Description

The invention relates to an opto-electronic focussing-error detection system for detecting, in an optical imaging system, a deviation between a radiation-reflecting surface and a focussing plane in which a radiation spot is focussed by an objective system, in particular for an apparatus for reading a record carrier having an optical radiation-reflecting information structure or an apparatus for optically recording information in a record carrier, which focussing-error detection system comprises a beam-splitting element, arranged in the part of a radiation beam produced by a radiation source, which beam has been reflected by the reflecting surface, and separated by a beam-dividing element from the radiation directed towards the reflecting surface, and a radiation-sensitive detection system, arranged behind the beam-splitting element and comprising a plurality of detectors arranged in two groups of which a first group is associated with a first sub-beam and a second group with a second sub-beam, said sub-beams being formed by the beam-splitting element, the outputs of the detectors being connected to the inputs of an electronic circuit which derives a focussing-error signal from the detector signals of all of the detectors of said first and second group.

Such a system is known, *inter alia* from Netherlands Patent Application No. 81 04588 which has been laid open to public inspection. The system described therein comprises a radiation source in the form of a semiconductor diode laser. An objective system focusses the read beam emitted by this laser onto an information structure on a disc-shaped record carrier. The read beam which has been reflected by the information structure traverses the objective system a second time and subsequently passes through a beam-dividing prism arranged between the radiation source and the objective system. This prism divides the modulated read beam from the radiation path of the beam which has been emitted by the source, so that the modulated beam can be received by a radiation-sensitive detection system which supplies an electric signal in conformity with the modulation of the latter beam.

In optical systems which are used for imaging very minute information details and which have a large numerical aperture the depth of focus is small. For imaging systems of this type, which are employed, for example, in microscopes, or in apparatus for reading an optical record carrier with very small details, or in apparatus for recording information in a record carrier, it is essential that a deviation between the actual and the desired plane of focussing can be detected to enable the focussing to be corrected accordingly. For this purpose, as described in the afore-mentioned Netherlands Patent Application No. 81 04588, a roof prism may be arranged on the exit surface of the beam dividing prism. This roof prism splits the beam into two sub-beams which are incident on two separate detectors of the radiation-sensitive detection system. This system comprises, for example, four radiation-sensitive detectors arranged along a line transverse to the refractive edge of the roof prism. Subtracting the sum of the signals from the two inner detectors from the sum of the signals from the two outer detectors yields a signal which is proportional to the focussing error.

In practice it may be desirable to separate the beam-splitting element from the beam-dividing element, for example if for reasons of cost an element other than the prism is to be used for beam-dividing. This other element may be, for example, a semitransparent mirror. The beam-splitting element, which should be arranged in the radiation path between the beam-dividing element and the detection system, may comprise wedge-shaped element having the same shape as the roof prism. This wedge-shaped element may be made of a cheap plastics and can be manufactured cheaply using the customary moulding techniques. However, such an element is sensitive to environmental influences such as temperature. A temperature variation causes the refractive index and the shape of this element to change so that the sub-beams and hence the radiation spots formed by these sub-beams in the plane of the radiation-sensitive detection systems are shifted relative to the associated detectors. In the case of the beam-splitting element and detector arrangement described in Netherlands Patent Application No. 81 04588 this shift would be in the same direction as the shift caused by focussing errors. The shift of the radiation spots caused by the temperature variation is then interpreted as a focussing error, the focussing servo-system responding to it and producing incorrect focussing.

The present invention aims at providing a focussing-error detection system comprising a beam-splitting element which substantially eleminates environmental influences on the focussing-error signal. According to the invention the system is characterized in that the beam-splitting element is a compound wedge comprising two wedge sections having a common surface and each having a upper surface situated opposite said base surface, which upper surfaces are inclined relative to each other in the plane of the interface between the two wedge sections, the plane of said interface extending substantially perpendicularly to the base surface and to the upper surfaces and containing the optical axis of the imaging system, and in that the two groups of detectors are situated on opposite sides of a plane containing the optical axis and extending substantially perpendicularly to the plane of the interface and perpendicularly to the base surface.

In this focussing-error detection system a variation of, for example, the ambient temperature gives rise to a shift of a radiation spot in the longitudinal direction of a strip separating the detectors in one group. This shift hardly affects the difference between the output signals of the detectors of a group and consequently does not give rise to an erroneous focussing-error signal.

