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(54) **AXIAL FLOW FAN**

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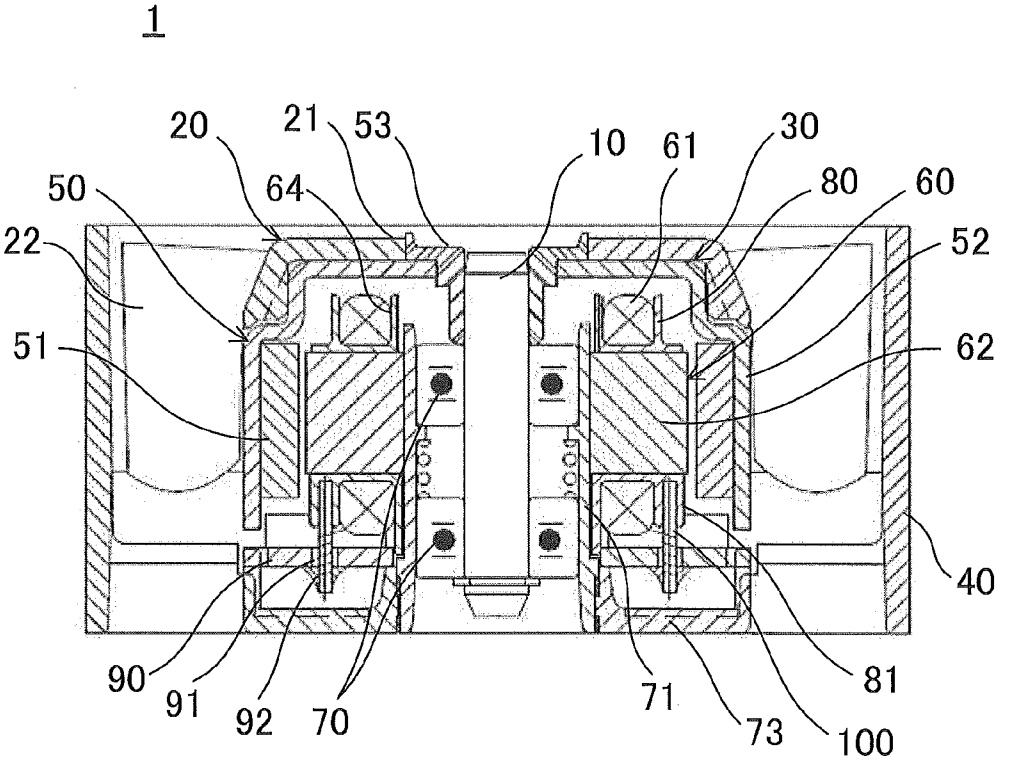
(57) **ABSTRACT**

The present invention provides an axial flow fan having conductive pins, each of which is configured to electrically connect a coil of a stator and a circuit board, and to hold a film conductor of the coil. In the conductive pin, one end is fixed to an electrical insulator covering a core stack of the stator, and the other end is electrically connected to the circuit board. The conductive pin is a quadrangular prism pin as a basic configuration and has, in at least a part of a portion exposed from the electrical insulator, a reduced diameter portion having no corners.



