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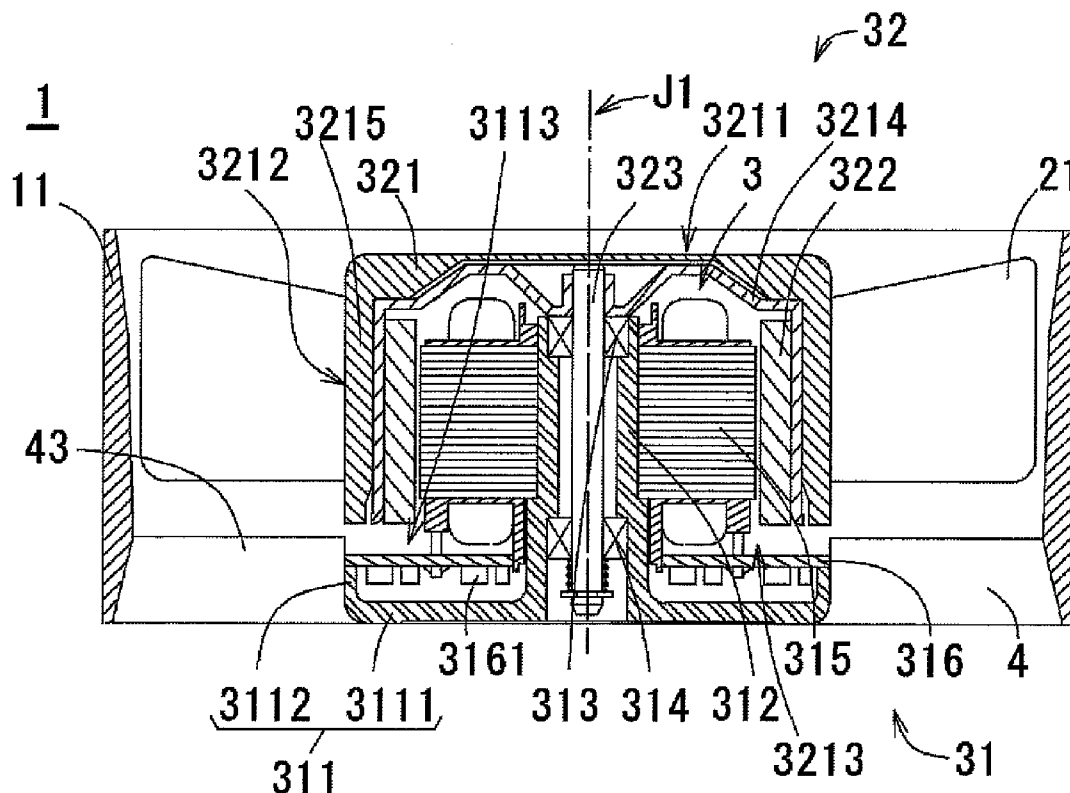


