The present invention relates to a moving-information-carrying medium in particular in the form of a disk comprising pre-etchings producing tracks along which optically readable information can be recorded. The invention also relates to a device for radially following these tracks.

Numerous devices for radially following tracks have been described in the prior art. When it involves recording information in sequential form, for example video information, generally the tracks are not produced in advance but rather created in real time whilst recording. The information is recorded along the tracks having the form of a single spiral extending from the peripheral zone of the disk to a central zone or vice versa or else having the form of concentric circles centred on the axis of rotation of the disk.

In the simplest systems, there is reliance upon the precision of the units for advancing the recording head to create this track. During reading, information recorded for example in the form of micro-reliefs, interfere with a reading beam focused in the plane of the recording face of the disk. The filing past of these micro-reliefs under the focusing task (sic) modulates the beam and this modulation is detected with the aid of photoelectric cells converting the variations of luminous intensity into electrical signals. These electrical signals may also be used with the aim of following tracks.

The method just described requires the advance of the recording head to exhibit very high mechanical stability in order to avoid two successive grooves overlapping or at least being poorly discernible during reading. With the aim of improving the system just described, a method using the last track inscribed or one of the previously inscribed tracks as reference has been proposed in the French Patent Application published under the number 2,366,636. There is appended to the system for mechanically advancing the recording head a system for optically deflecting the recording spot. The reading spot

is constrained to follow an already inscribed groove of the track through a conventional positional servocontrol. With the aid of the optical deflection system, the recording spot is maintained at a constant distance, equal to an integer multiple of the pitch of the track, from the reading spot.

It is also known from the document US-A-3,919,617 to carry out the following of a track in the middle of an array of adjacent elements by subdividing each track element into sites reserved alternately for information and for specific motifs making it possible to thwart any tendency of the exploration spot to stray from its ideal path. These specific motifs occupy regions which are not facing the data blocks but they are centred in relation to each track element. The recentring of the exploration spot depends exclusively on the optical interactions with the motifs present on the track elements which surround it. The measurement of the off-centring is indirect and sensitive to the variation of the pitch of the track. Moreover, if the specific motifs occupy all the sites reserved for their benefit, the tendency indicating signal cannot be obtained unless these motifs form distinct groupings, which requires a logic unit for detection with cyclic operation. To avoid this constraint, it is possible to restrict the number of sites occupied by the motifs without the possibility of recovering this lost space to house information.

However, when it is desired to record information in random fashion, for example in applications relating to computerisation, it is no longer possible to use the methods just described or analogous methods. It is in general necessary to produce in advance the tracks ahead of which information can be recorded. To do this, it is customary to create a pre-etching in whatever form this be. In an embodiment described in the French Patent Application published under the number 2,365,854, during manufacture of the medium, the tracks are produced in the form of a smooth groove created in an auxiliary layer of this medium. These tracks can be detected even in the

absence of any recording of information, this recording being performed 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 pre-etched tracks can be merged with the regions in which the information is recorded. A so-called single-track system is then obtained.

There is known from the document EP-A-0,032,271 a single-track system in which the pre-etching consists of a continuous groove at the bottom of which there is a modulation of relief marking the beginning of a sector and imparting moreover in the regions for storing information a periodic marking intended to synchronise the serial reading and writing of the binary data. This document makes provision for the periodic marking to be either at the bottom of the groove, or on a level with the surface of the information-carrying medium. The effect of this system is to make it possible to continuously follow the track by virtue of the particular properties of the code for modulating the data which means that the spectral density of the reading signal is reduced at the operating frequencies of the track-following device. A low-pass filter makes it possible to isolate the track-following signal and to rid it of the disturbing frequencies produced by reading the data.

In other methods, the pre-etched 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. To distinguish these two types of tracks it is possible to see to it that the pre-etching consists of a signal which can be decomposed in a first frequency spectrum and information which can be decomposed in a second disjoint frequency spectrum. During writing, the reading beam can be used to follow the pre-etched track as in the second abovementioned French Patent Application.

The main disadvantage of the method just described is that it does not make possible a maximum

recording density since it requires, at the very least, one additional pre-etch track for a pre-etched information track. Moreover, it requires the use of two beams, one for radially following the pre-etched track and the other for writing or reading information on the track intended for recording.

The document Patent Abstracts of Japan, Vol. 5, number 3 (P-61) (745), 15 May 1981, page 125 P61 which corresponds to JP-A-5,622,227 discloses a medium of the so-called single-track type, comprising one pre-etching. These media are also not free from disadvantages. They generally require the use of two beams, one for recording and the other for radial following. Moreover, if the pre-etched track is easily discernible from the rest of the disk (inter-track zones) in the absence of the recording of information, the same is not the case when information is recorded. If precautions are not taken, there can result therefrom reversals of contrast leading to errors in the following.

It is also known from the Patent EP-A-0,077,644 the content of which is included in the state of the art in accordance with Articles 54(3) and 54(4) an information-carrying medium comprising pre-etchings comprising a first centred motif of specific size followed by two motifs which are offset in relation to the mid axis of the track.

The present invention proposes a moving-information-carrying medium with pre-etching in disk form overcoming the disadvantages of the prior art and compatible with single-track/single-beam systems.

