Description

The invention relates to an apparatus for recording and/or reading information in/from a track of a radiation-reflecting record carrier by means of a light beam which is incident on the record carrier, which apparatus comprises:

— a light source for producing a light beam,

— an objective system for focusing the light beam so as to form a light spot on the record carrier depending on a control signal and for directing the reflected light beam towards

— a focusing-error detection system which comprises an astigmatic element and light-sensitive detector means, which means comprise four detectors which adjoin each other and which are each disposed in a quadrant of a system of orthogonal axes, which axes extend at angles of at least substantially 45° to the astigmatic focal lines of the astigmatic element, and

— means for deriving a control signal, which means have an input which is coupled to the detector means to receive the output signals from the four detectors and an output which is coupled to the objective system to supply the control signal. Such apparatus is disclosed in Netherlands Patent Application 77.03.076 (=FR—A—2385171). It is found that the focusing system in such an apparatus sometimes fails to operate correctly.

It has been recognized that one of the causes of this incorrect operation stems from the influence of the incorrect positioning on the four detectors of the light spot formed by the reflected light beam. FR—A—2,360,150 provides an apparatus having means for deriving a control signal which is less sensitive to spot-offset. To that purpose the said means further include means for deriving signals being proportional to S_1-S_4 and S_3-S_2 respectively, S_1 to S_4 being the output signals of the four detectors D_1 to D_4 respectively, the indices 1 to 4 being assigned to the four detectors in a clockwise sense.

It is the object of the invention to provide an apparatus which also generates a control signal being less sensitive to a spot-offset, by generating the control signal in an entirely different way than FR—A—2,360,150. According to the invention the apparatus is characterized in that the means for deriving a control signal are constructed to derive a control signal S_f which is proportional to

$$\frac{S_1-S_4}{S_1+S_4}+\frac{S_3-S_2}{S_3+S_2}$$

An embodiment of the invention may be characterized in that an output of the first detector is coupled to a first input of a first and a second signal-combination unit, an output of the fourth detector is coupled to a second input of the first and the second signal-combination unit, an output of the third detector is coupled to a first input of a third and a fourth signal-combination unit, an output of the second detector is coupled to a second input of the third and the fourth signal-combination unit, an output of the first and the second signal-combination unit is coupled to a first and a second input, respectively, of a first divider means, an output of the third and the fourth signal-combination unit is coupled to a first and a second input, respectively, of a second divider means, and an output of the first and the second divider means is coupled to a first and a second input respectively of a fifth signal-combination unit. The embodiment is characterized further in that the second inputs of the first and the third signal-combination unit are inverting inputs and the other inputs of all the signal-combination units are non-inverting inputs. In this way it is possible to derive the control signal.

According to the invention the apparatus may be characterized further in that the two pairs of detectors, *i.e.* the first and the fourth detector and the second and the third detector respectively, are so selected that the axis of the system of axes which extends between the pairs corresponds to the direction of the anticipated maximum offset of the reflected light beam which is incident on the detector means. Since the output signals of the detectors are combined in pairs, *i.e.* the output signals of the first and the fourth detector are combined and those of the second and the third detector are combined, a deviation of the light spot relative to the origin of the system of axes in a direction corresponding to one axis (namely the axis which extends between the pairs) has a smaller influence on the control signal than a deviation along the other axis. Preferably, the axis which extends between the pairs is made to coincide with said direction in which the maximum offset of the light spot is anticipated. In this way the influence of this offset on the control signal is minimized.

In an apparatus comprising positioning means for positioning the light beam on the record carrier which means comprise a first pivotal mirror for the radial tracking and a second pivotal mirror for the tangential tracking, the direction of the anticipated maximum offset of the reflected light beam which is incident on the detector means corresponds to the direction of the light-beam off-set caused by tilting of that mirror which is disposed farther from the objective system.

Such an apparatus comprising a mirror for radial tracking and a mirror for tangential tracking is described in Netherlands Patent Application 74.02.169 (=US—A—3978278), which has been laid open to public inspection. The mirror for the radial tracking is tilted to position the light spot on the track centre in a direction perpendicular to the track direction and the mirror for tangential tracking is tilted to position the light spot in the track direction.

