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(54) **BLOWER DEVICE AND CLEANER**

(57) A blower includes: an impeller rotatable about a central axis extending in a vertical direction; a motor that is positioned on a lower side of the impeller and rotates the impeller about the central axis; and a duct including an airflow passage in an inner space, a suction port through which a fluid flows in the inner space, and an air outlet through which the fluid is discharged from the inner space, the impeller being accommodated in the duct. The impeller includes: a plurality of blades arranged in a circumferential direction; a shroud that has an annular shape, connects upper portions of the plurality of blades, and includes an opening located opposite the suction port in an axial direction; and a base plate that connects lower portions of the plurality of blades and extends in a radial direction, the duct includes a cover covering at least a part of the blade and an upper portion of the shroud, an inner diameter of the shroud is equal to or larger than an outer diameter of the base plate, and the cover includes a first projection that projects axially downward from a bottom surface of the cover and is disposed on a radial inside of an inner circumferential surface of the shroud.

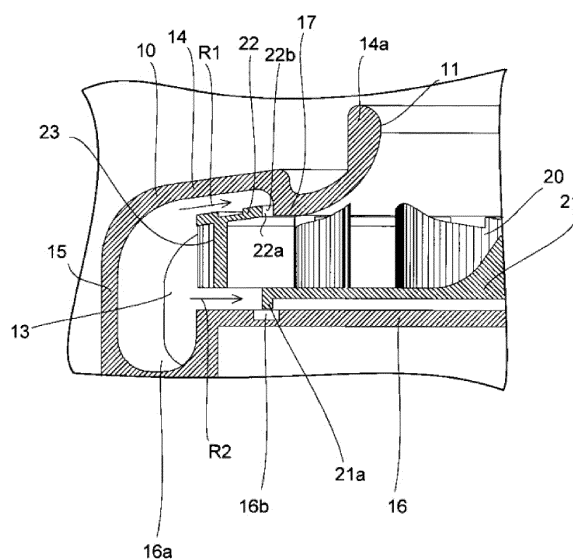


Fig. 7

Description**TECHNICAL FIELD**

[0001] The present invention relates to a blower and a vacuum cleaner.

BACKGROUND ART

[0002] For example, Japanese Laid-Open Patent Publication No. 2002-156128 discloses a conventional blower. A turbofan disclosed in Japanese Laid-open Patent Publication No. 2002-156128 includes a casing, a motor, a base plate, a blade, and a shroud. The base plate, the blade, and the shroud are accommodated in the casing. A plurality of blades are circumferentially arranged. The shroud connects ends of the plurality of blades. The plurality of blades are arranged on a circumference of the base plate.

[0003] The casing includes an intake-side end, a straight portion, and an inclined step. An inner diameter of an intake-side end is equal to or larger than an outer diameter of the base plate.

[0004] Air is discharged from a turbofan center portion to an outer circumferential direction. It is claimed that a noise of the turbofan is reduced because the shroud has the above characteristics.

CITATION LIST**PATENT LITERATURE**

[0005] Patent Literature 1: Japanese Laid-Open Patent Publication No. 2002-156128

SUMMARY OF INVENTION**TECHNICAL PROBLEM**

[0006] However, in the turbofan disclosed in Japanese Laid-Open Patent Publication No. 2002-156128, a part of the air discharged to a radial outside of the blade flows backward from a gap between the shroud and the casing to a radial inside. At this point, turbulence is generated in an airflow passage in the casing, or air resistance is generated by a flowing-back airflow to degrade blowing efficiency of the blower.

[0007] An object of the present invention is to provide a blower capable of preventing the generation of the turbulence in the airflow passage of a duct, and improving blowing efficiency by preventing the airflow from flowing backward to the radial inside. In addition, another object of the present invention is to provide a vacuum cleaner including the blower capable of improving the blowing efficiency.

SOLUTION TO PROBLEM

[0008] According to an exemplary embodiment of the present invention, a blower includes: an impeller rotatable about a central axis extending in a vertical direction; a motor that is positioned on a lower side of the impeller and rotates the impeller about the central axis; and a duct including an airflow passage in an inner space, a suction port through which a fluid flows in the inner space, and an air outlet through which the fluid is discharged from the inner space, the impeller being accommodated in the duct. The impeller includes: a plurality of blades arranged in a circumferential direction; a shroud that has an annular shape, connects upper portions of the plurality of blades, and includes an opening located opposite the suction port in an axial direction; and a base plate that connects lower portions of the plurality of blades and extends in a radial direction, the duct includes a cover covering at least a part of the blade and an upper portion of the shroud, an inner diameter of the shroud is equal to or larger than an outer diameter of the base plate, and the cover includes a first projection that projects axially downward from a bottom surface of the cover and is disposed on a radial inside of an inner circumferential surface of the shroud.

ADVANTAGEOUS EFFECTS OF INVENTION

[0009] An exemplary embodiment of the present invention can provide the blower capable of improving the blowing efficiency. Additionally, an exemplary embodiment of the present invention can provide the vacuum cleaner including the blower.

BRIEF DESCRIPTION OF DRAWINGS**[0010]**

Fig. 1 is a sectional view illustrating a cleaning robot according to an embodiment of the present invention.

Fig. 2 is a perspective view illustrating a blower of the embodiment of the present invention.

Fig. 3 is a longitudinal sectional view illustrating the blower of the embodiment of the present invention.

Fig. 4 is a perspective view illustrating an impeller of the embodiment of the present invention when the impeller is viewed from above.

Fig. 5 is a plan view illustrating the impeller of the embodiment of the present invention.

Fig. 6 is a side sectional view illustrating the impeller of the embodiment of the present invention.

Fig. 7 is an enlarged longitudinal sectional view illustrating a part of the blower of the embodiment of the present invention.

Fig. 8 is an enlarged longitudinal sectional view illustrating a part of the blower of the embodiment of the present invention.

Fig. 9 is an enlarged longitudinal sectional view illustrating a part of a blower according to a modification of the embodiment of the present invention.

Fig. 10 is an enlarged longitudinal sectional view illustrating a vicinity of a shroud in the blower of the modification of the embodiment of the present invention.

Fig. 11 is an enlarged longitudinal sectional view illustrating the vicinity of the shroud in the blower of the modification of the embodiment of the present invention.

DESCRIPTION OF EMBODIMENT

[0011] Hereinafter, an exemplary embodiment of the present invention will be described with reference to the drawings. Note that, in the following description, an extending direction of a central axis A of a blower 1 in Fig. 3 is simply referred to as an "axial direction", and a radial direction and a circumferential direction about the central axis A of the blower 1 are simply referred to as a "radial direction" and a "circumferential direction". Similarly, with respect to an impeller 20 in Figs. 4 to 6, directions matched with the axial direction, the radial direction, and the circumferential direction of the blower 1 in a state where the impeller 20 is incorporated in the blower 1 are simply referred to as the "axial direction", the "radial direction", and the "circumferential direction". Note that, a vertical direction is simply used for the description, but does not limit an actual positional relationship and a direction.

<1. Configuration of vacuum cleaner>

[0012] A blower according to an exemplary embodiment of the present invention will be described. Fig. 1 is a sectional view of a cleaning robot 100 according to an exemplary embodiment of the present invention. As illustrated in Fig. 1, the blower 1 is mounted on the cleaning robot (vacuum cleaner) 100 to serve as suction means.

[0013] The cleaning robot 100 sucks air containing dust on a floor surface F while self-propelling the floor surface F at an installed place, and exhausts the air from which the dust is removed, thereby cleaning the floor surface F. The cleaning robot 100 includes a disc-shaped chassis 101 and includes, in the disc-shaped chassis 101, a suction passage 104, a dust container 105, a filter 106, an exhaust passage 107, and the blower 1. A driving wheel 109 and a front wheels 110 are provided on a bottom surface of the chassis 101.

[0014] The chassis 101 includes an inlet port 103 in a center of the bottom surface and an exhaust port 108 at the side surface. By driving the blower 1, the cleaning robot 100 sucks the air including the dust on the floor surface F from the inlet port 103 while self-propelling. The air containing the dust sucked into the chassis 101 from the inlet port 103 passes through the suction passage 104, and flows into the dust container 105. The

airflow flowing in the dust container 105 passes through the filter 106, and is sucked in the blower 1 through the exhaust passage 107. The air sucked by the blower 1 is exhausted diagonally upward rearward from the exhaust port 108. At this point, the dust contained in the airflow in the dust container 105 is caught by the filter 106, and dust D is accumulated in the dust container 105.

<2. Configuration of blower>

[0015] Fig. 2 is a perspective view illustrating the blower 1 of the embodiment of the present invention. In addition, Fig. 3 is a longitudinal sectional view illustrating the blower 1 of the embodiment of the present invention. As illustrated in Figs. 2 and 3, the blower 1 includes the impeller 20, a motor 30, and a duct 10. The impeller 20 is accommodated in an internal space of the duct 10. The motor 30 is located below the impeller 20, and rotates the impeller 20 about the central axis A.

[0016] The impeller 20 is connected to a shaft (not illustrated) extending in an axial direction from the motor 30, and supported so as to be rotatable about the central axis A. That is, the impeller 20 is rotatable about the central axis A extending in the vertical direction. A control board 40 is disposed on a lower side of the motor 30 in the axial direction, and controls the motor 30.

<3. Configuration of duct>

[0017] The duct 10 includes an airflow passage 13 in the inner space thereof, a suction port 11 through which a fluid flows in the inner space, and an air outlet 12 through which the fluid is discharged from the inner space. The impeller 20 is accommodated in the duct 10.

