Description

The present invention relates to a device for carrying out a process for focusing a beam of light energy onto a reference plane of an information carrier, especially a carrier in the form of a disc on which the information is recorded along tracks in the form of disturbances detectable by optical means. The invention also relates to the carrier used for this purpose.

Numerous optical systems for the recording and/or reading of information along tracks have been described in the prior art. When what is involved is the recording of information in sequential form, for example video information, generally the tracks are not materially represented in advance but rather created in real time at the moment of the recording. The information is recorded along the tracks having the shape of a single spiral extending from the peripheral area of the disc towards a central area or the reverse or again having the shape of concentric circles centred on the axis of rotation of the disc.

In all these systems, arrangements must be made to ensure a correct radial monitoring of the tracks on recording and/or on reading, and first of all these tracks must be created in one manner or another.

In the simplest systems, reliance is placed on the precision of the components for advancing the recording head in order to create these tracks at the same time as the recording of the information, the tracks being defined simply by the presence of this information. In the course of reading, information recorded, for example, in the form of microreliefs interferes with a reading beam focused in the plane of the recording face of the disc. The movement of these microreliefs under the focusing spot modulates the beam and this modulation is detected by means of photoelectric cells converting the variations of light intensity into electrical signals. These electrical signals may be likewise utilized for the purpose of monitoring tracks.

The process which has just been described requires that the advance of the recording head must exhibit a very great mechanical stability, this being so in order to prevent a situation in which two successive grooves overlap or at least are poorly discernible in the course of reading. For the purpose of improving the system which has just been described, the French Patent Application published under the number 2,366,636 proposed a process utilizing the last track inscribed or one of the previously inscribed tracks as reference.

However, when it is desired to record information in a random manner, for example in the applications concerning data processing, it is in general necessary to represent materially in advance the tracks along which information may be recorded. To do this, it is customary to create a prerecording in any manner. In one embodiment described in the French Patent Application published under the number 2,365,854, in the course of the production of the carrier, the tracks are materially represented in the form of a smooth groove created in an auxiliary layer of this carrier. These tracks may be detected, even in the absence of any recording of information, this recording being carried out in a subsequent phase in a photosensitive or thermosensitive layer in contact with the auxiliary layer.

In a preferred variant of the prior art, the prerecorded tracks may coincide with the regions in which the information is recorded. A so-called single-track system is then obtained.

In other processes, the prerecorded track or tracks are distinct from the tracks along which the information is recorded. So-called two-track or multi-track systems are then obtained.

The principal disadvantage of the process which has just been described is that it does not permit a maximum recording density, since it requires, at a minimum, a prerecorded supplementary track for a prerecorded information track. Moreover, it requires the use of two beams, one for the radial monitoring of the

prerecorded track and the other for the writing or the reading of information on the track intended for recording.

The carriers of the so-called single-track type, comprising a prerecording, are not free from disadvantages either. They generally require the use of two beams, one for recording and the other for radial monitoring. Moreover, if the prerecorded track is easily discernible from the remainder of the disc (inter-track areas) in the absence of recording of information, the same no longer applies when information is recorded. If precautions are not taken, this may result in inversions of contrasts leading to errors of monitoring.

In order to alleviate these disadvantages, there has been proposed a device for radial track monitoring utilizing an information carrier comprising a prerecording used for this monitoring, which prerecording is constituted solely by discrete elements or "flags" distributed along the tracks.

Performed in accordance with a plurality of variants, the prerecording consists of a succession of non-adjoining discrete elements materially representing the middle axis of the tracks. The spatial distribution of these discrete elements may or may not be uniform. According to a first variant, each discrete element consists of a smooth track section. According to a second variant, each discrete element comprises a plurality of sections defining a particular code. According to other variants, each element comprises one or more portions offset in relation to the middle axis. Finally, each one of the prerecording elements may itself be preceded by an auxiliary prerecording element used for the purposes of synchronization. The track monitoring device comprises photodetector means, measurement circuits comprising, for example, sampler-blockers or memory integrator circuits, and sampling circuits. A track radial monitoring error signal is formed from the development of the signals detected in the course of successive passages in an illuminated area of the surface of the disc by a track

monitoring spot.

In addition to the correct radial monitoring ensured preferably by the process which has just been recalled, a second requirement associated with the reading or the writing of information on an optical carrier concerns the focusing of the light energy beams which are used. These beams must be focused on the carrier in a spot which must permanently monitor the possible fluctuations of level of the tracks. To do this, it is known that the correct focusing of the beam is obtained by means of a focusing slaving device comprising a feedback loop maintaining the distance between the optical device and the recorded surface of the carrier constant. The connection and the retention of the slaving device are obtained by detection of the fluctuations of an electrical signal derived, in a first variant, from the reading of the recorded information and, in a second variant, from the detection of the prerecording materially representing the tracks, for example in the form of a smooth groove.

In the circumstances, the same difficulties are encountered as previously stated in relation to the radial monitoring.

It has also been proposed to utilize the same prerecording discrete elements, in their variants comprising sections offset in relation to the middle axis of the tracks, in order thus to ensure the focusing.

