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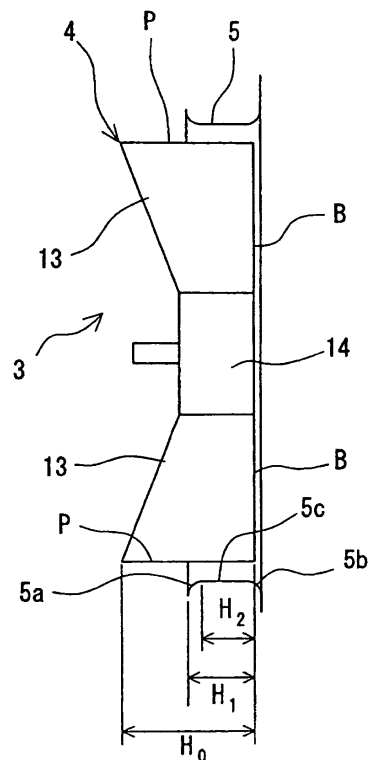
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(54) **BLOWER, AND OUTDOOR UNIT FOR AIR CONDITIONER**

(57) Generation and growth of a wing tip vortex in a part of an outer peripheral portion of a blade not surrounded by a bell mouth is restrained to reduce noise (i. e., operation noise) generated by collision of the wing tip vortex and a fan guard on a blowoff side of a propeller fan. A ratio H_1/H_0 is set in a range of $H_1/H_0 = 0.40$ to 0.65 where H_1 denotes a height of a portion of an axis directional height of the bell mouth 5 that is overlapped with an outer peripheral portion P of the blade 13, while H_0 denotes an axis directional height of the outer peripheral portion P of the blade 13, so as to restrain growth of a leakage flow (i.e., a wing tip vortex) from a positive pressure surface to a negative pressure surface of the blade 13 in a part of the outer peripheral portion P of the blade 13 not surrounded by the bell mouth 5 while maintaining a suction flow from the outer peripheral portion P of the blade 13.

Fig. 10



Description

TECHNICAL FIELD

[0001] The present invention relates to a blower device and an outdoor unit for air conditioner.

BACKGROUND ART

[0002] For example, an outdoor unit for air conditioner is, as shown in Fig. 1 through Fig. 3, constituted such that a blower device 3 composed of a propeller fan 4 having a plurality of (e.g. three) blades 13, 13, 13 formed on the outer periphery of a hub 14 that functions as the center of rotation, a bell mouth 5 disposed on the outer radial side of the propeller fan 4 for separating a suction area X and a blowoff area Y, and a fan guard 6 disposed on the blowoff side of the propeller fan 4, is disposed downstream from a heat exchanger 2 in a casing 1. Inside of the casing 1 is divided into a heat exchange chamber 8 and a machine chamber 9 by a dividing board 7. In the heat exchange chamber 8, there are disposed a heat exchanger 2 having an L-shaped cross section that faces air suction ports 10, 10 formed on the back side and on one lateral side of the casing 1, and a blower device 3 disposed downstream from the heat exchanger 2, whereas in the machine chamber 9, a compressor 11 is disposed. Reference numeral 12 denotes a fan motor.

[0003] Other than the above-constituted outdoor unit for air conditioner, equipment such as ventilating fans and air cleaners may also adopt the similarly constituted blower device 3 (i.e., a blower device composed of a propeller fan 4, a bell mouth 5 disposed outside of the propeller fan 4 for separating a suction area and a blow-off area, and a fan guard 6 disposed on the blowoff side of the propeller fan).

[0004] In the case of the above-constituted blower device 3, as shown in Fig. 4, the typical structure was to suck air from the front side and from the outer peripheral portion of the propeller fan 4, where a height H_1 that is the height of a portion of the bell mouth 5 overlapped with an outer peripheral portion P of a blade 13 of the propeller fan 4 is $H_1/H_0 = 0.25$ to 0.40 when expressed as a ratio to an axis directional height H_0 of the outer peripheral portion P of the blade 13.

[0005] When the propeller fan 4 is operated as shown in Fig. 5 and Fig. 6, pressure difference between a positive pressure surface 13a and a negative pressure surface 13b of the blade 13 becomes large, as a consequence of which on the outer peripheral portion not surrounded by the bell mouth 5, a wing tip vortex E is generated on the outer peripheral portion (i.e., the wing tip) P of the blade 13 by a leakage flow w from the positive pressure surface 13a to the negative pressure surface 13b. The wing tip vortex E, as shown in Fig. 7, grows toward the downstream side, travels between the blades 13, 13, 13 and collides with the fan guard 6 on the blowoff side, thereby generating airflow turbulence

e around blades 6a, 6a ... constituting the fan guard 6, which makes one of the noise emitting sources of the fan guard 6. Reference numeral 6b denotes a support rib 6b for supporting the blades 6a, 6a It is noted that airflows expressed by chain lines in Fig. 7 occur in a position symmetrical to the position of airflows expressed by solid lines (i.e., a position opposite to the center of rotation), though they are shown on the same cross section for convenience of description.

[0006] For improving aerodynamic performance of the propeller fan 4, some fans have a blade 13 having a thick airfoil shape as typified by airfoil wings. In the case of a propeller fan having such thick airfoil-shaped blade 13, a single-unit fan (in the state without a casing surrounding the fan and a fan guard on the blowoff side) achieves considerable improvement of blowing performance and reduction of noise compared to a propeller fan having a blade 13' in a thin plate shape whose thickness is approximately constant (e.g. about 3 mm) as shown in Fig. 8B. More particularly, in the case of the thin plate-shaped blade 13' as shown in Fig. 8B, airflow turbulence e' due to separation occurs even on the blade surface and the airflow turbulence e' is also large on a trailing edge portion B, while in the case of the thick airfoil-shaped blade 13 as shown in Fig. 8A, separation on the blade surface is restrained and airflow turbulence e due to separation occurs only on the trailing edge portion B, thereby achieving improvement of blowing performance and reduction of noise.

[0007] However, in the case of the propeller fan 4 having the above-described thick airfoil-shaped blade 13, pressure difference between the positive pressure surface 13a and the negative pressure surface 13b of the blade 13 becomes larger than that in the case of the fan having the thin plate-shaped blade 13', so that with the height of the bell mouth 5 being set in the range of $H_1/H_0 = 0.25$ to 0.40 as described above, a wing tip vortex E that occurs and grows on the outer peripheral portion (i.e. wing tip) P of the blade 13 becomes larger than that in the case of the fan having a thin plate-shaped blade 13'. As a result, noise generated from the fan guard 6 by collision of the wing tip vortex E and the fan guard 6 on the blowoff side of the propeller fan becomes larger than those in the case of the fan having the thin plate-shaped blade 13'.

[0008] Although a thicker airfoil blade enables considerable improvement of blowing performance and reduction of noise in a single-unit fan, the fan used in the state of being built in a blower device suffers larger noise generated in the fan guard. In recent years, modification of the blade shape has been conducted to reduce noise of a fan itself, and therefore in the blower device, noise generated in the fan guard is more serious than the noise from the propeller fan. As a consequence, how to reduce noise generated from the fan guard is a main object in development of the blower device.

DISCLOSURE OF THE INVENTION

[0009] In view of the above description, it is an object of the present invention to restrain generation and growth of a wing tip vortex on an outer peripheral portion of the blade that is not surrounded by a bell mouth for reducing noise (i.e. operation noise) generated by collision of the wing tip vortex and a fan guard on a blowoff side of a propeller fan.

[0010] In order to achieve the above object, there is provided a blower device comprising: a propeller fan 4 having a plurality of blades 13, 13 ... in a thick airfoil shape as typified by airfoil wings formed on an outer periphery of a hub 14 that functions as a center of rotation; a bell mouth 5 disposed on an outer radial side of the propeller fan 4 for separating a suction area X and a blowoff area Y; and a fan guard 6 disposed on a blowoff side of the propeller fan 4,

[0011] the bell mouth 5 being composed of a suction side circular arc portion 5a positioned on a suction side, a blowoff side circular arc 5b positioned on a blowoff side, and a cylinder portion 5c positioned in between the blowoff side circular arc 5b and the suction side circular arc portion 5a, a ratio of H_1/H_0 being set in a range of $H_1/H_0 = 0.40$ to 0.65 where H_1 denotes a height of a portion of an axis directional height of the bell mouth 5 that is overlapped with an outer peripheral portion P of each of the blade 13, while H_0 denotes an axis directional height of the outer peripheral portion P of each of the blade 13.