In an apparatus which is commercially available from the applicant under the same of "Laser Vision Player" the mirror which is disposed farther from the objective system is the radial tracking mirror.

The invention will now be described in more

detail, by way of example, with reference to the accompanying drawings. In the drawings:

Fig. 1 shows a recording and/or read apparatus in accordance with the invention,

Figs. 2a, 2b, and 2c show how the shape of the spot formed on the detector means varies as a function of the focusing,

Fig. 3a shows the spot without an offset and Fig. 3b shows the spot with an offset,

Fig. 4 shows a first example, and

Fig. 5 shows a second example of the means for deriving a control signal.

Fig. 1 shows a round disc-shaped record carrier 1. The information structure is for example a phase structure and comprises a multitude of concentric or quasi-concentric tracks 7, which tracks comprise consecutive areas *g* and intermediate areas *t*. The areas *g* may be situated for example at a different depth in the record carrier than the intermediate areas *t*. The information may be, for example, a (colour) television programme, but alternatively it may be other information such as a large number of different images or digital information.

The record carrier is illuminated with a light beam 3 produced by a light source 4, for example a laser. An objective system, which for simplicity is represented as a single lens 5, focuses the light beam so as to form a light spot V on the surface of the tracks 2. The focal length of the auxiliary lens 6 has been selected in such a way that the pupil of the objective system is filled adequately. The light beam is reflected by the record carrier and during reading, when the record carrier rotates relative to the objective system, it is modulated in conformity with the information stored in a track portion to be read. In order to separate the non-reflected (the unmodulated) and the reflected (modulated) light beam a beam splitter 8, for example a semi-transparent mirror, is arranged in the light path. The beam splitter directs the reflected light beam to light-sensitive detector means 9. These detector means are connected to an electronic circuit 10 which generates a high-frequency information signal S_i and, as will be explained hereinafter, a focusing signal S_f of a lower frequency.

For the detection of focusing errors an astigmatic element is arranged in the radiation path behind the beam splitter 8. As is shown in Fig. 1, this element may be a cylindrical lens 11. The astigmatism can also be obtained in a different way, for example by means of a plane transparent plate arranged obliquely in the beam or by means of a lens which is tilted relative to the beam. Instead of one focus an astigmatic system has two astigmatic focal lines which occupy different axial positions and which extend perpendicularly to one another. Thus, the objective system and the cylindrical lens ensure that the light spot V has two associated focal lines 12 and 13. The light-sensitive detector 9 is now arranged in a plane which, viewed along the optical axis, extends between the lines 12 and 13, suitably at a location where the dimensions in two mutually perpendicular directions of the focal lines associated with the light spot V are equal with an optimum accuracy when the focusing is correct.

In order to determine the shape of the spot V' and consequently the degree of focusing, the detector means 9 comprise four detectors which are disposed in the four quadrants of an X—Y coordinate system. Figures 2a, 2b and 2c are views, taken on the line 2, 2' in Figure 1 of the four detectors D_1, D_2, D_3 and D_4 on which the different shapes of the spot V' are projected for different values of the distance between the objective system and the plane containing the tracks. The X-axis and the Y-axis extend at angles of 45° to the axis 15 of the cylindrical lens, *i.e.* to the astigmatic focal lines 12 and 13, the X-axis now extending parallel to the effective track direction.

Figure 2a shows the situation in which the distance between the objective system and the plane of the tracks is correct. If this distance is too large the focal lines 12 and 13 will be situated closer to the cylindrical lens 11. The detector means 9 are then disposed closer to the focal line 13 than to the focal line 12. The image spot V' then has a shape as shown in Figure 2b. If the distance between the objective system and the plane of the tracks is too small the focal lines 12 and 13 will be situated farther from the cylindrical lens and the focal line 12 is then situated closer to the detector means 9 than the focal line 13. The image spot V' then has a shape as shown in Figure 2c.