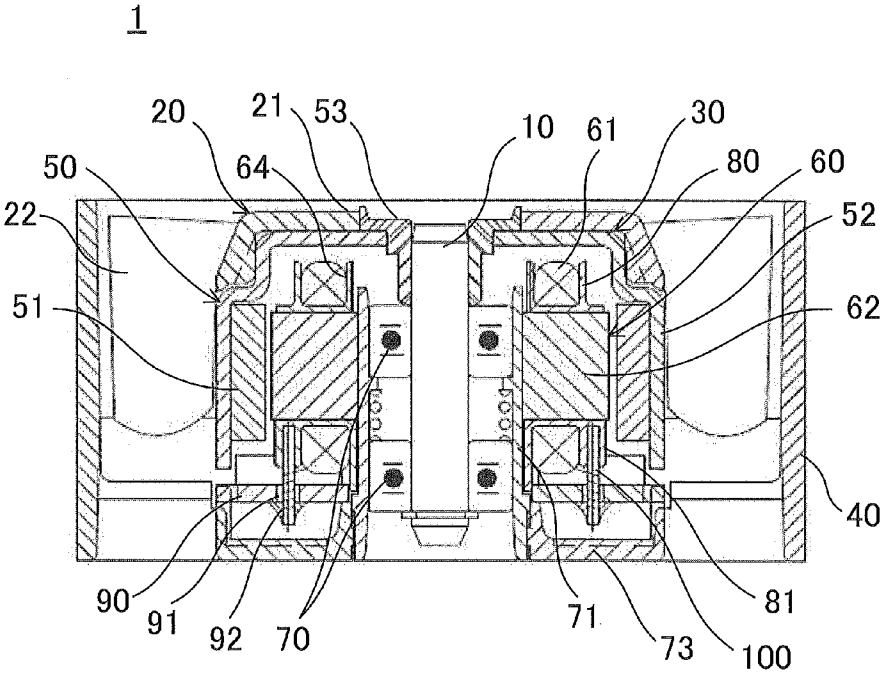


FIG. 1

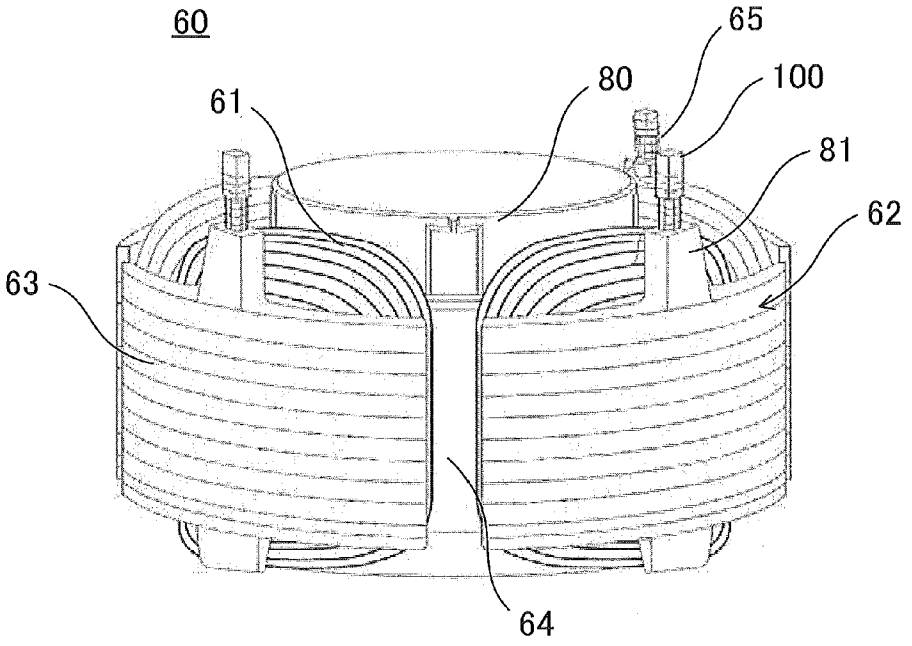


FIG. 2

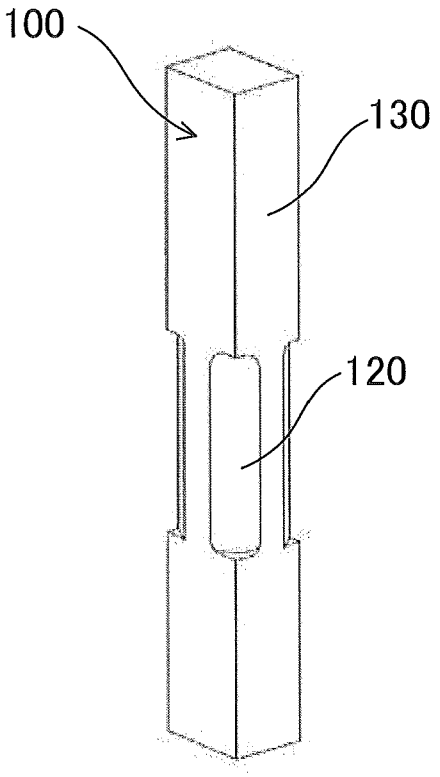


FIG. 3

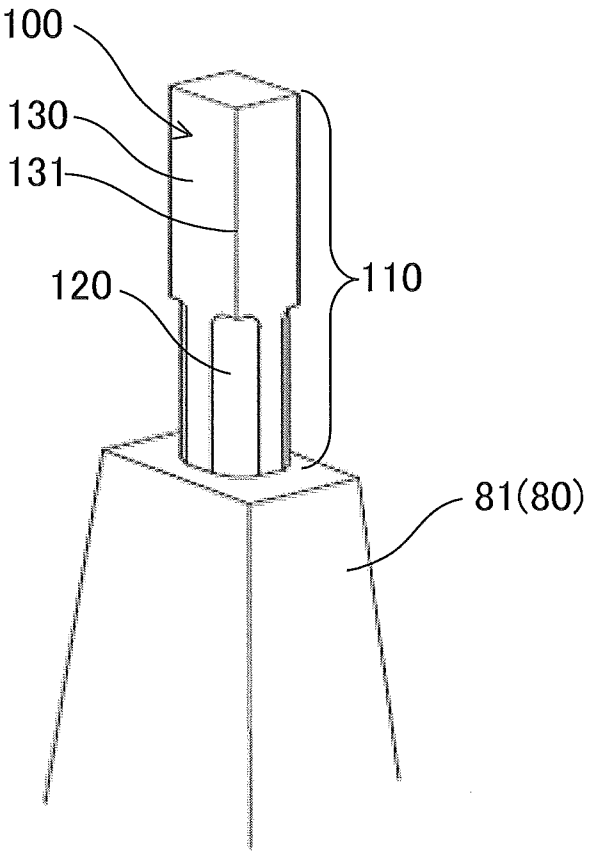


FIG. 4

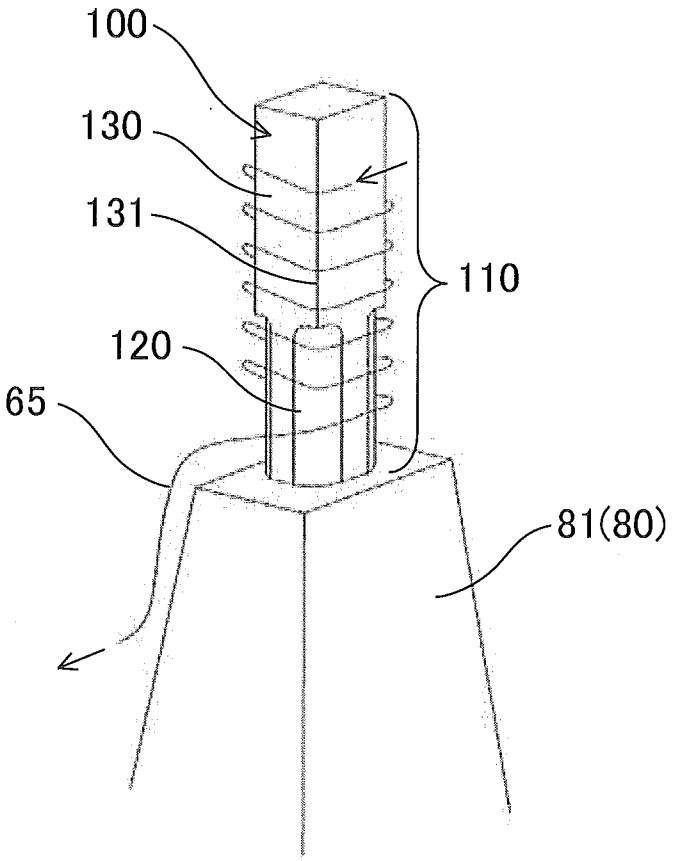


FIG. 5

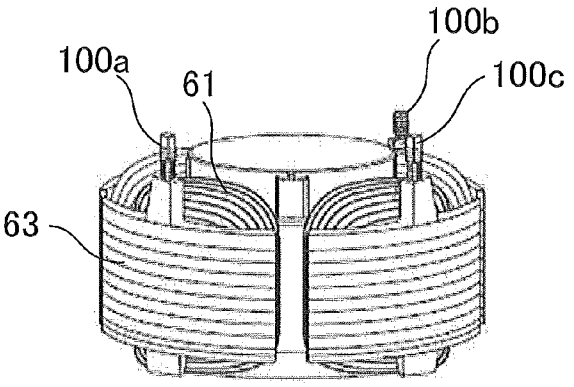


FIG. 6A

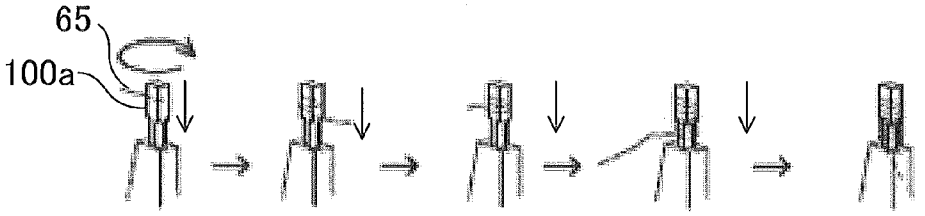


FIG. 6B

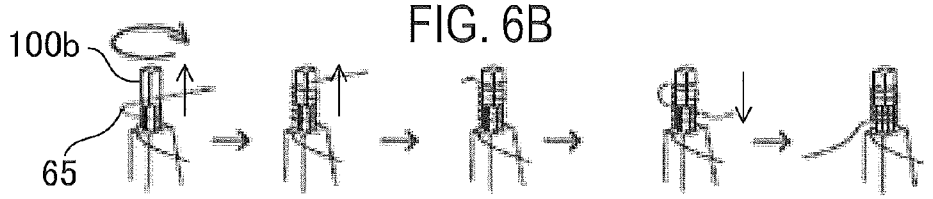


FIG. 6C

FIG. 6D

AXIAL FLOW FAN

BACKGROUND

[0001] 1. Technical Field

[0002] The invention relates to an axial flow fan having conductive pins with an improved structure for electrically connecting a coil and a circuit board as well as holding a film conductor of a coil.

