

ELECTRIC BLOWER AND VACUUM CLEANER

TECHNICAL FIELD

Embodiments described herein relate generally to an electric blower having a motor including a magnet part, and a vacuum cleaner including the electric blower.

BACKGROUND ART

Conventionally, the shaft of the motor in an electric blower is rotatably held by a plurality of bearings. In a known electric blower having such a configuration, the end parts of the bearings are covered by an additional member, in order to suppress the shortening of the life of the electric blower, by preventing the flowing-out of the lubricant applied between the rotating bodies arranged inside the bearings and the retainer holding the rotating bodies due to the pressure difference between the one end and the other end of the bearings caused by the negative pressure generated by the rotation of a fan. However, an electric blower capable of lengthening a life in a simple configuration with no additional member should be provided.

CITATION LIST

Patent Literature

PTL 1: Japanese Patent Publication No. 4567994

SUMMARY OF INVENTION

Technical Problem

The present invention is to provide an electric blower capable of lengthening a life in a simple configuration and a vacuum cleaner including the electric blower.

Solution to Problem

An electric blower in the embodiment includes a fan, and a motor configured to rotate the fan. The motor has a shaft, a magnet part arranged to the shaft, a spindle, and a bearing. The spindle is rotated together with the fan arranged to the shaft. The bearing rotatably holds the shaft. The suction side of the fan is arranged in the side of the magnet part. The bearing is arranged in the opposite side of the magnet part with respect to the fan.

BRIEF DESCRIPTION OF DRAWINGS

[Fig. 1]

Fig. 1 is a sectional view of an electric blower in one embodiment.

[Fig. 2]

Fig. 2 (a) is an oblique view of a fan of the electric blower of the embodiment viewed from a suction side of the fan, and Fig. 2 (b) is an oblique view of the fan of the electric blower of the embodiment viewed from an exhaust side of the fan.

[Fig. 3]

Fig. 3 is a sectional view of the electric blower of the embodiment substantially at an I-I line shown in Fig. 1.

[Fig. 4]

Fig. 4 is an oblique view of a vacuum cleaner including the electric blower of the embodiment.

DESCRIPTION OF EMBODIMENTS

The embodiment will be described below with reference to the drawings.

In Fig. 1, reference numeral 1 denotes an electric blower. The electric blower 1 generates a negative pressure, and sucks

air by use of the negative pressure and exhausts the air having passed through the inside thereof. In the description below of the present embodiment, the side from which air is sucked or an upstream side in the electric blower 1 is defined as one end side, and the side to which air is exhausted or a downstream side in the electric blower 1 is defined as the other end side. In Fig. 1, the side indicated by an arrow A is defined as one end side, and the side indicated by an arrow B is defined as the other end side.

The electric blower 1 includes a fan 2 configured to generate a negative pressure by rotation. The fan 2 is formed of synthetic resin or metal. In the present embodiment, the fan 2 is a turbofan or a 3D fan. A turbofan is a fan including a conical base part and a plurality of blades disposed on the base part. That is, in the present embodiment, the fan 2 includes a conical base part 3 and a plurality of blades 4 disposed on the base part 3. As shown in Fig. 2 (a) and Fig. 2 (b), the base part 3 is formed so as to expand from the one end serving as a suction side toward the other end serving as an exhaust side. The fan 2 is configured to suck air from the center part of the one end and exhaust the air to the outer peripheral side of the other end. Additionally, the base part 3 has, at the center part thereof, a bearing 5, which is a boss-shaped cylindrical part. Also, the blades 4 are formed integrally with the base part 3 on the surface of the base part 3. Each of the blades 4 is formed so as to curve with respect to the ridgeline of the base part 3 from the one end of the base part 3 toward the other end. It is noted that the fan 2 is not limited to a turbofan or a 3D fan, but may be a 2D fan including the plurality of blades 4.

The fan 2 is covered by a fan cover 6. In the present embodiment, the fan cover 6 includes a cylindrical cover body

portion 7, and a cylindrical suction portion 8 disposed so as to protrude from the one end of the cover body portion 7. The suction portion 8 is formed so as to be gradually reduced in diameter from the other end to the one end. In the suction portion 8, the one end side of the fan 2 is inserted. The suction portion 8 has an opening as a cover suction port 9 at the one end of the tip part thereof. The gap formed between the cover suction port 9 and the blades 4 of the fan 2 serves as a vent 10 through which the sucked air passes.

