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Description**BACKGROUND OF THE INVENTION****FIELD OF THE INVENTION**

[0001] The present invention relates to an indoor unit and an air-conditioner that provides a comfortable indoor environment by heating or cooling, and more particularly, to a technology that is suitable for use in an indoor unit and air-conditioner that is capable of reducing the operating noise generated in the air blowing system of an indoor unit that uses a tangential fan.

DESCRIPTION OF THE RELATED ART

[0002] Air-conditioners are composed of two large constituent elements in the form of an indoor unit and outdoor unit. Each of these units is equipped with an indoor heat exchanger and outdoor heat exchanger that perform heat exchange between a refrigerant and the indoor air and between refrigerant and the outside air.

[0003] These indoor and outdoor heat exchangers are elements that compose a refrigerant circuit in addition to elements such as a compressor and expansion valve. As a result of refrigerant physically circulating through the circuit, indoor cooling and heating are realized by following a circulation process of thermal changes in state consisting of high-temperature, high-pressure gas, low-temperature, low-pressure gas, high-temperature, high-pressure liquid and low-temperature, low-pressure liquid. Furthermore, this indoor cooling and heating is realized directly by heat exchange between refrigerant within the indoor heat exchanger and indoor air.

[0004] Incidentally, during heating operation, gaseous refrigerant transformed into a high-temperature, high-pressure gas with a compressor is sent to an indoor heat exchanger, and as a result of heat exchange between this refrigerant and indoor air, the refrigerant condenses, realizing a transformation to a high-temperature, high-pressure liquid refrigerant. In addition, during cooling operation, a high-temperature, high-pressure gaseous refrigerant is sent to an outdoor heat exchanger, where a high-temperature, high-pressure liquid refrigerant is formed as a result of heat exchange with the outside air. Subsequently, as a result of the high-temperature, high-pressure liquid refrigerant passing through an expansion valve, its pressure decreases resulting in the formation of a low-temperature, low-pressure liquid refrigerant, which is then sent to an indoor heat exchanger where heat exchange occurs between this refrigerant and the indoor air, causing the refrigerant to evaporate and realizing the formation of a low-temperature, low-pressure gas.

[0005] However, in the case of the above-mentioned air-conditioner, the shape of the casing of the indoor unit has conventionally been determined empirically. Among such air-conditioners, for example, among those widely popular for home use, a tangential fan (cross flow fan) has conventionally been employed as a typical fan provided in the indoor unit.

[0006] In this case, after air in a room (indoor air) that has been taken in by the tangential fan (to be simply referred to as the "fan") has been air-conditioned by passing through an indoor heat exchanger, it is blown into the room after passing through an air duct formed between the outer peripheral surface of the fan and the air duct wall surface of the casing. In this type of indoor unit, it is desirable to further improve the product performance of the air-conditioner by making additional improvements in terms of aerodynamic performance in the form of air quantity and noise level with respect to the fan air blowing system inside the casing, including the shape of the air duct and the shape of the stabilizer provided on the upstream side of the fan.

[0007] On the basis of this background, it is necessary to find basic rules for optimizing the shape of the air duct, shape of the stabilizer, the forms of inflow and discharge of air in the fan air blowing system, and so forth. Furthermore, it is desirable to be able to easily realize lower noise levels and higher efficiency of the air blowing system and casing shape by employing a design that complies with these rules.

[0008] JP-2001 124362 describes an indoor unit for an air conditioner with the features of the preamble portion of claim 1. This indoor unit is provided at an inlet portion of an air duct with a hump-like protrusion and a rear guider that protrudes in the upstream direction of the air duct. It terminates at a nob-like projection at the end of the rear guider which, in one embodiment, can include an arc-shaped tip portion. With this configuration the static pressure during blowing of air should be stabilized.

BRIEF SUMMARY OF THE INVENTION

[0009] In view of the above problems, an object of the present invention is to provide an indoor unit for an air conditioner that is improved with respect to the aerodynamic performance by optimizing the shape of the air blowing system formed in the indoor unit.

[0010] To solve this problem the present invention provides an indoor unit for an air conditioner as defined in claim 1. The invention also provides an air conditioner with such indoor unit. Preferred embodiments of the indoor unit are defined

in the dependent claims.

[0011] The present invention provides an indoor unit comprising a tangential fan that suctions in indoor air from an intake port and blows out that air from a blower outlet, an indoor heat exchanger that performs heat exchange between the above indoor air and refrigerant supplied from an outdoor unit, an indoor unit controller composed of various electrical circuit elements, and a casing that houses each of these devices, and provides the following constitution for solving the above problems.

[0012] A first aspect of the present invention is characterized by f/D being within the range of 0.002 to 0.003 ($0.002 \leq f/D \leq 0.003$) when the fan diameter of the above tangential fan is taken to be D , and the width of the intake diaphragm provided on the upstream side of the air duct inlet inside the above casing is taken to be f .

[0013] According to this type of indoor unit, by designing such that f/D is $0.002 \leq f/D \leq 0.003$, a reduction in the noise level of the fan air blowing system can be achieved for the same air quantity.

[0014] A second aspect of the present invention is characterized by g/D being 0.06 or more ($0.06 \leq g/D$) when the fan diameter of the above tangential fan is taken to be D , and the width of the inverted portion of incoming air flow provided on the upstream side of the air duct inlet inside the above casing is taken to be g .

[0015] According to this type of indoor unit, by designing such that g/D is $0.06 \leq g/D$, a reduction in the noise level of the fan air blowing system can be achieved for the same air quantity.

[0016] A third aspect of the present invention is characterized by e/D being within the range of 0.25 to 0.3 ($0.25 \leq e/D \leq 0.3$), and γ being within the range of 80 degrees to 90 degrees ($80 \text{ degrees} \leq \gamma \leq 90 \text{ degrees}$) when the fan diameter of the above tangential fan is taken to be D , the length of the auxiliary intake path provided on the upstream side of the air duct inlet inside the above casing is taken to be e , and the intake diaphragm angle is taken to be γ .

[0017] According to this type of indoor unit, by designing such that e/D is $0.25 \leq e/D \leq 0.3$ and γ is $80 \text{ degrees} \leq \gamma \leq 90 \text{ degrees}$, a reduction in the noise level of the fan air blowing system can be achieved for the same air quantity.

[0018] In addition, the above first through third aspects may be designed in combination in a single indoor unit.