[0003] 2. Description of Related Arts

[0004] In a small axial flow fan such as a cooling fan, an outer rotor type of brushless motor is usually used as a rotation driving device for an impeller. In the outer rotor type of brushless motor, an armature having coils of a plurality of phases is used as a stator, and an exciter having a permanent magnet is provided as a rotor at an outer circumference of the stator.

[0005] A winding start end and a winding finish end of the coil of each phase are electrically connected to a circuit board through a conductive pin fixed to an insulator of a stator core. A jumper wire connecting coils to each other to form the coils of respective phases is held by being wound around the conductive pin.

[0006] As a technique related to an axial flow fan having a conductive pin, there has been disclosed one in which the conductive pin penetrates through and is held by at least one of first and second insulators holding a stator core in between, an end of a coil is electrically connected to one end of the conductive pin, and the other end of the conductive pin is inserted into a hole portion of a circuit board to electrically connect to the circuit board (for example, see Japanese Patent Laid-Open Publication No. 6-253482).

[0007] Further, there has been disclosed an axial flow fan in which front ends of a plurality of teeth are different in length in a circumferential direction and are formed unsymmetrically, and on the shorter side surface of the front end, a terminal holding portion with an implanted terminal pin is disposed in a close contact state. In this axial flow fan, a terminal of a coil is wound around one end of an end terminal, and the other end is electrically connected to a circuit board (for example, see Japanese Patent Laid-Open Publication No. 2011-182612).

SUMMARY

[0008] A conventional axial flow fan has employed a columnar or quadrangular prism-shaped conductive pin.

[0009] Since the columnar conductive pin has no corner, a film conductor wound around the conductive pin is less likely to be broken even if an unexpected load is applied to the conductive pin.

[0010] On the other hand, the frictional force of the columnar conductive pin having no corner is small, and thus a film conductor wound around the conductive pin is easily shifted. Thus, in a wire winding process, the film conductor wound around the conductive pin could not have been held depending on the wire diameter of the film conductor. When the film conductor having been wound up by an automatic winding machine is automatically cut, the film conductor is cut by utilizing the corner of the conductive pin. Therefore, in the columnar conductive pin, the film conductor cannot be automatically cut, and the film conductor should be cut manually.

[0011] Meanwhile, since the quadrangular prism-shaped conductive pin have corners, the film conductor having been wound up by using the automatic winding machine can be automatically cut. Further, the film conductor wound around the conductive pin can be held by the frictional force of the corners of the conductive pin.

[0012] On the other hand, since the quadrangular prism-shaped conductive pin have corners, if an unexpected load is applied to the conductive pin, the film conductor wound around the conductive pin may be broken by the corners of the conductive pin.

[0013] In the techniques of Japanese Patent Laid-Open Publication No. 6-253482 and Japanese Patent Laid-Open Publication No. 2011-182612, the disconnection of the film conductor is prevented by improving a connection structure of the conductive pin (terminal pin) and the film conductor of the coil. However, even if the techniques of Japanese Patent Laid-Open Publication No. 6-253482 and Japanese Patent Laid-Open Publication No. 2011-182612 are applied, failures due to a cross-sectional shape of the conductive pin may still occur.

[0014] The present invention provides an axial flow fan having conductive pins, each of which can reliably hold a film conductor of a coil, is not less likely to be broken even if an unexpected load is applied to the film conductor, and can be used in automatic cutting of the film conductor having been wound up.

[0015] In order to achieve the above object, an axial flow fan according to the present invention is provided with a stator having coils of a plurality of phases and a rotor having a permanent magnet. The axial flow fan has conductive pins, each of which is used for electrically connecting the coil and a circuit board and holding a jumper wire connecting the coils to each other.

[0016] In the conductive pin, one end is fixed to an electrical insulator covering a core stack of the stator, while the other end is electrically connected to the circuit board.

[0017] The conductive pin is a quadrangular prism pin as a basic configuration and has, in at least a part of a portion exposed from the electrical insulator, a reduced diameter portion in which no corners of the quadrangular prism pin exist.

