DISC DRIVE TURBULENT WIND MANAGEMENT

Field of the Invention

This application relates generally to disc drives and more particularly to a disc drive housing for managing turbulent flow.

Background of the Invention

A typical disc drive includes a base to which various components of the disc drive are mounted. A top cover cooperates with the base to form a housing that defines an internal, sealed environment for the disc drive. The components include a spindle motor, which rotates one or more discs at a high speed. Information is written to and read from tracks on the discs through the use of an actuator assembly, which rotates during a seek operation about a bearing shaft assembly positioned adjacent the discs. The actuator assembly includes at least one actuator arm, which extends towards the discs, with one or more flexures extending from each of the actuator arms. Mounted at the distal end of each of the flexures is a head, which includes an air bearing slider enabling the head to fly in close proximity above the corresponding surface of the associated disc.

Particles in the disc drive have an adverse effect on drive reliability. Of particular concern are airborne particles that enter the head-disc interface. These particles can scratch the disc surface or become embedded in the disc, leading to catastrophic failures and/or irrecoverable data loss. Additionally, particles under the slider can damage the sensitive head transducer and possibly prevent any further read/write operations of the disc drive.

Additionally, vibrations in the disc drive can have an adverse effect on drive reliability by creating unpredicted movement between the head and the disc. Such unpredicted movement can cause read/write errors. Such movement also prevents narrower tracks from being used in disc drives, and thus limits the memory capability of the disc drive.

Accordingly there is a need for a disc drive that reduces the number of particles entering the head/disc interface and that decreases the vibrations in the disc drive. The present invention provides a solution to this and other problems, and offers other advantages over the prior art.

Summary of the Invention

Against this backdrop the present invention has been developed. One embodiment of the invention utilizes sloped surfaces to reduce turbulent flow within the disc drive. Another embodiment limits movement of an actuator arm of the disc drive to prevent it from entering a recirculation or turbulent flow region.

Accordingly, one embodiment of the invention is a disc drive that includes a housing. The housing encloses a spindle motor carrying a disc having a data surface. An actuator assembly includes an actuator arm carrying a head, such as a head for reading to and writing from the disc. The housing includes a first surface portion adjacent to the data surface of the disc. The housing also includes a plurality of surface portions that define a recess, which allows the actuator arm to move over the data surface of the disc. The plurality of surface portions include a sloped surface portion sloping away from the data surface and preventing wind generated by the disc rotating about an axis from separating from the sloped surface portion.

In an alternative embodiment of the invention, a disc drive includes a housing that defines a recess. The housing encloses a disc mounted on a spindle motor that rotates the disc about an axis and thereby generates wind within the housing. An upstream surface portion and a downstream surface portion of the housing both face toward a data surface of the disc. A discontinuity, such as a step, between the upstream surface portion and the downstream surface portion causes a wind recirculation region within the recess. The disc drive also includes an actuator arm that carries a head, which the recess allows to move over the data surface of the disc. An actuator limiting device prevents the actuator arm from entering the wind recirculation region.

These and various other features as well as advantages which characterize the present invention will be apparent from a reading of the following detailed description and a review of the associated drawings.

Brief Description of the Drawings

FIG. 1 is a plan view of a disc drive showing the primary internal components.

FIG. 2 is a perspective view of a base plate of a disc drive according to an embodiment of the present invention.

FIG. 3 is a sectional view taken along line 3-3 of **FIG. 2**, additionally illustrating actuator arms as would be used with the base plate and the direction of wind along the base plate.

FIG. 4 is a sectional view taken along line 4-4 of **FIG. 2**, additionally illustrating actuator arms as would be used with the base plate and the direction of wind along the base plate.

FIG. 5 is a perspective view of a base plate of a disc drive according to an alternative embodiment of the present invention.

FIG. 6 is a sectional view taken along line 6-6 of **FIG. 5**, additionally illustrating the direction of wind along the base plate.

FIG. 7 is a sectional view taken along line 7-7 of **FIG. 5**, additionally illustrating the direction of wind along the base plate.

