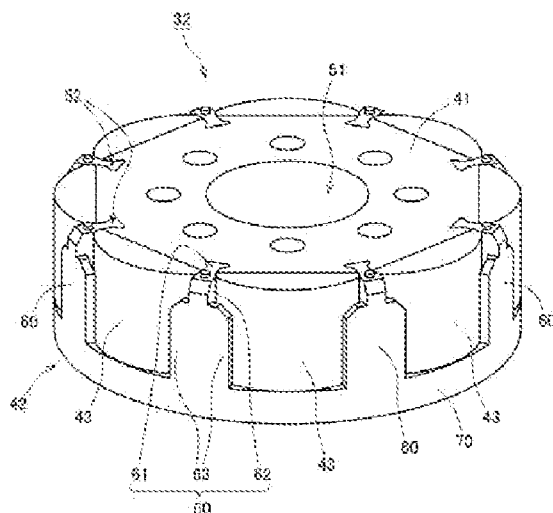




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(54) Title: ROTOR UNIT, ROTATING ELECTRICAL MACHINE, AND METHOD FOR MANUFACTURING ROTOR UNIT

[Fig. 4]



(57) Abstract: A rotor unit includes a rotor core made of laminated steel sheets that are vertically laminated, and a holder made of resin. The rotor core and the holder are fixed by insert molding. For this reason, the process of manufacturing the rotor core and the holder is shortened. Additionally, in the outer peripheral surface of the rotor core, a portion of resin that constitutes the holder is present between the plurality of steel sheets that constitutes the rotor core. For this reason, the fixing strength of the rotor core and the holder improves. Additionally, since the separation between the rotor core and the holder is suppressed, the magnets can be easily press-fitted.

## Description

### **Title of Invention: ROTOR UNIT, ROTATING ELECTRICAL MACHINE, AND METHOD FOR MANUFACTURING ROTOR UNIT**

#### **Technical Field**

[0001] The present invention relates to a rotor unit, a rotating electrical machine, and a method for manufacturing a rotor unit.

#### **Background Art**

[0002] In the related art, an inner rotor type motor that rotates a rotor unit having magnets inside a coil is known. For example, WO-A 2006-008964 discloses a brushless motor including a stator, and a rotor arranged inside the stator.

[0003] The rotor of WO-A 2006-008964 includes a rotor shaft, a rotor core, a magnet holder, and six rotor magnets. Paragraph 0026 of WO-A 2006-008964 discloses that the rotor core is fixed to the rotor shaft, and the six rotor magnets are attached to an outer periphery of the rotor core. Additionally, Paragraph 0027 of WO-A 2006-008964 discloses that the magnet holder is fixed to the rotor shaft.

#### **Citation List**

##### **Patent Literature**

[0004] PTL 1: WO-A 2006-008964

#### **Summary of Invention**

##### **Technical Problem**

[0005] Additionally, Paragraph 0029 of WO-A 2006-008964 discloses that a fitting projection of the magnet holder is fitted into an electrode holder attachment groove formed at an outer peripheral portion of the rotor core. In WO-A 2006-008964, such fitting prevents a holder arm of the magnet holder from slipping out of the rotor core in a radial direction.

[0006] However, WO-A 2006-008964 does not disclose how to obtain the axial fixing strength between the rotor core and the magnet holder. Particularly, if the rotor core and the magnet holder are not firmly fixed in an axial direction when the magnets are press-fitted to the magnet holder in the axial direction, there is a concern that the rotor core and the magnet holder may be separated from each other due to the load at the time of press-fitting.

[0007] An object of the invention is to provide the technique of improving the fixing strength between a rotor core and a holder in a rotor unit of a rotating electrical machine.

## Solution to Problem

- [0008] A rotor unit for a rotating electrical machine that is a first exemplary invention of the present application includes an annular rotor core made of laminated steel sheets that are vertically laminated; a plurality of magnets arranged in a circumferential direction around the rotor core; and a holder made of resin that holds the magnets. The holder has a plurality of partitioning portions that extends vertically along an outer peripheral surface of the rotor core, and a coupling portion that connects the plurality of partitioning portions. The rotor core and the holder are fixed by insert molding. In the outer peripheral surface of the rotor core, a portion of resin that constitutes the holder is present between the plurality of steel sheets that constitutes the rotor core. The magnet is press-fitted into a pair of partitioning portions that is mutually adjacent.
- [0009] A second exemplary invention of the present application is a method for manufacturing a rotor unit for a rotating electrical machine including an annular rotor core made of laminated steel sheets that are vertically laminated, a plurality of magnets arranged in a circumferential direction around the rotor core, and a holder made of resin that holds the magnets. The manufacturing method includes the following steps. One is a) arranging the rotor core inside a mold, injecting resin in a fluidized state into the mold, and insert-molding the holder in a shape having a plurality of partitioning portions that extends vertically along an outer peripheral surface of the rotor core, and a coupling portion that connects the partitioning portions. Another is b) press-fitting the magnet to the pair of partitioning portions that are mutually adjacent after step a).
- [0010] According to the first exemplary invention of the present application, in the outer peripheral surface of the rotor core, a portion of resin that constitutes the holder is present between the plurality of steel sheets that constitutes the rotor core. This improves the fixing strength of the rotor core and the holder.
- [0011] According to the second exemplary invention of the present application, the manufacturing process of the rotor core and the holder is shortened by the insert molding. Additionally, a portion of resin that constitutes the holder is present between the plurality of steel sheets that constitutes the rotor core. This improves the fixing strength of the rotor core and the holder. Additionally, since the separation between the rotor core and the holder is suppressed, the magnets can be easily press-fitted.
- The present invention is arranged to achieve an improvement in perpendicularity of the upper end surface of the thrust portion with respect to the outside surface of the shaft.
- The above and other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments of the present invention with reference to the attached

drawings.

