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SPECIFICATION

TRAVERSE DRIVING DEVICE FOR CONTROLLING DISPLACEMENT
OF LASER BEAM IRRADIATED ONTO OPTICAL DISC

5 TECHNICAL FIELD

The present invention relates to a device for focusing a laser beam onto a plane of the optical disc having a plurality of information tracks and making the laser beam trace the information track to record or
10 reproduce data from or to an optical disc, while controlling a traverse of the laser beam on the optical disc.

BACKGROUND ART

15 In an optical disc, information is recorded or reproduced along the information track (groove, pit string) of the optical disc while the position of an objective lens of an optical pickup is controlled finely. The whole optical pickup is traversed in a radial direction of the
20 optical disc by a traverse motor. A conventional traverse driving device for the optical disc has been described in Japanese Patent Laid-Open Publication No. 10-188324.

Fig. 5 is a block diagram showing the structure of the conventional traverse driving device for the optical
25 disc. In Fig. 5, an optical disc 1 has a concentric or

spiral information track. An optical pickup 2 includes a tracking actuator 2a for moving an objective lens 2c in a radial direction, and a light receiving section 2b for converting reflected light from the optical disc 1 into electric signal. The optical pickup 2 focuses a laser beam on the information plane of the optical disc 1 to form an optical spot and detects the reflected light. A tracking error detecting circuit 3 generates and outputs a tracking error signal from the output of the light receiving section 2b. A tracking controller 4 inputs the tracking error signal to perform tracking control. An actuator driving circuit 7 drives the tracking actuator 2a in the radial direction of the optical disc 1 according to the output of the tracking controller 4. A displacement detecting section 12 detects the displacement of the tracking actuator 2a, and comprises an optical spot position detecting section 12a and a low pass filter 12b. The optical spot position detecting section 12a detects the position of an optical spot based on a difference signal from a photoreceptor which has at least two regions divided along a direction perpendicular to an information track (not shown) formed on the light receiving section 2b. The low pass filter 12b extracts a low frequency component from the output signal of the optical spot position detecting section 12a. A low band raising circuit 19 amplifies a low

frequency band of the signal with a predetermined gain. A traverse driving circuit 17 drives a traverse 18 in response to the output of the low band raising circuit 19. A traverse 18 moves the optical pickup 2 in the radial direction of the optical disc 1.

The operation of the traverse driving device of the optical disc having such a structure will be described below.

During the optical disc 1 is rotating, the optical pickup 2 focuses a laser beam on the information plane of the optical disc 1 to form a optical spot. The light receiving section 2b detects the reflected light from the plane. The tracking error detecting circuit 3 generates a tracking error signal from the output of the light receiving section 2b to output the tracking error signal to the tracking controller 4. The tracking controller 4 gives a predetermined filter processing and a gain to the tracking error signal to output the tracking error signal to the actuator driving circuit 7. The actuator driving circuit 7 drives the tracking actuator 2a such that the optical spot traces the information track.

During such an operation of the tracking actuator 2a, in the displacement detecting section 12, the optical spot position detecting section 12a detects the position of a optical spot based on the difference signal from a

plurality of photoreceptors provided on the light receiving section 2b, and the low pass filter 12b extracts a low frequency component from the output of the optical spot position detecting section 12a. The low frequency band of the output of the low pass filter 12b is further amplified with a predetermined gain by the low band raising circuit 19. The traverse driving circuit 17 drives the traverse 18 in response to this signal, thereby moving the optical pickup 2 such that the displacement of the tracking actuator 2a is reduced.

In such a traverse driving device of the optical disc, the traverse 18 is required to move or trace such that the displacement of the tracking actuator 2a is not increased. The low frequency component of the position detecting signal of the optical spot is extracted to drive the traverse 18. Therefore, the precision of the tracing of the traverse 18 depends on the precision of detection of the absolute position of the optical spot.

SUMMARY OF THE INVENTION

The present invention has a purpose to provide a traverse driving device which can make the laser beam trace the information track in high precision with no influence of the detecting precision of the absolute position of the optical spot.

The present invention provides a device for focusing a laser beam onto a plane of an optical disc having a plurality of information tracks, and making the laser beam trace the information track to record or reproduce data from or to the optical disc. The device controls displacement of the laser beam irradiated onto the optical disc.

