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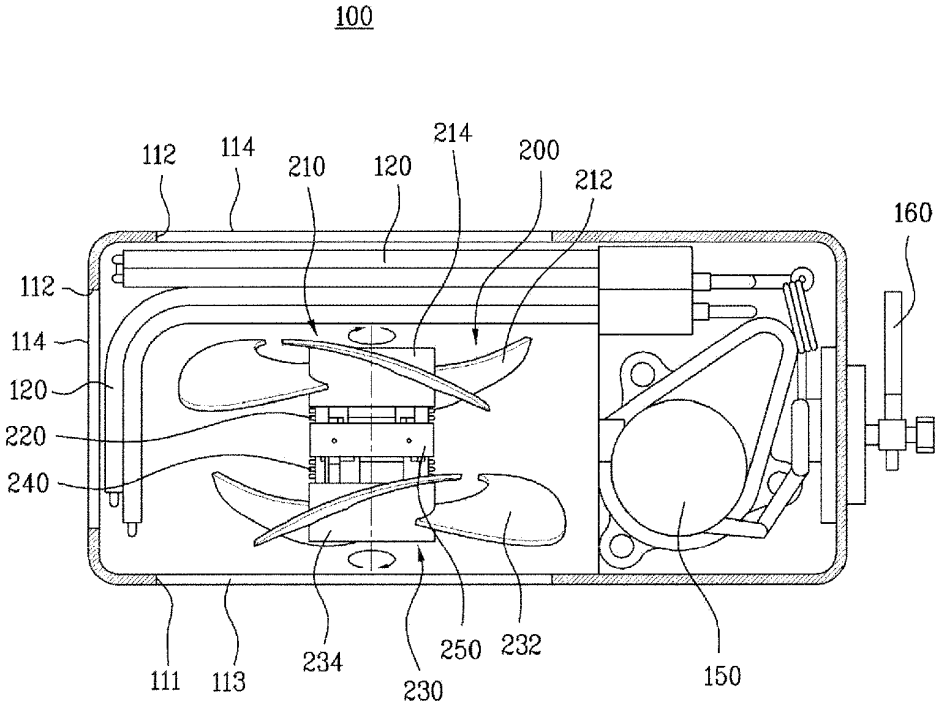
(54) Ventilating device and outdoor unit having the same

(57) A ventilating device and an outdoor unit including the same are disclosed. More particularly, the present invention relates to a ventilating device including a counter-rotating fan having improved wind ventilation efficiency as well as minimized noise generated during the fan operation.

FIG. 2



EP 2 354 685 A2

Description

[0001] The present invention relates to a ventilating device and an outdoor unit having the same.

[0002] In general, air conditioners are electric appliances configured to cool or heat an indoor space. Such an air conditioner includes an indoor unit installed in a room and an outdoor unit installed outside, with connected with the indoor unit via a refrigerant pipe or electric wire. Here, the indoor unit and the outdoor unit may be integrally formed according to the kind of the air conditioner including the same.

[0003] There may be a multi-type air conditioner including a plurality of indoor units connected to a single outdoor unit or a system air conditioner including a plurality of indoor units connected to a plurality of outdoor units, to operate the indoor and outdoor units selectively.

[0004] Such an outdoor unit includes a case configured to define an exterior appearance and a fan provided in the case to generate air flow, an outdoor unit heat-exchanger provided in the case to heat exchange air drawn into the case with refrigerant provided therein, and a compressor configured to compress the refrigerant heat-exchanged in the outdoor heat exchanger as well as an indoor exchanger.

[0005] An inlet configured to draw external air therein and an outlet configured to exhaust the drawn air after heat-exchanged by the outdoor heat exchanger may be formed in the case. A grill may be provided in the outlet to protect the fan and to prevent external foreign substance from being drawn toward the fan.

[0006] The outdoor unit may perform heat radiation and heat absorption according to cooling or heating for the room and it may operate the fan to improve heat exchange efficiency during the heat radiation or absorption. Because of that, the outdoor unit has to be supplied a sufficient air flow rate.

[0007] In addition, even though the outdoor unit is installed outdoor typically, severe noise has to be prevented.

[0008] The noise generated in the outdoor unit may be in proportion to the rotation speed of the fan and the rotation speed of the fan may be in proportion to the wind amount of the fan. As the air flow rate is increasing, the noise may be increasing together with that. Because of that, it is required to secure an appropriate air flow rate of a ventilating device provided in the outdoor unit and to reduce the noise.

[0009] An object of the present invention is to provide a ventilating device including a counter-rotating fan capable of minimizing the noise generated during the operation of the fan, with improved ventilation efficiency, and an outdoor unit including the ventilating device. This object is achieved with the features of the claims.

