

(19)



(11)

EP 3 076 022 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
05.10.2016 Bulletin 2016/40

(51) Int Cl.:
F04D 25/06 ^(2006.01) **F04D 29/28** ^(2006.01)
F04D 29/32 ^(2006.01) **F04D 29/66** ^(2006.01)

(21) Application number: **16155019.9**

(22) Date of filing: **10.02.2016**

(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
Designated Validation States:
MA MD

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(30) Priority: **30.03.2015 JP 2015070177**

(54) **IMPELLER AND BLOWER**

(57) An impeller(30,130) is fixed to a shaft(41) concentric with a center axis(J) extending in an up-down direction and is rotatable about the center axis(J) together with the shaft(41). The impeller(30,130) includes a boss portion (34) which is fixed to the shaft(41) and extends in an axial direction, an impeller body portion (31), a plurality of blade portions (32) arranged on an upper surface of the impeller body portion (31), and a rib portion (35, 135) arranged on a lower surface of the impeller body

portion (31). The impeller body portion (31) extends downward from an upper end of the boss portion (34) while being widened in a radial direction, and is arranged to surround the boss portion (34) in a circumferential direction. When viewed in the axial direction, a front side end portion of the rib portion (35, 135) is curved toward a rotation direction back side as the rib portion (35, 135) extends from a radial inner side toward a radial outer side.

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Description**Field of the Invention**

[0001] The present disclosure relates to an impeller and a blower.

Description of the Related Art

[0002] In the related art, there is available an impeller for a blower, which is molded with a resin. In this case, the interior of a hub portion is formed into a cavity, thereby suppressing generation of distortion, i.e., a so-called sink mark, which may be generated when molding the impeller with a resin.

[0003] If the interior of the hub portion is formed into a cavity, the thickness of the hub portion becomes thin. For that reason, there is a possibility that the strength of the hub portion is reduced and the hub portion is deformed during rotation. In order to prevent deformation of the hub portion, reinforcing ribs are provided in the cavity of the hub portion.

[0004] In a blower, if the impeller having the reinforcing ribs is rotated, there is a possibility that an air enters the cavity of the hub portion and a turbulent flow is generated between the reinforcing ribs of the cavity. Thus, the pressure of an air applied to the impeller increases and the shaft power for rotating the impeller becomes larger. This may reduce the blowing efficiency of the impeller.

Summary of the Disclosure

[0005] In one aspect of the present disclosure, there is provided an impeller which is directly or indirectly fixed to a shaft concentric with a center axis extending in an up-down direction and arranged to rotate about the center axis together with the shaft. The impeller includes: a boss portion which is fixed to the shaft and arranged to extend in an axial direction; an impeller body portion; a plurality of blade portions arranged on an upper surface of the impeller body portion; and a rib portion arranged on a lower surface of the impeller body portion. The impeller body portion extends downward from an upper end of the boss portion while being widened in a radial direction. The impeller body portion is arranged to surround the boss portion in a circumferential direction. When viewed in the axial direction, a front side end portion as a rotation direction front side end portion of the rib portion is curved toward a rotation direction back side as the rib portion extends from a radial inner side toward a radial outer side.

[0006] The above and other elements, features, steps, characteristics and advantages of the present disclosure will become more apparent from the following detailed description of the preferred embodiments made with reference to the attached drawings.

Brief Description of the Drawings**[0007]**

Fig. 1 is a perspective view illustrating a centrifugal fan according to one preferred embodiment.

Fig. 2 is an exploded perspective view illustrating the centrifugal fan according to one preferred embodiment.

Fig. 3 is a sectional view taken along line III-III in Fig. 1, illustrating the centrifugal fan according to one preferred embodiment.

Fig. 4 is a perspective view illustrating an impeller according to one preferred embodiment.

Fig. 5 is a bottom view illustrating the impeller according to one preferred embodiment.

Fig. 6 is a bottom view illustrating an impeller according to another example of one preferred embodiment.

Detailed Description of the Preferred Embodiments

[0008] An impeller and a blower according to one preferred embodiment of the present disclosure will now be described with reference to the drawings. In the preferred embodiment described below, descriptions will be made on a centrifugal fan as one example of a blower.

[0009] The scope of the present disclosure is not limited to the embodiment described below but may be arbitrarily changed without departing from the scope of the technical idea of the present disclosure. In the drawings referred to below, for the sake of making individual configurations easily understandable, individual structures are sometimes shown in the reduced scale and number differing from those of actual structures.

[0010] In the drawings, an XYZ coordinate system is appropriately shown as a three-dimensional rectangular coordinate system. In the XYZ coordinate system, the Z-axis direction is a direction parallel to the axial direction of a center axis J illustrated in Fig. 1. The X-axis direction is a direction orthogonal to the Z-axis direction and orthogonal to an exhaust port 62 illustrated in Fig. 1. The Y-axis direction is a direction orthogonal to both the X-axis direction and the Z-axis direction.

[0011] In the following description, the extension direction of the center axis J (the Z-axis direction is an up-down direction. The positive side (+Z side) in the Z-axis direction will be referred to as an "upper side". The negative side (-Z side) in the Z-axis direction will be referred to as a "lower side". The terms "up-down direction", "upper side" and "lower side" are used merely for the purpose of descriptions and are not intended to limit the actual positional relationships or the actual directions. Unless specifically mentioned otherwise, the direction (the Z-axis direction) parallel to the center axis J will be merely referred to as an "axial direction". The radius direction extending from the center axis J will be merely referred to as a "radial direction". The circumference direction

about the center axis J (θ_z direction), namely the direction extending around the center axis J, will be merely referred to as a "circumferential direction".

[0012] In the subject specification, the phrase "extending in the axial direction" includes not only a case where something extends strictly in the axial direction but also a case where something extends in a direction inclined at an angle of less than about 45 degrees with respect to the axial direction. In the subject specification, the phrase "extending in the radial direction" includes not only a case where something extends strictly in the radial direction, namely in the direction perpendicular to the axial direction but also a case where something extends in a direction inclined at an angle of less than 45 degrees with respect to the radial direction.

[0013] Fig. 1 is a perspective view of a centrifugal fan 10 according to one preferred embodiment. Fig. 2 is an exploded perspective view of the centrifugal fan 10 according to one preferred embodiment. Fig. 3 is a sectional view of the centrifugal fan taken along line III-III in Fig. 1. Fig. 3 is a sectional view of the centrifugal fan 10 which is viewed in the direction orthogonal to an exhaust port 62 (in the X-axis direction).

[0014] The centrifugal fan 10 is a blower. As illustrated in Figs. 1 to 3, the centrifugal fan 10 preferably includes a housing 20, an impeller 30 and a motor 40.

[0015] As illustrated in Fig. 3, the motor 40 is accommodated within the housing 20. The motor 40 is arranged radially inward of a motor cover portion 27 which will be described later. The motor 40 preferably includes a shaft 41 which is concentric with the center axis J extending in the up-down direction. The upper end portion of the shaft 41 protrudes toward the upper side of a motor cover portion 27 through an output shaft hole 27a which will be described later.