The fan cover 6 is attached to a motor 11. The motor 11 is arranged in the one end side of the fan 2. The motor 11 is a brushless motor. The motor 11 is driven by a driving circuit 13. The driving circuit 13 is arranged in the one end side of the electric blower 1, that is, in the upstream side of the fan 2. The motor 11 includes a frame 14. The frame 14 is formed of synthetic resin or the like. In the present embodiment, the frame 14 includes a first frame body 15 and a second frame body 16. The first frame body 15 is formed in a cylindrical shape. The first frame body 15 has a constant or substantially constant outside diameter over from the one end to the other end. In the present embodiment, the first frame body 15 is formed to have the same or substantially same diameter as the diameter of the cover body portion 7 of the fan cover 6. The second frame body 16 is formed in a disk shape. As shown in Fig. 3, the second frame body 16 has a vent hole 18, serving as a suction port of the electric blower 1. The vent hole 18 is configured with one hole or a plurality of holes. The second frame body 16 has an arm part 19 extending radially between adjacent vent holes 18. The second frame body 16 is attached to the one end of the first frame body 15. The suction portion 8 of the fan cover 6 and the one end side of the fan 2 positioned inside the suction portion 8 are

positioned in the other end side of the second frame body 16, and also positioned inside the first frame body 15 in the other end side of the first frame body 15. It is noted that the frame 14 is not limited to the configuration with the first frame body 15 and the second frame body 16, but may be configured with three pieces or more of frame bodies, or may be configured integrally with one frame body.

As shown in Fig. 1, the motor 11 includes a stator 20. The stator 20 is positioned inside the frame 14. In the present embodiment, the stator 20 is positioned inside the first frame body 15. The stator 20 is positioned by a gap in the other end side of the second frame body 16.

The stator 20 includes a stator core 21. The stator core 21 is formed by laminating magnetic bodies such as electromagnetic steel plates. The stator core 21 integrally includes a pair of teeth 22 and a yoke part 23 configured to form a magnetic path between the teeth 22. The teeth 22 protrude toward the center axis. The tip parts of the teeth 22 facing each other are positioned away from each other. Each of the teeth 22 has an opening portion 24 at the tip thereof. The stator 20 includes coils respectively wound around the teeth 22. The coils are insulated from the teeth 22, and form fixed magnetic poles to the teeth 22, respectively. Additionally, the coils and the teeth 22 are arranged so as to face the vent hole 18 of the frame 14.

The motor 11 includes a spindle 26. The spindle 26 is included in a rotor, and is rotated integrally with the fan 2. The spindle 26 includes a shaft 27 to which the fan 2 is connected. The shaft 27 is a long bar-shaped member formed of metal or the like. The other end side of the shaft 27 is inserted into the bearing 5 shown in Fig. 2 (b), of the base part 3 of the fan 2, and is fixed integrally with the fan 2.

Also, the spindle 26 shown in Fig. 1 includes a magnet part 30. The magnet part 30 is fixed to the shaft 27. The magnet part 30 is formed of a sintered magnet, a bond magnet, or the like. The magnet part 30 is formed in a cylindrical shape, and the shaft 27 is coaxially inserted thereinto. The magnet part 30 is arranged closer to the one end of the shaft 27. The magnet part 30 is positioned in the opening portion 24, so that the outer peripheral surface of the magnet part 30 faces the tip parts of the teeth 22 of the stator core 21 via a gap. Furthermore, the other end of the magnet part 30 is arranged so as to face the one end of the fan 2. The magnet part 30 is positioned in the suction side of the fan 2.

The motor 11 further includes a bearing 32. The bearing 32 rotatably holds the shaft 27. The bearing 32 includes an annular inner ring 51 to which the shaft 27 is connected, an annular outer ring 52 surrounding the inner ring 51, a plurality of rotating bodies 53 positioned between the inner ring 51 and the outer ring 52, and a retainer 54 which holds the rotating bodies 53. Balls or rollers serve as the rotating bodies 53. Grease, which is lubricant, is applied in the gap between the rotating bodies 53 and the retainer 54.

