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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G11B 17/02, 17/022, 17/028, 17/038, 17/22, 17/26, 17/32, 17/34, 17/00

A1

(11) International Publication Number: WO 00/67253

(43) International Publication Date: 9 November 2000 (09.11.00)

(21) International Application Number: PCT/US00/11614

(22) International Filing Date: 28 April 2000 (28.04.00)

(30) Priority Data:
60/131,554 29 April 1999 (29.04.99) US

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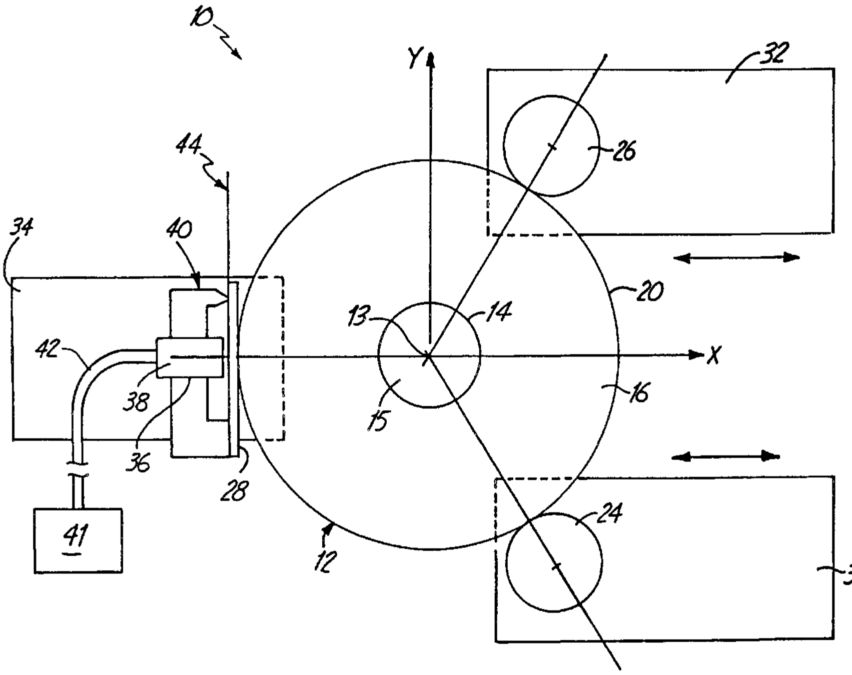
(81) Designated States: AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD AND APPARATUS FOR BALANCING A SPINDLE IN A HARD DISK DRIVE



(57) Abstract

An apparatus for balancing and centering a disk comprising a sensor that produces a signal indicative of the disk's deviation from a desired dimension and a movable reference surface that moves the disk in response to the signal from the sensor. The apparatus may include a microprocessor connected to a balance analyzer. Feedback from the balance analyzer can be used to compensate for setup errors, thermal drift, and tool wear.

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Title: **Method And Apparatus For Balancing A Spindle In A Hard Disk Drive**

RELATED APPLICATIONS

This application claims priority from Provisional Application Number 60/131,554, filed April 29, 1999.

TECHNICAL FIELD

The present invention relates a method and apparatus used to balance generally circular disks on a spindle. More particularly, the present invention relates to a method and apparatus for balancing one or more magnetic recording disks and spacer rings on a spindle for use in a computer hard drive.

BACKGROUND

A disk stack assembly ("DSA") is a major component of many computer hard disk drives. A DSA generally comprises a plurality of alternating magnetic recording disks and spacer rings mounted on a spindle. A drive motor typically turns the DSA around an axis of rotation at a high velocity (usually expressed in revolutions per minute or "RPM"). If the center of mass of the DSA does not lie along its axis of rotation, then an imbalance condition may result. This condition can produce unacceptable vibration and noise, which can lead to the premature failure of the motor bearings and which can decrease customer satisfaction.

One partial solution to this imbalance problem involves the use of balance weights. These weights can be strategically added to or subtracted from the DSA to correct the imbalance. One problem with this solution is that the weights take up space inside the drive enclosure. This problem is significant as disk drive manufacturers constantly strive to increase the drive's data storage capacity without increasing the drive's size. Consequently, there is a need for a balancing method that does not require separate balance weights, thereby allowing designers to use the available enclosure volume more efficiently.

Another problem with using balance weights to balance a DSA is the complex and lengthy installation procedure required by this solution. Applying balance weights typically requires that the manufacturer to: (1) center the rings and disks as accurately as possible using mechanical stops; (2) clamp spacer rings and disks onto the spindle; (3) test for any imbalance; (4) add the necessary balance weights; and (5) retest the DSA to verify that the drive is within its specification. Thus, there is a need for a faster, less complex method of balancing a DSA.

Another partial solution tries to form the outer diameter ("OD") of a DSA into a concentric cylinder centered on its rotational axis. This method typically uses two rigid hard stops and one spring-loaded stop for each disk and spacer ring. The hard stops are generally located 120 degrees from each other and are mechanically positioned for a nominal OD dimension. One problem with this method is that it only works well when all the disks in the DSA have the same OD. Another problem with this method is that the disk's OD dimensional tolerance is typically larger than what the balance specification allows. As a result, the OD tolerance prevents accurate centering and balancing. This problem may become more acute as the drive industry increases the operating speed of the drives.

Clearly, there is a need for an inexpensive, versatile centering and balancing apparatus that eliminates some of the inadequacies of the current systems, that produces accurate results, and that has a low turn around time ("TAT").