Although this process dissociates the focusing from the content of the recorded information, the accidental disturbances of the structure of the prerecording elements do however play a part in the quality of the focusing, even though this part is no longer decisive. Moreover, the quality of the focusing is influenced by possible signal losses due to the transient non-detection of these elements or "drop-outs" according to the well-known English expression, this being so for various reasons associated with the quality of the carrier and/or the optoelectronic means for detections of the prerecording elements.

The object of the invention is to alleviate the disadvantages of the prior art. To do this, there are formed along the tracks of the areas free from all recordings, including any in the forms (sic) of pre-recording discrete elements or of smooth track sections as they have just been recalled. Accordingly, these areas consist of blank zones of the surface of the disc. Now, it has been found experimentally that the surface of the discs exhibits fewer anomalies liable to be reflected in parasitic fluctuations of the focusing than the structures of the recorded elements used in the prior art for this purpose.

The invention takes advantage of this phenomenon and the focusing process according to the invention consists in deriving the signals required for the vertical slaving of a writing and/or reading head, that is to say for the correct focusing of a light energy beam onto a reference surface, from the detection of these blank areas with the aid of optoelectronic detecting means.

The subject of the invention is thus an information carrier comprising prerecorded patterns disposed in a reference surface, a smooth part of which completely surrounds each of said patterns; said patterns materially representing, in the form of elements, adjacent tracks having a regular spacing; each of said track elements being subdivided into non-adjoining areas reserved for the storage of the data and separated from each other by intermediate areas solely containing prerecorded patterns, characterized in that said smooth part encloses portions distributed along any one of said track elements; said portions being capable of containing entirely a circular contour line centred on the middle axis of the corresponding track element and the diameter of which corresponds approximately to said spacing.

The subject of the invention is also an optical device for focusing a light energy beam utilizing this information carrier.

The invention will be better understood and other features will appear with the aid of the description

which follows, with reference to the figures which are attached and in which:

Figure 1 represents a disc of the prior art and a device for track monitoring and for focusing a beam on such a disc;

Figures 2 and 3 represent a disc prerecording according to a plurality of modified embodiments;

Figure 4 is an example of encoding of the information on a disc which can be used by the process of the invention according to a first embodiment;

Figure 5 is an electrical diagram of a focusing device for implementation of this first embodiment;

Figures 6 and 7 illustrate two modified embodiments of the configuration of a disc in a second embodiment of the process of the invention;

Figure 8 is an electrical diagram of a focusing device for implementation of this first embodiment;

Figures 9 and 10 represent in detail optoelectronic components which can be used in the two embodiments;

Figure 11 is a diagram to explain the operation of the device of the invention according to the second mode.

As the invention relates to a process and a device for focusing in a system utilizing an information carrier of prerecorded type, it is useful to recall the principal constitutive elements of an optical system for recording and/or reading information carriers, especially carriers in the form of discs which can be read and written optically.

Figure 1 represents an information carrier 5 of the prior art in the form of a circular disc which can rotate in a plane XOY about an axis parallel to the third axis of a reference coordinate system XYZ. The lower face of this disc is in this case assumed to be smooth; the upper face, which is parallel to it, is likewise smooth, but comprises a prerecorded track 7 in the form of a smooth track, the substantially constant width of which is of the order of or less than one micrometre.

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It is possible to use such a disc either for inscribing information at a determined point of one of the smooth tracks which are inscribed in advance, or to read information inscribed at any point of this track. The disc, for example of a diameter of approximately 30 cm, is given a rotational movement communicated by a drive motor solid with the frame of the optical recording-reading system. In this embodiment, the device for access to a predetermined track of the disc comprises a fixed part comprising two sources of light energy (which are not represented in Figure 1) and a movable part constituted by the recording-reading head. As is known, the latter comprises an objective of the microscope type O_b, solid with an electromagnetic coil B which moves in the magnetic field of a permanent magnet (not represented) ensuring the vertical slaving and a galvanometer mirror M_1 ensuring the radial slaving. The sources of light energy, as is likewise known, comprise laser sources, for example He Ne gas lasers or semiconductor lasers. The gas lasers deliver a polarized parallel beam, the cross-section of which is very small. The laser beam must be enlarged in such a manner as to cover the entrance pupil of the objective, this taking place irrespective of the position of the objective along the optical axis. In order to meet this requirement, it has been proposed in French Patent Application FR-A-2,462,758, to intercalate between the sources of light energy and the movable recording-reading head an optical system of afocal type.

For the reading, a parallel laser beam f_1 produced by a laser source (not represented in Figure 1) is enlarged by means of an afocal system, the magnification of which is such that the emergent beam, which is likewise parallel, covers the entrance pupil of the objective O_b. The mirror M_1 deflects the rays propagating parallel to a direction parallel to the axis OX along a direction substantially parallel to the axis OZ. The objective O_b focuses the reading beam at the point 3 on the information carrier disc 5. This disc is given a rotational

movement symbolized by the arrow 6. The objective and the mirror are solid with a movable unit constituting the recording-reading head. The advance of this movable assembly may be obtained by any known means.

Use is then made of the same afocal system for the recording beam f_e, this having been previously modulated. In order to differentiate the reading and recording spots on the disc, the recording beam f_e is very slightly inclined in relation to the reading beam f_1 in such a manner that the decentring of the recording beam on the entrance pupil of the objective is very limited and that it is possible to disregard the displacement of the beam in the course of a radial displacement of the head. It follows that, irrespective of the position of the objective along the optical axis, the writing beam is focused at the focus of the objective. The writing spot is focused at the point 4.