### **Brief Description of Drawings**

- [0012] [fig.1]Fig. 1 is a perspective view of a rotor unit.  
 [fig.2]Fig. 2 is a longitudinal sectional view in the vicinity of a boundary portion between a rotor core and a holder.[Fig. 3] Fig. 3 is a longitudinal sectional view of a motor.[Fig. 4] Fig. 4 is a perspective view of the rotor unit.[Fig. 5] Fig. 5 is a top view of the rotor unit.[Fig. 6] Fig. 6 is a longitudinal sectional view of the rotor unit.[Fig. 7] Fig. 7 is a partially perspective view of the rotor core and a magnet holder.[Fig. 8] Fig. 8 is a flowchart showing a manufacturing procedure of the rotor unit.[Fig. 9] Fig. 9 is a longitudinal sectional view showing the state when insert molding is performed.[Fig. 10] Fig. 10 is a partially longitudinal cross-sectional view of the rotor unit before a magnet is press-fitted.[Fig. 11] Fig. 11 is a partially longitudinal sectional view of the rotor unit after the magnet is press-fitted.

### **Examples**

- [0013] Exemplary embodiments of the invention will be described below, referring to the drawings. In addition, the shapes and positional relationship of respective portions will be described with a direction along the central axis of a rotating electrical machine being a vertical direction. However, this merely defines the vertical direction for the convenience of description, and does not limit the posture of a rotor unit and a rotating electrical machine related to the invention when being used.
- [0014] Fig. 1 is a perspective view of a rotor unit 32A for a rotating electrical machine related to one embodiment of the invention. As shown in Fig. 1, the rotor unit 32A includes a rotor core 41A, a holder 42A, and a plurality of magnets 43A.
- [0015] The rotor core 41A is an annular member made of laminated steel sheets that are vertically laminated. The holder 42A is a member made of resin, which holds the magnets 43A. The holder 42A has a plurality of partitioning portions 60A and a coupling portion 70A. The plurality of partitioning portions 60A extends vertically along the outer peripheral surface of the rotor core 41A, respectively. The coupling portion 70A connects the plurality of partitioning portions 60A. The plurality of magnets 43A is arranged in the circumferential direction around the rotor core 41A. Each magnet 43A is press-fitted into a pair of partitioning portions 60 that is mutually adjacent.
- [0016] When the rotor unit 32A is manufactured, first, the rotor core 41A is arranged inside a mold. Then, resin in a fluidized state is injected into the mold. By injecting resin, the holder 42A is insert-molded in a shape having the plurality of partitioning portions 60A and a coupling portion 70A. Thereafter, the magnet 43A is press-fitted between a pair of partitioning portions 60A that is mutually adjacent.

- [0017] As such, in the present embodiment, the rotor core 41A and the holder 42A are fixed by insert molding. For this reason, the process of manufacturing the rotor core 41A and the holder 42A is shortened. Fig. 2 is a longitudinal sectional view in the vicinity of a boundary portion between the rotor core 41A and the holder 42A. As shown in Fig. 2, a portion of the resin that constitutes the holder 42A is present among a plurality of steel sheets 411A that constitutes the rotor core 41A in the outer peripheral surface of the rotor core 41A. This firmly fixes the rotor core 41A and the holder 42A. Additionally, since the separation between the rotor core 41A and the holder 42A is suppressed, the magnets 43A can be easily press-fitted.
- [0018] Subsequently, a more specific embodiment of the invention will be described.
- [0019] Fig. 3 is a longitudinal sectional view of the motor 1 that becomes an example of a rotating electrical machine. The motor 1 of the present embodiment is mounted on an automobile, and is used in order to generate a driving force for power steering. As shown in Fig. 3, the motor 1 includes a stationary portion 2 and a rotating portion 3. The rotating portion 3 is rotatably supported with respect to the stationary portion 2.
- [0020] The stationary portion 2 of the present embodiment has a housing 21, a lid portion 22, an armature 23, a lower bearing 24, and an upper bearing 25.
- [0021] The housing 21 is a bottomed, substantially cylindrical housing that accommodates the armature 23, the lower bearing 24, and the rotating portion 3 therein. A recess 211 that holds the lower bearing 24 is formed at the center of the bottom of the housing 21. The lid portion 22 is a plate-shaped member that closes an upper opening of the housing 21. A circular hole 221 that holds the upper bearing 25 is formed at the center of the lid portion 22.
- [0022] The armature 23 generates magnetic flux according to a driving current. The armature 23 has a stator core 26 and a coil 27. The stator core 26 is made of laminated steel sheets in which a plurality of steel sheets is laminated in an axial direction (a direction along the central axis 9; this is the same in the following).
- The stator core 26 has an annular core back 261, and a plurality of teeth 262 that protrude toward the inside in a radial direction (a direction orthogonal to the central axis 9; this is the same in the following) from the core back 261. The core back 261 is fixed to the inner peripheral surface of the side wall of the housing 21. The coil 27 is constituted by conducting wires that are wound around each tooth 262 of the stator core 26.
- [0023] The lower bearing 24 and the upper bearing 25 rotatably support a shaft 31 on the side of the rotating portion 3. Ball bearings that allow an outer ring and an inner ring to rotate relatively via balls are used for the lower bearing 24 and the upper bearing 25 of the present embodiment.
- [0024] An outer ring 241 of the lower bearing 24 is fixed to the recess 211 of the housing

