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(54) Stator core for a magnetic bearing

Statorkern für ein Magnetlager

Noyau statorique pour un palier magnétique

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GB-A- 290 655

- **PATENT ABSTRACTS OF JAPAN vol. 2000, no. 10, 17 November 2000 (2000-11-17) & JP 2000 205260 A (NSK LTD), 25 July 2000 (2000-07-25)**

Description

Background of the Invention

[0001] The present invention relates to a structure of a magnetic bearing that supports a rotor without making contact, particularly a stator core for a homo-polar type of magnetic bearing.

Prior art

[0002] A turbo compressor can be made larger in capacity and smaller in size than a reciprocating or screw compressor, and can be easily made to an oil-free type. Therefore, turbo compressors are used often as general-purpose compressors in applications such as a compressed air source for factories, a source of air for separation, and other various processes.

[0003] Conventionally, gas bearings, sliding bearings and magnetic bearings have been used to support a high-speed rotating shaft of a high-speed motor that is connected directly to and drives a turbo compressor. In particular, a homo-polar magnetic bearing can be used to support a rotor (rotating shaft) in a contact free manner that rotates to form the high speed shaft of a high speed motor by passing magnetic flux through the shaft to produce an electromagnetic sucking force which causes the shaft to float, this being one type of radial magnetic bearing for use with shafts that rotate at a high speed (for instance, 100,000 min^{-1} or more).

[0004] JP-A-2000205260 according to the precharacterizing part of the single claim discloses a homo-polar magnetic bearing for supporting a rotor with stator cores, wherein each of said stator cores includes a first yoke of which one end forms a magnetic pole surface and which is a first pole body with a predetermined width to pass the magnetic flux. The stator core comprises a second yoke of which one end forms a magnetic pole surface and which is a second pole body with a predetermined width to pass magnetic flux. Between the first and second yokes a stem unit is disposed to transmit the magnetic flux. The first yoke and the second yoke are arranged in a manner that they are aligned with the axial direction of the rotor.

[0005] EP-A-0 869 517 discloses stator cores comprising a magnetic material powder which is solidified in resin. The magnetic material composition can be molded in a desired core shape which includes toroidal, E, I, C, EE, EI,ER, EPC, jar, drum, pot and cup shapes, for example.

[0006] It is the object of the invention to provide a homo-polar magnetic bearing, the stator cores of which have reduced eddy current losses.

[0007] The object of the invention is solved by the features of claim 1.

[0008] According to the invention, the stem unit comprises a magnetic material powder, solidified in resin. The first pole body comprises a laminated body of magnetic steel sheets with an insulating material interleaved with the laminations, in the lateral direction. The second pole body also comprises a laminated body of magnetic steel sheets with an insulating material interleaved with the laminations, in the lateral direction.

[0009] Using this configuration, since the first yoke, stem unit and second yoke are integrated into a U-shape and the stem unit is made of the magnetic material powder solidified in resin, when the magnet is energized, the flux passes through the first yoke, rotor, second yoke and stem unit, in a closed path; since the magnetic pole surfaces at the ends of the first yoke and the second yoke support the rotor at the supporting surfaces, and as the magnetic material powder solidified in resin produces only a small amount of eddy current loss, eddy currents are not generated in the stem unit, so a magnetic bearing with few losses can be realized.

[0010] In the stator cores for a magnetic bearing according to the present invention, the aforementioned first pole body is a laminated body in which magnetic steel sheets are laminated in the direction orthogonal to a line normal to the above-mentioned magnetic pole surface, interleaved with a non-conducting substance, and the above-mentioned second pole body is a laminated body fabricated from magnetic steel sheets laminated in the direction orthogonal to a line normal to the aforementioned magnetic pole surface, with a non-conducting substance between the laminations.

[0011] According to the configuration described above, since the first pole body and the second pole body are provided with laminated bodies fabricated from magnetic steel sheets laminated in the direction orthogonal to a line normal to the above-mentioned magnetic pole surfaces, with a non-conducting substance between the laminations, eddy current losses due to flux passing through the yokes can be suppressed, so a magnetic bearing with further reduced losses can be produced.

[0012] In addition, the stator cores for a magnetic bearing according to the present invention are contrived in such a manner that the aforementioned first pole body is a laminated body fabricated from magnetic steel sheets laminated in the lateral direction with a non-conducting substance interleaved between each sheet, and the above-mentioned second pole body is a laminated body in which the magnetic steel sheets are laminated in the lateral direction with a non-conducting substance sandwiched between each sheet.

[0013] In this configuration, since the first pole body and the second pole body have laminated bodies made of magnetic steel sheets laminated in the lateral direction with a non-conducting substance sandwiched between the sheets, eddy current losses generated when the magnetic flux flows through yokes can be suppressed, so a magnetic bearing with further reduced losses can be offered in practice.

BRIEF DESCRIPTION OF DRAWINGS

[0014]

Figs. 1a and 1b are a front view and side elevation of the first embodiment of the stator cores according to the present invention.

Figs. 2a and 2b are side elevations of the second and third embodiments of stator cores according to the present invention.

Figs. 3a through 3c are isometric views of the first through third embodiments of stator cores based on the present invention.

Figs. 4a and 4b are a front view and side elevation. of the fourth embodiment of the stator cores according to the present invention.

Figs. 5a and 5b show front and side views of the fifth embodiment of stator cores according to the present invention.

Fig. 6 is a diagram showing the magnetic characteristics of a magnetic material powder, solidified in resin, and general-purpose silicon steel sheets.

[0015] Next, the first through fifth embodiments of the stator cores for a magnetic bearing according to the present invention are described below.

