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Electric rotating machine and manufacturing method thereof
Drehende elektrische Maschine und Verfahren zur Herstellung derselben
Machine électrique tournante et procédé de fabrication de celle-ci

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Proprietor: NISSAN MOTOR CO., LTD.
Yokohama-shi,
Kanagawa 221-0023 (JP)

Inventor: Furuse, Hisayuki
Yokosuka city,
Kanagawa (JP)

Representative: Weber, Joachim
Hofer & Partner
Patentanwälte
Gabriel-Max-Strasse 29
81545 München (DE)

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a method of manufacturing an electric rotating machine.

BACKGROUND OF THE INVENTION

[0002] A rotator core and stator core of an electric rotating machine are formed of layers of thin plates such as silicon-steel plate. Generally, thin plates are joined by welding. However, since a convex projection arises in the welding position, the gap between the cores cannot be made small. That is, if the gap is made small, the core facing the convex projection will interfere with the convex projection.

[0003] Hence, the opposite side of a magnetic pole-face is welded so that there is no weld part with a surface (magnetic pole-face) facing another core.

SUMMARY OF THE INVENTION


[0005] US 5793136 discloses an electric rotating machine, comprising a middle core comprising plural plates stacked in an axial direction, an outer core disposed outside the middle core, and which rotates relative to the middle core, and an inner core disposed inside the middle core, and which rotates relative to the middle core, where the plural plates are jointed to a first fixing member by a connecting member.

[0006] JP-A-52146807 discloses a method of manufacturing an electric rotating machine, the machine having a middle core comprising plural plates stacked in an axial direction, an outer core disposed outside the middle core which rotates relative to the middle core, and an inner core disposed inside the middle core which rotates relative to the middle core, and the method comprising: joining the plural plates to a first fixing member by a connecting member.

[0007] However, in the electric rotating machine in which one stator and two rotors are arranged coaxially as disclosed by JP-A-H9-275673 published by the Japanese Patent Office in 1997, both the inner and external surfaces of a core in the middle are magnetic pole-faces, so the opposite side of the magnetic pole-face cannot be welded as mentioned above.

[0008] If one of the surfaces is welded, the gap with the core facing the welded surface cannot be made small.

[0009] JP-A-53015502, the closest prior art, describes a method of manufacturing an electric rotating machine, wherein the machine has a middle core comprising plural plates stacked in an axial direction. Further, an outer core is provided, which is disposed outside the middle core, the middle core rotates relative to the outer core. Finally, an inner core is disposed inside the middle core, the inner core rotates relative to the middle core. The method further comprises the steps of joining the plural plates to a first fixing member by a connecting member, embedding coils to the plural plates, and inserting the inner core to the inside of the plural plates and attaching the inner core inside the plural plates via a bearing.

[0010] Finally, JP-A-62053158 describes a stator which is fixed to a main body, and a rotor is fastened to a rotor shaft rotatably connected to the main body through bearings. The inner circumferential surface of the stator and the outer circumferential surface of the rotor are polished and treated in order to reduce irregularities. Lubricating films of approximately 5 to 10 μm are coating-arranged onto the inner circumferential surface of the stator and the outer circumferential surface of the rotor through coating. An air gap in size such as approximately 40 μm is formed between the lubricating films.

[0011] It is therefore an object of this invention to eliminate the above-mentioned convex projection, and make the gap between cores small.

[0012] The solution of this object is achieved by the combination of features of claim 1. The dependent claims contain advantageous embodiments of the present invention.

[0013] The details as well as other features and advantages of this invention are set forth in the remainder of the specification and are shown in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Fig. 1 shows a schematic cross-sectional view of an electric rotating machine according to this invention.

Fig. 2 shows a thin plate forming an external rotor core of the electric rotating machine.

Fig. 3 shows a schematic cross-sectional view of the electric rotating machine during assembly.

Fig. 4 shows the left flange of the electric rotating machine.

Fig. 5 shows the detailed cross-sectional view of the electric rotating machine.

Fig. 6 is similar to Fig. 1, but showing a different example:

Fig. 7 shows a thin plate forming the stator core of the electric rotating machine of the different example.

Fig. 8 shows the fixed plate of the electric rotating machine of the different example.

Fig. 9 shows a schematic cross-sectional view of the
electric rotating machine of the different example during assembly.

Fig. 10 shows a detailed cross-sectional view of the electric rotating machine of the different example.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0015] It has to be mentioned that the different example according to Figs. 6-10 is not covered by the annexed claims, but shall serve for a better understanding of the present invention.

