# DESCRIPTION

## Title of Invention: ROTOR AND MOTOR

### TECHNICAL FIELD

[0001] The present disclosure relates to a rotor and a motor.

### BACKGROUND ART

[0002] A rotor that includes a magnet surrounding a stator core and is used in a brushless DC motor is known. For example, Patent Literature 1 discloses a rotor including a rotor yoke and a magnet provided on an inner periphery of a cylindrical portion of the rotor yoke.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Patent Unexamined Publication No. 2022-052814

### SUMMARY OF THE INVENTION

[0004] In the rotor described in Patent Literature 1, a plurality of magnets divided into segments are mounted on a cylindrical portion extending downward from a top plate portion of a rotor yoke, and a magnet holder made of resin is mounted thereon to hold the magnets at predetermined positions. Therefore, the rotor described in Patent Literature 1 has room for improvement from the viewpoint of assembly workability when the magnet is attached to the rotor yoke.

[0005] The present disclosure provides a rotor capable of improving assembly workability.

[0006] A rotor according to an aspect of the present disclosure includes a housing including a housing cylindrical portion having a cylindrical shape, and a magnet having an outer diameter equal to or larger than an inner diameter of the housing cylindrical portion and having a hollow cylindrical shape, the magnet being press-fitted into the housing in a first direction in an axial direction. A magnet outer peripheral surface of the magnet includes a first magnet outer peripheral surface that is pressed against the housing

cylindrical portion by press-fitting, and a tapered second magnet outer peripheral surface whose diameter gradually decreases toward an end portion of the magnet in the first direction.

[0007] Optional combinations of the above constituent elements, and embodiments obtained by converting expressions of the present disclosure among methods, apparatuses, systems, recording media, computer programs, are also effective as aspects of the present disclosure.

[0008] According to the present disclosure, it is possible to provide a rotor capable of improving assembly workability.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a side cross-sectional view schematically illustrating a motor including a rotor according to an embodiment of the present disclosure.

FIG. 2 is an exploded perspective view showing a stator core and an insulator of FIG. 1.

FIG. 3A is a perspective view illustrating a first insulator of FIG. 2.

FIG. 3B is a perspective view illustrating a first insulator of FIG. 2.

FIG. 4A is a perspective view illustrating a second insulator of FIG. 2.

FIG. 4B is a perspective view illustrating a second insulator of FIG. 2.

FIG. 5 is a cross-sectional view taken along a plane orthogonal to the axial direction of the stator of FIG. 1.

FIG. 6 is a cross-sectional view taken along a plane parallel to the axial direction of the stator of FIG. 1.

FIG. 7 is a diagram illustrating a stator core and windings of the stator of FIG. 1.

FIG. 8 is a developed view showing a stator core and windings of the stator of FIG. 1.

FIG. 9 is a perspective view showing a housing of the rotor of FIG. 1.

FIG. 10 is a diagram illustrating a magnet of the rotor of FIG. 1.

FIG. 11 is a cross-sectional view illustrating a press-fitting step in which the magnet is press-fitted into the housing of the rotor of FIG. 1.

FIG. 12 is a perspective view illustrating a state in which the magnet is press-fitted into the housing of the rotor of FIG. 1.

## DESCRIPTION OF EMBODIMENT

[0010] Hereinafter, embodiments of the present disclosure will be described with reference to the accompanying drawings. The embodiments described below each shows a preferred specific example of the present disclosure. Therefore, the numerical values, shapes, materials, constituent elements, arrangement positions and connection forms of the constituent elements, steps, the order of the steps, which shown in the following embodiment are merely examples, and are not intended to limit the present disclosure. Therefore, among the constituent elements in the following embodiments, constituent elements not recited in the independent claim indicating the highest-level concept of the present disclosure are described as optional constituent elements. In the drawings, substantially the same components are denoted by the same reference numerals, and redundant description will be omitted or simplified.

[0011] It will be understood that, although terms including ordinals such as first, second, etc. may be used herein to describe various components, these components are not limited by these terms. Such terms are used only for the purpose of distinguishing one component from another component. The ordinal number may be omitted when a component is not distinguished from other components.

[0012] [Embodiment] A configuration of a motor 10 including a rotor 40 according to an embodiment of the present disclosure will be described with reference to FIG. 1. FIG. 1 is a side sectional view schematically showing the motor 10. The motor 10 is, for example, a brushless DC motor suitably used as a motor for driving blades of a ceiling fan.

[0013] The motor 10 mainly includes a stator 20, a shaft 30, a rotor 40, a cover 42, a first bearing 31, a second bearing 32, and a circuit board 48. The stator 20, the shaft 30, and the circuit board 48 constitute a stationary body, and the rotor 40 and the cover 42 constitute a rotating body.

[0014] The stator 20 includes a stator core 21, a pair of insulators 22 and 23 sandwiching the stator core 21 from both sides in the axial direction, and a winding 24 wound around the stator core 21 via the insulators 22 and 23.

[0015] The shaft 30 is a fixed shaft fixedly supported by the stator 20. The shaft 30 is a pipe-shaped member having a hollow portion at the center for passing the lead wires 268 therethrough. The hollow portion of the shaft 30 penetrates vertically, and lateral holes 30h and 30j for passing the lead wires 268 are provided in a side surface of the shaft 30.

