.

[0031] Referring to FIG. 1, the air conditioner 1 according to this embodiment includes a compressor 20 to compress a refrigerant, an outdoor heat exchanger 170 installed outdoors to perform heat exchange between the refrigerant and outdoor air, an indoor heat exchanger 50 installed indoors to perform heat exchange between the refrigerant and indoor air, a switching valve 80 to guide the refrigerant discharged from the compressor 20 to the outdoor heat exchanger 170 during a cooling operation and to guide the refrigerant discharged from the compressor 20 to the indoor heat exchanger 50 during a heating operation.

[0032] The air conditioner 1 includes an outdoor unit disposed outdoors and an indoor unit disposed indoors. The outdoor unit and the indoor unit are connected to each other. The outdoor unit includes the compressor 20, the outdoor heat exchanger 170, an outdoor expansion valve 70, and a gas and liquid separator 27. The indoor unit includes the indoor heat exchanger 50 and an indoor expansion valve 60.

[0033] The compressor 20 is installed in the outdoor unit to compress a low-temperature, low-pressure refrigerant, introduced into the compressor 20, into a high-temperature, high-pressure refrigerant. The compressor 20 may be configured to have various structures. Example, the compressor 20 may be a reciprocation type compressor 20 using a cylinder and a piston, a scroll type compressor 20 using a rotatable scroll and a stationary scroll, or an inverter type compressor 20 to adjust a compression rate of the refrigerant based on a real indoor temperature, a real outdoor temperature, and the number of indoor units under operation when a desired indoor temperature is set. One or more compressors 20 may be provided. In this embodiment, two compressors 20 are provided.

[0034] The compressor 20 is connected to the switching valve 80 and the gas and liquid separator 27. The compressor 20 includes an inlet port 21, through which a refrigerant evaporated by the indoor heat exchanger

50 is introduced into the compressor 20 during the cooling operation or a refrigerant evaporated by the outdoor heat exchanger 170 is introduced into the compressor 20 during the heating operation, and an outlet port 23, through which a compressed refrigerant is discharged from the compressor 20.

[0035] The compressor 20 compresses the refrigerant introduced through the inlet port 21 in a compression compartment. The compressor 20 discharges the compressed refrigerant through the outlet port 23. The refrigerant discharged through the outlet port 23 flows to the switching valve 80.

[0036] The switching valve 80 is a flow channel switching valve 80 for switching between cooling and heating. The switching valve 80 guides the refrigerant compressed by the compressor 20 to the outdoor heat exchanger 170 during the cooling operation and guides the refrigerant compressed by the compressor 20 to the indoor heat exchanger 50 during the heating operation. That is, the switching valve 80 functions to guide the refrigerant compressed by the compressor 20 to a condenser.

[0037] The switching valve 80 is connected to the outlet port 23 of the compressor 20 and the gas and liquid separator 27. In addition, the switching valve 80 is connected to the indoor heat exchanger 50 and the outdoor heat exchanger 170. During the cooling operation, the switching valve 80 connects the outlet port 23 of the compressor 20 to the outdoor heat exchanger 170 and connects the indoor heat exchanger 50 to the gas and liquid separator 27. In another embodiment, however, the switching valve 80 may connect the indoor heat exchanger 50 to the inlet port 21 of the compressor 20 during the cooling operation.

[0038] During the heating operation, the switching valve 80 connects the outlet port 23 of the compressor 20 to the indoor heat exchanger 50 and connects the outdoor heat exchanger 170 to the gas and liquid separator 27. In another embodiment, however, the switching valve 80 may connect the outdoor heat exchanger 170 to the inlet port 21 of the compressor 20 during the heating operation.

[0039] The switching valve 80 may be embodied by various modules that are capable of connecting different flow channels to each other. In this embodiment, the switching valve 80 is a four-way valve. In another embodiment, however, the switching valve 80 may be embodied by various valves and combinations thereof, such as a combination of two three-way valves.

[0040] The outdoor heat exchanger 170 is disposed in the outdoor unit installed outdoors to perform heat exchange between the refrigerant passing through the outdoor heat exchanger 170 and outdoor air. During the cooling operation, the outdoor heat exchanger 170 functions as a condenser to condense the refrigerant. During the heating operation, on the other hand, the outdoor heat exchanger 170 functions as an evaporator to evaporate the refrigerant.

[0041] The outdoor heat exchanger 170 is connected to the switching valve 80 and the outdoor expansion valve 70. During the cooling operation, the refrigerant compressed by the compressor 20 passes through the outlet port 23 of the compressor 20 and the switching valve 80 and is then introduced into the outdoor heat exchanger 170, in which the refrigerant is condensed. The condensed refrigerant flows to the outdoor expansion valve 70. During the heating operation, on the other hand, the refrigerant expanded by the outdoor expansion valve 70 flows to the outdoor heat exchanger 170, in which the refrigerant is evaporated. The evaporated refrigerant flows to the switching valve 80.

[0042] During the cooling operation, the outdoor expansion valve 70 is fully opened to allow the refrigerant to pass therethrough. During the heating operation, on the other hand, an opening degree of the outdoor expansion valve 70 is adjusted to expand the refrigerant. The outdoor expansion valve 70 is disposed between the outdoor heat exchanger 170 and an injection module 90.

[0043] During the cooling operation, the outdoor expansion valve 70 allows the refrigerant introduced from the outdoor heat exchanger 170 to pass therethrough such that the refrigerant is guided to the injection module 90. During the heating operation, on the other hand, the outdoor expansion valve 70 may expand the refrigerant through heat exchange in the injection module 90 and guide the expanded refrigerant to the outdoor heat exchanger 170.

[0044] The indoor heat exchanger 50 is disposed in the indoor unit installed indoors to perform heat exchange between the refrigerant passing through the indoor heat exchanger 50 and indoor air. During the cooling operation, the indoor heat exchanger 50 functions as an evaporator to evaporate the refrigerant. During the heating operation, on the other hand, the indoor heat exchanger 50 functions as a condenser to condense the refrigerant.

[0045] The indoor heat exchanger 50 is connected to the switching valve 80 and the indoor expansion valve 60. During the cooling operation, the refrigerant expanded by the indoor expansion valve 60 flows to the indoor heat exchanger 50, in which the refrigerant is evaporated. The evaporated refrigerant flows to the switching valve 80. During the heating operation, on the other hand, the refrigerant compressed by the compressor 20 passes through the outlet port 23 of the compressor 20 and the switching valve 80 and is then introduced into the indoor heat exchanger 50, in which the refrigerant is condensed. The condensed refrigerant flows to the indoor expansion valve 60.

[0046] During the cooling operation, an opening degree of the indoor expansion valve 60 is adjusted to expand the refrigerant. During the heating operation, on the other hand, the indoor expansion valve 60 is fully opened to allow the refrigerant to pass therethrough. The indoor expansion valve 60 is disposed between the indoor heat exchanger 50 and the injection module 90.

[0047] During the cooling operation, the indoor expansion valve 60 expands the refrigerant flowing to the indoor heat exchanger 50. During the heating operation, on the other hand, the indoor expansion valve 60 allows the refrigerant introduced from the indoor heat exchanger 50 to pass therethrough such that the refrigerant is guided to the injection module 90.

[0048] The injection module 90 is disposed between the outdoor heat exchanger 170 and the indoor heat exchanger 50 to inject a portion of the refrigerant flowing between the outdoor heat exchanger 170 and the indoor heat exchanger 50 to the compressor 20. That is, the injection module 90 may inject a portion of the refrigerant flowing from the condenser to the expansion valve to the compressor 20. The injection module 90 is connected to the outdoor expansion valve 70 and the indoor expansion valve 60.

[0049] The injection module 90 includes an injection expansion valve 91 to expand a portion of the refrigerant flowing between the outdoor heat exchanger 170 and the indoor heat exchanger 50 and an injection heat exchanger 92 to perform heat exchange between another portion of the refrigerant flowing between the indoor heat exchanger 50 and the outdoor heat exchanger 170 and the refrigerant expanded by the injection expansion valve 91. The injection heat exchanger 92 guides the heat-exchanged and thus evaporated refrigerant to an injection port 22 of the compressor 20. In another embodiment, however, the injection module 90 may not be included in the air conditioner 1.

[0050] The gas and liquid separator 27 is disposed between the switching valve 80 and the inlet port 21 of the compressor 20. The gas and liquid separator 27 is connected to the switching valve 80 and the inlet port 21 of the compressor 20. The gas and liquid separator 27 separates the refrigerant evaporated by the indoor heat exchanger 50 during the cooling operation or the refrigerant evaporated by the outdoor heat exchanger 170 during the heating operation into a gas refrigerant and a liquid refrigerant and guides the gas refrigerant to the inlet port 21 of the compressor 20. That is, the gas and liquid separator 27 separates the refrigerant evaporated by the evaporator into a gas refrigerant and a liquid refrigerant and guides the gas refrigerant to the inlet port 21 of the compressor 20.

[0051] The refrigerant evaporated by the outdoor heat exchanger 170 or the indoor heat exchanger 50 is introduced into the gas and liquid separator 27 through the switching valve 80. Consequently, the gas and liquid separator 27 may be maintained at a temperature of about 0 to 5 °C and cold energy may be dissipated from the gas and liquid separator 27. The surface temperature of the gas and liquid separator 27 is lower than the temperature of the refrigerant condensed by the outdoor heat exchanger 170 during the cooling operation. The gas and liquid separator 27 may be formed in a cylindrical shape extending in a longitudinal direction.

[0052] FIG. 2 is a view showing an outdoor unit of an air conditioner according to an embodiment of the present invention. FIG. 3 is an exploded perspective view showing the outdoor unit of the air conditioner shown in FIG. 2.

[0053] Referring to FIGS. 2 and 3, the outdoor unit of the air conditioner 1 according to this embodiment includes an outdoor unit base 110 defining the bottom thereof, an outdoor unit body 100 coupled to the outdoor unit base 110, the outdoor unit body 100 being provided at the lateral side thereof with suction holes, through which air is suctioned, the outdoor unit body 100 being provided at the top thereof with a discharge hole 143, an outdoor heat exchanger 170 disposed in the outdoor unit body 100 such that the outdoor heat exchanger 170 corresponds to the suction holes, a blower apparatus 200 provided in the discharge hole 143 of the outdoor unit body 100 to blow air in a vertical direction, and an suction apparatus provided at the lower part of the outdoor unit body 100 to suction air in a horizontal direction.

