



(11) **EP 2 597 314 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.05.2013 Bulletin 2013/22

(51) Int Cl.:
F04D 25/06 (2006.01) F04D 29/52 (2006.01)

(21) Application number: **12194027.4**

(22) Date of filing: **23.11.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(72) Inventors:
• **Yen, KEVIN**
Toshima-ku, Tokyo 170-8451 (JP)
• **Mitomo, Shigekazu**
Toshima-ku, Tokyo 170-8451 (JP)

(30) Priority: **25.11.2011 JP 2011257545**

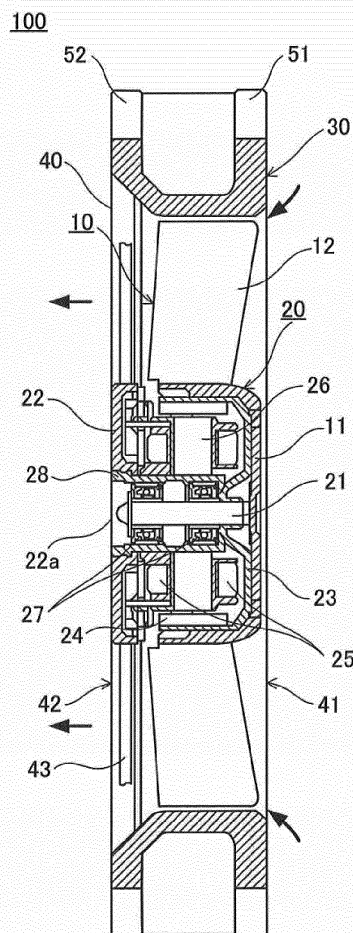
(74) Representative: **Copsey, Timothy Graham et al**
Kilburn & Strode LLP
20 Red Lion Street
London WC1R 4PJ (GB)

(71) Applicant: **Sanyo Denki Co., Ltd.**
Tokyo 170-8451 (JP)

(54) **Axial-flow fan**

(57) An axial-flow fan 100 includes an impeller 10 mounted on a rotating shaft 21 of a rotary drive device 20 and a venture casing 30 surrounding an outer periphery of the impeller 10 in a radial direction and including a suction port 41 and a discharge port 42 facing each other in an axial direction of the rotating shaft 21. An inner surface of the venture casing 30 includes a suction-side slant part 31 expending the suction port 41 outward in the radial direction of the impeller 10, a linear part 32 continuing from the suction-side slant part 31 and forming an axial flow of a fluid with the impeller 10, a discharge-side slant part 34 expanding the discharge port 42 outward in the radial direction of the impeller 10, and a curved part 33 connecting the linear part 32 and the discharge-side slant part 34.

FIG.1



Description

[0001] This application is based on Japanese Patent Application No. 2011-257545 filed on November 25, 2011, the contents of which are incorporated herein by reference.

BACKGROUND

1. Technical Field

[0002] The present invention relates to an axial-flow fan in which the shape of an inner surface of a venturi casing surrounding an outer periphery of an impeller in a radial direction is improved.

2. Description of Related Art

[0003] An axial-flow fan is provided with a cylinder-shaped venturi casing at an outer periphery of an impeller in a radial direction for forming an axial flow in conjunction with the impeller mounted on a rotating shaft of a rotary drive device. Because of its simple structure, the axial-flow fan is widely used for a cooling fan of a personal computer, a ventilating fan, and the like, for example.

[0004] The axial-flow fan typically has the flow characteristics in which air volume is large and a static pressure is small. To improve such flow characteristics of the axial-flow fan, the structure of the impeller or the structure of the venturi casing has been devised in various ways.

[0005] For example, the below-mentioned Patent Document 1 discloses a blower device in which a cross section of an orifice (venturi casing) is composed of a partial or a whole arc part at a suction side, a linear part, and an arc part at a discharge side, and in which the arc radius of the suction-side arc part is formed larger than the arc radius of the discharge-side arc part.

[0006] Further, the below-mentioned Patent Document 2 discloses an axial-flow fan in which a tapered surface concentric with the rotation center of a fan is formed on a casing (venturi casing), and in which a slant part along the above-described suction-side tapered surface is formed on a rotating blade.

[0007] See Japanese Patent Application Laid-Open No. 5-133398 (Patent Document 1) and Japanese Patent Application Laid-Open No. 2000-179490 (Patent Document 2).

[0008] Incidentally, the blower device disclosed in Patent Document 1 achieves noise reduction while obtaining a large air volume by forming the arc radius of the suction-side arc part larger than the arc radius of the discharge-side arc part. However, a discharge port of the venturi casing is expanded only at the discharge-side arc part. Therefore, because a discharged flow suddenly changes its direction in a curved manner by an inner surface of the venturi casing and passes therethrough, the maximum static pressure is more likely to be smaller than

when the discharge port is expanded in a linear manner.

