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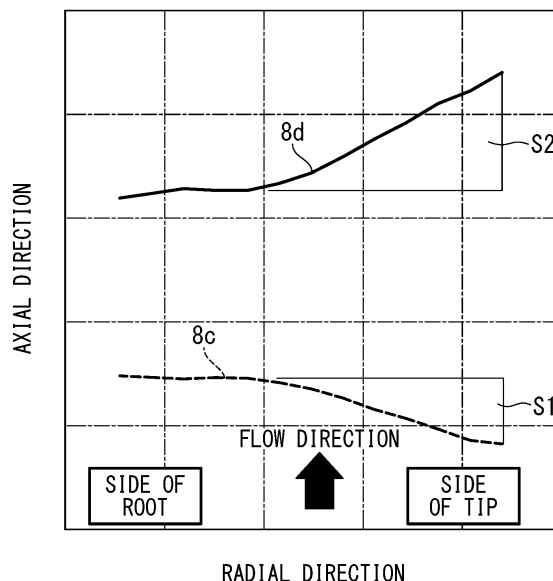
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(54) **PROPELLER FAN AND AIR CONDITIONER OUTDOOR UNIT PROVIDED WITH PROPELLER FAN**

(57) Provided is a propeller fan capable of improving performance. The propeller fan includes: a shaft portion that rotates about a center axial line; and a plurality of blades that have roots connected to an outer periphery of the shaft portion and extend in a radial direction, trailing edge side surface area increased regions (S2) and leading edge side surface area increased regions (S1) are included such that dimensions in an axial line direction parallel to the center axial line are larger on a side of tips than on a side of the roots in a case in which projection to a meridional plane including a blade center axial line is performed, and the trailing edge side surface area increased regions (S2) are larger than the leading edge side surface area increased regions (S1). A blade stagger angle with respect to a direction of the center axial line locally increases such that an amount of change from distribution that substantially linearly increases from the side of the roots toward the side of tips of the blades has a maximum value at a center position of a blade height with reference to the distribution.

FIG. 7



Description

[Technical Field]

[0001] The present invention relates to a propeller fan and an outdoor unit for an air conditioner provided with the same.

[Background Art]

[0002] For outdoor devices of air conditioners, propeller fans are used to blow air to outdoor heat exchangers. A propeller fan with a sickle shape in which blades are inclined forward in a rotation direction as disclosed in Patent Literature 1, for example, has been proposed in order to reduce input or reduce noise.

[Citation List]

[Patent Literature]

[0003] [PTL 1]
the Publication of Japanese Patent No. 4467952

[Summary of Invention]

[Technical Problem]

[0004] However, an outdoor heat exchanger is disposed on a side upstream of a propeller fan in an outdoor device of an air conditioner, it is not possible to cover a leading edge side of blades with a bellmouth due for a reason of disposition of the outdoor heat exchanger, and a configuration in which only a trailing edge side of the blades is covered with the bellmouth is employed. This leads to complicated flow field in which a flow from a tip side of the blades in a radial direction to the inner side in the radial direction and a flow in an axial direction parallel to a center axial line from the side upstream of the blades are present together. Thus, design of the propeller fan alone, that is, design that takes only the flow in the axial line direction into consideration does not lead to input reduction or noise reduction since the practical flow field is not taken into consideration, and it is thus not possible to sufficiently improve performance of the propeller fan.

[0005] The present invention was made in view of such circumstances, and an object thereof is to provide a propeller fan capable of improving performance and an outdoor unit for an air conditioner provided with the same.

[Solution to Problem]

[0006] A propeller fan according to an aspect of the present invention includes: a shaft portion that rotates around a center axial line; and a plurality of blades that have roots connected to an outer periphery of the shaft portion and extend in a radial direction, the blades have trailing edge side surface area increased regions and

leading edge side surface area increased regions such that dimensions in an axial line direction parallel to the center axial line are larger on a side of tips than on a side of the roots in a case in which the blades are projected to a meridional plane including the center axial line, and the trailing edge side surface area increased regions are larger than the leading edge side surface area increased regions.

[0007] The trailing edge side surface area increased regions are set to be larger than the leading edge side surface area increased regions to cause the trailing edge side to work more, and a flow in the radial direction is thus suppressed in the trailing edge side surface area increased regions. It is thus possible to curb peeling of a fluid from suction surfaces of the blades on the side of the roots, to uniformize flow amount distribution in a blade height direction (radial direction), and thereby to improve performance.

[0008] For example, solidity obtained by dividing a chord length of the blades by a pitch is equal to or greater than 0.5 and equal to or less than 1.0, and is preferably equal to or greater than 0.6 and equal to or less than 0.95. Further, the solidity preferably reaches a minimum value at a midpoint position of the blade height.

[0009] Also, a deflection angle obtained by subtracting an outlet angle from an inlet angle is set to substantially linearly decrease from the side of the roots to the side of the tips of the blades, for example.

[0010] In addition, the dimension of the blades in the axial direction in a case in which the blades are projected to a meridional plane is set to be substantially constant from the roots (blade height ratio of 0%) to a blade height ratio of about 35% and substantially linear increase from the blade height ratio of about 35% to the tips (blade height ratio of 100%) .

[0011] Further, in the propeller fan according to an aspect of the present invention, a blade stagger angle of the blades with respect to a direction of the center axial line locally increases such that an amount of change from distribution that substantially linearly increases from the side of the roots to the side of the tips has a maximum value at a center position of a blade height with reference to the distribution.

[0012] If the stagger angle of the blades is increased, that is, if the blades are caused to rotate such that the shortest distance from a leading edge and a trailing edge of a blade to an adjacent blade becomes short, the blades are directed in a direction in which the blades do not work, and the pressure thus decreases. It is possible to optimize pressure distribution on the surfaces of the blades in the radial direction, to reduce required input to the propeller fan, and thereby to improve performance by locally increasing the blade stagger angle such that the amount of change from the distribution that substantially linearly increases from the side of the roots to the side of the tips of the blades has a maximum value at the center position of the blade height with reference to the distribution.

[0013] Also, a propeller fan according to an aspect of

the present invention includes: a shaft portion that rotates about a center axial line; and a plurality of blades that have roots connected to an outer periphery of the shaft portion and extend in a radial direction, a stagger angle of the blades with respect to a direction of the center axial line locally increases such that an amount of change from distribution that substantially linearly increases from a side of the roots toward a side of tips of the blades has a maximum value at a center position of a blade height with reference to the distribution.

[0014] If the stagger angle of the blades is increased, that is, if the blades are caused to rotate such that the shortest distance from a leading edge and a trailing edge of a blade to an adjacent blade becomes short, the blades are directed in a direction in which the blades do not work, and the pressure thus decreases. It is possible to optimize pressure distribution on the surfaces of the blades in the radial direction, to reduce required input to the propeller fan, and thereby to improve performance by locally increasing the blade stagger angle such that the amount of change from the distribution that substantially linearly increases from the side of the roots to the side of the tips of the blades has a maximum value at the center position of the blade height with reference to the distribution.

[0015] Moreover, an outdoor unit for an air conditioner according to an aspect of the present invention includes: the propeller fan according to any of the aforementioned propeller fans; a heat exchanger that is provided on a side upstream of the propeller fan; and a bellmouth that is provided so as to cause a leading edge side to be exposed and cover a trailing edge side of the propeller fan.

