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(54) **CENTRIFUGAL FAN**

(57) A centrifugal fan(10,110,210) includes an impeller(30), a motor(40) rotating the impeller(30) about a center axis(J), and a housing(20,120,220) accommodating the impeller(30). The housing(20,120,220) includes an intake port(61) arranged above the impeller(30), an exhaust port(62,162) arranged radially outward of the impeller(30), an annular upper flow path(51), and a lower flow path(52,252) arranged below the upper flow path(51) and connected to the upper flow path(51). The annular upper flow path(51) can be partially arranged between a housing(20,120,220) inner circumferential surface and the impeller(30) in a radial direction. The upper flow path(51) and the lower flow path(52,252) are arranged to define a flow path having a scroll shape.

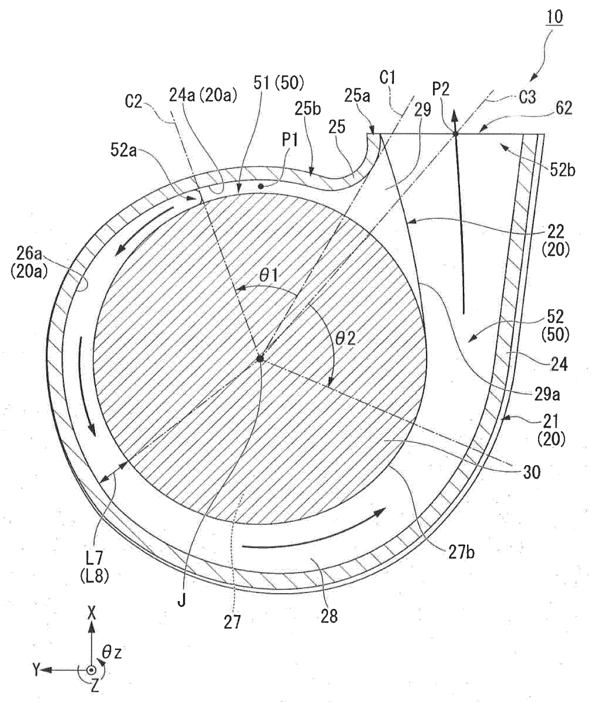

Fig.4

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Description

Field of the Invention

[0001] The present disclosure relates to a centrifugal fan.

Description of the Related Art

[0002] There is available a centrifugal fan which includes an air flow path positioned radially outward of an impeller and a wind tunnel positioned below the air flow path. The air discharged radially outward from the impeller flows from the air flow path toward the wind tunnel. Then, the air is discharged to the outside from an exhaust port.

[0003] In the centrifugal fan mentioned above, the wind tunnel positioned below the air flow path has an annular shape. For that reason, there may be a case where a part of the air guided to the vicinity of the exhaust port through the wind tunnel flows toward the upstream side of the wind tunnel without being discharged from the exhaust port. This poses a problem in that a loss of airflow is generated and the efficiency of the centrifugal fan is reduced.

Summary of the Disclosure

[0004] In one aspect of the present disclosure, there is provided a centrifugal fan includes: an impeller arranged to rotate about a center axis extending in an up-down direction; a motor arranged below the impeller and arranged to rotate the impeller about the center axis; and a housing arranged to accommodate the impeller. The housing includes an intake port arranged above the impeller, an exhaust port arranged radially outward of the impeller, an annular upper flow path, and a lower flow path arranged below the upper flow path and connected to the upper flow path. The annular upper flow path is at least partially arranged between a housing inner circumferential surface as an inner circumferential surface of the housing and the impeller in a radial direction. The upper flow path and the lower flow path are arranged to define a flow path having a scroll shape. The lower flow path extends along the housing inner circumferential surface. The lower flow path has a lower flow path terminal end as one circumferential end thereof opened toward the exhaust port. The lower flow path has a lower flow path start end as the other circumferential end thereof closed with respect to the exhaust port.

[0005] 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

[0006]

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

Fig. 5 is a side view illustrating the centrifugal fan according to one preferred embodiment.

Fig. 6 is a side view illustrating a centrifugal fan according to another example of one preferred embodiment.

Fig. 7 is a sectional view illustrating a portion of a centrifugal fan according to a further example of one preferred embodiment.

Detailed Description of the Preferred Embodiments

[0007] A centrifugal fan according to one preferred embodiment of the present disclosure will now be described with reference to the drawings. 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.

[0008] 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.

[0009] 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".

[0010] 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 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.

[0011] Fig. 1 is a perspective view of a centrifugal fan according to one preferred embodiment. Fig. 2 is an exploded perspective view of the centrifugal fan according to one preferred embodiment. Fig. 3 is a sectional view of the centrifugal fan according to one preferred embodiment, which is taken along line III-III in Fig. 1. Fig. 4 is a sectional view of the centrifugal fan according to one preferred embodiment, which is taken along line IV-IV in Fig. 3. Fig. 5 is a side view of the centrifugal fan according to one preferred embodiment. Fig. 3 is a sectional view of the centrifugal fan according to one preferred embodiment, which is viewed in the direction orthogonal to the exhaust port 62 (in the X-axis direction). Fig. 4 is a sectional view of the centrifugal fan according to one preferred embodiment, which is viewed from the upper side toward the lower side. In the subject specification, the term "side view" refers to a view seen in the X-axis direction.

[0012] As illustrated in Figs. 1 to 3, the centrifugal fan 10 preferably includes a housing 20, an impeller 30 and a motor 40. As illustrated in Fig. 3, the motor 40 is accommodated within the housing 20. The motor 40 is disposed 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 the motor cover portion 27 through an output shaft hole 27a which will be described later.

[0013] 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.

[0014] 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".

[0015] 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 $\pm\theta_z$ directions) about the center axis J extending in the up-down direction.

[0016] The impeller 30 preferably includes an impeller body portion 31, a plurality of blade portions 32 and a shroud portion 33. The impeller body portion 31 is a portion fixed to the shaft 41. The upper surface of the impeller body portion 31 is a gentle slant surface which extends downward and radially outward from the center axis J.

[0017] The blade portions 32 are disposed on the upper surface of the impeller body portion 31. The blade portions 32 extend upward from the upper surface of the impeller body portion 31. While not shown in the drawings, the blade portions 32 are disposed at regular intervals in the circumferential direction. The upper end portions of the blade portions 32 are connected to the shroud portion 33.

[0018] The shroud portion 33 is disposed 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. The shroud portion 33 is shaped to extend downward and radially outward. In other words, the shroud portion 33 preferably includes a curved surface or a slant surface inclined with reference to the center axis J.

[0019] As illustrated in Fig. 3, the housing 20 accommodates the impeller 30 and the motor 40. The housing 20 preferably includes an intake port 61, a flow path 50 and the 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 or substantially 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.

[0020] As illustrated in Fig. 3, the flow path 50 is provided within the housing 20. The flow path 50 interconnects the intake port 61 and the exhaust port 62. The flow path 50 has, e.g., a scroll 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 constitute the flow path 50 having a scroll or substantially scroll shape.

[0021] 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.

[0022] 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. The upper flow path 51 and the lower flow path 52 will be described later.

[0023] As illustrated in Fig. 4, 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. As illustrated in Fig. 5, the exhaust port 62 is connected to the upper flow path 51 and the lower flow path 52.

[0024] In order to reduce a loss of the airflow discharged from the centrifugal fan 10, it is preferred that, for example, the opening area of the exhaust port 62 is equal to or larger than the opening area of the intake port 61. In a configuration in which the exhaust port 62 is connected to only one of the upper flow path 51 and the lower flow path 52, the axial dimension of the upper flow path 51 or the axial dimension of the lower flow path 52 needs to be increased in order to secure the opening area of the exhaust port 62. This poses a problem in that the centrifugal fan 10 becomes larger in the axial direction.

[0025] In contrast, according to the present preferred embodiment, the exhaust port 62 is connected to the upper flow path 51 and the lower flow path 52. This makes it possible to provide the exhaust port 62 over the upper flow path 51 and the lower flow path 52. Thus, the opening area of the exhaust port 62 can be increased without having to increase the axial dimension of the upper flow path 51 and the axial dimension of the lower flow path 52. Accordingly, it is possible to restrain the centrifugal fan 10 from becoming larger in size.

