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(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

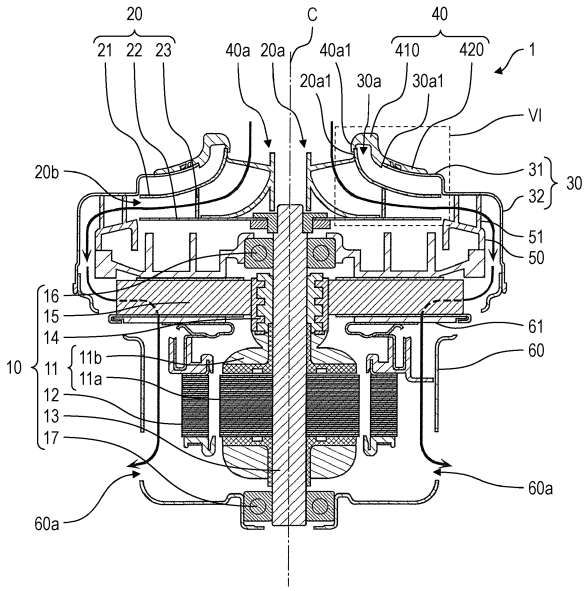
(72) Inventor: **YAMAGUCHI, Akira**
Chuo-ku, Osaka-shi, Osaka 540-6207 (JP)

(74) Representative: **SSM Sandmair**
Patentanwälte Rechtsanwalt Partnerschaft mbB
Joseph-Wild-Straße 20
81829 München (DE)

(54) ELECTRIC BLOWER

(57) An electric blower includes: a rotor that includes a rotary shaft; a centrifugal fan that includes a first opening and is attached to the rotary shaft; a fan case that includes a second opening and covers the centrifugal fan, the second opening including an opening end that is located outside an opening end of the first opening; and a fan case spacer that includes a third opening and is attached to the fan case, the third opening being in communication with the first opening. The fan case spacer includes: a spacer part that closes off a gap between the opening end of the first opening and the opening end of the second opening; and a cover part that extends outward from the opening end of the second opening and covers an outer surface of the fan case. The cover part includes a protrusion that is annular, protrudes toward the outer surface of the fan case, and surrounds the second opening. The protrusion is located between the opening end of the second opening and a tip part of the cover part and is in contact with the outer surface of the fan case.

FIG. 2



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to an electric blower.

BACKGROUND ART

[0002] Electric blowers are used in various electric apparatuses such as vacuum cleaners. An electric blower disposed in a vacuum cleaner employs, as a rotary fan, a centrifugal fan capable of providing a high suction pressure. The centrifugal fan is attached to the rotary shaft of a motor and rotates at high speed to generate a desired air pressure.

[0003] An electric blower employing a centrifugal fan includes, for example, a motor, a centrifugal fan attached to the rotary shaft of the motor, a fan case covering the centrifugal fan, and a fan case spacer attached to the fan case (see PTL 1, for example).

[0004] In order to improve the blowing efficiency of the electric blower, it is important to secure airtightness between the fan case and the fan case spacer. However, conventional electric blowers fail to sufficiently secure airtightness between the fan case and the fan case spacer, leading to a decrease in the blowing efficiency.

Citation List

[0005] Patent Literature

[0006] PTL 1: Unexamined Japanese Patent Publication No. 2008-180165

SUMMARY OF THE INVENTION

[0007] The present disclosure has been made in order to solve such problem. An object of the present disclosure is to provide an electric blower or the like capable of improving the airtightness between the fan case and the fan case spacer.

[0008] To achieve the above object, an electric blower according to one aspect of the present disclosure includes: a rotor that includes a rotary shaft; a centrifugal fan that includes a first opening and is attached to the rotary shaft; a fan case that includes a second opening and covers the centrifugal fan, the second opening including an opening end that is located outside an opening end of the first opening; and a fan case spacer that includes a third opening and is attached to the fan case, the third opening being in communication with the first opening. The fan case spacer includes: a spacer part that closes off a gap between the opening end of the first opening and the opening end of the second opening; and a cover part that extends outward from the opening end of the second opening and covers an outer surface of the fan case. The cover part includes a protrusion that is annular, protrudes toward the outer surface of the fan case, and surrounds the second opening. The protrusion is located between the opening end of the second opening and a tip part of the cover part and is in contact with the outer surface of the fan case.

[0009] An electric blower according to the present disclosure can enhance the airtightness between the fan case and the fan case spacer, and thus the blowing efficiency of the electric blower can be improved.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

FIG. 1 is an external perspective view of an electric blower according to an exemplary embodiment.

FIG. 2 is a cross-sectional view of the electric blower according to an exemplary embodiment.

FIG. 3 is an exploded perspective view of a fan case spacer, a fan case, and a centrifugal fan, as the electric blower according to an exemplary embodiment is viewed from an upper direction.

FIG. 4 is an exploded perspective view of the fan case spacer, the fan case, and the centrifugal fan, as the electric blower according to an exemplary embodiment is viewed from a lower direction.

FIG. 5 is a perspective view of the fan case spacer of the electric blower according to an exemplary embodiment.

FIG. 6 is an enlarged cross-sectional view of a region VI enclosed by a broken line in FIG. 2 in the electric blower according to an exemplary embodiment.

FIG. 7 is a partially enlarged cross-sectional view of the electric blower according to an exemplary embodiment taken along a section passing through a fixing part of the fan case spacer.

FIG. 8 is a diagram illustrating how the fan case spacer is assembled to the fan case of the electric blower according to an exemplary embodiment.

FIG. 9 is an enlarged cross-sectional view of an electric blower of a comparative example.

DESCRIPTION OF EMBODIMENT

[0011] An exemplary embodiment of the present disclosure will now be described with reference to the drawings. Any exemplary embodiment described below illustrates a specific example of the present disclosure. Accordingly, numerical values, shapes, materials, components, arranged positions and connection forms of the components, etc., to be used in the following exemplary embodiment are illustrative and are not to limit the scope of the present disclosure. Therefore, those components introduced in the following exemplary embodiment that are not recited in the independent claim(s) representing the most superordinate concept of the present disclosure are illustrated herein as optional components.

[0012] Note that each drawing shows a schematic view that may not necessarily be precise illustration. Further-

more, the same reference numerals are given to substantially the same components in individual figures, and duplicate descriptions are omitted or simplified.

(Exemplary embodiment)

[0013] First, the following describes an overall configuration of electric blower 1 according to an exemplary embodiment with reference to FIGS. 1 and 2. FIG. 1 is an external perspective view of electric blower 1 according to an exemplary embodiment. FIG. 2 is a cross-sectional view of electric blower 1. FIG. 2 shows a cross section of electric blower 1 taken along a plane passing through shaft center C of rotary shaft 13. Note that FIG. 2 only shows line drawings appearing on a cross section. Bold arrows shown in FIG. 2 each indicate a flow of air drawn into electric blower 1.

[0014] For convenience, the description below assumes that shaft center C extends along a vertical direction. Specifically, in FIG. 2, with respect to the direction in which shaft center C extends, it is assumed that centrifugal fan 20 is located above rotor 11 on the upper output shaft side, while second bearing part 17 is located below rotor 11 on the lower side opposite to the output shaft side. The vertical direction is defined as above for ease of understanding the following description. Therefore, the vertical direction may be different from an actual vertical direction depending on, for example, the state in which electric blower 1 is used.

[0015] As illustrated in FIGS. 1 and 2, electric blower 1 in the present exemplary embodiment includes motor 10, centrifugal fan 20, fan case 30, fan case spacer 40, air guide 50, and motor case 60. Motor 10 includes rotor 11 and stator 12. Centrifugal fan 20 is attached to rotary shaft 13, which is included in motor 10. Fan case 30 covers centrifugal fan 20. Fan case spacer 40 is attached to fan case 30. To air guide 50, the air discharged from the centrifugal fan 20 flows. Motor case 60 houses motor 10.

[0016] Motor 10 is an electric motor that causes centrifugal fan 20 to rotate. Motor 10 in the present exemplary embodiment is a commutator motor with a brush, and includes rotor 11, stator 12, rotary shaft 13, commutator 14, brush 15, first bearing part 16, and second bearing part 17.

[0017] Rotor 11 (rotating part) includes rotary shaft 13. Rotor 11 is an inner rotor disposed inside stator 12, as illustrated in FIG. 2. Specifically, rotor 11 is surrounded by stator 12 via a small air gap between rotor 11 and stator 12. Rotor 11 rotates around shaft center C of rotary shaft 13 as a rotation center. Rotor 11 rotates as fast as, for example, 40,000 rpm.

[0018] Rotor 11 is an armature. Rotor 11 includes rotor core 11a (rotor iron core) and wound coil 11b wound around rotor core 11a via an insulator. Note that FIG. 2 shows wound coil 11b schematically. Rotor core 11a is a magnetic body made of a magnetic material. For example, rotor core 11a is a stacked body in which multiple electromagnetic steel plates are stacked along the direction of shaft center C of rotary shaft 13 (shaft center direction). Rotor core 11a includes a plurality of teeth parts protruding in a radial direction. When a current flows through wound coil 11b, each teeth part generates a magnetic force to act on stator 12.

[0019] Stator 12 (stationary part), which is located to face rotor 11, generates a magnetic force to act on rotor 11. Stator 12 is disposed so as to surround rotor 11. Stator 12 is configured such that N poles and S poles alternately appear in the circumferential direction on the air gap surface. In this case, stator 12 may be configured such that a plurality of permanent magnets is arranged in the circumferential direction, or may include a stator core having a plurality of teeth parts and a wound coil being wound around the stator core. Stator 12 is fixed to, for example, motor case 60.

[0020] Rotary shaft 13 is a shaft serving as a center around which rotor 11 rotates. Rotary shaft 13 extends in the longitudinal direction, which is the shaft center direction. Rotary shaft 13 is, for example, a metal rod. Rotary shaft 13 is fixed to rotor 11. Specifically, rotary shaft 13 is fixed to rotor core 11a with, for example, rotary shaft 13 passing through the center of rotor core 11a of rotor 11. For example, rotary shaft 13 is fixed to rotor core 11a by press-fitting or shrink-fitting rotary shaft 13 into a center hole created in rotor core 11a.

