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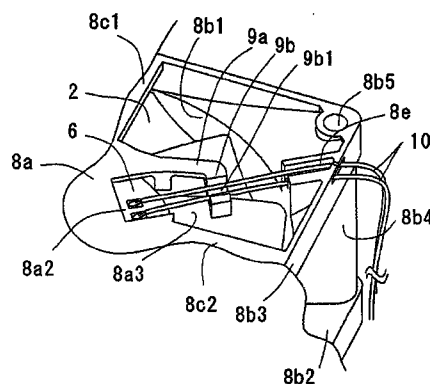
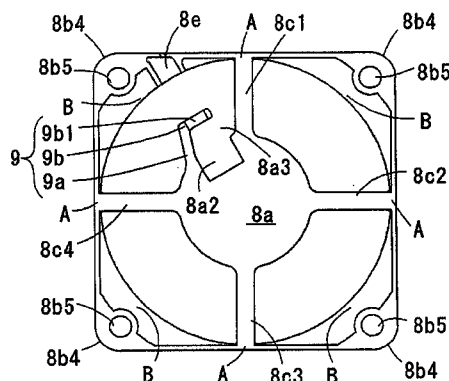
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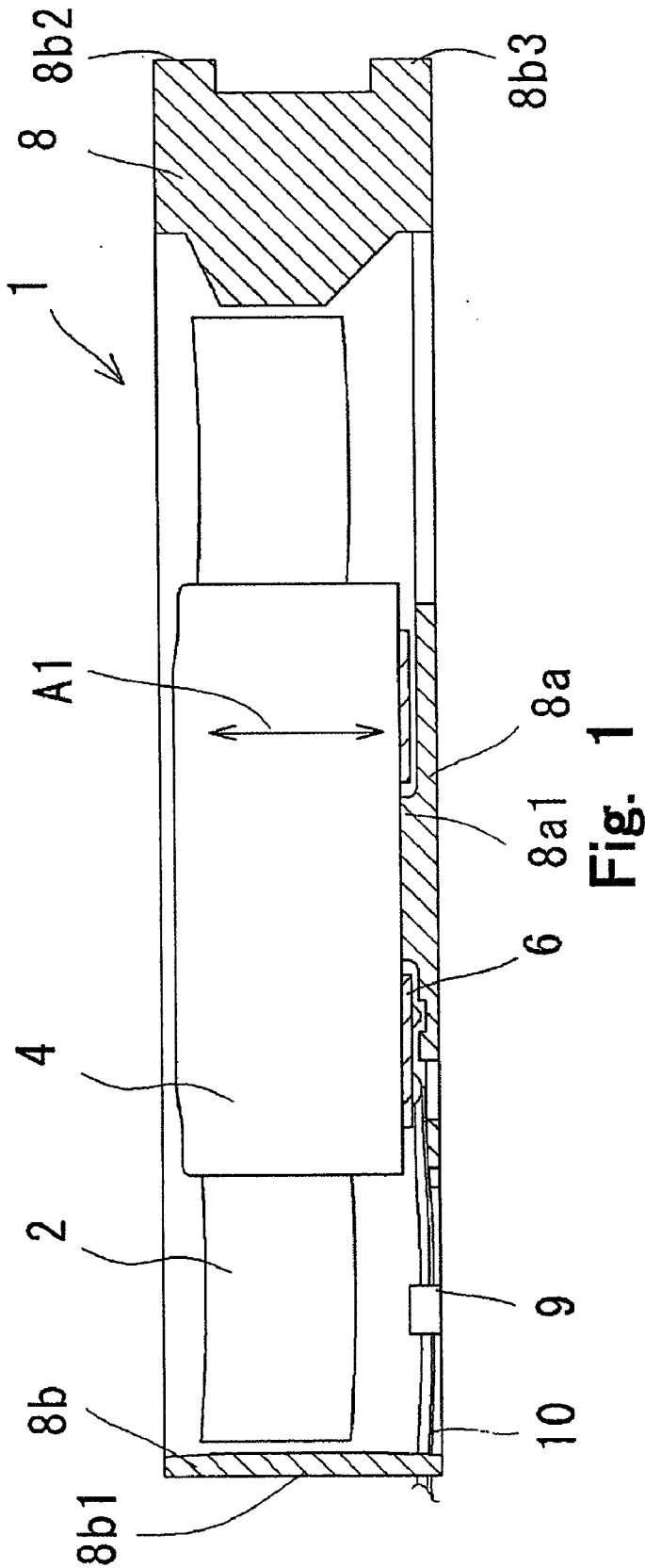
ABSTRACT

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A lead wire is led out to a fan outer frame portion side through a lead wire retaining portion that is provided to a motor support portion of a housing that fixes a fan motor so as to protrude to a fan outer frame portion side or is provided to the fan outer frame portion of the housing so as to protrude to the motor support portion side. The lead wire retaining portion is positioned between neighboring support beams for fixing the motor support portion to the fan outer frame portion.