FIG. 1

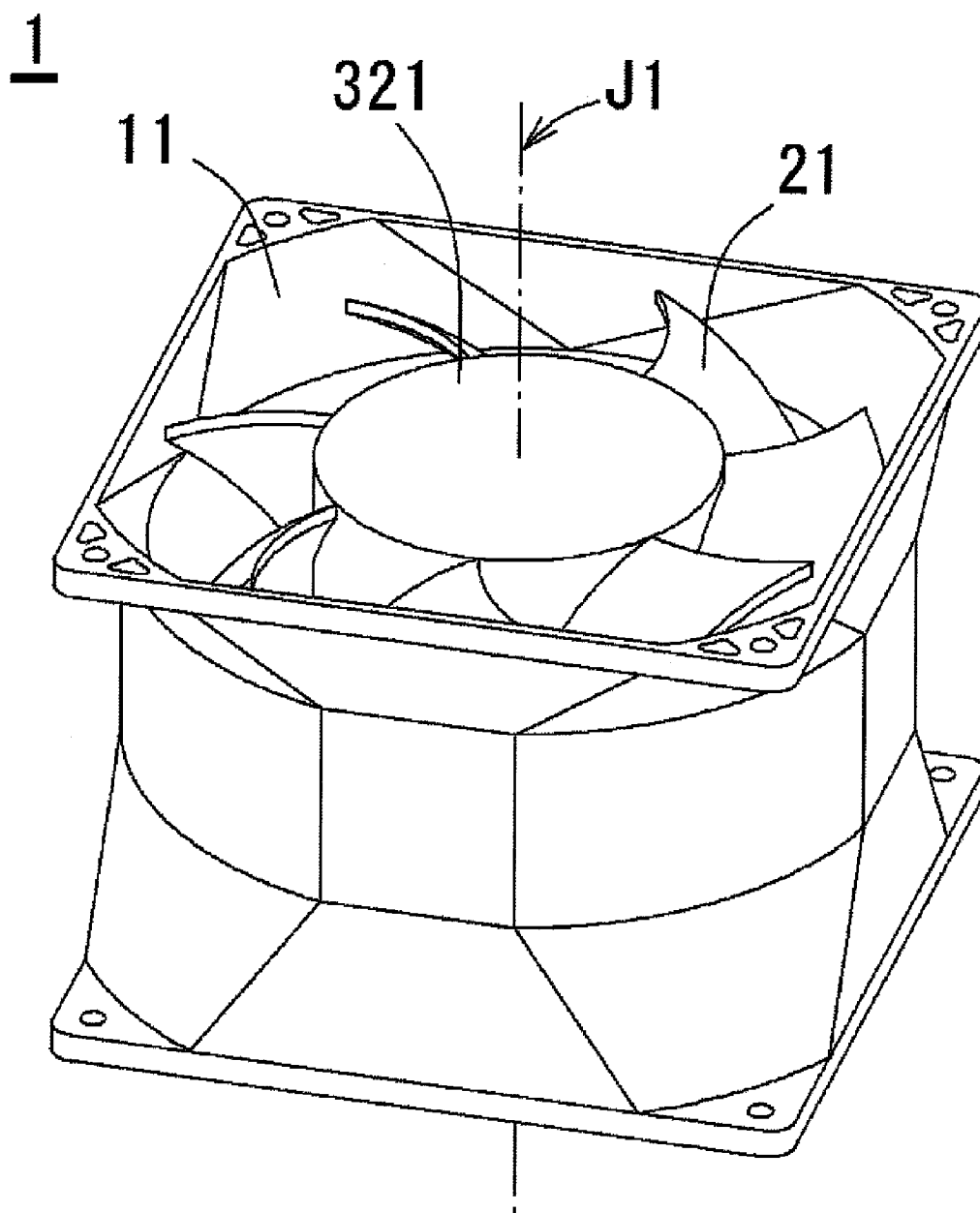


FIG. 2

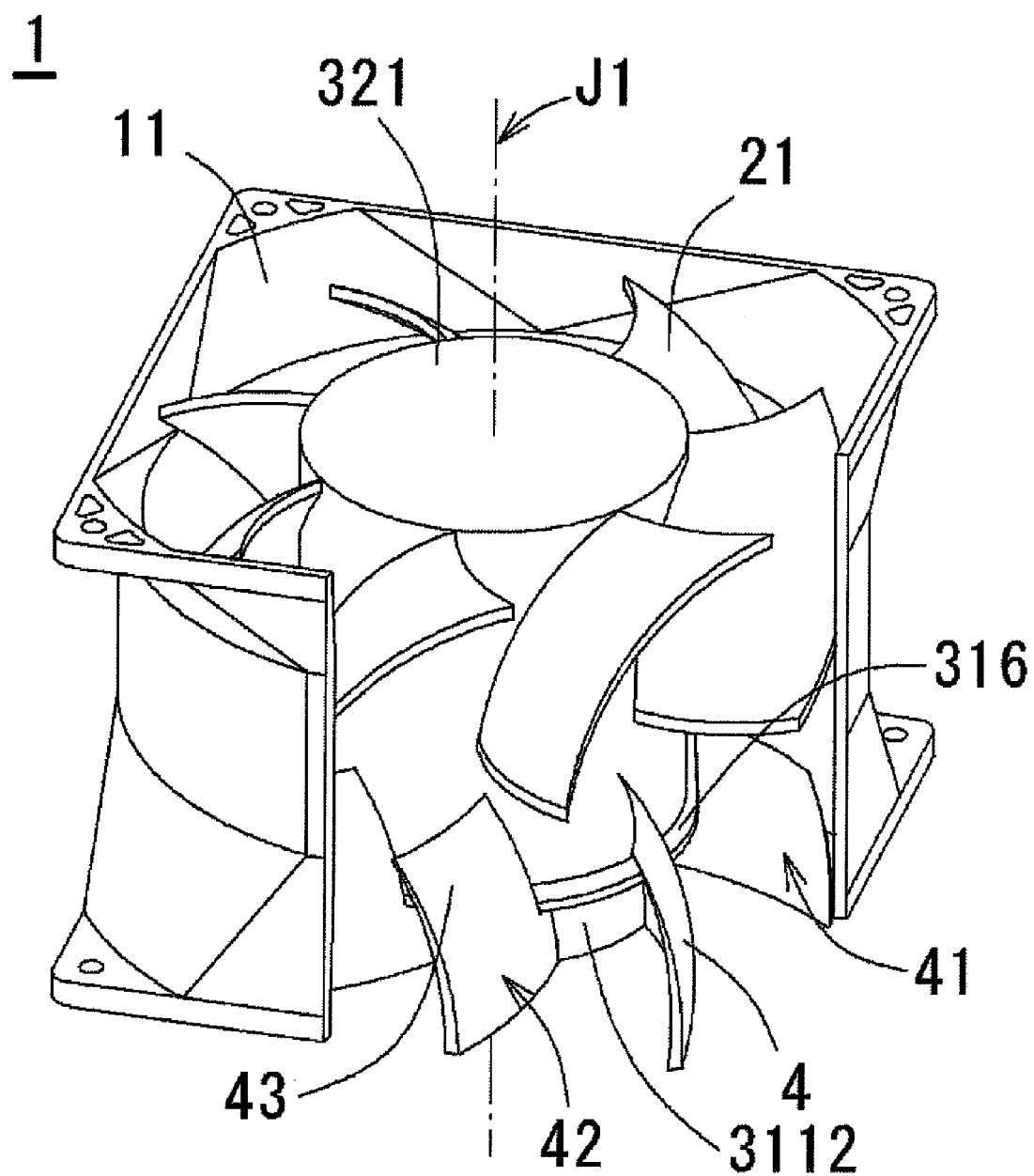


FIG. 3

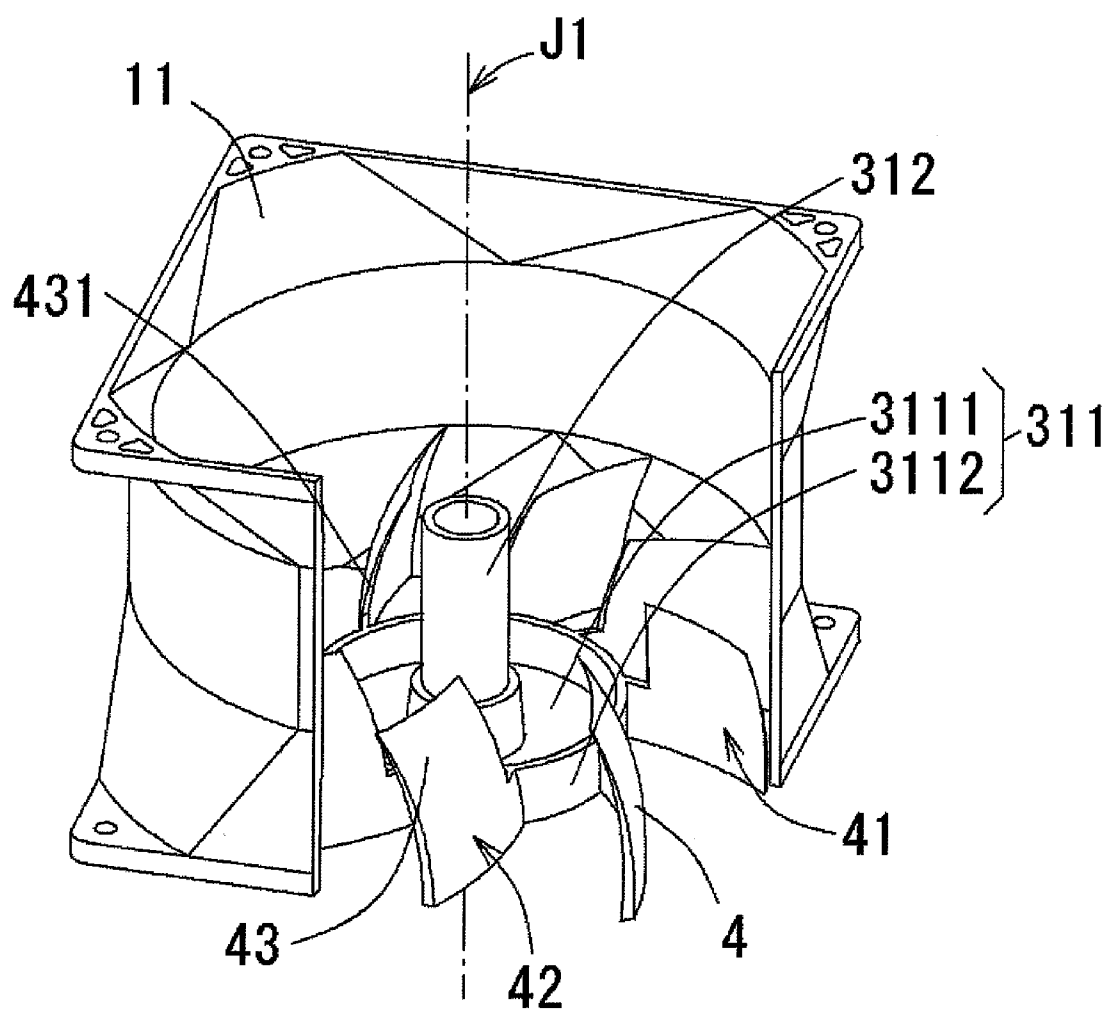


FIG. 4

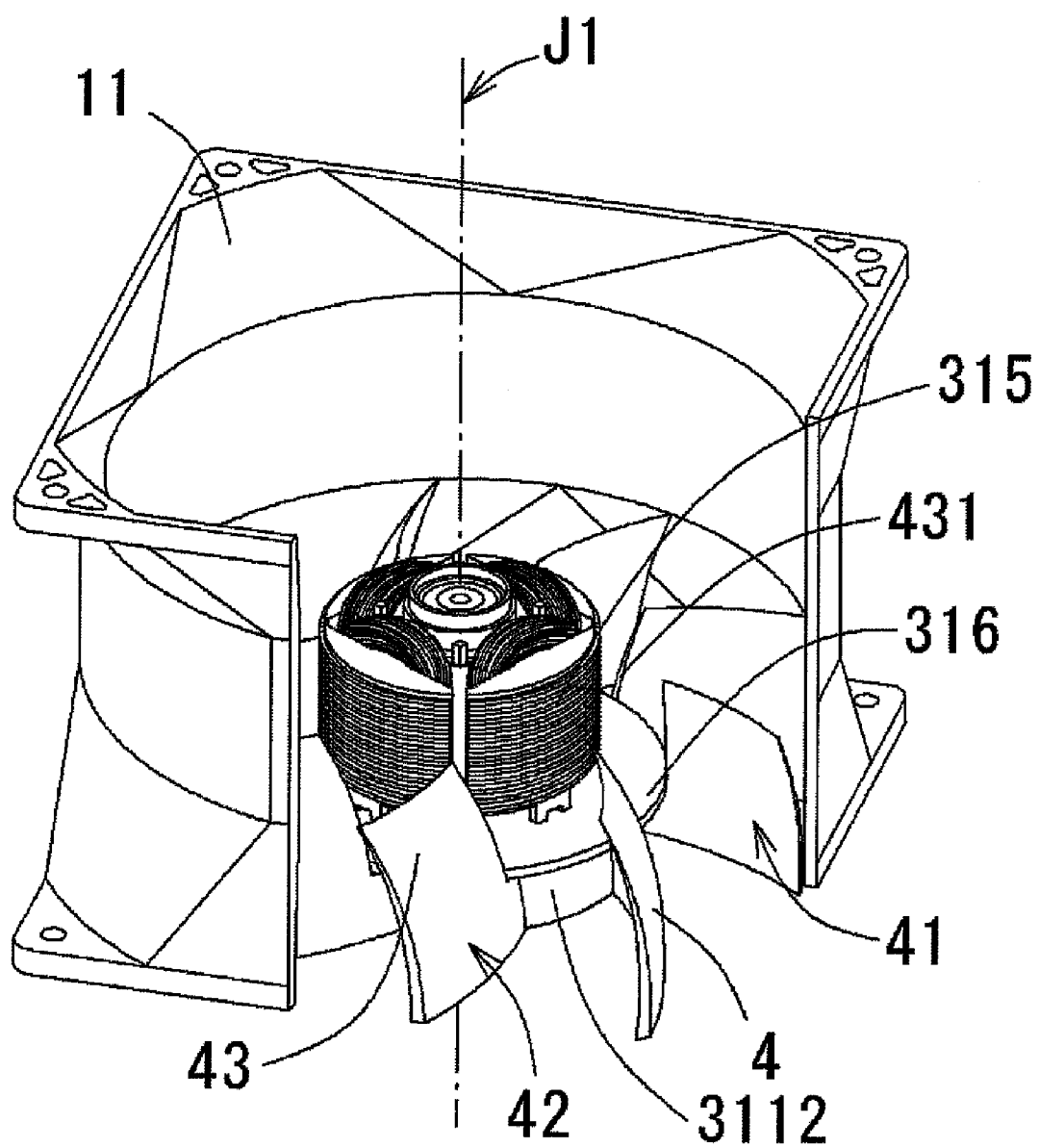


FIG. 5

FIG. 6

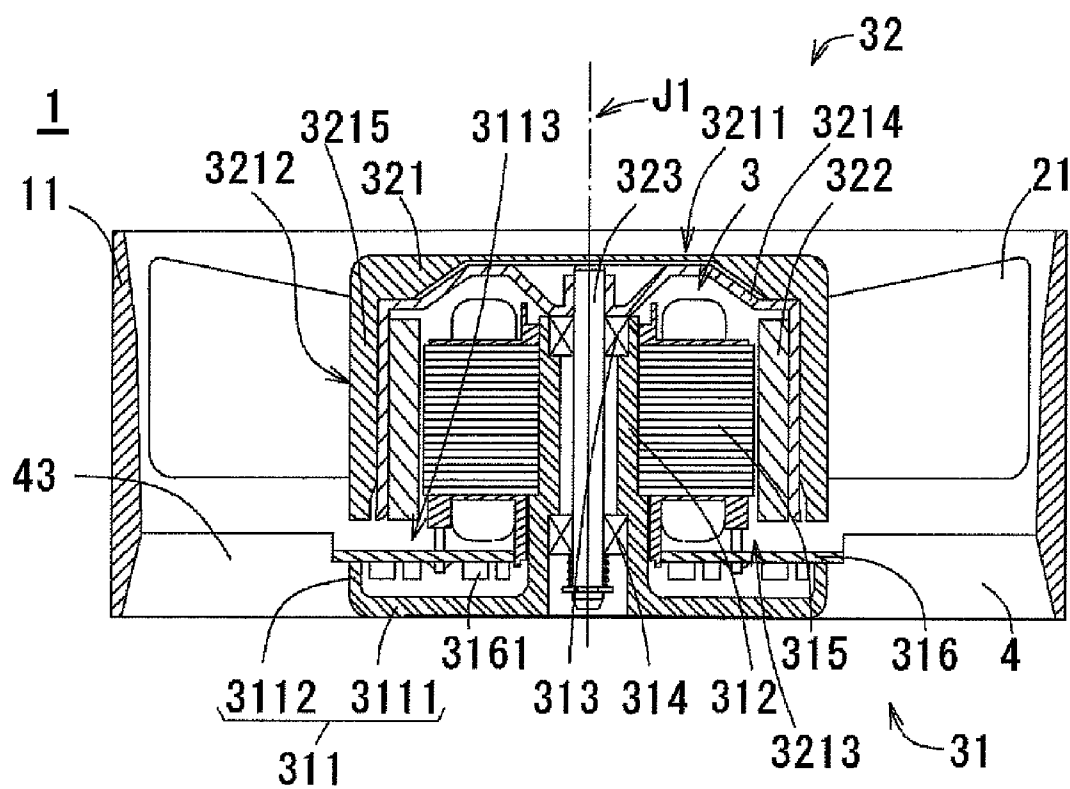


FIG. 7

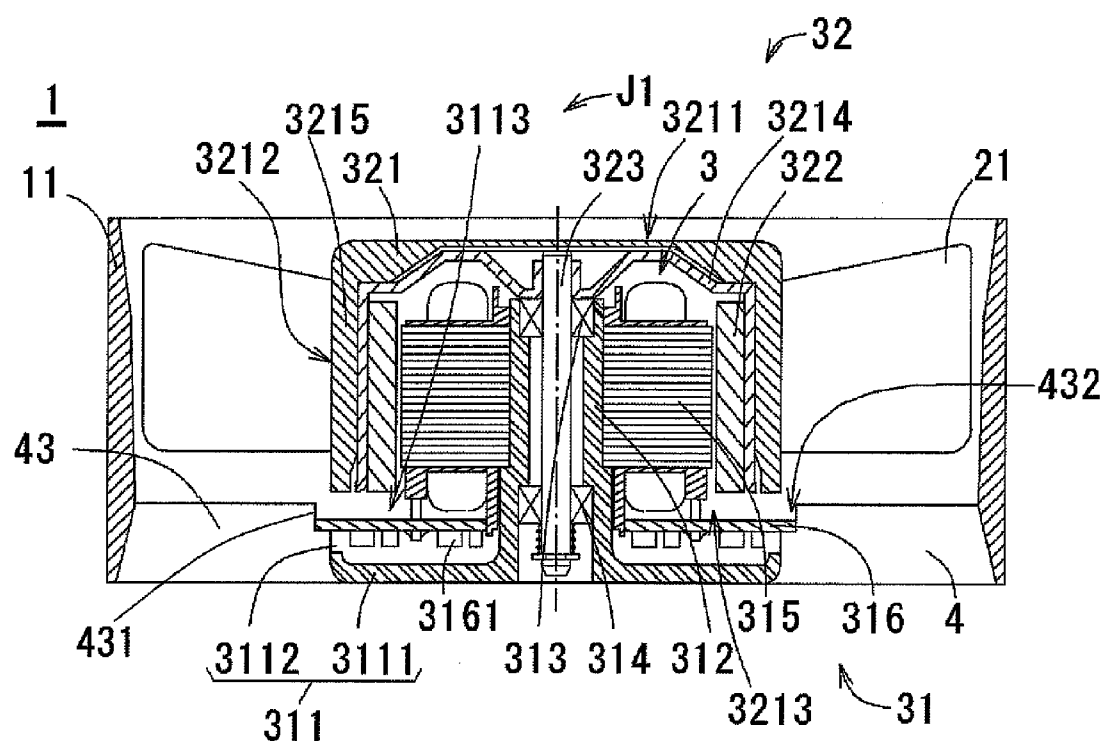


FIG. 8

FIG. 9

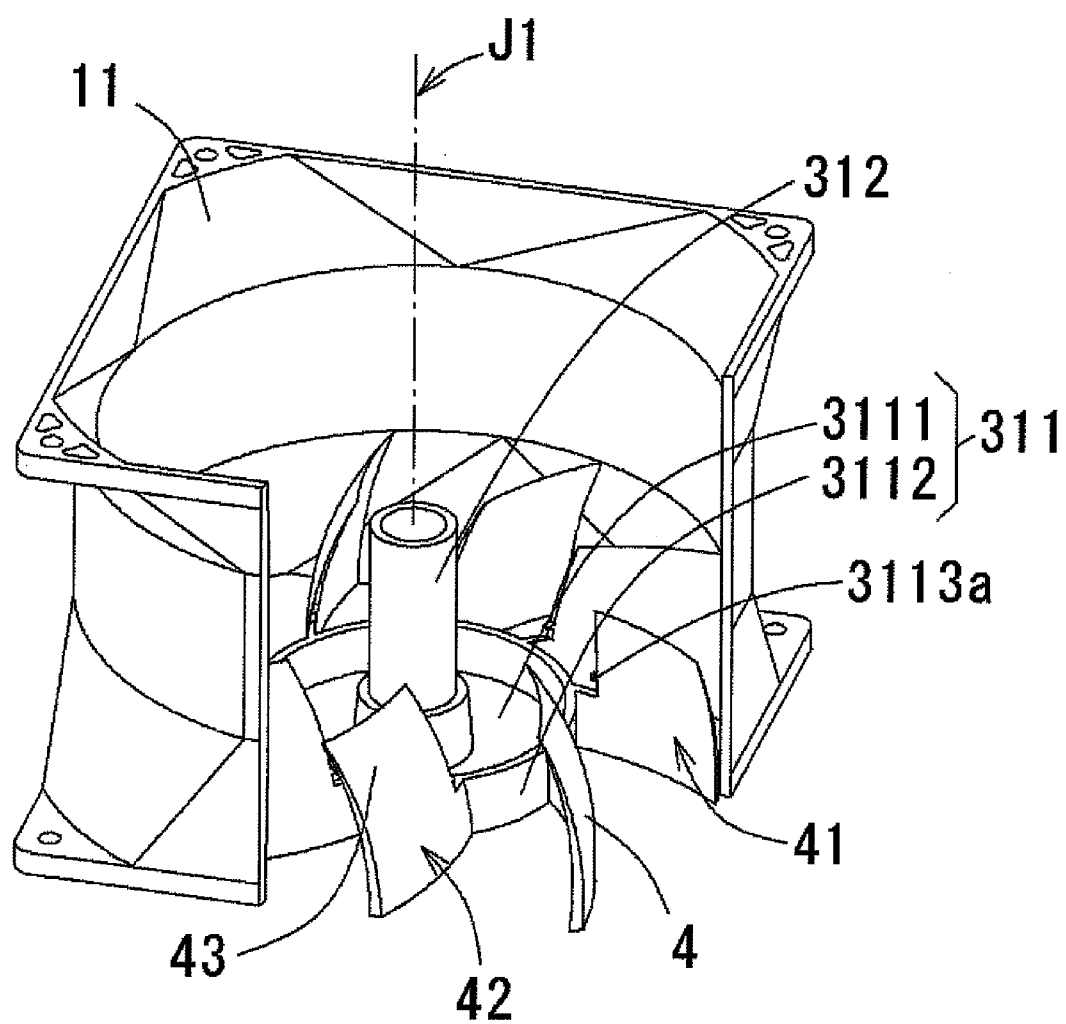


FIG. 10

AXIAL FLOW FAN

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to an electric axial flow fan used for sending air.

[0003] 2. Description of the Related Art

[0004] Axial flow fans are conventionally used in electronic devices for sending air to cool heat-generating electronic components so as to suppress temperature rise in the devices. Such an axial flow fan creates an air flow by rotating a plurality of rotor vanes by an electric motor. In order to deal with the increase in the amount of heat generation attendant on the performance improvement of electronic devices, demand is growing for high-speed rotation of such motors.