Detailed Description

A disc drive **100** constructed in accordance with a preferred embodiment of the present invention is shown in **FIG. 1**. The disc drive **100** includes a base **102** to which various components of the disc drive **100** are mounted. A top cover **104**, shown partially cut away, cooperates with the base **102** to form a housing **103** that defines an internal, sealed environment for the disc drive in a conventional manner. The components include a spindle motor **106**, which rotates one or more discs **108** at a constant high speed. Information is written to and read from tracks on the discs **108** through the use of an actuator assembly **110**, which rotates during a seek operation about a bearing shaft assembly **112** positioned adjacent the discs **108**. The actuator assembly **110** includes a plurality of actuator arms **114** which extend towards the discs **108**, with one or more flexures **116** extending from each of the actuator arms **114**. Mounted at the distal end of each of the flexures **116** is a head **118** which includes an air bearing slider enabling the head **118** to fly in close proximity above the corresponding surface of the associated disc **108**.

During a seek operation, the track position of the heads **118** is controlled through the use of a voice coil motor **124**, which typically includes a coil **126** attached to the actuator assembly **110**, as well as one or more permanent magnets **128** which establish a magnetic field in which the coil **126** is immersed. The controlled application of current to the coil **126** causes magnetic interaction between the permanent magnets **128** and the coil **126** so that the coil **126** moves in accordance with the well-known Lorentz relationship. As the coil **126** moves, the actuator assembly **110** pivots about the bearing shaft assembly **112**, and the heads **118** are caused to move across the surfaces of the discs **108**.

The spindle motor **106** is typically de-energized when the disc drive **100** is not in use for extended periods of time. The heads **118** are moved over park zones **120** near the inner diameter of the discs **108** when the drive motor is de-energized. The heads **118** are secured over the park zones **120** through the use of an actuator latch arrangement, which prevents inadvertent rotation of the actuator assembly **110** when the heads are parked.

A flex assembly **130** provides the requisite electrical connection paths for the actuator assembly **110** while allowing pivotal movement of the actuator assembly **110** during operation. The flex assembly includes a printed circuit board **132** to which head wires (not shown) are connected; the head wires being routed along the actuator arms **114** and the flexures **116** to the heads **118**. The printed circuit board **132** typically includes circuitry for controlling the write currents applied to the heads **118** during a write operation and a preamplifier for amplifying read signals generated by the heads **118** during a read operation. The flex assembly terminates at a flex bracket **134** for communication through the base deck **102** to a disc drive printed circuit board (not shown) mounted to the bottom side of the disc drive **100**.

Orientational terms such as up, down, lower, and higher are used herein to describe the relative orientation of structural elements of the disc drive **100**, and are not meant to limit the present invention to any particular orientation of the disc drive itself.

Referring now to **FIG. 2**, a generally rectangular base plate **102** defines a generally rectangular actuator assembly region **202** that opens to a generally circular disc region **204**. An actuator mounting boss **210** is centrally located in the floor of the actuator assembly region **202**. The actuator assembly **110** shown in **FIG. 1** is mounted to the actuator boss **210**. The actuator assembly **110** is then able to pivot about an actuator axis **212** in performing seek operations as discussed above. The base plate **102** also includes a spindle motor mounting boss **214** that is centrally located in the floor of the disc region **204**. The spindle motor **106** shown in **FIG. 1** is mounted to the mounting boss **214**. The spindle motor **106** rotates the discs **108** in a counterclockwise direction about he spindle axis **216** as viewed in **FIGS. 1** and **2**.

The base plate **102** also defines a recess **218** that allows an actuator arm **114** to rotate under a lower data surface **302** (see **FIGS. 3-4**) of the bottom disc **108** on the spindle motor **106** in the disc drive **100**. An upstream surface portion **230** of the base plate **102** is below and preferably substantially parallel to the discs **108**. The upstream surface portion **230** terminates at a discontinuity or step down **232**, which defines one side of the recess **218**. A first downstream surface portion or floor surface portion **234** then continues from the step down **232** to define a floor of the recess **218**. The floor surface portion **234** is preferably parallel to, but axially offset downwardly from, the upstream surface portion **230**. The floor surface portion **234** extends to a step up or discontinuity **236**, which extends axially to a second downstream surface portion **238**. The second downstream surface portion **238** is preferably parallel to the upstream surface portion **230** and the floor surface portion **234**. The second downstream surface portion **238** is axially

offset upwardly from the floor surface portion **234**, but substantially coplanar with the upstream surface portion **230**. The second downstream surface portion **238** preferably extends circumferentially to the upstream surface portion **230** so that the second downstream surface portion **238** and the upstream surface portion **230** form a continuous arcuate surface portion. The discontinuities **232** and **236** are preferably vertical radially extending walls beneath the lower data surface **302** of the lowest disc **108**. The discontinuities **232** and **236** could be sloped, rather than vertical, so long as they create recirculation regions within the recess **218**.

