

Description

Technical Field of the Invention

This invention relates in general to optical storage disk devices, and in particular to a method and apparatus for simultaneously reading both sides of an optical storage disk.

Background of the Invention

The use of optical storage disks for the recording of data has become a frequently used option. Data can be stored on a top and bottom side of the optical storage disk to increase the storage capacity of the disk. However, unlike magnetic storage disk readers, optical storage disk readers generally do not allow simultaneous reading of both sides of an optical storage disk. In those few devices allowing both sides of an optical disk to be read simultaneously, the device is generally a fixed media device capable of using only fixed disks.

In order to increase on-line data capacity and shorten the transfer time of data stored on an optical storage disk, it is desirable to store the data on both sides of a single disk (including the use of such methods as the "interleaving" of data). Thus, as optical readers simultaneously pass over both sides of the disk, the information stored thereon may be read in such a fashion as to allow twice the amount of data to be retrieved in the same time as normally required to read one side.

With optical storage disk readers, it is essential to keep the beam of light used to read and/or imprint the disk perpendicular to the surface thereof. The spot from the beam on the disk degrades (for optical reasons) as the beam varies from a perfectly perpendicular orientation. Thus, in a double side reader, it is necessary to provide a device that can maintain the vertical relationship between both sides of an optical disk and the optical readers associated therewith.

One attempt to utilize both sides of an optical storage disk is disclosed in U.S. Patent No. 4,387,452, to Bricot, et al., June 7, 1983. The Bricot patent discloses the use of optical readers/recorders capable of simultaneously reading/recording on oppositely facing sides of two separate optical storage disks. The Bricot invention requires the use of an intricate optical device capable of adjustably focusing on the surface of the disk. A plurality of optical storage disks are stacked with the optical reading/recording devices between the disks for reading of the opposite faces. The Bricot method requires the use of two separate disks for the utilization of the space on two sides of a disk. Therefore, it is necessary to record the data on sets of disks rather than on a single disk.

Another device designed to attempt to read both sides of an optical storage disk is disclosed in U.S.

Patent No. 4,271,489, to Siryj et al., June 2, 1981, and U.S. Patent No. 4,286,790, to Siryj et al., September 1, 1981. The Siryj devices use optics such as are disclosed in U.S. Patent No. 4,097,895, to Spong, June 27, 1978, and U.S. Patent No. 4,300,226, to Barnette et al., November 10, 1981. The optics in Barnette and Spong are capable of focusing on the surface of a disk which has discontinuities thereon from varying thicknesses of the surface coating material in the range of 3 mils (0.076 mm). Spong and Barnette do not take into consideration and are not capable of adjusting to disks having a thickness that varies beyond the minute surface discontinuities.

Document EP-A-0327033 discloses an apparatus for simultaneously reading both sides of a storage disk comprising first and second optical scanning units positioned about opposite sides of the disk and respectively associated with first and second focusing means having each a given focusing range.

Unfortunately, optical storage disks can typically vary in thickness from approximately 2.75 mm to approximately 3.50 mm. These thickness variations are due to the disk construction by various manufacturers and the coatings which are applied thereto for the recording of data. Thus, in order to properly read both sides of a single disk which varies in thickness, it is necessary to have optical devices capable of adjustably focusing on each surface while maintaining a perpendicular relationship to both sides. Heretofore, it has been too difficult and/or expensive to provide a device capable of sufficient focusing adjustment to compensate for the varying thicknesses of optical storage disks. Thus, there is a need for a method and apparatus capable of simultaneously focusing on both sides of a single optical storage disk of varying thickness for simultaneous reading of the two sides.

Summary of the Invention

The present invention disclosed herein and defined in the claims 1 and 21 describes a method and apparatus for simultaneously reading both sides of an optical storage disk which eliminates or substantially reduces problems associated with prior optical storage disk reading devices. The present invention allows the simultaneous reading of both sides of disks that vary in thickness without the need for relatively expensive optical mechanisms.

In accordance with one aspect of the invention, an optical storage disk encased within a cartridge is inserted into an optical reading device. Channels are provided for holding the cartridge in a fixed position relative to the storage disk by the case containing the optical reading device. A lower base plate including a spindle and a drive motor for rotating the disk is moved into position so that the optical disk is fixed parallel to and a known distance from the lower base plate. Simultaneously, an upper base plate is posi-

tioned parallel to the lower base plate and at a predetermined distance therefrom corresponding to the proper focal distance to the thinnest optical storage disk available. From this point, optics associated with the upper base plate provide data that allow the upper base plate to move to the proper focal distance from the disk. While the upper plate moves, the lower plate also moves to maintain the parallel orientation between the lower base plate, the optical storage disk and the upper base plate.

Once the base plates have moved to the proper position for focusing of the upper optics (the lower optics are in focus based on the fixed distance between the lower optics and the lower surface of the optical storage disk), the upper and lower optical reading devices are moved radially with respect to the disk along slides to allow reading thereof.

The upper and lower base plates are positioned by being raised or lowered as they pivot about hinges. Each base plate is hinged on one edge to the optical reading device case in opposite arrangements, and each is attached at a second edge to a yoke which is, in turn, interconnected through a follower nut to a lead screw. As the lead screw is turned by a motor, the follower nut travels therealong causing the yoke to pivot the base plate up and down about the hinges.

The optics provided for reading the upper and lower sides of the disk are of a type having a fixed focal length and are supported by a pair of parallel flexures. The flexures are surrounded by an electrical coil which may be charged to attract the parallel flexures, causing the optics to move toward or away from the optical disk surface. Due to the adjustability of the parallel base plates, it is possible to position the optics at a distance equal to their focal length from each surface of the optical storage disk. This allows the optics to be positioned in the center of their adjustable travel and movement thereof is only required to compensate for disk surface incongruities rather than for thickness variations.

It is a technical advantage of the present invention that both sides of an optical storage disk may be read simultaneously allowing on-line data to be doubled and data transfer time to be cut in half. It is a further technical advantage of the present invention that fixed focal length optics may be used while maintaining the ability to focus on the surface of the optical disk. It is a still further technical advantage of the present invention that a variety of optical disks may read on an interchangeable basis.

Brief Description of the Drawings

For a more complete understanding of the present invention and for further advantages thereof, reference is now made to the following Detailed Description taken in conjunction with the accompanying Drawings in which:

Fig. 1 is an isometric view of an optical disk reader constructed in accordance with the preferred embodiment of the present invention;

Fig. 2 is an isometric view of an optical disk reader of the present invention with an optical disk cartridge inserted therein;

Fig. 3 is a partially cut away isometric view of the optical disk reader and optical disk cartridge of the present invention;

Fig. 4 is a sectional view along the line 4-4 of Fig. 3;

Fig. 5 is a top plan view along the line 5-5 of Fig. 4;

Fig. 6 is a sectional view taken along the line 6-6 of Fig. 5;

Fig. 7 is a sectional view taken along the line 7-7 of Fig. 5;

Fig. 8 is a cross-sectional view along the line 8-8 of Fig. 6;

Fig. 9 is an isometric view of both lead screw assemblies of the present invention; and

Figs. 10, 11 and 12 are representations of the inter-relationship between the lead screws and the yokes in various operating positions.

Detailed Description of the Invention

In Figs. 1-12, like items are identified by like and corresponding numerals for ease of reference. Referring first to Fig. 1 an isometric view of an optical storage disk reading apparatus constructed in accordance with the preferred embodiment of the present invention is generally identified by the reference numeral 10. The reading apparatus 10 comprises a storage case 12 for containing the devices to simultaneously read both sides of an optical storage disk 44 (See Fig. 7), as will be subsequently described in greater detail. The case 12 has an opening slot 13 for receiving an optical storage disk cartridge 46 within receiving channels 48 and 50. A hinged door (not shown) may be provided for closing the opening slot 13 when the apparatus 10 is not in use. A power and control strap 15 extends from the case 12 for connection to other appropriate devices, not shown.

Referring to Fig. 2, the apparatus 10 is shown with an optical storage disk cartridge 46 inserted into the case 12. As can be appreciated, the cartridge 46 is fixed in position relative to the case 12 by the receiving channels 48 and 50. Thus, it is possible to reposition the optical storage disk 44 within the cartridge 46 without moving the cartridge 46, as will be subsequently described in greater detail.

Referring to Fig. 3, a more detailed, partially cut-away isometric view of the apparatus 10 is shown. Within the storage case 12 is positioned an upper base plate 14 and a lower base plate 16. The upper and lower base plates 14-16 are constructed essentially the same except that the lower base plate 16 is

provided with a disk drive motor 18 and a disk drive spindle 20 (Fig. 4).

