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BURNISHING HEAD

BACKGROUND OF THE INVENTION

This invention relates to burnish heads used during the manufacture of magnetic disks.

Magnetic disks are typically manufactured by the following procedure.

1. An Al alloy substrate is electroless plated with a layer of NiP.
2. The NiP layer is polished.
3. The NiP layer is textured, either using a laser texture technique and/or a mechanical texture technique.
4. Thereafter, an underlayer (e.g. NiP or Cr), a magnetic alloy (e.g., a Co or Fe alloy), and a protective overcoat (e.g. hydrogenated carbon or zirconia) are sputtered, in that order, onto the NiP layer.
5. A lubricant is then applied to the protective overcoat.
6. The magnetic disk is then subjected to a burnishing step to remove asperities and contaminants from the disk.

During burnishing (step 6), the disk is mounted on a spindle and rotated while a burnishing head is dragged across the disk surface. The burnishing head is made from a hard material, typically Al_2O_3-TiC. A normal loading force of about 6.5 grams is applied to the burnishing head. The speed of disk rotation is such that the burnishing head drags along the disk surface at about 100 to 400 inches per second (ips). While it is generally desirable to rotate the disk quickly during burnishing, if the disk rotates too quickly, the

burnishing head can start "flying", and therefore burnish ineffectively. If the disk rotates too quickly the burnishing head can also start bouncing on and making craters in the disk, which is also undesirable.

Unfortunately, we have discovered several problems that can arise during burnishing:

1. Particles from the burnishing head can chip off the head and onto the disk. These particles can become embedded in the disk and cause subsequent failures of the disk drive. In particular, these particles can damage the disk drive's read-write head.
2. The burnishing head can cause war marks on the disk.
3. A phenomenon called "dinging" can occur. Dinging can occur when the burnishing head sticks to the disk, is suddenly pulled free from the disk, and then springs back to strike and dent the disk.
4. A related phenomenon called "ringing" is caused when the burnishing head repeatedly strikes the disk, thereby creating an audible sound. Although the audible sound itself is not a major concern, it is believed that the mechanical action causing the audible sound can damage the disk.

It would be desirable to provide an improved burnishing head that reduces or eliminates these problems.

SUMMARY

A burnishing head in accordance with our invention is covered with a layer of carbon. We have discovered that this carbon layer has the following benefits.

1. The carbon reduces friction between the burnishing head and the disk. (This reduction in friction reduces wear of the disk.)
2. The reduced friction prevents the burnishing head from forming wear marks on the disk.
3. The carbon prevents burnishing head particles from chipping off the burnishing head and onto the disk. This helps to prevent disk drive failures during use.
4. The carbon can reduce or prevent the dinging and ringing phenomena.

In one embodiment, the burnishing head comprises a body of a first material having a burnishing pattern formed thereon. The first material is typically a ceramic such as Al_2O_3-TiC. The burnishing pattern is formed in the first material by cutting or abrading the first material, e.g. with a tool such as a diamond cutting wheel. Alternatively, the pattern can be formed by other techniques such as ion milling or chemical etching. The body of the first material is then coated with carbon, e.g. by sputtering, chemical vapor deposition, or other appropriate deposition technique.

In another embodiment, the burnishing head comprises a body of a first material. The carbon is deposited on the first material. The carbon is then lithographically patterned to form a burnishing pattern thereon.

In either embodiment, the burnishing pattern is used to remove asperities and loose particles and contamination from the surface of a magnetic disk during burnishing.

In yet another embodiment, a carbon layer is deposited on a ceramic material that is harder than Al_2O_3-TiC, e.g. SiC. Of importance, if such a hard ceramic material chips off the burnishing head and embeds in the magnetic disk, it may damage a disk drive read-write head during use more easily than Al_2O_3-TiC. Thus, the ability of the carbon

layer to prevent such chipping is an especially important benefit when used in conjunction with hard ceramic materials within a burnishing head.

In another embodiment, a pattern is formed on the bottom of a carbon-coated burnishing head comprising a set of channels that facilitate flushing debris through the channels toward the outside edge of the disk during burnishing.