[0019] According to this type of indoor unit, an even greater reduction in the noise level of the fan air blowing system can be achieved for the same air quantity due to mutual synergistic effects.

[0020] In addition, in the second aspect, a concave portion may be formed in the surface that forms width g of the above inverted portion.

[0021] According to this type of indoor unit, even if the value of the width g of the inverted portion is increased (increased in thickness) so as to be advantageous for lowering noise levels, the generation of strain caused by thermal stress during forming can be prevented.

[0022] In addition, the present invention provides an air-conditioner comprising an outdoor heat exchanger, a compressor that feeds a high-temperature, high-pressure gaseous refrigerant to the heat exchanger, an outdoor unit provided with an outdoor unit controller comprised of various electrical circuit elements, and the above indoor unit.

[0023] According to this type of air-conditioner, as a result of comprising an indoor unit capable of easily achieving a reduction in the noise level for the same air quantity, an air-conditioner can be provided having superior aerodynamic performance and a high degree of product appeal.

[0024] The indoor unit and air-conditioner of the present invention described above demonstrate the remarkable effect of improving product appeal by being able to significantly and easily reduce the operating noise of the fan air blowing system in the indoor unit to a greater extent than the prior art, thereby lowering the noise levels of the indoor unit and an air-conditioner that has said indoor unit as a constituent feature.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

Fig. 1 is a partial, cross-sectional perspective view showing one embodiment of the indoor unit and air-conditioner as claimed in the present invention.

Fig. 2 is a cross-sectional view taken along arrows A-A of Fig. 1 showing one embodiment of the tangential fan and its air blowing system of the indoor unit as claimed in the present invention.

Fig. 3 is a graph showing the results of measuring noise level based on the same air quantity for the ratio of intake diaphragm width (f) to fan diameter (D) in a first embodiment of the present invention.

Fig. 4 is a graph showing the results of measuring noise level based on the same air quantity for the ratio of inverted portion width (g) to fan diameter (D) in a second embodiment of the present invention.

Fig. 5 is a graph showing the results of measuring noise level based on the same air quantity for the ratio of the length of auxiliary intake path (e) to fan diameter (D) in a third embodiment of the present invention.

Fig. 6 is a graph showing the results of measuring noise level based on the same air quantity for intake diaphragm angle (γ) in a third embodiment of the present invention.

Fig. 7 is an essential portion cross-sectional view showing a variation of the shape of the inverted portion in the

present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0026] The following provides an explanation of the aspects for carrying out the indoor unit and air-conditioner according to the present invention with reference to the drawings.

[0027] Fig. 1 is an explanatory drawing showing the overall constitution of the air-conditioner. The air-conditioner is composed of indoor unit 10 and outdoor unit 20. This indoor unit 10 and outdoor unit 20 are connected by refrigerant lines 21, through which refrigerant passes, and electrical wiring and so forth not shown. There are two refrigerant lines 21 provided, and refrigerant flows from indoor unit 10 to outdoor unit 20 through one of the lines, and from outdoor unit 20 to indoor unit 10 through the other.

[0028] Indoor unit 10 is integrally composed of base 11 serving as a casing and front panel 12. Base 11 is equipped with various equipment including a plate fin tube type of indoor heat exchanger 13 and a roughly cylindrical tangential fan (to be simply referred to as a "fan") 14. Base 11 is also equipped with indoor unit controller 15 composed of various electrical circuit elements and so forth for performing various operational controls relating to indoor unit 10. Indoor unit controller 15 is equipped with a suitable indicator 15a for displaying the operating status and error modes. This indicator 15a can be confirmed visually from the outside through window 12a provided on front panel 12. Furthermore, installation plate 16 is provided on the back of base 11, and this enables indoor unit 10 to be installed on the wall and so forth of a room.

[0029] Intake grilles (intake ports) 12b are respectively formed in the front and top surfaces of front panel 12. Air inside a room (indoor air) is suctioned into indoor unit 10 from multiple directions by these intake grilles 12b. Incidentally, air filters 17 are equipped behind intake grilles 12b, and act to remove dust in the air and so forth that is suctioned in. In addition, blower outlet 12c is formed below front panel 12, and is designed so that warmed air or cooled air (namely, air-conditioned air) is blown out therefrom. Furthermore, this suctioning of air and blowing of air is performed due to the operation of fan 14.

[0030] The above-mentioned indoor unit 10 is equipped with a remote controller serving as a controller that performs control of various operations. Various switches, a liquid crystal display and so forth are provided on this remote controller 30, and various operation control signals, temperature settings and so forth of the air-conditioner can be transmitted in the form of, for example, infrared signals, towards the receiving unit (not shown) of indoor unit controller 15. Furthermore, partial operational control of the air-conditioner can also be performed by switches not shown provided at appropriate locations on the indoor unit.

[0031] Outdoor unit 20 is equipped with outdoor heat exchanger 20b, propeller fan 20c, compressor 20f and outdoor unit controller 20g in housing 20a. Outdoor heat exchanger 20b is composed of a refrigeration line equipped with a large number of blade-shaped fins around its periphery, and is for realizing heat exchange between the refrigerant and outside air. Propeller fan 20c continuously brings in fresh air to housing 20a by generating an air flow that escapes from the back to the front inside housing 20a, and is provided to improve the heat exchange efficiency in outdoor heat exchanger 20b.

[0032] Furthermore, fin guard 20d and fin guard 20e are respectively provided on the sides of housing 20a on which the above outdoor heat exchanger 20b and propeller fan 20c are facing the outside. Fan guard 20d is provided so as to prevent the above blade-shaped fins from being damaged by unexpected impacts from the outside. Fin guard 20e is also similarly provided for the purpose of protecting propeller fan 20c from external impacts.

[0033] Compressor 20f discharges low-temperature, low-pressure gaseous refrigerant by converting to a high-temperature, high-pressure gaseous refrigerant, and plays the most important role among the components that compose the refrigerant circuit. Incidentally, the refrigerant circuit refers to that which is roughly composed of this compressor 20f as well as the above-mentioned indoor heat exchanger 13, outdoor heat exchanger 20b, refrigerant lines 21, an expansion valve, a four-way valve that determines the direction of refrigerant flow (both the expansion valve and four-way valve are not shown) and so forth, and allows refrigerant to circulate between indoor unit 10 and outdoor unit 20.

[0034] Outdoor unit controller 20g performs operational control relating to the above-mentioned propeller fan 20c, compressor 20f and various other equipment provided in outdoor unit 20, and is composed of various electrical circuit elements.