[0026] In the present preferred embodiment, the axial dimension L2 of the portion of the exhaust port 62 connected to the lower flow path 52 is larger than the axial dimension L1 of the portion of the exhaust port 62 connected to the upper flow path 51.

[0027] 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. 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.

[0028] As illustrated in Figs. 1 and 2, the housing 20 preferably includes the upper housing 21 and the lower housing 22. That is to say, the housing 20 is configured by interconnecting two separate members. Thus, when assembling the centrifugal fan 10, it is possible for a worker to easily bring the impeller 30 into the housing 20. This makes it easy to assemble the centrifugal fan 10.

[0029] As illustrated in Fig. 3, 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.

[0030] 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. That is to say, the upper housing 21 includes the intake port 61. The intake port 61 axially extends through the upper housing cover portion 23.

[0031] 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.

[0032] The upper housing cover portion 23 is radially widened along the shape of the shroud portion 33. 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.

[0033] 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. As illustrated in Fig. 5, the upper housing wall portion 24 preferably includes a portion of the exhaust port 62.

[0034] An upper wall portion inner circumferential surface 24a is the inner circumferential surface of the upper housing wall portion 24. As illustrated in Fig. 3, the upper wall portion inner circumferential surface 24a extends downward and radially outward. In other words, the upper wall portion inner circumferential surface 24a is a curved surface or a slant surface inclined with respect to the center axis J. Thus, the air discharged radially outward from the impeller 30 can flow into the lower flow path 52 along the upper wall portion inner circumferential surface 24a.

[0035] As illustrated in Fig. 1, the upper housing wall portion 24 preferably includes a tongue portion 25. That is to say, the housing 20 preferably includes the tongue portion 25. The tongue portion 25 is a portion of the upper housing wall portion 24 connected to the exhaust port

62. As illustrated in Fig. 4, the tongue portion 25 is arranged between the exhaust port 62 and the below-mentioned lower flow path start end 52a in the circumferential direction. In the present preferred embodiment, the tongue portion 25 protrudes toward the side of the upper flow path 51 (namely, toward the rotation direction back side (-θ_z side) in the example of Fig. 4). Preferably, the tongue portion 25 is smoothly curved. An outer end portion 25a is the radial outer end portion of the tongue portion 25. The outer end portion 25a constitutes a portion of the rotation direction front side (+θ_z side) edge of the exhaust port 62.

[0036] As illustrated in Fig. 3, the lower housing 22 is attached to the lower side of the upper housing 21. As illustrated in Fig. 2, the lower housing 22 preferably includes the motor cover portion 27, a lower housing bottom portion 28, a lower housing wall portion 26 and a closing portion 29. That is to say, the housing 20 preferably includes the motor cover portion 27.

[0037] As illustrated in Fig. 3, 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. As illustrated in Figs. 2 and 3, the motor cover portion 27 has a cylindrical shape centered at the center axis J. As illustrated in Fig. 3, the motor cover portion 27 has the output shaft hole 27a axially extending through a cover region of the motor cover portion 27.

[0038] The impeller 30 is arranged above the motor cover portion 27. As illustrated in Fig. 4, when seen in a plan view, the motor cover portion 27 substantially overlaps with the impeller 30 in its entirety.

[0039] As illustrated in Fig. 3, 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 flush with the axial position of the upper surface of the motor cover portion 27. As illustrated in Fig. 5, the lower housing wall portion 26 preferably includes a portion of the exhaust port 62.

[0040] As illustrated in Fig. 2, the closing portion 29 is arranged between the motor cover portion 27 and the lower housing wall portion 26 in the radial direction. The closing portion 29 is connected to the motor cover portion 27, the lower housing wall portion 26 and the lower housing bottom portion 28. Thus, the closing portion 29 closes a circumferential portion of the gap between the motor cover portion 27 and the lower housing wall portion 26.

[0041] The upper surface of the closing portion 29 is arranged on the same axially-orthogonal plane as the upper surface of the motor cover portion 27. The upper surface of the motor cover portion 27, the upper surface of the closing portion 29 and the upper end of the lower housing wall portion 26 are connected to one another with no difference in level.

[0042] As illustrated in Fig. 4, when seen in a plan view, the closing portion 29 is arranged between the tongue portion 25 and the impeller 30 in the radial direction. The closing portion 29 is connected to the rotation direction front side (+θ_z side) edge of the exhaust port 62.

[0043] Next, the upper flow path 51 and the lower flow path 52 will be described in detail. As illustrated in Fig. 3, 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.

[0044] 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. A housing inner circumferential surface 20a is the inner circumferential surface of the housing 20. The upper wall portion inner circumferential surface 24a is a portion of the housing inner circumferential surface 20a. That is to say, at least a portion of the upper flow path 51 is arranged between the housing inner circumferential surface 20a and the impeller 30 in the radial direction.

[0045] As illustrated in Fig. 4, the upper flow path 51 has an annular or substantially annular shape. The upper flow path 51 extends along the upper wall portion inner circumferential surface 24a. That is to say, the upper flow path 51 extends along the housing inner circumferential surface 20a. As indicated by thick arrows in Fig. 4, 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 + θ_z direction). 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.

[0046] In the present preferred embodiment, the radial dimension L7 of the upper flow path 51 grows larger as the upper flow path 51 extends from a reference position P1 toward the exhaust port 62 in the rotation direction of the impeller 30 (in the + θ_z direction). In other words, the upper flow path 51 has a scroll or substantially scroll shape. Thus, it is possible to suppress generation of an air vortex within the upper flow path 51 and to smoothly discharge the air from the exhaust port 62. This makes it possible to reduce a loss of airflow in the centrifugal fan 10.

[0047] The reference position P1 is positioned between the exhaust port 62 and the below-mentioned lower flow path start end 52a. In the present preferred embodiment, the reference position P1 is a point at which a line extending in the direction orthogonal to the exhaust port 62 (in the X-axis direction) via the center axis J intersects the upper flow path 51.

[0048] The radial dimension L7 of the upper flow path 51 becomes smallest in the reference position P1. An inner end portion 25b is the radial inner end portion of the tongue portion 25. Within a range from the reference position P1 to the inner end portion 25b in the circumferential direction, the radial dimension L7 of the upper flow path 51 is equal to the radial dimension L7 of the upper flow path 51 in the reference position P1. That is to say, the radial dimension L7 of the upper flow path 51 becomes smallest over the range from the reference position P1 to the inner end portion 25b in the circumferential direction.

[0049] The axial dimension L3 of the upper flow path 51 illustrated in Fig. 3 is equal to the internal axial dimension L5 of the upper housing wall portion 24. The axial dimension L3 of the upper flow path 51 grows smaller from the radial inner side toward the radial outer side. The entirety of the upper flow path 51 is opened downward.

[0050] The upstream end of the upper flow path 51 is, for example, a position where the radial dimension L7 of the upper flow path 51 illustrated in Fig. 4 becomes smallest. That is to say, the position of the upstream end of the upper flow path 51 is the position where the upstream end of the upper flow path 51 is identical in the circumferential position with the inner end portion 25b of the tongue portion 25.

[0051] The term "upper flow path" refers to, e.g., an annular flow path arranged above the lower flow path having one closed end. That is to say, in the present preferred embodiment, the radial outer portion of the axial gap between the impeller 30 and the motor cover portion 27 illustrated in Fig. 3 is included in the upper flow path 51.

[0052] As illustrated in Fig. 2, the entirety of the lower flow path 52 is arranged inside the lower housing 22. A lower wall portion inner circumferential surface 26a is the inner circumferential surface of the lower housing wall portion 26. A motor cover portion outer circumferential surface 27b is the outer circumferential surface of the motor cover portion 27. A closing portion side surface 29a is the side surface of the closing portion 29. That is to say, the lower housing 22 preferably includes the entirety of the lower flow path 52. The lower flow path 52 is a flow path surrounded by the upper surface of the lower housing bottom portion 28, the lower wall portion inner circumferential surface 26a, the motor cover portion outer circumferential surface 27b and the closing portion side surface 29a.

[0053] The housing inner circumferential surface 20a is the inner circumferential surface of the housing 20. The lower wall portion inner circumferential surface 26a is a portion of the housing inner circumferential surface 20a. That is to say, the lower flow path 52 is arranged between the motor cover portion outer circumferential surface 27b and the housing inner circumferential surface 20a.