[0010] Accordingly, the present invention is directed to a ventilating device and an outdoor unit including the same.

[0011] Additional advantages, objects, and features of the disclosure will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0012] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, an outdoor unit includes a housing comprising an inlet and an outlet; an outdoor heat exchanger mounted in the housing; a first fan comprising a plurality of first blades arranged in a radial direction; a second fan comprising a plurality of second blades arranged in the radial direction; and at least one motor configured to rotate the first fan and the second fan in a different direction, wherein shafts of the first fan and the second fan are arranged on same straight line and the shaft direction height of each first blade of the first fan is different from the shaft direction height of each second blade of the second fan.

[0013] The first fan may be arranged between the outdoor heat exchanger and the second fan and the shaft direction height of each second blade of the second fan may be larger than the shaft direction height of each first blade of the first fan.

[0014] The shaft direction height of each second blade of the second fan may be one times or more and less than four times as much as the shaft direction height of each first blade of the first fan.

[0015] Each first blade of the first fan and each second blade of the second fan may have a pitch angle of 20 degree or more and less than 30 degree.

[0016] Each first blade of the first fan and each second blade of the second fan may have a sweep angle of 20 degree or more and less than 60 degree.

[0017] The number of the first blades of the first fan and the number of the second blades of the second fan may be 2 to 5, respectively.

[0018] The outdoor unit may further include a first motor configured to drive the first fan; and a second motor configured to drive the second fan, wherein shafts of the first and second motors are arranged on same straight line.

[0019] The first motor and the second motor are arranged in a different direction, to have the shafts arranged on same straight line.

[0020] The rotation speed of the first motor may be different from the rotation speed of the second motor.

[0021] The rotation speed of the second motor may be higher than the rotation speed of the first motor.

[0022] The rotation speed of the second motor may be two times or more and less than three times as much as the rotation speed of the first motor.

[0023] Each first blade of the first fan and each second blade of the second fan may have a different directional slope.

[0024] In another aspect of the present invention, a ventilating device includes a first fan comprising a plurality of first blades arranged in a radial direction; a first motor configured to drive the first fan; a second fan comprising a plurality of second blades arranged in the radial direction; and a second motor configured to drive the second fan, wherein each first blade of the first fan and each second blade of the second fan have a different directional slope and a shaft direction height of each second blade of the second fan is larger than a shaft direction height of each first blade of the first fan.

[0025] The height of each second blade of the second fan may be one times or more and less than four times as much as the height of each first blade of the first fan.

[0026] Each first blade of the first fan and each second blade of the second fan may have a pitch angle of 20 degree or more and less than 30 degree.

[0027] Each first blade of the first fan and each second blade of the second fan may have a sweep angle of 20 degree or more and less than 60 degree.

[0028] The number of the first blades of the first fan and the number of the second blades of the second fan may be 2 to 5, respectively.

[0029] The first motor and the second motor may be arranged in an opposite direction to each other, with a single motor mount located there between, and the rotation speed of the second motor may be higher than the rotation speed of the first motor.

[0030] The rotation speed of the second motor may be two times or more and less than three times as much as the rotation speed of the first motor.

[0031] The first motor and the second motor may rotate the first fan and the second fan in an opposite direction, respectively.

[0032] The first motor and the second motor may be mounted to a single motor mount in a different direction, to have shafts of the motors arranged on same straight line.

[0033] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

[0034] The accompanying drawings, which are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the disclosure and together with the description serve to explain the principle of the disclosure.

[0035] In the drawings:

[0036] FIG. 1 is a perspective view illustrating an outdoor unit according to the present invention;

[0037] FIG. 2 is a sectional view illustrating the outdoor unit according to the present invention;

[0038] FIG. 3 is a side-sectional view and a plane view illustrating a first fan according to the present invention;

[0039] FIG. 4 is a side-sectional view and a plane view illustrating a second fan according to the present invention;

[0040] FIG. 5 is a diagram illustrating the result of experiments on noise and the wind ventilation amount of a fan mounted to an indoor unit or ventilating device according to the present invention; and

[0041] FIG. 6 is a diagram illustrating relation of noise according to sweep angle change of each fan.

[0042] Reference will now be made in detail to the specific embodiments of the present invention, examples of which are illustrated in the accompanying drawings. It is to be understood by those of ordinary skill in this technological field that other embodiments may be utilized, and structural, electrical as well as procedural changes may be made without departing from the scope of the present invention. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0043] FIG. 1 is a perspective view illustrating an outdoor unit according to the present invention. The outdoor unit according to the present invention includes a housing 110 having an inlet 112 (not shown) and an outlet 111 formed therein, with a grill provided in the grill, and a ventilating device having a fan (not shown) provided between the inlet 112 and the outlet 111 to blow winds. The inlet 112 may be formed in a rear surface of the housing 110, in opposite to the outlet 111.