The device comprises an optical pickup, an actuator driving means, displacement detecting means, traverse, traverse driving means, storage means and a controller.

The optical pickup has an objective lens and a tracking actuator for moving the objective lens in a radial direction of the optical disc. The optical pickup focuses a laser beam on the optical disc through the objective lens to form an optical spot, and converts a light reflected from the optical disc into electric signal to be output. The actuator driving means drives the tracking actuator such that the optical spot traces the information track on the optical disc. The displacement detecting means detects a position of the tracking actuator in the radial direction in response to the electric signal output from the optical pickup, and generates a displacement detection value which indicates displacement of the tracking actuator from a neutral position of the tracking actuator based on the

detected position of the tracking actuator.

The traverse for moving the optical pickup in the radial direction.

5 The traverse driving means controls motion of the traverse.

The storage means stores a set value indicative of a predetermined displacement from the neutral position of the traverse actuator.

10 The controller controls the actuator driving means and the traverse driving means,

The controller controls the actuator driving means to move the tracking actuator from the neutral position in the radial direction, obtains, as the set value, the displacement detection value obtained in accordance with a position of the tracking actuator where the optical spot has traversed a predetermined number of information tracks, and stores the obtained set value to the storage means.

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During operation of recording or reproducing data to or from the optical disc, the controller compares the displacement detection value from the displacement detecting means with the set value stored in the storage means, and controls the traverse driving means to start driving the traverse when the displacement detection value is beyond the set value.

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To obtain the set value, the controller may control the actuator driving means to move the tracking actuator from the neutral position toward inside or outside of the optical disc in the radial direction, and determine,
5 as the set value, the displacement detection value corresponding to a position of the tracking actuator at which the optical spot traverses a predetermined number of information tracks.

According to the present invention, in data
10 recording or reproducing operation to the disc, it is possible suppress the displacement of the tracking actuator with high precision without an influence by the detection precision of the absolute position of the optical spot.

15 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the structure of a traverse driving device for an optical disc according to the present invention.

Fig. 2 is a characteristic chart showing a
20 displacement detection value for the number of information tracks traversed by a optical spot in a tracking actuator of the traverse driving device for the optical disc illustrated in Fig. 1.

Fig. 3 is a flowchart for a traverse activation
25 value setting operation of the controller in the traverse

driving device for the optical disc (shown in Fig. 1).

Fig. 4 is a flowchart for a traverse servo operation to the optical disc (shown in Fig. 1).

Fig. 5 is a block diagram showing the structure of a traverse driving device for an optical disc according to the prior art.

PREFERRED EMBODIMENTS OF THE INVENTION

Preferred embodiments of the present invention will be described below with reference to accompanying drawings.

<Structure of Traverse Driving Device>

Fig. 1 is a block diagram showing the structure of a traverse driving device for an optical disc according to the embodiment of the present invention. Fig. 2 is a characteristic chart, in a tracking actuator of the traverse driving device shown in Fig. 1, which shows a displacement detection value with respect to number of information tracks that a optical spot traverses. Fig. 3 is a flowchart of operation of a controller 15 for a traverse activation value setting operation in the traverse driving device for the optical disc shown in Fig. 1. Fig. 4 is a flowchart of operation of the controller 15 in a traverse servo for the optical disc shown in Fig. 1.

In Fig. 1, an optical disc 1 has concentric or spiral information tracks. An optical pickup 2 includes a tracking actuator 2a, a light receiving section 2b and an objective lens 2c. The tracking actuator 2a moves the objective lens 2c in a radial direction of the optical disc 1. The light receiving section 2b converts a light reflected from the optical disc 1 into an electric signal. The optical pickup 2 irradiates and focuses a laser beam on the information plane of the optical disc 1 to form a optical spot, and detects the reflected light from the plane. A tracking error detecting circuit 3 generates a tracking error signal from the output of the light receiving section 2b and outputs the generated error signal. A tracking controller 4 receives the tracking error signal to control the tracking actuator 2a with reference to the received error signal. An activation value setting controller 5 drives or moves the tracking actuator 2a in the radial direction in accordance with the control by the controller 15 during a traverse activation setting operation (described later). A selector 6 selects either the output of the tracking controller 4 or the output of the activation value setting controller 5 based on the control of the controller 15. An actuator driving circuit 7 drives or moves the tracking actuator 2a in the radial direction of the optical disc 1 based on the output of the