For the recording of numerical data, the tracks 7 are disposed preferably in the form of concentric circles. They may or may not be materially represented before any inscription of data by a prerecording in the form of "smooth" grooves. The width of the track elements is chosen to be slightly less than the diameter of the light spot, and these elements are separated by inter-track zones, the width of which is slightly greater than the width of the track. The upper surface of the carrier receives a thin layer which is suitable for the inscription by a thermo-optical process.

With regard to the recording phase of the disc, the insolation of the sensitive layer used for the inscription is carried out by a spot 4, the intensity of which is modulated, for example, by an electrical signal with castellations of widths which are variable or constant depending upon the applications which constitute the carrier of the information. The incorporation of the information in the modulating signal is carried out, depending upon the particular case, by frequency or phase modulation, or by any mode of encoding capable of supplying a message encoded by pulses; the information may also

itself be, directly, the modulating signal.

In order to detèct the reading beams reflected by the disc, there is interposed, for example, a semi-transparent plate M_2 along the path of the beam f_1. The reflected beam is then sent towards photodetector and signal processing means which can deliver, on the one hand, an error signal ϵ which permits the control of the motor 2 determining the position of the mirror M_1, thus achieving a radial slaving, and on the other hand, an error signal ϵ' which permits the control of the coil B solid with the objective OB (sic), thus achieving a focusing slaving.

The processing means also deliver a signal S(t) representative of the useful information recorded on the disc. In fact, in the course of the movement of the elements recorded on the tracks 7, a signal S(t) is received in reading, which faithfully reflects the time variations of the signal recorded on the track.

In the writing phase, the reading beam f_1 may be used to ensure the radial slaving by means of the pre-recording, but may also be used for the purpose of monitoring, in real time, of the information in the course of being recorded or "monitoring" according to the English expression in current use.

In a preferred variant of the prior art, the prerecording used for purposes of radial monitoring is presented in the form of discrete elements or "flags" 71 which alone define the middle axis of the track to be followed. This track is therefore virtual. Having regard to the speed of rotation of the disc, the spatial distribution of these prerecorded elements must be sufficient to satisfy the SHANNON criterion: typically on a disc having a diameter of 30 cm, a ring of which having a width of 8 cm represents the useful recording area, approximately 40,000 tracks are available and each comprise of the order of 3,500 flags.

These flags delimit areas 72 intended for the recording of useful information data.

Figure 2 illustrates an illustrative embodiment

among others of flags 71 defining the middle axis 70 of tracks 7 along which the information may be recorded. As has just been recalled, between two identical flags 71 there exists an area 72 intended for the recording of useful information data. The direction of rotation of the disc has been represented by the arrow R in Figure 2.

It must indeed be understood that the track 7 represented in the figure is a virtual track, the middle axis 70 of which represents the ideal path which should be followed by a writing beam. It may, however, be materially represented in certain applications by a "smooth" groove before recording in the areas 72. The signals required for the radial slaving of the writing head will be derived from the detection of the flags 71 by track-monitoring means which will be described in greater detail in the text which follows. When the prerecorded elements 71 move below the focusing spot of a reading beam or, as will likewise be detailed subsequently, the writing beam, a track-monitoring signal may be generated in the conventional manner. The means for processing the signals must, however, store the measurement during the time interval elapsing between two successive passages of flags in the area illuminated by the track-monitoring spot. According to the invention, the slaving signal may be deduced from the development of the signal measured at these two instants.

It is likewise necessary, if it is desired to record information only in the useful area 72 located between two successive flags 71, to inhibit the writing beam when one of these flags is situated in the area illuminated by the writing spot. the discrimination between the flags and the information recorded between two flags may be facilitated if these flags are given a structure which permits them to be identified selectively or if each flag is associated with an encoded supplementary synchronization flag.

Figure 2 illustrates one of these possibilities. Each flag 71 is divided into a plurality of sections 710, 711, the lengths and the spatial distribution of which

define a code which permits the identification of a flag without ambiguity.

In order to improve the quality of the radial slaving, it is likewise known to wobble the monitoring beam while imprinting on it a slight oscillation at fixed frequency on either side of the middle axis of the track. It is possible to create this wobbling in another manner by means of patterns which are asymmetric in relation to the axis 70 of the monitoring. To do this, each flag comprises not only one or more possible sections centred on the middle axis of the track and indicating the start of the flag, but also one or more other sections offset in relation to this middle axis.

In a variant, the simplest one, illustrated by Figure 3, a first flag 71 comprises a section 710 centred on the middle axis of the track 70 and a second section 711-G offset to the left of this axis. The following flag 71′ likewise comprises a first section 710 centred on the middle axis 70 and a second section 711-D offset to the right of the axis. This succession is repeated. The spacing between the offset sections and the axis 70 of the track is of the order of a fraction of the width of the monitoring spot.

In other variants, which are not illustrated, each flag comprises at least one section offset to the left and one section offset to the right.

If what is desired is a recording configuration in the form of a block, the spatial distribution of the flags 71, 71′ is preferably uniform.

