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5 LOW COST OVERMOLDED MAGNET AND POLE ASSEMBLY**Related Applications**

This application claims the benefit of United States Provisional
10 Application Number 60/222,992, filed August 4, 2000.

Field of the Invention

The present invention relates generally to disc drives. More
15 particularly, the present invention relates to a low cost voice coil motor for
use in a disc drive.

Background of the Invention

20 Disc drives are used extensively for data storage in various
applications. A typical disc drive includes discs on which data is written
and heads to read data from and to write data to the discs. The heads are
supported by an actuator assembly which allows the heads to be
positioned at the desired locations relative to the data tracks on the discs.

25 Rotational movement of the actuator assembly is generally enabled
by a voice coil motor. The voice coil motor is basically made up of a
magnet fixed relative to the disc drive housing and a voice coil fixed
relative to the actuator assembly. By providing an electric current through
the voice coil, a force is exerted on the voice coil, causing the actuator
30 assembly to rotate about a pivot. Pole plates are provided to maximize the
magnetic field in the vicinity of the voice coil so as to improve the
performance of the voice coil motor.

One important consideration in the production of disc drives is the
need to reduce particulate contamination within the disc drive. Particulate

5 contamination in a disc drive must be kept low in order to prevent physical
damage to the heads as well as to the discs. Disc drives are required to
operate with increasing precision, following the increase in the data
densities. Not only are the heads being placed in increasing proximity to
the disc surface, the number of data tracks per inch on the discs is also
10 increasing significantly. This increased precision means that particulate
contamination in the disc drive must be closely controlled, as the damage
caused by contaminants is becoming correspondingly serious. For
example, particulate buildup between the head and the disc can cause
degradation in the readback signal, head crashes and damage to the disc
15 surface.

The various components must therefore be designed with care so as
to avoid the use of materials likely to contribute to particulate
contamination. Pole plates are one potential source of particulate
contamination, as they are known to outgas when they reach high
20 temperatures. For this reason, pole plates are often coated with a nickel
plating, using nickel with high potassium, to prevent the pole plates from
outgassing and contaminating the interior environment of the disc drive.
Although nickel plating is effective in reducing outgassing, it is a relatively
expensive process.

25 A further potential source of contaminants is the adhesive typically
used to mount the magnet to the pole plate. While adhesives are effective
in rigidly securing the magnet to the pole plate, they are also prone to
outgassing when subjected to the heat typically generated within a disc
drive during operation.

30 What the prior art has been lacking is an easily assembled, low cost
voice coil motor which is resistant to outgassing.

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Summary of the Invention

The present invention relates to a voice coil motor for a disc drive suitable for low cost production. In accordance with one embodiment of the invention, the voice coil motor includes an overmold encapsulating a
10 voice coil motor assembly including a magnet and a pole. The overmold prevents outgassing by the pole and magnet.

These and other features and benefits will become apparent upon a review of the attached figures and the accompanying description.

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Brief Description of the Drawings

FIG. 1 is a perspective view of a disc drive.

FIG. 2 is schematic diagram of a voice coil motor.

FIG. 3 is a schematic cross-section of a sub-assembly, according to a
20 preferred embodiment of the present invention.

FIG. 4 is a schematic cross-section of an alternative sub-assembly.

FIG. 5 is a schematic cross-section of another sub-assembly.

FIG. 6 is a schematic cross-section of yet another embodiment of the present invention.

25 FIG. 7 is a schematic cross-section showing a top pole arranged for assembly to a bottom pole.

Detailed Description

30 FIG. 1 illustrates an exemplary disc drive that could be used to implement embodiments of the present invention. A disc drive 10, such as the one shown in FIG. 1, includes a base 12 and a cover (not shown), which when assembled together form a sealed environment within which various disc drive components are mounted. Disc drive controls are generally

5 embodied in a printed circuit board assembly 14 fixed to the underside of
the base 12. Part of the control circuitry drives a spindle motor 16 and
thereby puts a disc stack mounted on the spindle motor 16 into rotational
motion. The disc stack, having one or more discs 18, is secured to a hub of
the spindle motor by a disc clamp 20. Spacers 22 may form part of the disc
10 stack to keep the discs 18 spaced apart for access to disc surfaces by
read/write devices 24.

