[① Original Spec
② Replacement 11-2-98]

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SELF SERVO WRITING FILE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a direct access storage device (DASD) of the type in which a read/write transducer head is moved above a storage media for reading and writing data, and more particularly to improved servo writing methods and apparatus for a direct access storage device.

2. Description of the Prior Art

Disk drive units incorporating stacked, commonly rotated rigid magnetic disks are used for storage of data in magnetic form on the disk surfaces. Transducer heads driven in a path toward and away from the drive axis write data to the disks and read data from the disks. Data is recorded in concentric data information tracks arrayed on the surfaces of the disks.

All DASD units must have a method to position each data head over the proper radial location to write a track and again, to position it very close to the same location to read the track. With the higher level files using a voice coil type of actuator, a feedback mechanism must be provided to locate and stably hold the head on a given track. Typically,

track accessing and track following is provided by a magnetically written pattern in the DASD unit. A dedicated servo system employs one surface of one of the disks in the DASD on which to have all the tracking and access information. A sector servo system uses small portions of tracks between each or between several sectors on each track of each data surface to provide the tracking and access information. A hybrid servo system uses both to obtain advantages of each type of servo.

Typically the servo patterns are written on the disk or disks with a special servo writer system. This system usually includes a laser measured access system to accurately position the heads. This requires a retro-reflector to be attached to the file actuator. The system also includes a clock head or heads to write timing information. Each file that is to be servo written must be firmly clamped to the servo writer to maintain accurate positioning between the two machines. The servo writer must be used in a clean area since the file must be open during the track writing process. This increases the cost and increases the probability of contaminating the file.

In clamping the DASD unit to the servo writer, the natural resonances of the file are significantly changed. Thus while tracks written on the servo writer appear to be nearly perfect, they change when the file is removed and the resonances change, the servo system does not follow the servo tracks perfectly, creating repeatable runout, which makes

the determination of being on track difficult.

Examples of other known servo systems are provided by U.S. patents Oliver et al., 4,414,589; Penniman, 4,530,019; and Berger, 4,531,167.

Oliver et al.,4,414,589 discloses an embedded servo track following system and method for writing servo tracks that does not require a servo writer to write embedded servo data. However, a clock track for very accurate timing is required for providing an index of disc position and a measure of disc speed for writing servo data. The clock track is written by writing a single pulse on a fixed magnetic clock head, phase-lock looping to an intermediate clock track, which is written on a moving head, and then phase-lock looping up to the final clock track which is written on the fixed clock track head.

Berger, 4,531,167 discloses a portable servo writer system for writing clock and servo tracks either on a dedicated disk surface or embedded servo tracks on disks of a magnetic disk drive. Servo tracks are written by providing a master disk cartridge having one fixed head and a dedicated servo surface. The master disk cartridge is installed on the drive and the servo surface of the drive and the embedded servos are written using prewritten clock and index information from the fixed head of the master cartridge.

Penniman, 4,530,019 discloses a servo pattern

including an erased gap followed by an automatic gain control (AGC) information burst followed by a first burst of servo control information followed by a second burst of servo control information. The pattern is written on a disk by the disk drive unit using a mechanical index on an armature associated with the rotation of the disk as a primary time reference, with all other time references being based on a transition between the erased gap and the AGC burst. While the disclosed servo pattern eliminates the need for a separate clock track, the mechanical index, sensors for the mechanical index, and a positioning system are required for moving the read/write head to write the servo pattern.

While the prior art servo writing devices provide improvements, it is desirable to provide an improved method for writing servo information by the disk file and a self servo writing file where a special servo writer system and prewritten patterns on the disks are not required and further that does not require either a clock track timing reference or substantial different circuitry from the normally available circuitry of the disk file.

SUMMARY OF THE INVENTION

Important objects of the present invention are to provide an improved self servo writing file and methods of writing servo information; to provide improved methods of self servo writing in which variable track width and head dependent pitch are

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enabled and optimized use of the head/disk capability is supported; and to provide an improved self servo writing file and methods of writing servo information substantially without negative effects and that overcome many disadvantages of those used in the past.

In brief, the objects and advantages of the present invention are achieved by a self servo writing file and method for writing servo patterns in a direct access storage device. First servo information is written on a data storage media at a first crash stop. The transducer heads are moved offset from the written servo information while reading the last written servo information until the detected servo signal equals a predetermined value. Then servo information is written on the data storage media responsive to the detected servo signal equal to the predetermined value. The moving and writing steps are sequentially repeating until a second crash stop is reached. A quad-burst servo amplitude pattern or phase pattern can be used for the servo information. Significant advancements are that no clock head is required to achieve this high bandwidth system while sector placement is maintained in a repeatable radial spoke like arrangement.

In accordance with the invention, the servo writing method is adapted easily for many different servo options. When the file uses a hybrid servo or sector servo, the other surfaces can be written by duplicating the servo bursts or any servo pattern with

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a high bandwidth servo system. Alternatively, the servo writing steps can be repeated for each of the other surfaces providing head dependent pitch. Variable track pitch can be provided by selectively varying the predetermined value compared with the detected servo signal.

BRIEF DESCRIPTION OF THE DRAWING

The present invention together with the above and other objects and advantages may best be understood from the following detailed description of the embodiment of the invention illustrated in the drawing, wherein:

FIG. 1 is a schematic and simplified vertical sectional view of a rigid magnetic disk drive unit embodying the present invention;

FIG. 2 is a top plan view of the structure shown in FIG. 1;

FIG. 3 is a flow chart illustrating sequential operations of the self servo writing file of the invention;

FIGS. 4A, 4B, 4C and 4D are flow charts illustrating alternative sequential operations of the self servo writing file of the invention;

FIG. 5 illustrates a quad burst servo pattern for the self servo writing file of the invention;

FIG. 6 illustrates servo signals for the self servo writing file of the invention;

FIG. 7 is a flow chart illustrating alternative sequential operations of a self servo writing file of the invention; and

FIG. 8 is a flow chart illustrating sequential operations for identifying an offset table and rewriting calibration patterns in the method of the self servo writing file shown in FIG. 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 there is shown a partly schematic block diagram of parts of a data storage disk file 10 including a rigid magnetic disk drive unit generally designated as 12 and a control unit generally designated as 14. While a magnetic disk drive unit is illustrated, it should be understood that other mechanically moving memory configurations may be used. Unit 12 is illustrated in simplified form sufficient for an understanding of the present invention because the utility of the present invention is not limited to the details of a particular drive unit construction. After data storage disk file 10 is completely assembled, servo information used to write and read data is written using the disk file 10. The need for prerecorded servo patterns often written with a servo writer system is eliminated.

Referring now to FIGS. 1 and 2 of the drawing, disk drive unit 12 includes a stack 16 of disks 18 having at least one magnetic surface 20. The disks 18 are mounted in parallel for simultaneous rotation on and by an integrated spindle and motor assembly 26. Data information on each disk 18 are read and/or written to by a corresponding transducer head 28 movable across the disk surface 20. In a disk drive using a dedicated or hybrid servo, one of the disk surfaces 20' stores servo information used to locate information and data on the other disk surfaces 20.

Transducer heads 28 are mounted on flexure springs 30 carried by arms 32 ganged together for simultaneous pivotal movement about a support spindle 34. One of the arms 32 includes an extension 36 driven in a pivotal motion by a head drive motor 38. Although several drive arrangements are commonly used, the motor 38 can include a voice coil motor 40 cooperating with a magnet and core assembly (not seen) operatively controlled for moving the transducer heads 28 in synchronism in a radial direction in order to position the heads in registration with data information tracks or data cylinders 42 to be followed and access particular data sectors 44. Although a rotary actuator is shown, it should be understood that a disk drive with a linear actuator can be used. Data storage disk file 10 is a modular unit including a housing 46. The various components of the disk file 10 are controlled in operation by signals generated by control unit 14 such as motor control signals on line 26A and position control signals on line 38A.

Numerous data information tracks 42 are arrayed in a concentric pattern in the magnetic medium of each disk surface 20 of data disks 18. A data cylinder includes a set of corresponding data information tracks 42 for the data surfaces 20 in the data storage disk file 10. Data information tracks 42 include a plurality of segments or data sectors 44 each for containing a predefined size of individual groups of data records which are saved for later retrieval and updates. The data information tracks 42 are disposed at predetermined positions relative to servo information, such as a servo reference index. In FIG. 2 one sector 44 is illustrated as SECTOR 0 with a fixed index or mark INDEX for properly locating the first data sector. The location of each next sector 44 is identified by a sector identification (SID) pulse read by transducer heads 28 from surfaces 20, 20′.

In FIG. 3, there is shown a flow chart illustrating the self-servo writing accomplished by a boot-strap method of the invention beginning at a block 300. Sequential operations begin with the file started with the actuator at the inner diameter (ID) stop as indicated at a block 302. File 10 is spun up with the actuator latched against the inner (ID) crash stop as indicated at the block 302. Disks 18 in the DASD 10 preferably will have no signal present on the surfaces 20 and 20′. Alternatively, the disk surfaces 20 and 20′ will be erased in the file, however this is more difficult.

First the latch is released, and a small current is applied to move the actuator towards the outer crash stop. The actuator bounces to a stop at the outer (OD) crash stop as indicated at a block 304.

A quad-burst servo pattern as disclosed in "QUAD BURST SERVO NEEDING NO SYNC ID AND HAVING ADDED INFORMATION", IBM Technical Disclosure Bulletin Vol. 33, No. 3B, August 1990 advantageously is used. As illustrated in FIG. 5, the quad-burst servo pattern consists of four different base amplitude patterns with the same fundamental frequency. Each of the four pattern types are written in the corresponding offtrack positions separated in time designated by A, C, B, and D. Each burst has the capability of p-roviding self identification. Accurate timing of information between bursts is not required for reading the servo pattern. FIG. 6 illustrates the primary position error signal (PES) or P signal and the quadrature PES or Q signal used for writing the servo pattern. Alternatively, a more standard approach of an ID field and the servo burst could be used for each burst of the amplitude pattern, such that reading the pattern never requires the timing of information between tracks. Note that quad-burst patterns have at least one track width of erased data beside each burst so that no other signal is picked up even if the head is significantly offset from a given pattern.