[0016] Fig. 1 shows a plan view and sectional elevation of the first embodiment of the present invention. Fig. 2 shows elevation views of the second and third embodiments of the present invention. Fig. 3 shows isometric views of the stator cores of the first through third embodiments. Fig. 4 shows the plan and side elevation of the fourth embodiment. Fig. 5 shows the front view and elevation of the fifth embodiment.

[0017] For the convenience of description, abbreviations are used for the stator cores; A for the first embodiment, B for the second, C for the third, D for the fourth, E for the fifth.

(First embodiment)

[0018] First, the first embodiment of stator cores (type A) for a magnetic bearing according to the first embodiment of the present invention are described referring to Figs. 1a, 1b and 3a.

[0019] The magnetic bearing of the third embodiment is a homo-polar radial magnetic bearing. The homo-polar radial magnetic bearing 1 is provided with a casing 2 and a plurality of electromagnetic components 13 and a rotor 3. The rotor 3 is a rotor constructed with magnetic material at least on the outer surface thereof, and with a predetermined outer diameter D1. The rotor 3 is positioned on the centerline of the casing 2, parallel to it in the axial direction, and supported so it is free to rotate at a high speed. The plurality of electromagnetic components 13 supports the rotor 3 in a freely rotatable manner, and is arranged around the rotor 3. For instance, four electromagnetic components are assembled into a set, and the set of electromagnetic components 13 supports the rotor 3 at 2 locations. Four electromagnetic components are spaced at equal angles around the rotor at each supporting point.

[0020] The electromagnetic components 13 are provided with a stator core 16 and coils 5. The stator core 16 is composed of two yokes 6, 8 and a stem unit 7 (Fig. 3a). The yokes 6, 8 are pole units each end of which forms a magnetic pole surface 9 opposite the outer surface of the rotor 3 (that is, the supporting surface) with a predetermined gap between them through which the magnetic flux passes. The two yokes 6 and 8 are arranged with a predetermined spacing in the lateral direction. The stem unit 7 is a rectangular block that is sandwiched between the other ends of the yokes and through which the magnetic flux passes. A stator core 16 is shaped like a letter _U_ with a considerable thickness, as the two yokes 6 and 8 and the stem unit 7 are connected into one body without gaps, and the core is installed in a recessed portion on the inner periphery of the casing 2.

[0021] The coil 5 is a bundle of wire. The wire is wrapped in several layers around yokes 6, 8, and the coil 5 is formed into a block with the same shape as the cross sections of yokes 6, 8 but with an air gap between the coil and yokes.

[0022] The structure of stator cores 16 is described in further detail. A stator core 16 is composed of a first yoke component 17, stem unit component 18 and second yoke component 19.

[0023] The first yoke component 17 is a pole body with a predetermined width. The pole body is made of so-called laminated steel sheets, that is, is composed of a plurality of magnetic steel sheets and sheets of an insulating material. The magnetic steel sheet is a thin steel sheet with a thickness of T, shaped as a quadrilateral with one end curved with a radius of curvature R. The insulating material is a non-conducting material and is applied between each of the plurality of magnetic steel sheets. Magnetic steel sheets are laminated in the lateral direction, and when a stator core is assembled as an electromagnetic component, the lamination direction thereof is aligned with the axial direction of the rotor 3. The first yoke component 17 is a pole body with a uniform width W3 in the direction of lamination of the steel sheets, and one end of thereof forms a magnetic pole surface 9 with a radius of curvature R. Holes for assembling the core are provided with their axes in the lateral direction, at locations at the opposite end from the magnetic pole surface 9 (called counter-magnetic pole surface for short).

[0024] The construction of the second yoke component 19 is the same as that of the first yoke component 17, so no additional description is given here.

[0025] The first yoke component 17 and the second yoke component 19 are opposite each other in the lateral direction with a gap W2 between them.

[0026] The stem unit component 18 is a rectangular block with a width W2, height H3 and length L1. The stem unit component 18 is arranged such that one surface in the direction of the height of the component is in the same. plane as the counter-magnetic pole surfaces of the first yoke component 17 and the second yoke component 19, and the stem unit is sandwiched between the first yoke component 17 and the second yoke component 19. The stem unit component 18 as a whole is composed of a magnetic powder filled resin. Holes for assembling are provided with the axes thereof directed laterally.

[0027] The first yoke component 17, the stem unit component 18 and the second yoke component 19 are fastened together and to the casing 2 by bolts penetrating through the holes used for assembly, to form an integrated stator core 16.

(Second embodiment)

[0028] Next, a magnetic bearing and the stator core (type B) according to the second embodiment are described referring to Figs. 2a and 3b. The construction of the magnetic bearing is the same as that of the first embodiment, so the description is not duplicated, but the construction of the stator core (type B) is described in detail.

[0029] The stator core 20 consists of a first yoke component 21, a stem unit component 22 and a second yoke component 23.

[0030] The first yoke component 21 is a pole body with a predetermined width. The polar body is made of so-called laminated steel sheets, that is, is composed of a plurality of magnetic steel sheets and sheets of an insulating material. The magnetic steel sheet is a thin steel sheet with a thickness T, shaped as a quadrilateral with one end curved with a radius of curvature R. The insulating material is a non-conducting material and is applied between each of the plurality of magnetic steel sheets. Magnetic steel sheets are laminated in the lateral direction, and when a stator core is assembled as an electromagnetic component, the lamination direction thereof is aligned with the axial direction of the rotor. The first yoke component 21 is a pole body with a uniform width of in the direction of lamination of the steel sheets, and one end of thereof forms a magnetic pole surface 9 with a radius of curvature R. The surface at the opposite end from the magnetic pole surface 9 (called the counter-magnetic pole surface for short) is cut at an angle so as to intersect the surface of steel sheets at an angle less than 90°. Holes for assembling are provided at locations near the counter-magnetic pole surface, with their axes directed laterally.