[0005] On the other hand, drive current must be increased in order to rotate the motor at high speeds. This causes increase in the amount of rise in temperature of electronic components on the circuit board or coils of the armature inside the motor, which may affect the performance of the electronic components and the operation of the motor. For high-speed rotation of the motor, a circuit which can suppress heat generation or a circuit for reducing current, such as a current limiting circuit for the motor (a circuit that prevents the current at or above a predetermined current value from passing through the circuit), is provided on the circuit board, for example. In addition, a large locked rotor current (a current that flows through the circuit and coil when the motor is locked) flows at the time of motor lock in the case where the motor is run at a high speed; therefore, also available is the method for reducing current by arranging a lock protection circuit (a circuit that reduces the value of current that flows through the coil by increasing an on-to-off ratio of energization during motor lock time) to reduce the locked rotor current value.

[0006] Ever higher output is required for modern axial flow fans in many cases. In conventional axial flow fans, two-phase unipolar driven motors or single-phase bipolar driven motors have mainly been used. With the increase in motor output, three-phase bipolar driven motors have started to be frequently used, and the number of electronic components to be mounted on the circuit board has increased accordingly. Since the three-phase bipolar drive requires a large number of Hall elements and FETs (field effect transistors) to be mounted, the number of electronic components to be mounted inevitably becomes larger than that for the single-phase bipolar drive or the two-phase unipolar drive.

