[0006] Furthermore, an inner ring of bearing 104b is fixed to shaft 103 on a side opposite to bearing 104a, and rotor cover 108 is fixed to an outer ring of bearing 104b. Rotor yoke 105 and rotor cover 108 are fixed so that rotor yoke 105 and rotor cover 108 enclose stator core 101, and thus, brushless DC motor 109 is configured.

Citation List

[0007] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2016-63678

SUMMARY ~~OF INVENTION~~

[0008] However, such conventional brushless DC motor has the following problem.

[0009] To realize a ceiling fan having a larger blade-diameter and configured to supply high airflow, a stator core and a magnet that serve as constituents of a motor need to be increased in size. In other words, such ceiling fan can be realized by, for example, making the outer diameter of a stator core larger, increasing the thickness in the direction of stacking, or making a magnet axially longer. However, to newly design each of the constituents of the motor, new equipment and molds and dies are needed, so that development investment costs increase.

[0010] The present disclosure is devised to solve the above-described problem, and an object of the present disclosure is to provide a brushless DC motor capable of reducing investment in new equipment and molds and dies and achieving higher output at low cost and with high driving torque.

[0011] In order to accomplish this object, a brushless DC motor according to an aspect of the present disclosure includes a shaft defining a rotation axis, a first

stator, a second stator, a first rotor, a second rotor, and a coupling unit. The first stator has a cylindrical shape with a top face and a bottom face, and the center of the circle of the cylindrical shape is fixed to the shaft. The second stator has a cylindrical shape with a top face and a bottom face, and, while the second stator is adjacent to the first stator, the center of the circle of the cylindrical shape is fixed to the shaft. The first rotor has a hollow cylindrical shape with an opening on the bottom and includes a first flange extending from the outer circumferential edge of the bottom toward the further outer circumferential side, the bottom being ~~in a face~~ perpendicular to the rotation axis, and is rotatably attached to the shaft so as to face a side face of the first stator. The second rotor has a hollow cylindrical shape with an opening on the bottom and includes a second flange extending from the outer circumferential edge of the bottom toward the further outer circumferential side, ~~in a~~the face being perpendicular to the rotation axis, and is rotatably attached to the shaft so as to face a side face of the second stator. The coupling unit is configured to axially couple the first rotor to the second rotor. The first stator and the second stator are identical components, and the first rotor and the second rotor are identical components. The coupling unit has a hollow disk shape, and an inner diameter of a center opening of the hollow disk shape is larger than an outer diameter of the first stator and larger than an outer diameter of the second stator. The first rotor and the second rotor are arranged above and below the coupling unit by the first flange of the first rotor is fixed to the upper surface of the coupling unit having a hollow disk shape with the center opening and an opening on the bottom of the first rotor facing each other, and by the second flange of the second rotor is fixed to the lower surface of the coupling unit with the center opening and an opening on the bottom of the second rotor facing each other. The first rotor and the second rotor rotate the coupling unit,

and a blade is fixed to the coupling unit.

[0012] According to the present disclosure, a brushless DC motor capable of achieving high output at low cost can be provided.

BRIEF DESCRIPTION OF DRAWINGS

[0013] FIG. 1 is a side view of a ceiling fan equipped with a brushless DC motor according to a first embodiment of the present disclosure.

FIG. 2 is a perspective assembly view of an overall configuration of the brushless DC motor.

FIG. 3 is an assembly view of a configuration of a rotor of the brushless DC motor.

FIG. 4 is a cross-sectional view of the overall configuration of the brushless DC motor.

FIG. 5A is a diagram illustrating a state in which holding rings of the brushless DC motor are fixed.

CLAIMS

1. A brushless DC motor, comprising:

a shaft defining a rotation axis;

a first stator having a cylindrical shape with a top face and a bottom face, wherein a center of a circle of the cylindrical shape is fixed to the shaft;

a second stator having a cylindrical shape with a top face and a bottom face and being adjacent to the first stator, wherein a center of a circle of the cylindrical shape is fixed to the shaft;

a first rotor

having a hollow cylindrical shape with an opening on the bottom,

including a first flange extending from the outer circumferential edge of the bottom toward the further outer circumferential side, ~~in a face of the first rotor~~, the ~~face~~ bottom being perpendicular to the rotation axis, and

rotatably attached to the shaft to face a side face of the first stator;

a second rotor

having a hollow cylindrical shape with an opening on the bottom,

including a second flange extending from the outer circumferential edge of the bottom toward the further outer circumferential side, ~~in a face of the second rotor~~, the face being perpendicular to the rotation axis, and

rotatably attached to the shaft to face a side face of the second stator; and

a coupling unit configured to couple the first rotor to the second rotor along the rotation axis,

wherein the first stator and the second stator are identical components, and

wherein the first rotor and the second rotor are identical components

the coupling unit has a hollow disk shape, and an inner diameter of a center opening of the hollow disk shape is larger than an outer diameter of the first stator and larger than an outer diameter of the second stator,

the first rotor and the second rotor are arranged above and below the coupling unit

by the first flange of the first rotor is fixed to the upper surface of the coupling unit having a hollow disk shape with the center opening and an opening on the bottom of the first rotor facing each other, and

by the second flange of the second rotor is fixed to the lower surface of the coupling unit with the center opening and an opening on the bottom of the second rotor facing each other,

the first rotor and the second rotor rotate the coupling unit, and

a blade is fixed to the coupling unit.