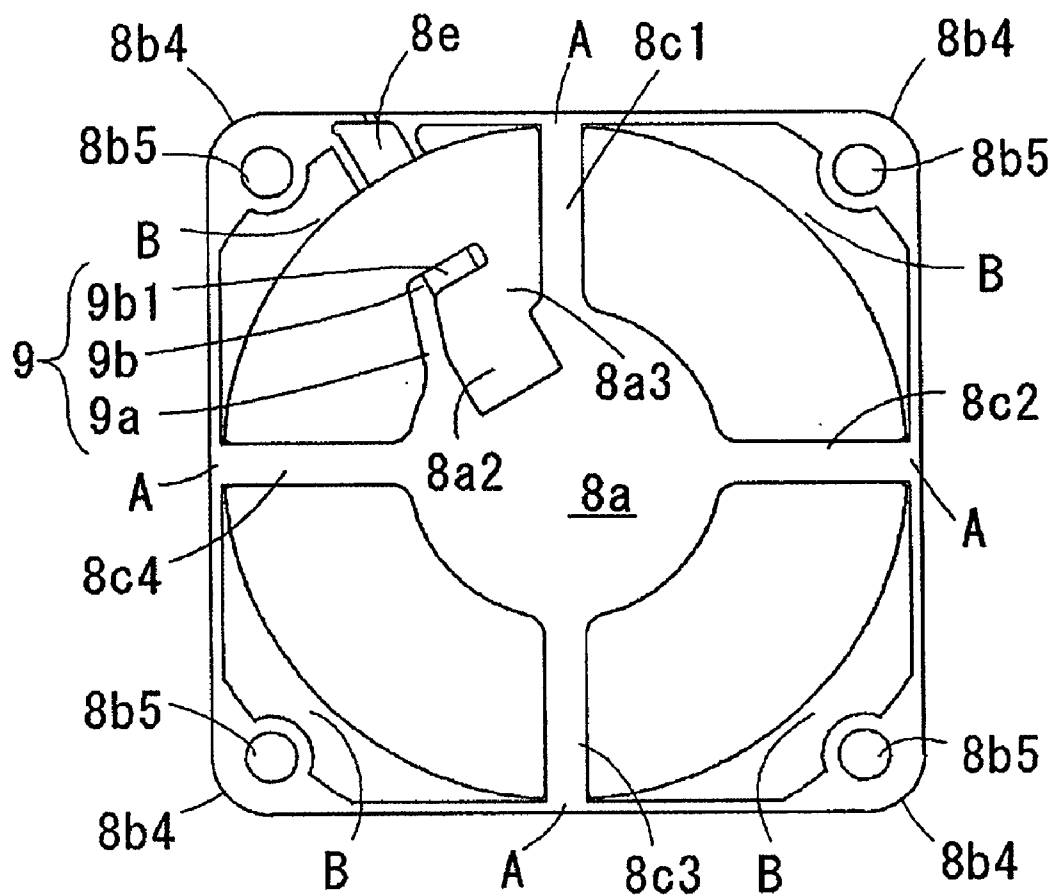


Fig. 2

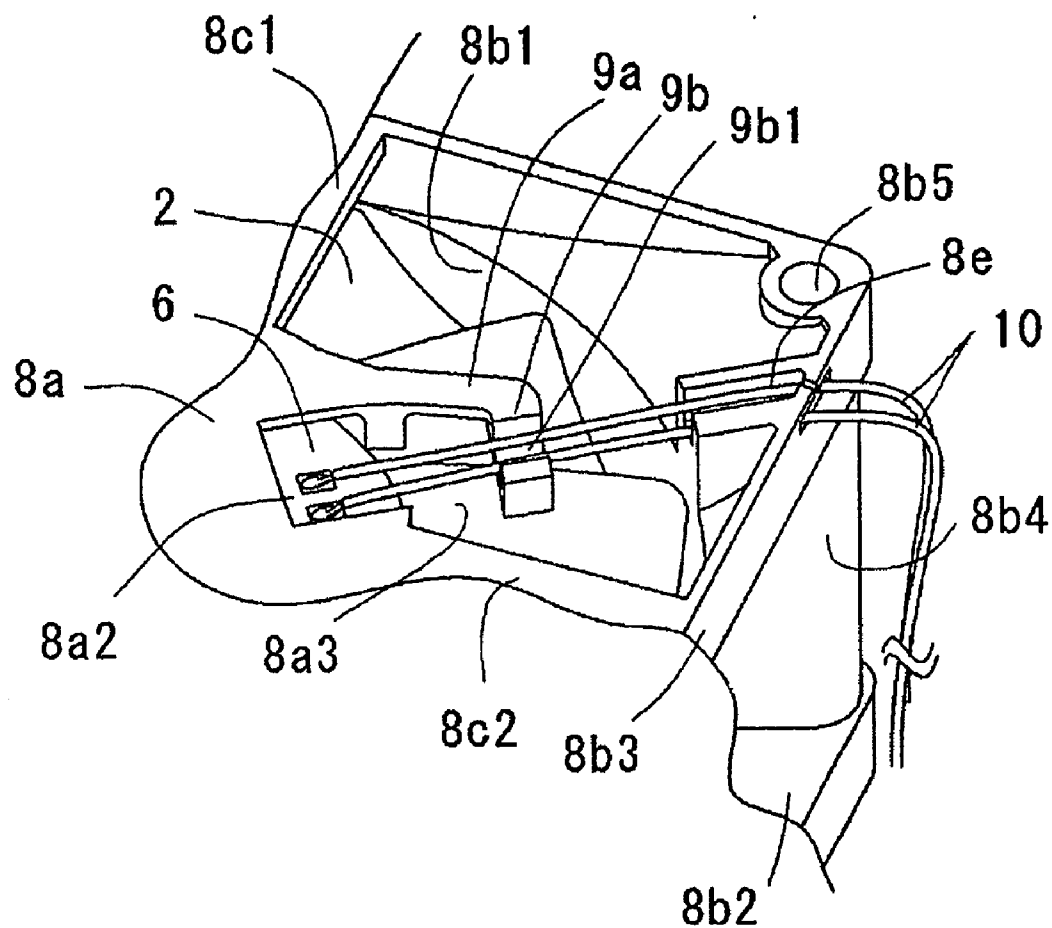


Fig. 3

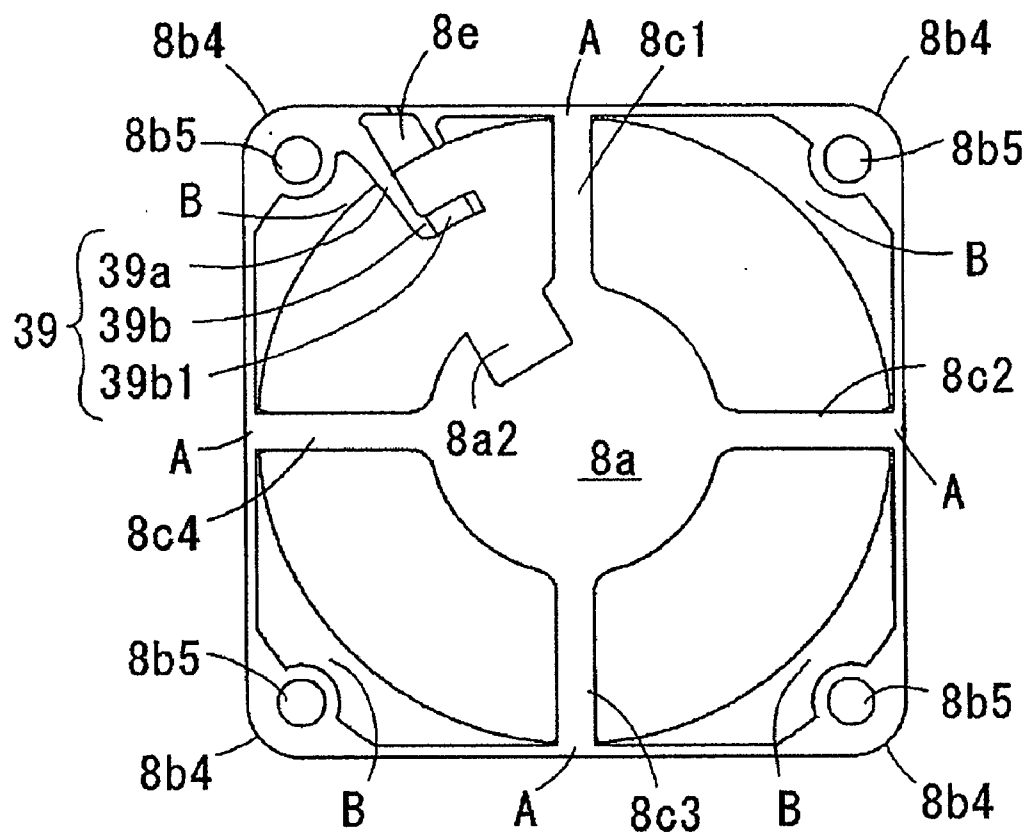