[0054] In this embodiment, a blower fan 300 is described as being located in the outdoor unit. On the other hand, the blower fan 300 may be located in the indoor unit. That is, the blower fan 300 may be located adjacent to the heat exchanger provided in the air conditioner.

[0055] In this embodiment, an upward and downward direction means a vertical direction, which is a direction of gravity, and a forward and backward direction and a left and right direction mean a horizontal direction perpendicular to the upward and downward direction.

[0056] An outdoor unit case, which is constituted by the outdoor unit base 110 and the outdoor unit body 100, defines the external appearance of the outdoor unit of the air conditioner 1. The outdoor unit base 110 defines the external appearance of the bottom of the outdoor unit case. A compressor 20, oil separators 28 and 29, a gas and liquid separator 27, and an outdoor heat exchanger 170 are installed at the top of the outdoor unit base 110.

[0057] The outdoor unit body 100 is coupled to the outdoor unit base 110. The outdoor unit body 100 is formed in the shape of a rectangular parallelepiped opened at the bottom thereof. The suction holes, through which air is suctioned, are formed at the lateral side of the outdoor unit body 100.

[0058] The discharge hole 143 is formed at an upper region of the outdoor unit case. Specifically, the discharge hole 143 is formed at the top of the outdoor unit body 100.

[0059] The suction holes may be formed at three side parts of the lateral side of the outdoor unit body 100. Specifically, the suction holes may be formed at the rear, the left side, and the right side of the outdoor unit body 100.

[0060] In this embodiment, the suction holes include left side suction holes 123, right side suction holes 133, and rear suction holes 163.

[0061] The outdoor unit body 100 includes a left side panel 120 defining the left side thereof, a right side panel 130 defining the right side thereof, a top panel 140 defining the top thereof, a front panel 150 defining the front thereof, and a rear panel 160 defining the rear thereof.

[0062] The left side panel 120 defines the external appearance of the left side of the outdoor unit. The left side panel 120 is coupled to the left side of the outdoor unit base 110. The left side panel 120 is provided with a left side grill 122, through which outdoor air is suctioned into the outdoor unit body 100. The left side grill 122 defines the left side suction holes 123, through which outdoor air is suctioned from the left side.

[0063] The right side panel 130 defines the external appearance of the right side of the outdoor unit. The right side panel 130 is coupled to the right side of the outdoor unit base 110. The right side panel 130 is provided with a right side grill 132, through which outdoor air is suctioned into the outdoor unit body 100. The right side grill 132 defines the right side suction holes 133, through which outdoor air is suctioned from the right side.

[0064] The top panel 140 defines the external appearance of the top of the outdoor unit. The top panel 140 is coupled to the upper end of the left side panel 120 and the upper end of the right side panel 130. The discharge hole 143 is formed at the top panel 140. The top panel 140 may be provided with a discharge grill 142, which is located above the discharge hole 143.

[0065] The front panel 150 defines the external appearance of the front of the outdoor unit. The front panel 150 is disposed at the front of a space defined by the outdoor unit base 110, the left side panel 120, the right side panel 130, and the top panel 140.

[0066] The rear panel 160 defines the external appearance of the rear of the outdoor unit. The rear panel 160 is disposed at the rear of the space defined by the outdoor unit base 110, the left side panel 120, the right side panel 130, and the top panel 140.

[0067] The rear panel 160 is provided with a rear grill 162, through which outdoor air is suctioned into the outdoor unit body 100. The rear grill 162 defines the rear suction holes 163, through which outdoor air is suctioned from the rear.

[0068] The outdoor heat exchanger 170 is disposed in the outdoor unit body 100 such that the outdoor heat exchanger 170 corresponds to the suction holes. In this embodiment, the suction holes include left side suction holes 123, the right side suction holes 133, and the rear suction holes 163. To this end, the outdoor heat exchanger 170 is formed in the shape of ⊃ in horizontal section such that the outdoor heat exchanger 170 has three sides.

[0069] The outdoor heat exchanger 170 having three sides is disposed so as to surround the compressor 20, the oil separators 28 and 29, and the gas and liquid separator 27 installed at the top of the outdoor unit base 110.

[0070] The left side of the outdoor heat exchanger 170 is disposed so as to correspond to the left side suction holes 123 formed at the left side grill 122, the right side of the outdoor heat exchanger 170 is disposed so as to correspond to the right side suction holes 133 formed at the right side grill 132, and the rear of the outdoor heat exchanger 170, which is located between the left side and the right side of the outdoor heat exchanger 170, is disposed so as to correspond to the rear suction holes 163 formed at the rear grill 162.

[0071] The blower apparatus 200 may include a blower fan 300 rotated by a motor 230 and an orifice 210, surrounding the blower fan 300, to guide air blown by the blower fan 300.

[0072] The blower fan 300 is disposed under the top panel 140 such that the blower fan 300 corresponds to the discharge hole 143.

[0073] The blower fan 300 is supported by a discharge bracket connected to the front panel 150 and the rear panel 160. The blower fan 300 is rotated by the motor 230. The motor 230 is installed at the discharge bracket.

[0074] The blower fan 300 is rotated to generate a pressure difference between the front and the rear of the blower fan 300 such that air flows in one direction. The blower fan 300 will hereinafter be described in detail.

[0075] The suction apparatus is provided at the lower part of the outdoor unit body 100 to suction air in a horizontal direction. The suction apparatus is disposed above the outdoor unit base 110. The suction apparatus includes a suction motor 196 and a suction fan 198 rotated by the suction motor 196. The suction fan 198 is supported by a suction bracket 197 connected to the top of the outdoor unit base 110. The suction fan 198 is rotated by the suction motor 196. The suction motor 196 is installed at the suction bracket 197.

[0076] The suction fan 198 circulates outdoor air together with the blower apparatus 200 such that the outdoor heat exchanger 170 performs heat exchange between the outdoor air and the refrigerant.

[0077] In a case in which the blower apparatus 200 and the suction fan 198 circulate outdoor air in cooperation with each other such that the outdoor heat exchanger 170 performs heat exchange between the outdoor air and the refrigerant, efficiency of the air conditioner 1 during a cooling/heating operation is higher than in a case in which only the blower apparatus 200 circulates the outdoor air without the suction fan 198 such that the outdoor heat exchanger 170 performs heat exchange between the outdoor air and the refrigerant.

[0078] The suction fan 198 may be an axial fan, having a horizontal shaft, to suction outdoor air into the outdoor unit body 100. The shaft of the suction fan 198 extends in a forward and backward direction to suction air in the forward and backward direction.

[0079] A controller 180 controls the compressor 20, the outdoor expansion valve 70, the indoor expansion valve 60, the switching valve 80, the suction motor 196, and the motor 230 based on required cooling and heating performance.

[0080] FIG. 4 is a perspective view showing a blower apparatus according to an embodiment of the present invention. FIG. 5 is a sectional view showing the blower apparatus according to the embodiment of the present invention.

[0081] Referring to FIGS. 4 and 5, the blower apparatus 200 according to the embodiment of the present invention includes a blower fan 300 rotated about a shaft thereof to blow air heat-exchanged with the refrigerant by the outdoor heat exchanger 170 in one direction and an orifice 210 installed in the case such that the inside and the outside of the case communicate with each other through the orifice 210 to guide the air blown by the blower fan 300. The orifice 210 includes a discharge part 211 to guide air discharged from the front F to the rear R of the blower apparatus 200 in an axial direction of the blower apparatus 200 by the blower fan 300. The sectional area of the discharge part 211 is gradually increased from the front F to the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200.

[0082] The blower fan 300 is disposed under the discharge hole 143 of the outdoor unit body in an upward and downward direction to blow air in the upward and downward direction (from the front F to the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200).

[0083] That is, the blower fan 300 discharges outdoor air from the outdoor unit body.

[0084] The blower fan 300 blows outdoor air such that the outdoor heat exchanger 170 performs heat exchange between the outdoor air and the refrigerant.

[0085] The blower fan 300 discharges outdoor air suctioned through the suction holes outward from the case. The blower fan 300 will hereinafter be described in detail.

[0086] The front F of the blower apparatus 200 in the axial direction of the blower apparatus 200 may be aligned with a direction of gravity (a downward direction).

[0087] The orifice 210 is installed in the case such that the inside and the outside of the case communicate with each other through the orifice 210 to guide the air blown by the blower fan 300.

[0088] Specifically, the orifice 210 may be located at the upper region of the case such that the orifice 210 communicates with the discharge hole 143.

[0089] The blower fan 300 is disposed inside the orifice 210.

[0090] Specifically, the orifice 210 may form a closed space to surround the blower fan 300 on a horizontal plane perpendicular to the axial direction of the blower apparatus 200. The axis means a shaft about which the blower fan 300 is rotated.

[0091] The internal space of the orifice 210 may be formed in a shape in which the front F and the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200 are opened and the orifice 210 surrounds the blower fan 300 in a direction perpendicular to the axial direction of the blower apparatus 200. That is, the orifice 210 is formed approximately in a cylindrical shape.

[0092] The internal space of the orifice 210 defines a flow channel to guide air blown by the blower fan 300. An inlet port 212, through which air is introduced by the blower fan 300, is formed in internal space of the orifice 210 at the front F of the blower apparatus 200 in the axial direction of the blower apparatus 200 and an outlet port 214, through which air is discharged by the blower fan 300, is formed in the internal space of the orifice 210 at the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200.

[0093] The orifice 210 may be installed in the case. Specifically, the orifice 210 is disposed under the top panel in a state in which the orifice 210 is connected to the front panel and the rear panel.

[0094] For example, the orifice 210 may include a discharge part 211, a connection part 215, and a suction part 213.

[0095] The discharge part 211 guides air discharged from the front F to the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200 by the blower fan 300.

[0096] The discharge part 211 defines the outlet port 214. Specifically, the discharge part 211 may have a shape having the outlet port 214 defined therein. For example, the discharge part 211 may be formed in a shape in which the front F and the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200 are opened and the discharge part 211 surrounds the blower fan 300 in a direction perpendicular to the axial direction of the blower apparatus 200. That is, the discharge part 211 is formed approximately in a cylindrical shape.

