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Title of the Invention: SPINDLE MOTOR WITH DISK STORAGE DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to a spindle motor structure that is free from inappropriate reading and writing of data on a magnetic recording medium mounted thereon and also relates to a hard disc drive unit that incorporates a spindle motor with a structure that is free from inappropriate reading and writing of data.

A spindle motor for driving a magnetic recording medium in a hard disc drive unit (HDD) of a computer usually comprises a bracket to be installed on the base of the HDD; a rotor hub mounted so as to rotate relative to the bracket; a rotor magnet corotably mounted on the hub; and a stator mounted to oppose the magnet. In such a spindle motor, when the hub is formed of a non-magnetic material such as aluminum, a yoke formed of a magnetic material such as iron is provided between the hub and the magnet.

Figure 9 shows the configuration of a hub and a yoke of a conventional spindle motor. In this Figure, a hub 2 includes a disc receiving section 4 on which a recording disc is mounted. An annular mount section 6 on which a yoke 8 is mounted is formed in the lower part of the disc receiving section 4. The yoke 8 comprises a vertically depending cylindrical portion 10 and a flange section 12 extending radially inwardly from the upper end of the vertically depending cylindrical portion 10. The yoke 8 is mounted on the hub with the top surface of the flange section 12 contacting the bottom surface of the disc receiving section 4 and the inner circumferential surface of the flange section 12 having been press-fitted to the outer circumferential surface of the mounting section 6. A rotor magnet 14 is mounted on the hub 2 via the yoke 8.

If the temperature rises in a HDD with such conventional spindle



motor mounted therein, the hub 2 and the yoke 8 are thermally expanded to generate thermal stress on the interface between the bottom surface of the disc receiving section 4 of the hub 2 and the top surface of the flange section 12 of the yoke 8. If the thermal stress increases, the two surfaces are thermally deformed, but the hub 2 made of aluminum is deformed more easily than the yoke 8 made of iron due to its thermal conductivity and material strength, thereby distorting the disc receiving section 4. As a result, the distorted hub 2 causes the recording disc to be significantly deflected during rotation, thereby causing inappropriate recording and writing of data.

SUMMARY OF THE INVENTION

It is thus an object of the present invention to provide a spindle motor in which a hub is not thermally deformed even when an HDD is at high temperature.

It is another object of the present invention to provide an HDD that can correctly record data on a recording disc or read data from the disc with the hub being free from thermal deformation even when the HDD is at high temperature, thereby preventing abnormal rotation of the recording disc caused by deformation of hub.

A spindle motor according to the present invention comprises a bracket and a hub that rotates relative to the bracket. A magnet is mounted on the hub and a stator is installed to oppose the magnet. The hub includes a disc receiving section on which a recording disc is supported, and a magnet is installed below the disc receiving section via a yoke. The hub includes a mounting projection for fixing the yoke. A spacer member is interposed between the hub and the yoke to form a gap so that if a change in the internal temperature of the HDD causes thermal stress between the hub and the yoke, the thermal stress can be absorbed by the elastic deformation of the mounting projection. The gap between the hub and the yoke can also allow the hub to be thermally expanded to



prevent the hub, particularly the disc receiving section thereof, from being thermally deformed, thereby preventing inappropriate reading and writing of data due to abnormal rotation of the disc.

In addition, a HDD according to the present invention comprises a spindle motor which includes a magnet installed on a hub and a stator installed to oppose the magnet, wherein the hub has a disc receiving section on which a recording disc is received and the magnet is installed below the disc receiving section via a yoke. The hub includes a mounting projection for fixing the yoke. A spacer member is interposed between the hub and the yoke to form a gap so that if a change in the internal temperature of the HDD causes thermal stress between the hub and the yoke, said thermal stress can be absorbed by the elastic deformation of the mounting projection. Furthermore the gap between the hub and the yoke can allow the hub to be thermally expanded, and the hub, particularly, its disc receiving section is not thermally deformed, thereby preventing inappropriate reading and writing of data due to abnormal rotation of the disc.