[0018] According to the present invention, the conductive pin is a quadrangular prism pin as a basic configuration and has, in at least a part of a portion exposed from an electrical insulator, a reduced diameter portion in which no corners of the quadrangular prism pin exist . Since no corners of the quadrangular prism pin exist in the reduced diameter portion, the film conductor is less likely to be broken even if an unexpected load is applied to a film conductor of a coil.

[0019] Since the exposed portion other than the reduced diameter portion of the conductive pin has a quadrangular prism shape having corners, the film conductor wound around the conductive pin can be reliably held by the corners. Further, the film conductor having been wound up can be automatically cut by utilizing the corners of the exposed portion other than the reduced diameter portion of the conductive pin.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. **1** is a cross-sectional view of an axial flow fan according to an embodiment of the present invention;

[0021] FIG. **2** is a perspective view of a stator of the embodiment;

[0022] FIG. **3** is a perspective view of a conductive pin of the embodiment;

[0023] FIG. **4** is a perspective view of a state in which the conductive pin of the embodiment is fixed to an electrical insulator;

[0024] FIG. **5** is a perspective view of a state in which a film conductor is wound around the conductive pin of the embodiment;

[0025] FIG. **6**A is a perspective view of a positional relationship of the conductive pins of the embodiment;

[0026] FIG. **6**B is a view provided for explaining how the film conductor is wound around the conductive pin;

[0027] FIG. **6**C is a view provided for explaining how the film conductor is wound around the conductive pin; and

[0028] FIG. **6**D is a view provided for explaining how the film conductor is wound around the conductive pin.

DETAILED DESCRIPTION

[0029] Hereinafter, an axial flow fan according to an embodiment of the present invention will be described with reference to the drawings.

[0030] In the axial flow fan according to the present embodiment, a conductive pin is a quadrangular prism pin as a basic configuration and has, in at least a part of a portion exposed from the electrical insulator, a reduced diameter portion in which no corners of the quadrangular prism pin exist. According to the embodiment, it is possible to realize the axial flow fan having conductive pins, each of which can reliably hold a film conductor of a coil, is not less likely to be broken even if an unexpected load is applied to the film conductor, and can be used in automatic cutting of the film conductor having been wound up. In the embodiment, although the basic shape of the conductive pin is a quadrangular prism having an inner angle of 90°, it may be a triangular prism having an inner angle of less than 90° or a polygonal shape whose at least one corner has an inner angle of not more than 90°. A reduced diameter portion in the embodiment is a portion in which a maximum distance in a diameter direction of the conductive pin, other than the reduced diameter portion, is reduced and has a polygonal shape having an inner diameter more than 90° or a circular shape having no corners.

[0031] [Configuration of Axial Flow Fan]

[0032] A configuration of the axial flow fan according to the present embodiment will be first described with reference to FIGS. **1** to **5**. FIG. **1** is a cross-sectional view of the axial flow fan according to the embodiment. FIG. **2** is a perspective view of a stator of the embodiment.

[0033] As shown in FIG. **1**, an axial flow fan **1** is a blower which sucks air from one end in the axial direction of a rotating shaft **10** by rotation of impellers **20** attached to the rotating shaft **10**, and discharges a fluid to the other end in the axial direction. The axial flow fan **1** has a simple structure and such a feature that although the static pressure is small, the air volume is large. The axial flow fan **1** is used for, for example, a cooling fan of an electronic device such as a server and a personal computer.

[0034] The axial flow fan **1** is provided with the impellers **20** attached to the rotating shaft **10**, a motor **30** as a rotation driving device for the impeller **20**, and a venturi casing (hereinafter referred to as "casing") **40** surrounding the outer circumference in the diameter direction of the impeller **20**.

[0035] The impeller **20** has a cupped hub portion **21** at its central portion. Blades **22** are attached radially and integrally around the hub portion **21**. Each of the blades **22** is inclined with respect to the axial direction of the rotating shaft **10**.

[0036] The motor **30** is provided in the hub portion **21**. The motor **30** is provided with an outer rotor **50** as an exciter having a permanent magnet **51** and an inner stator **60** as an armature around which coils **61** having a plurality of phases are wrapped.

[0037] The rotor **50** includes a rotor yoke **52** having a shape of a two stage cup, the rotating shaft **10** press-fitted into a fitting-in portion **53** at the center of the rotor yoke **52**, and the permanent magnet **51**. The stator **60** includes core stacks **62** and coil **61** stored in slots **64** of the core stacks **62**.