21. Additionally, an outer ring 251 of the upper bearing 25 is fixed to the edge of the circular hole 221 of the lid portion 22. On the other hand, inner rings 242 and 252 of the lower bearing 24 and the upper bearing 25 are fixed to the shaft 31. For this reason, the shaft 31 is rotatably supported with respect to the housing 21 and the lid portion 22.

[0025] The rotating portion 3 of the present embodiment has the shaft 31, a pair of rotor units 32 and 33, and a cover 34.

[0026] The shaft 31 is a substantially cylindrical member that extends in the vertical direction along the central axis 9. The shaft 31 rotates about the central axis 9, and is supported by the above-described lower bearing 24 and upper bearing 25. Additionally, the shaft 31 has a head 311 that protrudes upward from the lid portion 22. The head 311 is coupled to a power steering device of an automobile via a power transmission mechanism, such as a gear.

[0027] The pair of rotor units 32 and 33 and the cover 34 rotate along with the shaft 31 radially inside the armature 23. The pair of rotor units 32 and 33 has a rotor core 41, a magnet holder 42, and a plurality of magnets 43, respectively. The pair of rotor units 32 and 33 is arranged in the axial direction in a state where the units are turned upside down. The detailed structure of the rotor units 32 and 33 will be described below.

[0028] The cover 34 is a substantially cylindrical member that holds the pair of rotor units 32 and 33. The cover 34 covers the outer peripheral surface of the rotor units 32 and 33 and portions of upper and lower end surfaces of the rotor units. Thereby, the pair of rotor units 32 and 33 is maintained in a state where the units are brought close to each other or brought into contact with each other.

[0029] In such a motor 1, if a driving current is applied to the coil 27 of the stationary portion 2, radial magnetic flux is generated in the plurality of teeth 262 of the stator core 26. Then, circumferential torque is generated by the action of the magnetic flux between the teeth 262 and the magnet 43, and the rotating portion 3 rotates about the central axis 9 with respect to the stationary portion 2. If the rotating portion 3 rotates, a driving force is transmitted to the power steering device coupled to the shaft 31.

[0030] As described above, the motor 1 of the present embodiment has the pair of rotor units 32 and 33. The detailed structure of the rotor unit 32 arranged on the lower side will be described below. Although the rotor unit 33 arranged on the upper side is arranged in a state where the rotor unit 32 arranged on the lower side is vertically reversed, since the structure itself thereof is equivalent to that of the lower rotor unit 32, duplicate description thereof will be omitted.

[0031] Fig. 4 is a perspective view of the rotor unit 32. Fig. 5 is a top view of the rotor unit 32. As shown in Figs. 4 and 5, the rotor unit 32 has the rotor core 41, the magnet holder 42, and the plurality of magnets 43.

[0032] The rotor core 41 is an annular member fixed to the shaft 31. The rotor core 41 is

made of laminated steel sheets in which electromagnetic steel sheets are vertically laminated. The rotor core 41 of the present embodiment has a regular polygonal columnar appearance. A through hole 51 that allows the shaft 31 to be inserted therethrough is provided at the center of the rotor core 41. Additionally, the outer peripheral surface of the rotor core 41 is provided with a plurality of groove portions 52 that extends in the axial direction. The groove portions 52 are depressed radially inward at boundary portions of a plurality of planes that constitutes the outer peripheral surface of the rotor core 41.

- [0033] The magnet holder 42 is a member that holds the magnets 43 made of resin. The magnet holder 42 has a plurality of partitioning portions 60, and a coupling portion 70 that connects lower ends of the plurality of partitioning portions 60. The plurality of partitioning portions 60 is arranged at equal intervals in the circumferential direction. Each partitioning portion 60 extends in the axial direction along the lateral face of the rotor core 41 in the vicinity of each groove portion 52 of the rotor core 41. The coupling portion 70 is a circular portion located below the plurality of partitioning portions 60. A radial inside portion of the coupling portion 70 comes in contact with the lower surface of the rotor core 41.
- [0034] Fig. 6 is a longitudinal sectional view of the rotor unit 32 seen from the position A-A in Fig. 5. In the present embodiment, the magnet holder 42 is formed on the surface of the rotor core 41 by insert molding. When insert molding is performed, resin is injected into a mold for molding in a state where the rotor core 41 is arranged in advance inside the mold. Then, the rotor core 41 and the magnet holder 42 are fixed to each other with hardening of the resin.
- [0035] In Fig. 6, a portion of a boundary between the rotor core 41 and the magnet holder 42 is shown in an enlarged manner. As shown in the enlarged view, gaps 412 are present between the plurality of steel sheets 411 that constitutes the rotor core 41 in the vicinity of the outer peripheral surface of the rotor core 41. A portion of the resin that constitutes the magnet holder 42 is present in the gaps 412. This is formed as resin in a fluidized state enters the gaps 412 of the rotor core 41 when insert molding is performed.
- [0036] As for the rotor core 41 and the magnet holder 42 of the present embodiment, both the members slightly bite into each other at the boundary portion thereof. Thereby, the rotor core 41 and the magnet holder 42 are firmly fixed. Particularly, resin is present in an axial gap formed between a steel sheet 411 and a steel sheet 411. For this reason, the axial relative movement between the rotor core 41 and the magnet holder 42 is suppressed.
- [0037] The plurality of steel sheets 411 that constitutes the rotor core 41 is obtained by punching, respectively. For this reason, as shown in the enlarged view in Fig. 6, a