In yet another embodiment, the burnishing head is coupled to a suspension including a damper for damping vibration of the burnishing head. This advantageously reduces the dinging of the disk during burnishing. In one embodiment, the damper extends from a first point near the mounting plate of the suspension to another point near the flexure of the suspension.

In yet another embodiment, the burnishing head comprises a burnishing surface thereon. The burnishing surface comprises a set of burnishing pads and a set of channels extending between the pads. The channels extend in a direction that tends to push air and/or debris toward the outer diameter of the magnetic disk being burnished. A recess is formed in a central region of the burnishing surface that reduces or eliminates the above-mentioned aerodynamic force that would otherwise tend to push the burnishing head away from the magnetic disk.

In an alternative embodiment, the channels extend in a direction that tends to push air and/or debris toward the inner diameter of the disk.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 schematically illustrates a burnishing head burnishing a magnetic disk.

Fig. 2A illustrates in plan view the bottom of the burnishing head of Fig. 1.

Fig. 2B is a side cross section view of the burnishing head of Fig. 2A along lines B-B.

Fig. 3A is a bottom view of the burnishing head mounted on a suspension.

Fig. 3B is a side view of the burnishing head mounted on the suspension.

Fig. 3C is a top view of the burnishing head mounted on the suspension.

Fig. 3D is a cross section view of the burnishing head mounted on the suspension along lines 3D-3D of Fig. 3A.

Figs. 4A to 4C illustrate the relation between friction and time when a prior art Al_2O_3-TiC burnishing head is dragged across a magnetic disk for 30 minutes.

Figs. 5A to 4C illustrate the relation between friction and time when the burnishing head of Figs. 2 and 3 is dragged across a magnetic disk for 30 minutes.

Fig. 6A illustrates in plan view the bottom of a burnishing head in accordance with another embodiment of the invention.

Fig. 6B is a side view of the burnishing head of Fig. 6A.

Figs. 7A to 7C illustrate the burnishing head of Figs. 6A and 6B during manufacturing.

Fig. 8A illustrates in plan view the bottom of a burnishing head in accordance with another embodiment of the invention.

Fig. 8B illustrates in cross section the burnishing head of Fig. 8A along lines 8B-8B.

Fig. 9 illustrates a burnishing head similar to the head of Figs. 8A and 8B, except used to burnish the opposite side of a magnetic disk than the head of Figs. 8A and 8B.

Fig. 10 illustrates a burnishing head similar to the head of Figs. 8A and 8B, except that the walls of the burnishing pads are substantially straight.

Fig. 11A illustrates in plan view the bottom surface of a burnishing head in accordance with another embodiment of the invention comprising a channel extending across the bottom of the burnishing head.

Fig. 11B illustrates in cross section the burnishing head of Fig. 11A along lines 11B-11B.

Figs. 12A to 12C illustrates in cross section the burnishing head of Figs. 11A and 11B during a manufacturing process in accordance with the present invention.

DETAILED DESCRIPTION

First Embodiment of a Burnishing Head

Fig. 1 schematically illustrates a burnishing head 10 burnishing the top surface 11 of a magnetic disk 12. During burnishing, a 6.5 gram normal loading force is applied to the burnishing head. Head 10 drags along disk 12 as disk 12 is rotated, e.g. by a motor. In one embodiment, disk 12 spins at a speed such that the portion of surface 11 dragging against head 10 travels at between 80 and 800 ips relative to head 10. In one embodiment, surface 11 travels relative to head 10 at between 100 and 400 ips, e.g. 160 ips. In another embodiment, surface 11 travels at 350 ips relative to head 10. (Simultaneously, a second burnishing head 14 burnishes the bottom side 15 of disk 12.) Heads 10 and 14 are mounted on suspensions 16 and 18, respectively. Suspensions 16 and 18 are used to move heads 10 and 14 over the top and bottom surfaces of disk 10.

Unlike read-write heads used during normal magnetic disk operation, burnishing heads 10 and 14 do not "fly" over the surface of disk 10. Rather, heads 10 and 14 drag across the surface of disk 10. Further, burnishing heads 10 and 14 do not comprise a magnetic read-write element.

