(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 376 044 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
19.09.2018 Bulletin 2018/38

(21) Application number: **16864185.0**

(22) Date of filing: **08.11.2016**

(51) Int Cl.:
F04D 29/00 *(2006.01)* ***A47L 9/00*** *(2006.01)*
F04D 29/58 *(2006.01)*

(86) International application number:
PCT/JP2016/083019

(87) International publication number:
WO 2017/082224 (18.05.2017 Gazette 2017/20)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **09.11.2015 JP 2015219104**
22.04.2016 JP 2016086362

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(54) **BLOWING DEVICE AND CLEANER**

(57) A blowing device according to an exemplary embodiment of the present invention includes a motor that includes a shaft disposed along a central axis extending in an up-down direction, an impeller fixed to the shaft, the impeller being disposed above the motor, an impeller cover that surrounds an upper side and an outer side in a radial direction of the impeller, the impeller cover including an intake port at a middle, a motor cover disposed on an outer side in a radial direction of the motor, the motor including a rotor portion fixed to the shaft, the rotor portion including a magnet, a stator portion that opposes the magnet, and a bearing that rotatably supports the shaft with respect to the stator portion, the motor cover including a tubular motor cover cylindrical portion that is open downwards, an inner surface of the motor cover cylindrical portion opposing the motor with a gap in between in the radial direction, and the motor cover cylindrical portion including a communication portion that communicates an inner space of the motor cover cylindrical portion and an outer space of the motor cover cylindrical portion to each other.

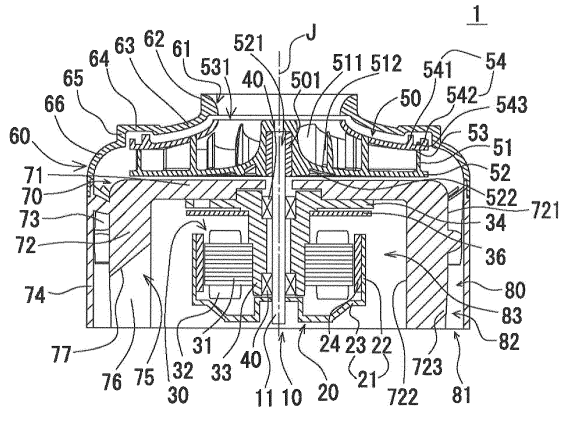

Fig. 2

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Description

Technical Field

[0001] The present invention is related to a blowing device and a vacuum cleaner.

Background Art

[0002] Hitherto, there is known an electric blower that is capable of cooling a drive semiconductor element. For example, an electric blower described in Japanese Unexamined Patent Application Publication No. 11-336696 distributes air that has been generated by an impeller and that has been guided by an air guide along a ventilation passage formed between an outer cylinder and a frame, and claims that a compact, efficient, and low-noise cooling mechanism can be obtained by attaching a drive semiconductor element to the outer cylinder.

Citation List

Patent Literature

[0003] PTL 1: Japanese Unexamined Patent Application Publication No. 11-336696

Summary of Invention

Technical Problem

[0004] However, in the electric blower described in Japanese Unexamined Patent Application Publication No. 11-336696, the air that has flowed along the ventilation passage does not flow into an inside of the frame; accordingly, there is a problem in that the motor cannot be efficiently cooled.

[0005] In view of the above problem, an object of an exemplary embodiment of the present invention is to obtain a blowing device that is capable of efficiently cooling a motor disposed inside a motor cover.

Solution to Problem

[0006] A blowing device according to an exemplary embodiment of the present invention includes a motor that includes a shaft disposed along a central axis extending in an up-down direction, an impeller fixed to the shaft, the impeller being disposed above the motor, an impeller cover that surrounds an upper side and an outer side in a radial direction of the impeller, the impeller cover including an intake port at a middle, a motor cover disposed on an outer side in a radial direction of the motor, the motor including a rotor portion fixed to the shaft, the rotor portion including a magnet, a stator portion that opposes the magnet, and a bearing that rotatably supports the shaft with respect to the stator portion, the motor cover including a tubular motor cover cylindrical portion that is open downwards, an inner surface of the motor cover cylindrical portion opposing the motor with a gap in between in the radial direction, and the motor cover cylindrical portion including a communication portion that communicates an inner space of the motor cover cylindrical portion and an outer space of the motor cover cylindrical portion to each other.

Advantageous Effects of Invention

[0007] A blowing device according to an exemplary embodiment of the present invention is capable of efficiently coming a motor disposed inside a motor cover. Furthermore, a vacuum cleaner provided with such a blowing device can be obtained.

Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is an upper perspective view of a blowing device according to a first embodiment.
[Fig. 2] Fig. 2 is a longitudinal section of the blowing device according to the first embodiment.
[Fig. 3] Fig. 3 is a bottom view of the blowing device according to the first embodiment.
[Fig. 4] Fig. 4 is a lower perspective view of the blowing device according to the first embodiment.
[Fig. 5] Fig. 5 is a longitudinal section of a blowing device according to a second embodiment.
[Fig. 6] Fig. 6 is a bottom view of the blowing device according to the second embodiment.
[Fig. 7] Fig. 7 is a perspective view of a vacuum cleaner.

Description of Embodiments

[0009] Hereinafter, referring to the drawings, a blowing device according to exemplary embodiments of the present invention will be described. In the description hereinafter, the direction in which a central axis J extends is referred to as an axial direction. Furthermore, the upper side in the axial direction is merely referred to as an upper side and the lower side in the axial direction is merely referred to as a lower side. Note that the axial direction, an up-down direction, the upper side, and the lower side are terms that are used merely for description and do not limit the actual positional relationships and directions. Furthermore, unless otherwise stated, a direction parallel to the central axis J is merely referred to as the "axial direction", a radial direction having the central axis J as the center is merely referred to as a "radial direction", and a circumferential direction about the central axis J is merely referred to as a "circumferential direction". Note that in the description hereinafter, for convenience sake, slanted lines in the cross sections and lines that illustrate partial structures may be omitted.

<First Embodiment>

[0010] Hereinafter, a blowing device 1 according to an exemplary first embodiment of the present invention will be described. Fig. 1 is an upper perspective view of the blowing device 1. The blowing device 1 includes an impeller cover 60, a blower cover 74, and an impeller 50.

[0011] Fig. 2 is a longitudinal section of the blowing device 1 of the first embodiment. The blowing device 1 includes a motor 10, the impeller 50, the impeller cover 60, and a motor cover 70. The motor 10 includes a shaft 11 disposed along the vertically extending central axis J. The motor 10 includes a rotor portion 20, a stator portion 30, and bearings 40. The bearings 40 rotatably supports the shaft 11 with respect to the stator portion 30.

<Rotor Portion>

[0012] The rotor portion 20 includes a rotor holder 21 that is fixed to the shaft 11 and that has a lidded cylindrical shape having an opening on the upper side. In the present embodiment, the rotor holder 21 is directly fixed to the shaft 11. However, the rotor holder 21 may be fixed to the shaft 11 with another member interposed therebetween.

[0013] The rotor holder 21 includes a rotor holder cylindrical portion 22 and a rotor holder bottom portion 23. The rotor holder cylindrical portion 22 is a tubular portion extending in the axial direction. A magnet 24 is fixed to an inner circumferential surface of the rotor holder cylindrical portion 22. In other words, the rotor portion 20 is fixed to the shaft 11 and includes the magnet 24. The magnet 24 has a cylindrical shape.

[0014] The rotor holder bottom portion 23 is disposed below the rotor holder cylindrical portion 22. More specifically, the rotor holder bottom portion 23 is a substantially plate-shaped portion that extends inwardly from a lower end of the rotor holder cylindrical portion 22.

<Stator Portion>

[0015] The stator portion 30 opposes the magnet 24. The stator portion 30 includes a stator core 31, and coils 32 are each formed in the stator core 31 by wounding conducing wire with an insulator (not shown) interposed therebetween. In the present embodiment, the motor 10 is of a so-called outer rotor type. Accordingly, the magnet 24 is fixed to an inner circumferential surface of the rotor holder cylindrical portion 22. The stator core 31 is disposed inside the magnet 24 with a gap therebetween in the radial direction.

[0016] The stator portion 30 includes a bearing housing 33, a mounting plate 34, and a circuit board 36. The bearing housing 33 is a tubular member extending in the axial direction. A portion of the bearing housing 33 is fixed to a portion of a motor cover top plate portion 71 described later. The bearings 40 are fixed to an inner surface of the bearing housing 33. In the present embodiment, the bearings 40 are ball bearings. Note that the bearings 40 may be slide bearings or the like.

[0017] The mounting plate 34 is disposed above the rotor holder 21 and the stator core 31. The mounting plate 34 on the outer side with respect to the bearing housing 33 extends in a direction orthogonal to the shaft 11. At least a portion of the mounting plate 34 is fixed to the bearing housing 33. The mounting plate 34 is formed of a metal member. As illustrated in Fig. 3, the mounting plate 34 includes mounting plate flange portions 35 that protrude from the outer edge thereof in the radial direction. In the present embodiment, the mounting plate flange portions 35 are formed at three portions in the circumferential direction. The mounting plate flange portions 35 and the motor cover top plate portion 71 described later are fixed to each other with screws.

[0018] Returning to Fig. 2, the motor 10 further includes the circuit board 36 disposed below the mounting plate 34 and above the rotor holder 21. The circuit board 36 on the outer side with respect to the bearing housing 33 extends in a direction orthogonal to the shaft 11. In other words, an outer end of the circuit board 36 in the radial direction is disposed radially outside an outer end of the bearing housing 33 in the radial direction. An inner end of the circuit board 36 in the radial direction is fixed to the bearing housing 33. Lead wire drawn out from each coil 32 is electrically connected to the circuit board 36. The electric connection between the circuit board 36 and each lead wire is achieved by soldering, for example.