[0016] The motor 40 is disposed below the impeller 30. The motor 40 rotates the impeller 30 about the center axis J. In the present preferred embodiment, the motor 40 rotates the impeller 30 counterclockwise (in the $+\theta_z$ direction) when viewed from the upper side toward the lower side.

[0017] In the following descriptions, there may be a case where the counterclockwise forward side ($+\theta_z$ side) when viewed from the upper side toward the lower side is referred to as a "rotation direction front side" and the clockwise ($-\theta_z$) forward side ($-\theta_z$ side) when viewed from the upper side toward the lower side is referred to as a "rotation direction back side".

[0018] The housing 20 preferably includes an upper housing 21 and a lower housing 22. That is to say, the housing 20 is configured by interconnecting two separate members. The housing 20 accommodates the impeller 30 and the motor 40.

[0019] The upper housing 21 accommodates the impeller 30 at the radial inner side thereof. The upper housing 21 preferably includes an upper housing cover portion 23 and an upper housing wall portion 24.

[0020] The upper housing cover portion 23 is arranged

above the impeller 30. That is to say, the upper housing cover portion 23 overlaps with the impeller 30 in the axial direction. The upper housing cover portion 23 includes the intake port 61. The intake port 61 axially extends through the upper housing cover portion 23.

[0021] The upper housing cover portion 23 preferably includes a cover inner edge portion 23a extending downward from the inner edge of the intake port 61. The cover inner edge portion 23a has a tubular shape. The lower end of the cover inner edge portion 23a is arranged radially inward of an inner edge 33a of the shroud portion 33. The intake port 61 communicates with the interior of the impeller 30 through the inside of the cover inner edge portion 23a.

[0022] The upper housing cover portion 23 is radially widened along the shape of the below-mentioned shroud portion 33 of the impeller 30. The upper housing cover portion 23 is shaped to extend downward and radially outward. In other words, the upper housing cover portion 23 preferably includes a curved surface or a slant surface inclined with respect to the center axis J.

[0023] The upper housing wall portion 24 is connected to the lower end of the upper housing cover portion 23. The upper housing wall portion 24 is arranged radially outward of the impeller 30. The upper housing wall portion 24 surrounds the impeller 30 in the circumferential direction.

[0024] The lower housing 22 is attached to the lower side of the upper housing 21. The lower housing 22 preferably includes a motor cover portion 27, a lower housing bottom portion 28 and a lower housing wall portion 26.

[0025] The motor cover portion 27 has a roofed tubular shape opened downward. The motor 40 is disposed radially inward of the motor cover portion 27. The motor cover portion 27 covers the motor 40. The motor cover portion 27 has an output shaft hole 27a axially extending through a cover region of the motor cover portion 27.

[0026] The impeller 30 is arranged above the motor cover portion 27. The lower housing bottom portion 28 extends radially outward from the lower end of the motor cover portion 27. The lower housing wall portion 26 extends upward from the radial outer end of the lower housing bottom portion 28. The axial position of the upper end of the lower housing wall portion 26 is the same as the axial position of the upper surface of the motor cover portion 27.

[0027] The housing 20 preferably includes an intake port 61, a flow path 50 and an exhaust port 62. The intake port 61 is a hole opened upward and arranged to bring the outside and inside of the housing 20 into communication with each other. The intake port 61 is arranged above the impeller 30. As illustrated in Figs. 1 and 2, when seen in a plan view, the edge of the intake port 61 has a circular shape centered at the center axis J. The plan-view shape of the edge of the intake port 61 is not limited to the circular shape and is not particularly limited.

[0028] As illustrated in Fig. 3, the flow path 50 is provided within the housing 20. The flow path 50 intercon-

nects the intake port 61 and the exhaust port 62. The flow path 50 has, e.g., a scroll shape or substantially scroll shape. The flow path 50 preferably includes an upper flow path 51 and a lower flow path 52. That is to say, the upper flow path 51 and the lower flow path 52 have, e.g., a scroll shape or substantially scroll shape.

[0029] As used herein, the term "scroll shape" refers to a shape in which the radial dimension of the flow path grows larger as the flow path extends in the circumferential direction. The expression "the flow path has a scroll shape" includes a case where at least one of the upper flow path and the lower flow path has a scroll shape. That is to say, the expression "the flow path has a scroll shape" includes a case where only the upper flow path has a scroll shape, a case where only the lower flow path has a scroll shape and a case where both the upper flow path and the lower flow path have a scroll shape.

[0030] The upper flow path 51 and the lower flow path 52 are disposed along the axial direction. The lower flow path 52 is arranged below the upper flow path 51. The lower flow path 52 is connected to the upper flow path 51. In the present preferred embodiment, the boundary between the upper flow path 51 and the lower flow path 52 is the boundary between the upper housing 21 and the lower housing 22.

[0031] In the present preferred embodiment, the entirety of the upper flow path 51 is arranged within the upper housing 21. That is to say, the upper housing 21 preferably include the entirety of the upper flow path 51. At least a portion of the upper flow path 51 is arranged between the upper wall portion inner circumferential surface 24a and the impeller 30 in the radial direction.

[0032] While not shown in the drawings, the upper flow path 51 has an annular shape or substantially annular shape. The upper flow path 51 extends along the housing inner circumferential surface 20a. The air introduced into the upper flow path 51 from the impeller 30 flows through the upper flow path 51 in the same direction as the rotation direction of the impeller 30 (in the $+0_z$ direction). The entirety of the upper flow path 51 is opened downward. A part of the air flowing through the upper flow path 51 is introduced into the lower flow path 52 until the air reaches the exhaust port 62.

[0033] As illustrated in Fig. 2, the entirety of the lower flow path 52 is arranged inside the lower housing 22. That is to say, the lower housing 22 preferably includes the entirety of the lower flow path 52. In other words, the lower flow path 52 is arranged between the outer circumferential surface of the motor cover portion 27 and the inner circumferential surface of the housing 20.

[0034] The lower flow path 52 extends along the inner circumferential surface of the housing 20. The air introduced from the upper flow path 51 into the lower flow path 52 flows through the lower flow path 52 in the same direction as the rotation direction of the impeller 30 (in the $+0_z$ direction). One circumferential end (the $+0_z$ side end) of the lower flow path 52 is opened toward the exhaust port 62. The other circumferential end (the -0_z side

end) of the lower flow path 52 is closed with respect to the exhaust port 62.

[0035] In the case of closing one circumferential end of the lower flow path, it is preferable that one end of the lower flow path is closed in the circumferential direction. That is to say, even when closing one circumferential end of the lower flow path, one circumferential end of the lower flow path may be opened upward.

[0036] The exhaust port 62 is arranged radially outward of the impeller 30. In the present preferred embodiment, the exhaust port 62 is opened in the direction (X-axis direction) orthogonal to the axial direction. As illustrated in Fig. 1, the exhaust port 62 is defined by connecting an upper housing 21 and a lower housing 22 which will be described later. The exhaust port 62 is connected to the upper flow path 51 and the lower flow path 52.

