TITLE OF THE INVENTION

Apparatus for Measuring Characteristics of Optical Pickup and Method for Measuring the Sensitivity of Tracking Actuator

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to an apparatus for measuring characteristics of an optical pickup for measuring the sensitivity of a tracking actuator of an optical pickup, and a method for measuring the sensitivity of the tracking actuator.

Description of the Related Art

There has hitherto been known an inspection device for an optical pickup used in an optical disc drive. The inspection device for an optical pickup is used in, for example, an optical pickup shipment inspection or acceptance inspection and is conducted for inspecting whether or not the optical pickup meets the prescribed specifications.

Among inspection items for the inspection device for an optical pickup, there is an inspection item of detecting the sensitivity of a so-called tracking actuator.

An optical disc drive performs tracking servo control so that the laser light radiated from the optical pickup will be in a just-track state on a recording track. For example, the optical disc drive detects the reflected light from the optical disc by an optical pickup and converts the detected reflected light by a photoelectric converter into electrical signals from which tracking error signals are generated. The optical disc

drive drives a tracking actuator adapted for causing movement of an objective lens for shifting the laser light illuminating position along the radius of the optical disc until the tracking error signals will be reduced to zero.

In the conventional inspection device for an optical pickup, the dc or ac driving voltage is applied from outside to the tracking actuator and the displacement of the objective lens at this time is detected to detect the sensitivity of the tracking actuator.

It should be noted that, for measuring the sensitivity of the tracking actuator, the displacement of the objective lens needs to be detected in a contact-free manner, so that, with the conventional measurement device of optical pickup characteristics, the displacement of the objective lens needs to be detected using an external equipment, such as a laser Doppler displacement meter.

Moreover, if the laser Doppler displacement meter is used for detecting the objective lens position, a reflective sheet for reflecting the laser light radiated from the laser Doppler displacement meter needs to be stuck to the objective lens to render facilitated inspection impossible. In addition, if the tracking actuator is actuated, the objective lens is moved in a direction perpendicular to the optical axis. However, the portion of the objective lens other than its portion extending along the optical axis is covered with an optical pickup casing. Thus, if the displacement of the objective lens moved in a direction perpendicular to the optical axis is to be detected by the laser Doppler displacement meter, this casing needs to be detached, again to render the facilitated inspection impossible.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an apparatus for measuring characteristics of an optical pickup and a method for measuring the sensitivity of a tracking actuator whereby the tracking actuator sensitivity can be measured easily.

In one aspect, the present invention provides a apparatus for measuring characteristics of an optical pickup, in which the sensitivity of a tracking actuator owned by the optical pickup is measured. The apparatus includes reflecting means for reflecting the laser light radiated by the optical pickup, focussing servo means for driving a focussing actuator owned by the optical pickup to focus the laser light radiated by the optical pickup to the reflecting means on a reflecting surface of the reflecting means, driving voltage generating means for according a pre-set driving voltage to the tracking actuator owned by the optical pickup and sensitivity measurement means for measuring the sensitivity of the tracking actuator. The sensitivity measurement means controls the driving voltage generating means to accord the driving voltage to the tracking actuator to move the illuminating position of the laser light illuminated on the reflecting means. The sensitivity measurement means detects the amount of movement of the laser light illuminating position based on the information obtained from the reflecting means to measure the sensitivity of the tracking actuator based on the driving voltage accorded to the tracking actuator and the amount of movement of the laser light illuminating position.

In another aspect, the present invention provides a method for measuring the sensitivity of a tracking actuator owned by an optical pickup, including according a driving voltage to the tracking actuator, as the laser light is radiated from the optical pickup to reflecting means to focus the laser light on the reflecting means, moving the illuminating position of the laser light on the reflecting means, detecting the information from the reflecting means by the optical pickup to detect the amount of movement of the illuminating position of the laser light based on the information and measuring the sensitivity of the tracking actuator based on the driving voltage applied to the tracking actuator and on the amount of movement of the illuminating position of the laser light.

According to the present invention, the laser light is illuminated from an optical pickup being measured to reflecting means and the reflected light is detected by an optical pickup. This reflecting means is, for example, an optical disc, having tracks formed thereon for representing the position information along the radial direction, that is the time information or addresses of the tracks in question, an optical disc having grooves or lands formed thereon as tracks, or a reflecting plate.