<Impeller>

[0019] The impeller 50 is fixed to the shaft 11 and is disposed above the motor 10. With the rotation of the motor 10 fixed to the shaft 11, the impeller 50 rotates about the central axis J together with the shaft 11. In the present embodiment, in plan view from the upper side in the axial direction, the impeller 50 rotates in the counterclockwise direction. In other words, in plan view from the upper side in the axial direction, a rotation direction R of the impeller is counterclockwise.

[0020] The impeller 50 includes a plurality of moving blades 51, a main plate 52, a shroud 53, and a balance correcting portion 54. The balance correcting portion 54 is formed on the shroud 53. Describing in more detail, the balance correcting portion 54 is disposed on an upper surface of the shroud 53 in an external area in the radial direction.

[0021] The balance correcting portion 54 includes a first protrusion 541 and a second protrusion 542. The first protrusion 541 is an annular portion that protrudes upwards from the upper surface of the shroud 53. The second protrusion 542 is an annular portion that protrudes upwards from the upper surface of the shroud 53. The second protrusion 542 is disposed on an outer side of the first protrusion 541 in the radial direction. In the present embodiment, the second protrusion 542 is disposed on an outer edge of the shroud 53. With the above, a space is formed between the first protrusion 541 and the second protrusion 542 in the radial direction.

[0022] When the balance of the assembly of the motor 10 and the impeller 50 is corrected, a weight 543 is put in in a space between the first protrusion 541 and the second protrusion 542 in the radial direction; accordingly, the rotational balance of the assembly of the impeller 50 and the rotor portion 30 is corrected with respect to the central axis J. Note that in the present embodiment, since the balance correcting portion 54 is formed on the upper surface of the shroud 53, the balance can be corrected easily even after the assembly has been formed. In other words, work efficiency when correcting the balance of the assembly is improved. Furthermore, since an upper end of the first protrusion 541 is disposed above an upper end of the second protrusion 542, air can be suppressed from flowing inside the first protrusion 541 in the radial direction when the impeller 50 is rotated. In other words, the labyrinth characteristics between the upper surface of the shroud 53 and the impeller cover 60 is improved.

[0023] The plurality of moving blades 51 are disposed in the circumferential direction. In the present embodiment, the plurality of moving blades 51 include first moving blades 511 and second moving blades 512. Inner ends of the first moving blades 511 in the radial direction are disposed radially inside inner ends of the second moving blades 512 in the radial direction. In other words, the plurality of moving blades 51 are constituted by two types of moving blades that have different lengths in the radial direction. In the present embodiment, the moving blades 51 are formed by disposing the first moving blades 511 and the second moving blades 512 in the circumferential direction. However, the plurality of moving blades 51 may all have the same shape or may have three types of different shapes.

[0024] The main plate 52 is molded as a member that is integral with the plurality of moving blades 51. The main plate 52 is disposed below the moving blades 51. Lower portions of the plurality of moving blades 51 are connected to the main plate 52. A vertically penetrating through hole 521 is formed on an inner side of the main plate 52. The impeller 50 is fixed to the shaft 11 through an impeller hub 501 fixed to the through hole 521. However, the impeller 50 and the shaft 11 may be fixed to each other through another fixing method. In the present embodiment, an upper surface of the main plate 52 forms a curved surface that is the highest at the middle portion thereof and that, as the curved surface extends towards the outer side, spreads downwards in a smooth manner. With the above, since the air flowing from the upper side is guided along the upper surface of the main plate 52 towards the outer side in the radial direction, air blowing efficiency of the impeller 50 is improved. Note that the main plate 52 may have another shape and, for example, may have a flat plate shape that extends in the direction orthogonal to the shaft 11.

[0025] An inner side of an underside of the main plate 52 is disposed above an underside of an outer edge of the main plate 52. The underside of the main plate 52 has a curved surface that extends towards the lower side in a smooth manner as the curved surface extends from the inside to the outer side. The main plate 52 includes, in the underside thereof, a plurality of main plate ribs 522 disposed in the circumferential direction. Positions of the lower ends of the main plate ribs 522 in the axial direction are substantially the same as the position of the underside of the outer edge of the main plate 52 in the axial direction. However, the lower ends of the main plate ribs 522 may be positioned above the outer edge of the main plate 52. The main plate ribs 522 are disposed more on the rear side in the rotation direction R of the impeller as the main plate ribs 522 extend from the inside towards the outer side. With the above, when the impeller 50 rotates, the main plate ribs 522 rotates as well in an integral manner; accordingly, the air between the main plate 52 and an upper surface of the motor cover top plate portion 71 described later can be discharged towards the outer side in the radial direction. Accordingly, a decrease in the air blowing efficiency caused by the air discharged by the rotation of the impeller 50 towards the outer side in the radial direction flowing into the gap between the main plate 52 and the motor cover top plate portion 71 in the axial direction can be reduced. Furthermore, the rigidity of the main plate 52 is increased owing to the formation of the main plate ribs 522.

[0026] The shroud 53 is disposed above the moving blades 52. The shroud 53 includes a through hole 531 that penetrates thereof in the axial direction. Upper portions of the plurality of moving blades 52 are connected to the upper shroud 53. In the middle portion of the upper shroud 53, the through hole 531 that penetrates thereof in the axial direction is formed. With the above, the air that has been taken in from above the impeller 50 passes through the through hole 531 of the shroud 53 and is taken in into the impeller 50. The shroud 53 curves towards the lower side in a smooth manner as the shroud 53 extends from an inner end to the outer side. Accordingly, the air taken in into the impeller 50 is guided downwards and outwards in a smooth manner along the underside of the shroud 53 and the upper surface of the main plate 52.

<Impeller Cover>

[0027] The impeller cover 60 surrounds an upper side and an outer side in the radial direction of the impeller 50, and includes an intake port 61 at the middle thereof. With the above, the air above the blowing device 1 can be taken in into the blowing device 1 through the intake port 61. The air taken in through the intake port 61 is taken in inside the impeller 50 through the through hole 531 formed in the shroud 53.

[0028] The impeller cover 60 includes an impeller cover upper end portion 62, an impeller cover inclination portion 63, an impeller cover projecting portion 64, an impeller cover cylindrical portion 65, and an impeller cover guide portion 66.

[0029] The impeller cover upper end portion 62 includes, at the middle thereof, the intake port 61. The impeller cover inclination portion 63 extends towards the outer side and the lower side in a smooth manner from an outer side of the impeller cover upper end portion 62. An underside of the impeller cover inclination portion 63 opposes the upper surface of the shroud 53 with a gap in between. The gap formed between the underside of the impeller cover inclination portion 63 and the upper surface of the shroud 53 is substantially uniform. With the above, a decrease in the air blowing efficiency of the blowing device 1 due to the air flowing in between the impeller cover inclination portion 63 and the upper shroud 53 can be suppressed.

[0030] The impeller cover projecting portion 64 projects upwards from an outer side of the impeller cover inclination portion 63. The impeller cover projecting portion 64 is a portion that projects upwards from the outer side of the impeller cover inclination portion 63. The impeller cover projecting portion 64 is formed in an annular manner about the central axis J. An underside of the impeller cover projecting portion 64 is disposed above an outer side of the underside of the impeller cover inclination portion 63. In other words, in the area where the impeller cover projecting portion 64 is disposed, an underside of the impeller cover 60 is recessed towards the upper side. The upper balance correcting portion 54 is disposed in a space formed below the impeller cover projecting portion 64.

[0031] The impeller cover cylindrical portion 65 is a tubular portion that extends downwards from an outer side of the impeller cover projecting portion 64. On an outer side of an outer end of the impeller 50, the impeller cover guide portion 66 extends downwards and outwards in the radial direction so as to form a smooth curved surface forming a convex from a lower end portion of the impeller cover cylindrical portion 65 towards the outer side of the impeller cover 60. With the above, the air exhausted from the impeller 50 is guided outwards in the radial direction and downwards in a smooth manner.

<Motor Cover>

[0032] The motor cover 70 is disposed on the outer side of the motor 10 in the radial direction. The motor cover 70 includes the motor cover top plate portion 71 and a motor cover cylindrical portion 72. The motor cover top plate portion 71 is disposed above the motor 10 and is a plate-shaped portion that extends in a direction substantially orthogonal to the central axis J. The motor cover cylindrical portion 72 is a tubular portion that extends downwards from an outer side of the motor cover top plate portion 71 in the radial direction. The motor cover cylindrical portion 72 is open downwards. In other words, the motor cover 70 includes a tubular motor cover cylindrical portion 72 that open downwards.

[0033] The blower cover 74 is disposed on the outer side of the outer surface 721 of the motor cover cylindrical portion in the radial direction. The blower cover 74 is connected to the impeller cover guide portion 66 and is a tubular portion that extends downwards. The outer surface 721 of the motor cover cylindrical portion and an inner surface of the blower cover 74 oppose each other with a gap in between in the radial direction. With the above, a flow passage 80 is formed between the outer surface 721 of the impeller cover cylindrical portion and the inner surface of the blower cover 74. The outer surface 721 of the motor cover cylindrical portion and a lower end of the blower cover 74 constitute an exhaust port 81 of the flow passage 80. Accordingly, the air discharged to the outside of the impeller 50 in the radial direction is smoothly guided along an inner surface of the impeller cover guide portion 66 towards the outer side in the radial direction and towards the lower side in the axial direction, passes the flow passage 80, and is discharged towards the lower side from the exhaust port 81.