SUMMARY

The present invention relates to a method and apparatus for balancing a disk stack assembly of a disk drive using a small offset of the magnetic recording disks to compensate for an imbalanced mass located near the rotational axis. These embodiments take advantage of the fact that most of a disk's mass is located closer to its outer diameter ("OD") than to its inner diameter ("ID") and the fact that the importance any particular imbalanced mass is directly proportional to its radial distance from the rotational axis.

Accordingly, one embodiment of the present invention comprises a sensor that produces a signal indicative of at least one disk's deviation from a desired dimension and a movable reference surface that moves the at least one disk in response to the signal from the sensor. This embodiment may further comprise a microprocessor operably connected to a balance analyzer, the sensor, and the moveable reference surface. Feedback from the balance analyzer can be used to compensate for a misaligned spacer ring or other setup errors, an imbalanced drive motor, and wear or other time varying errors.

Some embodiments of the present invention can be used to balance a plurality of disks and spacer rings assembled into a disk stack assembly. One such embodiment divides the disk stack assembly into at least two groups. The embodiment then displaces the disks in each group based on their average deviation from a desired or nominal dimension. This embodiment can be used to obtain either a one-plane ("static") balance or two-plane ("coupled" or "dynamic") balance.

Another embodiment of the present invention comprises a biasing member adapted to bias at least one of a plurality of disks against a disk reference surface, a sensor for producing a signal indicative of each disk's deviation from a desired dimension, and a positioning member that moves the disk reference surface in response to the signal from the sensor, thereby balancing the disk stack assembly.

Another aspect of the present invention is a method of balancing a disk on a spindle. One embodiment of this method comprises generating a signal indicative of a deviation of the disk from a desired dimension, and moving the disk in response to the signal. The method may further comprise providing a movable reference surface, and biasing a disk against the movable reference surface.

Another aspect of the present invention is a method of balancing a disk stack assembly independent of variations in an outer diameter of a disk member. One embodiment of this method comprises providing a plurality of movable reference surfaces, biasing a plurality of disks against the plurality of movable reference surfaces, generating a signal indicative of an average deviation of the plurality of disks from a nominal dimension, and moving the plurality of disks in response to the signal.

Two additional aspects of the present invention are a method of centering a disk on a spindle and a disk stack assembly having at least one imbalance. One embodiment of the method for centering a disk comprises providing a movable reference surface, biasing a disk against the movable reference surface, generating a signal indicative of a deviation of the disk from a desired dimension, and moving the disk in response to the signal. One embodiment of the disk stack assembly comprises a spindle and an offset disk rotationally coupled to the spindle. The offset disk in this embodiment compensates for the at least one imbalance.

Another aspect of the present invention is a method of centering a disk on a spindle, one embodiment of which comprises providing a movable reference surface, biasing a disk against the movable reference surface, generating a signal indicative of a deviation of the disk from a desired dimension, and moving the disk in response to the signal.

One feature and advantage of the present invention is that it displaces the magnetic recording disks to balance the DSA, which saves volumetric space inside the drive enclosure by eliminating the need for designated locations for installing balance weights. Another feature of the present invention is that it can compensate for setup errors and for wear. This feature may increase the accuracy of the balance procedure. These and other features, aspects, and advantages of the present invention will become better understood with reference to the following description, appended claims, and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a top view of one embodiment of the present invention used to center a disk.

Figure 2A is a top view of the embodiment in Figure 1 with a nominal disk.

Figure 2B is a top view of the embodiment in Figure 1 with an actual disk.

Figure 3A is a top view of an embodiment of the present invention used to balance a disk stack assembly.

Figure 3B is a side view of the embodiment in Figure 3A, showing a plurality of planar biasing members.

Figure 3C is a front view of the embodiment in Figure 3A.

DETAILED DESCRIPTION

Fig. 1 shows one embodiment of an apparatus 10 used to balance one or more disks 12 about an axis of rotation 13. Each disk 12 has a generally cylindrical interior surface 14 defining a central opening 15; two generally planar surfaces, each of which form, at least in part, a magnetic recording surface 16; and a generally cylindrical outer edge 20. The outer edge 20 defines a circumference having an outer diameter ("OD") that varies from a desired or specified (i.e., nominal) value. The apparatus 10 comprises two moveable cylindrical reference surfaces 24 and 26 and a moveable biasing member 28, each of which is fixedly attached to a slidable mount 30, 32, and 34, respectively. The apparatus 10 also includes a position sensor 36, which comprises a transducer 38 attached to the slidable mount 34 by a mounting bracket 40. The position sensor 36 may be connected to a microprocessor 41 by an electrical connector 42.

The biasing member 28 may be any device capable of holding the disk 12 against the reference surfaces 24 and 26 during operation. One suitable biasing member 28 is a flat spring. Flat springs are desirable because they are relatively inexpensive and because they can compensate some initial disk 12 misalignment. However, any biasing member 28 capable of assisting in holding the disk 12 against the reference surfaces 24 and 26 is within the scope of this invention. For example, the biasing member 28 could be a generally planar member biased by a compression spring or an air cylinder.

The position sensor 36 may be any device capable of measuring a deviation between an actual disk OD and the desired (or nominal) disk OD. This deviation may be measured directly or indirectly. For instance, direct measurement can be accomplished by measuring the distance to the outer edge 20 of the disk 12. Indirect measurement can be accomplished by measuring the distance to a back surface 44 of the biasing member 28. The position sensor 36 should be capable of providing accurate and precise results in a relatively brief sampling period. Suitable transducers 38 include, without being limited to: non-contacting sensors, such as laser interferometers, diode arrays, or eddy-current transducers; and contact based sensors, such as a linear variable-differential transformer ("LVDT").