Each head 28 is used to burst write a servo pattern A at the OD crash stop as indicated at a

block 306. The amplitude of each head is measured and saved as indicated at a block 308. As indicated at a decision block 310 offset measurements are made. The offset available by using the reduced track amplitude is less than the physical track width. Since the track width of a head is about 3/4 of the desired pitch, an offset of 1/2 of the track pitch can be used; however, it should be understood that another value may be used if desired. One head is selected arbitrarily indicated as head 1 in a block 312 to servo away from the stop a selected offset, for example, about 1/2 track. Head 1 is moved until an empirically predetermined ratio S of amplitude at 1/2 track offset to amplitude on track is detected.

Offset amplitudes of all the heads are measured and then compared to the original amplitudes at block 310. A maximum ratio head having the largest fraction or maximum ratio corresponding to the widest head on the actuator is identified and saved as indicated at a block 314. Then the written pitch is referenced to this maximum ratio head to allow enough room to prevent too much squeeze. This can be used to allow data to be written at larger radii reducing linear density and improving quality or by allowing higher capacity offerings from the same base model file 10.

Other information about the track misregistration (TMR) distribution on different heads, or from a squeeze test can be used to influence the selection of the nominal pitch for the file.

Once the selected pitch is determined, a reference head is selected to be the dominant servo head for writing the file. The reference head can be the widest head saved at the block 314. Alternatively, when a dedicated servo surface or a hybrid servo is to be written, the servo head is selected as the reference head. Other basis for the reference head selection could be the head with the highest signal or signal-to-noise estimate, or a position in the disk stack that is known to have the least TMR.

Then the maximum ratio head is moved until the measured ratio equals the empirically predetermined ratio S as indicated at a block 316. Then the amplitude for the selected reference head is measured and compared with the original amplitude and a ratio T is saved as indicated at block 318.

Next the OD stop outer track is written with the burst pattern of the type defined as A as shown in FIG. 4, if required, as indicated at blocks 320 and 322. On track amplitudes are measured and saved as indicated at a block 324. When the original amplitude track written at block 306 is adequate, it can be used; otherwise, a new pattern A is written at the block 322 with the erase left on between the bursts. When the start to stop timing or spacing of the first to last burst is inadequate, the burst pattern A is rewritten with erase on between bursts until adequate closure is obtained.

A low bandwidth servo system is used so that any written track will not contain any significant amount of repeatable runout, except for small noise deviations, and the head will therefore follow its natural course. The low bandwidth servo requirement prevents the build-up of repeatable runout, that would result if a high bandwidth system were used. The start of write is obtained from a motor pulse for index. The burst patterns are written with bursts phase lock loop (PLL) synchronized to motor revolution.

Next it is determined if the reference head is at the ID crash stop as indicated at a decision block 326. If not, the head actuator is moved offtrack by 1/2 of the track pitch identified by a measured ratio T for the reference head as indicated at a block 328. Then the buffer pattern is incremented as indicated at a block 330 so that following type A bursts, type C bursts are written at block 322 starting a given time after the start of each type A burst. The current is turned off between the bursts to avoid erasing edges of the previously written bursts.

The servo system measures the average ontrack amplitude of the type C bursts and establishes the threshold level T as the fraction of the measured average amplitude, to be used as the servo reference. The servo system is then switched to the C signal and the head accessed until the amplitude equals the calculated threshold.

Next the sequential steps are repeated and type B bursts are written, timing off the type C bursts. Then the type D bursts are written, timing off the type B bursts. The head is now approximately aligned with the type A bursts written two customer tracks back. The sequential steps are repeated until the reference head reaches the ID crash stop identified at block 326.

To maintain uniform burst spacing, an average timing value between previous track bursts is established. Uniform burst spacing can be accomplished using a given number of cycles of a crystal clock. The clock is high frequency so there are hundreds of cycles counted to establish the nominal burst spacing. The count of the reference clock counter at the time of the previous burst is compared to the expected count and correction is applied for the average error over multiple bursts. When the error indicates the bursts are occurring later on the average than the expected, the burst spacing count is corrected to delay the calculated expected positions. In this way, an averaging of the burst spacings is performed and bursts are written much more uniformly so that the variability of the burst spacing does not significantly accumulate.

This action provides a uniform spacing between bursts. However, there can still be a small timing offset between tracks that can accumulate and can produce a slow change in the circumferential position of the bursts versus radius. The average

circumferential position of the bursts can be compared to the motor drive timings. Any error is averaged over a larger period and can also be used to change the number of crystal clock counts per burst. Using this feedback, significant creep of bursts in the circumferential direction versus radius is prevented.

After one whole surface is written, the other surfaces are written for sector servo or hybrid servo files, by switching to the high bandwidth servo using the difference between two bands for the PES, and duplicating the servo bursts onto the other surfaces. For example, with the head centered between the type A and type B bursts, the type C bursts are written on all the other surfaces, multiplexing the read of the A and B signals with the write of the C burst between. In a similar manner, all the other bursts can be duplicated, except the last type on each end of the data band. These are not needed but could be written if desired by moving against the crash stops.

Alternatively the above sequential self-servo writing steps can be performed for separately writing each surface for providing head dependent pitch. In this case, each surface has a different track density, according to the track width of the next head. The use of a pitch to match each head allows more optimum use of each head's capability. Then each head defines the servo and the sequential steps of selecting the widest head for the maximum ratio head are eliminated.

The averaging of burst positions to create a circumferential or angular position reference allows the writing of servo tracks without requiring the use of a clock head. Eliminating use of the clock head is a significant advancement over known arrangements. Typically a clock head has been used to overcome the circumferential timing synchronizing problem on the surface of the disk. Using the motor drive or clock frequency multiples allows synchronization with the disk surface eliminating the need for a clock head.

Even though a clock head is not required, high bandwidth and high burst density can be achieved. The use of the file clock and PLL synchronized motor drive commands allows accurate placement of the servo bursts circumferentially around the track. The accurate burst placement allows a very high density of bursts to be written. The high burst density directly contributes to increasing the servo position sample rate which increases the available servo bandwidth capability. Hence the bandwidth is not limited by the number of motor poles or electrical drive cycles.

The technique for maintaining burst position synchronization with the angular displacement on the disk is key for providing a stable index and an orderly spoke like sector arrangement on the disk surface. This enhances the control over sector positioning on the disk surface and allows optimal arrangement of the sectors for maximum throughput.

It should be understood that for a track density

selected either for all surfaces in common, or for each surface separately, it is not necessary to maintain a constant track density across the radial band. The pitch can be selectively varied by using an algorithm to selectively vary the fraction of full amplitude that is detected for moving the actuator in the servo-writing offtrack positioning at block 328.

Referring now to FIGS. 4A, 4B, 4C and 4D, alternative sequential operations of the self servo writing file 10 are illustrated for implementing the burst writing step of block 322 of FIG. 3. In FIG. 4A, the sequential operations begin at a block 400 for a first case with bursts PLL synchronized to motor revolution. Counts of burst write starts and stops are initialized at a block 402 and a count value for a full revolution is set at a block 404. Next at a decision block 406, a modulo count is compared with a burst write start. When equal, the buffer pattern write is started as indicated at a block 408. Otherwise or after starting the buffer pattern write, then at a decision block 410 a modulo count is compared with a burst write stop. When equal, the buffer pattern write is stopped as indicated at a block 412. The sequential operations are repeated returning to the decision block 406, until a completed revolution is identified at a decision block 414. Then the sequential operations continue to block 324 in FIG. 3.

In FIG. 4B, the sequential operations begin at a block 418 for a second case with nonsynchronized

triggered burst writes that is subject to greater motor speed variation error. First it is determined if the head is forced against the OD stop at a decision block 420. If yes, then an initial burst track write is performed until closure is achieved as indicated at a block 422 and then the sequential operations continue to block 324 in FIG. 3. Otherwise, a new burst is written by first as indicated at a block 424 to lock the PLL on to previous track bursts, then to trigger the counter by threshold detection of the start of the previous track burst at a block 426. When a count equal to the burst start separation count is identified at a decision block 428, then the new burst is written at a block 430. The sequential operations are repeated returning to block 426, until the last burst on the track has been written identified at a decision block 432. Then the sequential operations continue to block 324 in FIG. 3.

In FIG. 4C, the sequential operations begin at a block 436 for a third case with nonsynchronized averaged triggered burst writes that reduces average burst start error. First it is determined if the head is forced against the OD stop at a decision block 438. If yes, then an initial burst track write is performed until closure is achieved as indicated at a block 440 and then the sequential operations continue to block 324 in FIG. 3. Otherwise, a new burst is written by first as indicated at a block 442 to lock the PLL on to previous track bursts, then to trigger the counter start by averaging burst start detected threshold

timings at a block 444. When a count equal to the burst start separation count is identified at a decision block 446, then the new burst is written at a block 448. The sequential operations are repeated returning to block 442, until the last burst on the track has been written identified at a decision block 450. Then the sequential operations continue to block 324 in FIG. 3.

In FIG. 4D, the sequential operations begin at a block 454 for a fourth case with nonsynchronized averaged triggered burst writes with index correction that reduces average burst start error and corrects for index drift around the revolution. First it is determined if the head is forced against the OD stop at a decision block 456. If yes, then an initial burst track write is performed until closure is achieved as indicated at a block 458 and then the sequential operations continue to block 324 in FIG. 3. Otherwise, a new burst is written by first as indicated at a block 459 to lock the PLL on to previous track bursts, then to trigger the counter start by averaging burst start detected threshold timings and track average time at a block 444. When a count equal to the burst start separation count is identified at a decision block 462, then the new burst is written at a block 464. The next step is to update average track time correction by the difference to the present driver or PLL motor lock time as indicated at a block 466. Then the sequential operations are repeated returning to block 460, until the last burst on the track has been written identified at a decision

block 468. Then the sequential operations continue to block 324 in FIG. 3.