[0016] Referring to Fig. 1 of the drawings, an electric rotating machine of this invention is equipped with an inner rotor core 1 (inner core), an outer rotor core 2 (middle core), and a stator core 3 (outer core) in a housing 7. The outer rotor core 2 is arranged outside the inner rotor core 1, and the stator core 3 is arranged outside the outer rotor core 2. The inner rotor core 1 and the outer rotor core 2 rotate relative to each other, and the outer rotor core 2 and stator core 3 also rotate relative to each other.

[0017] The inner rotor core 1, outer rotor core 2 and stator core 3 are respectively formed in stacks of plural thin silicon steel plates in the axial direction. The inner rotor core 1 is supported by a shaft 4. The outer rotor core 2 is fixed to a right flange 5 and a left flange 6. The stator core 3 is fixed to the housing 7.

[0018] The electric rotating machine shown in Fig. 1 is manufactured as follows.

[0019] In the inner rotor core 1 and stator core 3, only the surfaces facing the outer rotor core 2 are magnetic pole-faces, so the stacked thin plates can be joined by welding the opposite sides to the magnetic pole-faces. After welding, the parts corresponding to the magnetic pole-faces of the joined thin plates are surface-finished.

[0020] However, both the inner circumferential surface and outer circumferential surface of the outer rotor core 2 are magnetic pole-faces, so the thin plates cannot be joined by welding. Therefore, holes 2B are provided in the thin plates 2A forming the outer rotor core 2, as shown in Fig. 2, and the plates are joined by passing bolts 9 through these holes 2B.

[0021] Specifically, first, plural thin plates 2A, are stacked, and fixed to the right flange 5 by bolts 9 together with a plate 8. Next, as shown in Fig. 3, the right flange 5 to which the thin plates 2A and plate 8 are pre-attached is fitted on a chuck 100 of a grinding machine, and then the inner circumferential surface and outer circumferential surface of the outer rotor core 2 are ground with a grindstone 101 by rotating them. As the upper side of the figure is open, the inner circumferential surface of the outer rotor core 2 can easily be surface-finished. Here, grinding is used as the surface-finishing method, but other surface-finishing method may be used if the inner circumferential surface and outer circumferential surface of the outer rotor core 2 can be surface-finished by it.

[0022] After surface-finishing is complete, the inner rotor which is pre-assembled beforehand is inserted, and attached via a bearing.

[0023] Plural holes 11 through which the heads of the bolts 9 pass and plural holes 12 which have a seat for a fixing bolt 10 are alternately formed on the same circumference in the left flange as shown in Fig. 4. The outer rotor core 2 is fixed to the left flange 6 by the bolts 10.

[0024] Therefore, the outer core 2 is fixed to the right flange 5 by the bolts 9 (for example, three or more bolts on the same circumference) and is not fixed, to the left flange 6 in the state shown in Fig. 3, but after the inner rotor core 1 is inserted in the outer rotor core 2, it is fixed to both the left flange 6 and right flange 5 by the bolts 10 (for example, three or more bolts on the same circumference).

[0025] The outer rotor core 2, right flange 5, left flange 6, plate 8 and bolts 9 are formed in one piece to form the outer rotor.

[0026] Holes, not shown, in which permanent magnets are disposed, are provided in the inner rotor core 1 and the outer rotor core 2. parts, not shown, in which coils are installed, are provided in the stator core 3. These permanent magnets and coils are pre-attached to the rotor cores 1 and 2 or the stator core 3 prior to assembly.

[0027] Therefore, both the inner circumferential surface and outer circumferential surface are magnetic pole-faces, but according to this invention, the inner circumferential surface and outer circumferential surface can be finished in the state where only one side is attached to the right flange 5, so machining of the inner circumferential surface is easy. Hence, the magnetic pole-faces can be finished precisely and the gap between cores can be made small. Moreover, since welding is not used, the magnetic pole-faces are protected.

[0028] Fig. 5 shows a detailed cross section of the electric rotating machine shown in Fig. 1. In Fig. 1, the construction is simplified so that it is easy to understand. The shape of structural components is different between Fig. 1 and Fig. 5, but components referred to by the same symbols are the same components.

[0029] The thin plates forming the inner core 1 and stator 3 are joined by welding, but holes may be opened in the thin plates forming these components as in the case of the outer rotor core 2 and they may be joined by bolts.

[0030] Fig. 6 shows a different example.

[0031] The electric rotating machine of the different example, as in the case of the electric rotating machine shown in Fig. 1, is equipped with an inner rotor core 21 (inner core), outer rotor core 22 (outer core) and stator core 23 (middle core) which rotate relative to each other in the housing. In this embodiment, the stator core 23 is disposed outside the inner rotor core 21, and the outer rotor core 22 is disposed outside the stator core 23.