Moveable reference surfaces 24 and 26 and biasing member 28 hold the disk 12 while it is measured and positioned. The reference surfaces 24 and 26 should be made from a relatively hard material having good wear and corrosion resistance and a low thermal expansion coefficient. One example of a suitable reference surface 24 and 26 is a cylindrical post made of nickel plated steel. This embodiment is desirable because it can hold the disks and spacer rings in position during clamping. That is, the disks and spacer rings move axially by a small amount when they are clamped to the motor hub by a preheated collar, a threaded collar, or other appropriate method. Accordingly, a cylindrical reference surface 24 and 26 and a planar biasing member 28 are desirable because they allow the disks and spacer rings to move axially without changing their center position. However, reference surfaces 24 and 26 being made from other materials or having other shapes and orientations are within the scope of the invention.

The slidable mounts 30, 32, and 34 can be any apparatus capable of moving the reference surfaces 24 and 26 and the biasing member 28 in a controlled fashion. The mounts 30, 32, and 34 include an actuating device (not shown) that can individually or collectively slide the mounts in the X direction. Suitable actuating devices include, without being limited to: electro-mechanical actuators; hydraulics; or a cam, gear, or screw powered by an electric motor and controlled by suitable device, such as a linear encoder or a LVDT.

With reference to Figs. 2A-2B, a method of using one embodiment of the present invention to center the OD of a disk 12 on the DSA's axis of rotation 13 will be described. Fig. 2A shows a nominal disk of radius, R_o, whose OD center 52 is aligned with the axis of rotation 13. When the biasing member 28 pushes the nominal disk 12 against the reference surfaces 24 and 26, the position sensor 36 can measure a distance, X_o, between the transducer 38 and the outer edge 20 of the disk 12 (or, alternatively, the back surface 40 of the biasing member 28). Fig. 2B shows a disk 12 having a radius, R, that is slightly larger than the desired radius, R_o. When biasing member 28 pushes this disk 12 against the reference surfaces 24 and 26, its actual OD center 50 will be displaced a distance, "d," from the axis of rotation 13. This displacement, "d," may be calculated in this embodiment using the expression d=2*s/3, where "s" is the change in distance measured by the position sensor 36 between the actual disk and the nominal disk. However, other expressions should be used when the posts 24 and 26 and the biasing member 28 are other than 120 degrees apart. The two reference surfaces 24 and 26 and the biasing member 38 may then be moved along the "X" axis to eliminate the displacement, "d." That is, the disk 12 may be displaced until its actual OD center 50 is positioned along the axis of rotation 13.

Some current hard disk designs arrange several magnetic disks, separated by spacer rings, into a disk stack. This disk stack should be collectively balanced and centered. This process can be accomplished by several methods. One suitable method positions each disk in the disk stack using the procedure described with reference to Figs. 2A-2B. This method is effective, but can be complicated and time-consuming because each disk is moved individually. A second method displaces all of the disks 12 in the disk stack based on their average calculated displacement, $\bar{d}$. This method will result in one-plane (or "static") balancing and is a practical solution when the axial height of the disk pack is small compared to the disk radius (i.e., a "low aspect ratio"). A third method, described with reference to Figs. 3A-3C, may be used on large aspect ratio disk packs (i.e., packs with four or more disks 12). In this method, the balancing and centering is done along the entire length of the rotational axis by appropriately positioning groups of magnetic recording disks. This centering and positioning of the inertial (mass) axis to be both parallel and coincident to the rotational axis is called coupled (or "dynamic") balancing.

Figs. 3A-3C are top, side, and front views of an embodiment that may be used to balance a DSA that has two or more individual disks 12. The apparatus 10 comprises a transducer 38 and an associated biasing member 28 for each disk 12. The disks 12 are divided into a "top group" 60 and a "bottom group" 62. Each group 60 and 62 has its own reference surfaces 24 and 26 attached to their own slidable mounts 30 and 32. The second method, described above, is then used to balance each group 60 and 62 to obtain coupled balance. In the situation where the motor and/or spacer rings are sufficiently balanced by themselves to obtain the desired overall DSA balance, the disks 12 in each group are centered about the axis of rotation 13 by moving the stops in the X direction by the average displacement, $\bar{d}$, of the disks 12 in that group.

Each group 60 and 62 in this embodiment may have the same number of disks 12, or one more disk than in the other group to accommodate packs with various numbers of disks. The displacement calculation for each group 60 and 62 includes all disks 12 in that group. Although this embodiment uses two groups, those skilled in the art will realize that it is within the scope of the present invention to divide the stack into any number of groups. A larger number of groups may produce more accurate results, but will require additional hardware and will increase complexity. Those skilled in the art will also realize that this method may be used to balance a disk pack containing any number of disks 12.

