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(54) PROPELLER FAN, PROPELLER FAN DEVICE, AND OUTDOOR EQUIPMENT FOR AIR-CONDITIONING DEVICE

PROPELLERLÜFTER, PROPELLERLÜFTERVORRICHTUNG UND AUSSENEINHEIT FÜR KLIMAANLAGE

VENTILATEUR HÉLICOÏDE, DISPOSITIF DE VENTILATEUR HÉLICOÏDE, ET UNITÉ EXTÉRIEURE POUR DISPOSITIF DE CONDITIONNEMENT D'AIR

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Description

Technical Field

[0001] The present invention relates to a propeller fan, a propeller fan apparatus, and an outdoor unit for an air conditioning apparatus.

Background Art

[0002] Related-art propeller fan shapes may include a propeller fan shape as disclosed in Japanese Patent No. 2590514 (page 7, FIG. 9). In this propeller fan, a blade mounting angle β gradually decreases from a blade root portion to a blade intermediate portion, and the blade mounting angle β increases from the blade intermediate portion to a blade distal edge. With such a configuration, the blade mounting angle β at the blade distal edge is set large to increase axial velocity at the blade distal edge, thereby achieving the suppression of turbulence of air at the distal edge and reduction of noise. Further, the blade mounting angle β is set large at the blade root portion to secure a high airflow rate.

Citation List

Patent Literature

[0003]

[PLT 1] Japanese Patent No. 2590514 (page 7, FIG. 9)

[PTL 2] European Patent Application No. 2806221 A2 discloses propeller fan and air conditioner having the same.

[PTL 3] United States Patent Application US2012/0114498 A1 discloses a turbine wheel with protrusions on the fan blade.

Summary of Invention

Technical Problem

[0004] With the technology disclosed in Patent Literature 1, an airflow velocity distribution on downstream of the fan is not equalized, with the result that a region having a high airflow velocity is locally formed. Thus, there has been a problem in that noise is increased when a structure such as a grille is present on downstream of the fan.

[0005] The present invention has been made to solve the problem described above, and has an object to provide a propeller fan which is reduced in noise.

Solution to Problem

[0006] In order to achieve the above-mentioned object, there is provided a propeller fan as set forth in claim 1. Further, in order to achieve the same object, there is provided a propeller fan apparatus as set forth in claim 4.

Advantageous Effects of Invention

[0007] According to the present invention, the propeller fan which is reduced in noise can be provided.

Brief Description of Drawings

[0008]

FIG. 1 is a front view of an outdoor unit for an air conditioning apparatus according to a first embodiment of the present invention.
FIG. 2 is a plan view for illustrating an internal configuration of the outdoor unit for an air conditioning apparatus according to the first embodiment of the present invention.
FIG. 3 is a perspective view of a propeller fan according to the first embodiment of the present invention.
FIG. 4 is an illustration of a blowing airflow velocity distribution of a propeller fan according to a comparison example.
FIG. 5 is an illustration of a blowing airflow velocity distribution of the propeller fan according to the present invention.
FIG. 6 is a graph for showing the blowing airflow velocity distribution of the propeller fan according to the present invention.
FIG. 7 is a plan view for illustrating a propeller fan and a periphery thereof according to a second embodiment and a third embodiment of the present invention.
FIG. 8 is a perspective view of a propeller fan according to a fourth embodiment of the present invention.
FIG. 9 is a graph for showing L/Rt and a maximum value of a normalized airflow velocity of the propeller fan according to the fourth embodiment of the present invention.

Description of Embodiments

[0009] Embodiments of the present invention are described below with reference to the accompanying drawings. As is applied in common throughout the entire description of the specification and the drawings, the same reference symbols in the drawings denote the same or corresponding components. Further, the reference symbols relating to a plurality of blades are given to only one representative blade.

First Embodiment

[0010] FIG. 1 is a front view of an outdoor unit for an air conditioning apparatus according to a first embodiment of the present invention. FIG. 2 is a plan view of an internal configuration of the outdoor unit for an air conditioning apparatus according to the first embodiment of the present invention. FIG. 3 is a perspective view of a propeller fan according to the first embodiment of the present invention.

[0011] As illustrated in FIG. 1 to FIG. 3, an outdoor unit 100 for an air conditioning apparatus includes a case 51. The case 51 is configured as a housing which has a pair of left and right side surfaces 51a and 51c, a front surface 51b, a back surface 51d, a top surface 51e, and a bottom surface 51f. The side surface 51a and the back surface 51d have opening portions for taking air from outside (see the arrows A). Further, the front surface 51b has an air outlet being an opening portion for blowing air to outside (see the arrows A). The air outlet is covered with a lattice-shaped fan grille 4.

[0012] In the case 51 of the outdoor unit 100 for an air conditioning apparatus, there are accommodated a propeller fan 1, a fan motor (drive source) 61, a bellmouth 3, and a heat exchanger 68. The propeller fan 1, as one example, is connected to the fan motor 61 which is arranged on the back surface 51d side with respect to the propeller fan 1, and is rotated by a driving force of the fan motor 61.

[0013] The heat exchanger 68 is arranged in the vicinity of the side surface 51a and the back surface 51d, and extends to form a substantially L-shape in plan view along the side surface 51a and the back surface 51d.

[0014] On a radially outer side of the propeller fan 1, the bellmouth 3 is arranged. The bellmouth 3 forms a loop shape or a ring shape along a rotation direction of the propeller fan 1.

[0015] The arrows A in FIG. 2 and FIG. 3 exemplify a flow of air. However, the arrows A are mere examples for illustration, and do not accurately represent an actual flow.

[0016] The propeller fan 1 includes a boss 1a and a plurality of blades 2. As one example, in the first embodiment, the propeller fan 1 includes three blades 2.

[0017] The boss 1a forms a center portion of the propeller fan 1. In other words, a rotation center line RC of the propeller fan 1 extends through the boss 1a. The shape of the boss 1a is not particularly limited, and may be formed into, for example, a columnar shape or a conical shape.

[0018] The three blades 2 are fixed to an outer peripheral surface of the boss 1a. The blades 2 are partially surrounded by the bellmouth 3 in plan view. That is, respective downstream portions of the blades 2 are located, in plan view, within an inner region of the bellmouth 3 which is surrounded by the bellmouth 3, and respective upstream portions of the blades 2 are located, in plan view, outside the inner region of the bellmouth 3 which is surrounded by the bellmouth 3. That is, the respective upstream portions of the blades 2 are located on upstream of an upstream end, which is an inlet end, of the bellmouth 3. Further, the fan grille 4 is arranged on downstream of the propeller fan 1.