A disc **108** rotates over the base plate **102** above the surface portions **230**, **232**, **234**, **236**, and **238**. The spinning disc **108** creates a wind that flows in a substantially circumferential counterclockwise direction relative to the spindle axis **216**, although the wind likely also has a radial component. The wind thus flows along the upstream surface portion **230**, over the step down **232**, along the floor surface portion **234**, over the step up **236**, and along the second downstream surface portion **238**. The wind then flows in a substantially circumferential path back to the upstream surface portion **230**.

Referring now to **FIG. 3**, as the wind flows circumferentially below the lower data surface **302** of the lowest disc **108** along the wind direction **310** from the upstream surface portion **230** over the step down **232**, the wind separates from the surface of the base plate **102**. More specifically, the wind separates from the step down **232** and remains separated from the floor surface portion **234**, thereby creating a step down recirculation region or separation region **312**. The flow of the wind in the step down recirculation region **312** is turbulent. It is believed that this turbulent wind flow tends to distribute particles within the recirculation region **312** and to cause increased vibrations of members within the recirculation region **312**. However, it is also believed that downstream from the recirculation region **312**, the wind flow attaches to the floor surface portion **234** and again becomes laminar. The actuator arms **114** and the heads **118** mounted on the actuator arms **114** are located downstream from the recirculation region **312**, and are prevented from pivoting into the recirculation region **312** by a limiting device, which may be, e.g., software of the actuator control system or crash stops. Accordingly, the effects of the increased vibrations caused by the recirculation region **312** are minimized for the arms **114** and the heads **118**, thereby decreasing vibrations in the arms **114** and the heads **118**. Additionally, the particle deposition effects of the recirculation region **312** are minimized, thereby decreasing the probability of particles entering the lowest head-disc interface.

More particularly, the arms **114** each include an upstream side edge **314** facing the step down **232** and an opposing downstream side edge **316**. In a preferred embodiment, a distance **318** between the step down **232** and the upstream edge **314** of the actuator arms **114** is at least six times the axial offset distance between the upstream surface portion **230** and the floor surface portion **234**, or in other words the step height **320**. In a more preferred embodiment, the distance **318** is at least 6.2 times the step height **320**.

Referring now to **FIG. 4**, as the wind flows circumferentially along the wind direction **410** below the lower surface **302** of the lowest disc **108** from the floor surface portion **234** over the step up **236**, the wind again separates from the surface of the base plate **102**. More specifically, the wind separates from the floor surface portion **234** and remains separated as it flows upwardly and over the step up **236**, thereby creating a step up recirculation region or separation region **412**. As with the step down recirculation region **312**, the step up recirculation region **412** is turbulent, and is believed to cause the same problems as the step down recirculation region **312**. However, it is believed that upstream of the recirculation region **412**, the wind flow remains attached to the floor surface portion **234** and thus remains laminar until separation from the floor surface portion **234**. The actuator arms **114** and the heads **118** mounted on the actuator arms **114** are located upstream of the recirculation region **412**, and are prevented from pivoting into the recirculation region **312** by a limiting device, which may be, e.g., software of the actuator control system or crash stops. Accordingly, the effects of the increased vibrations caused by the recirculation region **412** are minimized for the arms **114** and the heads **118**, thereby decreasing vibrations in the arms **114** and the heads **118**. Additionally, the particle deposition effects of the recirculation region **412** are minimized, thereby decreasing the probability of particles entering the lowest head-disc interface.

In a preferred embodiment, a distance **418** between the step up **236** and the downstream edge **316** of the actuator arms **114** is at least six times the axial offset distance between the second downstream surface portion **238** and the floor surface portion **234**, or in other words the step height **420**. In a more preferred embodiment, the distance **418** is at least 6.2 times the step height **420**.