According to the present invention, a driving voltage is applied to the tracking actuator, with the tracking servo loop turned off, to cause compulsive movement of the illuminating position of the laser light. The information derived from the reflecting means is detected by an optical pickup being measured and, based on this information, the distance between the illuminating position of the laser light during movement and

the illuminating position of the laser light following the movement is detected. That is, according to the present invention, the amount of movement of the laser light on application of the driving voltage is detected from reflecting means.

For example, the amount of movement of the objective lens is detected by exploiting the fact that the time information or addresses recorded on the optical disc indicate the position information along the radius of the optical disc. That is, the addresses or the time information recorded on the track of the laser illuminating position before movement is detected. With the tracking servo loop turned off, the driving voltage is applied across the tracking actuator to cause compulsive movement of the laser light illuminating position, and the address or the time information recorded on the track of the laser light illuminating position following the movement is detected. The position information along the radial direction before and after the movement is detected to detect the amount of movement.

According to the present invention, the amount of movement of the objective lens is detected by exploiting the fact that the tracking error signals are increased or decreased in the positive or negative directions each time a laser spot traverses a track. That is, with the tracking servo loop turned off, the driving voltage is applied to the tracking actuator to cause compulsive movement of the laser light illuminating position. The number of pak values of the tracking error signals obtained from the optical disc carrying tracks or the reflecting plate is counted to detect the number of the traversed tracks. If the number of the traversed tracks is found, the number of the

tracks may be multiplied with the track pitch to detect the amount of movement.

With the apparatus for measuring characteristics of an optical pickup and the method for measuring the sensitivity of a tracking actuator, according to the present invention, the information derived from the reflecting means is detected by an optical pickup being measured. Based on this information, the distance between the laser light illuminating position during movement and that following the movement is detected to measure the sensitivity of the tracking actuator, thus enabling the sensitivity of the tracking actuator to be measured easily without using an external equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a block diagram showing an apparatus for measuring characteristics of an optical pickup according to a first embodiment of the present invention.

Fig.2 shows a photodetector of the optical pickup.

Fig.3 is a flowchart for illustrating the processing contents of the apparatus for measuring characteristics of an optical pickup shown in Fig.1.

Fig.4 is a block diagram showing an apparatus for measuring characteristics of an optical pickup according to a second embodiment of the present invention.

Fig.5A shows a waveform of a ramp signal generated by an apparatus for measuring characteristics of the optical pickup according to the second embodiment of the present invention and Fig.5B shows a traverse signals produced when the signal shown in Fig.5A is sent to the tracking actuator.

Fig.6A shows a waveform of a trapezoidal signal generated by an apparatus for

measuring characteristics of the optical pickup according to the second embodiment of the present invention and Fig.6B shows a traverse signals produced when the signal shown in Fig.6A is sent to the tracking actuator.

Fig.7A shows a waveform of a sine signal generated by an apparatus for measuring characteristics of the optical pickup according to the second embodiment of the present invention and Fig.7B shows a traverse signals produced when the signal shown in Fig.7A is sent to the tracking actuator.

Fig.8 is a flowchart for illustrating the processing contents of the apparatus for measuring characteristics of an optical pickup shown in Fig.4.

Fig.9 shows a plate on which are formed grooves operating as light reflecting means of the apparatus for measuring characteristics of an optical pickup shown in Fig.4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, an apparatus for measuring characteristics of an optical pickup according to a preferred first embodiment of the present invention will be explained in detail.

Fig.1 shows a block diagram of an apparatus 1 for measuring characteristics of an optical pickup according to the first embodiment of the present invention.

The apparatus 1 for measuring characteristics of an optical pickup, according to the first embodiment of the present invention, measures the sensitivity of a tracking actuator of an optical pickup used in an optical disc drive. The present apparatus 1 is

used for inspecting the specifications of the optical pickup or investigating into characteristics of the optical pickup and is a tool useful in the shipment inspection or acceptance inspection of the optical pickup.

The optical pickup 2 is an object of measurement by the apparatus 1 for measuring characteristics of an optical pickup, and includes a laser diode 2a, a beam splitter 2b, an objective lens 2c, a photodetector 2d, a focussing actuator 2e and a tracking actuator 2f.

The apparatus 1 for measuring characteristics of an optical pickup includes an optical disc 3, irradiated with the laser light emitted by the optical pickup 2, and a matrix circuit 4, fed with an output of the photodetector 2d owned by the optical pickup 2 to output signals such as playback signals (RF signals), focussing error signals (FE signals), tracking error signals (TE signals) and push-pull signals (PP signals).