[0019] In the first embodiment of the present invention, the three blades 2 have the same shape, though not particularly limited. Thus, description is made of one blade 2. According to the present invention, the blade has, as extending from an inner peripheral edge 23 to an outer peripheral edge 24 in a radial direction of the blade, at least one of a shape in which a part of a leading edge 21 protrudes toward a positive pressure surface 2a side, or a shape in which a part of a trailing edge 22 protrudes toward a negative pressure surface 2b side. In other words, the blade 2 has, as extending from an innermost periphery to an outermost periphery in the radial direction, at least one of a shape in which the leading edge 21 locally protrudes toward the positive pressure surface 2a side, or a shape in which the trailing edge 22 locally protrudes toward the negative pressure surface 2b side. The blade 2 of the illustrated example has both the shape in which a part of the leading edge 21 protrudes toward the positive pressure surface 2a side and the shape in which a part of the trailing edge 22 protrudes toward the negative pressure surface 2b side. Further, in another form of description, with respect to an air-blowing direction as viewed in an extending direction of the rotation center line RC, that is, the direction exemplified with the arrows A in FIG. 3, the above-mentioned protrusion at a part of the leading edge 21 is a protrusion toward downstream in the air-blowing direction, and the above-mentioned protrusion at a part of the trailing edge 22 is a protrusion toward upstream in the air-blowing direction.

[0020] As illustrated in FIG. 5 which is described later, when a radius from the rotation center line RC to the outer peripheral edge 24 of the blade 2 is a blade radius Rt, a center 28 of the protrusion at the leading edge 21 in the radial direction and a center 28 of the protrusion at the trailing edge 22 in the radial direction are located on a radially outer side with respect to a radial position of 0.5Rt from the rotation center line RC, that is, located on a radially outer side with respect to a radial position at a half of the blade radius from the rotation center line RC. Each of the center 28 of the protrusion at the leading edge 21 in the radial direction and the center 28 of the protrusion at the trailing edge 22 in the radial direction represents a central position in the radial direction between a protrusion-start radial position 26, which is an innermost position of the protrusion in the radial direction, and a protrusion-end radial position 27, which is an outermost position of the protrusion in the radial direction.

[0021] Further, both a partial leading edge-side protrusion area 31, which starts from the above-mentioned protrusion at a part 21a of the leading edge 21, and a partial trailing edge-side protrusion area 32, which starts from the above-mentioned protrusion at a part 22a of the trailing edge 22, extend in front-back direction of a rotation trajectory.

[0022] Further, a protrusion height of the partial leading edge-side protrusion area 31, which starts from the protrusion at the part 21a of the leading edge 21, is maximum at the leading edge 21 and gradually decreases toward the trailing edge 22. Similarly, a protrusion height of the partial trailing edge-side protrusion area 32, which starts from the protrusion at the part 22a of the trailing edge 22, is maximum at the trailing edge 22 and gradually decreases toward the leading edge 21. That is, the partial leading edge-side protrusion area 31, which starts from the protrusion at the part 21a of the leading edge 21, is lost in the positive pressure surface 2a without reaching the trailing edge 22, and the partial trailing edge-side protrusion area 32, which starts from the protrusion at the part 22a of the trailing edge 22, is lost in the negative pressure surface 2b without reaching the leading edge 21.

[0023] Further, on an imaginary plane obtained by developing a cylindrical surface-shaped cross section, which is taken along a cross-sectional line V arcuately extending about the rotation center line RC as a center at a radial position passing through the partial leading edge-side protrusion area 31 which starts from the protrusion at the part 21a of the leading edge 21 and the partial trailing edge-side protrusion area 32 which starts from the protrusion at the part 22a of the trailing edge 22, further into a flat surface, a curved line of a blade surface connecting the leading edge 21 or the part 21a to the trailing edge 22 or the part 22a has a substantially arc shape.

[0024] With reference to FIG. 4 to FIG. 6, description is made of an effect which can be obtained with the configuration described above. FIG. 4 is an illustration of a blowing airflow velocity distribution of a propeller fan according to a comparison example. FIG. 5 is an illustration of a blowing airflow velocity distribution of the propeller fan according to the present invention. FIG. 6 is a graph for showing the blowing airflow velocity distribution of the propeller fan according to the present invention.

[0025] As the comparison example, the blowing airflow velocity distribution of the propeller fan including only blades 2' each having neither the leading edge-side protrusion area 31 nor the trailing edge-side protrusion area 32 described above exhibits the airflow velocity distribution in which, as illustrated in FIG. 4, the airflow velocity is maximum in the vicinity of the outer peripheral edge 24 of the blade 2' . The airflow velocity gradually increases from the inner peripheral edge 23 toward the outer peripheral edge 24 of the blade 2' because the movement velocity of the blade 2' is higher on the outer peripheral side of the blade 2' to increase the amount of work of the blade 2'. The airflow velocity decreases at the outermost part in the vicinity of the outer peripheral edge 24 because there is leakage through a clearance between the blade 2' and the bellmouth 3 at the outer peripheral edge 24 of the blade 2' or because the amount of work is originally small due to protrusion at a part of the blade 2' on upstream in the air-blowing direction from the bellmouth 3.

[0026] In such a propeller fan according to the comparison example, when a blowing air stream from the propeller fan passes through the fan grille 4 arranged on downstream of the propeller fan, noise is generated. In general, the noise which is generated when the air stream passes through the fan grille 4 increases in proportion to the sixth power of the flow velocity. Thus, the presence of the maximum portion in the blowing airflow velocity distribution from the propeller fan may become a source of large noise.

[0027] In contrast, with regard to the blowing airflow velocity distribution, the above-mentioned configuration of the propeller fan 1 according to the first embodiment of the present invention reduces the velocity component in the turning direction in the region having the maximum airflow velocity in the blowing airflow velocity distribution from the propeller fan 1, thereby being capable of effectively decreasing the amount of work of the blade 2 and relatively increasing the amount of work of the blade 2 at the inner peripheral edge 23. Thus, as illustrated in FIG. 5, more equalized blowing airflow velocity distribution can be achieved in the radial direction of the blade 2 so that the noise which is generated when the air stream passes through the fan grille 4 arranged on downstream of the propeller fan 1 is reduced, thereby being capable of reducing noise of the propeller fan.

[0028] Further, as described above, on the imaginary plane obtained by developing the cylindrical surface-shaped cross section, which is taken along the cross-sectional line V arcuately extending about the rotation center line RC as a center at the radial position passing through the partial leading edge-side protrusion area 31 which starts from the protrusion at the part 21a of the leading edge 21 and the partial trailing edge-side protrusion area 32 which starts from the protrusion at the part 22a of the trailing edge 22, further into a flat surface, the curved line of the blade surface connecting the leading edge 21 or the part 21a to the trailing edge 22 or the part 22a has the substantially arc shape. Thus, the airflow smoothly proceeds along the blade surface. Such smooth airflow along the blade surface can effectively suppress generation of a vortex being a source of noise, thereby further reducing the noise of the propeller fan.

