Description

The present invention relates generally to systems for recording and/or reading information on an information recording medium and, more particularly, to apparatus for maintaining a beam of radiation in alignment with an information recording track on such a medium, which is for example a video disc or a memory storage disc in a computer.

Apparatus of this particular type is of special use in direct-read-after-write record disc systems, wherein both a write beam of radiation and a read beam of radiation are utilised to scan the disc. The write beam is modulated in intensity by an information signal to be recorded, so that as the disc is rotated relative to the beam, a succession of microscopic holes or pits is formed, representative of the information signal and arranged in a substantially circular recording track. Typically, after each track is recorded, the radial position of the write beam is incremented by means of a radially movable carriage, whereby a succession of concentrically arranged tracks is formed. The read beam of radiation is utilised to scan the successive pits immediately after they are formed, producing a reflected beam of radiation that is modulated by the recorded information. This reflected beam can be used to verify that the information signal was properly recorded.

Frequently, it is desirable to wait for a period of time between the writing of successive information tracks on the disc. During this time, the write beam is disabled, but variations in the environmental temperature of the system can cause the disc to expand or contract relative to the carriage, such that the radial position of the write beam, if it were again enabled, will have changed with respect to the location of the last-written information track. This is especially the case where very thin plastic recording discs are utilized. To minimize the time required to properly position the radially movable carriage such that the next information track is recorded in the proper radial position on the disc, then, it is desirable to maintain the carriage continuously in a prescribed relationship relative to the tracks on the disc, regardless of variations in environmental temperature.

One technique for accomplishing this is to monitor the temperature of the disc, and then estimate the actual radius of the next track to be recorded and maintain the carriage properly positioned with respect to that estimated radius. This technique is not entirely satisfactory, however, because the temperature is not ordinarily uniform throughout the system and throughout the disc. Thus, such a technique cannot ordinarily provide sufficient positioning precision to permit high information recording densities.

Another technique for compensating for temperature induced variations in the radii of information tracks on a recording disc is to mount the radially movable carriage on a special mounting that closely matches the physical characteristics of the disc. Thus, environmental temperature variations will affect the disc, and the carriage mounting by corresponding amounts, and the carriage will be automatically maintained in a prescribed relationship relative to the tracks on the disc. This technique is not entirely satisfactory, either, however, because it is not ordinarily possible to insure that environmental temperature variations will affect both the carriage mounting and the disc equally. As a result, information recording densities that can be achieved are unduly limited.

It will thus be appreciated from the foregoing that there is a need for an effective apparatus for maintaining a radially movable carriage in a prescribed relationship relative to information tracks on a storage disc, regardless of temperature variations that cause the disc to expand or contract relative to the carriage. The present invention fulfills this need.

According to the present invention as defined exactly in the claims, apparatus for maintaining a scanner in a prescribed transverse position relative to a selected substantially circular information track, has a stepping motor for moving a carriage for positioning the scanner, the spacing between adjacent tracks corresponding to a plurality of steps of the stepper motor, and there are means for receiving a control pulse signal in accordance with the actual position of the scanner, and controlling the stepper motor accordingly to position the carriage by one or more forward or reverse steps, together with means for selectively causing the stepper motor to advance that plurality of steps to advance the scanner to the next track.

Thomson-Brandt's French Specification No. 2366636 describes a write and read arrangement in which a read beam from a preceding track is received at a position sensor which is used to rock a mirror used by both write and read beams to maintain the read beam centered on the preceding track, and to maintain the write beam constantly spaced from it while writing a new track. General translational movement — as distinct from tracking centering — is provided by a motor driven by the filtered output of the sensor.

In the present invention, the position of the scanner is determined solely by operation of the stepper motor, so that instead of providing a continual transverse drive, as described by Thomson-Brandt, a stepper motor is used having steps of which a prescribed number corresponds to the spacing between adjacent tracks. The read beam and scanner can be centered over a recorded track while waiting for the recording of further information. Thus when recording is to recommence, a "move to next track" signal operates through the stepper motor to move the scanner the distance which

is the desired pitch between tracks.

It is true that stepper motors are known in themselves for similar applications as described for example in U.S. Specification Nos. 3956766 and 3977024 but the present invention uses a stepper motor for performing two functions, namely that of maintaining the scanner on the previously recorded track in spite of thermal expansion and contraction of the disc, and also deflecting the scanner by the pitch between tracks when recording is to be recommenced.