[0012] The above structure makes it possible to restrain growth of a leakage flow (i.e., a wing tip vortex E) from the positive pressure surface 13a to the negative pressure surface 13b of the blade 13 in a part of the outer peripheral portion P of the blade 13 not surrounded by the bell mouth 5 while maintaining a suction flow from the outer peripheral portion P of the blade 13. This makes it possible to reduce noise generated from the fan guard 6 by collision of the wing tip vortex E with the fan guard 6 on the blowoff side, resulting in forming remarkable contribution to decline of operation noise. It is noted that in the case of $H_1/H_0 < 0.40$, a growth area of the wing tip vortex E (i.e., a part of the outer peripheral portion P of the blade 3 not surrounded by the bell mouth 5) becomes too large, which makes interference noise by the wing tip vortex E and the fan guard 6 large, whereas in the case of $H_1/H_0 > 0.65$, an area on the suction side of the fan becomes too small, and an increased flow velocity makes noise on the suction side large. Because of the above reasons, the ratio of H_1/H_0 is preferably set in the range of $H_1/H_0 = 0.40$ to 0.65 . It is noted that measurement of blowing noise of the present invention (i.e., the blower device incorporating a propeller fan having a plurality of thick airfoil-shaped blades as typified by airfoil wings) with a value of H_1/H_0 being varied provided a result expressed by a solid line in Fig. 13. This result also indicates that the ratio of H_1/H_0 is preferably set in the range of $H_1/H_0 = 0.40$ to 0.65 . It is noted that a dotted

line in Fig. 13 expresses a measurement result of blowing noise generated by a blower device incorporating a propeller fan having a plurality of thin plate-shaped blades for comparison with the present invention.

[0013] In one embodiment of the present invention, the cylinder portion 5c of the bell mouth 5 is overlapped with the outer peripheral portion P of each of the blade 13, and a ratio of H_2/H_0 is set in a range of $H_2/H_0 = 0.25$ to 0.50 where H_2 denotes an axis directional height of the cylinder portion 5c. Therefore, the cylinder portion 5c of the bell mouth 5 makes it possible to restrain growth of a leakage flow (i.e., a wing tip vortex E) from the positive pressure surface 13a to the negative pressure surface 13b of the blade 13. If the axis directional height H_2 of the cylinder portion 5c is too small compared to the axis directional height H_0 of the outer peripheral portion P of the blade 13 (i.e., in the case of $H_2/H_0 < 0.25$), a growth area of the wing tip vortex E (i.e., a part of the outer peripheral portion P of the blade 3 not surrounded by the cylinder portion 5c of the bell mouth) becomes too large, making an effect of the cylinder portion 5c for restraining growth of the wing tip vortex E insufficient, thereby increasing interference noise by the wing tip vortex E and the fan guard 6. If the axis directional height H_2 of the cylinder portion 5c is too large compared to the axis directional height H_0 of the outer peripheral portion P of the blade 13 (i.e., in the case of $H_2/H_0 > 0.50$), curvature radiuses of the circular arc portions 5a, 5b on the suction side and the blowoff side become too small, which disturbs air from smoothly flowing in and out, thereby causing turbulence and increasing noise. Because of the above reasons, the ratio of H_2/H_0 is preferably set in the range of $H_2/H_0 = 0.25$ to 0.50 . It is noted that measurement of blowing noise of the present invention (i.e., the blower device incorporating a propeller fan having a plurality of thick airfoil-shaped blades as typified by airfoil wings) with a value of H_2/H_0 being varied provided a result shown in Fig. 14. This result also indicates that the ratio of H_2/H_0 is preferably set in the range of $H_2/H_0 = 0.25$ to 0.50 .

[0014] In one embodiment of the present invention, a start position of a circular arc of the blowoff side circular arc portion 5b in the bell mouth 5 is approximately identical to a position of a trailing edge portion B of each of the blade 13. Therefore, a trailing edge B of the blade 3 is away from the fan guard 6 by a size equivalent to the radius of the blowoff side circular arc portion 5b of the bell mouth 5, so that blowoff velocity is reduced and an airflow W blown from the trailing edge B of the blade 3 is smoothly spread toward outside without being separated from the blowoff side circular arc portion 5b of the bell mouth 5, which enables reduction of velocity without causing turbulence till the airflow reaches the fan guard 6, thereby implementing reduction of interference noise with the fan guard 6.

[0015] Also, there is provided an outdoor unit for air conditioner comprising the blower device 3 and a heat exchanger 2 disposed on a suction side of the blower

device 3. This outdoor unit for air conditioner can reduce operation noise.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a front view showing a general outdoor unit for air conditioner;

Fig. 2 is a cross sectional view taken along line II-II of Fig. 1;

Fig. 3 is a cross sectional view taken along line III-III of Fig. 1;

Fig. 4 is a cross sectional view showing a conventional propeller fan equipped with a bell mouth;

Fig. 5 is an enlarged perspective view showing a substantial part of a conventional propeller fan equipped with a bell mouth for explaining formation state of a wing tip vortex;

Fig. 6 is a cross sectional view showing a propeller fan for explaining a formation state of a wing tip vortex;

Fig. 7 is an enlarged fragmentary cross sectional view showing an interference state of an airflow blown from a conventional propeller fan equipped with a bell mouth and a fan guard;

Fig. 8A is a schematic view showing a state of an airflow that flows around an airfoil wing, while Fig. 8B is a schematic view showing a state of an airflow that flows around a thin plate wing;

Fig. 9A is a cross sectional view showing an airfoil wing, while Fig. 9B to Fig. 9D are cross sectional views showing three kinds of airfoil wings having a special form;

Fig. 10 is a cross sectional view showing a propeller fan equipped with a bell mouth for use in a blower device according to an embodiment of the present invention;

Fig. 11 is an enlarged cross sectional view showing a substantial part of a propeller fan equipped with a bell mouth for use in a blower device according to an embodiment of the present invention for explaining a formation state of a wing tip vortex;

Fig. 12 is an enlarged fragmentary cross sectional view showing an interference state of an airflow blown from a propeller fan and a fan guard in an outdoor unit for air conditioner using a blower device according to an embodiment of the present invention;

Fig. 13 is a characteristic graph showing changes of blowing noise by H_1/H_0 in the case of a propeller fan equipped with a bell mouth for use in a blower device according to an embodiment of the present invention (embodiment) and in the case of a propeller fan equipped with a bell mouth having a thin plate-shaped blade (conventional example);

Fig. 14 is a characteristic graph showing changes of blowing noise by H_2/H_0 in the case of a propeller

fan equipped with a bell mouth for use in a blower device according to an embodiment of the present invention;

Fig. 15 is a view showing a single-unit test of a propeller fan equipped with a bell mouth for use in a blower device according to an embodiment of the present invention;

Fig. 16 is a characteristic graph showing changes of blowing noise by H_3/H_0 in a single-unit test of a propeller fan equipped with a bell mouth for use in a blower device according to an embodiment of the present invention;

Fig. 17A to Fig. 17D are schematic views showing modified examples with positional relation between a blade of a propeller fan and a bell mouth being changed; and

Fig. 18 is a characteristic graph showing changes of blowing noise by H_1/H_0 in the case of a propeller fan equipped with a bell mouth shown in Fig. 16A (comparative example) and in the case of a propeller fan equipped with a bell mouth shown in Fig. 16D (embodiment).

BEST MODE FOR CARRYING OUT THE INVENTION

[0017] Hereinafter, embodiments of the present invention will be described with reference to accompanying drawings.

[0018] The blower device 3, which is for use in an outdoor unit for air conditioner shown in Fig. 1 to Fig. 3 like the device described in the technical field chapter, is composed of a propeller fan 4 having a plurality of (e.g. three) blades 13, 13, 13 formed on the outer periphery of a cylinder-shaped hub 14 that functions as the center of rotation, a bell mouth 5 disposed outside of the propeller fan 4 for separating a suction area X and a blowoff area Y, and a fan guard 6 disposed on the blowoff side of the propeller fan 4.

