description

MAGNETIC RECORDING APPARATUS

TECHNICAL FIELD

The present invention relates to improvement in the connection structure of a carriage arm and a load arm in a magnetic recording apparatus.

BACKGROUND ART

In magnetic recording apparatus, there has been a demand to reduce the overall size of the apparatus. And in order to reduce the size of the apparatus, the spacing between the neighboring magnetic discs must be reduced.

A typical prior art of a magnetic disc device of the configuration of a arm 5 and a load beam 6 which is a type of the magnetic recording apparatus was shown in FIG. 9 which is an exploded perspective assembly view. Referring to FIG. 9, the load beam 6 has a magnetic head 4 on one end portion, and has an opening 6A at the other end portion. A boss 11A of a base plate 11 made of stainless steel is inserted in the opening 6A, and the base plate 11 is fixed to the load beam 6 by spot welding. The spot welding is applied to positions marked with letter P, for example. The height of the boss 11A is larger than the thickness of the load beam 6. An opening 5A having an inner diameter slightly larger than the outer diameter of the boss 11A is formed at an end portion of the arm 5 made of aluminum. When the load beam 6 is connected to the arm 5, the boss 11A of the base plate 11 is inserted in the opening 5A of the arm

5. Subsequently, a steel ball 10 having a diameter larger than the opening 11B of the boss 11A is moved through the opening 11B. Consequently, the boss 11A expands outward and contacts closely to the inner wall of the opening 5A, and thereby the load beam 6 is fixedly mounted on the arm 5.

With the miniaturization of the magnetic disc device having plural magnetic discs, the spacing between neighboring magnetic discs is required to be narrowed.

A prior art to narrow the spacing between the neighboring magnetic discs is shown in the Japanese published an examined patent application Hei 2-294977. According to the prior art, plural recesses are formed on a boss of a base attached to a head suspension in a manner that hill portions (11, 12, 13) and valley portions are alternately arranged on the boss. When two head suspensions are mounted on an upper side and a lower side of an actuator, respectively, both the bosses are coupled with each other in a manner that the hill portions of the boss of an upper base are inserted into the valley portions of a lower base.

Another prior art is disclosed in the United States patent No. 5,172,286. According to the prior art, two load beams are mounted on an upper side and a lower side of an arm through bosses of respective base plates of two load beams. The outer diameter of the boss of the upper load beam is made slightly larger than the inner diameter of the boss of the lower load

beam. The boss of the upper load beam is press-fitted into the boss of the lower lord beam, thereby securing two load beams to the arm.

In these above-mentioned three prior arts, the head suspensions or the load beams are mounted on the actuator or the arm by using an intermediate matter such as base plate having the boss. The base plate must be thicker than the load beam, because the base plate requires a mechanical strength. The use of the thick base plate restricts to narrow the spacing between the neighboring magnetic discs. Since the load beams are connected to the arm with the base plates, a fabrication cost increases due to increase of an element cost for the base plate and an assembly cost for mounting the base plate on the load beam.

DISCLOSURE OF INVENTION

A magnetic recording apparatus of the present invention comprises: a carriage arm having a mounting opening at an end portion and connected at the other end to a driving unit for positioning the carriage arm on a magnetic disc, and a load arm having a magnetic head at one end portion and having at the other end portion a joining part to be fixedly mounted in the mounting opening of the carriage arm. The joining part includes a raised portion having a smaller dimension than the dimension of the mounting opening and protruding to the carriage arm.

When the raised portion of the load arm is press-fitted into the mounting opening of the carriage arm, the raised portion is flared so as to conform to the inner wall of the mounting opening and is pressed on the inner wall. The raised portion deforms the inner wall with plastic deformation of the inner wall and bites into the inner wall. Consequently the raised portion is fixed in the mounting opening, and the load arm is fixedly mounted on the carriage arm.

A magnetic recording apparatus of another aspect of the present invention comprises: an oblong carriage arm having a polygonal opening at an end portion and connected at the other end to a driving unit for positioning the carriage arm on a magnetic disc, and a load arm having a magnetic head at one end portion and a joining part to be fixedly mounted in the mounting opening of the carriage arm at the other end portion. The joining part includes a polygonal raised portion having a smaller dimension than the dimension of the mounting opening and has a protrusion toward the carriage arm.