[0034] The motor cover 70 includes a plurality of stator blades 73 disposed on an outer surface of the motor cover cylindrical portion 72 in the circumferential direction. Lower portions of the stator blades 73 in the axial direction are disposed on the front side in the rotation direction R of the impeller with respect to the upper portions of the stator blades 73 in the axial direction. Describing in more detail, the upper portions of the stator blades 73 in the axial direction are positioned on the rear side in the rotation direction R of the impeller, and are curved downwards in a smooth manner from upper ends towards the front side in the rotation direction R of the impeller and towards the lower side, and extend downwards towards the lower portions of the stator blades 73 in the axial direction. With the above, the air flowing inside the flow passage 80 is guided towards the exhaust port 81 in a smooth manner. In other words, since the air discharged by the rotation of the impeller 50 has a swirling component in the circumferential direction oriented towards the front side in the rotation direction R of the impeller, the air having a swirling component is guided in a smooth manner towards the lower side with the stator blades 73. With the above, the air blowing efficiency of the air flowing inside the flow passage 80 is improved.

[0035] In the present embodiment, the motor cover 70, the stator blades 73, and the blower cover 74 are formed by an integral resin member. Outer sides of the stator blades 73 in the radial direction are connected to the inner surface of the blower cover 74. In other words, the impeller cover 70 includes the tubular blower cover 74 that extends downwards from a lower end portion of the impeller cover 60 and that is connected to the outer ends of the stator blades 73 in the radial direction. Due to the above, the motor cover 70, the stator blades 73, and the blower cover 74 can be molded inexpensively as an integral member with a pair of molds that slide in the up-down direction. Furthermore, since the motor cover cylindrical portion 72 and the blower cover 74 can be formed as an integral member, compared with a case in which the cover cylindrical portion 72 and the blower cover 74 are different members, concentricity between an outer surface of the motor cover cylindrical portion 72 and the blower cover 74 is improved. Accordingly, since the width of the flow passage 80 in the radial direction becomes uniform in the circumferential direction, generation of pressure differences in the circumferential direction in the air flowing inside the flow passage 80 can be suppressed; accordingly, the air blowing efficiency of the blowing device 1 is improved

<Communication Portion>

[0036] The motor 10 is disposed on the inner side of the motor cover cylindrical portion 72 in the radial direction. An inner surface 722 of the motor cover cylindrical portion and the motor 10 oppose each other with a gap in between in the radial direction. With the above, either an inner rotor type motor or an outer rotor type motor can be disposed on the inner side of the motor cover cylindrical portion 72 in the radial direction. In the present embodiment, the motor 10 of the outer rotor type is disposed on the inner side of the motor cover cylindrical portion 72 in the radial direction. Since the motor 10 includes the rotor holder 21 that rotates, and there is a gap between the rotor holder 21 and the inner surface 722 of the motor cover cylindrical portion in the radial direction, the outer rotor type motor 10 can be used as a drive unit of the blowing device 1.

[0037] The motor cover cylindrical portion 72 includes communication portions 75 that communicate an inner space 83 of the motor cover cylindrical portion and an outer space 82 of the motor cover cylindrical portion to each other. Furthermore, since the motor cover cylindrical portion 72 is open downwards, a portion of the air that has flowed downwards in the flow passage 80, swirls towards the inside in the radial direction after being discharged from the exhaust port 81, enters the inner space 83 of the motor cover cylindrical portion that fills the inner side of the motor cover cylindrical portion 72 in the radial direction, passes the communication portions 75 from the inner space 83 of the motor cover cylindrical portion, and is discharged to the outer space 82 of the motor cover cylindrical portion. Since the outer space 82 of the motor cover cylindrical portion is the flow passage 80, the air that has been discharged to the flow passage 80 through the communication portions 75 merges with the flow of air flowing downwards inside the flow passage 80, flows downwards inside the flow passage 80 once again, and is discharged through the exhaust port 81.

[0038] The motor 10 is disposed in the inner space 83 of the motor cover cylindrical portion. Accordingly, due to the generation of heat by the coils 32, a circuit element mounted on the circuit board 36, and the like, a temperature of the inner space 83 of the motor cover cylindrical portion becomes higher than a temperature of the outer space 82 of the motor cover cylindrical portion. However, in the blowing device 1 of the present embodiment, since a portion of the air that flows in the flow passage 80 with the mechanism described above circulates through the inner space 83 of the motor cover cylindrical portion and the outer space 82 of the motor cover cylindrical portion through the communication portions 75, a portion of the heat generated in the inner space 83 of the motor cover cylindrical portion can be efficiently discharged to the outer space 82 of the motor cover cylindrical portion. With the above, the temperature of the inner space 83 of the motor cover cylindrical portion is decreased, and the motor 10 and the circuit element mounted on the circuit board 36 are cooled. Furthermore, the bearing housing 33 and the mounting plate 34 are members made of metal. With the above, since the bearing housing 33 and the mounting plate 34 exceed in thermal conductivity, the heat accumulated in the bearing housing 33 and the mounting plate 34 is efficiently cooled by the air flowing in the inner space 83 of the motor cover cylindrical portion. Accordingly, the cooling characteristics of the motor 10 are improved.

[0039] Note that in the present embodiment, the outer surface 721 of the motor cover cylindrical portion around the lower end of the motor cover cylindrical portion 72, in other words, around the exhaust port 81, is disposed on the inner side in the radial direction with respect to an upper side of the motor cover cylindrical portion 72, in other words, the outer surface 721 of the motor cover cylindrical portion in the area around where the stator blades 73 are disposed. Describing in more detail, the outer surface 721 of the motor cover cylindrical portion includes a motor cover lower area 723 that curves inwardly in the radial direction in a smooth manner as it extends towards the lower side. With the above, since a portion of the air flowing downwards through the flow passage 80 and that is discharged from the exhaust port 81 is smoothly guided towards the inner space 83 of the motor cover cylindrical portion so as to confirm the shape around the lower end of the outer surface 721 of the motor cover cylindrical portion, the flow of air circulating the inner space 83 of the motor cover cylindrical portion becomes smooth. Accordingly, the motor 10 disposed in the inner space 83 of the motor cover cylindrical portion can be cooled efficiently. Note that the motor cover lower area 723 may be a flat surface that is oriented inwards in the radial direction as the motor cover lower area 723 extends downwards.

[0040] Furthermore, in the present embodiment, the inner surface of the blower cover 74 is configured so as to be parallel to the axial direction. Accordingly, the width of the flow passage 80 formed between the outer surface 721 of the motor cover cylindrical portion and the inner surface of the blower cover 74 in the radial direction is narrow in the area where the stator blades 73 are disposed and is the widest in the area where the exhaust port 81 is formed. With the above, in the area where the stator blades 73 are disposed, the static pressure of the air flowing in the flow passage 80 becomes high and, in the area where the exhaust port 81 is formed, the static pressure of the air becomes gradually smaller; accordingly, air resistance around the exhaust port 81 can be reduced. Accordingly, a generation of turbulent flow in the flow passage 80 can be reduced, and the air blowing efficiency of the blowing device 1 can be improved.

[0041] A specific configuration of the communication portions 75 will be described next. Fig. 3 is a bottom view of the blowing device 1 of the first embodiment, and Fig. 4 is a lower perspective view of the blowing device 1 of the first embodiment. As illustrated in Figs. 3 and 4, in the present embodiment, the motor cover cylindrical portion 72 includes cylindrical portion side wall portions 76 that connect the outer surface 721 of the motor cover cylindrical portion and the inner surface 722 of the motor cover cylindrical portion to each other. The cylindrical portion side wall portions 76 connect radial-direction outer end portions 761 of the cylindrical portion side wall portions and radial-direction inner end portions 762 of the cylindrical portion side wall portions to each other. The cylindrical portion side wall portions 76 are side walls of the communication portions 75. The motor cover cylindrical portion 72 includes other cylindrical portion side wall portions 76 that oppose the cylindrical portion side wall portions 76 described above with a gap in between in the circumferential direction. The other cylindrical portion side wall portions 76 are side walls of the communication portions 75. In other words, the motor cover cylindrical portion 72 includes cylindrical portion side wall portions 76 that connect the outer surface 721 of the motor cover cylindrical portion and the inner surface 722 of the motor cover cylindrical portion to each other and that constitute the side walls of the communication portions 75. The width of each communication portion 75 in the circumferential direction is the same as a width in the circumferential direction between two cylindrical portion side wall portions 76 that oppose each other with a gap in between in the circumferential direction.

[0042] The communication portions 75 are formed so as to be, with respect to the radial direction, inclined in the circumferential direction. In other words, the cylindrical portion side wall portions 76 are, with respect to the radial direction, inclined in the circumferential direction. In the present embodiment, the radial-direction outer end portions 761 of the cylindrical portion side wall portions are disposed on the front side in the rotation direction R of the impeller with respect to the radial-direction inner end portions 762 of the cylindrical portion side wall portions. With the above, the air discharged to the outer space 82 of the motor cover cylindrical portion through the communication portions 75 includes swirling components in the circumferential direction and in the rotation direction R of the impeller. Accordingly, the air discharged through the communication portions 75 to the outer space 82 of the motor cover cylindrical portion flows in the flow passage 80 and can smoothly merge with the air including the swirling component in the rotation direction R of the impeller. Accordingly, the air blowing efficiency inside the flow passage 80 is improved. Note that since Fig. 3 is a bottom view of the blowing device 1, the rotation direction R of the impeller is clockwise.