curved portion 413 according to the direction of punching is formed at the end of each steel sheet. In the present embodiment, the curved portion 413 is curved toward the upside. For this reason, upward coming-off of the rotor core 41 with respect to the magnet holder 42 is further suppressed.

[0038] Additionally, as shown in Figs. 4 and 5, each partitioning portion 60 of the present embodiment has an engaging portion 61 that is held in each groove portion 52 of the rotor core 41. At the time of insert molding, the engaging portion 61 is formed as the resin that has flowed into the groove portion 52 hardens. For this reason, a gap is not easily generated between the engaging portion 61 and the rotor core 41 in the groove portion 52. Accordingly, the rotor core 41 and the magnet holder 42 are more firmly fixed.

[0039] Particularly, in the present embodiment, the engaging portion 61 of which the dimension in a width direction increases toward the inside in the radial direction engages the groove portion 52 of which the dimension in the width direction decreases toward the outside in the radial direction. This further suppresses the radial separation of the rotor core 41 and the magnet holder 42.

[0040] The plurality of magnets 43 is arranged around the rotor core 41. Each magnet 43A is substantially arcuate on the external diameter side thereof and substantially linear on the internal diameter side thereof, and is press-fitted into a pair of partitioning portions 60 that is mutually adjacent. The radial outside surface of the magnet 43 is a magnetic polar surface that faces the armature 23. The plurality of magnets 43 is arranged at equal intervals so that an N magnetic polar surface and an S magnetic polar surface are alternately arranged in the circumferential direction. In addition, for example, an Nd-Fe-B alloy based sintered magnet can be used for a magnet 43.

[0041] Fig. 7 is a partial perspective view of the rotor core 41 and the magnet holder 42. The detailed shape of the magnet holder 42 will be described, referring to Figs. 4, 5, and 7.

[0042] The partitioning portion 60 of the magnet holder 42 has the columnar portion 62 and a wall portion 63. The columnar portion 62 is a portion that extends in the axial direction between the magnets 43 that are mutually adjacent. The wall portion 63 is a portion that spreads toward one side or the other side in the circumferential direction from the columnar portion 62. The radial outside surface of the magnet 43 is partially covered with the wall portion 63.

[0043] An upper end of the wall portion 63 is located lower than an upper end of the rotor core 41. For this reason, when a magnet 43 is attached, the lower end of the magnet 43 is brought into contact with the lateral face of the rotor core 41, so that the magnet 43 can be positioned in the radial direction. The magnet 43 positioned in the radial direction can be press-fitted radially inward of the wall portion 63.

[0044] Additionally, the upper end of the wall portion 63 is located lower than an upper end

of the columnar portion 62. For this reason, when a magnet 43 is attached, the lower end of the magnet 43 can be easily inserted between the pair of columnar portions 62 that is mutually adjacent. Additionally, the magnet 43 can be positioned in the radial direction by the pair of columnar portions 62, and then, the magnet 43 can then be press-fitted radially inward of the wall portion 63.

[0045] If the magnet 43 is positioned in the radial direction and the circumferential direction in this way, the bias of the load at the time of press-fitting can be suppressed. Accordingly, it is possible to suppress the magnet 43 from shaving off the partitioning portions 60 of the magnet holder 42 and generating dust at the time of press-fitting.

[0046] Additionally, in the present embodiment, an inclined surface 631 is provided in the vicinity of an upper end of the radial inside surface of the wall portion 63. The inclined surface 631 gradually approaches the outer peripheral surface of the rotor core 41 downward from an upper end. The inclined surface 631 guides the magnet 43 radially inward of the wall portion 63 at the time of the press-fitting of the magnet 43. This facilitates the press-fitting work of the magnet 43. Additionally, as the magnet 43 is guided to a proper position, the bias of the load at the time of press-fitting is further suppressed. As a result, generation of dust accompanying the press-fitting is further suppressed.

[0047] Additionally, if such an inclined surface 631 is provided, the vicinity of the upper end of the wall portion 63 can be easily separated from a mold at the time of insert molding. In this way, the inclined surface 631 has technical value at the time of both press-fitting and insert molding.

[0048] The coupling portion 70 has a bottom 71 located below the magnet 43. That is, the bottom 71 is also arranged at a circumferential position between the partitioning portions 60 that are mutually adjacent. The lower surface of the magnet 43 after press-fitting faces the upper surface of the bottom 71 in the axial direction, and the lower surface of the magnet 43 and the upper surface of the bottom 71 separate from or come into contact with each other. Additionally, the bottom 71 has a recess 72 below both ends the magnet 43 in the circumferential direction. The recess 72 of the present embodiment is provided at a position surrounded by the lateral face of the rotor core 41, the columnar portion 62, and the wall portion 63.