[0097] The discharge part 211 is located at the rear R of the blower fan 300 in the axial direction of the blower apparatus 200.

[0098] The center of the discharge part 211 may be aligned with the shaft of the blower fan 300.

[0099] The sectional area of the discharge part 211 is gradually increased from the front F to the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200. In addition, the width of the discharge part 211 is also gradually increased.

[0100] Consequently, noise of air discharged by the blower fan 300 is proportional to flow speed of air. The flow speed of the air is a value obtained by dividing the flow rate of air by a sectional area perpendicular to a flow direction of the air.

[0101] According to law of mass conservation, the flow rate of air is uniformly maintained irrespective of position in a flow direction (axial direction) of the air. When the sectional area of the discharge part 211 is gradually increased, therefore, the flow speed of the air becomes slow. As a result, noise of the discharged air is reduced.

[0102] When the flow speed of the air is decreased, a difference in flow speed between the discharged air and external air at a rear end 211A of the discharge part 211 is reduced with the result that generation of an eddy in the air is restrained. As generation of an eddy in the air is restrained, efficiency of the outdoor unit is improved.

[0103] The sectional area means the area of a plane perpendicular to the axial direction.

[0104] Specifically, the front end of the discharge part 211 is connected to the connection part 215 and the rear end 211A of the discharge part 211 is located more adjacent to the rear R in the axial direction than the rear end of the blower fan 300. Consequently, it is possible to sufficiently reduce the flow speed of the air having passed through the blower fan 300.

[0105] The front end of the discharge part 211 means an end of the discharge part 211 located at the front F in the axial direction and the rear end 211A of the discharge part 211 means an end of the discharge part 211 located at the rear R in the axial direction.

[0106] That is, the discharge part 211 may have a uniform height. The height of the discharge part 211 means the distance from the front end of the discharge part 211 to the rear end 211A of the discharge part 211.

[0107] The axial section of the discharge part 211 may have a linear or curved shape. The axial section means the sectional area of a plane parallel to the axial direction.

[0108] A ratio of a width L2 of the rear end 211A of the discharge part 211 to a width L1 of the connection part 215 may be 1.6:1 to 1.4:1. If the width L2 of the rear end 211A of the discharge part 211 is greater than 1.6 times the width L1 of the connection part 215, the sectional area of the discharge part 211 is sharply increased with the result that it is not possible to guide air flowing into the discharge port 211. On the other hand, if the width L2 of the rear end 211A of the discharge part 211 is less than 1.4 times the width L1 of the connection part 215, the sectional area of the discharge part 211 is gently increased with the result that it is not possible to reduce the flow speed of the air discharged from the discharge part 211.

[0109] In a case in which the sectional shape of the discharge part 211 is circular, the width L2 of the rear end 211A of the discharge part 211 means the diameter of an internal space of the discharge part 211. On the other hand, in a case in which the sectional shape of the discharge part 211 is polygonal, the width L2 of the rear end 211A of the discharge part 211 means the average width of the internal space of the discharge part 211. In addition, in a case in which the sectional shape of the connection part 215 is circular, the width L1 of the connection part 215 means the diameter of an internal space of the connection part 215.

[0110] In addition, a difference between the width L2 of the rear end 211A of the discharge part 211 and the width L1 of the connection part 215 may be 50 % to 100 % the width L1 of the connection part 215. If the difference between the width L2 of the rear end 211A of the discharge part 211 and the width L1 of the connection part 215 is greater than 100 % the width L1 of the connection part 215, the sectional area of the discharge part 211 is sharply increased with the result that it is not possible to guide air flowing into the discharge port 211. On the other hand, if the difference between the width L2 of the rear end 211A of the discharge part 211 and the width L1 of the connection part 215 is less than 50 % the width L1 of the connection part 215, the sectional area of the discharge part 211 is gently increased with the result that it is not possible to reduce the flow speed of the air discharged from the discharge part 211.

[0111] The difference between the width L2 of the rear end 211A of the discharge part 211 and the width L1 of the connection part 215 is a value obtained by subtracting the width L1 of the connection part 215 from the width L2 of the rear end 211A of the discharge part 211. In addition, the width L1 of the connection part 215 is equal to the width of the front end of the discharge part 211.

[0112] In addition, the rear end 211A of the discharge part 211 may be located at the upper region of the case. Since the flow speed of the air discharged from the discharge part 211 is higher than that of the air introduced into the discharge part 211, noise is increased in the discharge part 211.

[0113] In a case in which the rear end 211A of the discharge part 211 is located at the upper region of the case and the front F of the blower apparatus 200 in the axial direction of the blower apparatus 200 is aligned with a direction of gravity, therefore, the air is discharged from the discharge part 211 toward the upper side of the case.

[0114] In general, the case has a predetermined height and, therefore, the discharge part 211 is installed at the predetermined height from the ground. As a result, it is possible to reduce noise that people may hear in ear.

[0115] Particularly, in a case in which the height of the rear end 211A of the discharge part 211 (which means the height from the ground) is designed to be equal to or greater than the average height of people, it is possible to further reduce noise of the air discharged from the discharge part 211.

[0116] The sectional holes may be located under the discharge part 211. Since the sectional holes are disposed at three sides of the case, the flow speed of the air suctioned through the sectional holes is reduced. Consequently, noise is low even when the sectional holes are disposed adjacent to ears of people.

[0117] The suction part 213 guides air suctioned from the front F to the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200 by the blower fan 300. That is, the suction part 213 increases the flow speed of the air suctioned by the blower fan 300.

[0118] The suction part 213 defines the inlet port 212 of the orifice 210. Specifically, the suction part 213 may have a shape having the inlet port 212 defined therein. For example, the suction part 213 may be formed in a shape in which the front F and the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200 are opened and the suction part 213 surrounds the blower fan 300 in a direction perpendicular to the axial direction of the blower apparatus 200. That is, the suction part 213 is formed approximately in a cylindrical shape.

[0119] The suction part 213 is located at the front F of the blower fan 300 in the axial direction of the blower apparatus 200. That is, the suction part 213 is located opposite to the discharge part 211 via the blower fan 300.

[0120] The center of the suction part 213 may be aligned with the shaft of the blower fan 300.

[0121] The sectional area of the suction part 213 is gradually increased from the front F to the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200. In addition, the width of the suction part 213 is also gradually increased.

[0122] Consequently, the flow speed of the air suctioned by the blower fan 300 is increased.

[0123] The sectional area means the area of a plane perpendicular to the axial direction of the blower apparatus 200.

[0124] Specifically, the rear end of the suction part 213 is connected to the connection part 215 and the front end 213A of the suction part 213 is located more adjacent to the front F of the blower apparatus 200 in the axial direction of the blower apparatus 200 than the front end of the blower fan 300.

[0125] Consequently, it is possible to sufficiently increase the flow speed of the air suctioned into the blower fan 300.

[0126] The front end 213A of the suction part 213 means an end of the suction part 213 located at the front F of the blower apparatus 200 in the axial direction of the blower apparatus 200 and the rear end of the suction part 213 means an end of the suction part 213 located at the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200.

[0127] That is, the suction part 213 may have a uniform height. The height of the suction part 213 means the distance from the front end 213A of the suction part 213 to the rear end of the suction part 213.

[0128] The axial section of the suction part 213 may have a linear or curved shape. The axial section means the sectional area of a plane parallel to the axial direction of the blower apparatus 200.

[0129] The connection part 215 connects the suction part 213 and the discharge part 211 to each other. Alternatively, the connection part 215 may be an ideal part meaning a connection point between the rear end of the suction part 213 and the front end of the discharge part 211.

[0130] The connection part 215 guides air suctioned from the front F to the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200 by the blower fan 300.

[0131] Specifically, the connection part 215 may be formed in a shape in which the front F and the rear R of the blower apparatus 200 in the axial direction of the blower apparatus 200 are opened and the connection part 215 surrounds the blower fan 300 in a direction perpendicular to the axial direction of the blower apparatus 200. That is, the connection part 215 is formed approximately in a cylindrical shape.

[0132] The blower fan 300 is disposed in the connection part 215. The connection part 215 defines an air flow channel around the blower fan 300.

[0133] The center of the connection part 215 may be aligned with the shaft of the blower fan 300.

[0134] The sectional area of the connection part 215 may be sufficient such that the blower fan 300 is disposed in the connection part 215 and the blower fan 300 is rotatable.

[0135] Specifically, the front end of the connection part 215 is connected to the rear end of the suction part 213 and the rear end of the connection part 215 is connected to the front end of the discharge part 211.

[0136] Ribs 217 to increase rigidity of the orifice 210 may be disposed at the outer circumference of the orifice 210.

[0137] The ribs 217 are disposed around the orifice 210 in a radial manner to increase rigidity of the orifice 210.

[0138] FIG. 6 is a perspective view showing a blower fan according to an embodiment of the present invention, FIG. 7 is a plan view of the blower fan shown in FIG. 6, and FIG. 8 is a side view of the blower fan shown in FIG. 6.

[0139] Referring to FIGS. 6 to 8, the blower fan 300 according to the embodiment of the present invention includes a hub 310 fixed to a rotary shaft 231, a main rib 320 disposed to surround the hub 310 while being spaced apart from the outer circumference of the hub 310, a plurality of auxiliary ribs 330 connected to the outer circumference of the main rib 320 to connect the hub 310 and the main rib 320 to each other, and a plurality of blades 340 coupled to the outer circumference of the hub 310 to generate an air stream during rotation of the blower fan 300.

[0140] The hub 310 is fixed to the rotary shaft 231. Specifically, the hub 310 may be formed in a cylindrical shape surrounding the rotary shaft 231.

[0141] More specifically, the hub 310 may be disposed at a plane perpendicular to the rotary shaft 231 to surround the rotary shaft 231 in a cylindrical shape.

[0142] The auxiliary rib 330 is connected to the outer circumference of the hub 310. A space in which the rotary shaft 231 is located is defined in the hub 310.

[0143] The hub 310 is rotated according to rotation of the rotary shaft 231 to transmit rotational force to the blades 340 and the auxiliary rib 330.

[0144] The main rib 320 is disposed to surround the hub 310 while being spaced apart from the outer circumference of the hub 310.