The duct 10 is constructed with a cover 14, a circumferential wall 15, and a motor housing 16, and the airflow passage 13 is formed in the internal space surrounded by these components. More particularly, the duct 10 includes the cover 14 covering at least a part of a blade 23 and an upper portion of a shroud 22. The cover 14 covers the upper portion of the impeller 20, and is formed into an annular shape as seen in axial plan view. An outer diameter of the cover 14 is larger than an outer diameter of the impeller 20. Note that, in the embodiment, the duct 10 is constructed with a member including the cover 14 and a part of the circumferential wall 15 and a member including a part of the circumferential wall 15 and the motor housing 16. Consequently, the duct 10 can be constructed at low cost because the two members can be molded as separate resin members.

[0018] A cylindrical portion 14a extending upward in the axial direction is provided at the central portion of the cover 14. The circular suction port 11 is formed in the cylindrical portion 14a as seen in axial plan view. The suction port 11 is disposed opposite an opening 22a of the shroud 22 (to be described later) in the axial direction, and gas (fluid) flows into the internal space of the duct 10 from the outside through the suction port 11.

[0019] The circumferential wall 15 covers the impeller 20 from the lateral side, extends downward in the axial direction from an outer circumference of the cover 14, and is formed into a cylindrical shape. In addition, a nozzle 15a extending to the radial outside is provided in the circumferential wall 15, and the air outlet 12 through which the gas (fluid) is discharged from the internal space of the duct 10 is formed in the nozzle 15a.

[0020] The motor housing 16 is located on a lower side in the axial direction of the impeller 20. More particularly, the blower 1 further includes the motor housing 16 located below a base plate 21 (to be described later). A top surface of the motor housing 16 spreads radially, extends to the lower end of the circumferential wall 15, and is connected to the circumferential wall 15. In addition, the circumferential surface of the motor housing 16 is formed in a cylindrical shape extending axially downward from the outer circumference of the circumferential wall 15, and the motor 30 and the control board 40 are accommodated in the motor housing 16.

[0021] An annular recess 16a recessed downward on the radial outside of the impeller 20 is formed on the top surface of the motor housing 16. The airflow passage 13 including an annular region on the radial outside of the impeller 20 is formed between the suction port 11 and the air outlet 12 by the circumferential wall 15, the recess 16a, and the cover 14.

<4. Configuration of impeller>

[0022] Fig. 4 is a perspective view illustrating the impeller 20 of the embodiment of the present invention when the impeller 20 is viewed from above, and Fig. 5 is a plan view illustrating the impeller 20 of the embodiment of the present invention. In addition, Fig. 6 is a side sectional view illustrating the impeller 20 of the embodiment of the present invention.

[0023] As illustrated in Figs. 4 to 6, the impeller 20 includes a plurality of blades 23, the annular shroud 22, and the base plate 21. The blade 23 is interposed between the base plate 21 and the shroud 22. The plurality of blades 23 are circumferentially arranged.

[0024] The shroud 22 has an annular shape connecting the upper portions of the plurality of blades 23, and has the opening 22a located opposite the suction port 11 in the axial direction. More particularly, the shroud 22 is formed into the annular shape by connecting upper portions of the plurality of blades 23, and the opening 22a for taking the gas is formed in a central portion of the shroud 22. The opening 22a has a circular shape as seen in axial plan view.

[0025] The base plate 21 connects the lower portions of the plurality of blades 23, and spreads in the radial direction. The base plate 21 is formed into a disc shape. The base plate 21 has a base plate protrusion 21a protruding downward from the bottom surface of the base plate 21. More particularly, the base plate protrusion 21a protrudes from the radial outer edge of the bottom surface

of the base plate 21, and is formed into the annular shape (see Fig. 6).

[0026] The blade 23 includes a first blade 23a and a second blade 23b, which have different radial lengths, and the first blades 23a and the second blades 23b are alternately arranged in the circumferential direction. The first blade 23a and the second blade 23b are a plate-shaped member, which rises in the axial direction and extends from the radial inside to the outside. The radially inner end of the first blade 23a is located on the radial inside of the radially inner end of the second blade 23b, and the first blade 23a is longer than the second blade 23b in the radial direction.

[0027] In addition, in the case that the impeller 20 is rotated counterclockwise as seen in axial plan view from above, the first blade 23a and the second blade 23b are curved such that the radially outer end is inclined on a rear side in the rotational direction with respect to the radial inner end, and such that the rear side in the rotation direction is recessed (see Fig. 5). In addition, a distance between the first blade 23a and the second blade 23b increases toward the radial outside.

[0028] In addition, the radially outer ends 24a, 24b of the first blade 23a and the second blade 23b extend to the radial outside of the outer circumference of the base plate 21 (see Fig. 4). That is, the radially outer ends 24a, 24b of the blade 23 extend to the radial outside of the outer circumference of the base plate 21. In addition, the radially inner ends of the first blade 23a and the second blade 23b extend to the radial inside of the suction port 11 (see Fig. 3). That is, the radially inner end of the blade 23 extends to the radial inside of the suction port 11. Consequently, the blade 23 can be formed large in the radial direction, and an amount of air generated by the rotation of the impeller 20 can be increased. The outer circumference of the base plate 21 may have another shape, for example, a part of a member from a circumferential outer edge may be notched radially inward.

[0029] The upper ends of the first blade 23a and the second blade 23b have protrusions 25a, 25b that protrude upward in the axial direction (see Fig. 6). The protrusions 25a, 25b are located on the radial inside of the opening 22a while aligned on an identical circle, and protrude upward from the upper end of the shroud 22.

[0030] In addition, the upper ends of the first blade 23a and the second blade 23b include inclined surfaces 26a, 26b extending downward from the protrusions 25a, 25b toward the radial inside and inclined surfaces 27a, 27b extending downward from the protrusions 25a, 25b toward the radial outside, respectively.

[0031] In addition, in the inclined surfaces 27a, 27b, protrusions 28a, 28b protruding axially upward are formed on the radial outside of the opening 22a of the shroud 22, and the upper ends of the protrusions 28a, 28b extend to the bottom surface of the shroud 22 and is connected to the shroud 22. That is, the blade 23 includes the protrusions 28a, 28b protruding axially upward on the radial outside of a first projection 17 (see Fig. 7)

(to be described later). Consequently, the blade 23 can axially be formed larger on the radial outside of the opening 22a, and the amount of air generated by the rotation of the impeller 20 can be increased.

[0032] The base plate 21, the shroud 22, and the blade 23 are formed by an identical resin molding product made of an identical material, and an inner diameter D2 of the shroud 22 is formed equal to an outer diameter D1 of the base plate 21 (see Fig. 6).

[0033] Consequently, in forming the impeller 20 straddling the base plate 21 and the shroud 22, upper and lower dies can be pulled out onto the upper side and the lower side in the axial direction, respectively, while mutual interference between the upper and lower dies is prevented. Thus, the impeller 20 can integrally be molded using the die, and mass productivity of the impeller 20 can be improved. Note that, even in the case that the inner diameter D2 of the shroud 22 is formed larger than the outer diameter D1 of the base plate 21, the impeller 20 can integrally be molded using the die.

<5. Relationship between duct and impeller>

[0034] Figs. 7 and 8 are enlarged longitudinal sectional views illustrating a part of the blower 1 of the embodiment of the present invention, and illustrate a relationship between the duct 10 and the impeller 20. In addition, as illustrated in Fig. 7, the shroud 22 includes an inner circumferential surface 22b constituting the opening 22a. The cover 14 includes the first projection 17, which projects axially downward from the bottom surface of the cover 14 and is disposed on the radial inside of the inner circumferential surface 22b of the shroud 22. The outer circumferential surface of the first projection 17 is radially opposed to the inner circumferential surface 22b of the shroud 22. Note that, the outer circumferential surface of the first projection 17 and the inner circumferential surface 22b of the shroud 22 are not necessarily opposed to each other on the circumferential surface. That is, the outer surface of the first projection 17 may radially be opposed to the inner surface 22b of the shroud 22. Note that, the shapes of the outer surface of the first projection 17 and the inner surface 22b of the shroud 22 are not limited to the circumferential surface. For example, in the outer surface of the first projection 17 and the inner surface 22b of the shroud 22, irregularities may be formed on a part of the circumferential surface.

[0035] The first projection 17 blocks the flow path of the air R1 that flows backward onto the radial inside from the gap between the shroud 22 and the cover 14. Consequently, a part of the air blown out onto the radial outside of the impeller 20 can be prevented from flowing backward from the gap between the shroud 22 and the cover 14. Thus, the degradation of the blowing efficiency can be prevented by the generation of the turbulence or the air resistance of the flowing-back air in the airflow passage 13. In addition, the radial gap between the outer circumferential surface of the first projection 17 and the

inner circumferential surface 22b of the shroud 22 is narrower than the axial gap between the shroud 22 and the cover 14. Thus, a flow of air R1 flowing backward to the radial inside from the gap between the shroud 22 and the cover 14 can be blocked.

[0036] In addition, the lower end of the radially outer end of the first projection 17 extends to the position where the height in the axial direction is substantially equal to or lower than the height at the lower end of the inner circumferential surface 22b of the shroud 22. Consequently, the air circulating toward the radial outside along the bottom surface of the cover 14 is smoothly guided from the lower end of the first projection 17 to the lower end of the inner circumferential surface 22b of the shroud 22, and blown out to the radial outside of the impeller 20 through the bottom surface of the shroud 22. This enables the further improvement of the blowing efficiency of the blower 1. In other words, a strike of the circulating air on the inner circumferential surface 22b of the shroud 22 is reduced, so that the air can efficiently be blown out onto the radial outside.

[0037] Note that, as illustrated in Fig. 8, the protrusions 28a, 28b (not illustrated in Fig. 7, see Fig. 4) of the first blade 23a and the second blade 23b are connected to the bottom surface of the shroud 22 on the radial outside with respect to the first projection 17, and the first projection 17 is vertically opposed to the inclined surfaces 27a, 27b. Consequently, assuming that a region of the first blade 23a and the second blade 23b located on the radial outside of the first projection 17 is a blade first region L1, and that a region vertically opposed to the first projection 17 is a blade second region L2, the upper end of the blade first region L1 is located above the upper end at the radially outer end of the blade second region L2 in the upper ends of the first blade 23a and the second blade 23b.