If the signals supplied by the detectors D_1, D_2, D_3 and D_4 are S_1, S_2, S_3 and S_4 respectively, the focussing-error signal S_f in apparatuses which are now commercially available from the applicant under the name of "Laser Vision Player" are given by:

$$S_f=\frac{(S_1+S_3)-(S_2+S_4)}{S_1+S_2+S_3+S_4} \qquad (1)$$

It will be evident that in the situation shown in Figure 2a

$$S_1+S_3=S_2+S_4$$

and hence $S_f=0$. For the situations shown in Figure 2b and in Figure 2c S_f is negative and positive respectively. By adding the signals S_1 and S_3 to each other and adding the signals S_2 and S_4 to each other and by subtracting the resulting sum signals from one another an unambiguous focusing-error signal is obtained. This signal can be processed electronically in a manner known *per se* to form a focussing-control signal by means of which the focusing of the objective system can be corrected, for example by moving the objective system relative to the plane of the tracks by means of a moving coil.

Figure 3a again shows the light spot V' on the four detectors in the case that the light spot V is focused exactly on the record carrier by the objective system. The detector signals S_1 to S_4 are now all equal to for example I_0. In the case of a

focusing error the deformation of the light spot in a diagonal sense gives rise to the following signals:

$$S_1=S_3=I_0+\delta I \qquad S_2=S_4=I_0-\delta I \tag{2}$$

so that the focusing-error signal in accordance with equation (1) becomes

$$S_f=\frac{\delta I}{I_0} \tag{3}$$

Now the situation shown in Figure 3b will be considered in which the light spot is in an asymmetrical position relative to the origin 0 of the system of axis owing to a displacement r_0 and t_0 along the X-axis and the Y-axis respectively. Such a displacement of the spot (or spot-offset) disturbs the relationship between the focusing-error signal S_f and the degree of focusing on the record carrier as will become apparent from the following. Although the light spot is circular, which means that the light beam is exactly "in focus", the focusing-error signal S_f will be found to differ from zero.

If the detector signals S_1 to S_4 are written as:

$$\begin{aligned} S_1&=I_0+E_{r_0}+E_{t_0}+E_{r_0,\,t_0}\\ S_2&=I_0+E_{r_0}-E_{t_0}-E_{r_0,\,t_0}\\ S_3&=I_0-E_{r_0}-E_{t_0}+E_{r_0,\,t_0}\\ S_4&=I_0-E_{r_0}+E_{t_0}-E_{r_0,\,t_0} \end{aligned} \tag{4}$$

where E_{r_0} is the contribution to a detector signal corresponding to the light intensity on the area indicated by the lines which extend from the bottom left to the top right, E_{t_0} is the contribution to a detector signal corresponding to the light intensity incident on the area indicated by the lines, which extend from the bottom right to the top left, and $E_{r_0,\,t_0}$ is the contribution to a detector signal corresponding to the light intensity incident on the area indicated by the cross-hatched rectangle, it is found by means of formula (1) that the focusing-error signal S_f is

$$S_f=\frac{E_{r_0,\,t_0}}{I_0} \tag{5}$$

By varying the position of the objective system relative to the record carrier the control system will now correct the focusing-error signal S_f until S_f is zero. However, as a result of this the objective system is now "out of focus".

In accordance with the invention the electronic circuit 10 comprises means for deriving a control signal, which means are constructed to derive a control signal (or focusing-error signal) S_f' which satisfies the formula

$$S_f'=\alpha\left(\frac{S_1-S_4}{S_1+S_4}+\frac{S_3-S_2}{S_3+S_2}\right) \tag{6}$$

from the output signals D_1 to D_m. In the case of a focusing error it follows from formula (2) that S_f' is

$$S_f'=\alpha\frac{2\delta I}{I_0}$$

so that for $\alpha=0.5$ the same sensitivity around the "in focus" condition is obtained as in the known apparatus, see formula (3). For the further calculations it has been assumed that $\alpha=0.5$.