The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional view showing one embodiment of a spindle motor according to the present invention.

Figure 2 (1) is a partially enlarged schematic view of a hub and a yoke of the spindle motor shown in Figure 1.

Figure 2 (2) is a partially enlarged schematic view of a hub and a yoke



of the spindle motor shown as shown in Figure 2 (1) but showing a modification of spacer member.

Figure 2 (3) is a partially enlarged schematic view of a hub and a yoke of the spindle motor shown as in Figure 2 (1) but showing a further modification of spacer member.

Figure 3 is a bottom view of the hub member shown in Figure 1.

Figure 4 is a bottom view of the hub member similar to Figure 3 but illustrating another embodiment.

Figure 5 is a partial enlarged view of a hub and a yoke of another shape.

Figure 6 is a bottom view of the hub member as shown in Figure 5 but showing a modification of protrusion.

Figure 7 is a partial cross-sectional view of a hub and a yoke of yet another shape.

Figure 8 is a partial cross-sectional view showing a spindle motor of a shaft rotating type according to the present invention.

Figure 9 is a partial enlarged view of a hub and a yoke of a conventional spindle motor.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a construction of a spindle motor as an embodiment of the present invention. The spindle motor of Figure 1 comprises a bracket 22 and a hub 24 that rotate relative to each other. The bracket 22 has a circular bottom

portion 26; a side wall 28 extending upward from the outer circumferential portion of the bottom portion 26; and a flange 30 extending radially outwards from the upper end of the side wall 28. The flange 30 is to be fixed to a base (not shown) of a disc driving device via, for example, a set screw (not shown). A shaft 32 is fixed to the center of the bottom portion 26 of the bracket 22. The shaft 32 extends substantially vertically from the bottom portion 26. A hub 24 is rotatably supported by the shaft 32 via a pair of bearings 34 and 36 which are mounted spaced apart from each other in the vertical direction. A yoke 40 is secured to the lower part of the hub 24. One or more discs shown with an imaginary line in Figure 1 are mounted on the outer circumference of the hub 24, with the lowest recording disc integrally provided on the lower part of the hub 24 and loaded on a disc supporting section 60 that protrudes radially outward.

A cylindrical permanent magnet 42 is installed on the inner circumferential surface of the yoke 40. A stator 44 opposes the magnet 42. The stator 44 includes a stator core 46 composed of a plurality of laminated core plates. The stator core 46 is attached to the outer circumferential surface of an annular protrusion 48 that protrudes axially inwardly from the bottom portion 26 of the bracket 22. A coil 50 is wound around the stator core 46. Thus, when a current is supplied to the coil, electromagnetic interaction occurs between the stator 44 and the magnet 42, causing the hub 24 to rotate in a predetermined direction.

A magnetic fluid seal means 52 is installed axially outside the upper bearing 34. The magnetic fluid seal means 52 is mounted on an upper cap member 54 that is installed on the hub 24. A lower cap member 56 for obtaining a labyrinth seal effect between the cap member 56 and the shield plate of the bearing 36 is installed axially outside the lower bearing 36. The magnetic fluid seal means 52 and the lower cap member 56 prevent grease in the bearing 34 and 36 from leaking outside the motor. In addition, the upper cap member 54 prevents magnet fluid in the magnetic fluid seal means 52 from splashing outside the motor.



Figure 2 (1) shows, in details, a portion of the spindle motor shown in Figure 1. The hub 24 is formed of aluminum or an aluminum alloy. An annular mounting protrusion 62 protruding downward is formed on the inner circumferential bottom surface of the disc supporting section 60.

The yoke 40 is formed of, for example, iron, and includes a cylindrical portion 64; and a flange section 66. The flange section 66 extends radially inwardly from the upper end of the cylindrical portion 64. The yoke 40 is positioned in the outer-down corner of the hub 24 in such a way that the radially inner-circumferential surface of the flange section 66 abut against the radially outer-circumferential surface of the mounting protrusion 62. The yoke 40 is mounted on the lower part of the disc supporting section 60 in such a way that the upper end of the inner circumference of the flange section 66 is brought into contact with the radially outer-circumferential surface of the mounting protrusion 62, and the flange section 66 is press fitted to the outer circumference of the mounting protrusion 62 to plastically deform it.