[0038] That is, the blade 23 includes the blade first region L1 located on the radial outside of the first projection 17 and the blade second region L2 vertically opposed to the first projection 17, and the upper end of the blade first region L1 is located above the upper end at the radially outer end of the blade second region L2. Thus, even if the impeller 20 vibrates vertically during the rotation, the first blade 23a and the second blade 23b can be prevented from contacting with the first projection 17.

[0039] In addition, referring to Fig. 7, an annular groove 16b, which is axially opposed to the base plate protrusion 21a protruding from the outer circumference of the bottom surface of the base plate 21, is provided on the top surface of the motor housing 16. A radial width of the groove 16b is larger than that of the base plate protrusion 21a. The axial gap between the bottom surface of the base plate 21 and the top surface of the motor housing 16 can be narrowed by disposing the base plate protrusion 21a close to the groove 16b.

[0040] Consequently, a part of the air blown out onto the radial outside of the impeller 20 can be prevented from flowing backward from the gap between the bottom

surface of the base plate 21 and the top surface of the motor housing 16, and the degradation of the blowing efficiency due to the generation of the turbulence or the air resistance of the flowing-back air in the airflow passage 13 can be prevented.

[0041] In addition, the axial gap between the lower end of the base plate protrusion 21a and the top surface of the motor housing 16 is narrower than the axial gap between the bottom surface of the base plate 21 and the top surface of the motor housing 16. Thus, a part of the air blown out onto the radial outside of the impeller 20 can be prevented from flowing in the gap between the bottom surface of the base plate 21 and the top surface of the motor housing 16 to flow backward onto the radial inside.

[0042] Note that, the base plate protrusion 21a may be formed at a position other than the radially outer edge of the base plate 21. For example, on the bottom surface of the base plate 21, the base plate protrusion 21a may be formed at a position inside the radially outer edge. Even in this case, a part of the air blown out onto the radial outside of the impeller 20 can be prevented from flowing in the gap between the bottom surface of the base plate 21 and the top surface of the motor housing 16 as air R2 to flow backward onto the radial inside.

<6. Drive of blower>

[0043] When the motor 30 is driven, the impeller 20 rotates about the central axis A. Consequently, the air is taken in the duct 10 through the suction port 11. The air taken in the duct 10 is accelerated toward the radial outside by the impeller 20. The air accelerated toward the radial outside passes between the shroud 22 and the base plate 21, and is blown out to the radial outside of the impeller 20. The air blown out to the radial outside of the impeller 20 is discharged from the air outlet 12 to the outside of the duct 10 through the airflow passage 13 formed in the circumferential direction in the duct 10.

<7. Modification>

[0044] Fig. 9 is an enlarged longitudinal sectional view illustrating a part of a blower 1 according to a modification of the exemplary embodiment of the present invention. The second projection 18 projecting downward in the axial direction may be provided on the bottom surface of the cover 14. The inner circumferential surface of the second projection 18 is radially opposed to the outer circumferential surface of the shroud 22.

[0045] The second projection 18 blocks the airflow flowing in a gap between the shroud 22 and the cover 14. Consequently, a part of the air blown out onto the radial outside of the impeller 20 can be prevented from flowing in the gap between the shroud 22 and the cover 14, and the generation of the turbulence or the backward flow in the airflow passage 13 can be prevented. Note that, although both of the first projection 17 and the sec-

ond projection 18 may be provided, the degradation of the blowing efficiency due to the generation of the turbulence or the air resistance of flowing-back air in the airflow passage 13 can be prevented even if only one of the first projection 17 and the second projection 18 is provided. In addition, the radial gap between the inner circumferential surface of the second projection 18 and the outer circumferential surface of the shroud 22 is narrower than the axial gap between the shroud 22 and the cover 14. Thus, the flow of air flowing backward to the radial inside from the gap between the shroud 22 and the cover 14 can be blocked.

[0046] Fig. 10 is an enlarged longitudinal sectional view illustrating a vicinity of the shroud 22 in the blower 1 of the modification of the exemplary embodiment of the present invention. The inner circumferential surface 22b of the shroud 22 includes a first inner circumferential surface 221 and a second inner circumferential surface 222, and the first inner circumferential surface 221 is disposed axially above the second inner circumferential surface 222. The first inner circumferential surface 221 is formed in parallel to the axial direction, and the second inner circumferential surface 222 is inclined with respect to the axial direction so as to be away from the central axis A toward the lower side in axial direction, and projectively curved toward the radial inside. In addition, the first inner circumferential surface 221 and the second inner circumferential surface 222 are connected to each other while a curved portion 223 projectively curved toward the radial inside is interposed therebetween. That is, the lower end of the first inner circumferential surface 221 and the upper end of the second inner circumferential surface 222 are smoothly connected to each other.

[0047] That is, the radial gap between the outer circumferential surface of the first projection 17 and the inner circumferential surface 22b of the shroud 22 is formed wider in the axial lower side than the axial upper side.

[0048] Consequently, even if the impeller 20 vibrates vertically during the rotation and even if the lower end of the inner circumferential surface 22b of the shroud 22 is axially lowered lower than the lower end of the radially outer end of the first projection 17, the air circulating toward the radial outside along the bottom surface of the cover 14 is smoothly guided from the lower end of the first projection 17 onto the radial outside along the second inner circumferential surface 222. Thus, reduction of the blowing efficiency of the blower 1 can be prevented even if the impeller 20 vibrates vertically during the rotation.

[0049] The first inner circumferential surface 221 and the second inner circumferential surface 222 are connected to each other while the curved portion 223 projectively curved toward the radial inside is interposed therebetween, and the second inner circumferential surface 222 is projectively curved toward the radial inside, which allows the air circulating along the inner circumferential surface 22b of the shroud 22 to be smoothly guided onto the radial outside. Consequently, the reduction in the blowing efficiency of the blower 1 can further

be prevented. As used herein, the expression "connected to each other with the curved portion 223 interposed therebetween" means that the lower end of the first inner circumferential surface 221 and the upper end of the second inner circumferential surface 222 are smoothly connected to each other.

[0050] In addition, when the inner circumferential surface 22b of the shroud 22 includes the first inner circumferential surface 221 formed in parallel to the axial direction, a vertical thickness of the shroud 22 is secured by a predetermined width from the upper end of the inner circumferential surface 22b, so that the reduction in rigidity of the shroud 22 can be prevented.

[0051] Note that, Fig. 11 is an enlarged longitudinal sectional view illustrating the vicinity of the shroud 22 of the blower 1 according to the modification of the exemplary embodiment of the present invention. As illustrated in Fig. 11, the plane parallel to the axial direction may be omitted in the inner circumferential surface 22b of the shroud 22. In this case, the entire inner circumferential surface 22b is constructed with the second inner circumferential surface 222. With this configuration, even if the impeller 20 vibrates vertically during the rotation, the reduction of the blowing efficiency of the blower 1 can further be prevented.

[0052] Note that, in Figs. 10 and 11, the second inner circumferential surface 222 is projectively curved toward the radial inside. Alternatively, the second inner circumferential surface 222 may be formed by a conical surface that is not curved but inclined with respect to the axial direction so as to be away from the central axis A toward the lower side in axial direction.

[0053] According to the embodiment, the inner diameter of the shroud 22 is formed equal to or larger than the outer diameter of the base plate 21, so that the upper and lower dies can be pulled out onto the upper side and the lower side in the axial direction, respectively, while the mutual interference between the upper and lower dies is prevented. Thus, the impeller 20 can integrally be molded using the die, and the mass productivity of the impeller 20 can be improved.

[0054] In addition, the first projection 17 projects axially downward from the bottom surface of the cover 14, and the first projection 17 is disposed on the radial inside of the inner circumferential surface of the shroud 22. This enables the first projection 17 to block the passage of the air flowing backward onto the radial inside due to the air flowing in the gap between the shroud 22 and the cover 14. Consequently, a part of the air blown out to the radial outside of the impeller 20 is prevented from flowing in the gap between the shroud 22 and the cover 14, and the degradation of the blowing efficiency due to the generation of the turbulence or the air resistance of the flowing-back air in the airflow passage 13 can be prevented.

[0055] In addition, the outer circumferential surface of the first projection 17 is radially opposed to the inner circumferential surface of the shroud 22. Consequently, the radial inside of the gap between the shroud 22 and the

cover 14 is closed by the first projection 17, and the degradation of the blowing efficiency due to the generation of the turbulence or the air resistance of the flowing-back air in the airflow passage 13 can be prevented. Note that, in the embodiment, the radial gap between the outer circumferential surface of the first projection 17 and the inner circumferential surface of the shroud 22 is kept constant in the axial direction. However, the radial gap between the outer circumferential surface of the first projection 17 and the inner circumferential surface of the shroud 22 may not be kept constant in the axial direction. For example, at least one of the outer circumferential surface of the first projection 17 and the inner circumferential surface of the shroud 22 may be curved.

[0056] The provision of the second projection 18, which projects axially downward from the bottom surface of the cover 14 and is opposed to the outer circumferential surface of the shroud 22, allows the second projection 18 to block the air flowing in the gap between the shroud 22 and the cover 14. Consequently, a part of the air blown out onto the radial outside of the impeller 20 is prevented from flowing in the gap between the shroud 22 and the cover 14, and the degradation of the blowing efficiency due to the generation of the turbulence or the air resistance of the flowing-back air in the airflow passage 13 can be prevented.