[0035] In addition to that indicated above, outdoor unit 20 is also equipped with a base plate 20h to avoid the effects of external vibrations and so forth while also supporting housing 20a. In addition, a removable panel 20i for performing maintenance and so forth on the above compressor 20f is provided in the wall of case 20 near the above compressor 20f.

[0036] The following provides an explanation of the action of the air-conditioner composed of these components, dividing into an explanation of that during heating operation and that during cooling operation.

[0037] To begin with, during heating operation, refrigerant that has been transformed into a high-temperature, high-pressure gas in compressor 20f is sent through refrigerant line 21 to indoor heat exchanger 13 of indoor unit 10. Inside indoor unit 10, heat from the high-temperature, high-pressure gaseous refrigerant that passes through indoor heat exchanger 13 is imparted to indoor air taken in from intake grilles 12 by fan 14. As a result, warm air is blown out from

blower outlet 12c below front panel 12. At the same time, high-temperature, high-pressure gaseous refrigerant condenses and liquefies in the above indoor heat exchanger 13 and becomes a high-temperature, high-pressure liquid refrigerant.

[0038] This high-temperature, high-pressure liquid refrigerant is sent again through refrigerant line 21 to outdoor heat exchanger 20b in outdoor unit 20. In outdoor unit 20, it passes through an expansion valve not shown where its pressure is reduced and it becomes a low-temperature, low-pressure liquid refrigerant. This low-temperature, low-pressure liquid refrigerant that passes through outdoor heat exchanger 20b then takes the heat from fresh outside air that has been taken into housing 20a by propeller fan 20c. This low-temperature, low-pressure liquid refrigerant evaporates to a gas as a result of this, becoming a low-temperature, low-pressure gaseous refrigerant. This is then again sent to compressor 20f where the above process is repeated.

[0039] Next, during cooling operation; the refrigerant flows through the refrigerant circuit in the opposite direction from that described above. Namely, after being transformed into a high-temperature, high-pressure gas in compressor 20f, the refrigerant is sent to outdoor heat exchanger 20b through refrigerant line 21 where it imparts heat to the outside air and condenses and liquefies to become a high-temperature, high-pressure liquid refrigerant. This high-temperature, high-pressure liquid refrigerant passes through an expansion valve not shown and becomes a low-temperature, low-pressure liquid refrigerant, after which it is sent to indoor heat exchanger 13 again through refrigerant line 21. The low-temperature, low-pressure liquid refrigerant takes the heat from the indoor air and together with cooling said indoor air, the refrigerant itself evaporates and vaporizes resulting in the formation of a low-temperature, low-pressure gaseous refrigerant. This is again sent out to compressor 20f where the above process is then repeated.

[0040] These operations are controlled by indoor unit controller 15 housed in indoor unit 10 and by outdoor unit controller 20g housed in outdoor unit 20.

[0041] The following provides an explanation of the characteristic portion of the present invention with reference to Fig. 2. Furthermore, Fig. 2 used in this explanation is a cross-section taken along arrows A-A of Fig. 1 that shows fan 14 and its air blowing system.

[0042] A fan air blowing system is provided inside the above-mentioned indoor unit 10 for suctioning in indoor air through intake grilles 12b by operating fan 14, passing that air through indoor heat exchanger 13, and blowing out the air-conditioned air that has undergone heat exchange from blower outlet 12c. Air duct 40 that guides air-conditioned air to blower outlet 12c is provided in this fan air blowing system.

[0043] Air duct 40 is a space formed between outer peripheral surface 14a of cylindrical fan 14 and air duct wall surface 41 provided in base 11 serving as a constituent member of the casing.

[0044] Inlet 42 of air duct 40 is on a line that connects fan center C that serves as the axial center during rotation of fan 14 and point K on air duct wall surface 41, and the width of this inlet is represented with W_i . Point K serves as the origin of the casing coil (concave curved surface in the direction of flow of air duct wall surface 41), and when viewed from the side of front panel 12 of indoor unit 10, is roughly positioned behind the upper portion of fan 14 (wall side).

[0045] Air duct 40 is formed to outlet 43 in the direction of rotation of fan 14 (clockwise direction in the example shown in the drawing) with inlet 42 serving as the origin. The width of air duct 40, namely air duct width W , gradually increases from inlet width W_i of inlet 42 to outlet width W_o of outlet 43. Outlet width W_o is the distance covered by a line perpendicular to air duct center line 44 extending from end point M of the casing coil on casing wall surface 41 to outlet upper surface 45.

[0046] Front panel 12 is arranged to the front of the direction of flow of outlet 43 (front side of indoor unit 10), and blower outlet 12c of said panel 12 is open facing into the room. In addition, in a typical configuration, louvers (not shown) are arranged near outlet 43 that adjust the blowing direction to the left and right, and flaps (not shown) are arranged in blower outlet 12c that adjust the blowing direction upward and downward.

[0047] Furthermore, as shown in Fig. 2, fan 14 is also provided with stabilizer 70, and air inflow back wall 50 located in the upper portion of air duct 40.

[0048] Air inflow back wall 50 is a portion that is located above inlet 42 of air duct 40 and provided in continuation from air duct wall surface 41, and inverted portion 52 is provided on the end (upper end) of auxiliary intake path 51. Auxiliary intake path 51 is a wall surface that forms a concave portion continuing from origin K of air duct wall surface 41 to wall surface starting point N, and the depth of the concave portion serving as auxiliary intake path 51 (depth from the line connecting origin K and wall surface starting point N to the deepest part of the concave portion) is hereinafter to be referred to as intake diaphragm width f .

[0049] On the other hand, inverted portion 52 is a portion that is arranged behind air duct wall surface 41 and air inflow back wall 50 that inverts the flow of air-conditioned air so as to guide air-conditioned air that has passed through indoor heat exchanger 13 to air duct 40, and its end shape is composed by providing a first flat portion 53, which forms a roughly vertical surface extending upward from wall surface starting point N to peak P, and a second flat portion 54, which forms a roughly horizontal surface extending backward (back side) from peak P to inverted portion starting point Q. Furthermore, back portion 55 is provided on the back side of auxiliary intake path 51 that forms an inclined surface facing downward on an angle from inverted portion starting point Q.