[0019] The outdoor unit for air conditioner is constituted such that the inside of a hexahedron-shaped casing 1 is divided into a heat exchange chamber 8 and a machine chamber 9 by a dividing board 7. In the heat exchange chamber 8, there are disposed a heat exchanger 2 having an L-shaped cross section that faces air suction ports 10, 10 formed on the back side and on one lateral side of the casing 1, and a blower device 3 disposed downstream from the heat exchanger 2, whereas in the machine chamber 9, a compressor 11 is disposed. Reference numeral 12 denotes a fan motor.

[0020] As each of the blade 13, those having the shape of an airfoil wing shown in Fig. 8A are adopted, but similar-shaped airfoil wings having a special form are also adoptable.

[0021] The airfoil wing having a special form includes those shown in Figs. 9B to 9D. The airfoil wing having a special form shown in Fig. 9B is in the shape of an airfoil which has a swelling portion in a leading edge F, and whose wing thickness is sharply reduced from the

swelling portion and then gradually reduced toward a trailing edge B. The airfoil wing having a special form shown in Fig. 9C is in the shape of an airfoil which has a circular arc portion in the leading edge F and whose wing thickness is gradually reduced toward the trailing edge B. The airfoil wing having a special form shown in Fig. 9D is in the shape of an airfoil which has a trailing edge F having the shape of a circular arc and whose wing thickness is once increased toward the trailing edge B, then sharply reduced, and gradually reduced toward the trailing edge B. These airfoil wings having a special form have capability similar to the airfoil wing.

[0022] In the present embodiment, as shown in Fig. 10, the bell mouth 5 is composed of a suction side circular arc portion 5a positioned on a suction side, a blow-off side circular arc 5b positioned on a blowoff side, and a cylinder portion 5c positioned in between the blowoff side circular arc portion 5b and the suction side circular arc portion 5a, and the trailing edge B of the propeller fan 4 is disposed in the position corresponding to the outer edge of the cylinder portion 5c of the bell mouth 5 (in other words, a start position of the circular arc of the blowoff side circular arc portion 5b in the bell mouth 5 is approximately identical to the position of the trailing edge portion B of the blade 13).

[0023] Also in the blower device 3, a ratio of H_1/H_0 is set in a range of $H_1/H_0 = 0.40$ to 0.65 where H_1 denotes a height of a portion of an axis directional height of the bell mouth 5 that is overlapped with an outer peripheral portion P of the blade 13, while H_0 denotes an axis directional height of the outer peripheral portion P of the blade 13.

[0024] As shown in Fig. 11 and Fig. 12, the above setting makes it possible to restrain growth of a leakage flow (i.e., a wing tip vortex E) from the positive pressure surface 13a to the negative pressure surface 13b of the blade 13 in a part of the outer peripheral portion P of the blade 13 not surrounded by the bell mouth 5 while maintaining a suction flow from the outer peripheral portion P of the blade 13. Comparison with the case of Fig. 5 and Fig. 7 proves that the wing tip vortex E is downsized. Consequently, noise generated from the fan guard 6 by collision of the wing tip vortex E with the fan guard 6 on the blowoff side may be reduced, resulting in formation of remarkable contribution to decline of operation noise. It is noted that in the case of $H_1/H_0 < 0.40$, a growth area of the wing tip vortex E (i.e., a part of the outer peripheral portion P of the blade 3 not surrounded by the bell mouth 5) becomes too large, which makes interference noise by the wing tip vortex E and the fan guard 6 large, whereas in the case of $H_1/H_0 > 0.65$, an area on the suction side of the fan becomes too small, and an increased flow velocity makes noise on the suction side large. Because of the above reasons, the ratio of H_1/H_0 is preferably set in the range of $H_1/H_0 = 0.40$ to 0.65 .

[0025] It is noted that measurement of blowing noise of the present invention (i.e., the blower device incorporating a propeller fan having a plurality of thick airfoil-

shaped blades as typified by airfoil wings) with a value of H_1/H_0 being varied provided a result expressed by a solid line in Fig. 13. This result also indicates that the ratio of H_1/H_0 is preferably set in the range of $H_1/H_0 = 0.40$ to 0.65 . It is noted that a dotted line in Fig. 13 expresses a measurement result of blowing noise generated by a blower device incorporating a propeller fan having a plurality of thin plate-shaped blades for comparison with the present invention.

[0026] Further in the blower device 3, as shown in Fig. 10, the cylinder portion 5c of the bell mouth 5 is overlapped with the outer peripheral portion P of each of the blade 13, and a ratio of H_2/H_0 is set in the range of $H_2/H_0 = 0.25$ to 0.50 where H_2 denotes an axis directional height of the cylinder portion 5c.

[0027] The above setting makes it possible to restrain growth of a leakage flow (i.e., a wing tip vortex E) from the positive pressure surface 13a to the negative pressure surface 13b of the blade 13 by the presence of the cylinder portion 5c of the bell mouth 5. If the axis directional height H_2 of the cylinder portion 5c is too small compared to the axis directional height H_0 of the outer peripheral portion P of the blade 13 (i.e., in the case of $H_2/H_0 < 0.25$), a growth area of the wing tip vortex E (i.e., a part of the outer peripheral portion P of the blade 3 not surrounded by the cylinder portion 5c of the bell mouth) becomes too large, making an effect of the cylinder portion 5c for restraining growth of the wing tip vortex E insufficient, thereby increasing interference noise by the wing tip vortex E and the fan guard 6. If the axis directional height H_2 of the cylinder portion 5c is too large compared to the axis directional height H_0 of the outer peripheral portion P of the blade 13 (i.e., in the case of $H_2/H_0 > 0.50$), an area on the suction side of the fan becomes too small and an increased flow velocity increases noise on the suction side. Because of the above reasons, the ratio of H_2/H_0 is preferably set in the range of $H_2/H_0 = 0.25$ to 0.50 .

[0028] It is noted that measurement of blowing noise of the present invention (i.e., the blower device incorporating a propeller fan having a plurality of thick airfoil-shaped blades as typified by airfoil wings) with a value of H_2/H_0 being varied provided a result shown in Fig. 14. This result also indicates that the ratio of H_2/H_0 is preferably set in the range of $H_2/H_0 = 0.25$ to 0.50 .

[0029] The propeller fan 4 equipped with a bell mouth for use in the blower device 3 as the present invention underwent a single-unit test under the following procedure.

[0030] More particularly, as shown in Fig. 15, a fan motor 12 was secured on a supporting base 15 to set the propeller fan 4 equipped with a bell mouth in a specified position, and a highly directional microphone 16 was set on the suction side of the propeller fan 4 for collecting operation noise by operating the propeller fan 4. Then, the test was carried out with a value of H_3 , a height of the bell mouth 5 and a value of H_0 , an axis directional height of the blade 13 being changed, and a

result shown in Fig. 16 was obtained.

[0031] According to the result, in the case of a single-unit fan, blowing noise can be reduced by decreasing the height H_3 of the bell mouth 5 for narrowing an area of the blade 13 surrounded by the bell mouth 5 (i.e., to decrease H_3/H_0) and increasing a suction amount by the blade 13 from the outer periphery. Decrease of the height H_3 of the bell mouth 5 increases an area for a wing tip vortex to occur and develop and locally enlarges turbulence in the outer peripheral portion of the blade 13, so that blowing noise is considered to increase, though in actuality the blowing noise decreases as shown in Fig. 16. This is because i) there is no increase of the blowing noise due to interference noise by a wing tip vortex and a fan guard without the presence of the fan guard on the blowoff side, and ii) reducing the height of a bell mouth expands an outer peripheral area of the blade, which brings about reduction and equalization of suction velocity, resulting in increase of noise reduction effect.

[0032] Like the present embodiment, however, with the presence of a fan guard on the blowoff side, a lower height of a bell mouth is not necessarily better and so there is an optimum position as described above.

[0033] Furthermore in the present embodiment, a start position of the circular arc of the blowoff side circular arc portion 5b in the bell mouth 5 is set approximately identical to a position of the trailing edge B of each of the blade 13. Consequently, a trailing edge B of the blade 3 is away from the fan guard 6 by a size equivalent to the radius of the blowoff side circular arc portion 5b of the bell mouth 5, so that blowoff velocity is reduced and an airflow W blown from the trailing edge B of the blade 3 is smoothly spread toward outside without being separated from the blowoff side circular arc portion 5b of the bell mouth 5, which enables reduction of velocity without causing turbulence till the airflow reaches the fan guard 6, thereby implementing reduction of interference noise with the fan guard 6.

