The invention relates to an optical recording and/or reproduction device in which a light beam is focused onto a rotating recording medium by means of a focusing regulation circuit and guided along the data tracks of the recording medium by means of a tracking regulation circuit, in which the regulating signal of the focusing and/or tracking regulation circuit is stored in a memory and in which instead of the momentary signal, the regulating signal present in the memory is fed to the adjusting member of the focusing and/or tracking regulation circuit for the duration of a disturbance.

The CD player might be named as a known example of an optical reproduction device. The generic term servo circuit is usually used for the focusing and the tracking regulation circuit.

The servo circuits of a CD player function very reliably as long as the disc-type recording medium, the so-called compact disc, has no defects whatsoever. However, the discs are often damaged by scratches or holes in the reflective layer, called black dots, and frequently also contaminated by dust or fingerprints.

Even scratches or the undesirable black dots can invalidate both the regulating signal for the focusing regulation circuit, the so-called focusing error signal, and also the regulating signal for the tracking regulation circuit, normally called the tracking error signal, in such a way that the light beam can neither be focused onto the disc nor guided along the data tracks.

An optical reproduction device is known from EP-A 0 403 196. The tracking error signals and the focusing error signals are stored by means of a plurality of sample-and-hold elements for a respective period of time. If faults appear in the focusing or tracking error signal, then the stored focusing or tracking error signal is supplied to the adjusting member of the focusing or

tracking regulation circuit respectively instead of the current focusing or tracking error signal respectively.

An optical reproduction device is described in JP-A 61-117738. If defects on the optical disc are detected, then the current focusing error signal is no longer supplied to the adjusting member of the focusing regulation circuit but rather the focusing error signal which was last valid prior to the defect location.

JP-A 60-151846 discloses, in an optical reproduction device, the detection of defects on the disc, such as cracks or scratches and dust, by means of a detector. If the light beam scanning the data comes to a defective or contaminated point on the disc, then the value of the tracking error signal valid prior to reaching the faulty point is retained and fed to the adjusting member of the tracking regulation circuit instead of the current tracking error signal.

It is now the object of the invention to design the servo circuit of an optical recording and/or reproduction device so that its servo circuits no longer fail when disc defects occur.

The invention achieves this object in that the regulating signal for the focusing and/or tracking regulation circuit for at least the last respective rotation of the rotating recording medium prior to the disturbance is stored in the memory, and that a disturbance is assumed when a shock sensor detects a mechanical shock to the recording and/or reproduction device.

There is shown:

Figure 1 a first embodiment,

Figure 2 a second embodiment,

Figure 3 a third embodiment of the invention,

Figure 4 the temporal course of the data signal,

Figure 5 the temporal course of the focusing and the tracking error signal.

The embodiment shown in Figure 3 will now be described and, with reference to Figure 3, explained.

The focusing error signal FE or the tracking error signal TE, which is generated by means of a photodetector PD, reaches the input of a regulator RG and an analog-to-digital converter AD. The output of the regulator RG is connected via a controllable switch S1 to the first input of a summation point SU, the output of which is connected to the adjusting member SG of the servo circuit. The output of the analog-to-digital converter AD is connected to the input of a memory SP, the output of which is connected via a controllable switch S2 and via a digital-to-analog converter DA to the second input of the summation point SU. The output of a shock sensor S, which detects mechanical shocks to the recording and/or reproduction device, is connected to the control inputs of both controllable switches S1 and S2.

If the shock sensor detects a mechanical impact to the recording and/or reproduction device, then its output signal has the effect of opening the controllable switch S1 and, in contrast, closing the controllable switch S2. If the effect of the mechanical shock wanes, then the shock sensor output signal causes the controllable switch S1 to close and, at the same time, the controllable switch S2 to open.

Now, the embodiment shown in Figure 1 is described and, with reference to Figure 4, explained. In addition to the detection of a disturbance by means of the shock sensor S, a disturbance can also be determined by means of the upper and lower generating envelope curves of the data signal HF.

The focusing error signal FE or the tracking error signal TE, which is

generated by means of a photodetector PD, reaches the input of a regulator RG and an analog-to-digital converter AD. The output of the regulator RG is connected via a controllable switch S1 to the first input of a summation point SU, the output of which is connected to the adjusting member SG of the servo circuit. The output of the analog-to-digital converter AD is connected to the input of a memory SP, the output of which is connected via a controllable switch S2 to the second input of the summation point SU. The data signal HF, which is generated by the photodetector PD or another photodetector, is fed to the input of a circuit arrangement HK which generates the lower envelope curve of the data signal HF. Such a circuit arrangement for generating the envelope curve of a data signal is known, e.g. from DE-OS 37 19 489. The output of the circuit arrangement HK is connected to the first input of a comparator VL which has a reference variable RE applied to its second input. The output of the comparator VL is connected to the control inputs of the controllable switch S1 and S2.