The detecting means can comprise a dither tracking system, wherein a periodic dither signal and an associated mirror are utilised to oscillate the read beam in a direction generally perpendicular to the axis of the recording track being scanned. This oscillation causes a corresponding variation in the average radiation intensity of the reflected beam. The phase angle of the resultant radiation intensity variations relative to that of the dither signal, and the amplitude of the intensity variations indicate the direction and magnitude of the deviation of the read beam from the centre line of the track being scanned.

Other aspects and advantages of the present invention will become apparent from the following description of the preferred embodiment, taken in conjunction with the accompanying drawings, which disclose, by way of example, the principles of the invention.

Brief Description of the Drawings

FIG. 1 is a simplified block diagram of a tracking apparatus in accordance with the present invention, for maintaining a read beam of radiation in alignment with the centerline of an information track on a recording disc;

FIG. 2a is a fragmentary cross-sectional view of the surface of the recording disc of Fig. 1; taken along a radial line through the center of the disc;

FIG. 2b is a graph showing the average intensity of a beam of radiation reflected by the disc of Fig. 2a, such intensity varying as a function of disc radius;

FIG. 3 is a graph of constant-frequency, constant-amplitude radial dither signal utilized in the apparatus of Fig. 1;

FIG. 4 is a graph of the reflected beam intensity signals for four different positions of the read beam relative to the track centerline, showing the effect of the radial dither signal; and

FIG. 5 is a graph of the intermediate signals obtained by multiplying the four intensity signals of Fig. 4 by the radial dither signal of Fig. 3.

Referring now to the drawings, and particularly to Fig. 1, there is shown a tracking servo apparatus for maintaining a beam of radiation in alignment with the centerline of an information recording track on a rotatable recording disc 11. The apparatus is shown in use in a direct-read-after-write system that utilizes a write beam of radiation 13 to record information in a plurality of substantially circular and concentrically arranged information tracks on the disc, and a read beam of radiation 15 to read the information immediately after it has been recorded.

The write beam of radiation 13 is produced by a write laser 17 and is initially transmitted to a modulator 19, which modulates the intensity of the beam in accordance with an information signal supplied over line 21. The modulated write beam is then transmitted through a first beam splitter 23, reflected by a mirror 25, and, in turn, focused onto the disc 11 by an objective lens 27. The disc is rotated at a prescribed angular velocity by a spindle motor 29, and the intensity of the modulated write beam is alternatively above and below a threshold at which melting or evaporation of the disc material occurs, so a sequence of spaced holes or pits 31 (Fig. 2a), representative of the information signal, is formed in the disc. The mirror 25 and the objective lens 27 are both mounted on a carriage 33 that is moved in a radial direction approximately 2 microns after each information track has been recorded, whereby a succession of closely-spaced, concentrically arranged information tracks is formed.

The read beam of radiation 15 is produced by a read laser 35 and has a substantially uniform intensity. It is initially transmitted through a second beam splitter 37, after which it is reflected by a bimorph mirror 39 to the first beam splitter 23, where it is reflected and combined with the intensity-modulated write beam of radiation 13. The read beam is then directed to the disc 11 by the carriage-mounted mirror 25 and objective lens 27. The read beam and write beam are aligned with respect to each other such that they impinge on the disc at a common radius, with the write beam leading the read beam by approximately 50 microns.

The information-bearing pits 31 formed by the write beam of radiation 13 are substantially non-reflective of the uniform-intensity read beam of radiation 15, whereas portions of the disc not occupied by such a pit are highly reflective of the read beam. Thus, a reflected beam of radiation 41 modulated in intensity by the recorded information, is produced. This reflected beam is collected by the objective lens 27 and transmitted along the same path as the read beam back to the second beam splitter 37, where it is reflected and transmitted to a photodetector 43, which produces an electrical signal proportional to the intensity of the beam. A data subsystem (not shown) in the direct-read-after-write system compares this intensity signal to a delayed version of the information signal previously supplied on line 21 to the write beam modulator 21, to verify that the information was properly recorded on the disc 11.

After an information track has been recorded on the disc 11, there is frequently an extended time delay before the information signal is

received for the next track to be recorded. During this time, the write beam of radiation 13 is disabled so that no pits will be formed in the disc. Nevertheless, it is desirable to maintain the radially movable carriage 33 aligned with respect to tracks on the disc, whereby, when the information signal is again received, the carriage will be properly positioned to direct the write beam onto the appropriate disc radius, without any undue delays.