[0145] Specifically, the main rib 320 may be disposed at a plane perpendicular to the rotary shaft 231 to surround the hub 310 while being spaced apart from the outer circumference of the hub 310

[0146] The main rib 320 may be formed in various shapes so long as the main rib 320 is disposed at a plane perpendicular to the rotary shaft 231 to surround the hub 310.

[0147] Specifically, the main rib 320 may be disposed at a plane perpendicular to the rotary shaft 231 such that the main rib 320 is symmetric with respect to the rotary shaft 231.

[0148] More specifically, the main rib 320 may be on a plane perpendicular to the rotary shaft 231 having a cylindrical shape with the rotary shaft 231 as its axis.

[0149] The main rib 320 may include a main rib inner circumference 321, to which the auxiliary rib 330 is coupled, and a main rib outer circumference 323, to which the blades 340 are coupled.

[0150] When the hub 310 is rotated to transmit rotational force to the blades 340, the main rib 320 eliminates stress concentrated between the blades 340 and the hub 310.

[0151] The blades 340 are connected to the main rib outer circumference 323 of the main rib 320 to generate an air stream directed from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300.

[0152] The blades 340 may be formed in various shapes so long as the blades 340 generates an air stream directed from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300 during rotation.

[0153] For example, the blades 340 may be disposed at a plane perpendicular to the rotary shaft 231 such that the blades 340 are gradually inclined toward the rear R of the blower fan 300 in the axial direction of the blower fan 300 from the front of the blades 340 in the rotational direction of the blades 340 to the rear of the blades 340 in the rotational direction of the blades 340.

[0154] As shown in FIG. 7, each blade 340 may include a blade inner edge 349 adjacent to the hub 310, a blade outer edge 343 opposite to the blade inner edge 349, a blade front edge 345 defining the front outline of the blade 340 in the rotational direction of the blade 340, and a blade rear edge 347 defining the rear outline of the blade 340 in the rotational direction of the blade 340. That is, the border of each blade 340 is defined by the blade inner edge 349, the blade outer edge 343, the blade front edge 345, and the blade rear edge 347.

[0155] The blade inner edge 349 of each blade 340 may be coupled to the outer circumference of the main rib 320.

[0156] The blade front edge 345 may be positioned forward than the blade rear edge 347.

[0157] The blade front edge 345 may be located more adjacent to the front F of the blower fan 300 in the axial direction of the blower fan 300 than the blade rear edge 347. When the blades 340 are rotated in the rotational direction of the blades 340, therefore, the blade front edge 345 generates an air stream directed from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300 since the blade front edge 345 is located more adjacent to the front F of the blower fan 300 in the axial direction of the blower fan 300 than the blade rear edge 347.

[0158] The blade front edge 345 may be positioned forward than the blade rear edge 347 in the axial direction of the blower fan.

[0159] Each blade 340 may be on a plane perpendicular to the rotary shaft 231 such that the blade 340 is shaped, from its front tip in the rotational direction of the blower fan 300 to its rear end, to be curved toward the rear of the blower fan.

[0160] Of course, in order to smoothly achieve the air stream generated from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300, the blades 340 may be rounded while being on a plane perpendicular to the rotary shaft 231 such that the blades 340 are gradually inclined toward the rear R of the blower fan 300 in the axial direction of the blower fan 300 from the front of the blades 340 in the rotational direction of the blades 340 to the rear of the blades 340 in the rotational direction of the blades 340.

[0161] The blade rear edge 347 may have a waveform shape 348. Specifically, the blade rear edge 347 may be convex and concave in the forward and backward directions of the blades 340 in the rotational direction of the blades 340. Alternatively, the blade rear edge 347 may be convex and concave from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300.

[0162] An air stream generated along a positive pressure plane of each blade 340 (a plane at the rear R of the blower fan 300 in the axial direction of the blower fan 300) generates noise when leaving the blade rear edge 347. In a case in which the blade rear edge 347 has a waveform shape 348, noise is reduced due to interference between air streams leaving the blade rear edge 347.

[0163] A radius R1 of the main rib 30 may be 20 % to 30 % a radius R2 of the blade outer edge 343. As shown in FIG. 7, the radius means a radius having the rotary shaft 231 as the center at a plane perpendicular to the rotary shaft 231. In particular, the radius R2 of the blade outer edge 343 is the largest in radii of the entire edges of the blades.

[0164] If the radius R1 of the main rib 30 is less than 20 % the radius R2 of the blade outer edge 343, the contact area between the blade outer edge 343 and the outer circumference 323 of the main rib 320 is decreased with the result that stress applied to the blade inner edge 349 is increased during rotation of the blades 340. On the other hand, if the radius R1 of the main rib 30 is greater than 30 % the radius R2 of the blade outer edge 343, stress applied to the blade inner edge 349 is decreased during rotation of the blades 340. However, the radius of the main rib 320 is increased with the result that manufacturing cost of the main rib 320 is increased. In addition, the area of the main rib 320 is increased with the result that a flow rate of the blower fan 300 is decreased.

[0165] The auxiliary rib 330 connects between the hub 310 and the main rib 320 to eliminate stress concentrated at the outer circumference of the hub 310 during rotation of the blades 340. In addition, the auxiliary rib 330 generates an air stream during rotation of the blades 340.

[0166] The auxiliary rib 330 is coupled to the outer circumference of the hub 310 such that the auxiliary rib 330 is connected between the hub 310 and the main rib 320.

[0167] The plurality of auxiliary ribs 330 is arranged around the hub 320.

[0168] The auxiliary rib 330 generates an air stream to one direction. For example, the auxiliary rib 330 may be rotated by the hub 310 to generate an air stream during the rotation of the blower fan in the same direction with the plurality of blades 340. The auxiliary rib 330 generates an air stream from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300.

[0169] Specifically, an inner edge of the auxiliary rib 330 is connected to the outer circumference of the hub 310 and an outer edge of the auxiliary rib 330 is connected to the inner circumference 321 of the main rib 320.

[0170] The auxiliary rib 330 may be on a plane perpendicular to the rotary shaft 231 such that the auxiliary rib 330 is disposed about the rotary shaft in a radial manner.

[0171] The plurality of auxiliary ribs 330 is shaped, from its front tip in the rotational direction of the blower fan 300 to its rear end, to be curved toward a rear of the blower fan 300.

[0172] A plurality of auxiliary ribs 330 may be provided. A plurality of auxiliary ribs may be arranged apart from each other. The number of the auxiliary ribs 330 is not particularly restricted. For example, the number of the auxiliary ribs 330 may correspond to that of the blades 340.

[0173] The auxiliary rib 330 may include an inner edge adjacent to the hub 310, an outer edge opposite to the inner edge, an auxiliary rib front edge 335 defining the front outline of the auxiliary rib 330 in the rotational direction of the blade 340, and an auxiliary rib rear edge 337 defining the rear outline of the auxiliary rib 330 in the rotational direction of the blade 340. That is, the border of auxiliary rib 330 is defined by the inner edge, the outer edge, the auxiliary rib front edge 335, and the auxiliary rib rear edge 337.

[0174] The auxiliary rib 330 may have a shape to generate an air stream directed from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300 during rotation. Specifically, the auxiliary rib 330 may be disposed at a plane perpendicular to the rotary shaft 231 such that the auxiliary rib 330 is gradually inclined toward the rear R of the blower fan 300 in the axial direction of the blower fan 300 from the front of the blades 340 in the rotational direction of the blades 340 to the rear of the blades 340 in the rotational direction of the blades 340.

[0175] More specifically, the auxiliary rib front edge 335 may be located more adjacent to the front F of the blower fan 300 in the axial direction of the blower fan 300 than the auxiliary rib rear edge 337. Also, the auxiliary rib front edge 335 is positioned forward than the auxiliary rib rear edge 337 in the axial direction of the blower fan.

[0176] When the auxiliary rib 330 are rotated in the rotational direction of the auxiliary rib 330, therefore, the auxiliary rib 330 generates an air stream directed from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300 due to the shape of the auxiliary rib 330.

[0177] Of course, in order to smoothly achieve the air stream generated from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300, the auxiliary rib 330 may be rounded while being disposed at a plane perpendicular to the rotary shaft 231 such that the auxiliary rib 330 is gradually inclined toward the rear R of the blower fan 300 in the axial direction of the blower fan 300 from the front of the auxiliary rib 330 in the rotational direction of the auxiliary rib 330 to the rear of the auxiliary rib 330 in the rotational direction of the auxiliary rib 330.

[0178] A thickness of the plurality of auxiliary ribs 330 increases gradually from the main rib 320 to the hub 310.

[0179] The auxiliary rib rear edge 337 may have a waveform shape 337-1. Specifically, the auxiliary rib rear edge 337 may be convex and concave in the forward and backward directions of the auxiliary rib 330 in the rotational direction of the auxiliary rib 330. Alternatively, the auxiliary rib rear edge 337 may be convex and concave from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300.

[0180] An air stream generated along a positive pressure plane of auxiliary rib 330 (a plane at the rear R of the blower fan 300 in the axial direction of the blower fan 300) generates noise when leaving the auxiliary rib rear edge 337. In a case in which the auxiliary rib rear edge 337 has a waveform shape, air streams may be slightly delayed when leaving the auxiliary rib rear edge 337 and, therefore, noise is reduced due to interference between the air streams.

[0181] The auxiliary rib rear edge 337 adjacent to the main rib 320 and the blade rear edge 347 adjacent to the main rib 320 may be adjacent to each other on a circumference (for example, the main rib 320) having the rotary shaft as the center.

[0182] FIG. 9A is a view illustrating the flow of air generated by a conventional blower fan. FIG. 9B is view illustrating the flow of air generated by the blower fan according to the embodiment of the present invention.

[0183] Referring first to FIG. 9A, the conventional blower fan is configured to have a structure in which a main plate extends from a hub in a radial direction of the hub and blades are coupled to the outer circumference of the main plate.

[0184] Specifically, the main plate is disposed at a plane perpendicular to the rotary shaft 231 such that the main plate extends outward from the outer circumference of the hub to surround the outer circumference of the hub.

[0185] When the blades are rotated, an air stream is generated from the front F to the rear R of the blower fan in an axial direction of the blower fan by the blades.