[0037] In Fig. 3, the airflow is indicated by thick arrows. As illustrated in Fig. 3, if the motor 40 rotates the impeller 30, an air is introduced into the housing 20 through the intake port 61. The air introduced into the housing 20 is blown toward the radial outer side of the impeller 30 through the interior of the impeller 30, namely through the gap between the shroud portion 33 and the impeller body portion 31 which will be described later. The air blown radially outward from the impeller 30 is moved through the upper flow path 51 and the lower flow path 52 and is discharged to the outside of the housing 20 from the exhaust port 62.

[0038] The impeller 30 is disposed above the motor 40. The impeller 30 is fixed to the upper end portion of the shaft 41. Thus, the impeller 30 is rotatable (in the $\pm 0_z$ directions) about the center axis J together with the shaft 41.

[0039] Fig. 4 is a perspective view illustrating the impeller 30. Fig. 5 is a bottom view illustrating the impeller 30. In the subject specification, the term "bottom view" refers to a view seen from the lower side toward the upper side.

[0040] As illustrated in Figs. 2, 4 and 5, the impeller 30 preferably includes a boss portion 34, an impeller body portion 31, blade portions 32, a shroud portion 33 and rib portions 35. In the present preferred embodiment, the impeller 30 is a single member. In the present preferred embodiment, the impeller 30 is made of a resin. The impeller 30 may be made of other materials.

[0041] As illustrated in Fig. 3, the boss portion 34 extends in the axial direction. The boss portion 34 has a fitting hole 34a opened downward. The upper end portion of the shaft 41 is fitted to the fitting hole 34a. Thus, the boss portion 34 is fixed to the shaft 41. That is to say, the impeller 30 is directly fixed to the shaft 41 in the boss portion 34.

[0042] The impeller body portion 31 extends downward from the upper end of the boss portion 34 while being widened in the radial direction. The impeller body portion 31 has an umbrella shape or substantially umbrella shape. In other words, the impeller body portion

31 has a curved surface or a slant surface inclined with respect to the center axis J. As illustrated in Figs. 3 and 4, the impeller body portion 31 surrounds the boss portion 34 in the circumferential direction. A cavity AH exists radially inward of the impeller body portion 31. The cavity AH is a space surrounded by the impeller body portion 31 and the boss portion 34.

[0043] As illustrated in Fig. 3, the impeller body portion 31 preferably includes a body portion upper surface 31a, which is the upper surface of the impeller body portion 31, and a body portion lower surface 31b, which is the lower surface of the impeller body portion 31. The body portion upper surface 31a is a gentle slant surface which extends downward from the center axis J toward the radial outer side.

[0044] The body portion lower surface 31b is connected to the boss portion 34 at the radial inner end thereof. The body portion lower surface 31b is a gentle slant surface which extends downward from the radial inner side toward the radial outer side. The body portion lower surface 31b is similar to the body portion upper surface 31a. The body portion lower surface 31b is substantially parallel to the body portion upper surface 31a. The thickness of the impeller body portion 31 is substantially uniform.

[0045] The blade portions 32 are arranged on the body portion upper surface 31a. The blade portions 32 extend upward from the body portion upper surface 31a. The upper ends of the blade portions 32 are connected to the shroud portion 33. As illustrated in Fig. 5, the blade portions 32 are uniformly arranged along the circumferential direction. When viewed in the axial direction, the blade portions 32 extend with a curvature on the body portion upper surface 31a. In the example illustrated in Fig. 5, each of the blade portions 32 has a single curvature.

[0046] The radial outer ends of the blade portions 32 are arranged at the radial outer edge of the body portion upper surface 31a. The radial inner ends of the blade portions 32 are arranged radially inward of the radial outer edge of the impeller body portion 31. When viewed in the axial direction, the blade portions 32 are curved toward the rotation direction back side ($-\theta_z$ side) as the blade portions 32 extend from the radial inner side toward the radial outer side. It is therefore possible to reduce the pressure of an air applied to the blade portions 32 when the impeller 30 rotates. This makes it possible to reduce the shaft power applied by the motor 40.

[0047] The thickness L5 of the blade portions 32 is substantially uniform. Thus, it is possible to suppress generation of a sink mark which may be generated when the blade portions 32 are manufactured by injection-molding a resin.

[0048] The blade portions 32 preferably include a plurality of first blade portions 32a and a plurality of second blade portions 32b. The first blade portions 32a and the second blade portions 32b are alternately disposed along the circumferential direction. The radial inner ends of the first blade portions 32a are arranged radially inward of the radial inner ends of the second blade portions 32b.

[0049] In the example illustrated in Fig. 5, the blade portions 32 includes five first blade portions 32a and five second blade portions 32b. That is to say, the number of the blade portions 32 in example illustrated in Fig. 5 is, e.g., ten. The number of the blade portions 32 is not limited to the aforementioned number.

[0050] As illustrated in Fig. 3, the shroud portion 33 is arranged above the blade portions 32. The shroud portion 33 is connected to the impeller body portion 31 via the blade portions 32. As illustrated in Fig. 2, the shroud portion 33 has an annular shape centered at the center axis J or substantially annular shape. The shroud portion 33 is shaped to extend radially outward and downward.

[0051] As illustrated in Fig. 4, the rib portions 35 are arranged on the body portion lower surface 31b. The rib portions 35 are disposed within the cavity AH. In the present preferred embodiment, the rib portions 35 are connected to the boss portion 34. This makes it possible to enhance the strength of the impeller body portion 31.

[0052] As illustrated in Fig. 5, when viewed in the axial direction, the rib portions 35 extend with a curvature on the body portion lower surface 31b. When viewed in the axial direction, the front side end portions 35a as the rotation direction front side ($+\theta_z$ side) end portions of the rib portions 35 are curved toward the rotation direction back side ($-\theta_z$ side) as the rib portions 35 extend from the radial inner side toward the radial outer side.

[0053] In this regard, it is assumed that the air flowing through the flow path 50 is introduced into an axial gap AP between the impeller 30 and the motor cover portion 27 illustrated in Fig. 3. The air introduced into the gap AP moves upward due to, e.g., screw holes arranged on the upper surface of the motor cover portion 27, and flows into the cavity AH. At this time, if a plurality of rib portions is radially disposed so as to extend in the radial direction, there may be a case where a turbulent flow is generated between the respective rib portions. Thus, the pressure of an air applied to the impeller 30 increases and the shaft power of the motor 40 becomes larger. There is possibility that the blowing efficiency of the impeller 30 is reduced.

[0054] In contrast, according to the present preferred embodiment, the front side end portions 35a of the rib portions 35 are curved toward the rotation direction back side ($-\theta_z$ side). For that reason, if the impeller 30 rotates, the air existing between the rib portions 35 is discharged from the cavity AH. This makes it possible to suppress generation of a turbulent flow within the cavity AH and to reduce the pressure of an air applied to the impeller 30. It is therefore possible to reduce the shaft power of the motor 40. As a result, it is possible to suppress reduction of the blowing efficiency.

[0055] Furthermore, it is possible to discharge the air, which may otherwise generate a turbulent flow and stay within the cavity AH, from the cavity AH. Thus, it is possible to suppress a loss of the air introduced from the intake port 61 into the housing 20. This makes it possible to enhance the blowing efficiency of the centrifugal fan

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[0056] As the air is discharged from the cavity AH, there is generated a flow of air which moves from the cavity AH toward the flow path 50 via the gap AP. Thus, it is possible to restrain the air from flowing into the cavity AH via the gap AP and to further suppress generation of a turbulent flow within the cavity AH.