[0009] On the other hand, the axial-flow fan disclosed in Patent Document 2 prevents the occurrence of a turbulent flow by forming the slant part of the rotating blade along the suction-side tapered surface of the venturi casing, whereby suctioning air flow is made smooth. However, because the expansion of the suction port by the suction-side tapered surface of the venturi casing is restricted in relation to the slant part of the rotating blade, there is a limit in increasing the air volume.

[0010] The present invention has been made in view of the foregoing problems, and an object of the present invention is to provide an axial-flow fan with a large air volume and static pressure.

SUMMARY

[0011] To achieve at least one of the abovementioned objects, an axial-flow fan reflecting one aspect of the present invention comprises an impeller and a venturi casing. The impeller is mounted on a rotating shaft of a rotary drive device. The venturi casing surrounds an outer periphery of the impeller in a radial direction and has a suction port and a discharge port facing each other in an axial direction of the rotating shaft.

[0012] An inner surface of the above-described venturi casing preferably includes a suction-side slant part expanding the suction port outward in the radial direction of the impeller, a linear part continuing from the suction-side slant part and forming an axial flow of a fluid with the impeller, a discharge-side slant part expanding the discharge port outward in the radial direction of the impeller, and a curved part connecting the linear part with the discharge-side slant part.

[0013] The discharge-side slant part preferably expands the discharge port in a linear manner from the curved part outward in the radial direction of the impeller.

[0014] The objects, features, and characteristics of this invention other than those set forth above will become apparent from the description given herein below with reference to preferred embodiments illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a cross-sectional view showing an axial-flow fan according to an embodiment.

Fig. 2 is a cross-sectional view showing a principal part of the axial-flow fan according to the embodiment.

Fig. 3 is a cross-sectional view showing a principal part of an axial-flow fan according to Comparative Example 1.

Fig. 4 is a cross-sectional view showing a principal part of an axial-flow fan according to Comparative Example 2.

Fig. 5 is a diagram illustrating characteristics of an axial-flow fan according to Example in relation to characteristics of Comparative Examples 1 and 2.

DETAILED DESCRIPTION

[0016] An axial-flow fan according to the present embodiment will be herein described with reference to the drawings.

[0017] First, the axial-flow fan according to the present embodiment will be described with reference to Fig. 1. Fig. 1 is a cross-sectional view showing the axial-flow fan according to the present embodiment. Fig. 2 is a cross-sectional view showing a principal part of the axial-flow fan according to the present embodiment.

[0018] The axial-flow fan is a blower device that takes in fluid from one of the axial directions of a rotating shaft 21 of a rotary drive device 20 described below and discharges the fluid to the other axial direction by the rotation of an impeller 10 mounted on the rotating shaft 21. An axial-flow fan 100 according to the present invention becomes capable of providing a large air volume and maximum static pressure by improving an inner surface shape of a casing 30 that surrounds an outer periphery of the impeller 10 in the radial direction.

[0019] The axial-flow fan 100 of the present embodiment includes, as shown in Fig. 1, the impeller 10 mounted on the rotating shaft 21 of the rotary drive device 20 as well as the venturi casing (hereinafter, simply referred to as "casing") 30 that surrounds the outer periphery of the impeller 10 in the radial direction. Further, the axial-flow fan 100 of the present embodiment includes a frame 40. The frame 40 supports a base part 22 of the rotary drive device 20 and integrally supports the casing 30.

[0020] The impeller 10 has a cup-shaped hub part 11 in the center, and a plurality of blades 12 is integrally and radially mounted on a periphery of the hub part 11. Each of the blades 12 is provided in a slanted manner with respect to the axial direction of the rotating shaft 21.

[0021] A motor as the rotary drive device 20 of the impeller 10 is provided inside the hub part 11. This motor 20 includes a nearly cup-shaped rotor yoke 23, the rotating shaft 21 pressed into the central part of the rotor yoke 23, and a stator core 26 in which a coil 25 is wound around.

[0022] The rotor yoke 23 is inserted into the hub part 11. A magnet 24 is secured on an inner peripheral surface of the rotor yoke 23.

[0023] The rotating shaft 21 is rotatably supported by a bearing 27. The bearing 27 is fixed to an inner surface of a cylinder-shaped support part 28. This support part 28 is integrally secured to a circular opening hole 22a formed in the center of the base part 22.

[0024] The stator core 26 is press-fit onto an outer surface of the support part 28. The stator core 26 and the magnet 24 of the rotor yoke 23 face each other with a gap therebetween.

[0025] The frame 40 is, for example, formed of synthetic resin and the like, disposes the motor 20 in the base part 22 at the suction side, and is integrally formed with the cylinder-shaped casing 30 to settle the impeller 10 in its inside. Further, the base part 22 and the casing 30 are connected by radial spokes 43.

