

DESCRIPTION

ELECTRIC MOTOR

5 TECHNICAL FIELD

[0001]

The present invention relates to an electric motor, and more particularly to an electric motor provided with insulators attached to a stator core with the stator core sandwiched from top and bottom in an axial direction.

10

BACKGROUND ART

[0002]

Conventionally, an electric motor of such a type employs a method for winding two-phase windings in a concentric fashion by performing an appropriate insulation process to an integrated stator core (see, for example, Patent Literature 1). This electric motor will be described with reference to FIGS. 11 to 14.

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[0003]

FIG. 11 is a plan view illustrating a stator core of a conventional electric motor. FIG. 12 is a plan view of the stator, around which a winding is wound, in the conventional electric motor. FIG. 13 is a perspective view of a segmented insulator of the conventional electric motor. FIG. 14 is a plan view illustrating a circumferential joint portion of the segmented insulator in the conventional electric motor. As illustrated in FIG. 11, stator core 100 has, on its center, hole 101 for holding a hollow shaft. Stator core 100 has, in the vicinity of the outer circumference thereof, a plurality of first tooth sections 102 and second tooth section 103 bifurcated and extending from first tooth sections

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102 in the outer circumferential direction. First tooth sections 102 and second tooth sections 103 form first slots 104 and second slots 105. As illustrated in FIG. 12, A-phase winding 109 is wound in first slots 104, and B-phase winding 110 is wound in second slots 105.

5 [0004]

In winding A-phase winding 109 and B-phase winding 110, the windings and stator core 100 need to be electrically insulated from each other. For this end, two types of insulators 111, 112 illustrated in FIG. 13 are attached to stator core 100 so as to sandwich stator core 100 in the axial direction.

10 [0005]

Insulators 111, 112 are formed of an insulating resin material, for example. As illustrated in FIG. 14, insulator 111 is a segmented insulator formed by combining a plurality of parts which can be segmented by first slot 104. Insulators 111, 112 are attached to stator core 100 in the axial direction, and first slots 104 and second slots 105 are overlapped with each other inside.

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Citation List

Patent Literature

[0006]

PTL 1: Unexamined Japanese Patent Publication No. 2009-71913

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SUMMARY OF THE INVENTION

[0007]

However, the conventional electric motor has problems described below.

[0008]

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In the segmented insulator, the upper and lower insulators are overlapped with each other on the inner wall parts of the slots in the direction of the rotary shaft in order to ensure spatial insulation distance between the

wound windings and the stator core. In addition, circumferentially adjacent joint portions of the insulators need to be overlapped with each other by a predetermined size.

[0009]

5 As illustrated in FIG. 14, the insulator has structure 123 in which the insulators are overlapped in the circumferential direction on the inner wall part of first slot 104. Therefore, the thickness of the resin on the inner wall part of the slot is increased, resulting in that the area of the slot on which the winding is to be wound is decreased. Accordingly, the length of the winding to
10 be wound may be increased. This results in an increase in electric resistance of the winding, and therefore, the efficiency of the electric motor is deteriorated. In addition, the number of components is increased, which may entail an increase in assembly man-hours.

[0010]

15 To address this problem, a method is considered in which a pair of upper and lower insulators is molded into a torus, and they are overlapped with each other. However, in inserting the insulator into slots, the insulator needs to be simultaneously inserted into the slots throughout the entire circumference, due to the toric shape thereof. Therefore, it is extremely
20 difficult to position the insulator with respect to the stator core upon the insertion, resulting in that a work for inserting and fitting the insulator cannot be performed in a sufficiently quick and efficient manner.

[0011]

25 The present invention is accomplished to solve the foregoing conventional problem. The present invention aims to provide an electric motor that can enhance inserting workability and fitting workability of an insulator, while sufficiently ensuring insulation property, and that can

implement power saving and reduction in production cost.

