

SPINDLE UNIT AND METHOD OF ASSEMBLING
THE SPINDLE UNIT

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BACKGROUND OF THE INVENTION

The present invention relates to a spindle unit for a magnetic disc device, an optical disc device and the like and a method of assembling the spindle
5 unit.

A disc of a magnetic disc device and optical disc device is rotated by a spindle unit. As a speed of the magnetic disc device and optical disc device is increased, a slide bearing system which supports a
10 spindle unit through an oil film is considered to employ as a bearing system of the spindle unit. The slide bearing system is complex in construction because a hub for driving a disc is journaled by a thrust slide bearing and a rotary shaft for driving the hub is
15 journaled by a radial slide bearing which is separate from the thrust slide bearing, respectively. Further, in the slide bearing, the dimension of a clearance between the bearing and the hub or the rotary shaft is important to exhibit the performance of the slide
20 bearing. Particularly, a bearing member and the hub constituting the thrust slide bearing portion must be finished with high accuracy, thus they have low mass-productivity and become a cause of high manufacturing cost.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a spindle unit which is simple in construction, can secure a necessary dimension of a clearance even if
5 a thrust slide bearing portion is not finished with high accuracy and is excellent in mass-productivity and a method of manufacturing the spindle unit.

A spindle unit according to the present invention comprises a cylindrical housing; a cup-shaped
10 hub including a boss projecting from a bottom center of the hub to an inside of the cup, having a shaft engaging straight through hole and loosely fitted into the housing; a substantially cylindrical bearing member including a radial slide bearing formed on an inner
15 cylindrical surface thereof and thrust slide bearings formed on both end surfaces thereof and press fitted into the housing with one of the thrust slide bearings being confronted with an end surface of the boss with a first predetermined clearance; a shaft loosely fitted
20 into the bearing member with a predetermined clearance and having a straight end portion press-fitted into the shaft engaging straight through hole of the boss and including a collar disposed at an end thereof opposite to the press-fitted straight end portion and confronting
25 the other of the thrust slide bearings with a second predetermined clearance; a fluid seal fixed to an end of the housing confronting the boss; a cap fixed to the other end of the housing to form an oil chamber together

with the housing and the fluid seal; fluid filled in the oil chamber, a motor for driving the hub in rotation including a stator fixed on an outer cylindrical surface of the housing and a rotor fixed on an inner cylindrical surface of the hub in opposed relationship with the stator.

Further, method of assembling the spindle unit according to the present invention comprises the steps of preparing a jig having an outside diameter fittable into the housing and a recess into which the collar is fitted having a depth of the thickness of the collar plus the first and second predetermined clearances; supporting the shaft on the jig in a state that the collar is fitted into the recess of the jig; fitting the housing into which the bearing member is press fitted onto the jig to abut an end surface of the jig against one of the end surfaces of the bearing member; press fitting the hub onto the shaft to abut the end surface of the boss against the other end surface of the bearing member; and removing the jig and fixing the cap to an end of the housing after filling the fluid.

In the spindle unit of the present invention, since the bearing member which is a single part includes the radial slide bearing and the thrust slide bearings, the bearing structure becomes a simple structure.

Further, since the coupling of the shaft with the hub is arranged as a press-fitted structure for compensating the finished dimension of the bearing member, the

clearance of the thrust slide bearing portion can be set to a necessary amount regardless of the finished dimension of the bearing member. As a result, since the bearing member need not be finished with high accuracy,
5 it can be made at a less expensive cost and the mass-productivity thereof can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical cross sectional view of a first embodiment of a spindle unit according to the
10 present invention;

FIG. 2 is a perspective view of a bearing member used in the spindle unit according to the present invention;

FIG. 3 is a plan view of the bearing member of
15 FIG. 2 showing distribution of dynamic pressure by a radial slide bearing;

FIG. 4 is a cross sectional view taken along the line IV - IV of FIG. 3 showing distribution of dynamic pressure by thrust slide bearing;