[0186] At this time, a space defined between the main plate and the hub is closed such that the air stream cannot pass through the space. As a result, the air stream generated by rotation of the blades forms an eddy on the main plate at the rear R in an axial direction of the blower fan.

[0187] The eddy reduces efficiency of the blower fan and increased noise.

[0188] Referring now to FIG. 9B, the blower fan 300 according to the embodiment of the present invention is configured such that the auxiliary rib 330 is connected between the hub 310 and the main rib 320 and the auxiliary rib 330 is formed in the shape of a blade. Consequently, stress generated during rotation of the blades 340 is distributed to the main rib 320 and the auxiliary rib 330. During rotation of the blades 340, the auxiliary rib 330 is also rotated to generate an air stream.

[0189] Consequently, an air stream flowing from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300 is generated in a space defined between the hub 310 and the main rib 320. When an air stream flowing from the front F to the rear R of the blower fan 300 in the axial direction of the blower fan 300 is generated in the space defined between the hub 310 and the main rib 320, efficiency of the blower fan is improved and an eddy generated at the hub 310 at the rear R of the blower fan 300 in the axial direction of the blower fan 300 is reduced, thereby reducing noise.

[0190] FIG. 10 is a plan view showing a blower fan according to another embodiment of the present invention.

[0191] Referring to FIG. 10, a blower fan 300A according to this embodiment is different from the blower fan according to the embodiment shown in FIG. 7 in that the position of the auxiliary rib 330 is changed.

[0192] Specifically, the auxiliary rib rear edge 337 adjacent to the main rib 320 and the blade rear edge 347 adjacent to the main rib 320 may be alternately arranged on a circumference (for example, the main rib 320) having the rotary shaft as the center.

[0193] More specifically, a connection of the auxiliary rib rear edge 337 to the main rib 320 and a connection of the blade rear edge 347 to the main rib 320 may alternate along the circumference of the main rib 320.

[0194] Also, a connection of the auxiliary rib rear edge 337 to the main rib 320 and a connection of the blade rear edge 347 to the main rib 320 correspond to each other on an inner and outer surface of the main rib 320.

[0195] When an air stream leaves the blade rear edge 347 and the auxiliary rib rear edge 337, noise is generated. In the above structure in which the auxiliary rib rear edge 337 adjacent to the main rib 320 and the blade rear edge 347 adjacent to the main rib 320 are alternately arranged on the circumference (having the rotary shaft as the center, noise is reduced due to interference between air streams leaving the blade rear edge 347 and the auxiliary rib rear edge 337.

[0196] As is apparent from the above description, the blower fan according to the present invention and the air conditioner having the same have one or more of the following effects.

[0197] In the blower fan and the air conditioner having the same according to the embodiment of the present invention, the auxiliary rib is connected between the hub and the main rib and the auxiliary rib is formed in the shape of a blade. Consequently, stress generated during rotation of the blades is distributed to the main rib and the auxiliary rib. During rotation of the blades, the auxiliary rib is also rotated to generate an air stream, thereby increasing a flow rate of air blown by the blower fan.

[0198] In addition, an air stream flowing from the front F to the rear R of the blower fan in the axial direction of the blower fan is generated in the space defined between the hub and the main rib, thereby improving efficiency of the blower fan. Furthermore, an eddy generated at the hub at the rear of the blower fan in the axial direction of the blower fan is reduced, thereby reducing noise.

[0199] As the flow rate of air blown by the blower fan is increased, heat exchange performance of the heat exchanger is improved, thereby improving efficiency of the air conditioner.

[0200] It will be appreciated by those skilled in the art that the present invention pertains that the effects that can be achieved through the present invention are not limited to what has been particularly described hereinabove and other advantages of the present invention will be more clearly understood from the accompanying claims.

[0201] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope of the invention as disclosed in the accompanying claims.

Claims

1. A blower fan comprising:

    a hub (310) fixed to a rotary shaft;
    a main rib (320) disposed to surround the hub while being spaced apart from an outer circumference of the hub;
    a plurality of auxiliary ribs (330) connecting the hub and the main rib; and
    a plurality of blades (340) connected to an outer circumference of the main rib so as to generate an air stream during rotation of the blower fan, wherein
    the plurality of auxiliary ribs (330) is arranged around the hub so as to generate an air stream during the rotation of the blower fan in the same direction with the plurality of blades (340).

2. The blower fan according to claim 1, wherein an inner edge of the plurality of auxiliary ribs (330) is connected to the outer circumference of the hub (310) and an outer edge of the plurality of auxiliary ribs (330) is connected to an inner circumference of the main rib (320), and
    the plurality of auxiliary ribs (330) is on a plane perpendicular to the rotary shaft such that the plurality of auxiliary ribs (330) is disposed about the rotary

shaft in a radial manner.

3. The blower fan according to claim 1 or 2, wherein the plurality of auxiliary ribs (330) is shaped, from its front tip in the rotational direction of the blower fan to its rear end, to be curved toward a rear of the blower fan.

4. The blower fan according to any of claims 1 to 3, wherein the plurality of auxiliary ribs (330) comprises:

   an auxiliary rib front edge (335) defining a front outline of the auxiliary rib in the rotational direction of the blades; and
   an auxiliary rib rear edge (337) defining a rear outline of the auxiliary rib in the rotational direction of the blades, and
   wherein the auxiliary rib front edge (335) is positioned forward than the auxiliary rib rear edge (337) in the axial direction of the blower fan.

5. The blower fan according to any of claims 1 to 4, wherein the number of the plurality of auxiliary ribs (330) corresponds to that of the plurality of blades (340).

6. The blower fan according to claim 4 or 5, insofar as dependent upon claim 4, wherein the auxiliary rib rear edge (337) has a waveform shape.

7. The blower fan according to any of preceding claims, wherein the main rib (320) is on a plane perpendicular to the rotary shaft, having a cylindrical shape with the rotary shaft as its axis.

8. The blower fan according to claim 7, wherein a radius of the main rib (320) is 20 % to 30 % a radius of rotation of the plurality of blades (340).

9. The blower fan according to any of preceding claims, wherein each blade (340) comprises:

   a blade front edge (345) defining a front outline of the blade in the rotational direction of the blade; and
   a blade rear edge (347) defining a rear outline of the blade in the rotational direction of the blade, and
   wherein the blade front edge (345) is positioned forward than the blade rear edge (347) in the axial direction of the blower fan.

10. The blower fan according to claim 9, insofar as dependent upon claim 4, wherein
an inner edge of each blade (340) is connected to the outer circumference of the main rib (320), and
a connection of the auxiliary rib rear edge (337) to the main rib (320) and a connection of the blade rear edge (347) to the main rib (320) alternate along the circumference of the main rib (320).

11. The blower fan according to claim 9, insofar as dependent upon claim 4, wherein a connection of the auxiliary rib rear edge (337) to the main rib (320) and a connection of the blade rear edge (347) to the main rib (320) correspond to each other on an inner and outer surface of the main rib (320).

12. The blower fan according to claim 9, 10 or 11, wherein the blade rear edge (347) has a waveform shape.

13. The blower fan according to any of preceding claims, wherein each blade (340) is on a plane perpendicular to the rotary shaft such that the blade (340) is shaped, from its front tip in the rotational direction of the blower fan to its rear end, to be curved toward the rear of the blower fan.

14. The blower fan according to any of preceding claims, wherein the plurality of auxiliary ribs (330) is arranged apart from each other.

15. The blower fan according to any of preceding claims, wherein a thickness of the plurality of auxiliary ribs (330) increases gradually from the main rib (320) to the hub (310).