[0012]

The electric motor according to the present invention includes a stator core provided with a slot having a winding wound, and a rotor mounted to be
5 rotatable and disposed opposite a side face of the stator core. In addition, the stator core includes two insulators attached to the stator core with the stator core sandwiched from top and bottom in the axial direction of a rotary shaft of the electric motor. In addition, each of the insulators has a base section formed of a surface orthogonal to the rotary shaft, a substantially cylindrical
10 wall section extending in the axial direction from the base section so as to cover a wall surface of the slot, and a protrusion protruding in the axial direction on a portion of an axial end of the wall section.

[0013]

The electric motor according to the present invention facilitates
15 insertion of the insulator into the stator core. Consequently, occurrence of damage on the insulator can be prevented, whereby quality can be enhanced. Thus, assembling workability is improved.

BRIEF DESCRIPTION OF DRAWINGS

20 [0014]

FIG. 1 is a view illustrating an entire configuration of an electric motor according to a first exemplary embodiment of the present invention.

FIG. 2 is a partially cutaway sectional view illustrating a stator in the electric motor according to the first exemplary embodiment of the present
25 invention.

FIG. 3 is an exploded perspective view illustrating the stator in the electric motor according to the first exemplary embodiment of the present

invention.

FIG. 4 is a perspective view of insulator A in the electric motor according to the first exemplary embodiment of the present invention as viewed from a stator core side.

5 FIG. 5 is a partial perspective view of insulator A in the electric motor according to the first exemplary embodiment of the present invention as viewed from the stator core side.

FIG. 6 is a perspective view of insulator B in the electric motor according to the first exemplary embodiment of the present invention as viewed
10 from the stator core side.

FIG. 7 is a partial perspective view of insulator B in the electric motor according to the first exemplary embodiment of the present invention as viewed from the stator core side.

FIG. 8A is a perspective view illustrating an engagement of insulator A
15 of the electric motor in the first exemplary embodiment of the present invention.

FIG. 8B is a perspective view illustrating an engagement of insulator B of the electric motor in the first exemplary embodiment of the present invention.

20 FIG. 8C is a perspective view illustrating an engagement of insulator A and insulator B of the electric motor in the first exemplary embodiment of the present invention.

FIG. 9 is a partial perspective view of insulator A in an electric motor according to a second exemplary embodiment of the present invention as
25 viewed from a stator core side.

FIG. 10 is a partial perspective view of insulator B in the electric motor according to the second exemplary embodiment of the present invention as

viewed from the stator core side.

FIG. 11 is a plan view illustrating a stator core of a conventional electric motor.

FIG. 12 is a plan view of the stator, around which a winding is wound,
5 in the conventional electric motor.

FIG. 13 is a perspective view of a segmented insulator of the conventional electric motor.

FIG. 14 is a plan view illustrating a circumferential joint portion of the segmented insulator in the conventional electric motor.

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DESCRIPTION OF EMBODIMENTS

[0015]

Exemplary embodiments of the present invention will be described below with reference to the drawings. Note that the exemplary embodiments
15 described below are one example for embodying the present invention, and do not restrict the technical scope of the present invention. Throughout all drawings, the same components are identified by the same reference marks and the description therefor will be omitted. In each drawing, the detailed description of components which do not directly relate to the present invention
20 will be omitted.

[0016]

(FIRST EXEMPLARY EMBODIMENT)

FIG. 1 is a view illustrating an entire configuration of electric motor 1 according to the first exemplary embodiment of the present invention.
25 Electric motor 1 is an external rotor-type brushless DC motor used as a drive source for an electric fan which is called a ceiling fan and mounted on a ceiling, for example.

[0017]

As illustrated in FIG. 1, electric motor 1 includes stator 20, rotor yoke 8, and rotor cover 10.