[0026] Further, flange parts 51 and 52 for fixing the frame 40 to an electronic device and the like are provided at the rims on the suction side and the discharge side of the casing 30. The flange parts 51 and 52 are respectively extended outward in the radial direction of the impeller 10 from the suction side and the discharge side of the casing 30. These flange parts 51 and 52 are square-shaped mounting members formed continuously to an outer peripheral wall of the casing 30. Screw holes (not shown) for screwing a mounting screw are formed at four corners of each of the flanges 51 and 52.

[0027] Therefore, the axial-flow fan 100 is, via a housing of an electronic device and the like, mounted to the housing or the like by screwing the mounting screw (not shown) to the suction-side flange part 51 or the discharge-side flange part 52. For example, if the axial-flow fan 100 of the present embodiment is used as a cooling fan of a personal computer (PC), the suction-side flange part 51 is mounted to a fan mounting part on an inner surface of the housing of the PC. Further, if the axial-flow fan 100 of the present embodiment is used as a ventilating fan, the discharge-side flange part 52 is mounted to a rim part of an opening of an inner wall of a building.

[0028] Next, an inner surface shape of the casing 30 according to the present embodiment will be described with reference to Fig. 2. The axial-flow fan 100 according to the present invention is characteristic in the inner surface shape of the casing 30.

[0029] As shown in Fig. 2, the inner surface of the casing 30 is constituted by a suction-side slant part 31, a linear part 32, a curved part 33, and a discharge-side slant part 34 from the suction side to the discharge side, and these parts sequentially continue in the order.

[0030] The suction-side slant part 31 is a portion that expands the suction port 41 outward in the radial direction of the impeller 10. The suction-side slant part 31 of the present embodiment is formed of a curved line such as an arc and expands the suction port 41 outward in the radial direction of the impeller 10 in a curved manner. It is not limited to such a manner, and the suction-side slant part 31 may expand the suction port 41 outward in the radial direction of the impeller 10 in a linear manner.

[0031] As described above, the suction port 41 is slanted and expanded by the suction-side slant part 31, whereby the fluid around the suction port 41 is taken in, and the air volume of the axial-flow fan 100 can be increased. Here, the air volume is a volume of air that the axial-flow fan 100 takes in and discharges in per unit time. The larger the pressure ratio, the smaller the air volume at the discharge side due to compression. Therefore, typically, the air volume at the suction side is used.

[0032] The linear part 32 is a portion that continues

from the suction-side slant part 31 and connects the suction-side slant part 31 with the curved part 33 in a straight line. The linear part 32 forms an axial flow of a fluid together with the impeller 10. This linear part 32 faces a side edge of the blade 12 of the impeller 10 with a gap therebetween and extends toward the discharge side in nearly parallel with the side edge of the blade 12.

[0033] The curved part 33 is a portion that continues from the linear part 32 and connects the linear part 32 with the discharge-side slant part 34 described below in a curved line. The curved part 33 of the present embodiment is formed of an arc with the radius R of 5 mm, for example. However, the radius is not limited to the numerical value in the present embodiment.

[0034] A boundary between the curved part 33 and the linear part 32 is positioned on a static pressure boundary line PL between a suction-side static pressure and a discharge-side static pressure of the impeller 10. Therefore, the boundary between the curved part 33 and the above-mentioned linear part 32 becomes a boundary between the suction side and the discharge side on the inner surface of the casing 30.

[0035] Here, a static pressure is a pressure generated by a centrifugal force of the impeller 10. And the larger the maximum static pressure is, the further the fluid will reach. The suction-side static pressure, as a negative static pressure, gradually decreases from 0 Pa and becomes the minimum pressure at the PL line. On the other hand, the discharge-side static pressure is to become the maximum static pressure at the PL line as a boundary and gradually decrease to 0 Pa again.

[0036] The discharge-side slant part 34 is a portion that continues from the above-mentioned curved part 33 and expands the discharge port 42 outward in the radial direction of the impeller 10. This discharge-side slant part 34 expands the discharge port 42 in a linear manner from the curved part 33 outward in the radial direction of the impeller 10. Therefore, a discharge flow which has passed through the impeller 10 changes its direction curvilinearly at the curved part 33 outward in the radial direction of the impeller 10 and is then smoothly guided along the linear discharge-side slant part 34. The discharge-side slant part 34 of the present embodiment has the inclination angle of, for example, 44 degrees with respect to a vertical line, but the inclination angle is not limited to the numerical value in the present embodiment.

[0037] Further, in the present embodiment, the inner diameter of the discharge port 42 expanded by the discharge-side slant part 34 is set larger than the inner diameter of the suction port 41 expanded by the suction-side slant part 31. As just described, because the inner diameter of the discharge port 42 is set larger than the inner diameter of the suction port 41, the discharge flow turns from an axial flow to a diagonal flow. And with addition of a pressure increasing action by the centrifugal force of the impeller, sufficient pressure characteristics can be obtained.