A plurality of the bearings 32 are provided. In the present embodiment, a pair of the bearings 32 is provided. As the bearings 32, a first bearing 32a and a second bearing 32b are provided. The first bearing 32a and the second bearing 32b are positioned away from each other in the longitudinal direction or the axial direction of the shaft 27, thereby stably supporting the spindle 26 or the rotary shaft of the rotor. The first bearing 32a and the second bearing 32b are respectively arranged to the one end and the other end of the shaft 27, while interposing the magnet part 30.

The first bearing 32a arranged to the one end of the

shaft 27 is one bearing in the pair of bearings, positioned far from the fan 2. The first bearing 32a is held by the frame 14. The first bearing 32a is positioned in the opposite side of the fan 2 with respect to the magnet part 30. In the present embodiment, the first bearing 32a is attached to a holding hole part 33 shown in Fig. 3, formed at the center part of the second frame body 16. The outer peripheral part of the outer ring 52 shown in Fig. 1 is fixed in the holding hole part 33.

In addition, the second bearing 32b arranged to the other end of the shaft 27 is the other bearing in the pair of bearings, positioned close to the fan 2. The second bearing 32b is positioned in the opposite side of the magnet part 30 with respect to the fan 2. The fan 2 is arranged between the second bearing 32b and the magnet part 30. The second bearing 32b is positioned in the exhaust side of the fan 2. In the present embodiment, the second bearing 32b is held by a straightening plate 35, which is a straightening body. The straightening plate 35 is configured to straighten the air exhausted from the fan 2. The straightening plate 35 includes an annular enveloping part 37, a circular-shaped body portion 38 surrounded by the enveloping part 37, and one or a plurality of straightening blades 39 connecting the body portion 38 and the enveloping part 37. The fan cover 6 is interposed between the straightening plate 35 and the motor 11. The cover body portion 7 of the fan cover 6 is interposed between the enveloping part 37 and the first frame body 15 of the frame 14 of the motor 11. In the present embodiment, the enveloping part 37 is formed to have the same or substantially same diameter as the diameter of the first frame body 15 of the frame 14. The straightening plate 35 has a bearing holding part 40, which protrudes so as to hold the second bearing 32b.

The bearing holding part 40 is disposed on the body portion 38 in a protruding manner. The tip part of the bearing holding part 40 extends to the inside of the fan 2. The inside of the fan 2 herein corresponds to the portion inside the outer shape obtained by projecting the shape of the fan 2 onto an arbitrary plane. In the present embodiment, the bearing holding part 40 is arranged so that the one end, which is the tip thereof, is positioned nearer to the one end of the fan 2 than the other end thereof. The one end of the bearing holding part 40 is inserted into a space part 41, which is surrounded by the base part 3 of the fan 2 and the bearing 5 in the back side of the base part 3. The space part 41 is formed so as to be gradually increased in diameter toward the second bearing 32b. The bearing holding part 40 has a concave part 42 in the one end thereof. The second bearing 32b is fixed in the concave part 42. The second bearing 32b is arranged so that the one end thereof faces the bearing 5 but apart from the bearing 5, and that the other end thereof abuts against the bottom part of the concave part 42. In the present embodiment, the whole part of the second bearing 32b is positioned inside the fan 2. Alternatively, at least a part of the second bearing 32b may be positioned inside the fan 2. A ventilation opening 43 is formed between the body portion 38 and the enveloping part 37. The straightening blades 39 are positioned in the ventilation opening 43. The straightening blades 39 are positioned away from each other in the circumferential direction of the straightening plate 35.