[Advantageous Effects of Invention]

[0016] It is possible to improve performance of the propeller fan by setting the trailing edge side surface area increased regions to be larger than the leading edge side surface area increased regions.

[Brief Description of Drawings]

[0017]

[Fig. 1]

Fig. 1 is a vertical sectional view of an outdoor unit for an air conditioner in a side view.

[Fig. 2]

Fig. 2 is a vertical sectional view of the outdoor unit for an air conditioner in a plan view.

[Fig. 3]

Fig. 3 is a front view of a propeller fan when seen in a direction of a center axial line.

[Fig. 4]

Fig. 4 is a sectional view of two blades cut at a predetermined blade height position.

[Fig. 5]

Fig. 5 is a graph illustrating a deflection angle with

respect to a blade height ratio.

[Fig. 6]

Fig. 6 is a graph illustrating a dimension of the blade in an axial direction with respect to the blade height ratio.

[Fig. 7]

Fig. 7 is a graph illustrating distribution of a leading edge and a trailing edge of the blade in a case in which these are projected to a meridional plane.

[Fig. 8]

Fig. 8 is a schematic diagram illustrating the blade projected to the meridional plane.

[Fig. 9]

Fig. 9 is a simulation result illustrating limit streamlines in a front view of a suction surface of a typical propeller fan when seen in a direction of a center axial line.

[Fig. 10]

Fig. 10 is a simulation result illustrating limit streamlines in a front view of a suction surface of a propeller fan according to a first embodiment when seen in a direction of a center axial line.

[Fig. 11]

Fig. 11 is a graph illustrating an input ratio when a blade stagger angle is changed at a position of a blade height of 25%, according to a second embodiment.

[Fig. 12]

Fig. 12 is a graph illustrating an input ratio when the blade stagger angle is changed at a position of a blade height of 50%.

[Fig. 13]

Fig. 13 is a graph illustrating an input ratio when the blade stagger angle is changed at a position of a blade height of 75%.

[Fig. 14]

Fig. 14 is a simulation result illustrating limit streamlines in a front view of a suction surface of a propeller fan according to the second embodiment when seen in a direction of a center axial line.

[Description of Embodiments]

[First embodiment]

[0018] Hereinafter, a first embodiment according to the present invention will be described with reference to drawings.

[0019] Fig. 1 illustrates a sectional view of an outdoor unit 1 for an air conditioner (hereinafter, simply referred to as an "outdoor unit 1") in a side view. The outdoor unit 1 is connected to one or a plurality of indoor units (not illustrated) with a refrigerant pipe. A propeller fan 5 is disposed in a casing 3 of the outdoor unit 1. The casing 3 has a substantially rectangular parallelepiped shape standing on a leg portion 4 placed on a floor surface.

[0020] The propeller fan 5 is rotated about a center axial line L1 by a motor 7. Since the center axial line L1

extends in the horizontal direction, the propeller fan 5 transversely blows air and causes the air to flow in the horizontal direction.

[0021] The propeller fan 5 has a shaft portion 6 that is connected to the motor 7, is located on the side of the center axial line L1, and serves as a hub and three blades 8 that are secured to an outer peripheral surface of the shaft portion 6. Note that the number of blades 8 may be two, four, or more. The blades 8 extend outward in the radial direction from roots 8a connected to the shaft portion 6 toward tips 8b.

[0022] An outdoor heat exchanger 9 is disposed on a side (the right side in the drawing) upstream of the air flow of the propeller fan 5. A bellmouth 10 is disposed on a side (the left side in the drawing) downstream of the air flow of the propeller fan 5.

[0023] The bellmouth 10 is provided so as not to be present in the surroundings of a leading edge side 5a of the propeller fan 5 and to cover the surroundings of a trailing edge side 5b of the propeller fan 5. Such disposition in which the leading edge side 5a of the propeller fan 5 is exposed from the bellmouth 10 is employed.

[0024] Fig. 2 illustrates a vertical sectional view of the outdoor unit 1 in Fig. 1 in a plan view. As can be understood from the drawing, the outdoor heat exchanger 9 is provided from a left side surface 3a on one side to a back surface 3b of the casing 3 and has a shape folded into an L shape. Since such an outdoor heat exchanger 9 with the L shape is employed, an air flow passing through the outdoor heat exchanger 9 and flowing into the propeller fan 5 forms a complicated flow field.

[0025] A machine chamber 12 in which a compressor that compresses a refrigerant and the like are disposed is provided on the side of the right side surface 3c of the casing 3. The machine chamber 12 and a space in which the air flows due to the propeller fan 5 are sectioned by the sectioning wall 14.

[0026] Fig. 3 illustrates a front view of the propeller fan 5 when seen in a direction of the center axial line L1. In the drawing, the counterclockwise direction corresponds to a rotation direction R. Leading edges 8c and trailing edges 8d of the blades 8 have such shapes that the blades further stick out on the side of the tips 8b than on the side of the roots 8a. Also, the blades 8 have a sickle shape in which the leading edges 8c are inclined forward in the rotation direction R.

[0027] Solidity σ of the blades 8 is equal to or greater than 0.5 and equal to or less than 1.0 and is preferably equal to or greater than 0.6 and equal to or less than 0.95. Also, the solidity σ reaches the minimum value at a midpoint position of the blade height. The solidity σ is a value obtained by dividing a chord length C by a pitch P that is a distance between the blades 8 in a section of each blade height, as in Fig. 4 which schematically illustrates the blades 8 ($\sigma = C/P$). In the drawing, the rotation direction R of the blades 8 is directed downward, and the air flow is directed from the left to the right. Therefore, an inclination angle of the leading edges 8c with respect to

the direction of the center axial line L1 is an inlet angle α_1 , and an inclination angle of the trailing edges 8d with respect to the direction of the center axial line L1 is an outlet angle α_2 , as illustrated in the drawing.

[0028] As illustrated in Fig. 5, a deflection angle $\Delta\alpha$ ($= \alpha_1 - \alpha_2$) obtained by subtracting the outlet angle α_2 from the inlet angle α_1 is set to substantially linearly decrease from the side of the roots 8a to the side of the tips 8b of the blades 8. In the drawing, the horizontal axis represents the blade height ratio while the vertical axis represents the deflection angle $\Delta\alpha$. The blade height ratio is 0 (0%) at the roots 8a and is 1.0 (100%) at the tips 8b (the dimension of the direction of the center axial line L1).

[0029] As illustrated in Fig. 6, the dimension of the blades 8 in the direction of the center axial line L1 in a case in which the blades 8 are projected to a meridional plane is set so as to be substantially constant from the roots 8a (blade height ratio of 0%) to the blade height ratio of about 35% and to substantially linearly increase from the blade height ratio of about 35% to the tips (blade height ratio of 100%). In the drawing, the horizontal axis represents the blade height ratio while the vertical axis represents the axial width expressed in a non-dimensional manner with the diameter at the tips 8b of the blades 8.

[0030] Fig. 7 illustrates distribution of the leading edges 8c and the trailing edges 8d of the blades 8 in a case in which the blades 8 are projected to a meridional plane, in the radial direction (horizontal axis) and the axial direction (vertical axis). As can be understood from the drawing, the axial width is larger on the side of the tips 8b than on the side of the roots 8a of the blades 8 as illustrated in Fig. 6.