[0038] As described above, by slanting and expanding

the suction port 41 at the suction-side slant part 31, the axial-flow fan 100 according to the present embodiment takes in the fluid around the suction port 41, whereby the air volume can be increased.

[0039] Also, the inner surface of the casing 30 connects the discharge-side slant part 34 with the linear part 32, that forms the axial flow together with the impeller 10, by the curved part 33. Further, the discharge-side slant part 34 expands the discharge port 42 outward in the radial direction of the impeller 10 from the curved part 33 in a linear manner.

[0040] Therefore, the direction of the discharge flow is changed outward in the radial direction of the impeller 10 at the curved part 33 in a curved manner, and the flow is then smoothly guided along the linear discharge-side slant part 34, whereby occurrence of a turbulent flow is suppressed while a large static pressure can be obtained.

[0041] Therefore, by expanding the discharge port 42 by combining the curved part 33 with the linear discharge-side slant part 34, the axial-flow fan 100 of the present embodiment exhibits an advantageous effect of suppressing the occurrence of the turbulent flow and of obtaining flow characteristics of a large air volume and maximum static pressure.

[0042] Although a preferred embodiment of the present invention has been described, it is for illustrative purpose only and is not intended to limit the scope of the present invention to the embodiment. The present invention may be practiced in various ways that differ from the above-described embodiment without departing from the scope of the invention.

[Examples]

[0043] Hereinafter, an axial-flow fan according to the present invention will be further described in detail by taking Example and Comparative Examples. However, the present invention is not limited to Example.

[Example]

[0044] Referring back to Figs. 1 and 2, Example of an axial-flow fan according to the present invention will be described. In Example, an axial-flow fan 100 shown in Figs. 1 and 2 was produced. In the axial-flow fan 100 of Example, as described above, an inner surface of a casing 30 at a discharge side is formed with a curved part 33 and a discharge-side slant part 34. The radius R of the curved part 33 is set to be 5 mm. Also, the discharge-side slant part 34 is set to 44 degree from a vertical line.

[0045] The flow characteristics of the axial-flow fan 100 of Example will be examined by measuring a flow speed, a maximum air volume, a maximum static pressure, a noise, as well as power consumption and by comparing these values with those of Comparative Examples 1 and 2 described below.

[Comparative Example 1]

[0046] In an axial-flow fan 200 of Comparative Example 1 will be described with reference to Fig. 3. Fig. 3 is a cross-sectional view showing a principal part of the axial-flow fan of Comparative Example 1. Note that substantially the same constituents as Example will be denoted using the same reference signs.

[0047] The axial-flow fan 200 of Comparative Example 1, as shown in Fig. 3, an inner surface shape of a casing 60 at a discharge side differs from Example. The inner surface of the casing 60 in Comparative Example 1 is composed of a suction-side slant part 31, a linear part 32, and a discharge-side slant part 64 from the suction side to the discharge side, and these parts sequentially continue.

[0048] The suction-side slant part 31 and the linear part 32 are formed in a similar manner to Example. Also, the discharge-side slant part 64 expands a discharge port 42 in a linear manner, and its inclination angle is set to 53 degrees from a vertical line. That is, in the axial-flow fan 200 of Comparative Example 1, the inner surface of the casing 60 at the discharge side is formed only by the linear discharge-side slant part 64.

[0049] The flow characteristics of the axial-flow fan 200 of Comparative Example 1 will be examined by measuring a flow speed, a maximum air volume, a maximum static pressure, a noise, as well as power consumption and by comparing these values with those of Example and Comparative Example 2.

[Comparative Example 2]

[0050] An axial-flow fan 300 of Comparative Example 2 will be described with reference to Fig. 4. Fig. 4 is a cross-sectional view showing a principal part of an axial-flow fan of Comparative Example 2. Note that substantially the same configurations as Example will be denoted using the same reference signs.

[0051] In the axial-flow fan 300 of Comparative Example 2, as shown in Fig. 4, an inner surface shape of a casing 70 at a discharge side differs from Example and Comparative Example 1. The inner surface of the casing 70 in Comparative Example 2 is composed of a suction-side slant part 31, a linear part 32, and a discharge-side arc part 74 from the suction side to the discharge side, and these parts sequentially continue.

[0052] The suction-side slant part 31 and the linear part 32 are formed in a similar manner to Example and Comparative Example 1. Further, the discharge-side arc part 74 expands a discharge port 42 in a curved manner and is set to be an arc with the radius R of 7.72 mm. That is, in the axial-flow fan 300 of Comparative Example 2, the inner surface of the casing 70 at the discharge side is formed only by the discharge-side arc part 74.

[0053] The flow characteristics of the axial-flow fan 300 of Comparative Example 2 will be examined by measuring a flow speed, a maximum air volume, a maximum

static pressure, a noise, as well as power consumption and by comparing these values with those of Example and Comparative Example 1.