[0054] As described above, the motor 40 is arranged radially inward of the motor cover portion 27. Thus, the motor 40 is arranged radially inward of the lower flow path 52. Accordingly, when the motor 40 is accommodated within the housing 20, it is possible to dispose the motor 40 in a radially overlapping relationship with the lower flow path 52. It is therefore possible to reduce the size of the centrifugal fan 10 in the axial direction.

[0055] As illustrated in Fig. 4, the lower flow path 52 extends along the lower wall portion inner circumferential surface 26a. That is to say, the lower flow path 52 extends along the housing inner circumferential surface 20a. As indicated by thick arrows in Fig. 4, 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 $+\theta_Z$ direction).

[0056] As illustrated in Figs. 2 and 4, a lower flow path terminal end 52b is one circumferential end ($+\theta_z$ side end) of the lower flow path 52 and is opened in the exhaust port 62. A lower flow path start end 52a is the other circumferential end ($-\theta_z$ side end) of the lower flow path 52 and is closed with respect to the exhaust port 62.

[0057] Thus, within the lower flow path 52, the air guided from the lower flow path start end 52a toward the lower flow path terminal end 52b does not flow from the vicinity of the exhaust port 62 toward the upstream side, namely the side of the lower flow path start end 52a. Accordingly., the entirety of the air flowing through the lower flow path 52 is discharged from the exhaust port 62. This makes it possible to reduce a loss of airflow.

[0058] If the air flowing toward the vicinity of the exhaust port 62 impinges against the tongue portion 25 (see Fig. 4), a turbulent flow of air is generated in the vicinity of the tongue portion 25. This poses a problem in that a noise is generated by the turbulent flow.

[0059] In contrast, according to the present preferred embodiment, the lower flow path start end 52a is closed with respect to the exhaust port 62. For that reason, a tongue portion is not provided within the lower flow path 52. Thus, the air flowing through the lower flow path 52 does not impinge against a tongue portion. This makes it possible to suppress generation of a turbulent flow of air. As a result, it is possible to suppress generation of a noise.

[0060] Referring to Fig. 4, a straight line passing through the center axis J and the center P2 of the exhaust port 62 is referred to as a "straight line C3". As used herein, the term "the vicinity of the exhaust port" includes a range in which the circumferential angle $\theta 2$ from the straight line C3 toward the rotation direction back side ($-\theta_z$ side) becomes 75 degrees or less. The center P2 of the exhaust port 62 is, for example, the center of the exhaust port 62 in the direction orthogonal to the center axis J and parallel to the exhaust port 62 (in the Y-axis direction).

[0061] As illustrated in Fig. 5, all the upper flow path 51 and the lower flow path 52 are connected to the exhaust port 62. The upper flow path 51 has an annular or substantially annular shape. Thus, there is a possibility that a part of the air guided from the interior of the upper flow path 51 toward the vicinity of the exhaust port 62 flows toward the upstream side of the upper flow path 51. Furthermore, there is a possibility that the air flowing toward the upstream side of the upper flow path 51 impinges against the tongue portion 25 and generates a noise.

[0062] In contrast, according to the present preferred embodiment, the axial dimension L2 of the portion of the exhaust port 62 connected to the lower flow path 52 is larger than the axial dimension L1 of the portion of the exhaust port 62 connected to the upper flow path 51. This makes it possible to reduce the flow rate of the air flowing through the upper flow path 51. It is therefore possible to restrain the air guided to the vicinity of the exhaust port 62 from flowing toward the upstream side of the upper flow path 51. Accordingly, it is possible to further reduce a loss of airflow and to further suppress generation of a noise.

[0063] 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.

[0064] As illustrated in Figs. 2 and 4, the lower flow path start end 52a is closed by the closing portion 29. That is to say, the circumferential position of the lower flow path start end 52a is the same as the circumferential position of the rotation direction front side ($+\theta_z$ side) end of the closing portion 29.

[0065] Preferably, the lower flow path start end 52a is arranged near the exhaust port 62 in the circumferential direction. If the lower flow path start end 52a is excessively spaced apart from the exhaust port 62 in the circumferential direction, the length of the lower flow path 52 becomes small. For that reason, the air discharged from the impeller 30 is not efficiently guided to the exhaust port 62. Thus, the blowing efficiency of the centrifugal fan 10 is reduced.

[0066] Referring to Fig. 4, when seen in a plan view, a straight line C2 is a straight line passing through the center axis J and meeting with the lower flow path start end 52a. A straight line C1 is a straight line passing through the center axis J and meeting with the tongue portion 25. The angle between the straight line C1 and the straight line C2 is assumed to be θ. The circumferential angle from the straight line C1 is assumed to be $\theta 1$. In this case, it is preferred that the angle θ is 75 degrees or less. That is to say, when seen in a plan view, the lower flow path start end 52a is located in the position where the circumferential angle $\theta 1$ from the straight line C1 becomes 75 degrees or less. The angle $\theta 1$ is a circumferential angle from the straight line C1 toward the rotation direction front side ($+\theta_z$ side).

[0067] By positioning the lower flow path start end 52a within this angular extent, it is possible to have the circumferential position of the lower flow path start end 52a lie near the exhaust port 62. It is therefore possible to suppress reduction of the blowing efficiency of the centrifugal fan 10.

[0068] The radial dimension L8 of the lower flow path 52 grows larger from the lower flow path start end 52a toward the lower flow path terminal end 52b. That is to say, the lower flow path 52 has a scroll or a substantially scroll shape. It is therefore possible to suppress generation of an air vortex within the lower flow path 52 and to smoothly discharge the air from the exhaust port 62. This makes it possible to further reduce a loss of airflow.

[0069] Furthermore, the upper housing wall portion 24 constitutes the radial outer inner circumferential surface of the upper flow path 51. The lower housing wall portion 26 constitutes the radial outer inner circumferential surface of the lower flow path 52. In the present preferred embodiment, the upper flow path 51 has a scroll shape or a substantially scroll shape. This makes it easy to interconnect the upper housing 21 having the upper flow path 51 and the lower housing 22 having the lower flow path 52. Specifically, the upper housing wall portion 24 and the lower housing wall portion 26 may be shaped to go away from the center axis J as they extend in the circumferential direction. This makes it easy to connect the upper housing wall portion 24 to the lower housing wall portion 26.

[0070] In the present preferred embodiment, the axial dimension L4 of the lower flow path 52 illustrated in Fig. 3 is uniform. The axial dimension L4 of the lower flow path 52 is equal to the internal axial dimension L6 of the lower housing 22. This makes it easy to increase the axial dimension L4 of the lower flow path 52.

[0071] The flow velocity of the air flowing through the flow path 50 tends to become larger in the position closer to the lower housing bottom portion 28. If the air having a large flow velocity is introduced from the vicinity of the exhaust port 62 toward the upstream side of the flow path 50, the loss of airflow grow larger. Moreover, the air having a large flow velocity impinges against the tongue portion 25. Thus, a turbulent flow is easily generated and a noise is increased. The upstream side of the flow path 50 is, for example, the upstream side of the upper flow path 51.

[0072] In contrast, according to the present preferred embodiment, it is possible to increase the axial dimension L4 of the lower flow path 52. This makes it possible to reliably prevent the air having a large flow velocity from being introduced toward the upstream side of the flow path 50. Accordingly, it is possible to further reduce the loss of airflow.

[0073] As illustrated in Figs. 2 and 4, the entirety of the lower flow path 52 is opened upward toward the upper flow path 51. For that reason, the air discharged radially outward from the impeller 30 is easily introduced from the upper flow path 51 into the lower flow path 52. This makes it easy to discharge the air from the exhaust port 62 via the lower flow path 52. Accordingly, it is possible to further reduce the loss of airflow.

[0074] As illustrated in Fig. 3, the axial dimension L4 of the lower flow path 52 is larger than the axial dimension L3 of the upper flow path 51. For that reason, the air discharged radially outward from the impeller 30 easily flows from the upper flow path 51 toward the lower flow path 52. This makes it possible to further reduce the loss of airflow.

[0075] The present disclosure is not limited to the configurations described above. 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.

[0076] One of the upper flow path 51 and the lower flow path 52 may not have a scroll shape. In this case, one of the upper flow path 51 and the lower flow path 52 may have, e.g., an annular or substantially annular shape. A portion of the lower flow path 52 may not be opened toward, e.g., the upper flow path 51.