20 FIG. 5 is a cross sectional view similar to FIG 4 showing a modification of the thrust slide bearing;

FIG. 6 is a plan view of another modification of the bearing member;

25 FIG. 7 is a cross sectional view of the bearing member and the shaft showing a grooved radial bearing;

FIG. 8 is a plan view of other modification of the bearing member showing a grooved thrust bearing;

FIG. 9A, FIG. 9B and FIG. 9C are cross sectional views showing assembling steps of the first
5 embodiment of the spindle unit according to the present invention;

FIG. 10 is a vertical cross sectional view of a second embodiment of the spindle unit according to the present invention; and

10 FIG. 11 is a partially enlarged view showing a sealed portion of the second embodiment of the spindle unit according to the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

A first embodiment of a spindle unit according
15 to the present invention will be described with reference to FIG. 1 to FIG. 9.

A cylindrical housing 13 is fixed to a base plate 3. A hub 1 to which a magnetic disc or optical disc 21 is fixed through a spacer 23 and a clamp 22 has
20 a substantially cup-shape and is formed with a boss 4 projected from a bottom center of the hub 1 toward an inside of the cup. The boss 4 has a shaft engaging straight through hole 31 and loosely fitted into the housing 13. A fluid seal 10 is fixed to an end portion
25 of the boss 4 confronting the housing 13. A stator 7 is fixed to an outer cylindrical surface of the housing 13 and a rotor 8 is fixed to an inner cylindrical surface

of the hub 1 in confronting relationship with the stator 7. The stator 7 and the rotor 8 constitute a motor 9 for driving the hub in rotation.

A substantially cylindrical bearing member 2 is press fitted into the housing 13 with an end surface thereof confronting an end surface of the boss 4. A shaft 5 is loosely fitted into the bearing member with a predetermined clearance and a straight end portion of the shaft 5 is press-fitted into the shaft engaging straight through hole 31 of the boss 4. A collar 6 is formed to the other end of the shaft 5 and it confronts the other end surface of the bearing member 2. A cap 12 is fixed to an end of the housing 13 and forms an oil chamber 14 together with the housing 13 and the fluid seal 10. The oil chamber 14 is filled with fluid 11.

As shown in FIG. 2, FIG. 3 and FIG. 4, the bearing member 2 includes a radial slide bearing 2a formed on an inner cylindrical surface thereof and thrust slide bearings 2b formed both end surfaces thereof. The bearing member 2 is disposed in the housing 13 such that when the hub 1 is rotated, one of the thrust slide bearings 2b has a predetermined clearance with the end surface of the boss 4 and the other thrust bearing 2b has a predetermined clearance with the collar 6 of the shaft 5.

As shown in FIG. 3, the radial slide bearing 2a comprises three arcs 15 disposed equiangularly and these three arcs 15 are disposed such that clearances

defined between the arcs and the shaft 5 are gradually narrowed in the rotational direction of the shaft 5. Therefore, when the shaft 5 is rotated, since dynamic pressures are distributed as shown in FIG. 3, the shaft 5 is held at a proper position. Further, first oil grooves 17a are formed between the adjacent arcs 15 and extend in a longitudinal direction of the bearing member 2. Cutout surfaces 16 are formed on portions of an outer cylindrical surface of the bearing member 2 corresponding to the first oil grooves 17a. Further, second oil grooves 17b are formed on the end surface of the bearing member 2 and extend in radial directions to communicate with the first oil grooves 17a and the cutout surfaces 16. The second oil grooves 17b form a circulation passages of the fluid together with the first oil grooves 17a and the cutout surfaces 16. In place of the cutout surfaces 16, third oil grooves 17c extending in the longitudinal direction of the bearing member 2 may be formed as shown in FIG. 6.

Further, it should be noted that the same bearing function can be obtained also in the case where the radial slide bearing 2a is formed on the surface of the shaft 5 in place of on the bearing member 2.