[0044] A ventilating ability as variable of heat exchange capacity of an indoor unit may be depending on a capacity of the ventilating device provided in the outdoor unit. The ventilating ability of the fan provided in the outdoor unit may be in proportion to the size of the fan. Here, it has to be put into consideration that the size of the outdoor unit is limited. Also, nose generated in the fan installed in a limited space has to be reduced as much as possible.

[0045] As a result, the outdoor unit according to the present invention includes the housing 110 having the inlet 112 and the outlet 111 formed therein, an outdoor heat exchanger 120 mounted in the housing, a first fan 210 having a plurality of blades arranged along a radial direction, a second fan 230 having a plurality of second blades arranged along a radial direction, and at least one motor configured to rotate the first fan 210 and the second fan 230 in a different direction. Shafts of the first fan and the second fan 230 may be arranged in a rectilinear direction. A first blade 212 of the first fan 210 and a second blade 232 of the second fan230 are slope in a different direction. The shaft-direction height of the first blade 212 provided in the first fan 210 is different from that of the second blade 232 provided in the second fan 230.

[0046] The outdoor unit according to the present invention may include the first fan 210 and the second fan 230 rotating in a different direction with respect to the first fan 210. As follows, the ventilating device including a counter-rotating fan according to the present invention and the outdoor unit including the ventilating device will be described in detail.

[0047] FIG. 2 is a sectional view of the outdoor unit 100 according to the present invention. The housing 110

of the outdoor unit according to the present invention may include the inlet 112 formed in at least one surface thereof. According to an embodiment shown in FIG. 2, the inlet 112 may be provided in rear and side surfaces of the housing 110.

[0048] An outdoor heat exchanger 120 may be further provided to heat-exchange with air drawn via the inlet 112 and the outdoor heat exchanger 120 may be extendedly bent to face the inlets provided in rear and side surfaces of the housing and to use the air drawn via the inlet 112in heat-exchanging.

[0049] A compressor 150 may be provided in the housing 110 to compress refrigerant used as heat-exchange medium, with circulating an indoor heat exchanger of an indoor unit and the outdoor heat exchanger 120.

[0050] The compressor 150 may be provided in a predetermined portion of the housing 110, connected with a high/low pressure refrigerant pipe 160 connecting the outdoor unit and the indoor unit with each other.

[0051] The outdoor unit according to the present invention may include a ventilating device 200 having counter-rotating fans configured to rotate in a different direction, to decrease noise generated in the outdoor unit and to compensate loss of air ventilation generated by the noise decrease.

[0052] Specifically, the ventilating device may include a first fan 210 having a plurality of first blades 212 arranged in a radial direction, a first motor 220 configured to drive the first fan, a second fan 230 having a plurality of second blades 232 arranged in a radial direction, a second motor 240 configured to drive the second fan 230. The first blades 212 o the first fan 210 and the second blades 232 of the second fan 230 may be inclined in a different direction. The shaft direction height of the second blades 232 provided in the second fan 230 may be larger than that of the first blades 212 provided in the first fan 210.

[0053] According to the embodiment shown in FIG. 2, the motors configured to drive the fans, respectively, may be provided separately. Each of the motors may be mounted in a single motor mount 250 oppositely.

[0054] In other words, as shown in FIG. 2, shafts of the motors may be on same straight line arranged in an opposite direction, with the motor mount 250 located there between.

[0055] Each shaft (not shown) configured to transmit a rotational force of each motor 220 and 240 to each fan 210 and 230 may be placed on the same line (shown as dotted line). However, each motor 220 and 240 rotates each shaft in a different direction and this is the characteristic of the present invention.

[0056] Specifically, the first fan 210 and the second fan 230 have shafts arranged on the same line, respectively, and they are rotated in an opposite direction. The rotation speeds of the motor may be different from each other, which will be described later.

[0057] As follows, the ventilating device according to the present invention and a fan of an outdoor unit having the ventilating device will be described in reference to FIG. 3.

[0058] FIG. 3 is a side sectional view and a plane view illustrating the first fan 210.

[0059] Typically, a fan mounted in the conventional outdoor unit includes a plurality of blades. As shown in FIG. 3, the first fan 210 includes three first-blades 212. The second fan 230 generates pressure difference used to make external air drawn via the inlet 112 formed in the housing 110 and then heat-exchanged in the outdoor heat exchanger 120, to be discharged via the outlet 111 formed in the housing. Because of that, the second fan 230 provided below the first fan 210 with respect to a sectional view of the outdoor unit shown in FIG. 2 may be rotated along a predetermined direction shown in FIG. 3(a), to exhaust air via the outlet 111 formed in the housing 110.