The upper and lower base plates 14-16 are each provided with a pair of hinges 22-24 and 26-28, respectively (hinges 26 and 28 shown in Fig. 5). The hinges 22-28 pivotally connect the upper and lower base plates 14-16 to a frame 19 within the case 12. Each base plate 14-16 is matched with a lead screw 30 or 32, respectively (lead screw 32 shown in Fig. 5). Lead screw 30 is provided with a follower nut 34, and lead screw 32 is provided with a follower nut 36, each of which are driven by separate stepper motors 38 and 39 (follower nut 36 and motor 39 shown in FIG. 5). The follower nuts 34-36 are connected to their respective base plates 14-16 by yokes 40 and 42.

As the stepper motors 38 and 39 turn the lead screws 30-32, the follower nuts 34-36 travel therealong causing the appropriate yoke 40-42 to raise or lower the attached base plates 14-16. Thus when the cartridge 46 is inserted into the reading apparatus 10 along the receiving channels 48 and 50, the upper and lower base plates 14-16 are pivotally adjusted by their respective motors 38 and 39. The base plates 14-16 are pivotally adjusted until the disk 44 is at the proper focal distance from optics associated with each base plate 14-16, as will be subsequently described in greater detail. The motors 38 and 39 are geared to allow manual rotation of the lead screws 30-32 should the need arise such as during a loss of power. The motors 38 and 39 are also designed to remain engaged to act as a brake to prevent unwanted movement of the base plates 14-16 once they are properly positioned.

Referring to Fig. 4, a sectional view is shown of the apparatus 10 along the line 4-4 of Fig. 3. The frame 19 is separated from the case 12 by shock mounts 21. The drive motor 18 depends downwardly from the lower base plate 16. The spindle 20 protrudes through the cartridge 46 into contact with the disk hub means 63 (see Fig. 7) for rotational drive thereof. The hub means 63 may be held by any appropriate means, such as magnetically, and torque may be applied thereto by a pin, not shown. A protrusion 23 depends downwardly from the upper base plate 14 opposite the spindle 20 to prevent damage to optics associated with each plate 14-16 by the disk 44. If the apparatus 10 were bumped hard enough to cause the disk 44 to momentarily move off the spindle 20, the protrusion 23 would prevent excessive wobble of the disk 44 by coming into contact with a hub means 63 (FIG. 7) fixed thereto.

The hinge 22 is pinned to the frame 19 through a bracket 25 while the hinge 26 is similarly pinned through a bracket 27. The yoke 40 is pivotally attached to the upper base plate 14 through an extension bracket 29, as will be subsequently described in greater detail. The receiving channels 48 and 50 are secured to the frame 19 by means, not shown, to fix

their position relative thereto.

Referring to Fig. 5, a top plan view of the apparatus 10 is shown with the upper base plate 14 removed for the sake of clarity. Fixed to an upper surface 64 of the lower base plate 16 is an optical reader 54, guide rails 58 and an optical transmitter/receiver assembly generally indicated by the reference numeral 62. The guide rails 58 are constructed and arranged to allow the optical reader 54 to move radially with respect to the optical storage disk 44. The reader 54 will move radially along the rails 58 in response to a signal from a controller (not shown) to read all the data on the surface of the disk 44.

The optical transmitter/receiver 62 is positioned at an end of the guide rails 58 opposite the spindle 20 to allow an infra-red laser 66 to direct a laser beam (not shown) at the optical reader 54. The laser beam is collimated by appropriate lenses such as a lens 67 and passed to a beam splitter 75. The beam splitter 75 has a polarizing screen 77 which deflects the laser beam toward the reader 54. Before reaching the reader 54, the laser beam passes through a quarter wave plate 85 which converts the linearly polarized beam into a circularly polarized beam for use by the optical reader 54, as will be subsequently described in greater detail.

Upon returning from the disk 44 and the reader 54, the laser beam again passes through the wave plate 85 and is reconverted into a linearly polarized beam. Now, however, upon striking the beam splitter 75 and the polarizing screen 77, the laser beam is passed through the screen 77 due to the two quarter wave changes from the plate 85 rather than deflected therefrom. After passing through the beam splitter 75, the laser beam is deflected through a toroidal lens (not shown) and into a detector means 87. The detector means 87, which may include, for example, a quad detector as is well known in the art, determines whether the optical reader 54 is correctly focused on the disk 44. Since the disk 44 is fixed at the proper focal length from the optical reader 54, the detector means 87 will only provide data to the optical reader 54 to make focusing adjustments, as will be subsequently described, to compensate for surface irregularities on the disk 44. The detector means 87 also includes a photodetector, for example, such as is disclosed in U.S. patent No. 4,097,895, to Spong, June 27, 1978, capable of interpreting the data on the disk 44.

The optical reader 54 is provided with mirror means 89 (Fig. 7) to deflect the laser beam from the laser 66 into an optical lens 70. The lens 70 focuses the deflected laser beam onto the reading surface of the optical storage disk 44. The reader 54 moves generally perpendicular relative to upper surface 64 of the lower plate 16 about a pair of parallel flexures 72, only one of which is shown. The parallel flexures 72 are encircled by a wire coil 74 which may magnetically

attract the flexures 72 to pull the lens 70 closer to or farther away from the optical storage disk 44. Thus, it is possible to refocus the lens 70 in response to any surface irregularities that may be present on the optical disk 44. As previously indicated above, the optical storage disk 44, when placed upon the spindle 20, is positioned parallel to and at a fixed distance from the lower base plate 16. The fixed distance is based upon the focal distance of the lens 70 from the center position of its perpendicular travel about the flexures 72. By positioning the optical disk 44 at this distance from the lens 70, the full refocusing range of the lens 70 is available to compensate for any surface irregularities.

Fixed to the frame 19 on opposite sides of the lower base plate 16 are the lead screws 30 and 32. The lead screw 32 provides pivotal raising and lowering motion for the lower base plate 16, and the lead screw 30 provides the same motion for the upper base plate 14. The lead screw 32 is driven by the stepper motor 39 and has a follower nut 36 which travels therealong. The lower base plate 16 is connected to the follower nut 36 by the yoke 42. As shown in Fig. 5, the lead screws 30-32 are each driven independently by separate stepper motors 38 and 39 due to different dimensions of the yokes 40-42 which are necessitated by the positioning of the base plates 14 and 16 relative thereto. As previously stated above, the stepper motors 38 and 39 are continuously driven to act as brakes to prevent unwanted movement of the plates 14-16 once they are properly positioned.

Referring to Fig. 6, a sectional view taken along the line 6-6 of Fig. 5, is illustrated. The relationship between the optical storage disk 44, the lower base plate 16 and the upper base plate 14 may be seen more clearly. As previously stated above, the optical storage disk 44 is fixed parallel to and at a known distance from the lower base plate 16 through the spindle 20. Thus, it can be seen that although the lower base plate 16 may pivotally move as indicated by an arrow 78, about the hinges 26 and 28 by the action of the yoke 42 and follower nut 36, the relationship between the lower base plate 16 and the disk 44 remains fixed, even though the cartridge 46 is fixed in position by the channels 48 and 50. Therefore, there must be sufficient space between the cartridge 46 and the disk 44 to allow the disk 44 to change its position relative thereto as the lower base plate 16 moves.

While the lower base plate moves along arrow 78, the upper base plate 14 pivotally moves as indicated by an arrow 79. As can be appreciated, the lower base plate 16 will move in one direction along arrow 78 and the upper base plate 14 will move in an opposite direction along arrow 79 to maintain the parallel relationship therebetween, as will be subsequently described in greater detail.

Referring to FIG. 7, a sectional view taken along

the line 7-7 of FIG. 6 is shown. The optical storage disk 44 contained within the cartridge 46 is slidably inserted into the reading apparatus 10 along the receiving channels 48 and 50. The disk 44 may be of varying thicknesses, for example, from 2.75mm to 3.50 mm. Optical readers 52 and 54 are slidably positioned along guide rails 56 and 58, respectively. Within each optical reader 52-54, there is a plurality of optical devices which are well known in the art to enable the optical storage disk 44 to be read, as will be subsequently described in greater detail. Fixed to the base plates 14-16 are optical transmitter/receivers 60 and 62, respectively, which are fixed in position relative to the optical readers 52-54. As the disk 44 is rotated about a central vertical axis, the readers 52-54 slide within the guide rails 56-58, traversing a radius of the optical storage disk 44 and reading the data thereon.

When the cartridge 46 containing the optical storage disk 44 is inserted into the receiving channels 48-50, each base plate 14-16 initiates an engagement sequence. During the engagement sequence, the lower base plate 16 is positioned to insert the spindle 20 into a receiving hole 116 in a central disk hub means 63 which securely holds the optical storage disk 44. The central hub means 63 is interconnected to the disk by means not shown and rests upon drive means associated with the lower base plate 16, as will be subsequently described in greater detail. The storage disk 44 is thus positioned parallel to and at a fixed distance from an upper surface 64 of the lower base plate 16. Simultaneously, the upper base plate 14 is lowered to a predesignated position which is determined by the thickness of the thinnest storage disk available. Thus, the optical reader 54 for the lower base plate 16 is positioned at the proper focal length from the disk 44, but the optical reader 52 for the upper base plate 14 is likely not yet properly positioned. The sequence for properly positioning the upper base plate 14 to place the optical reader 52 at the proper focal distance from the disk 44 will be subsequently described in greater detail.