Read/write devices 24, generally referred to as heads in this
document, are supported by an actuator assembly 26 for movement across
the disc surfaces. The heads 24 are usually found at the end of actuator
15 arms 28 that extend from a pivotably mounted body 30. Fixed to the
actuator assembly 26 is a support 32 to which a voice coil 34 is attached.
The voice coil 34 forms part of a voice coil motor 36 responsible for
imparting rotational forces to the actuator assembly 26 so that the actuator
assembly 26 swings about its pivot 38 and as a result, brings the heads 24 to
20 the desired location relative to data tracks on the disc surfaces.

In a preferred embodiment of the present invention, the voice coil
motor 36 includes a magnet assembly as well as the voice coil 34. The
magnet assembly includes a top magnet 40 and a bottom magnet 42
arranged to be vertically spaced apart. Referring to FIG. 2 for a schematic
25 diagram of the voice coil motor 36, it is shown that the voice coil 34 is
located between the top magnet 40 and the bottom magnet 42. Both the top
magnet 40 and the bottom magnet 42 have major surfaces 44, 46, 48, 49,
substantially parallel to a plane in which the actuator assembly 26 pivots.

The top magnet 40 has a direction of magnetization substantially
30 perpendicular to its major surfaces 44, 46, and is magnetized such that half
of the magnet has a top-to-bottom north-south magnetization, and the
other half has a top-to-bottom south-north magnetization. The bottom
magnet 42 also has a direction of magnetization that is substantially
perpendicular to its major surfaces 48, 49, and is magnetized such that half

5 of the magnet has a top-to-bottom north-south magnetization, and the other half has a top-to-bottom south-north magnetization. The top magnet 40 and the bottom magnet 42 are arranged such that on one half of the magnets, the magnetic field, as represented by the magnetic flux path 72, is directed from the bottom magnet 42 to the top magnet 40. For the other
10 half of the magnet, the magnetic field is directed from the top magnet 40 to the bottom magnet 42. In passing a current through the voice coil 34, a force, having a direction indicated by the arrow 82, is generated.

A magnetically permeable top pole 50 and a magnetically permeable bottom pole 52 are provided to close the magnetic flux path 72. The top
15 pole 50 and the bottom pole 52 can be essentially flat blocks of stainless steel, each having major surfaces 54, 56, 58, 60, substantially parallel to a plane in which the actuator assembly 26 pivots when in assembly in the disc drive 10. The top pole 50 is positioned above the top magnet 40. The bottom magnet 42 is fixed above the bottom pole 52. The bottom pole 52 is
20 in turn mounted to the base 12 of the disc drive 10. For this, the bottom pole 52 is provided with features for attachment to the base 12 of the disc drive 10. In one example, shown in FIG. 7, the bottom pole 52 of the sub-assembly includes at least two through holes 64 which can be used in conjunction with fasteners such as screws for assembly to the base 12 of the
25 disc drive 10.

In making a preferred embodiment of a sub-assembly 62 of the present invention, the bottom magnet 42 and the bottom pole 52 are separately plated using zinc with yellow chromate so that they each acquire a zinc plating 66, 68. The bottom magnet 42 and bottom pole 52 are
30 then joined together by use of an adhesive 70. Next, the bottom magnet 42 and the bottom pole 52 are placed in an appropriate mold or cast, and subjected to an overmolding process such that a sub-assembly 62 is formed. The sub-assembly 62 includes an overmold 74 of liquid crystal polymer which completely coats the bottom magnet 42 and the bottom