Fig. 5

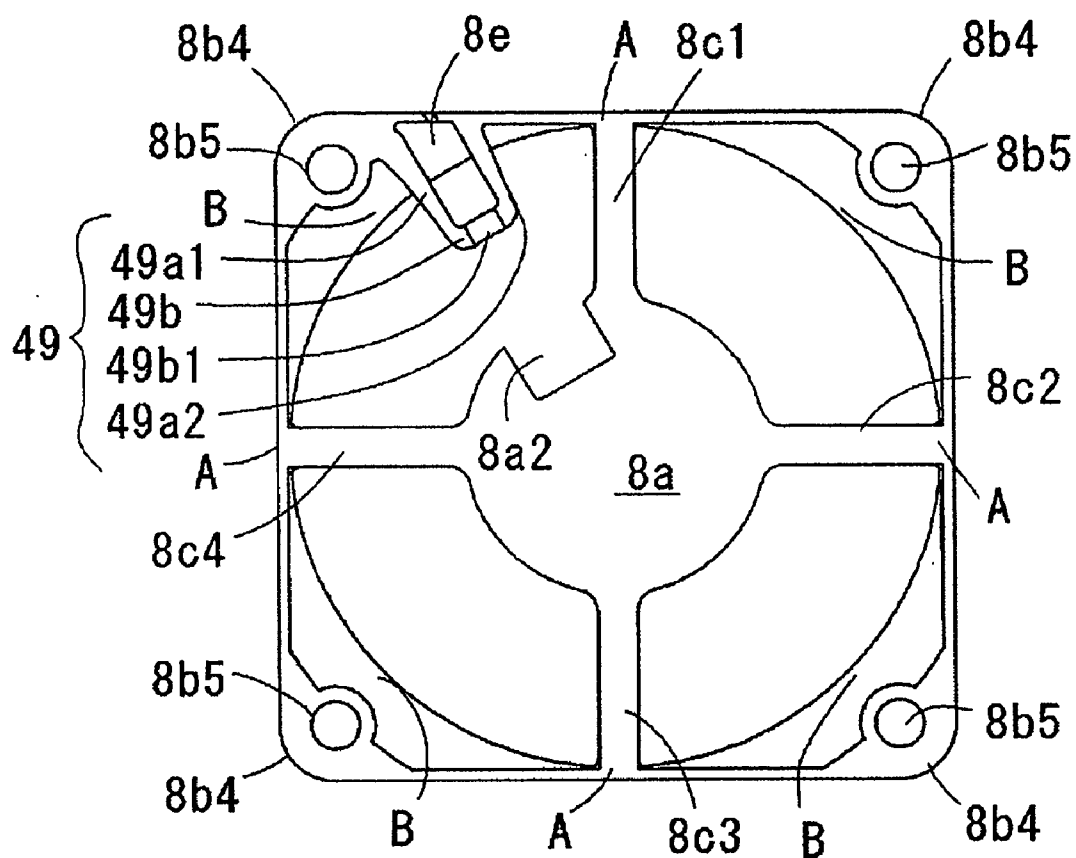
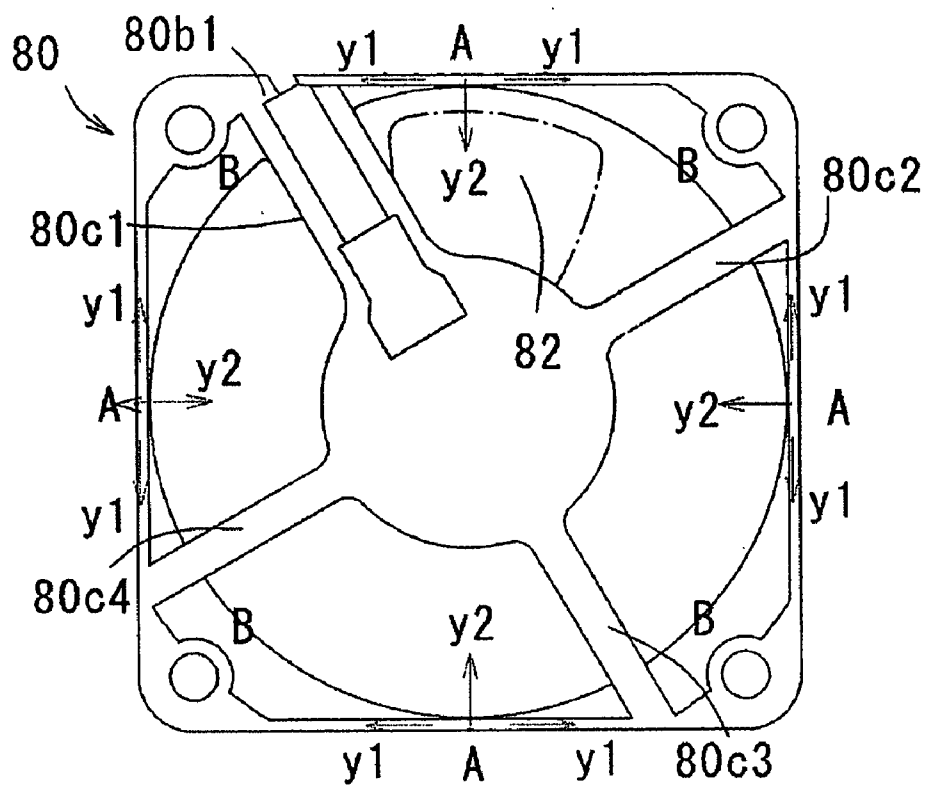
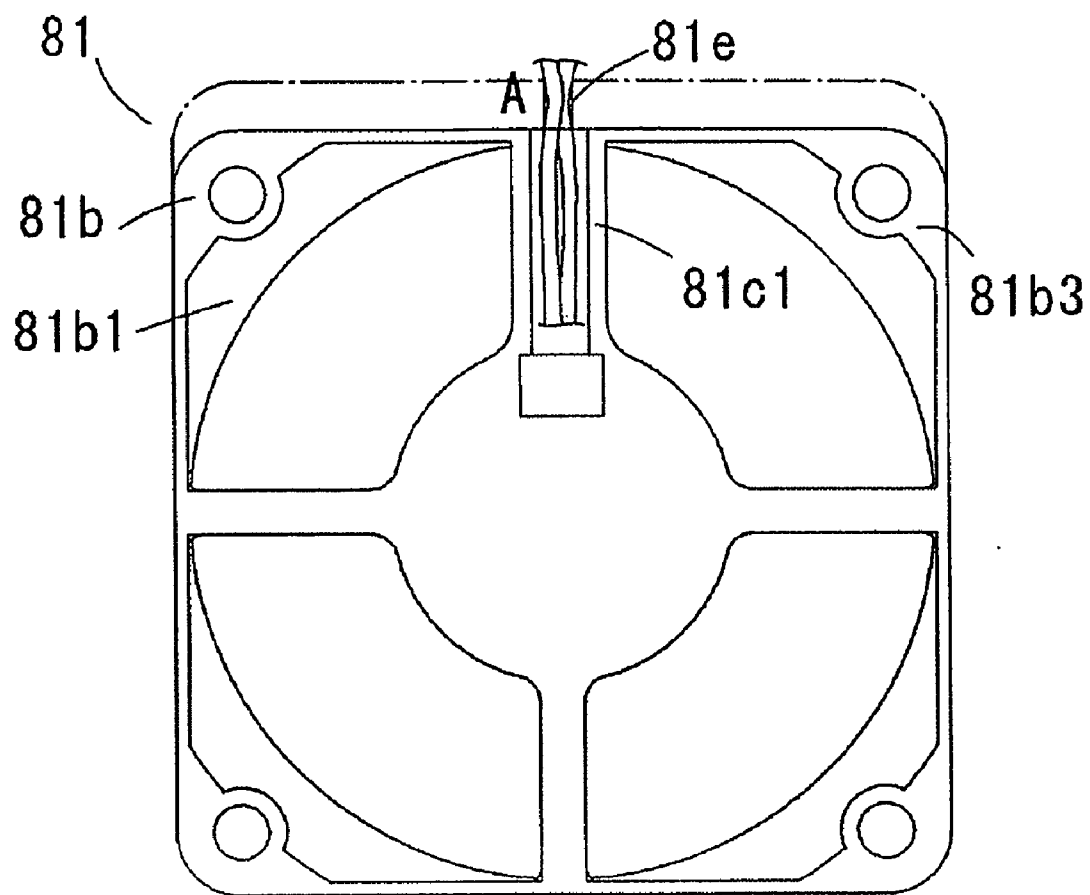


