

Method and apparatus for precisely controlling the angular velocity of an information storage disc

Technical field

This invention relates generally to information storage discs and, more particularly, to apparatus for precisely controlling the angular velocity of information disc relative to a radially movable transducer.

Background of the prior art

Discs for storing large quantities of video information have come into increasing usage in recent years as a result of an increasing need for storage media that provide instantaneous playback, fast random access, and relatively high recording density. The information is typically encoded on the disc in the form of an optically readable sequence of light-reflective and light-scattering regions arranged in substantially circular tracks forming a spiral or concentric circular pattern over the information-bearing surface of the disc.

Ordinarily, the light-reflective and light-scattering regions are initially formed in the disc using an optical transducer for directing onto the disc a collimated beam of high intensity light that is modulated by the information to be recorded. The disc is rotated about its central axis at a substantially constant angular velocity relative to the transducer, while the beam of light is moved radially with respect to the disc at a relatively slow, but constant, velocity. Each revolution of the disc thus results in the production of a separate information track. In the case of video signals, the disc is ordinarily rotated at approximately 1800 r.p.m., whereby each information track contains the information for one video frame.

Systems for encoding the discs at a constant angular velocity have not utilized all of the information storing capability of the discs, however, because the successive light-reflective and light-scattering regions forming information tracks near the periphery of discs are significantly larger in size than the corresponding regions forming tracks near the centers of the discs. As a result, the density of the recorded information is substantially less at the periphery of the disc than near the center of the disc.

Efforts have been made in the past to obtain a more uniform distribution of information over the surface area of the disc, by reducing the angular velocity of the disc as the radial position of the light beam increases. A uniform density of information can be produced if the angular velocity of the disc is made inversely proportional to the radius of the particular track being recorded, whereby the track being recorded on is moved at a constant linear velocity relative to the beam. If this is done, the nominal sizes of the successive light-reflective and light-scattering regions are the same for all of the information tracks.

Although constant linear velocity systems of the type described above do provide a more uniform density of recorded information over the surface of the disc than do constant angular velocity systems, and although they operate satisfactorily in some situations, the systems have been analog systems and are subject to non-linearities and drifts. The density of the recorded information thus cannot be made as uniformly high as it would be if the system were not susceptible to such errors. Additionally, such constant linear velocity systems ordinarily require elaborate calibration procedures to be performed prior to their actual use.

Other systems for rotating an information disc at a substantially constant linear velocity relative to a light beam have included a digital encoder coupled to the movable lens carriage, a counter, and a digital-to-analog (D/A) converter. In these alternative systems, pulses produced by the digital encoder are counted in the counter to produce a digital count proportional to the radius of the track being recorded. Application of this count to the input of the D/A converter, then, produces a corresponding analog signal that can be used in combination with a VCO (voltage controlled oscillator) and a spindle servo to control the angular velocity of the disc. Such hybrid digital/analog systems still require elaborate calibrating procedures to be performed, and are still susceptible to non-linearities and drifts in the VCO. Additionally, such systems are limited by the resolution capability of D/A converters currently available commercially.

It will be appreciated from the foregoing that there is still a need for a method and apparatus for rotating an information disc at a precisely controllable angular velocity, whereby information can be recorded in a series of concentrically arranged tracks with a uniformly high recording density, without being susceptible to non-linearities and drifts of various elements in the apparatus, and without necessitating substantial initial calibration procedures. The present invention fulfills this need.

Summary of the invention

The invention firstly relates to an apparatus for precisely controlling, in one or more operating modes, the angular velocity of an information disc relative to a transducer, said disc having a plurality of substantially circular and concentrically arranged information tracks, wherein said transducer is radially movable relative to said disc to be positioned in a prescribed relationship relative to a selected one of said tracks, and in a first operating mode the relative angular velocity of the information disc is controllably varied according to the radius of the selected information track, said apparatus being characterized by: means for producing a

(11)

digital signal indicative of the radius of the particular information track selected; oscillator means for producing a clock signal having a substantially constant frequency; digital means, responsive to the radius signal and the clock signal, for producing a disc velocity signal that has an instantaneous frequency corresponding to the frequency of the clock signal divided by the digital radius signal; and means for adjusting the angular velocity of the information disc according to the instantaneous frequency of the disc velocity signal.

By decreasing the angular velocity of the disc as the radius increases, according to said first operating mode, a greater density of information can be contained on the disc than if the angular velocity were maintained constant.

The invention secondly relates to a method, as characterized in claim 12, for precisely controlling the angular velocity of an information disc.

The apparatus includes a radius register for storing a digital signal indicative of the radius of the selected information track, means for producing a velocity signal having a frequency that varies according to the digital signal, and means for adjusting the angular velocity of the disc according to the frequency of the velocity signal. In accordance with the invention, the disc velocity signal is produced by frequency dividing a clock signal, which is generated by a stable reference oscillator, by the digital measure of radius, whereby the frequency of the velocity signal is substantially immune to component drifts, and elaborate preliminary calibration procedures are obviated. By making the radius measure a digital count directly proportional to the radius of the selected information track and in said first operating mode, a constant linear velocity of the track relative to the transducer is produced, and a maximum recording density over the entire surface of the disc can be achieved.

More particularly, an apparatus as characterized in claim 5 is especially adaptable for use with an information disc mastering machine wherein information is recorded onto a disc by an optical transducer. The transducer produces a collimated beam of light, which is modulated with the information to be recorded, and which is directed by a focusing lens onto a selected portion of the disc, as the disc is controllably rotated with respect to it. The lens is attached to a carriage that is movable in a radial direction by a lead screw to direct the light beam onto the selected track.

The means for producing the velocity signal preferably includes a digital counter that is continuously clocked by the clock signal from the reference oscillator, a digital magnitude comparator for comparing the count stored in the counter to the radius count stored in the radius register and for producing a pulse to reset the counter to an initial zero state every time it is determined that the two counts are equivalent.

Since the time period between successive reset pulses will be directly proportional to the magnitude of the digital measure of radius, it will be appreciated that the frequency of the reset pulses is inversely proportional to the measure of radius. The velocity signal can thus be produced by frequency dividing the succession of reset pulses, whereby the frequency of the velocity signal is, likewise, inversely proportional to the magnitude of the radius measure.