The apparatus 1 for measuring characteristics of an optical pickup also includes a focussing servo circuit 5 for performing focussing servo control based on the FE signals from the matrix circuit 4, a focussing driver 6 for amplifying an output of the focussing servo circuit 5 to route the driving voltage to the focussing actuator 2e of the optical pickup 2, a tracking servo circuit 7 for performing tracking servo control based on TE signals from the matrix circuit 4, and a tracking driver 8 for amplifying an output of the tracking servo circuit 7 to route the driving voltage to the tracking actuator 2f of the optical pickup 2. The apparatus 1 also includes a time information

detection circuit 9 for detecting the time information of a currently reproduced track based on PP signals from the matrix circuit 4.

The apparatus 1 also includes a driving voltage generating circuit 10 for routing a pre-set driving voltage to the tracking actuator 2f of the optical pickup 2, a switch 11 for switching between an output of the tracking driver 8 and an output from the driving voltage generating circuit 10 to route the driving voltage to the tracking actuator 2f and a control circuit 12 for controlling the respective circuits and for measuring the sensitivity of the tracking actuator 2f of the optical pickup 2.

The optical pickup 2 may be mounted or dismounted with respect to the apparatus 1 for measuring characteristics of an optical pickup.

This optical pickup 2 converges the laser light radiated from the laser diode 2a via the beam splitter 2b and the objective lens 2c on the optical disc 3. The optical pickup 2 forms an image of the reflected light from the optical disc 3 on the photodetector 2d. The photodetector 2d of the optical pickup 2 is the photo-electric transducer as described above and converts the imaged reflected light into electrical signals. The focussing actuator 2e of the optical pickup 2 is responsive to the driving voltage routed from the focussing driver 6 to shift the objective lens 2c along the optical axis of the laser light illuminated on the optical disc 3 in order to bring the focussing point of the laser light into coincidence with the recording surface of the optical disc 3. Also, the tracking actuator 2f of the optical pickup 2 is responsive to the driving voltage routed from the tracking driver 8 or from the driving voltage

generating circuit 10 to shift the objective lens 2c along the radius of the optical disc 3 to shift the laser light to a pre-set track on the optical disc 3.

The optical pickup 2 includes plural photodetectors 2d, an example of which is shown in Fig.2.

The optical pickup 2 includes four photodetectors A to D, arrayed in a 2-by-2 matrix configuration, and photodetector E, F for side spot detection on both sides of the photodetector A to D, as shown in Fig.2. These photodetector A to F are used in, for example, an optical pickup of the so-called three-spot system adapted for radiating three laser light beams to the light reflecting portion 3. On the photodetectors A to D is illuminated a main beam as a center light beam in the three-spot system. That is, the reflected light with respect to the light reflecting portion 3 is illuminated on the photodetectors A to D. Also, the photodetectors E, F are provided on both sides of the radial direction of the optical disc with respect to the photodetector A to D. The photodetectors are illuminated with side beams in the three-spot system. The photodetectors E, F are illuminated by the light reflected from the track edge of the optical disc.

The photodetectors A to F convert the light volumes of the reflected light into signals A to F, respectively. The optical pickup 2 routes these signals A to F to the matrix circuit 4.

The optical disc 3 is set on the rotationally driving device of the apparatus 1 for measuring characteristics of an optical pickup, and is run in rotation by this

rotationally driving device. The optical disc 3 is also used as a reference for the apparatus 1 for measuring characteristics of the optical pickup. That is, the apparatus 1 for measuring characteristics of an optical pickup measures the characteristics of the optical pickup 2 based on the information derived from the reflected light from the optical disc 3 used as this reference.

The matrix circuit 4 is fed with output signals A to F of the photodetector A to F of the optical pickup 2 to generate playback signals (RF signals), focussing error signals (FE signals), tracking error signals (TE signals), push-pull signals (PP signals), etc. The matrix circuit 4 generates the RF, FE, TE and PP signals, based on the signals A to F, in the following manner. That is, the matrix circuit 4 calculates A+B+C+D, based on the signals A to D, to generate RF signals. On the other hand, the matrix circuit 4 outputs the FE signals by the astigmatic method. That is, the matrix circuit 4 calculates (A+C) – (B+D), based on the signals A to D, to output the results as FE signals. On the other hand, the matrix circuit 4 calculates E – F, based on the signals E and F, to output the results as TE signals.