Fig. 6



Prior Art

Fig. 7



Prior Art

Fig. 8

STRUCTURE OF FAN DEVICES FOR LEADING OUT WIRES

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a structure of a fan device for leading out lead wires. Fan devices are used for various apparatuses such as office machines or home appliances.

[0003] 2. Description of the Prior Art

[0004] Fan devices are used widely in various apparatuses such as office machines or home appliances for cooling heat that is generated when the apparatuses operate. In particular, a personal computer or a server device requires a high efficiency fan device having a small size and being capable of supplying large quantity of air in proportion to the processing speed and the requirement for smaller size thereof, which make a CPU chip and other ICs generate more heat during operation. A fan device usually comprises a fan motor, a housing and a printed circuit board. The fan motor comprises a motor for generating a driving force and an impeller that is rotated by the driving force for generating a cooling air flow. The housing comprises a motor support portion for supporting a fan motor and a printed circuit board, a fan outer frame portion that is disposed at the perimeter side of the motor support portion with a predetermined space, and a plurality of support beams for connecting between the motor support portion and the fan outer frame portion. The printed circuit board is provided for controlling the motor. In addition, lead wires for supplying electric power from an external power source are led to a lead wire guide groove that is formed vertically in one of the plural support beams via the fan outer frame portion and are connected to the motor via the printed circuit board. This power supply enables the fan motor to rotate for driving the impeller, which generates a flow of air along the axial direction of the fan motor in a space between the fan outer frame portion and the motor support portion.

[0005] Typically, three or more support beams are disposed in the space between the fan outer frame portion and the motor support portion for supporting the motor support portion. In order to prevent these support beams from being obstacles to the air flow along an axial direction, areas of cross sections of these support beams in the direction perpendicular to the rotation axis are adjusted to be as small as possible.

[0006] However, in the above-mentioned fan device, the lead wires are housed in one of the support beams, and the support beam becomes thick. As a result, there is a limitation when trying to decrease the width of the support beam so as to reduce an air resistance for improving air blow performance.

[0007] In addition, a compact fan device has a small distance between the motor support portion and the fan outer frame portion. Therefore, some fan devices lead out the lead wires directly to the fan outer frame portion without leading to the support beam. This structure does not need a guide groove in the support beam, so that the air resistance of the support beam can be reduced. However, if the lead wires are loosened, there is a possibility that the lead wire contacts the

rotating impeller and an insulating coat of the lead wire is broken to make a short cut or the wire itself is broken.

[0008] Recently, a fan device is required to generate a larger quantity of the air flow. In such circumstances, it has been difficult to neglect a windage loss due to increase of thickness of the support beam that retains the lead wires. In addition, an office machine or the like is desired to be smaller in its outside shape. Therefore, it is required to minimize a space between the impeller and the fan outer frame portion, so that a constant outside shape of the fan device can house a largest impeller for generating a large quantity of air flow.

SUMMARY OF THE INVENTION

[0009] An object of the present invention is to provide a fan device that is capable of supplying a large quantity of air and has a small windage loss. Another object of the present invention is to provide a fan device that can retain lead wires simply and minimize a windage loss.

[0010] According to a first aspect of the present invention, there is provided a fan device comprising a fan motor, an impeller and a housing. The fan motor includes a rotor portion and a stator portion, the rotor being rotated around a rotation axis of the motor by a power supplied to the stator from an external power source via lead wires. The impeller is fixed to the rotor portion so as to generate an air flow when the motor rotates.

[0011] The housing includes a fan outer frame portion, a disk-like motor support portion extending outward in the rotation direction from a substantial center that is on the rotation axis of the motor so as to fix the fan motor, at least three support beams for connecting the motor support portion fixedly to the fan outer frame portion, and a lead wire retaining portion for retaining the lead wires. The lead wire retaining portion extends outward or inward in the rotation direction and includes an arm portion having one end that is fixed to the motor support portion or the fan outer frame portion and at the other end it has a lead wire retaining recess.

[0012] In this fan device, the lead wires are not housed in the support beam but passes through a space between the motor support portion and the fan outer frame portion nakedly. Therefore, the support beam can reduce its width as much as possible within the range where sufficient strength is secured. In addition, as the width of the support beam is reduced, air resistance of air that flows in the space between the motor support portion and the fan outer frame portion can be reduced so that air blow performance is improved. The lead wire is retained by the lead wire retaining portion that has a shape having a small windage loss. Therefore, a fan device is realized that has little possibility that lead wires contact the impeller and has a small windage loss.

[0013] In addition, another embodiment of the fan device according to the present invention has a following structure adding to the structure of first aspect of the present invention. Namely, the housing is made of a synthetic resin by injection modeling, and the fan outer frame portion comprises a fan outer frame cylinder portion enclosing the fan motor and a plurality of fixing end plate portions provided on an outer circumference surface of the fan outer frame cylinder portion. One end of the support beam is linked to

a substantial center of neighboring two side connecting corners of the fixing end plate portion, and the other end of the support beam is linked to the motor support portion.

[0014] In this fan device, the housing is made of a synthetic resin by injection modeling. One end of the support beam of the housing is linked to a substantial center of neighboring two side connecting corners of the fixing end plate portion. Therefore, a deformation at the substantial center portion can be minimized during cooling process that is a final stage of the injection modeling. Thus, the strength of the fan outer frame cylinder portion is enhanced so that the fan outer frame cylinder portion having a good circularity can be formed. As a result, as the circularity of the fan outer frame cylinder portion is high, an outer diameter of the impeller can be set to a value close to an inner diameter of the fan outer frame cylinder portion. Thus, the outer diameter of the impeller can be increased. For this reason, the capability of the impeller about air blowing can be improved. As the space between the impeller and the fan outer frame cylinder portion can be set narrower, air leakage quantity from the space can be reduced. Therefore, this fan device can realize a high efficiency of blowing air. In addition, the lead wires can be retained by the lead wire retaining portion that has a shape of small windage loss. Thus, a fan device having little possibility that lead wires contact the impeller and has a large quantity of air blow and a small quantity of windage loss.