In the case of an offset of the light spot as indicated in Fig. 3b, it follows from formula (4) that S_f' is:

$$S_f'=\frac{E_{r_0,\,t_0}-\dfrac{E_{r_0}\cdot E_{t_0}}{I_0}}{I_0[1-(E_{t_0}/I_0)^2]} \tag{8}$$

When it is assumed that the offset in the direction Y-axis is small then

$$(E_{t_0}/I_0)^2$$

remains negligible relative to 1, so that formula (8) may be simplified to

$$S_f'=\frac{E_{r_0,\,t_0}}{I_0}-\frac{E_{r_0}\cdot E_{t_0}}{I_0^2} \tag{9}$$

The value for S_f' in accordance with formula (9) is substantially smaller than the value for S_f in accordance with formula (5) as will be apparent from the following. If it is assumed that "infocus" the spot may be regarded as a circular spot having a radius r, within which the light intensity is constant and equal to i_0, this yields:

$$\begin{aligned} I_0&=\pi/4\; r^2 i_0\\ E_{r_0}&=r_0\cdot r\cdot i_0\\ E_{t_0}&=t_0\cdot r\cdot i_0\\ E_{r_0,\,t_0}&=t_0\cdot r_0\cdot i_0 \end{aligned} \tag{10}$$

so that inserting formulae (10) in formulae (5) and (9) yields:

$$S_f'=-\frac{1}{3.66}S_f$$

The offset error in the focusing-error detection signal S_f can thus be reduced by a factor 3.66 by the use of formula (6) instead of formula (1).

Preferably, the detector pairs, *i.e.* the pair of detectors D_1 and D_4 and pair of detectors D_2 and D_3, must be selected in such a way that the axis disposed between the pairs (*i.e.* the X-axis in Fig. 3) of the system of axes corresponds to the direction of anticipated maximum offset of the light spot over the detector means. This follows from the fact that for reducing formula (8) to formula (9) it has been assumed that the offset in the direction of Y-axis is small, which means that the offset in the direction of the X-axis may be larger.

In an apparatus in accordance with the invention comprising positioning means (not shown) for positioning the light beam on the record carrier, which means comprise a first pivotal mirror (not shown) for radial tracking and a second pivotal mirror (not shown) for tangential tracking, this direction of the anticipated maximum offset corresponds to the direction of the shift of the light beam caused by tilting the mirror which is disposed farther from the objective system. In the Laser Vision Players which are now commercially available from the applicant this is the radial tracking mirror.

Fig. 4 shows schematically an example of the means 20 for deriving a control signal S_f in conformity with formula (6). *Via* input 21 the output of the detector D_1 is coupled to the non-inverting inputs of a first and a second signal-combination unit 25 and 26 respectively. *Via* the input 22 the output of the detector D_4 is coupled to an inverting input of the signal-combination unit 25 and to a non-inverting input of the signal-combination unit 26. *Via* the input 24 the output of the detector D_3 is coupled to the non-inverting inputs of a third and a fourth signal combination unit 27 and 28 respectively. *Via* the input 23 the output of the detector D_2 is coupled to the inverting input of the signal-combination unit 27 and to the non-inverting input of the signal-combination unit 28. The outputs of the signal-combination units 25 and 26 are coupled to a first and a second input 30 and 31, respectively of a first divider means 32. The outputs of the signal-combination units 27 and 28 are coupled to a first and a second input 33 and 34, respectively of a second divider means 35. The outputs 36 and 37 of the divider means 32 and 35 respectively are each coupled to a non-inverting input of a fifth signal combination unit 38, whose output is coupled to the output 39 of the means 20 for supplying the control signal S_f in conformity with formula (6). The multiplication by the factor α may be effected for example in the signal-combination unit 38. In that case the signal combination units 26 and 28 merely have to perform an addition and the signal-combination units 25 and 27 a subtraction.

Fig. 5 shows another example of the means 20' for deriving the control signal S_f in conformity with formula (6) in more detail. The section bearing the reference numeral 41 corresponds to Fig. 7 of Netherlands Patent Application 82.00.208 (=GB—A—2113872) which has been laid open to public inspection, *i.e.* to the left-hand part bearing the reference numeral 30 in the latter Figure. In said Patent Application this section is used for producing the control signal S_f in conformity with formula (1) on the output 39. With the extension shown in Fig. 5 the section 41 can also be used for deriving the control signal S_f in conformity with formula (6).