5 [Examination of flow characteristics of Example, and Comparative Examples 1 and 2]

[0054] Fig. 5 is a diagram illustrating the characteristic of the axial-flow fan of Example in relation to the characteristics of Comparative Examples 1 and 2.

[0055] As shown in Fig. 5, the flow speeds in Example, Comparative Examples 1 and 2 are 5850 [min⁻¹] and all show the same value.

[0056] The maximum air volumes in Example and Comparative Example 2 are 1.74 [m³/min] and all show the same value. However, the maximum air volume in Comparative Example 1 is 1.70 [m³/min] and is inferior to the maximum air volumes in Example and Comparative Example 2. Therefore, it can be considered that a larger maximum air volume can be obtained when the discharge port 42 is expanded in a curved manner than when the discharge port 42 is expanded in a linear manner.

[0057] The maximum static pressures in Example and Comparative Example 1 are respectively 112.9 [Pa] and 112.8 [Pa] and show approximately the same value. However, the maximum static pressure in Comparative Example 2 is 109.0 [Pa] and is inferior to the maximum static pressures in Example and Comparative Example 1. It is considered that a larger maximum static pressure can be obtained when the discharge port 42 is expanded in a linear manner than when the discharge port 42 is expanded in a curved manner.

[0058] Noises in Example, Comparative Examples 1 and 2 are respectively 44.2 [dB], 44.3 [dB], and 44.2 [dB] and show approximately the same value.

[0059] The power consumption in Example, Comparative Examples 1 and 2 are respectively, 3.35 [W], 3.30 [W], and 3.35 [W] and show approximately the same value.

[0060] That is, according to Example, by expanding the discharge port 42 and combining the curved part 33 with the linear discharge-side slant part 34, the axial-flow fan 100 can achieve a large air volume and static pressure.

[0061] The axial-flow fan according to the present invention can be, for example, applied as a cooling fan of an electronic device such as a personal computer and a power supply device or as a ventilating fan.

Claims

1. An axial-flow fan comprising:

an impeller mounted on a rotating shaft of a rotary drive device; and
a venturi casing surrounding an outer periphery

of the impeller in a radial direction and including a suction port and a discharge port facing each other in an axial direction of the rotating shaft, wherein

an inner surface of the venturi casing includes
 a suction-side slant part expanding the suction
 port outward in the radial direction of the impeller,
 a linear part continuing from the suction-side
 slant part and forming an axial flow of a fluid with
 the impeller,
 a discharge-side slant part expanding the discharge
 port outward in the radial direction of the
 impeller, and
 a curved part connecting the linear part with the
 discharge-side slant part.

2. The axial-flow fan according to claim 1, wherein
 a boundary between the linear part and the curved
 part is positioned on a static pressure boundary line
 between a suction-side static pressure and a discharge-side static pressure of the impeller.
3. The axial-flow fan according to claim 1, wherein
 an inner diameter of the discharge port expanded by
 the discharge-side slant part is larger than an inner
 diameter of the suction port expanded by the suction-side slant part.
4. The axial-flow fan according to claim 1, wherein
 the discharge-side slant part expands the discharge
 port outward in the radial direction of the impeller
 from the curved part in a linear manner.