[0043] The cylindrical portion side wall portions 76 are smooth curved surfaces that protrude towards the rear side in the rotation direction R of the impeller and connect the radial-direction outer end portions 761 of the cylindrical portion side wall portions and the radial-direction inner end portions 762 of the cylindrical portion side wall portions to each other. With the above, the air discharged to the outer space 82 of the motor cover cylindrical portion through the communication portions 75 is guided so as to have swirling components that are oriented towards the front side in the rotation direction R of the impeller in a smooth manner along the smooth curved surfaces that are protruded towards the rear side in the rotation direction R of the impeller. Accordingly, since merging with the air flowing in the flow passage 80 can be performed in a further smooth manner, the air blowing efficiency inside the flow passage 80 is improved. Note that the shapes of the radial-direction outer end portions 761 of the cylindrical portion side wall portions and the radial-direction inner end portions 762 of the cylindrical portion side wall portions may be chamfered surfaces or rounded shapes. With the above, a decrease in the air blowing efficiency due to generation of air vortexes around the radial-direction outer end portions 761 of the cylindrical portion side wall portions and the radial-direction inner end portions 762 of the cylindrical portion side wall portions can be reduced.

[0044] The motor cover cylindrical portion 72 includes cylindrical portion upper wall portions 77 that connect the outer surface 721 of the motor cover cylindrical portion and the inner surface 722 of the motor cover cylindrical portion to each other. The cylindrical portion upper wall portions 77 are side walls of the communication portions 75. In other words, the motor cover cylindrical portion 72 includes cylindrical portion upper wall portions 77 that connect the outer surface 721 of the motor cover cylindrical portion and the inner surface 722 of the motor cover cylindrical portion to each other and that constitute the side walls of the communication portions 75. The communication portions 75 are open downwards in the axial direction. In other words, the communication portions 75 are recesses that are recessed towards the upper side from the lower end of the motor cover cylindrical portion 72. With the above, the motor cover 70 including the communication portions 75 can be formed by molds that slide in the up-down direction. Accordingly, the motor cover 70 can be formed inexpensively and mass-productiveness increases as well.

[0045] At least a portion of each communication portion 75 and at least a portion of the blower cover 74 oppose each other in the radial direction. With the above, the air discharged through the communication portions 75 to the outer space 82 of the motor cover cylindrical portion flows downwards along the flow passage 80 formed between the outer surface 721 of the motor cover cylindrical portion and the inner surface of the blower cover 74. In other words, by having the blower cover 74 be disposed on the outer sides of the communication portions 75 in the radial direction, the wind discharged to the outer side in the radial direction through the communication portions 75 is guided to flow downwards inside the flow passage 80 without flowing outside of the flow passage 80 in the radial direction; accordingly, the air blowing efficiency is improved.

[0046] Radial-direction outer end portions of the cylindrical portion upper wall portions 77 are disposed below the lower ends of the stator blades 73 in the axial direction. In other words, the communication portions 75 are formed in areas in the flow passage 80 where the stator blades 73 are not disposed. Accordingly, compared with a case in which the communication portions 75 are formed in areas where the cross sections of the flow passage 80 are small due to the disposition of the stator blades 73, since the air that has passed through the communication portions 75 merges in the flow passage 80 where the areas of the cross sections of the flow passage 80 are large, the pressure of the air flowing inside the flow passage 80 can be suppressed from becoming excessively high and a decrease in the air blowing efficiency inside the flow passage 80 can be suppressed. Furthermore, since the communication portions 75 are formed below the lower ends of the stator blades 73 in the axial direction, the air that has passed the communication portions 75 merges with the air inside the flow passage 80 that has been regulated downwards in the axial direction with the stator blades 73; accordingly, generation of turbulent flows inside the flow passage 80 can be reduced.

[0047] The communication portions 75 are disposed in plural numbers in the circumferential direction. With the above, since the air passes the plurality of communication portions 75 and circulates through the inner space 83 of the motor cover cylindrical portion and the outer space 82 of the motor cover cylindrical portion, the heat of the inner space 83 of the motor cover cylindrical portion can be released in a further efficient manner. Furthermore, in the present embodiment, the communication portions 75 are disposed at equal intervals in the circumferential direction. With the above, the flow of air passing the communication portions 75 can be made uniform to the extent possible in the circumferential direction. Accordingly, since the flow of the air inside the flow passage 80 in the circumferential direction can be made uniform, the air blowing efficiency is improved.

[0048] The plurality of communication portions 75 may be disposed unevenly in the circumferential direction. In other words, each of the intervals between certain communication portions 75 and other communication portions 75 in the circumferential direction do not have to be the same. With the above, since the flow of the air discharged to the outer space 82 of the motor cover cylindrical portion through the communication portions 75 becomes uneven inside the flow passage 80 in the circumferential direction, the sonic wave generated inside the flow passage 80 does not easily become a standing wave that has a specific frequency; accordingly, generation of a large noise can be reduced.

[0049] The number of communication portions 75, the number of moving blades 51, and the number of stator blades 73 are, desirably, relative primes. For example, the configuration may be such that the number of communication portions 75 is 11, the number of moving blades 51 is 10, and the number of stator blades 73 is 27. With the above, when the impeller 50 rotates, resonance of the noises generated by the communication portions 75, the moving blades 51, and the stator blades 73 can be reduced and generation of noise can be reduced. Note that the number of communication portions 75, the number of moving blades 51, and the number of stator blades 73 may be relative primes of other combinations. In such a case, desirably, the number of stator blades 73 is the largest. With the above, since the flow of air inside the flow passage 80 can be regulated with a number of stator blades 73, the air blowing efficiency is improved. Furthermore, desirably, the number of moving blades 51 is half or less than half of the number of the stator blades 73. With the above, since the gap between a moving blade 51 and the adjacent moving blade 51 can be widened, the flow of air is facilitated. Furthermore, desirably, the number of communication portions 75 is also half or less than half of the number of stator blades 73. With the above, since the cross sections of the communication portions 75 can be increased, the air blowing efficiency of the air flowing through the communication portions 75 is improved.

<Second Embodiment>

[0050] A blowing device 1A according to a second embodiment will be described next. Note that in the description hereinafter, description of components that overlap those of the blowing device 1 according to the first embodiment will be omitted. Furthermore, portions and members that have the same configuration as those of the first embodiment will be given reference numerals that are the same as those of the first embodiment.

[0051] Fig. 5 is a longitudinal section of the blowing device 1A according to the second embodiment, and Fig. 6 is a bottom view of the blowing device 1A according to the second embodiment. As illustrated in Fig. 5, in the blowing device 1A, a motor cover cylindrical portion 72A includes communication portions 75A that communicate an inner space 83A of the motor cover cylindrical portion and an outer space 82A of the motor cover cylindrical portion to each other. The communication portions 75A are through holes that penetrate the motor cover cylindrical portion 72A in the axial direction. In other words, different from the communication portions 75 of the blowing device 1 according to the first embodiment, the communication portions 75A are not cutaways open downwards but are through holes that penetrate the motor cover cylindrical portion 72A in the radial direction. With the above, compared with a case in which cutawayshaped communication portions 75 are formed, the rigidity of the motor cover cylindrical portion 72A can be improved. Furthermore, by forming the communication portions 75, the heat generated in the inner space 83A of the motor cover cylindrical portion can be efficiently discharged to the outer space 82A of the motor cover cylindrical portion. The mechanism of discharging the heat generated in the inner space 83A of the motor cover cylindrical portion to the outer space 82A of the motor cover cylindrical portion is similar to that of the blowing device 1 according to the first embodiment.

[0052] In the blowing device 1A, the motor cover cylindrical portion 72A is constituted by a first motor cover cylindrical portion 724A that extends downwards from an outer side of the motor cover top plate portion 71A in the radial direction, and an annular second motor cover cylindrical portion 725A that extends downwards from a lower end portion of the first motor cover cylindrical portion 724A. In other words, the second motor cover cylindrical portion 725A is a member that is separate from a motor cover 70A, and is an annular member that is disposed substantially coaxially with the first motor cover cylindrical portion 724A.

[0053] The motor cover 70A includes a plurality of stator blades 73A disposed on an outer surface 721A of the motor cover cylindrical portion in the circumferential direction. The plurality of stator blades 73A are formed on an outer surface of the first motor cover cylindrical portion 724A. The first motor cover cylindrical portion 724A, the plurality of stator blades 73A, and a blower cover 74A are an integral resin member. Since the first motor cover cylindrical portion 724A includes the motor cover top plate portion 71A, the rigidity thereof is higher than that of the second motor cover cylindrical portion 725A. Accordingly, by being configured as a portion integral with the first motor cover cylindrical portion 724A, the plurality of stator blades 73A can, compared with being configured in the second motor cover cylindrical portion 725A, improve the fixing strength. In other words, by forming the stator blades 73A on the outer surface of the first motor cover cylindrical portion 724A, vibrations of the stator blades 73A can be reduced when the air is flowing inside a flow passage 80A.

[0054] The motor cover cylindrical portion 72A includes cylindrical portion upper wall portions 77A that connect the outer surface 721A of the motor cover cylindrical portion and an inner surface 722A of the motor cover cylindrical portion to each other, and that constitute upper side walls of the communication portions 75A in the axial direction. In the present embodiment, the cylindrical portion upper wall portions 77A are constituted by portions of the underside of the first motor cover cylindrical portion 724A. Radial-direction outer end portions of the cylindrical portion upper wall portions 77A are disposed below radial-direction inner end portions of the cylindrical portion upper wall portions 77A in the axial direction. With the above, the air discharged from the inner space 83A of the motor cover cylindrical portion to the outer space 82A of the motor cover cylindrical portion through the communication portions 75A includes a velocity component oriented downwards in the axial direction. Accordingly, since the air flowing in the flow passage through the communication portions 75A can smoothly merge with the air flowing downwards inside the flow passage 80A, the air blowing efficiency inside the flow passage 80A is improved.

