PATENTS ACT 1977

IN THE MATTER OF an Application for a European Patent (UK) .

DECLARATION

I, Ian Harry McBride, M.A., M.I.T.I., of 15 Chaffinch Road, Beckenham, Kent BR3 4LT, England, declare that I am conversant with the English and German languages and I verify that the following is to the best of my knowledge and belief a true and correct translation of European Patent: EP 0 320 509

Signature of translator: .....

Dated this 7th day of February 1992.

The invention relates to an apparatus for reproducing data which can be read by means of an optical scanning device from the data tracks of a record carrier, by a light beam being able to be focused on the record carrier by means of a focus control circuit and guided by means of a track control circuit along the data tracks, by the light beam being reflected by the record carrier onto a photodetector by means of which an electric data signal is generated, by the upper and the lower envelope curve of the data signal being evaluated, by the lower envelope curve being compared in a first comparator with a lower threshold value, by the first comparator, if the lower threshold value is exceeded, emitting a signal at its output, which indicates that a disturbance exists which is caused by dirt, finger marks, scratches etc. on the record carrier or by vibrations, and by the upper envelope curve being compared in a second comparator with an upper threshold value, by the second comparator, if the upper threshold value is fallen below, emitting a signal at its output, which indicates that the light beam is skipping data tracks.

Apparatuses of this kind, e.g. CD players, magnetooptic apparatuses for reproduction and recording, recording and reproduction apparatuses for draw discs or video disc players, are equipped with an optical scanning device, consisting of a laser diode, a plurality of lenses, a prime beam splitter and a photodetector. The layout and function of an optical scanning device, a so-called optical pick-up, are described in "Electronic components and applications", Vol. 6, No. 4, 1984, pp. 209-215.

The light beam emitted by the laser diode is focused by means of lenses onto the compact disc and reflected from there onto a photodetector. From the output signal of the photodetector there are obtained the data stored on the compact disc and the actual value for the focus control circuit and the track control circuit. In the above-mentioned literature reference the actual value for the focus control circuit is described as the "focusing error", while for the actual value of the track control circuit the expression "radial tracking error" is chosen.

There serves as positioning element for the focus control circuit a coil, by means of whose magnetic field an objective lens may be moved along the optical axis. The focus control circuit now brings about, by displacement of the objective lens, that the light beam emitted by the laser diodes is focused continuously onto the compact disc. By means of the track control circuit, which is often also described as the radial drive, the optical scanning device is displaceable relative to the compact disc in radial direction. The light beam may as a result be guided on the spiral-shaped data tracks of the compact disc.

In some apparatuses the radial drive is composed of a so-called coarse and a so-called fine drive. The coarse drive is for example constructed as a spindle, by means of which the whole optical scanning device consisting of the laser diode, the lenses, the prime beam splitter and the photodetector is displaceable radially. With the fine drive the light beam may be tilted in radial direction, e.g. through a predetermined small

angle, so that the light beam may travel a short way along a radius of the compact disc simply by virtue of said tilting movement.

In order to achieve flawless reproduction of the data, whether e.g. image and sound are involved in the case of a video disc player or simply the sound in the case of a CD player, there is required, in addition to an accurate focusing of the light beam onto the video disc or compound disc, a precise guiding along the data tracks of the disc.

In the case of the photodetector, which is shown in the figure on page 213 of the above-mentioned literature reference, four square-shaped photodiodes A, B, C and D are joined together so that they in turn form a square. The light beam, which is focused onto the four photodiodes A, B, C and D, produces in the photodetector the data signal HF = AS + BS + CS + DS. By AS, BS. CS and DS are denoted respectively the photovoltages of the photodiodes A, B, C and D.

The data signal HF is disturbed by dirt, such as e.g. dust or finger marks and also by scratches on the compact disc, because the reflective properties of the disc surface, the so-called mirror surface, is thereby impaired. But vibrations of the CD player also lead to disturbances of the data signal HF, because the light beam can both lose the data track to be scanned and also get out of focus.

In the case of disturbances of the data signal HF which are caused by vibrations it is advantageous to increase the gain in the focus and track control circuit; on the other hand, disturbances which stem from impurities on the compact disc have a less pronounced effect if the gain in the focus and track control circuit is reduced.