The focussing servo circuit 5 is fed with the FE signals from the matrix circuit 4. After filtering the FE signals in a pre-set manner, the focussing servo circuit 5 routes a signal of a control volume which will reduce the FE signals to zero to the focussing actuator 2e of the optical pickup 2 via the focussing driver 6. Thus, the focussing servo circuit 5 controls the laser light radiated from the optical pickup 2 so that a just-focus state will be reached on the recording surface of the optical disc 3.

The tracking servo circuit 7 is fed with the FE signals from the matrix circuit 4. After filtering the FE signals in a pre-set manner, the tracking servo circuit 7 routes a signal of a control volume which will reduce the TE signals to zero to the tracking actuator 2f of the optical pickup 2 via the tracking driver 8. Thus, the tracking servo circuit 7 controls the laser light radiated from the optical pickup 2 so that a just-track state will be reached on the recording surface of the optical disc 3.

The time information detection circuit 9 is fed from the matrix circuit 4 with the PP signals. The time information detection circuit 9 detects wobbling signals obtained from the edge of the track formed on the optical disc 3 to extract the timing information and the address information etc of the track of the optical disc 3 currently illuminated by the laser light. If the timing information or the address information is not contained in the wobbling signals and, for example, formed as pre-pits on the track of the optical disc 3, it is possible for the time information detection circuit 9 to detect the timing information or the address information based on the RF signals. The time information detection circuit 9 routes the detected time information or the address information to the control circuit 12.

Under control by the control circuit 12, the driving voltage generating circuit 10 routes the pre-set driving voltage to the tracking actuator 2f.

The switch 11 switches between an output of the tracking driver 8 and an output of the driving voltage generating circuit 10 to route the selected output via tracking to the tracking coil 2b. The switching of the switch 11 is controlled by the computer 12.

For example, if the driving voltage is supplied from the tracking servo circuit 7 to the tracking actuator 2f, the switch 11 is set to the side of the tracking driver 8 to turn the tracking servo loop on. On the other hand, if the driving voltage is supplied from the driving voltage generating circuit 10 to the tracking actuator 2f, the switch 11 is set to the side of the driving voltage generating circuit 10 to turn the tracking servo loop off.

The control circuit 12 controls the entire system, such as rotation control of the optical disc 3, while measuring the sensitivity of the tracking actuator 2f of the optical pickup 2.

The processing contents of sensitivity measurement of the tracking actuator 2f by the apparatus 1 for measuring characteristics of the optical pickup are explained.

First, the principle of tracking actuator sensitivity measurement is explained.

The sensitivity of the tracking actuator is given as the amount of movement of the objective lens along the disc radius with respect to the change in the supplied driving voltage.

It is assumed that the position of the objective lens along the disc radius for the zero driving voltage supplied to the tracking actuator is r_0.

If the lens position from this position r_0 along the disc radius when the driving voltage V_1 ($V_1 > 0$) is applied to the tracking actuator is r_1 mm, the sensitivity S_1 (mm/V) of the tracking actuator on application of the voltage in the plus direction is given by:

$$S_1 = (r_0 - r_1)/V_1$$

$$\cdots(1).$$

Also, if the lens position from this position r_0 along the disc radius when the driving voltage V_2 ($V_2 > 0$) is applied to the tracking actuator is r_2 mm, the sensitivity S_2 (mm/V) of the tracking actuator on application of the voltage in the minus direction is given by:

$$S_2 = (r_0 - r_2)/V_2$$

$$\cdots(2).$$

Thus, the tracking actuator sensitivity can be measured by the equations (1) and (2) if the driving voltage supplied to the actuator and the amount of movement of the objective lens are detected. The reason the tracking actuator sensitivity is found separately for plus side movement and minus side movement is that there are occasions where the relation between the plus side movement and the minus side movement with respect to the supplied driving voltage is not linear.

The apparatus 1 for measuring characteristics of an optical pickup detects on which track of the optical disc 3 the laser light radiated to the optical disc 3 is being illuminated and computes the radial position on the optical disc 3 based on the track information to detect the amount of movement of the objective lens 2c of the optical pickup 2. That is, the amount of movement of the laser spot along the disc radius, produced by the driving of the tracking actuator 2f, is proportionate to the amount of the objective lens 2c. Thus, the sensitivity of the tracking actuator 2f can be measured by detecting the amount of movement of the laser spot from the information accorded

by the optical disc.