[0057] Assuming that the region of the blade 23 located on the radial outside of the first projection 17 is the blade first region, and that the region vertically opposed to the first projection 17 is the blade second region, the upper end of the blade first region is located above the upper end at the radially outer end of the blade second region in the upper end of the blade 23. Thus, even if the impeller 20 vibrates vertically during the rotation, the upper end of the blade 23 can be prevented from contacting with the first projection 17. The blade 23 can axially be formed larger on the radial outside of the first projection 17, and the amount of air generated by the rotation of the impeller 20 can be increased.

[0058] The lower end of the inner circumferential surface 22b of the shroud 22 and the lower end of the radially outer end of the first projection 17 have the substantially identical height in the axial direction. Consequently, the air circulating toward the radial outside along the bottom surface of the cover 14 is smoothly guided from the lower end of the first projection 17 to the lower end of the inner circumferential surface 22b of the shroud 22, and blown out to the radial outside of the impeller 20 through the bottom surface of the shroud 22. Thus, the blowing efficiency can further be improved by reducing the air resistance of the first projection 17.

[0059] Note that, the lower end of the inner circumferential surface 22b of the shroud 22 may axially be located above the lower end of the radially outer end of the first projection 17. Even in this case, the air circulating toward the radial outside along the bottom surface of the cover 14 is smoothly guided from the lower end of the first projection 17 to the lower end of the inner circumferential

surface 22b of the shroud 22, so that the blowing efficiency of the blower 1 can be improved. In this configuration, the radial gap between the inner circumferential surface 22b of the shroud 22 and the radially outer end of the first projection 17 is also narrowed, so that a part of the air blown out onto the radial outside of the impeller 20 can be prevented from flowing backward from the gap between the shroud 22 and the cover 14.

[0060] The radially outer end of the blade 23 extends to the radial outside of the outer circumference of the base plate 21, and the radially inner end of the blade 23 extends to the radial inside of the suction port 11, so that the blade 23 can radially be formed larger to increase the amount of air generated by the rotation of the impeller 20.

[0061] The axial gap between the lower end of the base plate protrusion 21a and the top surface of the motor housing 16 is narrower than the axial gap between the bottom surface of the base plate 21 and the top surface of the motor housing 16, so that the base plate protrusion 21a blocks the airflow flowing in the axial gap between the bottom surface of the base plate 21 and the top surface of the motor housing 16. Consequently, a part of the air blown out onto the radial outside of the impeller 20 can be prevented from flowing in the gap between the bottom surface of the base plate 21 and the top surface of the motor housing 16, and the degradation of the blowing efficiency due to the generation of the turbulence or the air resistance of the flowing-back air in the airflow passage 13 can be prevented.

[0062] The base plate protrusion 21a is located on the radially outer edge of the base plate 21. The groove 16b vertically opposed to the base plate protrusion 21a is provided on the top surface of the motor housing 16. The groove 16b is larger than the base plate protrusion 21a in the radial width. That is, the groove 16b is formed on the top surface of the motor housing 16. The groove 16b is vertically opposed to the base plate protrusion 21a and has the radial width larger than a radial width of the base plate protrusion 21a. Thus, the base plate protrusion 21a is disposed close to the groove 16b, so that the axial gap between the bottom surface of the base plate 21 and the top surface of the motor housing 16 can further be narrowed. Therefore, the part of the air flowing in the gap between the bottom surface of the base plate 21 and the top surface of the motor housing 16 can further be prevented.

[0063] The above embodiment and modifications are merely examples of the present invention. The configurations of the embodiment and modifications may appropriately be changed without departing from the technical idea of the present invention. In addition, the embodiment and the plurality of modifications may be implemented in combination within a feasible range.

[0064] Furthermore, the blower 1 of the present invention is mounted on the cleaning robot 100 as illustrated in Fig. 1. Note that, the blower 1 may be mounted on not only the cleaning robot 100 but also vacuum cleaners

such as a handy cleaner. Consequently, the vacuum cleaner having the high blowing efficiency can be constructed. The blower 1 may also be mounted on an apparatus other than the vacuum cleaner. For example, the blower 1 of the present invention may be mounted on an electronic device such as a personal computer for the purpose of internal cooling. The blower 1 of the present invention may also be mounted on various other office automation instruments, medical instruments, household electrical appliances, or transport instruments.

[0065] In addition, the detailed configuration of the blower 1 may be different from the above embodiment and modifications. Furthermore, each element appearing in the embodiment and the modifications may appropriately be combined within a range in which inconsistency is not generated.

INDUSTRIAL APPLICABILITY

[0066] For example, the blower of the present invention having the high blowing efficiency is suitable for the vacuum cleaner. Note that, the blower of the present invention can also be used for other electronic devices.

REFERENCE SIGNS LIST

[0067]

1	blower
10	duct
11	suction port
12	air outlet
13	airflow passage
14	cover
14a	cylindrical portion
15	circumferential wall
15a	nozzle
16	motor housing
16a	recess
16b	groove
17	first projection
18	second projection
20	impeller
21	base plate
21a	base plate protrusion
22	shroud
22a	opening
22b	inner circumferential surface
23	blade
23a	first blade
23b	second blade
24a, 24b	radially outer end
25a, 25b	protrusion
26a, 26b	inclined surface
27a, 27b	inclined surface
30	motor
40	control board
100	cleaning robot

101	chassis
103	inlet port
104	suction passage
105	dust container
106	filter
107	exhaust passage
108	exhaust port
109	driving wheel
110	front wheel
221	first inner circumferential surface
222	second inner circumferential surface
223	curved portion
A	central axis
D	dust
D1	outer diameter
D2	inner diameter
F	floor
R1	air
R2	air
L1	blade first region
L2	blade second region

Claims

1. A blower comprising:

an impeller rotatable about a central axis extending in a vertical direction;
a motor that is positioned on a lower side of the impeller and rotates the impeller about the central axis; and
a duct including an airflow passage in an inner space, a suction port through which a fluid flows in the inner space, and an air outlet through which the fluid is discharged from the inner space, the impeller being accommodated in the duct,
wherein
the impeller includes:

a plurality of blades arranged in a circumferential direction;
a shroud that has an annular shape, connects upper portions of the plurality of blades, and includes an opening located opposite the suction port in an axial direction;
and
a base plate that connects lower portions of the plurality of blades and extends in a radial direction,

the duct includes a cover covering at least a part of the blade and an upper portion of the shroud, an inner diameter of the shroud is equal to or larger than an outer diameter of the base plate, and
the cover includes a first projection that projects

axially downward from a bottom surface of the cover and is disposed on a radial inside of an inner circumferential surface of the shroud.

5 2. The blower according to claim 1, wherein an outer circumferential surface of the first projection is radially opposed to the inner circumferential surface of the shroud.

10 3. The blower according to claim 2, wherein a lower side in the axial direction is wider than an upper side in the axial direction in a radial gap between the outer circumferential surface of the first projection and the inner circumferential surface of the shroud.

15 4. The blower according to any one of claims 1 to 3, wherein
the blade includes:

20 a blade first region located on a radial outside of the first projection; and
 a blade second region vertically opposed to the first projection, and
25 an upper end of the blade first region is located above an upper end at a radially outer end of the blade second region.

30 5. The blower according to any one of claims 1 to 4, wherein the blade includes a protrusion that protrudes axially upward on the radial outside of the first projection.

35 6. The blower according to any one of claims 1 to 5, wherein a lower end of the inner circumferential surface of the shroud and a lower end of a radially outer end of the first projection have a substantially identical height in the axial direction.

40 7. The blower according to any one of claims 1 to 6, wherein a radially outer end of the blade extends to the radial outside of an outer circumference of the base plate.

45 8. The blower according to any one of claims 1 to 7, wherein the radially inner end of the blade extends to the radial inside of the suction port.

50 9. The blower according to any one of claims 1 to 8, further comprising a motor housing located below the base plate,
wherein
the base plate includes a base plate protrusion protruding downward from a bottom surface of the base plate, and
55 an axial gap between the lower end of the base plate protrusion and a top surface of the motor housing is narrower than an axial gap between the bottom surface of the base plate and the top surface of the

motor housing.

10. The blower according to claim 9, wherein the base plate protrusion is located at a radially outer edge of the base plate, and a groove is formed on the top surface of the motor housing, is vertically opposed to the base plate protrusion, and has a radial width larger than a radial width of the base plate protrusion.

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11. A vacuum cleaner comprising the blower according to any one of claims 1 to 10.

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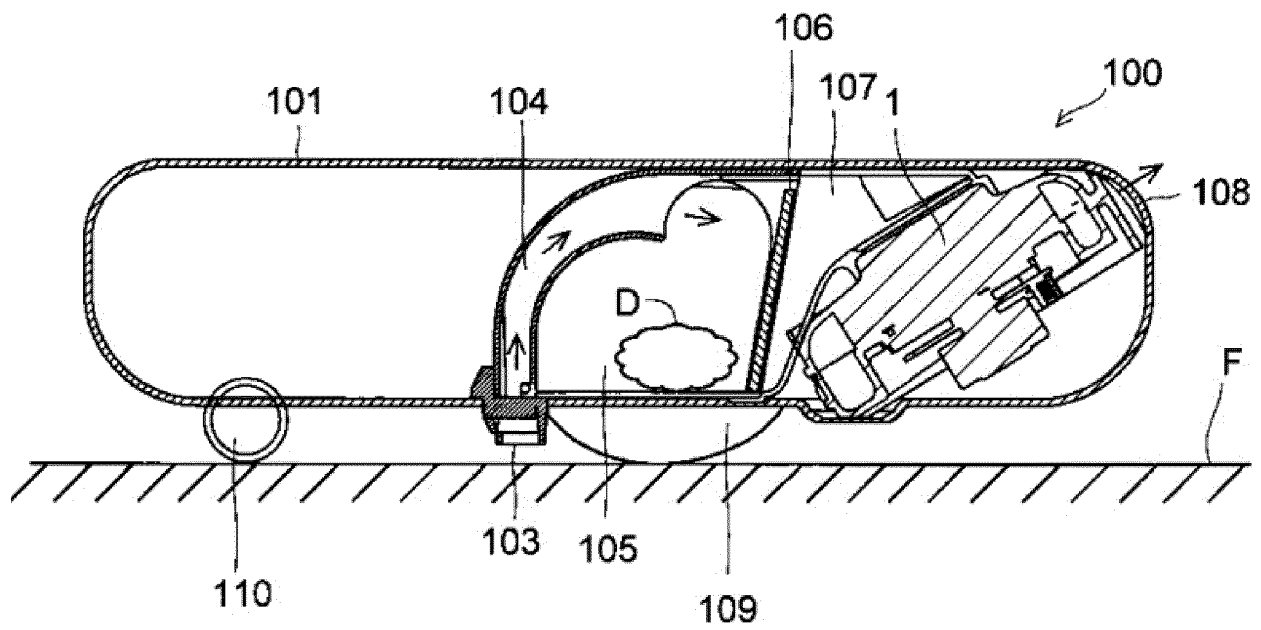