[0060] The first fan 210 includes a plurality of blades provided in a first body 214 coupled to a first shaft (not shown) rotated by the first motor 220. Each of the blades 212 may be connected to the first body 214 at a predetermined angle (pitch angle).

[0061] The pitch angle (θp) means an angle formed by a line connecting both right and left ends of the blade and a plane perpendicular to the shaft of the fan, in close relation to the wind ventilation amount and noise.

[0062] In addition, as shown in the plane view of the first fan 210 shown in FIG. 2(b), an angle of each blade with respect to a downward direction (sweep angle) may be in relation with to the wind ventilation amount and noise of the fan. The sweep angle (θs) may be defined as angle formed by a line connecting a connected point between the blade and the body with the shaft and a line connecting a connected point (P) between the blade and the body and an outer end of the blade.

[0063] The pitch angle of the first fan shown in FIG. 3, that is, a first pitch angle ($\theta p1$) may have a predetermined range of 20 to 25 degree and a first sweep angle ($\theta s1$) that is, the sweep angle (θs) may have a predetermined range of 20 to 60 degree.

[0064] The shaft direction height of each blade composing the fan may mean the maximum height of a single blade with respect to the side sectional view of the fan.

[0065] According to the embodiment shown in FIGS. 3 and 4, the shaft direction height (h1 and h2) may be determined by a diameter and the pitch angle of the blade of the fan. In case of the same pitch angle, the shaft direction height may be increasing as the diameter of the fan is increasing.

[0066] The ventilating device or outdoor unit according to the present invention has assumption of limited space. Because of that, the diameter of the fan may be fixed.

[0067] As a result, the shaft direction height (h1 and h2) may be in proportion to the pitch angle if the size of each body of the blade or the size of each blade is identical.

[0068] The number of the first blades 212 of the first fan 210 and the second blades 232 of the second fan

230 may be 2 less than 5.

[0069] FIG. 4 is a side sectional view and a plane view illustrating the second fan 230. Repeated description between FIG. 3 and FIG. 4 will be omitted. The second fan 230 may be provided in rear of the first fan 210. Because of that, air drawn via the inlet 112 of the housing may be ventilated by the first fan 210 and the second fan 230 sequentially, to be discharged via the outlet 111.

[0070] The first fan 210 and the second fan 230 may be rotated in an opposite direction and they ventilate air in an identical direction. Because of that, each of the blades may be coupled to the body of the fan to have a different slope. That is, the pitch angle of each blade composing each fan has a different direction.

[0071] Here, the pitch angle of the second fan shown in FIG. 4, that is, a second pitch angle (θp2) may have a range of 25 to 30 degree. The swift angel (θs), that is, a second sweep angle (θs2) also has a range of 20 to 60 degree.

[0072] Like the first fan 210, the second fan 230 generates pressure difference used to make external air drawn via the inlet 112 formed in the housing 110 and heat-exchanged in the outdoor heat exchanger 120, to be exhausted via the outlet 111 formed in the housing 110 after that.

[0073] Also, the second fan 230 may be configured to rotate in an opposite direction with respect to the first fan 210.

[0074] When the two fans are configured to rotate in an opposite direction, it is known that straightness of winds is improved and noise is reduced, with improved wind ventilation.

[0075] The ventilating device or the outdoor unit including the ventilating device is invented to achieve contrary objects of improved ventilation efficiency and noise reduction in a limited room, in a balanced way. As a result, the appearance (shaft direction height (h2/h1), pitch angle and/or sweep angle) of each fan may be determined based on a result of experiments shown in FIGS. 5 and 6.

[0076] FIG. 5 is the result of the experiments for noise and air ventilation amount of the fan mounted in the indoor unit or the ventilating device of the present invention. More specifically, FIG. 5(a) illustrates the size of noise generated according to the ratio of the shaft direction height of the first fan 210 to the shaft direction height of the second fan (h2/h1). FIG. 5(b) illustrates the size of the hourly air ventilation amount according to the ratio of the shaft direction height of the first fan 210 to the shaft direction height of the second fan (h2/h1).

[0077] A horizontal axis of a graph shown in FIG. 5(a) is a dimensionless variable meaning the second shaft direction height (h2)/the first shaft direction shaft (h1) as the ration of the shaft direction heights (h2/1). That is, the horizontal axis of the graph shown in FIG. 5 (a) shows that the second shaft direction height (h2) of the second fan 230 is getting larger than the shaft direction height (h1) of the first fan 210 as coming along a rightward direction. In other words, as coming rightward, the shaft direction height (h2) of the second fan 230, which is a rear fan, is getting larger than the shaft direction height (h1) of the first fan 210, which is a front fan. It means that the first fan 210 which is the front fan is slimmer than the second fan 230 which is the rear fan.