During the time period between the recording of successive information tracks, however, variations in the environmental temperature of the recording system can cause substantial expansion or contraction of the disc 11 relative to the carriage 33. This is especially the case where relatively thin plastic discs are used, since they will respond much more quickly to environmental temperature variations than the relatively more massive carriage. Thus, if no temperature compensation is made, and the carriage is simply incremented radially by one track spacing, the next-recorded information track could actually be superimposed directly upon a previously-recorded track. Thus, a tracking system is needed to ensure that the successive information recording tracks will be substantially equally spaced with respect to each other, regardless of temperature-induced expansion or contraction of the disc that can occur during the time between the writing of the successive tracks.

In the tracking servo apparatus of Fig. 1, the read beam of radiation 15 is utilized to continuously scan the disc 11, even during the time periods when the write beam of radiation 13 is disabled. During such times, when the write beam is disabled, the tracking servo apparatus operates to sense any radial deviation of the read beam from the centerline of the last-recorded information track. In accordance with the invention, a step forward or a step reverse signal are produced by the apparatus whenever it is determined that the read beam has deviated from the track centerline by more than a prescribed amount, and the apparatus further includes a stepper motor 45, responsive to the two step signals, for moving the carriage 33 radially and thereby maintaining the read beam in substantial alignment with the track centerline. Thus, the tracking apparatus operates to track the previously-recorded information track, regardless of any temperature variations that cause expansion or contraction of the disc.

In the preferred embodiment, the stepper motor 45 is coupled to a lead screw 47 that engages the radially movable carriage 33. Each discrete step of the motor preferably corresponds to one track spacing on the disc 11. Additionally, the apparatus utilizes a special stepper motor driver 49 that receives the step forward and step reverse pulse signals and, accordingly, controls the electrical currents supplied to the successive windings of the stepper motor, to accurately position the lead screw at a plurality of angular locations intermediate the discrete steps of the stepper motor. In the preferred embodiment, the stepper motor driver 49 and the stepper motor 45, in combination, require ten pulses to be received in order to increment the carriage 33 a distance of one track spacing.

The dither system operates to centre the read beam 15 on a recording track by making use of the fact that the average intensity of the reflected beam 41 varies according to the deviation the read beam from the track centerline. This is depicted in Figs. 2a and 2b, wherein Fig. 2a is a cross-section view of the disc 11, taken along a radial line through the center of the disc, with a pit 31 in each of the tracks n and n + 1 being intersected and wherein Fig. 2b is a graph showing the corresponding reflectivity of the disc as a function of radius.

As shown in Fig. 2b the average intensity of the reflected beam 41 is lowest when the read beam 15 is in precise alignment with an information track, since the beam then will impinge directly on a nonreflective pit 31 for a substantial proportion of the time. The average intensity is highest, on the other hand, when the read beam is centered midway between two tracks. It will be appreciated that this average intensity graph is approximately sinusoidal because the width of the point of impingement of the read beam with the disc 11 is comparable in size to the width of the various pits. Additionally, it will be appreciated that, when the read beam is properly aligned with a recording track, the reflected beam will actually comprise a high-frequency carrier signal, because of the pits being scanned. As will later be explained, however, the high frequency component is filtered out, and only the average beam intensity need be considered in describing the invention.

In one example with a disc rotating at 1800 rpm the tracks are 1 micron wide with 1 micron spacing between tracks. The pits might be between 1 and 1.5 microns long with a corresponding space between them. The beam diameter is about 1 micron or less. The apparatus includes an oscillator 51 for producing a constant amplitude, constant frequency radial dither signal, depicted in Fig. 3, that is supplied over line 53 to the bimorph mirror 39. The oscillator is disabled by a disable signal transmitted over line 54 from a control subsystem (not shown) whenever information is being recorded on the disc 11. The frequency of the dither signal produced by the oscillator is preferably about 250 Hz. This oscillates the mirror and thus causes the point of impingement of the read beam 15 on the disc 11 to oscillate in a direction transverse to the axes of the information tracks, the peak-to-peak magnitude of the oscillation preferably being approximately 20 to 30 percent of a track spacing. The point of impingement moves to the right when the signal is positive, and to the left when the signal is negative.

The oscillation of the read beam 15 relative to the information track being scanned causes a corresponding oscillation in the average intensity of the reflected beam of radiation 41. The amplitude of this radiation intensity variation, and its phase angle relative to that of the periodic dither signal, indicate the magnitude and direction of any deviation of the read beam from the centerline of the information track being scanned.

