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(71) Applicant: DIGITAL PAPYRUS CORPORATION [US/US]; Suite 440, 2025 Gateway Place, San Jose, CA 95110 (US).

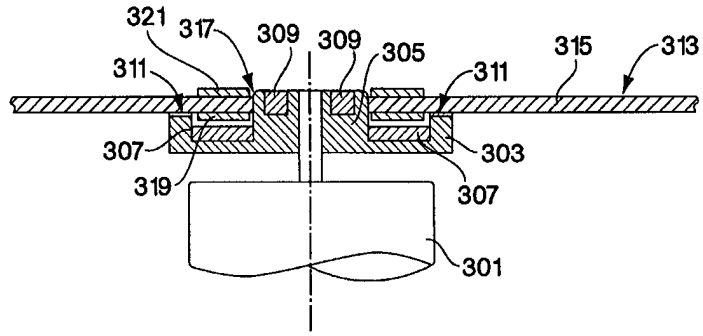
(72) Inventors: LEE, Neville, K.S.; Hong Kong University of Science and Technology, Dept. Of IEEM, Clear Water Bay, Kowloon, Honk Kong (CN). KATAO, Hisashi; 5940–2, Hino, Hino City, Tokyo 191 (JP).

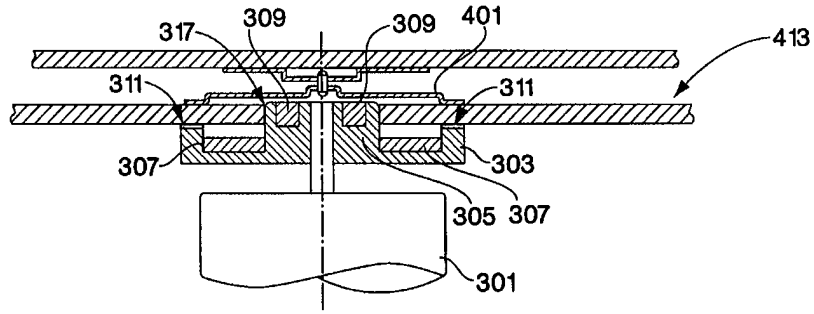
(74) Agent: ENGELSON, Gary, S.; Wolf, Greenfield & Sacks, P.C., 600 Atlantic Avenue, Boston, MA 02210 (US).

(54) Title: METHOD AND APPARATUS FOR CLAMPING REMOVABLE DATA STORAGE DISKS IN A DISK DRIVE

(57) Abstract

A disk clamping system receives two different types of removable data storage disks. Disks supported within a cartridge include a metal ring or metal segments circumferentially disposed about a centering hole. The metal is attracted to a magnet disposed in a turntable portion of a spindle, adjacent a hub portion of the spindle, so the disk is drawn down to the turntable without use of an external clamp. Disks not supported within a cartridge, or supported within a cartridge providing access for a clamp, are pressed down to the turntable by magnetic attraction between the clamp and a second magnet in the top of the hub. In both cases, magnets and metal elements can be interchanged, if so desired.





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METHOD AND APPARATUS FOR CLAMPING REMOVABLE DATA STORAGE DISKS IN A DISK DRIVE

Background

1. Field of the Invention

The present invention relates generally to methods and apparatus for clamping removable data storage disks in a disk drive.

2. Related Art

A clamping device secures a removable data storage disk in a predetermined position in a disk drive, at which position the disk is rotated for reading or writing thereon. A number of clamping devices exist that are suitable for use with removable data storage disks such as magnetic disks, magneto-optical (MO) disks, compact disks (CDs), compact disk read only memories (CD-ROMs) and digital versatile disks (DVDs). Each of these data storage disks carries information written thereon in circular or spiral tracks defined by a distance from a center point. In order to simplify data storage device design, it is desirable to rotate the disk precisely about the center point. Any offset between a center of rotation and the center point from which the track or tracks are defined gives rise to a wobble, called radial runout, which must then be followed by a read/write mechanism. Also, the track or tracks should preferably be made to consistently lie in a predetermined plane, so as to avoid requiring axial movement of the read/write mechanism to locate the track or tracks without contacting the disk in a harmful way.