[0078] According to the result of experiments shown in FIG. 5(a), when the ratio of the shaft direction height (h1) to the other (h2) is less than a predetermined value, it is shown that noise is increasing drastically. If the ratio of the second shaft height (h2) to the first shaft direction height (h1) is less than a predetermined value near '1', that is, if the shaft direction heights (h1 and h2) of the first fan 210 is identical to or larger than those of the second fan 230, it is shown that noise is increasing drastically. In other words, if the ratio of the second shaft direction height (h2) to the first shaft direction height (h1) is approximately less than 1, the generated noise may be approximately 55dB or more. If the ratio of the second shaft direction height (h2) to the first shaft direction height (h1) is approximately 1 or more, the generated noise may be less than 55dB.

[0079] According to FIG. 5(b) illustrating the result of experiments for the wind ventilation amount, if the ratio of the second shaft direction height (h2) to the first shaft direction height (h1) is increased to be a predetermined value or more, it is identified that the wind ventilation amount is decreasing drastically. According to the embodiment shown in FIG. 5, when the ratio of the second shaft direction height (h2) to the first shaft direction height (h1) is approximately 4 or more, it is identified that the wind ventilation amount is less than 30 M^3/m3.

[0080] In other words, when the ratio (h2/h1) is a large value, that is, when the first fan 210 which is the front fan is slimmer than the second fan 230 which is the rear fan, enough wind ventilation amount may be secured.

[0081] Because of that, it is preferable that the ratio of the second shaft direction height (h2) to the first shaft direction height (h1) is approximately 1 to less than 4, in an aspect of noise reduction and wind ventilation amount increase.

[0082] FIG. 6 illustrates a relation of noise with respect to sweep angle change of each fan.

[0083] As shown in FIG. 6, it is identified that noise is increasing drastically when the sweep angle is less than a predetermined value. In other words, when the sweep angle of each blade is less than 20 degree, noise is increasing steeply near to 60dB.

[0084] Because of that, the sweep angle of each blade composing each fan may be 20 degree or more. Increasing the sweep angle blindly because of the noise reduction effect may deteriorate the wind ventilation amount. As a result, the sweep angle may be less than 60 degree.

[0085] According to the result of experiments shown in FIGS. 5 and 6, it is preferable that the ratio of the second shaft direction height (h2) to the first shaft direction height (h1) is approximately between 1 and 4 and that the sweep angle of each blade composing each fan is approximately between 20 and 60.

[0086] Also, when the ratio (h2/h1) is determined in the limited internal space of the outdoor unit, the pitch angle of the blades composing each fan may be determined corresponding to the diameter of each fan.

[0087] The pitch angle of the first fan 210 may be approximately between 20 and 25 the pitch angle of the second fan 210 may be approximately between 25 and 35. That is, it is preferable that the pitch angle of each blade composing the second fan 230 which is the rear fan is formed lager than the pitch angle of each blade composing the first fan 210 which is the front fan. Here, it is assumed that the number of the blades of each fan is similar to each other.

[0088] Although not shown in the result of the experiments, when each rotation speed of the first and second fans 210 and 230 is varied, with the ratio (h2/h1) being approximately between 1 and 4 and the sweep angle of each blade composing each fan being approximately between 20 and 60, the ratio of the second fan rotation speed (rpm2) to the first fan rotation speed (rmp1) to satisfy a predetermined low noise reference and the required wind ventilation amount may be approximately 2 to less than 3.

[0089] That is, when the rotation speed of the second fan 230 rotating in the opposite direction with respect to the first fan 210, arranged in rear of the first fan 210, is 2 to 3, the effect of noise reduction and wind ventilation amount increase may be achieved. In other words, the noise reduction/wind ventilation amount increase effect may be achieved by the method of rotating the second fan 230 having a predetermined thickness of a side surface at a fast speed.

[0090] According to the ventilating device and the outdoor unit including the same described above, the generated noise may be reduced as much as possible, with the improved wind ventilation amount. Since the wind ventilation amount is increasing, the outdoor unit may be compact-sized. Since the noise generation is reduced, user satisfaction may be improved.

[0091] As mentioned above, the generated noise may be maximized and the wind ventilation efficiency may be improved according to the ventilating device and the outdoor unit including the same.

[0092] Furthermore, according to the ventilating device and the outdoor unit including the same described above, ventilation efficiency may be improved and the outdoor unit may be compact-sized.

[0093] Still further, according to the ventilating device and the outdoor unit including the same described above, noise generation is reduced and user satisfaction may be improved.