In accordance with another aspect of the present invention, the apparatus further includes means for producing a lens carriage velocity signal having a frequency proportional to the desired radial velocity for the light beam, along with a lens carriage driver, responsive to the lens carriage velocity signal, for controllably adjusting the radial velocity of the lens carriage, accordingly. For maximum information storage density over the surface of the disc, there must be equal spacing between successive information tracks (i.e., constant pitch). This can be accomplished by moving the lens carriage radially with a velocity proportional to the angular velocity of the disc. Thus, the lens carriage velocity signal is preferably produced by frequency dividing the succession of reset pulses.

Since the lens carriage velocity signal has a frequency directly proportional to the rate of change of the radius of the selected track, the signal can be utilized advantageously to update the measure of radius as the lens carriage is moved radially inwardly or outwardly depending upon whether the apparatus is being used to define a track which spirals towards or away from the centre of the disc. Thus, in accordance with another aspect of the present invention, a measure of the radius of the initial track selected is manually preset into the radius register, and the lens carriage velocity signal is coupled to the clock input of the register to increment (or decrement) the stored number as the lens carriage is moving radially outwardly (or inwardly). It will be appreciated that any particular embodiment need only be capable of changing the number stored in the register in one direction, which direction is determined by the direction of formation of the information track. In any particular embodiment, the lens carriage need only move in one direction. Thus, the digital count stored in the register is always representative of the radius of the particular information track that has been selected.

In accordance with still another aspect of the present invention, the apparatus further includes means for permitting a manual selection of one of two operating modes for rotation of the disc, one a constant linear velocity mode, and the other a constant angular velocity mode. This can be accomplished using a switch coupled to the clock input of the radius register, whereby, when the constant angular velocity mode is desired, the switch can be

selectively opened to inhibit the lens carriage velocity signal from changing the count stored in the register. As a result, the particular count at which the digital counter is reset to its zero state remains unchanged, and a constant frequency for the reset pulses, and, therefore, the disc velocity and lens carriage velocity signals, will be produced.

In an alternative embodiment of the present invention, the count stored in the radius register is updated not by the lens carriage velocity signal, but, rather, by pulses produced by an optical encoder coupled to the lead screw. The frequency of these optical encoder pulses is, like that of the lens carriage velocity signal, directly proportional to the rate of change of the radius of the selected track, so the count will, likewise, always be representative of such radius.

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

Figure 1 is a block diagram of a servo apparatus in accordance with the present invention, for rotating an information disc about its central axis to produce a constant linear velocity for the disc relative to an optical transducer; and

Figures 2(a)—2(e) together constitute a simplified timing diagram (not necessarily to scale) showing various timing signals produced by the apparatus of Figure 1.

Description of the preferred embodiment

Referring now to the drawings, and particularly to Figure 1, there is shown a servo apparatus for rotating an information disc 11 about its central axis 13 at a precisely controlled angular velocity. The disc 11 is rotated relative to an optical transducer 15, which operates to record onto the disc information such as a conventional color television signal frequency modulated on a carrier.

The optical transducer 15 includes means (not shown) for producing a collimated beam of light modulated by the information to be recorded, along with a lens carriage 17, which is controllably movable in a radial direction by a lead screw 19 to direct the beam of light onto a selected portion of the disc 11 as the disc is rotated with respect to it. This produces a series of substantially circular information tracks (not shown) forming either a spiral or concentric circle pattern on the surface of the disc, each track comprising an alternating sequence of light-reflective and light-scattering regions.

The servo apparatus includes a radius register 21 for storing a digital measure of the radius of the track on which information is currently being recorded, velocity signal cir-

cuitry 23 for producing a disc velocity signal having a frequency corresponding to the desired angular velocity of the information disc 11, and a spindle motor servo 25, responsive to the disc velocity signal, for controllably rotating the disc at a corresponding angular velocity. Additionally, the velocity signal circuitry 23 operates to produce a lens carriage velocity signal having a frequency corresponding to the desired radial velocity of the lens carriage 17, and the apparatus further includes a lens carriage driver 27, responsive to the lens carriage velocity signal, for moving the lens carriage, accordingly.

To achieve a uniform density of recorded information over the entire information-bearing surface of the disc 11, the disc must be rotated at a constant linear velocity relative to the lens carriage 17, and the radial distance between adjacent information tracks (i.e., pitch) must be maintained constant. This is accomplished by making the instantaneous frequencies of both the disc velocity signal and the lens carriage velocity signal inversely proportional to the radius of the particular information track being recorded.

The velocity signal circuitry 23 includes a crystal oscillator 29 for producing a clock signal having a substantially constant frequency. In accordance with the invention, both the disc velocity signal and the lens carriage velocity signal are derived from a master pulse signal that is produced by frequency dividing the clock signal by the digital measure of radius stored in the radius register 21. As a result, both velocity signals have frequencies inversely proportional to the radius measure, and the apparatus can operate properly to record information on the disc 11 at a uniformly high recording density, without the need for elaborate initial calibration procedures.

In the preferred embodiment, the velocity signal circuitry 23 includes a digital counter 31 that is clocked by the clock signal supplied on line 33 from the crystal oscillator 29, along with a digital word magnitude comparator 35 that continuously compares the magnitudes of the respective counts stored in the digital counter 31 and the radius register 21, supplied over lines 37 and 39, respectively. Every time it is determined by the magnitude comparator that the two counts are equivalent, a pulse is output on line 41 to reset the digital counter 31 to an initial zero state.

The successive reset pulses produced by the magnitude comparator on line 41 form the aforementioned master pulse signal, from which the disc velocity signal and lens carriage velocity signal are then derived. It will be appreciated that the instantaneous frequency of this master pulse signal is inversely proportional to the measure of radius currently stored in the radius register.

As the lens carriage 17 is moved radially outwardly from the centermost track on the disc 11, the magnitude of the radius count stored in

the radius register 21 will be continuously increasing, and additional time will be required for the count in the digital counter 31 to reach that magnitude. Thus, as the current track radius increases, the successive reset pulses in the master pulse signal on line 41 will be increasingly spread out and, likewise, the resultant disc velocity and lens carriage velocity signals, derived therefrom, will have diminishing instantaneous frequencies. The magnitudes of the successive step increases in the measure of radius are preferably small in comparison with the magnitude of measure of radius, itself, so that the spindle motor servo 25 and the lens carriage driver 27 will not operate to produce large accelerations of the disc 11 and the lens carriage 17, respectively.