[0021] One end of rotary shaft 13 (the end on the centrifugal fan 20 side) is supported by first bearing part 16. The other end of rotary shaft 13 is supported by second bearing part 17. Each of first bearing part 16 and second bearing part 17 is, for example, a ball bearing that supports rotary shaft 13. A slide bearing or some other bearing may be used as first bearing part 16 and second bearing part 17. In this way, both ends of rotary shaft 13 are rotatably held by first bearing part 16 and second bearing part 17.

[0022] One end of rotary shaft 13 protrudes from first bearing part 16. Centrifugal fan 20 is attached to the tip part of rotary shaft 13.

[0023] Commutator 14 is attached to rotary shaft 13. Commutator 14 is fixed on rotary shaft 13 between rotor 11 and first bearing part 16. Commutator 14 is electrically connected to wound coil 11b included in rotor 11, and is in sliding contact with brush 15. Commutator 14 is made up of a plurality of segments insulated and isolated from each other in the rotation direction of rotary shaft 13.

[0024] Brush 15 is a power supply brush for supplying electric power to rotor 11 by being in contact with commutator 14. Brush 15 supplies an armature current to commutator 14 by being in contact with commutator 14. Brush 15 is, for example, a carbon brush. Brush 15 is in a long and substantially rectangular solid shape.

[0025] Brush 15 is disposed so as to be in sliding contact with commutator 14. Apair of brushes 15 is provided. The pair of brushes 15 is disposed to face each other across commutator 14 so as to sandwich commutator 14. Specifically, the inner tip of each of the pair of brushes 15 abuts on commutator 14. An end face of brush 15 on

the inner side (on the rotary shaft 13 side) with respect to the longitudinal direction of brush 15 is the face in contact with commutator 14.

[0026] Centrifugal fan 20 draws air into an outer casing (housing) made up of fan case 30 and motor case 60. Centrifugal fan 20, which is attached to a predetermined part of rotary shaft 13 of motor 10, is caused to rotate by rotation of rotary shaft 13. Centrifugal fan 20 is attached to the tip part of rotary shaft 13. Centrifugal fan 20 can be fixed to rotary shaft 13 by, for example, press-fitting rotary shaft 13 into a through hole formed in centrifugal fan 20. Alternatively, centrifugal fan 20 may be pressed and held on rotary shaft 13 by tightening a fastening nut with a screw provided on the end face of rotary shaft 13.

[0027] Centrifugal fan 20 includes inlet 20a (intake port) for drawing air and outlet 20b (outtake port) for discharging the air drawn from inlet 20a. Inlet 20a of centrifugal fan 20 is a first opening. Inlet 20a opens on the side opposite to the position where rotor 11 is attached to rotary shaft 13 with respect to the direction along which shaft center C extends.

[0028] Centrifugal fan 20 includes first lateral plate 21 provided with inlet 20a, second lateral plate 22 facing first lateral plate 21 across a predetermined gap, and a plurality of fan blades 23 put between first lateral plate 21 and second lateral plate 22. First lateral plate 21, second lateral plate 22, and the plurality of fan blades 23 are made of, for example, a metal plate such as an aluminum plate; however, this is not restrictive.

[0029] First lateral plate 21 is an upper plate located upstream (on the fan case 30 side). Inlet 20a (first opening) provided on first lateral plate 21 faces inlet 30a (second opening) of fan case 30. Inlet 20a is, for example, a circular through hole. First lateral plate 21 is in a substantially truncated cone shape. Inlet 20a is provided on the top of first lateral plate 21. First lateral plate 21 in such shape can be formed by drawing a circular flat plate having a through hole corresponding to inlet 20a into a substantially truncated cone shape.

[0030] Second lateral plate 22 is a lower plate located downstream (on the motor case 60 side). Second lateral plate 22 is a circular flat plate. A through hole is provided in a central portion of second lateral plate 22. Rotary shaft 13 is inserted into, and fixed to, the through hole via a fan boss, a backing plate, and the like.

[0031] Each of the plurality of fan blades 23 is a plate curved in an arc and is disposed radially. The plurality of fan blades 23 is disposed between first lateral plate 21 and second lateral plate 22 at equal intervals so as to be vortex-shaped. Each fan blade 23 is fixed to each of first lateral plate 21 and second lateral plate 22 by swaging. The number of fan blades 23 is six, for example; however, the number of fan blades 23 is not limited to six but may be eleven, for example.

[0032] The space surrounded by two adjacent fan blades 23, first lateral plate 21, and second lateral plate 22 is an air flow path through which the air flowing from inlet 20a into centrifugal fan 20 passes. The opening radially outside the air flow path is outlet 20b. A plurality of the air flow paths is spirally formed along a plane normal to shaft center C of rotary shaft 13. In other words, outlet 20b opens in a direction along shaft center C of rotary shaft 13, and a plurality of outlets 20b is formed along the circumferential direction of centrifugal fan 20.

[0033] Fan case 30 is a cover covering centrifugal fan 20 and air guide 50. Specifically, fan case 30 is a metal cover made of a metal material. Fan case 30 has centrifugal fan 20 and air guide 50 inside fan case 30. In other words, centrifugal fan 20 and air guide 50 are housed in fan case 30.

[0034] Fan case 30 includes lid part 31 (first fan case part) that covers an upper portion of centrifugal fan 20 and air guide 50, and side wall part 32 (second fan case part) that covers side portions of centrifugal fan 20 and air guide 50.

[0035] Fan case 30 is fixed to motor case 60. Specifically, side wall part 32 of fan case 30 is connected to an opening end of motor case 60, whereby fan case 30 and motor case 60 are fixed to each other.

[0036] Fan case 30 includes inlet 30a (intake port) for drawing outside air. Inlet 30a is a circular through hole provided in a central portion of lid part 31. Inlet 30a, which is a second opening, of fan case 30 faces inlet 20a, which is the first opening, of centrifugal fan 20.

[0037] Opening end 30a1 of inlet 30a (second opening) of fan case 30 is located outward from opening end 20a1 of inlet 20a (first opening) of centrifugal fan 20. That is, the opening diameter of inlet 30a of fan case 30 is larger than the opening diameter of inlet 20a of centrifugal fan 20. In top view, opening end 30a1 of fan case 30 surrounds opening end 20a1 of centrifugal fan 20. Therefore, in top view, there is an annular gap between opening end 20a1 of centrifugal fan 20 and opening end 30a1 of fan case 30.

[0038] Fan case spacer 40 is attached to fan case 30. An outer surface of fan case 30 includes a mounting surface on which fan case spacer 40 is mounted. Specifically, fan case spacer 40 is mounted on lid part 31 of fan case 30 so as to surround inlet 30a of fan case 30. That is, the mounting surface where fan case spacer 40 is attached to fan case 30 is part of the outer surface of lid part 31.

[0039] Fan case spacer 40 closes off the annular gap formed between opening end 20a1 of centrifugal fan 20 and opening end 30a1 of fan case 30. When centrifugal fan 20 rotates, air flows into fan case 30 from inlet 30a of fan case 30. At the same time, the pressure around outlet 20b of centrifugal fan 20 rises, and thus a difference in air pressure is caused in the space path between first lateral plate 21 of centrifugal fan 20 and lid part 31 of fan case 30, and a circulating flow from outlet 20b of centrifugal fan 20 directed toward inlet 30a of fan case 30 is going to be generated. However, the circulating can be reduced by providing fan case spacer 40 as described above. That is, the pressure can be prevented from escaping by providing fan case spacer 40. Compared with

the case where fan case spacer 40 is not provided, the blowing efficiency of electric blower 1 can be improved. In addition, fan case 30 can be protected by providing fan case spacer 40.

[0040] Fan case spacer 40 includes inlet 40a (intake port) for drawing outside air. Inlet 40a is a circular through hole provided in a central portion of fan case spacer 40. Inlet 40a, which is a third opening, of fan case spacer 40 is in communication with inlet 20a, which is the first opening, of centrifugal fan 20. The opening diameter of inlet 40a of fan case spacer 40 is approximately equal to the opening diameter of inlet 20a of centrifugal fan 20. In top view, opening end 40a1 of fan case spacer 40 is substantially overlaid with opening end 20a1 of centrifugal fan 20. Note that fan case spacer 40 will be described in detail later.

[0041] The air drawn from inlet 30a of fan case 30 by rotation of centrifugal fan 20 is drawn from inlet 20a of centrifugal fan 20, blown out from outlet 20b, and flows into air guide 50.

[0042] Air guide 50 has a function of rectifying the air blown out from centrifugal fan 20 and smoothly flowing the rectified air into motor case 60. Air guide 50 includes a plurality of diffuser blades 51. Each of the plurality of diffuser blades 51 is plate-shaped, curved in an arc, and disposed radially. Specifically, the plurality of diffuser blades 51 is placed so as to be vortex-shaped. Air guide 50 is made of, for example, a resin material; however, this is not restrictive, and air guide 50 may alternatively be made of a metal material.

[0043] Motor case 60 is a casing (frame) for housing motor 10. Specifically, motor case 60 houses rotor 11 and stator 12. In other words, motor case 60 has rotor 11 and stator 12 inside motor case 60. Motor case 60 is, for example, a metal case made of a metal material.

[0044] Motor case 60 has a bottomed cylindrical shape with an opening. Motor case 60 has a bottom and a cylindrical side wall. Motor case 60 includes a plurality of outlets 60a disposed in the bottom and in the side wall for blowing out the air drawn by rotation of centrifugal fan 20. In other words, outlets 60a are outtake ports for discharging the air drawn into motor case 60 by centrifugal fan 20.

[0045] Furthermore, bracket 61 is disposed so as to partially cover the opening of motor case 60. For example, bracket 61 is disposed so as to extend across the opening of motor case 60. Bracket 61 has a plurality of openings provided therein. The air rectified by air guide 50 passes through the openings of bracket 61 and motor case 60 in a portion not covered by bracket 61 to flow into motor case 60. Bracket 61 is made of, for example, a resin material; however, this is not restrictive, and bracket 61 may alternatively be made of a metal material.