It is likewise possible to make use, at least if certain variants of flags are utilized, of these flags to generate the signal ϵ' which is necessary to ensure the correct focusing of the spot for exploration of the tracks on a determined plane of the disc.

Generally, the prerecorded elements 71 as well as, moreover, the recording corresponding to the information recorded in the areas 72, are present in the form of disturbances of the thermosensitive layer, in hollows or in humps. Most frequently, two levels are thus defined,

it being possible for one to be coincident with the plane defined by the surface of the superficial layer of the thermosensitive material before any recording, that is to say likewise with the plane of the inter-track areas. One of the logic states "1" or "0" is associated with these two levels.

In the single-track systems of the older prior art, the signal ϵ' is disturbed by the reading of the information recorded, even if the tracks are provided with prerecorded smooth grooves. In fact, the subsequent recording of information data tends to diminish the contrast which exists between the prerecorded areas in the form of a smooth groove and the inter-track areas and may even, in extreme cases, reverse it. These parasitic effects may lead to cases of desynchronization of the vertical slaving of the objective O_b.

Although the process of the prior art, being more recent, which consists in decoupling the focusing of the configuration of the recorded data, by nature random, and in generating the signals from flags of better defined structure and the distribution of which along the tracks may, in a preferred variant, be uniform, leads to better results, it is still possible to improve the quality of the focusing and this is the object of the invention. This process is described in the document EP-A-0,089,274 (which is included in the prior art defined in article 54 (3) EPC).

In fact, the losses of information remain possible ("drop-outs") and, as has been recalled, it has been found experimentally that the surface condition of the blank recording areas is statistically less disturbed than the planes defined by the two levels associated with the prerecorded elements.

The invention takes advantage of this phenomenon.

According to the main feature of the invention, zones free from any recording, including prerecording in the form of smooth sections or grooves, are formed along the tracks.

These zones must exhibit a configuration such

that the smallest of the dimensions of these zones is greater than the largest of the dimensions of the spot for exploration of the tracks, this being so when the beam is focused in the plane of the surface of these areas. Moreover, the spacing between two tracks, that is to say the inter-track distance, must be greater than the dimension of the spot in this direction.

By respecting this condition, the invention may be implemented according to two principal embodiments which are themselves capable of a plurality of modified embodiments.

According to a first mode, if the recording density is not critical, the blank zones may be interlaced with the recordings representing the information. For this, it is possible to use the track areas delimited by two successive recording elements. For this, it is necessary that the track should not be materially represented by a prerecording in the form of a smooth groove. Other conditions must likewise be implemented: the recorded patterns representing the information must preferably be of surface area markedly smaller than the surface of the exploration spot and leave sites between two successive recordings of length exceeding this spot. The location of these sites may be systematic, performed between two positions reserved for the recording or, on the other hand, the sites may be distributed in a more random manner.

According to a second embodiment, which constitutes a preferred mode, specific sites are provided along the tracks and these sites are preceded by flags, that is to say discrete prerecorded elements synchronizing the start of the blank zones intended for the sole purposes of generation of a focusing signal. These flags must be selectively detectable. To do this, they may be associated with a specific code, for example be constituted by a succession of prerecorded sections, the respective dimensions and/or the spatial distribution of which distinguish them from the codes associated with the other recorded elements, in particular the codes

associated with the useful recorded information data.

Figure 4 illustrates an example of recording of data, the configuration of which permits the implementation of a variant according to the first embodiment.

To fix the ideas, a four-bit binary word of arbitrary configuration "1011" is taken by way of example. One category of code among others which is capable of satisfying the previously enunciated requirements is the pulse code. The logic states "1" are represented by a brief positive pulse which will be reflected in a recorded element 720 of small dimension, created along the track 7 and centred on the middle axis 70. On the diagram of Figure 4 representing the pulse code, the time interval T corresponds to the base period of recording of a binary element or bit, having regard to the speed of movement of the information carrier. The logic states "0" are reflected in the absence of recording on the track and are coincident with the remaining zones of the carrier, in particular the inter-track zones, this being so, naturally, if the track does not include a prerecorded smooth groove; this constitutes one of the requirements to be respected.

It is appreciated that if the distance separating two recordings 720 is greater than the exploration spot 3 focused on the reference plane constituted by the surface of the layer of thermooptical material covering the carrier, the zones 73 corresponding to the recording of the logic states "0" possibly overflowing onto the two adjacent zones outside the recordings 720 can be used for the purposes of the generation of focusing slaving signals.

Figure 5 represents optoelectronic circuits permitting the generation of the vertical slaving signals ϵ'. These circuits may be inserted in a system similar to that described in relation to Figure 1 and are located in the control block bearing the reference 1 in this figure. Only the vertical slaving circuits are specific to the invention; the other circuits are common to the prior art

and do not require any particular description.