[0034] For example, as shown in Fig. 17A, if the blowoff side circular arc portion of the bell mouth 5 is removed, the blowoff airflow W becomes a rapid enlarged flow to generate turbulence e. If the blowoff side circular arc portion of the bell mouth 5 is removed and the fan guard 6 is set closer to the trailing edge B of the blade 13 as shown in Fig. 17B, interference noise by the blowoff airflow W and the fan guard 6 becomes large. If a taper-shaped expanded portion 5d is formed from upstream to the trailing edge B of the blade 3 on the blowoff side of the bell mouth 5 as shown in Fig. 17C, turbulence e is generated in a space between the outer periphery of the blade 13 and the taper-shaped expanded portion 5d, which increases interference noise with the fan guard 6. Because of the above reasons, a start position of the circular arc of the blowoff side circular arc portion 5b in the bell mouth 5 is preferably set approximately identical to a position of the trailing edge B of each of the blade 13.

[0035] As shown in Fig. 17A, blowing noises in the case where the blowoff side circular arc portion of the bell mouth 5 is removed (hereinbelow referred to as a reference example) and in the case where a start position of the circular arc of the blowoff side circular arc portion 5b in the bell mouth 5 is set approximately identical to a position of the trailing edge B of each of the blade 13 (hereinbelow referred to as a present embodiment) were measured with a value of H_1/H_0 varied, and a result shown in Fig. 18 was obtained. This also indicates that device of the present embodiment contributes to reduction of noise.

INDUSTRIAL APPLICABILITY

[0036] The present invention is applied to a blower device enabling reduction of operation noise by restraining generation of a wing tip vortex on a propeller fan, and to an outdoor unit for air conditioner using the same.

Claims

1. A blower device comprising: a propeller fan (4) having a plurality of blades (13), (13) ... in a thick airfoil shape as typified by airfoil wings formed on an outer periphery of a hub (14) that functions as a center of rotation; a bell mouth (5) disposed on an outer radial side of the propeller fan (4) for separating a suction area (X) and a blowoff area (Y); and a fan guard (6) disposed on a blowoff side of the propeller fan (4), the bell mouth (5) being composed of a suction side circular arc portion (5a) positioned on a suction side, a blowoff side circular arc (5b) positioned on a blowoff side, and a cylinder portion (5c) positioned in between the blowoff side circular arc (5b) and the suction side circular arc portion (5a), a ratio of H_1/H_0 being set in a range of $H_1/H_0 = 0.40$ to 0.65 where H_1 denotes a height of a portion of an axis directional height of the bell mouth (5) that is overlapped with an outer peripheral portion (P) of each of the blade (13), while H_0 denotes an axis directional height of the outer peripheral portion (P) of each of the blade (13).
2. The blower device as defined in Claim 1, wherein the cylinder portion (5c) of the bell mouth (5) is overlapped with the outer peripheral portion (P) of each of the blade (13), and a ratio of H_2/H_0 is set in a range of $H_2/H_0 = 0.25$ to 0.50 where H_2 denotes an axis directional height of the cylinder portion (5c).
3. The blower device as defined in Claim 1 or 2, wherein a start position of a circular arc of the blowoff side circular arc portion (5b) in the bell mouth (5) is approximately identical to a position of a trailing edge portion (B) of each of the blade (13).

4. An outdoor unit for air conditioner comprising the blower device (3) as defined in any one of Claim 1 to Claim 3 and a heat exchanger (2) disposed on a suction side of the blower device (3).