In FIG. 7, there is shown a flow chart illustrating an alternative self-servo writing method of the invention beginning at a block 700. First master disk surface is erased as indicated at a block 702 in the alternative self-servo writing method. Erasing can be accomplished by turning on the head write current with a DC data signal while slowly moving the head across the master disk surface. To minimize the number of missed spots that occur if the head moves too fast during erasing, repeated passes over the disk can be made. By controlling the velocity such that the head moves less than one head width per disk revolution, erasing can be provided with a single pass. Constant velocity moves can be accomplished by back EMF sensing of the actuator motor to determine its velocity. Also when a large percentage of the disk surface is erased, for example, such as more than 90%, then this self-servo writing method can be performed.

Next a clock track is written at one of the crash stops, such as the ID crash stop as indicated at a block 704. A stable clock source, such as a crystal clock, is used to write a required number of clocks on the disk using a single head at the block 704. After a clock track is written, the number of clocks actually written for one revolution is counted using an index mark encoded in the clock data to determine when to start and stop counting. When the disk is rotating at

the proper speed, the required number of clocks (N) are written on the disk and clock writing is complete. Otherwise, repeated clock writing trials and tests are made until exactly N clocks are written to the disk. Since the clock source is fixed in frequency, only the disk speed is varied for each clock writing trial until the correct number of N clocks are written.

Bursts of servo information are written over the clock track, periodically around the track as indicated at a block 706. Then each clock burst between the servo information bursts are divided into two halves, naming the first half the odd clock burst and the second half the even clock burst as indicated at a block 708. Next as indicated at a block 710, the head is moved using the odd clock track signal amplitude as a servo signal, until the amplitude drops to a predetermined value T1, for example, such as 60% as indicated in a decision block 712. Then even clock burst and servo information are written for this head position while servoing and synchronizing the system timing off the odd clock burst on the previous track as indicated at a block 714. At block 714, the servo information is written aligned in time with the servo burst on the previous track.

Next as indicated at a block 716, the head is moved using the even clock track signal amplitude as a servo signal until the amplitude drops to the predetermined value T1, as indicated in a decision

block 718. Then odd clock burst is written for this head position while servoing and synchronizing the system timing off the even clock burst on the previous track as indicated at a block 720. Then the sequential steps are repeated returning to block 710 until the head is moved all the way across the disk to the OD crash stop as indicated at a decision block 722 to complete the servo writing process. Then a calibration pattern is written between each odd and even clock bursts where no servo pattern had been written previously over the disk surface. The calibration patterns are written using the servo patterns for positioning the head as indicated at a block 724. After writing the entire surface with the calibration servo patterns at block 724, then each calibration servo pattern is read back as indicated at a block 726 in order to determine any offsets, for example due to head geometric effects and the coarse positioning used in blocks 710 and 716, as indicated at a block 726. Identified offsets are stored in an offset table as indicated at a block 728. Then moving to a next track, calibration patterns are repeatedly read at block 726 and stored in the offset table at the block 728 until all tracks have been read as identified at a decision block 730. Then the calibration patterns are rewritten as indicated at a block 732, using the stored offset table for position correction adjustments. The rewritten calibration patterns are evenly spaced at the proper track spacing and then serve as the master pattern for the disk file. The originally written servo patterns are no longer needed and can be overwritten. For sector

servo or hybrid servo files, the servo information and clock information between servo bursts can be written on the other surfaces.

Referring now to FIG. 8, there is shown a flow chart illustrating sequential steps for read back of the calibration patterns and rewriting the calibration patterns at blocks 726-732 of FIG. 7. The sequential operations begin at a first track as indicated at a block 802. Then servo information or servo pattern is read as indicated at a block 804 to determine an average for the track. Next the calibration patterns for that track are read as indicated at a block 806 to determine an average calibration value. The difference between the calibration and servo pattern averages is recorded as indicated at a block 808. Unless the last track is identified at a decision block 810, then the sequential operation continues with a next adjacent track as indicated at a block 812. After all the servo and calibration patterns from the last track have been read and the differences recorded, then an average value of all recorded differences is calculated as indicated at a block 814. Then the identified average value is subtracted from each recorded difference to store the offset table as indicated at a block 816. Then the calibration patterns are rewritten, using the stored offset table for position correction adjustments, as indicated at a block 818. The sequential steps at blocks 802-818, inclusive, then can be repeated to achieve the master pattern for the disk file.

While the invention has been described with reference to details of the illustrated embodiment, these details are not intended to limit the scope of the invention as defined in the appended claims.

What is claimed and desired to be secured by Letters Patent of the United States is:

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CLAIMS

1. A method for writing servo patterns in a direct access storage device comprising the steps of:

writing servo information on a data storage media at a first crash stop;

moving offset from said last written servo information and detecting said written servo information until said detected servo signal equals a predetermined value;

writing servo information on said data storage media responsive to said detected servo signal equal to said predetermined value; and

sequentially repeating said moving and writing steps until a second crash stop is reached.

2. A method for writing servo patterns as recited in claim 1 wherein said direct access storage device includes a low bandwidth servo system used for said servo information writing steps.

3. A method for writing servo patterns as recited in claim 1 wherein said servo information writing steps include writing a quad-burst servo amplitude pattern.

4. A method for writing servo patterns as recited in claim 1 further includes the steps of writing a clock track at said first crash stop and wherein said servo information is written over said clock track.

5. A method for writing servo patterns as recited in claim 4 wherein said step of moving offset from said last written servo information and detecting said written servo information until said detected servo signal equals a predetermined value further includes the steps of dividing said written clock track at said first crash stop into odd and even clock portions between said written servo information and wherein said odd and even clock portions alternately provide said detected servo signal.

6. A method for writing servo patterns as recited in claim 5 further includes the steps of writing a calibration pattern between each odd and even clock portions not previously written with servo information.

7. A method for writing servo patterns as recited in claim 6 further includes the steps of reading back said servo information and said calibration patterns to identify any offsets and rewriting said calibration patterns using said identified offsets.

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8. A method for writing servo patterns as recited in claim 3 wherein said quad-burst servo amplitude pattern is written with a complex frequency pattern.

9. A method for writing servo patterns as recited in claim 3 wherein said quad-burst servo amplitude pattern is written with four types of offtrack positions separated in time.

10. A method for writing servo patterns as recited in claim 9 wherein said predetermined value corresponds to a selected fraction of a selected track pitch.

11. A method for writing servo patterns as recited in claim 3 wherein said moving and detecting steps include the steps of averaging of burst positions to create a circumferential position reference for writing subsequent servo information.

12. A method for writing servo patterns as recited in claim 1 wherein said data storage media includes at least one disk surface and wherein said moving and detecting steps include the step of utilizing a crystal clock multiple count and a motor drive index input for maintaining an angular disk reference across a radial band of the disk surface.

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13. A method for writing servo patterns as recited in claim 1 wherein said direct access storage device includes a plurality of data storage surfaces and wherein said steps are sequentially repeated for each data storage surface.

14. A method for writing servo patterns as recited in claim 2 wherein said direct access storage device includes a plurality of data storage surfaces and further includes the steps of:

switching to a high bandwidth servo system; and

duplicating said written servo information onto others of said data storage surfaces.

15. A method for writing servo patterns as recited in claim 3 wherein said step of writing servo information on said data storage media responsive to said detected servo signal equal to said predetermined value further includes the steps of:

incrementing a burst type of said quad-burst servo amplitude pattern;

detecting and timing from said last written servo information; and

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writing said incremented burst type responsive to a predetermined time increment.

16. A method for writing servo patterns as recited in claim 1 wherein said servo information writing steps include writing a high density quad-burst servo amplitude pattern whereby high accuracy and high bandwidth capability are enabled for the direct access storage device.

17. A method for writing servo patterns as recited in claim 3 wherein the direct access storage device includes a plurality of disk surfaces and further includes the steps of:

reading said quad-burst servo pattern written over said data storage media; and

writing a predetermined servo pattern to at least one of the remaining disk surfaces to duplicate written quad burst servo track offsets.

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18. A self servo writing file comprising:

a housing;

a plurality of disk surfaces mounted in said housing for simultaneous rotation about an axis;

a plurality of transducer heads mounted for movement across said disk surfaces for reading and writing information to said disk surfaces;

a control system for writing quad-burst servo pattern over at least one disk surface; said control system including;

means for writing a first servo burst type pattern on a first one of said disk surfaces at a first crash stop;

means for moving offset from said last written servo burst type pattern and for detecting said written servo burst type pattern until said detected servo signal equals a predetermined value;

means for incrementing said servo burst type pattern and for writing servo burst type pattern responsive to said detected servo signal equal to said predetermined value.

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19. A self servo writing file as recited in claim 18 wherein said quad-burst servo pattern is an amplitude pattern.

20. A self servo writing file as recited in claim 18 wherein said control system further includes means for reading said quad-burst servo pattern written over said first disk surface and for writing to at least some of the remaining disk surfaces to duplicate said quad-burst servo pattern written.

21. A self servo writing file as recited in claim 18 wherein said control system further includes means for reading said quad-burst servo pattern written over said first disk surface and for writing a servo pattern to at least one of the remaining disk surfaces to duplicate written quad-burst servo track offsets.

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22. A method for writing servo patterns in a direct access storage device comprising the steps of:

writing a clock track on a data storage media at a first crash stop;

writing servo information over said clock track periodically around said clock track;

moving offset from said last written clock burst and detecting said last written clock burst until said detected signal equals a predetermined value;

writing clock burst and servo information on said data storage media responsive to said detected signal equal to said predetermined value; and

sequentially repeating said moving and writing steps until a second crash stop is reached.