The recirculation regions **312, 412** can be determined using flow simulation software, such as the software marketed under the trademark FLUENT by Fluent, Inc. located in Lebanon, New Hampshire. These determinations can be verified by performing standard computations for flow over a backward facing step and flow over a forward facing step.

Referring now to **FIG. 5**, a generally rectangular base plate **102** defines a generally rectangular actuator assembly region **502** that opens to a generally circular disc region **504**. An actuator mounting boss **510** is centrally located in the floor of the actuator assembly region **502**. The actuator assembly **110** shown in **FIG. 1** is mounted to the actuator mounting boss **510**. The actuator assembly **110** is then able to pivot about an actuator axis **512** in performing seek operations as discussed above. The base plate **102** also includes a spindle motor mounting boss **514** that is centrally located in the disc region **504**. The spindle motor **106** shown in **FIG. 1** is mounted to the mounting boss **514**. The spindle motor **106** rotates the discs **108** in a counterclockwise direction about a spindle axis **516** as viewed in **FIG. 5**.

The base plate **102** also defines a recess **518** that allows an actuator arm **114** to rotate under the lower data surface of the bottom disc **108** on the spindle motor **106** in the disc drive **100**. An upstream surface portion **530** of the base plate **102** is below and preferably substantially parallel to the discs **108**. The upstream surface portion **530** terminates at a slope down surface portion or ramp **532**, which defines one side of the recess **518**.

A first downstream surface portion or floor surface portion **534** then continues from the slope down surface portion **532** to define a floor of the recess **518**. The floor surface portion **534** is preferably parallel to, but axially offset downwardly from, the upstream surface portion **530**. The floor surface portion **534** extends to a slope up surface portion or ramp **536**. The slope up surface portion **536** slopes to a second downstream surface portion **538**.

The second downstream surface portion **538** is preferably parallel to the upstream surface portion **530** and the floor surface portion **534**. The second downstream surface portion **538** is preferably axially offset upwardly from the floor surface portion **534**, but substantially coplanar with the upstream surface portion **530**. The second downstream surface portion **538** preferably extends circumferentially to the upstream surface portion **530** so that the second downstream surface portion **538** and the upstream surface portion **530** form a continuous arcuate surface portion.

As a disc **108** rotates over the base plate **102**, above the surface portions **530, 532, 534, 536**, and **538**, the spinning disc creates a wind that flows in a substantially circumferential counterclockwise direction, although the wind likely also has a radial component. The wind thus flows along the upstream surface portion **530**, along the slope down surface portion **532**, along the floor surface portion **534**, along the slope up surface portion **536**, and along the second

downstream surface portion **538**. The wind then flows in a substantially circumferential path back to the upstream surface portion **530**.

Referring now to **FIG. 6**, the wind flows substantially circumferentially about the spindle axis **516** of **FIG. 5** in an upstream wind direction **610** along the upstream surface portion **530**, in a slope down wind direction **612** along the slope down surface portion **532** and in a first downstream wind direction **614** along the floor surface portion **534**. Prior disc drives included slope down surfaces that were either substantially normal to the upstream surface portion, as shown in **FIG. 3**, or that had large slope angles relative to the corresponding upstream surface portions. It is believed that the large slope angles cause flow separation and attendant turbulent flow.

In the embodiment of the present invention illustrated in **FIG. 6**, a slope angle **616** of the slope down surface portion **532** relative to the upstream surface portion **530** in a circumferential direction about the spindle axis **516** is small enough to prevent the wind from separating from the slope down surface portion **532**. Thus, the slope down surface portion **532**, having a sufficiently small slope angle **616**, spans the discontinuity between the upstream surface portion **530** and the floor surface portion **534** and thereby prevents flow separation and the attendant turbulent flow in the resulting recirculation region. Accordingly, the effects of the increased vibrations that would be caused by a recirculation region are minimized for the arms **114** and the heads **118** within the recess **518**, thereby decreasing vibrations in the arms **114** and the heads **118**. Additionally, the particle deposition effects of the recirculation region are avoided by preventing the formation of a recirculation region. Accordingly, the slope down surface portion **532** decreases the probability of particles entering the lowest head-disc interface.

More particularly, in a preferred embodiment, the slope angle **616** is less than about thirty degrees. More preferably, the slope angle **616** is from about ten degrees to about thirty degrees, and most preferably the slope angle **616** is about twelve degrees.