Fig. 4 shows the effect the radial dither signal has on the average reflectivity of the reflected beam of radiation 41, for four different read beam locations, designated A, B, C and D, relative to the centerline of a recording track. As shown in Fig. 2b, location A corresponds to a relatively large deviation to the left of the centerline, location B a relatively small deviation to the left, location C a relatively small deviation to the right, and location D a relatively large deviation to the right.

It will be noted in Fig. 4 that when the read beam 15 has deviated to the left of a track centerline (i.e., locations A and B), the average reflectivity signal is 180° out of phase with the radial dither signal (Fig. 3), whereas, when the read beam has deviated to the right (i.e., locations C and D), the reflectivity signal is in phase with the dither signal. Also, it will be noted that the amplitude of the light intensity variations is larger when the beam has deviated a substantial distance (i.e., locations A and D) from the centerline than when it has deviated only slightly (i.e., locations B and C).

Referring again to Fig. 1, it will be noted that the reflected light intensity signal produced by the photodetector 43 is supplied over line 55 to a bandpass filter 57, which has a center frequency corresponding to the frequency of the radial dither signal, i.e., about 250 Hz, and which operates to extract from the intensity signal the effect of the dithering.

The output signal of the bandpass filter 57 is supplied over line 59 to a multiplier circuit 61, where it is multiplied with the radial dither signal, supplied on line 53 from the oscillator 51. This produces an intermediate signal whose polarity is indicative of the direction of deviation of the read beam of radiation 15 with respect to a track centerline, and whose amplitude is indicative of the amount of such deviation.

Fig. 5 shows the intermediate signal produced by the multiplier circuit 61 for the four locations (A, B, C and D) of the read beam 15 relative to a track centerline. It will be noted that the signal has a frequency double that of the radial dither signal (Fig. 3), and that the d.c. level of the signal is positive when the beam has deviated to the right of the centerline (locations C and D) and negative when the beam has deviated to the left of the centerline (locations A and B). Also, it will be noted that the average magnitude of the signal, either positive or negative, is greater for large deviations of the read beam (locations A and D) than for small deviations (locations B and C).

The intermediate signal produced by the multiplier 61 is supplied over line 63 to a low pass filter 65, which removes from the signal the oscillations caused by the dither signal, leaving only relatively low-frequency variations, particularly those caused by temperature-induced expansion or contraction of the disc 11. The bandwidth of the low pass filter is preferably about 2 Hz. The filter output is positive when the read beam 15 has deviated to the right of a track centerline, and negative when it has deviated to the left, and the magnitude of the output is generally higher for larger deviations.

The output signal produced by the low pass filter 65 is coupled over line 67 to positive and negative threshold detectors 69 and 71, respectively, which compare the amplitude of the signal to prescribed positive and negative thresholds. When the signal exceeds the positive threshold, the output of the positive threshold detector 69 changes state to a logical "one", indicating that the read beam of radiation 15 has deviated to the right of a track centerline by more than a prescribed amount. Similarly, when the signal exceeds the negative threshold, the output of the negative threshold detector 71 changes state to a logical "one" indicating that the beam has deviated to the left of a track centerline by more than a prescribed amount. The magnitudes of the positive and negative thresholds preferably correspond to a deviation of about 10 to 15 percent of a track spacing.

The tracking apparatus of the present invention further includes pulse generation circuitry 73, which receives the outputs of the respective threshold detectors 69 and 71 on lines 75 and 77, respectively, and outputs either step forward or step reverse pulses, as appropriate, for coupling to the stepper motor 45 to step the read beam 15 in the direction of the track centerline. The circuitry 73 includes a clock generator 79, an OR gate 81 and two AND gates 83 and 85. The outputs of the two threshold detectors are connected to the input terminals of the OR gate, where they are "OR'ed" and, in turn, coupled over line 87 to an ENABLE terminal on the clock generator. When enabled, the clock generator immediately outputs a pulse on line 89, and continues to output pulses on that line, at a frequency of about 2 Hz, so long as it remains enabled. The output of the clock generator is coupled over line 89 to one input terminal on each of the two AND gates 83 and 85, and connected to the other input terminal on each AND gate is one of the respective threshold detector outputs. The AND gate 83 outputs the step forward pulse signal, and the AND gate 85 outputs the step reverse pulse signal, for coupling over lines 91 and 93, respectively, to the stepper motor driver 49. Each step pulse signal comprises a 2 Hz pulse

sequence that continues for as long as the corresponding threshold is exceeded by the output signal from the low pass filter 65.