23. A method for writing servo patterns as recited in claim 22 wherein said servo information writing steps include writing a selected servo pattern, said selected servo pattern includes one of phase aligned servo patterns and amplitude servo patterns whereby the method for writing servo patterns is not dependent on any particular servo pattern.

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24. A method for writing servo patterns as recited in claim 22 further includes the step of erasing the data storage media before the step of writing said clock track, whereby said data storage media is substantially erased in the disk file and the requirement for pre-erased disks is eliminated.

25. A method for writing servo patterns as recited in claim 22 further includes the step of writing a calibration pattern between clock bursts not previously written with servo information.

26. A method for writing servo patterns as recited in claim 25 further includes the step of rewriting said calibration patterns.

27. A method for writing servo patterns as recited in claim 26 wherein said step of rewriting said calibration patterns includes the steps of reading back adjacent servo and calibration patterns, identifying the spacing difference between the servo and calibration patterns, calculating an average value of all identified differences, subtracting said average value from each identified spacing difference and storing an offset table, and using said offset table for rewriting said calibration patterns.

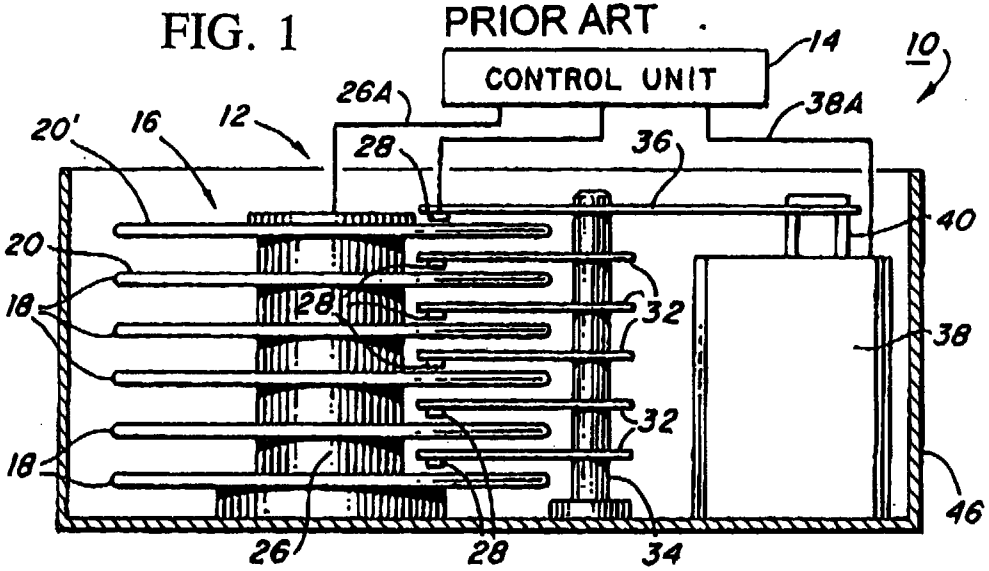
SELF SERVO WRITING FILE

ABSTRACT

A self servo writing file and method for writing servo patterns in a direct access storage device are provided. First servo information is written on a data storage media at a first crash stop. The transducer heads (28) are moved offset from the written servo information while reading the last written servo information until the detected servo signal equals a predetermined value. Then servo information is written on the data storage media (20) responsive to the detected servo signal equal to the predetermined value. The moving and writing steps are sequentially repeating until a second crash stop is reached. A quad-burst servo amplitude pattern or phase pattern can be used for the servo information. The servo writing method is adapted easily for many different servo options. When the file uses a hybrid servo or sector servo, the other surfaces can be written by duplicating the servo bursts with a high bandwidth servo system of the file.