[0057] In the case where the flow path 50 has a scroll shape, the air existing in the flow path 50 is easily introduced into the gap AP and a turbulent flow is easily generated within the cavity AH. However, in the present preferred embodiment, it is possible to suppress generation of a turbulent flow within the cavity AH.

[0058] If the air introduced from the gap AP into the cavity AH impinges against the rib portions 35, there is a possibility of generation of a noise. However, in the present preferred embodiment, it is possible to restrain the air from flowing into the cavity AH. This makes it possible to restrain the air from impinging against the rib portions 35 and generating a noise.

[0059] In the present disclosure, the expression "a certain subject is curved toward the rotation direction back side" includes a case where a certain subject as a whole bulges toward the rotation direction back side. That is to say, a portion of a certain subject may bulge toward the rotation direction front side or a portion of a certain subject may have a straight shape, as long as a certain subject as a whole bulges toward the rotation direction back side.

[0060] When viewed in the axial direction, the back side end portions 35b as the rotation direction back side (-0_z side) end portions of the rib portions 35 are curved toward the rotation direction back side as the rib portions 35 extend from the radial inner side toward the radial outer side. That is to say, the back side end portions 35b are curved toward the same side as the front side end portions 35a. Thus, it is easy to make uniform the thickness of the rib portions 35.

[0061] In the present preferred embodiment, the dimension between the front side end portions 35a and the back side end portions 35b of the rib portions 35, namely the thickness L4 of the rib portions 35, is substantially uniform. Thus, it is possible to suppress generation of a sink mark which may be generated when the impeller 30 is manufactured by injection-molding a resin. Thus, according to the present preferred embodiment, it is possible to manufacture the impeller 30 with high dimensional accuracy.

[0062] In the present disclosure, the expression "the dimension of a certain subject is substantially uniform" includes a case where the dimension ratio with respect to the average dimension of a certain subject is about 0.8 or more and 1.2 or less in any position.

[0063] As illustrated in Fig. 5, the radial inner end portions of the rib portions 35 are connected to the boss portion 34. The radial outer end portions of the rib portions 35 are arranged at the radial outer edge of the body portion lower surface 31b. That is to say, the radial outer end portions of the rib portions 35 are arranged at the

radial outer edge of the impeller body portion 31. Thus, in the radial direction, it is possible to broaden the range over which the rib portions 35 are arranged. This makes it easy to discharge the air from the interior of the cavity AH.

[0064] As illustrated in Fig. 3, the axial dimension L2 of the rib portions 35 is one half or more of the axial dimension L3 of the cavity AH. The axial dimension L3 of the cavity AH refers to the axial distance between the position P, in which the impeller body portion 31 and the boss portion 34 are connected to each other, and the lower end of the impeller body portion 31. Thus, it is possible to enhance the strength of the impeller body portion 31. Since the rib portions 35 can be provided to further extend toward the radial outer side, it is easy to discharge the air existing within the cavity AH.

[0065] The axial dimension L2 of the rib portions 35 refers to the axial dimension of the rib portions 35 measured in the radial inner end portions of the rib portions 35. The dimension L2 is the maximum value of the axial dimension of the rib portions 35.

[0066] In the present preferred embodiment, the axial dimension L2 of the rib portions 35 is equal to the axial dimension L3 of the cavity AH. That is to say, the rib portions 35 extend from the position P to the lower end of the impeller body portion 31 in the axial direction. Thus, it is possible to further enhance the strength of the impeller body portion 31. Since the rib portions 35 can be provided to extend to the radial outer edge of the impeller body portion 31, it is possible to further discharge the air existing within the cavity AH.

[0067] The axial dimension L2 of the rib portions 35 is one half or more of the axial dimension L1 of the impeller body portion 31. Thus, it is possible to secure the strength of the impeller body portion 31.

[0068] As illustrated in Fig. 5, the impeller 30 preferably includes a plurality of rib portions 35. Thus, it is possible to further enhance the strength of the impeller body portion 31. The rib portions 35 are uniformly disposed along the circumferential direction. Thus, it is possible to uniformly discharge the air from the interior of the cavity AH in the circumferential direction.

[0069] In the example illustrated in Fig. 5, the number of the rib portions 35 is seven. In the present preferred embodiment, the number of the rib portions 35 differs from the number of the blade portions 32. In the case where the number of the rib portions 35 is equal to the number of the blade portions 32, there is a risk that the impeller 30 resonates due to the flow of the air discharged by the rib portions 35 and the flow of the air discharged by the blade portions 32. If the impeller 30 resonates, there is a possibility that a load is applied to the shaft 41 and the shaft power of the motor 40 is increased.

[0070] In contrast, according to the present preferred embodiment, it is possible to suppress resonance of the impeller 30 because the number of the rib portions 35 differs from the number of the blade portions 32. As a result, it is possible to suppress the increase in the shaft

power of the motor 40.

[0071] When viewed in the axial direction, the rib portions 35 intersect the blade portions 32. Thus, it is possible to further enhance the strength of the impeller body portion 31. In the present preferred embodiment, each of the rib portions 35 has one curvature. The curvature of each of the rib portions 35 differs from the curvature of each of the blade portions 32. For that reason, when viewed in the axial direction, the rib portions 35 can intersect the blade portions 32.

[0072] The present disclosure is not limited to the embodiment described above. The present disclosure may employ, for example, the configurations which will be described below. In the following descriptions, there may be a case where the same configurations as described above are appropriately designated by like reference symbols with the descriptions thereof omitted.

[0073] As long as the front side end portions 35a are curved toward the rotation direction back side ($-\theta_z$ side), the shape of the back side end portions 35b is not particularly limited. The back side end portions 35b may have a configuration illustrated in Fig. 6. Fig. 6 is a bottom view illustrating an impeller 130 according to another example of one preferred embodiment.

[0074] As illustrated in Fig. 6, the impeller 130 preferably includes a plurality of rib portions 135. When viewed in the axial direction, the front side end portions 135a as the rotation direction front side ($+\theta_z$ side) end portions of the rib portions 135 are curved toward the rotation direction back side ($-\theta_z$ side) as the rib portions 135 extend from the radial inner side toward the radial outer side. When viewed in the axial direction, the back side end portions 135b as the rotation direction back side ($-\theta_z$ side) end portions of the rib portions 135 have a straight shape. That is to say, the shape of the rib portions 135 viewed in the axial direction is a substantially semi-elliptical shape.

[0075] Thus, it is possible to increase the dimension between the front side end portions 135a and the back side end portions 135b of the rib portions 135, namely the thickness L6 of the rib portions 135. This enables the curved front side end portions 135a to discharge the air existing within the cavity AH. It is therefore possible to further enhance the strength of the impeller body portion 31 while reducing the pressure of an air applied to the impeller 130.

[0076] Each of the front side end portions 35a may have a plurality of curvatures. In this case, the curvatures may include curvatures whose center positions are arranged at the opposite sides of the front side end portions 35a in the rotation direction (θ_z direction). Each of the front side end portions 135a may have a straight section.