In one embodiment, the burnishing heads do not land on, take off from, or come to a rest on disk 10 like conventional read-write heads. Rather, in this embodiment, heads 10 and 14 do not begin interacting with disk 10 until disk 10 is already rotating. (This is known as "dynamic loading.") However, in another embodiment, the burnishing heads do rest on disk 12, e.g. before and/or after burnishing.

Fig. 2A illustrates in plan view the bottom surface of burnishing head 10. While various dimensions, angles and other parameters related to an embodiment of head 10 are discussed herein, it is emphasized that these parameters are merely exemplary, and do not limit the invention.

Head 10 can have a length L1 of about 0.120 inches, a width W1 of about 0.08 inches, and a thickness T (Fig. 2B) of about 0.033 inches. The bottom of burnishing head 10 comprises a set of diamond-shaped burnish pads 20. (As used herein, the term "pads" encompasses portions of the bottom surface of a burnishing head that extend lower than other portions of the bottom surface of the burnishing head. Pads may be of any shape.) These pads extend by a distance D1 of about 0.005 inches from the main surface 22 of head 10, and serve to abrade, cut or otherwise remove asperities and contaminants from top surface 11 of disk 12. In one embodiment, burnishing head includes a taper 24 at its trailing end. (This is in contrast to read-write heads, which have a taper at their leading end.) This taper creates a negative pressure region that tends to pull head 10 downward

against disk 12. The surface of taper 24 can be at an angle θ of about 0.5 degrees relative to the bottom surface of head 10. Taper 24 extends a distance D2 of about 0.024 inches from the trailing edge 26 of head 10.

The body of head 10 can be any appropriate material, e.g. a ceramic such as Al_2O_3-TiC. Pads 20 are typically formed by cutting the Al_2O_3-TiC during manufacturing. (This can be accomplished by mechanically cutting the Al_2O_3-TiC or using a process such as ion milling or chemical etching.) After pads 20 and tapers 24 are formed, a hard carbon layer 28 (e.g. about 20 nm thick) is deposited on the bottom of head 10. Carbon 28 can be formed by a vacuum deposition technique such as sputtering or chemical vapor deposition. In one embodiment, a seed layer of a material such as silicon can be deposited on head 10 prior to deposition of carbon layer 28 to promote adhesion of the carbon to head 10. Carbon 28 provides the following benefits:

1. Carbon 28 reduces friction and stiction between the burnishing head and a magnetic disk during burnishing.
2. Carbon 28 prevents particles of the burnishing head body material from chipping off head 10 during burnishing.
3. Carbon28 prevents dinging and ringing.
4. Carbon 28 prevents head 10 from forming wear marks on a disk being burnished.
5. Carbon 28 reduces variations in the friction force between the burnishing head and the disk during burnishing.

Different types of carbon can be applied to a burnishing head in accordance with the invention. In one embodiment, carbon 28 contains between 10 and 20 atomic % hydrogen, as indicated by a B/A ratio of 1.19 of the Raman spectrum exhibited by the

carbon. The Id/Ig ratio of the Raman spectrum can be between about 0.435 and 0.481, thus indicating the presence of more SP3 atomic bonds than typically occurs in a carbon film on a magnetic disk. Based on a G peak of 1540.1 to 1542.4, carbon 28 is typically less graphite-like than the carbon on a magnetic disk. Carbon 28 is typically amorphous. It is typically desirable that carbon 28 be about the same hardness or slightly harder (and slightly more wear resistant) than the carbon on the disk being burnished. However, other types of carbon can be used for carbon 28.

In one embodiment, the burnishing head of the present invention can be used in conjunction with apparatus such as the Phase Metrics 150, 250 or 3500 disk testers. (These testers can burnish as well as test magnetic disks.) However, the burnishing head can be used in conjunction with other apparatus as well.