35

40

45

50

55

FIG.1

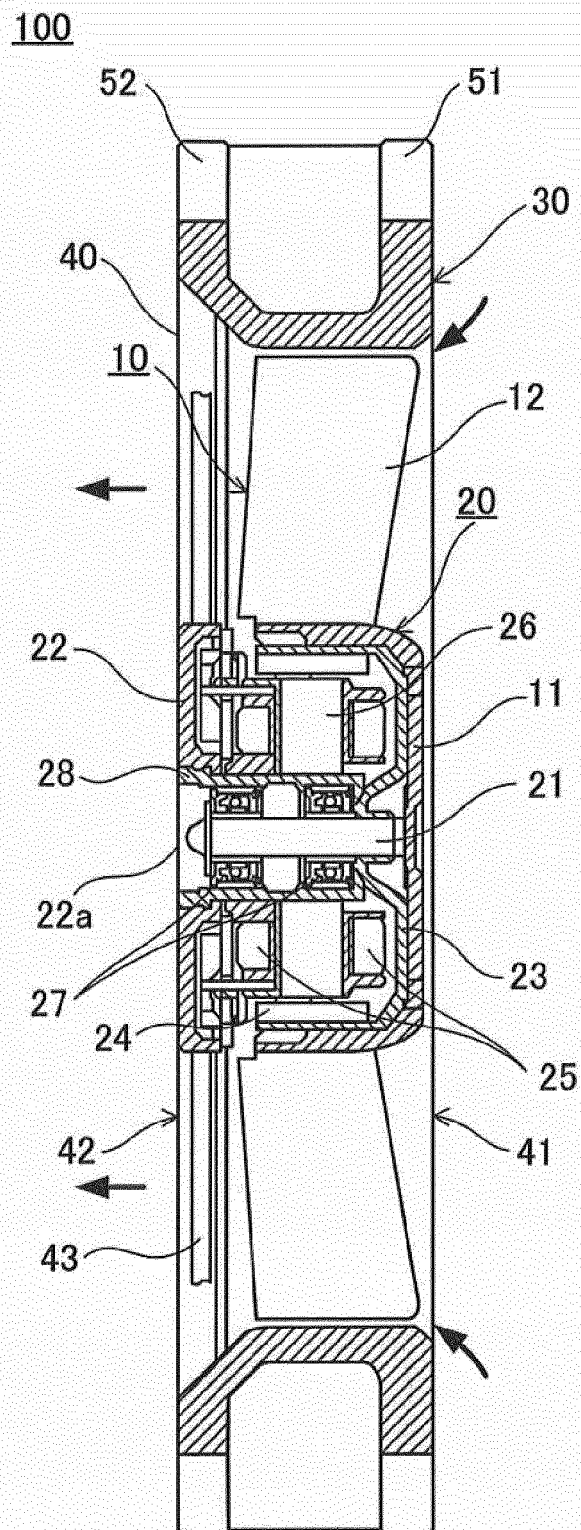


FIG.2

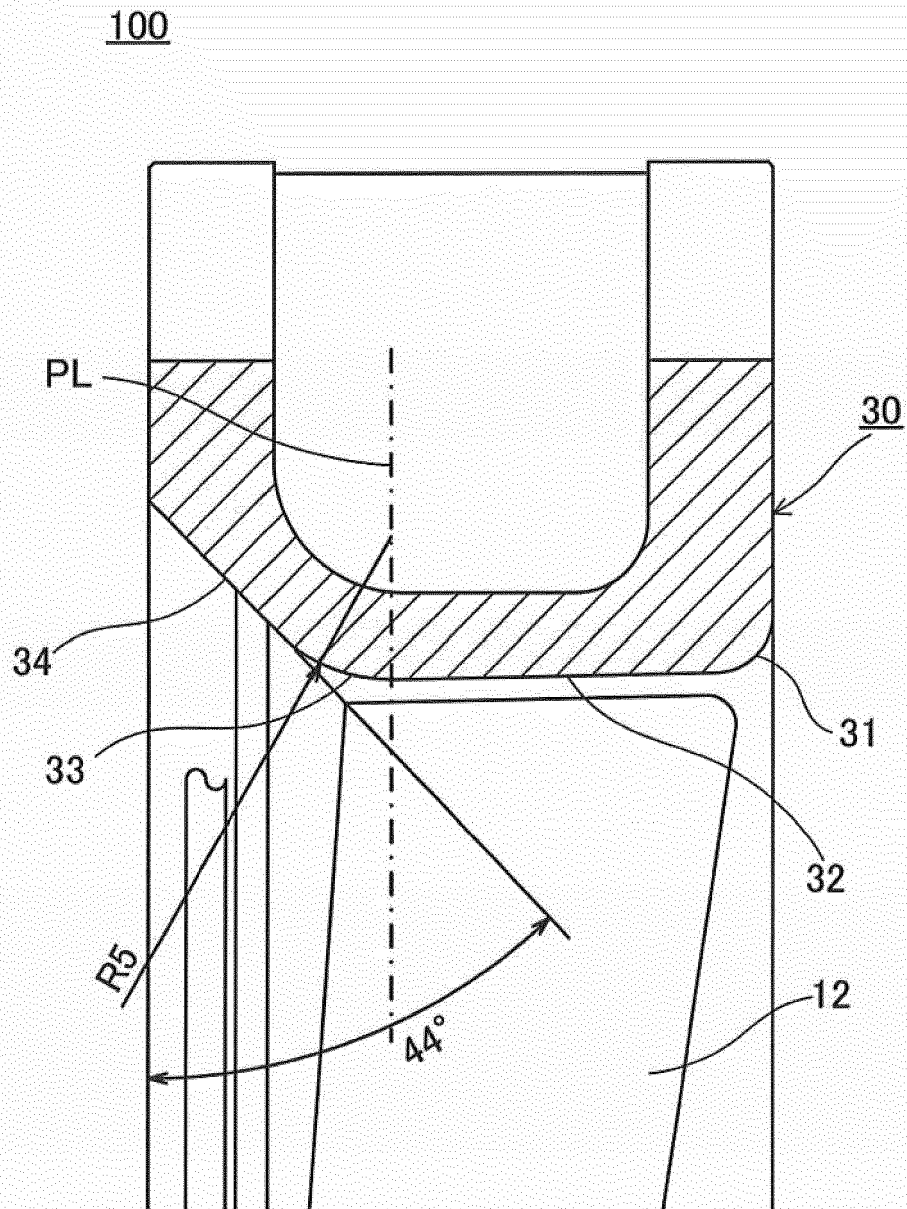


FIG.3