The master pulse signal is supplied over line 41 to a divide-by- N_1 circuit 43, which divides its frequency by an integral factor N_1 , to produce the disc velocity signal. Similarly, the master pulse signal is supplied to a divide-by- N_2 circuit 45, which divides its frequency by an integral factor N_2 , to produce the lens carriage velocity signal. The particular values for the factors N_1 and N_2 are selected to produce the prescribed frequencies for the respective velocity signals that enable the spindle motor servo 25 and lens carriage driver 27 to drive the disc 11 and the lens carriage 17 at the proper velocities.

The disc velocity signal and the lens carriage velocity signal are supplied over lines 47 and 49 from the velocity signal circuitry 23 to the spindle motor servo 25 and the lens carriage driver 27, respectively. The servo and the driver both operate in a conventional manner to controllably adjust either the angular velocity of the disc 11 and the radial velocity of the lens carriage 17, according to the instantaneous frequency of the corresponding velocity signal.

The spindle motor servo 25 includes a spindle motor 51 for rotating the disc 11, a tachometer 53 coupled to the spindle motor for producing a tachometer signal having a frequency proportional to its angular velocity, and a phase comparator 55 for comparing the respective phase angles of the tachometer signal and the disc velocity signal. The phase comparator 55 produces a control signal proportional to the phase difference, which is processed by a lead/lag compensator 56 and amplified by an amplifier 57 and, in turn, coupled to the spindle motor 51 to control its angular velocity. The servo 25 operates in a conventional manner to synchronize the respective frequencies and phase angles of the disc velocity signal and the tachometer signal, whereby the angular velocity of the spindle motor 51, and therefore, the disc 11, are made to follow the varying frequency of the disc velocity signal.

The lens carriage driver 27 includes an amplifier 59 and a synchronous lens carriage drive motor 61. The lens carriage velocity signal, supplied on line 49 from the velocity

signal circuitry, is suitably amplified in the amplifier 59 and, in turn, coupled to the motor 61, which turns the lead screw 19 at a corresponding angular velocity. Thus, the radial velocity of the lens carriage 17 will automatically follow the varying frequency of the lens carriage velocity signal.

In the preferred embodiment, the radius register 21 is a digital counter that can be initially manually preset with a count proportional to the radius of the initial track on which information is to be recorded. The count stored in the register is then continuously updated by means of the lens carriage velocity signal, which, as previously discussed, has a frequency proportional to the rate of change of the radius of the lens carriage 17. This signal is transmitted over line 49 from the velocity signal circuitry 23 to a divide-by- N_3 circuit 69, where it is frequency divided by an integral factor N_3 , and transmitted over line 71 to a mode switch 73, and, in turn, over line 75 to the CLOCK input terminal of the radius register 21. The radius count stored in the register is thus continuously updated as the lens carriage 17 is moved radially with respect to the disc 11. The divide-by- N_3 circuit 69 is utilized to suitably frequency divide the lens carriage velocity signal to achieve a properly scaled frequency for updating the radius count. If the lens carriage 17 is moved radially outwardly by the lens carriage driver 27, the count in the radius register 21 is incremented by the lens carriage velocity signal, whereas, if the carriage is moved radially inwardly, the count is decremented.

Referring now to Figure 2 of the drawings, Figure 2(a) shows, in simplified form, the magnitude of the count stored in the digital counter 31, along with the radius count stored in the radius register 21, both counts varying with time. It will be noted that the count registered in the digital counter increases linearly with time until it reaches the level of the radius count, at which time it is reset to its initial zero count by a reset pulse (Figure 2(b)) from the magnitude comparator 35. This counting and resetting process is continuously repeated as long as the apparatus continues to operate, whereby the succession of reset pulses, forming the master pulse signal on line 41 is produced.

Figures 2(c) and 2(d) depict the disc velocity signal and the lens carriage velocity signal, which are produced by the divide-by- N_1 and the divide-by- N_2 circuits, 43 and 45, respectively, for transmission over lines 47 and 49 to the spindle motor servo 25 and the lens carriage driver 27, respectively. It will be noted that, for simplicity, both of these velocity signals have instantaneous frequencies equal to one half of the instantaneous frequency of the master pulse signal produced by the magnitude comparator 35 (i.e., $N_1=N_2=2$). It should be appreciated, however, that the actual values selected

(14)

for the factors N_1 and N_2 will depend upon a number of factors, including the frequency of the crystal oscillator 29, the resolution of the radius register 21, and characteristics of the spindle motor servo 25 and the lens carriage driver 27.

Referring again to Figure 1, the lens carriage velocity signal is supplied over line 49 to the divide-by- N_3 circuit 69, which divides the instantaneous frequency of the signal by the factor N_3 to produce radius update pulses (Figure 2(e)) for transmission to the radius register 21. The count stored in the radius register is thus updated to reflect the current radius of the track on which information is being recorded. As shown in Figure 2(a), a staircase-like radius count will result.

In accordance with another aspect of the present invention, the radius update pulses produced by the divide-by- N_3 circuit 69 are coupled through the mode switch 73, which permits a manual selection of an operating mode for the apparatus. With the switch closed, the pulses are transmitted to the radius register 21 and the apparatus will function as previously described to produce a constant linear velocity for the information disc 11 relative to the lens carriage 17. With the switch opened, on the other hand, the transmission of pulses to the radius register 21 is prevented, so the count stored in the register remains unchanged. As a result, the instantaneous frequency of the reset pulses forming the master pulse signal on line 41 remains constant, and, likewise, the respective frequencies of the disc velocity signal and the lens carriage velocity signal remain unchanged. A constant angular velocity for the disc 11 will thereby result.

In an alternative embodiment of the present invention (not shown), the apparatus includes an optical encoder coupled to the lead screw 19 for producing a signal having a frequency proportional to the radial velocity of the lens carriage 17. The optical encoder signal, rather than the lens carriage velocity signal, is then coupled to the divide-by- N_3 circuit 69 to produce the radius update pulses (Figure 2(e)).

From the foregoing description, it should be apparent that the present invention provides an effective servo apparatus for precisely controlling the angular velocity of an information storage disc relative to an optical transducer for recording information thereon. The apparatus can operate to rotate the information disc at a substantially constant linear velocity relative to the transducer, without being susceptible to velocity changes due to component drifts, and without requiring elaborate initial calibration procedures, whereby a uniformly high density of information can be recorded over the entire information-bearing surface of the disc.