[0007] Also, while complex control over motor rotation using e.g. PWM (pulse width modulation) circuits and temperature sensors has conventionally been performed outside the motors, these features are incorporated in the modern motors. For this reason, the number of electronic components to be mounted on the circuit board in the motor becomes large.

[0008] Due to these factors, more electronic components are mounted on the circuit board in the motors today than in the conventional motors. With the sizes of the conventional circuit boards, however, it is not possible to ensure sufficient space for mounting electronic components to be necessitated in responding to the future demand, for the mounting space for the electronic components is too small.

SUMMARY OF THE INVENTION

[0009] An axial flow fan according to a preferred embodiment of the present invention includes a base portion, a circuit board, an armature, an impeller cup portion, a field-generating magnet, a bearing portion, and a plurality of rotor vanes. The base portion is hollow and has an open end at its top end. The circuit board is mounted to axially face the base portion. The armature is disposed above the circuit board. The impeller cup portion is hollow and approximately cylindrical about the central axis, and has an open end at its bottom. The open end of the impeller cup portion faces the open end of the base portion. The field-generating magnet is fixed on the inner side surface of the impeller cup portion for developing torque centered on the central axis, with the armature. The bearing portion supports the impeller cup portion relative to the base portion in a rotatable manner about the central axis. The plurality of rotor vanes radiate from the outer surface of the impeller cup portion, and rotate with the impeller cup portion in a predetermined rotation direction to produce an air flow in an axial direction.

[0010] In an axial flow fan according to a preferred embodiment of the present invention, the distance between the central axis and the outer surface of the circuit board is approximately the same as or larger than the distance between the central axis and the outer side surface of a sidewall of the base portion.

[0011] In an axial flow fan according to a preferred embodiment of the present invention, a plurality of locking portions may be circumferentially arranged on the top of the sidewall of the base portion, so that the circuit board can be fixed at its outer peripheral edge by these locking portions.

[0012] In an axial flow fan according to a preferred embodiment of the present invention, a plurality of stationary vanes may be provided in a radiating manner from the outer surface of the base portion, with each stationary vane slanting in an opposite direction to the rotation direction. The stationary vanes each include projecting portions that project toward the rotor vanes to a higher level than the upper surface of the sidewall of the base portion.

[0013] The outer surface of the circuit board has a portion in contact with an enveloping surface that is defined by the inner surfaces of the projecting portions.

[0014] With the structure of the axial flow fan according to preferred embodiments of the present invention, the area of the circuit board can be increased, and thus an increased number of electronic components can be mounted thereon.

[0015] Other features, elements, advantages and characteristics of the present invention will become more apparent from the following detailed description of preferred embodiments thereof with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 is a cross-sectional view of an axial flow fan according to a first preferred embodiment of the present invention.

[0017] FIG. 2 is a perspective view of the axial flow fan according to the first preferred embodiment.

[0018] FIG. 3 shows a positional relationship between rotor vanes and stationary vanes of the axial flow fan according to the first preferred embodiment.

[0019] FIG. 4 is a perspective view of a housing, a base portion, and the stationary vanes of the axial flow fan according to the first preferred embodiment.

[0020] FIG. 5 is a perspective view of the housing, a stator portion, and the stationary vanes of the axial flow fan according to the first preferred embodiment.

[0021] FIG. 6 is a cross-sectional view of a variant of the axial flow fan according to the first preferred embodiment.

[0022] FIG. 7 is a cross-sectional view of another variant of the axial flow fan according to the first preferred embodiment.

[0023] FIG. 8 is a cross-sectional view of still another variant of the axial flow fan according to the first preferred embodiment.

[0024] FIG. 9 is a cross-sectional view of an axial flow fan according to a second preferred embodiment of the present invention.

[0025] FIG. 10 is a cross-sectional view showing a modification of the axial flow fan according to the second preferred embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0026] Referring to FIGS. 1 through 10, preferred embodiments of the present invention will be described in detail. It should be noted that in the explanation of the present invention, when positional relationships among and orientations of the different components are described as being up/down or left/right, ultimately positional relationships and orientations that are in the drawings are indicated; positional relationships among and orientations of the components once having been assembled into an actual device are not indicated. Meanwhile, in the following description, an axial direction indicates a direction parallel to a central axis, and a radial direction indicates a direction perpendicular to the central axis.

First Preferred Embodiment

[0027] FIG. 1 is a cross-sectional view of an axial flow fan according to a first preferred embodiment of the present invention. FIG. 2 is a perspective view of the axial flow fan according to the first preferred embodiment of the present invention. FIG. 3 is a perspective view showing a positional relationship between stationary vanes and rotor vanes.

[0028] As shown in FIGS. 1 to 3, the axial flow fan 1 includes a housing 11, a plurality of rotor vanes 21, and a plurality of stationary vanes 4. In this preferred embodiment, seven rotor vanes 21 and nine stationary vanes 4 are provided, for example. The rotor vanes 21 rotate inside the housing 11 and are arranged to be inclined with respect to a central axis J1 of the axial flow fan 1. The stationary vanes 4 are disposed below the rotor vanes 21 in FIG. 2 and are fixed to the housing 11. In this preferred embodiment, the stationary vanes 4 are in the form of thin plates, and the stationary vanes 4 and the rotor vanes 21 are inclined with respect to the central axis J1 toward opposite directions from each other.

[0029] The axial flow fan 1 also includes a motor 3 that is connected to the rotor vanes 21 and rotates the rotor vanes 21 about a central axis J1, as shown in FIG. 2. The axial flow fan 1 is used as an electric fan for air-cooling an electric or electronic device, for example.

[0030] The motor 3 is an outer rotor motor, and includes a stationary assembly 31, and a rotor assembly 32. The rotor assembly 32 is supported via a bearing portion, which will be described later, in a rotatable manner about the central axis J1 relative to the stationary assembly 31. In the description below, although the side of the rotor assembly 32 is referred to as an upper side and the side of the stationary assembly 31 as

a lower side along the central axis J1 for convenience sake, the central axis J1 need not necessarily be coincident with the direction of gravitational force.

[0031] The stationary assembly 31 includes a base portion 311 which is hollow and open at its top end. In this preferred embodiment, the base portion 311 is approximately cylindrical about the central axis J1. The base portion 311 is fixed to the housing 11 through the stationary vanes 4, and holds portions of the stationary assembly 31. In this preferred embodiment, the base portion 311 is made of resin, and is formed through injection molding in a continuous manner with the stationary vanes 4 and the housing 11 that are also made of resin. The base portion 311 has a bearing holding portion 312 that protrudes upward (i.e. toward the rotor assembly 32) from the bottom 3111 of the base portion 311. Ball bearings 313 and 314 that constitute the bearing portion are provided at an upper portion and a lower portion in the central axis J1 direction inside the bearing holding portion 312.

[0032] The stationary assembly 31 further includes an armature 315, and a circuit board 316. The armature 315 is attached to the outer periphery of the bearing holding portion 312, namely, to the base portion 311 at the circumference of the bearing holding portion 312. The circuit board 316, which is approximately annular or disk-shaped, for example, is attached to a position that is below the armature 315 and radially within a sidewall 3112 of the base portion 311, and is electrically connected with the armature 315 for controlling the armature 315. In other words, the armature 315 is disposed above the circuit board 316 to oppose the circuit board 316 in the central axis J1 direction, in the stationary assembly 31. Electronic components 3161 are mounted on the lower surface (i.e. the surface that opposes the bottom surface on the inner side of the base portion 311) of the circuit board 316.

