The invention concerns a focus control circuit for an optical scanning device, in which a light beam is guided by means of a tracking control circuit along the data tracks wobbled about a centre frequency of a disc-shaped recording medium and in which by means of the 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.

From DE-PS3153674 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 shape. The advantage of this special form of the data tracks is that they can carry additional information, e.g. position information.

In the so-called push-pull-process the light beam e.g. scanning the data of such a recording medium is focussed by means of a focus control circuit onto the recording medium and guided by means of a tracking control circuit along the data tracks, which are 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 generate 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 fed to the adding inputs of a first differential amplifier, while the output signals of the other pair of adjacent photodiodes C and D are fed to the subtracting 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 are fed the output signals of the first pair of diagonally positioned photodiodes A and C, while the output signals of the other pair of diagonally positioned photodiodes B and D are applied to the subtracting inputs of the second differential amplifier.

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

This process has however the disadvantage that a drift of the offset voltages for instance due to ageing of the components or due to temperature variations is not taken into account. To be also able to compensate the drift of the offset voltages, the compensation voltage would thus have to be constantly adjusted by the potentiometer.

From GB-A-2 150 385 there is known a focus control circuit, the construction of which is described below.

The output voltages of the first pair of diagonally positioned photodiodes of a four-quadrant photodetector are added in a first adder, while a second adder adds the output voltages of the other pair of diagonally positioned photodiodes. In a first differential amplifier there is formed the difference of the sums of the first and second adder. In a third adder there is formed the sum of the output voltages of the first pair of oppositely positioned photodiodes, while in a fourth adder there is formed the sum of the output voltages of the other pair of oppositely positioned photodiodes. In a second differential amplifier there is formed the difference from the sums of the third and fourth adders. A fifth adder forms the sum from the output voltages of the first pair of overlying photodiodes while a sixth adder forms the sum from the output voltages of the other pair of overlying photodiodes. In a third differential amplifier there is formed the difference of the sums of the fifth and sixth adders. In a multiplier there is formed the product of the difference at the output of the second and at the output of the third differential amplifier, and the product is supplied to the first input of a fourth differential amplifier, to the other input of which is supplied the difference at the output of the first differential amplifier. The focus error signal can be derived at the output of the fourth differential amplifier.

It is therefore the object of the invention to compensate automatically in a focus control circuit of the above type the offset voltages and their drift e.g. due to ageing of the components or due to temperature variations.

The invention solves this object in that the tracking error signal is fed to the first and the focus error signal to the second input of a multiplier and in that the output signal of the multiplier is fed via a low-pass filter to the focus control circuit as compensation voltage.

Figure 1 shows a first embodiment of the invention;

Figure 2 an embodiment of a multiplier.

With reference to the embodiment shown in Figure 1 the invention will be described and explained.

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 the first pair of diagonally positioned photodiodes A and C are fed to the adding inputs of a differential amplifier V2, while the other pair of diagonally positioned photodiodes B and D are applied to the subtracting inputs of the differential amplifier V2. The outputs of both differential amplifiers V1 and V2 are connected respectively via a 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 an 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 V2. The output of the summing point SU, at which is supplied the compensated focus error signal, is connected to the control amplifier V4 of the focus control circuit.

The invention is based on the recognition 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 band-pass range of which corresponds to the wobble frequency of the data tracks on the recording medium, and the phase shifters PH are not absolutely necessary for the function 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 focus control circuit as offset compensation voltage. Thus all offset voltages and their drifts are compensated, which are caused for instance by ageing of components or due to temperature variations in the photodetector PD 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 differential amplifier V2, is formed by 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, is formed by 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 due to the wobbled data track is sinusoidal, 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 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 suited for the focus control circuit of an optical scanning device, which scans an optical recording medium, the data tracks of which are wobbled about a frequency.

Claims

1. A focus control circuit for an optical scanning device, in which a light beam is guided by means of a tracking control circuit along the data tracks of a disc-shaped recording medium, which are wobbled about a centre frequency, and is focussed by means of a focus control circuit onto the recording medium, and in which the light beam is reflected from the information medium onto a four-quadrant photodetector (PD), characterized in that the tracking error signal is fed to the first and the focus error signal to the second input of a multiplier (M) and in that the output signal of the multiplier (M) is fed via a low-pass filter (TP) as compensating voltage into the focus control circuit.

2. A focus control circuit according to claim 1, characterized in that the output signals of the first pair of adjacent photodiodes (A, B) of the photodetector (PD) are fed to the adding inputs and the output signals of the other pair of adjacent photodiodes (C, D) are fed to the subtracting inputs of a first differential amplifier (V1), at the output of which the tracking error signal can be derived, in that the output signals of the first pair of diagonally positioned photodiodes (A, C) are fed to the adding inputs and the output signals of the other pair of diagonally positioned photodiodes (B, D) are fed to the subtracting inputs of a second differential amplifier (V2), at the output of which the focus error signal can be derived, in that the output of the first differential amplifier (V1) is connected to the first input of the multiplier (M) and the output of the second differential amplifier (V2) is connected to the second input of the multiplier (M) and to the first input of a summing point (SU) and in that the output of the low-pass filter (TP) is connected to the second input of the summing point (SU), at the output of which the control signal for the focus control circuit can be derived.

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3. A focus control circuit according to claim 1 or 2, characterized In that both between the first differential amplifier (V1) and the multiplier (M) and also between the second differential amplifier (V2) and the multiplier (M) there is located a filter (F).

4. A focus control circuit according to claim 1, 2 or 3, characterized in that in at least one branch leading from an amplifier (V1, V2) to the multiplier (M), there is provided a phase shifter (PH).

5. A focus control circuit according to claim 1, 2, 3 or 4, characterized 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 second differential 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 inverting input of a third differential amplifier (DV), in that the out-put of the second change-over switch (U2) is connected via a second resistor (R2) to the non-inverting input of the third differential amplifier (DV), which is connected to reference potential via a first capacitor (C2), and in that the output of the third differential amplifier (DV), which forms the output (A1) of the multiplier (M), is fed-back via a second capacitor (C1) to the inverting input.