The output signals S_1 to S_4 of the detectors D_1 and D_4, respectively are applied to the inputs 21 and 22, respectively. The currents i_{l1} and i_{r1} in the left-hand and the right-hand branch, respectively, of the differential amplifier 42 are then equal to

$$\frac{S_1}{S_1+S_4} I_c \text{ and } \frac{S_4}{S_1+S_4} I_c$$

respectively. The output signals S_2 and S_3 of the detectors D_2 and D_3, respectively are applied to the inputs 23 and 24, respectively. The currents i_{l2} and i_{r2} in the left-hand and the right-hand branch, respectively of the differential amplifier 43 are then equal to

$$\frac{S_3}{S_2+S_3} I_c \text{ and } \frac{S_2}{S_2+S_3} I_c$$

respectively. Owing to the presence of the current-mirror circuit 44 this yields a signal which is equal to

$$\left(\frac{S_1-S_4}{S_1+S_4} + \frac{S_3-S_2}{S_2+S_3}\right) I_c$$

on the output 39. If the currents from the current sources I_c are both equal to α the control signal S_f on output 39 will be exactly in conformity with formula (6).

Although the invention has been described for an apparatus for reading information it is obvious that the invention may also be applied to apparatuses for recording information, because the description relates to the reflecting function of the record carrier both during recording and during reading.

Claims

1. An apparatus for recording and/or reading information in/from a track of a radiation-reflecting record carrier by means of a light beam which is incident on the record carrier, which apparatus comprises:

— a light source for producing a light beam,

— an objective system for focusing the light beam to form a light spot on the record carrier depending on a control signal and for directing the reflected light beam towards

— a focusing-error detection system which

The offset error in the focusing-error detection signal S_f can thus be reduced by a factor 3.66 by the use of formula (6) instead of formula (1).

Preferably, the detector pairs, *i.e.* the pair of detectors D_1 and D_4 and pair of detectors D_2 and D_3, must be selected in such a way that the axis disposed between the pairs (*i.e.* the X-axis in Fig. 3) of the system of axes corresponds to the direction of anticipated maximum offset of the light spot over the detector means. This follows from the fact that for reducing formula (8) to formula (9) it has been assumed that the offset in the direction of Y-axis is small, which means that the offset in the direction of the X-axis may be larger.

In an apparatus in accordance with the invention comprising positioning means (not shown) for positioning the light beam on the record carrier, which means comprise a first pivotal mirror (not shown) for radial tracking and a second pivotal mirror (not shown) for tangential tracking, this direction of the anticipated maximum offset corresponds to the direction of the shift of the light beam caused by tilting the mirror which is disposed farther from the objective system. In the Laser Vision Players which are now commercially available from the applicant this is the radial tracking mirror.

Fig. 4 shows schematically an example of the means 20 for deriving a control signal S_f in conformity with formula (6). *Via* input 21 the output of the detector D_1 is coupled to the non-inverting inputs of a first and a second signal-combination unit 25 and 26 respectively. *Via* the input 22 the output of the detector D_4 is coupled to an inverting input of the signal-combination unit 25 and to a non-inverting input of the signal-combination unit 26. *Via* the input 24 the output of the detector D_3 is coupled to the non-inverting inputs of a third and a fourth signal combination unit 27 and 28 respectively. *Via* the input 23 the output of the detector D_2 is coupled to the inverting input of the signal-combination unit 27 and to the non-inverting input of the signal-combination unit 28. The outputs of the signal-combination units 25 and 26 are coupled to a first and a second input 30 and 31, respectively of a first divider means 32. The outputs of the signal-combination units 27 and 28 are coupled to a first and a second input 33 and 34, respectively of a second divider means 35. The outputs 36 and 37 of the divider means 32 and 35 respectively are each coupled to a non-inverting input of a fifth signal combination unit 38, whose output is coupled to the output 39 of the means 20 for supplying the control signal S_f in conformity with formula (6). The multiplication by the factor α may be effected for example in the signal-combination unit 38. In that case the signal combination units 26 and 28 merely have to perform an addition and the signal-combination units 25 and 27 a subtraction.