[0015] These and other objects, features and advantages of the present invention will become more apparent upon reading of the following detailed description along with the accompanied drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 is a cross section showing a fan motor according to a first embodiment of the present invention.

[0017] FIG. 2 is a bottom view of a housing of the fan motor shown in FIG. 1.

[0018] FIG. 3 is a perspective view of a main portion of the fan motor shown in FIG. 1.

[0019] FIG. 4 is a bottom view of a housing of the fan motor according to a second embodiment of the present invention.

[0020] FIG. 5 is a bottom view of a housing of the fan motor according to a third embodiment of the present invention.

[0021] FIG. 6 is a bottom view of a housing of the fan motor according to a fourth embodiment of the present invention.

[0022] FIG. 7 is a reference diagram showing a basic structure of the housing of the fan motor.

[0023] FIG. 8 is a reference diagram showing a basic structure of the housing of another fan motor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] A best embodiment of a fan device according to the present invention will be described with reference to FIGS. 1-3 (hereinafter this is referred to as a first embodiment). FIG. 1 is a cross section showing the fan device schemati-

cally. FIG. 2 is a bottom view of a housing of the fan device shown in FIG. 1. FIG. 3 is an enlarged perspective view of a main portion of the fan device shown in FIG. 1 viewed from the bottom of the housing. Note that the axial direction in the description means the direction along which the rotation axis of the fan motor extends in this fan device (the direction shown by an arrow A1 in FIG. 1).

[0025] This fan device 1 comprises an impeller 2, a fan motor 4, a printed circuit board 6 and a housing 8. The printed circuit board 6 has a control circuit for controlling power supply to this fan motor 4 and rotation of the impeller 2. The housing 8 supports the fan motor 4 and the printed circuit board 6.

[0026] In addition, the housing 8 comprises a motor support portion 8a disposed at a middle portion for supporting the fan motor 4 and the printed circuit board 6, a fan outer frame portion 8b disposed at the outer circumferential side of the motor support portion 8a and the fan motor 4 with a predetermined space, and four support beams 8c1-8c4 for connecting the motor support portion 8a with the fan outer frame portion 8b. These portions of the housing 8 are made up of a synthetic resin integrally by injection molding. The motor support portion 8a has a substantially circular outside shape. The support beams 8c1-8c4 extends in the circumferential direction at a constant pitch between the motor support portion 8a and the fan outer frame portion 8b.

[0027] The motor support portion 8a has a circular shape and a support portion 8a1 disposed at the middle of a surface at one side in the axial direction. The motor support portion 8a is provided with a notch 8a2 cut inward in a rectangular shape in a plan view from a rim between the support beam 8c1 and the support beam 8c4. There is provided a lead wire retaining portion 9 that extends from one side end forming the notch 8a2 to the side of the fan outer frame portion 8b.

[0028] The fan outer frame portion 8b comprises a fan outer frame cylinder portion 8b1 that has both ends opened and surrounds the motor support portion 8a and the fan motor 4 from the outer circumference side. In addition, there is provided a pair of end plates 8b2 and 8b3 having a square shaped outer rim at the outer circumference surface that is positioned at both opened ends of the fan outer frame cylinder portion 8b1. Four corners of the pair of end plates 8b2 and 8b3 are provided with a column-like connection portion 8b4 that connects the both end plates 8b2 and 8b3. This connection portion 8b4 is provided with a through hole 8b5 in the axial direction. A side of the square that forms the outer rim of the end plates 8b2 and 8b3 is a little larger than a diameter of a circle that forms the fan outer frame cylinder portion 8b1. The through hole 8b5 is a screw hole for use when the fan device 1 is fixed to a predetermined position. An inclined surface is formed on each of the four corners of the both end plates 8b2 and 8b3 at the side connected to the cylinder portion 8b. In addition, as shown in FIG. 3 as an enlarged view, a groove 8e that extends in the radial direction of the fan motor 4 is formed on the inclined surface of the end plate 8b3 that is disposed between the support beam 8c1 and the connection portion 8b4. The outer end thereof becomes narrow and communicates to the side of the end plate 8b3. The lead wire 10 is engaged and retained by an opening portion of this groove 8e.

[0029] One end of each of the four support beams 8c1-8c4 is linked to the fan outer frame portion 8b (that is a point A

in FIG. 2) corresponding to the center of a side that connects neighboring corners of the end plate 8b3, and the other end extends from the position to the rotation center of the fan motor 4 so as to be linked to the motor support portion 8a. The support beams 8c1-8c4 are belt-like plates having a small thickness and a predetermined width.

[0030] The fan motor 4 has a stator and the printed circuit board 6 that are fit onto the outer circumference surface of the cylindrical support portion 8a1, and a coil of this stator is soldered to lands of the printed circuit board 6. Bearing means are fixed to the inner circumferential surface of the cylindrical support portion 8a1 and support a shaft. The shaft has a rotor comprising the impeller 2. Magnets to drive are provided at the inner circumference of the rotor via a yoke, and the magnets are opposed to the stator. The printed circuit board 6 is connected electrically to one end of the lead wire 10 for being connected to an external power source, and the other end thereof is led out to the fan outer frame portion 8b side via the groove 8e. Though the lead wire 10 has two pieces of wire in this example, it may have one piece or three or more pieces of wire depending on a specification of the control circuit or the lead wire. When electric current is supplied from the external power source to the stator via the lead wire 10, a driving torque is generated by magnetic interaction between the stator and the driving magnet so that the rotor rotates and the impeller 2 take air in so as to generate a flow of air. The generated flow of air goes through the space between the fan outer frame portion 8b and the support beams 8c1-8c4 in the axial direction of the fan motor 4.

[0031] Next, the above-mentioned lead wire retaining portion 9 will be described. The lead wire retaining portion 9 comprises an arm portion 9a that extends from one of side ends of the notch 8a2 of the motor support portion 8a to the fan outer frame portion 8b side and a tip portion 9b that bends from a tip of the arm portion 9a to the support beam 8c1 side. The arm portion 9a has a plate-like shape having a thickness substantially the same as the support beams 8c1-8c4, a width smaller than the same and a length substantially a half of the same. The arm portion 9a has a base portion on the motor support portion 8a that is thicker than the tip portion. The lead wire retaining recess 9b has a width substantially the same as the arm portion 9a and a length a little shorter than the arm portion 9a. The lead wire retaining recess 9b has a thickness twice the arm portion 9a and protrudes to the impeller 2 side, where a recess is formed in the thickness direction. A depth and a width of this lead wire retaining recess 9b is approximately such that two lead wires 10 can be housed in it sufficiently. The lead wire retaining recess 9b, the notch 8a2 and the groove 8e are positioned substantially on the same line. The lead wire retaining recess 9b is positioned at substantially the middle between the motor support portion 8a and the fan outer frame portion 8b.