The distance between the disk 44 and the lower base plate 16 is predetermined and set equal to the focal length of the lens 70 in the optical reader 54 when the lens 70 is in the center of its travel (or focusing range) about flexures 72. In order to compensate for variations in the surface of the disk 44 as well as any possible wobble thereof, the lens 70 and the mirror means 89 may move vertically up or down relative to the disk 44 as indicated by an arrow 80 due to the coil 74. The coil 74 acts as a magnet to attract the metallic material of the flexures 72 thus pulling or pushing the lens 70 and the mirror means 89 farther from or closer to the disk 44 along its vertical travel 80 due to any slight distance variations therebetween.

The distance between the disk 44 and the upper base plate 14 is also determined by a focal length of

lens 71 in mirror means 69 of the optical reader 52. In an important aspect of the present invention, unlike the lower plate 16 the distance from the lens 71 to the disk 44, is not preset or fixed due to a need to compensate for the various thicknesses available for optical storage disks. Thus, as previously described above, the upper base plate 14 is positioned during the engagement sequence parallel to and at a distance from the disk 44 equal to the focal length of the lens 71 to the surface of the thinnest available disk (i.e., at the closest distance therefrom). Subsequently, the optical transmitter/receiver 60 provides a signal to the stepper motor 39 (in the same fashion as previously described with respect to the receiver 62 and its detector means 87) to pivot the upper base plate 14 to a position in which the disk 44 is focused with the lens 71 and the mirror means 69 in the center of their vertical travel about parallel flexures 73. As the upper base plate 14 is pivoted, the lower base plate 16 is also pivoted in an opposite direction in order to maintain the parallel relationship between the upper base plate 14, the disk 44 and the lower base plate 16. Therefore, the disk 44 is positioned at the proper focal length from the upper base plate 14 and the lower base plate 16 to allow simultaneous reading of both sides thereof.

The optical readers 52-54 move radially with respect to the disk 44 along the guide rails 56 and 58, respectively, as indicated by arrows 106 and 108. Thus, as the disk 44 is rotated about the spindle 20 by the drive motor 18, the optical readers 52-54 scan the surface of each side of the disk 44.

Although not shown, it is to be understood that the cartridge 46 has window portions therethrough to allow the lens 70-71 to be actually positioned there-within. Since the lens 70-71 are within the cartridge 46 during the scanning or reading of the disk 44, it is necessary to ensure they are fully removed therefrom before attempting to pull the cartridge 46 from the apparatus 10. Therefore, during an unloading sequence, the base plates 14 and 16 must be pivoted sufficiently to remove the lens 70-71 from the windows in the cartridge 46. In the case of the upper base plate 14, it has been found that an upward pivoting movement of 2 degrees relative to horizontal is sufficient to remove the lens 71. However, the lower base plate 16 must be downwardly pivoted at least 5 degrees relative to horizontal in order to completely disengage the spindle 20 as well as to remove the lens 70. The cartridge 46 may then be removed and the base plates 14-16 are positioned to begin another engagement sequence upon insertion of a new cartridge. As previously described above, the protrusion 23 prevents damage to the optical readers 52-54 if the disk 44 were to wobble excessively.

Referring to Fig. 8, a more detailed isometric view of the lead screws 30 and 32 is shown. In Fig. 8, it can be seen that the lead screws 30 and 32 are fixed by

any appropriate method such as screws 122 to a portion of the frame 19 through brackets 82 and 84, respectively. Although the following discussion refers to the lead screw 32, the same description applies to the lead screw 30 with the appropriate reference number changes.

The lead screw 32 is driven by the stepper motor 39 which is powered by a source (not shown) through the power and control strap 15 (Fig. 1). As the stepper motor 39 turns the lead screw 32, the follower nut 36 travels therealong as indicated by an arrow 86. As the follower nut 36 travels along the lead screw 32, the yoke 42 which is pivotally attached to the nut 36 by pins 88 travels therewith. The yoke 42 is pivotally attached to the lower base plate 16 through a bracket 110 by pin and bearing means 90. The pin and bearing means 90 allows the yoke 42 to have limited two-dimensional movement thereabout needed to push or pull the lower base plate 16 in what is actually an arcuate path necessitated by the cooperating arrangement of parts. Thus, as the lead screw 32 is turned by the stepper motor 39, the follower nut 36 drives the yoke 42 which in turn causes the lower base plate 16 to move generally up and down as indicated by the arrow 78.

A pin 120 is fixed to the lower base plate 16 to protrude upwardly toward the base plate 14 as a cartridge lock. The different dimensions previously mentioned for the yokes 40 and 42 are more clearly shown in Fig. 8. The yoke 40 has a shorter connector 124 than a connector 126 on the yoke 42 due to the positioning of each lead screw 30-32 with reference to their respective base plates 14-16.

Referring to Figs. 9A-C, 10A-C and 11A-C, the interrelationship between the base plates 14-16, the yokes 40-42 and the lead screws 30-32 is illustrated. Referring first to Figs. 9A, 10A and 11A, the stepper motors 38 and 39 have each driven the lead screws 30-32 to place the follower nuts 34-36 at their extreme positions closest to the stepper motors 38 and 39.

In FIG. 9A, since the yoke 40 is attached at a first end 111 to the follower nut 34 and at a second end 113 to the upper base plate 14 by a bracket 109, as the first end 111 moves in a direction indicated by an arrow 91, the second end 113 moves generally in a direction as indicated by an arrow 93. Thus, the upper base plate 14 is positioned in its uppermost position in which a distance G₁ (defined as the distance from the storage case 12 to a bottom surface 124 of the upper base plate 14) has its greatest value.

Similarly, in Fig. 11A, the yoke 42 is attached at a first end 112 to the follower nut 36 and at a second end 114 to the lower base plate 16 by the bracket 110. As the first end 112 moves in a direction indicated by an arrow 92, the second end 114 moves generally in a direction as indicated by an arrow 94 (opposite the direction of arrow 93). Thus, the lower base plate 16

is positioned in its lowermost position in which a distance H_1 (defined as the distance from the storage case 12 to a bottom surface 65 of the lower base plate 16) has its smallest value. Therefore, in Fig. 10A, a distance J_1 (defined as the distance between the upper base plate 14 and the lower base plate 16) has its greatest value. The distance J_1 represents the spacing required between the plates 14 and 16 when loading and unloading the cartridge 46.

Referring to Figs. 9B, 10B and 11B, the stepper motors 38 have turned the lead screws 30-32 to move the follower nuts 34-36 to their extreme positions distal the stepper motors 38 and 39. The yokes 40-42 are now in approximately vertical orientations.

In Fig. 9B, it can be seen that as the first end 111 of the yoke 40 travels in a direction as indicated by an arrow 95, the second end 113 of the yoke 40 moves generally in a direction as indicated by an arrow 97. Thus, the upper base plate 14 is positioned where a distance G_2 has its lowest value (i.e., G_2 is less than G_1).

In Fig. 11B, as the first end 112 of the yoke 42 travels in a direction as indicated by an arrow 96, the second end 114 of the yoke 42 moves generally in a direction as indicated by an arrow 98 (opposite the direction of arrow 97). Thus, the lower base plate 16 is positioned where a distance H_2 has its greatest value (i.e., H_2 is greater than H_1). Therefore, in Fig. 10B, a distance J_2 has its lowest value representing the positioning immediately after the initiation sequence as previously described above with the plates 14 and 16 parallel to each other.

Referring to Figs. 9C, 10C and 11C, the stepper motors 38 and 39 have turned the lead screws 30-32 to drive the follower nuts 34-36 to intermediate positions along the lead screws 30-32. Thus, in Fig. 9C, the first end 111 of the yoke 40 moves in a direction indicated by an arrow 99 while the second end 113 moves generally in a direction indicated by an arrow 101. This causes the upper base plate 14 to move to a position where a distance G_3 is less than G_1 but greater than G_2 .

Referring to Fig. 11C, the first end 112 of the yoke 42 moves in a direction indicated by arrow 100 while the second end 114 moves generally in a direction indicated by arrow 102 (opposite the direction of arrow 101). This causes the lower base plate 16 to move to a position where the distance H_3 is less than the distance H_2 but greater than the distance H_1 . Thus, in Fig. 10C, a distance J_3 has a value less than J_1 , but greater than J_2 representing one possible operating position. Thus, the upper plate 14, the lower plate 16 and the optical disk 44 are all parallel to each other for simultaneous reading of both sides of the disk 44.