FIG. 1

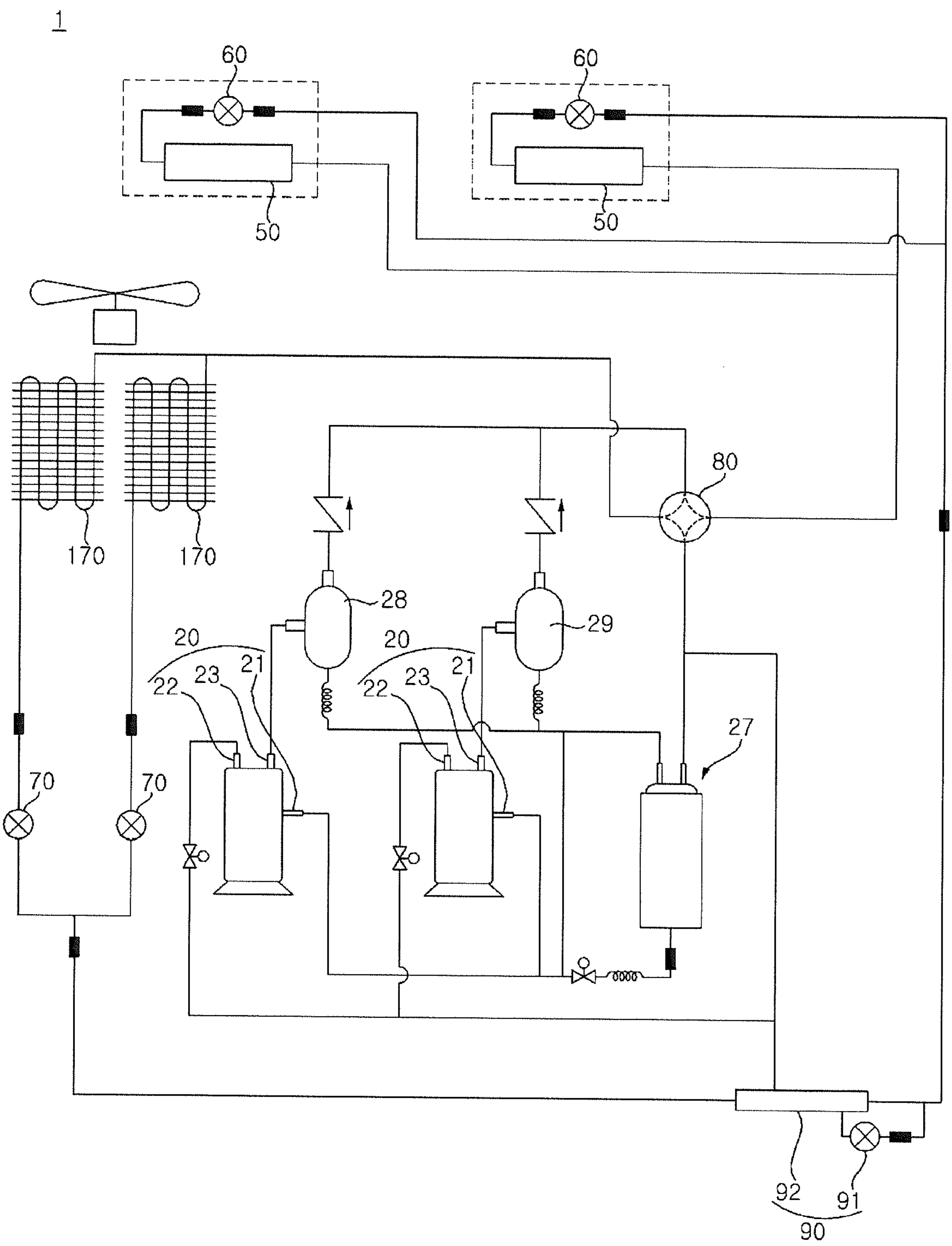

FIG. 2

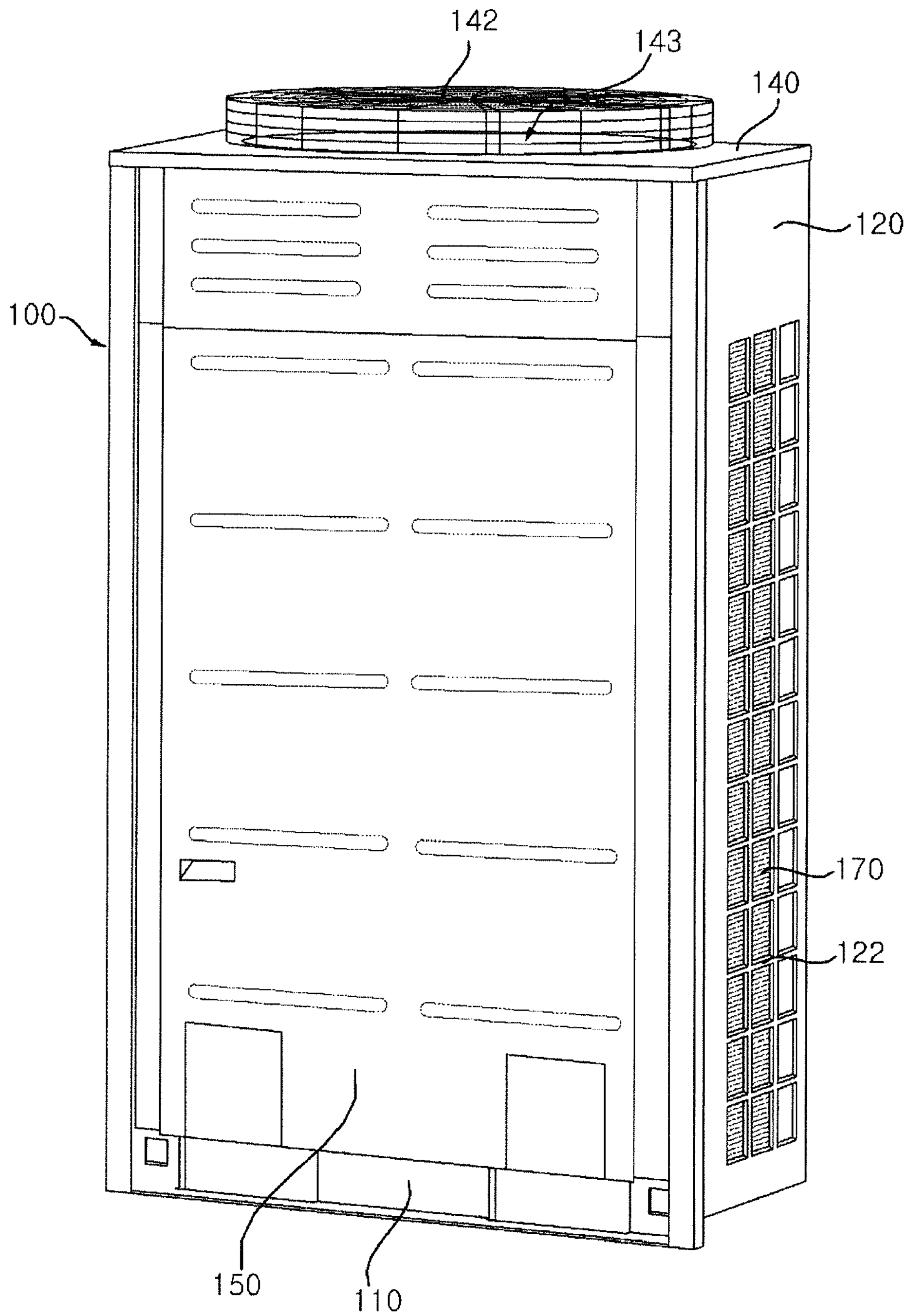

FIG. 3

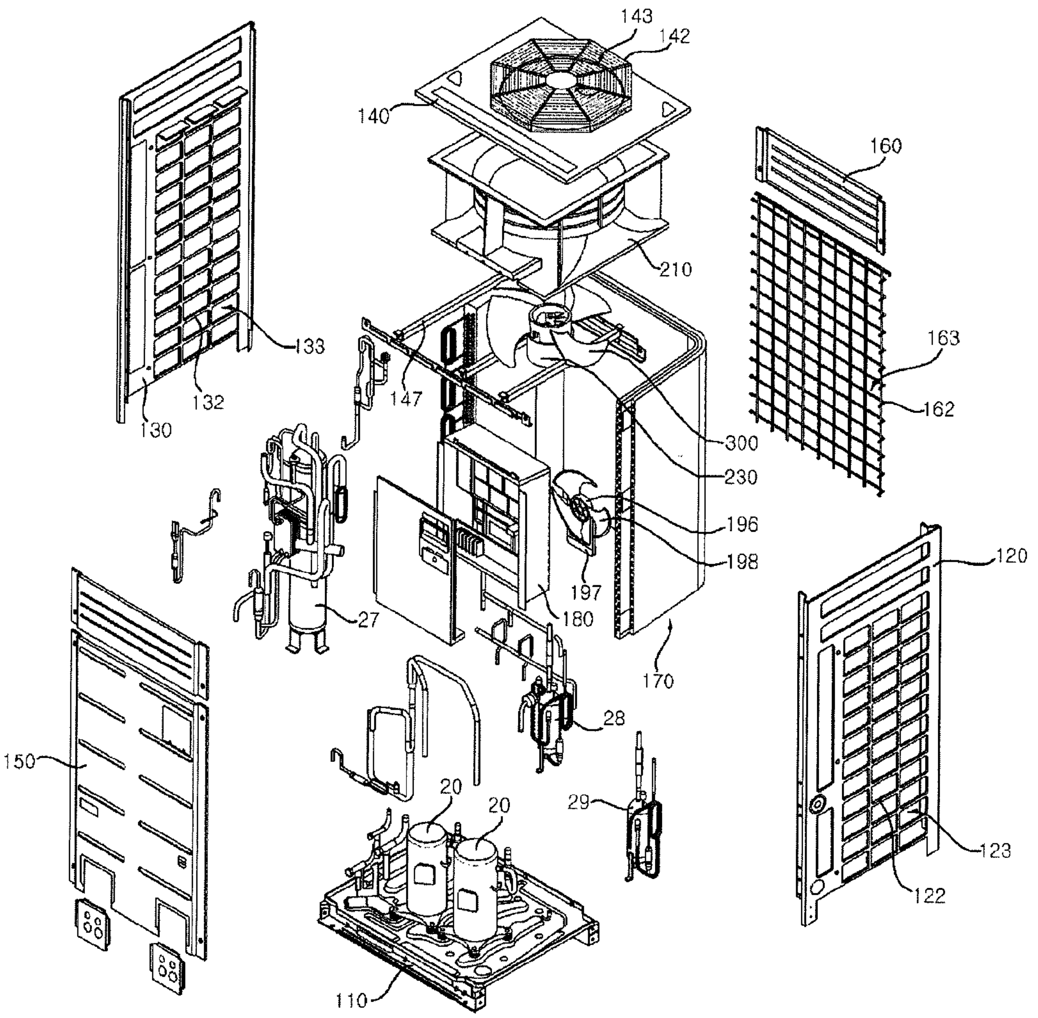
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FIG. 4