To facilitate the incrementing of the read beam of radiation 15 from one track radius to the next, as, for example, when the next track is to be recorded, the apparatus further includes an OR gate 95 for "OR'ing" the step forward pulses supplied on line 91 with a "move-to-next-track" signal, supplied on line 97 from a control subsystem (not shown). This move-to-next-track signal comprises a burst of about ten pulses, whereby the carriage 33 is moved radially by an amount that corresponds to one track spacing.

In an alternative embodiment of the present invention (not shown), two stepper motors, coupled together in a special series arrangement, are substituted for the stepper motor 45 and the stepper motor driver 49 of Fig. 1. In this special arrangement, the rotor or output shaft of the first motor is coupled to the stator or field structure of the second motor, whereby the output shaft of the second motor can be positioned at a selected angle intermediate its own steps.

It will be appreciated from the foregoing that the present invention represents a significant advance in the field of tracking systems, especially as applied in direct-read-after-write disc recording systems. In particular, the invention provides an effective apparatus for maintaining a beam of radiation in alignment with a selected information track on the disc, regardless of relative expansion or contraction of the disc due to environmental temperature variations.

Claims

1. Apparatus for maintaining a scanner (25, 27) in a prescribed transverse position relative to a selected substantially circular information track on a record medium (11) in the form of a rotatable thin disc having a plurality of parallel and substantially evenly spaced information tracks and for selectively advancing the scanner to an adjacent track; said apparatus comprising a carriage (33) for controllably positioning the scanner in a direction transverse to the axis of the information track; said scanner being arranged to receive a beam (15) of radiation read from the record medium; a detector (43) for detecting the transverse position of the scanner relative to the information track and for producing a control pulse signal (at 91, 93) in accordance with the detected position; and a motor (45) responsive to the control pulse signal for moving the carriage transversely to the information track to tend to maintain the scanner in the prescribed position relative to the track; characterised in that said motor (45) is a stepper motor and the spacing between adjacent tracks corresponds to a prescribed plurality of steps of said stepper motor; and further characterised by a first means (49) for receiving said control pulse signal and controlling accordingly the stepper motor (45) to position the carriage by one or more forward or reverse steps and by a second means for selectively causing said stepper motor to advance said prescribed plurality of steps to thereby advance said scanner to the next track.

2. Apparatus as defined in Claim 1 wherein the detector includes threshold detector means (69, 71) for detecting when the scanner has deviated from the prescribed position by more than a predetermined amount and for producing a corresponding control signal; and control pulse signal means (73) responsive to said control signal for producing the control pulse signal.

3. Apparatus as defined in any preceding claim wherein the control pulse signal is a pulse sequence having a constant pulse frequency.

4. Apparatus as defined in any preceding claim wherein the detector includes a low pass filter (65) for limiting the responsiveness of the detector to relatively slowly-varying changes in the position of the scanner, for example changes caused by temperature-induced expansion or contraction of the medium, rather than changes due to movement between the scanner and the medium in the direction of the axis of the track.

5. Apparatus as defined in any preceding claim in which the detector includes a photodetector for producing an information signal that corresponds to the intensity of the received beam of radiation, means responsive to variations in the average magnitude of the information signal, for sensing any deviation of the beam from the axis of the track and for producing a corresponding intermediate signal for producing the control pulse signal.

6. Apparatus as defined in any preceding claim including an oscillator (51) for producing a periodic dither signal, and means (39) responsive to the dither signal for causing the beam of radiation to oscillate transverse to the axis of the information track.

7. Apparatus as defined in Claim 6 in which the beam deviation sensing means operates to compare the information signal with the dither signal, thereby producing the intermediate signal, which is indicative of both the magnitude and direction of any deviation of the beam of radiation from the axis of the information track.

8. Apparatus as defined in any preceding claim used for tracking in a direct-read-after write recording system having a write beam of radiation and a read beam of radiation that are directed at a rotatable information recording disc by a radially movable carriage means, whereby as the disc is rotated, a sequence of substantially circular and concentrically arranged information tracks is formed on the disc, said tracking apparatus operating to align the read beam of radiation with respect to a selected one of the information tracks.

sequence that continues for as long as the corresponding threshold is exceeded by the output signal from the low pass filter 65.