5 pole 52. The sub-assembly 62 therefore has an outermost surface defined
by the encapsulating overmold 74, as illustrated in FIG. 3. The overmold
74 is formed such that it is of a sufficient thickness to provide the required
strength to hold the bottom magnet 42 and the bottom pole 52 together. At
the same time, it is kept as thin as possible. This is because the use of an
10 overmold over the sub-assembly may require the voice coil 34 to be
positioned at a higher elevation relative to the upper surface 66 of the
magnet 42. The air gap 76 between the voice coil 34 and the bottom
magnet 42 is thus increased. Excessive increase in the air gap 76 may lead
to an unsatisfactory decrease in the torque constant and a corresponding
15 decrease in the efficiency of the voice coil motor. Taking these and other
factors into consideration, a suitable thickness for the overmold 74 can be
determined.

One advantage of the present invention is that the overmold 74 acts
as a barrier to outgassing from the stainless steel core of the bottom pole 52
20 or from the adhesive 70 between the bottom magnet 42 and the bottom
pole 52. It is therefore not necessary to involve the use of high-grade nickel
plating which is a relatively expensive process. The present invention
allows the use of cheaper plating materials, such as zinc with yellow
chromate, giving a plating 66, 68, of zinc chromate. In addition, the
25 overmold 74 provides a barrier against corrosion of the bottom pole 52.

In an alternative embodiment illustrated in FIG. 4, the bottom
magnet 42 and the bottom pole 52 are joined together without first
undergoing a plating process. The bottom magnet 42 and the bottom pole
52 are cleaned and an adhesive 70 is applied at the intended interface
30 between the bottom magnet 42 and the bottom pole 52. An overmold 74 is
formed over all the exposed surfaces of the bottom magnet 42 and the
bottom pole 52 such that the resultant sub-assembly 62 has a continuous
surface defined by the overmold 74.

5 FIG. 5 shows yet another embodiment of the present invention. The
bottom magnet 42 and the bottom pole 52 are arranged adjacent to each
other and an overmold 74 is introduced to completely enclose the bottom
magnet 42 and the bottom pole 52. One advantage of this embodiment is
that the sub-assembly 62 can be produced without the need to undergo a
10 lengthy baking cycle that is typically required when an adhesive is used.
The overmold 74 is formed such that it provides sufficient strength to hold
the bottom magnet 42 and the bottom pole 52 together. By not using
adhesive, the risk of outgassing and contamination is also reduced.
Alternatively, the preliminary plating process can be done away with such
15 that an unplated bottom magnet 42 and an unplated bottom pole 52 are
overmolded to form an integrated unit, resulting in the sub-assembly 62
shown in FIG. 6.

The foregoing description has been made with reference to a sub-
assembly of a bottom magnet and a bottom pole. It will be understood that
20 the invention can be applied equally to a top magnet and a top pole.

In some disc drives, the voice coil motor does not include a top
magnet. A top pole 50 with standoffs 78 is provided to close the magnetic
flux path 72. The standoffs 78 include through holes 80 for receiving
fasteners, such as screws, for assembly to the bottom pole. In such an
25 example, as shown in FIG. 7, the top pole 50 can be overmolded to provide
the required barrier to outgassing and to avoid the use of expensive nickel
plating. The present invention is thus not limited to a system having the
specific magnetic flux pattern described above. The present invention can
be applied in conjunction with a variety of disc drive designs.

30 Preferred embodiments of the present invention may be
alternatively described as follows:

In a disc drive 10, a voice coil motor 36 includes a magnet 42 having
a magnetic field 72 and a pole 52 adjacent the magnet 42 to direct the
magnetic field 72. The voice coil motor 36 also includes a coil 34 in the

5 magnetic field 72. There is provided an overmold 74 encapsulating the magnet 42 and the pole 52. In one embodiment, the overmold 74 is a liquid crystal polymer. In another embodiment, the overmold 74 is a polyphenylene sulphide. The magnet 42 and the pole 52 may optionally be joined by an adhesive 70. Preferably, the pole 52 is covered by a first
10 plating layer 68 which is interior to the overmold 74. The magnet 42 may be covered by a second plating layer 66 interior to the overmold 74. In one embodiment, the first plating layer 68 and the second plating layer 66 each consists essentially of zinc chromate. In another embodiment, the first
15 plating layer 68 and the second plating layer 66 each consists essentially of nickel.