[0077] The lower housing 22 may have a portion of the upper flow path 51 and the lower flow path 52. In this case, the axial dimension L4 of the lower flow path 52 in the vicinity of the exhaust port 62 may be one half or more of the internal axial dimension L6 of the lower housing 22. According to this configuration, it is possible to sufficiently increase the axial dimension L4 of the lower flow path 52 and to prevent the air having a large flow velocity from flowing from the vicinity of the exhaust port 62 toward the upstream side of the upper flow path 51.

[0078] In the configuration in which the lower housing 22 has a portion of the upper flow path 51 and the lower flow path 52, for example, the axial position of the upper surface of the closing portion 29 illustrated in Fig. 2 may be lower than the axial position of the upper surface of the motor cover portion 27. In this case, the internal portion of the lower housing 22 arranged higher than the closing portion 29 has an annular or substantially annular shape. Thus, within the lower housing 22, a portion of the upper flow path 51 is provided above the upper surface of the closing portion 29, and the lower flow path 52 is provided below the upper surface of the closing portion 29.

[0079] Fig. 6 is a side view illustrating a centrifugal fan 110 according to another example of one preferred embodiment. As illustrated in Fig. 6, the exhaust port 62 may be connected to only the lower flow path 52.

[0080] As illustrated in Fig. 6, the centrifugal fan 110 preferably includes a housing 120. The housing 120 preferably includes an intake port 61, a flow path 50 and an exhaust port 162. The housing 120 preferably includes an upper housing 121 and a lower housing 122.

[0081] The upper housing 121 preferably includes an upper housing cover portion 23 and an upper housing wall portion 124. The configuration of the upper housing wall portion 124 is the same as the configuration of the upper housing wall portion 24 illustrated in Fig. 5, except that the upper housing wall portion 124 does not have a portion of the exhaust port 62. In Fig. 6, the upper housing wall portion 124 has a shape obtained by closing a portion of the exhaust port 62 defined by the upper housing wall portion 24 illustrated in Fig. 5.

[0082] The lower housing 122 preferably includes a lower housing bottom portion 28, a lower housing wall portion 126 and a closing portion 29. While not shown in the drawings, the lower housing 122 includes a motor cover portion 27. The configuration of the lower housing wall portion 126 is the same as the configuration of the lower housing wall portion 26 illustrated in Fig. 5, except that the lower housing wall portion 126 has the entirety of the exhaust port 162.

[0083] In this configuration, the exhaust port 162 is connected to only the lower flow path 52. For that reason, the entirety of the air discharged from the exhaust port 162 is discharged from the lower flow path 52. It is therefore possible to enable the air existing within the upper flow path 51 to easily flow toward the lower flow path 52 while the air flows from the upstream side of the upper flow path 51 to the vicinity of the exhaust port 162. Accordingly, it is possible to further restrain the air from flowing from the vicinity of the exhaust port 162 toward the upstream side of the upper flow path 51. As a result, it is possible to further reduce the loss of airflow and to further suppress generation of a noise.

[0084] In this configuration, the axial dimension of the lower housing 122 may be made larger than the axial dimension of the lower housing 22 (see Fig. 5). By doing so, it is possible to set the opening area of the exhaust port 162 larger than the opening area of the intake port 61.

[0085] Other configurations of the exhaust port 162 are the same as the configurations of the exhaust port 62 illustrated in Fig. 5. Other configurations of the centrifugal fan 110 are the same as the configurations of the centrifugal fan 10 illustrated in Fig. 5.

[0086] Fig. 7 is a sectional view illustrating a portion of a centrifugal fan 210 according to a further example of one preferred embodiment. As illustrated in Fig. 7, the lower end portion of the lower flow path 52 may be a slant surface.

[0087] As illustrated in Fig. 7, the centrifugal fan 210 preferably includes a housing 220. The housing 220 preferably includes a flow path 250. The flow path 250 preferably includes an upper flow path 51 and a lower flow path 252. The housing 220 preferably includes an upper housing 21 and a lower housing 222. The lower housing 222 preferably includes a lower housing bottom portion 228, a lower housing wall portion 26 and a closing portion 29. While not shown in the drawings, the lower housing 222 preferably includes a motor cover portion 27.

[0088] A bottom surface 228a of the lower housing bottom portion 228 is a slant surface. The bottom surface 228a extends downward in the portion connected to the closing portion 29. That is to say, the bottom surface 228a extends downward from a lower flow path start end 252a toward the rotation direction front side ($+\theta_z$ side). In other words, the bottom surface 228a is a slant surface inclined with respect to the center axis J or a curved surface. In the portion connected to the closing portion 29, the axial position of the bottom surface 228a is preferably the same as the axial position of the upper surface of the closing portion 29. That is to say, at the lower flow path start end 252a, the axial position of the bottom surface 228a is preferably the same as the axial position of the upper surface of the closing portion 29.

[0089] The bottom surface 228a is the lower end portion of the lower flow path 252. The position of the lower end portion of the lower flow path 252 goes away from the upper flow path 51 as the lower flow path 252 extends from the lower flow path start end 252a toward the lower flow path terminal end (not illustrated). In other words, the distance between the lower end portion of the lower flow path 252 and the upper flow path 51 grows larger from the lower flow path start end 252a toward the lower flow path terminal end (not illustrated). Thus, the axial dimension of the lower flow path 252 becomes larger from the lower flow path start end 252a toward the lower flow path terminal end.

[0090] The air introduced from the intake port 61 into the impeller 30 is discharged from the circumferential entirety of the impeller 30 to the upper flow path 51. A part of the air introduced into the upper flow path 51 flows toward the lower flow path 52 while moving through the upper flow path 51 in the rotation direction of the impeller 30 (+ θ7, direction). For that reason, at the upstream side of the upper flow path 51 from which the air begins to flow, the amount of the air flowing from the upper flow path 51 toward the lower flow path 52 is small. Thus, for example, in the case where the axial dimension of the lower flow path 52 is uniform over the entirety of the lower flow path 52, the air tends to stay within the lower flow path 52 in the vicinity of the lower flow path start end 52a. Thus, an air vortex is easily generated. Accordingly, there is a possibility that the loss of airflow becomes larger.

[0091] In contrast, according to the aforementioned configuration, the lower end portion of the lower flow path 252 goes away from the upper flow path 51 as the lower flow path 252 extends from the lower flow path start end 252a toward the lower flow path terminal end. In other words, the distance between the lower end portion of the lower flow path 252 and the upper flow path 51 grows larger from the lower flow path start end 252a toward the lower flow path terminal end. Thus, it is possible to reduce the axial dimension of the lower flow path 252 at the upstream side where the amount of the air introduced from the upper flow path 51 into the lower flow path 252 is small. This makes it possible to restrain the air from staying within the lower flow path 252. Accordingly, it is possible to restrain the loss of airflow from becoming larger.

[0092] At the downstream side, the amount of the air introduced from the upper flow path 51 into the lower flow path 252 is large. According to this configuration, it is possible to increase the axial dimension of the lower flow path 252 at the downstream side. Thus, it is possible to enable the air to efficiently flow from the upper flow path 51 toward the lower flow path 252.

[0093] According to the configuration described above, as indicated by thick arrows in Fig. 7, it is possible to enable the air to smoothly flow along the bottom surface 228a which is a slant surface. This makes it possible to enable the air to smoothly flow through the flow path 250, thereby further suppressing generation of an air vortex within the flow path 250.

[0094] Preferably, the axial dimension of the lower flow path 252 in the vicinity of the exhaust port 62 is, for example, one half or more of the axial dimension of the lower housing 222. This makes it possible to further reduce the loss of airflow.

[0095] According to the configuration described above, it is possible to further improve the blowing efficiency of the centrifugal fan 210. Other configurations of the centrifugal fan 210 are the same as the configurations of the centrifugal fan 10 illustrated in Figs. 1 to 5.

[0096] Furthermore, the upper housing 21 may have 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.

[0097] The upper housing 21 may not include the tongue portion 25. The motor 40 may not be accommodated within the housing 20.

[0098] Features of the above-described preferred embodiments and the modifications thereof may be combined appropriately as long as no conflict arises.

