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(54) **Electric blower and electric apparatus equipped therewith**

Elektrogebläse und damit ausgerüstetes Elektrogerät

Souffleur électrique et appareil électrique équipé dudit souffleur

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(56) References cited:
EP-A- 0 528 451 **EP-A- 0 874 442**
EP-A- 1 138 242

- **PATENT ABSTRACTS OF JAPAN vol. 2002, no. 06, 4 June 2002 (2002-06-04) -& JP 2002 048099 A (NIPPON DENSAN CORP), 15 February 2002 (2002-02-15)**

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Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates, in general, to an electric blower and an electric apparatus equipped with this electric blower, such as a vacuum cleaner. In particular, the invention relates to an electric blower which is equipped with a switching element for controlling the operation of the blower.

DISCUSSION OF THE BACKGROUND

[0002] Fig. 1 of the Japanese Patent Laid-Open No. Hei 6 (1994) 26494 shows an example in which a switching element is mounted in a close contact on the outer circumferential wall of a motor case facing a space formed by a step portion between the outer circumferential wall of the motor case and the outer circumferential wall of a fan case.

[0003] In the above-described construction, as the switching element is fitted to the outer circumferential wall of the motor case close to the stator, the switching element is significantly affected by heat emitted from the stator, and the cooling effect is therefore poor. This problem is especially serious in motors such as brushless motors equipped with a plurality of power devices that require cooling.

[0004] Fig. 3 of the Japanese Patent Laid-Open No. Hei 6 (1994) 261847 shows an example in which a package including a control/drive integrated circuit board is fixed on a case in the area closer to the fan than the partition plate where air from a diffuser directly hits in a position.

[0005] In the electric blower shown in Fig. 3, the package including a control/drive integrated circuit board is arranged in an air channel between the fan and the motor. However, the arrangement of the package-located in the air channel increases pressure loss of the channel and, therefore lowers the efficiency of the electric blower. In motors such as brushless motor equipped with a plurality of power devices that require cooling, the internal channel is more complex, causing even greater pressure loss of the channel.

[0006] EP1138242 describes an electric blower and cleaner having a circuit unit disposed in an airflow path of air expelled from an outer periphery of the impeller towards a stator and rotor of its motor unit.

[0007] It is desirable to enable power devices such as switching elements to be efficiently cooled without causing increase in pressure loss of the air channel. According to a first aspect of the present invention there is provided an electric blower according to claim 1.

[0008] According to a second aspect of the present invention there is provided an electric apparatus according to claim 9.

[0009] Therefore, a case for housing the motor and a centrifugal fan fitted to a rotation shaft of the motor is provided, and a power device or devices provided in a drive circuit to drive the motor are arranged on an outer surface of a partition wall constituting an air channel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] A more complete appreciation of the present invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

Fig. 1 is a partial cut-out profile of the configuration of an electric blower as a first preferred embodiment of the invention;
Fig. 2 is a plan of an example of the internal configuration thereof;
Fig. 3A is a schematic diagram showing for a form of a centrifugal fan;
Fig. 3B is a schematic diagram showing for a partial form of a centrifugal fan;
Fig. 4A is a plan of an example of a configuration of a diffuser;
Fig. 4B shows a bottom view of the example of a configuration of the diffuser;
Fig. 5 is a schematic circuit diagram of the drive circuit of the electric blower;
Fig. 6 is a partial cut-out profile of the configuration of an electric blower as a variation of the first embodiment;
Fig. 7 is a plan of a variation of the electric blower;
Fig. 8 is a partial cut-out profile of the configuration of an electric blower as a second preferred embodiment of the invention;
Fig. 9 is a plan of an example of an internal configuration thereof;
Fig. 10 is a partial cut-out profile of the configuration of an electric blower as a third preferred embodiment of the invention;
Fig. 11 is a plan of an example of an internal configuration thereof;
Fig. 12 is a schematic circuit diagram of the drive circuit of the electric blower;
Fig. 13 shows a perspective view of an external configuration of a vacuum cleaner as a fourth preferred embodiment of the invention;
Fig. 14 is a vertical cut profile of an example of the internal configuration thereof;
Fig. 15 is a partial cut-out profile of the configuration of the electric blower included in the vacuum cleaner;
Fig. 16 is a partial cut-out profile of the configuration of an electric blower as a fifth preferred embodiment of the invention; and
Fig. 17 is a partial plan of an example of the internal configuration of an electric blower as a sixth pre-

ferred embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] A first preferred embodiment of the present invention will be described below with reference to Fig. 1 through Fig. 5.

[0012] An electric blower 1 is basically comprised of a motor 2, a centrifugal fan 4 fitted to a rotor shaft 3 of this motor 2, and a case 5 for housing the motor 2 and centrifugal fan 4.

[0013] The motor 2 in this embodiment is a motor with brush, housed in a cylindrical shaped motor case 6. The front end of this motor case 6 constitutes an opening 7, and a long planar bracket 8 bridges over this motor case 6 in the diametric direction of the motor case 6, fitted with screws 9 so as to cover part of the opening 7. The opening 7 not covered by the bracket 8 therefore forms an air flow opening 10. Approximately at the center of the bracket 8 a bearing housing 13a is arranged to protrude forward (towards the centrifugal fan 4) in a substantially cylindrical shape. A bearing 11a is housed on the inner circumferential side of this bearing housing 13a. A through hole 12 for the rotor shaft 3 is formed at the center of the bearing housing 13a.

[0014] The centrifugal fan 4 comprises a main disk plate 322, a side disk plate 323 and a plurality of vanes 324. Each vane 324 has a plurality of ear portions 325, which are respectively fit and fastened up in their corresponding holes 326 formed in the main disk plate 322 and the side disk plate 323. Thus, vanes 324 are respectively fixed in a sandwiched manner between the main disk plate 322 and the side disk plate 323. An inlet 17 is formed at a center of the side disk plate 323 and exhaust ports 22 communicating to the inlet 17 along vanes 324 respectively are formed between a circumferential edge of the main disk plate 322 and that of the side disk plate 323.

[0015] A diffuser 14 is fixed to a forward side of the bracket 8. Farther ahead of this diffuser 4, the centrifugal fan 4 is arranged. Onto the outer circumferential portion of the motor case 6 is snapped (connected) a fan cover 15. This fan cover 15 covers the centrifugal fan 4 and the diffuser 14. This fan cover 15 has an intake opening 16, which is located opposite to the inlet 17 of the centrifugal fan 4, at the center of its front side and a rear opening (not shown) at the entire rear side. And the fan cover 15 is formed substantially as a cylindrical shape. These motor case 6 and fan cover 15 comprise the case 5. The fan cover 15 here is formed to have a larger outer circumferential wall than that of the motor case 6 in the centrifugal direction. The upper end of an outer circumferential wall of the motor case 6 (the upward direction being toward the fan cover 15 as viewed from the motor case 6) and the lower end of that of the fan cover 15 are connected through a linking portion 18.

[0016] On the circumferential wall near the rear side of the motor case 6, an air outlet (not shown) is opened, positioned in the radial direction. The rear side of the motor case 6 in the axial direction is sealed by a rear plate 21. The central part of this rear plate 21 protrudes backward in a substantially cylindrical shape to constitute a bearing housing 13b. A bearing 11b is housed in this bearing housing 13b.

[0017] On the other hand, the motor 2 is configured of a stator 19 fixed to the motor case 6 and a rotor 20 arranged inside this stator 19. Both ends of the rotor shaft 3 at the center of the rotor 20 are rotatably supported by the bearings 11a and 11b.

[0018] An example of configuration of the diffuser 14 will now be described with reference to Fig. 4. As shown in Figs. 4A and 4B, the diffuser 14 comprises: a substantially circular disk plate 81; a through hole 82, through which the rotor shaft 3 rotatably penetrates, formed substantially at the center of this disk plate 81 ; screw holes 83a and 83b for fixing the disk plate 81 to the bracket 8; a plurality of arcuate blades 84 erected on the circumferential area of the front surface of the disk plate 81 so as to be positioned outside of the circumferential edge of the centrifugal fan 4; and a plurality of arcuate blades 85 erected in a volute shape on the rear surface of the disk plate 81. The diffuser 14 having the above-described construction is located opposite to the linking portion 18 of the case 5, and secured to the bracket 8 with screws. The rotor shaft 3 penetrates the through hole 82 of the disk plate 81 and is supported by the bracket 8.

[0019] In this configuration, when the rotor shaft 3 rotates, the centrifugal fan 4 rotates integrally with that rotation. This rotation causes flow of air to pass the centrifugal fan 4 from the intake opening 16 opened at the front face of the fan cover 15 to exhaust port 22. Air from the exhaust port 22 flows between the arcuate blades 84 along the inner circumferential face of the fan cover 15 toward the rear side of the disk plate 81. The air further flows between the arcuate blades 85 in a volute manner along the rear surface of the disk plate 81 toward the center of the diffuser 14. The diffuser 14 in this way uniformly rectifies the air discharged from the exhaust port 22 of the centrifugal fan 4 and guides the air to the motor 2.

[0020] On the other hand, the electric blower 1 is connected to a commercial A.C. power source via a switching element 23 for controlling electric power to the motor 2 as shown in Fig. 5. A control terminal of this switching element 23 is connected with an electric blower control unit 26 consisting of a microcomputer 25 and the like. The electric blower control unit 26 is mounted on a circuit board 27 and terminals of the switching element 23 are connected with wired patterns on it. This electric blower control unit 26 is further connected with an operating unit 28 for starting and stopping power, or selecting from a plurality of different electric powers (Strong, Regular and Weak) a desirable power supplied to the electric blower 1. The switching element 23 and the electric blower control unit 26 in this way constitute a drive circuit 27a.

[0021] In the configuration of this embodiment of the

invention, a body of the switching element 23 contained in the drive circuit 27a as a power device is arranged on the outside of a partition wall 29a forming an air channel 29 between the exhaust port 22 of the centrifugal fan 4 and the motor 2, and secured by a screw 30.

[0022] The partition wall 29a is a wall forming the channel 19 between the exhaust port 22 of the centrifugal fan 4 and the upper end of the motor 2 in the electric blower 1 and separating air flowing through the air channel 29 from an outside air. In this electric blower 1, part of an outer circumferential wall 15a of fan cover 15 and part of an outer circumferential wall 6a of motor case 6 constitute the partition wall 29a.

[0023] Accordingly, air flowing through the air channel 29 is in no way disturbed by the switching element 23 controlling electric power to the motor 2.

[0024] It is therefore possible to release heat caused by the switching element 23 to the case 5 without increase in pressure loss of the air channel 29 of the electric blower 1. Also, as the partition wall 29a where the switching element 23 is fixed is located in a farther upstream position than the motor 2 in the air flow direction from the centrifugal fan 4, it is little affected by heat caused by the motor 2. Moreover, during the operation of the electric blower 1, temperature of the air flowing through the channel 29 in the partition wall 29a on which the switching element 23 is arranged is lower than that of the downstream side of the motor 2 because the partition wall 88 is located at the upstream side from the motor 2.