The invention may also be employed in a focussing-error detection system in which the beam-splitting element in the form of a roof prism is arranged on the beam-dividing element in the form of, for example, a prism. The optical behaviour of such a roof prism will also depend on, for example, the ambient temperature, if this prism, is not as in the system in accordance with Netherlands Patent Application No. 81 04588 (PHN 10.173) made of a thin layer of a polymerisable plastics in which changes in the refractive index and shape as a result of temperature changes substantially compensate for each other.

As already stated, if the beam-splitting element and the beam-dividing element are separated from each other, the latter may be an element other than a prism. For reasons of cost it is preferred to use a semitransparent mirror as beam-dividing element. For a convergent beam which traverses this mirror the mirror constitutes a plane-parallel plate which may give rise to astigmatism because of its oblique position in the beam. In order to mitigate this problem a preferred embodiment of the invention is characterized further in that the compound wedge is arranged on a surface of a cylindrical lens. This cylindrical lens can correct the astigmatism introduced by the plane-parallel plate.

Preferably, the compound wedge and the cylindrical lens are made of the same material and constitute one integrated optical element. This element can be manufactured cheaply using the customary moulding techniques.

Preferably, the strip separating the detectors of the first group extends at a first small angle and the strip separating the detectors of the second group extends at a second small angle, which is oriented oppositely to the first angle, relative to a line obtained by projecting the interface of the compound wedge onto the plane of the detection system. Thus, by moving the radiation-sensitive detection system relative to the sub-beams in two mutually perpendicular directions, the centres of the radiation spots can always be positioned symmetrically relative to the associated detectors in the case of correct focussing.

Embodiments of the invention, used in an apparatus for reading an optical record carrier, will now be described in more detail, by way of example with reference to the accompanying drawings. In the drawings:

Fig. 1 shows schematically a read apparatus equipped with a focussing-error detection system in accordance with the invention,

Fig. 2 is a perspective view of an example of the beam-splitting element used in said apparatus,

Fig. 3 is a plan view of the radiation-sensitive detection system employed in the apparatus,

Fig. 4 is a plan view of the beam-splitting element, showing the arrangement of the detectors relative to the interface of the wedge, and

Fig. 5 shows a circuit arrangement for processing the detector signals into a focussing-error signal.

Fig. 1 shows a small part of a disc-shaped record carrier 1 in radial cross-section. The radiation-reflecting information structure is situated on the upper side of the record carrier and comprises a multitude of information areas, not shown, arranged along information tracks 2. The information structure is scanned by a read beam b produced by a radiation source 3, for example, a semiconductor-diode laser. A collimator lens 4 converts the diverging beam into a parallel beam of such a cross-section that the pupil of an objective system 5 is filled correctly. This objective system forms a radiation spot V of minimal dimensions on the information structure.

The read beam is reflected by the information structure and, as the record carrier moves relative to the read beam, the reflected beam is time-modulated in conformity with the information in the record carrier. In order to separate the modulated beam from the beam emitted by the radiation source a beam-dividing element, for example a semi-transparent mirror 6, is arranged in the radiation path from the radiation source to the collimator lens 4. This mirror reflects a part of the radiation emitted by the source 3 to the record carrier and transmits a part of the radiation reflected by the record carrier to a radiation-sensitive detection system 7 which converts the modulated read beam into an electric signal. Preferably, this mirror has a reflection coefficient of the order of 0.3 so that, if losses in the radiation path are ignored about 21% of the radiation emitted by the source is incident on the detection system and only 9% returns to the radiation source.

In order to generate a focussing-error signal which provides an indication of the magnitude and the direction of a deviation between the plane of focussing of the objective system and the plane of the information structure, a compound wedge 8 is arranged in the radiation path, an example of such a wedge being shown in perspective and on an enlarged scale in Fig. 2. This wedge comprises two wedge-sections 9 and 10 whose upper surfaces 12 and 13 are inclined oppositely relative to the common base surface 14. Alternatively, one of the upper surfaces may extend parallel to the base surface 14 whilst the other upper surface is inclined relative to the base surface. The plane 11 is the interface of the two wedge sections. The optical axis of the imaging system, represented by the dash-dot line *a* in Fig. 1, is situated in the plane of this interface.