When the polygonal raised portion of the load arm is press-fitted into the polygonal mounting opening of the carriage arm, the raised portion is flared. Then the flared portion fits the inner wall of the mounting opening pressing the inner wall. The raised portion deforms the inner wall with the plasticity of the latter and bites into the inner wall. Consequently the raised portion is fixed in the mounting opening, and the load

arm is fixedly mounted on the carriage arm. Since the mounting opening and the raised portion are polygonal, mutual rotation between the load arm and carriage arm is prevented.

Fabrication method of the magnetic recording apparatus in the present invention comprises the steps of: forming a mounting opening at one end portion of a carriage arm which is connected at the other end to a driving unit for positioning the carriage arm on a magnetic disc, forming a raised portion having a smaller dimension than the mounting opening and protruding to the carriage arm at one end portion of a load arm having a magnetic head at another end portion, combining the load arm with the carriage arm so as to align the respective centers of the raised portion and the mounting opening, and press-fitting the raised portion into the mounting opening by the insertion of a press-fit tool into the mounting opening so that raised portion plastic-deforms the inner wall of the mounting opening and bites into the inner wall.

The raised portion is fixedly mounted in the mounting opening by only the insertion of the press-fit tool. Assembly process is simplified and an assembly cost is reduced.

BRIEF DESCRIPTON OF DRAWINGS

FIG. 1 is a perspective view of a magnetic recording apparatus that is common in all embodiments of the present invention.

FIG. 2 is a perspective view of a load arm mounted

on a carriage arm of a first embodiment in the present invention.

FIG. 3A is an exploded perspective assembly view showing a mounting position of the carriage arm and load arm of the first embodiment in the present invention.

FIG. 3B is a perspective view showing another example of the load arm.

FIG. 4A is an enlarged sectional view of an end portion of the load arm of the first embodiment in the present invention.

FIG 4B is an enlarged sectional view of the carriage arm and the load arm prior to assembling them of the first embodiment in the present invention.

FIG. 5A is an enlarged sectional view of the carriage arm and the load arm including jigs at an assembly step of the first embodiment in the present invention.

FIG. 5B and FIG. 5C are perspective views of other examples of a press-fit tool.

FIG. 6A and FIG. 6B are enlarged sectional views of assemblies of the carriage arm and load arm of the first embodiment in the present invention.

FIG. 7A is an exploded perspective assembly view of a carriage arm and a load arm of a second embodiment in the present invention.

FIG. 7B is a perspective view of a press-bit tool which is used for the second embodiment shown in FIG. 7A.

FIG. 8 is a perspective view of a carriage arm and

a load arm of a third embodiment in the present invention.

FIG. 9 is a perspective view showing the connecting method of the carriage arm and the load arm in the prior art.

BEST MODE OF CARRYING OUT THE INVENTION

Preferred embodiments of the present invention are described with reference to FIG. 1 to FIG. 8.

[First embodiment]

FIG. 1 is a perspective view showing relevant part of a magnetic disc device 1, which is a type of a magnetic recording apparatus, common in all embodiments of the present invention. Referring to FIG. 1, the magnetic disc device 1 comprises plural magnetic discs 2, a disc clamp 3 for holding the magnetic discs 2 and a spindle motor (not shown) for rotating the magnetic discs 2, which is omitted from drawing in the figure. A magnetic head 4 is supported by a load arm 16, and records information to and reproduces the information from the magnetic disc 2. The load arm 16 is fixedly mounted on a carriage arm 15. The carriage arm 15 is connected to a carriage block 7A including a voice coil motor 7.

FIG. 2 is a perspective view of the carriage arm 15 and the load arm 16 mounted on the forward end thereof in a first embodiment of the present invention. The carriage arm 15 is made of aluminum such as of material number A5052 and the load arm 16 is made of stainless steel such as of material number SUS304H.

The detailed structures of the load arm 16 and the

carriage arm 15 are described with reference to FIG. 3A to FIG. 6B.

FIG. 3A is an exploded perspective assembly view showing the forward end portion of the carriage arm 15 and the load arm 16 to be mounted on the carriage arm 15. The load arm 16 comprises a spring portion 8 and a base portion 9. The base portion 9 includes an opening such as a circular opening 9A. A raised portion 9B is formed coaxial with the opening 9A so as to surround the opening 9A and protrude toward the carriage arm 15. The part around the raised portion is shown in enlarged sectional views FIG. 4A and FIG. 4B of the base portion 9. A joining portion is formed of the opening 9A and the raised portion 9B. Known coining process can be used to form the raised portion 9B.

FIG. 3B is a perspective view of another example of a load arm 26. As shown in FIG. 3B, plural raised portions 39B are formed on a circle (in FIG. 3B, for example, three raised portions are formed in FIG. 3B).