In view of the above, clamping devices share two common design goals: 1) reliably center or radially position the disk for rotation about the center point from which the track or tracks are defined, so that tracks may be found and followed by a disk drive read/write mechanism; and, 2) axially position the disk reliably, so that transducer or optical elements of a read/write mechanism may be positioned relative to a surface of the disk. Figs. 1 and 2 illustrate two conventional clamping devices. Devices similar to that illustrated in Fig. 1 are commonly found in MO disk systems and devices similar to that illustrated in Fig. 2 are commonly found in CD, CD-ROM and DVD disk systems.

The device of Fig. 1 includes a spindle 101 having a shaft 103 mounted thereon. Further mounted to the shaft 103 is a turntable 105, which has a magnet 107 mounted thereto. The MO disk corresponding to this system includes an MO medium 109 (i.e., that part of the disk including a substrate, an information carrying layer, and any supporting or protective layers, as

well as possibly other layers) a hub 111 and a metal plate 113. Tracks are formed or written in the information carrying layer of the MO medium 109. In this system, axial position is reliably obtained because the magnet 107 draws the metal plate 113 toward the magnet 107, causing the MO medium 109 to tightly engage with a precision surface 106 of the turntable. However, a problem with this system arises because the hub 111 is a separate component, mounted during manufacture to the MO medium 109. The center of rotation of the MO medium 109 is determined by the engagement of the shaft 103 with the hub 111 or the metal plate 113, rather than engagement with the MO medium 109, itself. Therefore, some alignment of the hub 111 or metal plate 113 position with a center point of the tracks is typically required. Alignment processes may increase the cost of the media so constructed or may reduce the capacity thereof.

The device of Fig. 2 includes a spindle 201 having a hub 203 and a turntable 205 affixed thereto. A magnet 207 is supported in the top of the hub 203. A metal clamp 209 is supported, for example by a door 210 or other disk drive structure, above the spindle 201 and its associated components. When a disk 211 having a hole for engaging the hub 203 is loaded onto the hub 203, the clamp 209 is then lowered to a position where it is attracted to the magnet 207, axially positioning the disk 211 against a precision surface 206 of the turntable 205. Since a hole in the disk substrate, itself, engages the hub 203, more reliable centering of the disk 211 is obtained than with the device of Fig. 1. However, a problem with this system arises because the hub 203 is applied to the disk 211 from a first side of the disk 211 and the clamp 209 is applied to the disk 211 from a second side. Thus, both sides of the disk 211 must be accessible, making this system unsuitable for disks 211 supported within a cartridge having a closed surface, e.g., a closed top surface. But, a cartridge with a closed surface may be preferred for a purpose of excluding dust or other contaminants from the disk.

Summary of the Invention

According to one aspect of the invention, there is a disk clamping system, comprising a spindle having a first set of features that engage a disk centering hole and clamp the disk from only a first side and a second set of features that engage a disk centering hole from the first side and clamp the disk from a second side.

According to another aspect of the invention, there is a disk clamping system for use with a disk having a centering hole defined therethrough, wherein the centering hole has a diameter. This system includes a spindle comprising: a hub portion having a diameter that substantially

equals the diameter of the centering hole of the disk; a turntable portion defining a flat surface for supporting the disk; and a pair of magnetically attracted elements, one mounted to the disk, the magnetic attraction securely positioning the disk against the turntable portion when the hub is within the centering hole.

According to yet another aspect of the invention, there is a storage disk, comprising: a substrate; a hole defined through the substrate to engage with a centering device; and a first metal element adjacent the hole.

A method of clamping disks in a single disk drive system having a spindle comprises another aspect of the invention. The method includes steps of: engaging a disk with the spindle from one side of the disk; when the disk is of a first type, then attracting a part of the disk to the spindle; and when the disk is of a second type, then applying an external clamp to the disk engaged with the spindle, to clamp the disk thereto.