If the light beam - in the case of so-called track skipping - should skip across several tracks, e.g. at the start of a piece of music desired by the listener, first of all the number of tracks lying between the current position of the light beam and the target point, the start of the desired piece of music, will be calculated. Then the light beam, directed by the track control circuit, travels to the start of the desired piece of music. In order to land exactly on the target point, however, it is necessary to count accurately the number of data tracks skipped.

During the track skipping the upper envelope curve of the data signal HF assumes a sinusoidal shape. Its absolute amplitude becomes maximum when the light beam shines onto a data track, and conversely minimum when it falls on the space between two data tracks. During the track skipping, therefore, the number of detected maxima corresponds to the number of skipped tracks.

As already mentioned, the data signal can be disturbed by dirt on the compact disc and by vibrations, which fact may lead during the track skipping to errors in the counting of the maxima.

There is known from EP-A 0 160 095 a track control circuit for an optical reproduction apparatus according to the preamble of claim 1. The data signal supplied by a photodetector is passed via a capacitive coupling to a circuit arrangement that evaluates the upper and the lower envelope curve of the data signal in order to obtain a criterion for the gain of the track control circuit. To this end the upper envelope curve of the data signal is compared in a first comparator with a first threshold value, while the lower envelope curve is compared in a second comparator with a second threshold value. In the event of dips in the lower envelope curve, which are caused by mechanical vibrations, the gain in the track control circuit will be increased. In the event of dips in the upper envelope curve, the cause of which often proves to be dirt, scratches or a crack on the disc, the gain in the track control circuit will be reduced.

Although said track control circuit is able in most cases to recognize fairly accurately the cause of a disturbance in the data signal, its effectiveness is nevertheless limited. The accuracy in recognizing a disturbance in the data signal may however be increased by suitable measures.

The aim of the invention is therefore to recognize as accurately as possible the cause of a disturbance of the data signal and to derive from this a criterion for the control of the focus and/or the track control circuit.

The invention achieves this aim by the fact that the data signal is at the output of the photodetector fed via a dc coupling to a circuit arrangement for the evaluation of its envelope curve.

In the case of CD players known to date the data signal is not coupled dc-wise as in the case of the invention, but ac-wise by means of a capacitor. Because of the ac-wise coupling, however, it is possible to recognize only with difficulty from the signal shape whether disturbances of the data signal are present or whether the light beam skips over a plurality of tracks during the track skipping.

The invention will be explained with reference to an exemplifying embodiment.

Figure 1 shows the shape of an undisturbed data signal HF,

Figure 2 the shape of an undisturbed data signal HF during track skipping,

Figure 3 the shape of a data signal HF disturbed by dirt on the compact disc or by vibrations,

Figure 4 the shape of a data signal HF disturbed by impurity on the compact disc or by vibrations during track skipping,

Figure 5 a first exemplifying embodiment of the invention and

Figure 6 a second exemplifying embodiment of the invention.

In Figure 1 the shape of the data signal HF is shown under ideal conditions. The upper and the lower envelope curve are two straight lines in this case.

In Figure 2 the ideal shape during track skipping is shown. The lower envelope curve is once again a straight line, but the upper envelope curve has a sinusoidal shape.

In Figure 3 the upper envelope curve admittedly represents a straight line, but the lower envelope curve exhibits irregular bulges which stem from impurities or scratches on the compact disc or are caused by vibrations.

Finally, Figure 4 shows what the data signal looks like if the CD player is exposed to vibrations during track skipping or the compact disc is damaged by scratches, dust, finger marks or other dirt. The sinusoidal shape of the upper envelope curve may be interrupted by the lower envelope curve, which has a similar shape to that of Figure 3.

With reference to the exemplifying embodiment shown in Figure 5 the invention will first of all be described and then explained with the assistance of Figures 1 - 4.

