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DISK DRIVE WITH CHEMICAL FILTER

DESCRIPTION

This invention relates in general to data recording disk drives, and more particularly to disk drives with filters for preventing chemical contaminants from entering the drives.

Disk drives, also called disk files, are information storage devices that use a rotatable disk with concentric data tracks containing the information, a head or transducer for reading and/or writing data onto the various tracks, and an actuator connected to a carrier for the head for moving the head to the desired track and maintaining it over the track centerline during read and write operations. The head may be a single-element inductive read/write head or a dual element inductive write/magnetoresistive read head. There are typically a number of disks mounted on a hub that is rotated by a disk drive or spindle motor, and a number of head carriers connected to the actuator for accessing the surfaces of the disks. A walled enclosure, including a base and a cover, supports the drive motor and head actuator and surrounds the heads and disks to provide a substantially sealed environment. The enclosure has a breather opening to equalize pressure differences between the drive interior and the ambient atmosphere, and provides a defined source of makeup air for enclosure leaks. A particulate filter is located near the breather opening to prevent particulate matter from entering the drive interior.

In conventional magnetic recording disk drives, the head carrier is an air-bearing slider that rides on a bearing of air above the disk surface when the disk is rotating at its operational speed. The slider is maintained next to the disk surface by a biasing force from a suspension that connects the slider to the actuator. The disk has a liquid lubricant film on its surface to minimize head and disk damage that may be caused by inadvertent slider-disk contact during operation, and to facilitate starting of the disk drive when the slider is at rest on the disk surface.

In contrast to conventional air-bearing disk drives, contact or near-contact disk drives have been proposed that place the head carrier in constant or occasional contact with the disk or a liquid film on the

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disk during read and write operations. Examples of these types of disk drives are described in IBM's U.S. Patent 5,202,803 and published European application EP 367510; U.S. Patent 5,097,368 assigned to Conner Peripherals; and U.S. Patent 5,041,932 assigned to Censtor Corporation.

Magnetic recording disk drives are very sensitive to chemical contaminants. High molecular weight organic vapors can adsorb on the very smooth surfaces of the disks and sliders and modify the properties of the liquid lubricant. Other chemical contaminants, such as SO_2, may also induce corrosion of the metallurgy of the disks and heads, especially the magnetoresistive read elements. For these reasons, many disk drives use a chemical filter, in addition to a particulate filter, near the breather opening.

In conventional disk drives with a filter near the breather opening, the pressure gradient between the ambient atmosphere and the drive interior forces the air through the filter. This is desirable because it maximizes contact of the chemical vapors with the chemical filter material. The breather opening is typically located at the lowest pressure point in the drive to ensure that all air enters the drive through the breather filter attached to the breather opening. However, the impedance of a combined flow-through chemical and particle filter is increased by the addition of the chemical filter media. This can lead to contaminants entering the drive enclosure through other leaks or openings.

Accordingly, the invention provides a data recording disk drive including an enclosure containing at least one data disk, a transducer for reading data from or writing data to the disk, and an actuator for moving the transducer across the surface of the disk, said enclosure having a breather opening with a chemical filter located near the breather opening for removing chemical contaminants from air entering the enclosure through the breather opening;

and characterised by means for preventing the air entering the enclosure through the breather opening from flowing through the chemical filter, whereby all the air entering the breather opening is forced to pass across the surface of the chemical filter.

Such a disk drive breather filter assembly maximizes the gettering of chemical contaminants with the lowest possible flow impedance.

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In a preferred embodiment, the chemical filter is a sheet of adsorptive filter material, and the flow preventing means comprises a barrier having a surface maintained adjacent to one side of said sheet whereby air is forced to flow across the surface of the opposite side of said sheet.

Advantageously, a particulate filter is located near the breather opening for removing particulate matter from air entering the enclosure through the breather opening. Typically, the particulate filter is located downstream of the chemical filter, whereby air enters the particulate filter after it has passed across the surface of the chemical filter, with an air-permeable spacer layer between the preventing means and the particulate filter.