[0025] In this embodiment, the case 5 comprises the motor case 6 and the fan cover 15, and this fan cover 15 has an outer circumferential wall 15a greater in diameter than an outer circumferential wall 6a of the motor case 6. The partition wall 29a includes the linking portion 18 which is interposed between the outer circumferential wall 15a of the fan cover 15 and the outer circumferential wall 6a of the motor case 6. And the switching element 23 is fixed on the outside surface of the linking portion 18. Also, this type of linking portion 18 is a step portion created by the difference in outer circumferential size between the fan cover 15 and the motor case 6 in the centrifugal direction. It is therefore structurally easy to form the linking portion 18 as a planar portion. Since the switching element 23 can be mounted to this type of plane in this structure, there is greater degree of freedom in mounting of the switching element 23 compared with a case where the switching element is mounted on the outer circumferential surface of the motor case 6.

[0026] Further, this linking portion 18 also constitutes a region opposite the diffuser 14 for rectifying the channel flow of the air from the exhaust port 22 of the centrifugal fan 4 to the motor 2. Experimental findings by the present inventor have also confirmed the high cooling effect on the switching element 23 arranged in the region opposite the diffuser 14.

[0027] Incidentally, in a specific example of a configuration of this embodiment, the linking portion 18 in the case 5 is integrated with the motor case 6, and is configured of a flange 31 formed by bending the circumferential end portion'of this cylindrical shaped motor case 6 to protrude in the outer direction to have a substantially L-shaped section. As the flange 31 can be easily shaped flatly in this configuration, the switching element 23 can be easily secured to the flange 31.

[0028] Now is shown a modification of this embodiment in Fig. 6 and Fig. 7. In the first embodiment, the switching element 23 is arranged on the outer surface of the flange 31 formed by a step portion designed to make fixing easier and cooling more efficient. However, if the emphasis is to be on efficient cooling without being affected by heat generated by the stator 19, then the switching element 23 can also be fixed on the outer surface of the electric blower 1 in a position closer to the intake opening 16 than the motor 2 and opposite the diffuser 14, for instance on the outer surface of the outer circumferential wall 15a of the fan cover 15 as shown in Fig. 6 and Fig. 7.

[0029] A second preferred embodiment of the present invention will now be described with reference to Fig. 8 and Fig. 9. The same or similar constituent elements as those shown in the first embodiment will be denoted respectively by the same reference numerals, and their description is omitted (this also applies to subsequent embodiments).

[0030] While this embodiment is basically similar to the first embodiment, this embodiment uses a motor case 32 in place of the motor case 6. The motor case 32 in this embodiment is a bottomed structure using a rear plate portion 33, whose fan cover 15 side opens as an opening 34 to house the motor 2. A disk-shaped frame 35 larger than the motor case 32 in outer circumference is fitted to the motor case 32 with screws 36 so as to cover the opening 34 of the motor case 32. Further, the outer circumferential wall 15a of the fan cover 15 is secured tightly by a pressure fitting or the like to an outer circumferential edge 87 of the disk-shaped frame 35. The motor case 32 and the fan cover 15 are integrally affixed to each other. The disk-shaped frame 35 is therefore interposed between the motor case 32 and the fan cover 15. This disk-shaped frame 35 has an outer ring shaped plate portion 35a acting as the linking portion 18 and an inner disk shaped plate portion 35b integrally extending from the inner edge of the outer ring shaped plate portion 35a, as shown in Fig. 8.

[0031] Further a plurality of openings 37, which are shaped like a fan as shown in Fig. 9 for instance, are formed in the inner disk shaped plate portion 39 to flow the air from the exhaust port 22 of the centrifugal fan 4 to the motor 2. These openings 37 are designed to secure a required rate of air for cooling the motor 2 according to the performance of the centrifugal fan 4. The bearing housing 13a is formed at substantially the center of the disk-shaped frame 35, protruding forward in a substantially cylindrical shape. The bearing 11a is housed in the bearing housing 13a, and the through hole 12 for the rotor shaft 3 is formed at its center.

[0032] In this configuration, the outer ring shaped plate

portion 35a positioned outside the outer circumferential wall 6a of the motor case 32 constitutes part of the partition wall 29a forming the air channel 29 between the exhaust port 22 of the centrifugal fan 4 and the motor 2, and which acts as the linking portion 18. The switching element 23 is fixed on the outer surface of this outer ring shaped plate portion 35a, and secured with the screw 30.

[0033] Therefore; also in this embodiment by utilizing the outer ring shaped plate portion 35a of the disk-shaped frame 35, the same functions and effects as in the first embodiment using the flange 31 can be achieved. Incidentally in this embodiment, the motor case 6, the fan cover 15 and the outer ring shaped plate portion 35a of the disk-shaped frame 35 constitute the case 5.

[0034] In this configuration, the disk-shaped frame 35 of this embodiment is comprised of part of the partition wall 88 that forms the air channel 29 between the exhaust port 22 of the centrifugal fan 4 and the upper end of the motor 2 . Furthermore, the inner disk shaped plate portion 35b is arranged in a position farther upstream in the air flow direction than the motor 2 from which heat emits. This arrangement results in increase in a surface area of the disk-shaped frame 35 in contact with the air at the farther upstream than the motor 2 and accordingly a cooling effect of the disk-shaped frame 35 is enhanced. The switching element 23 therefore affixed integrally to this disk-shaped frame 35 is also cooled more efficiently.

[0035] A third preferred embodiment of the invention will now be described with reference to Fig. 10 through Fig. 12. While this embodiment is basically similar to the first embodiment, this embodiment applies the present invention to an electric blower 42 using a brushless motor 41 in place of the motor 2 with brushes.

[0036] First will be described with reference to Fig. 12 an example of configuration of a drive control system including a drive circuit 27b for the brushless motor 41. The centrifugal fan 4 is rotated by the brushless motor 41 which is driven by an inverter circuit 44. The DC voltage is supplied to the inverter circuit 44 from a D.C. power supply unit 43. An electric blower control unit 45 for controlling the electric blower 42 is connected to drivers 46a through 46f, and controls the switching timing of switching elements 47a through 47f, which are power devices such as power MOSFET devices that constitute the inverter circuit 44. The individual sections will be described in detail below.

[0037] The D.C. power supply unit 43 consists of a battery combining a plurality of secondary cells, such as nickel cadmium (NiCd) cells, nickel hydrogen cells or lithium ion cells, or is a circuit which converts an A. C. voltage of a commercial A. C. power supply into a D.C. voltage under rectifying and smoothing. This D.C. voltage is supplied to the inverter circuit 44.

[0038] The inverter drive circuit 44 has a configuration in which six switching elements 47a through 47f are connected in a three-phase bridge structure. These switching elements 47a through 47f are driven by the high voltage side drivers 46a through 46c and the low voltage side drivers 46d through 46f on the basis of pulse signals supplied from the electric blower control unit 45 mainly consisting of a microcomputer 48. They supply A.C. to the windings 49a through 49c of the electric blower 42.

[0039] The electric blower control unit 45 are connected with an operating unit 50 for starting, stopping or selecting power to supply to the electric blower 42, a current detecting means 51 for detecting a current flowing to the inverter circuit 44, and an input voltage detecting means 52 for detecting an input voltage.

[0040] The electric blower control unit 45 is further connected with a position detecting means 55 for detecting magnetic poles of a rotor 54 surrounded by a stator 53. Three magnetic sensors arranged at electrical angle intervals of 120° are used as this position detecting means 55. Hole sensors and hole ICs may also be utilized as these magnetic sensors. Other methods for detecting the magnetic poles include, though not shown, a method using an optical pulse encoder and another method for detecting by a voltage phase detecting means the voltages induced by the windings 49a through 49c.

[0041] In this configuration, terminals of the plurality of switching elements 47a through 47f, which are power devices, are connected with wired patterns on a circuit board 56. And bodies of the switching elements 47a through 47f are arranged on the outer surface of the linking portion 18 of the partition wall 88 and secured with the screws 30 or similar manners. Here, unlike the case where there is only one switching element 23, the plurality of switching elements 47a through 47f must be considered. These switching elements 47a through 47f, as shown in Fig. 11 are arranged on substantially the same circle around the rotor shaft 3 of the brushless motor 41 and radially arranged at nearly equal intervals.

[0042] By using this structure for arranging the switching elements 47a through 47f, as in the case of the first embodiment described above, the switching elements 47a through 47f can be effectively cooled without increasing pressure loss of the channel 29 of the electric blower 42. Since the drive circuit 27b of the brushless motor 41 in this embodiment is in particular configured of a plurality of switching elements 47a through 47f, this plurality of switching elements 47a through 47f are effectively cooled without increasing pressure loss of the channel 29 of the electric blower 42. This embodiment is therefore particularly effective. Furthermore, since this plurality of switching elements 47a through 47f are radially arranged on substantially the same circumferential region around the rotor shaft 3, the unevenly distributed cooling of these switching elements 47a through 47f is reduced, and they are uniformly cooled, resulting in an increased cooling effect. It is therefore possible to stabilize the operation of the switching elements 47a through 47 and accordingly the operation of all the circuitry.

[0043] This embodiment has been described as an application of the first embodiment and the second embodiment can also be applied using the disk-shaped frame 35.

[0044] Further, the motor cases 6 and 32 in these embodiments are supposed to have bottomed structures for blocking, their rear plate 21 and 33 may also be blocked using separate members.

[0045] These embodiments were described using examples in which the switching element 23 or elements 47a through 47f, such as Triac switches or power MOSFETs were used as a power device or devices. And, the present invention is not limited to these elements and is applicable to devices that emit heat during drive operation such as switching elements using insulated gate bipolar transistors (IGBTs). These elements can be used not only discretely but also in a packaged form or integrated into a device.

[0046] A fourth preferred embodiment of the invention will now be described with reference to Fig. 13 through Fig. 15. This embodiment is an application of the electric blower 1 or 42 of any of the configurations described above for a vacuum cleaner, which is particularly suitable. The other applications are kitchen equipments or electric tools, for example food processors or power drills.

[0047] A vacuum cleaner 61 as the present embodiment, is mounted with the electric blower 1.

[0048] The vacuum cleaner 61 is mainly configured of a cleaner body 62 which constitutes the basic constituent of the vacuum cleaner 61, a hose 63 one of whose ends is detachably connected to the cleaner body 62, a manual operating unit 64 arranged at the other end of the hose 63, an extension pipe 65 of a bisected structure one of whose ends is connected to the manual operating unit 64, a suction inlet unit 66 detachably connected to the other end of the extension pipe 65, the electric blower 1 housed and held within the cleaner body 62, and a dust chamber 67 formed within the cleaner body 62.

[0049] The hose 63 is connected to the cleaner body 62 in such a manner that its base end is made to communicate with the suction side of the electric blower 1 via the dust chamber 67. The manual operating unit 64 provided at the other end of the hose 63 is equipped with a grip 68 extending backwards and an operating means 69 positioned within manipulation range of the fingers of the operator holding this grip 68. The operating means 69 is equivalent to the operating unit 28 in Fig. 5.