[0031] The first yoke component 21 and the second yoke component 23 face each other in the lateral direction with a gap W2 between them such that their counter-magnetic pole surfaces face each other.

[0032] The stem unit component 22 is a rectangular wedge in shape. The inclined surfaces of the stem unit component 22 contact the counter-magnetic pole surfaces of the first and second yoke components 21 and 23, and the stem unit component is sandwiched by the first and second yoke components 21, 23. The stem unit component 22 is a solid made entirely of a magnetic material powder solidified in resin. Holes for assembling are provided with the axes thereof directed in the lateral direction.

[0033] The first yoke component 21, the stem unit component 22 and the second yoke component 23 are fastened together and to the casing 22 by bolts penetrating through the holes used for assembly, to form an integrated stator core 20.

(Third embodiment)

[0034] Next, a magnetic bearing and the stator core (type C) therefor according to the third embodiment is described referring to Figs. 2b and 3c. The construction of the magnetic bearing is the same as that of the first embodiment, so a duplicate description is omitted here, and the construction of the stator core (type C) 30 is detailed below.

[0035] The stator core 30 is provided with a first yoke component 31, a stem unit component 32 and a second yoke component 33.

[0036] The first yoke component 31 is a pole body with a predetermined width. The pole body is made of so-called laminated steel sheets consisting of a plurality of magnetic steel sheets and sheets of an insulating material. The magnetic steel sheet has a thin quadrilateral shape with a thickness T and one end is curved with a radius of curvature R. The insulating material is a non-conducting material and is applied between each of the plurality of magnetic steel sheets. Magnetic steel sheets are laminated in the lateral direction, and when stator cores are assembled as electromagnetic components, the lamination direction thereof is aligned with the axial direction of the rotor. The first yoke component 31 is a pole body having a uniform width W3 in the direction of lamination of the steel sheets, and one end thereof forms a magnetic pole surface 9 with a radius of curvature R. The surface at the opposite end from the magnetic pole surface 9 (called the counter-magnetic pole surface for short) is stepped in the direction of the thickness. Holes for assembling are bored' at locations near the counter-magnetic pole surface, with the axes thereof directed in the lateral direction.

[0037] The construction of the second yoke components 33 is same as that of the first yoke component, so no additional description is give below.

[0038] The first yoke component 31 and the second yoke component 33 face each other in the lateral direction with a gap W2 between them so that the locations with the stepped surfaces face each other.

[0039] The stem unit component 32 is a solid rectangle in shape with a width W4, height H3 and length L1. The stem unit component 32 engages with the stepped portion of the first yoke component 31 and the stepped portion of the second yoke component 32, and is sandwiched by the first and second yoke components 31, 33. The step unit component 18 is made entirely from a magnetic material powder, solidified in resin. Holes for assembling are provided with the axes thereof directed laterally.

[0040] The first yoke component 31, the stem unit component 32 and the second yoke component 33 are fastened together and to the casing 2 by bolts inserted through the holes for assembly, thus making an integrated stator core 30.

(Fourth embodiment)

[0041] Next, a magnetic bearing and the stator core (type D) thereof according to the fourth embodiment are described. The construction of the magnetic bearing is the same as that of the first embodiment, so a description is not given here, and the construction of the stator core (type D) 50 is described below.

[0042] Although the combination of stator cores 50 is described based on the above-mentioned A type shown in Figs. 4a and 4b, this is not restrictive, and any of types A through C can be employed.

[0043] The widths of the peripheral portions near the magnetic pole surfaces 9 of yokes 6 and 8 are extended along the outer surface of the rotor, and the portions in contact or in close proximity to those of adjacent magnetic pole surfaces of the stator core, that is, electromagnetic components.

(Fifth embodiment)

[0044] Next, a magnetic bearing and its stator core (type E) according to the fifth embodiment are described referring to Figs. 5a and 5b. Since the construction of the magnetic bearing is the same as that of the first embodiment, no description is given below, and only the construction of the stator core (type E) 60 is described.

[0045] Although the figures illustrate the aforementioned A type in the combination of stator cores 60, the design is not restricted only to type A, but any of A through C types can be used in practice.

[0046] The widths near the magnetic pole surfaces 9 of yokes 6, 8 are extended circumferentially along the rotor supporting surface, and are integrated with or in close proximity with the magnetic pole surfaces of adjacent electromagnetic components, that is, stator cores 60.

[0047] Fig. 6 shows a diagram comparing the magnetic characteristics of a solid made from a magnetic material powder solidified in resin with the magnetic characteristics of a general-purpose silicon steel sheet (0.35 mm thick) normally used as the material for laminated steel sheets. Obviously, the magnetic material powder solidified in resin has a larger hysteresis loss and a smaller eddy current loss than the general-purpose silicon steel sheet.

[0048] When the magnetic bearing of the first through fifth embodiments is energized with direct current, magnetic flux passes between the stator core and the rotor. For instance, the magnetic flux flows in a closed path from the counter-magnetic pole surface to the magnetic pole surface of the first yoke 6, through the surface of the rotor, through the second yoke 8 from the magnetic pole surface to the counter-magnetic pole surface,. through the stem unit 7, back to the first yoke. The magnetic flux path is curved in 3 dimensions and the flux flows through a place on the second yoke 8 to the stem unit 7, and through another place on the stem unit 7 to the first yoke, however because the stem unit is composed of a material in which an extremely small amount of eddy currents are produced, eddy current losses can be minimized.

[0049] On the other hand, the magnetic bearing is driven by direct current that contains very few AC components, so the hysteresis losses produced in the stator core are negligibly small.