[0046] In electric blower 1 configured as described above, when rotor 11 of motor 10 rotates, centrifugal fan 20 rotates to draw air from inlet 30a of fan case 30 into fan case 30. As a result, the air flows from inlet 20a of centrifugal fan 20 into centrifugal fan 20. The air drawn into centrifugal fan 20 is compressed to a high pressure by fan blades 23 of centrifugal fan 20, and is discharged in a radial direction from outlet 20b on the outer perimeter side of centrifugal fan 20. The air discharged from centrifugal fan 20 is guided to side wall part 32 of fan case 30 by diffuser blades 51 of air guide 50 surrounding centrifugal fan 20 to become a swirling flow, and flows into motor case 60. The swirling flow flowing into motor case 60 is then discharged to the outside of electric blower 1 from outlets 60a of motor case 60 while cooling rotor 11 and stator 12 of motor 10.

[0047] With reference to FIGS. 3 to 7, the following describes in detail a configuration of fan case spacer 40, which is used in electric blower 1 according to the present exemplary embodiment, the description including connection relationships among fan case spacer 40, fan case 30, and centrifugal fan 20. FIG. 3 is an exploded perspective view of fan case spacer 40, fan case 30, and centrifugal fan 20, as electric blower 1 according to an exemplary embodiment is viewed from an upper direction. FIG. 4 is an exploded perspective view of fan case spacer 40, fan case 30, and centrifugal fan 20, as electric blower 1 according to an exemplary embodiment is viewed from a lower direction. FIG. 5 is a perspective view of fan case spacer 40 of electric blower 1 according to an exemplary embodiment. FIG. 6 is an enlarged cross-sectional view of a region VI enclosed by a broken line in FIG. 2 in electric blower 1 according to an exemplary embodiment. FIG. 7 is a partially enlarged cross-sectional view of electric blower 1 according to an exemplary embodiment taken along a section passing through fixing part 413 of fan case spacer 40.

[0048] As illustrated in FIGS. 3 to 7, fan case spacer 40 includes spacer part 410 and cover part 420. Fan case spacer 40 is made of a resin material. Specifically, fan case spacer 40 is a resin molded product in which spacer part 410 and cover part 420 are integrally formed of a resin material. Fan case spacer 40 is made of a thermoplastic resin because fan case spacer 40 is to be fixed to fan case 30 by ultrasonic welding. Fan case spacer 40 is made of, for example, acrylonitrile butadiene styrene (ABS) resin or polypropylene.

[0049] As illustrated in FIGS. 6 and 7, spacer part 410 is formed so as to close off the gap between opening end 20a1 of inlet 20a (first opening) of centrifugal fan 20 and opening end 30a1 of inlet 30a (second opening) of fan case 30. Specifically, spacer part 410 is annular in top view, and is formed so as to extend across opening end 20a1 of centrifugal fan 20 and opening end 30a1 of fan case 30. Inlet 40a of fan case spacer 40 is provided on spacer part 410. Accordingly, opening end 40a1 of fan case spacer 40 is provided on spacer part 410.

[0050] Spacer part 410 includes first connecting part 411 connected to opening end 20a1 of centrifugal fan 20 and second connecting part 412 connected to opening end 30a1 of fan case 30. As illustrated in FIG. 5, first connecting part 411 and second connecting part 412 are each formed to protrude toward centrifugal fan 20 and to

be annular.

[0051] First connecting part 411 is formed into a cylindrical shape having a small thickness, and is connected to opening end 20a1 of centrifugal fan 20. Specifically, as illustrated in FIGS. 6 and 7, the side wall surface of first connecting part 411 is in contact with the inner surface of first lateral plate 21 of centrifugal fan 20. Therefore, first connecting part 411 is to be in sliding contact with first lateral plate 21 of centrifugal fan 20 when centrifugal fan 20 rotates. Second connecting part 412 is connected to opening end 30a1 of fan case 30 in such a way as to enter fan case 30 deeper than lid part 31 of fan case 30. Specifically, the side wall surface of second connecting part 412 is in contact with the side surface of lid part 31 of fan case 30 along the thickness of lid part 31.

[0052] As illustrated in FIGS. 5 and 7, fan case spacer 40 includes fixing part 413 for fixing fan case spacer 40 to fan case 30. Fixing part 413 is provided on spacer part 410. Specifically, a plurality of fixing parts 413 is provided as part of second connecting part 412. The plurality of fixing parts 413 is formed to protrude from second connecting part 412 toward centrifugal fan 20. Specifically, as illustrated in FIG. 5, multiple fixing parts 413 are equally spaced annularly so as to surround inlet 40a of fan case spacer 40. Eight fixing parts 413 are provided. The side wall surface of each fixing part 413 is flush with the side wall surface of second connecting part 412, and is in contact with the side surface of lid part 31 of fan case 30 along the thickness of lid part 31, as with the side wall surface of second connecting part 412.

[0053] Each of fixing parts 413 is a welded part welded to opening end 30a1 of inlet 30a (second opening) of fan case 30. Fixing parts 413 are welded to opening end 30a1 of fan case 30, whereby fan case spacer 40 is fixed to opening end 30a1 of fan case 30. Fixing parts 413 are welded to opening end 30a1 of fan case 30 by, for example, ultrasonic welding. That is, fixing parts 413 made of a thermoplastic resin are, by ultrasonic vibration and welding force, melted and joined to fan case 30 made of metal.

[0054] As illustrated in FIGS. 6 and 7, cover part 420 extends outward from opening end 30a1 of inlet 30a (second opening) of fan case 30 and covers the outer surface of fan case 30. Cover part 420 is annular in top view, and is formed to extend outward along the outer surface (mounting surface) of lid part 31 of fan case 30. Note that, as illustrated in FIG. 3, a plurality of ribs is formed radially from inlet 40a on the upper surface of cover part 420.

[0055] As illustrated in FIGS. 6 and 7, cover part 420 includes protrusion 421 protruding toward the outer surface of fan case 30. Protrusion 421 has a tapered shape on a cross section including shaft center C. As illustrated in FIG. 5, protrusion 421 is in a ring shape surrounding inlet (third opening) 40a of fan case spacer 40. Accordingly, protrusion 421 is in a ring shape surrounding inlet 30a (second opening) of fan case 30. Protrusion 421 is annular.

[0056] As illustrated in FIGS. 6 and 7, protrusion 421 is located between opening end 30a1 of inlet 30a of fan case 30 and tip part 422 of cover part 420, and is in contact with the outer surface of fan case 30. Specifically, protrusion 421 is located between fixing part 413, which is included in spacer part 410, and tip part 422 of cover part 420. Protrusion 421 is in contact with the mounting surface of fan case 30 on which fan case spacer 40 is mounted. Protrusion 421 protrudes from the inner surface (bottom surface) of a recess provided on a surface of cover part 420, the surface being on fan case 30 side. Protrusion 421 is in contact with the outer surface of lid part 31 of fan case 30. In other words, protrusion 421 serves as a partition that partitions the gap between cover part 420 and fan case 30.

[0057] Protrusion 421 protrudes from the inner surface of cover part 420, and at least the tip of protrusion 421 reaches the outer surface of fan case 30. Specifically, protrusion 421 is deformed to be curved and is inclined along the outer surface of fan case 30. Therefore, protrusion 421 can be in close contact with the outer surface of fan case 30 to come into pressure contact with the outer surface of fan case 30. That is, protrusion 421 is in pressure contact with the outer surface of fan case 30. Protrusion 421 is curved so as to extend outward from inlet 30a of fan case 30. In other words, protrusion 421 is deformed from the base to the tip of protrusion 421 so as to extend in a direction away from opening end 30a1 of fan case 30 to come into pressure contact with the outer surface of fan case 30.

[0058] Tip part 422 of cover part 420 includes first pressure contact surface 422a that adheres to the outer surface of fan case 30 annularly so as to surround inlet 30a of fan case 30. First pressure contact surface 422a is in pressure contact with the outer surface of lid part 31 of fan case 30. That is, on first pressure contact surface 422a, tip part 422 of cover part 420 gives a pressing force to lid part 31 of fan case 30. First pressure contact surface 422a is, for example, in an annular shape having a constant width of 0.1 mm.

[0059] Furthermore, cover part 420 includes pressure contact part 423 located between opening end 30a1 of inlet 30a of fan case 30 and protrusion 421. Pressure contact part 423 includes second pressure contact surface 423a that comes into pressure contact with the outer surface of fan case 30 annularly so as to surround inlet 30a of fan case 30. As with first pressure contact surface 422a, second pressure contact surface 423a is in pressure contact with the outer surface of lid part 31 of fan case 30. That is, on second pressure contact surface 423a, pressure contact part 423 gives a pressing force to lid part 31 of fan case 30.

[0060] Pressure contact part 423 is a projection protruding from tip part 422 toward the outer surface of fan case 30. As illustrated in FIG. 5, pressure contact part 423 is in an annular shape surrounding inlet 30a of fan case 30. The top surface of pressure contact part 423, which is a projection, is a ring-shaped flat surface having

a constant width. The entire top surface of pressure contact part 423 is in surface contact with the outer surface of fan case 30. Therefore, second pressure contact surface 423a is a ring-shaped flat surface having a constant width. Second pressure contact surface 423a is, for example, in an annular shape having a constant width of 1.0 mm.

[0061] As illustrated in FIGS. 6 and 7, pressure contact part 423 is located between opening end 30a1 of fan case 30 and protrusion 421. That is, protrusion 421 is located between pressure contact part 423 and tip part 422 of cover part 420.

[0062] As described above, cover part 420 of fan case spacer 40 is in pressure contact with the outer surface of fan case 30 radially outward at three parts: pressure contact part 423, protrusion 421, and tip part 422. When fan case spacer 40 is attached to fan case 30, cover part 420 brings pressure contact part 423, protrusion 421, and tip part 422 into pressure contact with fan case 30.

[0063] Description regarding this point is given below with reference to FIG. 8. FIG. 8 is a diagram illustrating how fan case spacer 40 is assembled to fan case 30 of electric blower 1 according to an exemplary embodiment.