Fig. 3

FIG. 1 PRIOR ART



PRIOR ART FIG. 2

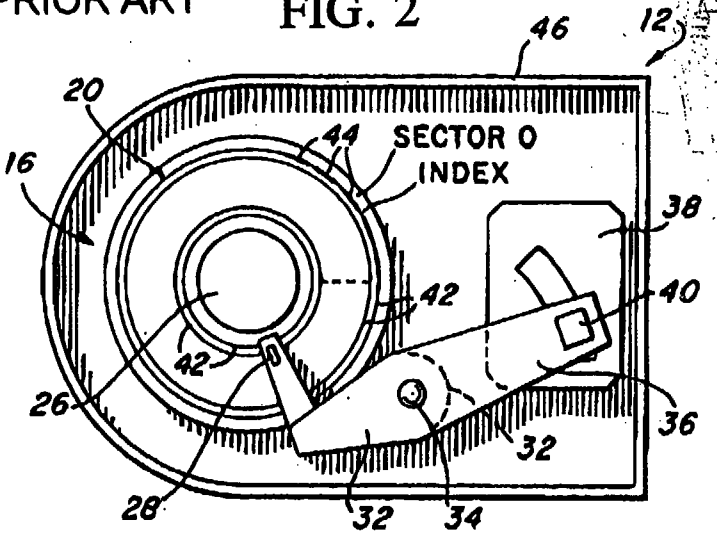


FIG. 5 PRIOR ART

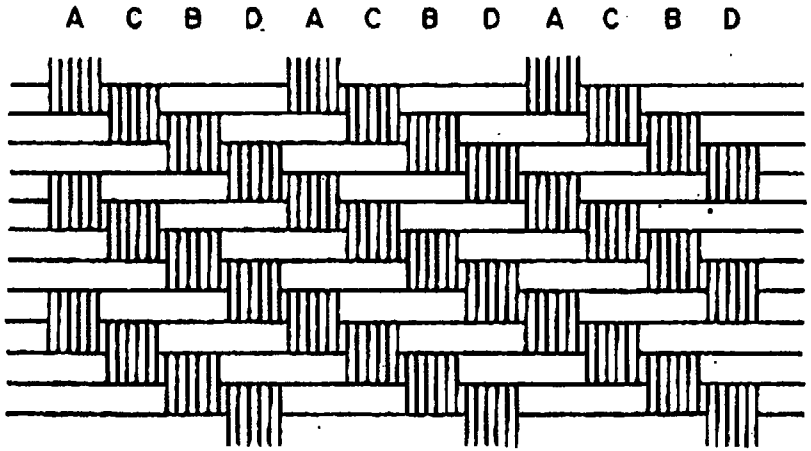


FIG. 6 PRIOR ART

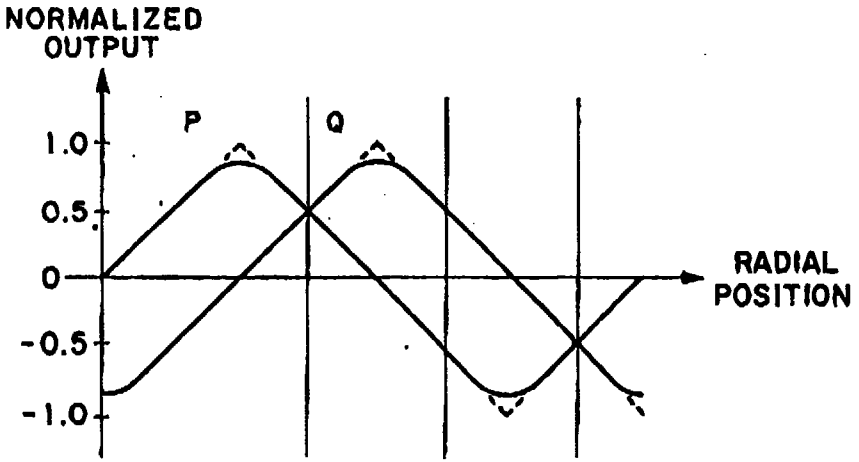


FIG.3

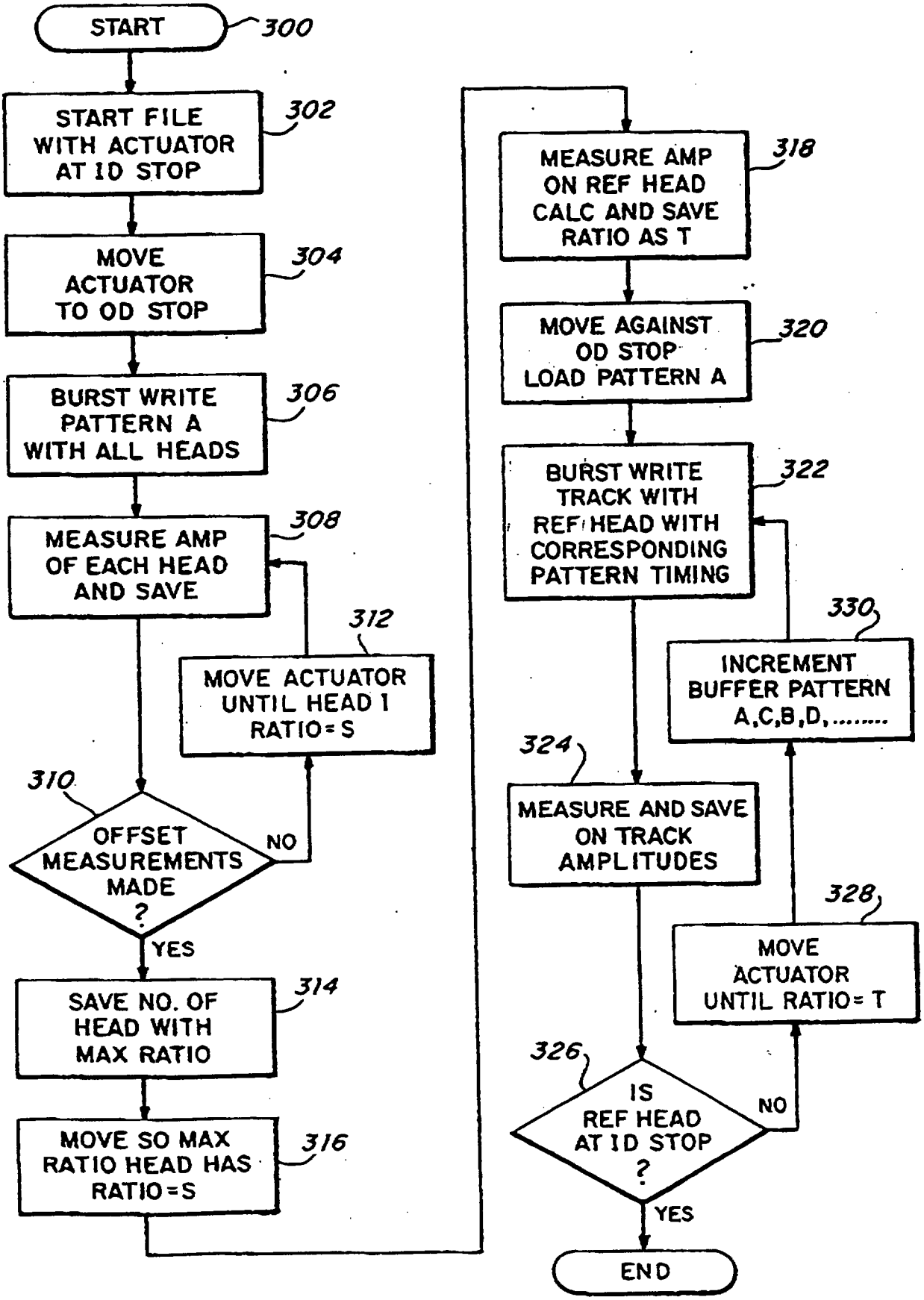

START
300
START FILE WITH ACTUATOR AT ID STOP
302
MOVE ACTUATOR TO OD STOP
304
BURST WRITE PATTERN A WITH ALL HEADS
306
MEASURE AMP OF EACH HEAD AND SAVE
308
MOVE ACTUATOR UNTIL HEAD 1 RATIO=S
312
OFFSET MEASUREMENTS MADE ?
310
NO
YES
SAVE NO. OF HEAD WITH MAX RATIO
314
MOVE SO MAX RATIO HEAD HAS RATIO=S
316
MEASURE AMP ON REF HEAD CALC AND SAVE RATIO AS T
318
MOVE AGAINST OD STOP LOAD PATTERN A
320
BURST WRITE TRACK WITH REF HEAD WITH CORRESPONDING PATTERN TIMING
322
INCREMENT BUFFER PATTERN A,C,B,D,.....
330
MEASURE AND SAVE ON TRACK AMPLITUDES
324
MOVE ACTUATOR UNTIL RATIO=T
328
IS REF HEAD AT ID STOP ?
326
NO
YES
END

FIG. 4A

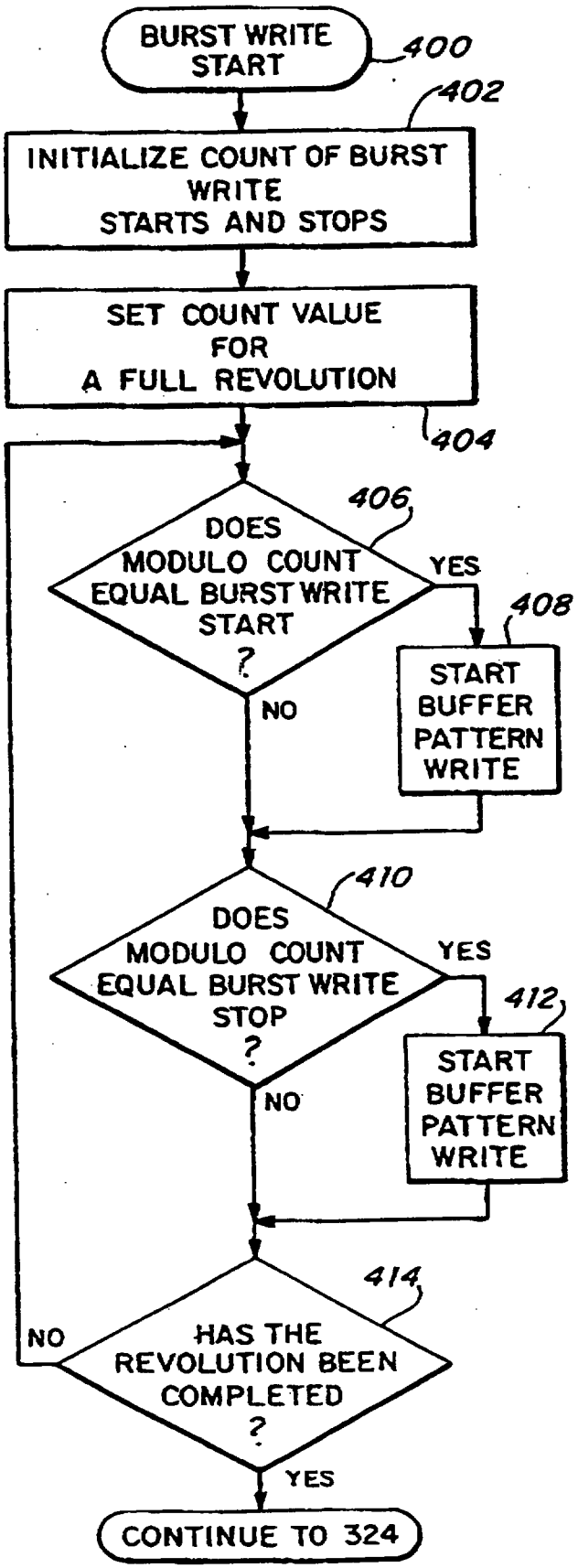

BURST WRITE START
400
INITIALIZE COUNT OF BURST WRITE STARTS AND STOPS
402
SET COUNT VALUE FOR A FULL REVOLUTION
404
DOES MODULO COUNT EQUAL BURST WRITE START ?
406
YES
NO
START BUFFER PATTERN WRITE
408
DOES MODULO COUNT EQUAL BURST WRITE STOP ?
410
YES
NO
START BUFFER PATTERN WRITE
412
HAS THE REVOLUTION BEEN COMPLETED ?
414
NO
YES
CONTINUE TO 324

FIG. 4B

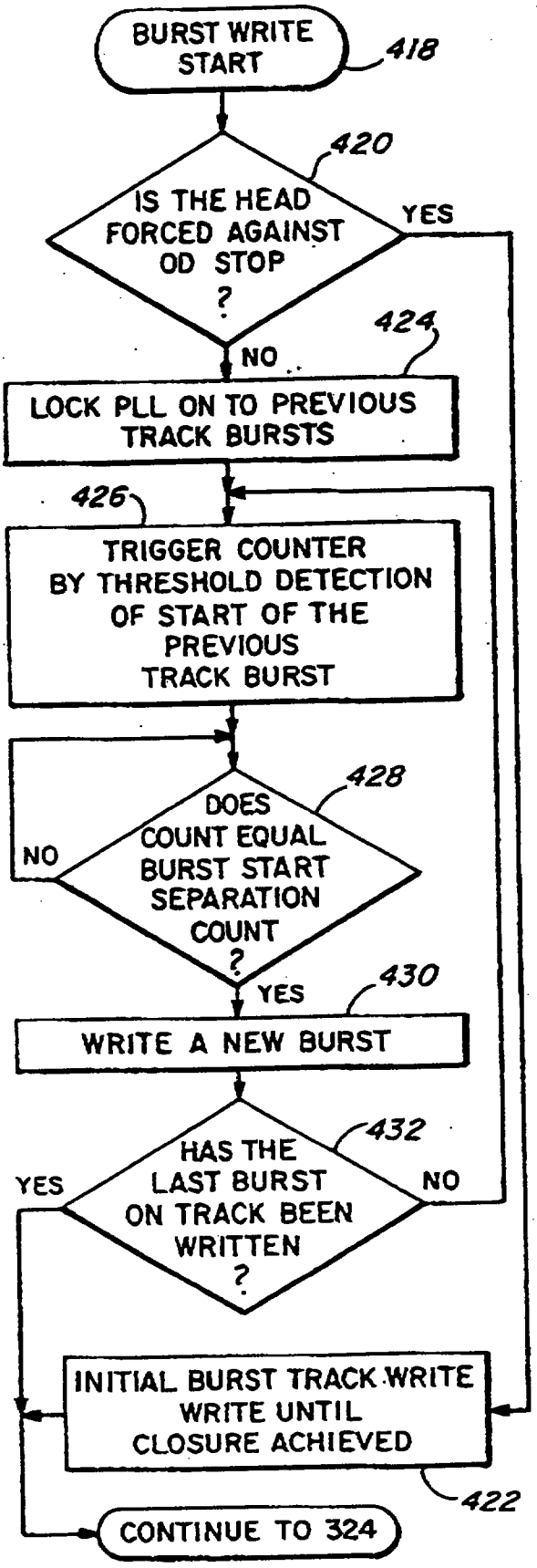

BURST WRITE START
418
IS THE HEAD FORCED AGAINST OD STOP ?
420
YES
NO
LOCK PLL ON TO PREVIOUS TRACK BURSTS
424
TRIGGER COUNTER BY THRESHOLD DETECTION OF START OF THE PREVIOUS TRACK BURST
426
DOES COUNT EQUAL BURST START SEPARATION COUNT ?
428
NO
YES
WRITE A NEW BURST
430
HAS THE LAST BURST ON TRACK BEEN WRITTEN ?
432
YES
NO
INITIAL BURST TRACK WRITE WRITE UNTIL CLOSURE ACHIEVED
422
CONTINUE TO 324