In one particular embodiment the disk drive has an improved breather filter assembly that removes both chemical contaminants and particulate matter. The filter assembly includes a housing having an internal passage and a recess that supports and contains the chemical and particulate filter elements. The passage in the filter housing provides fluid communication between the breather opening and a sheet of chemical filter material. A barrier plate is also located in the filter housing recess adjacent to the side of the chemical filter sheet not exposed to air from the passage. The barrier plate prevents air from flowing through the chemical filter material and redirects the air flow across the surface of the chemical filter sheet. After the air flows by the chemical filter sheet, it is redirected through the particulate filter element and into the disk drive enclosure. The air entering the disk drive enclosure does not generally enter into the interior of the chemical filter material by forced conduction, but flows by the surface of the material so that the chemical filter does not significantly reduce the pressure drop across the filter assembly, as in prior art breather filter assemblies. The flow across the surface of the material allows contaminants to diffuse into the getter material and become trapped.

Note that a filter assembly as described above is not restricted to use in disk drives, but may well find beneficial application in other sorts of devices. Typically such a filter assembly has a sheet of chemical filter material having one side in fluid communication with the breather opening, a barrier plate adjacent to the opposite side of said sheet for preventing air flow through said sheet, a layer of particulate

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filter material, and a housing for supporting said sheet, the barrier plate and the particulate filter, the housing having a passage with an inlet aligned with the breather opening and an outlet near said sheet.

Viewed from another aspect, such a filter assembly for use in a substantially sealed enclosure having an opening for pressure equalization comprises: a filter assembly housing having an entrance for receipt of air to be filtered and an exit for the filtered air into the enclosure; a sheet of chemical filter material supported within the housing for adsorbing chemical contaminants, the sheet having a first surface exposed to the housing entrance; a barrier plate supported within the housing and maintained in contact with the opposite surface of said sheet for preventing air flow through said sheet, whereby air is forced to flow across said first surface of said sheet; and a layer of particulate filter material supported by the housing and located near the housing exit for filtering particulate matter in the air after the air has passed said first surface of said sheet.

An embodiment of the invention will now be described in detail by way of example only with reference to the following drawings:

Fig. 1 is a side view of a magnetic recording disk drive incorporating a breather filter.

Fig. 2 is a sectional view of a portion of the disk drive cover and attached breather filter assembly.

Fig. 3 is a view of section 3-3 of Fig. 2 and illustrates the air passage in the breather filter assembly housing.

Fig. 4 is a graph illustrating the improved chemical contaminant trapping of the breather filter assembly.

Referring first to Fig. 1, there is illustrated in sectional view a schematic of the disk drive. The disk drive comprises a housing that includes a base 10 and a cover 11. A disk drive motor 12 and an actuator 14 are secured to the base 10. The base 10 and cover 11 provide a substantially sealed enclosure for the disk drive. A magnetic recording disk 16 is connected to drive motor 12 by means of hub 18 to which it is attached for rotation by the drive motor 12. A thin film 50 of a relatively high-viscosity lubricant is maintained on the surface of disk 16. The lubricant may be a conventional perfluoro-polyether (PFPE) disk lubricant. A read/write head or transducer 42 is formed on the

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trailing end of an air-bearing slider 20. Transducer 42 may be an inductive read and write transducer or an inductive write transducer with a magnetoresistive (MR) read transducer formed by thin film deposition techniques as is known in the art. The slider 20 is connected to the actuator 14 by means of a rigid arm 22 and a suspension 24, the suspension 24 providing a biasing force that urges the slider 20 onto the surface of the recording disk 16. During operation of the disk drive, the drive motor 12 rotates the disk 16 at a constant speed, and the actuator 14, which is typically a linear or rotary voice coil motor (VCM), moves the slider 20 generally radially across the surface of the disk 16 so that the read/write head may access different data tracks on disk 16.