[0029] Further, in FIG. 6, with regard to comparison of the blowing airflow velocity distribution, the propeller fan according to the comparison example and the propeller fan 1 according to the first embodiment of the present invention are compared. With regard to the propeller fan according to the comparison example, an apparent maximum portion of the airflow velocity can be seen near a radius ratio of 0.8. With regard to the propeller fan according to the first embodiment of the present invention, the airflow velocity near the radius ratio of 0.8 is reduced as compared to the case of the propeller fan according to the comparison example. Further, the airflow velocity in the region at the radius ratio of 0.6 or less on an inner peripheral side of the blade is increased as compared to the case of the propeller fan according to the comparison example. That is, with regard to the propeller fan according to the first embodiment of the present invention, an apparent maximum portion of the airflow velocity like the case of the propeller fan according to the comparison example cannot be seen. Thus, it can be understood that the airflow velocity distribution is more equalized as compared to the case of the propeller fan according to the comparison example. The radius ratio is a ratio of a radial position on the blade when the blade radius Rt, which is a radius of the propeller fan, is 1. The normalized airflow velocity is the airflow velocity which is normalized when a maximum value of the blowing airflow velocity distribution of the propeller fan according to the comparison example is 1.

[0030] As described above, according to the first embodiment of the present invention, a propeller fan and an outdoor unit for an air conditioning apparatus which are reduced in noise can be provided.

Second Embodiment

[0031] Next, with reference to FIG. 7, description is made of a second embodiment of the present invention. FIG. 7 is a plan view for illustrating a propeller fan and a periphery thereof according to the second embodiment of the present invention. In the second embodiment, details other than those described below are the same as the details of the above-mentioned first embodiment.

[0032] As illustrated in FIG. 7, in the propeller fan according to the second embodiment of the present invention, maximum protrusion radial positions 25 of the protrusion at the leading edge 21 and the protrusion at the trailing edge 22 are located on an outer side in the radial direction with respect to a radial position of the centers 28 of the protrusions in the radial direction between the protrusion-start radial position 26 and the protrusion-end radial position 27.

[0033] Description is made of an effect which can be obtained with such a configuration. As illustrated in FIG. 6, it can be understood that a gradient of a change in blowing airflow velocity distribution of the propeller fan 1 is relatively smaller on the inner peripheral side of the maximum portion of the airflow velocity distribution, and is relatively larger on the outer peripheral side of the maximum portion of the airflow velocity distribution. In contrast, with the configuration of the second embodiment, a change in gradient of the protrusion at the leading edge 21 and a change in gradient of the protrusion at the trailing edge 22 more suitably match with the gradient of the change in airflow velocity distribution. Thus, the blowing airflow velocity distribution from the propeller fan can be further equalized, and the noise which is generated when the air stream passes through the grille arranged on downstream of the propeller fan is reduced, thereby being capable of reducing noise of the propeller fan.

Third Embodiment

[0034] Next, with reference to FIG. 6 and FIG. 7, description is made of a third embodiment of the present invention. FIG. 7 is a plan view for illustrating a propeller fan and a periphery thereof according to the third embodiment of the present invention. In the third embodiment, details other than those described below are the same as the details of the first embodiment or the second embodiment described above.

[0035] As illustrated in FIG. 7, similar to the above-mentioned second embodiment, in the propeller fan according to the third embodiment of the present invention, the maximum protrusion radial positions 25 of the protrusion at the leading edge 21 and the protrusion at the trailing edge 22 are located on the outer side in the radial direction with respect to the radial position of the centers 28 of the protrusions in the radial direction between the protrusion-start radial position 26 and the protrusion-end radial position 27.

[0036] In addition to the description above, in the propeller fan according to the third embodiment of the present invention, the maximum protrusion radial positions 25 of the protrusion at the leading edge 21 and the protrusion at the trailing edge 22 are arranged at positions substantially matching with the maximum portion of the blowing airflow velocity distribution. That is, when the maximum protrusion radial positions 25 are to be set, the blowing airflow velocity distribution is obtained with regard to a blade which is different only in condition that the protrusion is arranged neither at the leading edge nor at the trailing edge. Then, the maximum protrusion radial positions 25 are set at positions of the maximum portion of the blowing airflow velocity distribution. Specifically, as described above in relation to FIG. 6, the blowing airflow velocity distribution of the propeller fan according to the comparison example has a maximum portion of the airflow velocity distribution near the radius ratio of 0.8, which is a radial position at 0.8Rt from the rotation center line RC. Thus, the maximum protrusion radial positions 25 of the protrusion at the leading edge 21 and the protrusion at the trailing edge 22 are arranged at the radial positions of 0.8Rt from the rotation center line RC.

[0037] With the above-mentioned configuration, the following advantage can be obtained. That is, at the maximum protrusion radial positions 25 of the protrusion at the leading edge 21 and the protrusion at the trailing edge 22 of the blade 2, the airflow velocity can be reduced at most. Thus, the positions at which the airflow velocity is reduced at most are set so as to substantially match with the maximum portion of the blowing airflow velocity distribution of the propeller fan 1. With this, the blowing airflow velocity distribution of the propeller fan 1 can be further equalized, and the noise which is generated when the air stream passes through the fan grille 4 arranged on downstream of the propeller fan 1 is reduced, thereby being capable of reducing noise of the propeller fan.

Fourth Embodiment

[0038] Next, with reference to FIG. 8 and FIG. 9, description is made of a fourth embodiment of the present invention. FIG. 8 is a perspective view of a propeller fan according to the fourth embodiment of the present invention. FIG. 9 is a graph for showing L/Rt and a maximum value of a normalized airflow velocity of the propeller fan according to the fourth embodiment of the present invention. In the fourth embodiment, details other than those described below are the same as the details of any one of the first embodiment, the second embodiment, and the third embodiment described above.

[0039] As illustrated in FIG. 8, in the propeller fan according to the fourth embodiment of the present invention, a protrusion height L of the maximum protrusion radial positions 25 of the protrusion at the leading edge 21 and the protrusion at the trailing edge 22 of the blade 2 is set so as to satisfy $L/Rt<0.1$.

