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TITLE OF THE INVENTION

DISK DEVICE

BACKGROUND OF THE INVENTION

5 The present invention relates to a disk device,
and more particularly, to a disk device using a
recording medium of a perpendicular magnetic recording
system.

10 A disk device, for example, a magnetic disk
device includes a rectangular box-shaped case. The
case accommodates a magnetic disk as a magnetic
recording medium, a spindle motor as drive means for
supporting and rotating the magnetic disk, a plurality
of magnetic heads for writing and reading out
information to and from the magnetic disk, a head
15 actuator for movably supporting the magnetic heads
with respect to the magnetic disk, a voice coil motor
for rotating and positioning the head actuator, a
substrate unit having head ICs, and the like.

20 Recently, a perpendicular magnetic recording
method is under development to increase a recording
density. A magnetic disk device to which the
perpendicular magnetic recording method is applied
ordinarily includes a head disk assembly having a
single magnetic pole head and a two-layered disk-
25 shaped recording medium. The magnetic disk device is
liable to be affected by the disturbance of a magnetic
field from the outside, and there is confirmed a



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phenomenon that data recorded on the disk-shaped recording medium is deleted by the disturbance of the magnetic field. Thus, the magnetic disk device using the perpendicular magnetic recording method is
5 required to more improve a shield function to an external magnetic field than a magnetic disk device using a conventional in-plane magnetic recording method. To fulfill the above requirement, in the disk device disclosed in Jpn. Pat. Appln. KOKAI Publication
10 No. 2003-77266, the shield function is improved by winding a tape-shaped or foil-shaped magnetic shield material on the upper surface, the lower surface, and the side surface of a case, in particular, on a region confronting with the moving range of a magnetic head.
15 Otherwise, there is proposed a disk device whose shield property is improved by winding a permeability steel sheet on the outer surface of a case.

However, when the tape-shaped or foil-shaped magnetic shield member or the steel sheet formed in a
20 predetermined shape is wound on the outer surface of the case of a magnetic disk device, the reduction in thickness and size of which is required, the thickness of the device is increased in its entirety and prevents the device from being thinned. When the
25 magnetic shield member is wound, the number of parts is increased as well as it becomes troublesome to manufacture and assemble the device, and thus

manufacturing cost is increased.

BRIEF SUMMARY OF THE INVENTION

An object of the present invention, which was made in view of the above problems, is to provide a
5 disk device which is excellent in a magnetic shield property and the thickness of which can be reduced.

A disk device according to an aspect of the invention is characterized by comprising a case having a plate-shaped base formed of a non-magnetic material and having an open upper surface, a plate-shaped top
10 cover formed of a non-magnetic material and attached to the base to cover the open upper surface of the base, a first plating layer formed of a magnetic material and covering an outer surface of the base,
15 and a second plating layer formed of a magnetic material, covering an outer surface of the top cover, and conducted to the first plating layer; a disk-shaped recording medium which is arranged in the case and which has a substrate, a soft magnetic backing
20 layer formed on the substrate, and a magnetic recording layer formed so as to overlap the soft magnetic backing layer and having perpendicular magnetic anisotropy; and a mechanical unit including a head which performs information processing with
25 respect to the recording medium, a head actuator supporting the head, and a drive motor which supports and rotates the recording medium and is disposed on

the base.

With the above arrangement, there can be provided a magnetic disk device which is excellent in a magnetic shield property as well as the thickness of which can be reduced by providing a case with a magnetic shield function by first and second plating layers.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention, and together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the invention.

FIG. 1 is exploded perspective view of a hard disk drive (hereinafter, referred to as "HDD") according to a first embodiment;

FIG. 2 is a view schematically showing a part of a magnetic head and a magnetic disk of the HDD;

FIGS. 3A to 3C are sectional views schematically showing a case of the HDD;

FIGS. 4A to 4C are sectional views schematically showing a case of an HDD according to a second
5 embodiment of the present invention;

FIG. 5 is a graph showing the relation between the thickness of a plating layer and a magnetic shield effect;

FIG. 6 is a sectional view schematically showing
10 a case of an HDD according to a third embodiment of the present invention; and

FIG. 7 is a sectional view schematically showing a case of an HDD according to a fourth embodiment of the present invention.