The compound wedge splits the beam *b* returning from the record into two sub-beams b_1 and b_2 which are deviated in opposite directions as a result of the opposite inclinations of the two wedge sections. The sub-beam b_2 is focussed in point F_2 which is situated, for example, before the plane of drawing in Fig. 1, whilst the sub-beam b_1 is focussed in point F_1 which is situated behind the plane of drawing. F is the point in which the beam *b* would be focussed in the absence of the compound wedge. For the sake of clarity the detection system 7 is shown slightly below points F_1 and F_2. In reality, this system is situated in the

plane containing points F_1 and F_2 and extending transversely of the optical axis.

The detection system 7 comprises four detectors arranged in two groups of two, one group being situated, for example, before the plane of drawing in Fig. 1 and the second group behind this plane. Fig. 3 is a plan view of the detection system comprising the detectors 15, 16, 17 and 18 in the situation in which the beam b is focussed correctly on the plane of the information structure. The radiation spots V_1 and V_2 formed by the sub-beams b_1 and b_2 respectively are then situated symmetrically relative to the associated detectors 15, 16 and 17, 18, respectively. In the presence of a focussing error each of the radiation spots will be enlarged asymmetrically so that the centre of its radiation distribution is shifted relative to the associated detectors. The centres of the radiation spots of the two groups also move in opposite directions.

When the beam b is focussed at a point situated above the plane of the information structure the radiation spot V_1 is shifted toward the detector 15 and the radiation spot b_2 towards the detector 17, as indicated by the broken lines V_1' and V_2' in Fig. 3. The detectors 15 and 17 then receive more radiation than the detectors 16 and 18. If the beam b is focussed in a point situated below the plane of the information structure, the situation is reversed and the detectors 16 and 18 receive more radiation than the detectors 15 and 17.

If the output signals of the detectors 15, 16, 17 and 18 are represented by S_1, S_2, S_3 and S_4, respectively the focussing error signal is given by:

$$S_f=(S_1+S_3)-(S_2+S_4).$$

By adding the output signals of the four detectors to each other these detectors will function as a single detector by means of which the information signal can be obtained. This information signal is given by:

$$S_i=S_1+S_2+S_3+S_4.$$

If the detectors are not positioned correctly the above focussing error signal S_f may be influenced by contamination of the optical elements in the course of time or by defects in the plane of the information structure, referred to as "drop-outs". Moreover, the focussing-error signal may be influenced by tracking errors. Therefore, preferably a normalised focussing-error signal is generated which is not affected by the said events. This focussing-error signal is given by:

$$S_f'=\frac{S_1-S_2}{S_1+S_2}+\frac{S_3-S_4}{S_3+S_4}$$

This signal is independent of the total radiation intensity in the plane of the radiation-sensitive detection system and is only a function of the radiation distribution among the individual detectors. The signal S_f' can be derived from the detection signals by means of known electronic circuits. Fig. 5 shows schematically an example of a signal-processing arrangement. The circuit arrangement comprises two subtractor circuits 30 and 31, four adder circuits 32, 33, 34 and 35, and two divider circuits 36 and 37 and requires no further explanation.

Preferably, a cylindrical lens is arranged in the radiation path behind the semitransparent mirror 6. The semitransparent mirror takes the form of a plane-parallel plate which is traversed by the convergent-beam and which may render it astigmatic because this plate is arranged obliquely in the convergent beam. A cylindrical lens is also an astigmatic element. By a suitable choice of the relevant parameters of this lens, such as the radius of curvature of the curved lens surface, such a lens is capable of eliminating the astigmatism introduced by the mirror. In Figs. 1 and 2 the cylindrical lens bears the reference numeral 21. This lens may have a plane surface 22 and a curved surface 23. Alternatively, the lens 21 may have two curved surfaces, chosen to provide cylindrical-lens action. The axis of the cylindrical lens extends transversely to the local optical axis *a* and, in the present example in which the cylindrical lens is a negative lens, it extends parallel to the plane of drawing in Fig. 1, thus coinciding with the x-axis in Figs. 1 and 2. If a positive cylindrical lens were used, the axis of this lens would coincide with the y-axis.

The cylindrical lens and the compound wedge may be separate elements and may be made of different materials. However, preferably these elements are made of the same material and are combined to form one integrated optical element. In that case the compound wedge need not be arranged on a separate support and, which is more important, the two elements can be manufactured together so that automatically their alignment relative to each other is correct. The integrated element may be made of a transparent plastics, such as polymethyl-methacrylate (PMMA) or polycarbonate (PC) and can be manufactured cheaply using known moulding techniques and dies.