[0099] 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. A centrifugal fan (10,110,210) comprising:

an impeller(30) arranged to rotate about a center axis(J) extending in an up-down direction;
a motor(40) arranged below the impeller(30) and arranged to rotate the impeller(30) about the center axis(J); and
a housing(20,120,220)) arranged to accommodate the impeller(30),
characterized in that the housing(20,120,220) includes an intake port(61) arranged above the impeller(30), an exhaust port(62,162) arranged radially outward of the impeller(30), an annular upper flow path(51) at least partially arranged between a housing inner circumferential surface(20a) as an inner circumferential surface of the housing(20,120,220) and the impeller(30) in a radial direction, and a lower flow path(52,252) arranged below the upper flow path and connected to the upper flow path(51),
the upper flow path(51) and the lower flow path(52,252) are arranged to define a flow path(50,250) having a scroll shape,
the lower flow path(52,252) extends along the housing inner circumferential surface(20a),

the lower flow path(52,252) has a lower flow path terminal end(52b) as one circumferential end thereof opened toward the exhaust port(62,162), and
the lower flow path(52,252) has a lower flow path start end(52a,252a) as the other circumferential end thereof closed with respect to the exhaust port(62,162)).

2. The fan(10,110,210) according to claim 1, wherein a radial dimension of the lower flow path(52,252)) grows larger from the lower flow path start end(52a,252a) toward the lower flow path terminal end(52b).

3. The fan(10,110,210) according to claim 1, wherein the housing includes an upper housing (21,121) having the intake port (61) and a lower housing(22,122,222) attached to a lower side of the upper housing(21,121).

4. The fan(10,110,210) according to claim 3, wherein the lower housing(22,122,222) includes a portion of the upper flow path(51) and the lower flow path(52,252), and
an axial dimension of the lower flow path(62,162) in the vicinity of the exhaust port is one half or more of an internal axial dimension of the lower housing(22,122,222).

5. The fan(10,110,210) according to any one of claim 3 and 4, wherein the upper housing(21,121) includes an upper housing cover portion(23) having the intake port(61) and overlapping with the impeller(30) in an axial direction and a upper housing wall portion(24) connected to a lower end of the upper housing cover portion(23) and arranged to surround the impeller(30) in a circumferential direction, and
the upper housing wall portion has an inner circumferential surface extending downward and radially outward.

6. The fan (10,110,210) according to any one of claims 1 to 5, wherein a radial dimension of the upper flow path(51) grows larger as the upper flow path(51) extends from a reference position existing between the exhaust port(62,162) and the lower flow path start end(52a,152a) toward the exhaust port(62,162) in a rotation direction of the impeller(30).

7. The fan(10,110,210) according to any one of claims 1 to 6, wherein the exhaust port(62,162) is connected to the upper flow path(51) and the lower flow path(52,252).

8. The fan(10,110,210) according to claim 7, wherein an axial dimension of a portion of the exhaust port(62,162) connected to the lower flow path(52,252) is larger than an axial dimension of a portion of the exhaust port(62,162) connected to the upper flow path(51).

9. The fan(10,110,210) according to any one of claims 1 to 6, wherein the exhaust port (62, 162) is connected to only the lower flow path(52,252).

10. The fan(10,110,210) according to any one of claims 1 to 9, wherein a position of a lower end portion of the lower flow path(52,252) goes away from the upper flow path(51) as the lower flow path(52,252) extends from the lower flow path start end (52a,152a)toward the lower flow path terminal end(52b).

11. The fan(10,110,210) according to any one of claims 1 to 10, wherein an axial dimension of the lower flow path(52,252) is larger than an axial dimension of the upper flow path(51).

12. The fan(10,110,210) according to any one of claims 1 to 11, wherein the entirety of the lower flow path(52,252) is opened toward the upper flow path(51).

13. The fan(10,110,210) according to any one of claims 1 to 12, wherein the housing(20,120,220) includes a tongue portion(25) arranged between the exhaust port(62,162) and the lower flow path start end(52a,152a) in a circumferential direction, and
when seen in a plan view, the lower flow path start end(52a,152a) is located in a position where a circumferential angle from a straight line passing through the center axis(J) and meeting with the tongue portion(25) becomes 75 degrees or less.

14. The fan(10,110,210) according to any one of claims 1 to 13, wherein the motor(40) is arranged radially inward of the lower flow path(52,252),
the housing(20,120,220) includes a motor cover portion(27) arranged to cover the motor(40), and
the lower flow path(52,252) is arranged between an outer circumferential surface of the motor cover portion(27) and the housing inner circumferential surface(20a).