In trouble-free operation, the upper and lower envelope curves of the data signal HF, which is illustrated in Figure 4, is a straight line. The controllable switch S1 is closed, while the controllable switch S2 is open. The analog focusing error signal FE or the analog tracking error signal TE is converted by means of the analog-to-digital converter AD into digital values which are stored in the memory SP for the respective last or the respective last n revolutions of the disc. The regulator RG supplies the regulating signal for the adjusting member SG of the servo circuit shown in Figure 2.

As soon as the light beam scans points on the disc which are damaged e.g. by scratches or holes, then a so-called HF break-down occurs, as shown in Figure 4. The lower envelope curve exhibits a bulge upwards because the data signal HF amplitudes decrease. The comparator VL establishes that the lower envelope curve exceeds the reference value RE and therefore modifies the signal at its output. This modification of the signal has the effect of opening the

controllable switch S1 and, or contrast, closing the controllable switch. The regulating signal from regulator RG is now no longer fed to the adjusting member SG but rather the regulating signal stored in the memory SP for the last or last n revolutions of the disc.

Therefore, as the adjusting member SG receives a regulating signal which, although not current is not invalid, failures in the servo circuit as a result of scratches, holes or contamination on the disc, are extensively avoided. During the disturbance the servo circuit no longer functions in real time.

As soon as the light beam again scans undamaged locations on the disc, the amplitudes of the data signal HF increase again; the lower envelope curve takes on a straight line shape again. If the level of the lower envelope curve again drops below the reference value RE, the comparator VL closes the controllable switch S1 while it simultaneously opens the controllable switch S2. The momentary regulating signal supplied by the regulator RG is now fed to the adjusting member SG again. The regulating circuit now functions in real time again.

The second embodiment shown in Figure 2 is now described and, with the help of Figure 5, explained. In addition to the signal from the shock sensor S, the level of the tracking and focusing error signal is evaluated in order to detect a disturbance.

The focusing error signal FE or the tracking error signal TE is fed to the input of a regulator RG as well as the first input of a comparator VL1 and a comparator VL2, the outputs of which are connected to the inputs of an OR gate O. A lower reference value RU is applied to the second input of the comparator VL1, while an upper reference value RO is applied to the second input of the comparator VL2. The output of the regulator RG is connected to the input of an

analog-to-digital converter AD and, via a controllable switch S1, to the first input of a summation point SU. The output of the analog-to-digital converter AD is connected to the input of a memory SP, the output of which is connected via a controllable switch S2 to the input of a digital-to-analog converter DA. The output of the digital-to-analog converter DA is connected to the second input of the summation point SU. The output of the summation point SU is connected to the input of the adjusting member SG. The output of the OR gate is connected to the control input of the controllable switch S1 and S2.

In trouble-free operation the adjusting member SG receives the regulating signal from the regulator RG. The focusing error signal FE and the tracking error signal TE have a sinusoidal course, as is shown in Figure 5. If the focusing error signal FE or the tracking error signal TE exceeds the upper reference value RO, the comparator VL2 supplies a signal to the OR gate O. If, on the contrary the focusing error signal FE or the tracking error signal TE drops below the lower reference value RU, the comparator VL1 supplies a signal to the OR gate O. In both cases a logical one is present at the output of the OR gate O, which has the effect of opening controllable switch S1 and, in contrast, closing controllable switch S2. As in the first embodiment, the adjusting member SG no longer receives the regulating signal from the regulator RG, but rather an analog regulating signal which is generated by the digital-to-analog converter from the digital values stored in the memory.

As soon as the disturbance decays, when the light beam again meets undamaged points on the disc, the level at the output of the OR gate returns to a logical zero. Therefore, the OR gate O causes the controllable switch S1 to close while opening the controllable switch S2 so that the servo circuit can again regulate the focusing or the tracking respectively of the light beam scanning the data in real time.

Finally, the three embodiments illustrated in the Figures 1, 2 and 3 can be combined with each other as desired. The outputs of the comparators and the shock sensor are connected to the inputs of an OR gate, the output signal of which switches over the controllable switches S1 and S2.

The invention is suitable for both optical reproduction devices such as CD players and video disc players, as well as for optical recording and reproduction devices. Examples of recording and reproduction devices might be DRAW disc players and magneto-optical devices.