selector 6. A direction detecting circuit 8 detects a direction in which the optical spot traverses the information track by calculating the outputs of a plurality of photoreceptors (not shown) which are provided on the light receiving section 2b. A track cross detecting section 9 detects traverse of the optical spot on the information track of the optical disc 1 based on the output from the optical pickup 2. The track cross detecting section 9 performs thresholding to the output of the tracking error detecting circuit 3 to obtain two-valued data. A counter 10 counts the rising edge of the output signal of the track cross detecting section 9 to output a count value to the controller 15. The count value is cleared or reset by the resetting operation of the controller 15. Based on the output of the direction detecting circuit 8, the count value is counted up when the direction of movement of the optical spot is toward the outer side of the disc 1, while the count value is counted down when the direction of movement of the optical spot is toward the inner side of the disc 1. The count value indicates the number of the information tracks which are traversed by the optical spot. A displacement detecting section 11 detects a displacement of the tracking actuator 2a, and includes a optical spot position detecting section 11a, a low pass filter 11b and an A/D converter 11c. The

optical spot position detecting section 11a detects the position of a optical spot based on a difference signal of a photoreceptor (not shown) which has a regions divided into at least two portions in a perpendicular direction to the information track. The information tracks are provided on the light receiving section 2b. The low pass filter 11b extracts a low frequency component from the output signal of the optical spot position detecting section 11a. The A/D converter 11c converts the output of the low pass filter 11b into a digital signal. A cutoff frequency of the low pass filter 11b is set to such a frequency as not to be influenced by the rotation cycle of the optical disc 1, for example, a few Hz. A memory 13 stores a displacement detection value which is the output of the displacement detecting section 11 in accordance with the control of the controller 15. An operation section 14 gives a start command for the traverse activation value setting operation to the controller 15. The controller 15 controls of the traverse device, detail of the operation of the controller 15 is described later. A traverse controller 16 drives the traverse 18 based on the control of the controller 15. A traverse 17 drives or moves the traverse 18 in the radial direction of the optical disc 1 in response to the output signal of the traverse controller 16. The traverse 18 moves the optical pickup 2 in the

radial direction of the optical disc 1.

In Fig. 2, an axis of abscissa indicates number of the information tracks traversed by the optical spot while the tracking actuator 2a moves from a neutral position of the actuator 2a to inside or outside of the disc in the radial direction. The neutral position of the actuator 2a is a reference position with displacement of zero. The number of the traversed information tracks for the outer side of the disc is positive, while the number of the traversed information tracks for the inner side of the disc is negative. The axis of ordinate indicates a displacement detection value which is the output of the displacement detecting section 11. "A" denotes an outside set value which is a displacement detection value obtained in response to a position of the tracking actuator 2a where the tracking actuator 2a reaches by moving outside of the disc from the neutral position of the actuator 2a so that the optical spot traverses toward outside X of information tracks. "B" denotes an inside set value which is a displacement detection value obtained in accordance with a position of the tracking actuator 2a where the tracking actuator 2a reaches by moving inside of the disc from the neutral position so that the optical spot traverses toward inside X of information tracks. The value of X is set to be the number of the information tracks traversed by the

optical spot which corresponds to a maximum displacement of the tracking actuator 2a with which the actuator 2a can stably perform focusing and tracking control during reproduction or recording operation.

5 As is apparent from Fig. 2, the position of the tracking actuator 2a at which the displacement detection value of the displacement detecting section 11 is zero is a point C which shifts inside from the neutral position. This shift represents a measuring error. Therefore, when
10 the control is performed based on the displacement detection value, a control would be performed with using, as a center, the point C at which the displacement detection value is zero in Fig. 2. When displacement detection values of $+D$ and $-D$ which are shifted from a zero
15 point is set, positions corresponding to those values in the axis of abscissa are $+Y_1$ and $-Y_2$, respectively. The displacement detection values from the displacement detecting section 11 indicates a shift to the inside from a position of $+X$ and $-X$ which are obtained with the neutral
20 position of point "O" as a center. That is, there is an error. In the present embodiment, for this error, the tracking actuator 2a is moved from the neutral position of the actuator 2a in the radial direction in a state (stop state) where the traverse 18 does not drive or stops. The
25 displacement detection value which is determined in

accordance with the position of the actuator 2a when the optical spot traverses a predetermined number of information tracks is stored as a set value in advance. Then the traverse servo is performed with reference to this
5 stored value. Consequently, there is no influence by the detection precision of an absolute position based on the displacement detection value.