[0050] The width of the above-mentioned inverted portion 52, namely distance NQ from wall surface starting point N to inverted portion starting point Q is to hereinafter be referred to as inverted portion width (inverted thickness) g , distance

KN from origin K to wall surface starting point N is to hereinafter be referred to as auxiliary intake path length e , and the angle from the line connecting fan center C and origin K to line KN that defines auxiliary intake path length e is hereinafter to be referred to as intake diaphragm angle γ .

[0051] In the fan air blowing system described above, intake diaphragm width f of the shape of air inflow back wall 50 is defined in the manner explained below in a first embodiment.

[0052] Intake diaphragm width f is a value indicating the concave depth of the concave wall surface provided in continuation facing upward from inlet 42 (origin K) of air duct wall surface 41 that forms air duct 40, namely auxiliary intake path 51, and indicates the vertical distance from line KN to the deepest part. Here, if the fan diameter of fan 14 is taken to be D , then intake diaphragm width f provided on the upstream side of the air duct inlet inside the casing is set so that the ratio to fan diameter D (f/D) is within the range of 0.002 to 0.003 ($0.002 \leq f/D \leq 0.003$).

[0053] Fig. 3 shows the results of respectively measuring noise level based on the same air quantity by suitably changing the above-mentioned f/D .

[0054] On the basis of these measurement results, the noise level was the lowest when f/D was roughly 0.025, and when intake diaphragm width f was increased or decreased from the value corresponding to this minimum noise level, the noise level was found to increase in both cases. Therefore, the range over which ΔdB increases 1 dB (A) from f/D at which the noise level is the lowest based on the same air quantity was determined to be the proper design range of intake diaphragm width f , and according to the results shown in Fig. 3, the range of f/D was defined as $0.002 \leq f/D \leq 0.003$.

[0055] Furthermore, the reason for assuming $\Delta dB = 1 \text{ dB (A)}$ is based on the reason that the value of 1 dB (A) is the level at which the effect of noise reduction can be clearly recognized in consideration of measurement error, variation and so forth.

[0056] Next, inverted portion width g of the shape of air inflow back wall 50 in the above-mentioned fan air blowing system is defined as explained below.

[0057] Inverted portion width (inverted thickness) g is the distance NQ from wall surface starting point N to inverted portion starting point Q that indicates the width of inverted portion 52. Here, if the fan diameter of fan 14 is taken to be D , inverted portion width g of intake air flow provided on the upstream side of the air duct inlet inside the casing is set so that the ratio to fan diameter D (g/D) is $0.06 \leq g/D$.

[0058] Fig. 4 shows the results of respectively measuring noise levels based on the same air quantity by suitably changing the above-mentioned g/D .

[0059] On the basis of these measurement results, it was found that the noise level was the lowest in the case g/D was 0.06, the noise level increased when g/D was smaller than 0.06, and there was hardly any change in the noise level, namely the noise level remained roughly constant, even if g/D was increased beyond 0.06. Therefore; a value of $g/D = 0.06$, at which the noise level for the same air quantity hardly decreases further, was determined to be the borderline value of inverted portion width g , and according to the results of Fig. 4, the proper design range was defined as $0.06 \leq g/D$.

[0060] However, although it is preferable with respect to inverted portion width g to make the ratio to fan diameter D as described above greater than or equal to 0.06, increasing g/D means that the inverted portion width g becomes thicker. However, if the wall thickness of inverted portion 52, which is a plastic molded part integrally formed with base 11, becomes thicker, there is greater susceptibility to strain caused by thermal deformation as a result of being greatly subjected to the effects of thermal contraction during molding. Consequently, the upper limit of inverted portion width g is subject to restriction due to problems in terms of production engineering in the form of the occurrence of thermal deformation.

[0061] Therefore, a shape is desired for inverted portion 52 that ensures an inverted portion width g capable of reducing noise levels while also increasing resistance to the occurrence of thermal deformation during molding.

[0062] Fig. 7 shows a variation of inverted portion 52 in which concave portion 56 having a rectangular cross-section is provided on first flat portion 53. In the case of this variation, the formation of thick walled portion in inverted portion 52 can be prevented while maintaining inverted portion width g . Thus, since the occurrence of strain caused by thermal deformation due to plastic molding can be prevented, restrictions in terms of production engineering can be minimized, thereby making it possible to increase the degree of freedom of inverted portion width g . Furthermore, in the example shown in the drawing, although concave portion 56 has a rectangular cross-section, the shape of concave portion 56 is not limited to this, but rather other variations are also effective, including the forming of surface 56a into a concave curved surface.

[0063] Next, auxiliary intake path length e and intake diaphragm angle γ of air inflow back wall 50 are defined in the manner explained below in a third embodiment in the fan air blowing system described above.

[0064] Auxiliary intake path length e is the distance KN from origin K to wall surface starting point N, while intake diaphragm angle γ is the angle from line CK that connects fan center C and origin K to line KN that defines auxiliary intake path length e . Here, if the fan diameter of fan 14 is taken to be D , then the ratio of auxiliary intake path length e provided on the upstream side of the air duct inlet inside the casing to fan diameter D (e/D) is set so as to be within the range of $0.25 \leq e/D \leq 0.3$. Moreover, intake diaphragm angle γ is set so as to be within the range of $80 \text{ degrees} \leq \gamma \leq 90 \text{ degrees}$.

[0065] Fig. 5 shows the results of respectively measuring noise levels for the same air quantity by suitably changing the above-mentioned angle γ .

[0066] Based on these measurement results, the noise level is the lowest when e/D is roughly 0.275, and when auxiliary intake path length e is increased or decreased from the value corresponding to this minimum noise level, the noise level was determined to increase in both cases. Therefore, similar to the intake diaphragm width f described above, the range over which ΔdB increases 1 dB (A) from e/D for which the noise level is the lowest based on the same air quantity was judged to be the proper design range of intake diaphragm width f , and according to the results shown in Fig. 5, the range of e/D was defined as $0.25 \leq e/D \leq 0.3$.

[0067] Fig. 6 shows the results of respectively measuring noise levels based on the same air quantity by suitably changing the above-mentioned γ .

[0068] According to these measurement results, the case of setting intake diaphragm angle γ to roughly 85 degrees resulted in the lowest noise levels, and noise levels were determined to demonstrate an increasing trend when the angle γ was increased or decreased from this value. Therefore, in the same manner as the above-mentioned intake diaphragm width f , the range over which ΔdB increases 1 dB (A) from the intake diaphragm angle γ at which noise level was the lowest for the same air quantity was judged to be the proper design range for intake diaphragm angle γ , and according to the results shown in Fig. 6, the range of γ is defined to be $80 \text{ degrees} \leq \gamma \leq 90 \text{ degrees}$.