[0018]

5 Stator 20 has a hollow cylindrical shape provided with stator core 3, insulator 4, and windings 5. That is, stator 20 is covered by a plurality of stator cores 3 on the outer circumference thereof. Winding 5 is wound around each of stator cores 3 through a pair of upper and lower insulators 4, that is, insulator A (first insulator) 4a and insulator B (second insulator) 4b. Insulator
10 4 generates a magnetic field when winding 5 is conducted. Hollow shaft 2 is fixed to the center part of stator cores 3.

[0019]

 An inner race of bearing 7a is fixed to be rotatable with respect to hollow shaft 2 on an axially upper side of hollow shaft 2 (upper side in FIG. 1).
15 An inner race of bearing 7b is fixed to hollow shaft 2 on an axially lower side (lower side in FIG. 1), which is the opposite side of bearing 7a across stator 20, so as to be rotatable with respect to hollow shaft 2.

[0020]

 Position detection element 6 that is provided on an inner
20 circumferential surface of rotor yoke 8 for detecting a magnetic flux of later-described magnet 9 is fixed on the outer circumference of stator 20.

[0021]

 Rotor yoke 8 has a cylindrical shape having a top surface, wherein an upper shaft opening through which hollow shaft 2 penetrates is formed on the
25 center of the top surface. The diameter of the cylinder is decreased between the bottom surface which is an opening section and the top surface, by which stepped section 12 is formed. Notably, rotor yoke 8 has, on an inner

circumferential surface thereof, a plurality of magnets 9 mounted on the side face of the cylinder in the circumferential direction with a predetermined space therebetween.

[0022]

5 Rotor cover 10 has substantially a circular shape larger than the opening on the bottom surface of rotor yoke 8, and a lower shaft opening through which hollow shaft 2 penetrates is formed on the center of the circular shape.

[0023]

10 Upon assembly, an outer race of bearing 7a is fixed on the inner circumferential surface of rotor yoke 8, and an outer race of bearing 7b is fixed on rotor cover 10. With this state, an upper part of hollow shaft 2 penetrates through the upper shaft opening, and a lower part of hollow shaft 2 penetrates through the lower shaft opening. Magnets 9 disposed on the inner
15 circumferential surface of rotor yoke 8 face the outer circumferential curved surfaces of stator cores 3 composing stator 20, that is, the opposed surfaces. Specifically, electric motor 1 is configured such that stator 20 is fixed while being enclosed by rotor yoke 8 and rotor cover 10.

[0024]

20 In electric motor 1, when controlled current flows through windings 5, rotor yoke 8 and rotor cover 10 integrally rotate around rotary shaft 2 as a center axis. That is, rotor yoke 8 and rotor cover 10 form a rotor.

[0025]

FIG. 2 is a partially cutaway sectional view illustrating stator 20 in
25 electric motor 1 according to the first exemplary embodiment of the present invention. In FIG. 2, an upper-left quarter chart is a sectional view illustrating the state before windings 5 are wound, a lower-left quarter chart is

a view of an appearance before windings 5 are wound, and a right half chart is a view of an appearance when windings 5 are wound. FIG. 3 is an exploded perspective view illustrating stator 20 in electric motor 1 according to the first exemplary embodiment of the present invention.

5 [0026]

Stator cores 3 are formed by laminating a plurality of magnetic steel sheets in the axial direction. Center hole 21 into which hollow shaft 2 is press fitted to be held is formed on a central part of stator cores 3. Tooth sections 22 around which windings 5 are wound are radially located on the outer
10 circumferential side of center hole 21 at equal spaces. In addition, slot 23 which is a space for winding windings 5 is formed by adjacent tooth sections 22.
[0027]

As illustrated in FIG. 3, toric insulator A 4a and insulator B 4b are mounted to sandwich stator cores 3 from both sides in the axial direction of
15 stator cores 3. The electrical insulation between stator cores 3 and the respective windings is implemented by interposing therebetween insulator A 4a and insulator B 4b which are synthetic resin moldings.