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Fig. 1

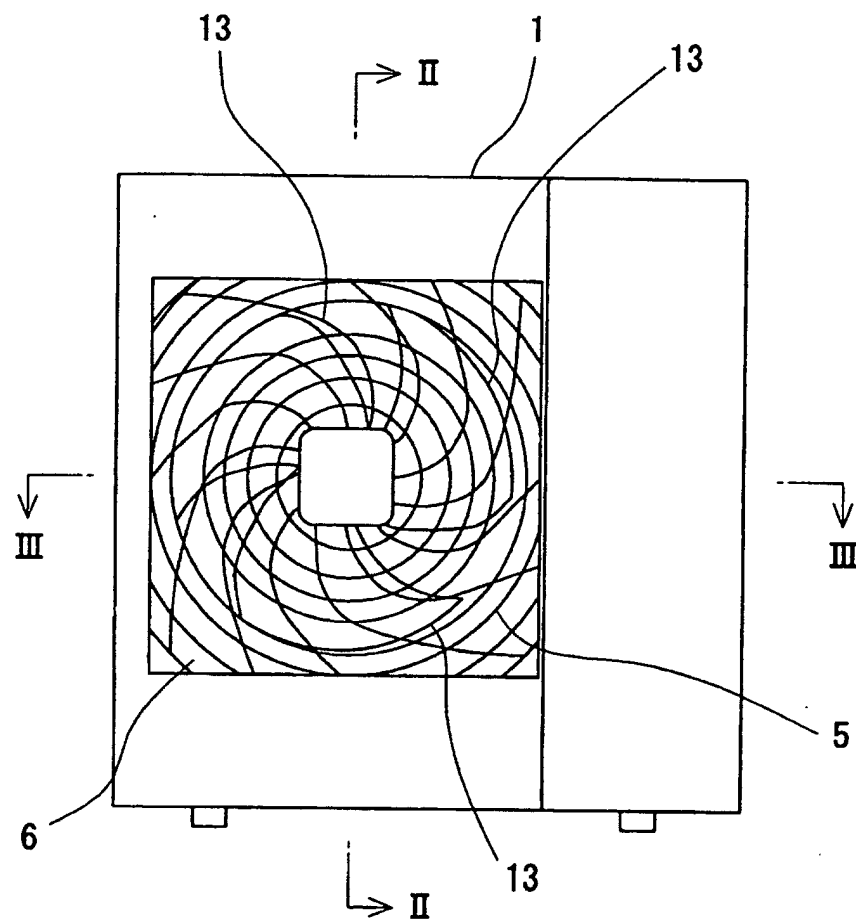


Fig. 2

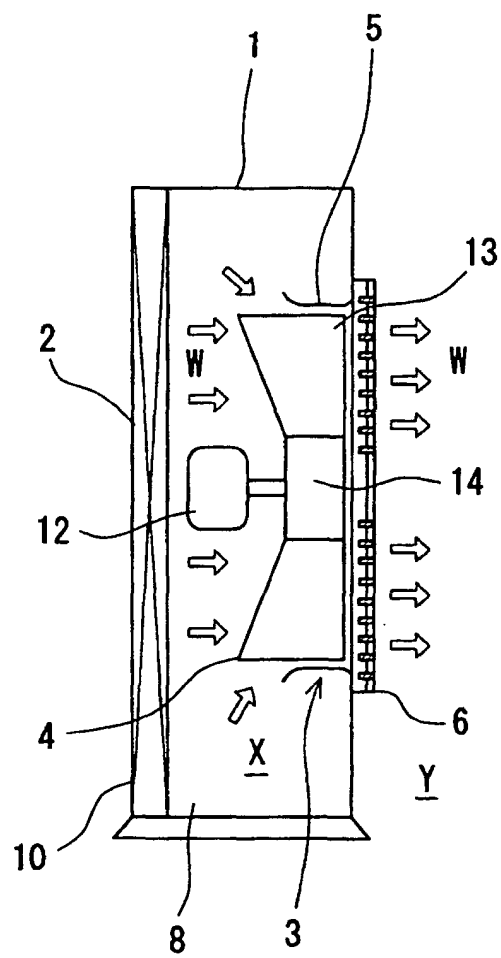


Fig. 3

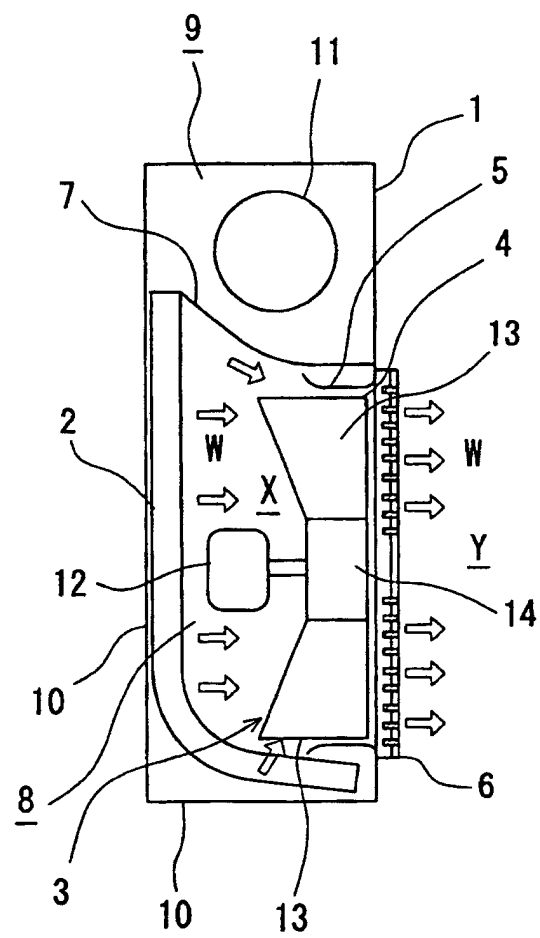


Fig. 4

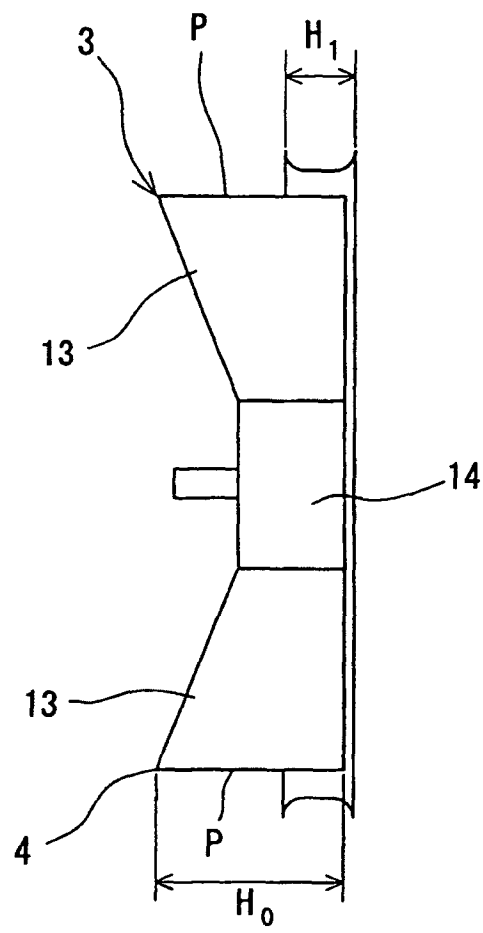


Fig. 5

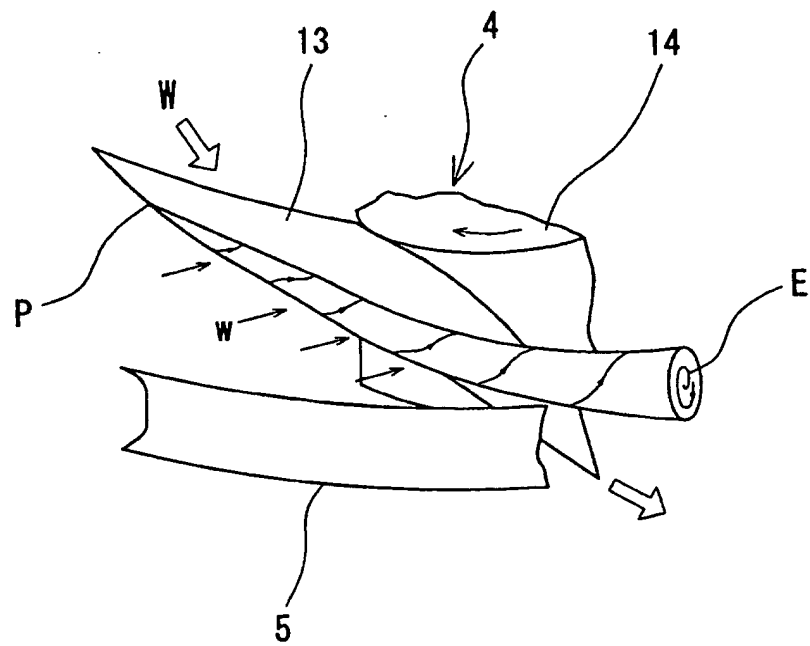


Fig. 6

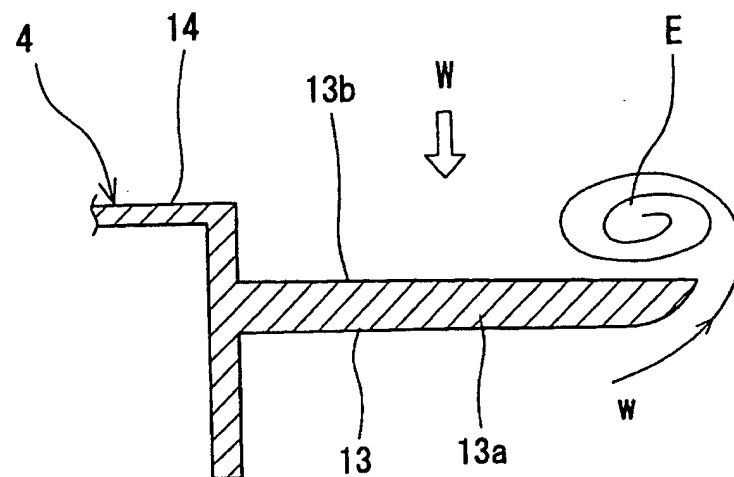


Fig. 7

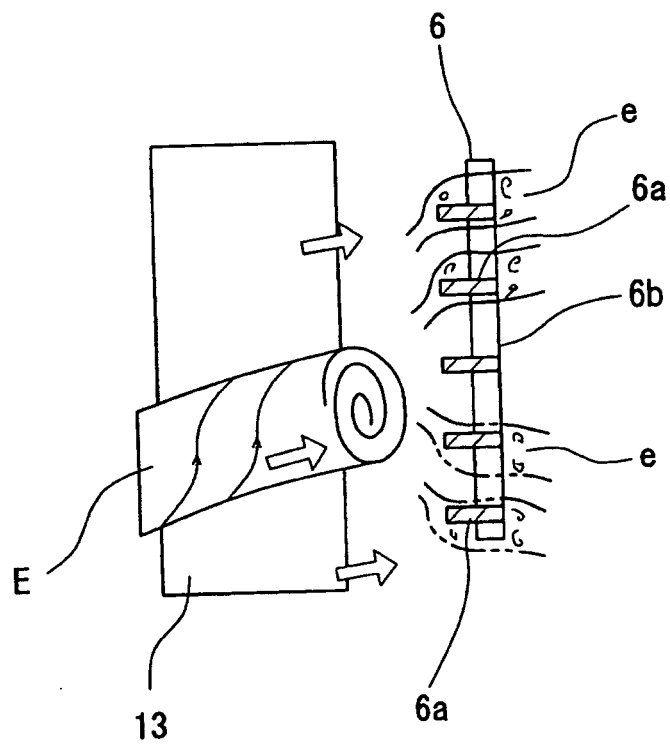


Fig. 8A

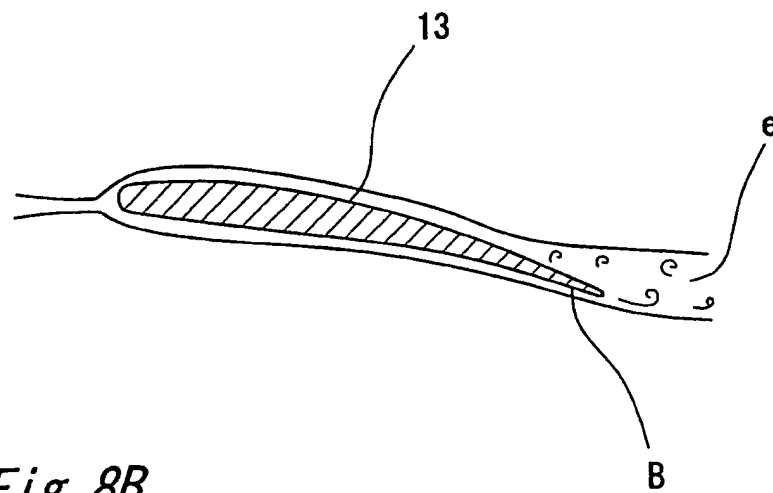


Fig. 8B

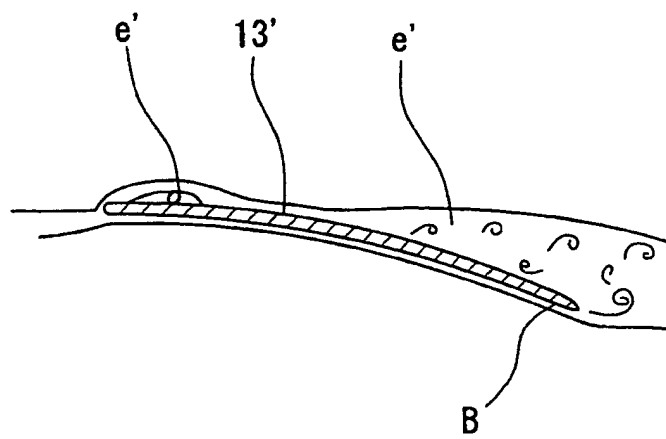


Fig. 9A

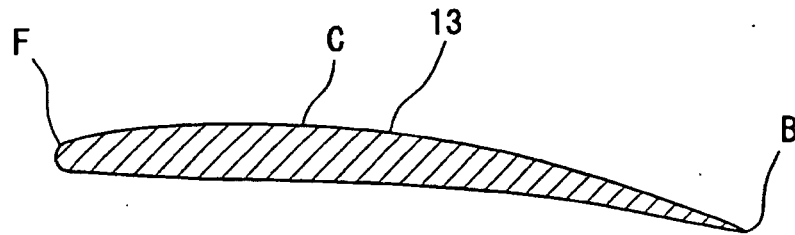


Fig. 9B

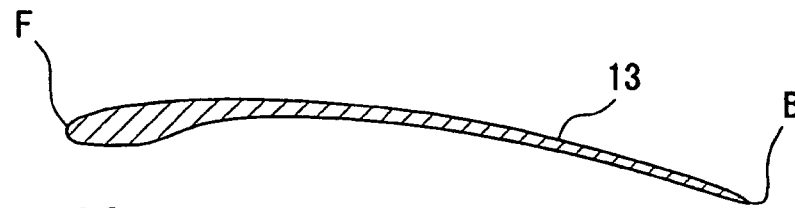