The present invention could also be used to compensate for recurring imbalances, such as misaligned spacer rings, by offsetting the magnetic recording disks 12 from the rotational axis 13 by an appropriate amount. Because the spacer rings are only about one-tenth the mass of the hard disks, any miscentering of the spacer rings can be easily counterbalanced by offsetting the hard disks 12. That is, the spacer rings do not need to be centered accurately if they are located at the same distance and rotation angle in the subassembly from one subassembly to the next. This constant, yet repeatable, miscentering of the spacer rings relative to the rotational axis can be counterbalanced by a constant, yet smaller, offset of the hard disks at 180 degrees from the imbalance. Accordingly, one embodiment would first measure the angle and magnitude of the imbalance by use of a balance analyzer (not shown), such as that disclosed in U.S. Patent Application 09/505,033, filed February 16, 2000 by Bowen et al. ("Bowen"), which is herein incorporated by reference in its entirety. The apparatus 10 would then calculate the appropriate disk offset using the information collected by the balance analyzer and well known mathematical formulas, and offset the disks accordingly. For example, an imbalance of 0.5 gm-mm at 273 degrees may be corrected by offsetting 50 gms of disks by 0.01 mm at 93 degrees. Another embodiment would measure the OD of the spacer rings in the same fashion as previously described with reference to Figs. 2A-2B. An average diameter, $\bar{d}$, can then be calculated for the spacer rings. The disks and/or the rings would be offset to account for the $\bar{d}$ of the spacer rings and their associated mass.

Motor imbalances can also be a significant, recurring contributor to the drive's overall imbalance in certain demanding applications. As with the misaligned spacer rings, the present invention can compensate for a known motor imbalance (magnitude and angle) by offsetting the disks 12 by an appropriate amount at 180 degrees from the imbalance. One embodiment determines the magnitude and angle of the motor imbalance relative to a readable mark that is permanently located on the spindle (an "index mark") using a standard balance analyzer, such as a pair of calibrated signal transducers that sense the vibration produced when the motor is operated or that shown in Bowen. This balance analyzer can be located at any convenient point in the assembly process, and usually before the disks and rings are installed. The data from the balance analyzer may be supplied to the microprocessor 41 and used to calculate the appropriate disk offset using well known mathematical formulas.

The company that supplies the motor typically uses a balance analyzer to achieve its own motor balance specification. Thus, the expense of a motor balancing analyzer at the DSA assembly line can be eliminated if the motor manufacturer supplies its data with each motor it ships. Accordingly, one embodiment uses a machine readable tag, such as a bar code, to correlate each particular motor with its corresponding imbalance data. This embodiment is desirable because it eliminates a balance procedure at the DSA assembly line.

The present invention can also compensate for time varying errors, such as wear and thermal drift. One embodiment detects changes over time by recording the data from the balance analyzer on a computer readable medium. This embodiment then compares the average displacement of several recently manufactured disk packs to the average displacement of several previously manufactured disk packs. Other embodiments, however, can use more sophisticated statistical techniques to identify and quantify changes in the data. Once the change is identified, the microprocessor 41 can calculate an appropriate disk offset that will compensate for the change. This feature is desirable because it can reduce the "down time" that results from having to replace parts and/or to recalibrate the apparatus 10, which results in a simpler and more reliable manufacturing process.

The present invention offers many advantages over the known disk balancing and centering apparatuses. For example, the disclosed apparatus 10 measures the OD dimension of each individual disk 12 in the pack prior to centering. This approach allows the full range of OD dimensions to be present in one pack and still achieve a high degree of balance. In addition, the present invention eliminates the need for a tool to add (or remove) balance weights because it uses the magnetic recording disks as the balance weight. This advantage reduces capital, labor costs, and TAT. Furthermore, the disclosed centering apparatus only needs feedback from a single balance tool in the assembly line. This eliminates the need for the second balancer and may result in additional capital cost, labor and throughput savings.

Although the present invention has been described in detail with reference to certain embodiments thereof, variations are possible. For example, although the embodiments shown in Figs. 1-3 only displace the disks 12 in the "X" direction, those skilled in the art will recognize that the principles described in this disclosure could be applied to displace the disk 12 along a plurality of arbitrary axes. The reference surfaces 24 and 26 may also be staggered at other angles and additional reference surfaces may be added. In addition, the present invention can be used in a variety of centering and balancing applications other than computer hard drives.

Accordingly, those skilled in the art will recognize that the accompanying figures and this description depicted and described embodiments of the present invention, and features and components thereof. With regard to means for fastening, mounting, attaching or connecting the components of the present invention to form the mechanism as a whole, unless specifically described otherwise, such means are intended to encompass conventional fasteners such as machine screws, nut and bolt connectors, machine threaded connectors, snap rings, screw clamps, rivets, nuts and bolts, toggles, pins, and the like. Components may also be connected by welding, soldering, brazing, friction fitting, adhesives, or deformation, if appropriate. Unless specifically otherwise disclosed or taught, materials for making components of the present invention are selected from appropriate materials, such as metal, metallic alloys, fibers, polymers, and the like; and appropriate manufacturing or production methods, including casting, extruding, molding, and machining, may be used. In addition, any references to front and back, right and left, top and bottom and upper and lower were intended for convenience of description, not to limit the present invention or its components to any one positional or spacial orientation. Therefore, it is desired that the embodiments described herein be considered in all respects as illustrative, not restrictive, and that reference be made to the appended claims for determining the scope of the invention.

CLAIMS

1. An apparatus for balancing at least one disk on a spindle, comprising:

a sensor, operably connected to at least one disk, that produces a signal indicative of a deviation from a desired dimension; and

a movable reference surface that moves the at least one disk in response to the signal from the sensor.

2. The apparatus of claim 1, further comprising:

biasing member that biases the at least one disk against the movable reference surface.