[0016] The rotor 40 is rotatably supported with respect to the stator 20 via the shaft 30, the first bearing 31, and the second bearing 32. Hereinafter, for convenience, a direction along the central axis La of the rotor 40 is referred to as an "axial direction", and the circumferential direction and a radial direction of a circle centered on the central axis La in a plane orthogonal to the central axis La are referred to as a "circumferential direction" and a "radial direction", respectively. The shaft 30 extends in the axial direction. A side where the rotor 40 covers the stator 20 in the axial direction is referred to as a first direction. That is, the top plate portion 411 of the rotor 40 overlaps the first direction side of the stator 20. In the drawings, the first direction is indicated by an arrow Z1. The first direction side may be referred to as an upper side, and the opposite side may be referred to as a lower side. The indication of such directions does not limit the posture of the motor 10, and the motor 10 can be used in any posture.

[0017] The rotor 40 includes a housing 41 including a housing cylindrical portion 412 having a cylindrical shape, and a magnet 43 having an outer diameter equal to or larger than an inner diameter of the housing cylindrical portion 412 and having a hollow cylindrical shape, the magnet 43 being press-fitted into the housing 41 in the first direction in the axial direction.

[0018] The circuit board 48, the first bearing 31, the rotor 40, the stator 20, the second bearing 32, and the cover 42 are arranged in this order from top to bottom and surround the shaft 30. The rotor 40 is disposed to face the stator 20 in the radial direction. Inner rings of the first bearing 31 and the second bearing 32 are fixed to the shaft 30. An outer ring of the first bearing 31 is accommodated in a recess formed in a central portion of the housing 41 of the rotor 40, and an outer ring of the second bearing 32 is accommodated in a recess formed in a central portion of the cover 42. The cover 42 is a substantially

disk-shaped member that covers the lower side of the stator 20 via a gap, and rotates integrally with the rotor 40. The cover 42 has substantially the same outer shape as the housing 41, and is fixed to the housing 41 of the rotor 40 by a plurality of tapping screws (not shown) arranged at predetermined intervals in the circumferential direction.

[0019] The circuit board 48 functions as a drive circuit for the brushless motor, and supplies a drive current to the stator 20 based on a detection signal from a rotation detection unit (not shown). The stator 20 generates a rotating magnetic field in accordance with the drive current. The rotor 40 and the cover 42 rotate about the central axis line La in accordance with the rotating magnetic field. Since the drive circuit of the brushless motor is known, the details thereof will be omitted.

[0020] The stator 20 will also be described with reference to FIGS. 2 to 8. FIG. 2 is an exploded perspective view illustrating a stator core 21 and a pair of insulators 22 and 23 of the stator 20. The stator core 21 can be formed by, for example, stacking a plurality of electromagnetic steel sheets having a predetermined shape. The stator core 21 includes a cylindrical portion 211 having a cylindrical shape, a plurality of tooth portions 212 protruding radially outward from an outer peripheral surface of the cylindrical portion 211, curved surface portions 213 protruding in the circumferential direction from distal ends of the tooth portions 212, and slots 214 formed between adjacent tooth portions 212. The number of slots 214 of the stator core 21 of the embodiment is twelve.

[0021] The insulators 22 and 23 are resin members formed by molding. The insulators 22 and 23 include a first insulator 22 mounted on the first direction side of the stator core 21 in the axial direction, and a second insulator 23 mounted on the opposite side of the first insulator 22 across the stator core 21 in the axial direction. FIG. 3A is a view of the first insulator 22 as viewed obliquely from above. FIG. 3B is a view of the first insulator 22 as viewed obliquely from below. FIG. 4A is a view of the second insulator 23 as viewed obliquely from below. FIG. 4B is a view of the second insulator 23 as viewed obliquely from above.

[0022] The first insulator 22 includes a first base portion 221, a first wall portion 222, a first inner peripheral wall 226, a first outer peripheral wall 227, a protrusion 228, a crossover wire arrangement portion 258, and a central inner peripheral wall 257. The first base portion 221 includes a surface orthogonal to the axial direction, and includes a

portion covering the cylindrical portion 211, the tooth portion 212, and the curved surface portion 213. The crossover wire arrangement portion 258 is constituted by a disk plane orthogonal to the axial direction on the inner peripheral side of the first base portion 221. The central inner peripheral wall 257 is a substantially cylindrical peripheral wall extending in the axial direction at the inner peripheral edge of the crossover wire arrangement portion 258. The central inner peripheral wall 257 has a wiring passage portion 257a that is partially open in a predetermined direction, and has a C shape when viewed in the axial direction.

[0023] The first wall portion 222 extends in the axial direction from the first base portion 221 along the core inner surface portion 215 surrounding the slot 214 of the stator core 21. The protrusion 228 protrudes from the first wall portion 222 toward the core inner surface portion 215, and a protruding end of the protrusion 228 comes into contact with the core inner surface portion 215.

[0024] The protrusion 228 includes a first tooth portion protrusion 223 protruding in the circumferential direction from a portion extending along the tooth portion 212 of the first wall portion 222, a first cylindrical portion protrusion 224 protruding radially inward from a portion extending along the outer peripheral surface of the cylindrical portion 211 of the first wall portion 222, and a first curved surface portion protrusion 225 protruding radially outward from a portion extending along the outer peripheral surface of the curved surface portion 213 of the first wall portion 222.