Fig. 9C

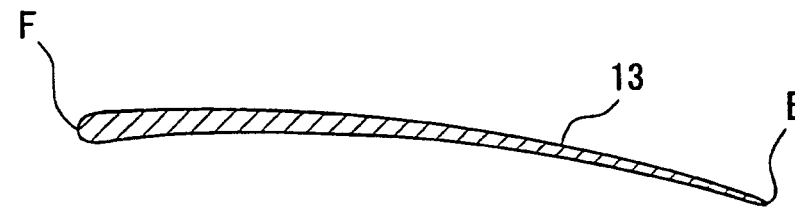


Fig. 9D

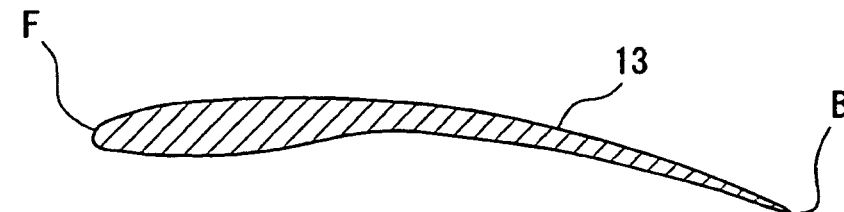


Fig. 10

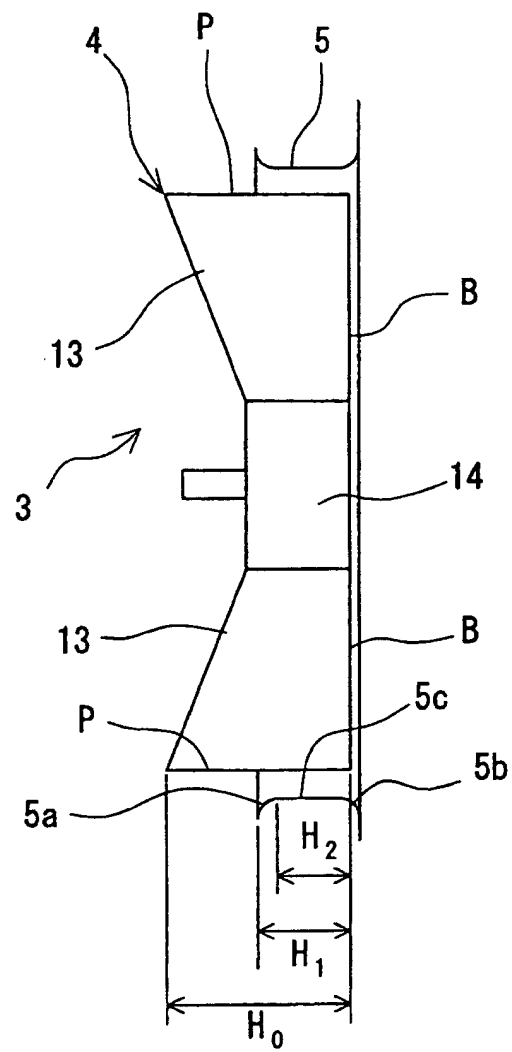


Fig. 11

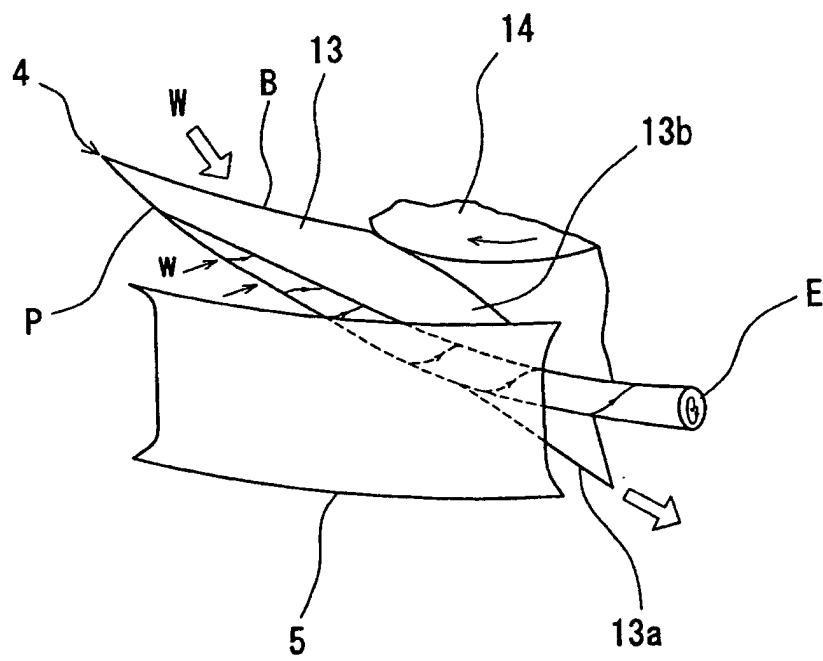


Fig. 12

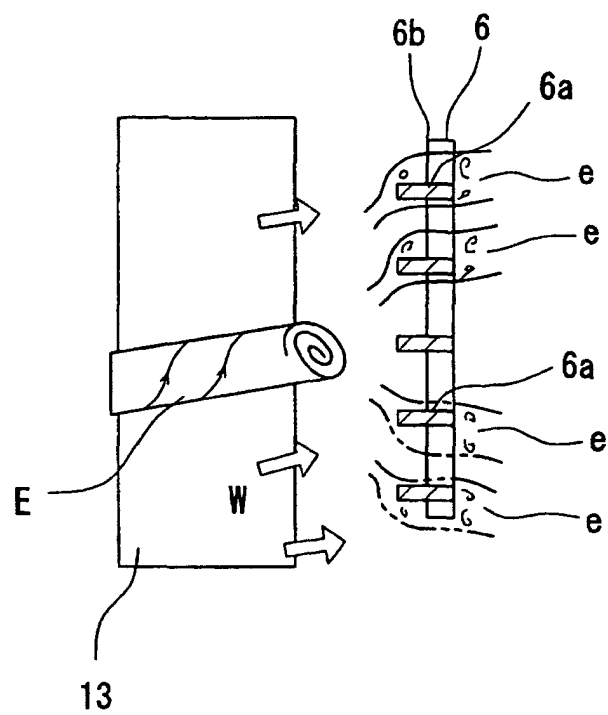


Fig. 13

----- CONVENTIONAL EXAMPLE
 — EMBODIMENT

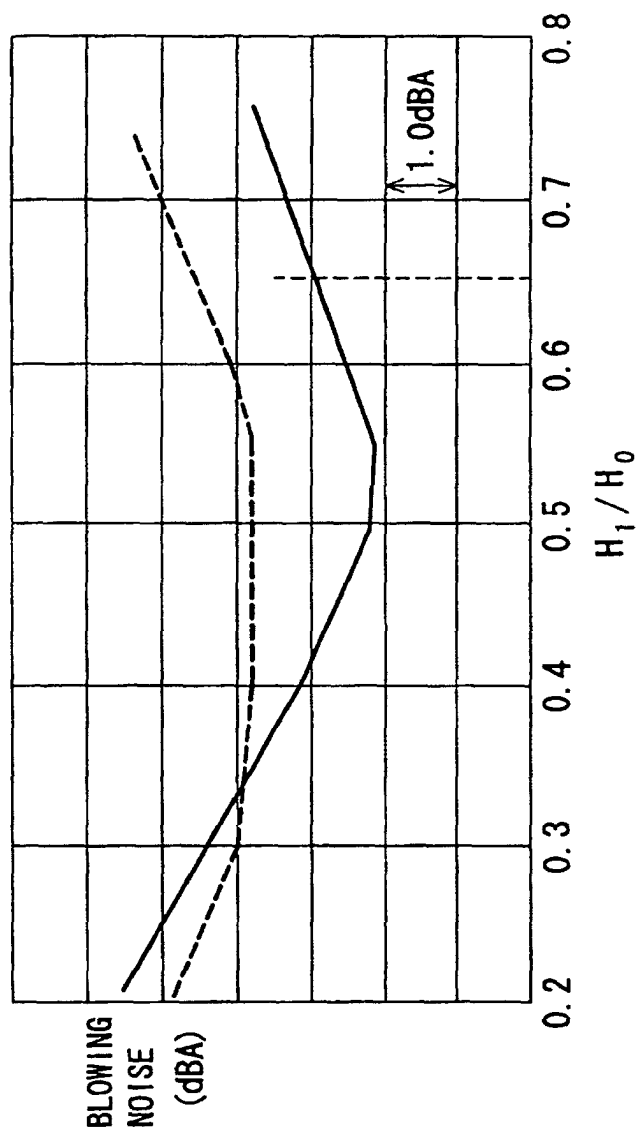


Fig. 14

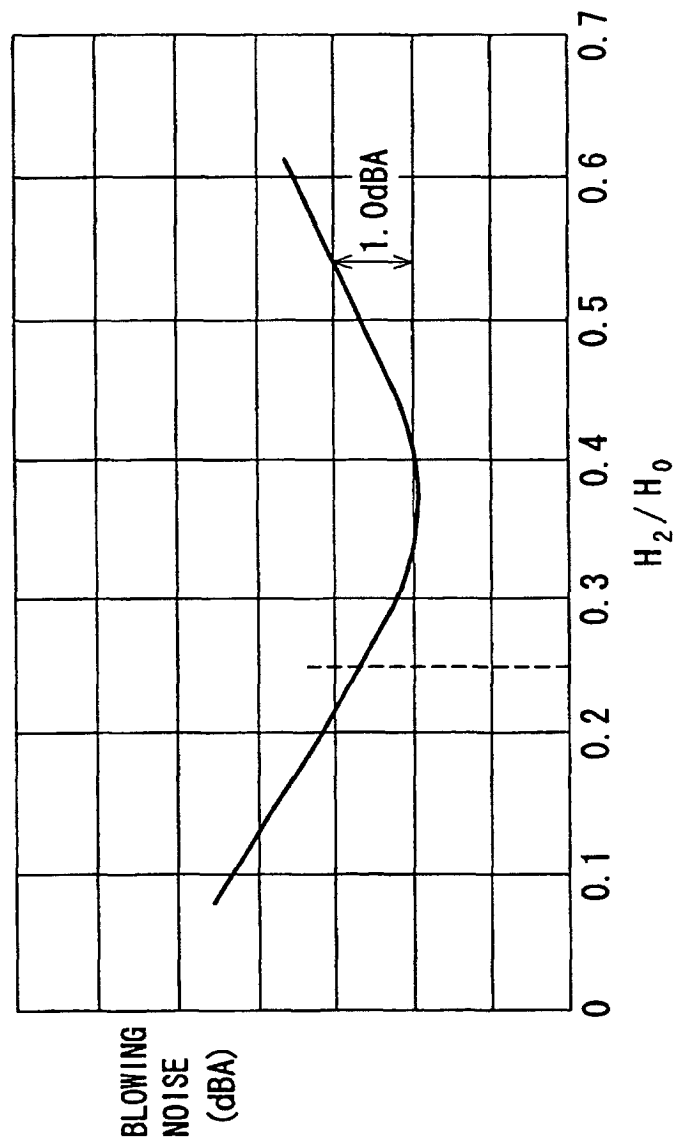


Fig. 15

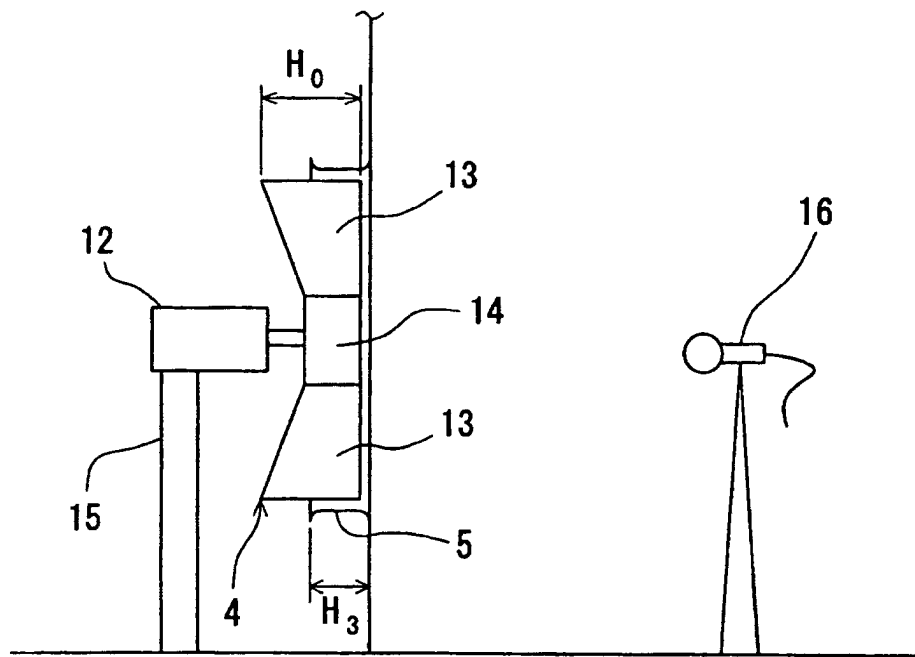


Fig. 16

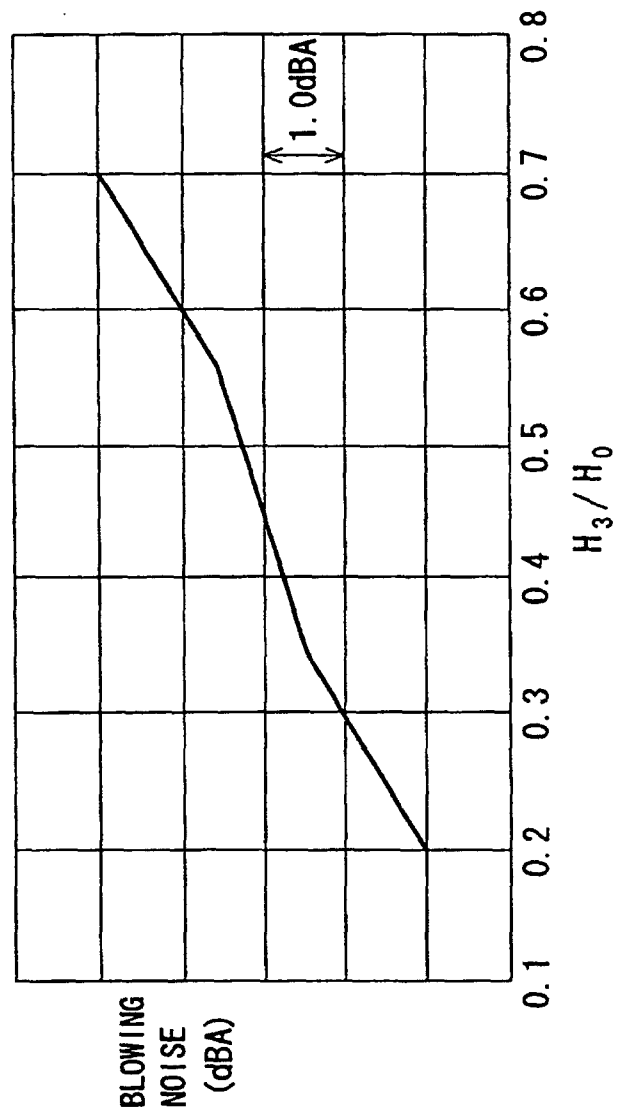


Fig. 17D

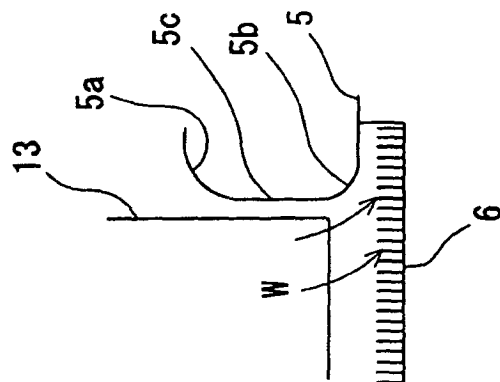


Fig. 17C