[0038] The rotor yoke **52** is fitted into the hub portion **21**. The permanent magnet **51** is fixed to the inner circumferential surface of the rotor yoke **52** . The rotor yoke **52** has a function of closing magnetic field lines from the exciter and maximizing an electromagnetic induction effect of the permanent magnet **51**. The rotor yoke **52** further has a function of preventing peripheral devices of the motor **30** from being affected by the electric field due to electromagnetic induction.

[0039] As a constituent material of the rotor yoke **52**, an iron-based magnetic material such as an SC material is used; however, the invention is not limited to the exemplified material.

[0040] The rotating shaft **10** is rotatably supported by a bearing **70**. The bearing **70** is fixed to an inner surface of a cylindrical bearing supporting portion **71**. The bearing supporting portion **71** is formed at the center of a base portion **73**.

[0041] A core stack **62** is fixed to an outer surface of the bearing supporting portion **71**. The core stack **62** and the permanent magnet **51** of the rotor yoke **52** face each other with a gap therebetween.

[0042] The core stack **62** is formed by stacking a plurality of cross-ring shaped thin metal plates in a plate thickness direction. As a constituent material of the core stack **62**, a silicon steel plate is preferred in order to realize both the performance and the cost. The metal plates of the core stack **62** are stacked while covering an insulating material such as varnish.

[0043] As shown in FIG. **1** or **2**, teeth portions **63** (see FIG. **2**) as protrusions used for wrapping the coil **61** therearound are formed in the core stack **62**. The slot **64** as a convex used for storing the coils **61** is formed between the teeth portions **63** by partitioning the teeth portions **63**. The teeth portions **63** and the slot **64** are evenly arranged along the circumferential direction of the core stack **62**.

[0044] In the embodiment, in order to form coil groups having two phases, the teeth portions **63** and the slots **64** respectively provided at four portions are formed in the circumferential direction of the core stacks **62**; however, the number of the phases of the coil **61** and each number of the teeth portions **63** and the slots **64** are not limited.

[0045] The inside of each of the slots **64** is covered with an electrical insulator **80**. Namely, the periphery of the coil **61** wrapped around the teeth portions **63** is covered with the electrical insulator **80**. As the electrical insulator **80**, a synthetic resin is employed, for example.

[0046] A circuit board **90** is supported on the base portion **73** (see FIG. **1**). A wiring pattern used for controlling the axial flow fan **1** is formed on the circuit board **90**.

[0047] Conductive pins **100** are fixed to the electrical insulator **80** around the coils **61**. A portion of the electrical insulator **80** corresponding to the teeth portion is provided with a pin fixing portion **81** used for fixing the conductive pin **100**. The pin fixing portion **81** is raised toward outside in the axial direction. Although the pin fixing portions **81** of the embodi-

ment are provided at three portions of the electrical insulator **80** corresponding to the teeth portions, the invention is not limited thereto.

[0048] [Structure of Conductive Pin]

[0049] Next, a structure of the conductive pin of the present embodiment will be described with reference to FIGS. **1** to **5**. FIG. **3** is a perspective view of the conductive pin of the embodiment. FIG. **4** is a perspective view of a state in which the conductive pin of the embodiment is fixed to the electrical insulator. FIG. **5** is a perspective view of a state in which the film conductor is wound around the conductive pin of the embodiment.

[0050] As shown in FIGS. **1** and **2**, one end of the conductive pin **100** is fixed to the pin fixing portion **81** of the electrical insulator **80**. As shown in FIG. **1**, the other end of the conductive pin **100** is inserted into a through-hole **91** of the circuit board **90** and electrically connected to the circuit board **90** by soldering **92**, or the like.

[0051] As a constituent material of the conductive pin **100**, a metal material having an excellent conductivity, such as copper, is used.

[0052] As shown in FIG. **3**, the conductive pin **100** is a quadrangular prism pin as a basic configuration. The conductive pin **100** has, in at least a portion in the axial direction, a reduced diameter portion **120** in which no corners of the quadrangular prism pin exist. Namely, although the conductive pin **100** of the embodiment has, in an intermediate potion in the axial direction, the reduced diameter portion **120** in which the corners of the quadrangular prism pin are chipped off, the present invention is not limited thereto. The conductive pin **100** may have the reduced diameter portion **120** in a multistage fashion.

[0053] The reduced diameter portion **120** of the embodiment is formed by mechanically crushing the corners of the quadrangular prism conductive pin **100** with a tool such as a caulking machine. A method of the reduced diameter portion **120** formation in which the corners are chipped off not limited, and although the reduced diameter portion **120** may be formed by using other means such as cutting, the crushing processing is simple.