Claims

1. An outdoor unit comprising:

a housing comprising an inlet and an outlet;

an outdoor heat exchanger mounted in the housing;

a first fan comprising a plurality of first blades arranged in a radial direction;

a second fan comprising a plurality of second blades arranged in the radial direction; and

at least one motor configured to rotate the first fan and the second fan in a different direction,

wherein shafts of the first fan and the second fan are arranged on same straight line and the shaft direction height of each first blade of the first fan is different from the shaft direction height of each second blade of the second fan.

2. The outdoor unit of claim 1, wherein the first fan is arranged between the outdoor heat exchanger and the second fan and the shaft direction height of each second blade of the second fan is larger than the shaft direction height of each first blade of the first fan.

3. The outdoor unit of claim 2, wherein the shaft direction height of each second blade of the second fan is one times or more and less than four times as much as the shaft direction height of each first blade of the first fan.

4. The outdoor unit of claim 1, 2, or 3, wherein each first blade of the first fan and each second blade of the second fan have a pitch angle of 20 degree or more and less than 30 degree.

5. The outdoor unit of claim 1, 2, or 3, wherein each first blade of the first fan and each second blade of the second fan have a sweep angle of 20 degree or more and less than 60 degree.

6. The outdoor unit of any of claims 1 to 5, wherein the number of the first blades of the first fan and the number of the second blades of the second fan are 2 to 5, respectively.

7. The outdoor unit of any of claims 1 to 6, further comprising:

a first motor configured to drive the first fan; and

a second motor configured to drive the second fan.

8. The outdoor unit of claim 7, wherein the first motor and the second motor are arranged in a different direction, to have the shafts arranged on same straight line.

9. The outdoor unit of claim 8, wherein the rotation speed of the first motor is different from the rotation speed of the second motor.

10. The outdoor unit of claim 9, wherein the rotation speed of the second motor is higher than the rotation speed of the first motor.

11. The outdoor unit of claim 10, wherein the rotation speed of the second motor is two times or more and less than three times as much as the rotation speed of the first motor.

12. The outdoor unit of any of claims 1 to 11, wherein each first blade of the first fan and each second blade of the second fan have a different directional slope.

13. The outdoor unit of any of claims 7 to 12, wherein the first motor and the second motor are mounted to a single motor mount.

14. The outdoor unit of any of claims 1 to 13, wherein the housing includes inlets provided in rear and side surfaces of the housing.

15. The outdoor unit of any of claims 1 to 14, wherein the outdoor heat exchanger is bent to face the inlets provided in rear and side surfaces of the housing and to use the air drawn via the inlet in heat-exchanging.

FIG. 1

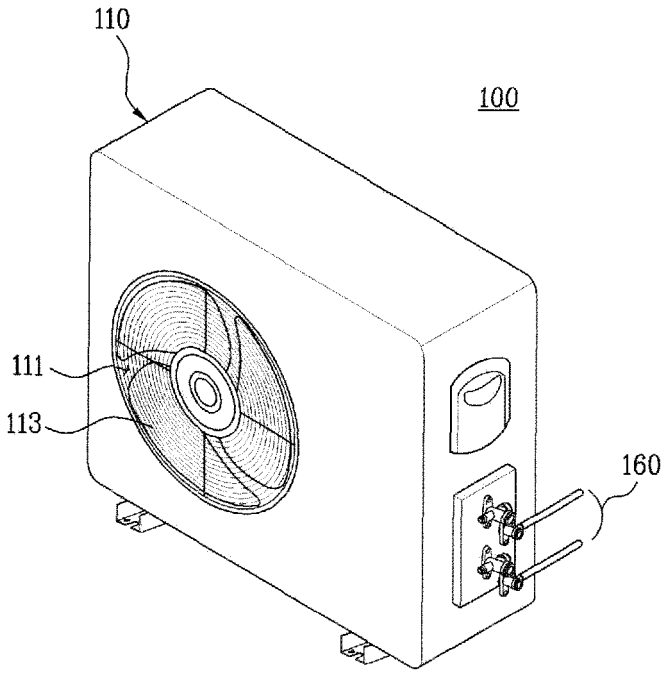
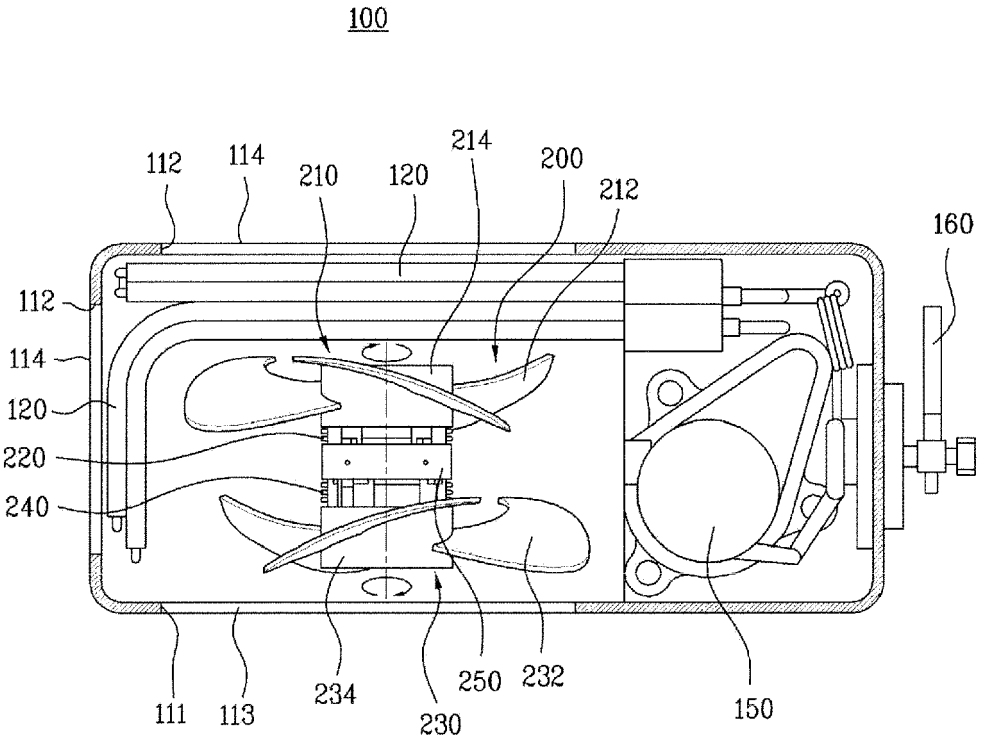