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The output signals S_1 to S_4 of the detectors D_1 and D_4, respectively are applied to the inputs 21 and 22, respectively. The currents i_{l1} and i_{r1} in the left-hand and the right-hand branch, respectively, of the differential amplifier 42 are then equal to

$$\frac{S_1}{S_1+S_4} I_c \text{ and } \frac{S_4}{S_1+S_4} I_c$$

respectively. The output signals S_2 and S_3 of the detectors D_2 and D_3, respectively are applied to the inputs 23 and 24, respectively. The currents i_{l2} and i_{r2} in the left-hand and the right-hand branch, respectively of the differential amplifier 43 are then equal to

$$\frac{S_3}{S_2+S_3} I_c \text{ and } \frac{S_2}{S_2+S_3} I_c$$

respectively. Owing to the presence of the current-mirror circuit 44 this yields a signal which is equal to

$$\left(\frac{S_1-S_4}{S_1+S_4}+\frac{S_3-S_2}{S_2+S_3}\right) I_c$$

on the output 39. If the currents from the current sources I_c are both equal to α the control signal S_f on output 39 will be exactly in conformity with formula (6).

Although the invention has been described for an apparatus for reading information it is obvious that the invention may also be applied to apparatuses for recording information, because the description relates to the reflecting function of the record carrier both during recording and during reading.

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— an objective system for focusing the light beam to form a light spot on the record carrier depending on a control signal and for directing the reflected light beam towards

— a focusing-error detection system which

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co[illegible]n astigmatic element and light-sensitive [illegible] means, which means comprise four detectors which adjoin each other and which are each disposed in a quadrant of a system of orthogonal axes, which axes extend at angles of at least substantially 45° to the astigmatic focal lines of the astigmatic element, and

— means for deriving a control signal, which means have an input which is coupled to the detector means to receive the output signals from the four detectors and an output coupled to the objective system to supply a control signal, wherein, when an index m (m being an integer from 1 to 4) being assigned to the four detectors D_m in a clockwise sense, the means for deriving the control signal include means for deriving signals being proportional to S_1-S_4 and S_3-S_2 respectively, S_1 to S_4 being the output signals of the four detectors D_1 to D_4 respectively, characterized in that the means for deriving a control signal are constructed to derive a control signal S_f which is proportional to

$$\frac{S_1-S_4}{S_1+S_4}+\frac{S_3-S_2}{S_3+S_2}$$

2. An apparatus as claimed in Claim 1, characterized in that an output of the first detector (D_1) is coupled to a first input (21) of a first and a second signal-combination unit (25, 26), an output of the fourth detector (D4) is coupled to a second input (22) of the first and the second signal-combination unit (25, 26), an output of the third detector (D3) is coupled to a first input (24) of a third and a fourth signal-combination unit (27, 28), an output of the second detector (D2) is coupled to a second input (23) of the third and the fourth signal-combination unit (27, 28), an output of the first and the second signal-combination unit is coupled to a first and a second input (30, 31), respectively, of a first divider means (32), an output of the third and the fourth signal-combination unit is coupled to a first and a second input (33, 34), respectively of a second divider means (35), and an output of the first and the second divider means is coupled to a first and a second input, respectively of a fifth signal-combination unit (38).

3. An apparatus as claimed in Claim 2, characterized in that the second inputs of the first and the third signal combination unit are inverting inputs and the other inputs of all the signal-combination units are non-inverting inputs.

4. An apparatus as claimed in any one of the preceding Claims, characterized in that the two pairs of detectors, *i.e.* the first and the fourth detector and the second and the third detector respectively, are so selected that that axis of the system of axes which extends between the pairs correspond to the direction of the anticipated maximum offset of the reflected light beam which is incident on the detector means.

5. An apparatus as claimed in Claim 4, comprising positioning means for positioning the light beam on the record carrier, which means comprise a first pivotal mirror for the radial tracking and a second pivotal mirror for tangential tracking, characterized in that the direction of the anticipated maximum offset of the reflected light beam which is incident on the detector means corresponds to the direction of the light-beam offset caused by tilting of that mirror which is disposed farther from the objective system.