[0055] Furthermore, in the present embodiment, the cylindrical portion upper wall portions 77A are smooth curved surfaces that connect the radial-direction outer end portions of the cylindrical portion upper wall portions 77A and the radial-direction inner end portions of the cylindrical portion upper wall portions 77A to each other and that protrude towards the upper side in the axial direction. With the above, since the air that passes through the communication portions 75A and that is discharged to the outer space 82A of the motor cover cylindrical portion is guided in a smooth manner along the cylindrical portion upper wall portions 77A towards the outer side in the radial direction and towards the lower side in the axial direction, the air can be merged in a more efficient manner with the air flowing downwards inside the flow passage 80A; accordingly, the air blowing efficiency inside the flow passage 80A is improved.

[0056] The radial-direction outer end portions of the cylindrical portion upper wall portions 77A are disposed above lower ends of the stator blades 73A in the axial direction. With the above, the communication portions 75A can be disposed on the upper side in the axial direction to the extent possible. When a portion of the air that has been discharged towards the outer side in the radial direction with the rotation of an impeller 50A, that has passed through the flow passage 80A, and that has been discharged downwards from an exhaust port 81A circulates the inner space 83A of the motor cover cylindrical portion, passes through the communication portions 75A, and merges again in the flow passage 80A, by disposing, to the extent possible, the communication portions 75A on the upper side in the axial direction, the distance in which the circulating air passes the inner space 83A of the motor cover cylindrical portion can be made longer; accordingly, the heat generated in the inner space 83A of the motor cover cylindrical portion can be discharged more efficiently to the outer space 82A of the motor cover cylindrical portion.

[0057] Particularly, in the present embodiment, since a circuit board 36A is disposed on the upper side of the inner space 83A of the motor cover cylindrical portion, by having the air that circulates in the inner space 83A of the motor cover cylindrical portion reach, to the extent possible, the upper side in the axial direction and flow to the outer space 82A of the motor cover cylindrical portion, the heat generated from the circuit element disposed on the circuit board 36A can be efficiently discharged.

[0058] Furthermore, in the present embodiment, the communication portions 75A are not cutaways that are open downwards but are through holes constituted by the first motor cover cylindrical portion 724A and the second motor cover cylindrical portion 725A. Accordingly, compared with a case in which the communication portions 75A are formed to the upper portion of the inner space 83A of the motor cover cylindrical portion with recesses that are greatly recessed upwards in the axial direction, the rigidity of the motor cover cylindrical portion 72A can be improved; accordingly, vibration of the motor cover cylindrical portion 72A caused by the air flowing inside the flow passage 80A can be reduced.

[0059] The motor cover cylindrical portion 72A includes cylindrical portion lower wall portions 78A that connect the outer surface 721A of the motor cover cylindrical portion and an inner surface 722A of the motor cover cylindrical portion to each other, and that constitute lower side walls of the communication portions 75A in the axial direction. In the present embodiment, the cylindrical portion lower wall portions 78A are constituted by portions of the upper surface of the second motor cover cylindrical portion 725A. Radial-direction outer end portions of the cylindrical portion lower wall portions 78A are disposed below radial-direction inner end portions of the cylindrical portion lower wall portions 78A in the axial direction. With the above, the air discharged from the inner space 83A of the motor cover cylindrical portion to the outer space 82A of the motor cover cylindrical portion through the communication portions 75A includes a velocity component oriented downwards in the axial direction. Accordingly, since the air flowing in the flow passage 80A through the communication portions 75A can smoothly merge with the air flowing downwards inside the flow passage, the air blowing efficiency inside the flow passage 80A is improved.

[0060] The motor cover cylindrical portion 72A includes cylindrical portion side wall portions 76A that connect the outer surface 721A of the motor cover cylindrical portion and the inner surface 722A of the motor cover cylindrical portion to each other. The cylindrical portion side wall portions 76A connect radial-direction outer end portions 761A of the cylindrical portion side wall portions and radial-direction inner end portions 762A of the cylindrical portion side wall portions to each other. The cylindrical portion side wall portions 76A are side walls of the communication portions 75A. The motor cover cylindrical portion 72A includes other cylindrical portion side wall portions 76A that oppose the cylindrical portion side wall portions 76A described above with a gap in between in the circumferential direction. The other cylindrical portion side wall portions 76A are side walls of the communication portions 75A. In other words, the motor cover cylindrical portion 72A includes cylindrical portion side wall portions 76A that connect the outer surface 721A of the motor cover cylindrical portion and the inner surface 722A of the motor cover cylindrical portion to each other and that constitute the side walls of the communication portions 75A. The width of each communication portion 75A in the circumferential direction is the same as a width in the circumferential direction between two cylindrical portion side wall portions 76A that oppose each other with a gap in between in the circumferential direction. In the present embodiment, the cylindrical portion side wall portions 76A are constituted by portions of the second motor cover cylindrical portion 725A. However, the cylindrical portion side wall portions 76A may be constituted by portions of the first motor cover cylindrical portion 724A.

[0061] The radial-direction outer end portions 761A of the cylindrical portion side wall portions are disposed on the front side in the rotation direction R of the impeller with respect to the radial-direction inner end portions 762A of the cylindrical portion side wall portions. Describing in more detail, the cylindrical portion side wall portions 76A are smooth curved surfaces that protrude towards the rear side in the rotation direction R of the impeller and connect the radial-direction outer end portions 761A of the cylindrical portion side wall portions and the radial-direction inner end portions 762A of the cylindrical portion side wall portions to each other. With the above, since merging with the air flowing in the flow passage 80A can be performed in a further smooth manner, the air blowing efficiency inside the flow passage 80A is improved. The mechanism in which the air blowing efficiency improves is similar to the mechanism in the cylindrical portion side wall portions 76 of the first embodiment. As illustrated in Fig. 6, the rotation direction R of the impeller is clockwise when viewed from the lower side in the axial direction.

[0062] Note that the communication portions 75A that penetrate in the radial direction may be formed of through holes that penetrate the motor cover cylindrical portion 72A, which is an integral member, in the radial direction. As in the present embodiment, in a case in which the motor cover cylindrical portion 72A is constituted by the first motor cover cylindrical portion 724A and the second motor cover cylindrical portion 725A, the first motor cover cylindrical portion 724A and the second motor cover cylindrical portion 725A can each be formed by molds that slide in the up-down direction; accordingly, mass-productiveness is improved when forming the communication portions 75A that penetrate the motor cover cylindrical portion 72A in the radial direction, which is a more desirable configuration.

[0063] The communication portions 75A are, desirably, configured in plural numbers in the circumferential direction. With the above, the heat generated in the inner space 83A of the motor cover cylindrical portion can be discharged to the outer space 82A of the motor cover cylindrical portion in a more effective manner. Furthermore, in the present embodiment, while a motor 10A is a so-called outer rotor side, the motor 10A may be an inner rotor type. In a case in which an inner rotor type motor is disposed, the air that circulates the inner space 83A of the motor cover cylindrical portion flows on the outer side of the motor cover that covers the outer side of the motor 10A. Accordingly, the heat that has been generated in the coils and the like and that has been transmitted to the motor cover through the stator can be discharged to the outer space 82A of the motor cover cylindrical portion.

[0064] Fig. 7 is a perspective view of a vacuum cleaner 100. The vacuum cleaner 100 includes the blowing device of the present invention. With the above, in the blowing device mounted in the vacuum cleaner 100, the heat generated in the inner space of the motor cover cylindrical portion can be discharged to the outer space of the motor cover cylindrical portion in an efficient manner. Accordingly, a vacuum cleaner 100 with a superior cooling function can be obtained.

[0065] While the exemplary embodiments of the present invention have been described above, the configuration of and the combination in each of the first embodiment and the second embodiment are examples, and adding of configurations, discarding thereof, replacing and other modifications can be made within the scope of the present invention. Furthermore, the present invention is not to be limited by the embodiments. Furthermore, the blowing device of the present invention can be used in electrical machineries other than the vacuum cleaner.

Reference Signs List

[0066]

J central axis R rotation direction of impeller 1, 1A blowing device 10, 10A motor 11 shaft 20 rotor portion
21 rotor holder 22 rotor holder cylindrical portion
23 rotor holder bottom portion 24 magnet 30 stator portion31 stator core 32 coil 33 bearing housing 34 mounting plate 35 mounting plate flange portion 36 circuit board 40 bearing 50, 50A impeller
501 impeller hub 51 moving blade 511 first moving blade 512 second moving blade 52 main plate 521 through hole 522 main plate rib53 shroud 531 through hole 54 balance correcting portion 541 first protrusion
542 second protrusion 543 weight 60 impeller cover 61 intake port 62 impeller cover upper end portion
63 impeller cover inclination portion64 impeller cover projecting portion 65 impeller cover cylindrical portion66 impeller cover guide portion70, 70A motor cover 71, 71A motor cover top plate portion 72, 72A motor cover cylindrical portion 721, 721A outer surface of motor cover cylindrical portion 722, 722A inner surface of motor cover cylindrical portion 723 motor cover lower area
724A first motor cover cylindrical portion 725A second motor cover cylindrical portion 73, 73A stator blades 74, 74A blower cover 75, 75A communication portion 76, 76A cylindrical portion side wall portion 761, 761A radial-direction outer end portion of cylindrical portion side wall portion 762, 762A radial-direction inner end portion of cylindrical portion side wall portion
77, 77A cylindrical portion upper wall portion 78A cylindrical portion lower wall portion 80, 80A flow passage 81, 81A exhaust port 82, 82A outer space of motor cover cylindrical portion 83, 83A inner space of motor cover cylindrical portion 100 vacuum cleaner

Claims

1. A blowing device comprising:

    a motor that includes a shaft disposed along a central axis extending in an up-down direction;
    an impeller fixed to the shaft, the impeller being disposed above the motor;
    an impeller cover that surrounds an upper side and an outer side in a radial direction of the impeller, the impeller cover including an intake port at a middle;
    a motor cover disposed on an outer side in a radial direction of the motor;
    the motor including

        a rotor portion fixed to the shaft, the rotor portion including a magnet,
        a stator portion that opposes the magnet, and
        a bearing that rotatably supports the shaft with respect to the stator portion;

    the motor cover including
    a tubular motor cover cylindrical portion that is open downwards;
    an inner surface of the motor cover cylindrical portion opposing the motor with a gap in between in the radial direction; and
    the motor cover cylindrical portion including a communication portion that communicates an inner space of the motor cover cylindrical portion and an outer space of the motor cover cylindrical portion to each other.