Many variations on these aspects are, of course, possible, including those with and without external clamps, magnets, metal rings, etc.

Brief Description of the Drawing

The related art and illustrative embodiments of the invention are illustrated in the accompanying drawings, in which like reference designations indicate like elements, and in which:

Fig. 1 is a cut-away elevation view of a spindle and disk according to a prior art design;

Fig. 2 is a cut-away elevation view of a spindle and disk according to another prior art design;

Fig. 3 is a cut-away elevation view of one embodiment of the invention illustrating aspects of a clamping device and one type of corresponding disk; and

Fig. 4 is a cut-away elevation view of the embodiment of Fig. 3 illustrating aspects related to a second type of disk.

Detailed Description

The present invention will be better understood upon reading the following detailed description of some embodiments thereof, in connection with the drawings.

Some general features of embodiments of the invention are first given, followed by a detailed description of the embodiment of Figs. 3 and 4. Embodiments of the invention may

include a spindle having features which cooperatively engage a centering hole of a disk to reliably center the disk. The spindle further has features which cooperate alternatively with features of the disk or with a clamp to reliably position the disk in an axial direction. A device according to the invention can properly position conventional data storage disks. Alternatively, a device according to the invention can be advantageously employed to position a data storage disk including features which cooperate with features of the spindle to reliably position the disk in an axial direction, but without using a clamp. The features included on the disk need not, however, replace or interfere with a centering hole through the recording medium portion of the disk, although they may, if so desired. Examples of a device according to one aspect of the invention, used with both a new type of data storage disk and a conventional data storage disk are shown respectively in Figs. 3 and 4.

The clamping device illustrated in Fig. 3 includes a spindle 301 which includes a turntable 303 and hub 305. Also included in this embodiment are two magnets 307, 309. One magnet 309 is embedded in the top of the hub 305 while a second magnet 307 is disposed adjacent the hub 305 but at a lower elevation than a disk supporting surface 311 of the turntable 303. Finally, Fig. 3 illustrates a disk 313 including a recording medium structure 315 with a centering hole 317 defined therethrough for engagement with the hub 305 and two metal rings 319, 321 circumscribing the hole 317. A clamping device such as shown in Fig. 3 is compatible with the requirements of both storage disks which are supported within a cartridge and storage disks which are not.

Proper sizing and tolerancing, as is known in this art, of the centering hole 317 and hub 305 achieves accurate and reliable centering of the disk 313 on the hub 305 of the spindle 301. The dimensions of the rings 319, 321 and the positions of the turntable surface 311, magnet 307 and hub 305 allow clearance therebetween, so that centering accuracy is determined by the fit between the hub 305 and hole 317, only. It should be noted that for compatibility with additional types of data storage disks, additional features can be provided, for example by adding a shaft such as used in the system of Fig. 1 to the illustrated embodiment of the invention. It is within the grasp of the skilled designer to supply the disk with either an appropriate hub adapting the disk to the turntable surface 311 or to supply the hub 305 with a second turntable surface on top of hub 305, as might be desired. That is, a portion of the top surface of the hub 305, for example including the exposed surface of the magnet 309, can be finished in a similar precision manner to the turntable surface 311.

The disk 313 shown in Fig. 3 may be supported within a cartridge giving access to only one side of the disk 313 at a time. That is, access can be provided on one side of the cartridge for entry of the hub 305 into the centering hole 317, but there need be no access provided on the other side of the cartridge to receive a clamp (209), such as in the prior art system of Fig. 2. Magnetic attraction between magnet 307 and ring 319 achieves accurate and reliable axial positioning of the disk 313, without a clamp, by drawing the disk 313 tightly down to the supporting surface 311 of the turntable 303. However, as will be seen in connection with Fig. 4, a conventional clamp can be used, for example, suspended from a disk drive door or a cartridge top member.