3. The apparatus of claim 1, further comprising a plurality of disks arranged into a disk stack assembly.

4. The apparatus of claim 3, wherein:

the disk stack assembly is split into at least two groups; and

the moveable reference surfaces move each group in the at least two groups based on an average deviation from the desired dimension.

5. The apparatus of claim 3, wherein the movable reference surface moves the plurality of disks to obtain a one-plane balance.

6. The apparatus of claim 3, wherein the moveable reference surface moves the plurality of disks to obtain a coupled balance.

7. The apparatus of claim 1, further comprising:

a microprocessor operably connected to the sensor and to the movable reference surface.

8. The apparatus of claim 7, further comprising:

a balance analyzer, operably connected to the microprocessor, for producing a signal indicative of an imbalance.

9. The apparatus of claim 8, wherein the signal from the balance analyzer is indicative of a recurring imbalance.

10. The apparatus of claim 8, wherein the signal from the balance analyzer is indicative of an imbalanced spacer ring.

11. The apparatus of claim 8, wherein the signal from the balance analyzer is indicative of an imbalanced motor.

12. The apparatus of claim 8, wherein the signal from the balance analyzer is indicative of setup errors.

13. The apparatus of claim 8, wherein the signal from the balance analyzer is indicative of wear.

14. The apparatus of claim 8, wherein the signal from the balance analyzer is indicative of thermal drift.

15. The apparatus of claim 8, wherein the microprocessor uses the signal from the balance analyzer to calculate a disk offset that will dynamically balance a plurality of disks arranged into a disk stack assembly.

16. The apparatus of claim 1, wherein the at least one disk comprises an outer surface that defines an outer diameter and wherein the desired dimension is the outer diameter.

17. A disk stack assembly balancing apparatus, comprising:

a biasing member adapted to bias at least one of a plurality of disks against a disk reference surface;

a sensor for producing a signal indicative of each disk's deviation from a desired dimension;

a positioning member that moves the disk reference surface in response to the signal from the sensor, thereby balancing the disk stack assembly.

18. A method of balancing a disk on a spindle, comprising:

generating a signal indicative of a deviation of the disk from a desired dimension; and

moving the disk in response to the signal.

19. The method of claim 18, further comprising:

providing a movable reference surface; and

biasing a disk against the movable reference surface.

20. The method of claim 18, wherein the disk comprises an outer surface that defines an outer diameter and wherein the desired dimension is the outer diameter.

21. A method of balancing a disk stack assembly independent of variations in an outer diameter of a disk member, comprising:

providing a plurality of movable reference surfaces;

biasing a plurality of disks against the plurality of movable reference surfaces;

generating a signal indicative of an average deviation of the plurality of disks from a nominal dimension; and

moving the plurality of disks in response to the signal.

22. The method of claim 21, further comprising:

dividing the plurality of disks into at least two groups;

generating a signal indicative of the average deviation of a first group in the at least two groups; and

moving the first group in response to the signal indicative of the average deviation of the first group.

23. A method of centering a disk on a spindle, comprising:

providing a movable reference surface;

biasing a disk against the movable reference surface;

generating a signal indicative of a deviation of the disk from a desired dimension; and

moving the disk in response to the signal.

24. A disk stack assembly having at least one imbalance, comprising:

a spindle; and

an offset disk rotationally coupled to the spindle, whereby the offset disk compensates for the at least one imbalance.