[0064] As illustrated in FIG. 8, before fan case spacer 40 is assembled to fan case 30, protrusion 421 of fan case spacer 40 is neither curved nor deformed but extends straight toward fan case 30.

[0065] When fan case spacer 40 is combined with fan case 30, fan case spacer 40 is pressed against fan case 30 such that the side walls of second connecting part 412 and fixing part 413 of fan case spacer 40 come into contact with the side surface of lid part 31 of fan case 30 along the thickness of lid part 31.

[0066] At the same time, cover part 420 of fan case spacer 40 comes into pressure contact with the outer surface of fan case 30 at three parts: pressure contact part 423, protrusion 421, and tip part 422. Specifically, tip part 422 and pressure contact part 423 lightly come into pressure contact with the outer surface of fan case 30 to have portions in pressure contact with fan case 30 designated as first pressure contact surface 422a and second pressure contact surface 423a, respectively.

[0067] The tip of protrusion 421 protrudes from a surface that is along the inner surface of cover part 420. Therefore, when fan case spacer 40 is assembled to fan case 30, protrusion 421 is pressed against the outer surface of fan case 30, bent, and deformed so as to be inclined. The shape of protrusion 421 in cross-sectional view is substantially an acute triangle in which the radially outer surface stands straight as compared with the radially inner surface (that is, substantially an acute triangle in which the radially outer surface has a smaller inclination angle with respect to the vertical direction than the radially inner surface face). Therefore, during the process of being pressed against the outer surface of fan case 30, protrusion 421 is curved to extend outward to be deformed into the shape as illustrated in FIG. 7.

[0068] In the state described above, fan case spacer 40 is joined to fan case 30 by ultrasonic welding. That is, fixing parts 413 made of a thermoplastic resin are, by ultrasonic vibration and welding force, melted and joined to fan case 30 made of metal. In this way, fan case spacer 40 can be joined to fan case 30. As a result, fan case spacer 40 can be assembled to fan case 30 in the state where three parts, namely pressure contact part 423, protrusion 421, and tip part 422, are in pressure contact with the outer surface of fan case 30.

[0069] Operation and effects of electric blower 1 according to the present exemplary embodiment will now be described with reference to FIG. 9, including the background of obtaining electric blower 1 according to the present exemplary embodiment. FIG. 9 is an enlarged cross-sectional view of electric blower 1X according to a comparative example. Note that FIG. 9 corresponds to FIG. 6.

[0070] As illustrated in FIG. 9, electric blower 1X of the comparative example is similar in configuration to electric blower 1 according to the above-described exemplary embodiment, except that the configuration of fan case spacer 40X is different. Specifically, fan case spacer 40 of electric blower 1 according to the above-described exemplary embodiment includes protrusion 421 and pressure contact part 423 disposed in cover part 420, whereas fan case spacer 40X of electric blower 1X of the comparative example has neither protrusion 421 nor pressure contact part 423 disposed in cover part 420X.

[0071] When centrifugal fan 20 in electric blower 1X of the comparative example illustrated in FIG. 9 is rotated, the pressure around outlet 20b of centrifugal fan 20 rises. Accordingly, a pressure difference is caused inside fan case 30, and the pressure around inlet 30a of fan case 30 becomes relatively negative. Therefore, although fan case spacer 40X that includes spacer part 410 and cover part 420X is mounted on fan case 30, the difference in air pressure between the inside and outside of fan case 30 may cause air to enter fan case 30 through the interface between cover part 420X and the outer surface of fan case 30, as indicated by the arrow in FIG. 9. In other words, the airtightness between fan case 30 and fan case spacer 40X will be reduced. As a result, the blowing efficiency of electric blower 1X is reduced. In contrast, in electric blower 1 according to the present exemplary embodiment, as illustrated in FIGS. 6 and 7, cover part 420 of fan case spacer 40 includes protrusion 421 that is annular, protrudes toward the outer surface of fan case 30, and surrounds inlet 30a, which corresponds to the second opening, of fan case 30. Protrusion 421 is located between opening end 30a1 of inlet 30a, which is the second opening, of fan case 30 and tip part 422 of cover part 420, and is in contact with the outer surface of fan case 30.

[0072] As illustrated in FIGS. 6 and 7, in this configuration, the recess formed in cover part 420 on a surface facing fan case 30 has space H located closer to tip part 422 than protrusion 421 and space L located closer to inlet 40a than protrusion 421, where space H is to have

a higher pressure and space L is to have a negative pressure. Accordingly, a force causing protrusion 421 to more closely adhere to fan case 30 acts on protrusion 421. That is, protrusion 421 serves as an adhering part (tight part) where fan case spacer 40 and fan case 30 adhere to each other. Therefore, the airtightness between fan case spacer 40 and fan case 30 can be enhanced. As a result, the blowing efficiency of electric blower 1 can be improved.

[0073] Moreover, since protrusion 421 is separated from fixing part 413 for fixing fan case spacer 40 to fan case 30, stable airtightness can be obtained.

[0074] In addition, in electric blower 1 according to the present exemplary embodiment, protrusion 421 is inclined along the outer surface of fan case 30.

[0075] This configuration allows protrusion 421 and fan case 30 to be in contact with each other on a wider area. Accordingly, the airtightness between fan case 30 and fan case spacer 40 can be further improved. Therefore, the blowing efficiency of electric blower 1 can be further improved. In addition, in electric blower 1 according to the present exemplary embodiment, protrusion 421 is curved so as to extend outward from inlet 40a, which corresponds to the third opening, of fan case spacer 40.

[0076] In this configuration, protrusion 421 is deformed to be further tilted by a difference in air pressure between the inside and outside of fan case 30. Accordingly, as centrifugal fan 20 rotates at higher speed to cause a greater difference in air pressure between the inside and outside of fan case 30, protrusion 421 and fan case 30 can be in contact with each other on a wider area. Therefore, as centrifugal fan 20 rotates at higher speed, the airtightness between fan case spacer 40 and fan case 30 can be enhanced.

[0077] In addition, in electric blower 1 according to the present exemplary embodiment, protrusion 421 is in a tapered shape. Specifically, as illustrated in FIG. 8, protrusion 421 before deformed in cross-sectional view is substantially in an acute triangular shape having an aspect ratio of 2 or higher. Therefore, as illustrated in FIGS. 6 and 7, protrusion 421 can be easily curved when pressed against fan case 30.

[0078] Note that protrusion 421 may be made of a resin material different from the material of parts of fan case spacer 40 other than protrusion 421. Specifically, protrusion 421 may be made of an elastomer having elasticity of rubber softer than cover part 420. As a result, protrusion 421 can be easily deformed when pressed against the outer surface of fan case 30. For example, parts of fan case spacer 40 other than protrusion 421 may be made of an ABS resin, and protrusion 421 may be made of a silicone resin or the like having rubber elasticity. In the case where protrusion 421 and parts other than protrusion 421 are made of different resin materials, protrusion 421 and parts other than protrusion 421 can be produced by two-color molding.

[0079] In electric blower 1 according to the present exemplary embodiment, tip part 422 of cover part 420 includes first pressure contact surface 422a that comes into close contact with the outer surface of fan case 30 annularly so as to surround inlet 30a, which corresponds to the second opening, of fan case 30.

[0080] This configuration allows two parts, namely protrusion 421 and tip part 422, to serve as adhering parts where fan case spacer 40 and fan case 30 adhere to each other. As a result, high and stable airtightness between fan case spacer 40 and fan case 30 can be easily obtained. Specifically, in the case where there is only one adhering part where fan case spacer 40 and fan case 30 adhere to each other, the airtightness between fan case spacer 40 and fan case 30 is likely to vary depending on the degree of adherence (the state of pressure contact) between fan case spacer 40 and fan case 30, which may cause unstable airtightness between fan case spacer 40 and fan case 30. In contrast, the two parts, namely protrusion 421 and tip parts 422, serve as adhering parts where fan case spacer 40 and fan case 30 adhere to each other. As a result, variations in the airtightness between fan case spacer 40 and fan case 30 can be significantly reduced, as compared with the case where there is only one adhering part. For example, by providing an adhering part on tip part 422 in addition to the adhering part of protrusion 421, or providing an adhering part on protrusion 421 in addition to the adhering part on tip part 422, variations in the airtightness between fan case spacer 40 and fan case 30 can be significantly reduced. As a result, high and stable airtightness between fan case spacer 40 and fan case 30 can be easily obtained. Therefore, the blowing efficiency of electric blower 1 can be kept high.

[0081] Furthermore, in electric blower 1 according to the present exemplary embodiment, cover part 420 includes pressure contact part 423 located between opening end 30a1 of inlet 30a, which is the second opening, of fan case 30 and protrusion 421. Pressure contact part 423 includes second pressure contact surface 423a that comes into pressure contact with the outer surface of fan case 30 annularly so as to surround inlet 30a, which corresponds to the second opening, of fan case 30.

[0082] This configuration additionally allows pressure contact part 423 to serve as an adhering part where fan case spacer 40 and fan case 30 adhere to each other. Therefore, high and stable airtightness between fan case spacer 40 and fan case 30 can be obtained more easily. In particular, as the three parts, namely protrusion 421, tip part 422, and pressure contact part 423, serve as adhering parts, variations in airtightness between fan case spacer 40 and fan case 30 can be much more significantly reduced. For example, by providing protrusion 421 as a third adhering part in addition to a first adhering part on tip part 422 and a second adhering part on pressure contact part 423, variations in the airtightness between fan case spacer 40 and fan case 30 can be much more significantly reduced. As a result, high and stable airtightness between fan case spacer 40 and fan case 30 can be more easily obtained. Therefore, the blowing efficien-

cy of electric blower 1 can be kept high more easily.

[0083] Furthermore, in electric blower 1 according to the present exemplary embodiment, fan case spacer 40 includes fixing part 413 for fixing fan case spacer 40 to fan case 30.

[0084] This configuration makes it easy to fix fan case spacer 40 to fan case 30. In particular, by providing fixing part 413 separately from the adhering parts on protrusion 421, tip part 422, and pressure contact part 423, it is ensured that fixing part 413 fixes fan case spacer 40 to fan case 30 and the adhering parts obtain stable airtightness between fan case spacer 40 and fan case 30.