[0040] With reference to FIG. 9, description is made of an effect which can be obtained with the above-mentioned configuration. As shown in FIG. 9, in the range of $L/Rt<0.1$, the maximum value of the normalized airflow velocity is reduced as L/Rt increases. However, in the range of $L/Rt\geq 0.1$, the maximum value of the normalized airflow velocity is constant. Herein, when a part of the leading edge 21 is caused to protrude toward the positive pressure surface 2a side, or a part of the trailing edge 22 is caused to protrude toward the negative pressure surface 2b side as described above, the blade surface of the protruding portion comes closer to a plane which is perpendicular to or orthogonal to the rotation center line RC. Thus, the relative velocity of the air stream which flows along the blade surface is increased. Such an increase in relative velocity may become a factor of increasing the noise. In particular, in the range of $L/Rt\geq 0.1$, the maximum value of the normalized airflow velocity is constant. Thus, the factor of increasing the noise may be dominant. As a result, there is a risk in that a sufficient noise reduction effect is not obtained. In contrast, according to the fourth embodiment of the present invention, the protrusion is formed so as to satisfy $L/Rt<0.1$ as described above. Thus, such increase of noise can be avoided, thereby being capable of further reducing noise of the propeller fan.

[0041] The details of the present invention are described above with reference to the exemplary embodiments. However, it is apparent that a person skilled in the art may employ various modified modes based on the basic technical idea and teaching of the present invention.

[0042] In the above-mentioned embodiments, description is made of the propeller fan incorporated into an outdoor unit for an air conditioning apparatus. However, the propeller fan according to the present invention is not limited thereto. The present invention can be carried out as a propeller fan apparatus including the propeller fan, the bellmouth, and the fan grille, which are described above. The bellmouth surrounds a portion of the propeller fan on downstream in the air-blowing direction in plan view, and a portion of the propeller fan on upstream in the air-blowing direction is arranged outside the bellmouth in plan view. The fan grille is arranged on downstream of the propeller fan in the air-blowing direction. One of embodiments employing such a propeller fan apparatus in combination with the heat exchanger corresponds to the embodiment of the outdoor unit for an air conditioning apparatus described above. Therefore, as another example, the propeller fan apparatus according to the present invention can be used for a refrigeration cycle system (system with a refrigeration circuit including at least a compressor, a condenser, an expansion device, and an evaporator) such as a refrigeration apparatus other than the air conditioning apparatus. Further, the propeller fan apparatus can also be used for a ventilation device, an air-sending device, and a drier, which do not require employment of a heat-exchanging element.

[0043] Further, in the examples described above, the case where three blades are arranged is illustrated as the preferred mode of carrying out the present invention. However, the present invention can also be carried out with the number of blades other than three. Also with such a configuration, the above-mentioned advantageous actions and effects can be obtained.

[0044] Further, in the above-mentioned embodiments, illustration is made of the mode in which the blade has both the shape in which a part of the leading edge protrudes toward the positive pressure surface side and the shape in which a part of the trailing edge protrudes toward the negative pressure surface side. However, this mode is a mere example of the present invention. The blade in relation to the present invention may be in a mode of having the protrusion at the leading edge and no protrusion at the trailing edge, or in a mode of having the protrusion at the trailing edge and no protrusion at the leading edge.

Reference Sings List

[0045] 1 propeller fan, 1a boss, 2 blade, 2a positive pressure surface, 2b negative pressure surface, 3 bellmouth, 4 fan grille, 21 leading edge, 22 trailing edge, 24 outer peripheral edge, 25 maximum protrusion radial position, 28 center of the protrusion in the radial direction, 100 outdoor unit for an air conditioning apparatus

Claims

1. A propeller fan (1), comprising:

a boss (la); and
a blade (2) fixed to the boss (la),
wherein the blade (2) has one of a shape in which a part of a leading edge (21) of the blade (2) protrudes toward a positive pressure surface

(2a) side and a shape in which a part of a trailing edge (22) of the blade (2) protrudes toward a negative pressure surface (2b) side,
wherein a center of a protrusion in a radial direction of the blade (2) is located on a radially outer side with respect to a radial position at a half of a blade radius from a rotation center line, **characterised in that** a maximum protrusion radial position of the protrusion is located on a radially outer side with respect to a radial position at the center of the protrusion in the radial direction.

2. A propeller fan (1) according to claim 1, wherein the fan has a blowing airflow velocity distribution, and wherein the maximum protrusion radial position is arranged at a position matching with a maximum velocity portion of the blowing airflow velocity distribution.

3. A propeller fan (1) according to claim 1 or 2, wherein a protrusion height L of the protrusion at the maximum protrusion radial position is set so as to satisfy $L/Rt<0.1$,
where Rt represents a blade radius from the rotation center line to an outer peripheral edge (24) of the blade (2).

4. A propeller fan apparatus, comprising:

   the propeller fan (1) of any one of claims 1 to 3;
   a bellmouth (3); and
   a fan grille (4),
   wherein the bellmouth (3) surrounds a downstream portion of the propeller fan (1) in an air-blowing direction in plan view,
   wherein an upstream portion of the propeller fan (1) in the air-blowing direction is located on an outside of the bellmouth (3) in plan view, and
   wherein the fan grille (4) is arranged on downstream of the propeller fan (1) in the air-blowing direction.

5. An outdoor unit (100) for an air conditioning apparatus, comprising the propeller fan (1) of any one of claims 1 to 3.

Patentansprüche

1. Propellerlüfter (1), der Folgendes umfasst:

   eine Nabe (1a) und
   ein an der Nabe (1a) befestigtes Blatt (2),
   wobei das Blatt (2) eine aus einer Form, in der ein Teil einer Vorderkante (21) des Blatts (2) in Richtung einer Seite einer Überdruckfläche (2a) vorsteht, und einer Form, in der ein Teil einer Hinterkante (22) des Blatts (2) in Richtung einer Seite einer Unterdruckfläche (2b) vorsteht, aufweist,
   wobei ein Mittelpunkt eines Vorsprungs in radialer Richtung des Blatts (2) auf einer radial äußeren Seite in Bezug auf eine radiale Position in der Hälfte des Blattradius von einer Rotationsmittellinie angeordnet ist, **dadurch gekennzeichnet, dass**
   die maximale radiale Vorsprungposition des Vorsprungs auf einer radial äußeren Seite in Bezug auf eine radiale Position des Mittelpunkts des Vorsprungs in radialer Richtung angeordnet ist.

2. Propellerlüfter (1) nach Anspruch 1,
wobei der Lüfter eine Blasluftstromgeschwindigkeitsverteilung aufweist und
wobei die maximale radiale Vorsprungposition an einer Position angeordnet ist, die mit einem Maximalgeschwindigkeitsabschnitt der Blasluftstromgeschwindigkeitsverteilung übereinstimmt.

3. Propellerlüfter (1) nach Anspruch 1 oder 2,
wobei eine Vorsprunghöhe L des Vorsprungs an der maximalen radialen Vorsprungposition so festgelegt ist, dass gilt: $L/Rt<0,1$,
worin Rt für einen Blattradius von der Rotationsmittellinie zu einer Außenumfangskante (24) des Blatts (2) steht.