Patentansprüche

1. Gerät zum Aufzeichnen und/oder Wiedergeben von Informationen in/von eine Spur eines Strahlung reflektierenden Informationsträgers mittels eines auf dem Informationsträger auftreffenden Lichtstrahls, und dieses Gerät enthält

— eine Lichtquelle zum Erzeugen eines Lichtstrahls,

— ein Objektivsystem zum Fokussieren des Lichtstrahls zur Bildung eines Lichtflecks auf dem Informationsträger abhängig von einem Steuersignal und zum Richten des reflektierten Lichtstrahls auf

— ein Fokusfehlerdetektorsystem mit einem astigmatischen Element und lichtempfindlichen Detektormitteln, die vier Detektoren enthalten, die nebeneinander angeordnet sind und in einem Quadrant eines Systems orthogonaler Achsen aufgestellt sind, die sich unter Winkeln von wenigstens hauptsächlich 45° gegen die astigmatischen Brennlinien des astigmatischen Elements erstrecken, und

— Mittel zum Ableiten eines Steuersignals, die einen Eingang, der mit den Detektormitteln für den Empfang der Ausgangssignale der vier Detektoren verbunden ist, und einen Ausgang hat, der für die Lieferung des Steuersignals mit dem Objektivsystem verbunden ist, wobei, wenn den vier Detektoren D_m im Uhrzeigersinn ein Index m (wobei m eine ganze Zahl von 1 bis 4 ist) zugeordnet wird, die Mittel zum Ableiten des Steuersignals Mittel zum Ableiten von Signalen proportional S_1-S_4 bzw. S_3-S_2 enthalten, wobei S_1 bis S_4 die Ausgangssignale der betreffenden vier Detektoren D_1 bis D_4 sind, dadurch gekennzeichnet, daß die Mittel zum Ableiten eines Steuersignals zum Ableiten eines Steuersignals S_f aufgebaut sind, das proportional

$$\frac{S_1-S_4}{S_1+S_4}+\frac{S_3-S_2}{S_3+S_2}\ \text{ist.}$$

2. Gerät nach Anspruch 1, dadurch gekennzeichnet, daß ein Ausgang des ersten Detektors (D_1) mit einem ersten Eingang (21) einer ersten und einer zweiten Signalverknüpfungseinheit (25, 26), ein Ausgang des vierten Detektors (D_4) mit einem zweiten Eingang (22) der ersten und der zweiten Signalverknüpfungseinheit (25, 26), ein Ausgang des dritten Detektors (D_3) mit einem ersten Eingang (24) einer dritten und einer vierten Signalverknüpfungseinheit (27, 28), ein Ausgang des zweiten Detektors (D_2) mit einem zweiten

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ngang (23) der dritten und vierten Signalverpfungseinheit (27, 28), ein Ausgang der ersten und zweiten Signalverknüpfungseinheit mit einem ersten bzw. einem zweiten Eingang (30, 31) eines ersten Teilers (32), ein Ausgang der dritten und vierten Signalverknüpfungseinheit mit einem ersten bzw. einem zweiten Eingang (33, 34) eines zweiten Teilers (35) und ein Ausgang des ersten und des zweiten Teilers mit einem ersten bzw. einem zweiten Eingang einer fünften Signalverknüpfungseinheit (38) verbunden sind.

3. Gerät nach Anspruch 2, dadurch gekennzeichnet, daß die zweiten Eingänge der ersten und dritten Signalverknüpfungseinheiten invertierende Eingänge und die anderen Eingänge aller Signalverknüpfungseinheiten nicht invertierende Eingänge sind.

4. Gerät nach einem oder mehreren der vorangehenden Ansprüche, dadurch gekennzeichnet, daß die zwei Detektorpaare, d.h. die ersten und vierten Detektoren bzw. die zweiten und dritten Detektoren, werden so gewählt, daß die Achse des Achsensystems, die sich zwischen den Paaren erstreckt, der Richtung der erwarteten maximalen Versetzung des reflektierten Lichtstrahls entspricht, der auf den Detektormitteln auftrifft.

5. Gerät nach Anspruch 4, mit Positionierungsmitteln zum Positionieren des Lichtstrahls auf dem Informationsträger, wobei die Mittel einen ersten drehbaren Spiegel für die radiale Spurnachführung und einen zweiten drehbaren Spiegel für die tangentiale Spurnachführung enthalten, dadurch gekennzeichnet, daß die Richtung der erwarteten maximalen Versetzung des auf den Detektormitteln auftreffenden reflektierten Lichtstrahls der Richtung der Lichtstrahlversetzung entspricht, die durch Kippen jenes Spiegels verursacht wird, der weiter vom Objektivsystem entfernt ist.