Specifically, the apparatus 1 for measuring characteristics of the optical pickup measures the time information or the address information of the track formed on the optical disc 3 to find the radial position on the optical disc illuminated by the laser light to detect the amount of movement of the laser light on application of the pre-set driving voltage from this radial position.

In a compact disc (CD), for example, the time information indicating the minutes, seconds or frame numbers is recorded on the frame basis (7350 frames/sec).

If the read-out current time information is t(sec), the radial position on the disc corresponding to the start of recording is R mm, the track pitch is p μm, and the line speed is v mm/sec, the current radial position (r mm) on the objective lens 2c can be calculated by:

$$\pi(r^2 - R^2) = p \times t \times v$$

$$r = \sqrt{\left(R^2 + p \times t \times v / \pi\right)}$$

···(3).

If the read-out information is the address information, the radial position r can be computed from e.g., the number of addresses of the entire disc.

The specified processing contents of sensitivity measurement of the tracking actuator 2f by the apparatus 1 for measuring characteristics of an optical pickup are explained by referring to the flowchart of Fig.3.

First, at step S1, with the zero driving voltage applied to the tracking actuator 2f, the apparatus 1 for measuring characteristics of the optical pickup turns on respective servos of the focussing servo, tracking servo or CL servo loops.

Then, at step S2, the apparatus 1 for measuring characteristics of the optical pickup reads out the then-prevailing time information or the address information to find the radial position r_0 currently illuminated by the laser light from the read-out time information.

Then, at step S3, the apparatus 1 for measuring characteristics of an optical pickup sets the rotational speed of the optical disc to a constant angular velocity, while turning the tracking servo loop off, with the focussing servo loop being in the on-state.

At step S4, the apparatus 1 for measuring characteristics of an optical pickup routes the pre-set dc voltage V (v) from the driving voltage generating circuit 10 to the tracking actuator 2f to shift the objective lens 2c along the radius of the disc.

Then, at step S6, the apparatus 1 for measuring characteristics of the optical pickup reads out the then-prevailing time information or the address information to find the radial position r_1 currently illuminated by the laser light from the read-out time information by the above equation (3).

Then, at step S7, the apparatus 1 for measuring characteristics of the optical pickup calculates the equations (1) or (2), from the radial position r_0, found at step S2, the driving voltage V routed at step S4 to the tracking actuator 2f, and the radial position r_1 as found at a step S6, to measure the sensitivity of the tracking actuator 2f.

The apparatus 1 for measuring characteristics of an optical pickup then repeats the sequence from step S1 to step S7, as the driving voltage V supplied at step S4 to the tracking actuator 2f is varied, to measure the sensitivity of the tracking actuator 2f with respect to plural impressed voltages.

By the above processing, it is possible with the apparatus 1 for measuring characteristics of the optical pickup to measure the sensitivity of the tracking actuator 2f without employing an external equipment such as a laser Doppler displacement meter as conventionally. Thus, the sensitivity of the tracking actuator 2f can be measured easily without the necessity of attaching a reflective sheet to the objective lens 2c or dismounting the casing of the optical pickup 2.

Referring to the drawings, an apparatus 20 for measuring characteristics of an optical pickup according to a second embodiment of the present invention is explained. In the following explanation of the second embodiment, the parts or components corresponding to those of the above-described apparatus 1 for measuring characteristics of the optical pickup are indicated by the same reference numerals without being explained specifically.

Fig.4 shows the block diagram of the apparatus 20 for measuring characteristics of the optical pickup.

This apparatus 20 for measuring characteristics of an optical pickup, according to the second embodiment of the present invention, measures the sensitivity of a tracking actuator of an optical pickup used in an optical disc drive. The present

apparatus 20 is used for inspecting the specifications of the optical pickup or investigating into characteristics of the optical pickup and is a tool useful in the shipment inspection or acceptance inspection of the optical pickup.

The optical pickup 2 is an object of measurement by the apparatus 20 for measuring the characteristics of an optical pickup, and includes a laser diode 2a, a beam splitter 2b, an objective lens 2c, a photodetector 2d, a focussing actuator 2e and a focussing actuator 2e and a tracking actuator 2f.

The apparatus 20 for measuring the characteristics of the optical pickup includes an optical disc 3, irradiated with the laser light emitted by the optical pickup 2, and a matrix circuit 4, fed with an output of the photodetector owned by the optical pickup 2 to output signals such as playback signals (RF signals), focussing error signals (FE signals), tracking error signals (TE signals) and push-pull signals (PP signals).