Claims

1. Apparatus for precisely controlling, in one

or more operating modes, the angular velocity of an information storage disc (11) relative to a transducer (15), said disc (11) having a plurality of substantially circular and concentrically arranged information tracks, wherein said transducer (15) is radially movable relative to said disc (11) to be positioned in a prescribed relationship relative to a selected one of said tracks, and in a first operating mode the relative angular velocity of the information disc is controllably varied according to the radius of the selected information track, said apparatus being characterized by: means (21) for producing a digital signal indicative of the radius of the particular information track selected; oscillator means (29) for producing a clock signal having a constant frequency; digital means (35, 31, 43), responsive to the radius signal and the clock signal, for producing a disc velocity signal that has an instantaneous frequency corresponding to the frequency of the clock signal divided by the digital radius signal; and means (25) for adjusting the angular velocity of the information disc (11) according to the instantaneous frequency of the disc velocity signal.

2. Apparatus as defined in claim 1, wherein the magnitude of said digital radius signal is directly proportional to the radius of the selected information track, whereby in said first operating mode the angular velocity of the disc (11) is maintained inversely proportional to the radius of the selected track and the disc (11) is moved at a constant linear velocity relative to the transducer.

3. Apparatus as defined in claim 1 or 2, further including: means (35, 31, 45) responsive to the radius signal and the clock signal, for producing a transducer velocity signal having an instantaneous frequency proportional to that of the disc velocity signal; and means (27) for adjusting the radial velocity of the transducer (15) relative to the information disc (11) according to the instantaneous frequency of the transducer velocity signal.

4. Apparatus as defined in claim 3, wherein the transducer (15) operates to record information in a sequential fashion on successive information tracks on the disc (11).

5. Apparatus for recording information on an information disc (11) in a plurality of substantially circular and concentrically arranged information tracks, wherein the successive information tracks are substantially equally-spaced with respect to each other, and in a first operating mode the density of information recorded on each track is substantially constant, said apparatus comprising: means (25) for rotating the information disc about its central axis at a controllable angular velocity; transducer means (15) controllably movable in a radial direction relative to the information disc (11) to record the information on a selected information track said apparatus being characterized by: means (21) for producing a digital signal indicative of the radius of the selected

14

for the factors N_1 and N_2 will depend upon a number of factors, including the frequency of the crystal oscillator 29, the resolution of the radius register 21, and characteristics of the spindle motor servo 25 and the lens carriage driver 27.

Referring again to Figure 1, the lens carriage velocity signal is supplied over line 49 to the divide-by- N_2 circuit 69, which divides the instantaneous frequency of the signal by the factor N_2 to produce radius update pulses (Figure 2(e)) for transmission to the radius register 21. The count stored in the radius register is thus updated to reflect the current radius of the track on which information is being recorded. As shown in Figure 2(a), a staircase-like radius count will result.

In accordance with another aspect of the present invention, the radius update pulses produced by the divide-by- N_2 circuit 69 are coupled through the mode switch 73, which permits a manual selection of an operating mode for the apparatus. With the switch closed, the pulses are transmitted to the radius register 21 and the apparatus will function as previously described to produce a constant linear velocity for the information disc 11 relative to the lens carriage 17. With the switch opened, on the other hand, the transmission of pulses to the radius register 21 is prevented, so the count stored in the register remains unchanged. As a result, the instantaneous frequency of the reset pulses forming the master pulse signal on line 41 remains constant, and, likewise, the respective frequencies of the disc velocity signal and the lens carriage velocity signal remain unchanged. A constant angular velocity for the disc 11 will thereby result.

In an alternative embodiment of the present invention (not shown), the apparatus includes an optical encoder coupled to the lead screw 19 for producing a signal having a frequency proportional to the radial velocity of the lens carriage 17. The optical encoder signal, rather than the lens carriage velocity signal, is then coupled to the divide-by- N_2 circuit 69 to produce the radius update pulses (Figure 2(e)).

From the foregoing description, it should be apparent that the present invention provides an effective servo apparatus for precisely controlling the angular velocity of an information storage disc relative to an optical transducer for recording information thereon. The apparatus can operate to rotate the information disc at a substantially constant linear velocity relative to the transducer, without being susceptible to velocity changes due to component drifts, and without requiring elaborate initial calibration procedures, whereby a uniformly high density of information can be recorded over the entire information-bearing surface of the disc.

Claims

1. Apparatus for precisely controlling, in one

or more operating modes, the angular velocity of an information storage disc (11) relative to a transducer (15), said disc (11) having a plurality of substantially circular and concentrically arranged information tracks, wherein said transducer (15) is radially movable relative to said disc (11) to be positioned in a prescribed relationship relative to a selected one of said tracks, and in a first operating mode the relative angular velocity of the information disc is controllably varied according to the radius of the selected information track, said apparatus being characterized by: means (21) for producing a digital signal indicative of the radius of the particular information track selected; oscillator means (29) for producing a clock signal having a constant frequency; digital means (35, 31, 43), responsive to the radius signal and the clock signal, for producing a disc velocity signal that has an instantaneous frequency corresponding to the frequency of the clock signal divided by the digital radius signal; and means (25) for adjusting the angular velocity of the information disc (11) according to the instantaneous frequency of the disc velocity signal.

2. Apparatus as defined in claim 1, wherein the magnitude of said digital radius signal is directly proportional to the radius of the selected information track, whereby in said first operating mode the angular velocity of the disc (11) is maintained inversely proportional to the radius of the selected track and the disc (11) is moved at a constant linear velocity relative to the transducer.

3. Apparatus as defined in claim 1 or 2, further including: means (35, 31, 45) responsive to the radius signal and the clock signal, for producing a transducer velocity signal having an instantaneous frequency proportional to that of the disc velocity signal; and means (27) for adjusting the radial velocity of the transducer (15) relative to the information disc (11) according to the instantaneous frequency of the transducer velocity signal.

4. Apparatus as defined in claim 3, wherein the transducer (15) operates to record information in a sequential fashion on successive information tracks on the disc (11).

5. Apparatus for recording information on an information disc (11) in a plurality of substantially circular and concentrically arranged information tracks, wherein the successive information tracks are substantially equally-spaced with respect to each other, and in a first operating mode the density of information recorded on each track is substantially constant, said apparatus comprising: means (25) for rotating the information disc about its central axis at a controllable angular velocity; transducer means (15) controllably movable in a radial direction relative to the information disc (11) to record the information on a selected information track said apparatus being characterized by: means (21) for producing a digital signal indicative of the radius of the selected



(5)

information track; oscillator means (29) for producing a clock signal having a constant frequency; velocity signal means, responsive to the clock signal and the digital radius signal; including digital means (35, 31, 43) for producing a disc velocity signal and digital means (35, 31, 45) for producing a transducer velocity signal, both of said signals having frequencies proportional to the frequency of the clock signal divided by the radius signal; and means (27) for controllably moving said transducer means (15) at a radial velocity corresponding to the frequency of the transducer velocity signal, whereby such velocity in said first operating mode is inversely proportional to the radius of the particular track being recorded; said means (25) for rotating the disc operating to rotate the disc (11) at an angular velocity corresponding to the frequency of the disc velocity signal, whereby in said first operating mode the disc (11) is moved at a constant linear velocity relative to said transducer means (15), and information is recorded on the disc (11) at the same recording density for all of the information tracks.