Revendications

1. Appareil d'enregistrement et/ou de lecture d'information dans une piste d'un support d'enregistrement à réflexion de rayonnement au moins d'un faisceau lumineux incident au support d'enregistrement, appareil comportant:

— une source lumineuse pour fournir un faisceau lumineux,

— un système d'objectifs pour focaliser le faisceau lumineux de façon à former un spot lumineux sur le support d'information en fonction d'un signal de réglage et pour diriger le faisceau lumineux réfléchi vers

— un système de détection d'erreurs de focalisation comportant un élément astigmate et des moyens détecteurs photoélectriques comportant quatre détecteurs situés les uns à côté des autres et disposés chacun dans un cadran d'un système d'axes octagonaux, axes qui font des angles d'au moins pratiquement 45% avec les lignes focales astigmates de l'élément astigmate, et

— des moyens pour déduire un signal de réglage, munis d'une entrée couplée aux moyens détecteurs pour recevoir les signaux de sortie des quatre détecteurs, et d'une sortie couplée au système d'objectifs pour fournir le signal de réglage, appareil dans lequel, un indice m (m étant un entier compris entre 1 à 4) étant attribué aux quatre détecteurs D_m dans le sens des aiguilles d'une montre, les moyens pour déduire le signal de réglage comportent des moyens pour déduire des signaux étant respectivement proportionnels à S_1-S_4 et à S_3-S_2, S_1 à S_4 étant respectivement les signaux de sortie des quatre détecteurs D_1 à D_4, caractérisé en ce que les moyens pour déduire un signal de réglage sont conçus pour déduire un signal de réglage S_f proportionnel à S_f proportionnel à

$$\frac{S_1-S_4}{S_1+S_4}+\frac{S_3-S_2}{S_2+S_3}$$

2. Appareil selon la revendication 1, caractérisé en ce qu'une sortie du premier détecteur (D_1) est couplée à une première entrée d'une première et d'une deuxième unité de combinaison de signaux, une sortie du quatrième détecteur est couplée à une seconde entrée de la première et de la deuxième unité de combinaison de signaux, une sortie du troisième détecteur est couplée à une première entrée d'une troisième et d'une quatrième unité de combinaison de signaux, une sortie du deuxième détecteur est couplée à une seconde entrée de la troisième et de la quatrième unité de combinaison de signaux, une sortie de la première et de la deuxième unité de combinaison de signaux est couplée respectivement à une première et à une seconde entrée de premiers moyens diviseurs, une sortie de la troisième et de la quatrième unité de combinaison de signaux est couplée respectivement à une première et à une seconde entrée de second moyens diviseurs et une sortie des premiers et des seconds moyens diviseurs est couplée respectivement à une première et à une seconde entrée d'une cinquième unité de combinaison de signaux.

3. Appareil selon la revendication 2, caractérisé en ce que les seconds entrées de la première et de la troisième unité de combinaison de signaux sont des entrées inverseuses et les autres entrées de toutes les unités de combinaison de signaux sont des entrées non inverseuses.

4. Appareil selon l'une quelconque des revendications précédentes, caractérisé en ce que les deux paires de détecteurs, c'est-à-dire les premier et quatrième détecteurs d'une part et les deuxième et troisième détecteurs d'autre part sont choisies de façon que l'axe du système d'axe s'étendant entre les paires correspond à la direction du décalage maximal prévu du faisceau lumineux réfléchi incident au$_x$ moyens détecteurs.

5. Appareil selon la revendication 4, comportant des moyens de positionnement du faisceau lumineux sur le support d'enregistrement et comportant un premier miroir basculant pour la poursuite radiale et un second miroir basculant pour la poursuite tangentielle, caractérisé en ce que la direction du décalage maximal prévisible du fais-

* C L M S *

ceau lineux réfléchi incident aux moyens détecteu correspond à la direction du décalage du faisceau lumineux causé par le basculement du miroir le plus éloigné du système d'objectifs.