[0032] The lead wire 10 is positioned so that a portion connected to the printed circuit board 6 is exposed from the notch 8a2. The lead wire 10 passes through the lead wire retaining recess 9b from the notch 8a2 and is guided to the groove 8e so as to be led out of the side surface of the end plate 8b3. An opening 8a3 that is formed between the lead wire retaining recess 9b and the notch 8a2 is useful when leading out the lead wire 10. For example, when soldering one end of the lead wire 10 to the printed circuit board 6 that is previously fixed to the motor support portion 8a, the lead

wire 10 is inserted from the opening 8a3 and the notch 8a2 for soldering work so that the printed circuit board 6 is connected to the lead wire 10 completely. In addition, the printed circuit board 6 that is connected to the lead wire 10 with a connector is attached to the cylindrical support portion 8a1, and then the connector side of the lead wire 10 is led out from the bottom side of the motor support portion 8a (the front side of paper in FIG. 2), when the lead wire 10 is guided from the opening 8a3 to the lead wire retaining recess 9b side so that it can be readily drawn out even if the lead wire 10 has a connector at one end.

[0033] In addition, the direction for the lead wire 10 to be drawn out and is substantially perpendicular to the lead wire retaining recess 9b. As the opening is narrow at the outer end of the groove 8e, the lead wire 10 will not be detached at a vicinity of the groove 8e even if it moves when the lead wire 10 is inserted from the opening into the groove 8e. In addition, the bottom surface of the lead wire retaining recess 9b is positioned more outward in the axial direction of the housing 8 than the plane that passes the plane in which the connection portion of the printed circuit board 6 with the lead wire 10 is formed and the bottom surface of the groove 8e pass through (the bottom side of the housing 8 shown in FIG. 3). Therefore, a frictional resistance of the lead wire 10 at the lead wire retaining recess 9b is increased so that the lead wire 10 is difficult to move.

[0034] The fan device 1 has a following characteristic. Namely, the lead wire 10 does not pass the support beams 8c1-8c4 but passes through the space between them and the motor support portion 8a. Therefore, width of the support beam, which had to be large for including a groove in the prior art, can be decreased as much as possible while securing a sufficient strength. Furthermore, air resistance of the air that flows over this space can be reduced so that air blowing performance can be improved.

[0035] In addition, the lead wire retaining portion 9 is provided to the motor support portion 8a and is disposed at the inner side of the space between the motor support portion 8a and the fan outer frame portion 8b. As the flow of air that passes the inner side of the space has a flow velocity lower than the flow of air that passes the outer side of the space, a loss of flow is small even if the flow of air collides the obstacle (the lead wire retaining portion 9). Note that though the lead wire retaining portion 9 causes an air resistance, it has a shape protruding from the motor support portion 8a and does not have a structure to be connected to the fan outer frame portion 8b like the support beams 8c1-8c4. Therefore, the area to be an obstacle to the flow of air (the area of the plane opposed in the axial direction) is small, and the air resistance of the lead wire retaining portion 9 is very small. In the same way, though the lead wire 10 becomes an air resistance, the area thereof exposed in the space is sufficiently small compared with the case where the support beam becomes wide for including a groove. Therefore, air resistance of the lead wire 10 is also very small. There is little influence to the air resistance by the lead wire retaining portion 9 and the lead wire 10.

[0036] One end of each of the support beams 8c1-8c4 is connected to a vicinity of the point A of the fan outer frame portion 8b, so the housing 8 is modeled to be hardly deformed and have high accuracy upon modeling. The reason for this will be described with reference to the reference diagram shown in FIG. 7.

[0037] The housing **80** shown in **FIG. 7** has the arrangement of four support beams **8c1-8c4** that are moved in the circumferential direction by 45 degrees from those of housing **8** in this embodiment (four support beams shown in **FIG. 7** are represented by **80c1-80c4**). When this housing **80** is modeled with a synthetic resin by injection modeling, the cylinder portion **80b1** of this housing **80** may have thick portions of the point B with the end plates **80b2** and **80b3** and thin portions of the point A without the end plates **80b2** and **80b3**, which are mixed and disposed in the circumferential direction. This housing **80** may be contracted largely at the vicinity of the point B of the cylinder portion **80b1** than at the vicinity of the point A. Therefore, the vicinity of the point A of the cylinder portion **80b1** is pulled to the point B at both sides (as shown in an arrow y1) with an action of a stress tilting inward (as shown in an arrow y2), so that the cylinder portion **80b1** may be modeled in bad circularity. Therefore, in a fan device with this housing **80**, the outer diameter of the impeller **82** must be small considering deformation quantity upon modeling so that the outer end of the impeller **82** does not contact the inner circumference surface of the cylinder portion **80b1**. Thus, air blowing performance of the impeller may be sacrificed. In addition, the space between the impeller **82** and the cylinder portion **80b1** becomes large so that leakage of air from this space may be increased. Therefore, this fan device does not have a good efficiency of blowing air.

[0038] On the contrary, in the housing **8** of this embodiment, four support beams **8c1-8c4** are connected to all the points A of the fan outer frame cylinder portion **8b1** as shown in **FIG. 2**. Therefore, the support beams **8c1-8c4** are supported by each other so as to absorb the stress generated when the resin is cured, so that a deformation of the fan outer frame cylinder portion **8b1** can be suppressed. Therefore, the fan outer frame cylinder portion **8b1** can be modeled with good circularity, so that the outer diameter of the impeller **2** can be set close to the inner diameter of this fan outer frame cylinder portion **8b1**. Thus, the air blowing performance of the impeller **2** can be improved as the outer diameter of the impeller **2** can be increased. In addition, as the space between the impeller **2** and the fan outer frame cylinder portion **8b1** can be set to a small value, leakage of air from the space can be reduced. Consequently, this fan device **1** can realize a high efficiency of blowing air.

[0039] In addition, the fan outer frame portion **8b** side of each of the support beams **8c1-8c4** is connected to a vicinity of the point A of the fan outer frame portion **8b**, so that no connection portion of the support beam is formed on the inclined surfaces at four corners of the fan outer frame portion **8b1**. Therefore, the flow of air goes on the inclined surface smoothly so that efficiency of blowing air can be improved.

[0040] Furthermore, though the arrangement of the support beams **8c1-8c4** is advantageous from a viewpoint of moldability as described above, lead wires can be off in the outside of the housing **81** if the structure is adopted in which the lead wire are led out via one of the four support beams (**81c1** in **FIG. 8**) as shown in **FIG. 8** as a reference diagram. In this case, when setting this fan device in an office machine or the like, it is necessary to secure a gap for drawing this lead wire through at the upper side portion of the fan device on which the lead wire is positioned. This will be a limiting factor to designing the office machine.

[0041] On the contrary, in this embodiment, the lead wire **10** is led out to the corner portion of the end plate **8b3** by using restriction means **9** as shown in **FIG. 2**. Therefore, the groove **8e** for retaining the lead wire **10** can be provided to the end plate **8b3** without enlarging the size thereof. In addition, the lead wire **10** can be retained without being off in the outside of the housing **8**. Furthermore, none of the support beams **8c1-8c4** has a guide groove for the lead wire, so the support beam cannot be an air resistance.

[0042] As described above, the fan device **1** of this embodiment can realize a high efficiency of blowing air by improving accuracy of molding the housing **8** so as to increase the outer diameter of the impeller **2** and because the support beams **8c1-8c4** are not obstacles to blowing air. Furthermore, the lead wire **10** can be led out without increasing resistance to blowing air by enlarging the outer diameter of the housing **8**.