[0033] The rotor assembly 32 includes a cup portion 321, a field-generating magnet 322, and a shaft 323. The cup portion 321 is hollow and approximately cylindrical about the central axis J1 and has an open end at its bottom end. The field-magnet magnet 322, which is approximately cylindrical in this preferred embodiment, is fixed on the inner side (i.e. on the inner side surface) of a sidewall 3212 of the cup portion 321 to face the armature 315. The shaft 323 protrudes downward from a lid portion 3211 of the cup portion 321. The cup portion 321 has a yoke 3214 and a hub 3215. The yoke 3214 is hollow and approximately cylindrical about the central axis and is open at its bottom end. In this preferred embodiment, the yoke 3214 is made of magnetic metal. The hub 3215 is hollow and approximately cylindrical in this preferred embodiment. In addition, the hub 3215 covers the exterior of the yoke 3214. The hub 3215 is made of resin, for example. The cup portion 321 is disposed such that its opening 3213 faces an opening 3113 of the base portion 311.

[0034] The shaft 323 is attached to the yoke 3214, more specifically, to a lid portion of the yoke 3214 in the cup portion 321, inserted into the bearing holding portion 312, and rotatably supported by the ball bearings 313 and 314. In the axial flow fan 1, the shaft 323 and the ball bearings 313 and 314 serve as the bearing portion for supporting the cup portion 321 relative to the base portion 311 in a rotatable manner about the central axis J1. Drive current that is supplied to the armature 315 is controlled by the circuit board 316, so that rotary torque centered on the central axis J1 is produced between the armature 315 and the field magnet 322. The rotary torque thus produced rotates, about the central axis

J1, the cup portion 321 together with the shaft 323 and the rotor vanes 21 that radiate from the exterior (i.e. the outer surface of the hub 3215) of the sidewall 3212 of the cup portion 321.

[0035] In the axial flow fan 1, the rotor vanes 21, together with the rotor assembly 32 of the motor 3, rotate counter-clockwise in FIG. 2, so that air is taken in from the upper side in FIG. 1 (i.e. the side of the lid portion 3211 of the cup portion 321) and delivered to the lower side (i.e. the side of the base portion 311 and the stationary vanes 4). That is, the upper side in FIG. 1 is the suction side, while the lower side is the discharge side, in the axial flow fan 1. In the description below, the rotation direction of the rotor vanes 21 is also referred to as a “motor rotation direction”.

[0036] The stationary vanes 4 radiate from the outer side surface of the sidewall 3112 of the base portion 311 below the rotor vanes 21 (i.e. on the discharge side) with each stationary vane 4 inclined in the opposite direction to the motor rotation direction (i.e. in the opposite direction to the rotation direction of the rotor vanes 21, and clockwise in FIG. 2), as shown in FIG. 3. The end of each stationary vane 4 on the side of the central axis J1 (i.e. the inner side) is connected to the sidewall 3112 of the base portion 311, while the other end on the opposite side to the central axis J1 (i.e. the outer side) is connected to the housing 11. In this preferred embodiment, each stationary vane 4 has a surface 41 that faces the motor rotation direction (i.e., a surface of which the normal is directed in a substantially opposite direction to the motor rotation direction) and curves inwardly. The surface facing the motor rotation direction 41 of each stationary vane 4 mainly receives wind from the rotor vanes 21, and is hereinafter referred to as a “wind receiving surface 41”. Also, a surface 42 of each stationary vane 4 on the side opposite the wind receiving surface 41 is hereinafter referred to as a “rear surface 42”.

[0037] FIG. 4 is a perspective view of the housing 11, the base portion 311, and the stationary vanes 4 when viewed obliquely from above. FIG. 5 is a perspective view showing a state in which the stationary assembly 31 is attached to the housing 11. As shown in FIG. 4, each stationary vane 4 has a projecting portion 43 that projects axially upward from the sidewall 3112 of the base portion 311. In other words, the stationary vanes 4 are higher than the sidewall 3112 of the base portion 311 in the axial direction. The projecting portion 43 of each stationary vane 4 has an inner side surface 431 on the side of the central axis J1 (i.e. on the inner side). A regular curved surface, namely, an enveloping surface (a virtual surface formed by connecting each of the inner side surfaces 431) is formed so as to contact substantially all of the inner side surfaces 431. As shown in FIG. 5, the outer side surface of the circuit board 316 radially contacts the enveloping surface when the stationary assembly 31 is attached to the housing 11. Also, the circuit board 316 touches the axially upper end surface of the sidewall 3112 of the base portion 311 in the axial direction, as shown in FIG. 1.

[0038] With these structures, the outer diameter of the circuit board 316, which has conventionally been set inside the inner side surface of the sidewall 3112 of the base portion 311 can be extended up to the positions of the inner side surfaces 431 of the projecting portions 43 of the stationary vanes 4. The area of the circuit board 316 can therefore be increased. That is, it becomes possible to mount an increased number of the electronic components 3161 on the circuit board 316. Also, the outer diameter of the circuit board 316 is set to be in

contact with the inner side surfaces 431 of the projecting portions 43 of the stationary vanes 4, thereby providing a tight fit of the circuit board 316 onto the stationary vanes 4. The circuit board 316 can also be fixed tightly in the axial direction, because the circuit board 316 meets the axially upper end surface of the sidewall 3112 of the base portion 311 in the axial direction.

[0039] Noted that the lower surface of the circuit board 316 may be fixed with adhesive on the axially upper end surface of the sidewall 3112. The outer surface of the circuit board 316 may be fixed with adhesive to the inner side surfaces 431 of the projecting portions 43 of the stationary vanes 4. With this structure, the circuit board 316 can be fixed even more firmly on the base portion 311.

[0040] The air flow generated by the rotation of the rotor vanes 21 hits the wind receiving surfaces 41 of the stationary vanes 4, whereby the vector of the air flow that spreads radially outward is transformed into the radially inward direction; therefore, the air flow is guided radially inward along the stationary vanes 4. The projecting portions 43 of the stationary vanes 4 project axially upward from the upper surface of the circuit board 316, as shown in FIG. 5. With this structure, the air flow that has been guided radially inward by the stationary vanes 4 is supplied through the stationary vanes 4 to the circuit board 316 and to the armature 315 from the opening 3213 of the cup portion 321, so that the armature 315 is cooled by the air flow. Since the flow rate of the air that passes over and around the circuit board 316 is large in comparison to the conventional axial flow fans, there arises a concern that vibration is caused in the circuit board 316 by the passage of air flow in the case where the circuit board 316 is not stably fixed. In the above configuration, however, the circuit board 316 is secured to the stationary vanes 4, and thus the vibration of the circuit board 316 can favorably be suppressed.

[0041] Further, the provision of the projecting portions 43 in the stationary vanes 4 allows for reduced axial distance between the rotor vanes 21 and the stationary vanes 4. The smaller the axial distance between the rotor vanes and the stationary vanes is, the better the stationary vanes can exert its primary effect of e.g. wind collecting effect and airflow rectifying effect. Another possible method is to dispose the rotor vanes 21 at closer positions to the stationary vanes 4. The rotor vanes 21, however, become more effective in producing air flows by disposing them in as close positions as possible to the suction port, and hence the axial height of the rotor vanes 21 needs to be increased in order to approximate the positions of the rotor vanes 21 to those of the stationary vanes. In the case where the axial height of the rotor vanes 21 is increased, however, the projected area of the rotating rotor vanes 21 in the circumferential direction of rotation becomes large, which brings about increase in air resistance, hence inviting increase in current value. It is thus preferable that the stationary vanes 4 be positioned closer to the rotor vanes 21 for reducing the axial distance between the rotor vanes 21 and the stationary vanes 4.