[0050] Therefore, using any of the stator cores according to the first through fifth embodiments, a magnetic bearing with small eddy current losses can be manufactured.

[0051] When using a stator core of any of the first through fifth embodiments, since the peripheral widths near the magnetic pole surfaces 9 of yokes 6, 8 are extended along the outer surface of the rotor, periodic variations in the intensity of the magnetic field produced on the surface of the rotor can be minimized when the rotor rotates, so eddy current losses created on the rotor surface can be reduced.

[0052] When one of types A through C is introduced into the stator cores for the fourth and fifth embodiments, since the magnetic pole surfaces are curved surfaces in the magnetic steel sheets of the yokes, even when the curved surface is machined by a lathe, the surfaces of the magnetic steel sheets can satisfactorily resist machining forces, so the laminated steel sheets are no longer peeled off so that a highly accurate curved surface can be manufactured.

[0053] When one of the stator cores for a magnetic bearing according to the above-mentioned embodiments is used, the magnetic bearing has few eddy current losses.

[0054] When any of the stator cores for a magnetic bearing according to the first through third (types A, B and C) embodiments is used, the features of laminated steel sheets and advantageous characteristics of a body made of magnetic material powder solidified in resin are effectively combined, and a magnetic bearing with small eddy current and hysteresis losses can be developed.

[0055] Using stator cores for a magnetic bearing according to the first through fifth (types A, B, C, D, and E) embodiments, eddy current losses on the surface of a rotor can be reduced.

[0056] In the aforementioned embodiments, a radial bearing was taken as an example, however, applicable bearings in practice are not limited only to this example, and the present invention can also be applied to a thrust bearing. In addition, although the descriptions were given assuming a structure for supporting a rotating rotor, the invention is not limited only to this example, but for instance, the present invention can also be applied to a guide for a linear motion drive. In addition, the foregoing descriptions referred to examples wherein a stator core was composed of one component or three components, but the scope of the present invention is not restricted only to these compositions, and two components or four or more components can be used for the composition. A biasing magnet may also be included as part of a stator core.

[0057] The above-mentioned stator cores for a magnetic bearing and the method of manufacturing them offer the following advantages.

1. Since the laminated steel sheets of a cut core are bonded satisfactorily, protrusions of a magnetic pole can also be fabricated in a laminated structure.
2. Protrusions are joined together magnetically but are isolated electrically, so losses can be reduced without degrading the characteristics of the bearing. That is, using cut cores, the protrusions of magnetic poles can also be made of laminated steel sheets, resulting in a reduction of iron losses.
3. A wider selection of types of electromagnetic steel sheets becomes possible, and amorphous materials that are difficult to laminate can also be used for the magnetic poles.

[0058] Therefore, the stator core for a magnetic bearing and the method of manufacturing it according to the present invention can be composed of laminated steel sheets even if the stator cores are provided with protrusions extending in the circumferential direction; in addition, laminated steel sheets can be prevented from becoming detached, crushed or peeled, so they can be efficiently cut and machined; furthermore, an amorphous material that is difficult to laminate can be used as a raw material; consequently, the cost of manufacturing and machining the stator cores can be reduced, while the eddy currents generated in the stator unit can also be greatly reduced, which are excellent advantages in practice.

[0059] According to the present invention, stator cores for a homo-polar magnetic bearing that supports a rotating body provide the following effects due to the configuration thereof.

[0060] Since the first yoke, stem unit and second yoke are integrated into a U shape and the stem unit is made of a magnetic material powder solidified in resin, when magnetic flux is passed through them, the flux passes in a closed path through the first yoke, the moving body, the second yoke and the stem unit, whereby magnetic pole surfaces at one end of each of the first and second yokes support the rotor at the supporting surfaces; because the magnetic material powder solidified in resin does not generate eddy currents, the stem unit produces little eddy current loss, so a magnetic bearing with low losses can be offered.

[0061] Moreover, since the first pole body and the second pole body are laminated bodies that are composed of magnetic steel sheets interleaved with a non-conducting substance and laminated in a direction orthogonal to a line normal to the aforementioned magnetic pole surfaces, when magnetic flux passes through the yokes, eddy current losses are suppressed and a magnetic bearing with still lower losses can be developed.

[0062] In addition, as the first pole body and the second pole body are laminated bodies made of magnetic steel sheets interleaved with a non-conducting material and laminated in the lateral direction, eddy current losses produced when magnetic flux is passed through the yokes are suppressed, so a magnetic bearing with even lower losses can be realized.

[0063] In addition, according to the present invention as described above, stator cores for a magnetic bearing used to support a rotor with a magnetic supporting surface are provided with a N-pole magnetic pole surface and S-pole magnetic pole surface facing the supporting surface, therefore when magnetic flux is passed through the stator cores of the magnetic bearing, N-pole and S-pole magnetic pole surfaces support the supporting surface of the rotor; because the magnetic material powder solidified in resin produces low eddy current losses, the losses are suppressed, so a magnetic bearing with low losses can be presented.

[0064] Also, when stator cores for a magnetic bearing according to the present invention support a rotating body, eddy current losses are suppressed and a low loss magnetic bearing for a rotor can be achieved.

[0065] As a consequence, the present invention provides stator cores for a magnetic bearing constructed in such a way that the utilization of materials is high, the work pieces can be machined with a high accuracy, and eddy currents are reduced to a minimum.

[0066] Although the present invention has been described referring to a number of preferred embodiments, it should be understood that the scope of rights included in the present invention is not restricted only to these embodiments. Conversely, the scope of rights of the present invention should include all improvements, modifications and equivalent entities that belong to the scope of the attached claims.