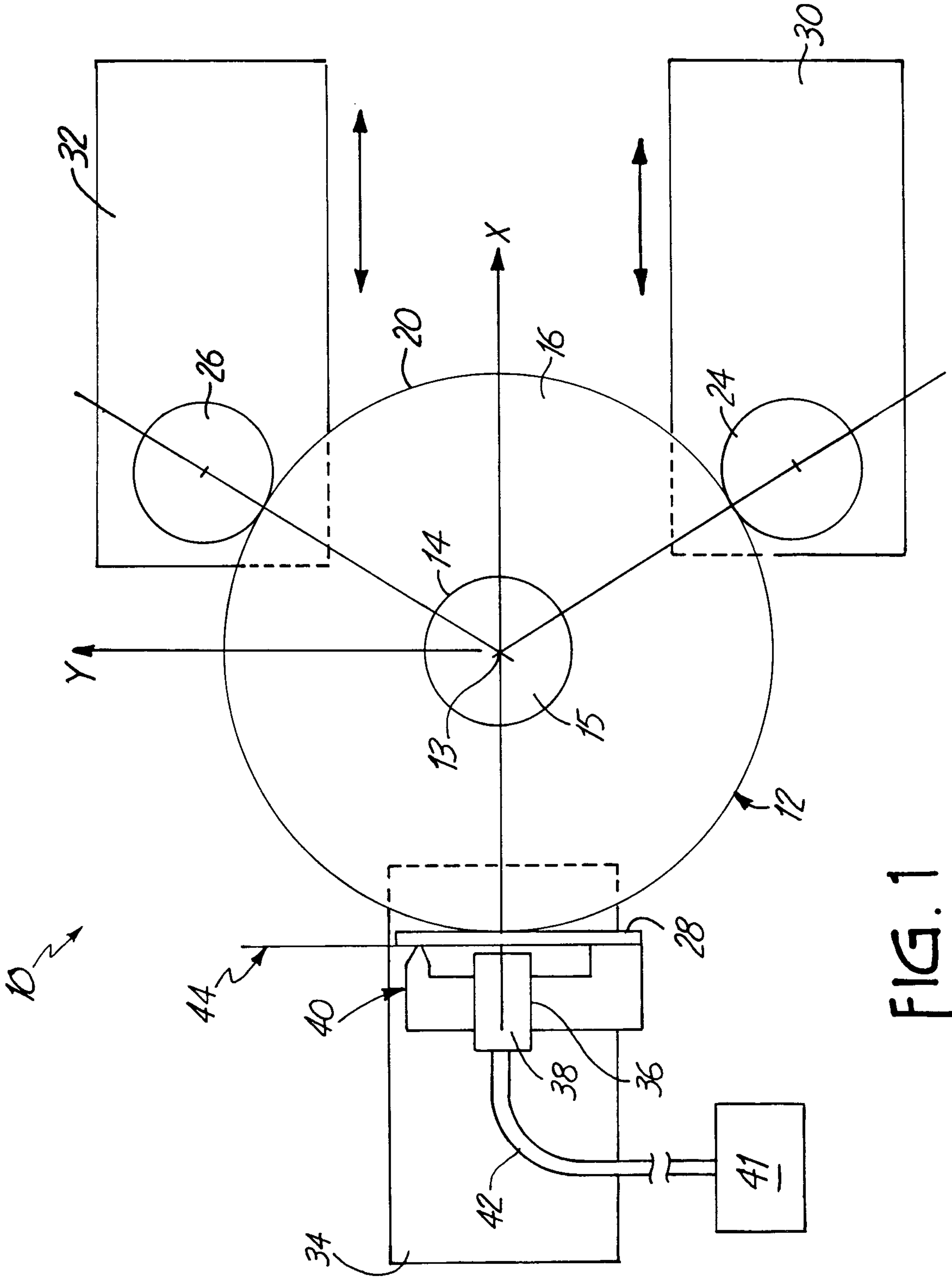

FIG. 1

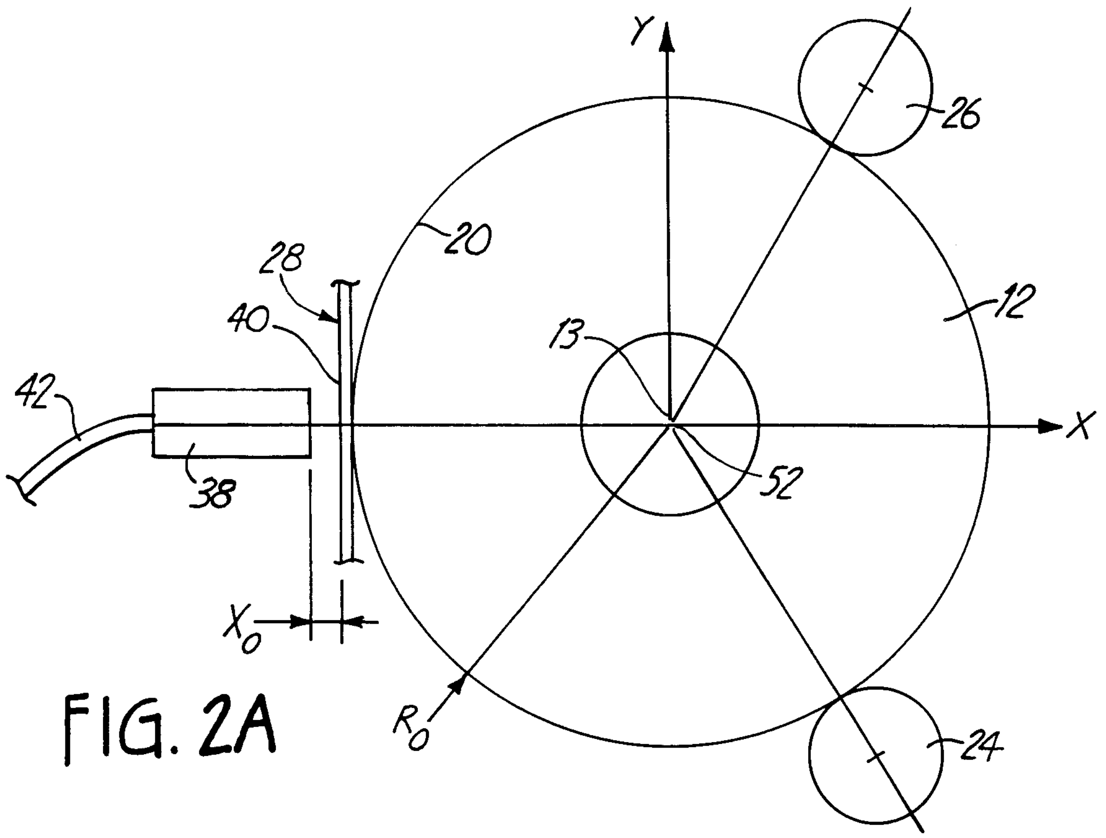
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FIG. 2A