Figs. 4A to 4C and 5A to 5C illustrate the results of drag tests that demonstrate some of the unique advantages derived from the invention. In the drag tests of Figs. 4A to 4C, a burnish head in accordance with the prior art comprising an Al_2O_3-TiC body and no carbon overcoat was dragged against a magnetic disk. During the test, a 6.5 gram normal loading force was applied to the prior art head against the disk while the disk was rotating at 682 rpm. The head was at a radius of 0.7 inches from the center of the disk. Thus, the disk was traveling at 50 ips relative to the head. The y axes in the graphs of Figs. 4A to 4C measure friction force exerted on the heads by the disks. This force is measured in grams. The x axes are in units of time. The drag tests of Figs. 4A to4C lasted 30 minutes each. (This represents conditions that are more aggressive than that experienced by typical burnishing heads, as burnishing a single disk typically takes about several seconds.) As can be seen, friction between the burnishing head and disk rose

significantly, e.g. to about 15 grams in Figs. 4A and 4B, and about 18 grams in Fig. 4C. Thereafter, the friction force in Figs. 4A to 4C decreased, but was very erratic. It is believed that this may be because a) the lubricant is depleted from the magnetic disk; b) friction and wear of the burnishing head and disk occur; and/or c) particles of the Al_2O_3-TiC body of the burnishing head broke away, and these particles exacerbated abrasive wear between the head and disk. (The wide variation in friction between a burnishing head and a disk is known as chatter, and is highly undesirable.)

Figs. 5A to 5C illustrate a test similar to that of Figs. 4A to 4C, except performed with a carbon-coated burnishing head as shown in Figs. 2 and 3. Again, the head was at a radius of 0.7 inches from the center of the disk, the disk was rotating at 682 rpm (i.e. the disk was traveling at 50 ips relative to the head), and a 6.5 gram loading force was applied to the head. As can be seen, the friction between the burnishing heads and the disks was very consistent—about 8.9 grams in Fig. 5A, 8 grams in Fig. 5B and slightly less than 10 grams in Fig. 5C. Figs. 4 and 5 demonstrate that a burnishing head constructed in accordance with our invention provides superior performance. The friction between the burnishing head and the magnetic disk is lower for the heads of Figs. 5A to 5C than the heads of Figs. 4A to 4C. This indicates less wear of the heads and disks in Figs. 5A to 5C than the heads and disks of Figs. 4A to 4C. In addition, there is less chatter shown in Figs. 5A to 5C compared to Figs. 4A to 4C.

Second Embodiment of a Burnishing Head

Fig. 6A illustrates in plan view a burnishing head 50 constructed in accordance with a second embodiment of our invention. Fig. 6B is a side view of head 50. Referring

to Fig. 6A, instead of including diamond-shaped burnishing pads 20, burnishing head 50 comprises tear-shaped pads 52 for burnishing a magnetic disk. Pads 52 typically have a length L2 of about 0.019 inches and a width W2 of about 0.019 inches. As with the previous embodiment, head 50 comprises a ceramic body 54 (e.g. Al_2O_3-TiC or SiC) having a carbon layer 56 deposited therein, e.g. to a thickness of 4 to 12 microns (in one embodiment, 8 microns). Instead of forming pads by cutting into Al_2O_3-TiC body 54, pads 52 are etched into carbon layer 56.

The embodiment of Figs. 6A and 6B has an advantage over the embodiment of Figs. 2A and 2B. One cannot easily tell by visual inspection of the head of Figs. 2A and 2B whether the carbon has worn off the burnishing pads. However, in the embodiment of Figs. 6A and 6B, pads 52 will wear first, and when pads 52 are abraded away and no longer visible, it is readily apparent that a new burnishing head should be installed.

Head 50 is typically formed by the following process:

1. Carbon layer 56 is deposited on an Al_2O_3-TiC wafer 58 (Fig.7A). As with the previous embodiment, carbon layer 56 is formed by a vacuum deposition process such as chemical vapor deposition or sputtering.
2. A lithographic mask 60 is deposited onto carbon layer 56 and then patterned, e.g. by e-beam lithography or photolithography (Fig. 7B). Mask 60 thus defines the locations where pads 52 are to be formed.
3. The exposed portions of carbon layer 56 are then etched, e.g. by plasma etching (Fig. 7C). Thereafter, mask 60 is then removed, e.g. by chemical etching. Al_2O_3-TiC wafer 58 is then cut into individual burnishing heads and mounted onto suspensions.