These circuits comprise an optoelectronic detection component which will be described in detail subsequently. This component, which detects the radiation emanating from the zone illuminated by the spot 3, comprises at least one photodetector cell delivering an output signal V_D transmitted to circuits 11 for formulating the vertical slaving error signal ϵ' and to sampling circuits 12. The function of the latter is to generate operation authorization signals transmitted to the circuits 11 centred on the time intervals corresponding to the recordings of logic states "0", that is to say track zones 7 without recording which are larger than the exploration spot 3 (Figure 4). To do this, the sampling circuits 12 comprise a component 120 for comparison with a threshold V_{REF}. The latter circuit may be constituted by an amplifier with differential inputs, which receives on direct (+) inputs and inverted (-) inputs respectively the signals V_D and V_{REF} and which delivers an output signal S, for example in the logic state "1", when the detected signal V_D passes below a determined threshold. The signal S is transmitted to one of the inputs of a logic AND gate: 121. The other input receives pulsed clock signals H which are centred on the middle of the periods T (Fig. 4). To do this, it is possible to derive these clock signals from the conventional clock signals referred to as "bits", which are utilized in the systems for recording/reading of numerical data. These signals define precisely the base period T and synchronize the recording or the reading of the data. In particular, the logic states "0" not being associated with any recording, these signals are necessary to distinguish the absence of recording corresponding to a "0" and the other zones without recording. When there is agreement between a logic state "0" and the appearance of a clock pulse H, an authorization signal S_A is present on the output of the AND gate: 122. This signal S_A defines an analysis window and authorizes the taking into account of the signal V_D by the circuits for the formulation of the error signal ϵ'

within the time interval of the analysis window. These circuits may consist, in the example illustrated by Figure 4, of a sampler-blocker element 110 storing the signal V_D between two samplings, that is to say between the passages within the zone illuminated by the exploration spot 3 of two zones without recording, as are defined in the aforegoing. The output signal ϵ'_M is then a staircase signal. To be usable, it must be "smoothed", for example by means of a low-pass filter 111 delivering on its output the error signal ϵ' transmitted to the components for the vertical slaving of the objective O_B, that is to say essentially to the coil B.

Figure 6 illustrates a first modified embodiment according to the second mode, which is preferred, of execution of the invention. Sites consisting of blank zones 73 are formed along the tracks 7 and are associated with flags 74 which precede them. If the radial slaving is performed by means of the detection of specific flags, these flags may be used within the scope of the invention in the place instead of the flags 74 and thus play a double part, while avoiding the diminution of the recording density resulting from the recording of supplementary flags.

The flags may be of all types and, without this being restrictive, may be constructed, for example in accordance with any one of the main variant embodiments illustrated by Figures 2 and 3. The sole constraint is that these flags must be selectively detectable between all the configurations of recordings present on the disc.

Although hatched in Figure 6 for the purpose of illustration, it must be understood that the limit of the blank zones 73 in directions other than those of the middle axis 70 are virtual. These limits are, moreover, not critical. It is sufficient that the inter-track spacing be greater than the dimension of the exploration spot 3 along a radial direction.

Figure 7 illustrates a second modified embodiment, which is preferred, of the same mode of execution. According to this variant, the disc is sectorized and all

the zones 73, as well as the associated flags 74, are aligned on a radial axis Δ_R passing through the centre of rotation of the disc 5. For the purpose of simplification, only five concentric tracks 7 have been represented. Along the axis Δ_R, all the blank zones 73 are coincident in a single zone having the shape of a rectangular quadrilateral, the major dimension of which is parallel to the axis Δ_R.

In reality, as has been indicated, a disc having a diameter of 30 cm comprises approximately 40,000 tracks distributed within a ring of width 8 cm or useful recording area. Each track comprises approximately 3,500 blank zones and as many associated flags.

This arrangement has the advantage of authorizing a smaller inter-track spacing, that is to say a larger recording density. In fact, the exploration spot 3 may overflow onto an adjacent track without risk of intercepting a recording element of this track. The focusing is then made entirely independent of the radial monitoring errors.

Figure 8 represents an example of circuits for formulating the signal ϵ' which are adapted to the preferred embodiment of the invention.

In addition to the detector 10 and the generator 11 of the error signal ϵ' which are common to the circuits described in relation to Figure 5 and which will not be described again, they likewise comprise sampling circuits 12 delivering the authorization signal S_A and receiving the signal V_D delivered by the detector 10. However, within the framework of the preferred mode, these circuits comprise a circuit for the identification of flags 122, for example a logic decoder recognizing the specific code associated with the flags 74 preceding the blank zones 73 and delivering an initialization signal S_C, for example pulsed, of a generator 123 of the authorization signal S_A. The latter may be advantageously constituted on the basis of monostable flip-flops initialized by one of the transitions of the signal S_C and delivering an output signal defining an analysis window

of duration θ and sufficiently delayed in such a manner that, having regard to the speed of movement of the tracks in the area illuminated by the exploration spot 3, the latter is centred on the blank zone 73 at the moment when the authorization signal S_A is generated and, correlatively, the measurement taken into account by the sampler-blocker 110.

In all the variants which have just been described, it is possible to replace the sampling-blocking (Figure 5: circuit 110) by a peak detection or an integration which is likewise followed by a comparison of one pulse with the other, generation of a staircase signal ϵ'_N and smoothing to obtain the final signal ϵ'.

The process which has just been described in its two principal embodiments is compatible with all the track monitoring and information reading processes. It may, in particular, be implemented in a single-track single-beam system. In this case the single beam serves for writing, for ensuring the radial monitoring, preferably by using the flags 74 and for the generation of the vertical slaving signal ϵ' according to the teaching of the invention. The optoelectronic components which are used in these processes may likewise be used to generate the signal V_D.