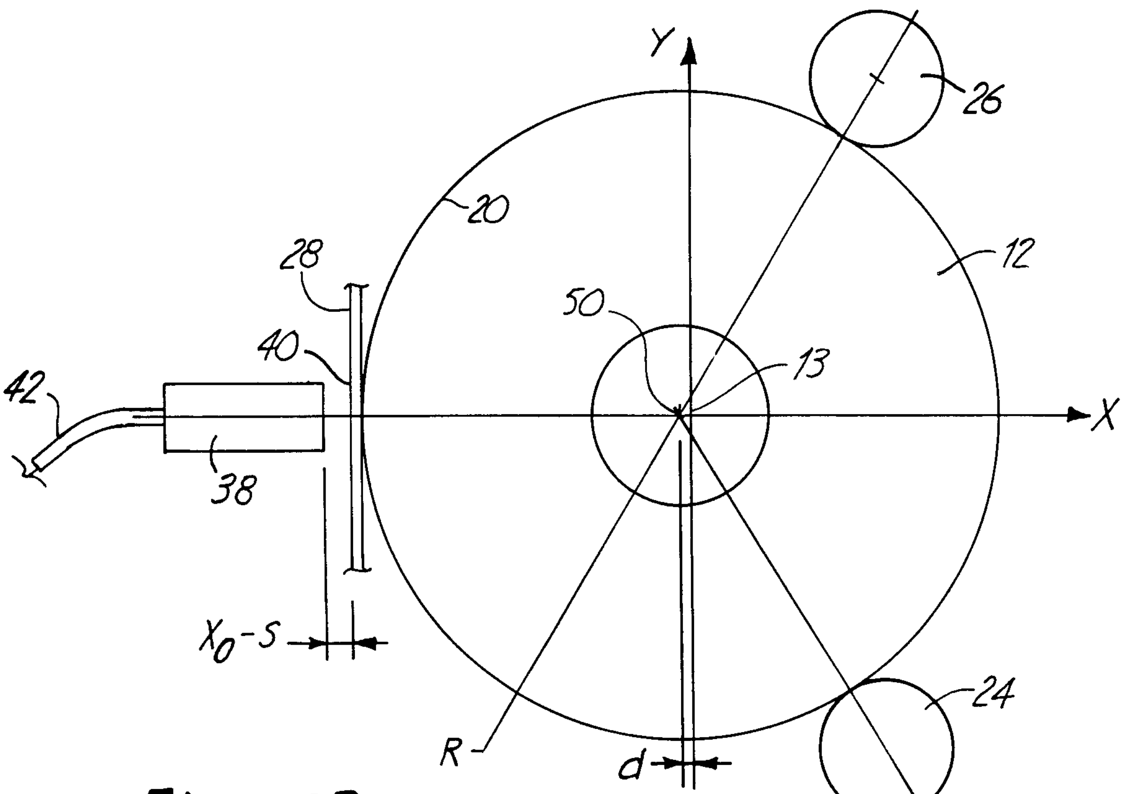
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FIG. 2B