One advantage of this method is that because pads 52 are formed lithographically, they can be formed in any desired shape. (When using cutting and abrading techniques, it is much more difficult to form heads into certain shapes such as the tear shapes of Fig. 6A.) It is believed that a tear shape helps to prevent accumulation of debris at the trailing edge of the pad than certain other shapes, such as circular pads.

Third Embodiment of a Burnishing Head

Figs. 8A and 8B illustrate a burnishing head 100 constructed in accordance with another embodiment of the invention comprising pads 102a, 102b, 102c, 102d which are arranged as curved stripes, and channels 103a, 103b and 103c between pads 102. (Instead of being arranged as curved stripes, pads 102 can be arranged so that their edges are straight lines as shown in Fig. 10.) Each of pads 102 and channels 103 extend from one edge of head 100 to another edge of head 100. In one embodiment, channels 103 are arranged so that any particle that enters one of channels 103 will tend to rush toward the outside edge of the disk. For example, pad 102a and channel 103a extend from a leading edge 104 of head 100 to the left edge 105 of head 100. Because of the rotation of the magnetic disk during burnishing, air flows in a direction A through channels 103 during burnishing. (The disk moves in a direction D during burnishing.) By designing pads 102 so that there are channels 103 therebetween, air can easily flow through channels 103 to flush out any debris that may accumulate on the bottom of the burnishing pad. Of importance, along the entirety of their length, channels 103 extend in a direction such that the wind generated by the rotating disk tends to flush any debris therethrough, thereby preventing such debris from being trapped. To put it slightly differently, there are no

pockets in channels 103 which would cause the debris to accumulate, since the walls of the channel are oriented so that air always tends to blow the debris out of the channel and toward the outside edge of the disk.

Widths Wa and Wb of leading edges 110a, 110b of pads 102a, 102b are typically minimized. In one embodiment, the leading edges of the pads can be rounded, e.g. as shown by dotted lines 106. Although Fig. 8A shows four pads, other numbers of pads can be formed on the bottom of head 100. Of importance, pads 102 are lithographically etched into a carbon layer 112 which is deposited on a hard body material 114 (e.g. a ceramic material). During this process,

a) a mask is deposited on carbon layer 112;

b) the mask is patterned (e.g. using e-beam patterning or photolithographic patterning) to expose portions of carbon layer 112; and

c) the exposed portions of carbon layer 112 are etched, e.g. by ion milling, sputter etching, or chemical etching.

Lithographic manufacturing techniques make it easy to design pads of any arbitrary shape. Thus, the above-described manufacturing process is particularly useful when forming pads 102 of head 100. However, in other embodiments, pads 102 of head 100 are formed by a mechanical cutting technique.

As mentioned above, typically the top and bottom surfaces of a magnetic disk are burnished simultaneously. The burnishing head applied to the bottom surface of the magnetic disk is typically a "mirror image" of the head applied to the top surface, e.g. as shown in Fig. 9. Channels 103' in head 100' of Fig. 9 extend in a direction to accommodate the air flow generated by the spinning magnetic disk on the bottom side of

the disk. The pattern may be made symmetrical about a diagonal line such that the top and bottom slider can be the same parts but assembled to the suspension differently.

In summary, carbon has a unique beneficial effect when applied to a burnishing head. While carbon has been applied to read-write heads in the past (see Wang, et al., "Tribology of Laser Textured Disks With Thin Overcoat", IEEE Trans. Mag. Vol. 33, NO. 5, Sept. 1997, p. 3184), carbon on a burnishing head provides different advantages than carbon on a read-write head. For example, Wang reports that putting carbon on a read-write head prevents wear of laser bumps on the disk. However, there is nothing in Wang to suggest that carbon would be appropriate for a burnishing head, in which the carbon head is used to remove asperities from a disk. Also, there is nothing in Wang to suggest that carbon can be used to prevent burnishing head particles from chipping off a burnishing head and embedding in the disk.

Fourth Embodiment of a Burnishing Head

Fig. 11A illustrates in plan view the bottom surface of burnishing head 310. While various dimensions, angles and other parameters related to an embodiment of head 310 are discussed herein, it is emphasized that these parameters are merely exemplary, and do not limit our invention.