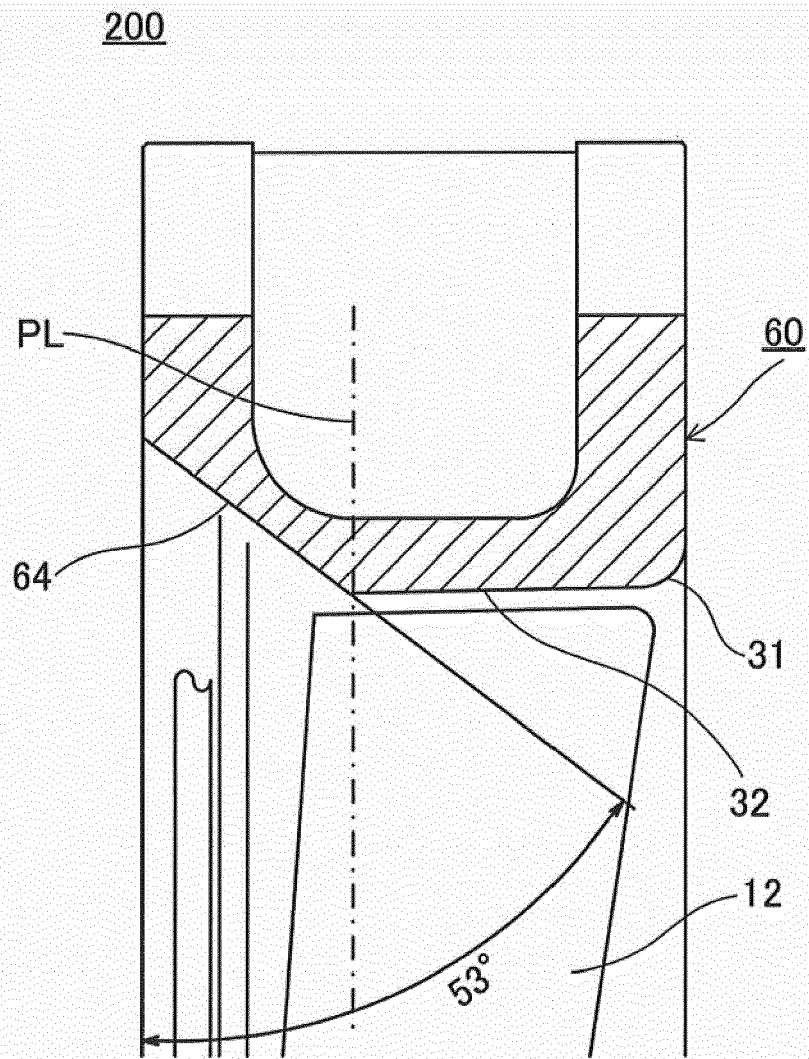


FIG.4

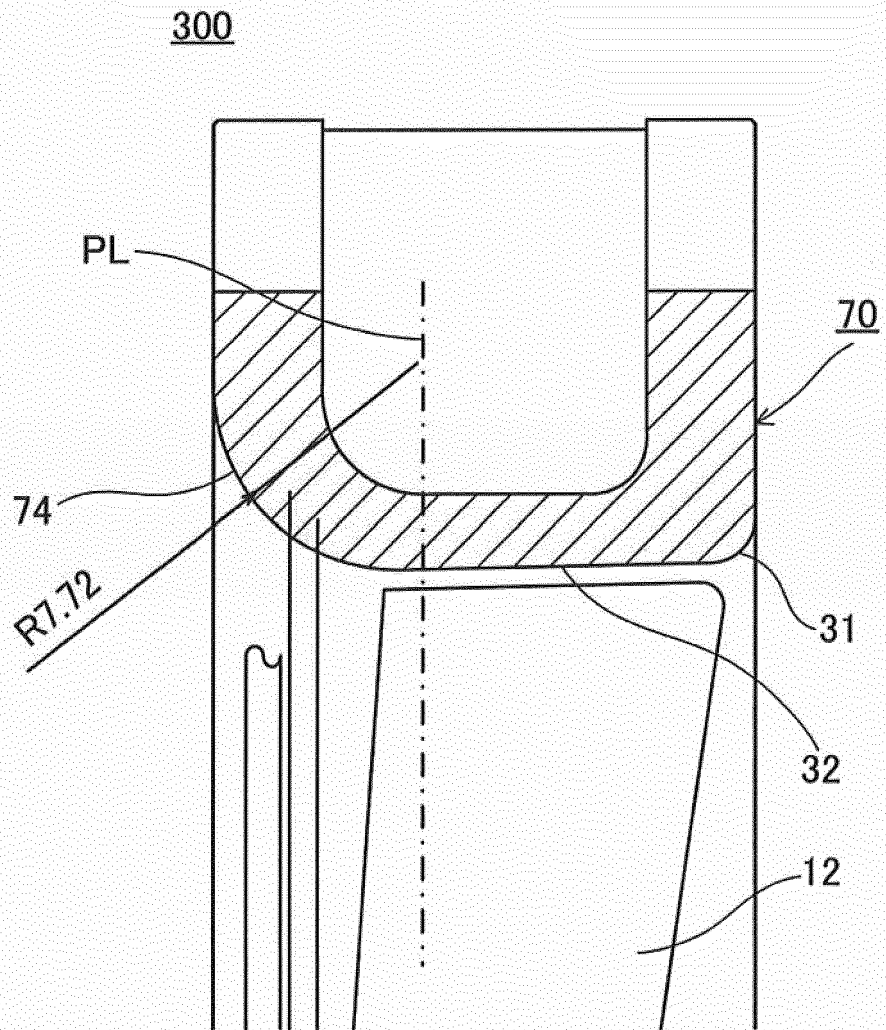
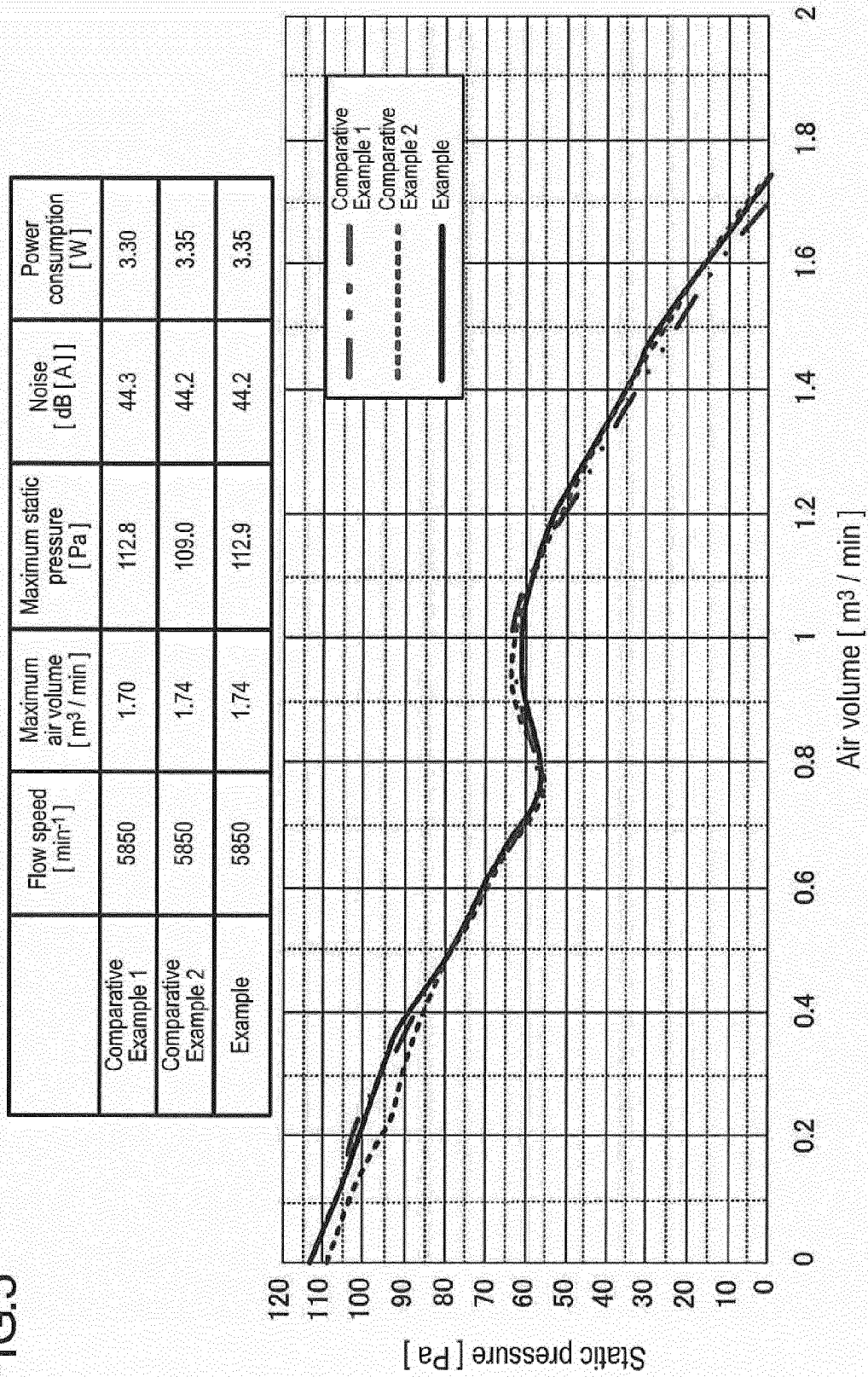


FIG.5



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2011257545 A [0001]
- JP 5133398 A [0007]
- JP 2000179490 A [0007]