It is to be understood that even though numerous characteristics and advantages of various embodiments of the present invention have been set forth in the foregoing description, together with details of the structure and function of various embodiments of the invention, this disclosure is
20 illustrative only. For example, the material that is chosen for the overmold is not limited to liquid crystal polymer. An alternative material that may be used for the overmold is polyphenylene sulphide. The choice of other suitable materials is not intended to be precluded by the examples given in this disclosure. Similarly, an alternative lower grade plating material that
25 can be used is electroless nickel with medium phosphorus, thus giving a plating of nickel. Changes may therefore be made in detail, especially in matters of materials, structure and arrangement of parts without departing from the scope and spirit of the present invention. In addition, although the preferred embodiment described is directed to a magnet and pole sub-
30 assembly for a disc drive, it will be appreciated by one skilled in the art that the teachings of the present invention can be applied to other systems without departing from the scope and spirit of the present invention.



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Claims

1. An assembly for use in a disc drive, the assembly comprising:
a magnet;
a pole adjacent the magnet; and
10 an overmold encapsulating the magnet and the pole.
2. An assembly of Claim 1 wherein the overmold comprises a liquid
crystal polymer.
- 15 3. An assembly of Claim 1 wherein the overmold comprises a
polyphenylene sulphide.
4. An assembly of Claim 1 further comprising an adhesive joining the
magnet to the pole.
- 20 5. An assembly of Claim 1 further comprising a first plating layer
covering the pole, wherein the first plating layer is interior to the
overmold.
- 25 6. An assembly of Claim 5 further comprising a second plating layer
covering the magnet, wherein the second plating layer is interior to
the overmold.
7. An assembly of Claim 6 wherein the first plating layer and the
30 second plating layer consists essentially of zinc chromate.
8. An assembly of Claim 6 wherein the first plating layer and the
second plating layer consists essentially of nickel.



- 5 9. A disc drive comprising:
a voice coil motor comprising:
a magnet having a magnetic field;
a pole adjacent the magnet and configured to direct the
magnetic field;
- 10 a coil in the magnetic field; and
an overmold encapsulating the magnet and the pole.
10. A disc drive of Claim 9 wherein the overmold is a liquid crystal
polymer.
- 15 11. A disc drive of Claim 9 wherein the overmold is a polyphenylene
sulphide.
12. A disc drive of Claim 9 further comprising an adhesive joining the
magnet to the pole.
- 20 13. A disc drive of Claim 9 further comprising a first plating layer
covering the pole, wherein the first plating layer is interior to the
overmold.
- 25 14. A disc drive of Claim 13 further comprising a second plating layer
covering the magnet, wherein the second plating layer is interior to
the overmold.
- 30 15. A disc drive of Claim 14 wherein the first plating layer and the
second plating layer consists essentially of zinc chromate.
16. A disc drive of Claim 14 wherein the first plating layer and the
second plating layer consists essentially of nickel.



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17. A disc drive, comprising:
a movable actuator;
a magnet assembly for effectuating movement of the actuator; and
means for preventing release of contaminants from the magnet

10 assembly.

18. The disc drive of claim 17, the preventing means further comprising:
an overmold encapsulating at least a portion of the magnet
assembly.

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19. The disc drive of claim 17, in which the magnet assembly comprises
a pole plate, the preventing means further comprising:
an overmold encapsulating a surface of the pole plate.

- 20 20. The disc drive of claim 17, in which the magnet assembly comprises
a magnet and a pole, the preventing means further comprising:
an overmold encapsulating surfaces of the magnet and pole plate.

21. The disc drive of claim 17, the preventing means further comprising:
25 a polymeric material on a surface of the magnet assembly.