[0054] As shown in FIG. **4**, one end of the conductive pin **100** is fixed by being embedded in the pin fixing portion **81** of the electrical insulator **80**. While the conductive pin **100** is fixed to the electrical insulator **80**, the conductive pin **100** is provided along the axial direction of the rotating shaft **10** (see FIG. **1**).

[0055] The reduced diameter portion **120** having no corners of the conductive pin **100** is disposed in at least a part of a portion **110** exposed from the pin fixing portion **81** of the electrical insulator **80**. The reduced diameter portion **120** of the embodiment is positioned at a base end (root) of the portion **110** exposed from the electrical insulator **80**.

[0056] Since the reduced diameter portion **120** is positioned at the base end of the exposed portion **110** of the conductive pin **100**, all the embedding sides of the conductive pin **100** may be formed by the reduced diameter portions **120**. In order to prevent the conductive pin **100** from being slipped off from the electrical insulator **80**, it is preferable that the reduced diameter portion **120** is formed at the intermediate portion of the conductive pin **100**, as shown in FIG. **3**.

[0057] As shown in FIGS . **2** and **5**, the film conductor **65** of the coil **61** is held by being wound around the other end of the conductive pin **100**. Winding of the film conductor **65** of the coil **61** is started from an exposed portion, other than the reduced diameter portion of the exposed portion **110** of the conductive pin **100**, and finished at the reduced diameter portion **120** on the base end side. Alternatively, winding of the film conductor **65** of the coil **61** is started from the reduced diameter portion **120** on the base end side of the conductive pin **100** and finished at a portion **130** other than the reduced diameter portion on the front end side.

[0058] As the film conductor **65** of the coil **61**, a coated copper wire such as an enamel wire is used, for example.

[0059] As shown in FIGS. **1** and **5**, the conductive pin **100** is inserted into the through-hole **91** of the circuit board **90** in such a state that the film conductor **65** of the coil **61** is wound around the conductive pin **100** concerned, and the conductive pin **100** is electrically connected by the soldering **92**, or the like.

[0060] [Operation of Axial Flow Fan]

[0061] Next, the operation of the axial flow fan **1** according to the present embodiment will be described with reference to FIGS. **1** and **6**A to **6**D.

[0062] As shown in FIGS . **1** and **2**, in the axial flow fan **1** according to the embodiment, the winding start end and the winding finish end of the film conductor **65** of the coil **61** of each phase are wound around the exposed portion **110** of the conductive pin **100** fixed to the electrical insulator **80**. The conductive pin **100** around which the film conductor **65** is wound is inserted into the through-hole **91** of the circuit board **90**, and is electrically connected by the soldering **92**, or the like.

[0063] A transition portion of the film conductor **65** connecting the coils to each other to form the coils **61** of respective phases is held by being wound around the conductive pin **100** in the same manner as above.

[0064] As shown in FIG. **5**, the film conductor **65** is held by being wound around the exposed portion **110** of the conductive pin **100**. More specifically, the winding of the film conductor **65** is started from the portion **130** other than the reduced diameter portion on the front end side in the exposed portion **110** of the conductive pin **100** and finished at the reduced diameter portion **120** on the base end side. Alternatively, the winding of the film conductor **65** is started from the reduced diameter portion **120** on the base end side in the exposed portion **110** of the conductive pin **100** and finished at the portion **130** other than the reduced diameter portion on the front end side. Even when the film conductor **65** is wound in any one of the above procedures, both the property of the portion **130**, having corners **131**, other than the reduced diameter portion and the property of the reduced diameter portion **120** in which no corners **131** exist can be received.

[0065] Next, the procedure for winding the coil in the embodiment will be described with reference to FIGS. **6**A to **6**D. FIG. **6**A is a perspective view of a positional relationship of the conductive pins of the embodiment, and FIGS. **6**B to **6**D are views provided for explaining how the film conductor is wound around the conductive pin.

As shown in FIG. **6**B, the film conductor **65** is wound from the front end portion of a conductive pin **100***a* toward the base end side. The winding start portion of the film conductor **65** is the portion **130** other than the reduced diameter portion, and there are the corners **131** (see FIG. **4**).

[0066] Once the winding of the film conductor **65** is wound up to the reduced diameter portion **120** on the base end side of the conductive pin **100***a*, the film conductor **65** is wrapped around a teeth portion **63** of the core stack **62** to form the coil **61**. In the reduced diameter portion **120** in which no corners

131 exist, the winding of the film conductor **65** is finished (see FIG. **4**), so that the film conductor **65** is laid to the teeth portion **63**.