[0042] FIG. 6 is a cross-sectional view showing a modification of the axial flow fan according to the first preferred embodiment. The axial flow fan 1 is used in a wide variety of applications, and it is sometimes used in a harsh environment such as a dusty and humid environment. In such a case, it is necessary to prevent the entering of an air flow into the stationary assembly 31 and onto the mounting surface for electronic components on the circuit board 316 so as to protect the

axial flow fan against dust. This purpose can be achieved by disposing the circuit board 316 to contact the axially upper end surface of the sidewall 3112 of the base portion 311, plus making the stationary vanes 4 such that the axially upper ends of the projecting portions 43 come at the same level as or to a lower level than that of the upper surface of the circuit board 316, as shown in FIG. 6.

[0043] With the above structure, the air flow generated by the rotation of the rotor vanes 21 hits the wind receiving surfaces 41 of the stationary vanes 4, whereby the vector of the air flow that is spread radially outward is transformed into the radially inward direction. The air flow that has been vector-transformed into the radially inward direction hits the outer side surface of the circuit board 316 or the sidewall 3112 of the base portion 311, and is discharged in the axially downward direction. It is therefore possible to limit the entering of air flows onto the circuit board 316, especially its mounting surface, and into the stationary assembly 31.

[0044] FIG. 7 is a cross-sectional view showing a modification of the axial flow fan according to the first preferred embodiment. In the preferred embodiment shown in FIG. 1, the projecting portions 43 of the stationary vanes 4 are provided fully from the connected portions with the housing 11 to the connected portions with the base portion 311 of the stationary vanes 4. It is, however, also possible to provide missing areas in the projecting portions 43 on the radially inner side of the stationary vanes 4, as shown in FIG. 7. Each projecting portion 43 has an inner side surface 431 on the side of the central axis J1 (i.e. the inner side). In FIG. 7, the radius from the central axis J1 to the outer surface of the circuit board 316 is taken larger than the radius from the central axis J1 to the outer side surface of the sidewall 3112 of the base portion 311. The outer surface of the circuit board 316 meets the inner side surfaces 431 of the projecting portions 43 of the stationary vanes 4. The lower surface of the circuit board 316 may meet the axially upper surfaces of the portions that are radially formed from the inner side surfaces 431 of the projecting portions 43 to the outer side surface of the sidewall 3112 of the base portion 311. In this configuration, the circuit board 316 can be enlarged until it touches the inner side surfaces 431. That is, it is possible to widen the region for mounting the electronic components 3161 on the circuit board 316. And besides, the circuit board 316 can be placed stably by bringing the lower surface and the outer surface of the circuit board 316 into contact with the upper surface of the sidewall 3112 of the base portion 311 and the inner side surfaces 431 of the stationary vanes 4, respectively.

[0045] In addition, by providing a structure in which the circuit board 316 and the axially upper end surface of the sidewall 3112 of the base portion 311 do not touch each other as shown in FIG. 8, it is possible to further enlarge the region for mounting the electronic components 3161 on the circuit board 316. This structure can be realized by e.g. reducing the axial height of the sidewall 3112 of the base portion 311. In this modification, a cutout 432 is provided in each stationary vane 4 on the side of the central axis J1 (i.e. the inner side) as shown in FIG. 8. In this case, the lower surface at the outer peripheral edge of the circuit board 316 is brought into contact with the axially end surfaces on the cutouts 432 provided in the projecting portions 43 of the stationary vanes 4.

[0046] In FIGS. 7 and 8, the radius from the central axis J1 to the outer surface of the circuit board 316 is taken larger than the radius of the cup portion 321 from the central axis J1. This structure allows part of the air flow to pass through the motor

3 to come in contact with the interior of the motor 3, especially the armature 315, so that the interior of the motor 3 can be cooled. Particularly in FIG. 8, the air flow also goes in and out through the gap between the circuit board 316 and the axially upper end surface of the sidewall 3112 of the base portion 311, so that the electronic components mounted on the lower surface of the circuit board 316 can be cooled. Note that the gaps may be formed in an interrupted manner in the circumferential direction between the circuit board 316 and the axially upper end surface of the sidewall 3112 of the base portion 311. That is, portions where the lower surface of the circuit board 316 meets the axially upper end surface of the sidewall 3112 may be provided in separation from one another in the circumferential direction.

[0047] It should also be noted that in the case where the lower surface at the outer peripheral edge of the circuit board 316 is on the axially end surfaces on the cutouts 432 as shown in FIG. 8, the outer surface of the circuit board 316 need not necessarily meet the inner side surfaces 431 of the projecting portions 43. For the purpose of increasing the area of the circuit board 316, however, the outer surface of the circuit board 316 is preferably sized so as to be closer to the inner side surfaces 431 of the projecting portions 43.

[0048] As described above, a substantial feature of the present invention resides in the facts that the outer diameter of the circuit board 316 can be increased into the area where the base portion or the stationary vanes has/have been disposed in the conventional axial flow fans, and that the region on the circuit board 316 for mounting the electronic components 3161 can be enlarged.

Second Preferred Embodiment

[0049] Next, a description is given on an axial flow fan according to a second preferred embodiment of the present invention. FIG. 9 is a cross-sectional view showing the axial flow fan according to the second preferred embodiment. FIG. 10 is a perspective view showing a modification of the axial flow fan according to the second preferred embodiment. In FIGS. 9 and 10, like structures and components as shown in FIGS. 1 to 7 are designated by like reference numerals in the description below.

[0050] In the axial flow fan according to the second preferred embodiment, on the axially upper end of the sidewall 3112 of the base portion 311 locking portions 3113 are provided in at least four positions in the circumferential direction for locking the circuit board 316, as shown in FIG. 9. The number of positions for disposing the locking portions 3113 is not limited to four, and any number will do so long as the locking portions are provided in more than one positions. The plurality of locking portions 3113 are protruded axially upward from the axially upper end of the sidewall 3112 of the base portion 311. At the tip of each locking portion 3113, a locking hook is provided in a protruding manner toward the central axis J1 (i.e. to the inner side).

[0051] When the circuit board 316 is brought close to the base portion 311 to fix it thereon, the outer peripheral edge of the circuit board 316 comes into contact with the locking portions 3113. The circuit board 316 is further pressed to the base portion 311, whereby the locking portions 3113 are elastically bent radially outward. The circuit board 316 is further pressed against the base portion 311, and the locking portions 3113 are restored toward the central axis J1 (i.e. to the inner side) by the elasticity of the locking portions 3113 at the point where the locking hooks come axially above the

circuit board **316**. The locking hooks thus engage on the upper surface at the outer peripheral edge of the circuit board **316**, so that the movement of the circuit board **316** can be restricted in the axial direction.