[0050] The operating means 69 also serves as the power switch for the electric blower 1, and is configured to allow selecting one of a plurality of operating modes in which this electric blower 1 is driven to different states of power. More specifically, there are successively arranged in a row, in the direction from the grip 68 to the extension pipe 65, a stop button 69a for setting the operating mode to a stopped state, a low power operation button 69b for setting low power operation, and a high power operation button 69c for setting high power operation. In high power operation mode for instance, the electric blower 1 turns at a high speed of 30,000 rpm and sucks up the dust.

[0051] The cleaner body 62 has a body case 70. This body case 70 is configured by joining a lower case 70a which is open on the top face and formed for example of acrylonitrile butadiene styrene (ABS) or similar material, and an upper case 70b of the same material to block the rear top face of this lower case 70a with a bumper (not shown) being held by the circumferential edges including the front face, and is thereby formed into a case whose front upper face is open. A lid 71 is fitted to this body case 70, pivoting on it to make the opening in the front upper face closable.

[0052] The body case 70 is fitted with turning wheels 72 on the front under face of the cleaner body 62 in the running direction, and following wheels 73 of a larger diameter are fitted to the rear side faces of the cleaner body 62. The turning wheels 72 and the following wheels 73 allow the vacuum cleaner 61 to move along the floor (not shown). A handle 74 which is vertically slidable is provided at the top of the cleaner body 62.

[0053] On the other hand, A dust chamber 77 is partitioned and formed in the running direction of the cleaner body 62 within the cleaner body 62. A inside wall 76 having ventilated grids 75 is formed behind the dust chamber 77. And the dust chamber 77 is opened upward. An electric blower chamber 78 for housing the electric blower 1 is partitioned and formed behind the dust chamber 77. A dust bag 90 is detachably fitted by a holder 79 formed within the dust chamber 77.

[0054] An auxiliary dust filter 91 covering those ventilated grids 75 is detachably fitted to the front side of the inside wall 76. This auxiliary dust filter 91 has a frame 92 and an auxiliary filter 93 to be snapped onto this frame 92.

[0055] The dust bag 90 and the auxiliary dust filter 91 are attached or detached through the top opening of the dust chamber 77. The lid 71, whose rear end pivots on the upper case 70b, is formed so as to cover the dust chamber 77 from above.

[0056] On the other hand, the electric blower 1 is provided within the electric blower chamber 78. This electric blower 1 is structured in the same way as the electric blower 1 as the first preferred embodiment of the invention. On the circumferential surface near the rear'part of the motor case 6 is opened an electric blower outlet 94 as the exhaust port. Though not shown, the electric blower outlet 94 may also be formed in the rear surface of the motor case 6.

[0057] In this configuration, when the motor 2 rotates, the centrifugal fan 4 rotates integrally with that rotation, and this rotation guides air from the intake opening 16 of the fan cover 15 through the centrifugal fan 4, its exhaust port 22, the diffuser 14 and the motor 2 to the electric blower outlet 94.

[0058] An airtight supporter 95, which is an annular and made of natural rubber or synthetic rubber for instance, is fitted into the front end of the outer circumferential edge of the electric blower 1. On the other hand, an upper rib front 78a and a lower rib front 78b constituting part of a chamber wall of the electric blower chamber 78 are protrusively formed at the lower face of the upper case 70b and the upper face of the lower case 70a. The

airtight supporter 95 is brought into contact with the upper rib front 78a and lower rib front 78b to set the electric blower 1 in the electric blower chamber 78.

[0059] A negative pressure generated by the drive of the electric blower 1 deforms the airtight supporter 95. On the front end of the electric blower 1, this airtight supporter 95 makes an airtight communication between the intake opening 16 of the electric blower 1 and the dust chamber 77 via the ventilated grids 75.

[0060] The airtight supporter 95 has a substantial L-shaped section and is arranged between the outer surface of the fan cover 15 and the chamber wall of the electric blower chamber 78. The airtight supporter 95 is made of absorbing vibration material which is natural rubber or synthetic rubber, for instance, as mentioned above. In this embodiment, since the switching element 23 as the power device to drive the electric blower 1 is directly fixed to the outer surface of the case 5, the vibration of the body case 70 caused by steps and/or unevenness of floors is directly transmitted to the switching element 23 when the vacuum cleaner 61 is moved on the floors. However, by making the airtight supporter 95 of the absorbing vibration material, it is possible to suppress the transmission of vibrations from the body case 70 and thereby increase the mechanical reliability of the switching element 23.

[0061] On the other hand in this embodiment, since the switching element 23 and the airtight supporter 95 are close to each other, the airtight supporter 95 is affected by heat from the switching element 23 when the electric blower 1 is being driven. Therefore, by using highly heat resisting material, such as silicone rubber or ethylene propylene rubber for the airtight supporter 95, the thermal reliability of the vacuum cleaner 61 can be enhanced.

[0062] On the other hand, so that heat caused by the switching element 23 when the electric blower 1 is being driven will not affect the chamber wall of the electric blower chamber 78, namely, the body case 70, it is necessary to make the airtight supporter 95 of thermally insulated material, which is natural foam rubber or synthetic foam rubber having a lot of air bubbles inside. Since foam material even of the same component parts may differ in thermal insulation performance if density of the air bubbles varies, the density should be adjusted according to the level of heat caused by the switching element 23.

[0063] According to a characteristic of the vacuum cleaner 61, the material of the airtight supporter 95 is chosen from among the absorbing-vibration material, heat resisting material or thermally insulated material and/or the component parts are adjusted.

[0064] An electric blower mounted in the vacuum cleaner 61 may be not only the electric blower of the first embodiment but that of other embodiments.

[0065] There are a number of factors that can influence the dust sucking power of the vacuum cleaner 61. These factors include the input power and pressure loss of a channel. While a greater input power would increase the dust sucking power, the heat caused by the switching element 23 or elements 47a through 47f which control that input power would also increase. If temperature of the switching element 23 or elements 47a through 47f is too high, the input power might be limited. In addition, the larger pressure loss of the channel, the weaker the dust sucking power. Therefore, it is particularly effective in enhancing the dust sucking performance of the vacuum cleaner 61 to be equipped with the aforementioned electric blower 1 or 42, which can effectively cool the switching element 23 or elements 47a through 47f, which are the power devices, without increasing pressure loss of the channel.

[0066] A fifth preferred embodiment of the present invention will now be described with reference to Fig. 16. While this embodiment is basically similar to the first embodiment, a cooling opening 100 is formed on the partition wall 88 near the switching element 23. Thus the cooling opening 100 is formed at a position where a blown air directly hits the switching element 23 or a position where the blown air directly gives rise to forced convection around the switching element 23. Fig. 16 specifically shows a case in which the cooling opening 100 is formed on the partition wall 88 parallel to the rotor axis 3 in the vicinity of the fixed switching element 23. The number of cooling openings 100 may be one or more.

[0067] In this configuration an air with only a slight rise in temperature before passing the motor 2 flows on the surface of the switching element 23 or to the vicinity of it. It is therefore possible to cool the switching element 23 using the blown air forcibly and release the heat to the partition wall 88 which is part of the case 5 at the same time. And the cooling effect to the switching element 23 is significantly enhanced.

[0068] A sixth preferred embodiment of the invention will now be described with reference to Fig. 17. While this embodiment is basically similar to the third embodiment, cooling openings 101 are formed on the flange 31 near the switching elements 47a through 47f. Thus the cooling openings 101 are formed in a position where the blown air directly gives rise to forced convection around the switching elements 47a through 47f. Fig. 17 specifically shows a case in which a plurality of cooling openings 101 are formed on the flange 31 orthogonal to the rotor shaft 3 in the vicinity of the switching elements 47a through 47f.

[0069] In this configuration an air with only a slight rise in temperature before passing the brushless motor 41 flows to the vicinity of the switching elements 47a through 47f. It is therefore possible to cool the switching element 23 using the blown air forcibly and release the heat to the flange 31 which is part of the motor case 6 at the same time. And the cooling effect to the switching elements 47a through 47f is significantly enhanced.

Claims

1. An electric blower (1, 42) comprising a motor (2, 41) having a rotation shaft (3) a centrifugal fan (4) fixed to the rotation shaft of the motor, the fan having an exhaust port (22); a case (5) for housing the centrifugal fan and the motor, the case having a partition wall (29a) for constituting an air channel (29) between the exhaust port of the centrifugal fan and the motor
said partition wall (29a) separating air flowing though the channel (29) from an outside air and having an inner surface towards said air channel (29) and an outer surface towards the outside air;
and a drive circuit (27a, 27d) having a power device (23, 47a-47f) for driving the motor, **characterized in that** the power device is arranged on the outer surface of the partition wall.

2. An electric blower according to claim 1, wherein the case includes a fan cover (15) for covering the centrifugal fan and a motor case (6, 32) for housing the motor, the fan cover having an outer circumferential wall (15a) greater in width than that of the motor case, the partition wall having a linking portion (18) interposed between the outer circumferential wall of the fan cover and the outer circumferential wall of the motor case wherein the power device is arranged on the linking portion of the partition wall.

3. An electric blower according to claim 2, wherein the linking portion is a flange portion (31) integrally outwardly extending from the edge of the motor case.

4. An electric blower according to claim 2, wherein the linking portion includes an outer ring shaped plate portion (35a) on which the power device is arranged and an inner disk shaped plate portion (35b) integrally extending from the inner edge of the outer ring shaped plate portion, the inner disk shaped plate portion having an air flow opening (37) through which the air channel is communicated to the inside of the motor case.

5. An electric blower according to claim 1 further comprising a diffuser (14) located between the centrifugal fan and the motor for rectifying an air flow from the exhaust port of the centrifugal fan toward the motor, the diffuser being opposite to the partition wall, wherein the power device is fixed on a portion of the partition wall opposite to the diffuser.

6. An electric blower according to claim 1, **characterized**
in that a cooling opening (100,101) is formed on the case in the vicinity of the power device.

7. An electric blower according to claim 1, wherein the motor is a brushless motor (41) and the drive circuit includes a plurality of the power devices on the partition wall arranged radially on substantially the same circle around the rotation shaft.

8. An electric apparatus (61) for causing air flow, comprising:

   an electric blower according to any preceding claim,

9. An electric apparatus (61) according to claim 8 wherein the case of the electric blower has a fan cover (15) for covering the fan, a motor case for housing the motor, and the partition wall (29a) of the case being located between the fan cover and the motor case for constituting an air channel (29) from the fan to the motor, the fan cover having an outer circumferential wall (15a) grater in width than that of the motor case; and wherein the electric apparatus further comprises
a blower chamber (78) having a wall for housing the electric blower; and
a supporter (95) located between the wall of the blower chamber and the outer circumferential wall of the fan cover for supporting the electric blower.