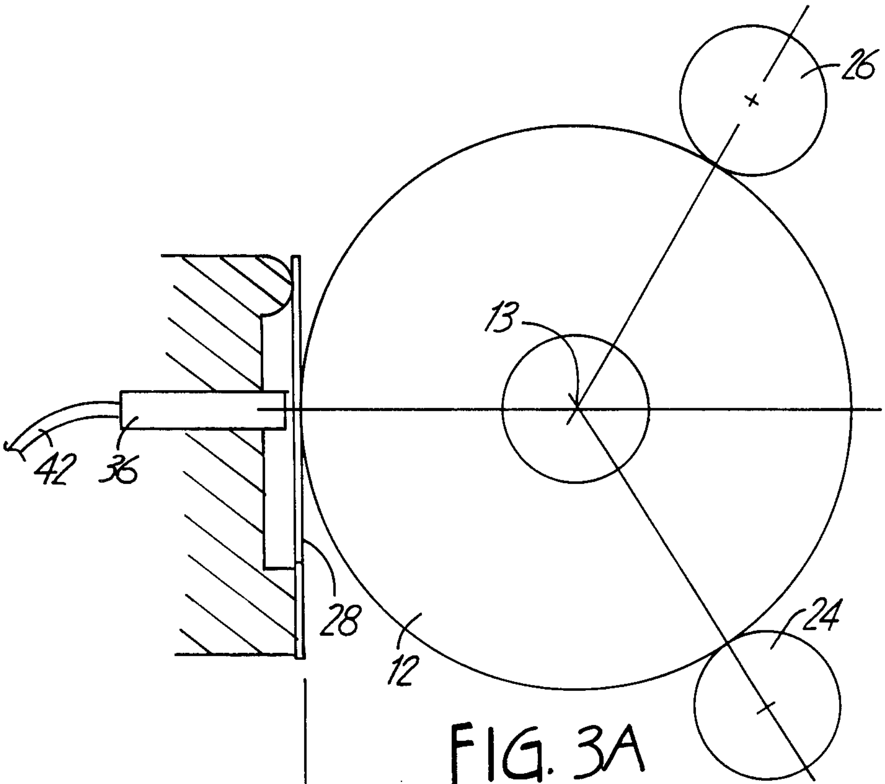

FIG. 3A

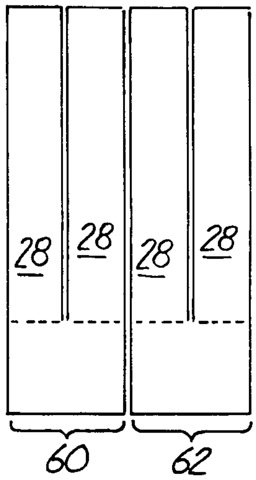

FIG. 3B

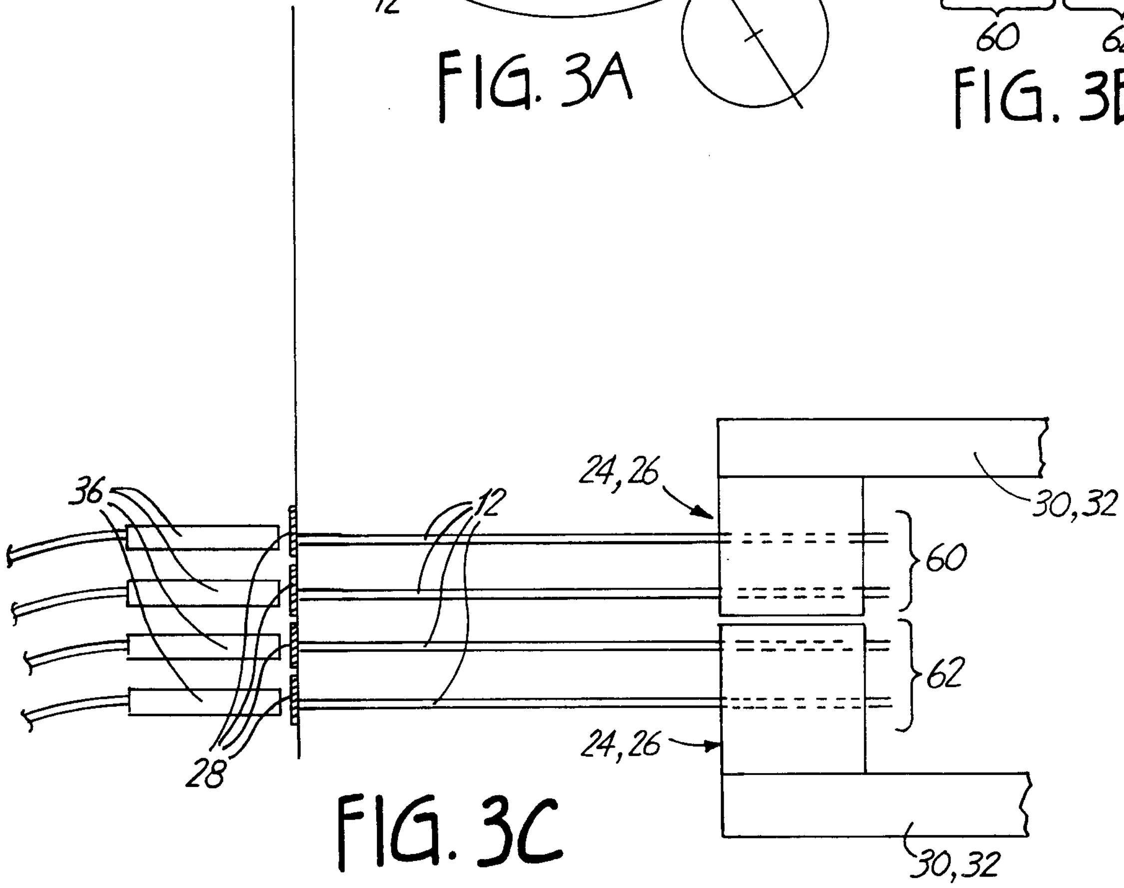

FIG. 3C

INTERNATIONAL SEARCH REPORT

International Application No:
PCT/US 00/11614

A. CLASSIFICATION OF SUBJECT MATTER
G11B17/02,G11B17/022,G11B17/028,G11B17/038,G11B17/22,
G11B17/26,G11B17/32,G11B17/34,G11B17/00

According to International Patent Classification (IPC) or to both national classification and IPC[7]

B. FIELDS SEARCHED

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

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 287 (M-264), 21 December 1983 & JP 58 160058 A (NIPPON TOKUSHU TOGYO K.K.) 22 September 1983, abstract. --	1,2, 18,24
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 289 (M-845), 05 July 1989, & JP 01 083945 A (OKUMA MACH WORKS LTD) 29 March 1989, abstract. --	1,2, 18,24
A	EP 0211964 A1 (CARL SCHENCK AG) 04 March 1987,	1,2, 18,24

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:
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Date of the actual completion of the international search
01 August 2000

Date of mailing of the international search report
-9. 10. 2000

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C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	abstract, fig. 1, claims 1-11. --	
A	DE 4122340 A1 (KABUSHIKI KAISHA TOYODA JIDOSHOKKI SEISAKUSHO K.K.) 16 January 1992, abstract, fig. 1,2, claims 1-6. ----	1,2, 18,24

ANHANG	ANNEX	ANNEXE
Zum internationalen Recherchenbericht über die internationale Patentanmeldung Nr.	To the International Search Report to the international Patent Application No.	Au rapport de recherche international relativ à la demande de brevet international n°

PCT/US 00/11614 SAE 283065

In diesem Anhang sind die Mitglieder der Patentfamilien der im obengenannten internationalen Recherchenbericht angeführten Patentdokumente angegeben. Diese Angaben dienen nur zur Unterrichtung und erfolgen ohne Gewähr.

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La presénte annexe indique les membres de la famille de brevets relatifs aux documents de brevets cités dans le rapport de recherche international visée ci-dessus. Les renseignements fournis sont donnés à titre indicatif et n'engagent pas la responsibilité de l' Office.

Im Recherchenbericht angeführte Patentdokumente Patent document cited in search report Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung Publication date Date de publication	Mitglied(er) der Patentfamilie Patent family member(s) Membre(s) de la famille de brevets	Datum der Veröffentlichung Publication date Date de publication
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For more details about this annex see Official Journal of the European Patent Office, No. 12/82.