2. The blowing device according to Claim 1, wherein the communication portion is disposed in plural numbers in a circumferential direction.

3. The blowing device according to Claim 1 or 2, wherein a plurality of the communication portions are disposed at equal intervals in a circumferential direction.

4. The blowing device according to any one of Claims 1 to 3, wherein the communication portion is open downwards in an axial direction.

5. The blowing device according to any one of Claims 1 to 3,

wherein the communication portion is a through hole that penetrates the motor cover cylindrical portion in the radial direction.

6. The blowing device according to any one of Claims 1 to 5,
wherein the motor cover cylindrical portion includes a cylindrical portion side wall portion that connects an outer surface of the motor cover cylindrical portion and an inner surface of the motor cover cylindrical portion to each other, the cylindrical portion side wall portion constituting a side wall of the communication portion, and
wherein a radial-direction outer end portion of the cylindrical portion side wall portion is disposed on a front side in a rotation direction of the impeller with respect to a radial-direction inner end portion of the cylindrical portion side wall portion.

7. The blowing device according to Claim 6,
wherein the cylindrical portion side wall portion is a smooth curved surface that connects the radial-direction outer end portion of the cylindrical portion side wall portion and the radial-direction inner end portion of the cylindrical portion side wall portion to each other and that protrudes towards a rear side in the rotation direction of the impeller.

8. The blowing device according to any one of Claims 1 to 7,
wherein the motor cover cylindrical portion includes a cylindrical portion upper wall portion that connects an outer surface of the motor cover cylindrical portion and an inner surface of the motor cover cylindrical portion to each other, the cylindrical portion upper wall portion constituting a side wall of the communication portion, and
wherein a radial-direction outer end portion of the cylindrical portion upper wall portion is disposed below a radial-direction inner end portion of the cylindrical portion upper wall portion in an axial direction.

9. The blowing device according to Claim 8,
wherein the cylindrical portion upper wall portion is a smooth curved surface that connects the radial-direction outer end portion of the cylindrical portion upper wall portion and the radial-direction inner end portion of the cylindrical portion upper wall portion to each other and that protrudes towards an upper side in the axial direction.

10. The blowing device according to any one of Claims 1 to 9,
wherein the motor cover includes a plurality of stator blades disposed on the outer surface of the motor cover cylindrical portion in the circumferential direction.

11. The blowing device according to Claim 10,
wherein lower portions of the stator blades in the axial direction are disposed on a front side in a rotation direction of the impeller with respect to upper portions of the stator blades in the axial direction.

12. The blowing device according to Claim 10 or 11,
wherein the motor cover includes a tubular blower cover that extends downwards from a lower end portion of the impeller cover, the blower cover being connected to outer ends of the stator blades in the radial direction.

13. The blowing device according to Claim 12,
wherein the motor cover, the stator blades, and the blower cover are formed of an integral resin member, and
wherein at least a portion of the communication portion and at least a portion of the blower cover oppose each other in the radial direction.

14. The blowing device according to Claim 8 or 9,
wherein the motor cover includes a plurality of stator blades disposed on the outer surface of the motor cover cylindrical portion in the circumferential direction, and
wherein a radial-direction outer end portion of the cylindrical portion upper wall portion is disposed below lower ends of the stator blades in the axial direction.

15. The blowing device according to Claim 8 or 9,
wherein the motor cover includes a plurality of stator blades disposed on the outer surface of the motor cover cylindrical portion in the circumferential direction, and
wherein a radial-direction outer end portion of the cylindrical portion upper wall portion is disposed above lower ends of the stator blades in the axial direction.

16. A vacuum cleaner comprising:
the blowing device according to any one of Claims 1 to 15.

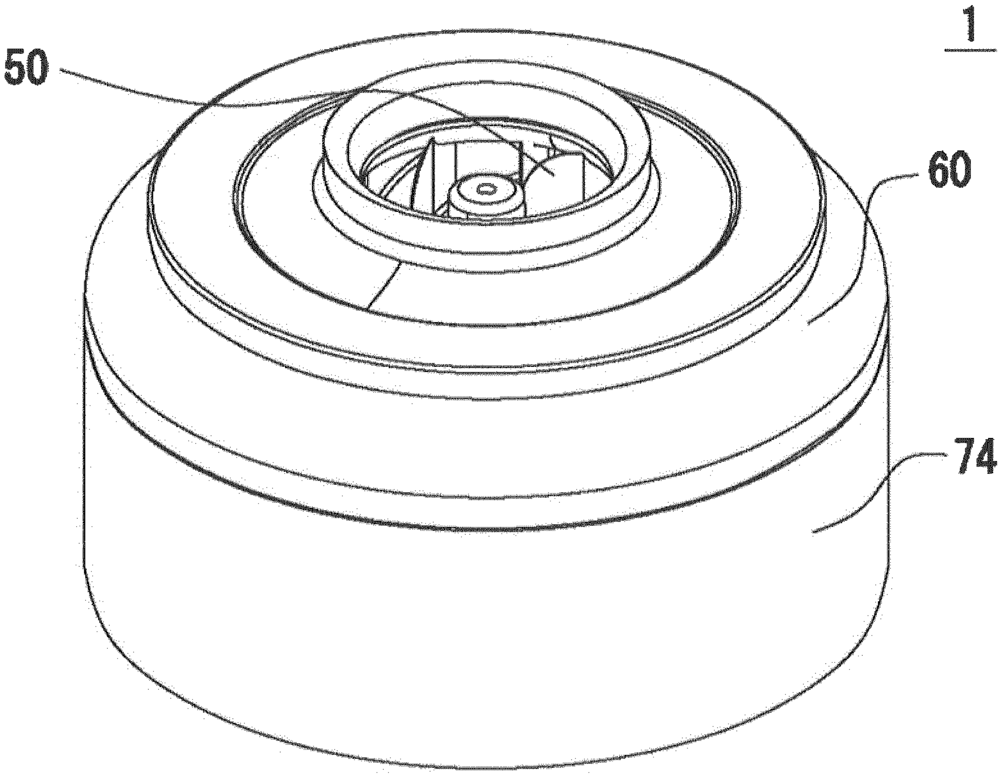

Fig. 1

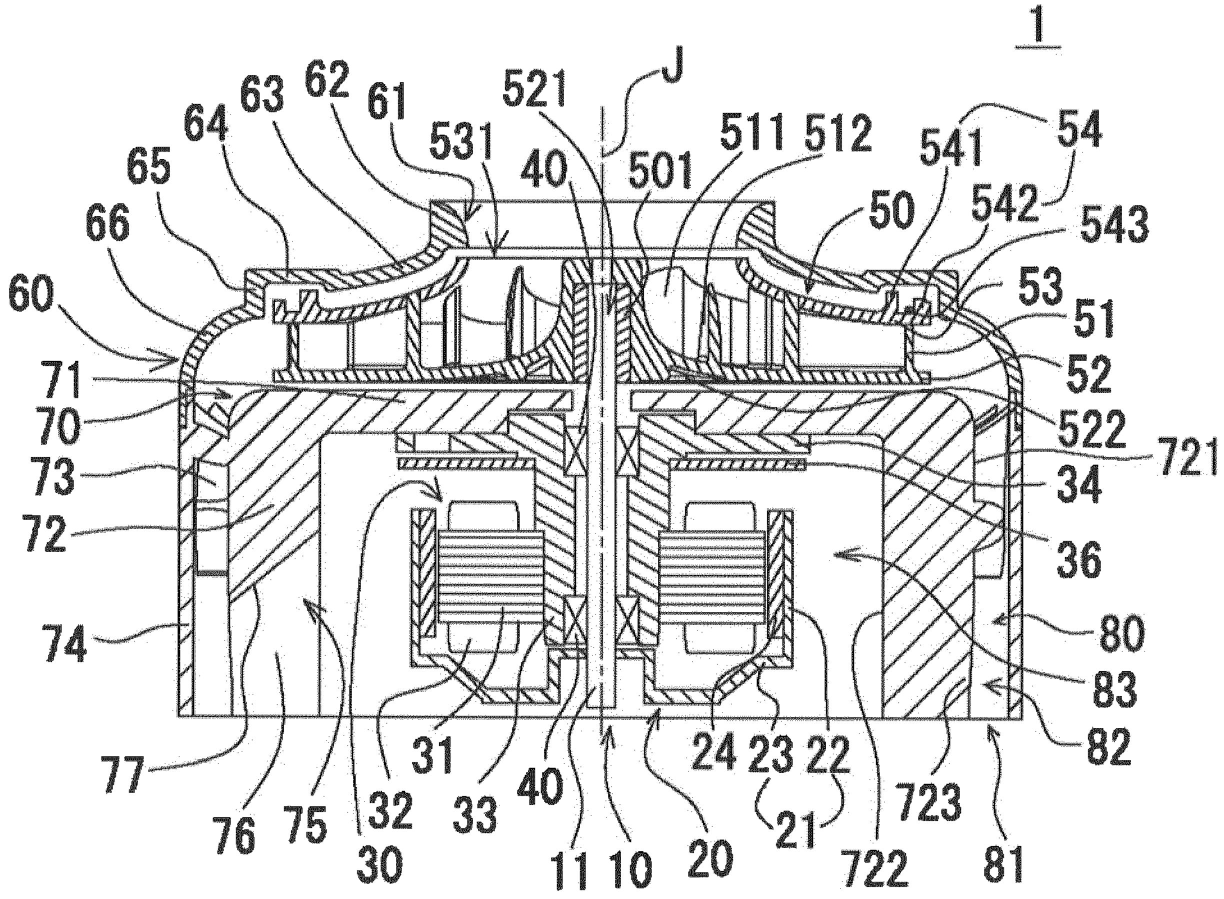
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Fig. 2