A number of alternative arrangements are also possible. For example rings 319 and 321 are disposed on both surfaces of the disk 313, so that the disks 313 can be loaded onto the spindle 301 with either surface facing the supporting surface 311. However, the invention can be practiced using only one ring disposed on either surface of or embedded within the structure of the disk 313. Instead of mounting the magnet 307 on the spindle and one or more metal rings 319, 321 on the disk, one or more magnets can be mounted on or embedded in the disk 313 (for example at locations 319 or 321) and a ring of metal of a type attracted to the magnet mounted on the spindle (for example at location 307). Also, the metal 319, 321 and the magnet 307 need not be rings and can be numerous other shapes. For example, the metal 319, 321 or magnet 307 or both can be segmented or otherwise shaped as convenient while geometrically suitable for generating the desired positioning and clamping forces. Finally, magnet 307 can be mounted on the spindle in any other position which achieves the above-described function.

Alternatively, as shown in Fig. 4, a conventional disk 413, unsupported by a cartridge, or supported by a cartridge giving suitable access to both top and bottom sides of the disk may be clamped using the clamping device of this embodiment. Hub 305 is inserted through centering hole 317 as previously described in connection with Fig. 3. Magnet 309, disposed in the top of hub 305 is positioned to attract a clamp 401, which may be metal or which may include a metal component, to accurately and reliably axially position the disk 413 against the supporting surface 311 of the turntable 303, in the same manner as done in the conventional system of Fig. 2. In configurations using a clamp 401, variations similar to those described above are possible. For example, one or more magnets can be incorporated into the clamp 401 while magnet 309 can be replaced with one or more pieces of metal attracted to the magnet, suitably situated. The clamp

401 and magnet 309 can be positioned in other locations at which they produce the requisite attractive force and do not interfere with magnet 307 or disks employing magnet 307.

The clamping system embodiment of Figs. 3 and 4 is particularly useful as a universal clamp for both new data storage disks configured as in Fig. 3 and conventional data storage disks configured as in Fig. 4. New disks can be supplied with or without an inexpensive protective cartridge. Conventional disks are preferably supplied in or inserted into a cartridge carrying clamp 401 (Fig. 4) inside. Alternatively, a disk drive system can include a clamp 401 (Fig. 4) which is either manually or automatically moved into position only when conventional disks are used. It is contemplated that the invention be practiced in a disk drive which accepts both rewritable data storage disks and DVD-ROM disks. The rewritable data storage disk would be constructed as shown in Fig. 3 and accommodated in a cartridge preventing simultaneous access to both surfaces of the disk. The DVD-ROM is accommodated by manual insertion into a special cartridge or caddy which includes a metal hub as shown in Fig. 4.

Rotation speed accuracy is important in large capacity data storage media. The interaction of the magnetic field in the spindle motor with other magnetic fields affects rotation speed accuracy. A magnetic shield can be mounted between the spindle motor or other magnetically sensitive devices and the clamping apparatus. The shield prevents the magnetic field from magnets in the clamping device from affecting the magnetic field inside the spindle motor. The magnetic shield may be, for example, steel, soft iron, magnet stainless steel, etc.

The present invention has been described and illustrated in connection with some embodiments thereof. Numerous variations also contemplated as within the scope of the invention should now be apparent to the skilled artisan. Therefore, the scope of the invention is not limited to the embodiments shown, but rather is defined by properly construing the following claims.

Claims

1. A clamping device in a disk drive for clamping a disk having a centering hole and a material attracted to a magnet disposed away from the centering hole, comprising:

a spindle having a first feature that enters the centering hole and clamp the disk from only a first side and a second set of features that engage a disk centering hole from the first side and clamp the disk from a second side.

2. The device of claim 1, wherein the first set of features of the spindle includes a first material which is attracted to a second material disposed adjacent the disk centering hole.

3. The device of claim 2, wherein at least one of the first and second material is a permanent magnet.

4. The device of claim 2, wherein at least one of the first and second material is ring-shaped.

5. The device of claim 2, wherein the second set of clamping features further comprises:

a clamp that contacts the disk from the second side.