In Figure 5 the light beam L reflected from the compact disc is focused on the photodetector PD which is composed of four square-shaped photodiodes A, B, C and D. The data signal HF generated by the photodetector PD, the sum of the photovoltages AS, BS, CS and DS of the photodiodes A, B, C and D, is passed for decoding to a circuit (not shown for the sake of simplicity), as is generally the practice in the case of CD players. In addition the data signal HF reaches the cathode of a diode D1 which is connected to the anode of a diode D2. The anode of the diode D1 is connected to the one terminal of a capacitor C1 whose other terminal lies at reference potential, to the one pole of a current source Q1 to whose other pole a voltage U1 is applied, and to the one input of a comparator V1 whose other input is connected to the pick-off of a potentiometer P1. To the one terminal of the potentiometer P1 a voltage U2 is applied, while its other terminal lies at reference potential. The cathode of the diode D2 is connected to the one terminal of a capacitor C2 whose other terminal lies at reference potential, to the one pole of a current source Q2 whose other pole likewise lies at reference potential, and to the one input of a comparator V2 whose other input is connected to the pick-off of a potentiometer P2. To the one terminal of the potentiometer P2 a voltage U3 is applied, its other terminal lies on the other hand at reference potential.

The lower envelope curve with the lower threshold value SU shown in dashes in Figure 4 is compared with that part of the circuit arrangement shown in Figure 5 which consists of the components D1, C1, Q1, V1 and P1. The upper envelope curve with the upper threshold value S0 likewise shown in dashes in Figure 4 is

compared with the other part of the circuit arrangement shown in Figure 5 and formed of the components D2, C2, Q2, V2 and P2. The comparator V2 emits a signal at its output A2 if the upper envelope curve of the data signal HF drops below the upper threshold value SO. Said signal at the output A2 indicates that the light beam is skipping over tracks. Conversely the comparator V1 emits a signal at its output A1 if the lower envelope curve of the data signal exceeds the lower threshold value SU. The signal at the output A1 indicates that a disturbance is present which is caused by dirt, finger marks, scratches, etc. on the compact disc or by vibrations of the CD player. The two threshold values, the lower value SU and the upper value SO, are determined by the setting of the two potentiometers P1 and P2.

It is particularly advantageous to clamp the data signal to the upper or lower envelope curve. The lower envelope curve, which corresponds to a reflective spot, is dependent to a high degree on the reflective properties of the compact disc. The gap between the lower envelope curve and the abscissa is at its smallest in Figures 1 to 4 in the case of a highly reflective, clean compact disc. The worse the reflective properties become, however, e.g. due to dust, finger marks, etc., the more will the lower envelope curve be displaced upwards towards the upper envelope curve. For this reason it makes sense to clamp to the upper envelope curve, because the latter corresponds to a dark, non-reflective spot on the compact disc.

In Figure 6 there is shown an exemplifying embodiment of the invention, in which the data signal is clamped to the maximum value of the upper envelope curve, i.e. to the darkest value - no reflection of any kind on the compact disc. Said exemplifying embodiment is distinguished from the exemplifying embodiment in Figure 5 by the fact that between the photodetector PD and the diodes D1 and D2 a clamping circuit with the following layout is provided.

The data signal HF lies at the non-inverting input of an amplifier V3 whose output is connected to the common junction point of the cathode of the diode D1 and the anode of the diode D2. In addition the output of the amplifier V3 lies via a serial circuit consisting of two resistors R1 and R2 at reference potential. The common connection point of the two resistors R1 and R2 is connected to the inverting input of the amplifier V3 and to the output of an amplifier V4 to whose inverting input a reference voltage UR is applied. The non-inverting input of the amplifier V4 is connected to the one pole of a current source Q3 to whose other pole a voltage U4 is applied, to the one terminal of a capacitor C4 whose other terminal lies at reference potential and to the cathode of a diode D3 whose anode is connected to the output of the amplifier A3. If clamping to the lower envelope curve is desired, the polarity of the diode D3 simply has to be changed.

Due to the fact that the CD player recognizes immediately from the data signal HF whether the light beam is skipping over tracks, whether disturbances caused by vibrations or by dirt on

the compact disc, or whether both phenomena, are present, the focus and track control circuits are capable of controlling quicker and more accurately.