To facilitate the incrementing of the read beam of radiation 15 from one track radius to the next, as, for example, when the next track is to be recorded, the apparatus further includes an OR gate 95 for "OR'ing" the step forward puises supplied on line 91 with a "move-to-next-track" signal, supplied on line 97 from a control subsystem (not shown). This move-to-next-track signal comprises a burst of about ten pulses, whereby the carriage 33 is moved radially by an amount that corresponds to one track spacing.

In an alternative embodiment of the present invention (not shown), two stepper motors, coupled together in a special series arrangement, are substituted for the stepper motor 45 and the stepper motor driver 49 of Fig. 1. In this special arrangement, the rotor or output shaft of the first motor is coupled to the stator or field structure of the second motor, whereby the output shaft of the second motor can be positioned at a selected angle intermediate its own steps.

It will be appreciated from the foregoing that the present invention represents a significant advance in the field of tracking systems, especially as applied in direct-read-after-write disc recording systems. In particular, the invention provides an effective apparatus for maintaining a beam of radiation in alignment with a selected information track on the disc, regardless of relative expansion or contraction of the disc due to environmental temperature variations.

Claims

1. Apparatus for maintaining a scanner (25, 27) in a prescribed transverse position relative to a selected substantially circular information track on a record medium (11) in the form of a rotatable thin disc having a plurality of parallel and substantially evenly spaced information tracks and for selectively advancing the scanner to an adjacent track; said apparatus comprising a carriage (33) for controllably positioning the scanner in a direction transverse to the axis of the information track; said scanner being arranged to receive a beam (15) of radiation read from the record medium; a detector (43) for detecting the transverse position of the scanner relative to the information track and for producing a control pulse signal (at 91, 93) in accordance with the detected position; and a motor (45) responsive to the control pulse signal for moving the carriage transversely to the information track to tend to maintain the scanner in the prescribed position relative to the track; characterised in that said motor (45) is a stepper motor and the spacing between adjacent tracks corresponds to a prescribed plurality of steps of said stepper motor; and further characterised by a first means (49) for receiving said control pulse signal and controlling accordingly the stepper motor (45) to position the carriage by one or more forward or reverse steps and by a second means for selectively causing said stepper motor to advance said prescribed plurality of steps to thereby advance said scanner to the next track.

2. Apparatus as defined in Claim 1 wherein the detector includes threshold detector means (69, 71) for detecting when the scanner has deviated from the prescribed position by more than a predetermined amount and for producing a corresponding control signal; and control pulse signal means (73) responsive to said control signal for producing the control pulse signal.

3. Apparatus as defined in any preceding claim wherein the control pulse signal is a pulse sequence having a constant pulse frequency.

4. Apparatus as defined in any preceding claim wherein the detector includes a low pass filter (65) for limiting the responsiveness of the detector to relatively slowly-varying changes in the position of the scanner, for example changes caused by temperature-induced expansion or contraction of the medium, rather than changes due to movement between the scanner and the medium in the direction of the axis of the track.

5. Apparatus as defined in any preceding claim in which the detector includes a photodetector for producing an information signal that corresponds to the intensity of the received beam of radiation, means responsive to variations in the average magnitude of the information signal, for sensing any deviation of the beam from the axis of the track and for producing a corresponding intermediate signal for producing the control pulse signal.

6. Apparatus as defined in any preceding claim including an oscillator (51) for producing a periodic dither signal, and means (39) responsive to the dither signal for causing the beam of radiation to oscillate transverse to the axis of the information track.

7. Apparatus as defined in Claim 6 in which the beam deviation sensing means operates to compare the information signal with the dither signal, thereby producing the intermediate signal, which is indicative of both the magnitude and direction of any deviation of the beam of radiation from the axis of the information track.

8. Apparatus as defined in any preceding claim used for tracking in a direct-read-after write recording system having a write beam of radiation and a read beam of radiation that are directed at a rotatable information recording disc by a radially movable carriage means, whereby as the disc is rotated, a sequence of substantially circular and concentrically arranged information tracks is formed on the disc, said tracking apparatus operating to align the read beam of radiation with respect to a selected one of the information tracks.