As shown in FIG. 4, each of the thrust slide bearings 2b comprises ridges 18 formed between adjacent second oil grooves 17b. Therefore, when the hub 1 is rotated, dynamic pressure is generated between the thrust slide bearing 2b and the end surface of the boss

4 of the hub 1 (refer to FIG. 4) to thereby support the weights of the hub 1, disc 21 and the like. Inclined surfaces 18' each having a clearance between it and the hub 1 gradually narrowed in the rotational direction of the hub 1 may be formed in place of the ridges 18, as shown in FIG. 5. When the bearing member 2 is made of sintered metal, the ridges 18 have mass-productivity higher than that of the inclined surfaces 18'. That is, when the bearing member 2 is made of the sintered metal, the radial slide bearing 2a is formed after the thrust slide bearings 2b are molded. In this case, since the ridge 18 is formed in a symmetrical shape, it can cope with rotation in both directions. As a result, the radial slide bearing 2a can be formed without taking the rotational direction of the thrust slide bearings 2b into consideration. On the other hand, since a rotational direction is limited in the inclined surface 18', the radial slide bearing 2a must be formed so that it does not conflict with the rotational direction. As a result, the rotational direction of the thrust slide bearings must be taken into consideration upon forming the radial slide bearing, thus the inclined surfaces 18' are inferior to the ridges 18 in mass-productivity.

As shown in FIG. 6, lands 19, 27 as high as apexes 20 of the ridges 18 may be disposed to an inside edge and an outside edge. In the thrust slide bearings 2b arranged as described above, since the fluid 11 introduced from the second oil grooves 17b to the ridges

18 is dammed up by the lands 19, 17 disposed to the inside and outside edges, a pressure increase effect is improved to thereby improve a pressure distribution of fluid film and the rigidity of the bearing is increased.

5 Further, it should be noted that the same bearing function can be obtained also in the case where the thrust slide bearing 2b is formed on the end surface of the boss 4 or the collar 6 in place of on the bearing member 2.

10 Instead of the radial slide bearing 2a and the thrust slide bearing 2b, a grooved radial bearing as shown in FIG. 7 and grooved thrust bearings as shown in FIG. 8 may be employed. In the radial grooved bearing shown in FIG. 7, a plurality of grooves 32 having an
15 arrow-head shape are formed on the shaft 5. When the shaft 5 is rotated, the fluid is forced into the grooves 32 and pressure is increased, so that bearing function is generated. In the thrust grooved bearing shown in FIG. 8, a plurality of grooves 33 extending radially are
20 formed on the end surface of the bearing member 2. When the hub 1 or collar 6 opposing to the grooves 33 is rotated, the fluid is forced into the grooves 33 and pressure is increased, so that bearing function is generated. Also in these grooved bearings, the grooves
25 may be formed on the bearing member 2 in place of the shaft 5 and the end surface of the boss 4 or the collar 6 in place of the bearing member.

Next, a method of assembling the spindle unit

will be described with reference to FIG. 7a to FIG. 7c.

First, a jig 24 having an outside diameter fittable into the housing 13 and a recess 25 into which the collar 6 is fitted is prepared. The recess 25 has a depth of the thickness of the collar 6 plus sum e of the first and second predetermined clearances. The shaft 5 is supported on the jig 24 in a state that the collar 6 is fitted into the recess 25 of the jog 24. The housing 13 into which the bearing member 2 is press fitted is fitted onto the jig 24 and the end surface of the jig 24 is abutted against one of the end surfaces of the bearing member 2. The hub 1 is press fitted onto the shaft 5 to cause the end surface of the boss 4 to be abutted against the other end surface of the bearing member 2. The jig 24 is removed and the cap 12 is fixed to the end of the housing 13 after the fluid is filled.

It must be noted that when the bearing member 2 is finished smaller than a predetermined dimension, the press-fitted length of the hub 1 onto the shaft 5 is automatically increased, whereas when the bearing member 2 is finished larger than the predetermined dimension, the press-fitted length of the hub 1 onto the shaft 5 is automatically decreased so that the clearance of thrust slide bearing portions is automatically set to the predetermined value e .