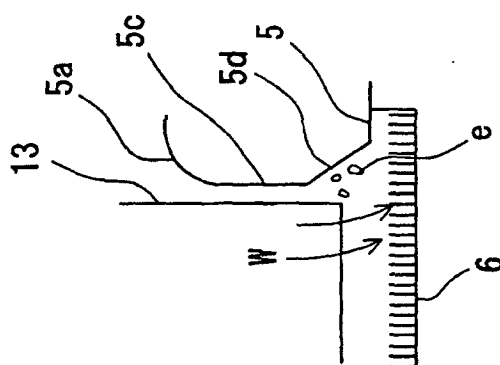


Fig. 17B

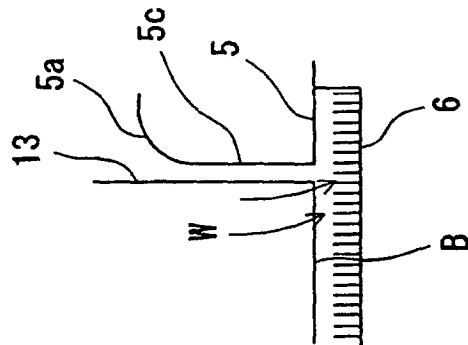


Fig. 17A

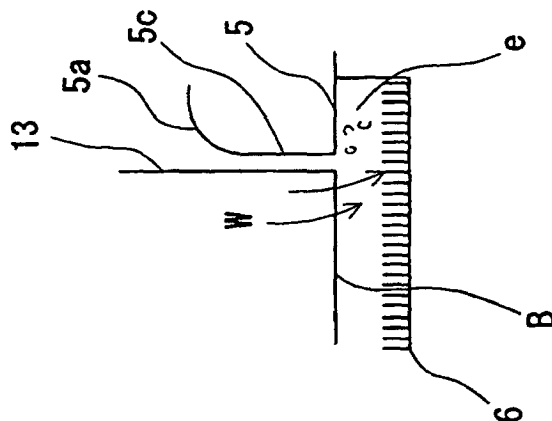
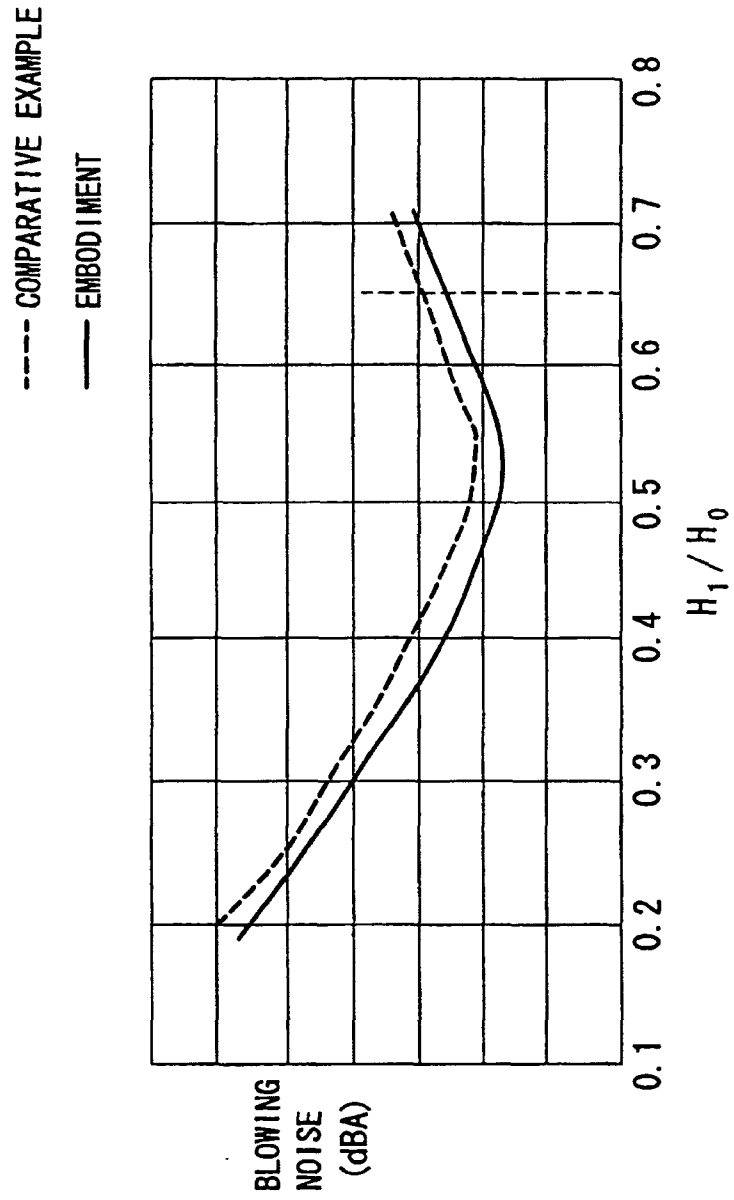


Fig. 18



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP01/11675

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁷ E03D9/08, A61H35/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) Int.Cl. ⁷ E03D9/08, A61H35/00, A47L15/20, B05B3/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2002 Kokai Jitsuyo Shinan Koho 1971-2002 Jitsuyo Shinan Toroku Koho 1996-2002		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) JICST		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2000-8452 A (Toto, Ltd.), 11 January, 2000 (11.01.2000), Full text; all drawings (Family: none)	1-49
A	JP 8-246535 A (Aiwa Co., Ltd.), 24 September, 1996 (24.09.1996), Full text; all drawings (Family: none)	1-49
A	JP 2000-282545 A (Toto, Ltd.), 10 October, 2000 (10.10.2000), Full text; all drawings (Family: none)	1-49
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 05 February, 2002 (05.02.02)		Date of mailing of the international search report 19 February, 2002 (19.02.02)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)