10. An electric apparatus according to claim 9, wherein the supporter is made of a vibration absorbing material.

11. An electric apparatus according to claim 9, wherein the supporter is made of thermally insulating material.

12. An electric apparatus according to claim 9, wherein the supporter is made of a heat resisting material.

Patentansprüche

1. Ein elektrisches Gebläse (1, 42), umfassend einen Motor (2, 41) mit einer Drehwelle (3), einen Zentrifugalventilator (4), der an der Drehwelle des Motors befestigt ist, während der Ventilator eine Auslassöffnung (22) aufweist, ein Gehäuse (5) zum Aufnehmen des Zentrifugalventilators und des Motors, während das Gehäuse eine Trennwand (29a) zum Bilden eines Luftkanals (29) zwischen der Auslassöffnung des Zentrifugalventilators und dem Motor aufweist, während die Trennwand (29a) durch den Kanal (29) strömende Luft von einer äußeren Luft trennt und eine innere Oberfläche in Richtung des Luftkanals (29) und eine äußere Oberfläche in Richtung der äußeren Luft aufweist, sowie eine Antriebsschaltung (27a, 27d) mit einer Leistungsvorrichtung (23, 47a-47f) zum Antreiben des Motors, **dadurch gekennzeichnet, dass** die Leistungsvorrichtung an der äu-

ßeren Oberfläche der Trennwand angeordnet ist.

2. Ein elektrisches Gebläse gemäß Anspruch 1, während das Gehäuse umfasst eine Ventilatorabdekkung (15) zum Abdecken des Zentrifugalventilators und ein Motorgehäuse (6, 32) zum Aufnehmen des Motors, während die Ventilatorabdeckung aufweist eine äußere umfängliche Wand (15a), die eine größere Breite als die des Motorgehäuses aufweist, während die Trennwand einen Verbindungsbereich (18) aufweist, der zwischen der äußeren umfänglichen Wand der Ventilatorabdeckung und der äußeren umfänglichen Wand des Motorgehäuses angeordnet ist, während die Leistungsvorrichtung angeordnet ist an dem Verbindungsbereich der Trennwand.

3. Ein elektrisches Gebläse gemäß Anspruch 2, während der Verbindungsbereich ein Flanschbereich (31) ist, der sich integral auswärts von dem Rand des Motorgehäuses erstreckt.

4. Ein elektrisches Gebläse gemäß Anspruch 2, während der Verbindungsbereich aufweist einen äußeren ringförmigen Plattenbereich (35a), auf dem die Leistungsvorrichtung angeordnet ist, sowie einen innerer scheibenförmiger Plattenbereich (35b), der sich integral von dem inneren Rand des äußeren ringförmigen Plattenbereichs erstreckt, während der innere scheibenförmige Plattenbereich eine Luftstromöffnung (37) aufweist, durch die der Luftkanal mit der Innenseite des Motorgehäuses verbunden ist.

5. Ein elektrisches Gebläse gemäß Anspruch 1, weiterhin umfassend einen Diffusor (14), der zwischen dem Zentrifugalventilator und dem Motor zum Korrigieren eines Luftstroms von der Auslassöffnung des Zentrifugalventilators in Richtung des Motors angeordnet ist, während der Diffusor gegenüber der Trennwand angeordnet ist, wobei die Leistungsvorrichtung befestigt ist an einem Bereich der Trennwand gegenüber dem Diffusor.

6. Ein elektrisches Gebläse gemäß Anspruch 1, **dadurch gekennzeichnet, dass** eine Kühlöffnung (100, 101) in dem Gehäuse in der Nähe der Leistungsvorrichtung ausgebildet ist.

7. Ein elektrisches Gebläse gemäß Anspruch 1, während der Motor ein bürstenloser Motor (41) ist und die Antriebsschaltung umfasst eine Mehrzahl an Leistungsvorrichtungen an der Trennwand, die radial im Wesentlichen auf demselben Kreis um die Drehzelle angeordnet sind.

8. Eine elektrische Vorrichtung (61) zum Bewirken eines Luftstroms, umfassend: ein elektrisches Gebläse gemäß einem der vorhergehenden Ansprüche.

9. Eine elektrische Vorrichtung (61) gemäß Anspruch 8, während das Gehäuse des elektrischen Gebläses eine Ventilatorabdeckung (15) zum Abdecken des Ventilators aufweist, ein Motorgehäuse zum Aufnehmen des Motors sowie eine Trennwand (29a) des Gehäuses, die zwischen der Ventilatorabdeckung und dem Motorgehäuse zum Bilden eines Luftkanals (29) von dem Ventilator zu dem Gehäuse angeordnet ist, während die Ventilatorabdeckung eine äußere umfängliche Wand (15a) mit einer größeren Breite als die des Motorgehäuses aufweist, und wobei die elektrische Vorrichtung weiterhin umfasst:

   eine Gebläsekammer (78) mit einer Wand zum Aufnehmen des elektrischen Gebläses und
   eine Unterstützungsstruktur (95), die zwischen der Wand der Gebläsekammer und der äußeren umfänglichen Wand der Ventilatorabdeckung zum Unterstützen des elektrischen Gebläses angeordnet ist.

10. Eine elektrische Vorrichtung gemäß Anspruch 9, während die Unterstützungsstruktur aus einem vibrationsabsorbierenden Material hergestellt ist.

11. Eine elektrische Vorrichtung gemäß Anspruch 9, während die Unterstützungsstruktur aus einem thermisch isolierenden Material besteht.

12. Eine elektrische Vorrichtung gemäß Anspruch 9, während die Unterstützungsstruktur aus einem hitzebeständigen Material hergestellt ist.

Revendications

1. Souffleur électrique (1, 42) comprenant un moteur (2, 41) ayant une arbre de rotation (3) ; un ventilateur centrifuge (4) fixé sur l'arbre de rotation du moteur, le ventilateur ayant un orifice d'échappement (22) ; un boîtier (5) pour loger le ventilateur centrifuge et le moteur, le boîtier ayant une paroi de séparation (29a) pour constituer un canal d'air (29) entre l'orifice d'échappement du ventilateur centrifuge et le moteur :

   ladite paroi de séparation (29a) séparant l'air s'écoulant par le canal (29) d'un air extérieur et ayant une surface interne vers ledit canal d'air (29) et une surface externe vers l'air extérieur ; et un circuit d'entraînement (27a, 27d) ayant un dispositif de puissance (23, 47a - 47f) pour entraîner le moteur, **caractérisé en ce que** le dispositif de puissance est agencé sur la surface externe de la paroi de séparation.

2. Souffleur électrique selon la revendication 1, dans lequel le boîtier comprend un couvercle de ventilateur (15) pour recouvrir le ventilateur centrifuge et un boîtier de moteur (6, 32) pour loger le moteur, le couvercle de ventilateur ayant une paroi circonférentielle externe (15a) de largeur supérieure à celle du boîtier de moteur, la paroi de séparation ayant une partie de liaison (18) intercalée entre la paroi circonférentielle; externe du couvercle de ventilateur et la paroi circonférentielle externe du boîtier de moteur, dans lequel le dispositif de puissance est agencé sur la partie de liaison de la paroi de séparation.

3. Souffleur électrique selon la revendication 2, dans lequel la partie de liaison est une partie de rebord (31) s'étendant de manière solidaire vers l'extérieur à partir du bord du boîtier de moteur.

4. Souffleur électrique selon la revendication 2, dans lequel la partie de liaison comprend une partie de plaque en forme de bague externe (35a) sur laquelle le dispositif de puissance est agencé et une partie de plaque en forme de disque interne (35b) s'étendant de manière solidaire à partir du bord interne de la partie de plaque en forme de bague externe, la partie de plaque en forme de disque interne ayant une ouverture d'écoulement d'air (37) à travers laquelle le canal d'air est en communication avec l'intérieur du boîtier de moteur.

5. Souffleur électrique selon la revendication 1, comprenant en outre un diffuseur (14) positionné entre le ventilateur centrifuge et le moteur pour rectifier un écoulement d'air de l'orifice d'échappement du ventilateur centrifuge vers le moteur, le diffuseur étant opposé à la paroi de séparation, dans lequel le dispositif de puissance est fixé sur une partie de la paroi de séparation opposée au diffuseur.

6. Souffleur électrique selon la revendication 1, **caractérisé en ce qu'**une ouverture de refroidissement (100, 101) est formée sur le boîtier à proximité du dispositif de puissance.

7. Souffleur électrique selon la revendication 1, dans lequel le moteur est un moteur sans balai (41) et le circuit d'entraînement comprend une pluralité de dispositifs de puissance sur la paroi de séparation agencée de manière radiale sensiblement sur le même cercle autour de l'arbre de rotation.

8. Appareil électrique (61) pour provoquer l'écoulement d'air, comprenant :

   un souffleur électrique selon l'une quelconque des revendications précédentes.

9. Appareil électrique (61) selon la revendication 8, dans lequel le boîtier du souffleur électrique a un couvercle de ventilateur (15) pour recouvrir le ventilateur, un boîtier de moteur pour loger le moteur, et la paroi de séparation (29a) du boîtier étant positionnée entre le couvercle de ventilateur et le boîtier de moteur pour constituer un canal d'air (29) du ventilateur vers le moteur, le couvercle de ventilateur ayant une paroi circonférentielle externe (15a) de largeur supérieure à celle du boîtier de moteur ;
   et dans lequel l'appareil électrique comprend en outre :

   une chambre de souffleur (78) ayant une paroi pour loger le souffleur électrique ; et
   un dispositif de support (95) positionné entre la paroi de la chambre de souffleur et la paroi circonférentielle externe du couvercle de ventilateur pour supporter le souffleur électrique.

10. Appareil électrique selon la revendication 9, dans lequel le dispositif de support est réalisé avec un matériau absorbant les vibrations.

11. Appareil électrique selon la revendication 9, dans lequel le dispositif de support est réalisé avec un matériau thermiquement isolant.

12. Appareil électrique selon la revendication 9, dans lequel le dispositif de support est réalisé avec un matériau résistant à la chaleur.