The operation of the traverse driving device for the optical disc having the above-mentioned structure will
10 be described below with reference to flowcharts of Figs. 3 and 4.

<Traverse Activation Value Setting Operation>

Fig. 3 shows the control flow of the controller
15 of the traverse activation value setting operation in this traverse driving device for the optical disc illustrated in Fig. 1. The traverse activation value setting operation implies an operation for recording a displacement detection value for driving the traverse 18 as
20 a set value to the memory 13 in a traverse servo control. The traverse servo control is to control the traverse 18 to follow the tracking actuator 2a on recording/reproducing the information to/from the optical disc 1.

To start the traverse activation value setting
25 operation, after the present device is laid horizontally,

the optical disc 1 is set, then operation to start the activation value setting is done on the operation section 14. It is noted that laying horizontally the present device is an important condition in order to obtain a correct set value. The operation on the operation section 14 to start the activation value setting input sends a command for start of the activation value setting to the controller 15. Thus, the control of the traverse activation value setting operation shown in Fig. 3 is started. In the traverse activation value setting operation, the optical pickup 2 forms a optical spot on the information plane of the optical disc 1 in the same manner as in the reproduction of the information on the optical disc 1. The reflected light is detected by the light receiving section 2b. During this setting operation, the optical disc 1 is set in a stop state where the optical disc 1 stops rotating, and the traverse 18 is also set in the stop state.

At step S20, the controller 15 switches the input of the selector 6 to the activation value setting controller 5. At the subsequent step S21, the counter 10 is reset. A command for driving toward the outer side is given to the activation value setting controller 5 at step S22. In the Step S21, the tracking actuator 2a is set in a neutral state when the counter 10 is reset. At the step

S22, the activation value setting controller 5 receiving the command for driving toward the outside moves the tracking actuator 2a from the neutral position of the actuator toward the outside of the disc 1.

5 At step S23, the controller 15 is set in a standby state until the output of the counter 10 becomes +X or more. When the controller 15 detects that the output of the counter 10 is +X or more, the control shown in Fig. 3 is restarted. At step S24, the controller 15 stops the
10 driving operation of the activation value setting controller 5. At step S25, subsequently, a command for writing an outside set value is given to the memory 13. Consequently, the tracking actuator 2a is moved from the neutral position to the outside. Thus, a displacement
15 detection value obtained in accordance with the actuator's position when the optical spot traverses X of information tracks is stored to the memory 13 as the outside set value.

 At the subsequent step S26, a command for driving or moving inside is given to the activation value setting
20 controller 5. At step S27, the controller 15 is set in a standby state until the output of the counter 10 becomes -X or less. The counter 10 increments by one when the optical spot moving outside traverses one information track, and decrements by one when the optical spot moving inside
25 traverses one information track. Consequently, when the

tracking actuator 2a returns from the out side to the neutral position, the output of the counter 10 becomes zero. Furthermore, the number of the information tracks traversed by the optical spot moving inside is output as a negative
5 number.

When the controller 15 detects that the output of the counter 10 is -X, the control shown in Fig. 3 is restarted. At step S28, the controller 15 stops the driving operation of the activation value setting
10 controller 5. At the subsequent step S29, a command for writing the inside set value is sent to the memory 13. Then, the tracking actuator 2a is moved from the neutral position thereof toward the inside of the disc 1. Thus, a displacement detection value obtained in accordance with
15 the actuator's position when the optical spot moving inside traverses X of information tracks is stored as the inside set value to the memory 13.

At the subsequent step S30, a command for driving or moving outside is given to the activation value setting
20 controller 5. At step S31, the controller 15 is in a standby state until the output of the counter 10 is zero. When the controller 15 detects that the output of the counter 10 is zero, the control shown in Fig. 3 is restarted. At Step S32, the controller 15 switches the
25 input of the selector 6 to the tracking controller 4. Thus,

the control of the traverse activation value setting operation ends.