[0069] In this manner, if the shape of air inflow back wall 50 in the fan air blowing system is designed using as indices the stipulations explained in the above-mentioned first through third embodiments, aerodynamic performance in terms of air quantity and noise level can be easily improved. In addition, since the values stipulated in each embodiment are determined so as to be contained within the range over which the noise level based on the same air quantity is 1 dB (A) higher than the minimum noise level, the shape of an air duct having a low noise level can be easily set by using a shape for the air duct that is within the above defined values.

[0070] In addition, although each of the above embodiments allows the obtaining of the action and effect of improving aerodynamic performance even if each is used alone, if each embodiment is suitably used in combination, namely by using a suitable combination of at least two of the above embodiments, reduction in noise levels of air inflow back wall 50 and the fan air blowing system for the same air quantity can be further promoted due to mutual synergistic effects.

[0071] Namely, indoor unit 10, which is equipped with air inflow back wall 50 having a shape designed using the above-mentioned stipulations, has superior aerodynamic performance with respect to low noise levels of the fan air blowing system and so forth, and is able to improve the product appeal of an air-conditioner having this for its constituent element.

Claims

1. An indoor unit (10) for an air conditioner, comprising:

- a tangential fan (14) for suctioning in indoor air from an intake port (12b) and blowing out that air from a blower outlet (12c), said tangential fan (14) having a fan diameter "D";
- a casing (11) that houses an air duct (40) defined between an outer peripheral surface (14a) of said tangential fan (14) and an air duct wall surface (41) for guiding the air to the blower outlet (12c), said air duct (40) having an air duct inlet (42) and comprising a wall surface upstream of said air duct inlet (42) defining an auxiliary intake path (51);
- an indoor heat exchanger (13) that is adapted to perform heat exchange between the indoor air and a refrigerant supplied from an outdoor unit (20); and
- an indoor unit controller composed of various electrical circuit elements;

characterized in that

said wall surface defining said auxiliary intake path (51) forms a concave portion continuing from an origin (K) of the air duct wall surface (41) to a wall surface starting point (N) and has a depth "f" from a line connecting the origin (K) and the wall surface starting point (N) to the deepest part of the concave portion, wherein the following condition is met:

$$0.002 \leq f/D \leq 0.003.$$

2. The indoor unit according to claim 1, wherein a distance "e" from said origin (K) to said wall surface starting point (N) and an angle " γ " defined between a line connecting a center (C) of said tangential fan (14) and said origin (K) and said line connecting the origin (K) and the wall surface starting point (N) meet the following conditions:

$$0.25 \leq e/D \leq 0.3;$$

and

$$80 \text{ degrees} \leq \gamma \leq 90 \text{ degrees}.$$

3. The indoor unit according to claim 1 or 2, wherein an inverted portion (52) is provided on an upstream end of said auxiliary intake path (51) for inverting the flow of incoming air so as to guide the flow to said air duct (40), said inverted portion (52) having a width "g" from the wall surface starting point (N) to an inverted portion starting point (Q) that meets the following condition:

$$0.06 \leq g/D.$$

4. An air-conditioner comprising:

an outdoor unit (20) provided with an outdoor heat exchanger (20b);
a compressor (20f) that is adapted to feed a high-temperature, high-pressure gaseous refrigerant to the heat exchanger (20b);
a controller (15,30) comprised of various electrical circuit elements, and
an indoor unit (10) according to any one of claims 1 to 3.

Patentansprüche

1. Innenraumeinheit (10) für eine Klimaanlage, mit:

einem Tangentialgebläse (14) zum Ansaugen von Innenraumluft über eine Einlassöffnung (12b) und zum Ausblasen dieser Luft aus einem Gebläseauslaß (12c), wobei das Tangentialgebläse (14) einen Gebläsedurchmesser "D" aufweist,
einem Gehäuse (11), das einen Luftkanal (40) enthält, der zwischen einer Außenumfangsfläche (14a) des Tangentialgebläses (14) und einer Luftkanal-Wandfläche (41) zum Leiten der Luft zu dem Gebläseauslaß (12c) festgelegt ist, wobei der Luftkanal (40) einen Luftkanaleinlaß (42) aufweist und eine Wandfläche stromauf des Luftkanaleinlasses (42) umfasst, welche einen Hilfs-Einlaßweg (51) festlegt,
einem Innenraum-Wärmetauscher (13), der einen Wärmeaustausch zwischen der Innenraumluft und einem von einer Außenraumeinheit (20) gelieferten Kältemittel durchführen kann, und
einem Controller für die Innenraumeinheit, der aus mehreren elektrischen Schaltungselementen gebildet ist,
dadurch gekennzeichnet, dass
die den Hilfs-Einlassweg (51) festlegende Wandfläche einen konkaven Abschnitt bildet, der sich von einem Ursprung (K) der Luftkanal-Wandfläche (41) zu einem Wandflächen-Startpunkt (N) fortsetzt und eine Tiefe "f" von einer den Ursprung (K) und den Wandflächen-Startpunkt (N) verbindenden Linie bis zum tiefsten Teil des konkaven Abschnitts aufweist, wobei die folgende Bedingung erfüllt ist:

$$0,002 \leq f/D \leq 0,003.$$

2. Innenraumeinheit nach Anspruch 1, wobei ein Abstand "e" von dem Ursprung (K) zu dem Wandflächen-Startpunkt (N) und ein Winkel "γ", der zwischen einer Mitte (C) des Tangentialgebläses (14) und den Ursprung (K) verbindenden Linie, und die den Ursprung (K) sowie der den Wandflächen-Startpunkt (N) verbindenden Linie festgelegt ist, die folgenden Bedingungen erfüllen:

$$0,25 \leq e/D \leq 0,3;$$

und

$$80 \text{ Grad} \leq \gamma \leq 90 \text{ Grad}.$$

3. Innenraumeinheit nach Anspruch 1 oder 2, wobei ein Umkehr- bzw. Wendeabschnitt (52) an einem stromaufwärtigen Ende des Hilfs-Einlasswegs (51) zum Umkehren der Strömung ankommender Luft vorgesehen ist, so dass die Strömung zu dem Luftkanal (40) geleitet wird, wobei der Umkehrabschnitt (52) eine Breite "g" von dem Wandflächen-Startpunkt (N) zu einem Umkehrabschnitt-Startpunkt (Q) aufweist, die die folgende Bedingung erfüllt:

$$0,06 \leq g/D.$$

4. Klimaanlage mit:

einer Außenraumeinheit (20), die mit einem Außenraum-Wärmetauscher (20b) versehen ist, einem Kompressor (20f), der dem Wärmetauscher (20b) ein Hochtemperatur-, Hochdruck-Gaskältemittel zuführen kann, einem Kontroller (15,30), der aus verschiedenen elektrischen Schaltungselementen gebildet ist, und einer Innenraumeinheit (10) gemäß einem der Ansprüche 1 bis 3.