[0085] In addition, in electric blower 1 according to the present exemplary embodiment, fixing part 413 is welded to opening end 30a1 of inlet 30a, which is the second opening, of fan case 30.

[0086] Therefore, by melting fixing part 413, fixing part 413 is allowed to be joined to opening end 30a1 of fan case 30.

[0087] For example, fixing part (welded part) 413 is welded to opening end 30a1 of inlet 30a, which is the second opening, of fan case 30 by ultrasonic welding. In this case, fixing part 413 is preferably made of a thermoplastic resin.

[0088] Therefore, fixing part 413 can be melted by ultrasonic vibration and welding force and joined to opening end 30a1 of fan case 30.

[0089] As described above, electric blower 1 of the present exemplary embodiment includes: rotor 11 that includes rotary shaft 13; centrifugal fan 20 that includes inlet 20a and is attached to rotary shaft 13, inlet 20a being a first opening; fan case 30 that includes inlet 30a and covers centrifugal fan 20, inlet 30a being a second opening whose opening end 30a1 is located outside opening end 20a1 of inlet 20a, which is the first opening; and fan case spacer 40 that includes inlet 40a and is attached to fan case 30, inlet 40a being a third opening in communication with inlet 20a, which is the first opening. Fan case spacer 40 includes: spacer part 410 that closes off the gap between opening end 20a1 of inlet 20a, which is the first opening, and opening end 30a1 of inlet 30a, which is the second opening; and cover part 420 that extends outward from opening end 30a1 of inlet 30a, which is the second opening, and covers the outer surface of fan case 30. Cover part 420 includes a protrusion that is annular, protrudes toward the outer surface of fan case 30 and surrounds inlet 30a, which is the second opening. Protrusion 421 is located between opening end 30a1 of inlet 30a, which is the second opening, and tip part 422 of cover part 420, and is in contact with the outer surface of fan case 30.

[0090] As a result, the airtightness between fan case 30 and fan case spacer 40 in electric blower 1 can be enhanced, and thus the blowing efficiency of electric blower 1 can be improved.

(Modifications)

[0091] An electric blower according to the present disclosure has been described above on the basis of an exemplary embodiment; however, the present disclosure is not limited to the above exemplary embodiment.

[0092] For example, in the above exemplary embodiment, a commutator motor with a brush is used as motor 10 employed in electric blower 1; however, motor 10 is not limited thereto. Motor 10 may be a brushless motor or the like.

[0093] Electric blower 1 according to the above exemplary embodiment may be used for a vacuum cleaner, an air towel, or the like. Electric blower 1 may be applied not only to a vacuum cleaner or an air towel but also to equipment for cars, and to other household appliances or industrial equipment.

[0094] In addition, the present disclosure includes other embodiments obtained by making various modifications conceived by those skilled in the art to the above exemplary embodiment, or other embodiments achieved by any combination of the components and functions in each exemplary embodiment without departing from the spirit of the present disclosure.

INDUSTRIAL APPLICABILITY

[0095] The technology of the present disclosure can be used for various electric apparatuses in which an electric blower is used. The technology of the present disclosure is particularly useful for an electric blower disposed in a vacuum cleaner or the like in which a centrifugal fan is rotated at high speed.

REFERENCE MARKS IN THE DRAWINGS

[0096]

1	electric blower
10	motor
11	rotor
11a	rotor core
11b	wound coil
12	stator
13	rotary shaft
14	commutator
15	brush
16	first bearing part
17	second bearing part
20	centrifugal fan
20a	inlet (first opening)
20a1	opening end
20b	outlet
21	first lateral plate
22	second lateral plate
23	fan blade
30	fan case
30a	inlet (second opening)

30a1	opening end
31	lid part
32	side wall part
40	fan case spacer
40a	inlet (third opening)
40a1	opening end
50	air guide
51	diffuser blade
60	motor case
60a	outlet
61	bracket
410	spacer part
411	first connecting part
412	second connecting part
413	fixing part
420	cover part
421	protrusion
422	tip part
422a	first pressure contact surface
423	pressure contact part
423a	second pressure contact surface

Claims

1. An electric blower comprising:

a rotor that includes a rotary shaft;
a centrifugal fan that includes a first opening and is attached to the rotary shaft;
a fan case that includes a second opening and covers the centrifugal fan, the second opening including an opening end that is located outside an opening end of the first opening; and
a fan case spacer that includes a third opening and is attached to the fan case, the third opening being in communication with the first opening,
wherein the fan case spacer includes: a spacer part that closes off a gap between the opening end of the first opening and the opening end of the second opening; and a cover part that extends outward from the opening end of the second opening and covers an outer surface of the fan case,
the cover part includes a protrusion that is annular, protrudes toward the outer surface of the fan case, and surrounds the second opening, and
the protrusion is located between the opening end of the second opening and a tip part of the cover part and is in contact with the outer surface of the fan case.

2. The electric blower according to claim 1, wherein the protrusion is inclined along the outer surface of the fan case.

3. The electric blower according to claim 2, wherein the protrusion is curved to extend outward from the third opening.

4. The electric blower according to claim 2 or 3, wherein the protrusion is in a tapered shape.

5. The electric blower according to any one of claims 1 to 4, wherein the tip part of the cover part includes a first pressure contact surface that adheres annularly to the outer surface of the fan case, the first pressure contact surface surrounding the second opening.

6. The electric blower according to claim 5, wherein the cover part includes a pressure contact part located between the opening end of the second opening and the protrusion, and the pressure contact part includes a second pressure contact surface that is annularly in pressure contact with the outer surface of the fan case, the second pressure contact surface surrounding the second opening.

7. The electric blower according to any one of claims 1 to 6, wherein the fan case spacer includes a fixing part for fixing the fan case spacer to the fan case.

8. The electric blower according to claim 7, wherein the fixing part is welded to the opening end of the second opening.

9. The electric blower according to claim 8, wherein the fixing part is welded to the opening end of the second opening by ultrasonic welding.