Referring now to **FIG. 7**, the wind flows circumferentially about the spindle axis **516** of **FIG. 5** in the first downstream wind direction **614** along the first downstream surface portion **534**, in a slope up wind direction **716** along the slope up surface portion **536**, and in a second downstream wind direction **718** along the second downstream surface portion **538**. Prior disc drives included slope up surfaces that were either substantially normal to the floor surface portion, as shown in **FIG. 4**, or that had slope angles relative to the upstream surface portion which were large enough to cause flow separation and attendant turbulent flow.

In the embodiment of the present invention illustrated in **FIG. 7**, a slope angle **720** of the slope up surface portion **536** relative to the second downstream surface portion **538** in a circumferential direction about the spindle axis **516** is small enough to prevent the wind from separating from the slope up surface portion **536**. Thus, the slope up surface portion **536**, having a sufficiently small slope angle **720**, spans the discontinuity between the floor surface portion **534** and the second downstream surface portion **538** and thereby prevents flow separation and the attendant turbulent flow in the resulting recirculation region. Accordingly, the effects of the increased vibrations that would be caused by a recirculation region are minimized for the arms **114** and the heads **118** within the recess **518**, thereby decreasing vibrations in the arms **114** and the heads **118**. Additionally, the particle deposition effects of the recirculation region are avoided by preventing the formation of a recirculation region. Accordingly, the slope up surface portion **536** decreases the probability of particles entering the lowest head-disc interface.

More particularly, in a preferred embodiment, the slope angle **720** is less than about thirty degrees. More preferably, the slope angle **720** is from about ten degrees to about thirty degrees, and most preferably the slope angle **720** is about twelve degrees.

The slope down surface portion **532** and the slope up surface portion **536** may be curved, rather than planar, surface portions. In this case, the respective slope angles **616**, **720** are maximum angles of the surface portions **532**, **536** relative to the adjacent surface portions **530**, **538**.

In an embodiment of a disc drive **100** including the slope down surface portion **532** and the slope up surface portion **536**, the position error signal, including both non-repeatable runout and repeatable runout components, decreased by 0.1 micro-inch compared to disc drives with slope angles large enough to cause flow separation. As discussed above, it is believed that this decrease is due to the absence of flow separation in the step down and step up regions at the borders of the recess **518**.

An embodiment of the invention may be alternatively described as a disc drive (such as **100**) that includes a housing (such as **103**). The housing encloses a spindle motor (such as **106**) carrying a disc (such as **108**) having a data surface (such as **302**). An actuator assembly (such as **110**) includes an actuator arm (such as **114**) carrying a head (such as **118**). The housing includes a first surface portion (such as **530** or **538**) adjacent to the data surface of the disc. The housing also includes a plurality of surface portions (such as **532**, **534**, and **536**) that define a recess (such as **518**), which allows the actuator arm to move over the data surface of the disc. The plurality of

surface portions include a sloped surface portion (such as **532** or **536**) sloping away from the data surface and preventing wind generated by the disc rotating about an axis (such as **516**) from separating from the sloped surface portion.

In one embodiment, the first surface portion (such as **530**) faces upwardly and is upstream of the actuator arm. In that embodiment, the sloped surface portion (such as **532**) slopes downwardly from the first surface portion. The housing may further include a second upwardly facing surface portion (such as **538**) downstream from and adjacent to the recess. In that case, the plurality of surface portions additionally includes a second sloped surface portion (such as **536**) downstream from the first aforesaid sloped surface portion. The second sloped surface portion slopes away from the data surface and prevents wind generated by the disc rotating about the axis from separating from the sloped surface portion. The plurality of surface portions may also include an upwardly facing floor surface portion (such as **534**) between the first sloped surface portion and the second sloped surface portion. Preferably, the first upwardly facing surface portion, the second upwardly facing surface portion, and the plurality of surface portions together form an annular surface portion beneath the disc.

The first surface portion is preferably substantially parallel to the data surface of the disc. A slope angle (such as **616** or **720**) of the sloped surface portion relative to the first surface portion in a circumferential direction about the axis is preferably from about ten degrees to about thirty degrees, and more preferably about twelve degrees.

The plurality of surface portions may be portions of a surface of a base plate (such as **102**) of the housing or they may be portions of a surface of a cover (such as **104**) of the housing.