[0077] The number of the rib portions 35 is not particularly limited and may be six or less or eight or more. That is to say, it is preferred that the number of the rib portions 35 is at least one or more. The number of the rib portions 35 may be equal to the number of the blade portions 32.

[0078] The rib portions 35 may have an identical shape or different shapes. In addition to the rib portions 35, there may be provided straight rib portions extending in the radial direction when viewed in the axial direction.

[0079] The rib portions 35 may not be connected to the boss portion 34. In this case, the rib portions 35 may be connected to only the impeller body portion 31. The rib portions 35 may be connected to the boss portion 34 via other portions.

[0080] The impeller 130 is directly or indirectly fixed to the shaft 41. That is to say, the impeller 130 may be indirectly fixed to the shaft 41.

[0081] In the example illustrated in Fig. 3, the boss portion 34 is fitted to the shaft 41. However, the boss portion 34 may be fixed to the shaft 41 in any way. For example, the boss portion 34 may be fixed to the shaft 41 by a screw.

[0082] Each of the blade portions 32 may have a plurality of curvatures. The number of the blade portions 32 is not particularly limited.

[0083] The impeller 30 may not include the shroud portion 33.

[0084] the upper housing 21 may include the entirety of the upper flow path 51 and the entirety of the lower flow path 52. The housing 20 may be configured by axially interconnecting three or more independent members. The housing 20 may be a single member.

[0085] The flow path 50 may not have a scroll shape. The motor 40 may not be accommodated within the housing 20.

[0086] The impeller of the present disclosure may be applied to not only the centrifugal fan but also other kinds of blowers such as a mixed flow fan and the like. The use of the impeller and the blower according to the present disclosure is not particularly limited.

[0087] Features of the above-described preferred embodiments and the modifications thereof may be combined appropriately as long as no conflict arises.

[0088] While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

Claims

1. An impeller (30,130) which is directly or indirectly fixed to a shaft(41) concentric with a center axis(J) extending in an up-down direction and arranged to rotate about the center axis(J) together with the shaft(41), the impeller(30,130) comprising:

a boss portion(34) which is fixed to the shaft(41) and arranged to extend in an axial direction;
an impeller body portion (31) extending down-

- ward from an upper end of the boss portion(34) while being widened in a radial direction, the impeller body portion (31) arranged to surround the boss portion(34) in a circumferential direction;
- a plurality of blade portions(32) arranged on an upper surface of the impeller body portion (31); and
- a rib portion(35,135) arranged on a lower surface of the impeller body portion (31), wherein when viewed in the axial direction, a front side end portion as a rotation direction front side end portion of the rib portion(35,135) is curved toward a rotation direction back side as the rib portion extends from a radial inner side toward a radial outer side.
2. The impeller(30,130) according to claim 1, wherein the rib portion(35,135) is connected to the boss portion(34).
 3. The impeller(30,130) according to claims 1 or 2, wherein the rib portion(35,135) includes a plurality of rib portions(35,135), and the number of the rib portions(35,135) differs from the number of the blade portions(32).
 4. The impeller(30,130) according to any one of claims 1 to 3, wherein a radial outer end of the rib portion(35,135) is arranged at a radial outer edge of the impeller body portion (31).
 5. The impeller(30,130) according to any one of claims 1 to 4, wherein when viewed in the axial direction, a back side end portion as a rotation direction back side end portion of the rib portion(35,135) is curved toward the rotation direction back side as the rib portion(35,135) extends from the radial inner side toward the radial outer side.
 6. The impeller(30,130) according to claim 5, wherein a dimension between the front side end portion(35a, 135a) and the back side end portion (35b, 135b) of the rib portion(35,135) is uniform.
 7. The impeller(30,130) according to any one of claims 1 to 4, wherein when viewed in the axial direction, a back side end portion (35b, 135b) as a rotation direction back side end portion of the rib portion(35,135) has a straight shape.
 8. The impeller(30,130) according to claim 1, wherein when viewed in the axial direction, the rib portion (35,135) intersects one of the blade portions.
 9. The impeller(30,130) according to any one of claims 1 to 8, wherein when viewed in the axial direction, the blade portions(32) are curved toward the rotation direction back side as the blade portions(32) extend from the radial inner side toward the radial outer side.
 10. The impeller(30,130) according to claim 9, wherein a curvature of the rib portion(35,135) differs from a curvature of each of the blade portions(32).
 11. The impeller (30,130) according to any one of claims 1 to 10, wherein an axial dimension of the rib portion(35,135) is one half or more of an axial distance between a position, in which the impeller body portion (31) and the boss portion(34) are connected to each other, and a lower end of the impeller body portion (31).
 12. The impeller(30,130) according to claim 11, wherein the axial dimension of the rib portion (32) is equal to the axial distance between the position, in which the impeller body portion (31) and the boss portion(34) are connected to each other, and the lower end of the impeller body portion (31).
 13. The impeller(30,130) according to any one of claims 1 to 12, wherein the rib portion(32) includes a plurality of rib portion(32)s uniformly arranged along the circumferential direction.
 14. A blower(10) comprising:
 - the impeller(30,130) according to any one of claims 1 to 13;
 - a motor(40) provided with the shaft(41) and arranged to rotate the impeller(30,130) about the center axis(J); and
 - a housing(20) arranged to accommodate the impeller(30,130).