A gasket 13 is located between base 10 and cover 11. A small breather opening 64 is located in the cover 11 for equalizing pressure between the interior of the disk drive and the outside environment. A filter assembly 60 is mounted to the inside of one of the walls of the disk drive enclosure, i.e., the inside of cover 11 in Fig. 1, and aligned with the breather opening 64. The breather opening 64 and filter assembly 60 are located in a low-pressure region of the disk drive so that air entering the disk drive will enter through the filter assembly and not through other openings or leaks around gasket 13.

The details of the filter assembly 60 are shown in Fig. 2. The assembly 60 includes a cylindrically-shaped filter housing 62 that is mounted to the inside surface of disk drive cover 11. The housing 62 is preferably formed of plastic material such as polycarbonate. The housing 62 has an inlet 80 that is aligned with the breather opening 64 in cover 11. The filter housing 62 is located within a circular locating ring 61 formed on the inside of cover 11 and is secured to the cover 11 by means of double-sided adhesive tape 65 that has a hole aligned with breather opening 64 and housing inlet 80. Another possibility is for the filter housing 62 to be located within a locating depression or a raised boss on the inside of the cover 11 and secured to the cover 11 by means of a double-sided adhesive tape 65.

The filter housing 62 has a central recess 66 that contains a first air-permeable open mesh spacer 70, an adsorbent chemical filter sheet 72, a barrier plate 74, and a second air-permeable open mesh spacer 76. The chemical filter sheet 72 is made of a permeable media containing

activated carbon, such as commercially available Kynol activated carbon cloth, that removes chemical contaminants, including organic gases. The open mesh spacers are a thin three-dimensional net of inert material, such as commercially available Delnet. The barrier plate 74 may be formed of any nonporous material, such as Mylar, that will prevent the flow of gas. A particulate filter 78 is located over the end of housing 62 and covers the recess 66, holding the internal components within the housing 62. The particulate filter 78 is preferably made of expanded polytetrafluoroethylene membrane, such as commercially available Tetratex (Donaldson-Tetratec) or electrostatically-charged nonwoven fabric, such as commercially available Filtreet (3M Corporation) and Donaldson Electret (Donaldson Company).

As shown in Fig. 2, the filter housing 62 has a passage for conducting air from breather opening 64 to chemical filter sheet 72. The passage includes an inlet 80 aligned with breather opening 64, a channel 81 for limiting diffusive flow of external contaminant to the filter, a vertical channel 82, and an outlet channel 83. Channel 83 is covered by an annular adhesive ring 85 except at the outlet end 87 (see Fig. 3). The outlet end 87 directs the air centrally through the open mesh spacer 70 in a direction generally perpendicular to the chemical filter sheet 72. A view of filter housing 62 taken through section 3-3 of Fig. 2 is shown in Fig. 3 and better illustrates the air flow path. Inlet 80 (a part of hidden channel 81) directs air through a curved diffusion path formed by channel 81. Channel 81 terminates at vertical channel 82 that connects to outlet 83. Elements 82 and 83 provide additional resistance to diffusive flow. Channel 83 terminates at outlet end 87.

The operation of the filter assembly 60 will now be explained with reference to the previously described Figs. 2 and 3. When the pressure within the disk drive enclosure immediately adjacent to the breather filter is less than the ambient atmosphere pressure, a pressure gradient is established across the breather filter assembly. Air is drawn through the breather opening 64 and into inlet 80 of filter housing 62. As shown by the directional arrows in Fig. 2, the air passes through the channel 81, down vertical channel 82, and through outlet channel 83 through the outlet hole 87 in the adhesive ring 85. Air emerges through the outlet 87 in a direction generally perpendicular to mesh spacer 70 and the chemical filter sheet 72. Because of the barrier plate 74 adjacent to

the surface 71 of chemical filter sheet 72, the air cannot pass through the chemical filter sheet 72, but is redirected across and generally parallel to the opposite surface 73 of sheet 72. Any passage of air into the interior of sheet 72 is by diffusion rather than forced conduction. After passing across surface 73 of chemical filter sheet 72, the air is directed into the annular gap within recess 66 and then back across mesh spacer 76. It then passes through particulate filter 78 into the interior of the disk drive.