As indicated by the dashed line 103 passing through a pin and bearing means 126 associated with upper base plate 14 and the dashed line 104 through the pin and bearing means 90 associated with the

lower plate 16 in each of Figs. 9A-C and 11A-C, it can be seen that the pins 126 and 90 are always in the same vertical axis. Thus, as the yokes 40-42 are moved by the follower nuts 34-36, the base plates 14 and 16 must pivot in opposite directions about the hinges 22-24 and 26-28, respectively. When the base plates 14-16 are in positions in which the distance from the storage case 12 is equal to G and H , the base plates 14-16 are in position for loading or unloading the cartridge 46.

As the cartridge 46 is inserted into the apparatus 10, the stepper motors 38-39 drive the follower nuts 34-36 to the positions indicated in Figs. 9B and 11b in which the distances between the base plates 14-16 and the storage case 12 are equal to G_2 and H_2 . In this closest position, the optics associated with the upper base plate 14 can then determine whether the optical storage disk 44 is in focus and make appropriate adjustments as required.

In Figs. 9C, 10C and 11C, for example, appropriate adjustments have been made, positioning the upper base plate 14 at the proper distance from the optical storage disk 44 to place the optics in focus. Since the lower base plate 16 was already in focus at a fixed distance from and parallel to the optical storage disk 44, the apparatus 10 may now read both sides of optical storage disks that vary in thickness, thus cutting information transfer time in half compared with a device that reads only one side at a time.

Claims

1. Apparatus (10) for simultaneously reading both sides of a storage disk (44) having a variable thickness, comprising first and second optical scanning units positioned about opposite sides of the disk and respectively associated with first and second focusing means, each of said focusing means having a focusing range, characterized by the presence of means for positioning the disk (44) between said first and second optical scanning units wherein said first and second optical scanning units are parallel to and at a focal distance from the respective side of the disk and wherein said first and second focusing means are focused on their respective side of the disk and kept in a center of said focusing range irrespective of the thickness of the disk.
2. Apparatus of Claim 1, characterized in that the focusing means comprise at least one flexure (72) attached to an optical mirror means and an electric coil (74) encircling said flexure to cause said flexure to be magnetically attracted thereto allowing a lens (70) to move closer to or farther from the disk (44) through said focusing range.

is positioned in its lowermost position in which a distance H_1 (defined as the distance from the storage case 12 to a bottom surface 65 of the lower base plate 16) has its smallest value. Therefore, in Fig. 10A, a distance J_1 (defined as the distance between the upper base plate 14 and the lower base plate 16) has its greatest value. The distance J_1 represents the spacing required between the plates 14 and 16 when loading and unloading the cartridge 46.

Referring to Figs. 9B, 10B and 11B, the stepper motors 38 have turned the lead screws 30-32 to move the follower nuts 34-36 to their extreme positions distal the stepper motors 38 and 39. The yokes 40-42 are now in approximately vertical orientations:

In Fig. 9B, it can be seen that as the first end 111 of the yoke 40 travels in a direction as indicated by an arrow 95, the second end 113 of the yoke 40 moves generally in a direction as indicated by an arrow 97. Thus, the upper base plate 14 is positioned where a distance G_2 has its lowest value (i.e., G_2 is less than G_1).

In Fig. 11B, as the first end 112 of the yoke 42 travels in a direction as indicated by an arrow 96, the second end 114 of the yoke 42 moves generally in a direction as indicated by an arrow 98 (opposite the direction of arrow 97). Thus, the lower base plate 16 is positioned where a distance H_2 has its greatest value (i.e., H_2 is greater than H_1). Therefore, in Fig. 10B, a distance J_2 has its lowest value representing the positioning immediately after the initiation sequence as previously described above with the plates 14 and 16 parallel to each other.

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Referring to Fig. 11C, the first end 112 of the yoke 42 moves in a direction indicated by arrow 100 while the second end 114 moves generally in a direction indicated by arrow 102 (opposite the direction of arrow 101). This causes the lower base plate 16 to move to a position where the distance H_3 is less than the distance H_2 but greater than the distance H_1 . Thus, in Fig. 10C, a distance J_3 has a value less than J_1 , but greater than J_2 representing one possible operating position. Thus, the upper plate 14, the lower plate 16 and the optical disk 44 are all parallel to each other for simultaneous reading of both sides of the disk 44.

As indicated by the dashed line 103 passing through a pin and bearing means 126 associated with upper base plate 14 and the dashed line 104 through the pin and bearing means 90 associated with the

lower plate 16 in each of Figs. 9A-C and 11A-C, it can be seen that the pins 126 and 90 are always in the same vertical axis. Thus, as the yokes 40-42 are moved by the follower nuts 34-36, the base plates 14 and 16 must pivot in opposite directions about the hinges 22-24 and 26-28, respectively. When the base plates 14-16 are in positions in which the distance from the storage case 12 is equal to G and H , the base plates 14-16 are in position for loading or unloading the cartridge 46.

As the cartridge 46 is inserted into the apparatus 10, the stepper motors 38-39 drive the follower nuts 34-36 to the positions indicated in Figs. 9B and 11b in which the distances between the base plates 14-16 and the storage case 12 are equal to G_2 and H_2 . In this closest position, the optics associated with the upper base plate 14 can then determine whether the optical storage disk 44 is in focus and make appropriate adjustments as required.

In Figs. 9C, 10C and 11C, for example, appropriate adjustments have been made, positioning the upper base plate 14 at the proper distance from the optical storage disk 44 to place the optics in focus. Since the lower base plate 16 was already in focus at a fixed distance from and parallel to the optical storage disk 44, the apparatus 10 may now read both sides of optical storage disks that vary in thickness, thus cutting information transfer time in half compared with a device that reads only one side at a time.

Claims

1. Apparatus (10) for simultaneously reading both sides of a storage disk (44) having a variable thickness, comprising first and second optical scanning units positioned about opposite sides of the disk and respectively associated with first and second focusing means, each of said focusing means having a focusing range, characterized by the presence of means for positioning the disk (44) between said first and second optical scanning units wherein said first and second optical scanning units are parallel to and at a focal distance from the respective side of the disk and wherein said first and second focusing means are focused on their respective side of the disk and kept in a center of said focusing range irrespective of the thickness of the disk.
2. Apparatus of Claim 1, characterized in that the focusing means comprise at least one flexure (72) attached to an optical mirror means and an electric coil (74) encircling said flexure to cause said flexure to be magnetically attracted thereto allowing a lens (70) to move closer to or farther from the disk (44) through said focusing range.



3. Apparatus of Claim 1, characterized in that the means for positioning comprise:

- first plate means for positioning the disk (44) parallel thereto at a fixed distance therefrom,
- first lead screw means for pivotally moving said first plate means,
- second plate means constructed and arranged to pivot parallel to said first plate means while a distance therebetween varies, the disk being positioned between said first and second plate means, and
- second lead screw means for pivotally moving said second plate means, wherein said first and second lead screw means cooperate to position said first and second plate means to allow simultaneous reading of both sides of the disk.

4. Apparatus of Claim 3, characterized in that the first and second lead screw means each comprise:

- a lead screw (30, 32),
- a follower nut (34, 36) for travelling along said lead screw,
- a stepper motor (38, 39) for turning said lead screw, and
- a yoke (40, 42) for interconnecting said plate means to said follower nut, wherein as said stepper motor turns said lead screw, said follower nut travels therealong and said yoke pushes or pulls said plate means.

5. Apparatus of Claim 3, characterized in that the lead screw means are manually drivable to allow emergency disengagement.

6. Apparatus of Claim 3, characterized in that the lead screw means are separately controlled.

7. Apparatus of Claim 3, characterized in that the presence of a storage case (12) for housing said plate means and said lead screw means.

8. Apparatus of Claim 3, characterized in that the first and second plate means each comprise:

- a generally flat plate (14, 16),
- a pair of hinges (22-24, 26-28) along first edges of said plates, and
- a bracket (25, 27) along second edges of said plates for interconnection to said first lead screw means.

9. Apparatus of Claim 8, characterized in that first plate means further include disk drive means.

10. Apparatus of Claim 9, characterized in that the disk drive means comprise a disk drive motor (18)

interconnected to said first plate means and depending therefrom and a drive spindle (20) extending from said drive motor toward said second plate means in order to contact and rotationally drive the disk (44).

11. Apparatus of Claim 8, characterized in that the second plate means further comprise a protrusion (23) depending therefrom toward said first plate means, said protrusion providing protection for optical reading means associated with the optical scanning units.

12. Apparatus of Claim 1, characterized in that said scanning units comprise optical reading means comprising:

- a fixed focal length optical lens (70, 71),
- optical mirror means (69, 89) for containing said lens and for deflecting light to and from said lens, and
- optical transmitter/receiver means for transmitting light to said lens and for receiving a response from the disk, wherein said transmitter/receiver means transmits said light to said lens through said mirror means, said lens directs said light onto the disk (44), and said response from the disk is returned to said transmitter/receiver means through said lens and said mirror means.

13. Apparatus of Claim 12, characterized in that the transmitter/receiver means further comprise means for determining whether the disk is in focus.