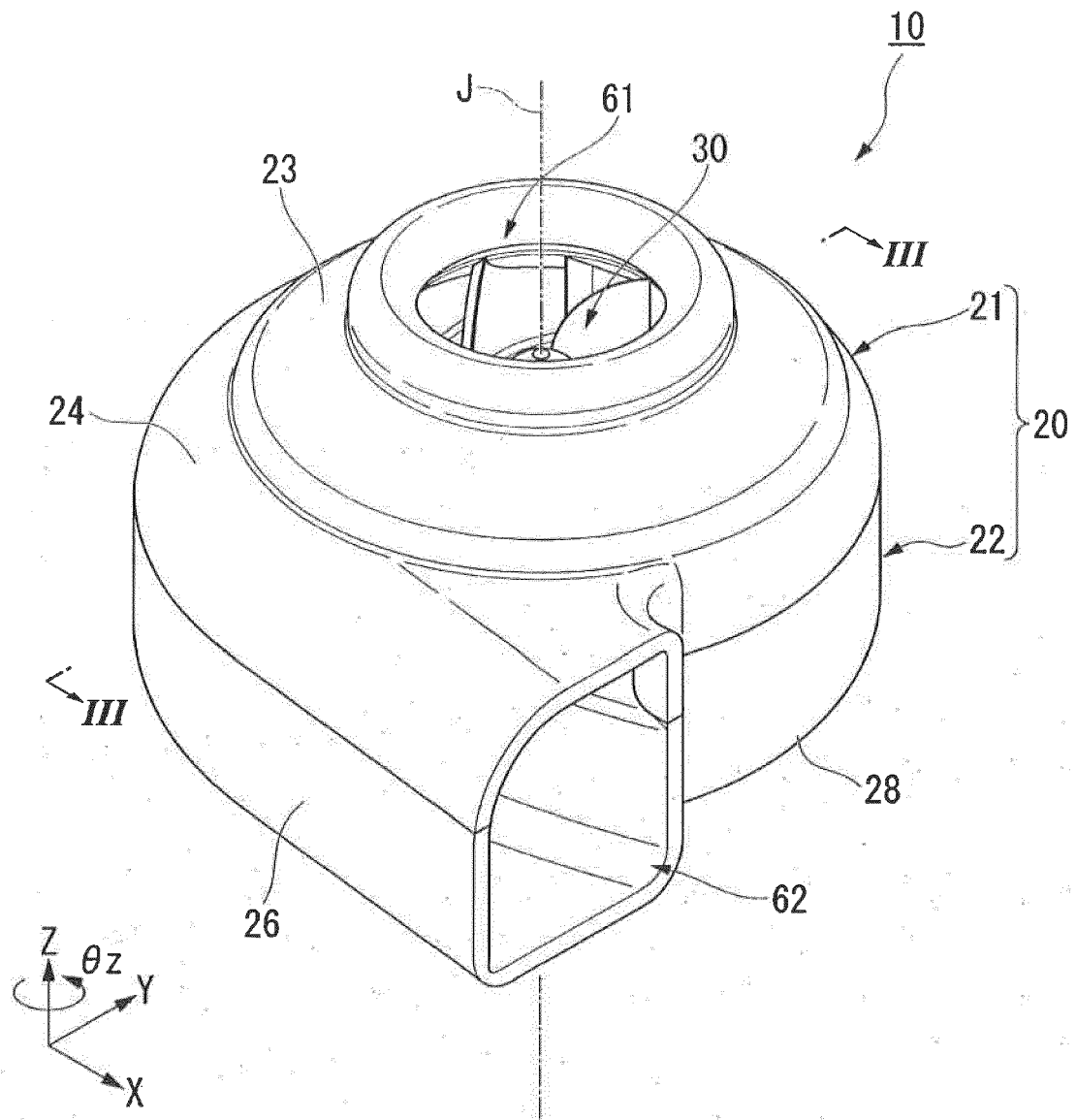


Fig.1

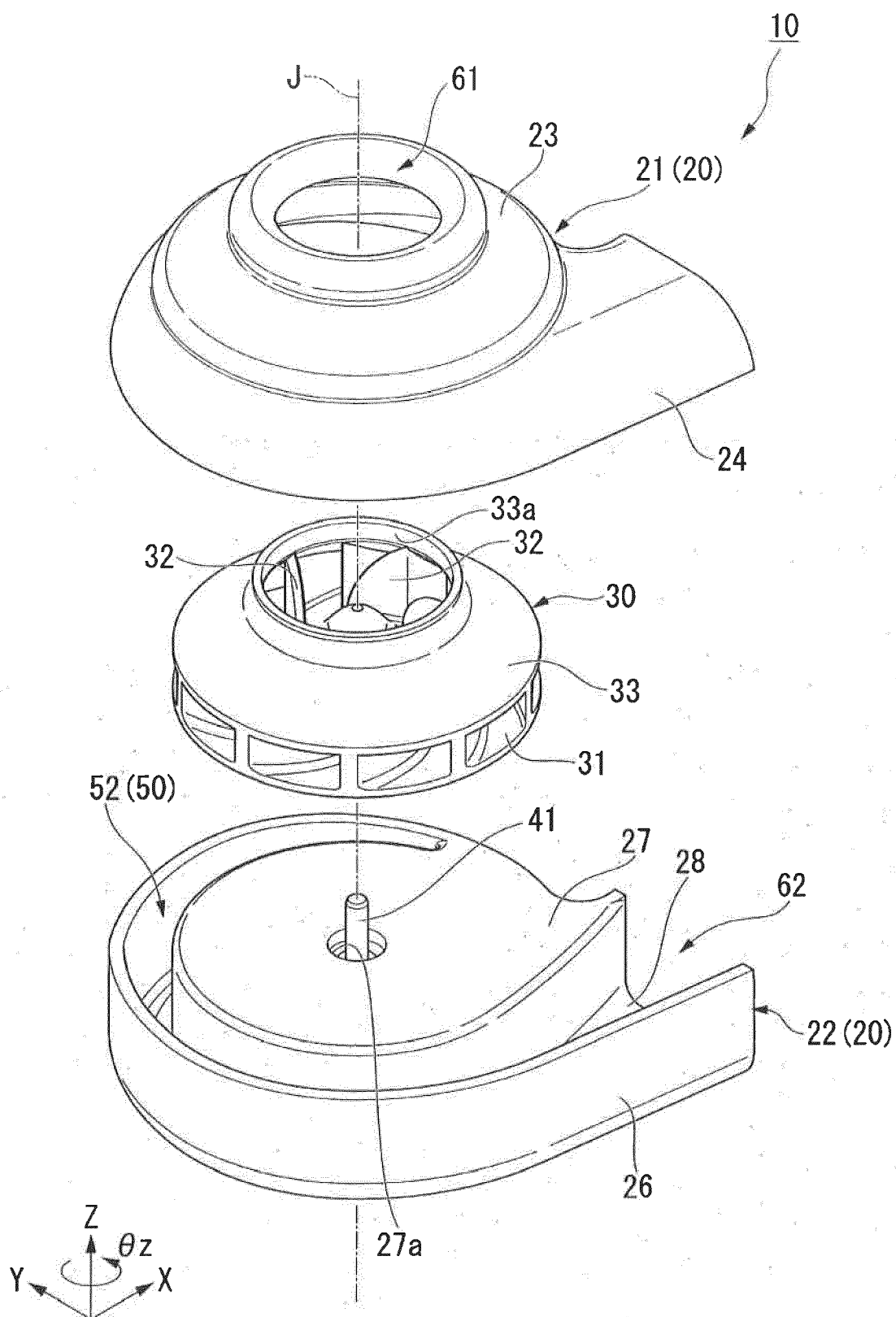


Fig.2

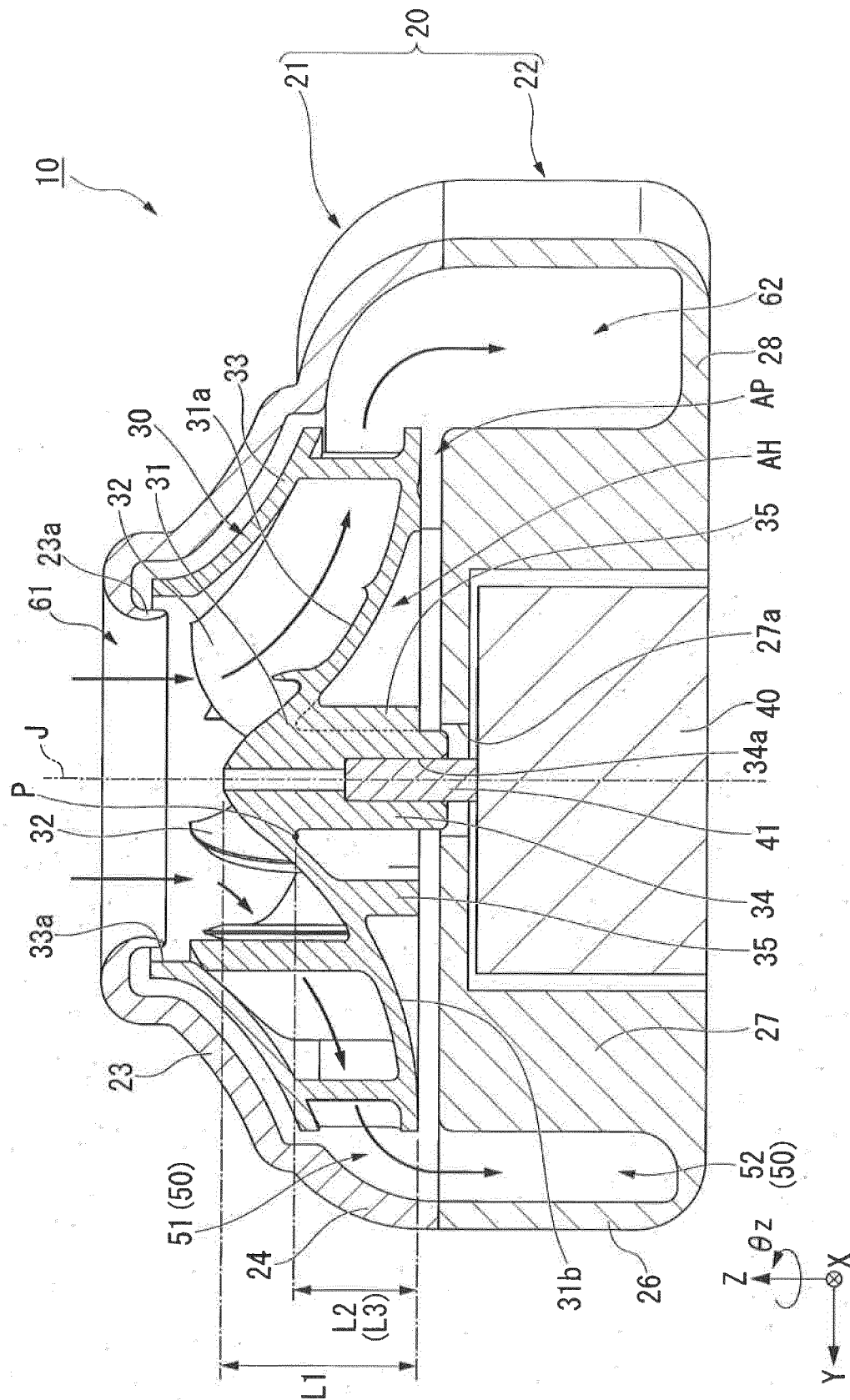


Fig.3

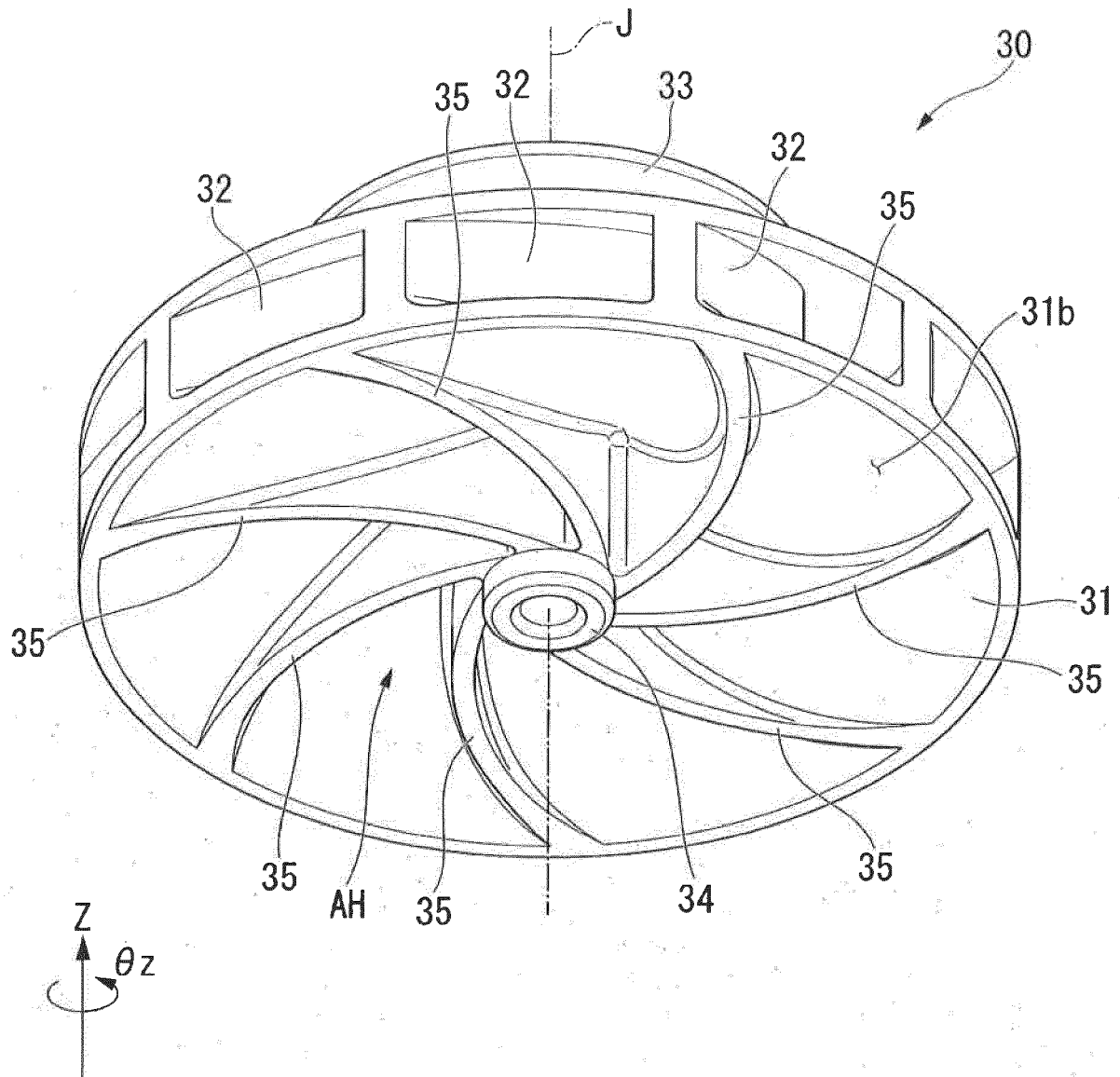


Fig.4