Fig. 1

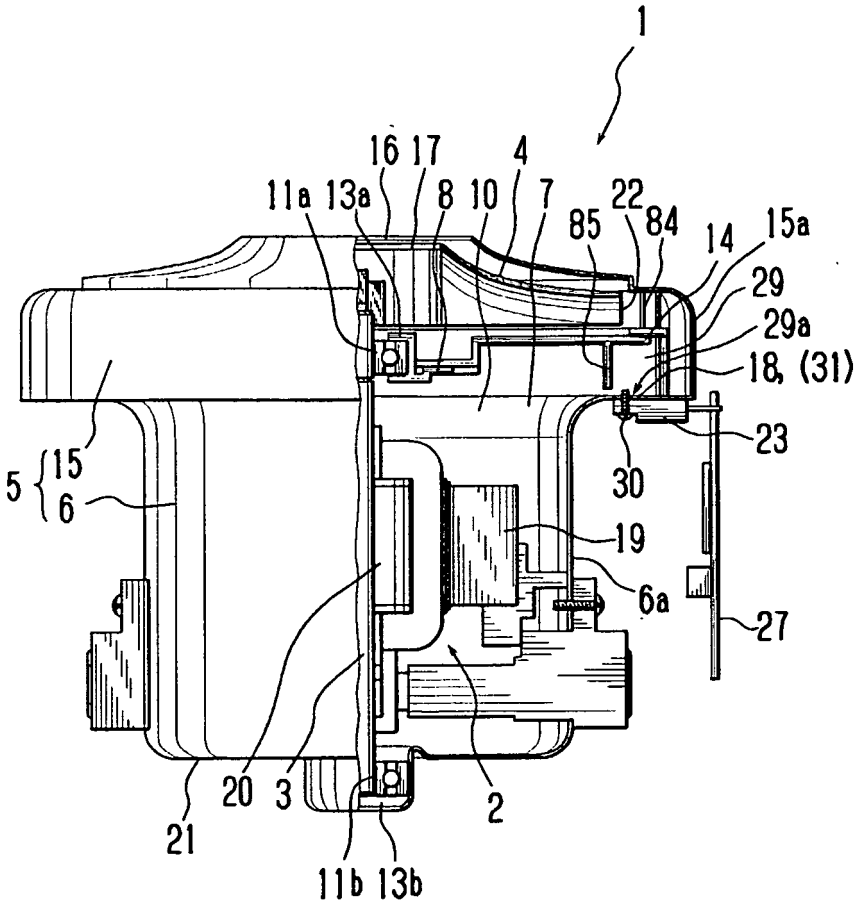

1
16
17
4
11a
13a
8
10
7
22
85
84
14
15a
29
29a
18, (31)
23
30
5
15
6
19
6a
27
20
3
2
21
11b
13b