Head 310 can have a length L31 of about 0.08 inches, a width W31 of about 0.08 inches, and a thickness T31 (Fig. 11B) of about .033 inches. The bottom of burnishing head 310 comprises a set of rail-shaped burnish pads 320. Pads 320 abrade, cut or otherwise remove asperities and contaminants from the top surface of the disk.

Pads 320 extend diagonally across the bottom surface of the burnishing head. Pads 320 can have a width W32 between about 0.004 and 0.006 inches. A set of slots 324 extend between pads 320. Slots 324 typically have a width W33 of about 0.02 inches. Slots 324 are recessed by a distance D31 of about 4 μm relative to the top surface 321 of pads 320. Slots 324 extend diagonally across the bottom of the burnishing head such that during use (i.e. when the disk is rotating), air flows through slots 324, tending to flush debris toward the outer diameter of the disk. Slots 324 can be at an angle between 20 and 70 degrees relative to the length of head 310 and typically 45 degrees relative to the length of head 310. In one embodiment, slots 324 are linear, but in other embodiments, slots 324 are non-linear. Typically there are no pockets on the bottom of the burnishing head where debris can accumulate.

As seen in Fig. 11A, a central recess 326 is cut into the bottom surface of burnishing head 310 to a depth D32 of about .001 to .005 inches relative to top surface 321 of pads 320. In one embodiment, recess 326 has a width W34 of .020 inches. Recess 326 reduces or prevents an aerodynamic force from developing while the disk is rotating that would otherwise push head 310 away from the disk.

Although some embodiments (and in Fig. 11B) distance D31 is considerably less than distance D32, in other embodiments, distance D31 is not less than distance D32.

The burnishing head of the present invention is different from the burnishing head of Fig. 2. In particular, the head of Fig. 2 includes a set of diamond shaped pads, with a set of channels between the pads that criss-cross. In this embodiment, slots 324 extend in one direction, are generally or substantially parallel, and do not intersect.

Optionally, burnishing head 310 can include a taper at its trailing end 327. (This is in contrast to read-write heads, which have a taper at their leading end.) This taper creates a negative pressure region that tends to pull head 310 downward against the disk. The surface of the taper can be at an angle θ of about .5 degrees relative to the bottom surface of head 310. The taper extends a distance D32 of about .002 to .006 inches from the trailing edge 327 of head 310.

Method of Making Burnishing Head in Accordance with the Fourth Embodiment

In a fourth embodiment of the invention, a carbon layer 328 is deposited on a hard substrate 330 (Fig. 12A). As in the above-mentioned embodiments, substrate 330 is typically a ceramic material such as Al_2O_3-TiC. The Al_2O_3-TiC serves as the body of burnishing head 310. Carbon 328 can be deposited to a thickness T32 of about 5 μm, and can be formed by a vacuum deposition process such as sputtering or chemical vapor deposition. A seed layer of a material such as silicon can be deposited on substrate 330 prior to carbon deposition to promote adhesion of the carbon to head 310.

After carbon 328 is deposited on substrate 330, slots 324 are cut through carbon layer 228 and into substrate 330 (Fig. 12B). (This can be accomplished by mechanically cutting the Al_2O_3-TiC with a cutting wheel, or using a process such as ion milling or chemical etching.) As mentioned above, slots 324 are typically cut to a depth D31 of about 4 μm. Although depth D31 is typically less than thickness T32 of carbon layer 328, in other embodiments, depth D31 is greater than thickness T32.

After slots 324 are cut into substrate 330, carbon coated pads 320 remain on the burnishing surface of burnishing head 310.

This Sheet Has Been Replaced



After slots 324 are cut into substrate 330, recess 326 is cut through carbon 328 and into substrate 330 (Fig. 12C). Recess 326 can also be cut by mechanically cutting the Al_2O_3-TiC with a cutting wheel or using a process such as ion milling or chemical etching. (Forming recess 326 means that the portion of pads 320 that would otherwise extend across the middle of head 310 are cut.)

Thereafter, substrate 330 is cut into individual burnishing heads and mounted onto a suspension, e.g. a suspension as described below.

In the above-described embodiment, slots 324 are cut into substrate 330 before recess 326. However, in other embodiments, recess 326 is cut into the substrate before slots 324.