CLAIMS

1. An optical recording and/or reproduction device in which a light beam is focused onto a rotating recording medium by means of a focusing regulation circuit and guided along the data tracks of the recording medium by means of a tracking regulation circuit, in which the regulating signal (FE, TE) of the focusing and/or tracking regulation circuit is stored in a memory (SP) and in which instead of the momentary signal, the regulating signal present in the memory (SP) is fed to the adjusting member (SG) of the focusing and/or tracking regulation circuit for the duration of a disturbance, **characterised in that** the regulation signal (FE, TE) for the focusing and/or tracking regulation circuit is stored in the memory (SP) for at least the last respective rotation of the rotating recording medium prior to the disturbance, and that a disturbance is assumed when a shock sensor (S) detects a mechanical shock to the recording and/or reproduction device.

2. An optical recording and/or reproduction device according to claim 1, **characterised in that** only individual values of the regulating signal (FE, TE) are stored in the memory (SP), which follow each other at a predeterminable temporal separation.

3. An optical recording and/or reproduction device according to claim 1 or 2, **characterised in that** a disturbance is assumed when the level of the data signal (HF) drops below a predeterminable threshold value (RE).

4. An optical recording and/or reproduction device according to claim 1 or 2, **characterised in that** a disturbance is assumed when the regulating signal (FE, TE) of the focusing and/or tracking regulation circuit exceeds a predeterminable upper threshold value (RO) or drops below a predeterminable lower threshold value (RU).

5. An optical recording and/or reproduction device according to claim 4, **characterised in that**, in order to detect a disturbance, the regulating signal (FE, TE) of the focusing and/or tracking regulation circuit is supplied via a filter to a comparator.

6. An optical recording and/or reproduction device according to claim 3 and 4, **characterised in that** a disturbance is only assumed when both the level of the data signal (HF) and also of the regulating signal (FE, TE) of the focusing and/or tracking regulation circuit deviate from the predetermined threshold values.

7. An optical recording and/or reproduction device according to claim 1, **characterised in that** the focusing error signal (FE) or the tracking error signal (TE) is fed to the input of a regulator (RG) and the input of an analog-to-digital converter (AD), that the output of the regulator (RG) is connected via a first controllable switch (S1) to the first input of a summation point (SU), the output of which is connected to an adjusting member (SG), that the output of the analog-to-digital converter (AD) is connected to the input of a memory (SP), the output of which is connected via a second controllable switch (S2) to the input of a digital-to-analog converter (DA), the output of which is connected to the second input of the summation point (SU), and that the output of the shock sensor (S) is connected to the control input of the first and the second controllable switch (S1, S2).

8. An optical recording and/or reproduction device according to claim 3, **characterised in that** the focusing error signal (FE) or the tracking error signal (TE), which is generated by a photodetector (PD), is fed to the input of a regulator (RG) and an analog-to-digital converter (AD), that the output of the regulator (RG) is connected via a controllable switch (S1) to the first input of a summation point (SU), the output of which is connected to the adjusting member

(SG) of the servo circuit, that the output of the analog-to-digital converter (AD) is connected to the input of a memory (SP), the output of which is connected via a second controllable switch (S2) to the second input of the summation point (SU), that the data signal (HF), which is generated by the photodetector (PD), is fed to the input of a circuit arrangement (HK) which generates the lower envelope curve of the data signal (HF), that the output of this circuit arrangement (HK) is connected to the first input of a comparator (VL) which has a reference variable (RE) applied to its second input, and that the output of the comparator (VL) is connected to the control inputs of the controllable switches (S1, S2).

9. An optical recording and/or reproduction device according to claim 4, **characterised in that** the focusing error signal (FE) or the tracking error signal (TE), which a photodetector (PD) generates, is fed to the input of a regulator (RG) as well as to the first input of a first comparator (VL1) and a second comparator (VL2), the outputs of which are connected to the inputs of an OR gate (O), that a first predeterminable lower reference value (RU) is applied to the second input of the first comparator (VL1), while a predeterminable upper reference value (RO) is applied to the second input of the second comparator (VL2), that the output of the regulator (RG) is connected to the input of an analog-to-digital converter (AD) and, via a first controllable switch (S1), to the first input of a summation point (SU), that the output of the analog-to-digital converter (AD) is connected to the input of a memory (SP), the output of which is connected via a second controllable switch (S2) to the input of a digital-to-analog converter (DA), the output which is connected to the second input of the summation point (SU), that the output of the summation point (SU) is connected to the input of an adjusting member (SG), and that the output of the OR gate (O) is connected to the control input of the first and the second controllable switch (S1, S2).