14. Apparatus of Claim 13, characterized in that the means for determining comprise a quad detector.

15. Apparatus of Claim 12, characterized in that the transmitter/receiver means comprise:

- an infra-red laser (66),
- a beam splitter (75) including a polarizing screen (77) thereon,
- a quarter wave plate (85), and
- a quad detector.

16. Apparatus of Claim 1, characterized in that the means for positioning comprise:

- first positioning means for placing the disk (44) parallel to and a fixed distance from a first optical reader (54) of said first optical scanning unit, said first reader attached to said first means, and
- second positioning means for cooperatively moving the disk with said first means to place the disk parallel to and a focal distance from a second optical reader (52) of said second scanning unit, said second



reader attached to said second means, wherein said first and second readers are focused on the disk for simultaneous reading of both sides thereof.

17. Apparatus of Claim 16, characterized in that each of said positioning means comprise a hinged plate (14, 16).

18. Apparatus of Claim 17, characterized in that each of said positioning means further include:

- a stepper motor (38, 39),
- a lead screw (30, 32) driven by said motor,
- a follower nut (34, 36) for travelling along said lead screw, and
- a yoke (40, 42) connecting said follower nut and said plate, wherein as said stepper motor drives said follower nut along said lead-screw, said plate is pivoted about hinges.

19. Apparatus of Claim 16, characterized in that each of said first and second optical readers comprise:

- parallel flexures (72, 73),
- an electric coil surrounding said flexures,
- mirror means fixed to said flexures opposite said coil, and
- a fixed focal length lens (70, 71) attached to said mirror means.

20. The apparatus of Claim 19, characterized in that each of said optical readers further includes:

- a light source,
- a detector means, and
- means for transmitting light from said source to said fixed focal length lens and from said lens to said detector means.

21. Method for positioning a variable thickness storage disk (44) to allow a simultaneous reading of both sides of the disk, comprising the step of placing the disk between first and second optical scanning units positioned opposite to each other and respectively associated with first and second focusing means, each of said focusing means having a focusing range, characterized by the step of positioning said first and second optical scanning units and focusing means with respect to the respective side of the disk so that they focus on their respective side of the disk (44) and keep said first and second focusing means in a center of said focusing range irrespective of the thickness of the disk.

22. Method of Claim 21, characterized in that the step of positioning comprises:

- placing the disk (44) parallel to and a fixed distance from a first pivoting plate (16) containing said first focusing means, said fixed

distance being equal to a focal length of said first focusing means in said center of said focusing range,

- positioning a second pivoting plate (14) containing said second focusing means parallel to said disk and said first plate,
- pivoting said first plate with first lead screw means, and
- cooperatively pivoting said second plate with second lead screw means wherein the disk is positioned parallel to and a distance equal to a focal length of said second focusing means in said center of said focusing range to allow simultaneous reading of both sides of the disk.

23. Method of Claim 22, characterized in that the step of placing comprises securing a cartridge (46) containing the disk (44) to a case (12) enclosing said first and second plates (14, 16) to hold said cartridge from movement while allowing the disk to move with said first plate (16).

24. Method of Claim 22, characterized in that the step of positioning further comprises initiating a closing sequence in which said first and second plates (14, 16) are positioned parallel to and a predetermined distance from each other.

25. Method of Claim 22, characterized in that the steps of pivoting comprise:

- turning first and second lead screws (30, 32) with stepper motors (38, 39) to drive follower nuts (34, 36) along said lead screws, and
- interconnecting said follower nuts and said pivoting plates (14, 16) with yokes (40, 42), wherein as said follower nuts drive along said lead screws, said pivoting plates are pivotally moved by said yokes.

26. Method of Claim 21, characterized by the further steps of:

- sliding optical readers (52, 54) radially relative to the disk (44), said optical readers comprising a portion of said focusing means, and
- directing beams of light through said optical readers to allow data on the disk to be interpreted.

27. Method of Claim 21, characterized by the steps of:

- positioning a first fixed focal length optical reader of the first optical scanning unit parallel to and a fixed distance from a first side of the disk (44),
- positioning a second fixed focal length opt-



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ical reader of the second optical scanning unit parallel to and a variable distance from a second side of the disk,

- cooperatively adjusting said first and second readers until said second reader is at a proper focal distance from said second side of the disk, and wherein said first and second readers may simultaneously read said first and second sides of the disk.

28. Method of Claim 27, characterized in that the step of positioning a first optical reader (54) comprises the steps of:

- inserting a cartridge (46) containing the disk (44) into position fixing means between said first and second readers (52, 54), and
- pivotally moving a first plate (16) about a hinge, said plate containing a drive spindle (20) and said first reader, in order to place said spindle in contact with the disk, wherein said spindle fixes the disk parallel to and said fixed distance from said first reader and said first plate.

29. Method of Claim 28, characterized in that the step of pivotally moving said first plate comprises the steps of:

- turning a lead screw (32) with a stepper motor (39) responsive to said first reader,
- driving a follower nut (36) along said lead screw, and
- interconnecting said follower nut to said first plate with a yoke (42), wherein said follower nut pivotally moves said plate through said yoke.

30. Method of Claim 27, characterized in that the step of positioning a second optical reader (52) comprises the steps of pivotally moving a second plate (14) about a hinge, said plate containing said second reader.

31. Method of Claim 30, characterized in that the step of pivotally moving said second plate (14) comprises:

- turning a lead screw (30) with a stepper motor (38) responsive to said second reader;
- driving a follower nut (34) along said lead screw, and
- interconnecting said follower nut to said second plate with a yoke, wherein said follower nut pivotally moves said plate through said yoke.

Patentansprüche

1. Gerät (10) zum gleichzeitigen Lesen beider Seiten einer Speicherplatte (44) von unterschiedlicher Dicke, der erste und zweite optische Abtastvorrichtungen umfaßt, welche an entgegengesetzten Seiten der Platte positioniert und jeweils mit ersten und zweiten Scharfstellungs-
vorrichtungen verbunden sind, wobei jede der besagten Scharfstellungs-
vorrichtungen über einen Brennweitenbereich verfügt, der durch das Vorhandensein von Mitteln für die Positionierung der Platte (44) zwischen besagten ersten und zweiten optischen Abtastvorrichtungen gekennzeichnet wird, worin die besagten ersten und zweiten optischen Abtastvorrichtungen parallel zu und in einer Brennweite von der jeweiligen Seite der Platte liegen und worin die besagten ersten und zweiten Scharfstellungs-
vorrichtungen auf ihre jeweilige Seite der Platte fokussiert und im Zentrum des besagten Brennweitenbereichs gehalten werden, ungeachtet der Dicke der Platte.

2. Gerät von Anspruch 1, dadurch gekennzeichnet, daß die Scharfstellungs-
vorrichtung mindestens ein gebogenes Element (72) umfaßt, das an einer Vorrichtung mit optischem Spiegel und einer elektrischen Spule (74) befestigt ist, welche besagtes gebogenes Element umgibt, um besagtes gebogenes Element zu veranlassen, magnetisch dorthin angezogen zu werden, was wiederum einer Linse (70) gestattet, sich durch besagten Brennweitenbereich weiter von der Platte (44) zu entfernen oder sich dieser zu nähern.

3. Gerät von Anspruch 1, dadurch gekennzeichnet, daß die Mittel zur Positionierung folgendes umfassen:

- eine erste Platte zum Positionieren der Platte (44) parallel und in einem festen Abstand dazu,
- eine erste Leitspindel zum schwenkenden Bewegen besagter erster Platte,
- eine zweite Platte, die so konstruiert und angeordnet ist, daß sie sich parallel zur ersten Platte schwenken läßt, während der Abstand zwischen ihnen schwankt, wobei die Platte zwischen besagte erste und zweite Platte positioniert wird, und
- eine zweite Leitspindel zum schwenkenden Bewegen besagter zweiter Platte, wobei die erste und die zweite Leitspindel zusammenwirken, um besagte erste und zweite Platte zu positionieren und dadurch ein gleichzeitiges Lesen beider Seiten der Platte zu gestatten.

4. Gerät von Anspruch 3, dadurch gekennzeichnet,



daß die erste und zweite Leitspindereinheit jeweils folgendes umfassen :

- eine Leitspindel (30, 32),
- eine mitlaufende Mutter (34, 36) zum Verfahren entlang besagter Leitspindel,
- einen Schrittmotor (38, 39) zum Drehen besagter Leitspindel, und
- einen Bügel (40, 42) zur Verbindung besagter Platte mit der besagten

mitlaufenden Mutter, wobei besagte mitlaufende Mutter - wenn besagter Schrittmotor die besagte Leitspindel dreht - an dieser Leitspindel entlangläuft und besagter Bügel besagte Platte drückt oder zieht.