In the above-described embodiments, carbon 328 is deposited onto substrate 330 before slots 324 and recess 326 are cut. However, in other embodiments, carbon 328 is deposited on substrate 330 after slots 324 and recess 326 are cut. In yet other embodiments, the body of the burnishing head is made of carbon, and there is no carbon deposition process. In another embodiment, carbon deposition is not provided on the burnishing head surface.

In the above-described embodiment, pads 320 and slots 324 are generally linear in shape. However, pads 320 and slots 324 can have non-linear shapes as well. For example, pads 320 and slots 324 can be curved. However, it is generally desirable that pads 320 and slots 324 extend in a direction such that they permit air flow to flush debris through slots 324 toward the outer diameter of the disk.

Novel Suspension for Holding the Burnishing Head

Figs. 3A to 3D illustrate suspension 16 for holding a burnishing head. Suspension 16 comprises a load beam 200, a flexure 202 affixed to one end of load beam 200 at a welding point, and a mounting plate 204 affixed to a second end of load beam 200 at welding points. Burnishing head 10 is affixed to flexure 202. Mounting plate 204 is affixed to an arm that is used to move burnishing head 10 across the surface of a disk being burnished. Load beam 200, flexure 202 and mounting plate 204 are typically made from stainless steel, but can be made from other materials as well.

Flanges 210a, 210b extend upward from, and add stiffness to, the sides of load beam 200. Flanges 210a, 210b do not extend to mounting plate 204. Rather, they terminate at points 212a, 212b, respectively, spaced apart from mounting plate 204. The portion 213 of load beam 200 between points 212a, 212b and mounting plate 204 is sometimes referred to as the "bend zone" of the load beam.

Structures 200 to 210, within suspension 16 and described above, are known in the art. However, in accordance with one novel feature of the invention, a damper 220 is affixed to at least one side of suspension 16 (in Figs. 3A to 3D, the top side). Damper 220 extends from a point 220a near flexure 202, to a point 220b close to mounting plate 204. (Point 220b is spaced a slight distance (about 0.005 inches), i.e. close but not touching mounting plate 204.) In accordance with this design, damper 220 extends over most of bend zone 213 of suspension 16.

Damper 220 comprises a stiff, upper stainless steel layer 222 (sometimes referred to as a "constraint layer") affixed to a viscoelastic organic polymer layer 224, which in turn is affixed to load beam 202. In one embodiment, layer 224 can be affixed to load

beam 200 using a thermally active adhesive mechanism. Of importance, damper 220 damps and reduces vibration of load beam 202 during burnishing, primarily through a viscoelastic damping mechanism. Damper 220 is an energy absorber, that absorbs vibrational energy in a manner similar to a shock absorber. In one embodiment, damper 220 is model number SJ2396, manufactured by 3M, or an equivalent. The advantage of damper 220 is that it significantly reduces dinging of the disk by head 10.

In another embodiment, damper 220 does not comprise a polymer affixed to a constraint layer. Further, the mechanism by which damper 220 damps vibration need not be primarily viscoelastic. Rather, other materials can be affixed to load beam 202 to damp vibration of the load beam, e.g. lead tape.

While the invention has been described with respect to specific embodiments, those skilled in the art will recognize that changes can be made in form and detail without departing from the spirit and scope of the invention. For example, the body of the burnishing head can be made from appropriate hard materials other than Al_2O_3-TiC. Further, the burnishing head can be used in conjunction with a magnetic disk made from any of a number of materials. For example, the burnishing head can be used in conjunction with magnetic disks comprising a glass substrate. The pads on the burnishing head can be any desired shape. In yet another embodiment, pads are not formed on the burnishing head. Accordingly, all such changes come within the present invention.

We claim:

1. Apparatus comprising a burnishing head for burnishing the surface of a disk, said burnishing head comprising one or more pads on at least one side thereof, and a carbon layer disposed on said at least one side.



2. Apparatus of claim 1 wherein said carbon layer reduces the friction between said burnishing head and a magnetic disk during burnishing.