[0032] The inner rotor core 21, outer rotor core 22 and stator core 23 are respectively formed in stacks of plural thin silicon steel plates. The inner rotor core 21 is supported by a shaft 24, and the outer rotor core 22 is supported by a shaft 25. The stator core 23 is fixed to a flange.
[0033] Fig. 7 shows a thin-plate 23A which forms the stator core 23. The thin-plate 23A comprises plural I-shaped split cores 23B on the same circumference. A space 23C through which a bolt 28 passes is formed between adjacent split cores.

[0034] Fig. 8 shows the plate 27. Holes 27A which have a seat for the bolt 28 are provided in the plate 27 at positions corresponding to the spaces 23C of the stator core 23.

[0035] The electric rotating machine shown in Fig. 6 is manufactured as follows.

[0036] In the inner rotor core 21 and outer rotor core 22, as only the surfaces facing the stator core 23 are magnetic pole-faces, plural thin plates are joined by welding the opposite side of the magnetic pole-faces. After welding, the parts which are the magnetic pole-faces of the joined thin plates are surface-finished. In the stator core 23, both the inner circumferential surface and outer circumferential surface are magnetic pole-faces, so the thin plates cannot be fixed by welding. The spaces 23C are thus provided in each thin plate 23A and the thin plates 23A are then fixed by passing the bolts 28 through the spaces 23C.

[0038] First, as shown in Fig. 9, the thin-plates 23A which form the stator core 23 are stacked, and are fixed to the flange 26 by the bolts 28 together with the plate 27. Next, the flange 26 to which the plates 23A and plate 27 are pre-attached are fitted on the chuck 100 of the grinding machine, and then the inner circumferential surface and outer circumferential surface of the stator core 23 are ground with the grindstone 101 by rotating them.

[0039] After surface finishing, the inner rotor assembled beforehand is inserted, and attached via a bearing. Also, the outer rotor assembled beforehand is attached to the outside of the inner core via a bearing.

[0040] Holes, not shown, are provided for installing permanent magnets in the inner rotor core 21 and the outer rotor core 22, and parts, not shown, arc provided for installing coils in the stator core 23. The permanent magnets and coils are respectively pre-attached to the rotor cores 21 and 22 or the stator core 23 prior to assembly.

[0041] Therefore, both the inner and outer circumferential surfaces are magnetic pole-faces, but the inner and outer surfaces are surface-finished when the stator core 23 is fixed only to the flange 26, so machining of the inner surface can be performed easily. The magnetic pole-faces can be finished precisely and the gap between cores can also be made small. Moreover, as welding is not used, the magnetic pole-faces are protected.

[0042] Fig. 10 shows a detailed cross section of the electric rotating machine shown in Fig. 6. In the schematic view of Fig. 6, shapes are drawn simplified for ease of understanding. The shapes of structural components are different between Fig. 6 and Fig. 10, but components referred to by the same number are identical components.

[0043] Herein, the thin plates forming the inner rotor core 21 and outer rotor core 22 are joined by welding, but holes may be opened in the thin plates forming them as in the case of the stator core 23, and they may then be joined by bolts.

[0044] This invention may be applied also to constructions other than the one shown in Fig. 1. For example, this invention may be applied in a similar way to the inner rotor core of an electric rotating machine where the inner rotor core is disposed inside the outer rotor core and the stator core is disposed inside the inner rotor core by forming the inner rotor core in the same manner as shown in Fig. 1 or Fig. 3.

[0045] Although the invention has been described above by reference to a certain embodiment of the invention, the invention is not limited to the embodiment described above. Modifications and variations of the embodiment described above will occur to those skilled in the art, in light of the above teachings. The scope of the invention is defined with reference to the following claims.

**Claims**

1. A method of manufacturing an electric rotating machine, the machine having a middle core (2) comprising plural plates (2A) stacked in an axial direction, an outer core (3) disposed outside the middle core (2) which rotates relative to the outer core (3), and an inner core (1) disposed inside the middle core (2), the inner core (1) rotating relative to the middle core (2), and the method comprising:

   - joining the plural plates (2A) to a first fixing member (5) by a connecting member (9), finishing the inner and outer circumferential surfaces of the plural plates (2A) in the state where the plural plates (2A) are joined only to the first fixing member (5), embedding permanent magnets to the plural plates, inserting the inner core to the inside of the plural plates and attaching the inner core inside the plural plates via a bearing, and joining the opposite side of the side of the plural plates, which was joined to the first fixing member, to a second fixing member after finishing the inner and outer circumferential surfaces of the plural plates.