[0043] Note that though one end of each of the support beams **8c1-8c4** is positioned at the middle (the point A) of the neighboring corners, it may be shifted a little from the point A as long as it is substantially the same part at the vicinity of the point A for obtaining the same effect. The housing **8** has a structure in which a pair of end plates **8b2** and **8b3** is provided to both opening ends of the fan outer frame cylinder portion **8b1**. Another structure is possible in which the end plate is positioned at one of them or at the middle part of the fan outer frame cylinder portion **8b1**. As the same difference of the contraction factor is generated, deformation can be hardly generated by adopting the support beams **8c1-8c4** of this embodiment. Though the end plates **8b2** and **8b3** has a square outer rim because the screw holes (through holes **8b5**) are positioned at four corners, the screw holes may be positioned at two or more corners from the viewpoint of attachment and the outer rim is not limited to the square shape. In this case, considering deformation, it is preferable to dispose the support beam away from a vicinity of the screw hole.

[0044] Next, a fan device according to a second embodiment of the present invention will be described mainly about the difference from the first embodiment with reference to **FIG. 4**. **FIG. 4** shows a bottom view of the housing of the fan device according to the second embodiment, and the same reference numerals represent the same parts as in **FIG. 2**.

[0045] The difference between the fan device of this embodiment and the fan device of the first embodiment is the lead wire retaining portion. The lead wire retaining portion **9** in the first embodiment has a structure in which the lead wire retaining recess **9b** is provided to the tip portion of one arm portion **9a**, while a guide portion **29** in this embodiment has a structure in which two arm portions **29a1** and **29a2** protrude from both side ends of the notch **8a2** of the motor support portion **8a** to the fan outer frame portion side. Tip portions of the arm portions **29a1** and **29a2** are linked by a lead wire retaining recess **29b**. The lead wire retaining portion **29** and the rim of the notch **8a2** define the opening **8a2'**. The lead wire retaining recess **29b** is provided with a recess similarly to the first embodiment. The lead wire (not shown) is led out via the lead wire retaining recess **29b1** to the fan outer frame portion in the same way as in the first embodiment. If the printed circuit board is attached to the cylindrical support portion (not shown), connection work of

the lead wire is performed by inserting the lead wire through the opening **8a2'**. If the printed circuit board that is connected to the lead wire with a connector is attached to cylindrical support portion, it is preferable to attach the printed circuit board to the cylindrical support portion before leading out the connector through the opening **8a'**.

[0046] In the fan device according to this embodiment, the lead wire is led out not through the support beams **8c1-8c4** but through the space between the same and the motor support portion **8a**. Furthermore, the fan device of this embodiment has the same feature as the fan device of the first embodiment in that the lead wire retaining portion **29** is positioned at the motor support portion **8a** side. Particularly, as the lead wire retaining recess **29b** is supported by the two arm portions **29a1** and **29a2**, the lead wire retaining portion **29** has a high rigidity and is fixed to the motor support portion **8a** securely. Thus, the housing **8** itself or the completed fan device is resistant to be broken even if a certain obstacle comes into collision with the lead wire retaining portion **29**.

[0047] Next, a fan device according to a third embodiment of the present invention will be described mainly about the difference from the first embodiment with reference to **FIG. 5**. **FIG. 5** shows a bottom view of the housing of the fan device according to the third embodiment, and the same reference numerals represent the same parts as in **FIG. 2**.

[0048] The difference between the fan device of this embodiment and the fan device of the first embodiment is the lead wire retaining portion. The lead wire retaining portion **9** in the first embodiment has a structure in which it is attached to the motor support portion **8a** so as to protrude to the fan outer frame portion side, while a lead wire retaining portion **39** of this embodiment has a structure in which an arm portion **39a** is attached to the fan outer frame portion **8b** so as to protrude to the motor support portion **8a** side. The lead wire retaining recess **39b** is provided so as to bend from the tip portion of the arm portion **39a** to the support beam **8c1** side. A recess is formed in the lead wire retaining recess **39b** and is positioned on a straight line that connects the notch **8b2** and the groove **8e**. The lead wire (not shown) is led out via the lead wire retaining recess **39b** to the fan outer frame portion **8b** similarly to the first embodiment.

[0049] The fan device according to this embodiment has the same feature as the fan device according to the first embodiment in that the lead wire does not pass through the support beams **8c1-8c4** but passes through the space between the same and the motor support portion **8a**.

[0050] Next, a fan device according to a fourth embodiment of the present invention will be described mainly about the difference from the third embodiment with reference to **FIG. 6**. **FIG. 6** shows a bottom view of the housing of the fan device according to the fourth embodiment, and the same reference numerals represent the same parts as in **FIG. 5**.

[0051] The difference between the fan device of this embodiment and the fan device of the third embodiment is the lead wire retaining portion. The lead wire retaining portion **39** of the third embodiment has a structure in which the lead wire retaining recess **39b** is provided to the tip of one arm portion **39a**, while a lead wire retaining portion **49** of this embodiment has a structure in which two arm

portions **49a1** and **49a2** are attached to the fan outer frame portion **8b** so as to protrude to the motor support portion **8a** side. The tip portions of the arm portions **49a1** and **49a2** are linked by a lead wire retaining recess **49b**. Thus, the arm portions **49a1** and **49a2** and the fan outer frame portion **8b** define the opening. The lead wire retaining recess **49b** is provided with a recess similarly to the third embodiment. The lead wire (not shown) is led out via the lead wire retaining recess **49b** to the fan outer frame portion **8b** in the same way as in the third embodiment.

[0052] In the fan device according to this embodiment, the lead wire is led out not through the support beams **8c1-8c4** but through the space between the same and the motor support portion **8a**. The fan device of this embodiment has the same feature as the fan device of the third embodiment in that the lead wire retaining portion **49** is positioned at the fan outer frame portion side. However, especially the two arm portions **49a1** and **49a2** support the lead wire retaining recess **49b**, so the lead wire retaining portion **49** has a high rigidity and is fixed to the motor support portion **8a** securely. Thus, the housing **8** itself or the completed fan device is resistant to be broken even if a certain obstacle comes into collision with the lead wire retaining portion **49**.

[0053] Though preferred embodiments for implementing the fan device according to the present invention are described above, the present invention is not limited to these embodiments and various modifications are possible in the scope or spirit of the present invention.

[0054] For example, though the housing **8** in each embodiment has a structure including end plates **8b2** and **8b3**, it can be only the fan outer frame cylinder portion **8b1** without end plates. In addition, though the four support beams **8c1-8c4** extend in the direction parallel to the outer rims of the end plates **8b2** and **8b3**, it is possible that the end portion at the motor support portion **8a** side is shifted to be inclined to the circumferential direction and is not parallel. In addition, cross sections of arm portions and the lead wire retaining recesses of the lead wire retaining portions **9**, **29**, **39** and **49** are preferably formed to make curved surfaces in order to reduce air resistances of the lead wire retaining portions **9**, **29**, **39** and **49** further. In addition, though each of the lead wire retaining recesses of the lead wire retaining portions **9**, **29**, **39** and **49** is provided with a recess, the shape of the lead wire retaining recess is not limited to a recess if the lead wire **10** does not move to the impeller **2** side. Namely, it is possible to make a structure in which a side wall is provided to one side, a structure having an inclined surface, a structure in which not a recess but a flat surface is provided for increasing contact resistance between the lead wire **10** and the flat surface or a structure in which a fixing member is used for retaining the lead wire **10** between the fixing member and the lead wire retaining recess.