[0028]

Next, the structure of insulator 4 will be described with reference to
20 FIGS. 4 to 7.

[0029]

FIG. 4 is a perspective view of insulator A (first insulator) 4a in electric motor 1 according to the first exemplary embodiment of the present invention as viewed from stator core 3 side. Insulator A 4a is integrally molded by using
25 synthetic resin. Insulator A 4a has toric base section 31 which is in contact with the lower surfaces (or may be upper surfaces) of stator cores 3 and substantially cylindrical first wall sections 32 extending from base section 31 in

the direction of the rotary shaft to cover the wall surfaces of slots 23. The wall surface of each slot 23 is an outer circumference of tooth section 22, and it is an outer circumferential surface parallel to the rotary shaft and the inner circumferential wall surface of slot 23. When insulator A 4a is disposed on slots 23, the outer circumferences of first wall sections 32 are in contact with the inner circumferential wall surfaces of slots 23.

[0030]

Note that each first wall section 32 is provided with an opening (slit) into which winding 5 is wound on the position corresponding to the outer circumferential side of stator 20. The opening (slit) is formed by cutting a portion of the cylinder in the axial direction.

[0031]

In addition, FIG. 5 is a partial perspective view of insulator A 4a in electric motor 1 according to the first exemplary embodiment of the present invention as viewed from stator core 3 side. First wall section 32 has protrusion 33 protruding in the axial direction on the innermost side in the radial direction. In addition, axial ends of first wall section 32 are provided with tilt sections 34a, 34b, 34c, 34d having a predetermined angle only on portions where the circumferential direction and the radial direction intersect each other.

[0032]

Slot 23 is formed from a surface along the radial direction and a surface along the circumferential direction. First wall section 32 has tilt sections 34a, 34b, 34c, 34d, which are not parallel to the surface of base section 31, on corner portions corresponding to corners formed by the surface along the radial direction and the surface along the circumferential direction. In other words, first wall section 32 has tilt sections 34a, 34b, 34c, 34d having predetermined

angle α (α_1 , α_2) with respect to base section 31 on the corner portions. Tilt sections 34a, 34b, 34c, 34d have a tilt gradually ascending toward protrusion 33 from the outer circumference of stator 20. That is, tilt angle α_1 on tilt sections 34b, 34d on the outer circumferential side with respect to base section 31 is
5 smaller than tilt angle α_2 on tilt sections 34a, 34c on the inner circumferential side with respect to base section 31. Due to this tilt structure, the height of first wall section 32 from base section 31 is increased toward both sides of protrusion 33 from the outer circumference of stator 20.

[0033]

10 FIG. 6 is a perspective view of insulator B (second insulator) 4b in electric motor 1 according to the first exemplary embodiment of the present invention as viewed from stator core 3 side. Insulator B 4b is integrally molded by using synthetic resin. Insulator B 4b has toric base section 41 which is in contact with the upper surfaces (or may be lower surfaces) of stator
15 cores 3 and substantially cylindrical second wall sections 42 extending from base section 41 in the direction of the rotary shaft to cover the wall surfaces of slots 23. Note that each second wall section 42 is provided with an opening (slit) into which winding 5 is wound on the position corresponding to the outer circumferential side of stator 20. The opening (slit) is formed by cutting a
20 portion of the cylinder in the axial direction.

[0034]

FIG. 7 is a partial perspective view of insulator B 4b in electric motor 1 according to the first exemplary embodiment of the present invention as viewed from stator core 3 side. Second wall section 42 has protrusion 43 protruding in
25 the axial direction on the innermost side in the radial direction. In addition, axial ends of second wall section 42 are provided with tilt sections 44a, 44b, 44c, 44d having a predetermined angle only on corner portions where the

circumferential direction and the radial direction intersect each other, as in first wall section 32 in insulator A 4a. In other words, second wall section 42 has tilt sections 44a, 44b, 44c, 44d having predetermined angle β (β_1 , β_2) with respect to base section 41 on the corner portions. Tilt sections 44a, 44b, 44c, 5 44d have a tilt gradually ascending toward protrusion 43 from the outer circumference of stator 20. That is, tilt angle β_1 on tilt sections 44b, 44d on the outer circumferential side with respect to base section 41 is smaller than tilt angle β_2 on tilt sections 44a, 44c on the inner circumferential side with respect to base section 41. Due to this tilt structure, the height of second wall section 42 from base section 41 is increased toward both sides of protrusion 43 from the outer circumference of stator 20.