[0049] Even if the magnet 43 contacts the columnar portion 62 or the wall portion 63 to generate dust at the time of the press-fitting of the magnet 43, the dust is received in the recess 72. For this reason, it is possible to suppress a problem of the dust being caught between the upper surface of the bottom 71 and the lower surface of the magnet 43, whereby the axial position of the magnet 43 deviates. Additionally, the recess 72 is sealed by the lower surface of the magnet 43 after press-fitting, and becomes a closed space. For this reason, scattering of the dust received in the recess 72 to the outside is

prevented.

[0050] In addition, at the time of the press-fitting of the magnet 43, the columnar portion 62 receives a stronger load from the magnet 43 than the wall portion 63. Accordingly, the columnar portion 62 becomes a source of dust more easily than the wall portion 63. If this point is taken into consideration, it is preferable that the recess 72 be provided at least at a position adjacent to the lower end of the columnar portion 62.

[0051] Subsequently, an example of a method for manufacturing the rotor unit 32 will be described, referring to Figs. 8 to 11. Fig. 8 is a flowchart showing a manufacturing procedure of the rotor unit 32. Fig. 9 is a longitudinal sectional view showing the state where insert molding is performed. The position of the section of Fig. 9 is equivalent to the position A-A in Fig. 5 after manufacture. Additionally, Figs. 10 and 11 are longitudinal sectional views showing the state when the magnet 43 is press-fitted to the magnet holder 42. The positions of the sections of Figs. 10 and 11 are equivalent to the position B-B in Fig. 5 after manufacture.

[0052] When the rotor unit 32 is manufactured, first, a pair of molds 81 and 82 and the rotor core 41 made in advance are prepared (Step S1). The pair of molds 81 and 82 form a cavity 83 inside the pair of molds 81 and 82 by bringing mutually opposed surfaces into contact with each other. The cavity 83 corresponds to the shape of the rotor core 41 and the magnet holder 42. The rotor core 41 is made of laminated steel sheets in which steel sheets subjected to punching are laminated in the axial direction.

[0053] Next, the rotor core 41 is arranged inside the pair of molds 81 and 82 (Step S2). Here, first, the rotor core 41 is set inside one mold 81. Then, the upper portion of the mold 81 is closed by the other mold 82. Thereby, the cavity 83 is formed inside molds 81 and 82, bringing a state where the rotor core 41 is arranged in the cavity 83.

[0054] Thereafter, resin 421 in a fluidized state is injected into the cavity 83 (Step S3). Here, as shown in Fig. 9, the resin 421 in the fluidized state is injected into the cavity 83 through a runner 821 provided in the mold 82. The resin 421 in the fluidized state also flows into the groove portions of the rotor core 41. Additionally, in the lateral face of the rotor core 41, the resin 421 in a fluidized state also enters gaps among the plurality of steel sheets 411 that constitute the rotor core 41.

[0055] If the resin 421 in the fluidized state spreads in the cavity 83, the resin 421 in the mold 81 and 82 is cooled and solidified (Step S4). The resin 421 in the mold 81 and 82 is solidified into the magnet holder 42. The magnet holder 42 is molded in a shape having the plurality of partitioning portions 60 and the coupling portion 70, including the above engaging portion 61, the columnar portion 62, the wall portion 63, the inclined surface 631, the bottom 71, and the recess 72.

[0056] Additionally, the rotor core 41 and the magnet holder 42 are fixed along with the solidification of the resin. Thereby, in the lateral face of the rotor core 41, a portion of the

resin that constitutes the magnet holder 42 is present among the plurality of steel sheets 411 that constitutes the rotor core 41. Thereby, the rotor core 41 and the magnet holder 42 are firmly fixed.

[0057] Thereafter, the pair of molds 81 and 82 are opened, and the rotor core 41 and the magnet holder 42 are separated from the molds 81 and 82 (Step S5). The inclined surface 631 is formed at the upper end of the wall portion 63 of the magnet holder 42. For this reason, the wall portion 63 can be easily separated from the mold 82.

[0058] The above Steps S1 to S5 are the procedure that becomes an example of the insert molding. Thereby, the rotor core 41 and the magnet holder 42 of Fig. 6 are obtained. At the time of insert molding, both the molding of the magnet holder 42 and the fixation of the rotor core 41 and the magnet holder 42 are performed. For this reason, the process of manufacturing the rotor core 41 and the magnet holder 42 is shortened.

[0059] Subsequently, a magnet 43 is prepared, and the magnet 43 is positioned at a position to be inserted with respect to the rotor core 41 and the magnet holder 42 (Step S6). Here, first, a lower end of the magnet 43 is brought close to the lateral face of the rotor core 41 above the wall portion 63 as indicated by an arrow 84 in Fig. 10. Then, the lower end of the magnet 43 is brought into contact with the lateral face of the rotor core 41. This determines the radial position of the magnet 43. Further, the lower end of the magnet 43 is inserted between a pair of columnar portions 62 that is mutually adjacent. This determines the circumferential position of the magnet 43.

[0060] Next, the magnet 43 is moved downward as indicated by an arrow 85 in Fig. 10. Here, the inclined surface 631 is provided at the upper end of the wall portion 63. For this reason, even if the position of the magnet 43 has deviated slightly, if the lower end of the magnet 43 is moved along the inclined surface 631, the magnet 43 is guided radially inward of the wall portion 63. This more precisely determines the position of the magnet 43.