Revendications

1. Groupe (10) intérieur pour un conditionneur d'air comprenant :

un ventilateur (14) tangentiel pour aspirer dans l'air intérieur par un orifice (12b) d'admission et souffler cette air par une sortie (12c) de soufflante, le ventilateur (14) tangentiel ayant un diamètre "D" de ventilateur ; une enveloppe (11) qui loge un conduit (40) pour de l'air défini entre une surface (14a) périphérique extérieure du ventilateur (14) tangentiel et une surface (41) de paroi du conduit pour de l'air afin de guider l'air vers la sortie (12c) de soufflante, le conduit (40) pour de l'air ayant une entrée (42) de conduit pour de l'air et comprenant une surface de paroi en amont de l'entrée (12) de conduit pour de l'air définissant un trajet (51) d'admission auxiliaire ;

un échangeur de chaleur (13) intérieur qui est conçu pour effectuer un échange de chaleur entre l'air intérieur et un agent réfrigérant fourni par un groupe (20) extérieur ; et

un dispositif de commande du groupe intérieur composé de divers éléments de circuit électrique ;

caractérisé en ce que

la surface de paroi définissant le trajet (51) d'admission auxiliaire forme une partie concave se continuant d'une origine (K) de la surface (41) de paroi du conduit pour de l'air à un point (N) commençant sur une surface de paroi et à une profondeur "f" allant d'une ligne reliant l'origine (K) au point (N) commençant sur une surface de paroi à la partie la plus profonde de la partie concave, la condition suivante étant satisfaite :

$$0.002 \leq f./D \leq 0.003.$$

2. Groupe d'intérieur suivant la revendication 1, dans lequel une distance "e" de l'origine (K) au point (N) commençant sur une surface de paroi et un angle "Y" défini entre une ligne reliant un centre (C) du ventilateur (14) tangentiel à l'origine (K) et la ligne reliant l'origine (K) et le point (N) commençant sur une surface de paroi satisfont aux relations suivantes :

$$0.25 \leq e/D \leq 0.3 ;$$

et

$$80 \text{ degrés} \leq \gamma \leq 90 \text{ degrés}.$$

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3. Groupe d'intérieur suivant la revendication 1 ou 2, dans lequel une partie (52) inversée est prévue sur une extrémité en amont du trajet (51) d'admission auxiliaire pour inverser le courant d'air arrivant de manière à guider le courant vers le conduit (40) pour de l'air, la partie (52) inversée ayant une largeur "g" allant du point (N) commençant sur une surface de paroi à un point (Q) commençant sur une partie inversée qui satisfait la condition suivante :

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$$0.06 \leq g/D.$$

- 10 4. Conditionneur d'air comprenant :

un groupe (20) extérieur muni d'un échangeur de chaleur (20b) extérieur ;
un compresseur (20f) qui est conçu pour alimenter l'échangeur de chaleur (20) en réfrigérant gazeux à haute température et à haute pression ;
15 un dispositif (15, 30) de commande constitué de divers éléments de circuit électrique, et
un groupe (10) intérieur suivant l'une quelconque des revendications 1 à 3.