A positioning protrusion 68 protruding downward is formed on the bottom surface of the flange section 66 of the yoke 40, and the magnet 42 is installed on the yoke 40 with its top surface contacting the top of the protrusion 68.

In the present embodiment, a spacer member 70 is formed at a corner where the bottom surface of the disc supporting section 60 and the outer circumferential surface of the mounting protrusion 62 intersect. The spacer member 70 provides a small gap 72 between the bottom surface of the disc supporting section 60 and the top surface of the flange section 66 of the yoke 40.

Thus, if the temperature of the motor rises and thermal stress occurs due to the difference in the thermal expansion coefficient between the materials of the hub 24 and the yoke 40, the thermal stress is absorbed by the elastic deformation of the mounting protrusion 62. The small gap 72 formed by the



spacer member 70 in effect prevents the bottom surface of the disc supporting section 60 from contacting the top surface of the flange section 66 of the yoke 40 except for the radially inward end of the flange section 66 which engages the mounting protrusion 62. Consequently, thermal stress does not occur in the disc supporting section 60 of the hub 24, and the hub 24 is not thermally deformed.

In this embodiment, the spacer member 70 is integrally formed with the mounting protrusion 62, but the spacer member 70 may be modified as shown in Figures 2 (2) and 2 (3). A spacer member 71 as shown in Figure 2 (2) is integrally formed with the yoke 40. A spacer member 73 as shown in Figure 2 (3) is independently formed and interposed between the bottom surface of the disc supporting section 60 and the top surface of the flange section 66 as shown in Figure 2 (3). Further, the spacer member 70 may be circumferentially formed as shown in Figure 3 or formed at intervals as shown in Figure 4.

Figure 5 shows another embodiment of the present invention. According to this embodiment, a protrusion 74 is formed on the radially middle of the bottom surface of the disc supporting section 60. The top surface of the flange section 66 of the yoke 40 is in contact with the protrusion 74. In this embodiment, the presence of the protrusion 74 also provides a small gap 72 between the bottom surface of the disc supporting section 60 and the top surface of the flange section 66 of the yoke 40. Consequently, when a large thermal stress occurs between the disc supporting section 60 and the yoke 40, the protrusion 74 is elastically deformed, and the small gap 72 absorbs the thermal deformation of the disc supporting section 60 and the yoke 40. Thus, the embodiment of Figure 5 attains effects similar to those obtained by the embodiments shown in Figures 1 to 4. The protrusion 74 may be partially and concentrically formed as shown in Figure 6.

Figure 7 shows still another embodiment of the present invention. According to this embodiment, the structure of the hub and the position of the protrusion are changed, but the remaining part of the structure is almost the



same as in the spindle motor shown in Figure 1. In the hub 24 shown in Figure 7, the mounting protrusion 62 is spaced radially inwardly from the disc supporting section 60 instead of being formed directly below the disc supporting section 60. The spacer member 70 is formed at the intersection of the outer circumferential surface of the mounting protrusion 62 and the bottom surface of the hub 24. The flange section 66 of the yoke 40 extends radially inward further than that shown in Figure 1, and the inner circumferential surface of the flange section 66 is pressed against the outer circumferential surface of the mounting protrusion 62 in such a way that the inner-circumferential upper surface of the flange section 66 is in contact with the bottom surface of the spacer member 70. Thus, the small gap 72 is formed between the bottom surface of the disc supporting section 60 and the top surface of the flange section 66 to prevent the hub 24 from being deformed by thermal stress and to prevent the disc supporting section 60 from being deformed by processing stress caused during the pressing of the mounting protrusion 62 and the yoke 40.