4. Propellerlüftervorrichtung, die Folgendes umfasst:

   einen Propellerlüfter (1) nach einem der Ansprüche 1 bis 3;
   einen Trichter (3) und
   ein Lüftergitter (4),
   wobei der Trichter (3) einen stromabwärts gelegenen Abschnitt des Propellerlüfters (1) in eine Luftblasrichtung in einer Draufsicht umgibt,
   wobei ein stromaufwärts gelegener Abschnitt des Propellerlüfters (1) in der Luftblasrichtung in einer Draufsicht an einer Außenseite des Trichters (3) angeordnet ist, und
   wobei das Lüftergitter (4) stromabwärts in Bezug auf den Propellerlüfter (1) in der Luftblasrichtung angeordnet ist.

5. Außeneinheit (100) für eine Klimatisierungsvorrichtung, die einen Propellerlüfter (1) nach einem der Ansprüche 1 bis 3 umfasst.

Revendications

1. Ventilateur hélicoïde (1), comprenant :

   un bossage (1a) ; et

une pale (2) fixée sur le bossage (la), dans lequel la pale (2) possède l'une d'une forme selon laquelle une partie d'un bord d'attaque (21) de la pale (2) dépasse vers une surface à pression positive (2a) et d'une forme selon laquelle une partie d'un bord de fuite (22) de la pale (2) dépasse vers une surface à pression négative (2b),
dans lequel un centre d'une saillie dans une direction radiale de la pale (2) se trouve sur un côté radialement externe par rapport à une position radiale au niveau d'une moitié d'un rayon de pale par rapport à une ligne de centre de rotation, **caractérisé en ce qu'**une position radiale de saillie maximale de la saillie se trouve sur un côté radialement externe par rapport à une position radiale au niveau du centre de la saillie dans la direction radiale.

2. Ventilateur hélicoïde (1) selon la revendication 1, dans lequel le ventilateur possède une répartition de vitesse de flux d'air de soufflage, et
dans lequel la position radiale de saillie maximale est prévue à un emplacement qui correspond à une partie de vitesse maximale de la répartition de vitesse de flux d'air de soufflage.

3. Ventilateur hélicoïde (1) selon la revendication 1 ou 2,
dans lequel une hauteur de saillie L de la saillie au niveau de la position radiale de saillie maximale est définie de façon à satisfaire $L/Rt<0,1$,
où Rt représente un rayon de pale entre la ligne de centre de rotation et un bord périphérique externe (24) de la pale (2).

4. Ventilateur hélicoïde, comprenant :

le ventilateur hélicoïde (1) selon l'une quelconque des revendications 1 à 3 ;
un évasement (3) ; et
une grille de ventilateur (4),
dans lequel l'évasement (3) entoure une partie aval du ventilateur hélicoïde (1) dans une direction de soufflage d'air sur une vue de dessus,
dans lequel une partie amont du ventilateur hélicoïde (1) dans la direction de soufflage d'air se trouve sur un extérieur de l'évasement (3) sur une vue de dessus, et
dans lequel la grille de ventilateur (4) est prévue en aval du ventilateur hélicoïde (1) dans la direction de soufflage d'air.

5. Unité extérieure (100) destinée à un appareil de climatisation, comprenant le ventilateur hélicoïde (1) selon l'une quelconque des revendications 1 à 3.