The apparatus 20 for measuring characteristics of the optical pickup also includes a focussing servo circuit 5 for performing focussing servo control based on the FE signals from the matrix circuit 4, a focussing driver 6 for amplifying an output of the focussing servo circuit 5 to route the driving voltage to the focussing actuator 2e of the optical pickup 2, a tracking servo circuit 7 for performing tracking servo control based on TE signals from the matrix circuit 4, and a tracking driver 8 for amplifying an output of the tracking servo circuit 7 to route the driving voltage to the tracking actuator 2f of the optical pickup 2. The apparatus 20 also includes a traverse

signal counting circuit 21 for counting the peaks of the traverse signal based on PP signals from the matrix circuit 4.

The apparatus 20 also includes a signal generating circuit 22 for routing pre-set voltage signals to the tracking actuator 2f of the optical pickup 2, a switch 11 for switching between an output of the tracking driver 8 and an output from the signal generating circuit 22 to route the driving voltage to the tracking actuator 2f and a control circuit 12 for controlling the respective circuits and for measuring the sensitivity of the tracking actuator 2f of the optical pickup 2.

The traverse signal counting circuit 21 is fed with TE signals from the matrix circuit 4. If, with the tracking servo loop turned off, the objective lens 2c is moved radially of the optical disc 3, the laser spot on the optical disc 3 traverses plural tracks. If the laser traverses plural tracks, the laser spot position repeats on-track and off-track so that the tracking error signals are increased to a positive polarity or decreased to a negative polarity. The tracking error signals, thus increased or decreased in magnitude in traversing the tracks, are termed traverse signals. The one period of the traverse signals corresponds to the track pitch of the optical disc 3. The traverse signal counting circuit 21 counts the peak values of the traverse signals to route the number of counts to the control circuit 12.

The signal generating circuit 22 outputs driving voltages of a pre-set signal waveform, such as a pre-set ramp signal, a trapezoidal signal or a sine wave, under control by the control circuit 12, to route the driving voltage to the tracking actuator

2f. The signal generating circuit 22 sends a driving signal of a pre-set waveform to the tracking actuator 2f to displace the objective lens 2c to cause movement of the laser light radiated by the optical pickup 2 in a direction along the radius of the optical disc 3. The signal generating circuit 22 generates a repetitive signal, such as a sine wave, to cause reciprocating movement of the laser light illuminating position traversing a pre-set number of tracks.

If a driving signal of a ramp waveform which rises with a pre-set gradient from the 0 (v) state to reach V_1 (v) after pre-set time, as shown in Fig.5A, is applied, the objective lens 2c is moved radially of the optical disc 3 to generate traverse signals which are increased or decreased in magnitude responsive to the traversed tracks, as shown in Fig.5B.

It is possible to route a driving voltage, such as a trapezoidal signal or a sine wave signal, to the tracking actuator 2f, as shown in Figs.6A and 7A. In this case, traverse signals shown in figs.6B and 7B are generated responsive to the increase or decrease in magnitude of the trapezoidal or sine wave signals.

The switch 11 changes over to an output of the tracking driver 8 or to an output of the signal generating circuit 22 to route the driving voltage to the tracking actuator 2f. The control circuit 12 controls the entire system, such as rotation control of the optical disc 3, while measuring the sensitivity of the tracking actuator 2f of the optical pickup 2.

The processing contents of the tracking actuator 2f by the apparatus 20 for

measuring characteristics of an optical pickup are explained.

The apparatus 20 for measuring characteristics of the optical pickup routes a pre-set driving voltage to the tracking actuator 2f of the optical pickup 2 to detect the amount of movement of the objective lens 2c of the optical pickup 2. That is, the amount of movement of the laser spot along the disc radius, produced by the driving of the tracking actuator 2f, is proportionate to the amount of movement of the objective lens 2c. Thus, the sensitivity of the tracking actuator 2f can be measured by detecting the amount of movement of the laser spot from the information accorded by the optical disc.

Specifically, the apparatus 20 for measuring characteristics of the optical pickup accords a pre-set driving voltage to the tracking actuator 2f of the optical pickup 2 to generate traverse signals which are detected to count the number of traversed tracks, and multiplies the count value with the track pitch to detect the amount of movement on the optical disc of the laser light on application of the pre-set driving voltage to the tracking actuator 2f.