FIG. 4C

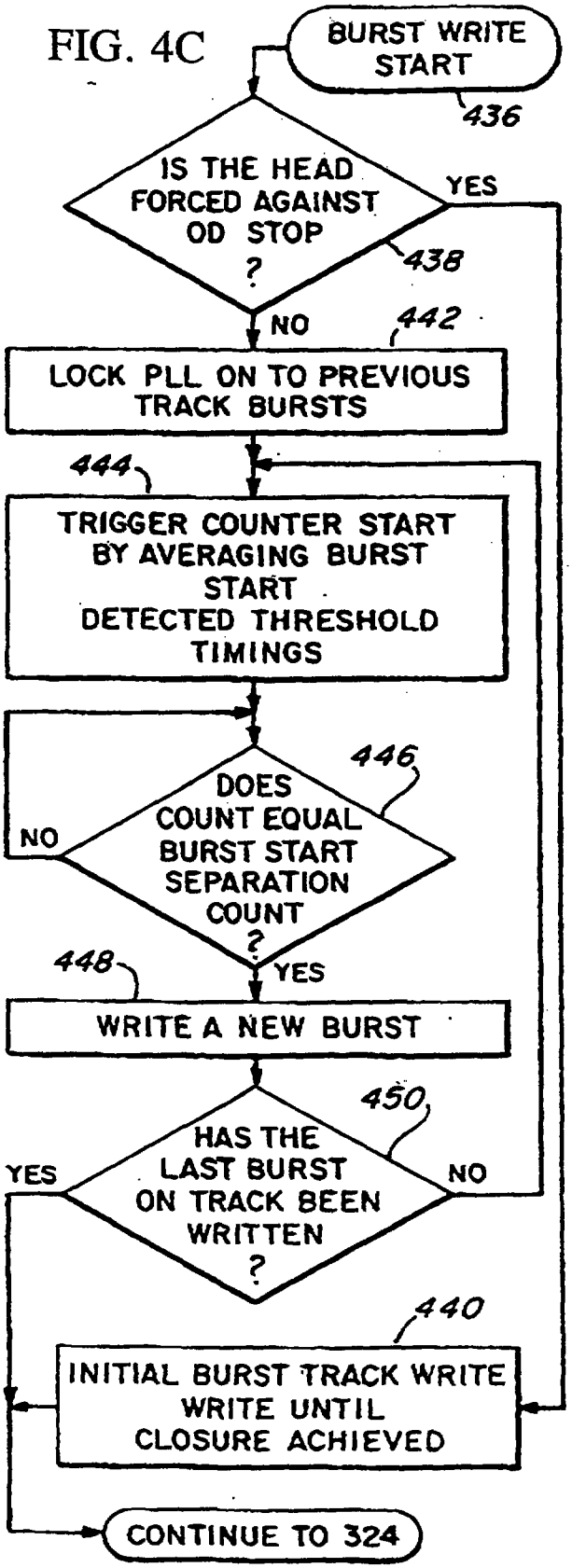

BURST WRITE START
436
IS THE HEAD FORCED AGAINST OD STOP ?
438
YES
NO
442
LOCK PLL ON TO PREVIOUS TRACK BURSTS
444
TRIGGER COUNTER START BY AVERAGING BURST START DETECTED THRESHOLD TIMINGS
446
DOES COUNT EQUAL BURST START SEPARATION COUNT ?
NO
YES
448
WRITE A NEW BURST
450
HAS THE LAST BURST ON TRACK BEEN WRITTEN ?
YES
NO
440
INITIAL BURST TRACK WRITE WRITE UNTIL CLOSURE ACHIEVED
CONTINUE TO 324

FIG. 4D

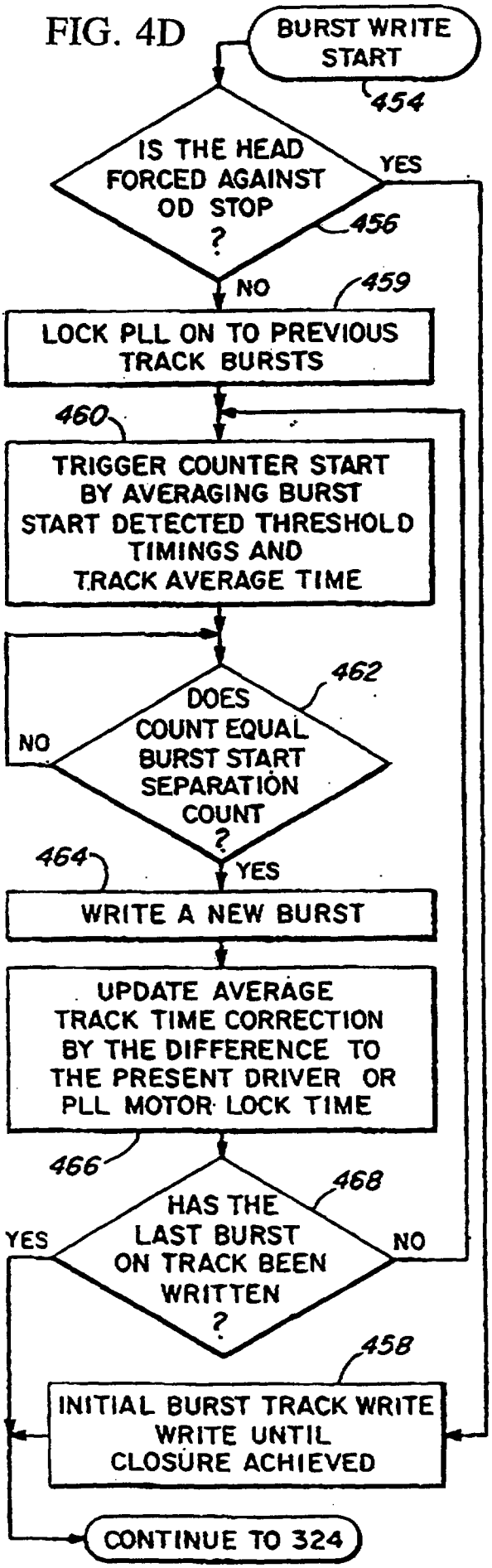

BURST WRITE START
454
IS THE HEAD FORCED AGAINST OD STOP ?
456
YES
NO
459
LOCK PLL ON TO PREVIOUS TRACK BURSTS
460
TRIGGER COUNTER START BY AVERAGING BURST START DETECTED THRESHOLD TIMINGS AND TRACK AVERAGE TIME
462
DOES COUNT EQUAL BURST START SEPARATION COUNT ?
NO
YES
464
WRITE A NEW BURST
UPDATE AVERAGE TRACK TIME CORRECTION BY THE DIFFERENCE TO THE PRESENT DRIVER OR PLL MOTOR LOCK TIME
466
468
HAS THE LAST BURST ON TRACK BEEN WRITTEN ?
YES
NO
458
INITIAL BURST TRACK WRITE WRITE UNTIL CLOSURE ACHIEVED
CONTINUE TO 324

FIG. 7

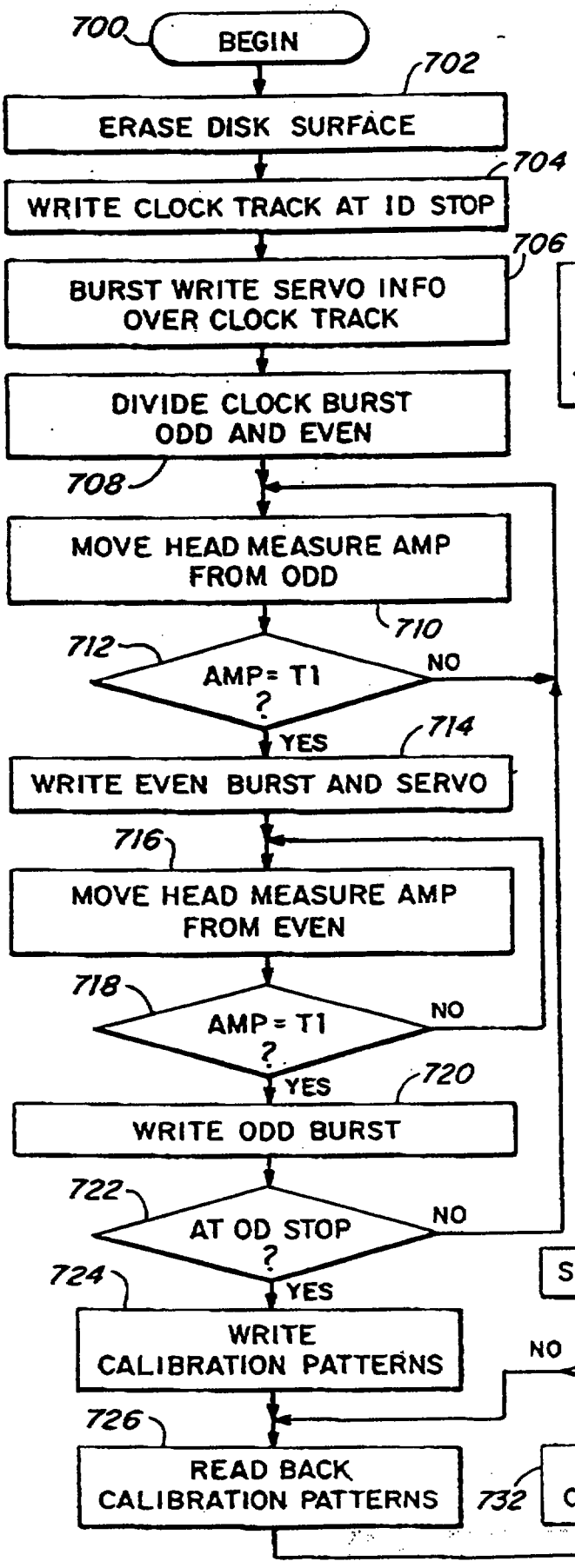
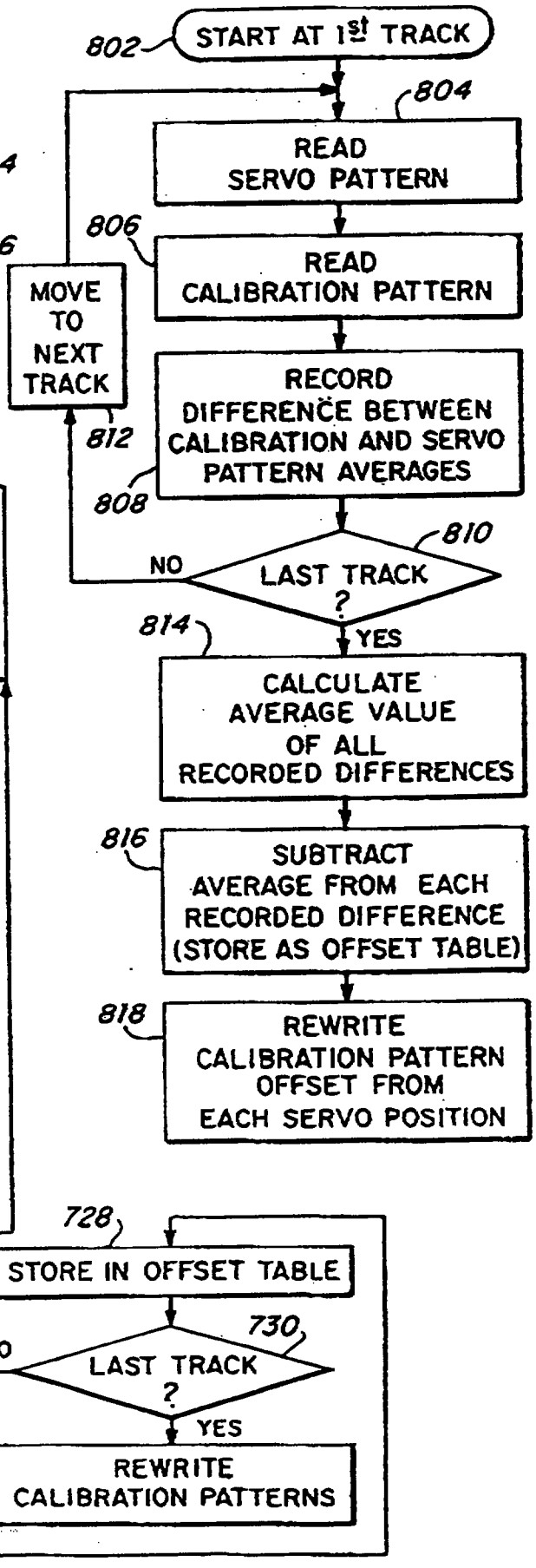