[0025] The second insulator 23 includes a second base portion 231, a second wall portion 232, a second inner peripheral wall 236, a second outer peripheral wall 237, and a protrusion 238. The second base portion 231 is formed by a surface orthogonal to the axial direction, and includes a portion covering the cylindrical portion 211, the tooth portion 212, and the curved surface portion 213.

[0026] The second wall portion 232 extends in the axial direction from the second base portion 231 along the core inner surface portion 215 surrounding the slot 214 of the stator core 21. The protrusion 238 protrudes from the second wall portion 232 toward the core inner surface portion 215, and the protruding end of the protrusion 238 abots against the core inner surface portion 215.

[0027] The protrusion 238 includes a second tooth portion protrusion 233 protruding in the circumferential direction from a portion of the second wall portion 232 extending along the tooth portion 212, a second cylindrical portion protrusion 234 protruding radially inward from a portion of the second wall portion 232 extending along an outer peripheral surface of the cylindrical portion 211, and a second curved surface portion protrusion 235 protruding radially outward from a portion of the second wall portion 232 extending along an outer peripheral surface of the curved surface portion 213.

[0028] Since the protrusions 228 and 238 are provided, the protrusions 228 and 238 come into contact with the core inner surface portion 215 in the mounted state. Therefore, the insulators 22 and 23 can be fixed to the stator core 21 by a frictional force of the contact portions. Further, since a clearance is formed between distal ends of the wall portions 222 and 232 and the core inner surface portion 215, the insulators 22 and 23 can be smoothly mounted to the stator core 21.

[0029] The first tooth portion protrusion 223 and the second tooth portion protrusion 233 are collectively referred to as tooth portion protrusions 223 and 233. The first cylindrical portion protrusion 224 and the second cylindrical portion protrusion 234 are collectively referred to as cylindrical portion protrusions 224 and 234. The first curved surface portion protrusion 225 and the second curved surface portion protrusion 235 are collectively referred to as curved surface portion protrusions 225 and 235. The first base portion 221 and the second base portion 231 are collectively referred to as base portions 221 and 231. The first wall portion 222 and the second wall portion 232 are collectively referred to as wall portions 222 and 232.

[0030] The number of the protrusions 228 and 238 is not limited. In the embodiment, two tooth portion protrusions 223 and 233 are provided so as to be separated from each other in the radial direction corresponding to each side surface of the tooth portion 212 of each slot 214. One cylindrical portion protrusion 224 and 234 is provided corresponding to the cylindrical portion 211 of each slot 214. Two curved surface portion protrusions 225 and 235 are provided so as to be separated from each other in the circumferential direction corresponding to the curved surface portion 213 of each slot 214.

[0031] Since the cylindrical portion protrusions 224 and 234 and the curved surface portion protrusions 225 and 235 are provided, these protrusions come into contact with

the stator core 21 in the radial direction, and the fixing force in the radial direction can be increased by the frictional force of the contact portions. By providing the tooth portion protrusions 223 and 233, these protrusions come into contact with the stator core 21 in the circumferential direction, and the fixing force in the circumferential direction can be increased by the frictional force of the contact portions.

[0032] The clearance between the wall portions 222 and 232 and the core inner surface portion 215 will be described. In the present specification, the respective maximum clearances between the wall portions 222 and 232 and the core inner surface portion 215 are simply referred to as clearances. FIG. 5 is a cross-sectional view of the stator 20 taken along a plane orthogonal to the axial direction. Although FIG. 5 shows the wall portion 222 and the protrusion 228 of the first insulator 22, the same applies to the wall portion 232 and the protrusion 238 of the second insulator 23. FIG. 6 is a cross-sectional view of the stator 20 taken along a plane parallel to the axial direction and passing through the curved surface portion protrusion 225 and the cylindrical portion protrusion 224. As shown in FIG. 6, the axial range of the wall portion 222 overlaps the axial range of the wall portion 232.

[0033] By the insulators 22 and 23 having the protrusions 228 and 238, clearances are formed between the wall portions 222 and 232 and the core inner surface portion 215. The radial clearance 12 between the wall portions 222 and 232 and the cylindrical portion 211 and the radial clearance 13 between the wall portions 222 and 232 and the curved surface portion 213 are larger than the circumferential clearance 11 between the wall portions 222 and 232 and the tooth portion 212. The insulators 22 and 23 are resin members and are formed by injection molding. In injection molding, not a little deformation occurs due to a temperature difference in a mold and a shrinkage ratio. In particular, in a cylindrical molded article, the outer peripheral portion tends to warp in the first direction or warp in the direction opposite to the first direction in the axial direction. That is, the wall portions 222 and 232 of the insulators may come close to the cylindrical portion 211 and the curved surface portion 213 of the core. In this case, the mountability of the first insulator 22 to the stator core 21 is improved as compared with a case where the circumferential clearance is larger than the radial clearance. The circumferential clearance 11, the radial clearance 12, and the radial clearance 13 can be set by adjusting

the protruding dimensions of the protrusions 228 and 238 so as to obtain desired mountability.