[0052] More specifically, a slant surface and a lower surface are formed in each locking hook. The slant surface slants axially downward toward the central axis **J1**. The lower surface is defined axially under the slant surface and is to lie against the upper surface of the circuit board **316** in the axial direction. The slant surface and the lower surface are formed integrally. The circuit board **316** and the slant surfaces of the locking hooks come into contact with each other, whereby the locking portions are elastically bent radially outward due to the force applied against the slant surfaces. When the circuit board **316** is fixed on the base portion **311**, the lower surfaces of the locking hooks lie against the upper surface at the outer peripheral edge of the circuit board **316** in the axial direction, thereby restricting the movement of the circuit board **316** in the axially upward direction.

[0053] According to the second preferred embodiment, the locking portions **3113** are disposed at radially different positions from the positions of the stationary vanes **4**. That is, each locking portion **3113** is disposed in between the adjacent stationary vanes **4**. In the case where a locking portion **3113** overlaps in position with a stationary vane **4** in the radial direction, it is difficult to secure the space for allowing the locking portion **3113** to elastically deform in fitting the circuit board **316**. The present invention aims at increasing the outer diameter (the area) of the circuit board **316**; however, if a stationary vane **4** is disposed at a position overlapping with the position of a locking portion **3113**, the area of the circuit board **316** is decreased by the area of the overlap.

[0054] In the case where the locking portion **3113** is disposed at the position overlapping with the position of the stationary vane **4**, it is necessary to minimize the reduction in area of the circuit board **316**. For this reason, the circuit board **316** needs to be enlarged until the outer side surface thereof touches the inner side surfaces **431** of the projecting portions **43** of the stationary vanes **4**. In order to make the outer side surface of the circuit board **316** touch the inner side surfaces **431** of the projecting portions **43**, it is only necessary to provide a locking portion **3113a** at the inner side surface **431** of each projecting portion **43** in a protruding manner toward the central axis **J1** (i.e. to the inner side), as shown in FIG. **10**. In this manner, the upper surface at the outer peripheral edge of the circuit board **316** is locked with the locking portions **3113a** while the outer side surface of the circuit board **316** meets the inner side surfaces **431** of the projecting portions **43**. As a result, the axial movement of the circuit board **316** can be restricted.

[0055] While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

What is claimed is:

1. An axial flow fan comprising:

- a base portion centered on a central axis, being hollow and approximately cylindrical, and having an open end at its top end;
- a circuit board arranged to axially face the base portion;
- an armature arranged above the circuit board;

an impeller cup which is hollow and approximately cylindrical about the central axis and has an open end at its bottom end, the open end of the impeller cup facing the open end of the base portion;

a field-generating magnet fixed to an inner side surface of the impeller cup and arranged to generate together with the armature a torque about the central axis;

a bearing portion arranged to support the impeller cup in a rotatable manner about the central axis relative to the base portion;

a plurality of rotor vanes extending radially from an outer side surface of the impeller cup and arranged to generate an axial airflow by rotating together with the impeller cup, the rotor vanes being inclined with respect to the central axis; and

a stationary vanes extending radially from an outer side surface of the base portion and being inclined with respect to the central axis toward an opposite direction to the inclination direction of the rotor vanes, wherein

the stationary vanes project from a top of a sidewall defining the outer side surface of the base portion, and an outer side surface of the circuit board is in radial contact with an envelope defined by connecting inner side surfaces of portions of the stationary vanes above the top of the sidewall of the base portion.

2. The axial flow fan according to claim 1, wherein a bottom of the circuit board is in axial contact with the top of the sidewall of the base portion.

3. The axial flow fan according to claim 1, wherein a plurality of locking portions are circumferentially arranged on the top of the sidewall of the base portion, and an outer peripheral edge of the circuit board is locked by the locking portions.

4. The axial flow fan according to claim 3, wherein the locking portions are arranged circumferentially between the stationary vanes.

5. The axial flow fan according to claim 1, wherein at least two of the stationary vanes include locking portions on the inner side surfaces thereof above the sidewall of the base portion, and an outer peripheral edge of the circuit board is locked by the locking portions.

6. An axial flow fan comprising:

a base portion being hollow and approximately cylindrical about a central axis, and having an open end at its top end;

a circuit board arranged to axially face the base portion;

an armature arranged above the circuit board;

an impeller cup which is hollow and approximately cylindrical about the central axis and has an open end at its bottom end, the open end of the impeller cup facing the open end of the base portion;

a field-generating magnet fixed to an inner side surface of the impeller cup and arranged to generate together with the armature a torque about the central axis;

a bearing portion arranged to support the impeller cup in a rotatable manner about the central axis relative to the base portion;

a plurality of rotor vanes extending radially from an outer side surface of the impeller cup and arranged to generate an axial airflow by rotating together with the impeller cup, the rotor vanes being inclined with respect to the central axis; and

a stationary vanes extending radially from an outer side surface of the base portion and being inclined with

respect to the central axis toward an opposite direction to the inclination direction of the rotor vanes, wherein a distance between an outer side surface of the circuit board and the central axis is approximately the same as or larger than a distance between the outer side surface of the base portion and the central axis.

7. The axial flow fan according to claim 6, wherein the distance between the outer side surface of the circuit board and the central axis is larger than a distance of the outer side surface of the impeller cup and the central axis.

8. The axial flow fan according to claim 6, wherein the stationary vanes project from a top of a sidewall of the base portion which defines the outer side surface of the base portion, and

an outer peripheral edge of the circuit board is in contact with inner side surfaces of portions of the stationary vanes above the top of the sidewall of the base portion.

9. The axial flow fan according to claim 6, wherein a bottom of the circuit board is axially spaced apart from the top of the sidewall of the base portion.

10. The axial flow fan according to claim 6, wherein the stationary vanes project from a top of a sidewall of the base portion which defines the outer side surface of the base portion, and

the distance between the outer side surface of the circuit board is approximately the same as or larger than a radius of an envelope defined by connecting the inner side surfaces of portions of the stationary vanes above the top of the sidewall of the base portion.

11. The axial flow fan according to claim 6, wherein the stationary vanes project from a top of a sidewall of the base portion which defines the outer side surface of the base portion,

at least two of the stationary vanes respectively include locking portions on the inner side surface thereof above the top of the sidewall of the base portion, and

an outer peripheral edge of the circuit board is locked by the locking portions.

12. An axial flow fan comprising:

a base portion centered on a central axis, being hollow and approximately cylindrical, and having an open end at its top end;

a circuit board arranged to axially face the base portion; an armature arranged above the circuit board;

an impeller cup which is hollow and approximately cylindrical about the central axis and has an open end at its bottom end, the open end of the impeller cup facing the open end of the base portion;

a field-generating magnet fixed to an inner side surface of the impeller cup and arranged to generate together with the armature a torque about the central axis;

a bearing portion arranged to support the impeller cup in a rotatable manner about the central axis relative to the base portion; and

a plurality of rotor vanes extending radially from an outer side surface of the impeller cup and arranged to generate an axial airflow by rotating together with the impeller cup, wherein

a plurality of locking portions are circumferentially arranged on a top of a sidewall of the base portion which defines an outer side surface of the base portion, and

an outer peripheral edge of the circuit board is locked by the locking portions.

13. The axial flow fan according to claim 12, further comprising a stationary vanes extending radially from the outer side surface of the base portion, wherein

the stationary vanes and the rotor vanes are inclined with respect to the central axis toward opposite directions from each other, and

the locking portions are arranged circumferentially between the stationary vanes.

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