10. The electric blower according to claim 8 or 9, wherein the fixing part includes a thermoplastic resin.

FIG. 1

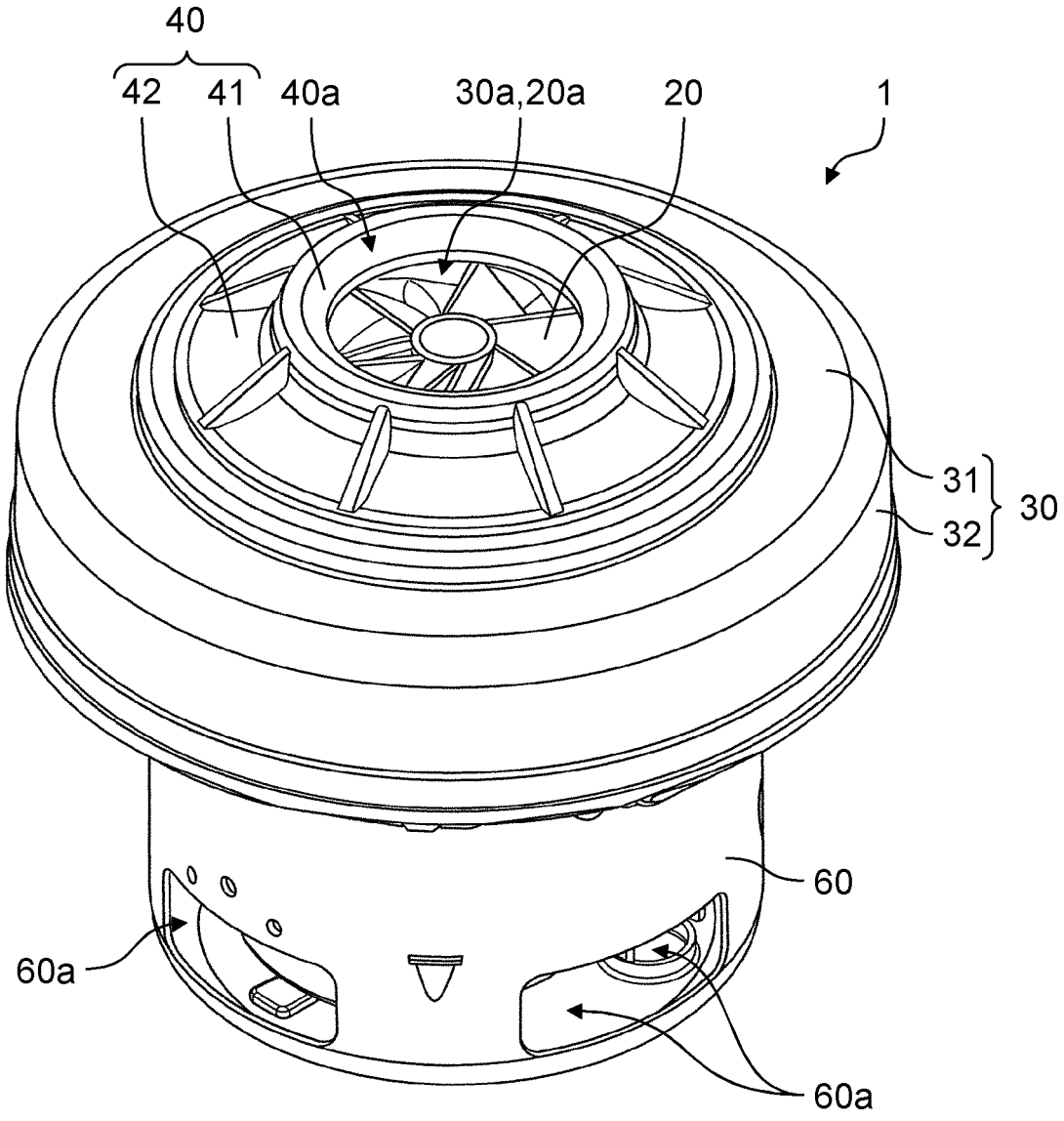

FIG. 2

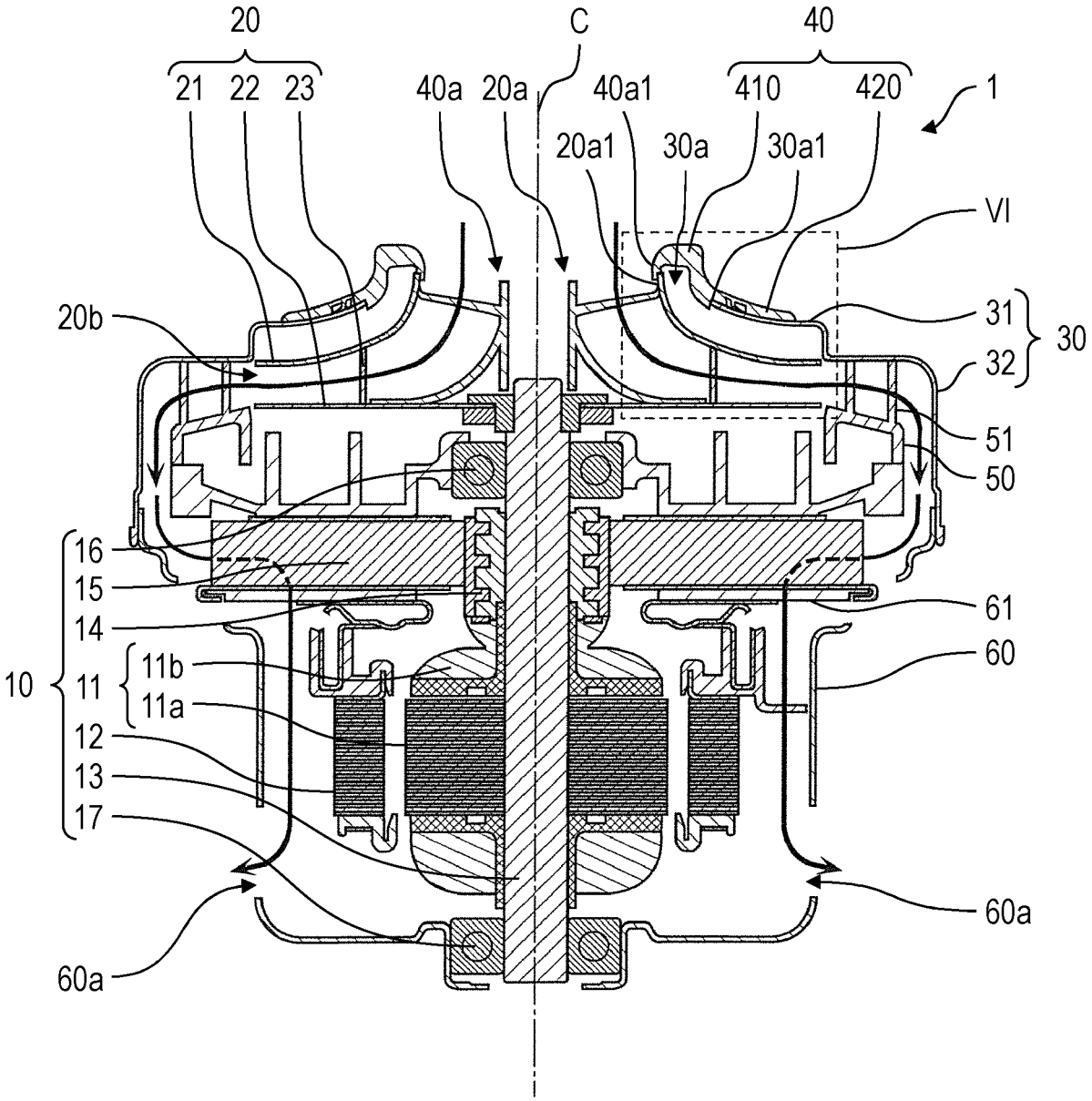
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FIG. 3

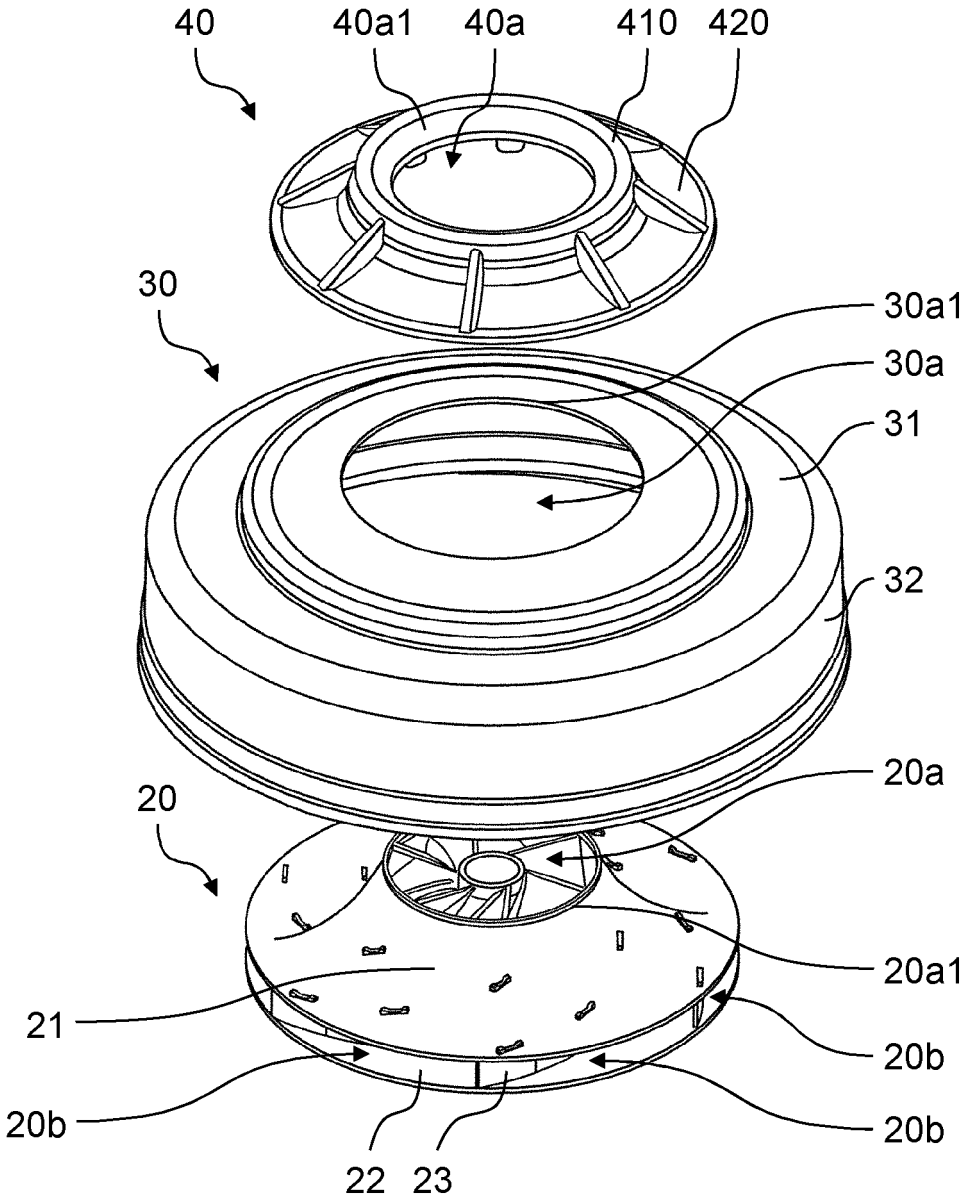
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FIG. 4