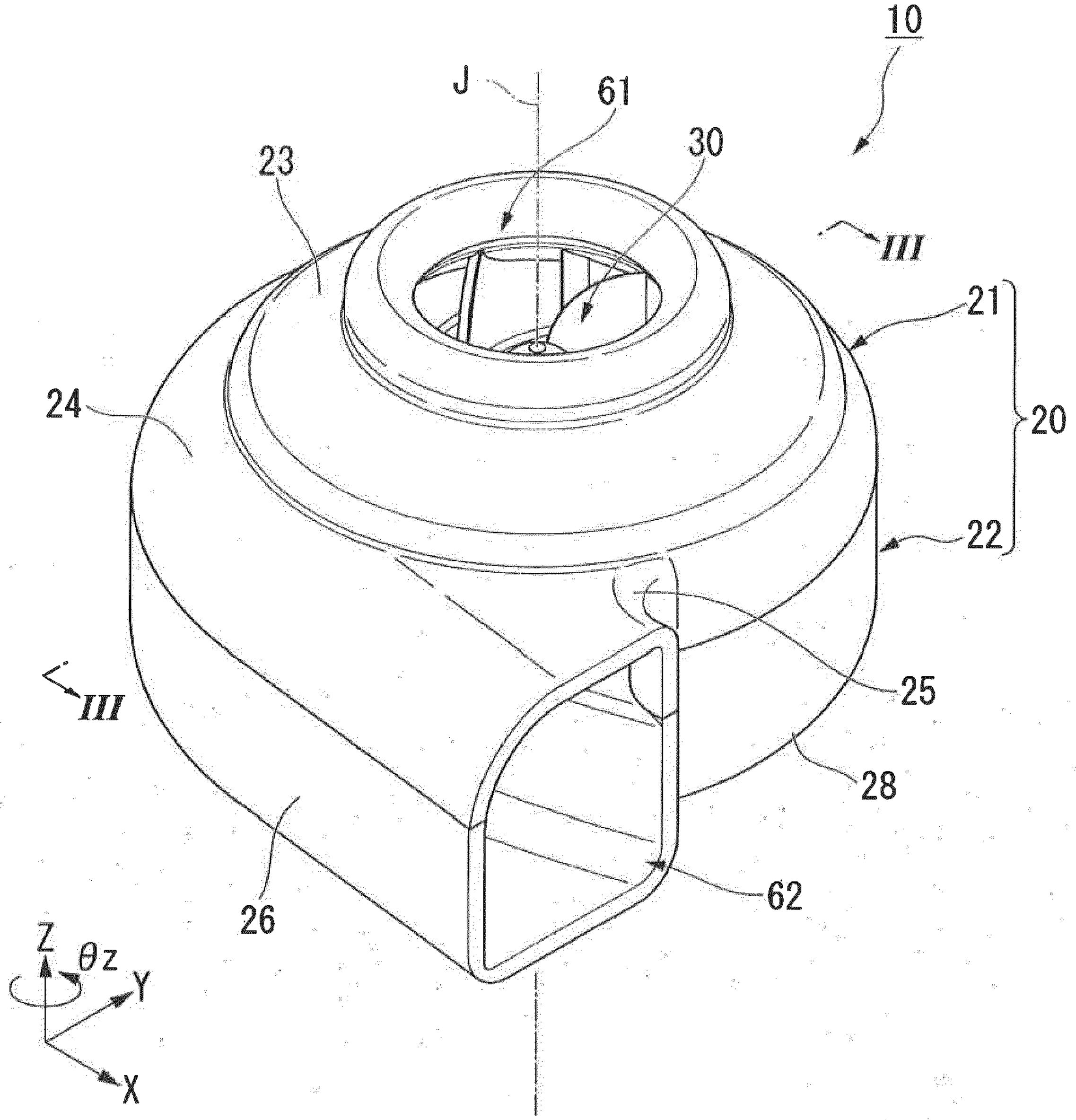


Fig.1

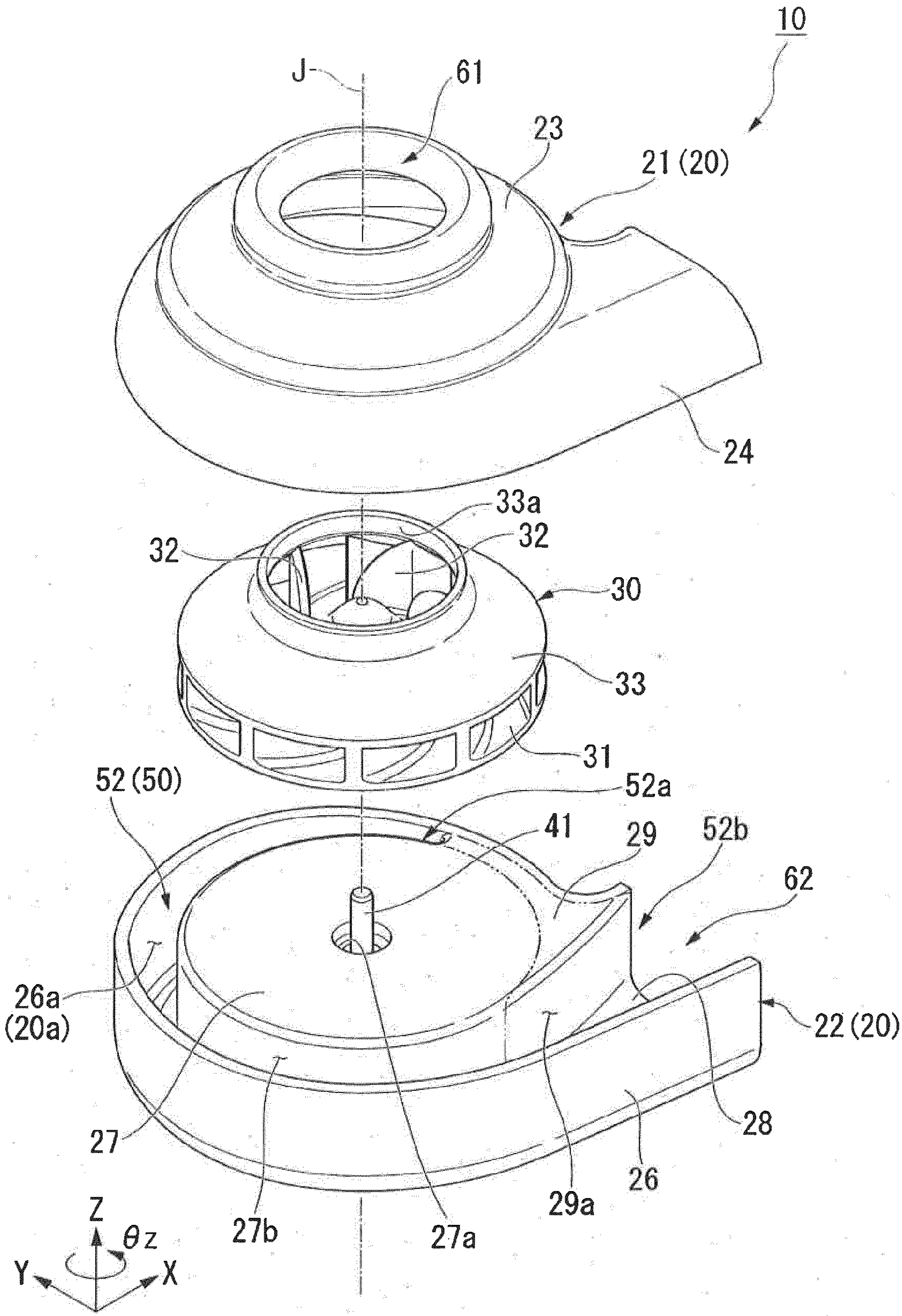
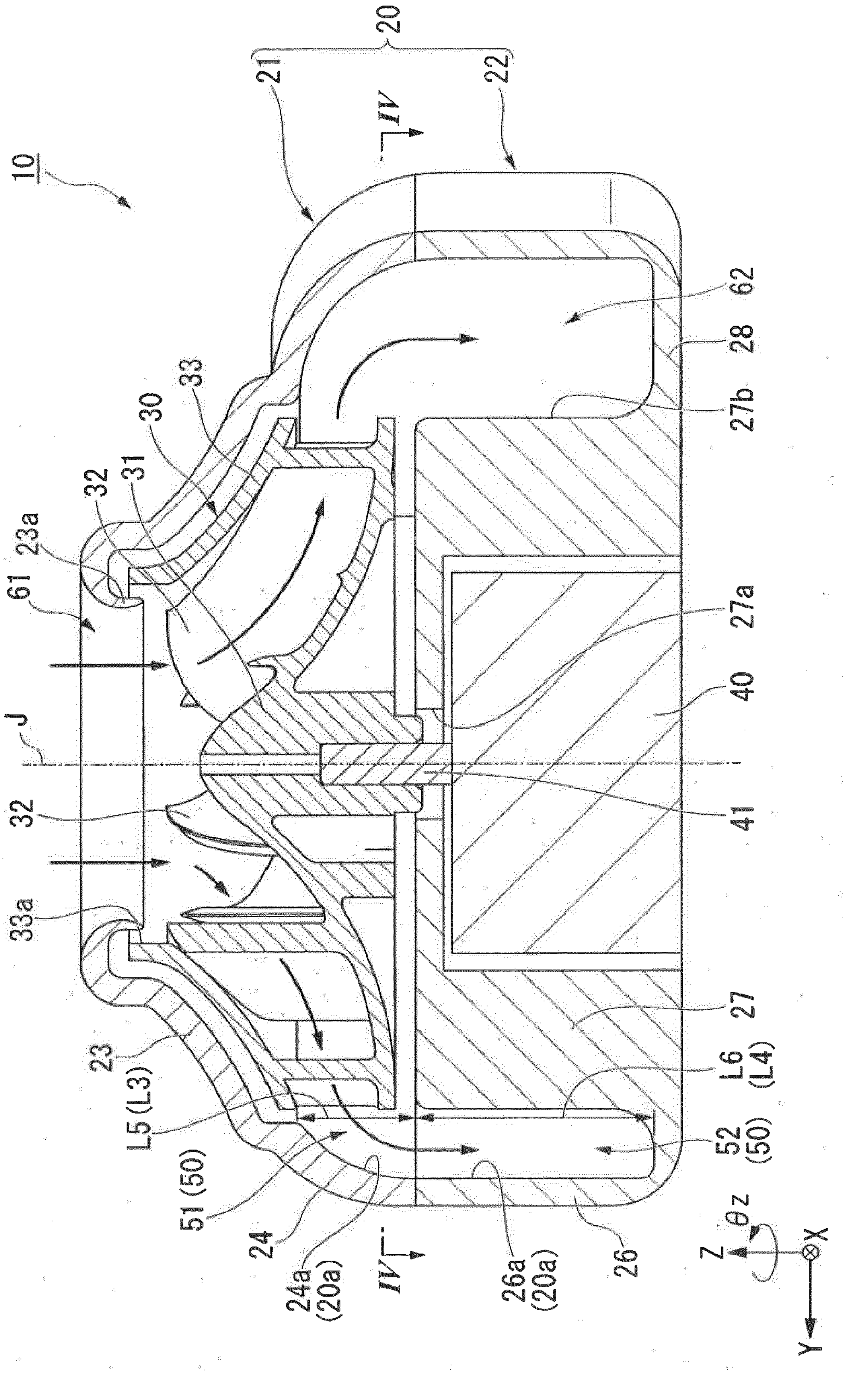

10
J
61
23
21(20)
24
33a
32
32
30
33
31
52(50)
52a
41
29
52b
62
26a
(20a)
22(20)
27
28
26
29a
27b
27a
Z
θz
Y
X

Fig.2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20
21
22
IV
62
28
27b
33
30
32
31
23a
61
J
27a
40
41
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33a
27
23
L5 (L3)
L6
(L4)
51 (50)
52
(50)
24
24a
(20a)
26a
(20a)
26
IV
Z
θz
X
Y

