The invention concerns a tracking control circuit for an optical scanning device, in which a light beam is guided by the tracking control circuit along the data tracks, which are wobbled about a frequency, of a disc-shaped recording medium, in which by means of a focus control circuit the light beam is focussed onto the recording medium and in which the light beam is reflected from the recording medium onto a four-quadrant photodetector with four photodiodes, the output signals of which are added in an adding amplifier, the output of which is connected to the first input of a multiplier.

From DE-PS-3153674 a disc-shaped recording medium is known, the data tracks of which are wobbled about a centre frequency. The data tracks thus have a sinusoidal course. The advantage of this special form of the data tracks is that they can carry additional information, e.g. position information.

With the so-called push-pull process the light beam scanning the data of such a recording medium, is focussed by a focus control circuit onto the recording medium and guided by a tracking control circuit along a data track, which is wobbled about a predetermined frequency. The light beam scanning the data tracks is reflected by the recording medium onto a four-quadrant photodetector, which is constructed of four photodiodes A, B, C and D. The output signals of the four photodiodes A, B, C and D are added in an adding amplifier. In order to produce the tracking error signal, the control signal for the tracking control circuit, the output signals of the first pair of adjacent photodiodes A and B are supplied to the adding inputs of a first differential amplifier, while the output signals of the other pair of adjacent photodiodes C and D are supplied to the subtracking inputs of the first differential amplifier. The control signal for the focus control circuit, the so-called focus error signal, is tapped at the output of a second differential amplifier, to the adding inputs of which there are supplied the output signals of the first pair of diagonally opposed photodiodes A and C, while the output-signals of the other pair of diagonally opposed photodiodes B and D are applied to the subtracting inputs of the second differential amplifier.

For compensation of undesired offset voltages, which occur in the photodetector and in the amplifiers, a compensation voltage once fixedly set by means of a potentiometer is fed into the tracking control circuit.

This method has however the disadvantage that a drift of the offset voltages for instance due to aging of components or due to temperature variations is not taken into account. In

order to compensate also the drift of the offset voltages, the compensation voltage would have to be continually adjusted by a potentiometer.

From JP-A-59 198540 there is known a tracking control circuit, of which the construction will now be described.

The output voltages of the first pair of diagonally opposed photodiodes of a four-quadrant photodetector are added in a first adder, while the output voltages of the other pair of diagonally opposed photodiodes of the four-quadrant photodetector are added in a second adder. The output signals of the first and second adders are subtracted one from the other in a subtractor and added in a third adder. The difference at the output of the subtractor and the sum at the output of the third adder are multiplied in a multiplier, at the output of which the tracking error signal can be derived.

Thus the invention seeks to automatically compensate, in a tracking control circuit of the above type offset voltages and their drift e.g. due to aging of the components or due to temperature variations.

The invention solves this object in that the output signals of the first pair of adjacent photodiodes are supplied to the adding inputs and the output signals of the other pair of adjacent photodiodes are supplied to the subtracting inputs of a differential amplifier, in that the output of the differential amplifier is connected to the second input of the multiplier and the first input of a summing point, and in that the output of the multiplier is connected to the second input of the summation point, at the output of which the control signal for the tracking control circuit can be derived.

Figure 1 shows a first embodiment of the invention;

Figure 2 shows an embodiment of a multiplier.

The invention is described and explained with reference to the embodiment shown in Figure 1.

In Figure 1 a four-quadrant-photodetector PD is shown having four photodiodes A, B, C and D. The output signals of the first pair of adjacent photodiodes A and B are fed to the adding inputs of a differential amplifier V1, while the output signals of the other pair of adjacent photodiodes C and D are applied to the subtracting inputs of the differential amplifier V1. The output signals of all photodiodes A, B, C and D are moreover added in an adding amplifier V2. The output of the adding amplifier V2 and of the differential amplifier V1 are connected via a respective filter F and a phase shifter PH to the two inputs of a

multiplier M, the output of which is connected via a low pass filter TP and a amplifier V3 to the first input of a summing point SU. To the other input of the summing point SU is connected the output of the differential amplifier V1. The output of the summing point SU, at which is applied the compensated tracking error signal, is connected to the control amplifier V4 of the tracking control circuit.

It is also possible to divide the light beam reflected by the recording medium by means of a beam splitter and to direct the first part to a second photodetector. Instead of the sum formed from the output signals of the four photodiodes A, B, C and D in the adding amplifier V2, the output signal of the second photodetector can be fed to the multiplier M, because it is identical with the sum.