The detection may be carried out in accordance with numerous known processes. By way of examples, use may be made of an implementing device of asymmetric type according to the teaching of the French Patent FR-B-2,325,953 or of astigmatic type according to the teaching of the French Patent FR-B-2,271,590.

In order to illustrate the invention in a specific manner, the operation of an astigmatic device cooperating with the device of Figures 5 or 8 will be recalled in relation to Figures 9 to 10. Consideration will be given to a single-track single-beam system.

Figure 9 shows a source of radiated energy L_a emitting a beam f along the axis OZ of an orthonormed coordinate system OXYZ; means M for the separation of the radiant energy, such as a semi-transparent mirror,

forming with the axis OZ an angle of $\pi/4$ radians, for example; an objective O_b of optical axis Ox, causing the beam f to converge into a spot 3 on the carrier 5. The source L_a may be considered as being a point source. It is, for example, the emission face of a laser diode.

At least a fraction of the beam f is reflected by the carrier 5: this reflected beam passes through the objective O_b and is then reflected by the semi-transparent mirror M so as to converge at a point A, symmetrical with the source L_a with respect to the mirror M, situated on an axis Δ_x parallel to OX; a plane normal to the axis Δ_x referenced P_1 passes through the point A. There is interposed on the axis Δ_x an optical device C, permitting the optical assembly placed on the path of the reflected beam f to be made astigmatic; such a device may be constructed with the aid of a cylindrical lens, the axis of the cylinder being, for example, chosen to be parallel to the axis OZ. As is known, the effect of the cylindrical lens C is to cause the point source L_a to correspond to a line segment 80, on either side of the point A in the plane P_1, parallel to the axis OY in the example represented in the figure. For the purposes of clarity, a diagrammatic representation is given, in the drawing, of the traces 82 and 83, which are substantially circular, of the reflected beam f', on the mirror M and on the cylindrical lens C, as well as the diameters 830 and 831 respectively; the rays 85 define the segment 81 after convergence to a point A' of the axis Δ_x in the plane P_2; the rays converge to the point A. An observation plane P_o is selected; the plane P_o is situated on the axis Δ_x between the points A and A' where the surface of the spot 8 is minimal; the plane P_o is orthogonal to the axis Δ_x.

What is described hereinabove corresponds to the case where the beam 3 is correctly focused onto the carrier 5, at the point 3.

In the opposite case, it is found that there is formed on the plane P_o a focused spot which is deformed in relation to the spot 8 by elongation in directions parallel to the axes OY and OZ, depending upon whether

the beam converges forwardly or rearwardly of the reference surface of the disc 5, that is to say, within the scope of the invention, of the surface of the blank zones 73.

In the observation plane P_o there are placed means for the detection of the shape of the focused spot, these means, for example, constructed by means of photoelectric cells as illustrated by Figure 10, delivering a focusing monitoring signal. The detection means comprise, in this embodiment, four photoelectric cells D_1, D_2, D_3, D_4, which are placed in accordance with a square, the diagonals of which are parallel to the axes OY and OZ, and placed in such a manner that the focused spot 8 is formed substantially at the centre of the square.

The cells belonging to a same diagonal are connected to the input of an adder; that is to say, in Figure 10, the cells D_1 and D_2 on the diagonal parallel to the axis OY, to the inputs of the adder 35, and the cells D_3 and D_4, on the other diagonal, to the inputs of an adder 36. The adders are connected to a differential amplifier 37: the adder 35 to the positive input of the amplifier and the adder 36 to its negative input. At the output of the amplifier 37 the electrical signal V_D is available, which constitutes the focusing monitoring signal.

The three forms of focusing spots which are liable to be formed in the observation plane P_o are represented in Figure 10: the contour 8, of minimal surface area, mentioned hereinabove; a contour 801 which is elongated along the axis OY, and a contour 802 which is elongated along the axis OZ. It is clear that, having regard to the connection of the photoelectric cells which is indicated hereinabove, the signal V_D is zero when the focusing is correct (spot 8, substantially circular), positive when the surface of the zones 73 has become removed from the objective O_b (spot 801) and negative when the surface of the zones 73 has approached the objective O_b (spot 802).

By this process, the signal V_D is representative

of the focusing error of the beam f, in amplitude and in sign. According to the invention, the signal V_D is sampled during the analysis windows and stored between two samples by the devices which have been described in relation to Figures 5 and 8.

The diagram of Figure 11 illustrates an example of development of the vertical slaving error signal ϵ' as a function of the time. In this example consideration is given, more particularly, to the case of the second embodiment. The curve of the upper part of the diagram represents the position δ_Z along a vertical coordinate axis of the exploration spot 3 in relation to the reference plane, of altitude zero, constituted by the surface of the blank zones 73. The curve ϵ' on the lower part of the diagram diagrammatically represents the corresponding development, as a function of the time, of the smoothed focusing error signal ϵ'. The analysis windows corresponding to the passages of the blank zones within the area illuminated by the exploration spot 3 are represented in a simplified manner as the blank zones by points referenced θ_1 to θ_8. The same diagram shows the staircase curve of the signal ϵ'_N as stored between each passage of the blank zones 73. The time interval elapsing between two analysis windows is dependent upon the speed of rotation of the disc and upon the length of the areas 72.