[0061] Thereafter, the magnet 43 is press-fitted to the pair of columnar portions 62 that is mutually adjacent and the wall portion 63 (Step S7). In the above step S6, the magnet 43 is positioned in the radial direction and in the circumferential direction. For this reason, the bias of load at the time of press-fitting is suppressed. As a result, generation of dust accompanying the press-fitting is suppressed.

[0062] Additionally, the magnet holder 42 of the present embodiment has the recess 72 below both ends the magnet 43 in the circumferential direction. For this reason, even if the magnet 43 shaves off the partitioning portion 60 generating dust 86 at the time of press-fitting, as shown in Fig. 11, the dust 86 can be received in the recess 72. For this reason, it is possible to suppress a problem of the dust being caught between the upper surface of the bottom 71 and the lower surface of the magnet 43, whereby the axial position of the magnet 43 deviates. Additionally, the recess 72 is sealed by the lower

surface of the magnet 43 after press-fitting. For this reason, scattering the dust 86 received in the recess 72 to the outside is prevented.

[0063] Additionally, the rotor core 41 and the magnet holder 42 are firmly fixed by insert molding. For this reason, the load at the time of the press-fitting of the magnet 43 suppresses the rotor core 41 and the magnet 42 from being separated from each other. Accordingly, the magnet 43 can be easily press-fitted.

[0064] If a plurality of magnets is intended to be arranged inside the mold at the time of the above insert molding, it is necessary to fix the magnets to the surface of the rotor core by adhesion or the like. In contrast, in the present embodiment, the magnet 43 is press-fitted into the magnet holder 42 after insert molding is completed and hardening is made. For this reason, the time and effort to adhere the magnet 43 to the rotor core 41 can be saved. Additionally, a plurality of magnets 43 can be easily positioned with high precision.

[0065] Features of the above-described preferred embodiments and the modifications thereof may be combined appropriately as long as no conflict arises.

While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

[0066] The inclined surface 631 of the magnet holder 42 may be a curved surface as shown in Fig. 7, or may be a planar surface. Additionally, a chamfered inclined surface may be provided not only at the magnet holder 42 but also at the lower end of the magnet 43. If so, the magnet 43 can be more smoothly press-fitted to the magnet holder 42. Additionally, generation of dust accompanying the press-fitting can be further suppressed.

[0067] The number of the partitioning portions 60 of the magnet holder 42 and the number of the magnets 43 may be different numbers from those of the above embodiment. Additionally the coupling portion 70 of the magnet holder 42 may connect portions other than the lower ends of the plurality of partitioning portions 60.

[0068] Additionally, the number of the rotor units 32 included in the rotating portion 3 of the motor 1 may be one, or may be three or more.

[0069] Additionally, the rotating electrical machine of the invention may be the above motor 1 for power steering, or may be motors used for other portions of an automobile. For example, the rotating electrical machine of the invention may be a motor for generating the driving force of an electric motorcar. Additionally, the rotating electrical machine of the invention may be a motor used for an electric power-assisted bicycle, an electric motorcycle, home electronics, OA equipment, a medical instrument, or the like.

[0070] Additionally, a generator can also be configured with the structure equivalent to the

motor of the above embodiment or modification. The rotating electrical machine of the invention may be a generator used for an automobile, an electric power-assisted bicycle, wind power generation, or the like.

[0071] Additionally, the respective elements appeared in the above embodiment or modification may be appropriately combined together within a range where inconsistency does not occur.

[0072] The invention can be used for a rotor unit, a rotating electrical machine, and a method for manufacturing a rotor unit.

### **Reference Signs List**

[0073] 1: motor  
 2: stationary portion  
 3: rotating portion  
 9: central axis  
 21: housing  
 22: lid portion  
 23: armature  
 24: lower bearing  
 25: upper bearing  
 26: stator core  
 27: coil  
 31: shaft  
 32, 32A, 33: rotor unit  
 34: cover  
 41, 41A: rotor core  
 42: magnet holder  
 42A: holder  
 43, 43A: magnet  
 51: through hole  
 52: groove portion  
 60, 60A: partitioning portion  
 61: engaging portion  
 62: columnar portion  
 63: wall portion  
 70, 70A: coupling portion  
 71: bottom  
 72: recess  
 81, 82: mold