700
BEGIN
702
ERASE DISK SURFACE
704
WRITE CLOCK TRACK AT ID STOP
706
BURST WRITE SERVO INFO OVER CLOCK TRACK
DIVIDE CLOCK BURST ODD AND EVEN
708
MOVE HEAD MEASURE AMP FROM ODD
710
712
AMP = T1 ?
NO
YES
714
WRITE EVEN BURST AND SERVO
716
MOVE HEAD MEASURE AMP FROM EVEN
718
AMP = T1 ?
NO
YES
720
WRITE ODD BURST
722
AT OD STOP ?
NO
YES
724
WRITE CALIBRATION PATTERNS
726
READ BACK CALIBRATION PATTERNS

FIG. 8


802
START AT 1st TRACK
804
READ SERVO PATTERN
806
READ CALIBRATION PATTERN
RECORD DIFFERENCE BETWEEN CALIBRATION AND SERVO PATTERN AVERAGES
808
812
MOVE TO NEXT TRACK
810
NO
LAST TRACK ?
YES
814
CALCULATE AVERAGE VALUE OF ALL RECORDED DIFFERENCES
816
SUBTRACT AVERAGE FROM EACH RECORDED DIFFERENCE (STORE AS OFFSET TABLE)
818
REWRITE CALIBRATION PATTERN OFFSET FROM EACH SERVO POSITION
728
STORE IN OFFSET TABLE
730
NO
LAST TRACK ?
YES
732
REWRITE CALIBRATION PATTERNS

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enabled and optimised use of the head/disk capability is supported; and to provide an improved self servo writing file and methods of writing servo information substantially without negative effects and that overcome many disadvantages of those used in the past.

According to one aspect of the present invention there is provided a method for writing servo patterns in a direct access storage device including at least one data storage media mounted for rotation by a drive motor and an actuator for moving transducer means relative to the data storage media for reading and writing data to the data storage media, said method comprising the steps of: rotating said data storage media using the drive motor; using said transducer means, writing servo information on the data storage media at a first portion of the data storage media using timing information developed without requiring the use of a clock track; using said actuator and transducer means, moving offset from said last written servo information and detecting said written servo information until said detected servo signal equals a predetermined value; developing timing information from said last written servo information; using said transducer means, writing servo information on said data storage media responsive to said detected servo signal equal to said predetermined value using said timing information developed from said last written servo information without requiring the use of a clock track; and sequentially repeating said moving, developing timing information from said last written servo information and writing steps until a second portion of the data storage media is reached.

According to another aspect of the present invention there is provided a self servo writing file comprising: a housing; a plurality of disk surfaces mounted in said housing for simultaneous rotation about an axis; a plurality of transducer heads mounted for movement across said disk surfaces for reading and writing information to said disk surfaces; a control system for writing quad-burst servo pattern over at least one disk surface; said control system including; means responsive to a motor rotating said disk surfaces for developing timing information; means for writing a first servo burst type pattern on a first one of said disk surfaces at a first portion of the data storage media

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using said timing information developed without requiring the use of a clock track; means for moving offset from said last written servo burst type pattern and for detecting said written servo burst type pattern until said detected servo signal equals a predetermined value; means for developing timing information from said last written servo information; and means for incrementing said servo burst type pattern and for writing servo burst type pattern responsive to said detected servo signal equal to said predetermined value using said timing information developed from said last written servo information without requiring the use of a clock track.

According to still another aspect of the present invention there is provided a method for writing servo patterns in a direct access storage device including at least one data storage media mounted for rotation by a drive motor and an actuator for moving transducer means relative to the data storage media for reading and writing data to the data storage media, said method comprising the steps of: initialising a plurality of predefined count values, said count values including multiple count values for burst write starts and stops and a complete revolution count value; rotating said data storage media using the drive motor; developing timing information including a timing count value; comparing said timing count value with said initialised plurality of predefined count values and when said timing count value is equal to a burst write start count value, writing servo information on a data storage media at a first portion of the data storage media using said timing information and stopping when said timing count value is equal to a burst write stop count value and repeating said servo information writing until said timing count value is equal to said complete revolution count value; moving offset from said last written servo information and detecting said written servo information until said detected servo signal equals a predetermined value; developing timing information from said last written servo information; writing servo information on said data storage media responsive to said detected servo signal equal to said predetermined value using said timing information developed from said last written servo information; and sequentially

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repeating said moving, developing timing information from said last written servo information and writing steps until a second portion of the data storage media is reached.

According to still another aspect of the present invention there is provided a method for writing servo patterns in a direct access storage device comprising the steps of: (a) writing a clock track on a data storage media at a first portion of said data storage media; (b) writing servo information on said data storage media at said first portion, wherein said servo information is written over said clock track; (c) dividing the written clock track into odd and even clock portion between the written servo information; (d) moving offset from said written clock track and detecting said written clock track until a detected servo signal provided by said odd clock portion equals a predetermined value; (e) writing an even clock burst on said data storage media responsive to said detected servo signal equal to said predetermined value in moving step (d); (f) moving offset from the last written even clock burst and detecting said last written even clock burst until a detected servo signal provided by said last written even clock burst equals a predetermined value; (g) writing an odd clock burst on said data storage media responsive to said detected servo signal equal to said predetermined value in moving step (f); (h) moving offset from the last written odd clock burst and detecting said last written odd clock burst until a detected servo signal provided by said last written odd clock burst equals a predetermined value; (i) writing an even clock burst on said data storage media responsive to said detected servo signal equal to said predetermined value in moving step (h), one of said writing steps (g) and (i) including the step of writing servo information; (j) sequentially repeating said moving and writing steps (f), (g), (h) and (i) until a second portion of said data storage media is reached; and (k) writing a calibration pattern between odd and even clock bursts not previously written with said servo information, including the step of using said servo information for positioning.

According to still another aspect of the present invention there is provided a method for writing servo patterns in a direct access storage device comprising the steps

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of: (a) writing a clock track on a data storage medium at a first portion of said data storage media; (b) writing servo information over said clock track periodically around said clock track; (c) moving offset from said clock track and detecting said clock track until a detected signal provided by said clock track equals a predetermined value; (d) writing a clock burst on said data storage media responsive to said detected signal equal to said predetermined value in moving step (c); (e) moving offset from the last written clock burst and detecting said last written clock burst until a detected signal provided by said last written clock burst equals a predetermined value; (f) writing a clock burst and servo information on said data storage media responsive to said detected signal equal to said predetermined value in moving step (e); (g) sequentially repeating said moving and writing steps (e) and (f) until a second portion of said data storage media is reached; and (h) writing a calibration pattern between said clock bursts not previously written with said servo information, including the step of using said servo information for positioning.