5. Gerät von Anspruch 3, dadurch gekennzeichnet, daß sich die Leitspindelvorrichtung von Hand antreiben läßt, um ein Auskuppeln im Notfall zu gestatten.
6. Gerät von Anspruch 3, dadurch gekennzeichnet, daß die Leitspindelvorrichtung separat gesteuert wird.
7. Gerät von Anspruch 3, dadurch gekennzeichnet, daß ein Aufnahmegehäuse (12) zur Unterbringung besagter Platte und besagter Leitspindelvorrichtung vorhanden ist.
8. Gerät von Anspruch 3, dadurch gekennzeichnet, daß die erste und zweite Platte jeweils folgendes beinhaltet :
 - eine allgemein flache Platte (14, 16),
 - ein Paar Scharniere (22-24, 26-28) an den ersten Kanten besagter Platten, und
 - eine Halterung (25, 27) an den zweiten Kanten besagter Platten zur Verbindung mit der ersten Leitspindelvorrichtung.
9. Gerät von Anspruch 8, dadurch gekennzeichnet, daß die erste Platte außerdem ein Mittel zum Antrieb der Platte enthält.
10. Gerät von Anspruch 9, dadurch gekennzeichnet, daß die Antriebsvorrichtung der Platte einen Plattenantriebsmotor (18) umfaßt, der an der ersten besagten Platte angeschlossen ist und von ihr abhängt, und eine Antriebsspindel (20), die von besagtem Antriebsmotor in Richtung zur zweiten Platte verläuft, um die Platte zu berühren und drehend anzutreiben (44).
11. Gerät von Anspruch 8, dadurch gekennzeichnet, daß die zweite Platte außerdem eine Auskrägung (23) aufweist, die von ihr ausgeht und in Richtung auf die erste Platte verläuft, wobei besagte Auskrägung einen Schutz für die mit der optischen Abtastvorrichtung verbundene optische Lese-

vorrichtung bildet.

12. Gerät von Anspruch 1, dadurch gekennzeichnet, daß besagte Abtastvorrichtungen optische Lesevorrichtungen enthalten, die folgendes umfassen :
 - eine optische Linse mit fester Brennweite (70, 71),
 - eine Vorrichtung mit optischem Spiegel (69, 89) zur Aufnahme besagter Linse und zur Ablenkung des Lichts zu und von besagter Linse, und
 - eine optische Sende-/Empfangsvorrichtung zur Übertragung des Lichts zu besagter Linse und zum Empfang einer Antwort von der Platte, wobei besagte Sende/Empfangsvorrichtung das Licht durch besagte Spiegelvorrichtung an besagte Linse überträgt, besagte Linse besagtes Licht auf die Platte (44) überträgt und die besagte Antwort von besagter Platte wieder an besagte Sende-/Empfangsvorrichtung durch besagte Linse und besagte Spiegelvorrichtung zurückgesandt wird.
13. Gerät von Anspruch 12, dadurch gekennzeichnet, daß die Sende-/Empfangsvorrichtung außerdem Mittel enthält, durch die bestimmt wird, ob sich die Platte im Brennpunkt befindet.
14. Gerät für Anspruch 13, dadurch gekennzeichnet, daß die Vorrichtung für die Bestimmung einen Quadridetektor umfaßt.
15. Gerät von Anspruch 12, dadurch gekennzeichnet, daß die Sende-/Empfangsvorrichtung folgendes enthält :
 - einen Infrarot-Laser (66),
 - einen Strahlenteiler (75) einschließlich Polarisationsschirm (77),
 - eine Lambda-Viertel-Platte (85), und
 - einen Quadridetektor.
16. Gerät von Anspruch 1, dadurch gekennzeichnet, daß die Positionierungsvorrichtung folgendes umfaßt :
 - eine erste Positionierungsvorrichtung zum Placieren der Platte (44) parallel zu und in einem festen Abstand von einem ersten optischen Leser (54) besagter erster optischer Abtastvorrichtung, wobei besagter erster Leser an besagter erster Vorrichtung befestigt ist, und
 - eine zweite Positionierungsvorrichtung zum Bewegen der Platte gemeinsam mit besagter erster Vorrichtung, um die Platte parallel zu und in einer Fokaldistanz (Brennweite) von einem zweiten optischen



- Leser (52) besagter zweiter Abtastvorrichtung zu positionieren, wobei der zweite Leser an der besagten zweiten Vorrichtung befestigt ist und besagter erster und zweiter Leser auf die Platte fokussiert sind zum gleichzeitigen Lesen beider Seiten derselben. 5
17. Gerät von Anspruch 16, dadurch gekennzeichnet, daß jede der besagten Positionierungsvorrichtungen eine gelenkig befestigte Platte (14, 16) umfaßt. 10
18. Gerät von Anspruch 17, dadurch gekennzeichnet, daß jede der besagten Positionierungsvorrichtungen außerdem folgendes umfaßt : 15
- einen Schrittmotor (38, 39),
 - eine von besagtem Motor angetriebene Leitspindel (30, 32),
 - eine mitlaufende Mutter (34, 36), die an besagter Leitspindel entlangläuft, und 20
 - einen Bügel (40, 42), der besagte mitlaufende Mutter und besagte Platte verbindet, wobei besagter Schrittmotor besagte mitlaufende Mutter an der Leitspindel entlang bewegt und besagte Platte an Scharnieren geschwenkt wird. 25
19. Gerät von Anspruch 16, dadurch gekennzeichnet, daß jeder der besagten ersten und zweiten optischen Leser folgendes umfaßt : 30
- parallele gebogene Elemente (72, 73),
 - eine elektrische Spule, welche besagte gebogene Elemente umgibt,
 - eine an besagten gebogenen Elementen gegenüber der besagten Spule befestigte Spiegelvorrichtung, und 35
 - eine Linse mit fester Brennweite (70, 71), die an besagter Spiegelvorrichtung befestigt ist. 40
20. Gerät von Anspruch 19, dadurch gekennzeichnet, daß jeder der besagten optischen Leser außerdem folgendes umfaßt : 45
- eine Lichtquelle,
 - eine Detektorvorrichtung und
 - eine Vorrichtung zur Übertragung von Licht aus besagter Quelle zu besagter Linse mit fester Brennweite und von besagter Linse zu besagter Detektorvorrichtung. 50
21. Methode zum Positionieren einer Speicherplatte (44) von unterschiedlicher Dicke, um ein gleichzeitiges Lesen beider Seiten der Platte zu gestatten, was den Schritt umfaßt, die Platte zwischen die erste und zweite optische Abtastvorrichtung zu placieren, die einander gegenüberliegen und mit der ersten bzw. der zweiten optischen Scharf-
- stellungsvorrichtung verbunden sind, wobei jede der besagten optischen Abtastvorrichtungen über einen Scharfbereich verfügt, weiterhin gekennzeichnet durch den Schritt des Positionierens der besagten ersten und zweiten Scharfstellungsvorrichtung zum Scharfstellen im Hinblick auf die jeweilige Seite der Platte (44), wobei die besagte erste und zweite Scharfstellungsvorrichtung im Zentrum des besagten Scharfbereichs (oder Brennweiten)bereichs gehalten werden muß, ungeachtet der Dicke der Platte.
22. Methode von Anspruch 21, dadurch gekennzeichnet, daß der Positionierungsschritt folgendes beinhaltet : 55
- die Platte (44) ist parallel zu und in einem festen Abstand von einer ersten schwenkbaren Platte 16 zu placieren, die besagte erste Scharfstellungsvorrichtung enthält, wobei besagter fester Abstand gleich einer Brennweite der besagten ersten Scharfstellungsvorrichtung in besagtem Zentrum des besagten Scharfbereichs ist,
 - die Positionierung einer zweiten schwenkbaren Platte (14), die besagte zweite Scharfstellungsvorrichtung enthält, parallel zu besagter Platte und besagter erster (schwenkbarer) Platte,
 - das Schwenken der besagten ersten Platte mit Hilfe der ersten Leitspindelvorrichtung und
 - das Schwenken der besagten zweiten Platte mit Hilfe der zweiten Leitspindelvorrichtung, wobei die Platte parallel zu und in einem Abstand gleich der Brennweite der besagten Scharfstellungsvorrichtung in besagtem Zentrum des besagten Scharfbereichs positioniert wird, um ein gleichzeitiges Lesen beider Seiten der Platte zu gestatten.
23. Methode von Anspruch 22, dadurch gekennzeichnet, daß der Schritt des Placierens die Befestigung einer die Platte (44) enthaltenden Kassette (46) an einem Gehäuse (12) beinhaltet, welches die besagten ersten und zweiten Platten (14, 16) umschließt, um eine Bewegung besagter Kassette zu verhindern, während der Platte gestattet wird, sich mit besagter erster Platte (16) zu bewegen.
24. Methode von Anspruch 22, dadurch gekennzeichnet, daß der Schritt des Positionierens außerdem die Einleitung einer Schließsequenz beinhaltet, in welcher besagte erste und zweite Platte (14, 16) parallel zueinander und in einem vorbestimmten Abstand voneinander positioniert



werden.