6. Apparatus as defined in claim 3, 4, or 5, wherein said means for producing a transducer signal include an encoder coupled to said transducer means.

7. Apparatus as defined in any of claims 1—5, wherein said means for producing a digital radius signal includes: a digital radius register (21) for storing the radius signal; means for loading an initial digital word into said register, said initial word having a magnitude that corresponds to the radius of the initial information track selected; and means for producing a signal indicative of radial movement of the transducer in a predetermined direction relative to the information disc, for use in updating the count stored in said radius register, whereby the digital word stored therein is continuously indicative of the radius of the selected track.

8. Apparatus as defined in any of claims 1—7, wherein said means for producing a disc velocity signal includes: digital counter means (31) for continuously counting the successive cycles of the clock signal; digital comparator means (35) for comparing the magnitude of the count stored in said digital counter means (31) to the magnitude of the radius signal; and means for producing a signal to reset said digital counter means (31) to an initial state every time it is determined by said digital comparator means (35) that the respective magnitudes are equivalent, whereby the instantaneous frequency of the reset signal is inversely proportional to the magnitude of the radius signal.

9. Apparatus as defined in claim 8, wherein said means for producing a disc velocity signal further includes: means (43) for frequency dividing the reset signal to produce the disc velocity signal.

10. Apparatus as defined in any of claims 1—9, in which, in the first operating mode, the information disc is rotated at a constant linear velocity relative to the transducer means and further including: switch means (73) for permitting a manual selection between the first operating mode, and a second operating mode, wherein the information disc is rotated at a constant angular velocity.

11. Apparatus as defined in claim 10, wherein: said switch means (73) includes means for selectively preventing the transducer signal from updating the count stored in said radius register, whereby said count remains constant and, likewise, the frequencies of the respective disc velocity and transducer velocity signals remain constant.

12. A method of precisely controlling the angular velocity of an information storage disc relative to a transducer, said disc having a plurality of substantially circular and concentrically arranged information tracks, wherein said transducer is radially movable relative to said disc to be positioned in a predetermined relationship relative to a selected one of said tracks, and the relative angular velocity of the information disc is controllably varied according to the radius of the selected information track, and said method being characterised by the steps of: producing a digital signal indicative of the radius of the particular information track selected; generating a clock signal having a constant frequency; dividing the frequency of the clock signal by the radius signal to produce a disc velocity signal; and adjusting the angular velocity of the information disc according to the instantaneous frequency of the disc velocity signal.

13. A method as defined in claim 12, wherein the magnitude of said digital radius signal is directly proportional to the radius of the selected information track, whereby the angular velocity of the disc is maintained inversely proportional to the radius of the selected track and the disc is moved at a constant linear velocity relative to the transducer.

14. A method as defined in claim 13, wherein said step of producing a radius signal includes the steps of: storing an initial digital word having a magnitude corresponding to the radius of the initial information track selected; and monitoring relative radial movement of the transducer in a predetermined direction and continuously updating the digital word being stored, whereby such word is continuously indicative of the radius of the selected information track.

15. A method as defined in any of claims 12—14, wherein said step of dividing includes the steps of: continuously counting the successive cycles of the clock signal and storing such count in a digital counter; comparing the magnitude of the count stored in said digital counter to the magnitude of the radius signal;



producing a reset signal to reset the digital counter to an initial state every time it is determined in said step of comparing that the respective magnitudes are equal, thereby the instantaneous frequency of the reset signal is inversely proportional to the magnitude of the radius measure.

16. A method as defined in claim 15, wherein said step of dividing further includes the step of: frequency dividing the reset signal to produce the disc velocity signal.

17. A method as defined in any of claims 12—16, further including the steps of: producing a transducer velocity signal having an instantaneous frequency proportional to that of the disc velocity signal; and adjusting the radial velocity of the transducer relative to the information disc according to the instantaneous frequency of the transducer velocity signal.

18. A method as defined in claim 17, wherein the transducer operates to record information in a sequential fashion on successive information tracks on the disc.

Patentansprüche

1. Apparat zur präzisen Steuerung der Winkelgeschwindigkeit einer Informationsspeicherplatte (11) relativ zu einem Wandler (15) in einer oder mehreren Betriebsarten, welche Platte (11) eine Vielzahl von im wesentlichen kreisförmigen und konzentrisch angeordneten Informationsspuren aufweist, wobei der Wandler (15) relativ zur Platte (11) radial bewegbar ist, um in einem vorgeschriebenen Verhältnis relativ zu einer ausgewählten Spur in Position gebracht zu werden, und in einer ersten Betriebsart die relative Winkelgeschwindigkeit der Informationsplatte gemäß dem Radius der ausgewählten Informationsspur steuerbar variiert wird, welcher Apparat gekennzeichnet ist durch Mittel (21) zur Erzeugung eines den Radius der einzelnen ausgewählten Informationsspur kennzeichnenden digitalen Signals; Oszillatormittel (29) zur Erzeugung eines Taktsignals mit konstanter Frequenz; auf das Radiussignal und das Taktsignal ansprechende digitale Mittel (35, 31, 43) zur Erzeugung eines Plattengeschwindigkeitssignals, das eine momentane Frequenz entsprechend der Frequenz des Taktsignals, dividiert durch das digitale Radiussignal, aufweist; und durch Mittel (25) zur Einstellung der Winkelgeschwindigkeit der Informationsplatte (11) gemäß der momentanen Frequenz des Plattengeschwindigkeitssignals.

2. Apparat nach Anspruch 1, bei dem die Größe des digitalen Radiussignals direkt proportional dem Radius der ausgewählten Informationsspur ist, wodurch in der ersten Betriebsart die Winkelgeschwindigkeit der Platte (11) umgekehrt proportional dem Radius der ausgewählten Spur beibehalten und die Platte (11) mit einer konstanten linearen Geschwindigkeit relativ zum Wandler bewegt wird.