FIG. 4B is a sectional view illustrating a state preceding the assemblage of the load arm 16 and the carriage arm 15 at which the center of the opening 9A is placed in concentric relation with the center of the mounting opening 5A. As shown in the figure, the diameter D2 of the raised portion 9B of the load arm 9 is made slightly smaller than the diameter D1 of the mounting opening 5A of the carriage arm 5.

Particular dimensions of relevant parts are as follows:

the diameter D1 is 2.05 mm,

the diameter D2 is 1.83 mm and

the diameter D3 of the opening 9A is 1.53 mm.

The board-thickness t of the base portion 9 is 0.064 mm and the height H of the top face of the raised portion 9B protruding over the face of the base portion 9 is 0.03 mm. The height H is preferably about one half of the board-thickness t in order to prevent the base portion 9 from breakage in the coining process. The mounting opening 5A of the carriage arm 15 is chamfered so as to form a chamfer 5B of about 2.10 mm in diameter.

A process for assembling the load arm 16 to the carriage arm 15 is described with reference to FIG. 4B and FIG. 5A. A sectional view of FIG. 5A shows the state that the carriage arm 15 and the load arm 16 are mounted on respective jigs 15A and 15B. The jig 15A includes a mechanism for positioning the carriage arm 15, and the jig 15B includes a mechanism for positioning the load arm 16. These mechanisms are well known to one with ordinary skill in the art, and therefore omitted from drawings. The jigs 15A and 15B clamp the carriage arm 15 and the load arm 16 with a pressure aligning both axes of the mounting opening 5A and the opening 9A to coaxial relation. Subsequently, a steel ball 10 having a higher hardness than the

stainless steel of the load arm 16 is moved to pass through the mounting opening 5A and the opening 9A in the direction shown by an arrow A. The steel ball 10 serves as a press-fit tool. The outer diameter of the steel ball 10 is designed to be smaller than the diameter D1 (see FIG. 4B) of the mounting opening 5A and larger than the amount d which is given as the difference between the diameter D1 and twice the board thickness t of the load arm 16, (d=D1-2d). In the above-mentioned particular example of dimensions, the outer diameter of the steel ball is 2.00 mm. A circular region surrounding the raised portion 9B is bent so as to conform to the chamfer 5B. And the raised portion 9B becomes flared, thereby to tightly contact to and is pressed onto the inner wall of the mounting opening 5A as a result of the passage of the steel ball 10 through the opening 9B and the mounting opening 5A.

As shown in FIG. 5B, a different type press-fit tool 20 of a steel rod having a hemispherical top 21 may be used as an alternative tool to the steel ball 10.

Figs. 6A and 6B are enlarged sectional views of an adjacent part of the mounting opening 5A of the carriage arm 15 after the passage of the steel ball 10. Since the carriage arm 15 is made of aluminum and the load arm 16 (shown in FIG. 2 and 3A) is made of stainless steel, the load arm 16 is harder than the carriage arm 15. As shown in FIG. 6B of an enlarged sectional view of a region K in FIG. 6A, the flared raised portion

9B bites into the inner wall of the mounting opening 5A of the carriage arm 15. Although the raised portion 9B flared by the steel ball 10 slightly spring-backs to the original shape after passage of the steel ball 10, the load arm 16 can be firmly mounted to the carriage arm 15 at the mounting opening 5A, because the raised portion 9B bites into the inner wall of the mounting opening 5A.

FIG. 5C is a perspective view of a press-fit tool 23 in a modified example. The rod-shaped press-fit tool 23 includes a spherical top 24 and at least one projection 25 formed on the side face. As shown in FIG. 5, the carriage arm 15 and the load arm 16 are clamped between the jigs 15A and 15B. When the press-fit tool 23 is moved through the opening 9A and the mounting opening 5A, a part of the raised portion 9B is pushed strong into the inner wall of the mounting opening 5A by the projection 25 of the press-fit tool 23. Consequently, the part of the raised portion 9A pushed by the projection 25 bites deep into the inner wall of the mounting opening 5A in comparison with the other part of the raised portion 9B. The part of the raised portion 9B which bites deep into the inner wall of the mounting opening 5A functions as a member to prevent mutual rotation between the carriage arm 15 and the load arm 16. Consequently, reliability of the connection between the carriage arm 15 and the load arm 16 is further improved.