[0034] As an example, the amount of radial protrusion of the cylindrical portion protrusions 224 and 234 and the curved surface portion protrusions 225 and 235 from the wall portions 222 and 232 may be set in a range of 0.5 mm to 1.5 mm, and is set to 1.0 mm in the embodiment. As an example, the amount of circumferential protrusion of the tooth portion protrusions 223 and 233 from the wall portions 222 and 232 may be set in a range of 0.2 mm to 0.6 mm, and is set to 0.4 mm in the embodiment. The radial protrusion amount may be non-uniform, for example, 2.5 times the circumferential protrusion amount.

[0035] As shown in FIG. 6, each of the protrusions 228 and 238 has an insertion inclined surface 27 whose amount of protrusion in the radial direction gradually decreases as it goes away from the base portions 221 and 231 in the axial direction. In this case, when the insulators 22 and 23 are mounted, the insertion inclined surfaces 27 of the protrusions 228 and 238 are first inserted into the core inner surface portion 215, and thus the protrusions 228 and 238 can be smoothly inserted along the insertion inclined surfaces 27. That is, when the insulators 22 and 23 are mounted, the protrusions 228 and 238 do not become obstacles. An inclination angle of the insertion inclined surface 27 with respect to the axial direction may be in a range of 10° to 80°, and is set to 45° in the embodiment.

[0036] The first inner peripheral wall 226 and the second inner peripheral wall 236 are collectively referred to as inner peripheral walls 226 and 236, and the first outer peripheral wall 227 and the second outer peripheral wall 237 are collectively referred to as outer peripheral walls 227 and 237. As shown in FIGS. 3A, 3B, 4A, and 4B, the inner peripheral walls 226 and 236 are cylindrical peripheral walls extending in the axial direction from outer edges of regions of the base portions 221 and 231 corresponding to the cylindrical portions 211. The outer peripheral walls 227 and 237 are cylindrical peripheral walls extending in the axial direction from regions corresponding to the curved surface portions 213 of the base portions 221 and 231, and portions corresponding to gaps between two adjacent curved surface portions 213 are cut out.

[0037] An example of the routing of the wire of the winding 24 will be described with reference to FIGS. 7 and 8. FIG. 7 is a diagram illustrating the stator core 21 and the winding 24. FIG. 8 is a developed view showing the stator core 21 and the winding 24 in a developed state. The winding 24 is formed by winding the wires 8 and 9 around the tooth portions 212 via the insulators 22 and 23. The wires 8 and 9 are magnet wires which are copper wires insulated by a resin such as polyurethane.

[0038] As shown in FIG. 7, the crossover wire arrangement portion 258 of the insulator 22 is provided with metal terminal pins 24U, 24V, 24W, and 24N and hooks 251, 252, 253, 254, and 255 on which wires are hooked.

[0039] Four windings 24 connected in series in each phase constitute a U-phase coil 261, a V-phase coil 262, and a W-phase coil 263. The coils 261, 262, and 263 are three-phase star-connected, one wire end of each coil is connected to the terminal pin 24N, and the other wire end is connected to the terminal pins 24U, 24V, and 24W. The terminal pin 24N is a neutral point.

[0040] In FIGS. 7 and 8, reference numerals V2, V1, U2, U1, W1, W2, V3, V4, U4, U3, W4, and W3 denote the windings 24 wound around the respective tooth portions 212. In FIG. 8, a clockwise winding indicated by an arrow is referred to as a forward winding, and a counterclockwise winding indicated by an arrow is referred to as a reverse winding.

[0041] The wires 8 and 9 include a first wire 8 indicated by a broken line and a second wire 9 indicated by a solid line in FIG. 8. The first wire 8 forms a U-phase coil 261 and a V-phase coil 262, and the second wire 9 forms a W-phase coil 263.

[0042] The winding start 9s of the second wire 9 is tied around the terminal pin 24W, the winding W1 is wound in the forward direction, the winding W2 adjacent to the winding W1 is wound in the reverse direction, and the second wire 9 extends from the winding W2 to reach the hook 251. Next, the second wire 9 changes its direction at the hook 251, reaches the central inner peripheral wall 257, makes about a half turn counterclockwise around the central inner peripheral wall 257, and reaches the winding W3.

[0043] Next, the second wire 9 is wound around the winding W3 in the forward direction, is wound around the winding W4 adjacent to the winding W3 in the reverse direction, extends from the winding W4, and reaches the hook 252. Next, the direction of

the second wire 9 is changed by the hook 252, and the winding end 9e is tied to the terminal pin 24N.

[0044] The winding start 8s of the first wire 8 is tied around the terminal pin 24V, the first wire 8 is reversely wound around the winding V1, is forwardly wound around the winding V2 adjacent to the winding V1, extends from the winding V2, and reaches the central inner peripheral wall 257. Next, the first wire 8 makes about a half turn in the counterclockwise direction around the central inner peripheral wall 257, changes its direction at the hook 253, and reaches the winding V3.

[0045] Next, the first wire 8 is reversely wound around the winding V3, is forwardly wound around the winding V4 adjacent to the winding V3, extends from the winding V4, and reaches the terminal pin 24N. Next, the first wire 8 is tied around the terminal pin 24N and changes its direction to reach the winding U4.

[0046] Next, the first wire 8 is reversely wound around the winding U4, is forwardly wound around the winding U3 adjacent to the winding U4, extends from the winding U3, and reaches the hook 254. Next, the first wire 8 changes its direction at the hook 254 and further changes its direction at the hook 255 to reach the winding U2. Next, the first wire 8 is wound in the forward direction around the winding U2, is wound in the reverse direction around the winding U1 adjacent to the winding U2, extends from the winding U1, and reaches the terminal pin 24U. The winding end 8e of the first wire 8 is tied to the terminal pin 24U.