Fig. 2

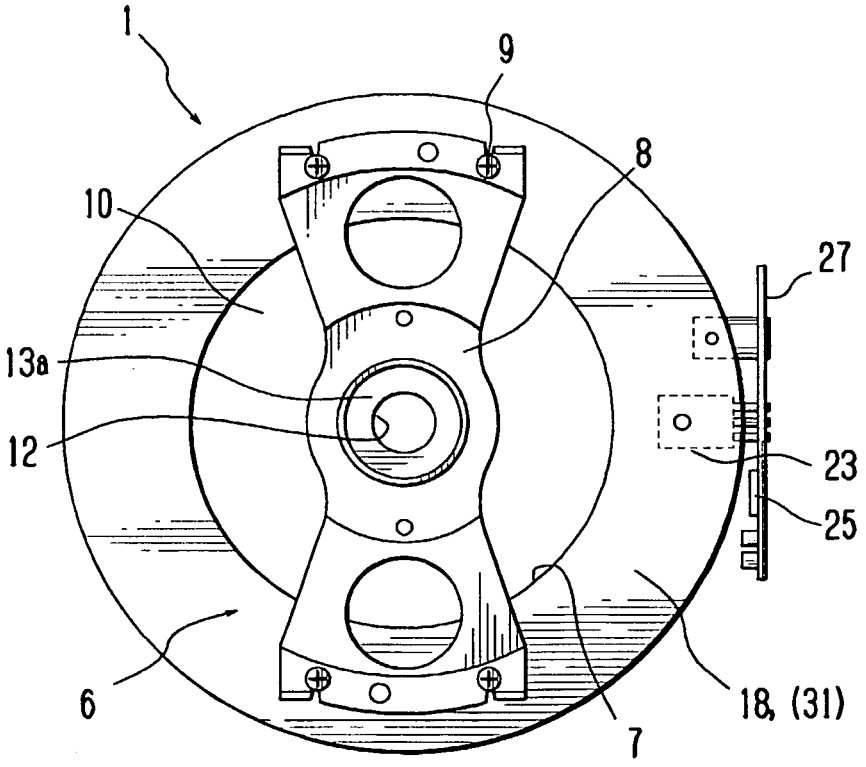


Fig. 3A

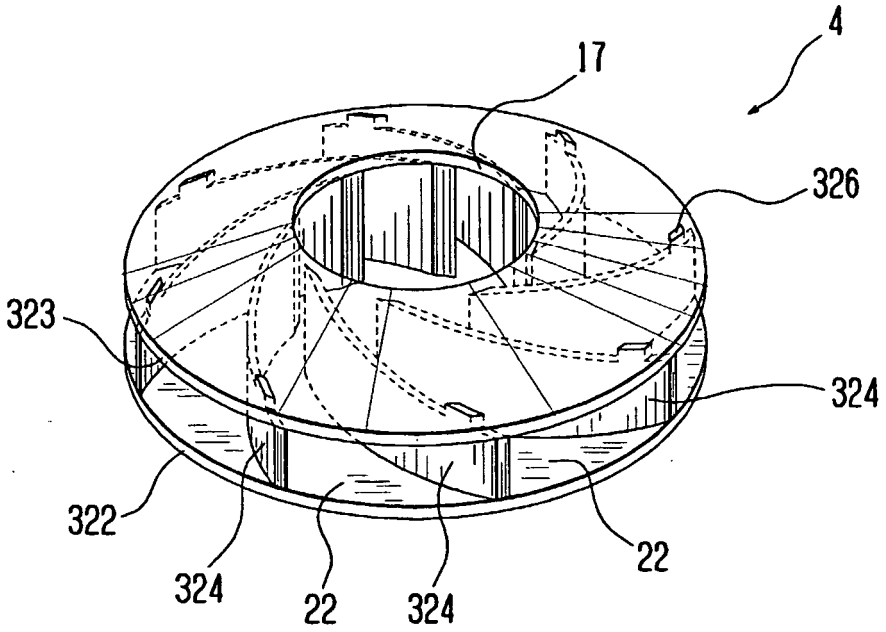


Fig. 3B

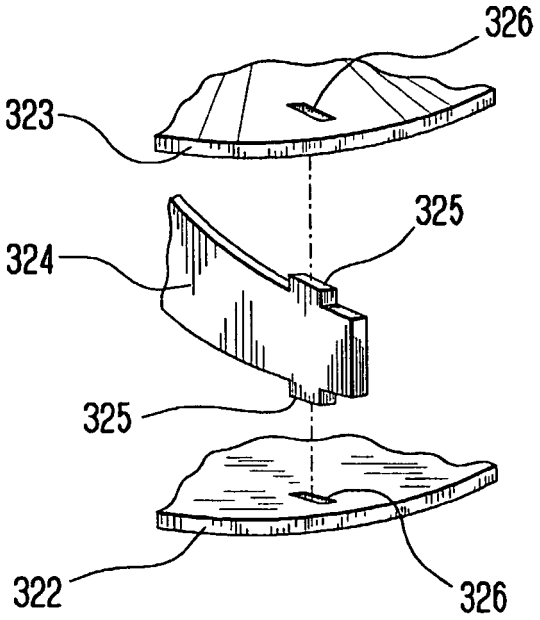


Fig. 4A

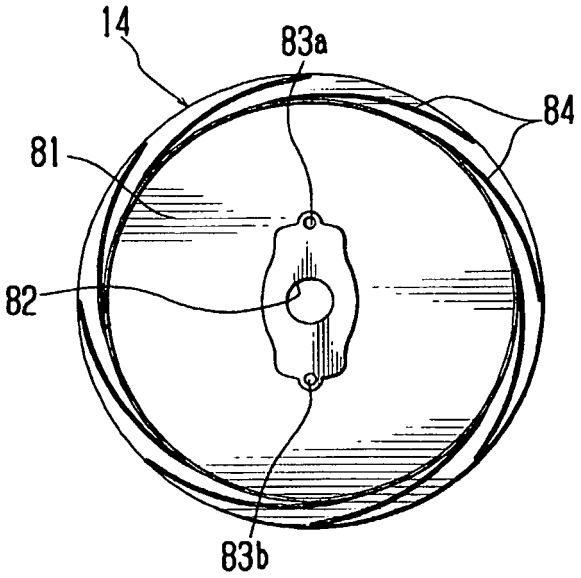


Fig. 4B

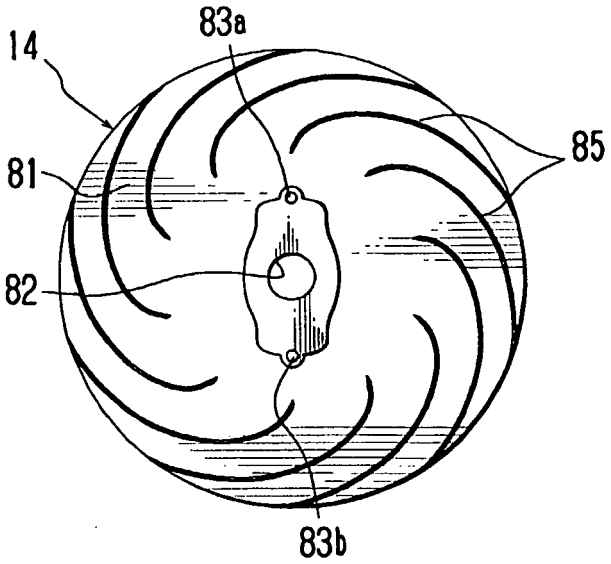


Fig. 5

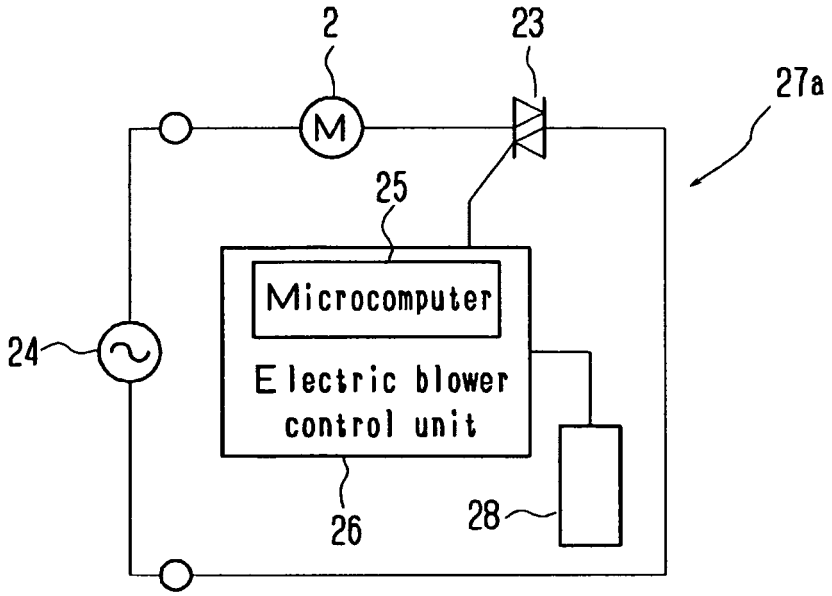

2
23
27a
M
25
Microcomputer
24
Electric blower
control unit
26
28

Fig. 6

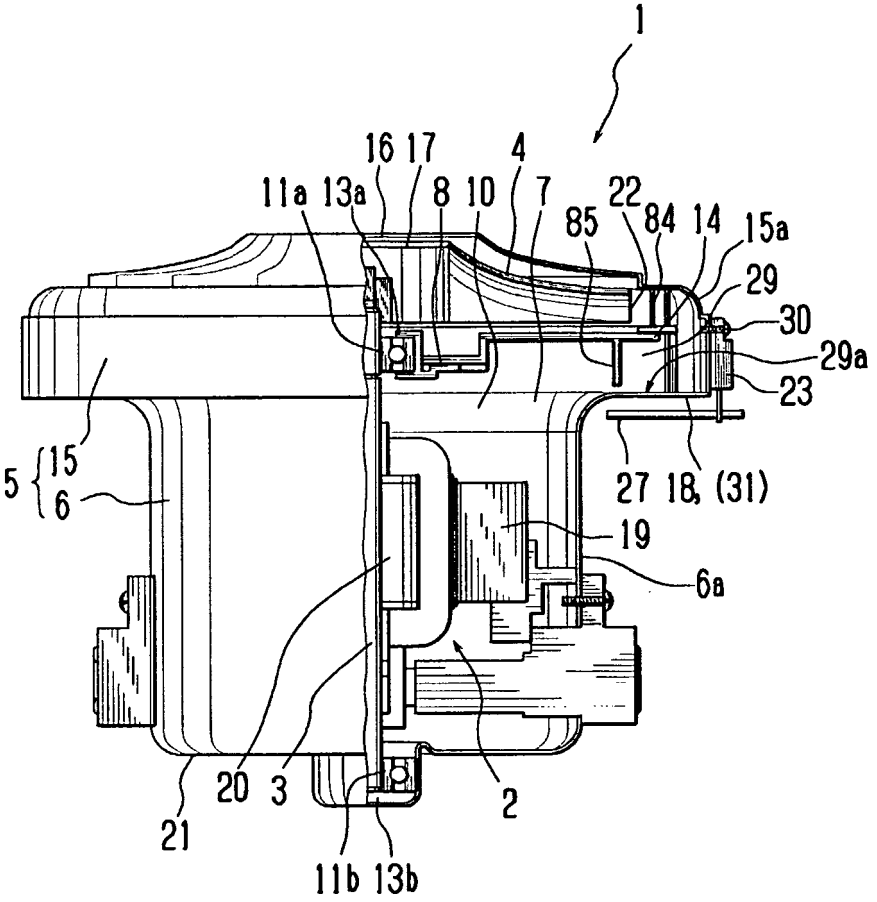

1
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11a
13a
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22
85
84
14
15a
29
30
29a
23
5
15
6
27
18, (31)
19
6a
20
3
2
21
11b
13b

Fig. 7

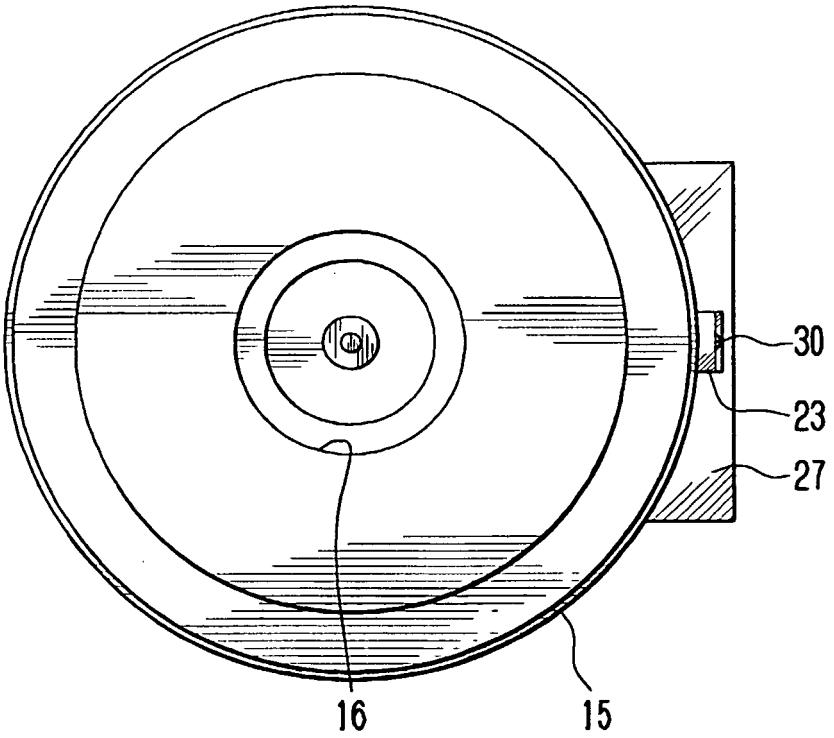


Fig. 8

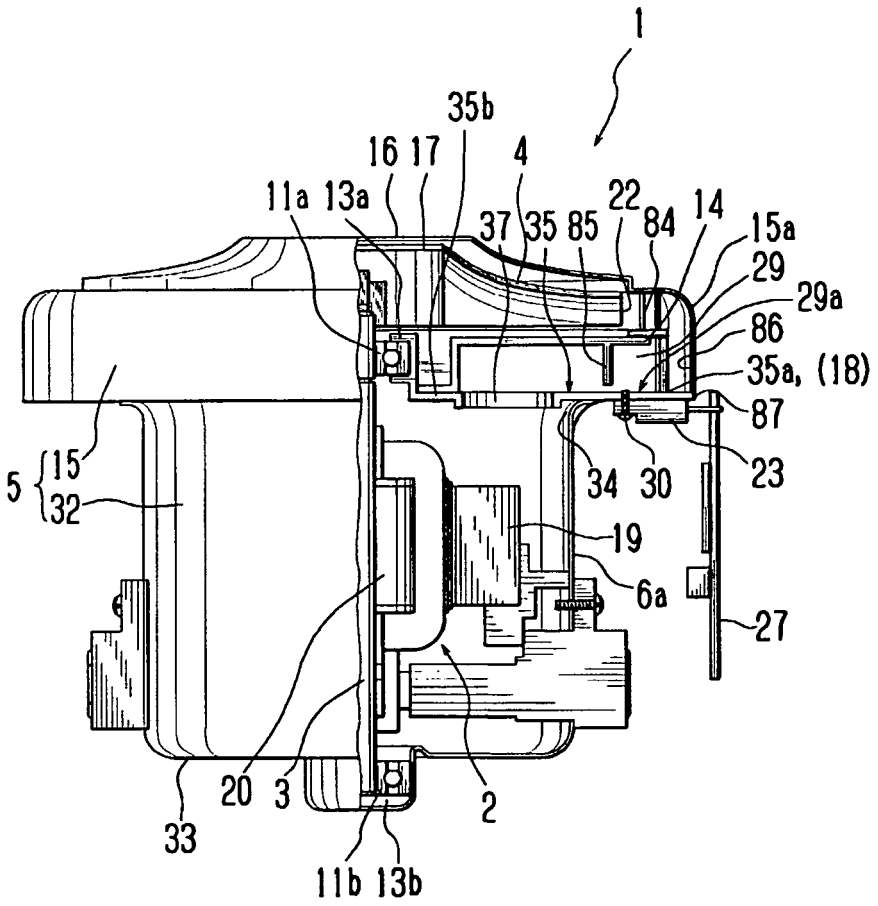

1
35b
16 17
4
11a 13a
37 35 85
22
84
14
15a
29
29a
86
35a, (18)
87
23
34 30
19
6a
27
5
15
32
20 3
2
33
11b 13b

Fig. 9

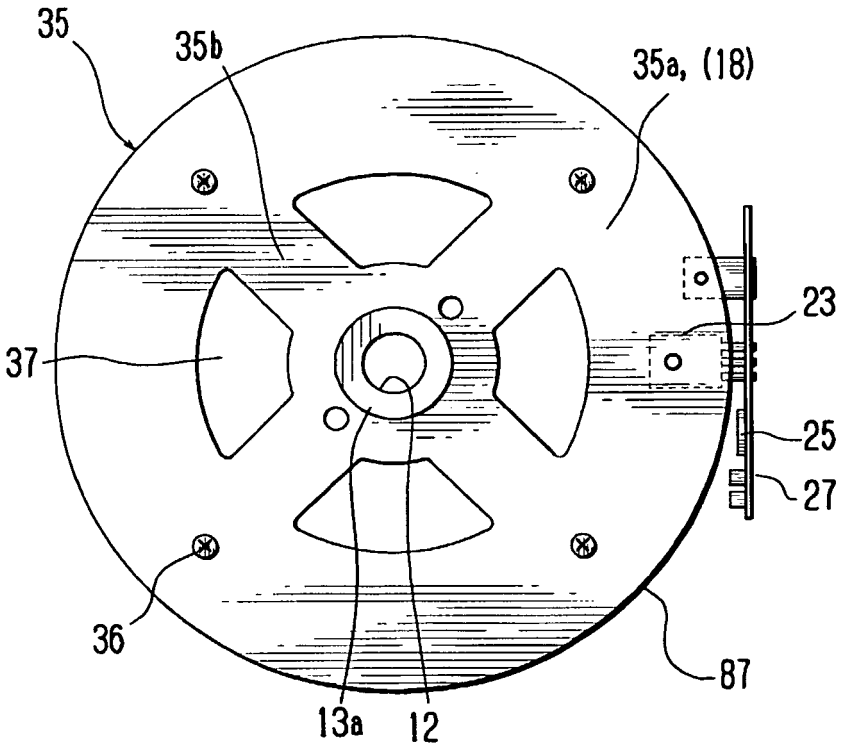


Fig. 10

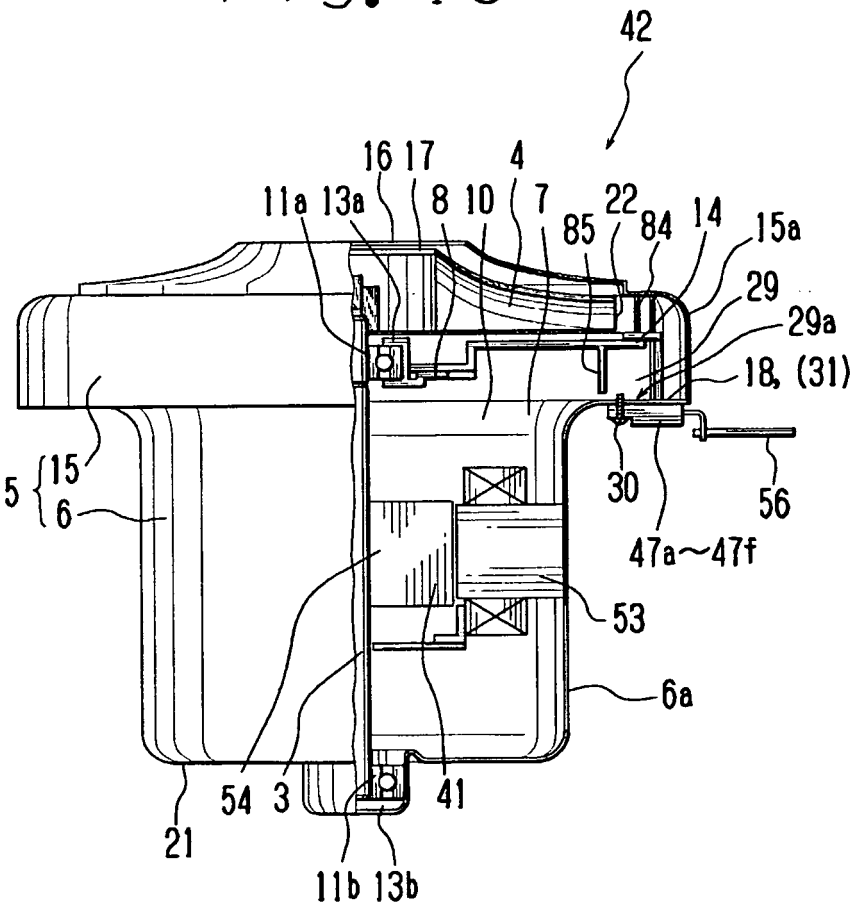

42
16
17
4
11a
13a
8
10
7
22
85
84
14
15a
29
29a
18, (31)
5
15
6
30
56
47a~47f
53
6a
54
3
41
21
11b
13b