Claims

1. Apparatus for reproducing data which can be read by means of an optical scanning device from the data tracks of a record carrier, by a light beam (L) being able to be focused on the record carrier by means of a focus control circuit and guided by means of a track control circuit along the data tracks, by the light beam (L) being reflected by the record carrier onto a photodetector (PD) by means of which an electric data signal (HF) is generated, by the upper and the lower envelope curve of the data signal (HF) being evaluated, by the lower envelope curve being compared in a first comparator (V1) with a lower threshold value (SU), by the first comparator (V1), if the lower threshold value (SU) is exceeded, emitting a signal at its output (A1), which indicates that a disturbance is present which is caused by dirt, finger marks, scratches etc. on the record carrier or by vibrations, and by the upper envelope curve being compared in a second comparator (V2) with an upper threshold value (SO), by the second comparator, if the upper threshold value (SO) is fallen below, emitting a signal at its output (A2), which indicates that the light beam (L) is skipping over data tracks, characterised in that the data signal is at the output of the photodetector fed via a DC coupling to a circuit arrangement for the evaluation of its envelope curves.

2. Apparatus according to claim 1, characterised in that the data signal (HF) is fed to the common connection point of the cathode of a first diode (D1) and the anode of a second diode (D2), that the anode of the first diode (D1) is connected to the one terminal of a first capacitor (C1) whose other terminal lies at reference potential, to the one pole of a first current source (Q1) to whose other pole a first voltage (U1) is applied, and to the one input of the first comparator (V1) whose other input is connected to the pick-off of a first potentiometer (P1), that to the one terminal of the first potentiometer (P1) a second voltage (U2) is applied, that its other terminal lies at reference potential, that the cathode of the second diode (D2) is connected to the one terminal of a second capacitor (C2) whose other terminal lies at reference potential, to the one pole of a second current source (Q2) whose other pole lies at reference potential, and to the one input of the second comparator (V2) whose other input is connected to the pick-off of a second potentiometer (P2), that to the one terminal of the second potentiometer (P2) a third voltage (U3) is applied and that the other terminal of the second potentiometer (P2) lies at reference potential.

* C L M S *

the compact disc, or whether both phenomena, are present, the focus and track control circuits are capable of controlling quicker and more accurately.

Claims

1. Apparatus for reproducing data which can be read by means of an optical scanning device from the data tracks of a record carrier, by a light beam (L) being able to be focused on the record carrier by means of a focus control circuit and guided by means of a track control circuit along the data tracks, by the light beam (L) being reflected by the record carrier onto a photodetector (PD) by means of which an electric data signal (HF) is generated, by the upper and the lower envelope curve of the data signal (HF) being evaluated, by the lower envelope curve being compared in a first comparator (V1) with a lower threshold value (SU), by the first comparator (V1), if the lower threshold value (SU) is exceeded, emitting a signal at its output (A1), which indicates that a disturbance is present which is caused by dirt, finger marks, scratches etc. on the record carrier or by vibrations, and by the upper envelope curve being compared in a second comparator (V2) with an upper threshold value (SO), by the second comparator, if the upper threshold value (SO) is fallen below, emitting a signal at its output (A2), which indicates that the light beam (L) is skipping over data tracks, characterised in that the data signal is at the output of the photodetector fed via a DC coupling to a circuit arrangement for the evaluation of its envelope curves.

2. Apparatus according to claim 1, characterised in that the data signal (HF) is fed to the common connection point of the cathode of a first diode (D1) and the anode of a second diode (D2), that the anode of the first diode (D1) is connected to the one terminal of a first capacitor (C1) whose other terminal lies at reference potential, to the one pole of a first current source (Q1) to whose other pole a first voltage (U1) is applied, and to the one input of the first comparator (V1) whose other input is connected to the pick-off of a first potentiometer (P1), that to the one terminal of the first potentiometer (P1) a second voltage (U2) is applied, that its other terminal lies at reference potential, that the cathode of the second diode (D2) is connected to the one terminal of a second capacitor (C2) whose other terminal lies at reference potential, to the one pole of a second current source (Q2) whose other pole lies at reference potential, and to the one input of the second comparator (V2) whose other input is connected to the pick-off of a second potentiometer (P2), that to the one terminal of the second potentiometer (P2) a third voltage (U3) is applied and that the other terminal of the second potentiometer (P2) lies at reference potential.