[0047] The portions of the wires 8 and 9 tied to the terminal pins 24U, 24V, 24W, and 24N are soldered to the respective terminal pins.

[0048] The lead wires 268 will be described with reference to FIGS. 1 and 7. The lead wires 268 are constituted by three insulated electric wires, one end of each of which is electrically connected to the terminal pins 24U, 24V, and 24W, and the other end of each of which is electrically connected to the circuit board 48. The lead wires 268 extend from the terminal pins 24U, 24V, and 24W, pass through the wiring passage portion 257a open in the central inner peripheral wall 257, pass through the hollow portion from one lateral hole 30j of the shaft 30, extend from the other lateral hole 30h to the circuit board 48, and are electrically connected to a predetermined portion of the circuit board 48. The lead wires 268 are accommodated in the sheath tube 269 from portions before passing through

the wiring passage portion 257a to portions beyond the lateral hole 30h. Portions of the lead wires 268 before passing through the wiring passage portion 257a may be fixed to the crossover wire arrangement portion 258 by the support member 266.

[0049] According to the embodiment, since the wiring passage portion 257a is provided, it is possible to avoid interference between the lead wires 268 and the central inner peripheral wall 257 when the lead wires 268 pass through the lateral hole 30j, and thus it is possible to configure the motor 10 to be thin. In addition, the work of passing the lead wires 268 through the hollow portion of the shaft 30 is facilitated.

[0050] The rotor 40 will be described with reference to FIGS. 9 to 12. FIG. 9 is a perspective view showing the housing 41 of the rotor 40. FIG. 9(A) is a view of the housing 41 as viewed obliquely from above, and FIG. 9(B) is an enlarged view of the housing engagement recess 415 and the pin insertion opening 416. FIG. 10 is a diagram illustrating the magnet 43. FIG. 10(A) is a view of the magnet 43 as viewed obliquely from above, FIG. 10(B) is an enlarged view of the magnet engagement protrusion 435, and FIG. 10(C) is a cross-sectional view of the magnet 43 taken along line A-A.

[0051] The housing 41 includes a top plate portion 411, a housing cylindrical portion 412, a magnet end-surface support portion 413, and a flange 414, each of which has a circular shape. The housing cylindrical portion 412 is a cylindrical portion that supports a side surface of the magnet 43. The magnet end-surface support portion 413 is an annular portion that extends radially inward from an upper portion of the housing cylindrical portion 412 and supports the upper end surface of the magnet 43. The top plate portion 411 is a hollow disk-shaped portion that covers a central portion above the magnet end-surface support portion 413. The flange 414 is an annular portion extending radially outward from a lower portion of the housing cylindrical portion 412. The housing cylindrical portion 412 is provided with one or more housing engagement recesses 415, and the flange 414 is provided with one or more pin insertion openings 416. In this example, two housing engagement recesses 415 and two pin insertion openings 416 are provided at intervals of 180° in the circumferential direction. The housing engagement recesses 415 and the pin insertion openings 416 will be described later.

[0052] The magnet 43 has a hollow cylindrical shape having a magnet inner peripheral surface 431, a magnet outer peripheral surface 460, an upper end surface 433, and a lower

end surface 434. The magnet inner peripheral surface 431 has fourteen drive magnetic poles that supply field magnetic flux to the stator core 21. The magnet 43 of the embodiment is a polar-anisotropic plastic magnet having a high residual magnetic flux density, but may be an isotropic plastic magnet. One or more magnet engagement protrusions 435 are provided on the magnet outer peripheral surface 460. In this example, two magnet engagement protrusions 435 are provided at an interval of 180° in the circumferential direction corresponding to the two housing engagement recesses 415.

[0053] The magnet 43 has an outer diameter equal to or larger than the inner diameter of the housing cylindrical portion 412, and is fixed to the housing cylindrical portion 412 of the housing 41 by press-fitting. In this case, compared with a case where fixation is achieved by adhesion, the labor of managing a curing time of an adhesive can be saved, and productivity is improved. The magnet outer peripheral surface 460 of the magnet 43 includes a first magnet outer peripheral surface 461 that is pressed against the housing cylindrical portion 412 by press-fitting, and a tapered second magnet outer peripheral surface 462 whose diameter gradually decreases toward the end portion of the magnet 43 in the first direction. In this case, since the tapered outer peripheral surface is provided on the upper end surface 433 side which precedes at the time of press-fitting, the magnet 43 can be easily press-fitted into the housing 41 along an inclination of the outer peripheral surface. At the time of press-fitting, the upper end surface 433 of the magnet 43 is brought into contact with the magnet end-surface support portion 413. As a result, variations in the axial position of the magnet 43 can be reduced.

[0054] In the embodiment, the magnet outer peripheral surface 460 has a third magnet outer peripheral surface 463 that is continuous with the second magnet outer peripheral surface 462 and extends parallel to the axial direction toward the end portion in the first direction. In this case, the third magnet outer peripheral surface 463 having a diameter smaller than that of the first magnet outer peripheral surface 461 can be hooked on an inner edge of the housing 41 to be axially aligned with the housing 41, so that the productivity can be further improved.