15 DETAILED DESCRIPTION OF THE INVENTION

A first embodiment in which the present invention is applied to an HDD will be described below in detail with reference to the drawings.

As shown in FIG. 1, the HDD has a case 11. The
20 case 11 has a rectangular box-shaped base 10 having an open upper surface and a rectangular plate-shaped top cover 15. The top cover 15 is fixed to the base by a plurality of screws and closes the upper opening of the base.

25 A magnetic disk 12 as an information recording medium and a mechanical section are disposed in the base 10. The mechanical section includes a spindle

motor 13 for supporting and rotating the magnetic disk 12, a plurality of magnetic heads 33 for recording and reproducing information to and from the magnetic disk, a head actuator 14 for movably supporting the magnetic heads 33 with respect to the magnetic disk 12, a voice coil motor (hereinafter, referred to as "VCM") 22 for rotating and positioning the head actuator, a lamp load mechanism 18 for keeping the magnetic heads at a position spaced apart from the magnetic disk when the magnetic heads move to the outermost periphery of the magnetic disk, and an inertia latch mechanism 20 for holding the head actuator at an evacuating position when a shock and the like act on the HDD. A flexible print circuit board unit (hereinafter, referred to as "FPC unit") 17, on which electronic parts such as an preamplifier and the like are mounted, is accommodated in the base 10.

A print circuit board (not shown) is fixed on the outer surface of the base 10 by screws and opposes to a bottom wall of the base 10 to control the operations of the spindle motor 13, the VCM 22, and the magnetic heads through the FPC unit 17.

The head actuator 14 includes a bearing assembly 24 fixed on the bottom wall of the base 10. The bearing assembly 24 acting as a bearing unit includes a shaft 23 standing on the bottom surface of the base 10 and a cylindrical hub 26 rotatably supported by the

shaft through a pair of bearings. The head actuator
14 includes two arms 27 attached to the hub 26, two
suspensions 30 extending from the respective arms, the
magnetic heads 33 supported by the extending ends of
5 the suspensions, and a plurality of spacer rings.

As shown in FIG. 2, the magnetic disk 12 has a
diameter of, for example, 65 mm (2.5 inch). Further,
the magnetic disk 12 has such a structure that a soft
magnetic backing layer 72 called a soft magnetic under
10 layer and a magnetized recording layer 73 with
perpendicular magnetic anisotropy are sequentially
laminated on each surface of the substrate 70 which is
formed in a disk shape and composed of a non-magnetic
member, and a protective layer 74 is further formed
15 thereon.

As shown in FIG. 1, the magnetic disk 12 is
coaxially fitted to a hub (not shown) of the spindle
motor 13 and clamped by a clamp spring 21 so that it
is fixed to the hub. The magnetic disk 12 is driven
20 in rotation at a predetermined speed of, for example,
5400 rpm by the spindle motor 13 as a drive unit.

As shown in FIG. 2, the magnetic heads 33 are
arranged as a single magnetic pole head and includes a
main magnetic pole 75 for applying a recording
25 magnetic field to the magnetic disk 12 and a return
yoke 76 acting as a magnetic flux return path. A
recording coil 77 is wound around the main magnetic

pole 75 to excite the main magnetic pole 75 when a
signal is written to the magnetic disk 12. A read
head reproducing element 78 is disposed adjacent to
the return yoke 76 to read out a signal from the
5 magnetic disk 12.

As shown in FIG. 1, the respective magnetic heads
33 are fixed to gimbal sections formed on the distal
ends of the suspensions 30. The respective magnetic
heads 33 are electrically connected to a main FPC 42
10 to be described later through relay flexible print
circuit boards (hereinafter, referred to as relay
FPCs), respectively. The relay FPCs are bonded on the
surfaces of the respective arms 27 of the head
actuator 14 and on the surfaces of the suspensions 30
15 and extend from the distal ends of the suspensions to
the rotation base ends of the arms 27. Each relay FPC
is formed in a slender band shape in its entirety, and
has a distal end electrically connected to each
magnetic head 33 and a base end portion electrically
20 connected to the main FPC 42. With this arrangement,
the respective magnetic heads 33 are electrically
connected to the FPC unit 17 through the relay FPCs
and the main FPC 42.