Although the hub and yoke according to the present invention have been described in conjunction with a spindle motor with a fixed shaft, similar effects can be obtained when the hub and yoke according to the present invention are used in a spindle motor of a shaft rotating type in which the hub 24 is directly fixed to the shaft 32 so that it rotates with the shaft 32, as shown in Figure 8.

In addition, the hub and yoke according to the present invention have been described in conjunction with a spindle motor with ball bearings, similar effects can be obtained when the hub and yoke according to the present invention are used in a spindle motor having hydrodynamic pressure type bearing.

The terms and expressions which have been employed in the foregoing specification are used therein as terms of description and not as terms of limitation, and there is no intention, in the use of such terms and expressions, of excluding the equivalents of the features shown and described or the portions thereof, it being recognized that the scope of the invention is defined and limited



only by the claims which follow.

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What is claimed is:

Claim 1:

A spindle motor comprising:
a stationary member;
a cup-shaped rotor rotatably supported by the stationary member;
a stator fixed on the stationary member;
a rotor magnet disposed so as to oppose the stator;
a yoke member having a cylindrical portion and a flange portion
extending radially inwardly from the upper end portion of the cylindrical portion,
the rotor magnet fixed on the inner peripheral surface of the cylindrical portion;
a disc supporting portion formed integrally with the rotor and projecting
radially outwardly from the lower portion of the outer peripheral surface of the
rotor; and
a spacer member interposed between the lower surface of the disc
supporting portion and the upper surface of the flange portion to form a narrow
gap therebetween.

Claim 2:

A spindle motor of claim 1, wherein the rotor includes a mounting
projection to which the flange portion of the yoke member is fixedly fitted.

Claim 3:

A spindle motor of claim 2, wherein the spacer member is located at the
corner where the lower surface of the disc supporting portion intersects with
outer surface of the mounting projection.

Claim 4:

A spindle motor of claim 1, wherein the spacer member is formed
integrally with the rotor.



Claim 5:

A spindle motor of claim 1, wherein the spacer member is formed integrally with the yoke member.

Claim 6:

A spindle motor of claim 2, wherein the spacer member is protrusion formed between the mounting projection and outer peripheral surface of the disc supporting portion.

Claim 7:

A spindle motor of claim 2, wherein the mounting projection is formed on radially middle of the bottom surface of the rotor.

Claim 8:

A disc storage device comprising:
a clean chamber isolated by a partition;
at least one data storage disk provided in the clean chamber and having a central opening with a first diameter;
a motor for rotating the data storage disk about an axis;
a support member connected to the clean chamber partition for supporting the motor within the clean chamber;
the motor including a stationary member, a cup-shaped rotor rotatably supported by the stationary member, a stator fixed on the stationary member, a rotor magnet disposed so as to oppose the stator, a yoke member having a cylindrical portion and a flange portion extending radially inwardly from the upper end portion of the cylindrical portion, the rotor magnet fixed on the inner peripheral surface of the cylindrical portion, a disc supporting portion formed integrally with the rotor and projecting radially outwardly from the lower portion of the outer peripheral surface of the rotor, and a spacer member interposed between the lower surface of the disc supporting portion and the upper surface of the flange portion to form a narrow gap therebetween.



Claim 9:

A disc storage device of claim 8, wherein the rotor includes a mounting projection to which the flange portion of the yoke member is fixedly fitted.

Claim 10:

A disc storage device of claim 9, wherein the spacer member is located at the corner where the lower surface of the disc supporting portion intersects with outer surface of the mounting projection.

Claim 11:

A disc storage device of claim 8, wherein the spacer member is formed integrally with the rotor.

Claim 12:

A disc storage device of claim 8, wherein the spacer member is formed integrally with yoke member.

Claim 13:

A disc storage device of claim 9, wherein the spacer member is protrusion formed between the mounting projection and outer peripheral surface of the disc supporting portion.

Claim 14:

A disc storage device of claim 9, wherein the mounting projection is formed on radially middle of the bottom surface of the rotor.