FIG. 2


100
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114
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120
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111
113
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230
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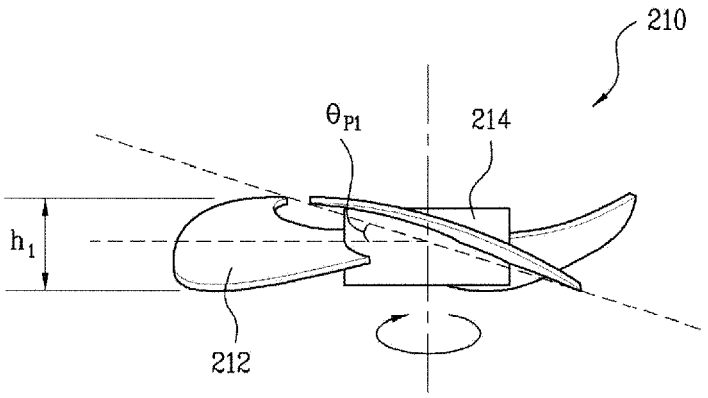
232
150

FIG. 3

(a)



(b)

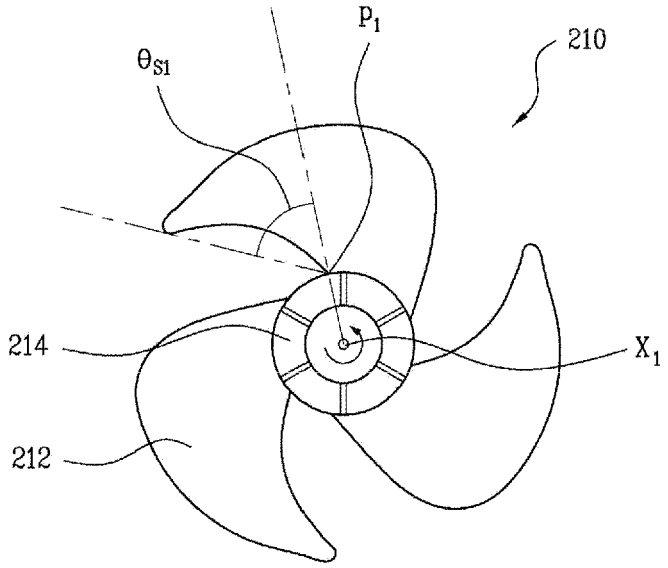
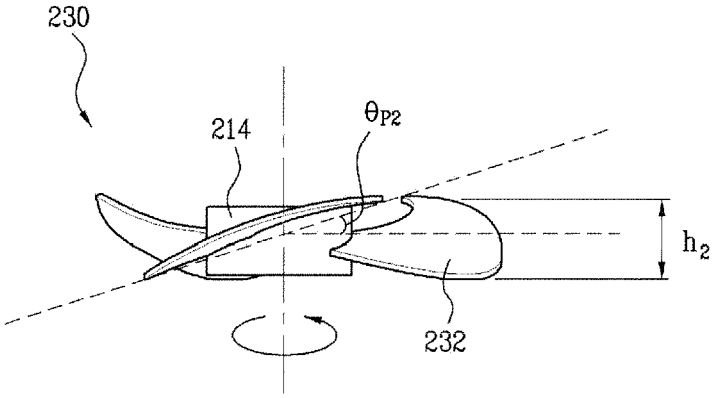