For example, the compact disc CD has a track pitch of 1.6 μm. Thus, if the optical disc 3 is a CD, the amount of movement d mm of the objective lens 2c for the count value N of the peak value of the traverse signal is given by

$$d = 1.6 \times 10^{-3} \times N \quad \cdots(4).$$

Referring to the flowchart of Fig.8, the specified contents of the processing for

measuring the sensitivity of the tracking actuator 2f by the apparatus 20 for measuring characteristics of an optical pickup are explained.

First, at step S11, the apparatus 20 for measuring characteristics of an optical pickup turns on the focussing servo loop, while turning off the tracking servo loop, with the driving voltage applied across the tracking actuator 2f being 0 (v). The optical disc is run at a constant angular velocity.

The apparatus 20 for measuring characteristics of the optical pickup 20 then routes the driving voltage of the pre-set signal waveform from the signal generating circuit 22 to the tracking actuator 2f. For example, the apparatus 20 sends ramp signals, trapezoidal signals or sine wave signals of a pre-set gradient, as shown in Figs.5A, 6A and 7A. The tilt of the rising or decaying of the respective signals is set so as to avoid overshooting of the objective lens.

If, at this step S12, the driving voltage of the pre-set signal waveform is routed from the signal generating circuit 22 to the tracking actuator 2f, the objective lens 2c is moved along the radius of the optical disc 3 to produce traverse signals.

Then, at step S13, the apparatus 20 counts the peak values of the generated traverse signals by the traverse signal counting circuit 21. This counting is continued until the movement of the objective lens 2c ceases.

The apparatus 20 for measuring characteristics of the optical pickup then finds the amount of movement of the objective lens 2c, from the count value on cassation of movement of the objective lens 2c and the track pitch of the optical disc 3, based

on the above equation (4), to measure the sensitivity of the tracking actuator 2f based on the amount of movement thus found and the driving voltage V supplied at step S12 to the tracking actuator2f.

By the above processing, it is possible with the present second embodiment of the apparatus 20 for measuring characteristics of an optical pickup to measure the sensitivity of the tracking actuator 2f without using an external equipment such as a laser Doppler displacement meter. Thus, the sensitivity of the tracking actuator 2f can be measured easily without attaching the reflective sheet to the objective lens 2c or dismounting the casing of the optical pickup 2.

Meanwhile, if an optical disc of the type employing pits for tracking is used, the optical disc needs to be run in rotation to detect the traverse signals. However, in an optical disc in which tracks are formed by a groove or a land, tracking can be taken without rotationally driving the optical disc. Thus, in the apparatus 20 for measuring characteristics of an optical pickup, the traverse signals can be detected without rotationally driving the optical disc 3 by employing an optical disc whose track is formed by a groove, such as a MD or a CD-R. By not rotationally driving the optical disc 3, there is no error produced due to eccentric components caused by offset between the disc center and the rotary shaft, thus enabling measurement of the sensitivity of the tracking actuator 2f to high accuracy.

Also, in the apparatus 20 for measuring characteristics of an optical pickup, the sensitivity of the tracking actuator 2f can be measured using a plate formed with a

straight groove as shown in Fig.9, in place of the optical disc formed with a groove, with the laser spot being moved to traverse the groove formed on the plate to detect the traverse signal to measure the sensitivity of the tracking actuator 2f.



WHAT IS CLAIMED IS:

1. An apparatus for measuring characteristics of an optical pickup, in which the sensitivity of a tracking actuator owned by the optical pickup is measured, comprising:

reflecting means for reflecting the laser light radiated by said optical pickup;

focussing servo means for driving a focussing actuator owned by said optical pickup to focus the laser light radiated by said optical pickup to said reflecting means on a reflecting surface of said reflecting means;

driving voltage generating means for according a pre-set driving voltage to the tracking actuator owned by said optical pickup; and

sensitivity measurement means for measuring the sensitivity of said tracking actuator, said sensitivity measurement means controlling said driving voltage generating means to accord the driving voltage to the tracking actuator to move the illuminating position of the laser light illuminated on said reflecting means, said sensitivity measurement means detecting the amount of movement of the laser light illuminating position based on the information obtained from said reflecting means to measure the sensitivity of the tracking actuator based on the driving voltage accorded to said tracking actuator and the amount of movement of the laser light illuminating position.