As shown in Fig. 4, the electric blower 1 is used in a vacuum cleaner 45. The vacuum cleaner 45 includes a main body 46, a control circuit, an air path 48, and a dust-collecting unit 49. The control circuit controls the electric blower 1 and the like. The air path 48 is

communicated with the suction side of the electric blower 1. The dust-collecting unit 49 catches and collects the dust and dirt sucked through the air path 48 together with air. It is noted that although the vacuum cleaner 45 shown in Fig. 4 is a floor traveling type cleaner configured so that a user makes the main body 46 travel on a cleaning-object surface in cleaning, the vacuum cleaner 45 may be of various types of cleaners, such as a stick type or an upright type in which the air path 48 having a straight-pipe shape is connected to the main body 46, a handy type in which a user directly holds the main body 46 in cleaning, or a self-propelled type in which the main body 46 performs cleaning while traveling autonomously.

The operation of the electric blower 1 in the embodiment is described next.

When the motor 11 is driven by the driving circuit 13 so as to rotate the spindle 26 together with the fan 2, air is sucked into the electric blower 1 by the negative pressure generated by the rotation of the fan 2. The air flows into the frame 14 through the vent hole 18 positioned in the one end, while flowing along the entire driving circuit 13, and flows through the wirings of the stator 20 and through the opening portion 24 toward the other end to cool the stator 20 and the magnet part 30. Then, the air flows through the vent 10 positioned between the cover suction port 9 and the fan 2, and flows into the suction portion 8 by the blades 4 of the fan 2 toward the outer peripheral side of the fan 2. Thereafter, the air is exhausted through the ventilation opening 43 to the other end, while being straightened by the straightening blades 39 of the straightening plate 35 from the outer peripheral side of the fan 2.

As described above, in the embodiment, the suction side

of the fan 2 is arranged in the side of the magnet part 30, and the second bearing 32b is arranged in the opposite side of the magnet part 30 with respect to the fan 2. Therefore, at the position of the second bearing 32b, the air is exhausted from the fan 2 and thus the air pressure is released, whereby the pressure difference between the one end and the other end of the second bearing 32b is small. Thus, this enables to suppress the flowing-in of air into the second bearing 32b caused by the pressure difference between the one end and the other end of the second bearing 32b, thereby enabling to suppress the intrusion of dust and dirt into the second bearing 32b, and the flowing-out of the lubricant applied between the rotating bodies 53 and the retainer 54. Accordingly, the electric blower 1 is provided in a simple configuration with no additional member so as to be further lengthened a life.

If the second bearing 32b is arranged in the side of the magnet part 30 with respect to the fan 2, the second bearing 32b should be set away by a sufficient distance from the fan 2 in order to suppress such pressure difference between the both ends of the second bearing 32b. In the present embodiment, the second bearing 32b is arranged in the opposite side of the magnet part 30 with respect to the fan 2. The configuration eliminates the need of arranging the second bearing 32b to be away from the fan 2, resulting in enabling to provide the electric blower 1 not increased in size in the axial direction.

Furthermore, in prior art, the suction side of the fan 2 is arranged in the side of the magnet part 30, and a pocket part is disposed inside the fan 2 in the suction side. The second bearing 32b is arranged inside the pocket part so that the end part of the second bearing 32b is sealed. In this case, the diameter of the base part 3 of the fan 2 in the one end

side needs to be larger than the pocket part in which the second bearing 32b is arranged. Therefore, in the case of the fan 2 having a constant diameter, the width of each of the blades 4 is shorter, and thus the performance of the electric blower 1 is lowered. In the case of the blades 4 each having a constant width, the fan 2 has a larger diameter, and thus the electric blower 1 is increased in size in the radial direction. On the other hand, in the present embodiment, the second bearing 32b is arranged in the opposite side of the magnet part 30 with respect to the fan 2, and the configuration hardly lowers the performance of the electric blower 1 and hardly increases size of the electric blower 1 in the radial direction, as compared to prior art.

Since the other end of the second bearing 32b abuts against the bottom of the concave part 42 of the bearing holding part 40, the other end side is sealed by the bearing holding part 40. Therefore, this further suppresses the flowing-in of air into the second bearing 32b, thereby enabling to effectively suppress the flowing-out of the lubricant applied inside the second bearing 32b and the intrusion of dust and dirt. Accordingly, the electric blower 1 capable of further lengthening a life is provided.