411, 411A: steel sheet

412: gap

413: curved portion

421: resin in fluidized state

631: inclined surface

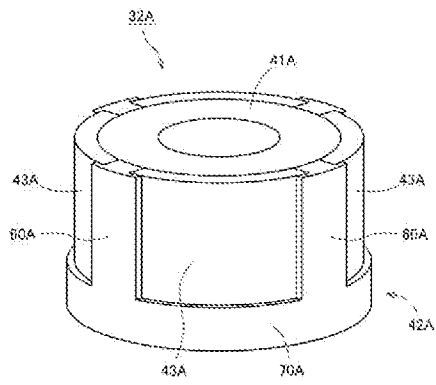
## Claims

- [Claim 1] A rotor unit for a rotating electrical machine comprising:  
an annular rotor core made of laminated steel sheets that are vertically laminated;  
a plurality of magnets arranged in a circumferential direction around the rotor core; and  
a holder made of resin that holds the magnets, wherein the holder has a plurality of partitioning portions that extends vertically along an outer peripheral surface of the rotor core, and a coupling portion that connects the plurality of partitioning portions,  
wherein the rotor core and the holder are fixed by insert molding,  
wherein a portion of resin that constitutes the holder is present between the plurality of steel sheets that constitutes the rotor core in the outer peripheral surface of the rotor core, and  
wherein the magnet is press-fitted into the pair of partitioning portions that is mutually adjacent.
- [Claim 2] The rotor unit according to Claim 1,  
wherein the partitioning portion has  
a columnar portion located between the magnets that are mutually adjacent, and  
a wall portion that partially covers a radial outside surface of the magnet, and  
wherein the inner peripheral surface of the wall portion includes an inclined surface that gradually approaches the outer peripheral surface of the rotor core downward from an upper end.
- [Claim 3] The rotor unit according to Claim 2,  
wherein an upper end of the wall portion is located lower than an upper end of the rotor core.
- [Claim 4] The rotor unit according to Claim 2 or 3,  
wherein an upper end of the wall portion is located lower than an upper end of the columnar portion.
- [Claim 5] The rotor unit according to any one of Claims 1 to 4,  
wherein the coupling portion has a bottom that faces a lower surface of the magnet,  
wherein the bottom has a recess located below both ends of the magnet in the circumferential direction, and  
wherein the recess is sealed by the magnet.

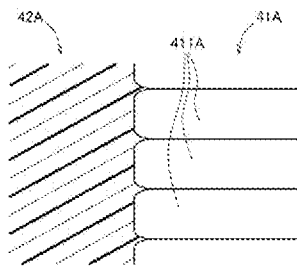
- [Claim 6] The rotor unit according to any one of Claims 1 to 5,  
wherein the rotor core has a plurality of vertically extending groove portions in an outer peripheral surface thereof, and  
wherein the groove portion has a shape of which the dimension in a width direction decreases toward the outside in a radial direction, and  
wherein the partitioning portion has an engaging portion held within the groove portion.
- [Claim 7] The rotor unit according to any one of Claims 1 to 6,  
wherein the ends of the plurality of steel sheets are curved toward the upside in the vicinity of the outer peripheral surface of the rotor core.
- [Claim 8] A rotating electrical machine comprising:  
a stationary portion; and  
a rotating portion rotatably supported with respect to the stationary portion,  
wherein the rotating portion has the rotor unit according to any one of Claims 1 to 7, and a shaft inserted into the rotor core, and  
wherein the stationary portion has a bearing that rotatably supports the shaft, and an armature arranged radially outside the rotor unit.
- [Claim 9] A method for manufacturing a rotor unit for a rotating electrical machine including an annular rotor core made of laminated steel sheets that are vertically laminated, a plurality of magnets arranged in a circumferential direction around the rotor core, and a holder made of resin that holds the magnets, the method comprising:  
a) arranging the rotor core inside a mold, and injecting resin in a fluidized state into the mold to insert-mold the holder,  
wherein a plurality of partitioning portions that extends vertically along an outer peripheral surface of the rotor core, and a coupling portion that connects the partitioning portions are formed by insert molding, and  
b) a magnet is press-fitted to the pair of partitioning portions that are mutually adjacent after step a).
- [Claim 10] The manufacturing method according to Claim 9,  
wherein, in step a),  
the partitioning portion is molded in a shape having a columnar portion located between the magnets that are mutually adjacent, and a wall portion that partially covers a radial outside surface of the magnet, and  
an inclined surface that gradually approaches the outer peripheral surface of the rotor core downward from an upper end is molded on the inner peripheral surface of the wall portion.

- [Claim 11] The manufacturing method according to Claim 10, wherein an upper end of the wall portion is molded at a position lower than an upper end of the rotor core in step a).
- [Claim 12] The manufacturing method according to Claim 10 or 11, wherein an upper end of the wall portion is molded at a position lower than an upper end of the columnar portion in step a).
- [Claim 13] The manufacturing method according to any one of Claims 9 to 12, wherein the coupling portion is molded in a shape having a bottom arranged at a circumferential position between the partitioning portions that are mutually adjacent, and a recess located at both ends of the bottom in a circumferential direction, in step a), and wherein the magnet seals the recess in step b).

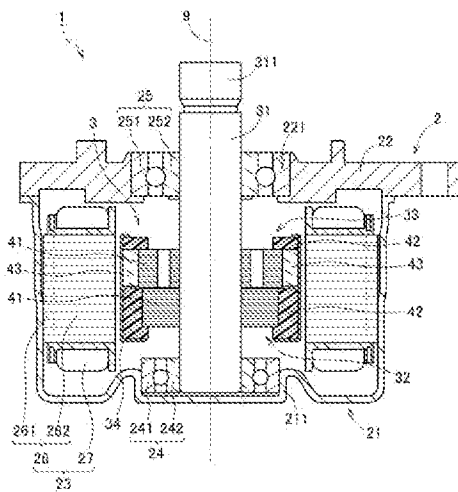
[Fig. 1]



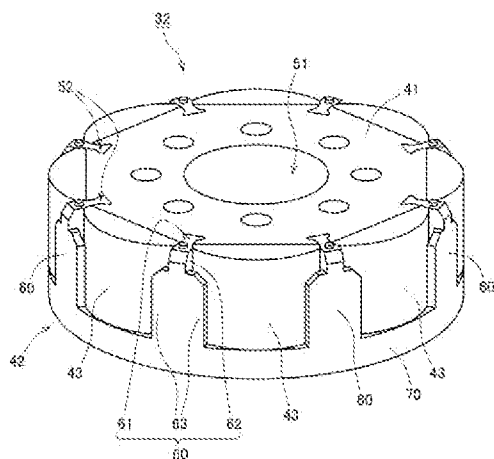
[Fig. 2]