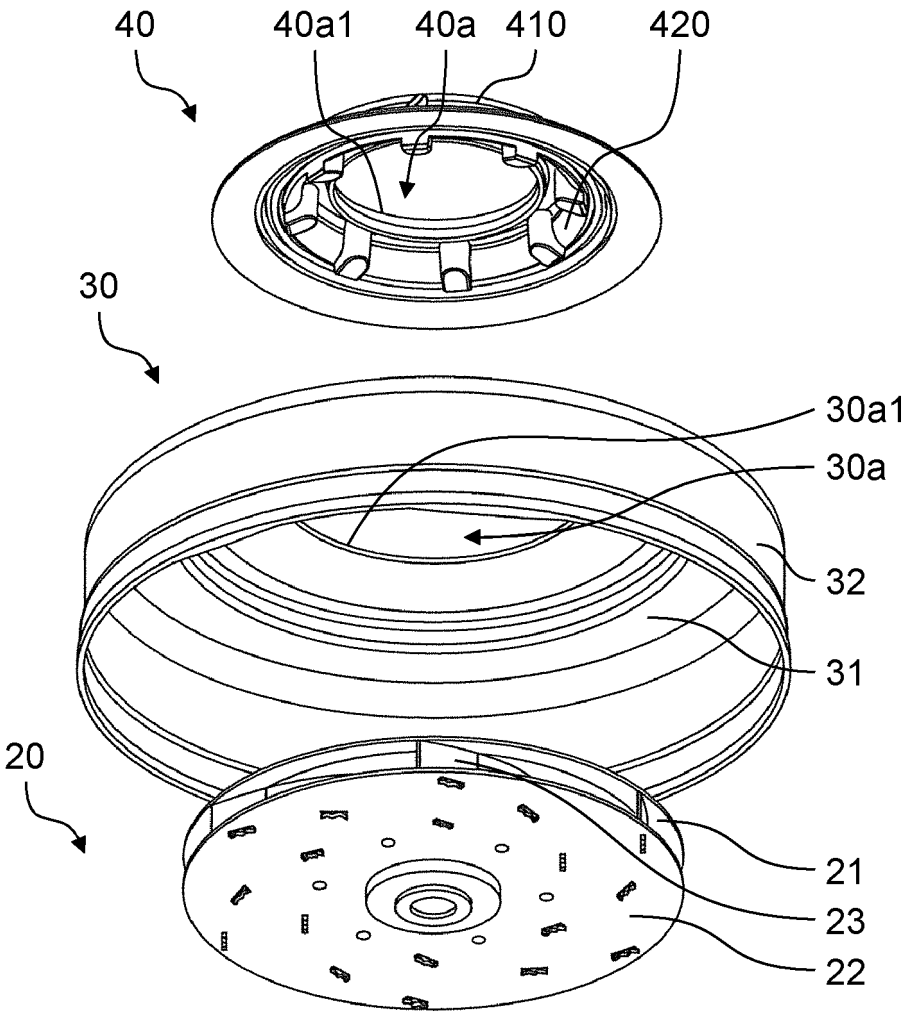

FIG. 5

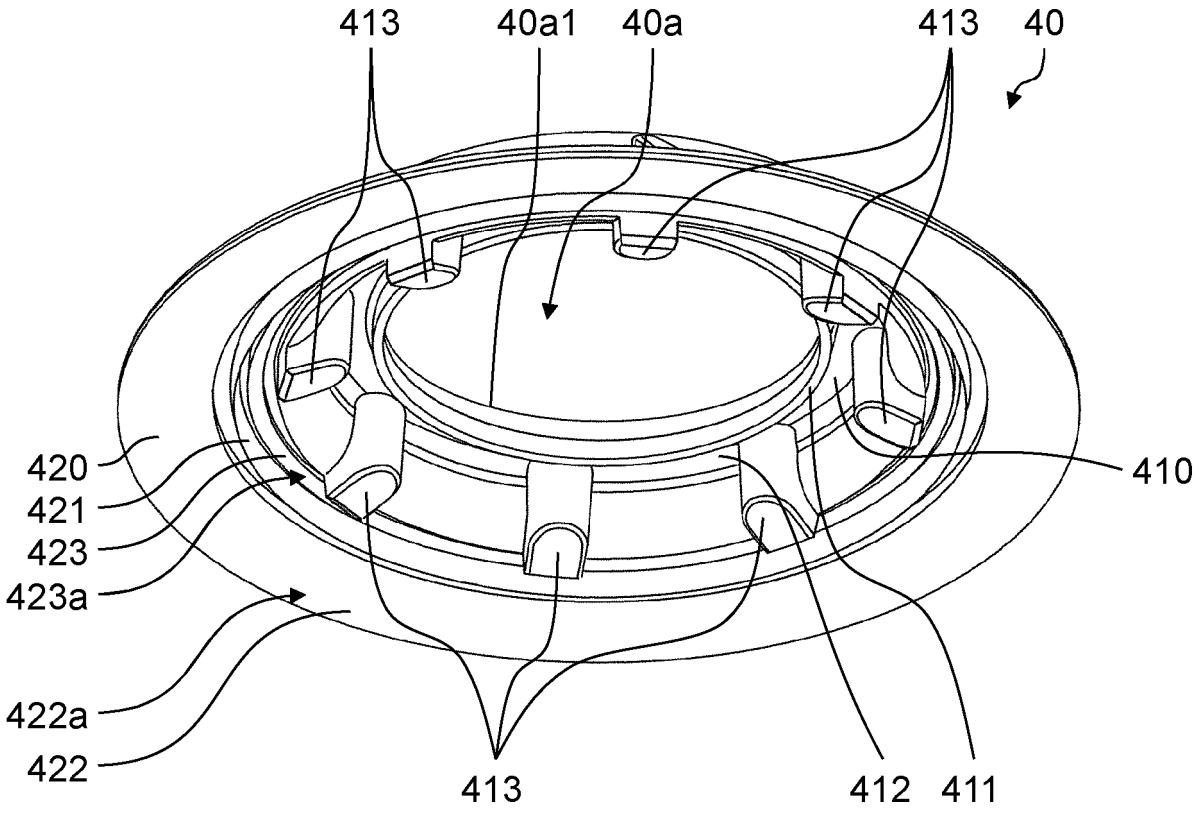

FIG. 6

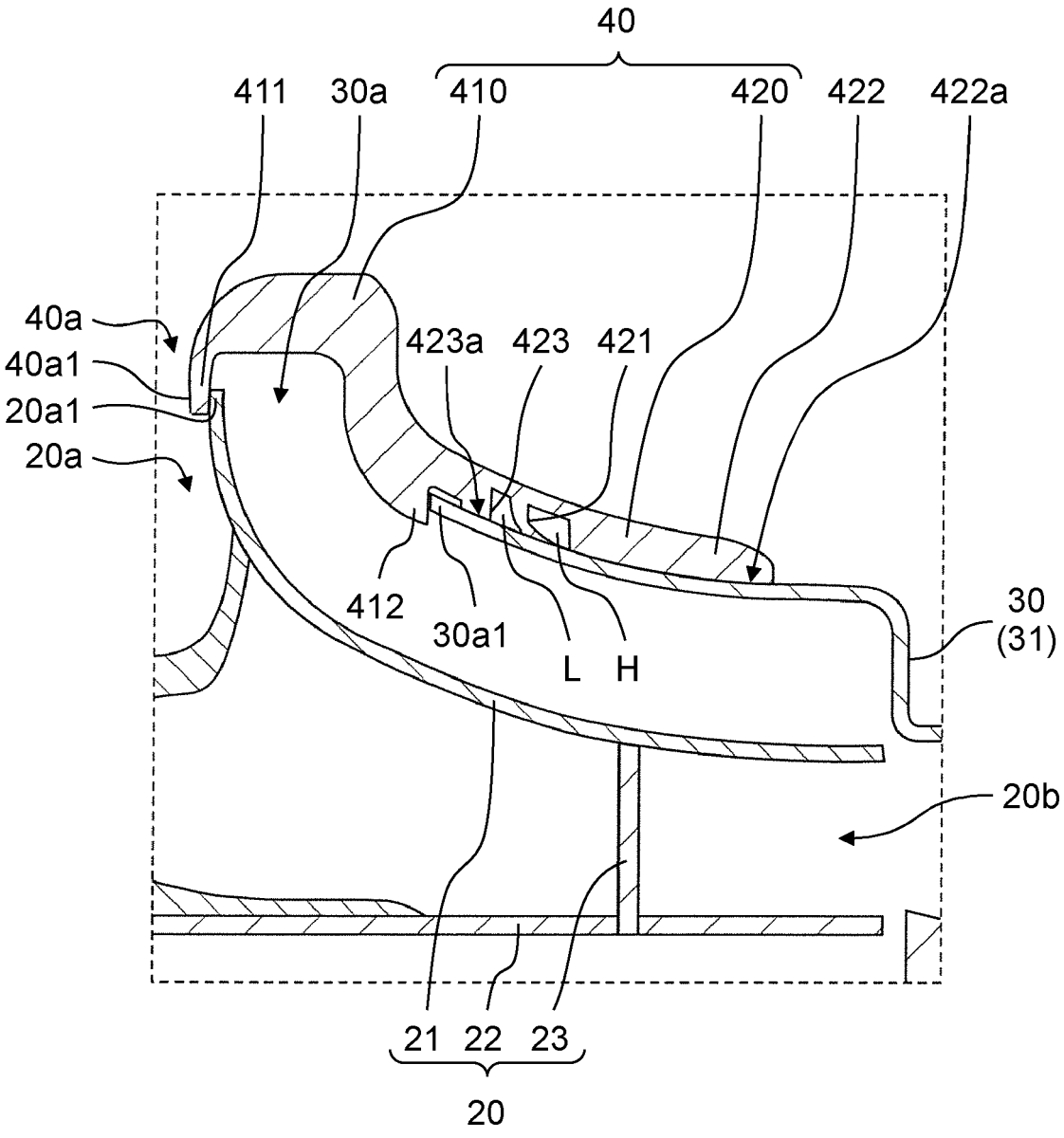
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FIG. 7

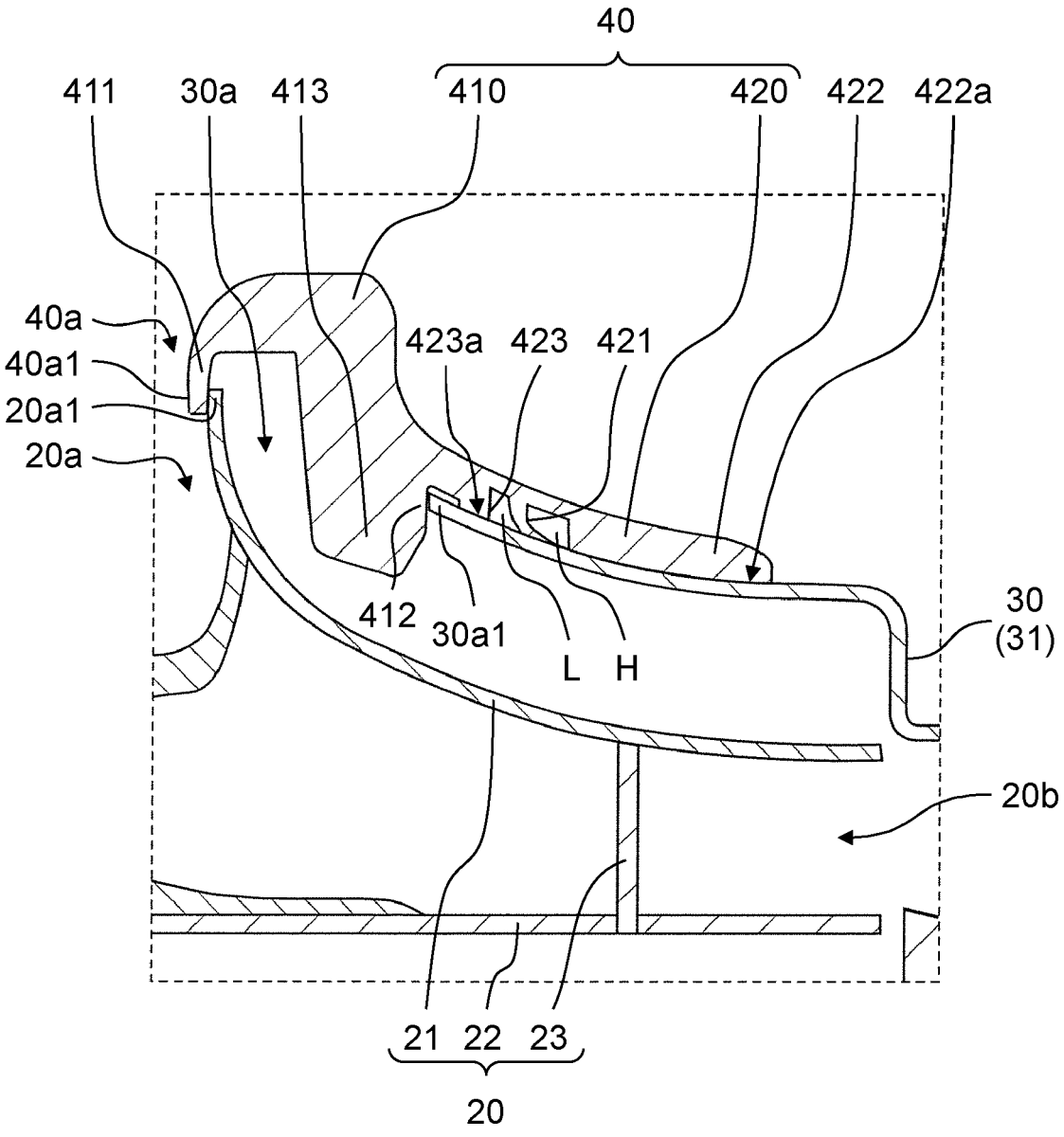
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FIG. 8