If the steel ball 10 is moved through the opening 9A

and the mounting opening 5A without clamping the load arm 16 and the carriage arm 15 with the jigs 15A and 15B, a region around and adjacent to the raised portion 9B is bent and dragged into the mounting opening 5A due to plastic-deformation. As a result, the base portion 9 is liable to occur undesirable deformation. The jigs 15A and 15B clamp the region of the base portion 9 at slightly larger circular part than the mounting opening 5A having the diameter D1. Since the part clamped by the jigs 15A and 15B is protected from the undesirable deformation, the load arm 16 can be mounted without deformation on the carriage arm 15.

[Second embodiment]

The shapes of the mounting opening 5A of the carriage arm 15 and the raised portion 9B of the load arm 16 shown in FIG. 3A are not limited to circles. The mounting opening 5A and the raised portion 9B may be a polygon such as a square or a hexagon. FIG. 7A is a perspective view of a carriage arm 35 and a load arm 36 of a second embodiment in the present invention. In FIG. 7A, the carriage arm 35 includes a hexagonal mounting opening 35A, and the load arm 36 includes a hexagonal raised portion 39B having a hexagonal opening 39A.

In this second embodiment, as shown in FIG. 7B, a rod-shaped press-fit tool 27 with a hexagonal cross-section is used to press-fit the raised potion 39B into the mounting opening 35A. Consequently, the hexagonal raised portion 39B bites into

the inner wall of the hexagonal mounting opening 35A, and the load arm 36 is firmly mounted on the carriage arm 35. Since the mounting opening 35A and the raised portion 39B are hexagonal, reliable firm fixing to prevent undesirable mutual (relative) rotation between the load arm 36 and the carriage arm 35.

The mounting opening 5A and the raised portion 9B may even be oval. The oval raised portion is press-fitted into the oval mounting opening by using a press-fit tool having an oval cross-section. According to such embodiment, since the mounting opening and the raised portion are oval, a firm mutual (relative) rotation-prevention effect is achieved.

[Third embodiment]

FIG. 8 is a perspective view of a load arm 46 of a third embodiment in the present invention. The carriage arm 15 is the same as that shown in FIG. 3A. The load arm 46 includes a raised portion 49A at a base portion 49. The raised portion 49A comprises at least one (three in this example) side protrusions 49B in the raised portion which is protruded from the circular raised portion 49A to the circumferential direction. When the raised portion 49A including the side protrusions 49B is press-fitted into the mounting opening 5A in a manner shown in FIG. 5A, the raised portions 49A and 49B bite into the inner wall of the mounting opening 5A, and the load arm 46 is firmly fixed on the carriage arm 15. The side protrusions 49B bite more deeply into the inner wall of the mounting opening 5A in

comparison with the raised portion 4A. The side protrusions 49B having bitten deeply into the inner wall have the function to prevent mutual (relative) rotation between the load arm and the carriage arm.

INDUSTRIAL APPLICABILITY

According to the present invention, the conventional base plate is not used to connect a load arm to a carriage arm. Therefore, a space corresponding to the thickness of the base plate is dispensed with. Consequently, each spacing between neighboring magnetic discs can be narrowed, and have a magnetic disc device with reduced thickness is obtainable. The number of elements in the magnetic disc device decreases and a fabrication cost is also reduced, due to omission of the base plate.

CLAIMS

1. A magnetic recording apparatus comprising:

a load arm having a magnetic head at one end portion and a connecting part at the other end,

a carriage arm having a mounting opening at an end portion for connecting thereat said connecting part of said load arm, and connected at the other end portion to a driving unit for driving to position said head on selected part of a data carrying disc, and

said load arm to be fixedly mounted to said mounting opening in relatively rotation prevented manner,

said connecting part including a raised portion having an opening of smaller dimension than that of said mounting opening and protruding toward said carriage arm and surrounding said opening, and said load arm being fixedly mounted on said carriage arm by plastic-deformation of the inner wall of said mounting opening by press-fitting said raised portion into said mounting opening.

2. A magnetic recording apparatus comprising:

a carriage arm having a polygonal mounting opening for connecting a load arm at an end portion, and connected at another end to a driving unit for positioning the carriage arm on a magnetic disc, and

said load arm having a magnetic head at one end portion and having at another end portion a joining part to be fixedly

This Sheet Has Been Replaced

THIS SHEET HAS BEEN REPLACED



mounted in said mounting opening of said carriage arm, said joining part including a polygonal raised portion having a smaller dimension than the dimension of said mounting opening and protruding to said carriage arm, and being fixedly mounted on said carriage arm in a manner of plastic deformation of the inner wall of said mounting opening by press-fitting said raised portion into said mounting opening.