* C L M S *

Revendications

1. Appareil pour maintenir un explorateur (25, 27) en une position transversale prescrite par rapport à une piste choisie sensiblement circulaire d'information sur un milieu d'enregistrement (11) sous la forme d'un disque mince rotatif ayant un certain nombre de pistes d'information parallèles et sensiblement régulièrement espacées et pour fair sélectivement avancer l'explorateur vers une piste adjacente; ledit appareil comprenant un chariot (33) pour placer, de manière réglable, l'explorateur dans une direction transversale à l'axe de la piste d'information; ledit explorateur étant agencé pour recevoir un faisceau (15) de rayonnement lu du milieu d'enregistrement; un détecteur (43) pour détecter la position transversale de l'explorateur par rapport à la piste d'information et pour produire un signal impulsionnel de réglage (en 91, 93) selon la position détectée; et un moteur (45) répondant au signal impulsionnel de commande pour déplacer le chariot transversalement à la piste d'information pour tendre à maintenir l'explorateur à la position prescrite par rapport à la piste; caractérisé en ce que ledit moteur (45) est un moteur pas à pas et l'espace entre des pistes adjacentes correspond à une quantité prescrite d'étapes dudit moteur pas à pas; et caractérisé de plus par un premier moyen (49) recevant ledit signal impulsionnel de réglage et commandant en conséquence le moteur pas à pas (45) pour placer le chariot par une ou plusieurs étapes d'avance ou inverse et par un second moyen pour forcer sélectivement ledit moteur pas à pas à avancer de ladite quantité prescrite d'étapes pour faire ainsi avancer ledit explorateur vers la piste suivante.

2. Appareil selon la revendication 1, où le détecteur comprend un moyen détecteur de seuil (69, 71) pour détecter le moment où l'explorateur s'est écarté de la position prescrite de plus d'une quantité prédéterminée et pour produire un signal correspondant de réglage; et un moyen de signaux impulsionnels de réglage (73) répondant audit signal de réglage pour produire le signal impulsionnel de réglage.

3. Appareil selon l'une quelconque des revendications précédentes, où le signal impulsionnel de réglage est une séquence d'impulsions ayant une fréquence constante des impulsions.

4. Appareil selon l'une quelconque des revendications précédentes, où le détecteur comprend un filtre passe-bas (65) pour limiter la réponse du détecteur à des changements variant relativement lentement de la position de l'explorateur, par exemple des changements provoqués par une dilatation ou une contraction du milieu induites par la température plutôt que des changements dus aux mouvements entre l'explorateur et le milieu dans la direction de l'axe de la piste.

5. Appareil selon l'une quelconque des revendications précédentes, où le detecteur comprend un photodétecteur pour produire un signal d'information qui correspond à l'intensité du faisceau reçu de rayonnement, un moyen répondant aux variations de la grandeur moyenne du signal d'information, pour détecter tout écart du faisceau par rapport à l'axe de la piste et pour produire un signal intermédiaire correspondant pour produire le signal impulsionnel de réglage.

6. Appareil selon l'une quelconque des revendications précédentes, comprenant un oscillateur (51) pour produire un signal périodique de tremblotement, et un moyen (39) répondant au signal de tremblotement pour forcer le faisceau de rayonnement à osciller transversalement à l'axe de la piste d'information.

7. Appareil selon la revendication 6, où le moyen détectant la déviation du faisceau sert à comparer le signal d'information au signal de tremblotement, pour produire ainsi le signal intermédiaire qui indique la grandeur et la direction de tout écart du faisceau de rayonnement par rapport à l'axe de la piste d'information.

8. Appareil selon l'une quelconque des revendications précédentes, utilisé pour suivre dans un système d'enregistrement à lecture directe après écriture ayant un faisceau de rayonnement d'écriture et un faisceau de rayonnement de lecture qui sont dirigés sur un disque rotatif d'enregistrement de l'information par un moyen formant chariot radialement mobile, et où tandis que le disque tourne, une séquence de pistes d'information sensiblement circulaires et agencées concentriquement est formée sur le disque, ledit appareil suiveur servant à aligner le faisceau de rayonnement de lecture par rapport à une piste choisie des pistes d'information.