[0055] Since the magnet 43 receives a large torque relative to the housing 41 at startup, the magnet 43 may rotate relative to the housing 41 when start and stop are repeated. Increasing the press-fitting strength for this purpose is also conceivable, but if the press-

fitting strength is excessively increased, the magnet 43 may crack at the time of press-fitting. In order to prevent relative rotation, a protrusion may be provided on one of the magnet 43 and the housing 41, and a recess that engages with the protrusion may be provided on the other.

[0056] In the embodiment, a magnet engagement protrusion 435 and a housing engagement recess 415, which engage with each other, are provided as the protrusion and the recess for prevention of relative rotation. The magnet engagement protrusion 435 is a portion protruding radially outward at an end portion of the magnet outer peripheral surface 460 on a side opposite to the first direction. The housing engagement recess 415 is a portion recessed radially outward at an end of the housing cylindrical portion 412 opposite to the first direction, and has a shape engageable with the magnet engagement protrusion 435. Shapes and numbers of the magnet engagement protrusions 435 and the housing engagement recesses 415 can be determined by experiments or simulations according to desired engagement strength.

[0057] When the magnet 43 is formed by resin molding using a mold, a corner R remains at a root of the magnet engagement protrusion 435 due to restrictions in mold processing. The circumferential corner R of the magnet engagement protrusion 435 may be a factor that lowers the engagement position accuracy with the housing engagement recess 415. Therefore, in the embodiment, as shown in FIG. 10(B), recesses 436 recessed radially inward are provided on both circumferential sides of the magnet engagement protrusion 435 of the magnet outer peripheral surface 460. In this case, the influence of the circumferential corner R can be avoided. In addition, even when burrs or raised edges are present in the housing engagement recess 415, the recesses 436 function as burr escapes that avoid the influence thereof.

[0058] Next, the positioning recess 437 of the magnet 43 will be described. After the magnet 43 is press-fitted into the housing 41, the magnet inner peripheral surface 431 is magnetized in a state where the magnet 43 is fitted into a magnetizing jig (not shown). The polar-anisotropic plastic magnet exhibits expected performance by being magnetized in the same phase as magnetic field orientation at the time of resin molding (hereinafter, simply referred to as “magnetic field orientation”). For this purpose, the magnet 43 has a magnet engagement protrusion 435 and a positioning recess 437 associated with the

magnetic field orientation. The positioning recess 437 is a recess recessed in the axial direction in a lower end surface 434 of the magnet 43 opposite to the first direction. As will be described later, the magnet 43 is press-fitted into the housing 41 such that the positioning recess 437 is located at the same position as the pin insertion opening 416 in the circumferential direction.

[0059] As an example, the positioning recesses 437 are recesses formed by pin members that push the magnet 43 after resin molding out from a mold, and are provided on the lower end surface 434 at predetermined intervals in the circumferential direction. In this example, fourteen recesses are provided in the lower end surface 434, and two of the fourteen recesses located at the same positions as the magnet engagement protrusions 435 in the circumferential direction are the positioning recesses 437. The positioning recess 437 has, for example, a circular shape when viewed in the axial direction, a diameter of 4 mm, and a depth of 0.5 mm.

[0060] Next, the pin insertion opening 416 of the flange 414 will be described with reference to FIGS. 11 and 12. FIG. 11 is a cross-sectional view showing a press-fitting step for press-fitting the magnet 43 into the housing 41. FIG. 12 is a perspective view showing a state in which the magnet 43 is press-fitted into the housing 41. As described above, the housing 41 has the flange 414 extending radially outward from an outer edge of the housing cylindrical portion 412. The flange 414 has a pin insertion opening 416 through which a guide pin 472 protruding in the axial direction from the press-fitting jig 47 is inserted when the magnet 43 is press-fitted. The pin insertion opening 416 functions as a mark for magnetizing the magnet 43 press-fitted into the housing 41 in the same phase as the magnetic field orientation of the magnet 43. In this example, two pin insertion openings 416 are provided at an interval of 180° in the circumferential direction.

[0061] The magnet 43 is press-fitted by using the press-fitting jig 47 so that the pin insertion opening 416 is located at the same position as the magnet engagement protrusion 435 in the circumferential direction. The press-fitting jig 47 includes a press-fitting jig body 471, a guide pin 472, and an alignment jig 476. The press-fitting jig body 471 is formed of a block-shaped base material, and includes a flange placement portion 473 on which the flange 414 is placed, and a jig recess 474 recessed downward from the flange placement portion 473. As shown in FIG. 11, the jig recess 474 has a shape

capable of accommodating the housing cylindrical portion 412, the magnet end-surface support portion 413, and the top plate portion 411.

[0062] The guide pin 472 has a cylindrical pin shape and is provided on the flange placement portion 473 so as to protrude vertically upward from the flange placement portion 473. The alignment jig 476 includes a flat plate-shaped pressing portion 476a that presses the flange 414 against the flange placement portion 473, a vertical extension portion 476b that extends vertically upward from the pressing portion 476a, a horizontal extension portion 476c that extends horizontally from the vertical extension portion 476b, and a guide protrusion 476d that protrudes downward from the horizontal extension portion 476c. The pressing portion 476a is provided with a pin hole 476e through which the guide pin 472 passes.

[0063] The manufacturing steps of the rotor 40 will be described.