3. A magnetic recording apparatus in accordance with claim 1, wherein

the hardness of the material of said load arm is higher than the hardness of the material of said carriage arm.

4. A magnetic recording apparatus in accordance with claim 2,wherein

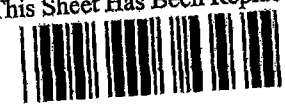
the hardness of the material of said load arm is higher than the hardness of the material of said carriage arm.

5. A magnetic recording apparatus in accordance with claim 1, wherein

the dimension of said raised portion of said load arm is smaller than the dimension of said mounting opening, so that a region surrounding said raised portion is bent so as to conform to the edge of said mounting opening by press-fitting said raised portion into said mounting opening and said raised portion reaches the inner wall of said mounting opening.

6. A magnetic recording apparatus in accordance with claim 2, wherein

This Sheet Has Been Replaced



THIS SHEET HAS BEEN REPLACED

the dimension of said raised portion of said load arm is smaller than the dimension of said mounting opening, so that a region surrounding said raised portion is bent so as to conform to the edge of said mounting opening by press-fitting said raised portion into said mounting opening and said raised portion reaches the inner wall of said mounting opening.

7. A magnetic recording apparatus in accordance with claim 1, wherein

the height of the raised portion of said load arm is selected to a predetermined value so as to bite into the inner wall of the mounting opening of said carriage arm by press-fitting.

8. A magnetic recording apparatus in accordance with claim 2, wherein

the height of the raised portion of said load arm is selected to a predetermined value so as to bite into the inner wall of the mounting opening of said carriage arm by press-fitting.

9. A magnetic recording apparatus in accordance with claim 7, wherein

the height of the raised portion of said load arm is equal to the thickness of the load arm and below.

10. A magnetic recording apparatus in accordance with claim 8, wherein

the height of the raised portion of said load arm is

This Sheet Has Been Replaced

THIS SHEET HAS BEEN REPLACED

equal to the thickness of the load arm and below.

11. A magnetic recording apparatus in accordance with claim 1, wherein

the raised portion of said load arm has an opening smaller than the dimension of said raised portion to guide a press-fit tool.

12. A magnetic recording apparatus in accordance with claim 2, wherein

the raised portion of said load arm has an opening smaller than the dimension of said raised portion to guide a press-fit tool.

13. A magnetic recording apparatus in accordance with claim 1, wherein

said mounting opening and said raised portion are circular.

14. A magnetic recording apparatus in accordance with claim 2, wherein

said mounting opening and said raised portion are circular.

15. A magnetic recording apparatus in accordance with claim 1, wherein

said mounting opening and said raised portion are oval.

16. A magnetic recording apparatus in accordance with claim 2, wherein

This Sheet Has Been Replaced

THIS SHEET HAS BEEN REPLACED



said mounting opening and said raised portion are oval.

17. A magnetic recording apparatus in accordance with claim 1, wherein

said raised portion partly protrudes outward in the radial direction.

18. A magnetic recording apparatus in accordance with claim 2, wherein

said raised portion partly protrudes outward in the radial direction.

19. A magnetic recording apparatus in accordance with claim 1, wherein

said mounting opening and said raised portion are hexagonal.

20. A magnetic recording apparatus in accordance with claim 2, wherein

said mounting opening and said raised portion are hexagonal.

21. A magnetic recording apparatus in accordance with claim 1, wherein

said raised portion comprises plural raised portions formed on a circumference.

22. A magnetic recording apparatus in accordance with claim 2, wherein

said raised portion comprises plural raised portions

This Sheet Has Been Replaced



THIS SHEET HAS BEEN REPLACED

* C L M S *

formed on a circumference.

23. A fabrication method of a magnetic recording apparatus comprising the steps of:

forming a mounting opening for connecting a load arm at one end portion of a carriage arm connected at another end to a driving unit for positioning said carriage arm on a magnetic disc,

forming a raised portion having a smaller dimension than the mounting opening and protruding to the carriage arm at one end portion of the load arm having a magnetic head at another end portion,

combining the load arm with the carriage arm so as to align in coaxial relation of the raised portion and the mounting opening, and

press-fitting the raised portion into the mounting opening by the insertion of a press-fit tool into the mounting opening so that the raised portion deforms due to plastic deformation so as to conform to the inner wall of the mounting opening and bites into the inner wall.

24. A fabrication method of the magnetic recording apparatus in accordance with claim 23, wherein

said fabrication method comprises a step for inserting a press-fit tool having at least one protrusion on an outer surface into said mounting opening.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN REPLACED