As described above, the control of the controller 15 in the traverse activation value setting operation is carried out. In this control, with the traverse 18 in the stop state, the tracking actuator 2a is moved from the neutral position of the actuator 2a toward the outside or the inside of the disc 1. Then, the displacement detection value obtained when the optical spot traverses X of information tracks is stored as the outside set value or the inside set value to the memory 13.

<Traverse Servo Operation>

With reference to Fig. 4, the control of the controller 15 in the traverse servo will be described. While the optical disc 1 rotating, a laser beam is focused on the information plane of the optical disc 1 by the optical pickup 2 to form an optical spot. The reflected light is detected by the light receiving section 2b. The tracking error detecting circuit 3 generates a tracking error signal from the output of the light receiving section 2b, and outputs the tracking error signal to the tracking controller 4. The tracking controller 4 gives a predetermined filter processing to the tracking error signal, multiplies the error signal by a predetermined gain,

and outputs the error signal to the actuator driving circuit 7. The actuator driving circuit 7 drives the tracking actuator 2a such that the optical spot follows or traces the information track. For such an operation of the tracking actuator 2a, the traverse servo is carried out by the controller 15 in the following manner.

At step S40, the controller 15 compares the displacement detection value which is the output of the displacement detecting section 11 with the outside set value stored in the memory 13. When the displacement detection value is equal to or greater than the outside set value, the routine proceeds to step S41. Otherwise, the routine proceeds to step S44. At the step S41, the controller 15 gives a command for driving outside to the traverse controller 16. At Step S42, subsequently, the controller 15 keeps being in a standby state until the displacement detection value becomes equal to or smaller than a destination value.

The destination value is a displacement detection value corresponding to a value indicative of correction amount of the displacement of the tracking actuator 2a. When the optical spot is driven gradually outside by the tracking control, the destination value is set as follows. When a position of the tracking actuator 2a is corrected into a neutral point, the optical spot is gradually driven

from the neutral point toward the outside after the correction. Therefore the tracking actuator 2a would move within a range from the neutral point to the outside set value. On the other hand, when a position of the tracking
5 actuator 2a is corrected into a inside set value, the tracking actuator 2a theoretically would operate within a range from the inside set value to the outside set value. However, when a position of the tracking actuator 2a is corrected to be in the vicinity of the inside set value,
10 the control would become unstable. Therefore, the destination value may be set within a range from the neutral position to the inside set value.

When the displacement detection value is equal to or smaller than the destination value, the processing shown
15 in Fig. 4 is restarted. At step S43, the controller 15 gives a stop command to the traverse controller 16. At step S44, subsequently, the controller 15 compares the displacement detection value with the inside set value. When the displacement detection value is equal to or
20 smaller than the inside set value, the routine proceeds to step S45. Otherwise, the processing ends. At step S45, the controller 15 gives the traverse controller 16 a command for driving inside. At step S46, subsequently, the controller 15 keeps in a standby state until the
25 displacement detection value is equal to or greater than

the destination value. From the above mentioned reason, the destination value is next set within a range from the neutral position to the outside set value. When the displacement detection value is equal to or greater than
5 the destination value, the processing shown in Fig. 4 is restarted. At step S47, the controller 15 gives a stop command to the traverse controller 16, and the processing ends.

In the steps S41 to S43 and the steps S45 to S47,
10 the description is made with the traverse 18 which is a DC motor. In the case in which the traverse 18 is a stepping motor, the amount of movement can be set accurately. At the steps S41 and S45, therefore, the traverse may be driven to a position corresponding to the destination value,
15 and the control operations at the steps S42-S43 and the steps S46-S47 can be omitted.

Fig. 4 shows a processing in which one traverse servo is carried out. The processing shown in Fig. 4 is continuously repeated in the state in which information is
20 to be recorded or reproduced on the optical disc 1.

According to the present embodiment, as described above, while the tracking actuator 2a moving from the neutral position thereof to the outside or the inside in the state where the traverse 18 stops, the displacement
25 detection value obtained when the optical spot traverses X

information tracks is stored in advance as the outside set value and the inside set value to the memory 13. When the information is to be recorded/reproduced to/from the optical disc 1, the displacement detection value of the displacement detecting section 11 is compared with the
5 outside set value or the inside set value which are stored in the memory 13 by the above-mentioned traverse activation value setting operation. When the displacement detection value exceeds the outside set value, the traverse 18 is
10 driven toward the outside. On the other hand, when the displacement detection value is smaller than the inside set value, the traverse 18 is driven toward the inside. Therefore, it is possible to carry out the tracing which can suppress the displacement of the tracking actuator 2a
15 with high precision without an influence by the detection precision of the absolute position of the optical spot.