Especially in the case where the fan 2 is a turbofan, in which a degree of vacuum is increased, if the second bearing 32b is arranged in the suction side of the fan 2, the pressure difference between the one end and the other end thereof becomes larger. Therefore, even in the case where the fan 2 is a turbofan, the arrangement as in the present embodiment, of the second bearing 32b in the opposite side of the magnet part 30 with respect to the fan 2 enables to suppress the flowing-out of the lubricant from the inside of the second bearing 32b caused by the flowing-in of the air due to the

pressure difference.

Furthermore, in the case where the motor 11 is a brushless motor, the magnet part 30 is formed of a sintered magnet or a bond magnet. Especially, a bond magnet is easily affected by heat, and thus the suction side of the fan 2 is arranged so as to face the magnet part 30 positioned in the vicinity of the shaft 27. This enables to effectively cool the magnet part 30 by the air to be sucked in the center side of the fan 2, thereby enabling to suppress the deterioration of the magnet part 30 caused by heat and the lowering of the performance of the electric blower 1 caused by overheating of the magnet part 30.

The second bearing 32b is held by the straightening plate 35, and this eliminates the need of any additional member for holding the second bearing 32b. Accordingly, the electric blower 1 is provided in a simple configuration at low cost.

Since the second bearing 32b is arranged inside the fan 2, the second bearing 32b is able to be arranged at a position where air flow is less. The arrangement enables to further effectively suppress the intrusion of dust and dirt into the second bearing 32b and the flowing-out of the lubricant applied inside the second bearing 32b, thereby enabling to suppress the shortening of the life caused by the flowing-out of the lubricant. Moreover, with the arrangement, the distance between the first bearing 32a and the second bearing 32b becomes shorter, and thus the spindle 26 or the shaft 27 is configured to be shorter in length. Accordingly, the electric blower 1 with higher rigidity, less vibration, and less noise is provided.

Especially, the fan 2 is a turbofan having the conical base part 3, and thus the space part 41 in the other end side of the base part 3 is utilized for the arrangement of the second

bearing 32b in the space part 41. This enables to ensure the sufficient width of the blades 4 without large change of the shape of the fan 2 in the suction side, thereby enabling to ensure the performance of the electric blower 1.

The driving circuit 13 configured to drive the motor 11 is arranged in the upstream side of the fan 2, whereby the entire driving circuit 13 is able to be exposed to the air to be sucked. This enables to effectively cool the driving circuit 13.

The usage of the electric blower 1 in the vacuum cleaner 45 realizes the vacuum cleaner 45 in a compact size with light weight, low noise and a long life.

It is noted that in the embodiment described above, the arrangement of the second bearing 32b is not limited to the inside of the fan 2, as long as the second bearing 32b is arranged in the opposite side of the magnet part 30 with respect to the fan 2.

The second bearing 32b may be held by an arbitrary structure member positioned in the opposite side of the magnet part 30 with respect to the fan 2, not limited to being held by the straightening plate 35, as long as the second bearing 32b is arranged in the opposite side of the magnet part 30 with respect to the fan 2.

The electric blower 1 may be used in a vacuum cleaner using exhaust air such as a blower, or may be used in an electric device other than a vacuum cleaner, not limited to a suction type cleaner.

While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions,

substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

REFERENCE SIGNS LIST

- 1 ELECTRIC BLOWER
- 2 FAN
- 11 MOTOR
- 13 DRIVING CIRCUIT
- 26 SPINDLE
- 27 SHAFT
- 30 MAGNET PART
- 32b SECOND BEARING
- 45 VACUUM CLEANER

CLAIMS

[Claim 1]

An electric blower comprising:
a fan; and
a motor configured to rotate the fan, wherein the fan is a turbofan,
the motor having:
a shaft;
a magnet part arranged to the shaft;
a spindle configured to be rotated together with the fan arranged to the shaft; and
a bearing configured to rotatably hold the shaft,
wherein
a suction side of the fan is arranged in a side of the magnet part, and
the bearing is arranged inside the fan and in an opposite side of the magnet part with respect to the fan.

[Claim 2]

The electric blower according to claim 1, the electric blower comprising:
a driving circuit configured to drive the motor, wherein
the driving circuit is arranged in an upstream side of the fan.

[Claim 3]

A vacuum cleaner comprising the electric blower according to claim 1 or 2.