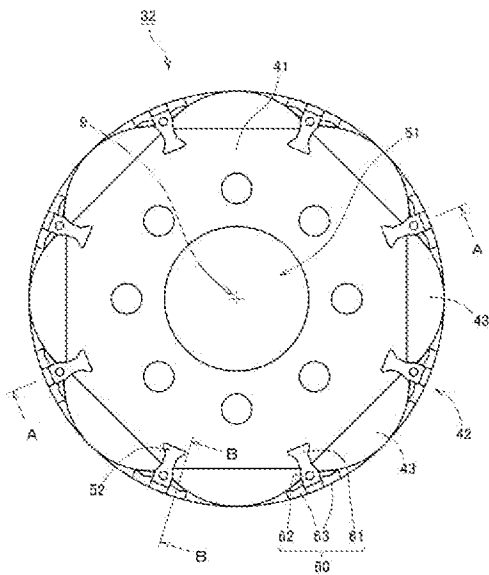
[Fig. 3]



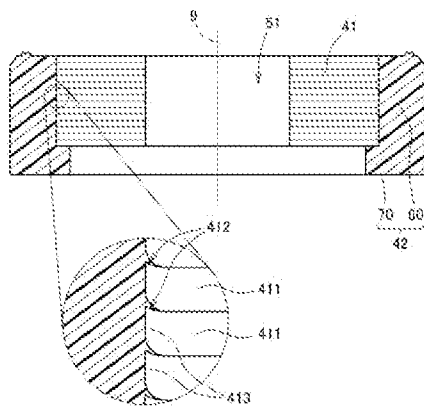
[Fig. 4]



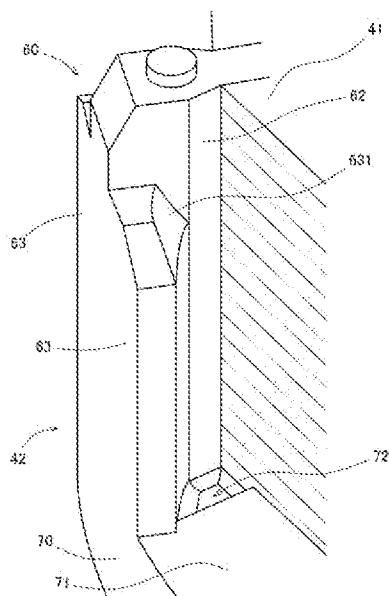
[Fig. 5]



[Fig. 6]



[Fig. 7]



[Fig. 8]

START

S1: PREPARE MOLD AND ROTOR CORE

S2: ARRANGE ROTOR CORE IN MOLD

S3: INJECT RESIN

S4: SOLIDIFICATION

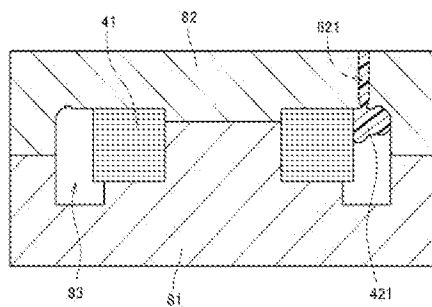
S5: MOLD SEPARATION

S6: POSITION MAGNET

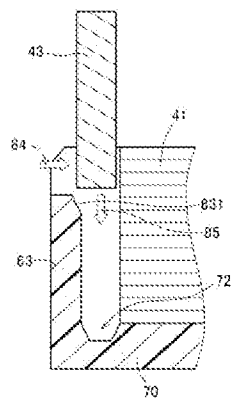
S7: PRESS-FIT MAGNET

END

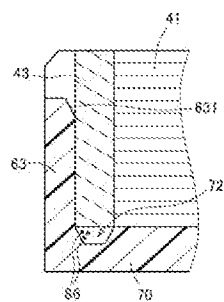
[Fig. 9]



[Fig. 10]



[Fig. 11]



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/002273

## A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H02K1/27 (2006.01) i, H02K15/03 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. H02K1/27, H02K15/03

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996  
 Published unexamined utility model applications of Japan 1971-2012  
 Registered utility model specifications of Japan 1996-2012  
 Published registered utility model applications of Japan 1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                           | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Y         | WO 2010/090303 A1 (JTEKT CORPORATION)<br>2010.08.12, Paragraphs [0026]-[0042], [0050],<br>Figures 1-4 & JP 2010-207075 A & EP 2395631 A1<br>& CN 102308456 A | 1-13                  |
| Y         | JP 2011-67057 A (MITSUBA Corporation)<br>2011.03.31, Paragraphs [0005], [0023]-[0036],<br>[0043]-[0046], Figures 2-5 (No Family Member)                      | 1-13                  |
| Y         | JP 2010-141993 A (MITSUBA Corporation)<br>2010.06.24, Paragraphs [0004], [0019]-[0028],<br>Figures 3-7 (No Family Member)                                    | 2-8, 10-13            |

☐ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

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Date of the actual completion of the international search

30.05.2012

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