Claims

1. Homo-polar magnetic bearing with stator cores and with a magnetic supporting surface for supporting a rotor (3), each stator core comprising
a first yoke (6) of which one end forms a magnetic pole surface (9) and which is a first pole body with

a predetermined width (W3) to pass magnetic flux, a second yoke (8) of which one end forms a magnetic pole surface and which is a second pole body with a predetermined width (W3) to pass the magnetic flux, and

a stem unit (7) that is sandwiched between the other end of the first and other end of the second yoke and transmits the magnetic flux, wherein the first yoke (6) and the second yoke (8) are displaced with respect to one another in the lateral direction of the pole bodies, said lateral direction is aligned with the axial direction of the rotor (3),

characterized in that

the stem unit (7) comprises a magnetic material powder, solidified in resin,

the first pole body (6) comprises a laminated body (17, 21, 31) of magnetic steel sheets with an insulating material interleaved with the laminations, in the lateral direction, and

the second pole body (8) comprises a laminated body (19, 23, 33) of magnetic steel sheets with an insulating material interleaved with the laminations, in the lateral direction.

Patentansprüche

1. Homopolares Magnetlager mit Statorkernen und mit einer magnetischen stützenden Oberfläche zum Stützen eines Rotors (3), wobei jeder Statorkern aufweist

ein erstes Joch (6), von welchem ein Ende eine Magnetpoloberfläche (9) ausbildet und welches ein erster Polkörper mit einer vorbestimmten Breite (W3) ist, um einen Magnetfluss durchzulassen,

ein zweites Joch (8), von welchem ein Ende eine Magnetpoloberfläche ausbildet und welches ein zweiter Polkörper mit einer vorbestimmten Breite (W3) ist, um den Magnetfluss durchzulassen, und

eine Schafteinheit (7), die sandwichartig zwischen dem anderen Ende des ersten und dem anderen Ende des zweiten Joches angeordnet ist und den Magnetfluss überträgt, wobei das erste Joch (6) und das zweite Joch (8) im Hinblick aufeinander in der lateralen Richtung der Polkörper versetzt sind, die laterale Richtung mit der Axialrichtung des Rotors (3) ausgerichtet ist,

dadurch gekennzeichnet, dass

die Schafteinheit (7) ein Magnetmaterialpulver aufweist, das in einem Harz verfestigt ist,

der erste Polkörper (6) einen geschichteten Körper (17, 21, 31) aus Magnetstahlblechen aufweist, wobei ein isolierendes Material zwischen die Schichtungen eingebracht ist, in der lateralen Richtung und

der zweite Polkörper (8) einen geschichteten Körper (19, 23, 33) aus Magnetstahlblechen aufweist, wobei ein isolierendes Material zwischen die Schichtungen eingebracht ist, in der lateralen Richtung.

Revendications

1. Palier magnétique homopolaire avec des noyaux statoriques et avec une surface de support magnétique pour soutenir un rotor (3), chaque noyau statorique comprenant :

une première culasse (6) dont une extrémité forme une surface de pôle magnétique (9) et qui est un premier corps de pôle ayant une largeur prédéterminée (W3) pour transmettre un flux magnétique,

une deuxième culasse (8) dont une extrémité forme une surface de pôle magnétique et qui est un deuxième corps de pôle ayant une largeur prédéterminée (W3) pour transmettre le flux magnétique, et

une unité de tige (7) qui est prise en sandwich entre l'autre extrémité de la première et l'autre extrémité de la deuxième culasse et transmet le flux magnétique, dans lequel la première culasse (6) et la deuxième culasse (8) sont déplacées l'une par rapport à l'autre dans la direction latérale des corps de pôle, ladite direction latérale est alignée avec la direction axiale du rotor (3),

caractérisé en ce que

l'unité de tige (7) comprend une poudre de matériau magnétique, solidifiée dans de la résine,

le premier corps de pôle (6) comprend un corps stratifié (17, 21, 31) de feuilles d'acier magnétiques avec un matériau isolant intercalé avec les stratifications, dans la direction latérale, et

le deuxième corps de pôle (8) comprend un corps stratifié (19, 23, 33) de feuilles d'acier magnétiques avec un matériau isolant intercalé avec les stratifications, dans la direction latérale.