The arms 27 fitted to the outer periphery of the
25 hub 26 are located in parallel with each other at
predetermined intervals, and the suspensions 30 and
the magnetic heads 33 attached to the arms are

opposite to each other. The VCM 22 includes a not shown support frame extending from the hub 26 in a direction opposite to the arms 27 and a voice coil supported by the support frame. When the head
5 actuator 14 is assembled to the base 10, the voice coil is located between a pair of yokes 38 fixed on the base 10 and constitutes the VCM 22 together with the yokes and a magnet (not shown) fixed to one of the yokes. The head actuator 14 is rotated by energizing
10 the voice coil, and the magnetic heads 33 move to a desired track of the magnetic disk 12 and is positioned on the track.

As shown in FIGS. 1, 3A, 3B, and 3C, the base 10 is molded of relatively light metal such as aluminum, magnesium, and the like as a non-magnetic material.
15 The base 10 has a bottom wall 10a and a rectangular frame-shaped side wall 10b standing along the peripheral edge of the bottom wall integrally with the bottom wall 10a. Screw clamping portions 50 are
20 formed to the extended end of the side wall 10b at the four corners and approximately the centers of the respective long sides of the side wall 10b. Each screw clamping portion 50 has a boss 50a projecting from the extended end of the side wall 10b and a
25 threaded hole 50b formed on the flat distal end surface of the boss. The respective bosses 50a also act as abutment portions coming into contact with the

top cover 15. Abutment portions 52 project from two corners of the extended end of the side wall 10b. These abutment portions 52 have flat distal end surfaces abutting against the top cover 15.

5 The base 10 has an inside wall located on the top cover 15 side and an outer surface exposing to the outside. At least one of the inside and outer surfaces of the base 10 is entirely covered with a first plating layer 54a formed of a magnetic material.
10 In the embodiment, the entire surfaces of the base 10 including the inner and outer surfaces are covered with the first plating layer 54a formed of, for example, iron. The first plating layer 54a is formed to have a thickness t1 set to 30% or less of the plate
15 thickness of the base 10, for example, to 0.05 to 0.12 μm . To prevent corrosion of the first plating layer 54a, painting, coating, and the like are applied to the outer surface of the first plating layer 54a.

 As shown in FIGS. 1 and 3, the top cover 15 is
20 formed to a rectangular shape having a size corresponding to the base 10. The top cover 15 is formed to a predetermined shape by press molding a plate member composed of relatively light metal as a non-magnetic material, for example, aluminum,
25 magnesium, and the like and having a thickness of 0.4 mm. The top cover 15 has an inner surface located on the base 10 side and an outer surface exposing to

the outside. The peripheral edge of the inner surface of the top cover 15 constitutes a flat abutment portion 15a opposing to the side wall 10b of the base 10.

5 At least one of the inner and outer surfaces of the top cover 15 is entirely covered with a second plating layer 54b formed of a magnetic material. In the embodiment, the entire surfaces of the top cover 15 including the inner and outer surfaces are covered with the second plating layer 54b formed of, for
10 example, iron. The second plating layer 54b is formed to have a thickness t_2 set to 30% or less of the plate thickness of the top cover 15, for example, to 0.05 to 0.1 μm . To prevent corrosion of the second plating
15 layer 54b, painting, coating, and the like are applied to the outer surface of the second plating layer 54b.

 In the abutment portion 15a, first through holes 40 are formed to the four corners and approximately the center of the side edges of a pair of long sides,
20 respectively. The top cover 15 is fastened to the base by screwing screws 16 inserted through the respective first through holes 40 into threaded holes 50b formed on the side wall 10b of the base 10 and closes the upper end opening of the base. A gasket 56
25 is sandwiched between the abutment portion 15a of the top cover 15 and the extended end of the side wall 10b to keep the inside of the base 10 airtight. As shown

in FIG. 1, the gasket 56 is formed in a rectangular frame shape in correspondence to the abutment portion 15a of the top cover 15. The gasket 56 is formed by sandwiching a thin metal or resin sheet between gasket members composed of, for example, rubber and the like from above and below them.