The optical behaviour of elements made of such plastics is temperature-dependent, but because in the present arrangement the change in refractive index of the material as a result of a temperature variation gives rise to a displacement of the radiation spots V_1 and V_2 in the longitudinal direction of the separating strips 19 and 20, *i.e.* in the y-direction in Fig. 2, these changes will not affect the focussing-error signal.

Instead of the rectangular shape shown in Fig. 2 the integrated element (*8*, 21) may have a circular shape. In plan view this element is then as shown in the upper part of Fig. 4. In this Figure CA is the cylinder axis and WA the wedge axis, *i.e.* the line of intersection of the interface 11 of the wedge with the upper surface 22 of the cylindrical lens. The lower part of Fig. 4 shows how the detectors are preferably oriented relative to the wedge axis.

WA' is the projection of the wedge axis in the plane of the detectors. The longitudinal directions of the separating strips 19 and 20 make small angles β_1 and β_2, respectively, of the order of 10° with the line WA'. If the connecting line between the radiation spots V_1 and V_2 is offset relative to the separating strips 19 and 20, it is not possible to position the radiation spots for correct focussing symmetrically relative to the detectors 15, 16 and 17, 18 respectively during assembly of the focussing-error detection system by shifting the radiation spots and the substrate carrying the detectors relative to each other in two mutually perpendicular directions.

For the actual focussing-error detection the orientation of the wedge interface 11 is irrelevant. It is important only that the plane of this interface contained the optical axis *a*. When the focussing-error detection system is employed in an apparatus for reading an optical record carrier, this interface preferably extends effectively parallel to the track directions, *i.e.* this interface should extend perpendicularly to the plane of drawing in or parallel to the y-direction in Fig. 2. The detectors 15, 16, 17 and 18 may then be used for generating a tracking signal which provides an indication of the degree of coincidence of the centre of the read spot V with the track centre. This tracking signal S_r is given by

$$S_r=(S_1+S_4)-(S_2+S_3).$$

The invention has been described for a system used in an optical read unit, but the invention may also be used in a write unit or in a combined read/write unit. The write unit is of a construction similar to the construction of the read unit described herein. For recording information, for example by melting pits into a metal layer, more power is required than for reading and, moreover, the write beam should be time-modulated in conformity with the information to be recorded. The radiation source in the write unit may be a gas laser, such as a HeNe laser, and a modulator such as an electro-optical or an acousto-optical modulator should be arranged in the path of the write beam. Alternatively, a diode laser may be used, in which case the write beam is modulated by varying the electric current in the diode laser, so that no separate modulator is needed.

The focussing-error detection system described does not utilize any special properties of the optical information structure or surface on which the beam must be focussed. It is merely necessary that this surface is radiation-reflecting. Therefore, the focussing-error detection system may be used in various apparatus in which very accurate focussing is required, for example in microscopes.

Claims

1. An opto-electronic focussing-error detection system for detecting, in an optical imaging system, a deviation between a radiation-reflecting surface (2) and a focussing plane in which a radiation spot is focussed by an objective system (5), in particular for an apparatus for reading a record carrier (1) having an optical radiation-reflecting information structure (2) or an apparatus for optically recording information in a record carrier, which focussing-error detection system comprises a beam-splitting element (8) arranged in the path of a radiation beam (b) produced by a radiation source (3), which beam (b) has been reflected by the reflecting surface (2), and separated by a beam-dividing element (6) from the radiation directed towards the reflecting surface (2), and a radiation-sensitive detection system (7), arranged behind the beam-splitting element (8) and comprising a plurality of detectors (15, 16, 17, 18) arranged in two groups, of which a first group is associated with a first sub-beam (b_1) and a second group with a second sub-beam (b_2), said sub-beams being formed by the beam-splitting element (8), the outputs of said detectors (15, 16, 17, 18) being connected to the inputs of an electronic circuit which derives a focussing-error signal from the detector signals of all of the detectors (15, 16, 17, 18) of said first and second group, characterized in that the beam-splitting element (8) is a compound wedge comprising two wedge sections (9, 10) having a common base surface (14) and each having an upper surface (12, 13) situated opposite said base surface (14) which upper surfaces (12, 13) are inclined relative to each other in the plane (11) of the interface between the two wedge sections (9, 10) the plane (11) of said interface extending substantially perpendicularly to the base surface (14) and to the upper surfaces (12, 13) and containing the optical axis (a) of the imaging system, and in that the two groups of detectors (15, 16, 17, 18) are situated on opposite sides of a plane containing the optical axis (a) and extending substantially perpendicularly to the plane (11) of the interface and perpendicularly to the base surface (14).