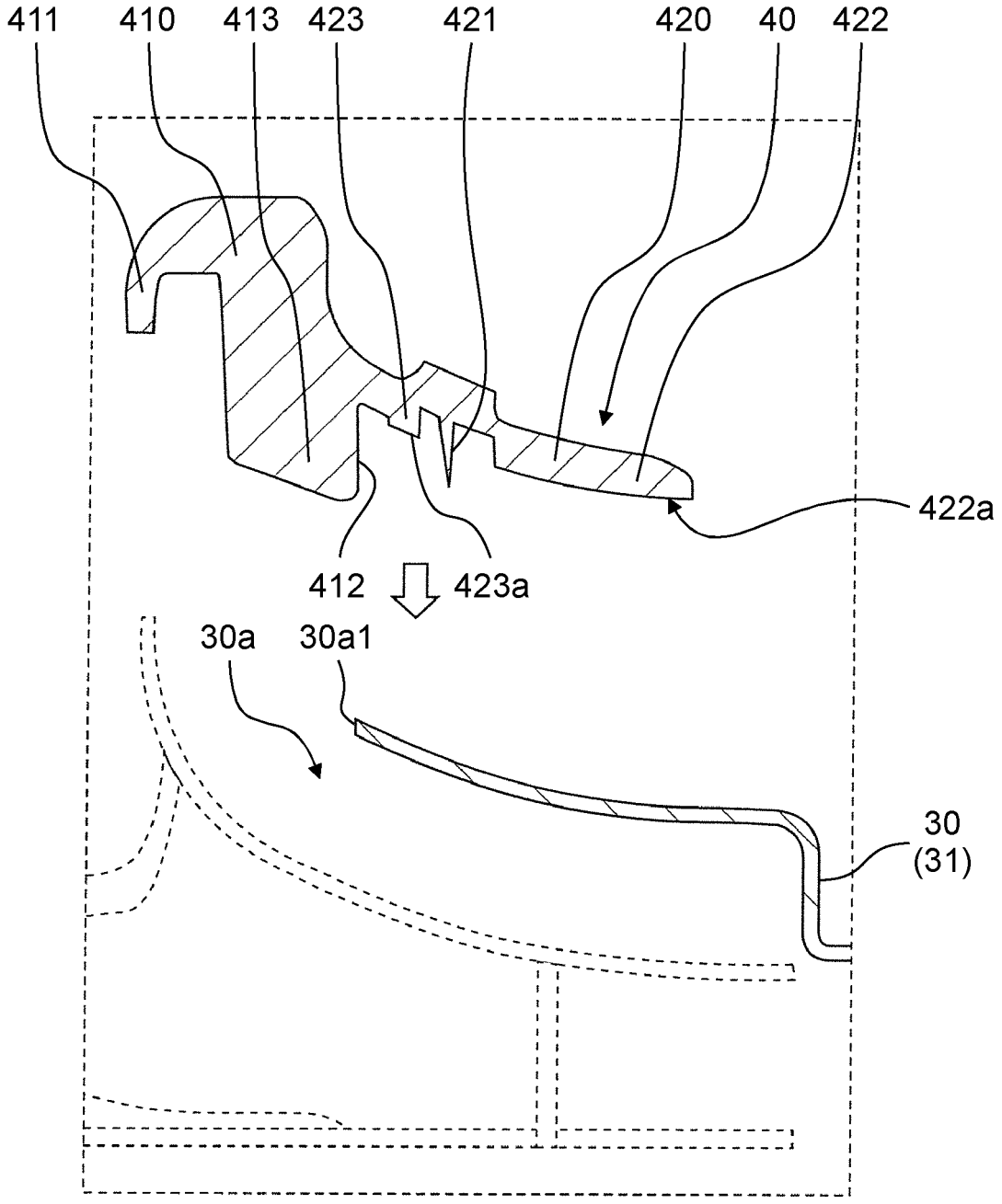
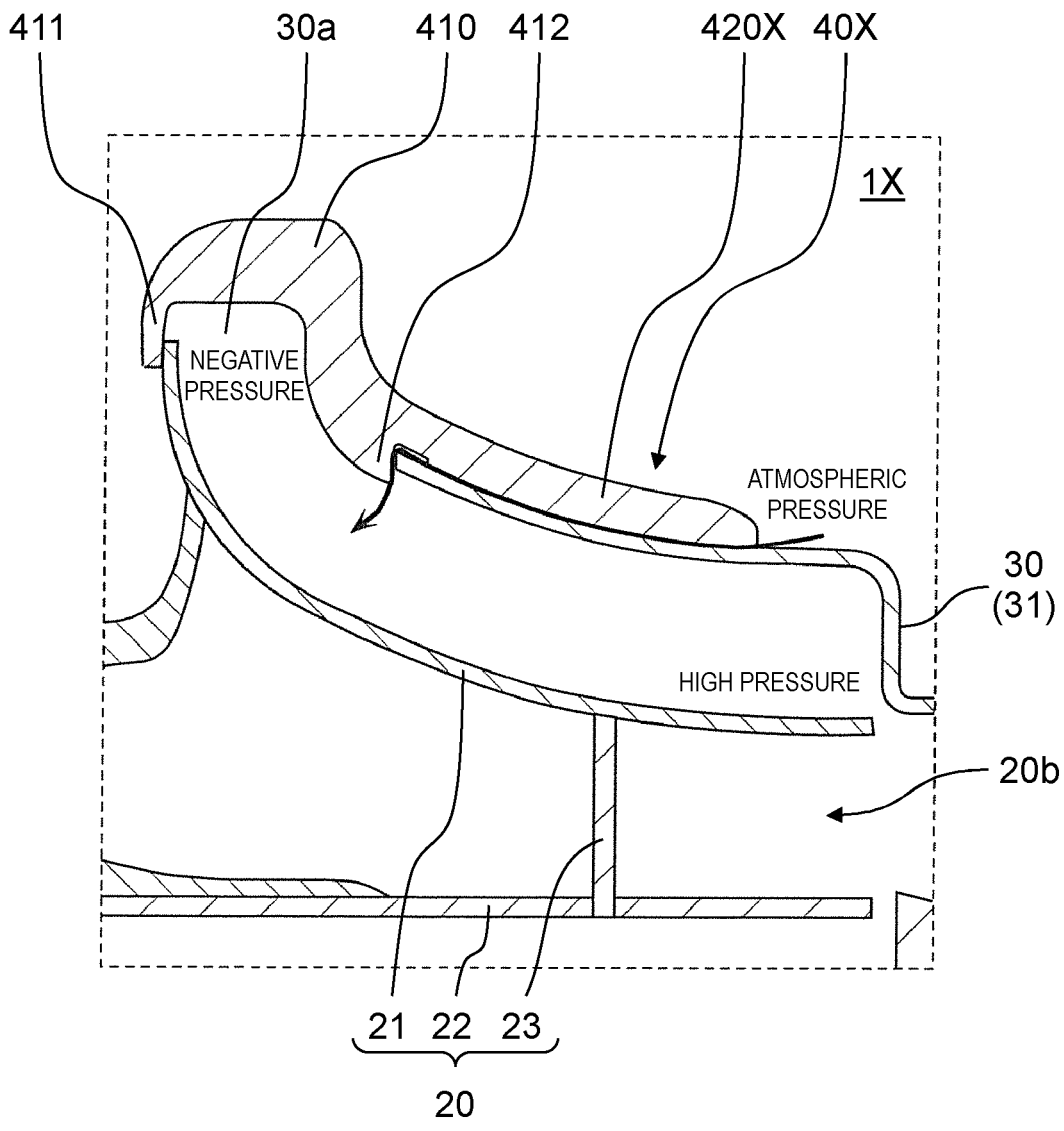


FIG. 9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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/051322

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F04D29/16(2006.01)i, F04D29/44(2006.01)i
FI: F04D29/44 N, F04D29/16, F04D29/44 Y, F04D29/44 P

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. F04D29/16, F04D29/44

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2020
Registered utility model specifications of Japan 1996-2020
Published registered utility model applications of Japan 1994-2020

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 A	JP 2000-64993 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 03 March 2000, paragraphs [0007]-[0010], fig. 1-3	1-4, 7-10 5-6
A	JP 2008-64066 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 21 March 2008, fig. 1-4	1-10
A	DE 102013111051 A1 (MIELE & CIE. KG) 09 April 2015, fig. 1-3	1-10

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

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"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
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"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	Date of mailing of the international search report
02.03.2020	17.03.2020

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2019/051322

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 2000-64993 A	03.03.2000	(Family: none)	
JP 2008-64066 A	21.03.2008	(Family: none)	
DE 102013111051 A1	09.04.2015	EP 2857693 A1	

REFERENCES CITED IN THE DESCRIPTION

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- JP 2008180165 A **[0006]**