[0031] Regions (leading edge side surface area increased regions S1) sticking on the side (the lower side in the drawing) upstream of the air flow is present from the side of the roots 8a at which the position of the leading edges 8c in the axial direction is constant to the side of the tips 8b. Similarly, regions (trailing edge side surface area increased regions S2) sticking on the side (the upper side in the drawing) downstream of the air flow is present from the side of the roots 8a at which the position of the trailing edges 8d in the axial direction is constant to the side of the tips 8b. Also, the trailing edge side surface area increased regions S2 are set to be larger than the leading edge side surface area increased regions S1 ($S2 > S1$).

[0032] According to the present embodiment, the following advantages are achieved.

[0033] Since the trailing edge side surface area increased regions S2 are set to be larger than the leading edge side surface area increased regions S1, the side of the trailing edges 8d is caused to work more, and the flow in the radial direction is thus suppressed in the trailing edge side surface area increased regions S2. In other words, it is possible to direct the flow having a radial direction component illustrated by the solid line arrow to the horizontal direction (the direction of the center axial line L1) by reducing the radial direction component as

illustrated by the dashed line arrow, as schematically illustrated in Fig. 8. It is thus possible to curb peeling of a fluid from the suction surfaces of the blades 8 on the side of the roots 8a, to uniformize flow amount distribution in the blade height direction, and thereby to improve performance.

[0034] Figs. 9 and 10 illustrate a simulation result of the present embodiment. The simulation was conducted under a condition of a positional relationship among the propeller fan 5, the outdoor heat exchanger 9, and the bell mouth 10 as illustrated in Figs. 1 and 2. In other words, this is not a simulation result of the propeller fan 5 alone. The rotation direction R of the blades 8 in Figs. 9 and 10 is clockwise turning (right turning) unlike in Fig. 3.

[0035] Fig. 9 is a simulation result of a typical propeller fan in a comparative example. As can be understood from the drawing, it is possible to ascertain that limit streamlines illustrated on the suction surfaces of the blades 8 are directed in the radial direction. On the other hand, in the propeller fan 5 to which the present embodiment is applied, the radial direction component of the limit streamlines illustrated on the suction surfaces of the blades 8 are reduced, and the limit streamlines are in the direction that substantially follows the rotation direction R, as illustrated in Fig. 10. The trend significantly appears in the regions of the roots 8a of the blades 8.

[Second embodiment]

[0036] A second embodiment of the present invention will be described. The present embodiment was achieved by partially changing the shape of the blades in the first embodiment. Thus, description of matters that are common to those in the first embodiment will be omitted.

[0037] The attachment angle of the blades 8 described in the first embodiment is changed. As illustrated in Fig. 4, a blade stagger angle β_1 is an angle formed between a tangential line L2 that is in contact with each blade 8 cut at a predetermined position in the blade height direction on the side of the pressure surface (front surface side) and the direction of the center axial line L1. In the present embodiment, an intersection between a line connecting a gravity center of the blade 8 to the center axial line L1 with a shortest distance and a blade sectional surface cut at a predetermined position in the blade height direction was defined as a center position A, and performance in a case in which the blade stagger angle β_1 was changed by causing the blades 8 to rotate about the center position A was compared. In regard to the rotation direction around the center position A, the counterclockwise turning in Fig. 4, that is, the direction in which the blades 8 are closed, in other words, the direction in which the leading edge 8c and the trailing edge 8d approach the adjacent blade 8 was defined as + (positive). Specifically, the cases in which the blades 8 were caused to rotate by $\pm 10^\circ$ at positions of the blade height ratios of 25%, 50%, and 75% were examined.

[0038] Fig. 11 illustrates a case in which the blades are caused to rotate at the position of the blade height ratio of 25% to change the blade attachment angle β_1 . In the drawing, the horizontal axis represents the rotation angle of the blades 8 around the center position A while the vertical axis represents an input ratio of the blades 8, that is, a value obtained by dividing a power required to cause the blades 8 to rotate by a reference value. As can be understood from the drawing, the input ratio is the smallest at the rotation angle of about $+5^\circ$.

[0039] On the other hand, the input ratio is the smallest at the rotation angle of about $+10^\circ$ at the position of the blade height ratio of 50% as illustrated in Fig. 12, and the input ratio is the smallest at the rotation angle of about $+5^\circ$ at the position of the blade height ratio of 75% as illustrated in Fig. 13.

[0040] It is possible to ascertain from Figs. 11 to 13 that the blade stagger angle β is preferably increased by causing the blades 8 to rotate on the + (positive) side to the maximum extent around the center in the blade height direction. In other words, it is preferable to locally increase the blade stagger angle β_1 of the blades 8 such that the amount of change from distribution that substantially linearly increases from the side of the roots 8a toward the side of the tips 8b of the blades 8 has a maximum value at the center position of the blade height with reference to the distribution.

[0041] Fig. 14 illustrates limit streamlines on the suction surfaces of the blades 8 according to the present embodiment, similarly to Figs. 9 and 10. It is possible to ascertain from comparison between Figs. 10 and 14 that the radial direction component on the side of the roots 8a further decreases.

[0042] The present embodiment has the following advantages.

[0043] If the blade stagger angle β_1 is caused to increase, that is, if the blades 8 are caused to rotate such that the shortest distance from the leading edge 8c and the trailing edge 8d to the adjacent blade 8 becomes short, the blades 8 are directed in a direction in which the blades 8 do not work, and the pressure thus decreases. Thus, the blade attachment angle β_1 is caused to locally increase such that the amount of change from the distribution that substantially linearly increases from the side of the roots toward the side of the tips of the blades 8 has the maximum value at the center position of the blade height with reference to the distribution. It is thus possible to optimize the pressure distribution on the blade surfaces in the radial direction, to reduce required input to the propeller fan 5, and thereby to improve performance.

[0044] Note that although the second embodiment is used to adjust the shape of the blades in the first embodiment, the present invention is not limited thereto and can be used not only for the blade in the first embodiment but also for blades with other shapes.

[Reference Signs List]

[0045]

1	Outdoor unit (outdoor unit for air conditioner)	5
3	Casing	
3a	Left side surface	
3b	Back surface	
3c	Right side surface	
4	Leg portion	10
5	Propeller fan	
5a	Leading edge side	
5b	Trailing edge side	
6	Shaft portion (hub)	
7	Motor	15
8	Blade	
8a	Root	
8b	Tip	
8c	Leading edge	
8d	Trailing edge	20
9	Outdoor heat exchanger	
10	Bellmouth	
12	Machine chamber	
14	Sectioning wall	
A	Center position	25
C	Chord length	
L1	Center axial line	
L2	Tangential line	
P	Pitch	
R	Rotation direction (of propeller fan)	30
$\alpha 1$	Inlet angle	
$\alpha 2$	Outlet angle	
$\beta 1$	Blade stagger angle	
σ	Solidity	35

blade stagger angle of the blades with respect to a direction of the center axial line locally increases such that an amount of change from distribution that substantially linearly increases from the side of the roots to the side of the tips has a maximum value at a center position of a blade height with reference to the distribution.

3. A propeller fan comprising:

a shaft portion that rotates about a center axial line; and
a plurality of blades that have roots connected to an outer periphery of the shaft portion and extend in a radial direction, wherein a blade stagger angle of the blades with respect to a direction of the center axial line locally increases such that an amount of change from distribution that substantially linearly increases from a side of the roots toward a side of tips of the blades has a maximum value at a center position of a blade height with reference to the distribution.