Fig. 11

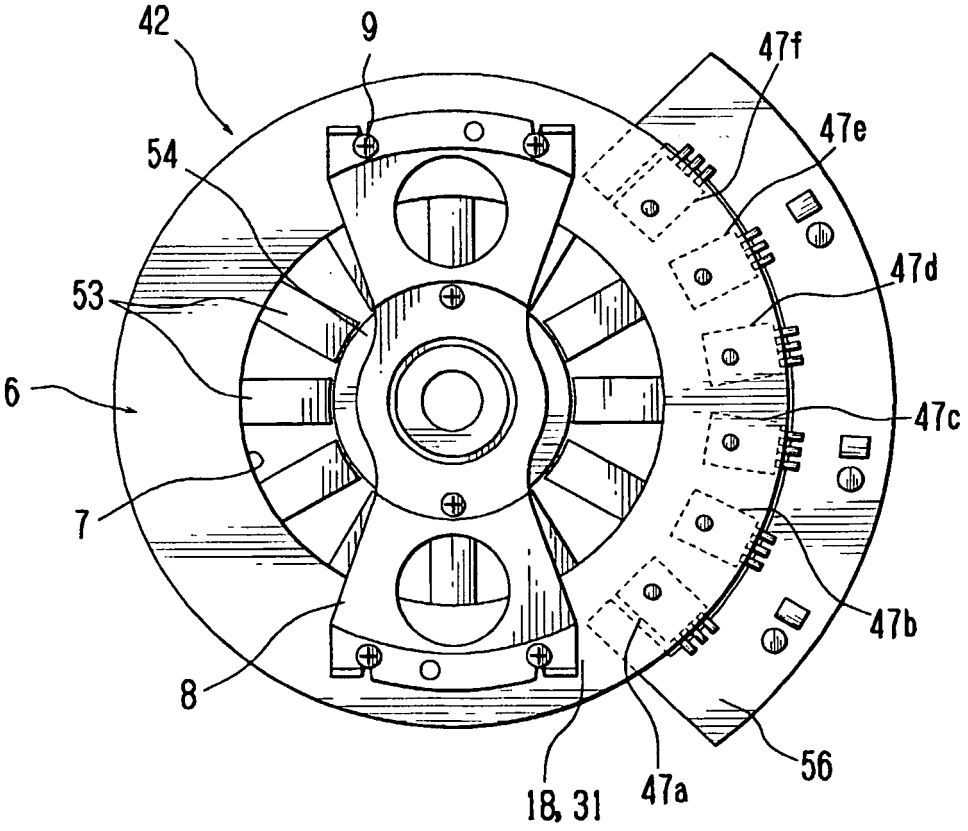


Fig. 12

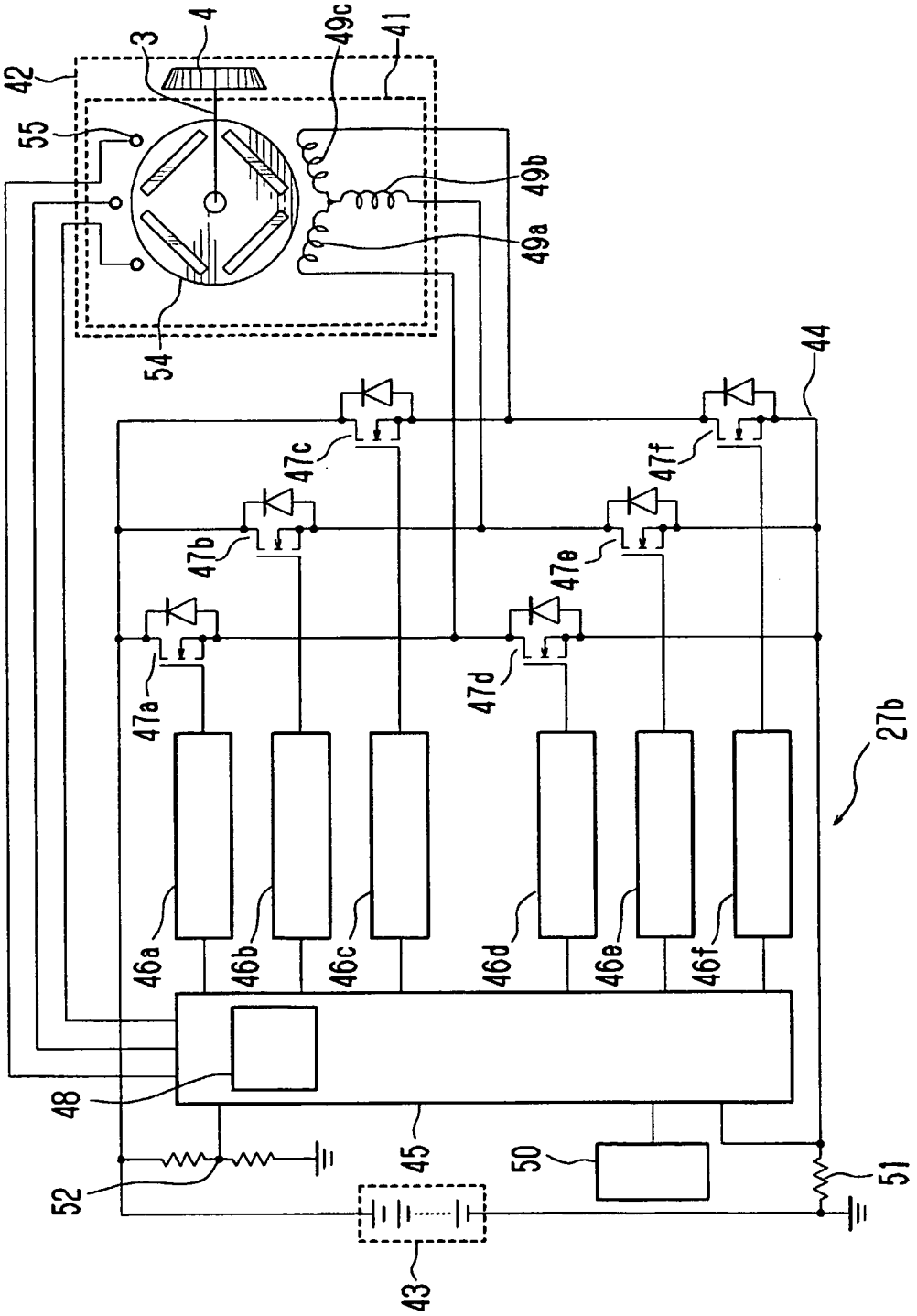

42
55
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49c
41
49b
49a
54
44
47c
47f
47b
47e
47a
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Fig. 13