More briefly, the second process of the type described in the first aforementioned French Patent consists, after having introduced an asymmetry into the exploration beam, in forming the image of the focusing spot on photoelectric cells in a number at least equal to two, and in measuring the distortions of this image. The signals delivered by the photoelectric cells are a function of the spacing existing between the focusing plane and the reference plane constituted, within the scope of the present invention, by the surface of the blank zones.

In order to initialize the focusing device, it is possible to implement a process similar to that described

in the French Patent Application FR-A-2,330,062.

In a general way, the loop of the focusing slaving circuits is open and a sawtooth signal is transmitted to one of the solenoids with which the means for slaving the vertical position of the objective O_b are provided, for example the solenoid B in Figure 1 or again a supplementary solenoid specific to this use. The objective will therefore move from a rest position to a position for which the focusing spot will be situated in a plane close to the reference plane as it has been defined.

According to a first modified embodiment, if the spot has a radial dimension at least of the order of magnitude of the width of the inter-track areas, irrespective of its radial position, the circuits for identification of flags 122 of the device described with reference to Figure 8 will start to produce control signals S_c, the instant of appearance of which may be used to generate a signal to close the vertical slaving loop. The spot is then situated in a plane which is sufficiently close to the reference surface in order that the vertical slaving circuits should be able "to lock on" to this surface.

In another variant, if the spot is of smaller radial dimension than the width of the inter-track areas or again, in the first embodiment, it is possible to use the value of the amplitude of the signal V_D compared with a reference threshold to generate a signal to close the vertical slaving loop.

In the event of accidental loss of focusing, the same procedures may be implemented according to the teaching of the aforementioned patent application.

The invention is not limited only to the illustrative embodiments which have been described and, in particular, only to the devices for carrying out the process which have been described with reference to Figures 5 and 8.

Claims

1. Information carrier comprising prerecorded patterns (710, 711, 74) disposed in a reference surface, a smooth part of which completely surrounds each of said patterns; said patterns materially representing, in the form of elements, adjacent tracks (7) having a regular spacing; each of said track elements being subdivided into non-adjoining areas (72) reserved for the storage of the data and separated from each other by intermediate areas (71) solely containing prerecorded patterns, said smooth part enclosing portions (73) distributed along any one of said track elements; said portions (73) being capable of containing entirely a circular contour line (3) centred on the middle axis (70) of the corresponding track element and the diameter of which corresponds approximately to said spacing.

2. Carrier according to Claim 1, characterized in that said portions (73) are all situated in said intermediate areas where they occupy a position which is predetermined with respect to said prerecorded patterns (74).

3. Carrier according to Claim 1, characterized in that, said data being transcribed by a succession of recorded (720) and non-recorded (73) areas, said portions occupy non-recorded areas.

4. Carrier according to Claim 1, characterized in that two prerecorded patterns (74) which follow each other within an intermediate area surround one of said portions.

5. Carrier according to Claim 1, characterized in that one of said portions (73) occupies an end position within an intermediate area.

6. Carrier according to Claim 1, characterized in that said portion (73) covers the entirety of the middle axes of said track elements; the circular contour lines surrounded by said region forming an orthogonal alignment (ΔR) with respect to said middle axes.

7. Carrier according to any one of the preceding claims, characterized in that said middle axes are curved

and have a centre (o) which coincides with a reference surface of annular shape.

8. Device for exploring an information carrier according to any one of the preceding claims, comprising optical exploration means projecting into said reference surface a focused light spot intended to interact solely with any one of the track elements; means (B) for regulating the focusing of said spot being controlled by photodetector means (10) which receive a fraction of the radiation which emerges from the portion of said reference surface illuminated by said spot, said spot not extending beyond said circular contour line (3) when it is centred on the middle axis (70) of the track element which is in the course of being explored and when it passes over one of said portions; the sampled value (ϵ'N) of the signal (V_D) produced by the photodetector means during said passage ensuring said focusing.

9. Device according to Claim 8, characterized in that the sampling of said value is determined by circuit (123) for identification of the prerecorded patterns (74).

10. Device according to Claim 8, characterized in that the sampling of said value is determined by a circuit (12) detecting the passage of said spot from a recorded region to an immediately following non-recorded region.

* C L N S *

Claims

1. An information carrier comprising prerecorded motives (710, 711, 74) disposed in a reference surface, an even part of which completely surrounds each of said motives ; said motives materializing, in the form of elements, adjacent tracks (7) having a regular spacing ; each of said track elements being subdivided into not adjoining areas (72) reserved for the storage of data and separated from each other by intermediates areas (71) solely containing prerecorded motives, said even part enclosing portions (73) distributed along any one of said track elements ; said portions (73) being apt to contain entirely a circular contour line (3) centered on the middle axis (70) of the corresponding track element and the diameter of which corresponds approximately to said spacing.

2. A carrier according to claim 1, characterized in that said portions (73) are all situated in said intermediate ares where they occupy a position which is predetermined with respect to said prerecorded motives (74).

3. A carrier according to claim 1, characterized in that, said data being transcribed by a succession of recorded (720) and non-recorded areas (73), said portions occupy non-recorded areas.

4. A carrier according to claim 1, characterized in that two prerecorded motives (74) which follow each other within an intermediate area, surround one of said portions.