An embodiment of the invention may be alternatively described as a disc drive (such as **100**) that includes a housing (such as **103**) that defines a recess (such as **218**). The housing encloses a disc (such as **108**) mounted on a spindle motor (such as **106**) that rotates the disc about an axis (such as **216**) and thereby generates wind within the housing. An upstream surface portion (such as **230** or **234**) and a downstream surface portion (such as **234** or **238**) of the housing both face toward a data surface (such as **302**) of the disc (such as **108**). A discontinuity (such as **232** or **236**) between the upstream surface portion and the downstream surface portion causes a wind recirculation region (such as **312** or **412**) within the recess. The disc drive also includes an actuator arm (such as **114**) that carries a head (such as **118**), which the recess allows to move over the data surface of the disc. An actuator limiting device prevents the actuator arm from entering the wind recirculation region.

Preferably, the actuator limiting device maintains a distance (such as **318** or **418**) between the actuator arm and the discontinuity that is at least six times an axial displacement distance (such as **320** or **420**) between the upstream surface portion and the downstream surface portion. The discontinuity may be a step between the upstream surface portion and the downstream surface portion.

The housing may include a cover (such as **104**) and a base plate (such as **102**), and the upstream surface portion, the downstream surface portion, and the discontinuity may all be surface portions of the base plate.

In one embodiment, the downstream surface portion (such as **234**) is axially lower than the upstream surface portion (such as **230**) and the actuator arm is downstream from the wind recirculation region (such as **312**). In that case, the housing may further include a second downstream surface portion (such as **238**) downstream from the first aforesaid downstream surface portion, the second downstream surface portion being higher than the first downstream surface portion. A second discontinuity (such as **236**) between the first downstream surface portion and the second downstream surface portion causes a second wind recirculation region (such as **412**) within the recess. In that case, the actuator arm is upstream from the second wind recirculation region.

Additionally, an embodiment of the invention may be alternatively described as a disc drive (such as **100**) that includes a housing (such as **103**) enclosing a spindle motor (such as **106**) and an actuator arm (such as **114**) supporting a head (such as **118**). The spindle motor rotates a disc (such as **108**) about an axis (such as **516**) and thereby produces a wind that flows over a first surface portion (such as **530** or **538**) of the housing. The housing includes a recess (such as **518**) adjacent the first surface portion, the recess allowing the actuator arm to access the disc, and the recess being defined by a plurality of surface portions (such as **532**, **534**, and **536**). The housing also includes means for providing a smooth transition between the first surface portion and the plurality of surface portions and for preventing the wind from separating from the plurality of surface portions.

The means for providing a smooth transition may include a sloped surface portion (such as **532** or **536**) of the plurality of surface portions, such that the sloped surface portion prevents the wind from separating from the sloped surface portion.

It will be clear that the present invention is well adapted to attain the ends and advantages mentioned as well as those inherent therein. While embodiments have been described for

purposes of this disclosure, various changes and modifications may be made which are well within the scope of the present invention. For example, the recess and the surface portions discussed above could be formed in the cover of the disc drive rather than, or in addition to, the base plate. Additionally, a base plate or cover could include a combination of steps as disclosed in FIGS. **2-4** and sloped surface portions as disclosed in FIGS. **5-7**, rather than having all sloped surfaces or all steps. Numerous other changes may be made which will readily suggest themselves to those skilled in the art and which are encompassed in the scope of the invention disclosed and as defined in the appended claims.

Claims

What is claimed is:

1. A disc drive comprising a housing enclosing a spindle motor carrying a disc having a data surface, and an actuator assembly adjacent the disc, the actuator assembly comprising an actuator arm carrying a head, the housing comprising:

a first surface portion of the housing adjacent to the data surface of the disc; and

a plurality of surface portions of the housing defining a recess, the recess allowing the actuator arm to move over the data surface of the disc, the plurality of surface portions comprising a sloped surface portion sloping away from the data surface and preventing wind generated by the disc rotating about an axis from separating from the sloped surface portion.

2. The disc drive of claim 1, wherein the first surface portion faces upwardly and is upstream of the actuator arm and wherein the sloped surface portion slopes downwardly from the first surface portion.