According to yet another aspect of the present invention there is provided a method for writing servo patterns in a direct access storage device comprising the steps of: (a) writing a clock track on a data storage media at a first portion of said data storage media; (b) writing servo information over said clock track periodically around said clock track; (c) moving offset from said clock track and detecting said clock track until a detected signal provided by said clock track equals a predetermined value; (d) writing a clock burst on said data storage media responsive to said detected signal equal to said predetermined value in moving step (c); (e) moving offset from the last written clock burst and detecting said last written clock burst until a detected signal provided by said last written clock burst equals a predetermined value; (f) writing a clock burst and servo information on said data storage media responsive to said detected signal equal to said predetermined value in moving step (e); (g) sequentially repeating said moving and writing steps (e) and (f) until a second potion of said data storage media is reached; (h) writing a calibration patter between clock bursts not previously written with servo

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information; and (i) rewriting said calibration pattern, wherein said step of rewriting said calibration patterns includes the steps of reading back adjacent servo and calibration patterns, identifying the spacing difference between the servo and calibration patterns, calculating an average value of all identified differences, subtracting said average value from each identified spacing difference and storing an offset table, and using said offset table for rewriting said calibration patterns.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention together with the above and other objects and advantages may best be understood from the following detailed description of the embodiment of the invention illustrated in the drawing, wherein:

FIG. 1 is a schematic and simplified vertical sectional view of a rigid magnetic disk drive unit embodying the present invention;

FIG. 2 is a top plan view of the structure shown in FIG. 1;

FIG. 3 is a flow chart illustrating sequential operations of the self servo writing file of the invention;

FIGS. 4A, 4B, 4C and 4D are flow charts illustrating alternative sequential operations of the self servo writing file of the invention;

FIG. 5 illustrates a quad burst servo pattern for the self servo writing file of the invention;

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CLAIMS

1. A method for writing servo patterns in a direct access storage device including at least one data storage media mounted for rotation by a drive motor and an actuator for moving transducer means relative to the data storage media for reading and writing data to the data storage media, said method comprising the steps of:

rotating said data storage media using the drive motor;

using said transducer means, writing servo information on the data storage media at a first portion of the data storage media using timing information developed without requiring the use of a clock track;

using said actuator and transducer means, moving offset from said last written servo information and detecting said written servo information until said detected servo signal equals a predetermined value;

developing timing information from said last written servo information;

using said transducer means, writing servo information on said data storage media responsive to said detected servo signal equal to said predetermined value using said timing information developed from said last written servo information without requiring the use of a clock track; and

sequentially repeating said moving, developing timing information from said last written servo information and writing steps until a second portion of the data storage media is reached.

2. A method for writing servo patterns as recited in claim 1 wherein said direct access storage device includes a low bandwidth servo system used for said servo information writing steps.

3. A method for writing servo patterns as recited in claim 1 wherein said servo information writing steps include writing a quad-burst servo amplitude pattern.

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13. A method for writing servo patterns as recited in claim 1 wherein said direct access storage device includes a plurality of data storage surfaces and wherein said steps are sequentially repeated for each data storage surface.

14. A method for writing servo patterns as recited in claim 2 wherein said direct access storage device includes a plurality of data storage surfaces and further includes the steps of:

switching to a high bandwidth servo system; and

duplicating said written servo information onto others of said data storage surfaces.

15. A method for writing servo patterns as recited in claim 3 wherein said step of writing servo information on said data storage media responsive to said detected servo signal equal to said predetermined value further includes the steps of:

incrementing a burst type of said quad-burst servo amplitude pattern;

detecting said last written servo information and identifying a predetermined time increment using timing information developed from said last written servo information; and

writing said incremented burst type responsive to a predetermined time increment.

16. A method for writing servo patterns as recited in claim 1 wherein said servo information writing steps include writing a high density quad-burst servo amplitude pattern whereby high accuracy and high bandwidth capability are enabled for the direct access storage device without requiring the use of a clock track.

17. A method for writing servo patterns as recited in claim 3 wherein the direct access storage device includes a plurality of disk surfaces and further includes the steps of:

reading said quad-burst servo pattern written over said data storage media; and

writing a predetermined servo pattern to at least one of the remaining disk surfaces to duplicate written quad burst servo track offsets.

18. A self servo writing file comprising:

a housing;

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a plurality of disk surfaces mounted in said housing for simultaneous rotation about an axis;

a plurality of transducer heads mounted for movement across said disk surfaces for reading and writing information to said disk surfaces;

a control system for writing quad-burst servo pattern over at least one disk surface; said control system including;

means responsive to a motor rotating said disk surfaces for developing timing information;

means for writing a first servo burst type pattern on a first one of said disk surfaces at a first portion of the data storage media using said timing information developed without requiring the use of a clock track;

means for moving offset from said last written servo burst type pattern and for detecting said written servo burst type pattern until said detected servo signal equals a predetermined value;

means for developing timing information from said last written servo information; and

means for incrementing said servo burst type pattern and for writing servo burst type pattern responsive to said detected servo signal equal to said predetermined value using said timing information developed from said last written servo information without requiring the use of a clock track.

19. A self servo writing file as recited in claim 18 wherein said means for writing said quad-burst servo pattern includes means for writing an amplitude pattern.

20. A self servo writing file as recited in claim 18 wherein said control system further includes means for reading said quad-burst servo pattern written over said first disk surface and for writing a predetermined servo pattern to at least some of the remaining disk surfaces to duplicate said quad-burst servo pattern written.

21. A method for writing servo patterns in a direct access storage device including at least one data storage media mounted for rotation by a drive motor and an actuator for

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moving transducer means relative to the data storage media for reading and writing data to the data storage media, said method comprising the steps of:

initialising a plurality of predefined count values, said count values including multiple count values for burst write starts and stops and a complete revolution count value;

rotating said data storage media using the drive motor;

developing timing information including a timing count value;

comparing said timing count value with said initialised plurality of predefined count values and when said timing count value is equal to a burst write start count value, writing servo information on a data storage media at a first portion of the data storage media using said timing information and stopping when said timing count value is equal to a burst write stop count value and repeating said servo information writing until said timing count value is equal to said complete revolution count value;

moving offset from said last written servo information and detecting said written servo information until said detected servo signal equals a predetermined value;

developing timing information from said last written servo information;

writing servo information on said data storage media responsive to said detected servo signal equal to said predetermined value using said timing information developed from said last written servo information; and

sequentially repeating said moving, developing timing information from said last written servo information and writing steps until a second portion of the data storage media is reached.

22. A method for writing servo patterns in a direct access storage device comprising the steps of:

(a) writing a clock track on a data storage media at a first portion of said data storage media;

(b) writing servo information on said data storage media at said first portion, wherein said servo information is written over said clock track;

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(c) dividing the written clock track into odd and even clock portion between the written servo information;

(d) moving offset from said written clock track and detecting said written clock track until a detected servo signal provided by said odd clock portion equals a predetermined value;

(e) writing an even clock burst on said data storage media responsive to said detected servo signal equal to said predetermined value in moving step (d);

(f) moving offset from the last written even clock burst and detecting said last written even clock burst until a detected servo signal provided by said last written even clock burst equals a predetermined value;

(g) writing an odd clock burst on said data storage media responsive to said detected servo signal equal to said predetermined value in moving step (f);

(h) moving offset from the last written odd clock burst and detecting said last written odd clock burst until a detected servo signal provided by said last written odd clock burst equals a predetermined value;

(i) writing an even clock burst on said data storage media responsive to said detected servo signal equal to said predetermined value in moving step (h), one of said writing steps (g) and (i) including the step of writing servo information;

(j) sequentially repeating said moving and writing steps (f), (g), (h) and (i) until a second portion of said data storage media is reached; and

(k) writing a calibration pattern between odd and even clock bursts not previously written with said servo information, including the step of using said servo information for positioning.

23. A method for writing servo patterns as recited in claim 22 further includes the steps of reading back said servo information and said calibration patterns to identify any offsets and rewriting said calibration patterns using said identified offsets.

24. A method for writing servo patterns in a direct access storage device comprising the steps of:

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(a) writing a clock track on a data storage medium at a first portion of said data storage media;

(b) writing servo information over said clock track periodically around said clock track;

(c) moving offset from said clock track and detecting said clock track until a detected signal provided by said clock track equals a predetermined value;

(d) writing a clock burst on said data storage media responsive to said detected signal equal to said predetermined value in moving step (c);

(e) moving offset from the last written clock burst and detecting said last written clock burst until a detected signal provided by said last written clock burst equals a predetermined value;

(f) writing a clock burst and servo information on said data storage media responsive to said detected signal equal to said predetermined value in moving step (e);

(g) sequentially repeating said moving and writing steps (e) and (f) until a second portion of said data storage media is reached; and

(h) writing a calibration pattern between said clock bursts not previously written with said servo information, including the step of using said servo information for positioning.

25. A method for writing servo patterns as recited in claim 24 wherein said servo information writing steps include writing a selected servo pattern, said selected servo pattern includes one of phase aligned servo patterns and amplitude servo patterns whereby the method for writing servo patterns is not dependent on any particular servo pattern.

26. A method for writing servo patterns as recited in claim 24, further includes the step of erasing the data storage media before the step of writing said clock track, whereby said data storage media is substantially erased in the disk file and the requirement for pre-erased disks is eliminated.

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27. A method for writing servo patterns as recited in claim 24 further includes the step of rewriting said calibration patterns.

28. A method for writing servo patterns in a direct access storage device comprising the steps of:

(a) writing a clock track on a data storage media at a first portion of said data storage media;

(b) writing servo information over said clock track periodically around said clock track;

(c) moving offset from said clock track and detecting said clock track until a detected signal provided by said clock track equals a predetermined value;

(d) writing a clock burst on said data storage media responsive to said detected signal equal to said predetermined value in moving step (c);

(e) moving offset from the last written clock burst and detecting said last written clock burst until a detected signal provided by said last written clock burst equals a predetermined value;

(f) writing a clock burst and servo information on said data storage media responsive to said detected signal equal to said predetermined value in moving step (e);

(g) sequentially repeating said moving and writing steps (e) and (f) until a second potion of said data storage media is reached;

(h) writing a calibration pattern between clock bursts not previously written with servo information; and

(i) rewriting said calibration pattern, wherein said step of rewriting said calibration patterns includes the steps of reading back adjacent servo and calibration patterns, identifying the spacing difference between the servo and calibration patterns, calculating an average value of all identified differences, subtracting said average value from each identified spacing difference and storing an offset table, and using said offset table for rewriting said calibration patterns.