Fig. 1b
Type A

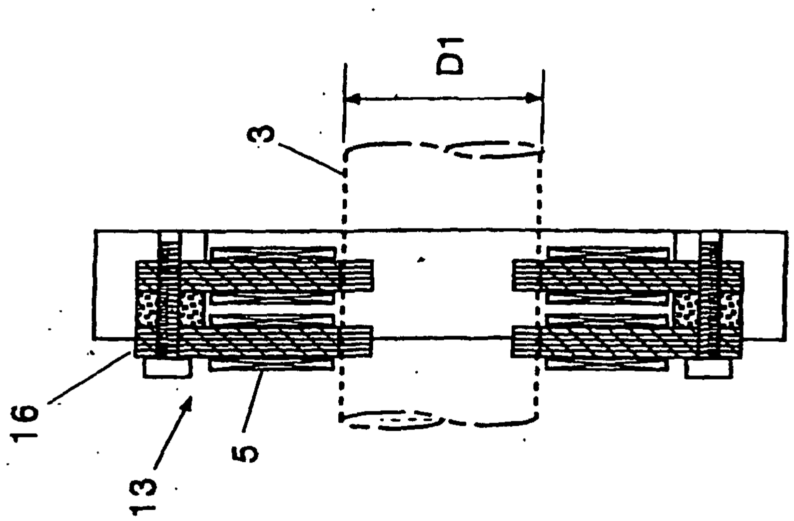


Fig. 1a
Type A

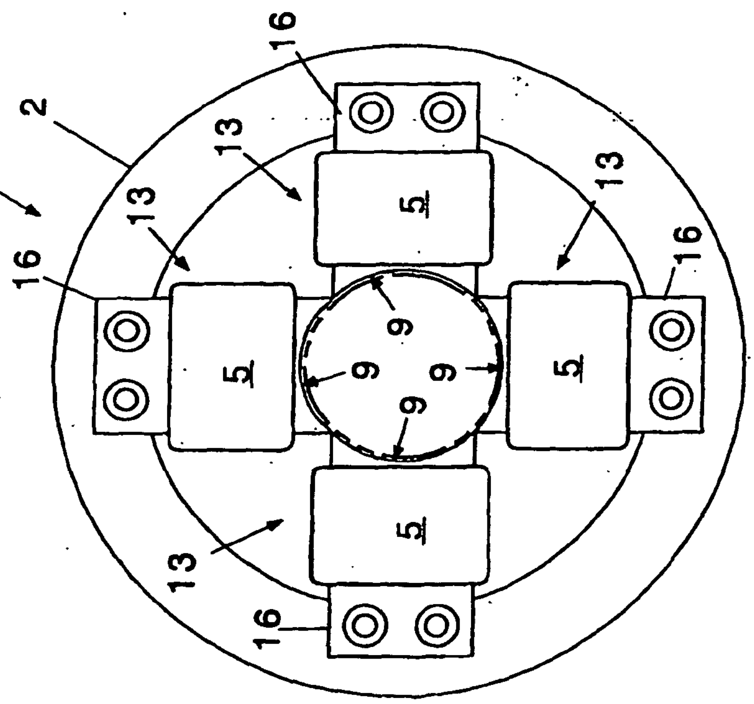


Fig. 2a
Type B

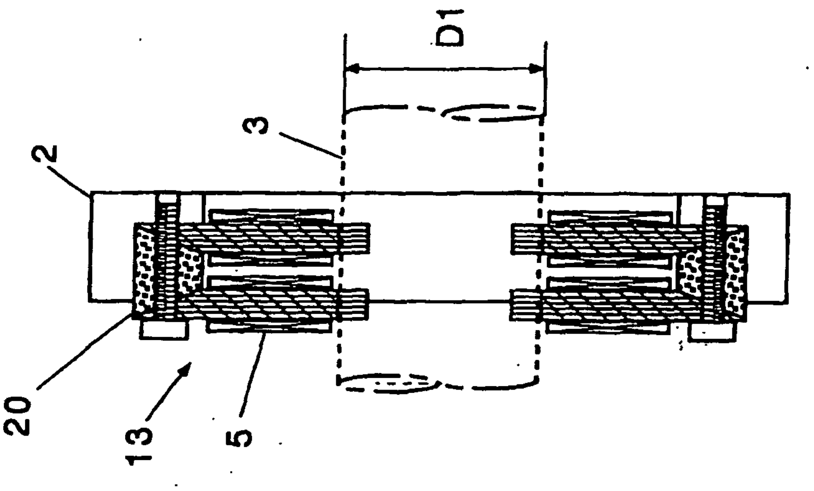


Fig. 2b
Type C

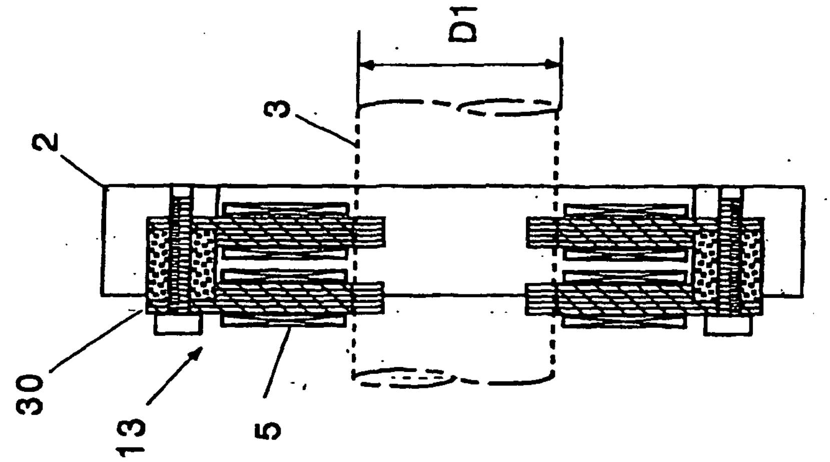


Fig. 3a
Type A