3. The disc drive of claim 2, wherein:

the housing further comprises a second upwardly facing surface portion downstream from and adjacent to the recess; and

the plurality of surface portions further comprises a second sloped surface portion downstream from the first aforesaid sloped surface portion, the second sloped surface portion sloping away from the data surface and preventing wind generated by the disc rotating about the axis from separating from the sloped surface portion.

4. The disc drive of claim 3, wherein the plurality of surface portions further comprises an upwardly facing floor surface portion between the first sloped surface portion and the second sloped surface portion.

5. The disc drive of claim 3, wherein the first upwardly facing surface portion, the second upwardly facing surface portion, and the plurality of surface portions together form an annular surface portion beneath the disc.

6. The disc drive of claim 1, wherein the first surface portion is substantially parallel to the data surface of the disc, and wherein a slope angle of the sloped surface portion relative to the first surface portion in a circumferential direction about the axis is from about ten degrees to about thirty degrees.

7. The disc drive of claim 6, wherein the slope angle is about twelve degrees.

8. The disc drive of claim 1, wherein the first surface portion and the plurality of surface portions are portions of a surface of a base plate of the housing.

9. The disc drive of claim 1, wherein the first surface portion and the plurality of surface portions are portions of a surface of a cover of the housing.

10. A disc drive comprising:

a housing enclosing a disc mounted on a spindle motor, the housing defining a recess and the spindle motor being effective to rotate the disc about an axis and thereby generate wind within the housing;

an upstream surface portion of the housing facing toward a data surface of the disc;

a downstream surface portion of the housing facing toward the data surface of the disc, the downstream surface portion being downstream from the upstream surface portion; and

a discontinuity between the upstream surface portion and the downstream surface portion, the discontinuity causing a wind recirculation region within the recess;

an actuator arm carrying a head, the recess allowing the head to move over the data surface of the disc; and

an actuator limiting device operably connected to the actuator arm, the actuator limiting device preventing the actuator arm from entering the wind recirculation region.

11. The disc drive of claim 10, wherein the actuator limiting device maintains a distance between the actuator arm and the discontinuity that is at least six times an axial displacement distance between the upstream surface portion and the downstream surface portion.

12. The disc drive of claim 10, wherein the discontinuity is a step between the upstream surface portion and the downstream surface portion.

13. The disc drive of claim 10, wherein the housing comprises a cover and a baseplate, and wherein the upstream surface portion, the downstream surface portion, and the discontinuity are all surface portions of the base plate.

14. The disc drive of claim 10, wherein:

the disc is above the upstream surface portion and the downstream surface portion;

the downstream surface portion is axially lower than the upstream surface portion; and

the actuator arm is downstream from the wind recirculation region.

15. The disc drive of claim 14, wherein the housing further comprises:

a second downstream surface portion downstream from the first aforesaid downstream surface portion, the second downstream surface portion being higher than the first downstream surface portion; and

a second discontinuity between the first downstream surface portion and the second downstream surface portion, the second discontinuity causing a second wind recirculation region within the recess;

wherein the actuator arm is upstream from the second wind recirculation region.

16. A disc drive comprising a housing enclosing a spindle motor and an actuator arm supporting a head, the spindle motor operable to rotate a disc about an axis and thereby produce a wind that flows over a first surface portion of the housing, the housing comprising:

a recess adjacent the first surface portion, the recess allowing the actuator arm to access the disc, and the recess being defined by a plurality of surface portions; and

means for providing a smooth transition between the first surface portion and the plurality of surface portions and for preventing the wind from separating from the plurality of surface portions.

17. The disc drive of claim 16, wherein the means for providing a smooth transition comprises a sloped surface portion of the plurality of surface portions and wherein the sloped surface portion prevents the wind from separating from the sloped surface portion.

18. The disc drive of claim 17, wherein:

the housing further comprises a second upwardly facing surface portion downstream from and adjacent to the plurality of surface portions; and

the plurality of surface portions further comprises a second sloped surface portion downstream from the first aforesaid sloped surface portion, the second sloped surface portion preventing the wind from separating from the second sloped surface portion.

19. The disc drive of claim 17, wherein the first surface portion is substantially parallel to a data surface of the disc, and wherein a slope angle of the sloped surface portion relative to the first surface portion in a circumferential direction about the axis is from about ten degrees to about thirty degrees.