6. The device of claim 3, wherein the spindle comprises:

a hub defined on the spindle that is adapted to the centering hole in the disk; and

a turntable defined on the spindle, the turntable defining a flat surface for supporting the disk;

wherein the permanent magnet is located on the spindle adjacent the hub.

7. The device of claim 6, wherein the permanent magnet is ring-shaped.

8. The device of claim 5, wherein at least one of the clamp and the spindle further comprises:

a second magnet located in a position to attract the clamp toward the top of the hub.

9. A disk clamping system comprising:

a spindle including

a hub having a diameter; and

a turntable defining a support surface;

a disk including

a centering hole defined therethrough, having a diameter substantially equal to the diameter of the hub; and

a pair of magnetically attracted elements, one mounted to the disk spaced from the centering hole and one mounted to the spindle, the magnetic attraction securely positioning the disk against the turntable when the hub is within the centering hole.

10. The disk clamping system of claim 9, wherein the element mounted to the disk is a metal ring.

11. The disk clamping system of claim 9, further comprising:

a magnet located in the hub; and

a metal clamp disposed in a position to press a disk against the turntable portion when attracted to the magnet.

12. The disk clamping system of claim 9, further comprising a magnetic shield positioned to prevent a magnetic field from the pair of magnetically attracted elements interfering with a proximally mounted magnetically sensitive device.

13. A storage disk, comprising:

a substrate;

a hole defined through the substrate to engage with a centering device; and

a first metal element spaced from the hole.

14. The disk of claim 13, further comprising a second metal element spaced from the centering hole, the first and second metal elements disposed on opposite surfaces of the substrate.

15. The disk of claim 14, in combination with a cartridge that houses the disk and prevents simultaneous access to both surfaces of the substrate.

16. A method of clamping disks in a single disk drive system having a spindle, comprising steps of:

engaging a disk with the spindle from one side of the disk;

when the disk is of a first type, attracting a part of the disk to the spindle; and

when the disk is of a second type, applying an external clamp to clamp the disk to the spindle.

17. The method of claim 16, wherein the step of applying the external clamp further comprises:

attracting the clamp to the spindle.

18. The method of claim 16, further comprising a step of:

supporting the disk in a cartridge.

19. A spindle for use with a disk having a centering hole therethrough, the spindle comprising:

a hub positioned to engage the centering hole;

a turntable which supports the disk at a predetermined elevation; and

means cooperative with a part of the disk spaced from the centering hole for securing the disk to the means for supporting.

20. The spindle of claim 19, wherein the means for securing is a magnet.

21. The spindle of claim 20, further comprising:

a clamp having a clamping surface positioned opposite the turntable;

means cooperative with the clamp for clamping the disk to the turntable.

22. The spindle of claim 20, wherein the means for securing engages the part of the disk at all rotational positions of the disk relative to the spindle.

23. The spindle of claim 20, further comprising a magnetic shield positioned to prevent a magnetic field from the pair of magnetically attracted elements interfering with a proximally mounted magnetically sensitive device.

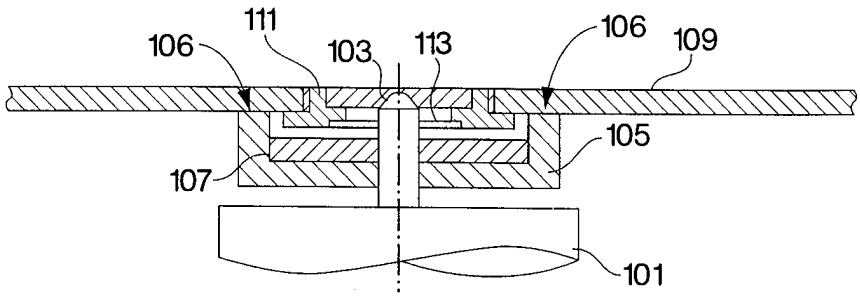

Fig. 1
(Prior Art)