Fig.3

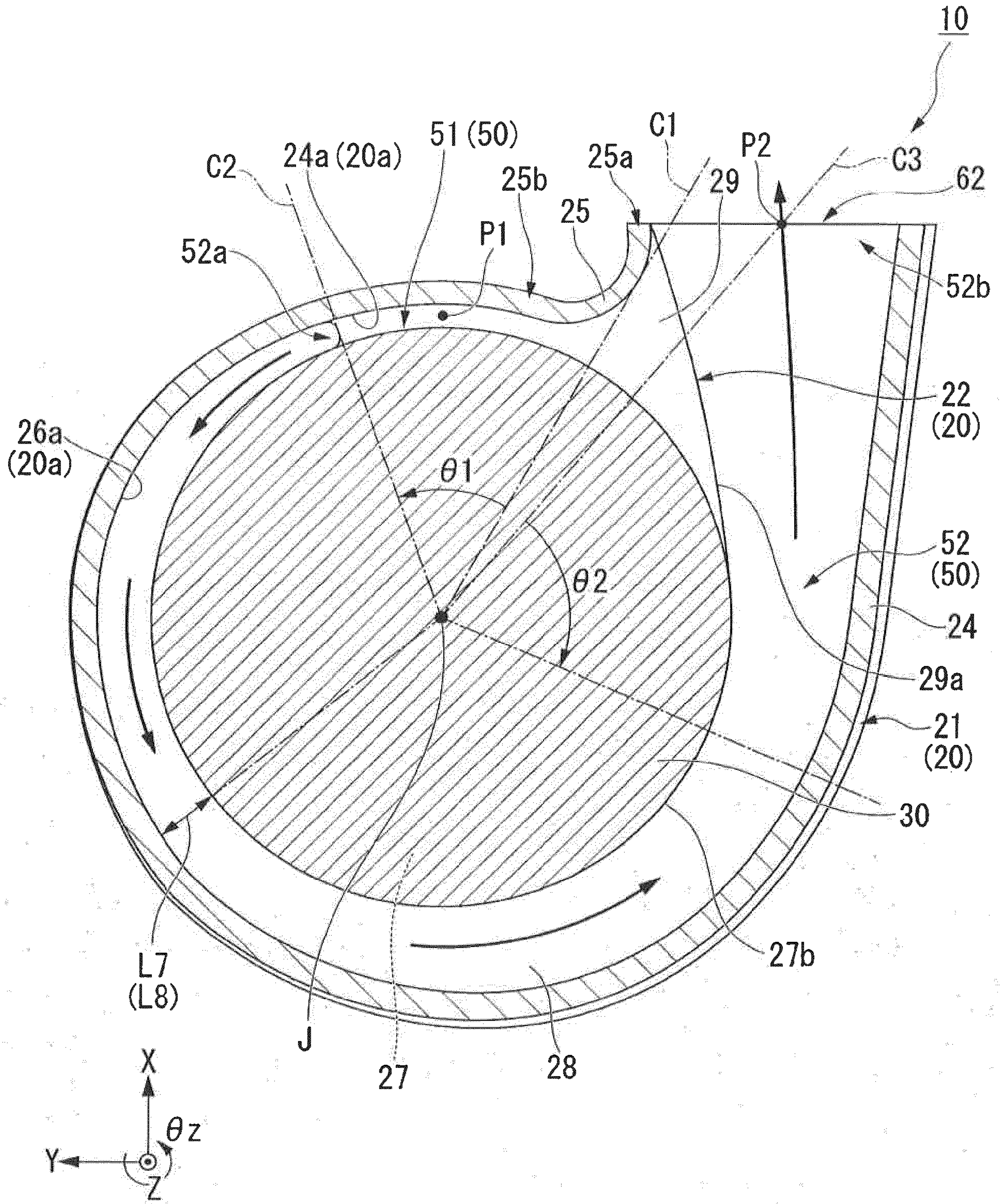
10
C1
P2
C3
62
C2
24a (20a)
51 (50)
25a
29
25b
25
P1
52a
52b
22
(20)
26a
(20a)
θ1
θ2
52
(50)
24
29a
21
(20)
30
L7
(L8)
27b
J
27
28
X
θz
Y
Z