(1) First, the housing 41 is placed on the press-fitting jig 47 such that the top plate portion 411 faces downward, and a position in the circumferential direction is adjusted such that the guide pin 472 passes through the pin insertion opening 416.

(2) The magnet 43 is placed on the housing 41 such that the third magnet outer peripheral surface 463 faces downward. At this time, the third magnet outer peripheral surface 463 enters the housing cylindrical portion 412, and the first magnet outer peripheral surface 461 is positioned above the housing cylindrical portion 412.

(3) The alignment jig 476 is set so that the guide pin 472 passes through the pin hole 476e, and the magnet 43 is rotated so that the positioning recess 437 engages with the guide protrusion 476d, thereby achieving the state shown in FIG. 11.

(4) In this state, the lower end surface 434 is pushed to a position where the upper end surface 433 abuts on the magnet end-surface support portion 413. At this time, the magnet engagement protrusion 435 is fitted into the housing engagement recess 415.

(5) The rotor 40 is taken out from the press-fitting jig 47, set in a magnetizing jig, and magnetized. At this time, by using the pin insertion opening 416 as a mark in the circumferential direction, magnetization can be performed in the same phase as the magnetic field orientation of the magnet 43. The rotor 40 is taken out from the magnetizing jig, whereby the rotor 40 is completed.

[0064] The rotor 40 has been described above.

[0065] An operation of the motor 10 configured as described above will be described. When a three-phase drive current is supplied from the circuit board 48 to the coils 261, 262, and 263 of the stator 20 through the lead wires 268, a rotating magnetic field corresponding to the drive current is generated around the stator core 21 of the stator 20. Due to the interaction between the rotating magnetic field and the drive magnetic poles of the magnet 43, a rotational torque is generated in the rotor 40, and the rotor 40 and a driven body such as blades (not shown) of a ceiling fan connected to the rotor 40 rotate according to the torque.

[0066] Features of the rotor 40 configured as described above will be described. The rotor 40 includes a housing 41 including a housing cylindrical portion 412 having a cylindrical shape, and a magnet 43 having an outer diameter equal to or larger than an inner diameter of the housing cylindrical portion 412 and having a hollow cylindrical shape, the magnet 43 being press-fitted into the housing 41 in the first direction in the axial direction. The magnet outer peripheral surface 460 of the magnet 43 includes a first magnet outer peripheral surface 461 that is pressed against the housing cylindrical portion 412 by press-fitting, and a tapered second magnet outer peripheral surface 462 whose diameter gradually decreases toward an end portion of the magnet 43 in the first direction.

[0067] According to this configuration, since the magnet 43 that can be easily press-fitted along an inclination of the second magnet outer peripheral surface 462 is provided, the assemblability of the rotor 40 can be improved.

[0068] An overview of one aspect of the present disclosure is as follows.

[0069] Item 1.

A rotor (40), comprising:

a housing (41) including a housing cylindrical portion (412) having a cylindrical shape; and

a magnet (43) having an outer diameter equal to or larger than an inner diameter of the housing cylindrical portion (412) and having a hollow cylindrical shape, the magnet (43) being press-fitted into the housing (41) in a first direction in an axial direction;

wherein

a magnet outer peripheral surface (460) of the magnet (43) includes:

a first magnet outer peripheral surface (461) pressed against the housing cylindrical portion (412) by press-fitting; and

a second magnet outer peripheral surface (462) having a tapered shape whose diameter gradually decreases toward an end portion of the magnet (43) in the first direction.

[0070] Item 2.

The rotor (40) according to Item 1,

wherein

the magnet outer peripheral surface (460) includes a third magnet outer peripheral surface (463) continuous with the second magnet outer peripheral surface (462) and extending parallel to the axial direction toward an end portion in the first direction.

[0071] Item 3.

The rotor (40) according to Item 1,

wherein

the magnet (43) includes a magnet engagement protrusion (435) protruding radially outward at an end portion of the magnet outer peripheral surface (460) on a side opposite to the first direction; and

the housing (41) includes a housing engagement recess (415) in the housing cylindrical portion (412) for engaging with the magnet engagement protrusion (435).

[0072] Item 4.

The rotor (40) according to Item 1,

wherein

the magnet (43) includes a magnet engagement recess recessed radially inward at an end portion of the magnet outer peripheral surface (460) on a side opposite to the first direction; and

the housing (41) includes a housing engagement protrusion in the housing cylindrical portion (412) for engaging with the magnet engagement recess.

[0073] Item 5.

The rotor (40) according to Item 1,

wherein

the housing (41) includes a flange (414) extending radially outward from an outer edge of the housing cylindrical portion (412); and

the flange (414) includes a pin insertion opening (416) through which a guide pin (472) protruding in an axial direction from a press-fitting jig (47) is inserted when the magnet (43) is press-fitted.

[0074] Item 6.

The rotor (40) according to Item 1,

wherein

the magnet (43) includes a positioning recess (437) recessed in the axial direction on an end surface opposite to the first direction; and

the magnet (43) is press-fitted into the housing (41) such that the positioning recess (437) is located at the same position as the pin insertion opening (416) in the circumferential direction.

[0075] Item 7.

A motor (10), comprising:

a rotor (40) according to any one of Items 1 to 6.