The traverse activation value setting operation may be adjusted before shipment in a factory, or may be carried out by a user.

20 In the present embodiment the optical disc 1 is stopped rotating during the traverse activation value setting operation. However, the optical disc 1 may rotate. Then a relative change in an information track position may be corrected by the operation of a control system through
25 the spiral information track and the rotation of the

optical disc 1.

In the traverse activation value setting operation, when the tracking actuator 2a is moved from the neutral position thereof in the radial direction and the displacement detection value is stored to the memory 13, the inside and outside set values are obtained when the optical spot traverses the same number of information tracks (that is X). The number of the information tracks traversed by the optical spot for calculating the inside set value may be different from the number of the information tracks for calculating the outside set value.

Although the present invention has been described in connection with specified embodiments thereof, many other modifications, corrections and applications are apparent to those skilled in the art. Therefore, the present invention is not limited by the disclosure provided herein but limited only to the scope of the appended claims.

WHAT IS CLAIMED IS:



1. A device for focusing a laser beam onto a plane
of an optical disc having a plurality of information tracks
5 and controlling displacement of the laser beam irradiated
onto the optical disc, the device comprising:

an optical pickup having an objective lens and a
tracking actuator for moving the objective lens in a radial
direction of the optical disc, the optical pickup focusing
10 a laser beam on the optical disc through the objective lens
to form a optical spot, and converting light reflected from
the optical disc into electric signal to be output;

an actuator driving means for driving the
tracking actuator such that the optical spot traces the
15 information track on the optical disc;

displacement detecting means for detecting a
position of the tracking actuator in the radial direction
in accordance with the electric signal output from the
optical pickup to generate a displacement detection value
20 which indicates displacement of the tracking actuator from
a neutral position of the tracking actuator based on the
detected position of the tracking actuator;

traverse means for moving the optical pickup in
the radial direction;

25 traverse driving means for controlling motion of



the traverse means;

storage means for storing a set value indicative of a predetermined displacement from the neutral position of the traverse actuator; and

5 a controller for controlling the actuator driving means and the traverse driving means,

wherein the controller controls the actuator driving means to move the tracking actuator from the neutral position in the radial direction, obtains, as the
10 set value, the displacement detection value obtained in accordance with a position of the tracking actuator where the optical spot has traversed a predetermined number of information tracks, and stores the obtained set value to the storage means,

15 and during operation of recording and reproducing data for the optical disc, the controller compares the displacement detection value from the displacement detecting means with the set value stored in the storage means, and controls the traverse driving means to start
20 driving the traverse when the displacement detection value is beyond the set value.

2. The device according to claim 1, wherein the set value comprises a first set value indicative of a
25 predetermined displacement inside of the neutral position



of the tracking actuator, and a second set value indicative of a predetermined displacement outside of the neutral position of the tracking actuator.

5 3. The device according to claim 2, wherein to obtain the first set value, the controller controls the actuator driving means to move the tracking actuator from the neutral position toward inside of the optical disc in the radial direction, and determines, as the first set
10 value, the displacement detection value corresponding to a position of the tracking actuator at which the optical spot traverses a predetermined number of information tracks.

4. The device according to claim 2, wherein to
15 obtain the second set value, the controller controls the actuator driving means to move the tracking actuator from the neutral position toward outside of the optical disc in the radial direction, and determines, as the second set value, the displacement detection value corresponding to a
20 position of the tracking actuator at which the optical spot traverses a predetermined number of information tracks.

5. The device according to claim 1, further comprising a track cross detecting means for detecting
25 whether the optical spot traverses the information track

based on the output of the optical pickup.



6. The device according to any one of claims 1,
wherein the optical disc stops rotating while the set value
5 is obtained and stored to the storage means.

7. The device for an optical disc according to claim
1, wherein the device is laid horizontally while the set
value is obtained and stored to the storage means.