Fig. 1

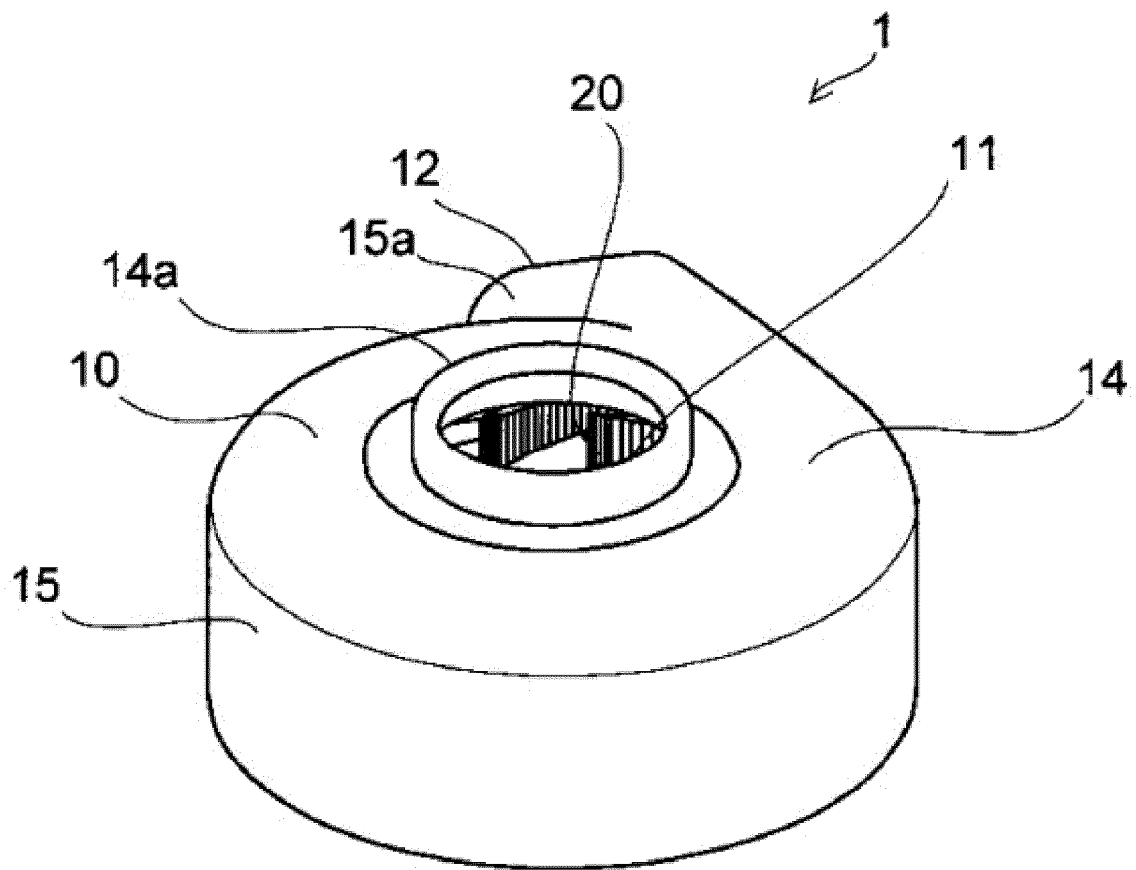


Fig. 2

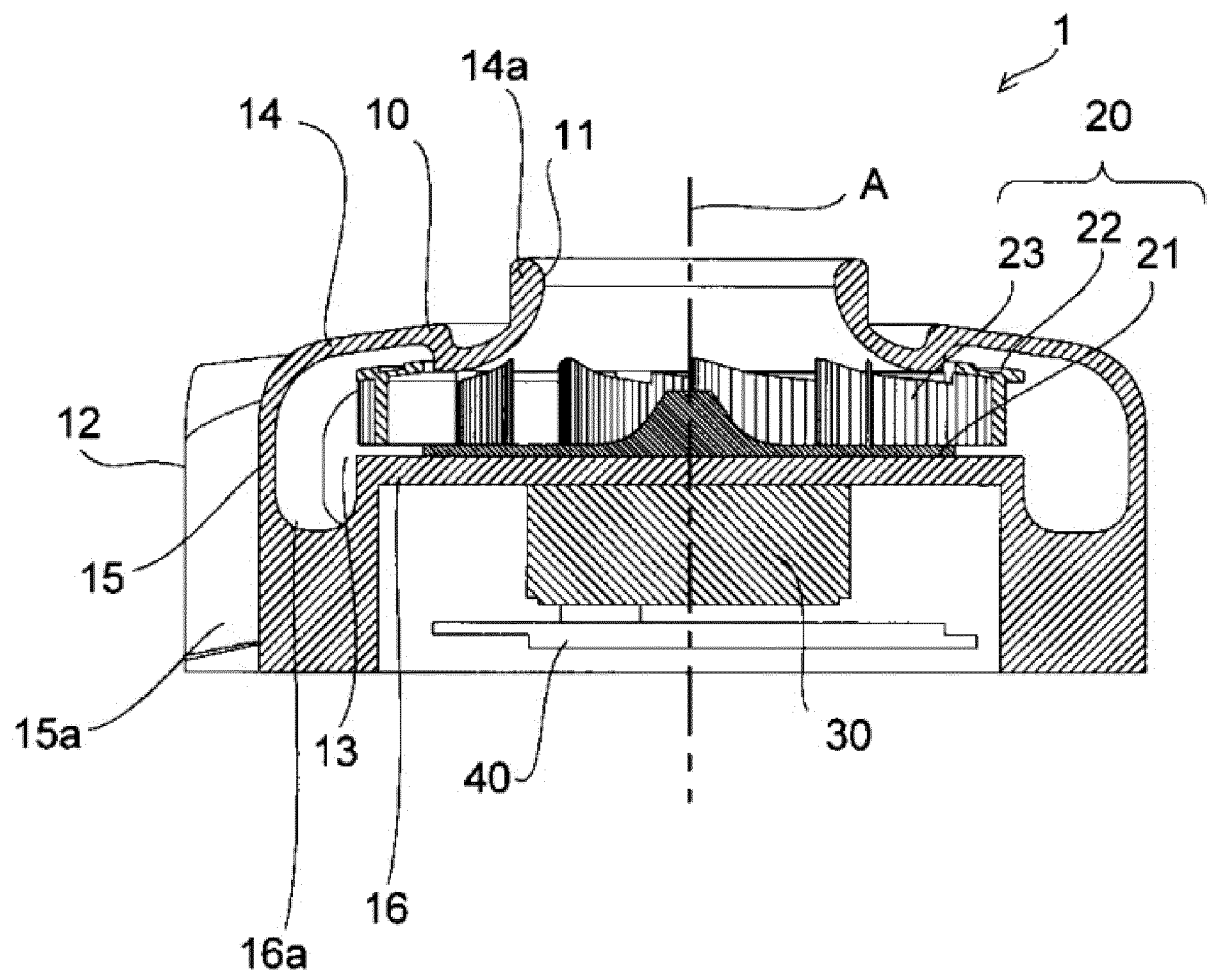


Fig. 3

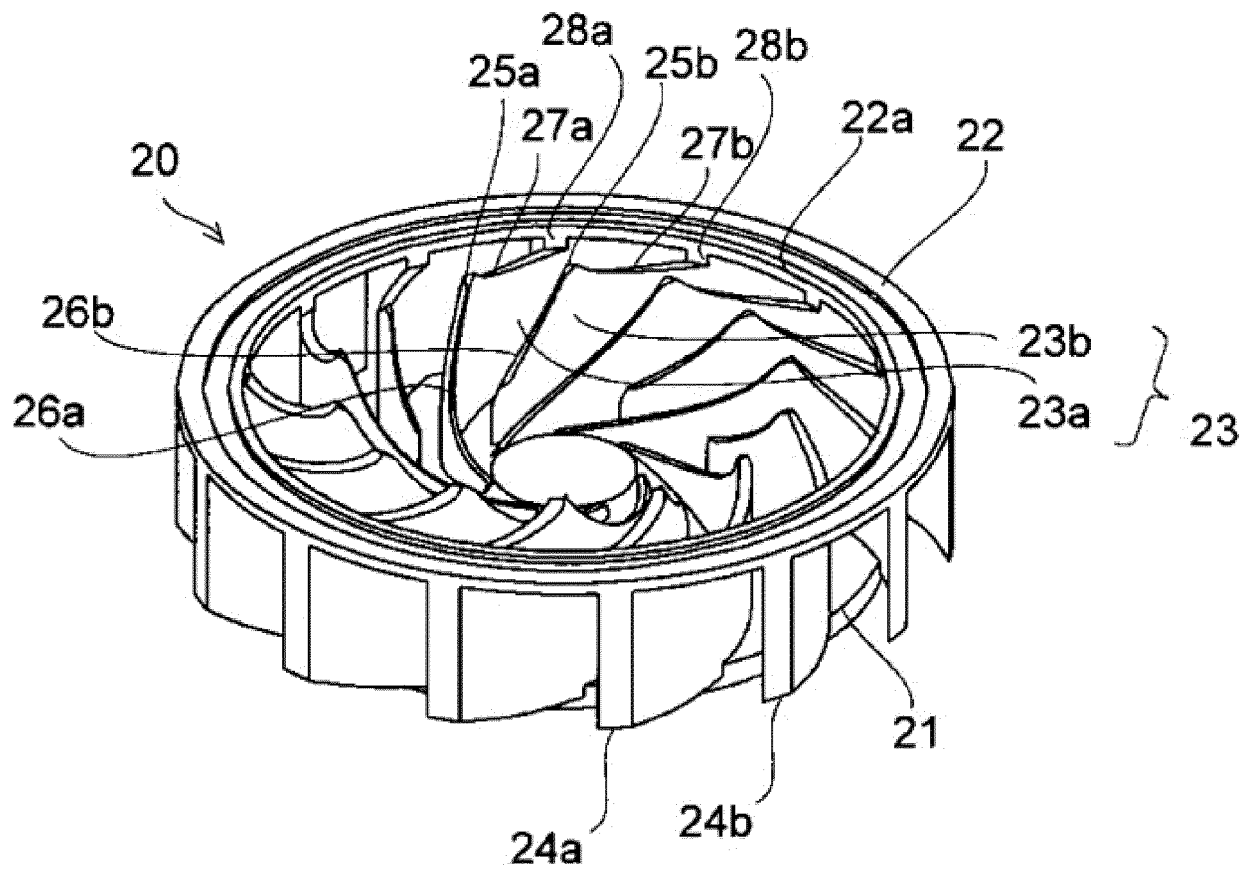


Fig. 4

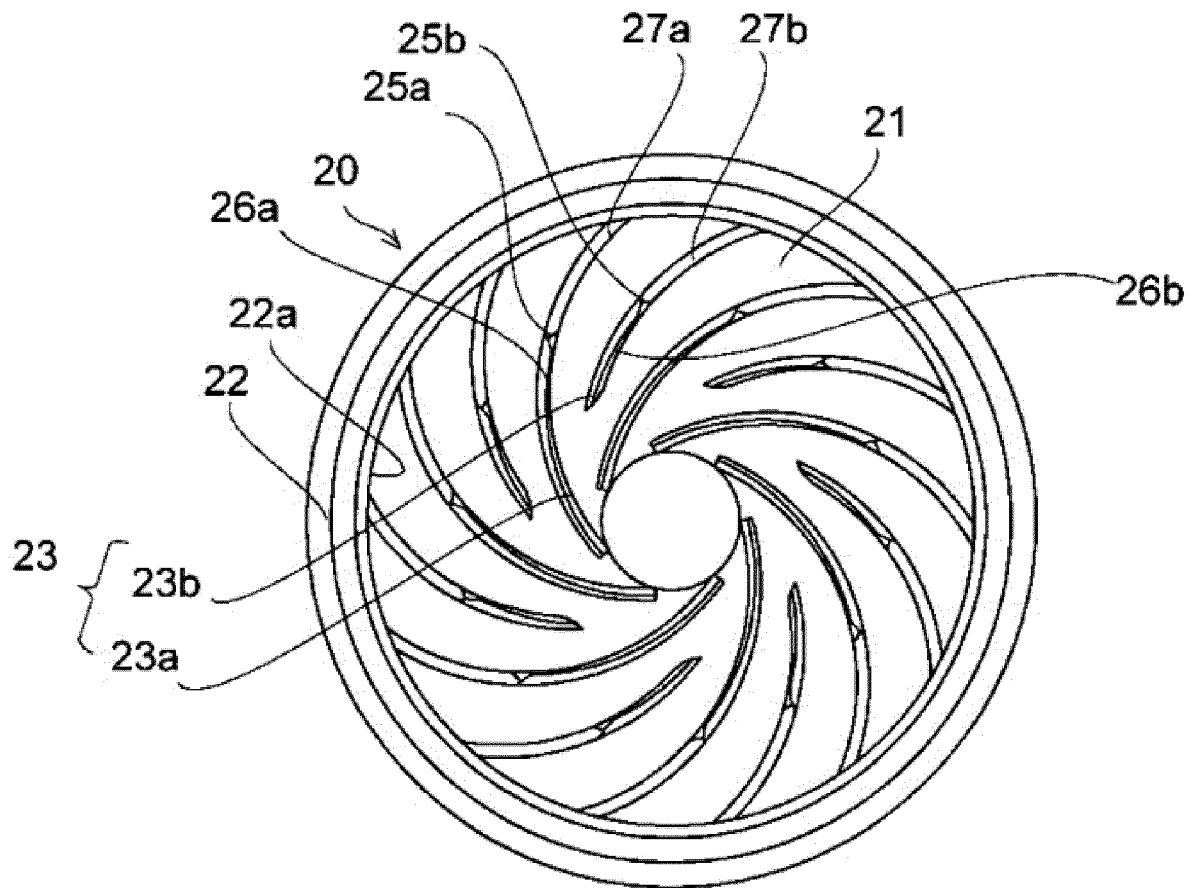


Fig. 5

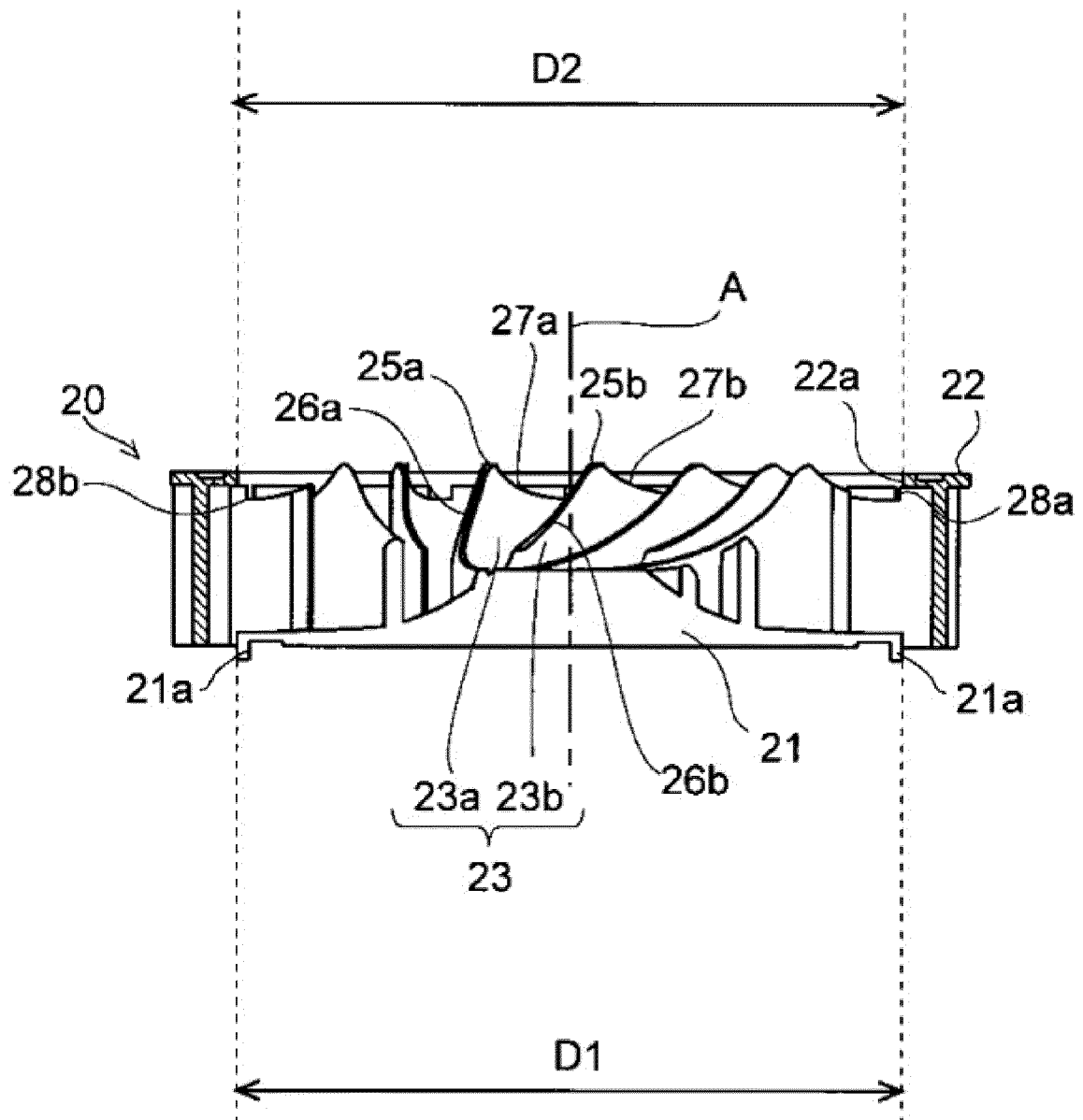


Fig. 6

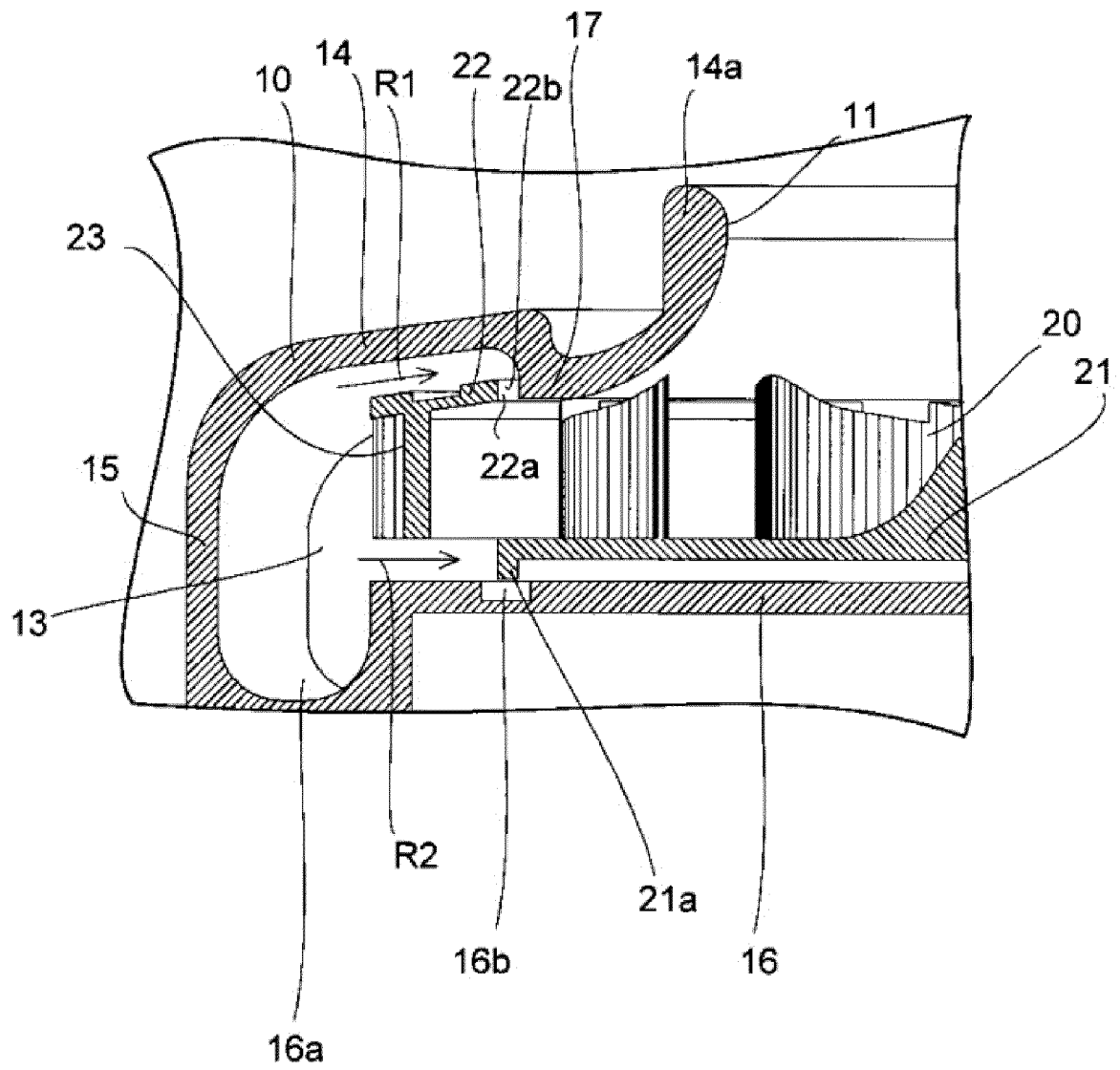


Fig. 7

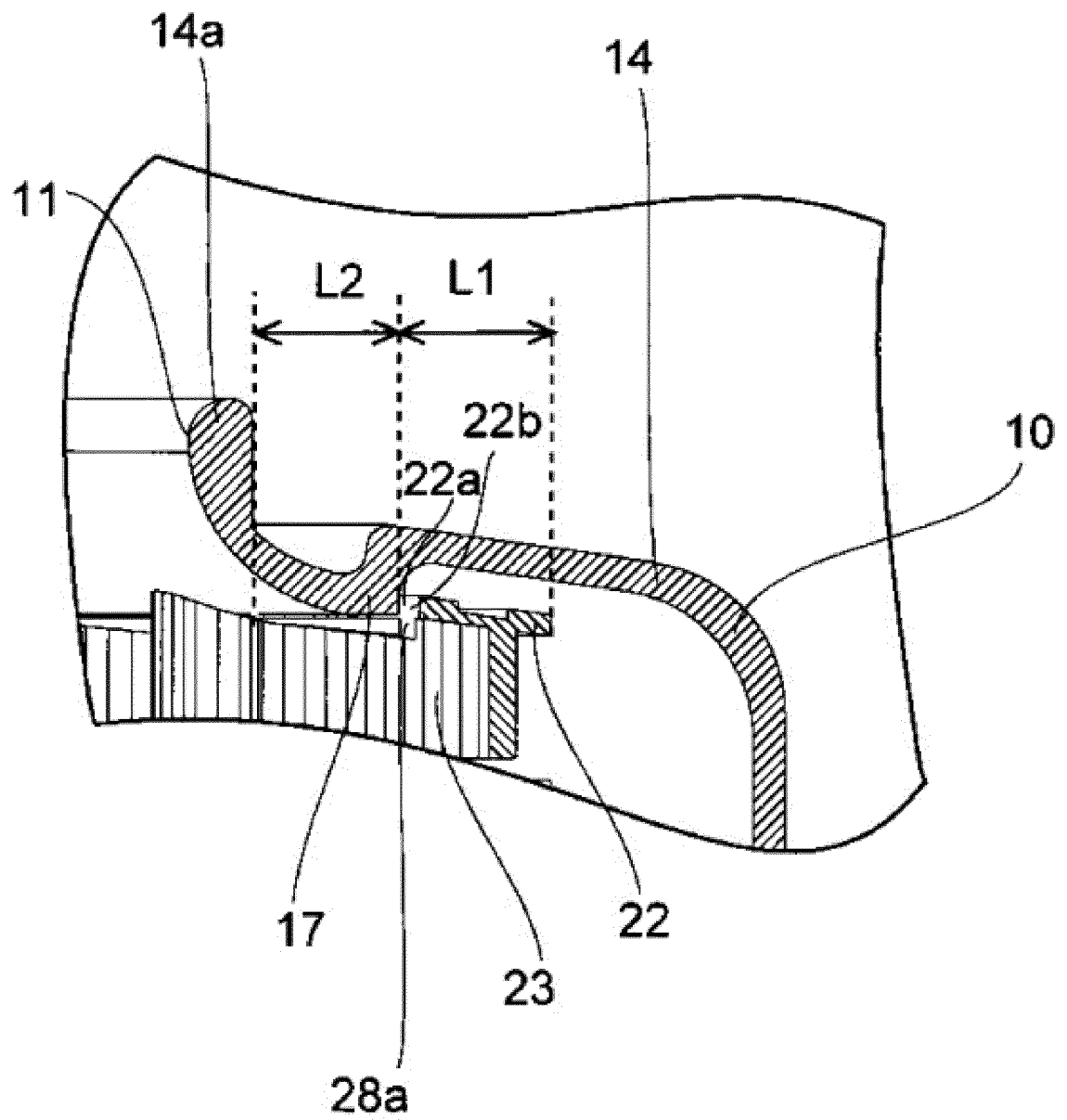


Fig. 8

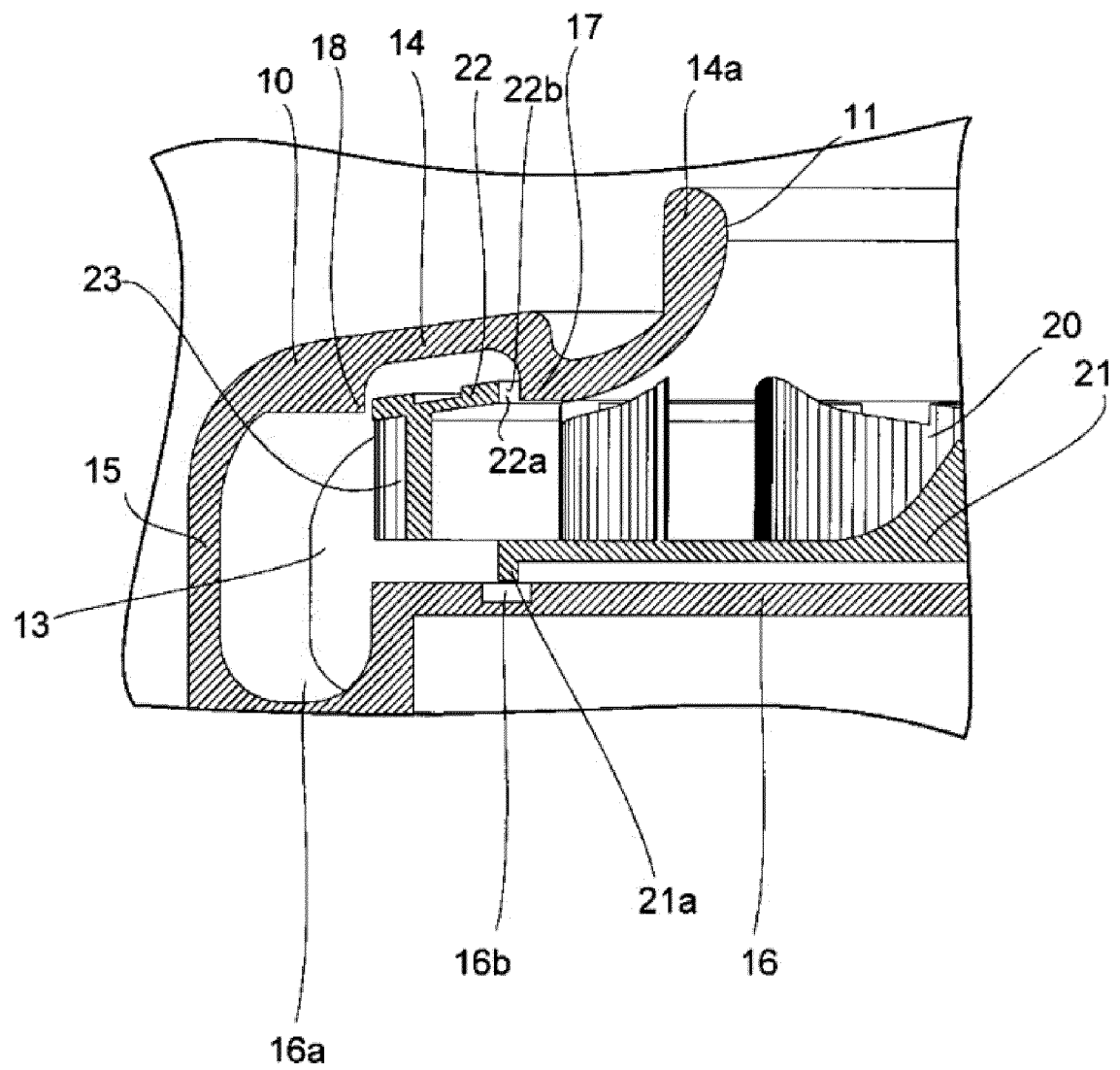


Fig. 9

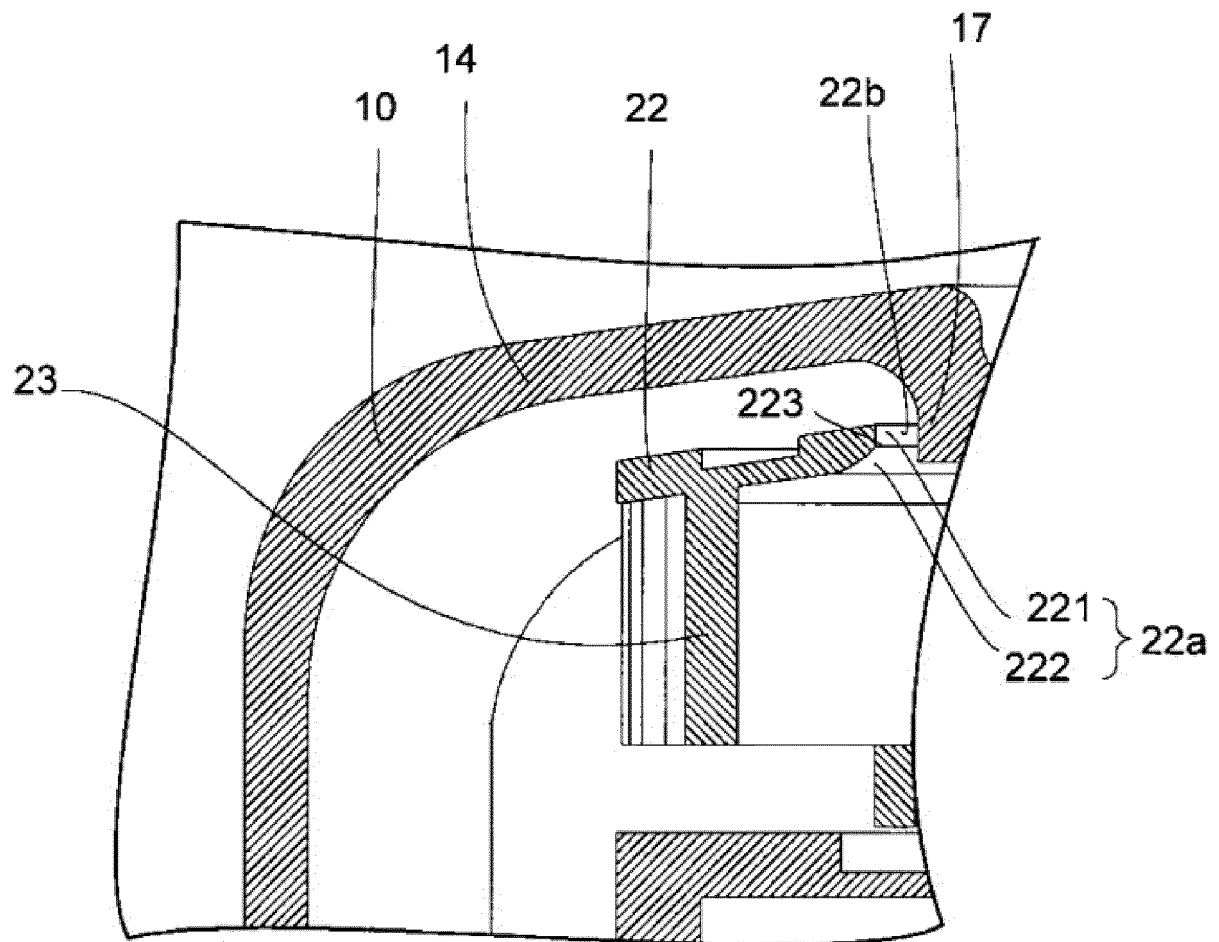


Fig. 10