2. An opto-electronic focussing-error detection system as claimed in Claim 1, characterized in that the beam-dividing element (6) is a semi transparent mirror, and in that the compound wedge (8) is arranged on a surface (14) of a cylindrical lens (23).

3. An opto-electronic focussing-error detection system as claimed in Claim 2, characterized in that the compound wedge (8) and the cylindrical lens (23) are made of the same material and constitute one integrated optical element.

4. An opto-electronic focussing-error detection system as claimed in Claim 1, 2 or 3, characterized in that a strip (19) separating the detectors (15, 16) of the first group extends at a first small angle (β_1) and a strip (20) separating the detectors (17, 18) of the second group extends at a second small angle (β_2), which is oriented oppositely to the first angle (β_1), relative to the line obtained by projecting the plane (11) of the interface of the compound wedge (8) onto the plane of the detection system.

5. An apparatus for reading and/or recording information in a trackwise arranged optical infor-

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For the actual focussing-error detection the orientation of the wedge interface 11 is irrelevant. It is important only that the plane of this interface contained the optical axis *a*. When the focussing-error detection system is employed in an apparatus for reading an optical record carrier, this interface preferably extends effectively parallel to the track directions, *i.e.* this interface should extend perpendicularly to the plane of drawing in Fig. 2 or parallel to the y-direction in Fig. 2. The detectors 15, 16, 17 and 18 may then be used for generating a tracking signal which provides an indication of the degree of coincidence of the centre of the read spot V with the track centre. This tracking signal S_r is given by

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The focussing-error detection system described does not utilize any special properties of the optical information structure or surface on which the beam must be focussed. It is merely necessary that this surface is radiation-reflecting. Therefore, the focussing-error detection system may be used in various apparatus in which very accurate focussing is required, for example in microscopes.

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2. An opto-electronic focussing-error detection system as claimed in Claim 1, characterized in that the beam-dividing element (6) is a semi transparent mirror, and in that the compound wedge (8) is arranged on a surface (14) of a cylindrical lens (23).

3. An opto-electronic focussing-error detection system as claimed in Claim 2, characterized in that the compound wedge (8) and the cylindrical lens (23) are made of the same material and constitute one integrated optical element.

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5. An apparatus for reading and/or recording information in a trackwise arranged optical infor-

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mation structure (2) of a record carrier (1), which apparatus has been equipped with an opto-electronic focussing error detection system as claimed in Claim 1, 2, 3 or 4, characterized in that the plane (11) of the interface of the compound wedge (8) extends parallel to the track direction.

Patentansprüche

1. Optoelektronisches Fokussierfehlerdetektionssystem zum Detektieren einer Abweichung zwischen einer Strahlung reflektierenden Oberfläche (2) und einer Fokussierebene in einem optischen Abbildungssystem, wobei ein Objektivsystem (5) in dieser Ebene einen Strahlungsfleck fokussiert, insbesondere für ein Gerät zum Lesen eines Aufzeichnungsträgers (1) mit einer optischen, Strahlung reflektierenden Informationsstruktur (2) oder für ein Gerät zum optischen Aufzeichnen von Information auf einem Aufzeichnungsträger, wobei dieses Fokussierfehlerdetektionssystem ein Strahlaufspaltungselement (8) im Wege eines von einer Strahlungsquelle (3) erzeugten Strahlungsbündels (b), das an der Reflexionsfläche (2) reflektiert und durch ein Strahlteilerelement (6) von der Strahlung nach der Reflexionsfläche (2) getrennt wurde, und ein strahlungsempfindliches Detektionsystem (7) hinter dem Strahlaufspaltungselement (8) enthält, wobei dieses Detektionsystem eine Anzahl in zwei Gruppen verteilter Detektoren (15, 16, 17, 18) enthält, von denen eine erste Gruppe einem ersten Teilstrahl (b_1) und eine zweite Gruppe einem zweiten Teilstrahl (b_2) zugeordnet sind, die Teilstrahlen durch das Strahlaufspaltungserelement (8) gebildet werden, und die Ausgänge der Detektoren (15, 16, 17, 18) an die Eingänge einer Elektronikschaltung angeschlossen sind, die ein Fokussierfehlersignal aus den Detektorsignalen aller Detektoren (15, 16, 17, 18) der ersten und der zweiten Gruppe ableitet, dadurch gekennzeichnet, daß das Strahlaufspaltungselement (8) ein zusammengesetzter Keil ist, der aus zwei Keilabschnitten (9, 10) mit einer gemeinsamen Grundfläche (14) besteht, die beide mit einer gegenüber der Grundfläche (14) liegen, oberen Fläche (12, 13) versehen sind und die beiden oberen Flächen (12, 13) in der Ebene (11) der Schnittstelle zwischen den beiden Teilabschnitten (9, 10) gegeneinander geneigt sind, wobei sich die Ebene (11) der Schnittstelle im wesentlichen senkrecht zur Grundfläche (14) und zu den oberen Flächen (12, 13) verläuft und die optische Achse (a) des Abbildungssystems umfaßt, und daß die zwei Detektorgruppen (15, 16, 17, 18) sich an gegenüber-liegenden Seiten einer Ebene befinden, die die optische Achse (a) umfaßt und sich im wesentlichen senkrecht zur Ebene (11) der Schnittstelle und senkrecht zur Grundfläche (14) erstreckt.