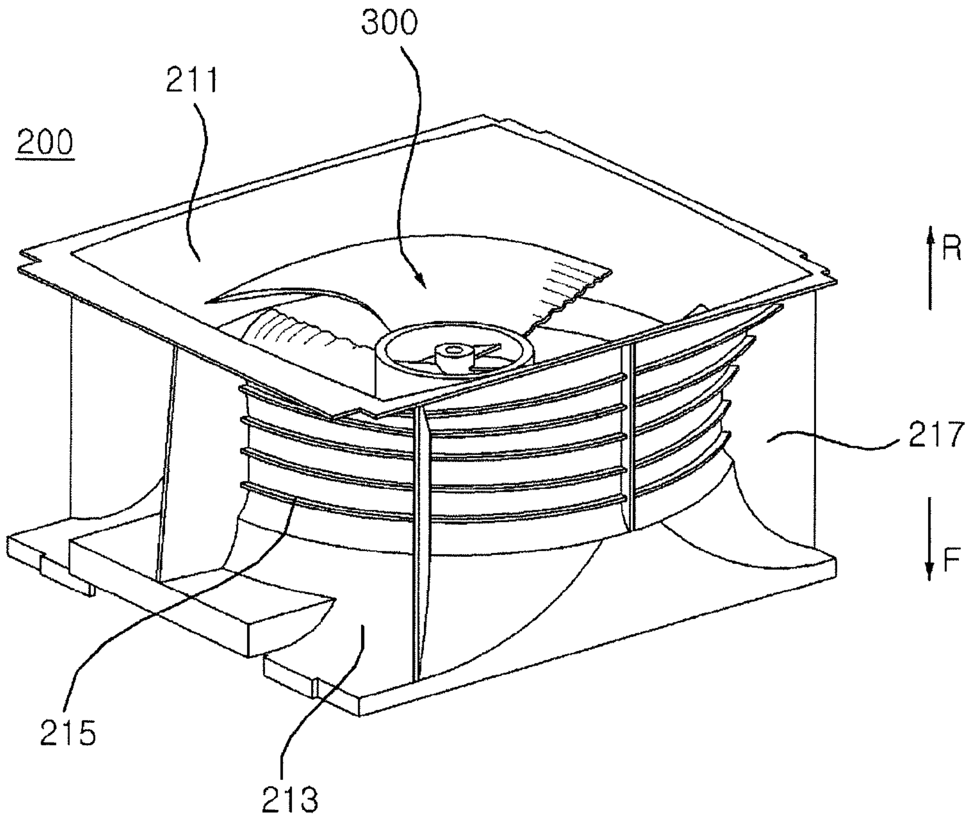
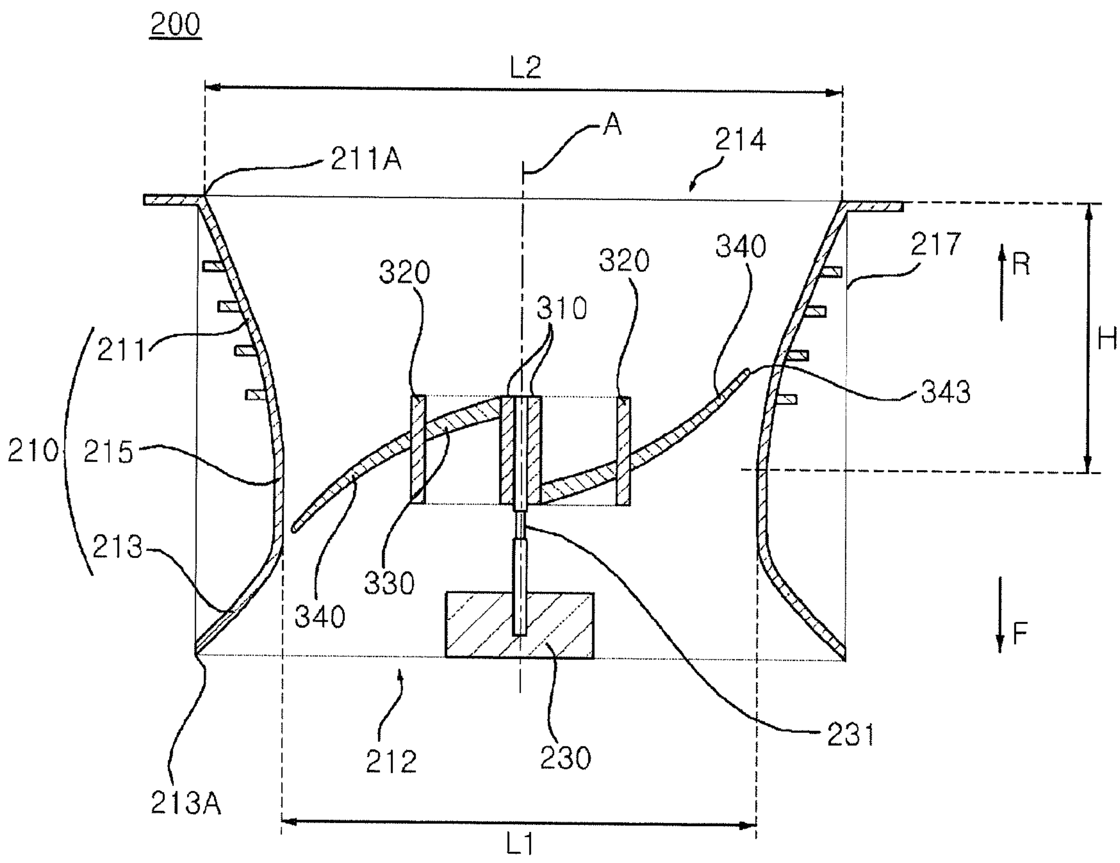


FIG. 5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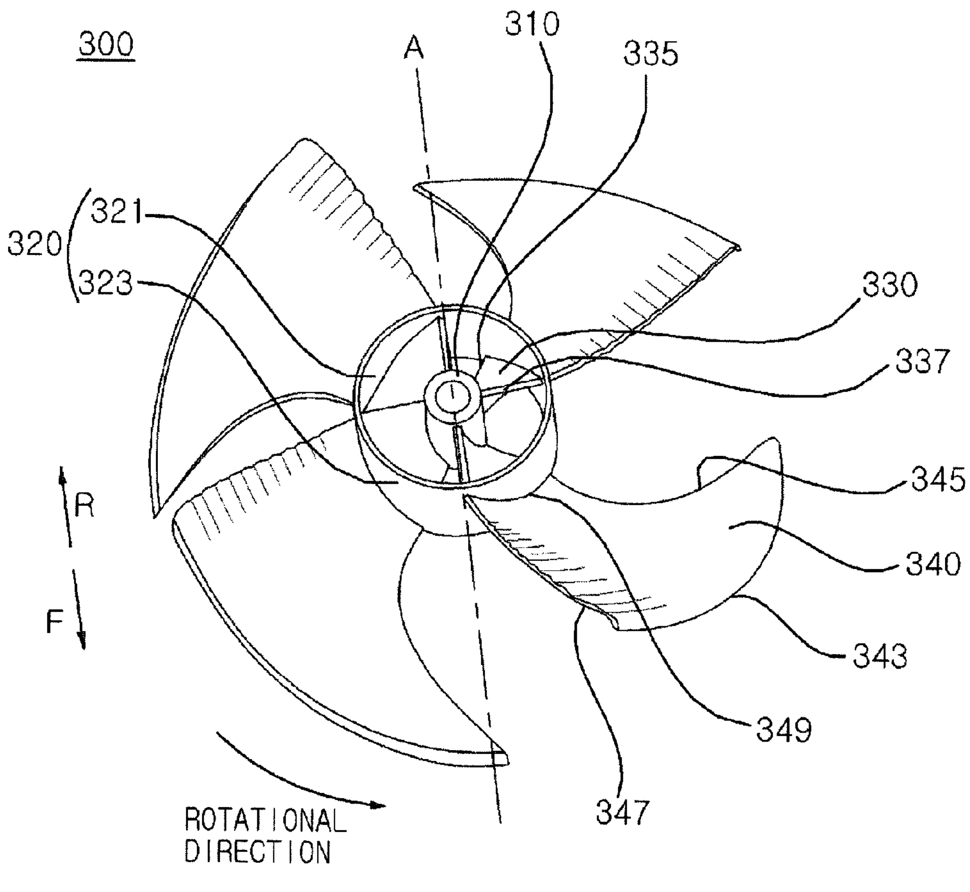
211A
320
320
340
217
R
310
H
211
343
210
215
213
330
340
F
212
230
231
213A
L1

FIG. 6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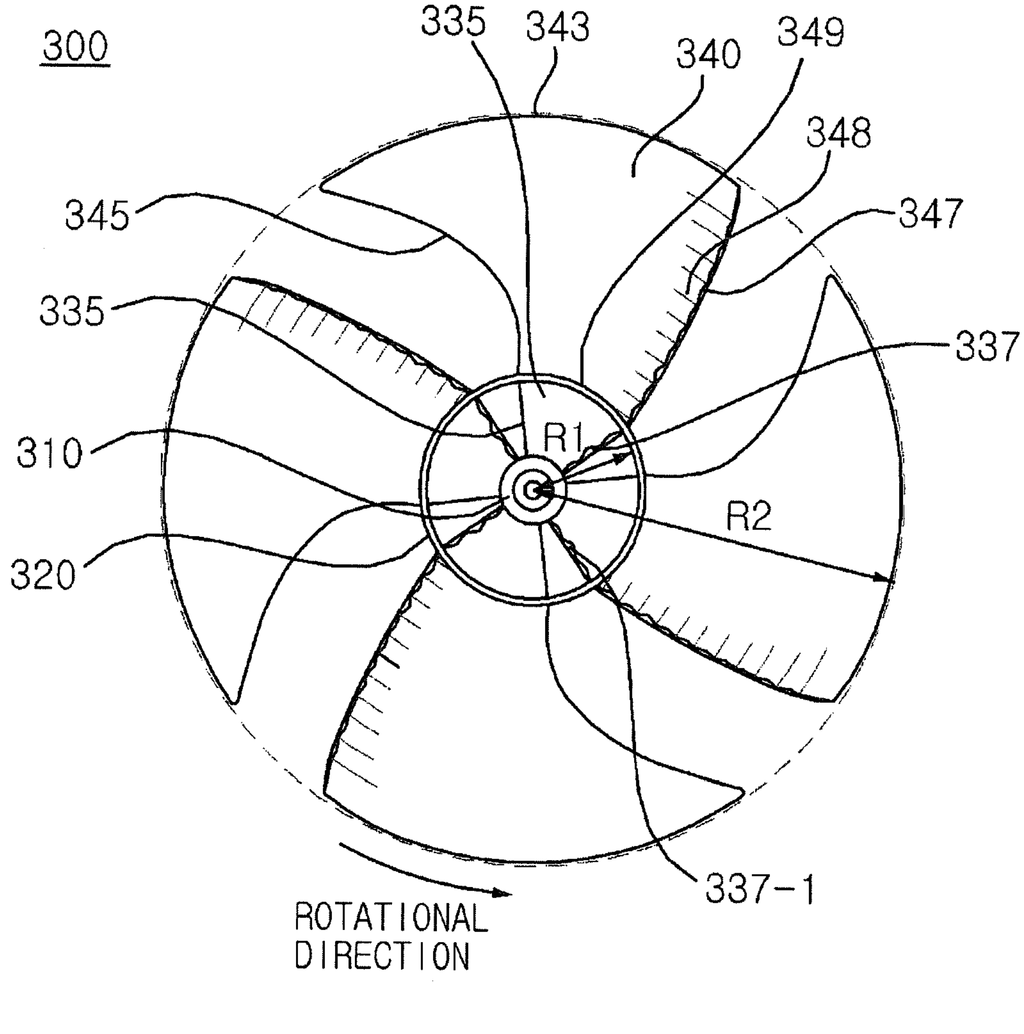
DIRECTION