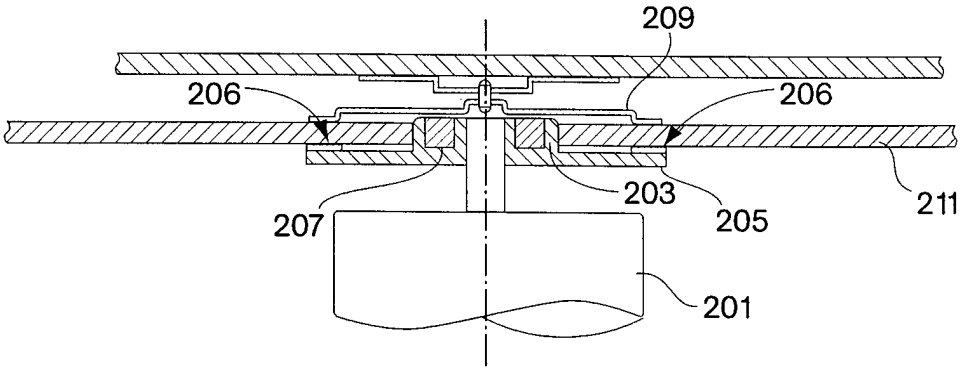

Fig. 2
(Prior Art)

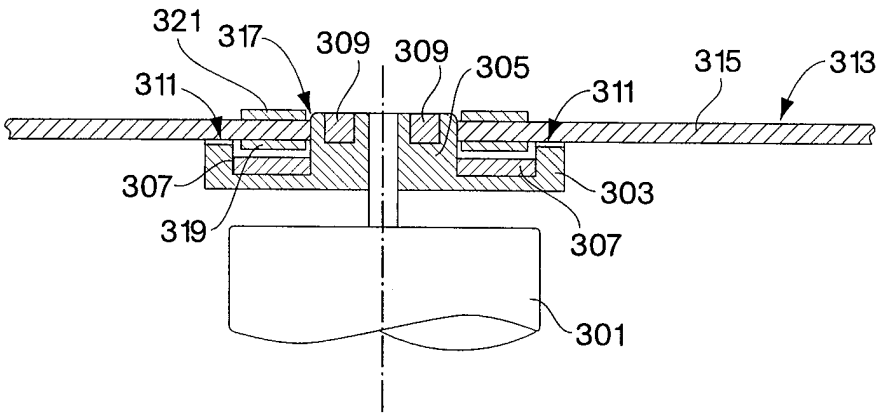
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Fig. 3

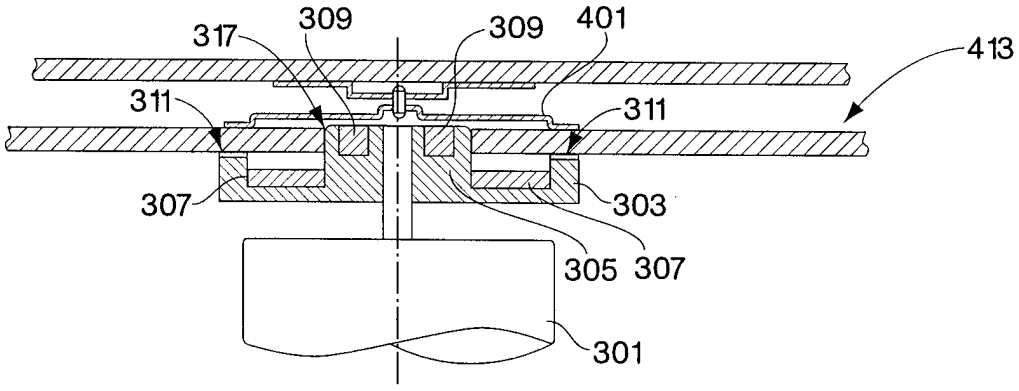
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Fig. 4

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G11B17/028 G11B17/04 G11B19/20 G11B23/00

According to International Patent Classification(IPC) or to both national classification and IPC

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Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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