3. Apparat nach Anspruch 1 oder 2, der ferner auf das Radiussignal und das Taktsignal ansprechende Mittel (35, 31, 45) zur Erzeugung eines Wandlergeschwindigkeitssignals, das eine momentanen Frequenz aufweist, die proportional jener des Plattengeschwindigkeitssignals ist; und Mittel (27) zur Einstellung der Radialgeschwindigkeit des Wandlers (15) relativ zur Informationsplatte (11) gemäß der momentanen Frequenz des Wandlergeschwindigkeitssignals enthält.

4. Apparat nach Anspruch 3, bei dem der Wandler (15) arbeitet, um Information in sequentieller Weise in aufeinanderfolgenden Informationsspuren auf der Platte (11) aufzuzeichnen.

5. Apparat zur Aufzeichnung von Information auf einer Informationsplatte (11) in einer Vielzahl von im wesentlichen kreisförmigen und konzentrisch angeordneten Informationsspuren, wobei die aufeinanderfolgenden Informationsspuren im wesentlichen gleiche Abstände voneinander aufweisen und in einer ersten Betriebsart die Dichte der in jeder Spur aufgezeichneten Information im wesentlichen konstant ist, welcher Apparat Mittel (25) zum Drehen der Informationsplatte um ihre Mitlenachse mit einer steuerbaren Winkelgeschwindigkeit; und in radialer Richtung relativ zur Informationsplatte (11), steuerbar bewegliche Wandlermittel (15) zum Aufzeichnen der Information in einer ausgewählten Informationsspur aufweist, welcher Apparat gekennzeichnet ist durch Mittel (21) zur Erzeugung eines den Radius der ausgewählten Informationsspur kennzeichnenden digitalen Signals; Oszillatormittel (29) zur Erzeugung eines Taktsignals mit konstanter Frequenz; auf das Taktsignal und das digitale Radiussignal ansprechende Geschwindigkeitssignalmittel, die digitale Mittel (35, 31, 43) zur Erzeugung eines Plattengeschwindigkeitssignals und digitale Mittel (35, 31, 45) zur Erzeugung eines Wandlergeschwindigkeitssignals enthalten, wobei diese beiden Signale Frequenzen aufweisen, die proportional der Frequenz des Taktsignals, dividiert durch das Radiussignal, sind; und durch Mittel (27) zum steuerbaren Bewegen der Wandlermittel (15) mit einer Radialgeschwindigkeit entsprechend der Frequenz des Wandlergeschwindigkeitssignals, wodurch diese Geschwindigkeit in der ersten Betriebsweise umgekehrt proportional dem Radius der einzelnen Spur ist, in der gerade aufgezeichnet wird; wobei die Mittel (25) zum Drehen der Platte wirken, um die Platte (11) mit einer Winkelgeschwindigkeit entsprechend der Frequenz des Plattengeschwindigkeitssignals zu drehen, wodurch in der ersten Betriebsart die Platte (11) mit einer konstanten linearen Geschwindigkeit relativ zu den Wandlermitteln (15) bewegt wird, und Information auf der Platte (11) mit derselben Aufzeichnungsdichte für alle Informationsspuren aufgezeichnet wird.

6. Apparat nach Anspruch 3, 4 oder 5, bei



dem die Mittel zur Erzeugung eines Wandler-signals einen mit den Wandlermitteln gekuppelten Kodierer aufweisen.

7. Apparat nach einem der Ansprüche 1 bis 5, bei dem die Mittel zur Erzeugung eines digitalen Radiussignals ein digitales Radius-Register (21) zur Speicherung des Radius-signals; Mittel zum Laden eines digitalen Anfangswortes in das Register, wobei dieses Anfangswort eine Größe entsprechend dem Radius der ausgewählten Anfangs-Informationsspur aufweist; und Mittel zur Erzeugung eines die Radialbewegung des Wandlers relativ zur Informationsplatte in einer vorherbestimmten Richtung kennzeichnenden Signals zur Verwendung beim Auf-den-Standbringen der im Radius-Register gespeicherten Zählung enthalten, wodurch das darin gespeicherte digitale Wort laufend für den Radius der ausgewählten Spur kennzeichnend ist.

8. Apparat nach einem der Ansprüche 1 bis 7, bei dem die Mittel zur Erzeugung eines Plattengeschwindigkeitssignals digitale Zählermittel (31) zum laufenden Zählen der aufeinanderfolgenden Zyklen des Taktsignals; digitale Komparatormittel (35) zum Vergleichen der Größe der in den digitalen Zählermitteln (31) gespeicherten Zählung mit der Größe des Radiussignals; und Mittel zur Erzeugung eines Signals zum Rückstellen der digitalen Zählermittel (31) auf einen Anfangszustand immer dann, wenn von den digitalen Komparatormitteln (35) festgestellt wird, daß die jeweiligen Größen gleichwertig sind, enthalten, wodurch die momentane Frequenz des Rückstellsignals umgekehrt proportional der Größe des Radius-signals ist.

9. Apparat nach Anspruch 8, bei dem die Mittel zur Erzeugung eines Plattengeschwindigkeitssignals weiters Mittel (43) zur Frequenzteilung des Rückstellsignals enthalten, um das Plattengeschwindigkeitssignal zu erzeugen.

10. Apparat nach einem der Ansprüche 1 bis 9, bei dem die Informationsplatte von der ersten Betriebsart mit einer konstanten linearen Geschwindigkeit relativ zu den Wandlermitteln gedreht wird, und der ferner Schaltmittel (73) zur Ermöglichung einer händischen Auswahl zwischen der ersten Betriebsart und einer zweiten Betriebsart enthält, in der die Informationsplatte mit einer konstanten Winkelgeschwindigkeit gedreht wird.

11. Apparat nach Anspruch 10, bei dem die Schaltmittel (73) Mittel enthalten, um das Wandler-signal selektiv am Auf-den-Standbringen der im Radius-Register gespeicherten Zählung zu hindern, wodurch die Zählung konstant bleibt und ebenso die Frequenz der jeweiligen Plattengeschwindigkeits- und Wandlergeschwindigkeitssignals konstant bleiben.