FIG. 7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DIRECTION

FIG. 8

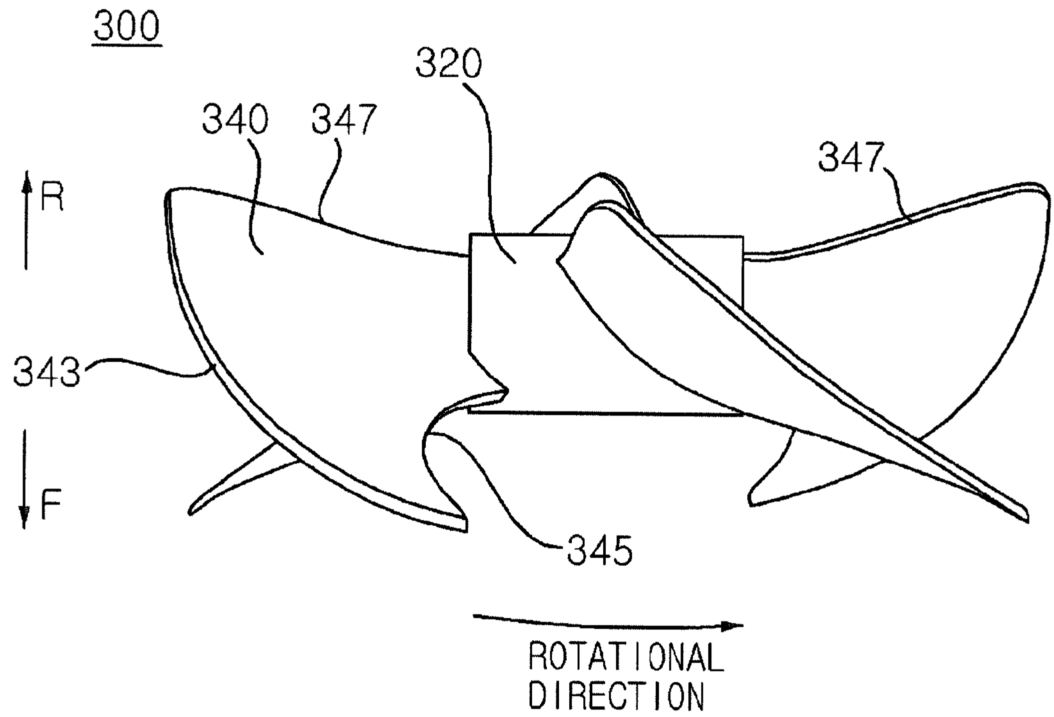


FIG. 9a

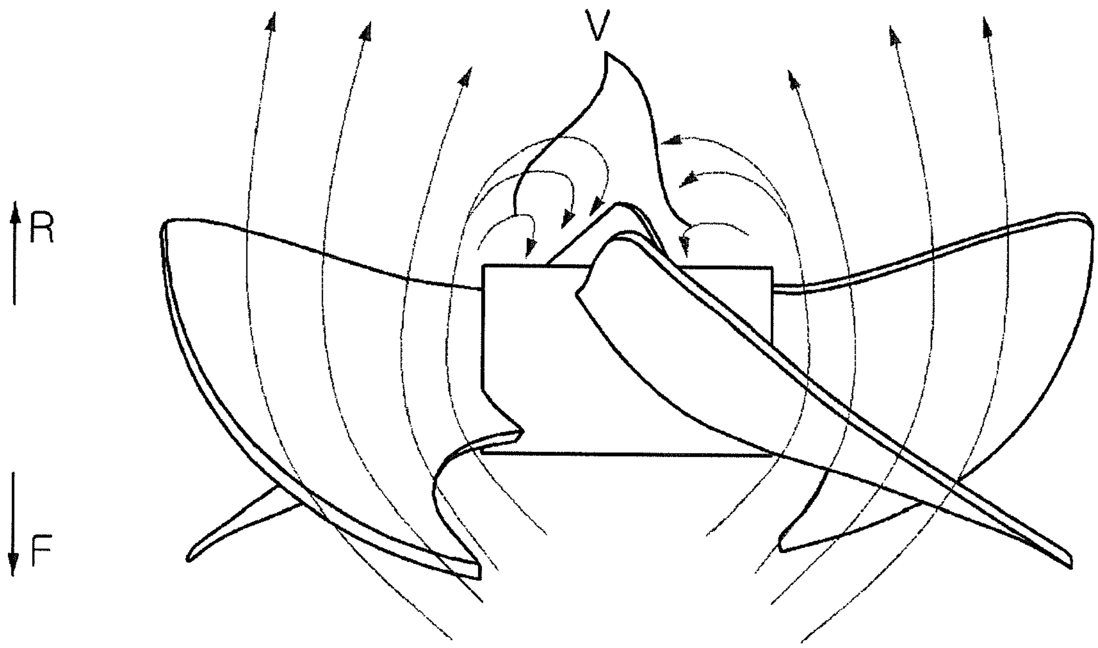


FIG. 9b

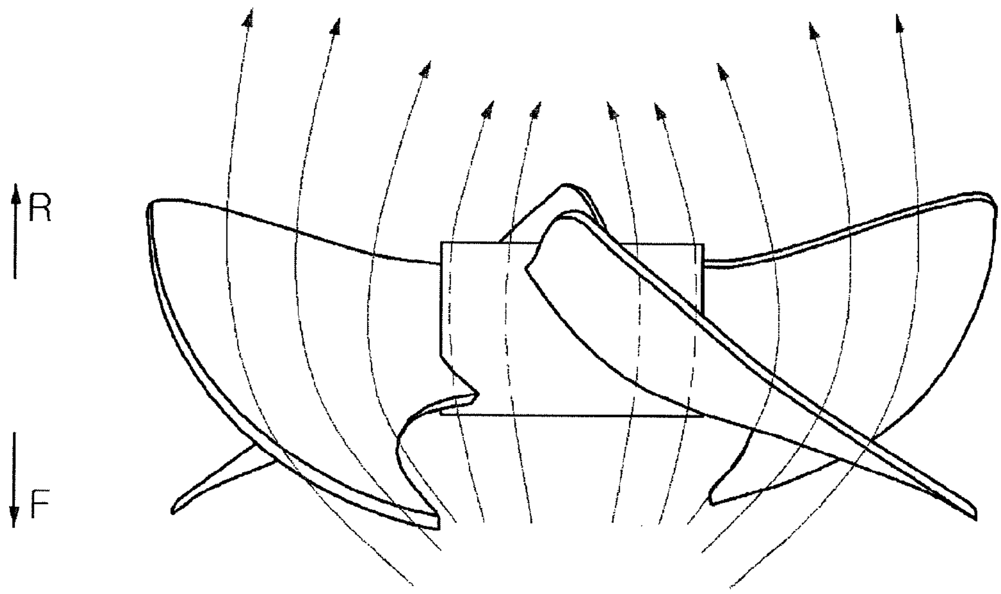
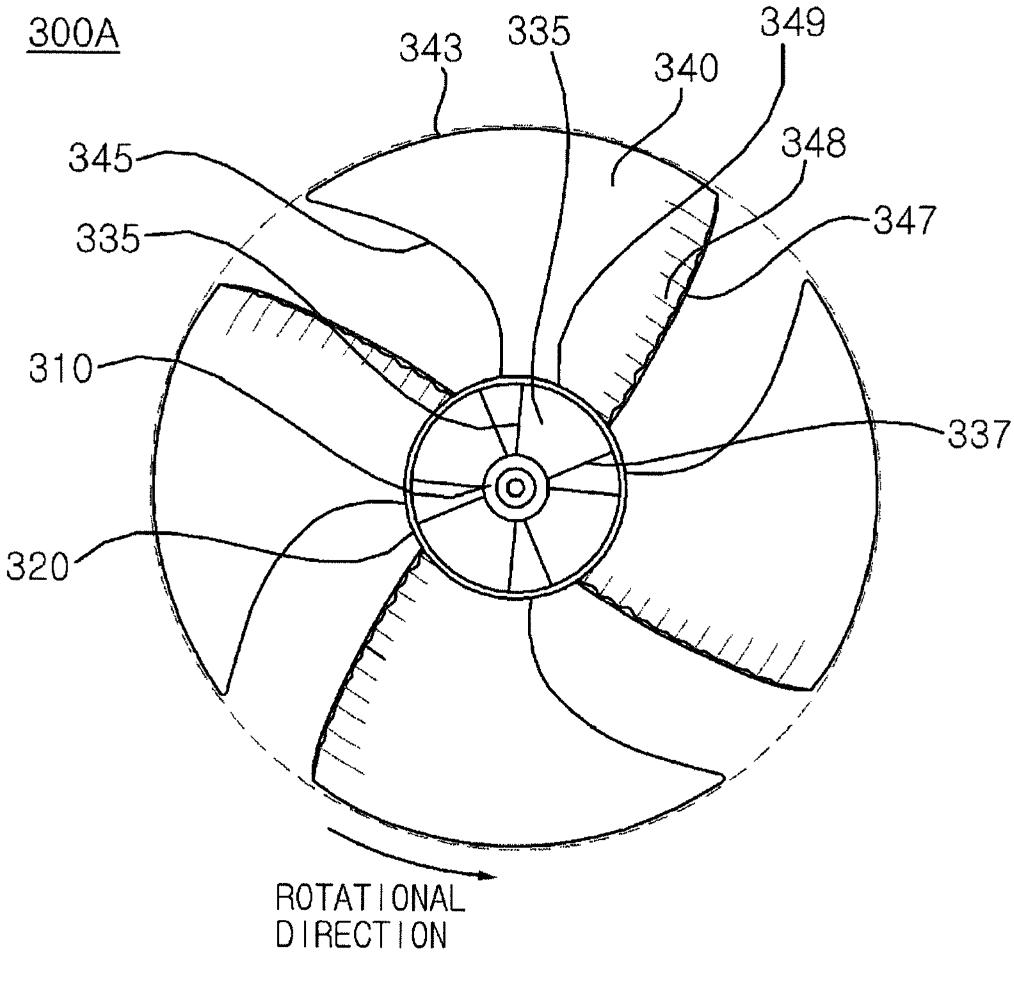


FIG. 10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EUROPEAN SEARCH REPORT

Application Number
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X	JP S64 53496 U (KAWASAKI) 3 April 1989 (1989-04-03) * figures 1,2 * -----	1-15	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 October 2015	de Martino, Marcello

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