2. The brushless DC motor according to claim 1, further comprising

a motor drive circuit connected to the first stator and the second stator and configured to output a driving signal,

wherein each of the first stator and the second stator includes:

a core including 3n salient poles radially formed from the center, where n is integer of 1 or more; and

a star connection coil including three phase windings and wound around each of the salient poles,

wherein the star connection coil

is configured to connect phases of the first stator to phases of

the second stator in parallel so that each of the phases of the first stator coincides with a corresponding one of the phases of the second stator, and

pulled out only in one direction of the rotation axis,

wherein the first stator and the second stator are drive-controlled by the motor drive circuit that is pulled out only in the one direction of the rotation axis and connected to the star connection coil.

~~2. The brushless DC motor according to claim 1, wherein~~

~~the bottom face of the first stator is adjacent to the top face of the second stator, and~~

~~a circumferential base point of the first stator and a circumferential base point of the second stator coincide with each other on the rotation axis.~~

~~3. The brushless DC motor according to claim 1, wherein~~

~~the bottom face of the first stator is adjacent to the bottom face of the second stator, and~~

~~a circumferential base point of the first stator and a circumferential base point of the second stator coincide with each other on the rotation axis.~~

~~4~~3. The brushless DC motor according to claim 1, wherein

~~the first rotor includes a first magnet,~~

~~the second rotor includes a second magnet, and,~~

with a first direction of magnetization of the first magnet and a direction of magnetization of the second magnet being identical to each other, the coupling unit axially couples the first flange to the second flange, the first magnet and the second magnet being adjacent to each other along the rotation axis between the first rotor and the second rotor.

~~5~~4. The brushless DC motor according to claim ~~4~~3, wherein

each of the first flange and the second flange includes a flange-side mark to make the first directions and the second directions identical to each other.

~~6~~5. The brushless DC motor according to claim ~~5~~4, wherein

the coupling unit

includes coupling-unit-side marks on both sides, each of the coupling-unit-side marks being paired with a corresponding one of the flange-side mark of the first flange and the flange-side mark of the second flange,

wherein the coupling-unit-side mark provided in one face of the coupling unit and the flange-side mark of the first flange are disposed to coincide with each other, and the coupling-unit-side mark provided in another face of the coupling unit and the flange-side mark of the second flange are disposed to coincide with each other, so that the first and second directions of magnetization of the first and second magnets adjacent to each other between the first rotor and the second rotor are identical to each other.

~~7~~6. The brushless DC motor according to claim ~~6~~5, wherein

the flange-side mark of the first flange and the flange-side mark of the second flange are notches, and

the coupling-unit-side marks are recesses.

~~8~~7. The brushless DC motor according to claim ~~6~~5, wherein

the flange-side mark of the first flange and the flange-side mark of the

second flange are notches,

the coupling-unit-side marks are projections, and

each of the notches and a corresponding one of the projections are disposed to coincide with each other.

~~9. The brushless DC motor according to claim 1, wherein~~

~~the coupling unit has a hollow disk shape, and an inner diameter of a center opening of the hollow disk shape is larger than an outer diameter of the first stator and larger than an outer diameter of the second stator.~~

~~10. The brushless DC motor according to claim 1 or 2, further comprising~~

~~a motor drive circuit connected to the first stator and the second stator and configured to output a driving signal,~~

~~wherein each of the first stator and the second stator includes:~~

~~a core including 3n salient poles radially formed from the center, where n is integer of 1 or more; and~~

~~a star connection coil including three phase windings and wound around each of the salient poles,~~

~~wherein the star connection coil~~

~~is configured to connect phases of the first stator to phases of the second stator in parallel so that each of the phases of the first stator coincides with a corresponding one of the phases of the second stator, and~~

~~is drive-controlled by the motor drive circuit.~~

~~11. The brushless DC motor according to claim 3, further comprising~~

~~a motor drive circuit connected to the first stator and the second stator and configured to output a driving signal,~~

~~wherein each of the first stator and the second stator includes:~~

~~a core including 3n salient poles radially formed from the center, where n is an integer of 1 or more; and~~

~~a star connection coil including three phase windings and wound around each of the salient poles,~~

~~wherein the star connection coil~~

~~is configured to connect one of phases of the first stator to one of phases of the second stator in parallel, the one of the phases of the first stator coinciding with the one of the phases of the second stator,~~

~~is configured to exchange other two of the phases of the first stator and other two of the phases of the second stator, the other two of the phases of the first stator coinciding with the other two of the phases of the second stator, and connect the other two of the phases of the first stator and the other two of the phases of the second stator in parallel.~~

~~12~~8. The brushless DC motor according to claim 1, further comprising

one temperature detector configured to detect ambient temperatures of both of the first stator and the second stator.

~~13~~9. The brushless DC motor according to claim 1, further comprising

one set of position detectors configured to detect rotation positions of both of the first rotor and the second rotor.