12. Verfahren zur präzisen Steuerung der Winkelgeschwindigkeit einer Informationsspeicherplatte relativ zu einem Wandler, welche Platte eine Vielzahl von im wesentlichen kreisförmigen und konzentrisch angeordneten Infor-

mationsspuren aufweist, wobei der Wandler relativ zur Platte radial bewegbar ist, um in einem vorgeschriebenen Verhältnis relativ zu einer ausgewählten Spur in Position gebracht zu werden, und die relative Winkelgeschwindigkeit der Informationsplatte gemäß dem Radius der ausgewählten Informationsspur steuerbar variiert wird, welches Verfahren durch die Schritte gekennzeichnet ist, daß ein dem Radius der einzelnen ausgewählten Informationsspur kennzeichnendes Signal erzeugt wird; daß ein Taktsignal mit konstanter Frequenz erzeugt wird; daß die Frequenz des Taktsignals durch das Radiussignal dividiert wird, um ein Plattengeschwindigkeitssignal zu erzeugen; und daß die Winkelgeschwindigkeit der Informationsplatte gemäß der momentanen Frequenz des Plattengeschwindigkeitssignals eingestellt wird.

13. Verfahren nach Anspruch 12, bei dem die Größe des digitalen Radiussignals direkt proportional dem Radius der ausgewählten Informationsspur ist, wodurch die Winkelgeschwindigkeit der Platte umgekehrt proportional dem Radius der ausgewählten Spur beibehalten und die Platte mit einer konstanten linearen Geschwindigkeit relativ zum Wandler bewegt wird.

14. Verfahren nach Anspruch 13, bei dem der Schritt der Erzeugung eines Radiussignals die Schritte beinhaltet, daß ein digitales Anfangswort mit einer Größe entsprechend dem Radius der ausgewählten Anfangs-Informationsspur gespeichert wird; und daß die radiale Relativbewegung des Wandlers in einer vorherbestimmten Richtung überwacht und das gespeicherte digitale Wort laufend auf Stand gebracht wird, wodurch dieses Wort laufend für den Radius der ausgewählten Informationsspur kennzeichnend ist.

15. Verfahren nach einem der Ansprüche 12 bis 14, bei dem der Dividierschritt die Schritte beinhaltet, daß die aufeinanderfolgenden Zyklen des Taktsignals laufend gezählt und diese Zählung in einem digitalen Zähler gespeichert wird; daß die Größe der im digitalen Zähler gespeicherten Zählung mit der Größe des Radiussignals verglichen wird; daß ein Rückstellsignal erzeugt wird, um den digitalen Zähler jedesmal, wenn im Vergleichsschritt festgestellt wird, daß die jeweiligen Größen gleich sind, auf einen Anfangszustand rückzustellen, wobei dadurch die momentane Frequenz des Rückstellsignals verkehrt proportional der Größe des Radiusmaßes ist.

16. Verfahren nach Anspruch 15, bei dem der Dividierschritt weiters den Schritt beinhaltet, daß das Rückstellsignal in der Frequenz geteilt wird, um das Plattengeschwindigkeitssignal zu erzeugen.

17. Verfahren nach einem der Ansprüche 12 bis 16, mit den weiteren Schritten, daß ein Wandlergeschwindigkeitssignal erzeugt wird, das eine momentane Frequenz aufweist, die proportional jener des Plattengeschwindig-



keitssignals ist; und daß die Radialgeschwindigkeit des Wandler relativ zur Informationsplatte gemäß der momentanen Frequenz des Wandlergeschwindigkeitssignals eingestellt wird.

18. Verfahren nach Anspruch 17, bei dem der Wandler wirkt, um Information in sequentieller Weise in aufeinanderfolgenden Informationsspuren auf der Platte aufzuzeichnen.

Revendications

1. Dispositif pour contrôler avec précision, dans un ou plusieurs modes de fonctionnement, la vitesse angulaire d'un disque (11) par rapport à un transducteur (15), ledit disque (11) ayant un certain nombre de pistes de l'information sensiblement circulaires et agencées concentriquement, où ledit transducteur (15) est radialement mobile par rapport audit disque (11) pour être placé à une relation prescrite par rapport à une piste choisie desdites pistes et dans un premier mode de fonctionnement, la vitesse angulaire relative du disque de l'information est modifiée de façon réglable selon un rayon de la piste de l'information choisie, ledit dispositif étant caractérisé par un moyen (21) pour produire un signal numérique indiquant le rayon de la piste particulière de l'information choisie; un moyen oscillateur (29) pour produire un signal d'horloge ayant une fréquence constante; un moyen numérique (35, 31, 43) répondant au signal de rayon et au signal d'horloge, pour produire un signal de vitesse du disque dont la fréquence instantanée correspond à la fréquence du signal d'horloge divisée par le signal numérique de rayon; et un moyen (25) pour ajuster la vitesse angulaire du disque de l'information (11) selon la fréquence instantanée du signal de vitesse du disque.

2. Dispositif selon la revendication 1, où la grandeur dudit signal numérique de rayon est directement proportionnelle au rayon de la piste de l'information choisie, et dans ledit premier mode de fonctionnement, la vitesse angulaire du disque (11) est maintenue inversement proportionnelle au rayon de la piste choisie et le disque (11) est déplacé à une vitesse linéaire constante par rapport au transducteur.

3. Dispositif selon la revendication 1 ou 2 comprenant de plus: un moyen (35, 31, 45) répondant au signal de rayon et au signal d'horloge, pour produire un signal de vitesse du transducteur dont la fréquence instantanée est proportionnelle à celle du signal de vitesse du disque; et un moyen (27) pour ajuster la vitesse radiale du transducteur (15) par rapport au disque de l'information (11) selon la fréquence instantanée du signal de vitesse du transducteur.

4. Dispositif selon la revendication 3, où le transducteur (15) fonctionne pour enregistrer l'information de façon séquentielle sur des

pistes successives de l'information sur le disque (11).

5. Dispositif pour enregistrer une information sur un disque de l'information (11) dans un certain nombre de pistes de l'information sensiblement circulaires et agencées concentriquement, où les pistes successives de l'information sont sensiblement également espacées les unes par rapport aux autres, et dans un premier mode de fonctionnement, la densité de l'information enregistrée sur chaque piste est sensiblement constante, ledit dispositif comprenant: un moyen (25) pour faire tourner le disque de l'information autour de son axe central à une vitesse angulaire réglable; un moyen transducteur (15) mobile de façon réglable dans une direction radiale par rapport au disque de l'information (11) pour enregistrer l'information sur une piste choisie de l'information, ledit dispositif étant caractérisé par: un moyen (21) pour produire un signal numérique indiquant le rayon de la piste choisie de l'information; un moyen oscillateur (29) pour produire un signal d'horloge ayant une fréquence constante; un moyen de signal de vitesse répondant au signal d'horloge et au signal numérique de rayon, comprenant un moyen numérique (35, 31, 43) pour produire un signal de vitesse du disque et un moyen numérique (35, 31, 45) pour produire un signal de vitesse du transducteur, ces deux signaux ayant des fréquences proportionnelles à la fréquence du signal d'horloge divisée par le signal de rayon; et un moyen (27) pour déplacer, de façon réglable, ledit moyen transducteur (15) à une vitesse radiale correspondant à la fréquence du signal de vitesse du transducteur, ainsi la vitesse, dans le premier mode de fonctionnement, est inversement proportionnelle au rayon de la piste particulière qui est enregistrée; ledit moyen (25) pour faire tourner le disque servant à faire tourner le disque (11) à une vitesse angulaire correspondant à la fréquence du signal de vitesse du disque, ainsi dans ledit premier mode de fonctionnement, le disque (11) est déplacé à une vitesse linéaire constante par rapport audit moyen transducteur (15), et l'information est enregistrée sur le disque (11) à la même densité d'enregistrement pour toutes les pistes de l'information.