[0035]

In addition, second wall section 42 on insulator B 4b has first projecting section 42a on a joint portion between second wall section 42 and toric base section 41, first projecting section 42a being in contact with the wall surface of slot 23 and extending from toric base section 41 by a predetermined size in the direction of the rotary shaft. In other words, first projecting section 42a can be referred to as a section formed by increasing the thickness of second wall section 42. First projecting section 42a is formed throughout the entire circumference of second wall section 42 except for the cutout portion.

[0036]

FIG. 8A is perspective view illustrating the engagement of insulator A 4a of electric motor 1 in the first exemplary embodiment of the present invention. FIG. 8B is a perspective view illustrating the engagement of insulator B 4b of electric motor 1. FIG. 8C is a perspective view illustrating the engagement of insulator A 4a and insulator B 4b of electric motor 1. In these drawings, windings 5 are not illustrated. Insulator A 4a and insulator B

4b are attached to stator cores 3 from the direction of the rotary shaft.

[0037]

Firstly, the attachment of insulator A 4a will be described. Insulator A 4a is positioned with respect to stator cores 3 in such a way that protrusions 33 protruding on the axial ends of first wall sections 32 on the innermost side in the radial direction are in contact with stator cores 3. Following the insertion of protrusions 33, the circumferential surfaces of first wall sections 32 on which protrusions 33 are provided are inserted. Following the insertion of the circumferential surfaces, the surfaces along the radial direction are inserted. At that time, tilt section 34a is formed on the end of each first wall section 32, whereby the portion where the circumferential surface and the radial surface intersect each other is smoothly inserted from the circumferential wall section which has already been inserted. In addition, on the tip of tooth section 22 on the outer circumferential side, the smooth insertion of the circumferential surface from the radial surface is similarly implemented by tilt section 34b on the portion where the circumferential surface and the radial surface intersect each other.

[0038]

Next, the attachment of insulator B 4b will be described. Insulator B 4b is positioned with respect to stator cores 3 in such a way that protrusions 43 protruding on the axial ends of the wall sections on the innermost side in the radial direction are in contact with stator cores 3. As in insulator A 4a, insulator B 4b is smoothly attached. Specifically, following the insertion of protrusions 43 on second wall sections 42, the circumferential surfaces on which protrusions 43 are provided are inserted. Following the insertion of the circumferential surfaces, the surfaces along the radial direction are inserted. At that time, tilt section 44a is formed on the end of each second wall section 42,

whereby the portion where the circumferential surface and the radial surface intersect each other is smoothly inserted from the circumferential surface which has already been inserted. In addition, on the tip of tooth section 22 on the outer circumferential side, the smooth insertion of the circumferential surface from the radial surface is similarly implemented by tilt section 44b on the portion where the circumferential surface and the radial surface intersect each other.

[0039]

After the attachment, first projection sections 42a provided on insulator B 4b are in contact with the wall surfaces of slots 23. First wall sections 32 provided on insulator A 4a are located between second wall sections 42 provided on insulator B 4b and stator core 3. That is, insulator A 4a and insulator B 4b are overlapped with each other throughout the entire circumference except for the cutout portions.