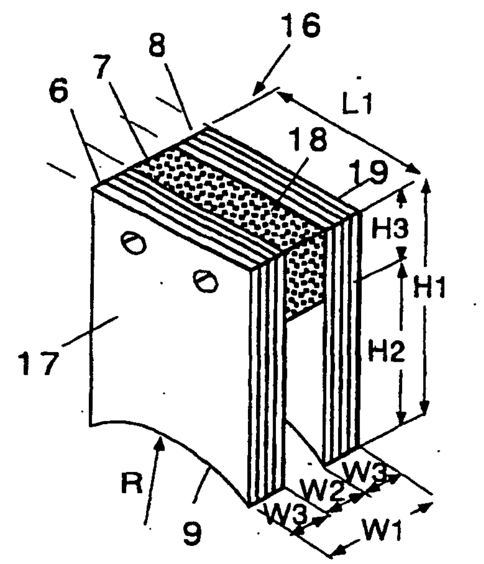


Fig. 3b
Type B

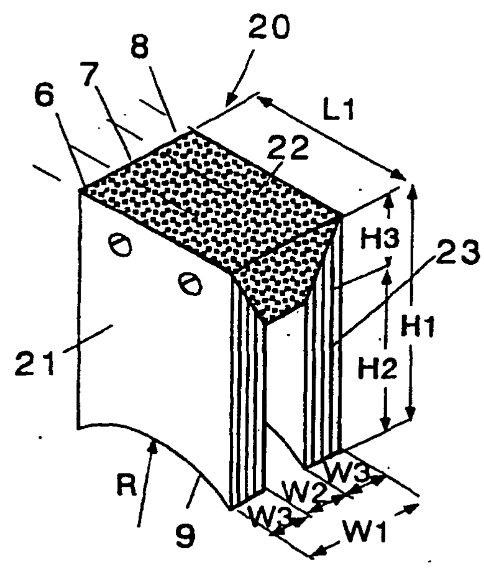


Fig. 3c
Type C

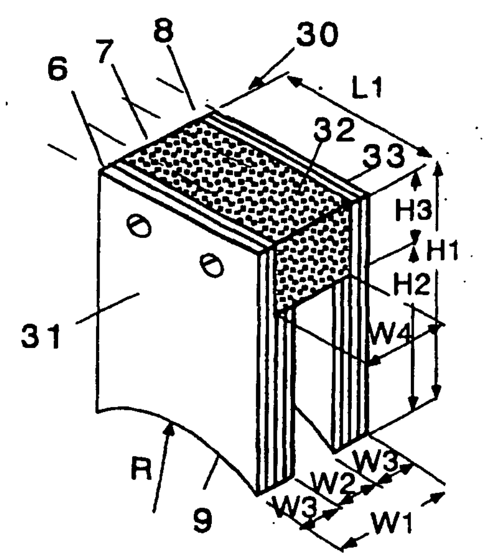


Fig. 4b
Type D

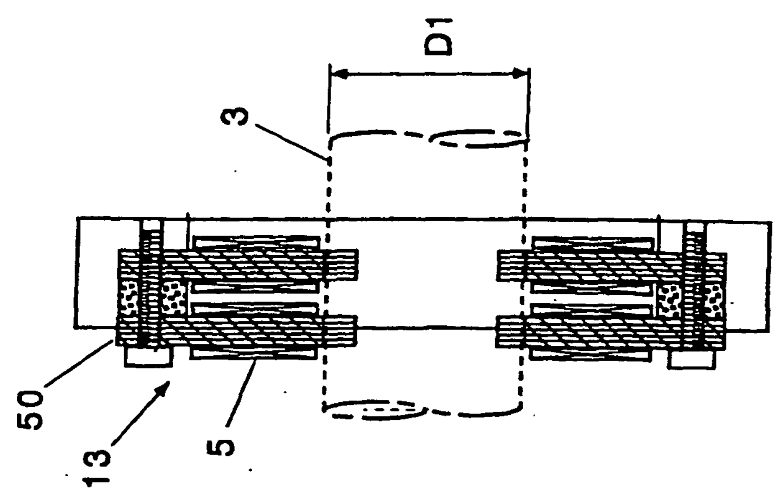
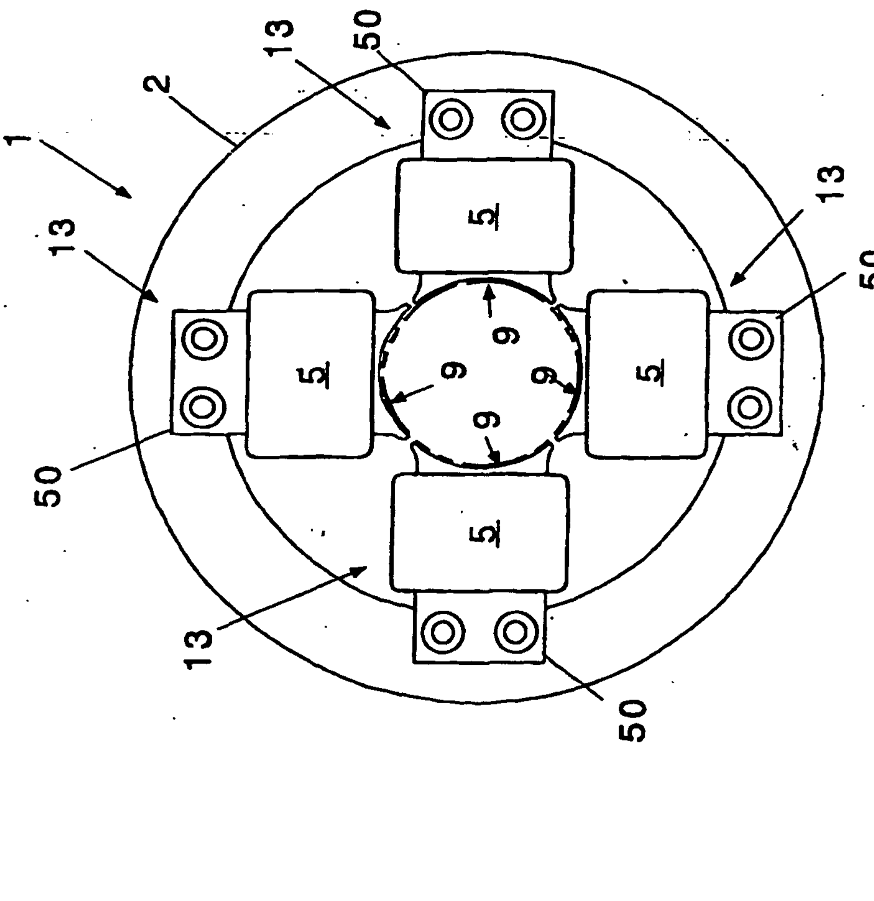