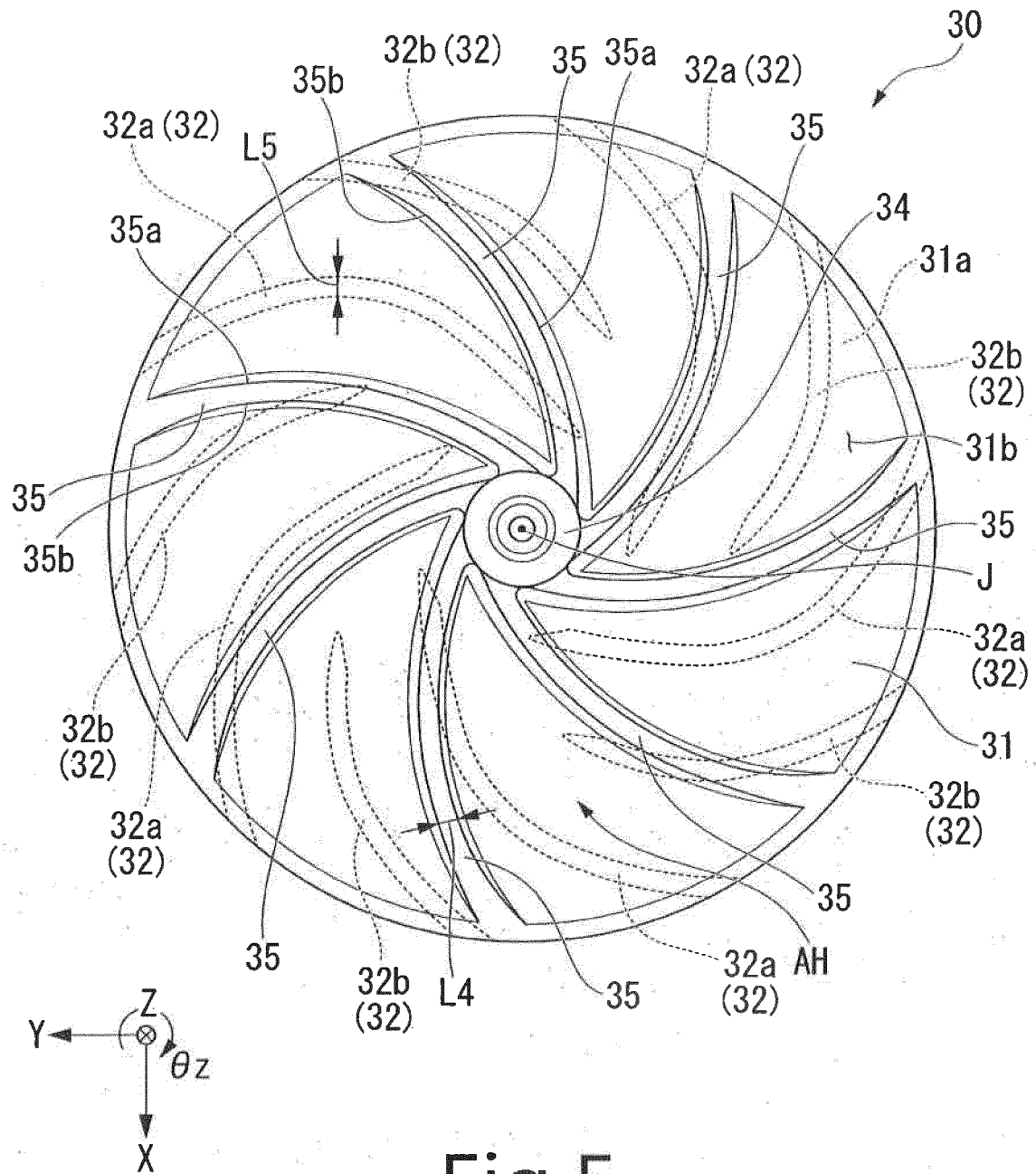


Fig.5

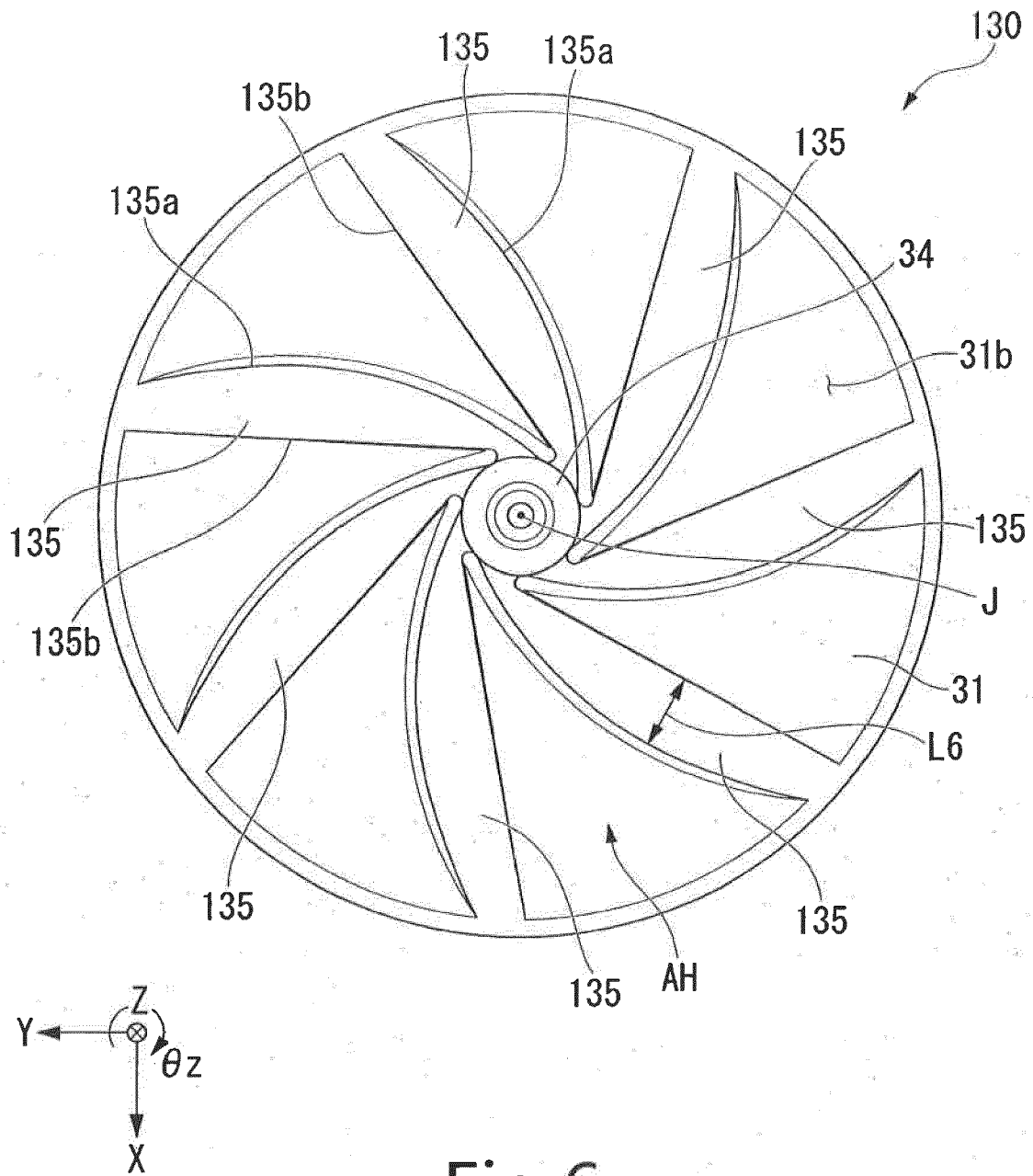


Fig.6



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Application Number
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			F04D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 August 2016	Examiner de Martino, Marcello
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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