[0067] Once wrapping of the coil **61** around the teeth portions **63** of one or two portions is finished, the film conductor **65** is wound around the next conductive pin **100***b*, as shown in FIG. **6**C. The winding start position, where the film conductor **65** laid from the teeth portion **63** in a preceding process is started to be wound around the conductive pin **100***b*, is the reduced diameter portion **120**.

[0068] Upon completion of winding of the film conductor **65** up to the front end side of the conductive pin **100***b*, the film conductor **65** is wound up to the base end of the conductive pin **100***b* again. The film conductor **65** wound up to the base end side of the conductive pin **100***b* is laid to the next teeth portion **63** to form the coil **61**.

[0069] Upon completion of the formation of the coils **61** in all the teeth portions **63**, the film conductor **65** is wound around a conductive pin **100***c*, as shown in FIG. **6**D. The film conductor **65** is moved from the base end side of the conductive pin **100***c* to the front end side and wound up to the front end, and the winding process is terminated. Since a transition portion from the teeth portion **63** in a preceding process as the winding start of the film conductor **65** is the reduced diameter portion **120** having no corners **131**, and the front end as the winding finish of the film conductor **65** is the portion **130**, having the corners **131**, other than the reduced diameter portion (see FIG. **4**).

[0070] According to the embodiment, as shown in FIGS. **3** and **4**, the conductive pin **100** is in a quadrangular prism shape as a basic configuration. The conductive pin **100** has, in at least a portion of the exposed portion **110** exposed from the electrical insulator **80** of the conductive pin **100**, the reduced diameter portion **120** where no corners of the quadrangular prism exist.

[0071] Namely, the reduced diameter portion **120** is processed so that the corners are eliminated by crushing, for example. Since the reduced diameter portion **120** has no corners, even if an unexpected load is applied to the film conductor **65** of the coil **61**, the film conductor **65** wound around the conductive pin **100** is less likely to be broken.

[0072] The portion **130** other than the reduced diameter portion of the exposed portion **110** of the conductive pin **100** has a quadrangular prism shape having the corners **131**. Accordingly, the film conductor **65** wound around the conductive pin **100** can be reliably held by the corners **131** of the portion **130** other than the reduced diameter portion.

[0073] The reduced diameter portion **120** is positioned at the base end (root) of the exposed portion **110** of the conductive pin **100**. Accordingly, the film conductor **65** wound around the reduced diameter portion **120** of the exposed portion **110** is prevented from being shifted from the reduced diameter portion **120** to come out, because the portion **130** on the front end side other than the reduced diameter portion is enlarged to be larger than the reduced diameter portion **120**.

[0074] By virtue of the use of the corners **131** of the portion **130** other than the reduced diameter portion of the exposed portion **110** of the conductive pin **100**, the film conductor **65** having been wound up can be automatically cut by using an automatic winding machine.

[0075] Hereinbefore, although the preferred embodiment of the present invention has been described, the embodiment is an example for the purpose of describing the invention, and it is not intended to limit the scope of the invention to only the above embodiment. That is, the invention can be practiced in various aspects different from the above embodiment without departing from the gist of the invention.

What is claimed is:

1. An axial flow fan comprising:

a stator having coils of a plurality of phases;

a rotor having a permanent magnet; and

conductive pins each of which is configured to electrically connect the coil and a circuit board and hold a film conductor of the coil,

wherein, in the conductive pin, one end is fixed to an electrical insulator covering a core stack of the stator, and the other end is electrically connected to the circuit board, and

the conductive pin is a prismatic pin as a basic configuration and has, in at least a part of a portion exposed from the electrical insulator, a reduced diameter portion in which no corners of the prismatic pin exist.

2. The axial flow fan according to claim **1**, wherein the reduced diameter portion is a portion in which a maximum distance in a diameter direction of the conductive pin other than the reduced diameter portion is reduced.

3. The axial flow fan according to claim **2**,

wherein the reduced diameter portion has a polygonal shape having an inner diameter more than 90° or a circular shape having no corners.

4. The axial flow fan according to claim **1**,

wherein the prismatic pin is in a quadrangular prism shape or a triangular prism shape.

5. The axial flow fan according to claim **1**,

wherein the reduced diameter portion is positioned at a base end of the exposed portion in such a state that the conductive pin is fixed to the electrical insulator.

6. The axial flow fan according to claim **1**,

wherein the film conductor is held by being wound around the exposed portion of the conductive pin, and

winding of the film conductor is started from a portion other than the reduced diameter portion of the exposed portion and finished at the reduced diameter portion, or alternatively, the winding of the film conductor is started from the reduced diameter portion of the exposed portion and finished at a portion other than the reduced diameter portion.

* * * * *