As described above, since the bearing member 2 as a single part includes the radial slide bearing 2a and the thrust slide bearings 2b, the bearing structure

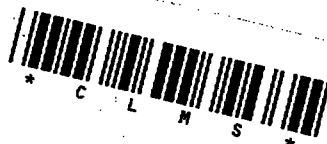
becomes a simple structure. Further, since the coupling of the shaft 5 with the hub 1 is arranged as a press-fitted structure for compensating the finished dimension of the bearing member 2, the clearance of the thrust slide bearing portions can be set to a necessary amount regardless of the finished dimension of the bearing member 2. As a result, since the bearing member 2 need not be finished with high accuracy, it can be made by molding and thus the mass-productivity thereof can be improved. Further, since the thrust slide bearings 2b are disposed on both end surfaces of the bearing member 2, bearing rigidity is increased to thereby prevent the falling-down of the hub 1 and the shaft 5.

Next, a second embodiment of the spindle unit according to the present invention will be described with reference to FIG. 8 and FIG. 9. The second embodiment is different from the first embodiment in that a magnetic fluid is filled in the oil chamber 14, the seal 10 is a magnetic fluid seal and a screw seal 28 is disposed on an outer cylindrical surface of the boss 4 confronting the magnetic fluid seal 10. The screw seal 28 is disposed in such a direction as to force the magnetic fluid 11 into the oil chamber 14 by the rotation of the boss 4. The magnetic fluid seal 10 comprises a magnet 30 disposed to generate a line of magnetic force in the direction for forcing the magnetic fluid 11 into the oil chamber 14 as shown by an arrow in FIG. 9 and pole pieces 29, 29' disposed on both ends of

the magnet 30.

With this arrangement, the magnetic fluid 11 is sealed by the magnetic circuit of the magnetic fluid seal 10 in a stationary state, whereas the magnetic fluid 11 is sealed by the action of the magnetic fluid seal 10 and the screw seal 28 when the hub is rotated. As a result, the seal performance of the second embodiment is improved as compared with the first embodiment which does not comprise the screw seal.

10 Although the radial slide bearing 2a and the thrust slide bearings comprise the three dynamic pressure generating arcs and ridges, respectively in both the above embodiments, they may comprise dynamic pressure generating arcs and ridges more than three.



WHAT IS CLAIMED IS:

1. A spindle unit, comprising:

a cylindrical housing (13);

a cup-shaped hub (1) including a boss (4) projecting from a bottom center of said hub (1) to an inside of the cup, having a shaft engaging straight through hole and loosely fitted into said housing (13);

a substantially cylindrical bearing member (2) including a radial slide bearing (2a) formed on an inner cylindrical surface thereof and thrust slide bearings (2b) formed on both end surfaces thereof and press fitted into said housing (13) with one of said thrust slide bearings (2b) being confronted with an end surface of said boss (4) with a first predetermined clearance;

a shaft (5) loosely fitted into said bearing member (2) with a predetermined clearance and having a straight end portion press-fitted into the shaft engaging straight through hole of said boss (4) and including a collar (6) disposed at an end thereof opposite to said press-fitted straight end portion and confronting the other of said thrust slide bearings (2b) with a second predetermined clearance;

a fluid seal (10) fixed to an end of said housing (13) confronting said boss (4);

a cap (12) fixed to the other end of said housing (13) to form an oil chamber (14) together with said housing (13) and said fluid seal (10);

fluid (11) filled in said oil chamber (14);



a motor (9) for driving said hub (1) in rotation including a stator (7) fixed on an outer cylindrical surface of said housing (13) and a rotor (8) fixed on an inner cylindrical surface of said hub (1) in opposed relationship with said stator (7).