The air entering the disk drive enclosure does not generally enter into the interior of the chemical filter material by forced conduction, but flows by the surface of the material so that the chemical filter does not significantly increase the flow impedance of the filter assembly, as in prior art breather filter assemblies. The flow across the surface of the material allows contaminants to diffuse into the getter material and become trapped.

The advantage of such an approach is illustrated in Fig. 4, which is a graph of the ratio of contaminant concentration "out" to contaminant concentration "in" during an accelerated chemical test for different filter assemblies. The horizontal "clip level" line in Fig. 4 is the maximum contaminant concentration ratio allowed for a particular disk drive design. The curve A in Fig. 4 is the behavior of a conventional "flow-through" filter in which the air is forced by a pressure gradient to pass through the chemical filter material. The curve B in Fig. 4 is the behavior of a "flow-by" filter assembly in accordance with the present invention. As is apparent, the new filter assembly provides a much lower ratio of chemical concentration "out" to chemical concentration "in", and thus better chemical trapping over the entire duration of the test. In addition, the new filter assembly provides adequate chemical filtration below the clip level for approximately 50% longer, i.e., in an accelerated test the time to reach the clip level is approximately 1.5 hours for the new filter assembly versus 1 hour for a conventional "flow-through" filter assembly. In this accelerated test, 1 hour is equivalent to approximately 2.5-5 years of product lifetime.

Modifications to the embodiment described above may occur to the skilled person. For example, the filter assembly may include a second chemical filter sheet with the barrier plate located between the two chemical filter sheets so that air passes across one surface of each of the sheets.

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CLAIMS

1. A data recording disk drive including an enclosure (10, 11) containing at least one data disk (16), a transducer (42) for reading data from or writing data to the disk, and an actuator (14) for moving the transducer across the surface of the disk, said enclosure having a breather opening (64) with a chemical filter (72) located near the breather opening for removing chemical contaminants from air entering the enclosure through the breather opening;

and characterised by means (72) for preventing the air entering the enclosure through the breather opening from flowing through the chemical filter, whereby all the air entering the breather opening is forced to pass across the surface of the chemical filter.

2. The disk drive according to claim 1 wherein the chemical filter is a sheet of adsorptive filter material, and wherein the flow preventing means comprises a barrier having a surface maintained adjacent to one side of said sheet whereby air is forced to flow across the surface of the opposite side of said sheet.

3. The disk drive according to claim 1 or 2 further comprising a particulate filter (78) located near the breather opening for removing particulate matter from air entering the enclosure through the breather opening.

4. The disk drive according to claim 3 wherein the particulate filter is located downstream of the chemical filter, whereby air enters the particulate filter after it has passed across the surface of the chemical filter.

5. The disk drive according to claim 3 or 4 further comprising an air-permeable spacer layer (76) between the preventing means and the particulate filter.

6. The disk drive according to any preceding claim further comprising a filter housing (72) supporting the chemical filter, the housing being attached to the enclosure and having a passage (81, 82, 83) providing fluid communication between the breather opening and the chemical filter.

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7. The disk drive according to claim 6 wherein the passage in the filter housing defines a diffusion path.

8. The disk drive according to claim 6 or 7 wherein the passage in the filter housing has an inlet near the breather opening and an outlet oriented generally perpendicular to the surface of the chemical filter, whereby air entering the breather opening is directed generally perpendicular to the surface of the chemical filter and reoriented generally parallel to and across the surface of the chemical filter by the flow preventing means.

9. The disk drive according to any of claims 6 to 8, further comprising an air-permeable spacer layer (70) located within the housing between the breather opening and the sheet of chemical filter material.

10. A filter assembly suitable for use in the disk drive of any preceding claim.

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