FIG.1

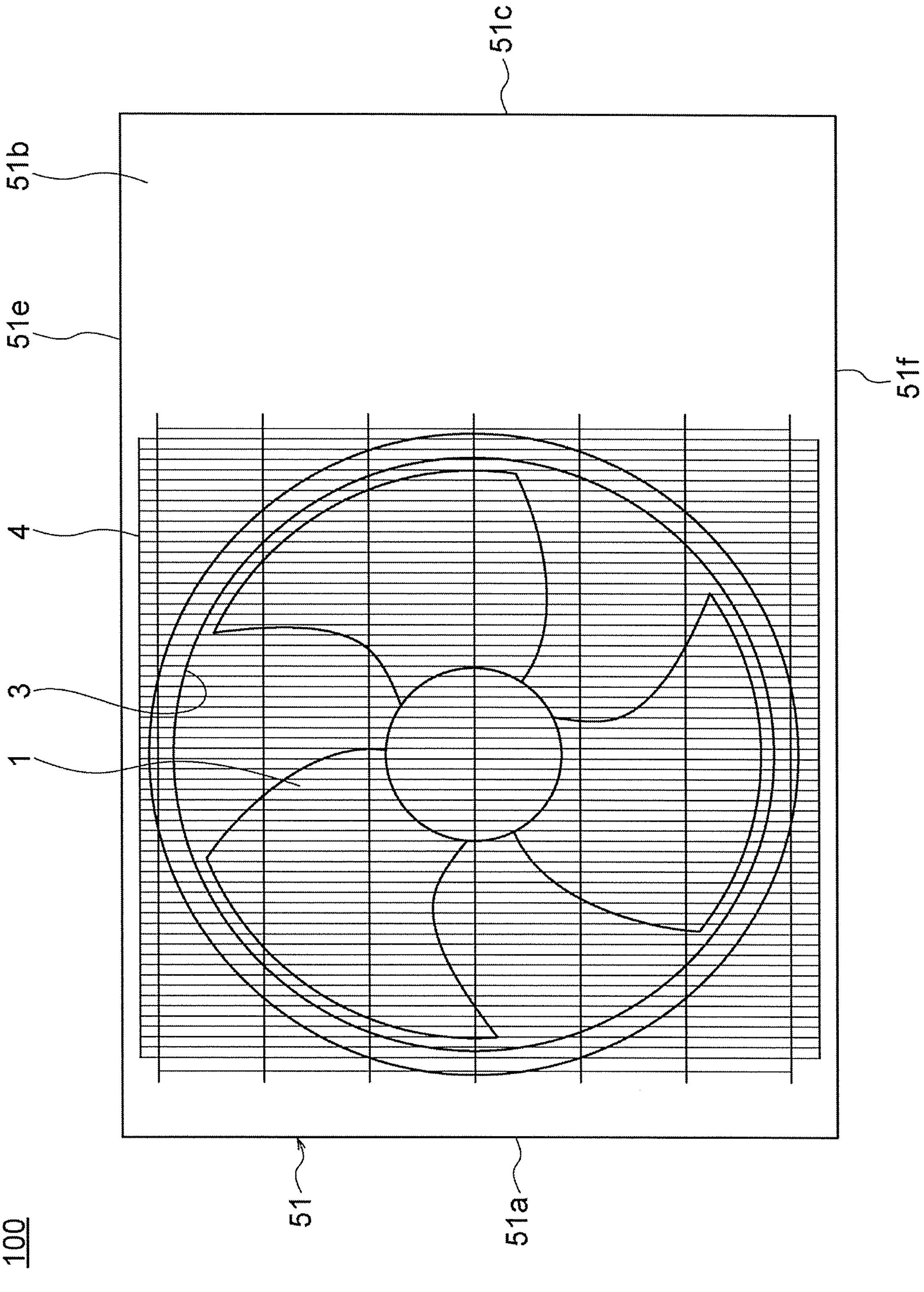


FIG.2

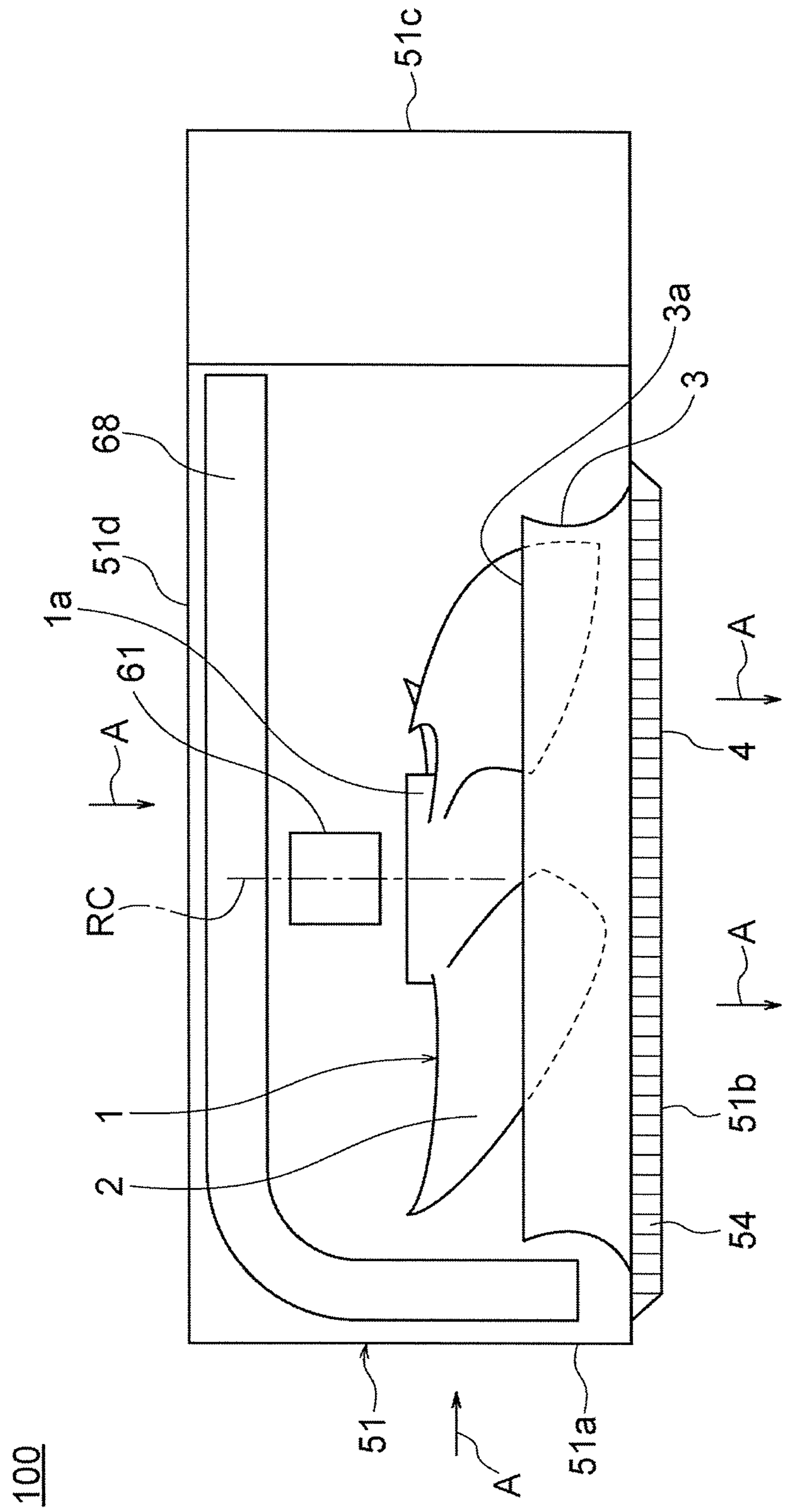


FIG.3

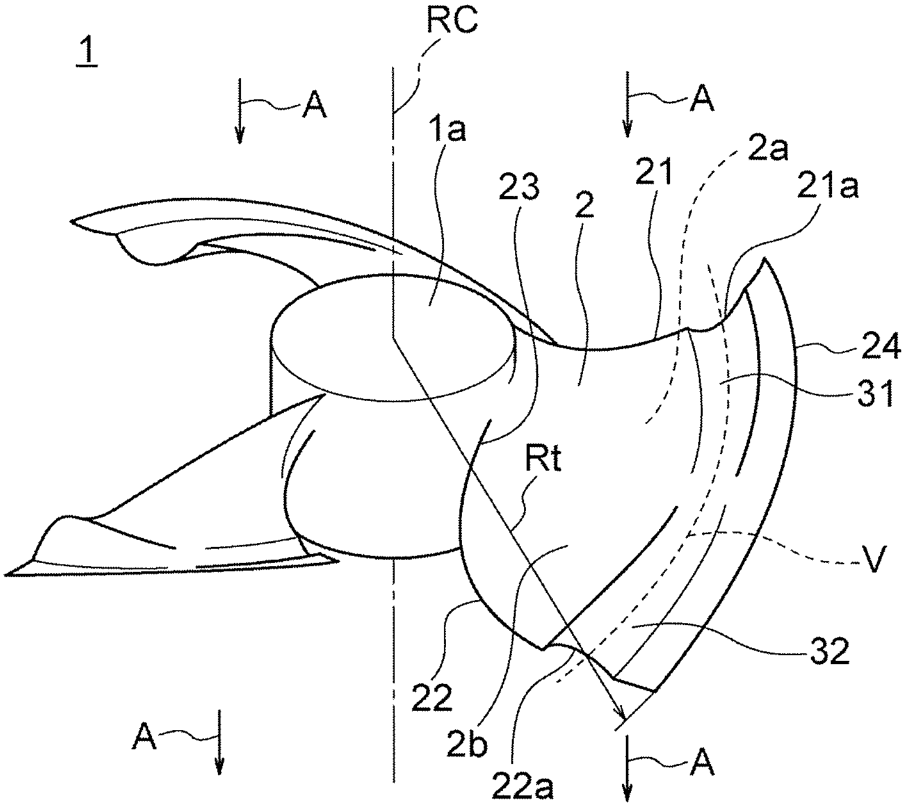


FIG.4

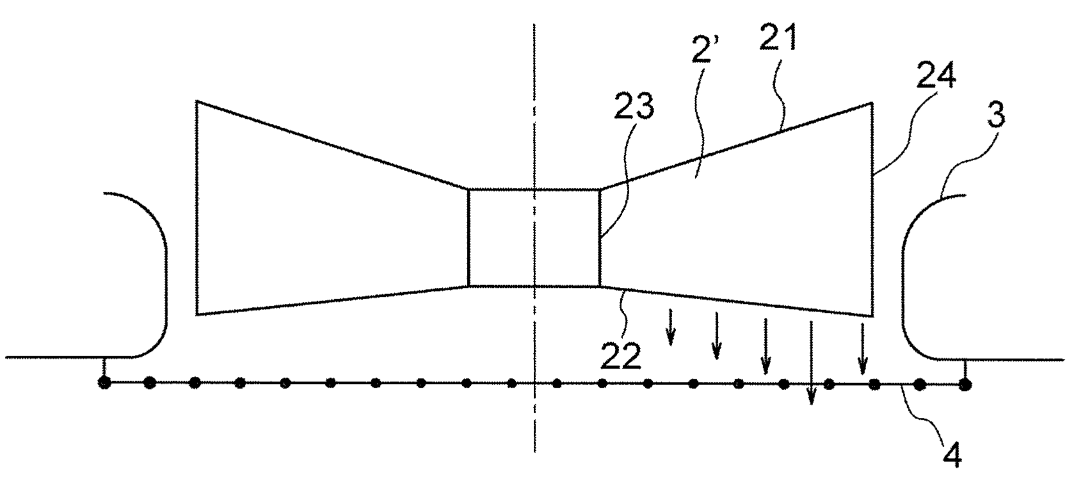


FIG.5

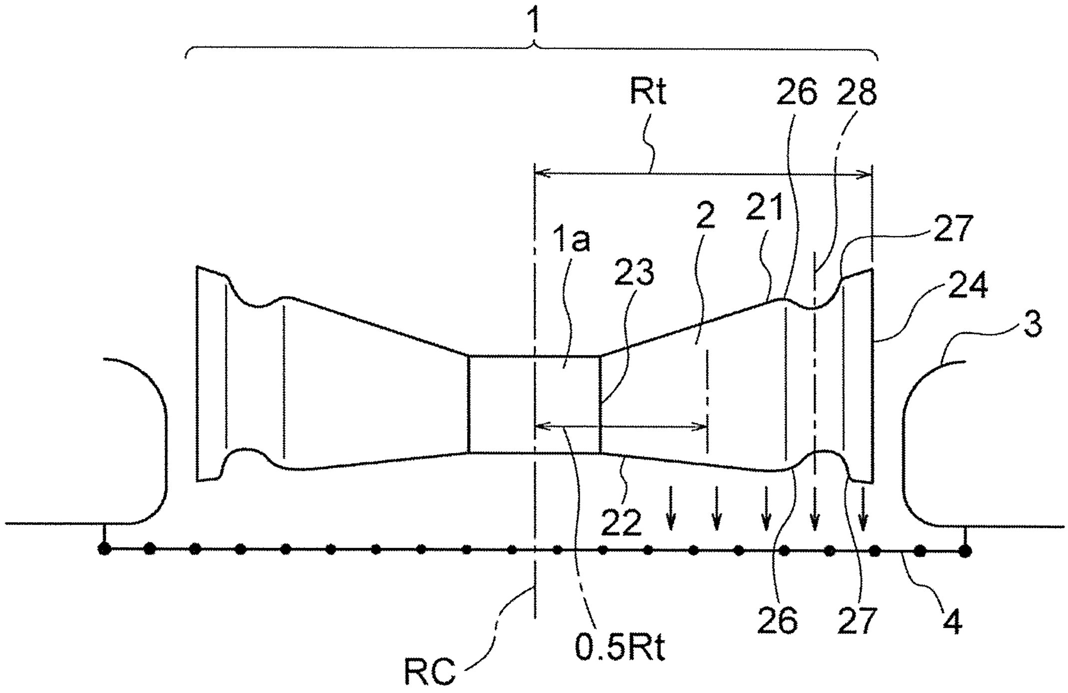

1
Rt
26
28
2
21
1a
27
23
24
3