Fig. 4a
Type D



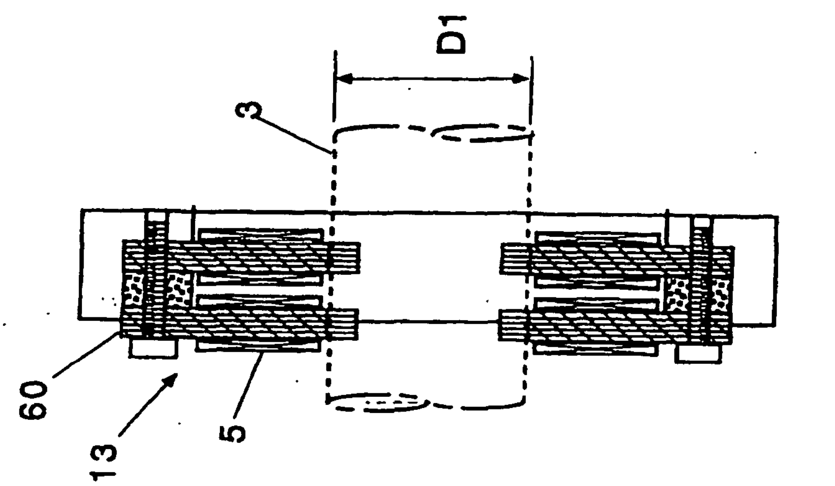


Fig. 5b
Type E

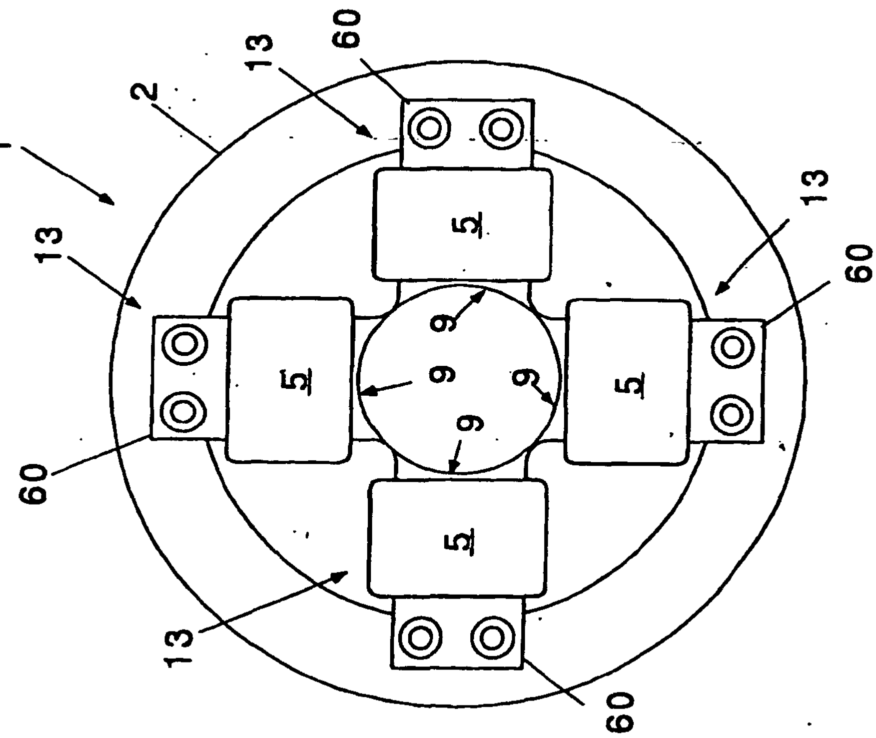
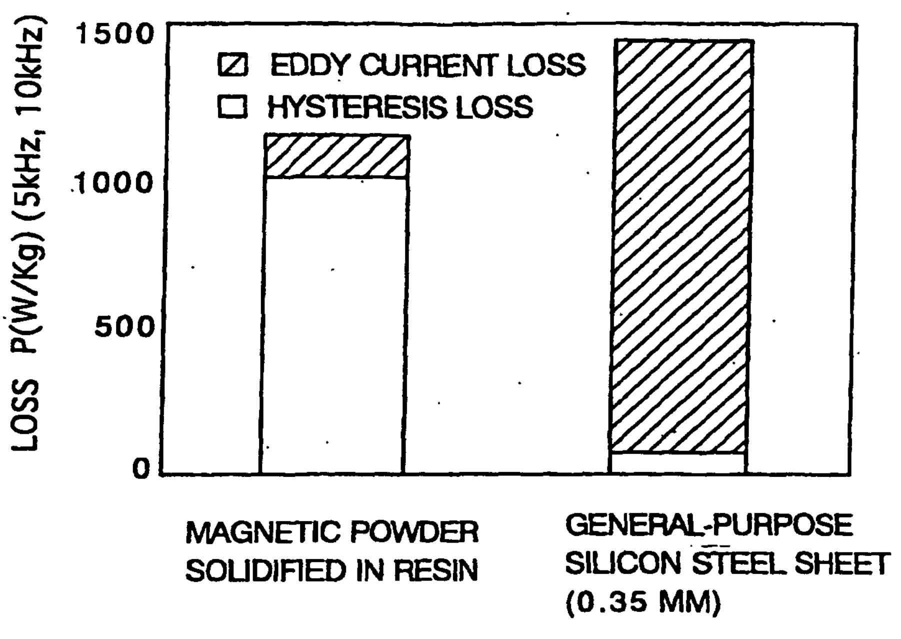


Fig. 5a
Type E

Fig.6


1500
1000
500
0
LOSS P(W/Kg) (5kHz, 10kHz)
EDDY CURRENT LOSS
HYSTERESIS LOSS
MAGNETIC POWDER SOLIDIFIED IN RESIN
GENERAL-PURPOSE SILICON STEEL SHEET (0.35 MM)