25. Methode von Anspruch 22, dadurch gekennzeichnet, daß die Schritte des Schwenkens folgendes umfassen :

- das Drehen der ersten und zweiten Leitspindel (30, 32) mit Schrittmotoren (38, 39), um die mitlaufenden Muttern (34, 36) an den Leitspindeln entlang zu bewegen, und
- das Verbinden der besagten mitlaufenden Muttern und der besagten schwenkbaren Platten (14, 16) mit Bügeln (40, 42), wobei
 - während sich besagte mitlaufende Muttern an besagten Leitspindeln entlang bewegen - besagte schwenkbare Platten durch besagte Bügel schwenkend bewegt werden.

26. Methode von Anspruch 21, durch folgende weitere Schritte gekennzeichnet :

- radiales Gleiten der optischen Leser (52, 54) in bezug auf die Platte (44), wobei besagte optische Leser einen Teil der besagten Scharfstellungsrichtung enthalten, und
- das Leiten von Lichtstrahlen durch besagte optische Leser, damit die Daten auf der Platte interpretiert werden können.

27. Methode von Anspruch 21, durch folgende Schritte gekennzeichnet :

- Positionieren eines ersten optischen Lesers feststehender Brennweite der ersten optischen Abtastvorrichtung parallel zu und in festem Abstand von einer ersten Seite der Platte (44),
- Positionieren eines zweiten optischen Lesers feststehender Brennweite der zweiten optischen Abtastvorrichtung parallel zu und in variablem Abstand von einer zweiten Seite der Platte,
- zusammenwirkende Anpassung des besagten ersten und zweiten Lesers, bis sich besagter zweiter Leser in angemessener Fokaldistanz (Brennweite) von der besagten zweiten Seite der Platte befindet, wobei besagter erster und zweiter Leser die besagte erste und zweite Seite der Platte lesen können.

28. Methode von Anspruch 27, dadurch gekennzeichnet, daß der Schritt des Positionierens eines ersten optischen Lesers (54) folgende Schritte umfaßt:

- Einführen einer Kassette (46), welche die Platte (44) enthält, in eine die Position fixierende Vorrichtung zwischen dem besagten ersten und zweiten Leser (52, 54), und

- Schwenkbewegung der ersten Platte (16) um ein Scharnier, wobei besagte Platte eine Antriebsspindel (20) und besagten ersten Leser umfaßt, um besagte Spindel mit der Platte in Berührung zu bringen, wobei besagte Spindel die Platte parallel zu und in einem festen Abstand von besagtem ersten Leser und besagter erster Platte fixiert.

29. Methode von Anspruch 28, dadurch gekennzeichnet, daß der Schritt des schwenkenden Bewegens besagter erster Platte folgende Schritte umfaßt:

- Drehen einer Leitspindel (32) mit Hilfe eines Schrittmotors (39), der auf besagten ersten Leser anspricht,
- Bewegen einer mitlaufenden Mutter (36) entlang besagter Leitspindel, und
- Verbinden der besagten mitlaufenden Mutter mit besagter erster Platte über einen Bügel (42), wobei die besagte mitlaufende Mutter besagte Platte durch besagten Bügel schwenkend bewegt.

30. Methode von Anspruch 27, dadurch gekennzeichnet, daß der Schritt des Positionierens eines zweiten optischen Lesers (52) den Schritt des Schwenkens einer zweiten Platte (14) um ein Scharnier beinhaltet, wobei die zweite Platte besagten zweiten Leser enthält.

31. Methode von Anspruch 30, dadurch gekennzeichnet, daß der Schritt des Schwenkens der zweiten Platte (14) folgendes umfaßt :

- Drehen einer Leitspindel (30) mit Hilfe eines Schrittmotors (38), der auf besagten zweiten Leser anspricht;
- Bewegen einer mitlaufenden Mutter (34) entlang besagter Leitspindel, und
- Verbinden der besagten mitlaufenden Mutter mit besagter zweiter Platte durch einen Bügel, wobei besagte mitlaufende Mutter besagte Platte durch besagten Bügel schwenkend bewegt.

Revendications

1. Appareil (10) de lecture simultanée des deux faces d'un disque de stockage (44) d'épaisseur variable, comprenant des première et deuxième unités de balayage optique positionnées autour des faces opposées du disque et respectivement associées à des premier et deuxième moyens de focalisation, chacun desdits moyens de focalisation possédant une plage de focalisations, caractérisé par la présence de moyens de positionnement du disque (44) entre lesdites première et



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deuxième unités de balayage optique, dans lequel lesdites première et deuxième unités de balayage optique sont parallèles à et à une distance focale de la face correspondante du disque et dans lequel lesdits premier et deuxième moyens de focalisation sont focalisés sur leur face respective du disque et maintenus dans un centre de ladite plage de focalisations, quelle que soit l'épaisseur du disque

2. Appareil selon la revendication 1, caractérisé en ce que les moyens de focalisation comprennent au moins une courbure (72) fixée à un moyen à miroir optique et une bobine électrique (74) entourant ladite courbure pour amener ladite courbure à être magnétiquement attirée vers elle, permettant à une lentille (70) de se rapprocher ou de s'écarter du disque (44) dans la plage de focalisations.

3. Appareil selon la revendication 1, caractérisé en ce que les moyens de positionnement comprennent :

- un premier moyen à plaque pour positionner le disque (44) parallèlement à et à une distance fixe de celui-ci;
- un premier moyen à vis fileté pour déplacer à pivotement ledit premier moyen à plaque;
- un deuxième moyen à plaque construit et disposé pour pivoter parallèlement audit premier moyen à plaque, tandis que la distance intermédiaire varie, le disque étant positionné entre lesdits premier et deuxième moyens à plaque, et
- un deuxième moyen à vis fileté pour déplacer à pivotement ledit deuxième moyen à plaque, dans lequel lesdits premier et deuxième moyens à vis fileté coopèrent pour positionner lesdits premier et deuxième moyens à plaque afin de permettre la lecture simultanée des deux faces du disque.

4. Appareil selon la revendication 3, caractérisé en ce que les premier et deuxième moyens à vis fileté comprennent chacun :

- une vis fileté (30, 32);
- un écrou suiveur (34, 36) destiné à se déplacer le long de ladite vis fileté;
- un moteur pas à pas (38, 39) pour faire tourner ladite vis fileté, et
- un étrier (40, 42) pour interconnecter ledit moyen à plaque audit écrou suiveur, dans lequel, lorsque ledit moteur pas à pas fait tourner ladite vis fileté, ledit écrou suiveur se déplace le long de celle-ci et ledit étrier pousse ou tire ledit moyen à plaque.

5. Appareil selon la revendication 3, caractérisé en ce que les moyens à vis fileté peuvent être commandés manuellement pour permettre un dégagement d'urgence.

6. Appareil selon la revendication 3, caractérisé en ce que les moyens à vis fileté sont commandés séparément.

7. Appareil selon la revendication 3, caractérisé par la présence d'un boîtier de stockage (12) pour loger lesdits moyens à plaque et lesdits moyens à vis fileté.

8. Appareil selon la revendication 3, caractérisé en ce que les premier et deuxième moyens à plaque comprennent chacun :

- une plaque généralement plate (14, 16);
- une paire de charnières (22-24, 26-28) le long des premiers bords desdites plaques, et
- un support (25, 27) le long des deuxième bords desdites plaques en vue d'une interconnexion auxdits premiers moyens à vis fileté.

9. Appareil selon la revendication 8, caractérisé en ce que les premiers moyens à plaque comprennent par ailleurs des moyens d'entraînement du disque.

10. Appareil selon la revendication 9, caractérisé en ce que les moyens d'entraînement du disque comprennent un moteur d'entraînement de disque (18) inter-connecté auxdits premiers moyens à plaque et dépendant de ceux-ci et un axe d'entraînement (20) s'étendant dudit moteur d'entraînement vers ledit deuxième moyen à plaque afin de toucher et d'entraîner le disque (44) par rotation.

11. Appareil selon la revendication 8, caractérisé en ce que les deuxième moyens à plaque comprennent, par ailleurs, une saillie (23) dépendant de ceux-ci vers lesdits premiers moyens à plaque, ladite saillie assurant la protection des moyens de lecture optique associés aux unités de balayage optique.

12. Appareil selon la revendication 1, caractérisé en ce que lesdites unités de balayage comprennent des moyens de lecture optique comprenant :

- une lentille optique de longueur focale fixe (70, 71);
- des moyens à miroir optiques (69, 89) destinés à contenir ladite lentille et à dévier la lumière vers et à partir de ladite lentille, et
- des moyens émetteurs/récepteurs opti-



ques destinés à transmettre la lumière à ladite lentille et à recevoir une réponse du disque, dans lequel lesdits moyens émetteurs/récepteurs transmettent ladite lumière à ladite lentille à travers lesdits moyens à miroir, ladite lentille dirigeant ladite lumière sur le disque (44), et ladite réponse du disque étant ramenée auxdits moyens émetteurs/récepteurs à travers ladite lentille et lesdits moyens à miroir.