When the top cover 15 is fastened to the base 10 by the screws, the second plating layer 54b formed on the inner surface of the top cover is abutted against the abutment portions 52 and the bosses 50a formed on the side wall 10b of the base 10. At this time, the abutment portions 52 and the bosses 50a of the side wall 10b are covered with the first plating layer 54a. As a result, since the first plating layer 54a of the base 10 comes into contact with the second plating layer 54b of the top cover 15 at the positions of the abutment portions 52 and the bosses 50a, they are made magnetically conductive with each other. With this arrangement, the first plating layer 54a and the second plating layer 54b form a magnetically closed loop so as to cover members to be shielded and act as a magnetic shield.

As shown in FIG. 1, in the top cover 15, a second through hole 44 is formed at the position confronting the shaft 23 of the bearing assembly 24. A part of the top cover 15 is fastened to the shaft 23 by screwing a fixing screw 43 inserted through the second

through hole 44 into the upper end portion of the shaft 23. Accordingly, the shaft 23 is supported by the base 10 and the top cover 15 of the case 11 at both ends of it. As described above, the top cover 15
5 has the peripherally positioned six first through holes 40 for clamping the screws and the second through hole 44 located above the shaft 23 to clamp the screw.

According to the HDD arranged as described above,
10 the base 10 and the top cover 15 of the case 11 are formed of the relatively light non-magnetic material such as aluminum and magnesium, respectively. Accordingly, it is possible to reduce the weight of the case 11 and the HDD in their entireties. The
15 overall outer surfaces of the base 10 and the top cover 15 are covered with the first and second plating layers 54a, 54b composed of the magnetic material such as iron. The first and second plating layers 54a, 54b are electrically conductive with each other, form the
20 closed loop covering the inside of the case 11, and electromagnetically shield the inside of the case.

As described above, it is possible to prevent an external magnetic field from entering the inside of the case 11 from the outside by shielding the external
25 magnetic field by the first and second plating layers 54a, 54b. Thus, since there is not a possibility that data recorded on the magnetic disk 12 is deleted by

the external magnetic field, the reliability of the HDD can be improved. The writing property of the HDD can be improved by the improvement of a resistance to external magnetic field. Thus, there can be provided
5 a high density recording magnetic disk device of a perpendicular magnetic recording method with high reliability. Further, since it is not necessary to wind a magnetic shield material and the like on the outer surface of the case 11, the number of parts can
10 be reduced and an assembly property can be improved.

Since the first and second plating layers 54a, 54b are formed very thin, a magnetic shield effect can be obtained without greatly increasing the dimension of the case 11. As a result, it is possible to
15 further reduce the thickness of the device in its entirety. Since the first and second plating layers 54a, 54b are strongly coupled with the base 10 and the top cover 15, the base 10 and the top cover 15 can be easily handled when they are assembled.

20 Since the first and second plating layers are formed after the base 10 and the top cover 15 are molded, the plating layers can be evenly formed even if the base and the top cover have a complicated shape. Further, since the base 10 and the top cover
25 15 are covered with the first and second plating layers 54a, 54b composed of iron, respectively, it is possible to improve the mechanical strength of parts

and the strength of the HDD in its entirety.

Next, an HDD according to a second embodiment of the present invention will be explained.

5 A permeability material, that is, a magnetic material having a larger thickness can more improve a magnetic shield effect. In the first embodiment described above, the plating layers having the uniform thickness t_1 or t_2 are entirely formed to the outer and inner surfaces of the base 10 and to the outer and inner surfaces of the top cover 15. In this case, 10 although the total thickness of the plating layers formed on the outer and inner surfaces is $t_1 \times 2$ or $t_2 \times 2$, the thickness of the plating layer acting as a path of magnetism is t_1 or t_2 .

15 According to the second embodiment, the first and second plating layers are arranged as partly plating layers and formed on a part of the base 10 and a part of the top cover 15 as shown in FIGS. 4A, 4B, and 4C. That is, the first plating layer 54a is formed only on 20 the inner surface of the base 10 to a thickness of $2t_1$. Here, the inner surface of the base 10 includes the extended end surface of a side wall 10b. The second plating layer 54b is formed only on the inner surface of the top cover 15 to a thickness $2t_2$.

25 According to this arrangement, when it is assumed that the thickness of the first plating layer 54a and the thickness of the second plating layer 54b are the

same as those of the first embodiment, the thickness of the first plating layer and the thickness of the second plating layer acting as a path of magnetism are twice those of the first embodiment. As a result, it is possible to improve the magnetic shield effect.