[0076] The present disclosure has been described above based on the embodiment. The embodiment is intended to be illustrative only, and it will be obvious to those skilled in the art that various modifications to constituent elements or processes could be developed and that such modifications are also within the scope of the present disclosure.

[0077] In the description of the embodiment, an example in which the protrusion is provided on the magnet 43 and the recess that engages with the protrusion is provided on the housing 41 for prevention of relative rotation has been described, but the present disclosure is not limited thereto. A protrusion may be provided on the housing 41, and a recess that engages with the protrusion may be provided on the magnet 43. For example, the magnet 43 may have a magnet engagement recess recessed radially inward at an end portion of the magnet outer peripheral surface 460 on a side opposite to the first direction, and the housing 41 may have a housing engagement protrusion on the housing cylindrical portion 412 for engaging with the magnet engagement recess.

[0078] The configuration of the winding 24 described with reference to FIGS. 7 and 8 is an example, and the configuration of the winding 24 is not particularly limited as long as the coils 261, 262, and 263 constitute a three-phase winding, and a known configuration can be employed.

REFERENCE MARKS IN THE DRAWINGS

[0079]

| | |
|---|---|
| 8 | first wire |
| 9 | second wire |
| 10 | motor |
| 11 | circumferential clearance |
| 12, 13 | radial clearance |
| 20 | stator |
| 21 | stator core |
| 22 | first insulator |
| 23 | second insulator |
| 24 | winding |
| 24N, 24U, 24V, 24W | terminal pin |
| 27 | insertion inclined surface |
| 30 | shaft |
| 30h, 30j | lateral hole |
| 31 | first bearing |
| 32 | second bearing |
| 40 | rotor |
| 41 | housing |
| 42 | cover |
| 43 | magnet |
| 47 | press-fitting jig |
| 48 | circuit board |
| 211 | cylindrical portion |
| 212 | tooth portion |
| 213 | curved surface portion |

214 slot
215 core inner surface portion
221 first base portion
222 first wall portion
223 first tooth portion protrusion
224 first cylindrical portion protrusion
225 first curved surface portion protrusion
226 first inner peripheral wall
227 first outer peripheral wall
228 protrusion
231 second base portion
232 second wall portion
233 second tooth portion protrusion
234 second cylindrical portion protrusion
235 second curved surface portion protrusion
236 second inner peripheral wall
237 second outer peripheral wall
238 protrusion
251, 252, 254, 255 hook
257 central inner peripheral wall
257a wiring passage portion
258 crossover wire arrangement portion
261, 262, 263 coil
268 lead wires
269 sheath tube
411 top plate portion
412 housing cylindrical portion
413 magnet end-surface support portion
414 flange
415 housing engagement recess
416 pin insertion opening

| | |
|---|---|
| 431 | magnet inner peripheral surface |
| 433 | upper end surface |
| 434 | lower end surface |
| 435 | magnet engagement protrusion |
| 436 | recess |
| 437 | positioning recess |
| 460 | magnet outer peripheral surface |
| 461 | first magnet outer peripheral surface |
| 462 | second magnet outer peripheral surface |
| 463 | third magnet outer peripheral surface |
| 471 | press-fitting jig body |
| 472 | guide pin |
| 473 | flange placement portion |
| 474 | jig recess |
| 476 | jig |
| La | central axis |

# CLAIMS

[Claim 1] A rotor, comprising:

a housing including a housing cylindrical portion having a cylindrical shape; and

a magnet having an outer diameter equal to or larger than an inner diameter of the housing cylindrical portion and having a hollow cylindrical shape, the magnet being press-fitted into the housing in a first direction in an axial direction,

wherein

a magnet outer peripheral surface of the magnet includes:

a first magnet outer peripheral surface pressed against the housing cylindrical portion by press-fitting; and

a second magnet outer peripheral surface having a tapered shape and gradually decreasing in diameter toward an end portion of the magnet in the first direction.

[Claim 2] The rotor according to claim 1,

wherein

the magnet outer peripheral surface further includes

a third magnet outer peripheral surface continuous with the second magnet outer peripheral surface and extending parallel to the axial direction toward the end portion of the magnet in the first direction.

[Claim 3] The rotor according to claim 1,

wherein

the magnet includes a magnet engagement protrusion protruding radially outward at the end portion of the magnet outer peripheral surface of the magnet on a side opposite to the first direction; and

the housing includes a housing engagement recess in the housing cylindrical portion for engaging with the magnet engagement protrusion.

[Claim 4] The rotor according to claim 1,

wherein

the magnet includes a magnet engagement recess recessed radially inward at the end portion of the magnet outer peripheral surface of the magnet on a side opposite to the first direction; and

the housing includes a housing engagement protrusion in the cylindrical portion of the housing for engaging with the magnet engagement recess.

[Claim 5] The rotor according to claim 1,

wherein

the housing includes a flange extending radially outward from an outer edge of the housing cylindrical portion; and

the flange includes a pin insertion opening through which a guide pin protruding in an axial direction from a press-fitting jig is inserted when the magnet is press-fitted.

[Claim 6] The rotor according to claim 5,

wherein

the magnet includes a positioning recess recessed in the axial direction on an end surface opposite to the first direction; and

the magnet is press-fitted into the housing such that the positioning recess is located at the same position as the pin insertion opening in the circumferential direction.

[Claim 7] A motor, comprising:

a rotor according to any one of claims 1 to 6.