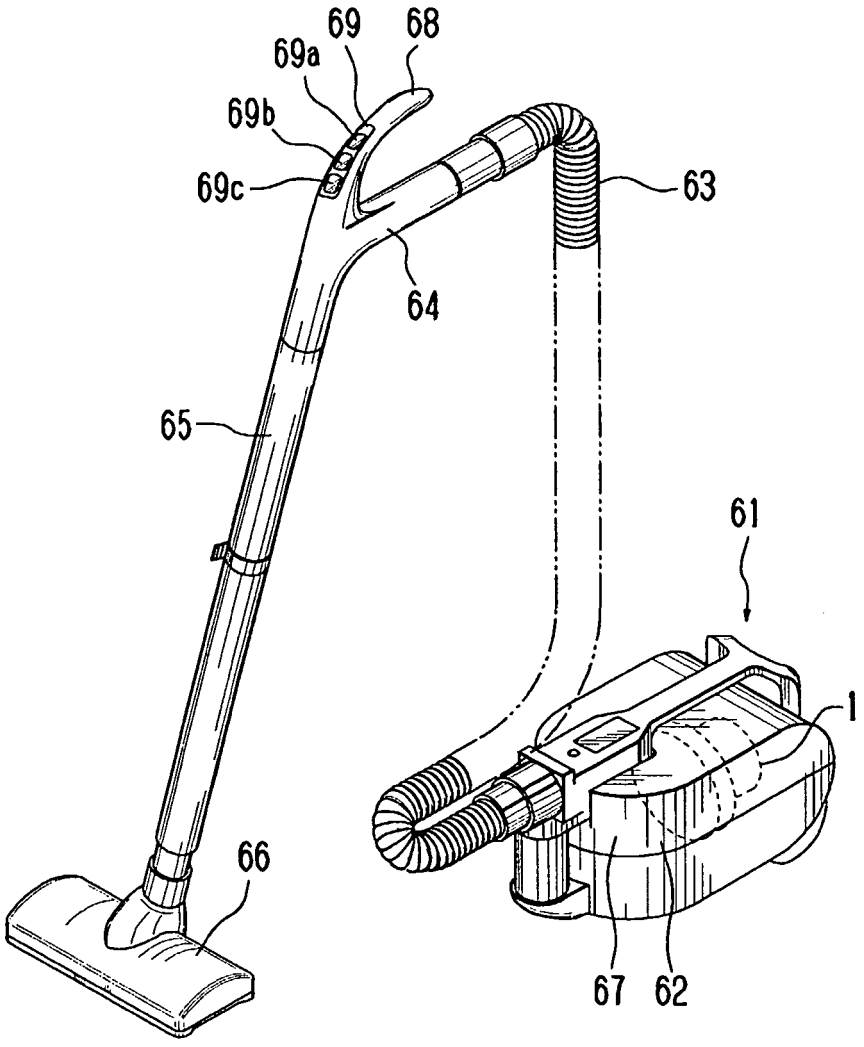


Fig. 14

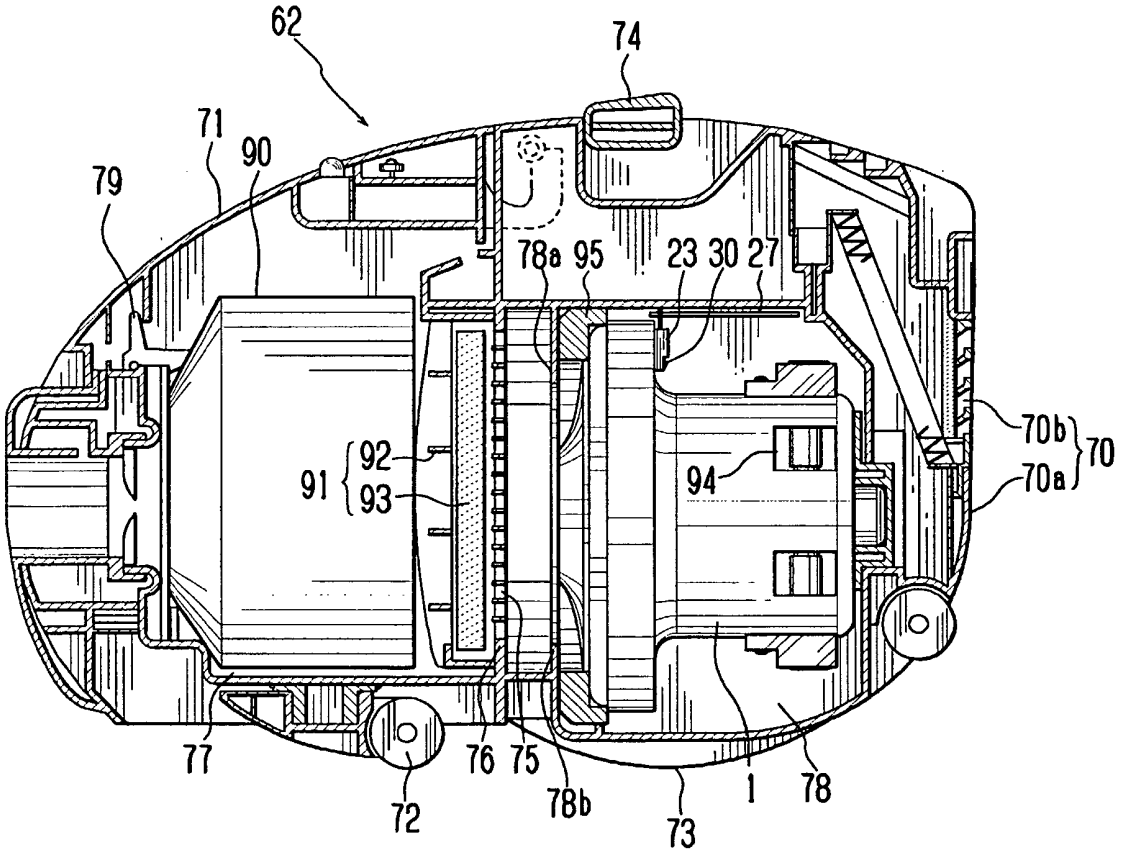

62
74
71
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78a
95
23
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27
70b
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70a
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75
78b
1
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72
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Fig. 15

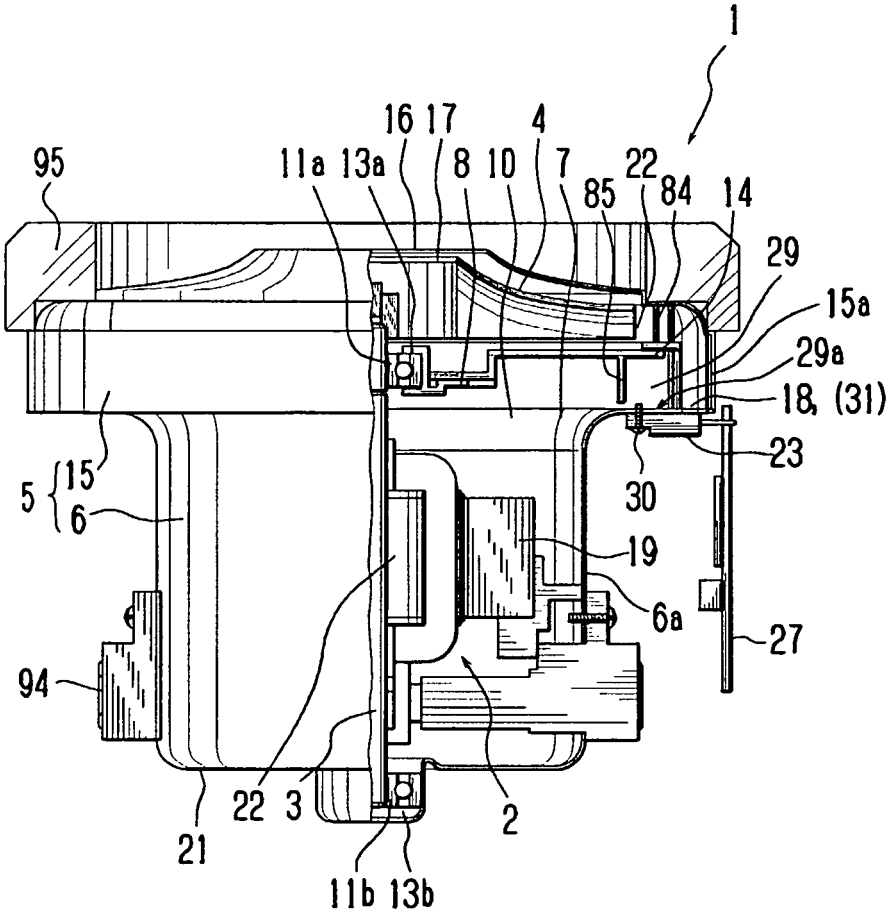

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11a
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11b
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Fig. 16

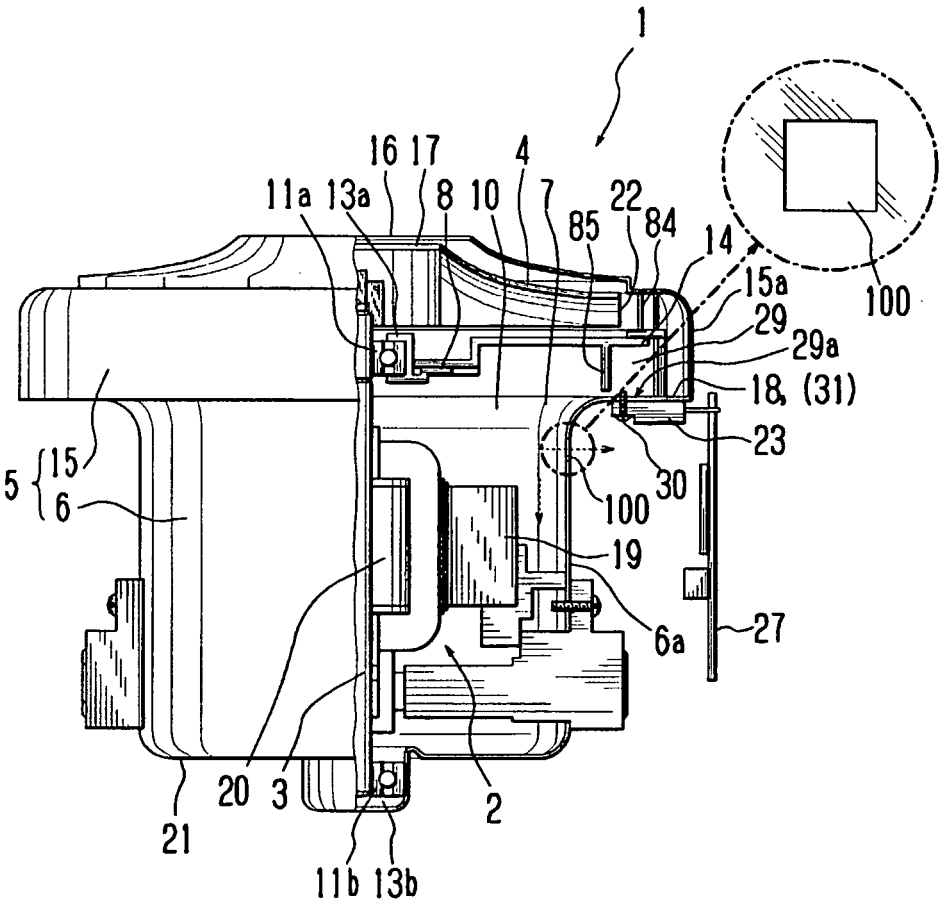
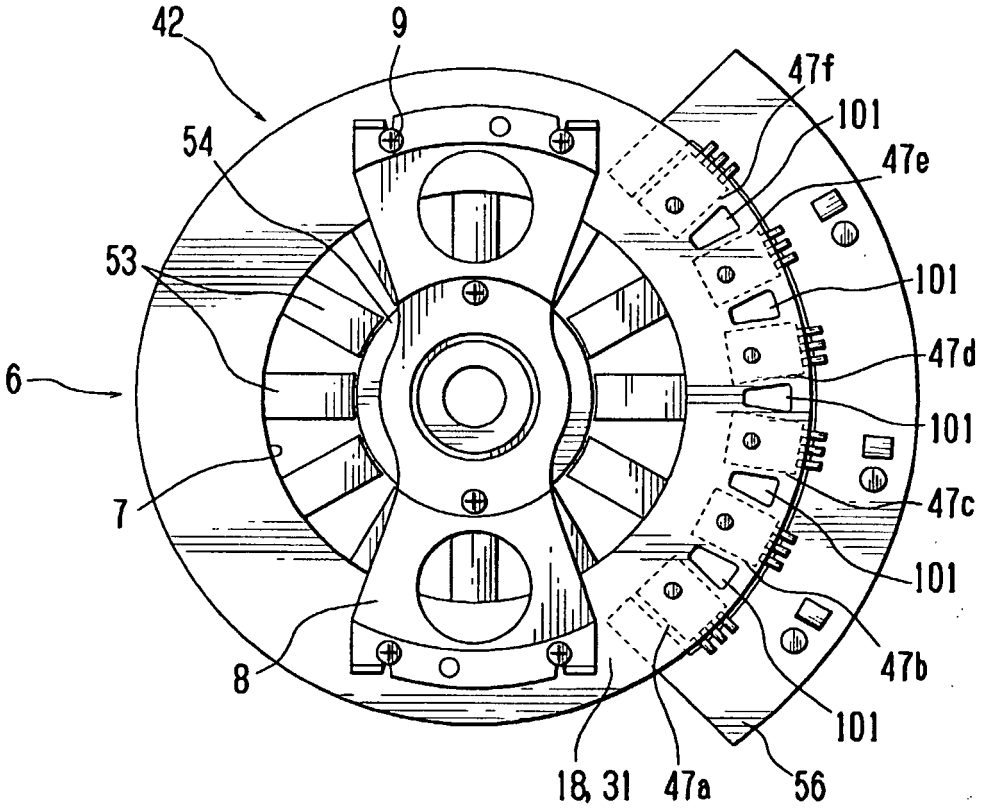

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11a
13a
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22
85
84
14
15a
29
29a
18, (31)
23
30
100
19
6a
27
5
15
6
20
3
2
21
11b
13b
100

Fig. 17



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 6001994 A **[0002]**
- JP 26494 A **[0002]**
- JP HEI61994261847 A **[0004]**
- EP 1138242 A **[0006]**