2. The apparatus for measuring characteristics of an optical pickup according to claim 1 wherein said reflecting means is an optical disc having a plurality of tracks formed on its reflecting surface and having the information on the position along the radius of

* C L M S *

the disc recorded on each track;

there being provided tracking servo means for driving the tracking actuator owned by said optical pickup for tracking the laser light illuminated on said optical disc on a pre-set track of the optical disc;

said sensitivity measurement means turning said tracking servo means and said focussing servo means on at a first position on the optical disc to detect the first position information recorded on the track of said fist position via said optical pickup, said sensitivity measurement means according the driving voltage to said tracking actuator by controlling the driving voltage generating means, with the tracking servo means turned off, to shift the illuminating position of the laser light on the optical disc to a second position on the optical disc, said sensitivity measurement means turning the tracking servo means and the focussing servo means on at said second position on the optical disc to detect the second position information recorded on a track of said second position via said optical pickup from the optical disc, said sensitivity measurement means measuring the sensitivity of the tracking actuator based on the first position information, second position information and the driving voltage applied to said tracking actuator.

3. The apparatus for measuring characteristics of an optical pickup according to claim 2 wherein said sensitivity measurement means finds the amount of movement of the illuminating position of the laser light along the radius of the optical disc from said first position to said second position based on said first position information and the

second position information.

4. The apparatus for measuring characteristics of an optical pickup according to claim 1 wherein said reflecting means includes a plurality of tracks on its reflecting surface;

there being provided tracking error detection means for detecting tracking error signals based on the reflected light from said reflecting means as detected by said optical pickup, said tracking error signals indicating an error between a track formed on said reflecting means and an illuminating position of the laser light;

said sensitivity measurement means controlling said driving voltage generating means to accord the driving voltage to the tracking actuator to move the illuminating position of the laser light illuminated on said reflecting means to traverse the plural tracks formed on said reflecting means to detect the number of traversed tracks based on the tracking error signals as detected during movement of the laser light illuminating position to measure the sensitivity of the tracking actuator based on the driving voltage accorded to said tracking actuator and on the number of the detected tracks.

5. The apparatus for measuring characteristics of an optical pickup according to claim 4 wherein said driving voltage generating means accords the ac voltage to the tracking actuator.

6. The apparatus for measuring characteristics of an optical pickup according to claim 4 wherein said reflecting means includes a groove as the track.

7. A method for measuring the sensitivity of a tracking actuator owned by an optical

pickup, comprising:

according a driving voltage to said tracking actuator, as the laser light is radiated from said optical pickup to reflecting means to focus the laser light on said reflecting means, moving the illuminating position of the laser light on the reflecting means, detecting the information from said reflecting means by said optical pickup to detect the amount of movement of the illuminating position of the laser light based on said information; and

measuring the sensitivity of the tracking actuator based on the driving voltage applied to the tracking actuator and on the amount of movement of the illuminating position of the laser light.

8. The method for measuring the sensitivity of a tracking actuator according to claim 7 wherein said reflecting means is an optical disc having a plurality of tracks formed on a reflecting surface thereof and also having the position information along the radius of the disc recorded on each track, comprising:

turning a tracking servo loop and a focussing servo loop on at a first position on said optical disc and, in this state, detecting the first position information recorded on a track of said first position from said optical disc via said optical pickup;

turning the tracking servo loop off and, in this state, according the driving voltage to said tracking actuator to cause movement of the illuminating position of the laser light on said optical disc to a second position on the optical disc;

turning the tracking servo loop and the focussing servo loop on at said second

position on the optical disc and, in this state, detecting the second position information recorded on the track of the second position from the optical disc via said optical pickup; and

finding the sensitivity of the tracking actuator based on the first position information, second position information and the driving voltage accorded to the tracking actuator.

9. The method for measuring the sensitivity of a tracking actuator according to claim 8 wherein the amount of the laser light relative to the radial direction of the optical disc from said first position and said second position is found based on the first position information and the second position information.

10. The method for measuring the sensitivity of a tracking actuator according to claim 7 wherein

a driving voltage is accorded to said tracking actuator to cause movement of the illuminating position of the laser light on said reflecting means across plural tracks formed on said reflecting means;

the number of traversed tracks is detected on the basis of the tracking error signals detected in the course of movement of the laser light illuminating position; and wherein

the sensitivity of the tracking actuator is measured on the basis of the driving voltage accorded to said tracking actuator and the number of detected tracks.

11. The method for measuring the sensitivity of a tracking actuator according to claim

10 wherein an ac voltage is applied to the tracking actuator.

12. The method for measuring the sensitivity of a tracking actuator according to claim 10 wherein said reflecting means includes a groove as the track.

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