FIG. 4

(a)



(b)

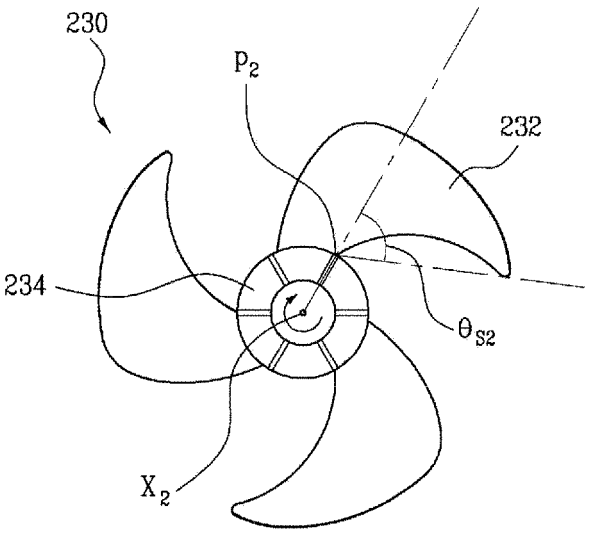
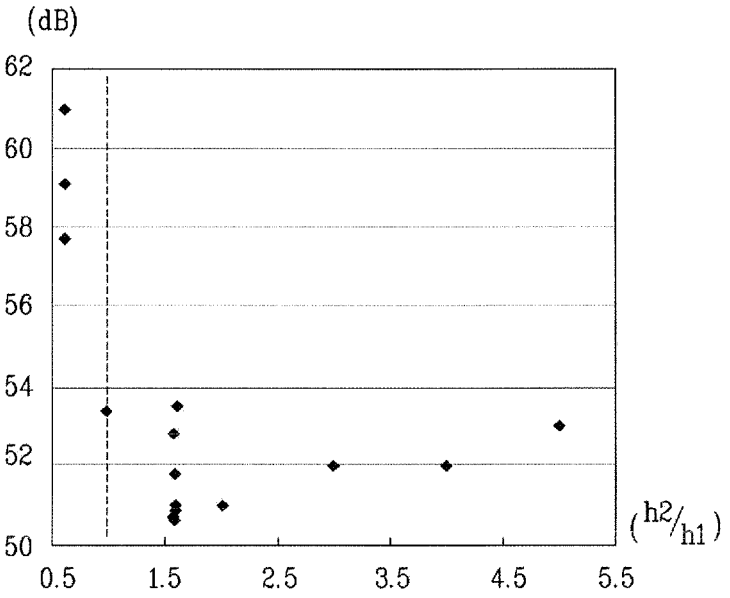


FIG. 5

(a)


(dB)
62
60
58
56
54
52
50
0.5
1.5
2.5
3.5
4.5
5.5
(h2/h1)

(b)

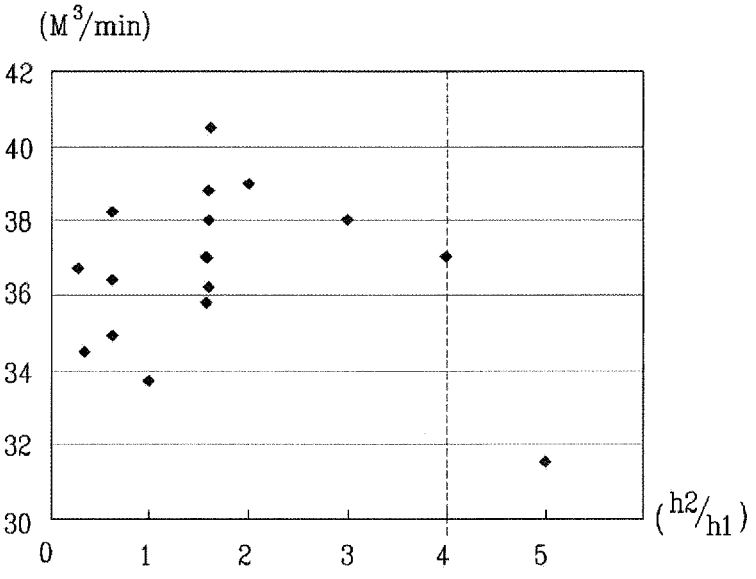

(M3/min)
42
40
38
36
34
32
30
0
1
2
3
4
5
(h2/h1)

FIG. 6