6. Dispositif selon la revendication 3, 4 ou 5, où ledit moyen pour produire un signal de transducteur comprend un codeur qui est couplé audit moyen transducteur.

7. Dispositif selon l'une quelconque des revendications 1 à 5, où ledit moyen pour produire un signal numérique de rayon comprend: un registre numérique de rayon (21) pour stocker le signal de rayon; un moyen pour introduire un mot numérique initial dans ledit registre, ledit mot initial ayant une grandeur qui correspond au rayon de la piste de l'information initiale choisie; et un moyen de production d'un signal indiquant le mouvement radial du transducteur dans une direction pré-



déterminée par rapport au disque de l'information, pour une utilisation pour la remise au point du compte stocké dans ledit registre de rayon, ainsi le mot numérique qui y est stocké indique continuellement le rayon de la piste choisie.

8. Dispositif selon l'une quelconque des revendications 1 à 7, où ledit moyen de production d'un signal de vitesse du disque comprend: un moyen formant compteur numérique (31) pour compter continuellement les cycles successifs du signal d'horloge; un moyen formant comparateur numérique (35) pour comparer la grandeur du compte stocké dans ledit moyen formant compteur numérique (31) à la grandeur du signal de rayon; et un moyen de production d'un signal pour remettre ledit moyen formant compteur numérique (31) à un état initial à chaque fois que ledit moyen formant comparateur numérique (35) détermine que les grandeurs respectives sont équivalentes, la fréquence instantanée du signal de remise à l'état initial étant inversement proportionnelle à la grandeur du signal de rayon.

9. Dispositif selon la revendication 8, où ledit moyen pour produire un signal de vitesse du disque comprend de plus: un moyen (43) pour diviser, en fréquence, le signal de remise à l'état initial pour produire le signal de vitesse du disque.

10. Dispositif selon l'une quelconque des revendications 1 à 9, où, dans le premier mode de fonctionnement, le disque de l'information est entraîné en rotation à une vitesse linéaire constante par rapport au moyen formant transducteur et comprenant de plus: un moyen formant commutateur (73) pour permettre une sélection manuelle entre le premier mode de fonctionnement, et un second mode de fonctionnement, le disque de l'information étant entraîné en rotation à une vitesse angulaire constante.

11. Dispositif selon la revendication 10, où ledit moyen formant commutateur (73) comprend un moyen pour empêcher sélectivement le signal du transducteur de remettre au point le compte stocké dans ledit registre de rayon, ledit compte restant ainsi constant et de même, les fréquences des signaux respectifs de vitesse du disque et de vitesse du transducteur restent constantes.

12. Méthode pour contrôler avec précision la vitesse angulaire d'un disque de stockage de l'information par rapport à un transducteur, ledit disque ayant un certain nombre de pistes de l'information sensiblement circulaires et agencées concentriquement, où ledit transducteur est radialement mobile par rapport audit disque pour se trouver placé à une relation prédécrite par rapport à une piste choisie desdites pistes, et la vitesse angulaire relative du disque de l'information est modifiée de façon réglable selon le rayon de la piste choisie de l'information, et ladite méthode étant carac-

térisée par les étapes de: produire un signal numérique indiquant le rayon de la piste particulière de l'information choisie; produire un signal d'horloge ayant une fréquence constante; diviser la fréquence du signal d'horloge par le signal de rayon pour produire un signal de vitesse du disque; et

ajuster la vitesse angulaire du disque de l'information selon la fréquence instantanée du signal de vitesse du disque.

13. Méthode selon la revendication 12, où la grandeur dudit signal numérique de rayon est directement proportionnelle au rayon de la piste choisie de l'information, ainsi la vitesse angulaire du disque est maintenue inversement proportionnelle au rayon de la piste choisie et le disque est déplacé à une vitesse linéaire constante par rapport au transducteur.

14. Méthode selon la revendication 13, où ladite étape de production d'un signal de rayon comprend les étapes de: stocker un mot numérique initial d'une grandeur correspondant au rayon de la piste initiale de l'information choisie; et surveiller un mouvement radial relatif du transducteur dans une direction prédéterminée et remettre continuellement au point le mot numérique qui est stocké, ledit mot indiquant ainsi continuellement le rayon de la piste choisie de l'information.

15. Méthode selon l'une quelconque des revendications 12 à 14, où ladite étape de diviser comprend les étapes de: compter continuellement les cycles successifs du signal d'horloge et stocker ce compte dans un compteur numérique; comparer la grandeur du compte stocké dans ledit compteur numérique à la grandeur du signal de rayon; produire un signal de remise à l'état initial pour remettre le compteur numérique à un état initial à chaque fois que l'on détermine, dans ladite étape de comparaison, que les grandeurs respectives sont égales, ainsi la fréquence instantanée du signal de remise à l'état initial est inversement proportionnelle à la grandeur de la mesure de rayon.

16. Méthode selon la revendication 15, où ladite étape de diviser comprend de plus l'étape de: diviser en fréquence le signal de remise à l'état initial pour produire le signal de vitesse du disque.

17. Méthode selon l'une quelconque des revendications 12 à 16, comprenant de plus les étapes de: produire un signal de vitesse du transducteur ayant une fréquence instantanée proportionnelle à celle du signal de vitesse du disque; et ajuster la vitesse radiale du transducteur par rapport au disque de l'information selon la fréquence instantanée du signal de vitesse du transducteur.

18. Méthode selon la revendication 17, où le transducteur sert à enregistrer l'information d'une façon séquentielle sur des pistes successives de l'information sur le disque.