FIG. 5 shows the relation between the thickness of a plating layer and a magnetic shield effect (intensity of magnetic field). It can be found also from the graph that the shield effect can be more improved by an increase of the thickness of the plating layer.

As shown in FIG. 6, according to a third embodiment, the first plating layer 54a is formed only on the outer surface of the base 10 to the thickness of $2t_1$. The second plating layer 54b is formed only on the outer surface of the top cover 15 to the thickness of $2t_2$. The first plating layer 54a and the second plating layer 54b are in contact with each other on the outer surface of a side wall 19b and made magnetically conducive with each other.

The third embodiment can also obtain the same operation/working effect as the second embodiment described above. Note that since the other arrangement of the second and third embodiments is the same as the first embodiment described above, the same portions are denoted by the same reference numerals and the detailed description thereof will be omitted.

The first and second plating layers 54a, 54b are

not limited to the arrangement for forming the closed loop and may form an approximately U-shaped loop with one end opened as in a fourth embodiment shown in FIG. 7. That is, the first plating layer 54a covers almost all the portions of the inner surface and the outer surface of the base 10 and a part of the outer surface of the side surfaces 10b is omitted. Further, the second plating layer 54b covers almost all the portions of the inner surface and the outer surface of the top cover 15 and is omitted in a part of the side edges.

It is possible also in this arrangement to obtain the magnetic shield effect by covering the magnetic disk, the magnetic heads and the like disposed in the case 11 with the first and second plating layers.

While certain embodiments of the inventions have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel methods and systems described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the methods and systems described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

For example, the number of the magnetic disk is not limited to one and may be increased if necessary. Any non-magnetic material may be used as the material of the base and the top cover constituting the case, and synthetic resin and the like may be used.

5 Further, any magnetic material may be used for the first and second plating layers, and it is not limited to iron and any other metal may be used.

WHAT IS CLAIMED IS:

1. A disk device comprising:

a case having a plate-shaped base formed of a non-magnetic material and having an open upper
5 surface, a plate-shaped top cover formed of a non-magnetic material and attached to the base to cover the open upper surface of the base, a first plating layer formed of a magnetic material and covering an outer surface of the base, and a second plating layer
10 formed of a magnetic material, covering an outer surface of the top cover, and conducted to the first plating layer;

a disk-shaped recording medium which is arranged in the case and which has a substrate, a soft magnetic
15 backing layer formed on the substrate, and a magnetic recording layer formed so as to overlap the soft magnetic backing layer and having perpendicular magnetic anisotropy; and

a mechanical unit including a head which performs
20 information processing with respect to the recording medium, a head actuator supporting the head, and a drive motor which supports and rotates the recording medium and is disposed on the base.

2. The disk device according to claim 1, wherein
25 the base and the top cover are formed of aluminum, magnesium, or synthetic resin.

3. The disk device according to claim 1 or 2,

wherein the first and second plating layers are formed of iron.

4. The disk device according to claim 1, wherein the first and second plating layers form a
5 magnetically closed loop for covering members to be shielded, which are disposed in the case.

5. The disk device according to claim 1, wherein:

the base has an inner surface located on the top
10 cover side and an outer surface exposed to the outside, and the top cover has an inner surface located on the base side and an outer surface exposed to the outside; and

the first plating layer is formed to entirely
15 cover at least one of the inner surface and the outer surface of the base, and the second plating layer is formed to entirely cover at least one of the inner surface and the outer surface of the top cover.

6. The disk device according to claim 1, wherein:
20

the base has a bottom wall, a side wall standing along a peripheral edge of the bottom wall, a plurality of screw clamping portions disposed on the extended end of the side wall, and a plurality of
25 abutment portions which abut against the top cover; and

the top cover is supported on the extended end of

the side wall, fastened to the screw clamping portions
by screws, and abutting against the abutment portions,
and the first and second plating layers come into
contact with each other in the screw clamping portions
5 and the abutment portions and are electrically
conductive with each other.

7. The disk device according to claim 1, wherein
the head has a main magnetic pole which applies a
recording magnetic field to the recording medium, a
10 return yoke to which a flux return path is formed, and
a reproducing element which reads out a signal from
the recording medium.