3. Apparatus of claim 1 wherein said burnishing head is incorporated into burnishing apparatus, said apparatus comprising a suspension for applying a normal loading force to the burnishing head against a magnetic disk, said apparatus also comprising means for rotating said magnetic disk so that said burnishing head burnishes a surface of said disk.

4. Apparatus of claim 3 wherein said disk spins between 50 and 800 ips relative to said burnishing head.

5. Apparatus of claim 3 wherein said burnishing head removes asperities and contaminants on said magnetic disk during burnishing.

6. Apparatus of claim 1 wherein said burnishing head comprises a body of a first material, and one or more pads formed on a surface of said body, said carbon layer covering said surface.

7. Apparatus of claim 1 wherein said burnishing head comprises a recess extending across a central portion of the burnishing head for reducing or eliminating an aerodynamic force that tends to push said head away from said disk.



8. A method for burnishing a surface of a disk, said method comprising:

rotating a disk; and

dragging a burnishing head along the surface of said disk during said step of rotating to thereby burnish said disk, said burnishing head comprising a body of a first material and a carbon layer formed over said body.

9. Method of claim 8 wherein said disk is rotated between 50 and 800 ips relative to said burnishing head.

10. Method of claim 8 wherein said burnishing head removes asperities and contaminants from said disk.

11. Method for manufacturing a burnishing head comprising:

forming a pattern on a surface of a body of a first material; and

forming a carbon layer on said surface of said body.

12. Method of claim 11 wherein said first material is ceramic, and said step of coating comprises vacuum depositing carbon onto said body.

13. A burnishing head comprising a set of burnishing pads, said burnishing pads extending from one edge of said burnishing head to another edge of said burnishing head, a set of channels being formed between said burnishing pads, said channels extending from one edge of said burnishing head to another edge of said burnishing head to facilitate removal of debris through said channel.



14. Burnishing head of claim 13 wherein the channels extend in a direction such that air flow caused by rotation of a disk being burnished by said head tends to blow debris through said channels toward the outside edge of said disk without entrapping said debris in said channels.

15. Burnishing head of claim 13 wherein said channels extend in a substantially linear direction across said burnishing head.

16. Burnishing head of claim 13 further comprising a recess extending across a central portion of the burnishing head for reducing or eliminating an aerodynamic force that tends to push said head away from a disk being burnished by said burnishing head.

17. Burnishing head of claim 16 wherein said disk moves relative to said burnishing head in a first direction, and said recess extends in a second direction perpendicular to said first direction.

18. Burnishing head of claim 17 wherein said pads and channels extend across said surface in a third direction between 20 and 70 degrees relative to said second direction.



19. A method for burnishing a magnetic disk comprising the steps of:

rotating said magnetic disk; and

dragging a burnishing head along the surface of said disk during said step of rotating to thereby burnish said disk, said burnishing head comprising burnishing pads extending from one edge of said burnishing head to another edge of said burnishing head, a set of channels being formed between said burnishing pads, said channels extending from a first edge of said burnishing head to another edge of said burnishing head to facilitate removal of debris through said channel.

20. Method of claim 19 wherein the side of said burnishing head facing said disk comprises a recess for reducing or eliminating an aerodynamic force that tends to push said head away from said disk.

21. Structure comprising:

a burnishing head;

a suspension holding said burnishing head, said suspension comprising a first end and a second end, said burnishing head being coupled to said first end of said suspension, the second end of the suspension being coupled to a mounting structure, said suspension comprising a damper for damping vibration of said burnishing head.

22. Structure of claim 21 wherein said suspension comprises:

a flange extending upwardly from at least one side of said suspension from a point near said first end of said suspension to a first point spaced a distance away from a second end of said suspension, the portion of said suspension between said first point and said mounting structure comprising a bending zone of said suspension; and

a damper coupled to said suspension, said damper extending from a location adjacent the first end of said suspension to a second point within said bending zone.

23. Structure of claim 22 wherein said second point is adjacent said mounting structure, and said damper comprises a polymer layer, a bottom side of said polymer layer being affixed to said suspension and a metallic layer being affixed to a top side of said polymer layer.



24. A burnishing head having a burnishing surface for burnishing disks, said burnishing surface being covered with a carbon layer.