2. Optoelektronisches Fokussierfehlerdetektorsystem nach Anspruch 1, dadurch gekennzeichnet, daß der zusammengesetzte Keil (6) ein halbdurchlässiger Spiegel und der zusammengesetzte Keil (8) auf einer Oberfläche (14) einer Zylinderlinse (23) angeordnet ist.

3. Optoelektronisches Fokussierfehlerdetektorsystem nach Anspruch 2, dadurch gekennzeichnet, daß das Strahlteilerelement (8) und die Zylinderlinse (23) aus demselben Material hergestellt sind und ein einstückiges integriertes optisches Element bilden.

4. Optoelektronisches Fokussierfehlerdetektorsystem nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß ein die Detektoren (15, 16) der ersten Gruppe trennender Streifen (19) sich unter einem ersten spitzen Winkel (β_1) und ein die Detektoren (17, 18) der zweiten Gruppe trennender Streifen (20) sich unter einem zweiten spitzen Winkel (β_2) erstrecken, der dem ersten Winkel (β_1) entgegengesetzt orientiert ist in bezug auf jene Linie, die durch Projektion der Schnittstelle des zusammengesetzten Keils (8) auf die Ebene des Detektorsystems erhalten wird.

5. Gerät zum Lesen und/oder Aufzeichnen von Information in einer spurweise geordneten optischen Informationsstruktur (2) eines Aufzeichnungsträgers (1), das mit einem optoelektronischen Fokussierfehlerdetektorsystem nach Anspruch 1, 2, 3 oder 4 versehen, dadurch gekennzeichnet, daß die Ebene (11) der Schnittstelle des zusammengesetzten Keils (8) sich parallel zur Spurrichtung erstreckt.

Revendications

1. Système de détection d'erreurs de focalisation opto-électronique pour la détection, dans un système de formation d'image optique, d'une déviation entre une surface réflectrice de rayonnement (2) et un plan de focalisation dans lequel est focalisée une tache de rayonnement par un système d'objectif (5) notamment un dispositif pour la lecture d'un porteur d'enregistrement (1) présentant une structure d'information réflectrice de rayonnement (2) ou un appareil pour l'enregistrement optique d'information dans un porteur d'enregistrement, système de détection d'erreurs de focalisation qui comporte un élément diviseur de faisceau (8) disposé dans le trajet d'un faisceau de rayonnement (b) délivré par une source de rayonnement (3), faisceau (b) qui est réfléchi par la surface réflectrice (2) et séparé par un élément séparateur de faisceau (6) du rayonnement dirigé vers la surface réflectrice (2), et un système de détection (7) sensible au rayonnement disposé derrière l'élément diviseur de faisceau (8) comprenant plusieurs détecteurs (15, 16, 17, 18) disposés en deux groupes dont un premier groupe est associé à un premier sous-faisceau (b_1) et un deuxième groupe avec un deuxième sous-faisceau (b_2), lesdits sous-faisceaux étant formés par l'élément diviseur de faisceau (8), les sorties desdits détecteurs étant connectées aux entrées d'un circuit électronique, qui dérive un signal d'erreur de focalisation des signaux de détection de tous les détecteurs (15, 16, 17, 18) desdits premier et deuxième groupes, caractérisé en ce que l'élément diviseur de faisceau (8) est un coin composé comprenant deux parties cunéiformes (9, 10) présentant une surface de case commune

* C L M S *