[0040]

As described above, according to electric motor 1 in the first exemplary embodiment of the present invention, the wall section protruding on the axial end of each wall section on the innermost side in the radial direction positions insulator 4 and stator cores 3 with respect to each other. Further, the portion on the axial end of the wall section where the circumferential direction and the radial direction intersect each other has a tilt with a predetermined angle, whereby the insulator is sequentially inserted from the inner side in the radial direction. Thus, insertion is facilitated. Accordingly, occurrence of damage on insulator 4 can be prevented, and thus, quality can be enhanced. Consequently, assembling workability is improved.

[0041]

In addition, spatial insulation distance between winding 5 wound on

slot 23 and stator core 3 can be ensured, whereby insulating property can sufficiently be achieved.

[0042]

Furthermore, in the present exemplary embodiment, the end of each first wall section 32 opposite to base section 31 has protrusions and recesses 49 which are meshed with the end of first projecting section 42a opposite to base section 41 throughout the entire circumference except for the cutout portion. According to this configuration, a pair of insulators is fixedly fitted to each other, whereby vibration of electric motor 1 is prevented while in rotation.

[0043]

(SECOND EXEMPLARY EMBODIMENT)

FIG. 9 is a perspective view of insulator A (first insulator) 4a in electric motor 1 according to a second exemplary embodiment of the present invention as viewed from stator core 3 side. As in the first exemplary embodiment, in insulator A 4a, tilt sections 52a, 52b, 52c, 52d by which the height of insulator A 4a on the inner circumferential side is larger than the height on the outer circumferential side are formed on portions where a circumferential wall section and a radial wall section intersect each other, on axial ends of the wall section. In addition, protrusion 51 protruding in the axial direction due to the tilts of tilt section 52a and tilt section 52c is formed on the axial end of the wall section on the innermost side in the radial direction. In other words, tilt section 52a and tilt section 52c are formed on both sides of protrusion 51, and the tilts of tilt sections 52a, 52c are continuously connected to the apex of protrusion 51. That is, it can be expressed such that protrusion 51 is formed integral with tilt section 52a and tilt section 52c. Tilts from tilt sections 52a, 52c to the apex of protrusion 51 are smoothly continuous straight lines or curved lines.

[0044]

FIG. 10 is a perspective view of insulator B (second insulator) 4b in electric motor 1 according to the second exemplary embodiment of the present invention as viewed from stator core 3 side. As in the first exemplary
5 embodiment, in insulator B 4b, tilt sections 62a, 62b, 63c, 62d by which the height of insulator B 4b on the inner circumferential side is larger than the height on the outer circumferential side are formed on portions where a circumferential wall section and a radial wall section intersect each other, on axial ends of the wall section. In addition, as in insulator A 4a, protrusion 61
10 protruding in the axial direction due to the tilts of tilt section 62a and tilt section 62c is formed on the axial end of the wall section on the innermost side in the radial direction. Tilts from tilt sections 62a, 62c to the apex of protrusion 51 are smoothly continuous straight lines or curved lines.

[0045]

15 Next, a method for attaching insulator A 4a and insulator B 4b to stator cores 3 will be described.

[0046]

Firstly, the attachment of insulator A 4a will be described. Protrusions 51 formed by the tilts of tilt sections 52a and 52c are in contact with stator
20 cores 3, by which insulator A 4a and stator cores 3 are positioned with respect to each other. Following the insertion of protrusions 51, tilt sections 52a are sequentially inserted, whereby the sequential insertion from the circumferential surfaces to the radial surfaces is implemented. In addition, on the tips of tooth sections, the portions where the circumferential surfaces and
25 the radial surfaces intersect each other are similarly sequentially inserted from the radial surfaces, which have been already inserted, due to tilt sections 52b formed on the portions where the circumferential surfaces and the radial

surfaces intersect each other.