22
26
27
4
RC
0.5Rt

FIG.6

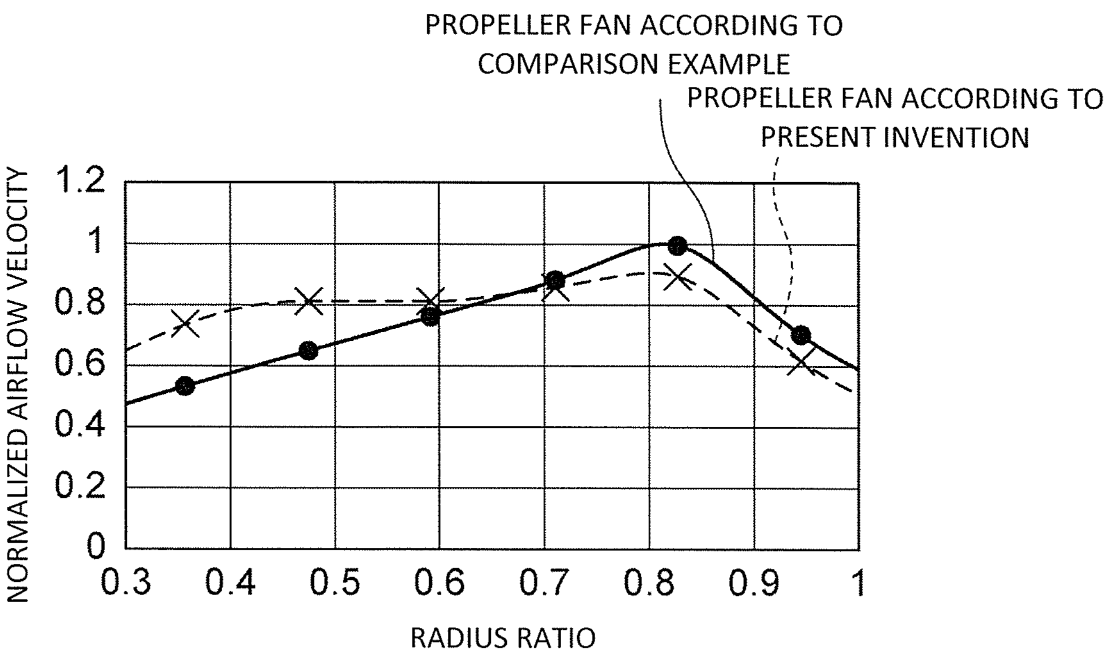

PROPELLER FAN ACCORDING TO
COMPARISON EXAMPLE
PROPELLER FAN ACCORDING TO
PRESENT INVENTION
NORMALIZED AIRFLOW VELOCITY
1.2
1
0.8
0.6
0.4
0.2
0
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
RADIUS RATIO