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FIG. 1

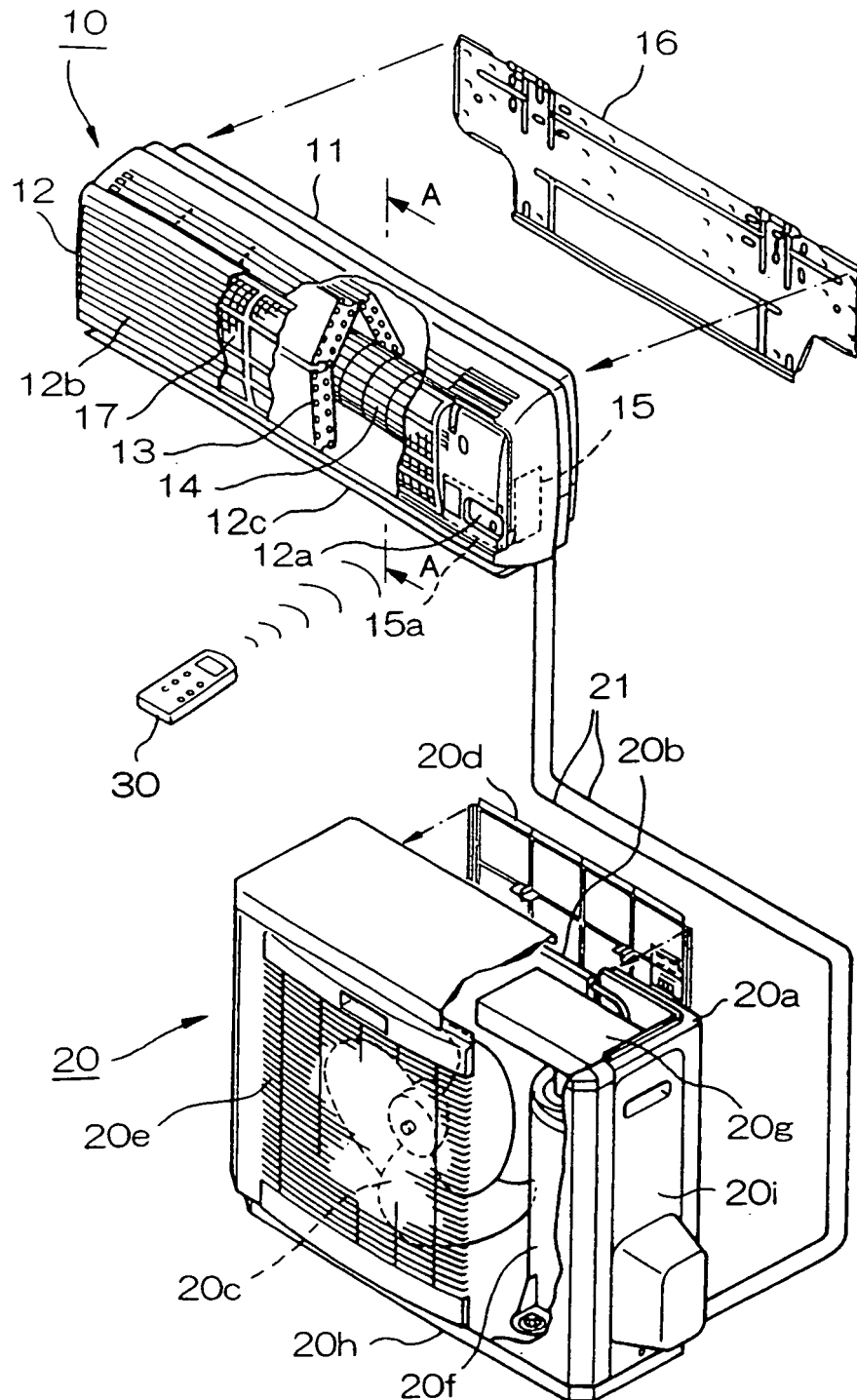


FIG. 2

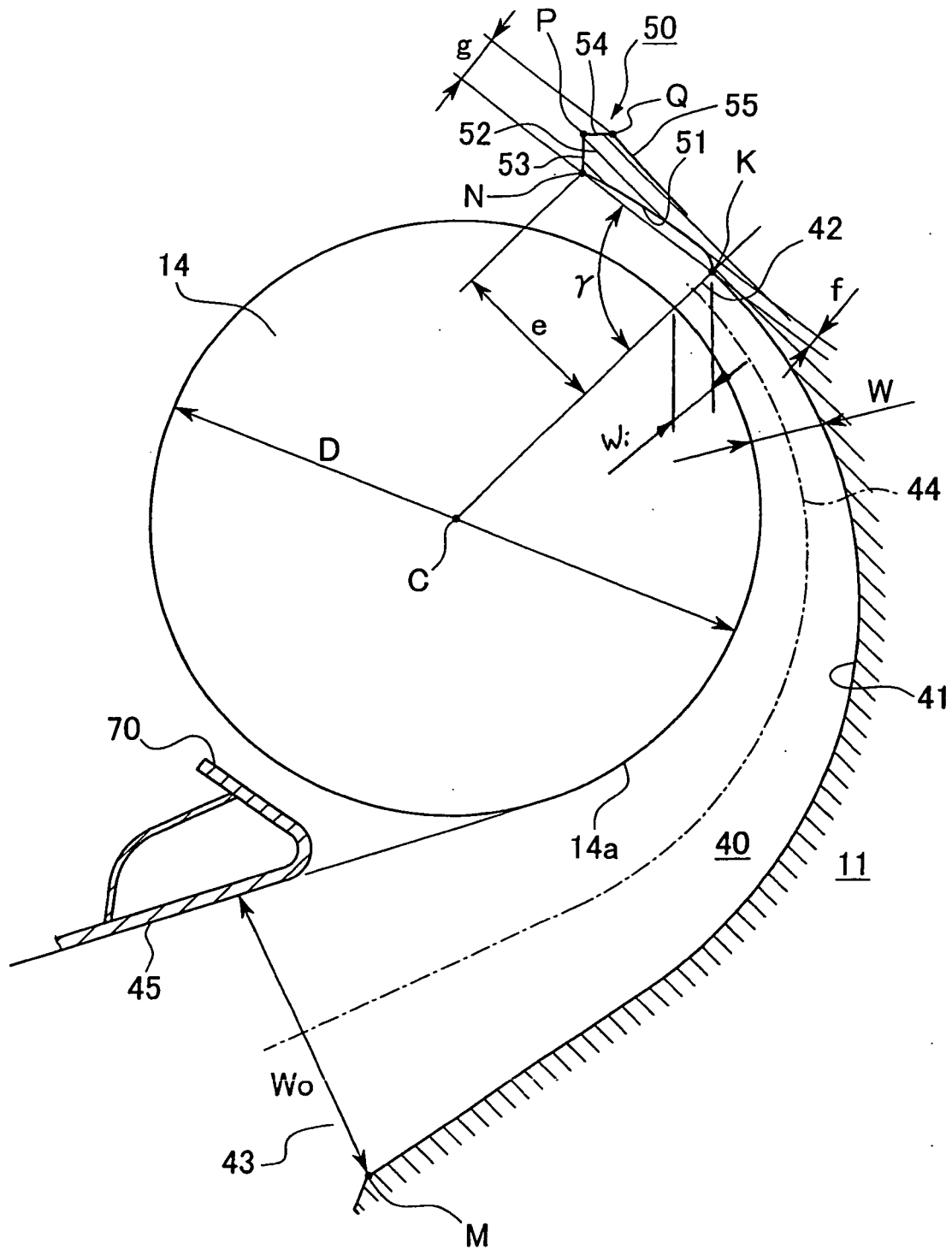


FIG. 3

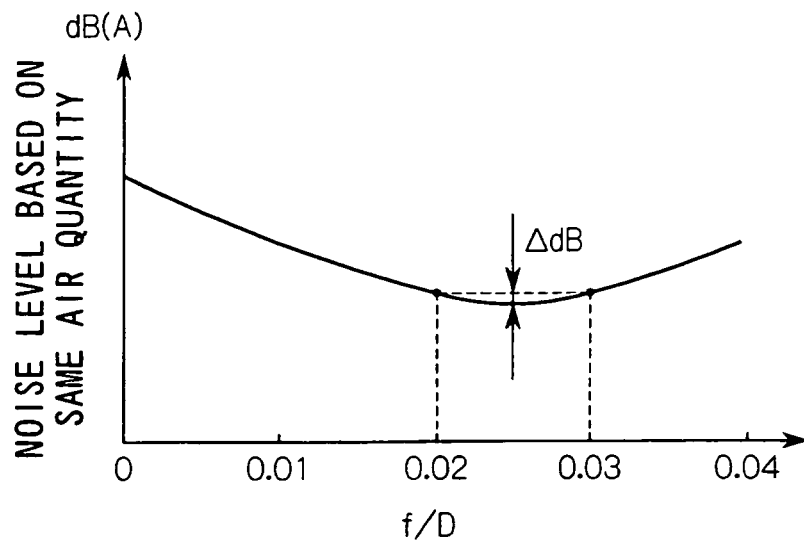


FIG. 4

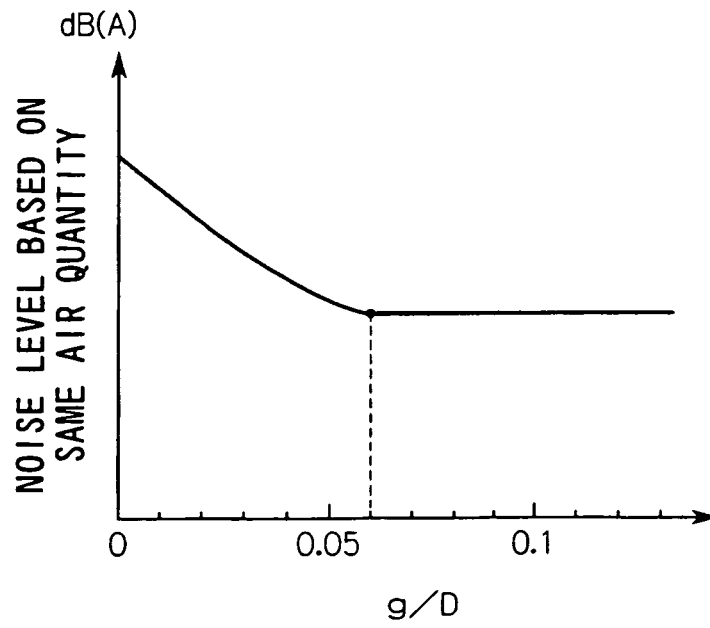