Patentansprüche

1. Vorrichtung zum Halten eines Abtasters (25, 27) in einer vorgeschriebenen Querposition relativ zu einer ausgewählten, in wesentlichen kreisförmigen Informationsspur auf einem Aufzeichnungsmedium (11) in Form einer drehbaren dünnen Platte mit einer Vielzahl von parallelen und im wesentlichen in gleichen Abständen vorgesehenen Informationsspuren, und zum selektiven Vorrücken des Abtasters zu einer benachbarten Spur; welche Vorrichtung einen Schlitten (33) zum regelbaren Positionieren des Abtasters in einer Richtung quer zur Achse der Informationsspur; wobei der Abtaster zum Empfang eines vom Aufzeichnungsmedium abgetasteten Strahlungsbündels (15) eingerichtet ist; einen Detektor (43) zum Detektieren de Querposition des Abtasters relativ zur Informationsspur und zur Erzeugung einers Impulsregelsignals (bei 91, 93) in Entsprechung zur detektierten Position; und einen auf das Impulsregelsignal an-

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sprechenden Motor (45) zum Bewegen des Schlittens quer zur Informationsspur aufweist, um danach zu trachten, den Abtaster in der vorgeschriebenen Position relativ zur Spur zu halten; dadurch gekennzeichnet, daß der Motor (45) ein Schrittmotor ist und der Abstand zwischen benachbarten Spuren einer vorherbestimmten Vielzahl von Schritten des Schrittmotors entspricht; und ferner gekennzeichnet durch eine erste Einrichtung (49) zum Empfangen des Impulsregelsignal und entsprechenden Regeln des Schrittmotors (45), um den Schlitten um einen oder mehrere Vorwärts- oder Rückwärtsschritte zu positionieren, und durch eine zweite Einrichtung, um den Schrittmotor selektiv zu veranlassen, sich die vorgeschriebene Anzahl von Schritten weiterzubewegen, um dadurch den Abtaster auf die näschte Spur vorzubewegen.

2. Vorrichtung nach Anspruch 1, bei der der Detektor eine Schwellenwertdetektoreinrichtung (69, 71), um zu detektieren, wenn der Abtaster um mehr als eine vorherbestimmte Größe von der vorgeschriebenen Position abgewichen ist, und um eine entsprechendes Regelsignal zu erzeugen; und eine Impulsregelsignaleinrichtung (73) enthält, die auf das Regelsignal anspricht, um das Impulsregelsignal zu erzeugen.

3. Vorrichtung nach einem der vorhergehenden Ansprüche, bei der das Impulsregelsignal eine Impulsfolge mit einer konstanten Impulsfrequenz ist.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, bei der der Detektor ein Tiefpaßfilter (65) zur Beschränkung den Ansprechempfindlichkeit des Detektors auf relativ langsam erfolgende Änderungen in der Position des Abtasters, z.B. Änderungen zufolge der temperaturbedingten Expansion und Kontraktion des Mediums, anstatt Änderungen zufolge der Bewegung zwischen dem Abtaster und dem Medium in Richtung der Achse der Spur enthält.

5. Vorrichtung nach einem der vorhergehenden Ansprüche, in welcher der Detektor einen Fotodetektor zur Erzeugung eines Informationssignals enthält, das der Intensität des empfangenen Strahlungsbündels entspricht, wobei eine Einrichtung auf Änderungen in der durchschnittlichen Größe des Informationssignals anspricht, um jede Abweichung des Bündels von der Achse der Spur zu erfassen und ein entsprechendes Zwischensignal zur Erzeugung des Impulsregelsignals zu erzeugen.

6. Vorrichtung nach einem der vorhergehenden Ansprüche, mit einem Oszillator (51) zum Erzeugen eines periodischen Zittersignals, und mit einer auf das Zittersignal ansprechenden Einrichtung (39), um zu bewirken, daß das Strahlungsbündel quer zur Achse der Informationsspur oszilliert.

7. Vorrichtung nach Anspruch 6, in welcher die die Bündelabweichung erfassende Einrichtung im Betrieb das Informationssignal mit dem Zittersignal vergleicht, wodurch sie das Zwischensignal erzeugt, welches sowohl für die Größe als auch für die Richtung einer jeden Abweichung des Strahlungsbündels von der Achse der Informationsspur kennzeichnend ist.

8. Vorrichtung nach einem der vorhergehenden Ansprüche bei Verwendung zur Spurnachführung in einem Direkt-Kontrollese-Aufzeichnungssystem mit einem Schreib-Strahlungsbündel und einem Lese-Strahlungsbündel, die durch eine radial bewegliche Schlitteneinrichtung auf eine drehbare Informationsaufzeichnungsplatte gerichtet werden, wodurch bei Drehen des Platte eine Folge von im wesentlichen kreisförmigen und konzentrisch angeordneten Informationsspuren auf der Platte geformt wird, wobei die Spurnachführungsvorrichtung im Betrieb das Lese-Strahlungsbündel bezüglich einer ausgewählten Informationsspur ausrichtet.

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