The invention is based on the realisation that in the tracking error signal at the output of the differential amplifier V1 there is contained the frequency with which the data track of the recording medium is wobbled.

The filters F, the pass band of which corresponds with the wobble frequency of the data tracks of the recording medium, and the phase shifters PH are not absolutely necessary for the functioning of the invention, but they improve the compensation of the offset voltages.

The signal at the output of the amplifier V3 is fed into the tracking control circuit as offset compensation voltage. Therefore all offset voltages and their drifts are compensated, which are caused for instance by aging of components or due to temperature variations in the photodetector PH and in the amplifiers V1 and V2.

Figure 2 shows an embodiment of a multiplier M.

The first input E1 of the multiplier M, at which is applied the output signal of the adding amplifier V2, form the interconnected first inputs of two jointly controllable change-over switches U1 and U2, the second inputs of which are at reference potential. The second input E2 of the multiplier M, which is supplied with the tracking error signal at the output of the differential amplifier V1, forms the input of a comparator K or limiter, the output of which is connected to the control inputs of the two change-over switches U1 and U2. The output of the first change-over switch U1 is connected via a resistor R1 to the inverting input of a differential amplifier DV. The output of the other change-over switch U2 is connected via a resistor R2 to the non-inverting input of the differential amplifier DV, which is connected via a capacitor C2 to reference potential. The output of the differential amplifier DV, which forms the output A1 of the multiplier M, is fed back via a capacitor C1 to the inverting input.

The comparator K converts the signal which is sinusoidal due to the wobbled data track at the output of the differential amplifier V1 into a rectangular signal. The two controllable change-over switches U1 and U2 are therefore switched-over by the comparator K at the frequency of the sinusoidal signal at the output of the differential amplifier V1. The differential amplifier DV integrates the signal at the output of the adding amplifier V2 in dependence on the position of the two change=over switches U1 and U2 either in one or the other direction.

The invention is suitable for the tracking control circuit of an optical scanning device, which scans an optical recording medium, the data tracks which are wobbled about a frequency.

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Claims

1. A tracking control circuit for an optical scanning device, in which a light beam is guided by the tracking control circuit along the data tracks, which are wobbled about a frequency, of a disc-shaped recording medium, in which by means of a focus control circuit the light beam is focussed onto the recording medium and in which the light beam is reflected from the recording medium onto a four-quadrant photodetector (PD) with four photodiodes (A,B,C,D), the output signals of which are added in an adding amplifier (V2), the output of which is connected to the first input of a multiplier (M), characterised in that the output signals of the first pair of adjacent photodiodes (A,B) are supplied to the adding inputs and the output signals of the other pair of adjacent photodiodes (C,D) are supplied to the subtracting inputs of a differential amplifier (V1), in that the output of the differential amplifier (V1)is connected to the second input of the multiplier (M) and the first input of a summing point (SU), and in that the output of the multiplier (M) is connected to the second input of the summation point (SU), at the output of which the control signal for the tracking control circuit can be derived.

2. A tracking control circuit according to claim 1, characterised in that a low pass filter (TP) is located between the output of the multiplier (M) and the second input of the summing point (SU).

3. A tracking circuit according to claim 1 or 2, characterised in that a filter (F) is located between the adding amplifier (V2) and the multiplier (M) and also between the differential amplifier (V1) and the multiplier (M).

4. A tracking control circuit according to claim 1, 2 or 3, characterised in that a phase shifter (PH) is provided in at least one branch, which leads from one amplifier (V1, V2) to the multiplier (M).

5. A tracking control circuit according to claim 1, 2, 3 or 4 characterised in that the interconnected first inputs of a first and a second controllable change-over switch (U1, U2) form the first input (E1) of the multiplier (M), which is supplied with the output signal of the adding amplifier (V2), in that the second inputs of the two controllable change-over switches (U1, U2) are at reference potential, in that the input of a comparator or limiter (K), the output of which is connected to the control inputs of the two change-over switches (U1, U2), forms the second input (E2) of the multiplier (M), in that the output of the first change-over switch (U1) is connected via a first resistor (R1) to the

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inverting input of a differential amplifier (DV), in that the output of the second change-over switch (U2) is connected via a second resistor (R2) to the non-inverting input of the differential amplifier (DV), which is connected to reference potential via a first capacitor (C2), and in that the output of the differential amplifier (DV), which forms the output (A1) of the multiplier (M), is fed back to the inverting input via a second capacitor (C1).