FIG. 5

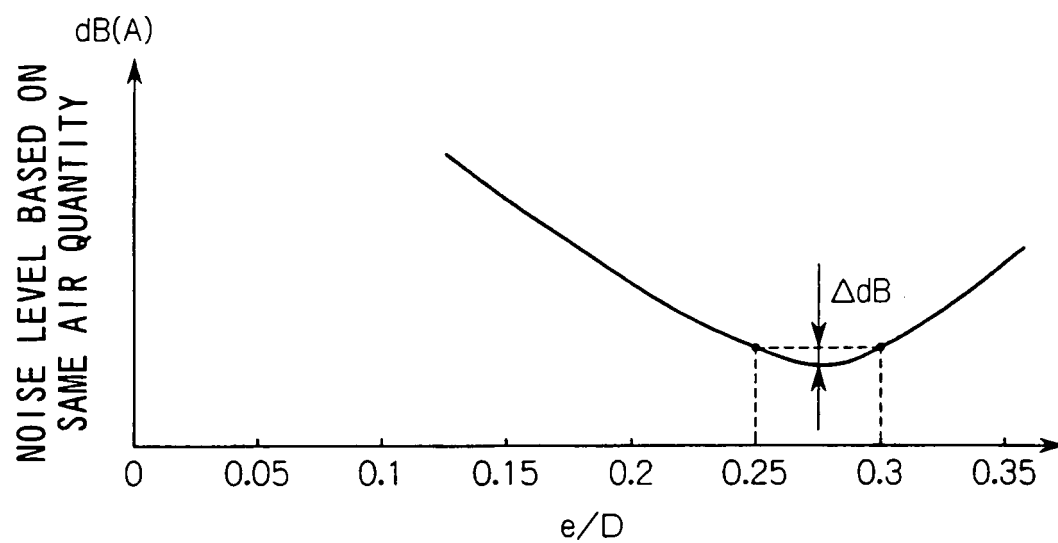


FIG. 6

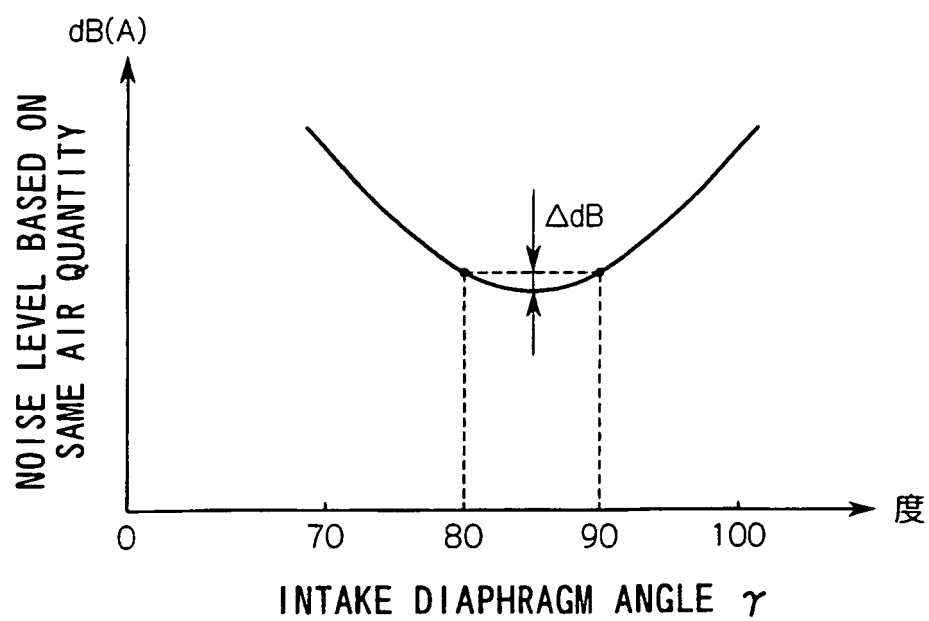
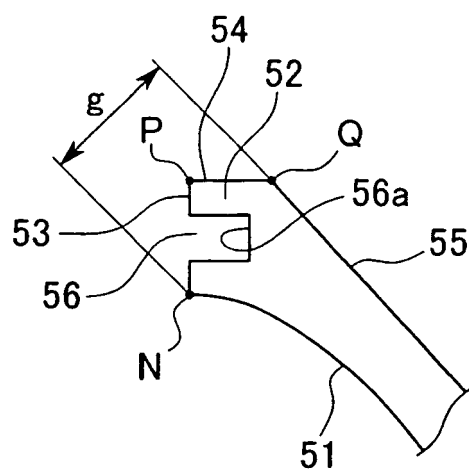


FIG. 7



REFERENCES CITED IN THE DESCRIPTION

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