[0047]

Next, the attachment of insulator B 4b will be described. Insulator B 4b and stator cores 3 are positioned with respect to each other in such a way that protrusions 61 formed by the tilts of tilt sections 62a and 62c are in contact with stator cores 3. Following the insertion of protrusions 61, tilt sections 62a are sequentially inserted, whereby the sequential insertion from the circumferential surfaces to the radial surfaces is implemented. In addition, on the tips of the tooth sections, the portions where the circumferential surfaces and the radial surfaces intersect each other are similarly sequentially inserted from the radial surfaces, which have been already inserted, due to tilt sections 62b formed on the portions where the circumferential surfaces and the radial surfaces intersect each other.

[0048]

As described above, according to electric motor 1 in the second exemplary embodiment of the present invention, the protrusion, which is formed by the tilt on the portion where the circumferential surface and the radial surface intersect each other and which protrudes in the axial direction on the innermost wall section in the radial direction, positions insulator 4 and stator cores 3 with respect to each other. After the positioning, the tilt sections are sequentially inserted, following the insertion of the protrusion, and thus, insertion is facilitated. Accordingly, occurrence of damage on insulator 4 can be prevented, whereby quality can be enhanced. Consequently, assembling workability is improved.

[0049]

(OUTLINE OF EXEMPLARY EMBODIMENTS)

Electric motor 1 according to the exemplary embodiments includes

stator core 3 provided with slot 23 having a winding wound, and a rotor mounted to be rotatable and disposed opposite the side face of stator core 3. Stator core 3 includes two insulators 4 attached to the stator core with the stator core sandwiched from top and bottom in the axial direction of the rotary shaft of electric motor 1. Each of insulators 4 has: base section 31 formed of the surface orthogonal to the rotary shaft; substantially cylindrical wall section 32 extending in the axial direction from base section 31 so as to cover the wall surface of slot 23; and protrusion 33 protruding in the axial direction on the portion of the axial end of wall section 32.

10 [0050]

According to this configuration, in attaching insulator 4 to stator core 3, positioning upon the start of the insertion is facilitated, whereby insertion is facilitated. Accordingly, occurrence of damage on insulator 4 can be prevented, whereby quality can be enhanced. Consequently, this configuration provides an effect of improving assembling workability.

15 [0051]

In addition, tilt sections 34a, 34b, 34c, 34 by which the height of the wall is increased toward protrusion 33 may be provided on both the sides of protrusion 33.

20 [0052]

According to this configuration, in attaching insulator 4 to stator core 3, positioning upon the start of the insertion is facilitated. In addition, upon the insertion, the portion on the axial end of the wall section of each slot where the circumferential direction and the radial direction intersect each other is gradually inserted into slot 23. Thus, the insertion is facilitated, whereby occurrence of damage on insulator 4 can be prevented, and quality can be enhanced. Consequently, this configuration provides an effect of improving

assembling workability.

[0053]

In addition, protrusion 51 may be formed such that the apex in the protruding direction is formed from the curved line or straight line continuous
5 with tilt sections 52a, 52b, 52c, 52d.

[0054]

According to this configuration, in attaching insulator 4 to stator core 3, the portion on the axial end of the wall section of each slot where the circumferential direction and the radial direction intersect each other is
10 gradually inserted into slot from the inner side of the slot in the radial direction. Thus, the insertion is facilitated, whereby occurrence of damage on insulator 4 can be prevented, and quality can be enhanced. Consequently, this configuration provides an effect of improving assembling workability.

[0055]

15 In addition, protrusion 33 may be formed on the innermost side on the wall section corresponding to first wall section 32 in the radial direction.

[0056]

According to this configuration, in attaching insulator 4 to stator core 3, positioning upon the start of the insertion is implemented on the innermost
20 side of the wall section of each slot 23. Accordingly, the positioning is facilitated, whereby the insertion is facilitated. Consequently, occurrence of damage on the insulator can be prevented, whereby quality can be enhanced. Consequently, this configuration provides an effect of improving assembling workability.