2. A method as defined in claim 1, wherein the connecting member (9) is a bolt, a hole (2B) through which the bolt passes is formed in the plural plates (2A), and the plural plates (2A) are joined to the first fixing member (5) by passing the bolt through the hole (2B).

3. A method as defined in claim 1, wherein the plates...
4. A method as defined in claim 1, wherein the middle core and inner core are rotor cores, and the outer core is a stator core

Revendications

1. Procédé de fabrications d’une machine électrique tournante, la machine comportant un noyau intermédiaire (2) comprenant des plaques multiples (2A) empilées dans une direction axiale, un noyau extérieur (3) étant disposé à l’extérieur du noyau intermédiaire (2), lequel tourne par rapport au noyau extérieur (3), ainsi qu’un noyau intérieur (1), placé à l’intérieur du noyau intermédiaire (2), le noyau intérieur (1) tournant par rapport au noyau intermédiaire (2), et le procédé comprenant :
   le raccordement des plaques multiples (2A) sur un premier élément de positionnement (5) par un élément d’assemblage (9),
   la finition des surfaces circonférentielles intérieure et extérieure des plaques multiples (2A) dans un état où les plaques multiples (2A) ne sont jointes qu’au premier élément de positionnement (5),
   l’intégration d’aimants permanents sur les plaques multiples,
   l’insertion du noyau intérieur à l’intérieur des plaques multiples et la fixation du noyau intérieur à l’intérieur des plaques multiples par l’intermédiaire d’un roulement, et
   le raccordement du flanc opposé du côté des plaques multiples, qui ont été jointes au premier élément de positionnement, sur un second élément de positionnement après la finition des surfaces circonférentielles intérieure et extérieure des plaques multiples.

2. Procédé selon la revendication 1, dans lequel l’élément d’assemblage (9) est un boulon, un alésage (2B) que traverse le boulon est formé dans les plaques multiples (2A), et les plaques multiples (2A) sont jointes au premier élément de positionnement (5) en faisant traverser le boulon par l’alésage (2B).

3. Procédé selon la revendication 1, dans lequel les plaques (2A) sont des plaques minces en forme d’anneau.

4. Procédé selon la revendication 1, dans lequel le noyau intermédiaire et le noyau intérieur sont des noyaux de rotor et le noyau extérieur est un noyau de stator.

Patentansprüche

1. Verfahren zur Herstellung einer drehenden elektrischen Maschine, wobei die Maschine einen mittleren Kern (2), der mehrere Bleche (2A) aufweist, die in einer axialen Richtung gestapelt sind, einen äusseren Kern (3), der außerhalb des mittleren Kerns (2) angeordnet ist, der sich relativ zum äusseren Kern (3) dreht und einen inneren Kern (1) aufweist, der innerhalb des mittleren Kerns (2) angeordnet ist, wobei sich der innere Kern (1) relativ zum mittleren Kern (2) dreht, und das Verfahren aufweist:
   Verbinden der mehreren Bleche (2A) durch ein Verbindungselement (9) mit einem ersten. Befestigungselement (5),
   Endbearbeiten der inneren und äusseren Umfangsflächen der mehreren Bleche (2A) in einem Zustand, in dem die mehreren Bleche (2A) nur mit dem ersten Befestigungselement (5) verbunden sind,
   Einbetten von Permanentmagneten in die mehreren Bleche,
   Einsetzen des inneren Kerns in das Innere der mehreren Bleche und Befestigen des inneren Kerns im Inneren der mehreren Bleche über ein Lager, und
   Verbinden der gegenüberliegenden Seite der Seite der mehreren Bleche, die mit dem ersten Befestigungselement verbunden wurde, mit einem zweiten Befestigungselement, nachdem die inneren und äusseren Umfangsflächen der mehreren Bleche endbearbeitet wurden.

2. Verfahren gemäß Anspruch 1, wobei das Verbindungselement (9) ein Bolzen, ein Loch (2B), durch das der Bolzen hindurchgeht, in den mehreren Bleche (2A) ausgebildet ist, und die mehreren Bleche (2A) mit dem ersten Befestigungselement (5) durch Durchführen des Bolzens durch das Loch (2B) verbunden werden.

3. Verfahren gemäß Anspruch 1, wobei die Bleche (2A) ringförmige dünne Bleche sind.

4. Verfahren gemäß Anspruch 1, wobei der mittlere Kern und innere Kern Rotorkerne sind und der äusserere Kern ein Statorkern ist.
FIG. 6