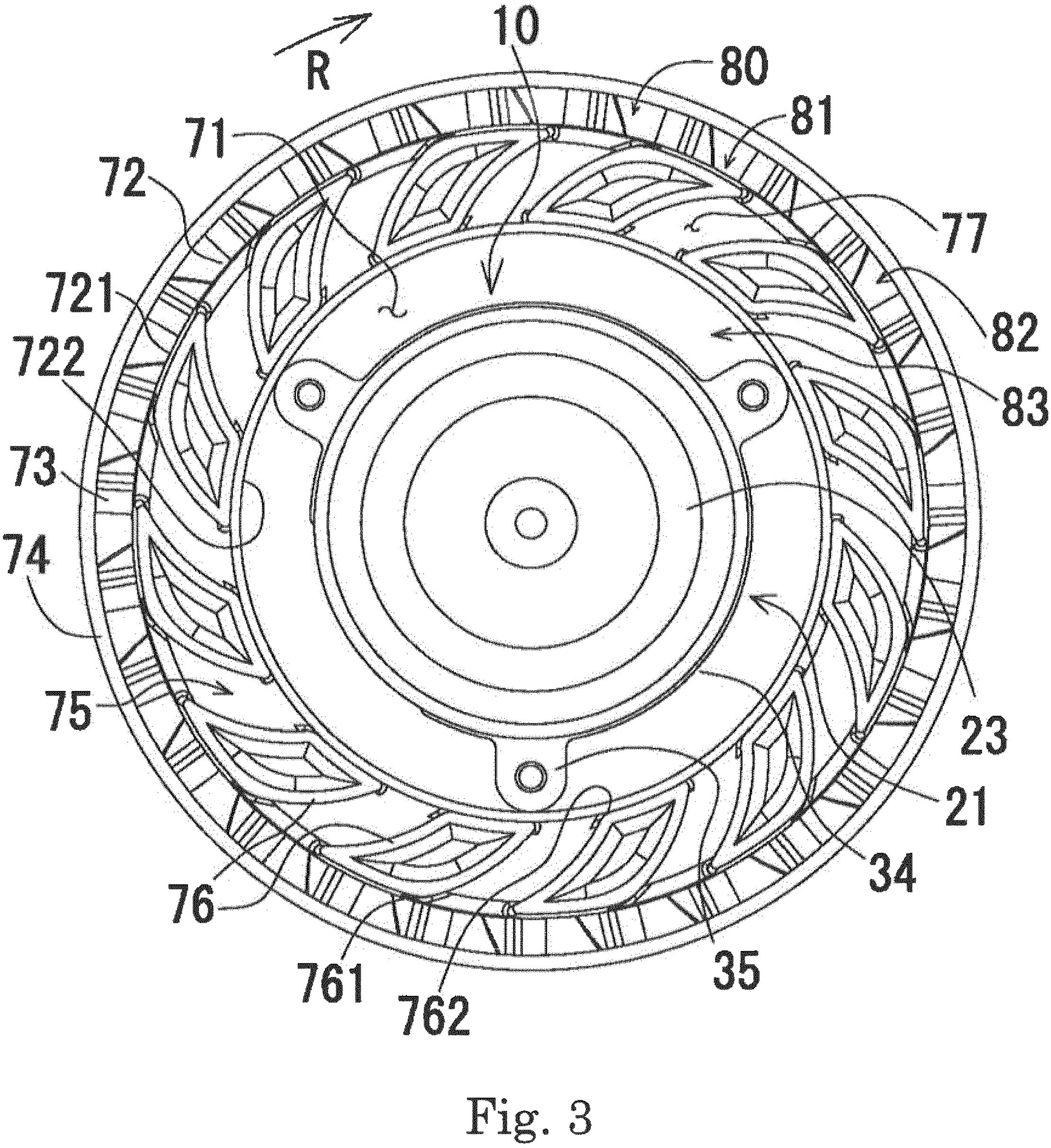


Fig. 3

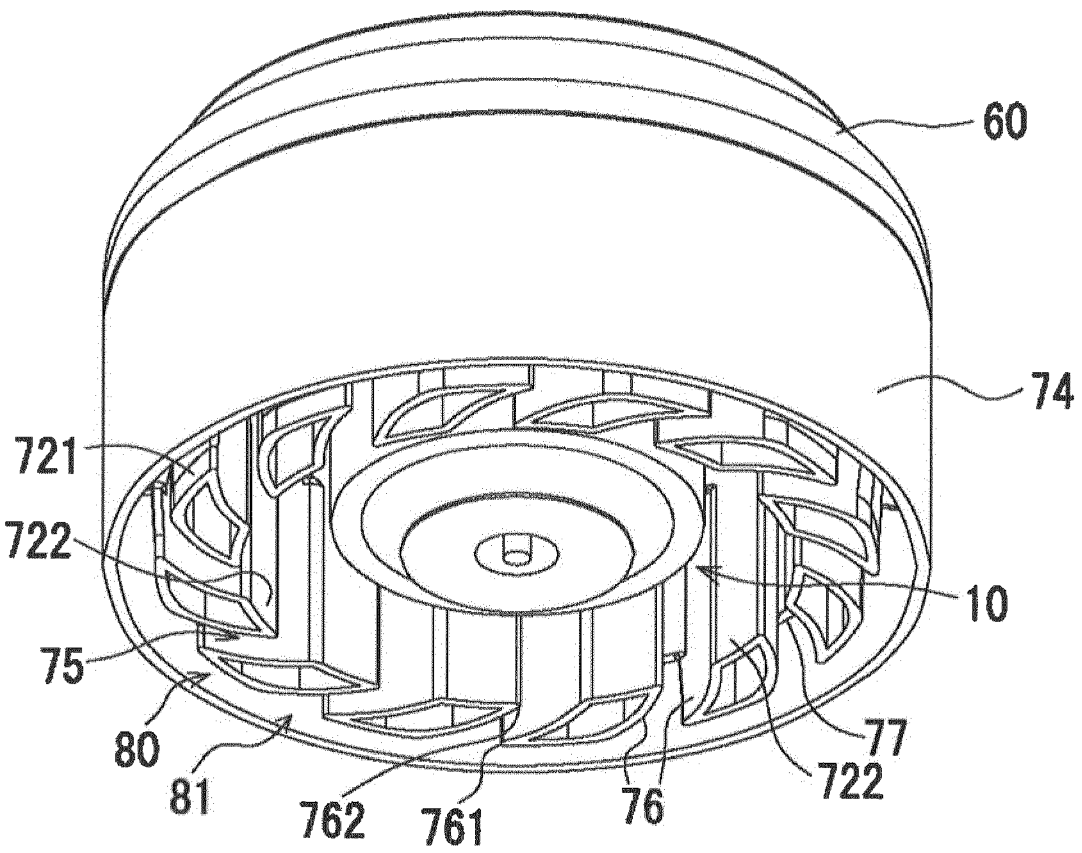
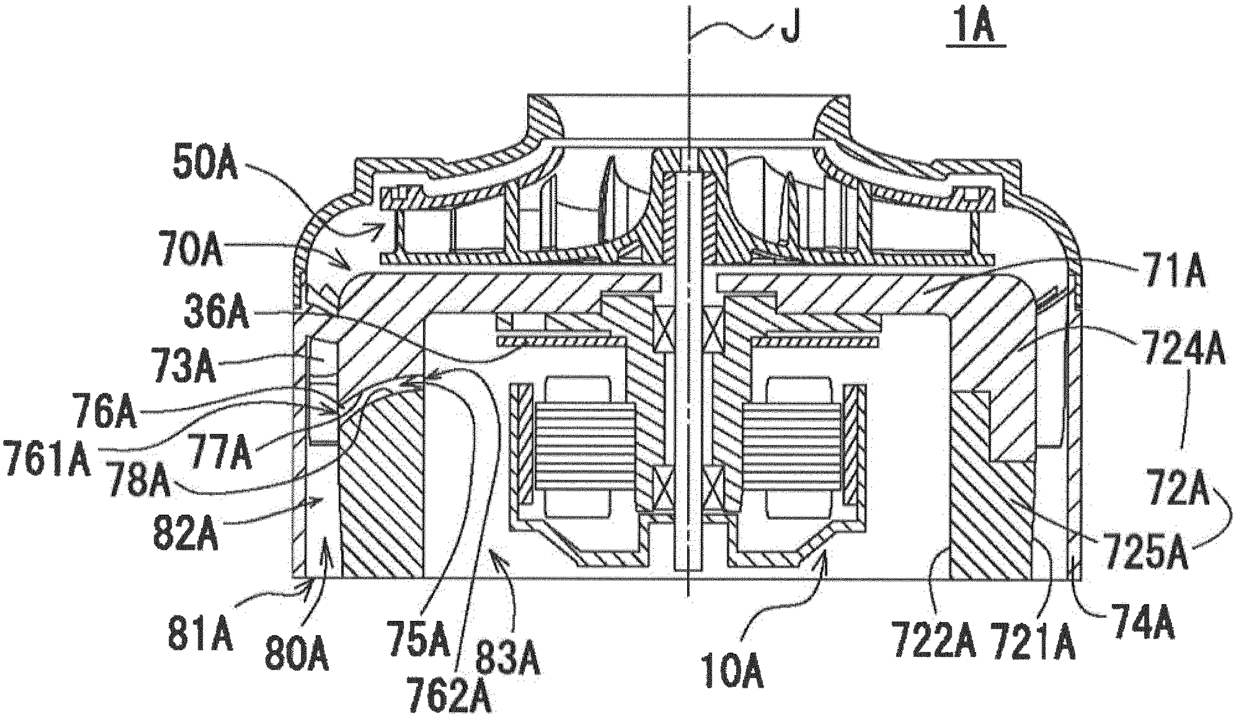