4. An outdoor unit for an air conditioner comprising:

the propeller fan according to any one of claims 1 to 3;
a heat exchanger that is provided on a side upstream of the propeller fan; and
a bellmouth that is provided so as to cause a leading edge side to be exposed and cover a trailing edge side of the propeller fan.

Claims**1. A propeller fan comprising:**

a shaft portion that rotates around a center axial line; and
a plurality of blades that have roots connected to an outer periphery of the shaft portion and extend in a radial direction,
wherein the blades have trailing edge side surface area increased regions and leading edge side surface area increased regions such that dimensions in an axial line direction parallel to the center axial line are larger on a side of tips than on a side of the roots in a case in which the blades are projected to a meridional plane including the center axial line, and
the trailing edge side surface area increased regions are larger than the leading edge side surface area increased regions.

2. The propeller fan according to claim 1, wherein a

FIG. 1

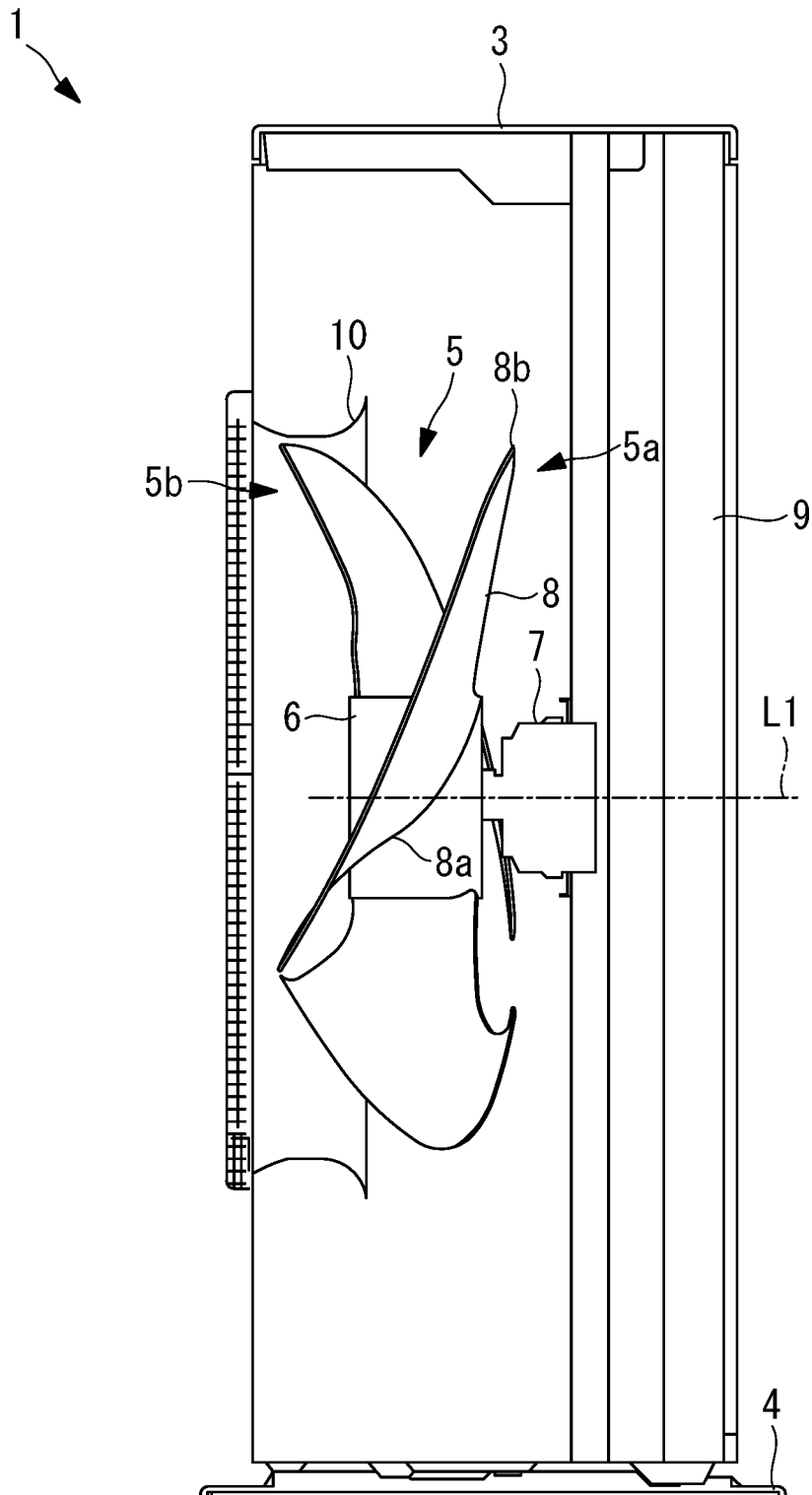


FIG. 2

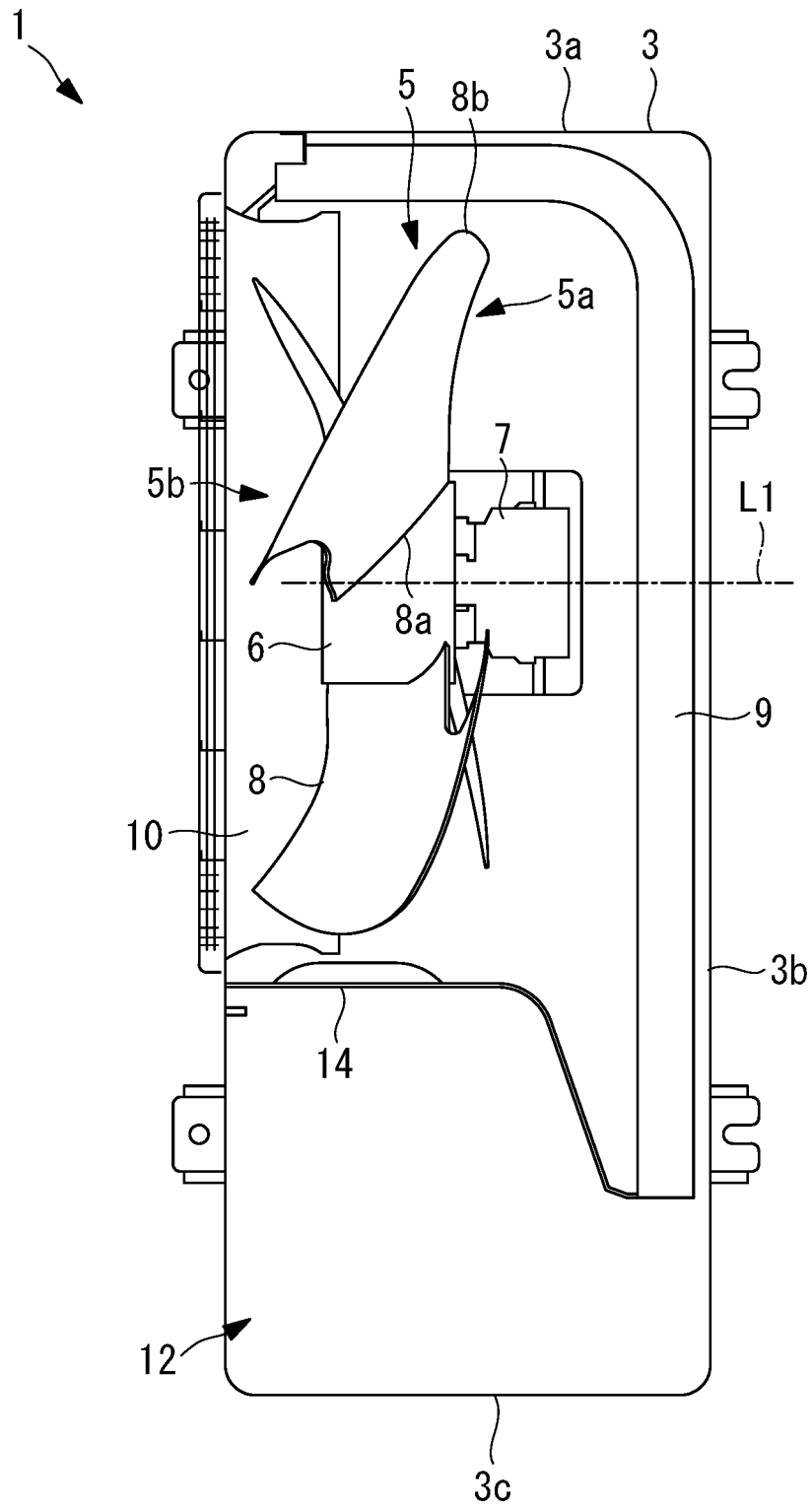


FIG. 3

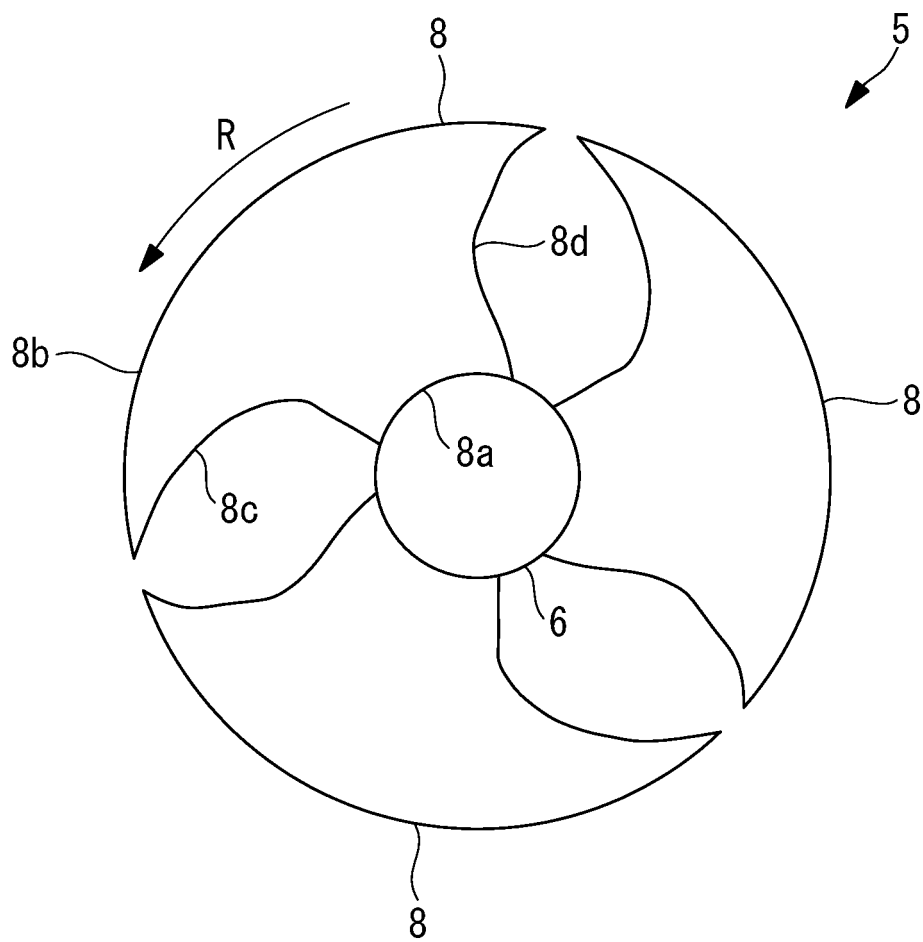


FIG. 4

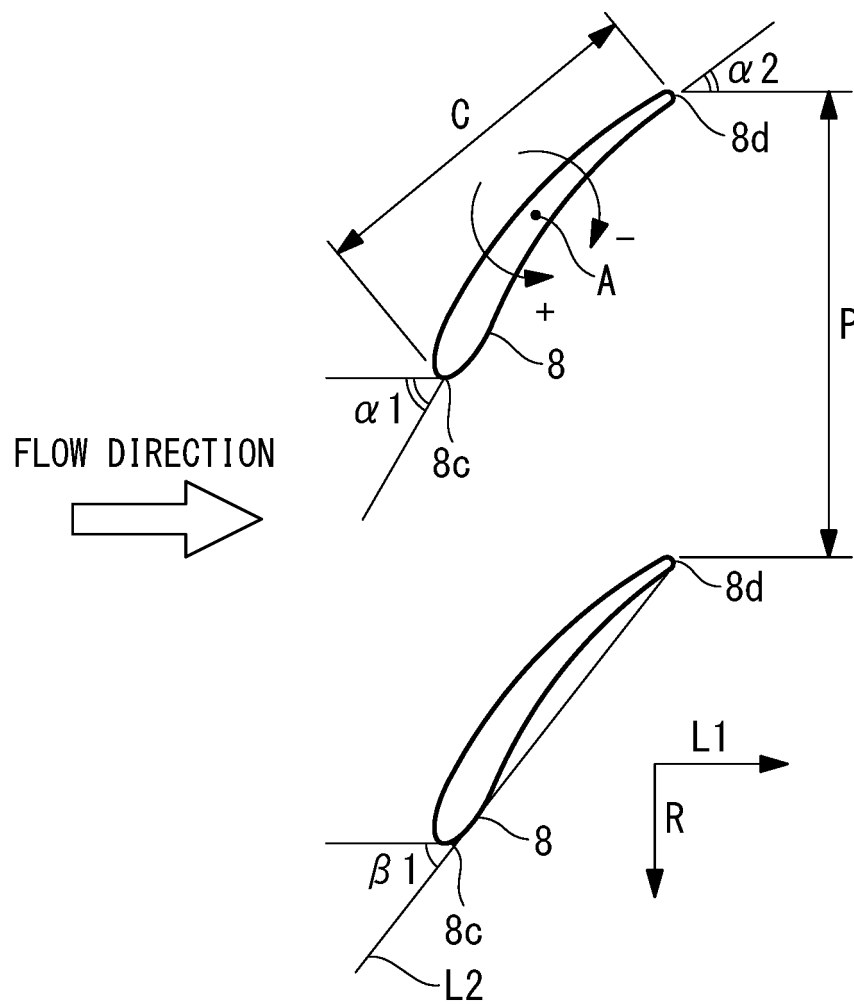


FIG. 5