2. A spindle unit according to claim 1, wherein said fluid (11) comprises magnetic fluid and said fluid seal (10) comprises a magnetic fluid seal and a screw seal (28) for forcing said magnetic fluid (11) into said oil chamber (14) by rotation of said boss (4) is disposed to a portion of said boss (4) confronting said magnetic fluid seal (10).

3. A spindle unit according to claim 1 or claim 2, wherein said radial slide bearing (2a) of said bearing member (2) comprises a plurality of arcs (15) disposed equiangularly and said plurality of arcs (15) are disposed such that clearances defined between said arcs (15) and said shaft (5) are gradually narrowed in the rotational direction of said shaft (5).

4. A spindle unit according to claim 3, wherein first oil grooves (17a) extending in lengthwise direction of said bearing member (2) are disposed between adjacent arcs of said plurality of arcs (15) and second oil grooves (17b) communicating with said first oil grooves (17a) and extending in radial directions are disposed on an end surface of said bearing member (2).

5. A spindle unit according to claim 4, wherein cutout surfaces (16) communicating with said second oil



grooves (17b) and extending in the lengthwise direction of said bearing member (2) are formed on an outer cylindrical surface of said bearing member (2).

6. A spindle unit according to claim 3, wherein third oil grooves (17c) communicating with said second oil grooves (17b) and extending in the lengthwise direction of said bearing member (2) are formed on the outer cylindrical surface of said bearing member (2).

7. A spindle unit according to claim 1 or claim 2, wherein each of said thrust slide bearings (2b) of said bearing member (2) includes a plurality of second oil grooves (17b) extending in radial directions and disposed equiangularly and ridges (18) between adjacent second oil grooves (17b).

8. A spindle unit according to claim 7, wherein each of said thrust slide bearings (2b) of said bearing member (2) further includes lands (19, 27) which are as high as apexes (20) of said ridges (18) and disposed to an inside edge and an outside edge.

9. A method of assembling a spindle unit comprising:

a cylindrical housing (13);

a cup-shaped hub (1) including a boss (4) projecting from a bottom center of said hub (1) to an inside of the cup, having a shaft engaging straight through hole and loosely fitted into said housing (13);

a substantially cylindrical bearing member (12) including a radial slide bearing (2a) formed on an



inner cylindrical surface thereof and thrust slide bearings (2b) formed on both end surfaces thereof and press fitted into said housing (13) with one of said thrust slide bearings being confronted with an end surface of said boss (4) with a first predetermined clearance;

a shaft (5) loosely fitted into said bearing member (2) with a predetermined clearance and having a straight end portion press-fitted into the shaft engaging straight through hole of said boss (4) and including a collar (6) disposed at an end thereof opposite to said press-fitted straight end portion and confronting the other of said thrust slide bearings (2b) with a second predetermined clearance;

a fluid seal (10) fixed to an end of said housing (13) confronting said boss (4);

a cap (12) fixed to the other end of said housing (13) to form an oil chamber (14) together with said housing (13) and said fluid seal (10);

fluid (11) filled in said oil chamber (14);

a motor (9) for driving said hub (1) in rotation including a stator (7) fixed on an outer cylindrical surface of said housing (13) and a rotor (8) fixed on an inner cylindrical surface of said hub (1) in opposed relationship with said stator (7), said method comprising the steps of:

preparing a jig (24) having an outside diameter fittable into said housing (13) and a recess

(25) into which said collar (6) is fitted having a depth of the thickness of said collar (6) plus said first and second predetermined clearances;

supporting said shaft (5) on said jig (24) in a state that said collar (6) is fitted into said recess (25) of said jig (24);

fitting said housing (13) into which said bearing member (2) is press fitted onto said jig (24) to abut an end surface of said jig (24) against one of the end surfaces of said bearing member (2);

press fitting said hub (1) onto said shaft (5) to abut the end surface of said boss (4) against the other end surface of said bearing member (2); and

removing said jig (24) and fixing said cap (12) to an end of said housing (13) after filling the fluid.