13. Appareil selon la revendication 12, caractérisé en ce que les moyens émetteurs/récepteurs comprennent, par ailleurs, des moyens destinés à déterminer si le disque est focalisé.

14. Appareil selon la revendication 13, caractérisé en ce que les moyens destinés à déterminer comprennent un détecteur quadruple.

15. Appareil selon la revendication 12, caractérisé en ce que les moyens émetteurs/récepteurs comprennent :

- un laser à infrarouges (66);
- un dispositif de décomposition du faisceau (75) comprenant un écran de polarisation (77) à sa surface;
- une lame quart d'onde (85), et
- un détecteur quadruple.

16. Appareil selon la revendication 1, caractérisé en ce que les moyens de positionnement comprennent :

- un premier moyen de positionnement pour placer le disque (44) parallèlement à et à une distance fixe d'un premier lecteur optique (54) de ladite première unité de balayage optique, ledit premier lecteur étant fixé audit premier moyen, et
- un deuxième moyen de positionnement pour déplacer le disque de manière concourante avec ledit premier moyen afin de placer le disque parallèlement à et à une distance focale d'un deuxième lecteur optique (52) de ladite deuxième unité de balayage, ledit deuxième lecteur étant fixé audit deuxième moyen, dans lequel lesdits premier et deuxième lecteurs sont focalisés sur le disque en vue de la lecture simultanée de ses deux faces.

17. Appareil selon la revendication 16, caractérisé en ce que chacun desdits moyens de positionnement comprend une plaque articulée sur charnière (14, 16).

18. Appareil selon la revendication 17, caractérisé en ce que chacun desdits moyens de positionnement

ment comprend par ailleurs :

- un moteur pas à pas (38, 39);
- une vis fileté (30, 32) entraînée par ledit moteur;
- un écrou suiveur (34, 36) destiné à se déplacer le long de ladite vis fileté, et
- un étrier (40, 42) reliant ledit écrou suiveur et ladite plaque, dans lequel, lorsque ledit moteur pas à pas entraîne ledit écrou suiveur le long de ladite vis fileté, ladite plaque pivote autour de charnières.

19. Appareil selon la revendication 16, caractérisé en ce que chacun desdits premier et deuxième lecteurs optiques comprend :

- des courbures parallèles (72, 73);
- une bobine électrique entourant lesdites courbures;
- des moyens à miroir fixés auxdites courbures opposés à ladite bobine, et
- une lentille à longueur focale fixe (70, 71) fixée auxdits moyens à miroir.

20. Appareil selon la revendication 19, caractérisé en ce que chacun desdits lecteurs optiques comprend par ailleurs :

- une source lumineuse;
- un détecteur, et
- des moyens de transmission de lumière depuis ladite source vers ladite lentille à longueur focale fixe et depuis ladite lentille vers ledit détecteur.

21. Procédé de positionnement d'un disque de stockage d'épaisseur variable (44) destiné à permettre la lecture simultanée des deux faces du disque, comprenant l'étape de placement du disque entre les première et deuxième unités de balayage optique positionnées à l'opposé l'une de l'autre et respectivement associées aux premier et deuxième moyens de focalisation, chacune des unités de balayage optique et lesdits moyens de focalisation possédant une plage de focalisations, caractérisé par l'étape de positionnement desdits premier et deuxième moyens de focalisation, caractérisé par l'étape de positionnement desdits premier et deuxième moyens de focalisation par rapport à la face correspondante du disque de sorte qu'ils soient focalisés sur leur face respective du disque (44) et maintiennent lesdits premier et deuxième moyens de focalisation dans un centre de ladite plage de focalisations, quelle que soit l'épaisseur du disque.

22. Procédé selon la revendication 21, caractérisé en ce que l'étape de positionnement comprend :

- le placement du disque (44) parallèlement à et à une distance fixe d'une première pla-



que pivotante (16) contenant ledit premier moyen de focalisation, ladite distance fixe étant égale à la longueur focale desdits premiers moyens de focalisation dans ledit centre de ladite plage de focalisations;

- le positionnement d'une deuxième plaque pivotante (14) contenant ledit deuxième moyen de focalisation parallèle audit disque et à ladite première plaque;
- le pivotement de ladite première plaque avec le premier moyen à vis fileté, et
- le pivotement concourant de ladite deuxième plaque avec le deuxième moyen à vis fileté, dans lequel le disque est positionné parallèlement à et à une distance égale à la longueur focale dudit deuxième moyen de focalisation dans ledit centre de ladite plage de focalisations pour permettre la lecture simultanée des deux faces du disque.

23. Procédé selon la revendication 22, caractérisé en ce que l'étape de placement comprend la fixation d'un chargeur (46) contenant le disque (44) dans un boîtier (12) renfermant lesdites première et deuxième plaques (14, 16) afin d'empêcher ledit chargeur de bouger tout en permettant au disque de se déplacer avec ladite première plaque (16).

24. Procédé selon la revendication 22, caractérisé en ce que l'étape de positionnement comprend, par ailleurs, l'amorçage d'une séquence de fermeture dans laquelle lesdites première et deuxième plaques (14, 16) sont positionnées parallèlement à et à une distance prédéterminée l'une de l'autre.

25. Procédé selon la revendication 22, caractérisé en ce que les étapes de pivotement comprennent :

- la rotation des première et deuxième vis filetées (30, 32) avec les moteurs pas à pas (38, 39) pour entraîner les écrous suiveurs (34, 36) le long desdites vis filetées, et
- l'interconnexion desdits écrous suiveurs et desdites plaques pivotantes (14, 16) avec des étriers (40, 42), dans lequel lorsque lesdits écrous suiveurs se déplacent le long desdites vis filetées, lesdites plaques pivotantes sont déplacées à pivotement par lesdits étriers.

26. Procédé selon la revendication 21, caractérisé par les étapes de :

- coulisement des lecteurs optiques (52, 54) radialement par rapport au disque (44), lesdits lecteurs optiques comprenant une partie desdits moyens de focalisation, et
- le guidage des faisceaux de lumière à travers lesdits lecteurs optiques pour permet-

tre d'interpréter les données sur le disque.

27. Procédé selon la revendication 21, caractérisé par les étapes de :

- positionnement d'un premier lecteur optique de longueur focale fixe de la première unité de balayage optique parallèle à et à une distance fixe d'une première face du disque (44);
- positionnement d'un deuxième lecteur optique de longueur focale fixe de la deuxième unité de balayage optique parallèle à et à une distance variable d'une deuxième face du disque, et
- réglage concourant desdits premier et deuxième lecteurs jusqu'à ce que ledit deuxième lecteur se trouve à une distance focale appropriée de ladite deuxième face du disque, et dans lequel lesdits premier et deuxième lecteurs peuvent lire simultanément lesdites première et deuxième faces du disque.

28. Procédé selon la revendication 27, caractérisé en ce que l'étape de positionnement d'un premier lecteur optique (54) comprend les étapes suivantes :

- insertion d'un chargeur (46) contenant le disque (44) dans les moyens de fixation en position entre lesdits premier et deuxième lecteurs (52, 54), et
- déplacement à pivotement d'un première plaque (16) autour d'une charnière, ladite plaque contenant un axe d'entraînement (20) et ledit premier lecteur, afin de placer ledit axe en contact avec le disque, dans lequel ledit axe fixe le disque parallèlement à et à une distance fixe dudit premier lecteur et de ladite première plaque.

29. Procédé selon la revendication 28, caractérisé en ce que l'étape de déplacement à pivotement de ladite première plaque comprend les étapes suivantes :

- rotation d'une vis fileté (32) à l'aide d'un moteur pas à pas (39) en réaction audit premier lecteur;
- entraînement d'un écrou suiveur (36) le long de ladite vis fileté, et
- interconnexion dudit écrou suiveur à ladite première plaque avec un étrier (42), dans lequel ledit écrou suiveur déplace à pivotement ladite plaque par ledit étrier.

30. Procédé selon la revendication 27, caractérisé en ce que l'étape de positionnement d'un deuxième lecteur optique (52) comprend les étapes de déplacement à pivotement d'une deuxième plaque



(14) autour d'une charnière, ladite plaque contenant ledit deuxième lecteur.

31. Procédé selon la revendication 30, caractérisé en ce que l'étape de déplacement à pivotement de ladite deuxième plaque (14) comprend :
- la rotation d'une vis fileté (30) à l'aide d'un moteur pas à pas (38) en réaction audit deuxième lecteur; 5
 - l'entraînement d'un écrou suiveur (34) le long de ladite vis fileté, et 10
 - l'interconnexion dudit écrou suiveur à ladite deuxième plaque avec un étrier, dans lequel ledit écrou suiveur déplace à pivotement ladite plaque par ledit étrier. 15

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