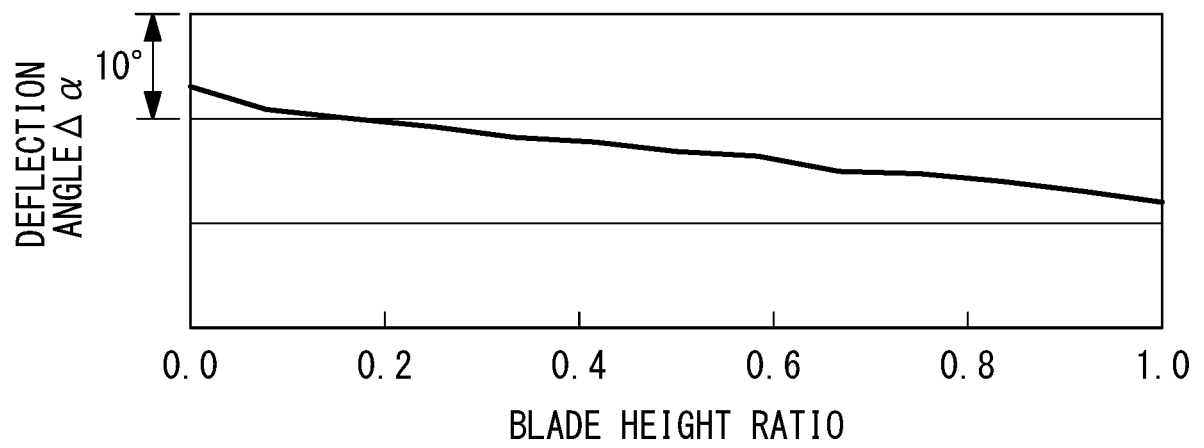


FIG. 6

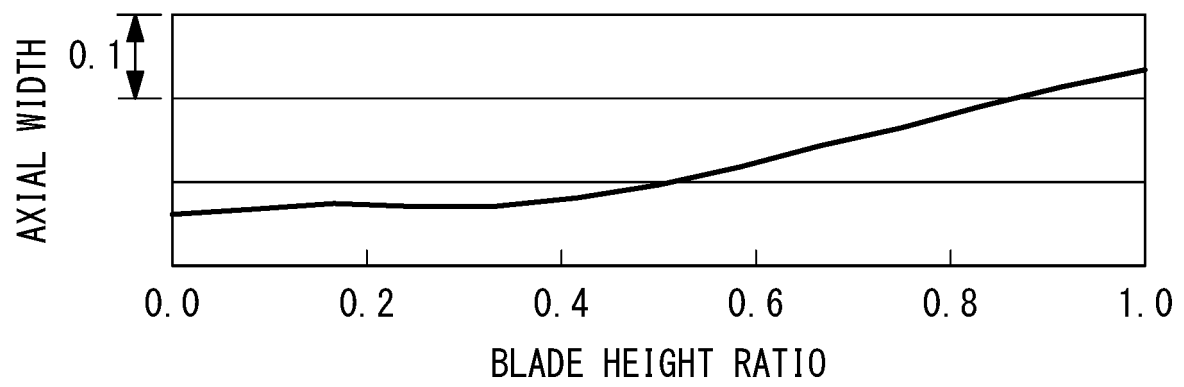


FIG. 7

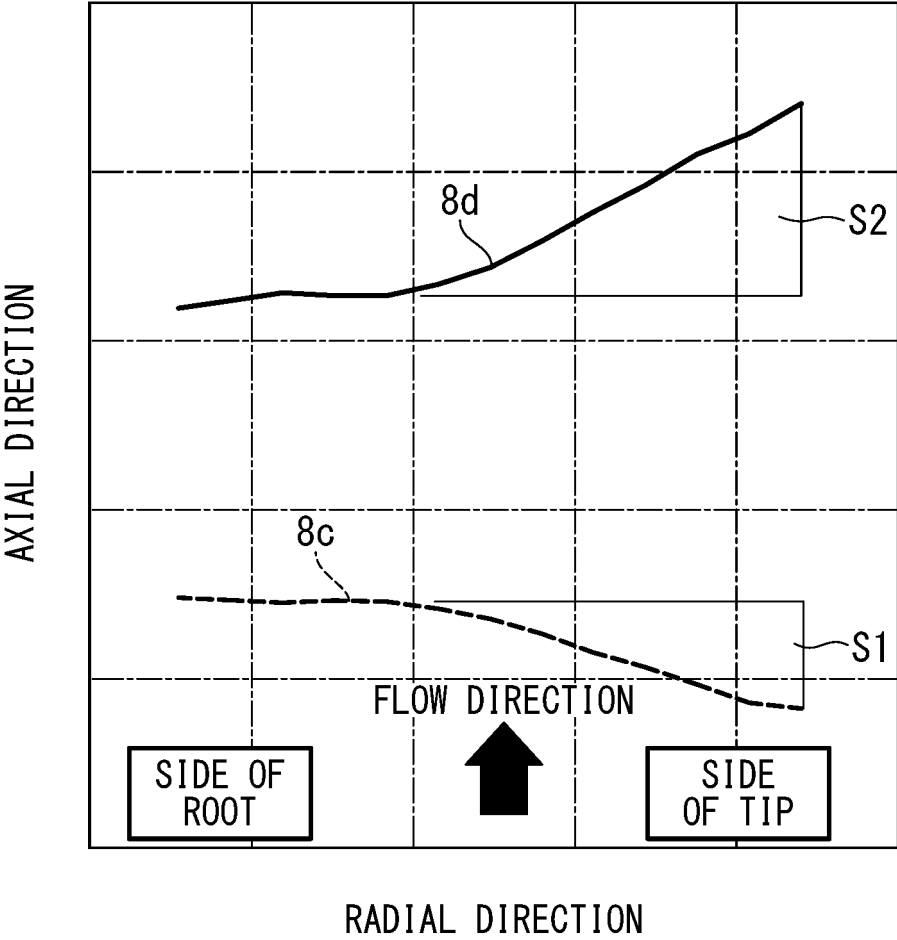


FIG. 8

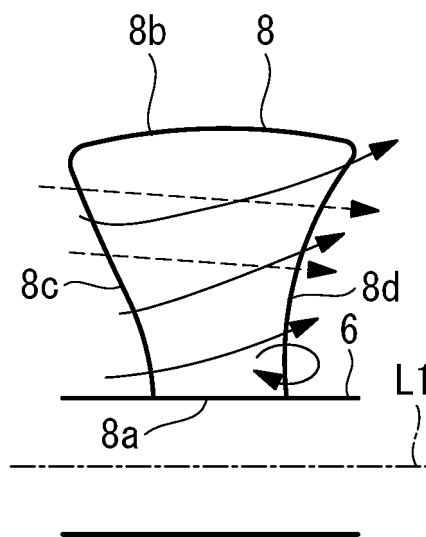


FIG. 9

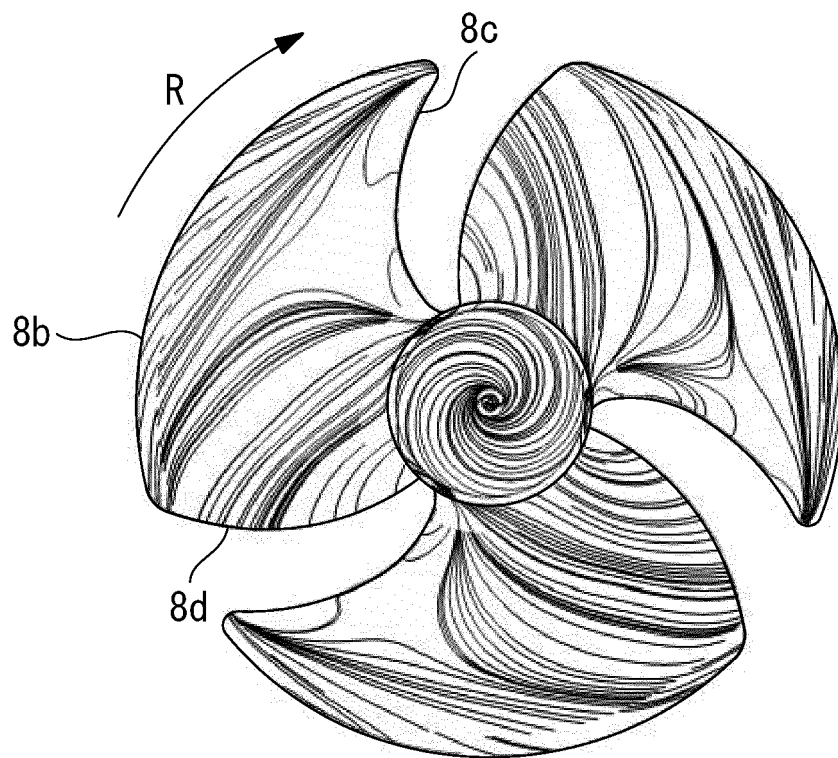


FIG. 10

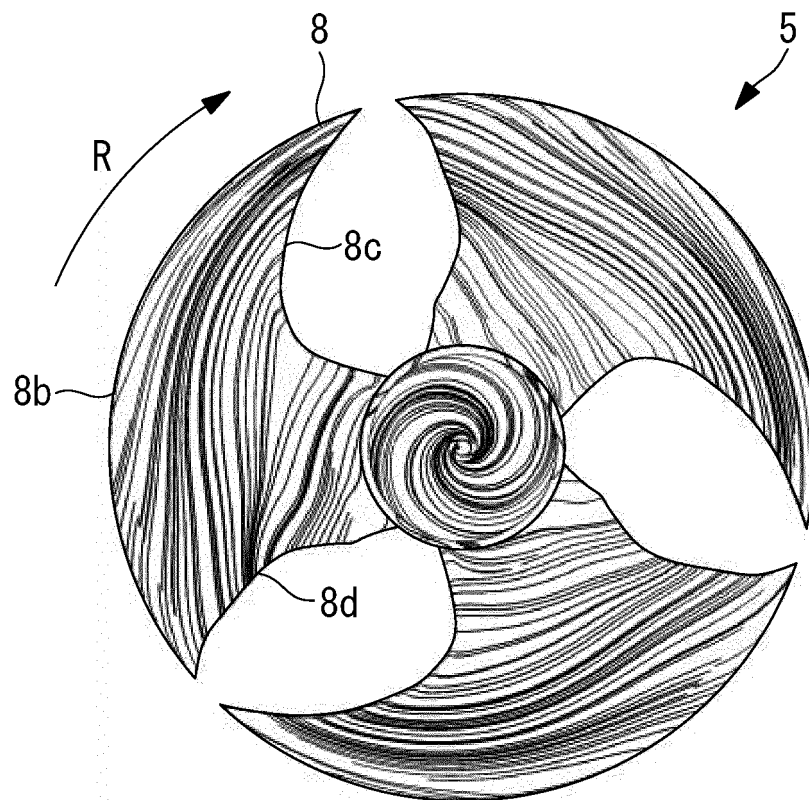


FIG. 11

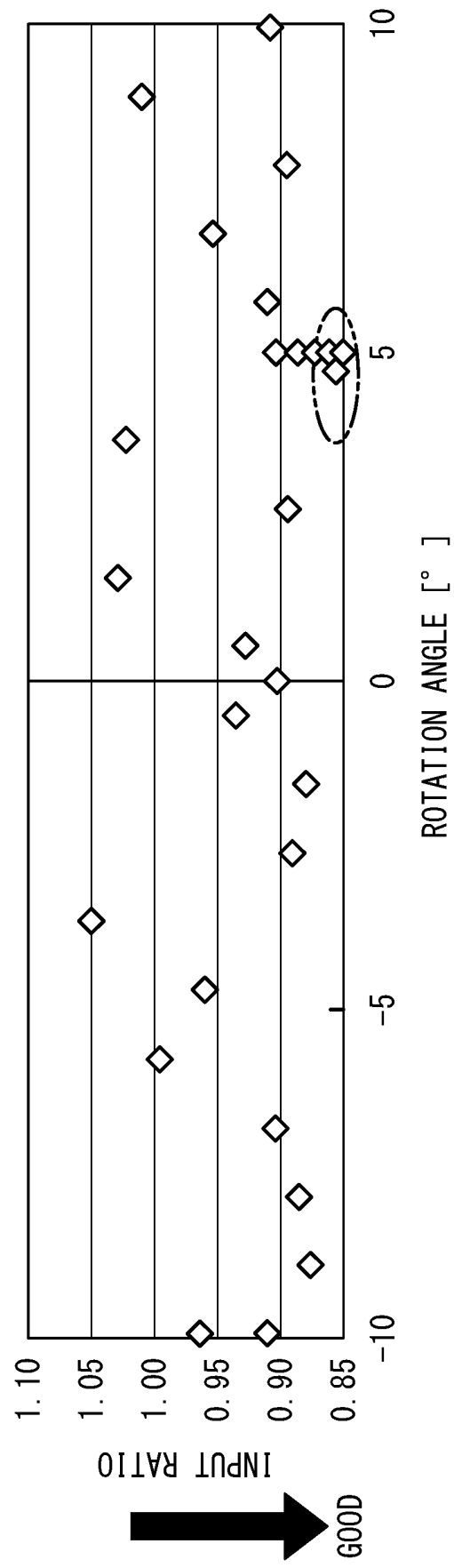


FIG. 12

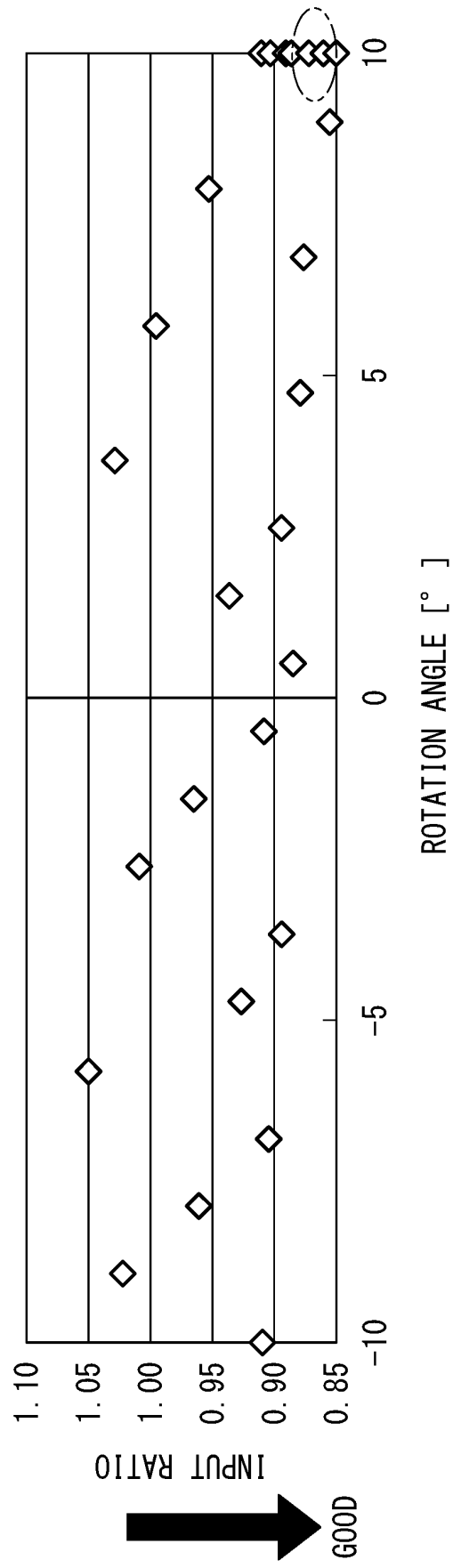


FIG. 13

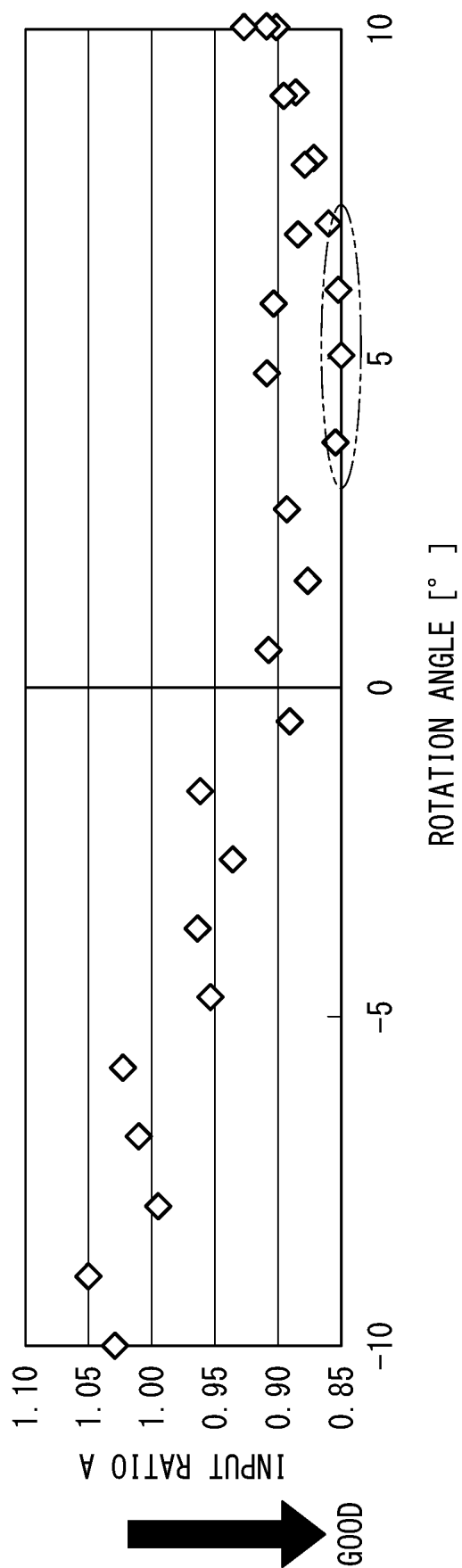
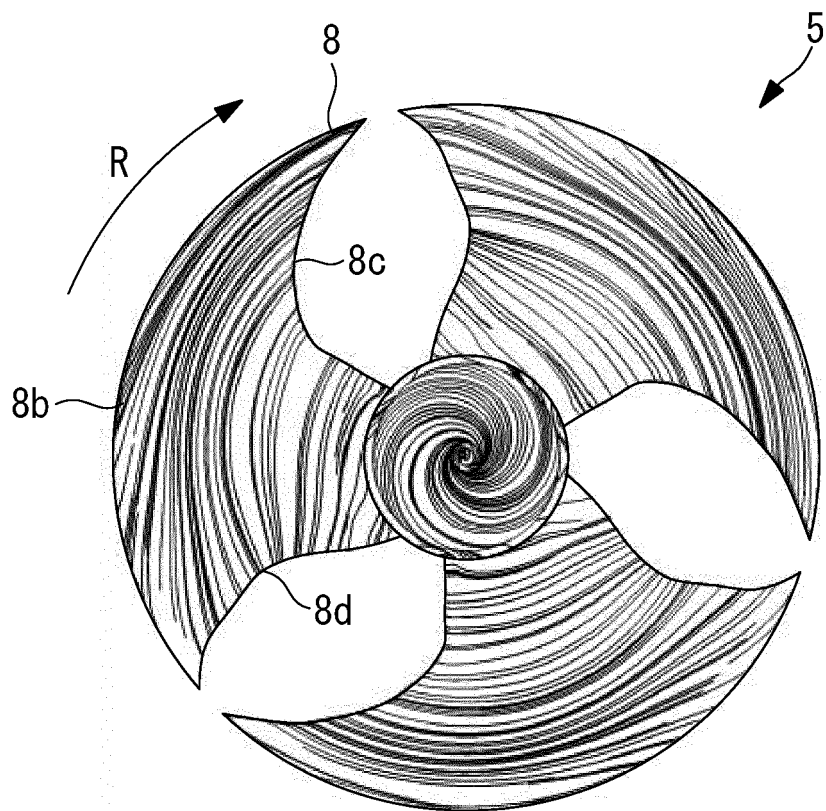


FIG. 14



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/020593

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F04D29/38 (2006.01) i, F24F1/0029 (2019.01) i, F24F1/38 (2011.01) i