Fig.4

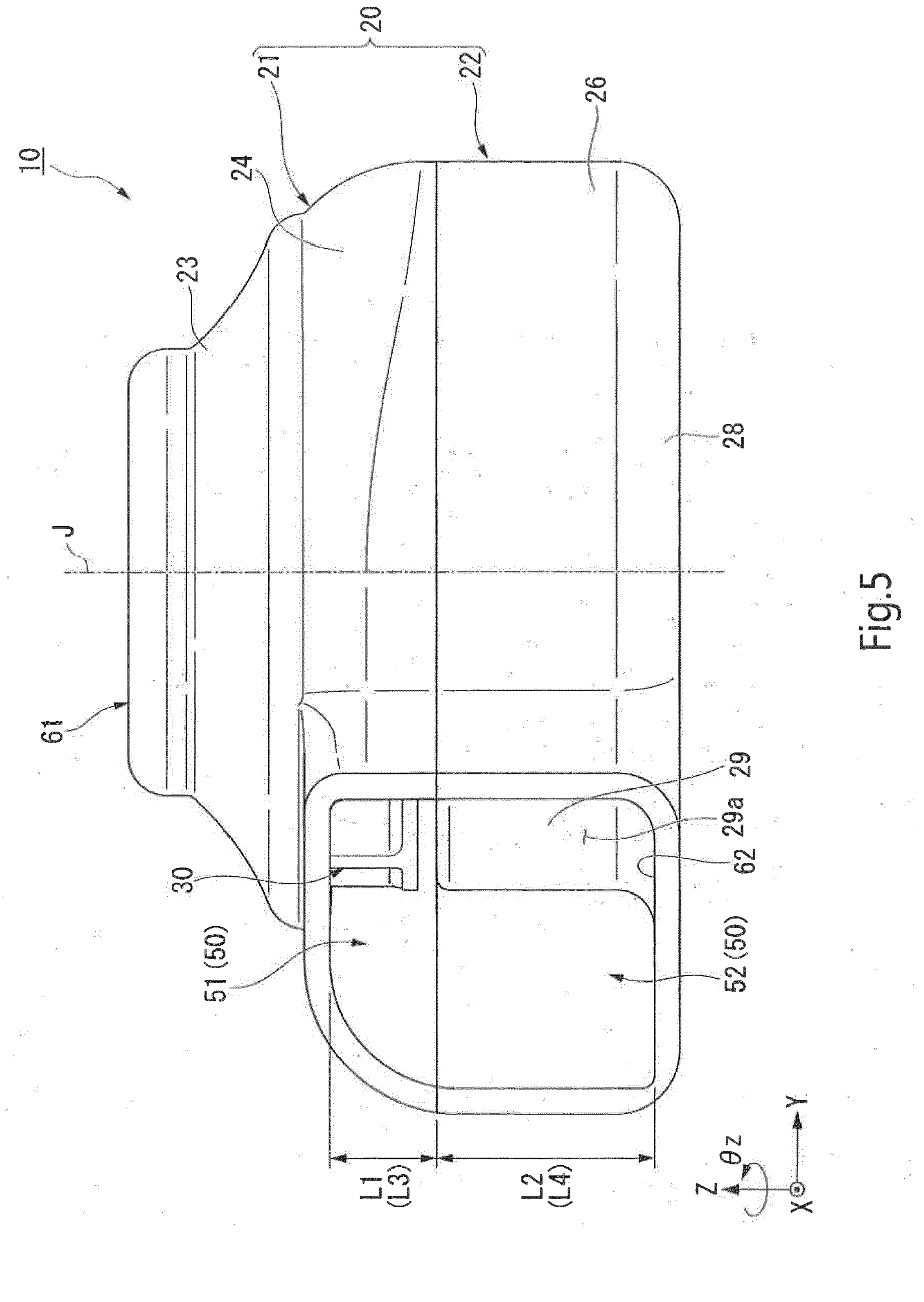

Fig.5

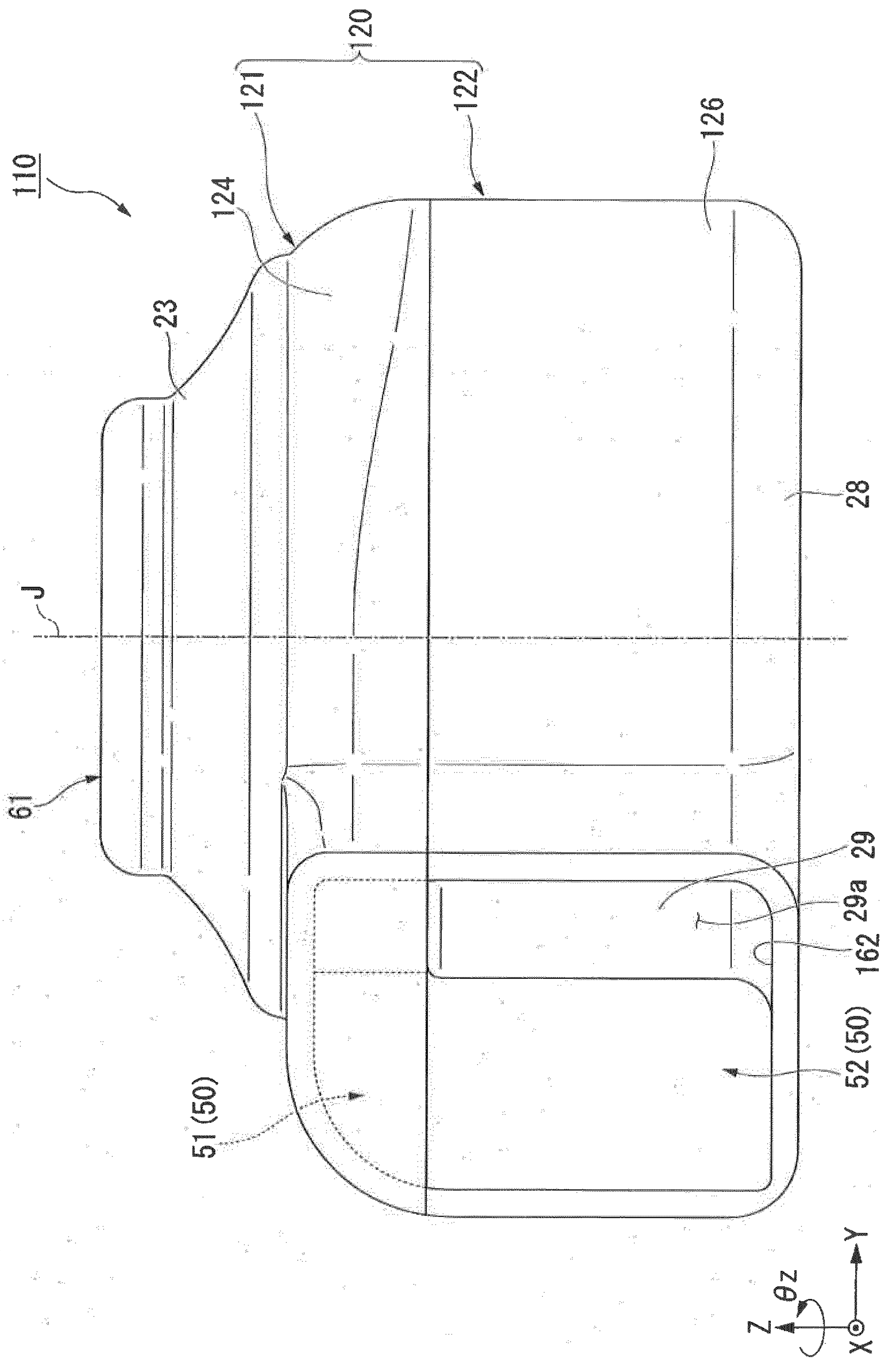

Fig.6

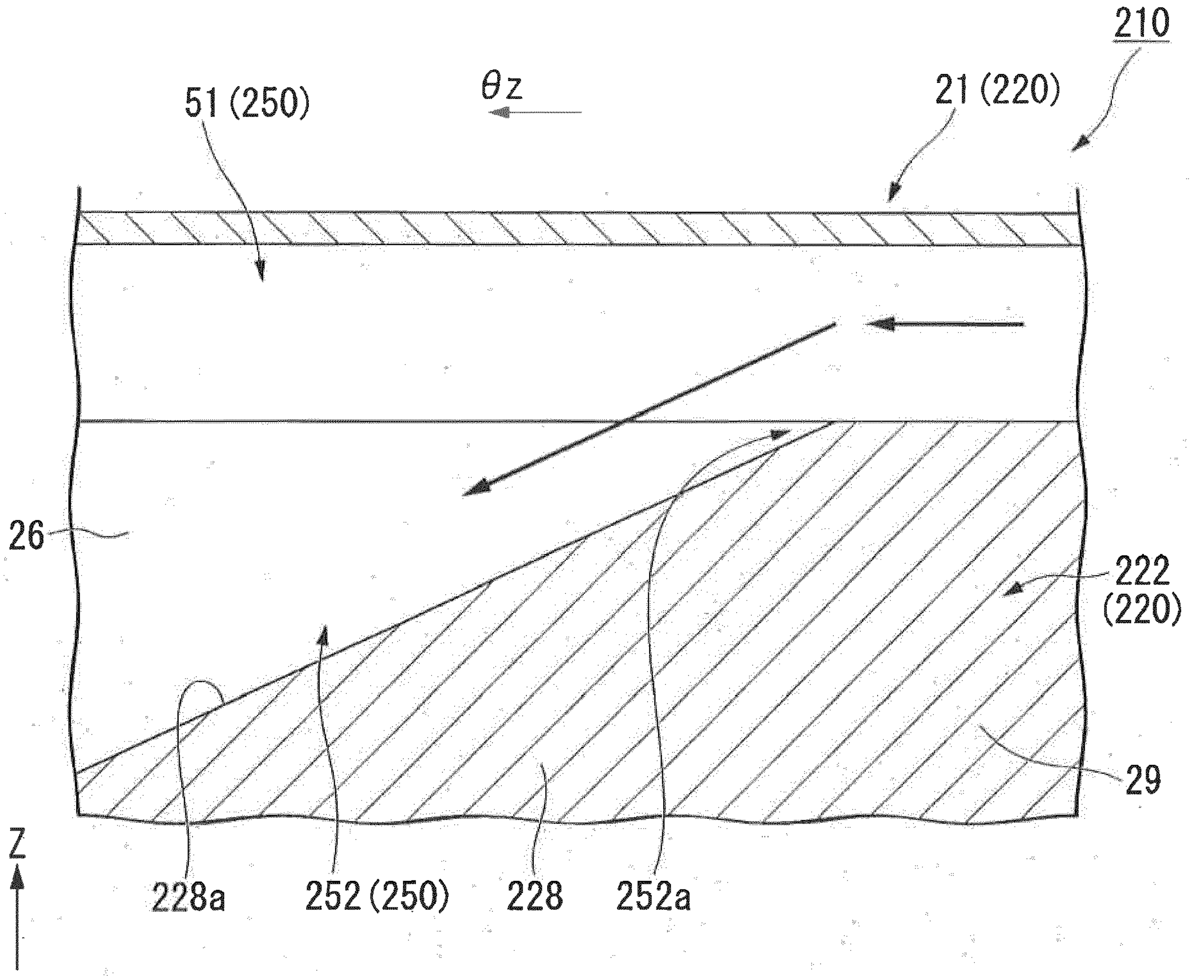

Fig.7

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EUROPEAN SEARCH REPORT

Application Number
EP 16 15 5020

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2010/014965 A1 (WATANABE CHIE [JP] ET AL) 21 January 2010 (2010-01-21) * paragraphs [0011] - [0025]; figures 1-6 *	1-8, 10-14	INV. F04D25/06 F04D29/42 F04D29/44
X	WO 99/64747 A1 (RESMED LTD [AU]; VIRR ALEXANDER [AU]; MAGIKAR ATUL SHRIKRISHNA [AU]) 16 December 1999 (1999-12-16) * abstract; figures 1,2,6 *	1-6, 9-11,13, 14	

TECHNICAL FIELDS SEARCHED (IPC)

F04D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	11 August 2016	de Martino, Marcello

CATEGORY OF CITED DOCUMENTS

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11-08-2016

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82