25 [0057]

In addition, insulators 4 include insulator A 4a attached from one side in the axial direction and insulator B 4b attached from the other side in the

axial direction. Furthermore, when insulator A 4a and insulator B 4b are attached to stator core 3, the wall section of insulator B 4b may be overlapped with the wall section of insulator A 4a.

[0058]

5 According to this configuration, a spatial insulation distance between stator core 3 and an A-phase winding wound on a first slot as well as a B-phase winding wound on a second slot can be ensured. Accordingly, this configuration can provide an effect of sufficiently ensuring insulating property.

[0059]

10 In addition, each of insulator A 4a and insulator B 4b is made of synthetic resin integrally formed into a torus.

[0060]

 This configuration eliminates the need of a structure, in which circumferentially adjacent insulator joint portions are overlapped with each
15 other, required by a segmented insulator including a plurality of parts segmented on wall surfaces of slots. Accordingly, a slot area can be increased, a length of a winding to be wound can be decreased, and the electric resistance of the winding can be reduced. Consequently, the efficiency of the electric motor can be improved. In addition, the effect of being capable of decreasing
20 the number of components can be provided.

INDUSTRIAL APPLICABILITY

[0061]

 The electric motor according to the present invention can implement
25 enhancement in quality, easiness in assembly, and rationalization, while sufficiently ensuring insulating property. Accordingly, the electric motor is useful for an electric motor for driving a ceiling fan and the like.

REFERENCE MARKS IN THE DRAWINGS

[0062]

	1: electric motor
5	2: hollow shaft
	3: stator core
	4: insulator
	4a: insulator A
	4b: insulator B
10	5: winding
	6: position detection element
	7a, 7b: bearing
	8: rotor yoke
	9: magnet
15	10: rotor cover
	20: stator
	21: center hole
	22: tooth section
	23: slot
20	31: base section
	32: first wall section
	33: protrusion
	34a, 34b, 34c, 34d: tilt section
	41: base section
25	42: second wall section
	42a: first projecting section
	43: protrusion

	44a, 44b, 44c, 44d: tilt section
	49: recesses and protrusions
	51: protrusion
	52a, 52b, 52c, 52d: tilt section
5	61: protrusion
	62a, 62b, 62c, 62d: tilt section

CLAIMS

1. An electric motor comprising:
 - a stator core provided with a slot having a winding wound; and
 - 5 a rotor mounted to be rotatable and disposed opposite a side face of the stator core,
 - wherein
 - the stator core includes two insulators that are attached to the stator core with the stator core sandwiched from top and bottom in an axial direction
 - 10 of a rotary shaft of the electric motor, and
 - each of the insulators has:
 - a base section formed of a surface orthogonal to the rotary shaft;
 - a substantially cylindrical wall section extending in the axial direction from the base section so as to cover a wall surface of the slot; and
 - 15 a protrusion protruding in the axial direction on a portion of an end of the wall section in the axial direction.
2. The electric motor according to claim 1, wherein
 - tilt sections by which a height of a wall is increased toward the
 - 20 protrusion are formed on both sides of the protrusion.
3. The electric motor according to claim 2, wherein
 - the protrusion is formed such that an apex in a protruding direction is formed from a curved line or a straight line continuous with the tilt sections.
 - 25
4. The electric motor according to claim 2 or 3, wherein
 - the protrusion is formed on an innermost side of the wall section in a

radial direction.

5. The electric motor according to claim 1, wherein
a portion, corresponding to a corner portion on an inner circumferential
5 surface of the slot, on the end of the wall section is tilted with respect to a
surface of the base section.

6. The electric motor according to claim 1, wherein
the insulators include:
10 a first insulator attached from one side in the axial direction; and
a second insulator attached from the other side in the axial direction,
and
when the first insulator and the second insulator are attached to the
stator core, a wall section of the second insulator is overlapped with a wall
15 section of the first insulator.

7. The electric motor according to claim 1, wherein
each of the insulators is made of synthetic resin integrally formed into a
torus.

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