Fig. 4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70A
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73A
76A
761A
77A
78A
82A
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724A
72A
725A
722A
721A
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Fig. 5

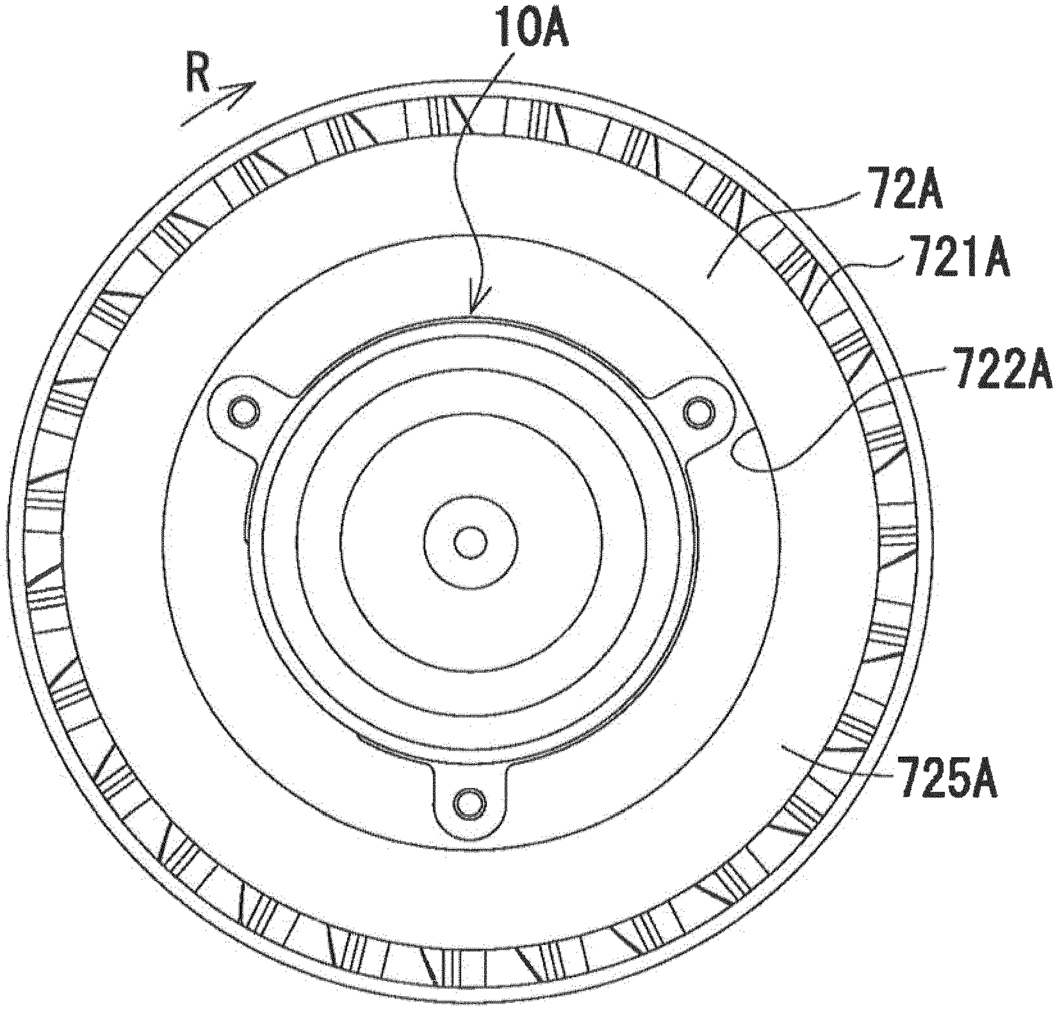

Fig. 6

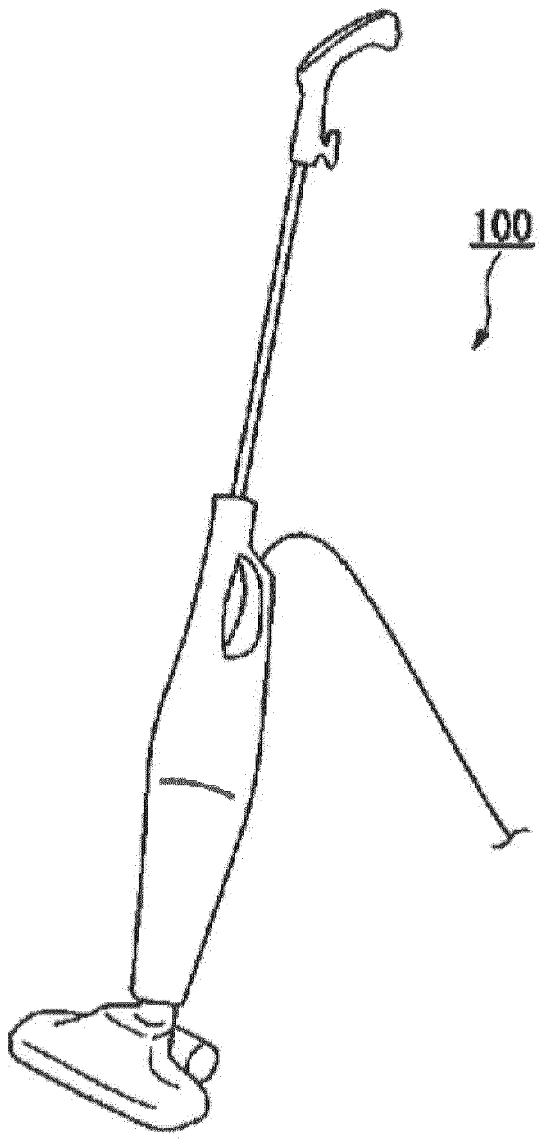

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2016/083019

A. CLASSIFICATION OF SUBJECT MATTER
F04D29/00(2006.01)i, *A47L9/00*(2006.01)i, *F04D29/58*(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)
F04D29/00, A47L9/00, F04D29/58

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 Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 17151/1975(Laid-open No. 98807/1976) (Fuji Denki Seizo Kabushiki Kaisha), 07 August 1976 (07.08.1976), specification, page 3, line 8 to page 4, line 10; all drawings (Family: none)	1-5,10-12 13,16 6-9,14-15
Y	JP 2010-281231 A (Panasonic Corp.), 16 December 2010 (16.12.2010), paragraphs [0051] to [0052]; fig. 9 (Family: none)	13,16

☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:
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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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 January 2017 (12.01.17)	24 January 2017 (24.01.17)

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

International application No.
PCT/JP2016/083019

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 143908/1976(Laid-open No. 60109/1978) (Matsushita Electric Industrial Co., Ltd.), 22 May 1978 (22.05.1978), specification, page 5, lines 11 to 17; fig. 4 to 5 (Family: none)	1-16
A	JP 2014-15853 A (NIDEC Corp.), 30 January 2014 (30.01.2014), all drawings & CN 103532299 A	1-16
A	JP 2015-34514 A (NIDEC Corp.), 19 February 2015 (19.02.2015), fig. 3 (Family: none)	1-16
A	JP 11-125197 A (Matsushita Electric Industrial Co., Ltd.), 11 May 1999 (11.05.1999), fig. 3, 6 (Family: none)	1-16
A	JP 2010-59811 A (Panasonic Corp.), 18 March 2010 (18.03.2010), fig. 4 (Family: none)	1-16
A	JP 2012-202282 A (Panasonic Corp.), 22 October 2012 (22.10.2012), paragraph [0029]; fig. 3 & WO 2012/132199 A1	6-7
A	JP 2011-80427 A (Panasonic Corp.), 21 April 2011 (21.04.2011), paragraph [0045]; fig. 1 (Family: none)	8-9,14-15
A	JP 60-166798 A (Matsushita Electric Industrial Co., Ltd.), 30 August 1985 (30.08.1985), fig. 3 (Family: none)	8-9,14-15
A	JP 2013-29034 A (Panasonic Corp.), 07 February 2013 (07.02.2013), fig. 3 (Family: none)	6-9,14-15

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 11336696 A **[0002] [0003] [0004]**