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. F04D29/38, F24F1/0029, F24F1/38

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2019

Registered utility model specifications of Japan 1996-2019

Published registered utility model applications of Japan 1994-2019

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2002-48094 A (KOMATSU LTD.) 15 February 2002, paragraphs [0015]-[0028], fig. 1-5 & CN 1356479 A	1, 4 2
Y A	JP 53-96512 A (TORIN CORPORATION) 23 August 1978, fig. 1-2 (Family: none)	1, 4 2
Y A	JP 2013-160142 A (MINEBEA CO., LTD.) 19 August 2013, fig. 1 (Family: none)	1, 4 2

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search
29 July 2019 (29.07.2019)Date of mailing of the international search report
06 August 2019 (06.08.2019)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2002-507699 A (SPAL S.R.L) 12 March 2002,	3
Y	paragraphs [0015], [0018]-[0020], [0025], [0049]-	4
A	[0051], fig. 1, 3, 6, 8 & US 6554574 B1, column 3, lines 1-4, 21-36, 65-67, column 6, lines 41-53, fig. 1, 3, 6, 8 & WO 1999/49223 A1 & EP 945625 A1 & CN 1294659 A	2
Y	JP 4467952 B2 (TOSHIBA CARRIER CORPORATION) 26 May 2010, paragraph [0019], fig. 11 & CN 1616832 A	4
A	JP 2005-121310 A (HITACHI, LTD.) 12 May 2005, paragraph [0036] (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 4467952 B [0003]