FIG.7

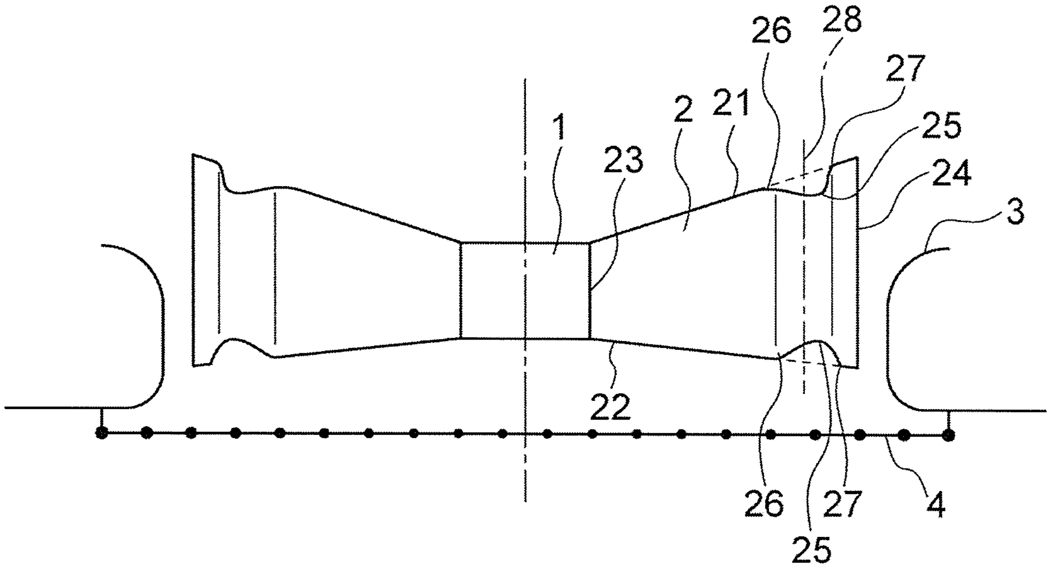


FIG.8

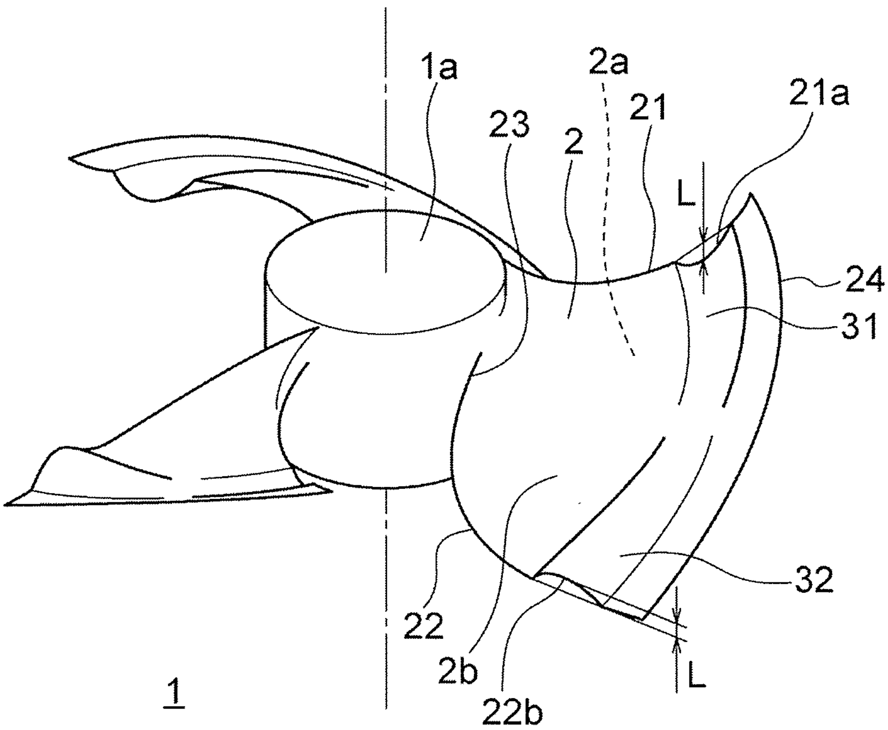
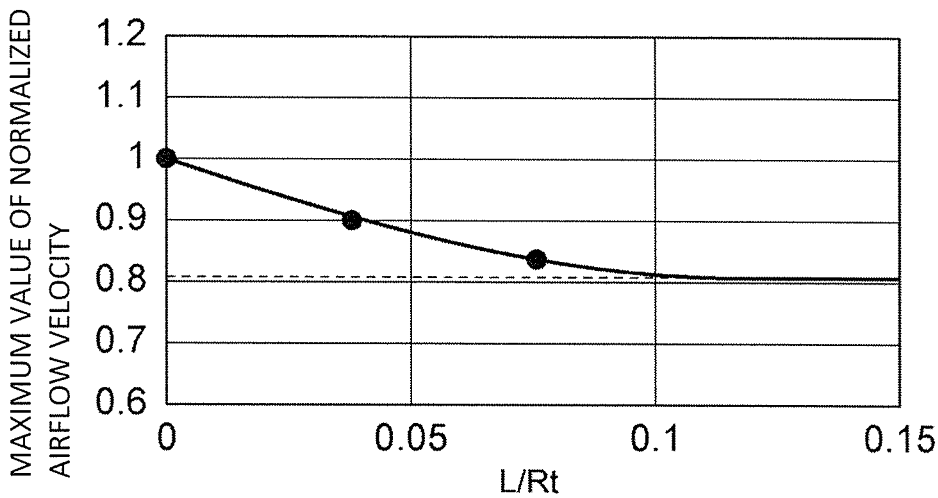


FIG.9


MAXIMUM VALUE OF NORMALIZED AIRFLOW VELOCITY
1.2
1.1
1
0.9
0.8
0.7
0.6
0
0.05
0.1
0.15
L/Rt

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2590514 B **[0002] [0003]**
- EP 2806221 A2 **[0003]**
- US 20120114498 A1 **[0003]**