5. A carrier according to claim 1, characterized in that one of said portions (73) occupies an end position within an intermediate zone.

6. A carrier according to claim 1, characterized in that said portion (73) covers the entirety of the middle axes of said track elements ; the circular contour lines surrounded by said area forming an orthogonal alignment (ΔR) with respect to said middle axes.

7. A carrier according to any one of the preceding claims, characterized in that said middle axes are incurved and have a center (o) which coincides with a reference surface of annular shape.

8. A device for exploring an information carrier according to any one of the preceding claims, comprising optical exploration means projecting onto said reference surface a focalized light spot which is to interact solely with any one of the track elements, regulating means (B) of the focalisation of said spot being controlled by photodetector means (10) which receive a fraction of the radiation which emerges from the portion of said reference surface illuminated by said spot, said spot not extending beyond said circular contour line (3) when it is centered on the middle axis (70) of the track element which is about to be explored and when it passes over one of said portions ; the sampled value (ε'N) of the signal (V_D) produced by the photodetector means during said passage ensuring said focalisation.

9. A device according to claim 8, characterized in that the sampling of said value is determined by an identification circuit (123) of the prerecorded motives (74).

10. A device according to claim 8, characterized in that the sampling of said value is determined by a circuit (12) detecting the passage of said spot from a recorded region to an immediately following non-recorded region.

Patentansprüche

1. Informationsträger mit Vorprägungs-Motiven (710, 711, 74), die in einer Bezugsoberfläche angeordnet sind, von der ein glatter Teil jedes dieser Motive völlig umgibt, wobei diese Motive in Form von Elementen benachbarte Spuren (7) mit regelmäßigem Abstand bilden und jedes dieser Spurelemente in nicht-aneinandergrenzende Bereiche (72) unterteilt ist, die für die Speicherung von Daten reserviert sind und voneinander durch Zwischenbereiche (71) getrennt sind, die nur Vorprägungs-Motive aufweisen, wobei der glatte Teil Abschnitte (73) umfaßt, die entlang irgendeines der Spurelemente verteilt sind und einen ganzen kreisförmigen Umriß (3) aufweisen können, der auf die Mittelachse (70) des entsprechenden Spurelements zentriert ist und dessen Durchmesser dem genannten Abstand ähnelt.

2. Träger nach Anspruch 1, dadurch gekennzeichnet, daß die Abschnitte (73) sich alle in den Zwischenbereichen befinden, wo sie eine vorbestimmte Lage in bezug auf die Vorprägungs-Motive (74) einnehmen.

3. Träger nach Anspruch 1, dadurch gekennzeichnet, daß die Daten durch eine Folge von geprägten (720) und nicht-geprägten Bereichen (73) übertragen werden, wobei die Abschnitte nicht-geprägte Bereiche belegen.

4. Träger nach Anspruch 1, dadurch gekennzeichnet, daß zwei Vorprägungs-Motive (74) innerhalb eines einen dieser Abschnitte einrahmenden Zwischenbereichs aufeinanderfolgen.

5. Träger nach Anspruch 1, dadurch gekennzeichnet, daß einer der Abschnitte (73) eine Endla-

innerhalb eines Zwischenbereichs einnimmt.

6. Träger nach Anspruch 1, dadurch gekennzeichnet, daß dieser Abschnitt (73) die Gesamtheit der Mittelachsen der Spurelemente bedeckt, wobei die von diesem Bereich eingeschlossenen kreisförmigen Umrisse eine orthogonal fluchtende Linie (ΔR) in bezug auf die Mittelachsen bilden.

7. Träger nach einem beliebigen der vorstehenden Ansprüche, dadurch gekennzeichnet, daß die Mittelachsen gekrümmt sind und eine Mitte (o) aufweisen, die mit einer ringförmigen Bezugsoberfläche zusammenfällt.

8. Vorrichtung zur Abtastung eines Informationsträgers nach einem beliebigen der vorstehenden Ansprüche, mit optischen Abtastmitteln, die auf die Bezugsoberfläche einen gebündelten Licht-Fleck richten, der nur mit einem beliebigen der Spurelemente zusammenwirkt, wobei Mittel (B) zur Einstellung der Fokalisierung des Flecks von Photodetektormitteln (10) gesteuert werden, die einen Bruchteil der Strahlung auffangen, die von dem von dem Fleck erleuchteten Abschnitt der Bezugsoberfläche ausgeht, wobei der Fleck nicht über den kreisförmigen Umriß (3) hinausgeht, wenn er auf die Mittelachse (70) des gerade abzutastenden Spurelements zentriert ist und wenn er einen dieser Abschnitte überquert, wobei der von den Photodetektormitteln während dieses Überquerens erzeugte Abtast-Wert (ε'N) des Signals (V_D) die Fokalisierung bewirkt.

9. Vorrichtung nach Anspruch 8, dadurch gekennzeichnet, daß die Abtastung des Werts von einem Identifikationskreis (123) der Vorprägungs-Motive (74) bestimmt wird.

10. Vorrichtung nach Anspruch 8, dadurch gekennzeichnet, daß die Abtastung des Werts von einem Kreis (12) bestimmt wird, der den Übergang des Flecks von einem geprägten Bereich zu einem direkt darauffolgenden nicht-geprägten Bereich feststellt.