[0055] In addition, though a so-called axial flow fan device, in which air flows in the axial direction of the fan motor **4**, is exemplified in each of the embodiments described above, the present invention can be also applied to a centrifugal type fan device or a cross-flow type fan device.

[0056] The fan device of the present invention can obtain the following effect.

[0057] Namely, as the lead wire passes through not the support beam but the space between the motor support

portion and the fan outer frame portion in the fan device of the present invention, the width of the support beam that had to be wide for including the lead wire retaining portion can be reduced as much as possible within the range sufficient for securing necessary strength. As air resistance of air that flows through this space can be reduced, characteristics of blowing air can be improved. A movement direction of the lead wire is restricted by the lead wire retaining portion, so it does not move to the impeller side and contact the same. The lead wire retaining portion is provided so as to protrude from the motor support portion to the fan outer frame portion side or from the fan outer frame portion to the motor support portion side. The lead wire retaining portion does not have a structure like the support beam that links the motor support portion to the fan outer frame portion, so this lead wire retaining portion does not increase air resistance. Especially, the lead wire retaining portion has smaller air resistance if it is provided to the motor support portion so as to protrude to the fan outer frame portion side because a flow of air that collide the lead wire retaining portion has a small flow velocity.

[0058] In addition, the fan device of the present invention has one arm portion of the lead wire retaining portion, so that the lead wire retaining portion is small, and the lead wire retaining portion is positioned at the motor support portion side where a flow of air has a small flow velocity. Thus, air resistance can be reduced.

[0059] If the lead wire retaining portion has a structure in which two arm portions support the lead wire retaining recess, the lead wire retaining portion can be provided to the motor support portion stiffly. Furthermore, as the lead wire retaining portion is positioned at the motor support portion side where a flow of air has a small flow velocity, air resistance can be reduced.

[0060] When the lead wire retaining portion has a structure in which two arm portions support the lead wire retaining recess, the lead wire retaining portion can be provided to the fan outer frame portion stiffly.

[0061] The fan device of the present invention has good air blowing characteristics in a structure in which a fixing end plate portion is provided to the outer rim of the housing that is made of a synthetic resin by injection molding. Furthermore, as there is little deformation when molding the housing, the space between the same and the impeller can be reduced so that air blowing characteristics can be improved.

[0062] Although the present invention has been fully described by way of example with reference to the accompanying drawings, it is to be understood that various changes and modifications will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention hereinafter defined, they should be construed as being included therein.

What is claimed is:

1. A fan device, comprising:

a fan motor including a rotor portion and a stator portion, the rotor being rotated around a rotation axis of the motor by a power supplied to the stator from an external power source via lead wires;

an impeller fixed to the rotor portion so as to generate an air flow when the motor rotates; and

a housing including a fan outer frame portion, a disk-like motor support portion extending outward in the rotation direction from a substantial center that is on the rotation axis of the motor so as to fix the fan motor, at least three support beams for connecting the motor support portion fixedly to the fan outer frame portion, a lead wire retaining portion for retaining the lead wires, the lead wire retaining portion including an arm portion and a lead wire retaining recess, one end of the arm portion fixed to the motor support portion, the lead wire retaining recess located on the other end of the arm portion, and the lead wires from the fan motor being led out of the fan device via the lead wire retaining portion and the fan outer frame portion.

2. The fan device as set forth in claim 1, wherein the arm portion is made up of at least one support rod.

3. The fan device as set forth in claim 1, wherein a printed circuit board for controlling the fan motor is fixed to the motor support portion, and the lead wires are connected to the printed circuit board and are led out through the lead wire retaining portion and the fan outer frame portion to the outside of the fan device.

4. The fan device as set forth in claim 1, wherein the housing is made up of a material containing a synthetic resin mainly by injection molding.

5. The fan device as set forth in claim 4, wherein the housing has four support beams, the fan outer frame portion comprises a fan outer frame cylinder portion that encloses the fan motor and four fixing end plate portions formed on an outer circumference surface of the fan outer frame cylinder portion so as to make the fan outer frame portion form a square shape in plan view, one end of each of the support beams is linked onto a substantial center of neighboring two corners of the fixing end plate portion.

6. The fan device as set forth in claim 5, wherein the fixing end plate portion of the housing that is positioned in the direction where the lead wire retaining portion extends includes a groove portion for retaining the lead wires, and the lead wires are led out via the groove portion to the outside of the fan device.

7. The fan device as set forth in claim 6, wherein a printed circuit board for controlling the fan motor is fixed to the motor support portion, and the lead wires are connected to the printed circuit board and are led out through the lead wire retaining portion and the groove portion to the outside of the fan device.

8. A fan device, comprising:

a fan motor including a rotor portion and a stator portion, the rotor being rotated around a rotation axis of the motor by a power supplied to the stator from an external power source via lead wires;

an impeller fixed to the rotor portion so as to generate an air flow when the motor rotates; and

a housing including a fan outer frame portion, a disk-like motor support portion extending outward in the rotation direction from a substantial center that is on the rotation axis of the motor so as to fix the fan motor, at least three support beams for connecting the motor support portion fixedly to the fan outer frame portion, a lead wire retaining portion for retaining the lead wires, the lead wire retaining portion including an arm portion and a lead wire retaining recess, one end of the arm portion being fixed to the fan outer frame portion,

the lead wire retaining recess located on the other end of the arm portion, and the lead wire from the fan motor being led out of the fan device via the lead wire retaining portion and the fan outer frame portion.

9. The fan device as set forth in claim 8, wherein the arm portion is made up of at least one support rod.

10. The fan device as set forth in claim 8, wherein a printed circuit board for controlling the fan motor is fixed to the motor support portion, and the lead wires are connected to the printed circuit board and are led out through the lead wire retaining portion and the fan outer frame portion to the outside of the fan device.

11. The fan device as set forth in claim 8, wherein the housing is made up of a material containing a synthetic resin mainly by injection molding.

12. The fan device as set forth in claim 11, wherein the housing has four support beams, the fan outer frame portion comprises a fan outer frame cylinder portion that encloses the fan motor and four fixing end plate portions formed on

an outer circumference surface of the fan outer frame cylinder portion so as to make the fan outer frame portion form a square shape in plan view. One end of each of the support beams is linked onto a substantial center of neighboring two corners of the fixing end plate portion.

13. The fan device as set forth in claim 12, wherein the fixing end plate portion of the housing that is positioned in the direction where the lead wire retaining portion extends includes a groove portion for retaining the lead wires, and the lead wires are led out via the groove portion to the outside of the fan device.

14. The fan device as set forth in claim 13, wherein a printed circuit board for controlling the fan motor is fixed to the motor support portion, and the lead wire is connected to the printed circuit board and is led out through the lead wire retaining portion and the groove portion to the outside of the fan device.

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