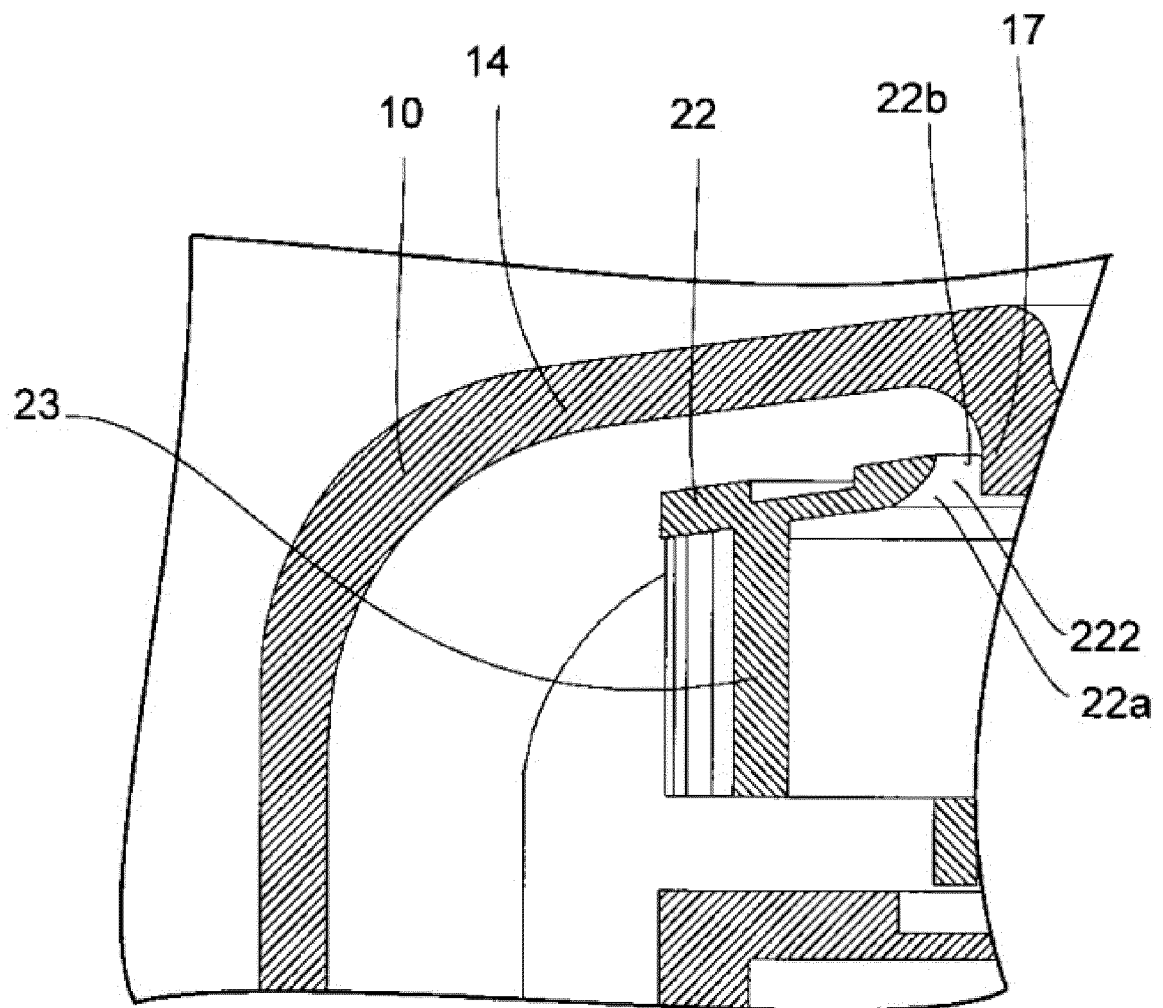


Fig. 11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/014450

A. CLASSIFICATION OF SUBJECT MATTER

F04D29/16(2006.01)i, F04D29/28(2006.01)i, F04D29/42(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04D29/16, F04D29/28, F04D29/42

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017

Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2008-232020 A (Denso Corp.),	1-2, 4-8, 11
Y	02 October 2008 (02.10.2008), paragraphs [0031] to [0091]; fig. 1 to 10, particularly, fig. 10 (Family: none)	3, 9-10
Y	JP 10-311294 A (Matsushita Seiko Co., Ltd.), 24 November 1998 (24.11.1998), paragraphs [0018] to [0021]; fig. 1 to 2 (Family: none)	3, 9-10

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
13 June 2017 (13.06.17)Date of mailing of the international search report
20 June 2017 (20.06.17)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/014450

C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 175148/1978 (Laid-open No. 92100/1980) (Mitsubishi Heavy Industries, Ltd.), 25 June 1980 (25.06.1980), specification, page 2, line 15 to page 3, line 16; fig. 2 (Family: none)	9-10
A	WO 2006/106744 A1 (Mitsubishi Heavy Industries, Ltd.), 12 October 2006 (12.10.2006), entire text; all drawings & US 2008/0279681 A1 entire text; all drawings	1-11

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002156128 A [0002] [0005] [0006]