The subject of the invention is therefore an information-carrying medium comprising in at least one optically recordable reference surface an array of adjacent track elements along which is arranged a sequence of non-contiguous sites intended for the storing of information in an optically readable form, the said storing sites being separated from each other by interstitial sites comprising motifs for producing the non-sinuous mid axis of the said track elements, which axis

represents the ideal path to be followed by the mid transcriptor of the said information; the said motifs appearing in the discrete form of non-contiguous portions with completed outlines of the said reference surface and maintaining their optical characteristics during the said storing of information, each of the said interstitial sites comprising at least one first motif centred in relation to the said mid axis, characterised in that each of the said interstitial sites comprises at least one second motif, the said motifs having the same width perpendicular to the mid axis and jointly forming along the said mid axis a structure which is specific as regards the length of these two motifs and/or as regards their spatial distribution in the length direction which is identical to itself from one interstitial site to the next.

According to other embodiment variants, each of the said interstitial sites comprises at least one second motif, the said motifs jointly forming along the said mid axis a structure which is specific as regards the length of these two motifs and/or as regards their spatial distribution in the length direction which is identical to itself from one interstitial site to the next and in that the first motif has a width perpendicular to the mid axis substantially equivalent to the width of the tracks.

Similarly, each of the said interstitial sites comprises at least one second motif, offset in relation to this axis; the projection on an axis perpendicular to the mid axis of the second motif not being included in the projection on the same axis of the first motif, the said motifs jointly forming along the said mid axis a structure which is specific as regards the length of these two motifs and/or their spatial distribution in the length direction which is identical to itself from one interstitial site or (sic) next.

The subject of the invention is also an optical device for radially following a track appearing in at least one reference surface of an information-carrying medium in the form of an array of adjacent elements along

which is arranged a sequence of non-contiguous sites intended for the storing of information in an optically readable form, the said storing sites being separated from each other by interstitial sites each comprising at least one first motif centred in relation to a non-sinuous mid axis which represent the ideal path to be followed by the means for optically exploring the said track, which means is constituted by a light spot constrained by the said device to follow the said mid axis; the said motifs being pre-etch motifs which maintain their optical characteristics during the said storing of information and appearing in the discrete form of non-contiguous portions with completed outlines of the said reference surface; the said device comprising photodetecting means supplying, in response to the radiation emerging from the portion of the said reference surface illuminated by the said spot, an electrical signal sensitive to the transverse displacement of the said spot in relation to the said track elements and means for measuring variations, from one pre-etch motif to the next, the said measuring means being sensitive to the values of the said signal which are detected exclusively while exploring the said interstitial sites and generating a compensating signal intended to maintain the said reading spot between the ideal paths of the two guide track elements, characterised in that decoding means analyse the said electrical signal in order to recognise selectively the exploring by the said spot of a structure which is specific as regards its spatial distribution in the length direction and identical to itself from one interstitial site to the next with the exclusion of interstitial sites comprising at least one first centred motif with width greater than the track width; the said structure comprising jointly in each interstitial site at least the said first centred motif and at least one second motif whose lengths and/or spatial distribution define a code which makes it possible to identify a site without ambiguity; the said detected values being selected by command signals derived from the recognition by

the said decoding means of each phase of exploring the said specific structure; each detected value being significant of the optical interaction of the said spot with a pre-etch motif contributing to producing the mid optical axis of the track element during the course of exploration; the said compensating signal changing value in a discrete manner by modification of the content of a memory circuit comprised in the measuring means.

The invention will be better understood and other characteristics will emerge with the aid of the description which follows with reference to the attached Figures in which:

- Figure 1 represents a disk of the prior art and a device for following a track on such a disk;
- Figure 2 represents a disk pre-etching according to the prior art;
- Figures 3 to 6 represent a disk pre-etching according to several embodiment variants conforming to the invention;
- Figures 7 to 9 represent electrical diagrams of track-following devices according to several variants conforming to the invention;
- Figures 10 and 11 are diagrams which explain the functioning of the device of the invention.

The invention relating to a pre-etched type information-carrying medium and a device for radially following one of the tracks of such an information-carrying medium, it is useful to recall the main elements constituting a system for recording and/or reading information-carrying media, in particular media in the form of optically writable and readable disks.

Figure 1 represents an information-carrying medium 5 of the prior art in the form of a circular disk able to rotate in a plane XOY about an axis parallel to the third axis of a reference triad XYZ. The lower face of this disk is here assumed smooth; the upper face which is parallel to it is also smooth, but includes a pre-etched track 7 in the form of a smooth track the substantially constant width of which is of the order of or less

than a micrometre.

Such a disk can be used either to write information at a specified point of one of the smooth tracks written earlier, or to read information written at any point of this track. The disk, for example of a diameter of about 30 cm, is instilled with a rotary motion communicated by a drive motor integral with the chassis of the optical recording-reading system. In this embodiment, the device for access has (sic) a specified track of the disk comprises a fixed part comprising two sources of light energy (not represented in Figure 1) and a moving part constituted by the recording-reading head. As is known, the latter comprises an objective of the microscope type O_b, integral with an electromagnetic coil B displacing in the magnetic field of a permanent magnet (not represented) ensuring the vertical servocontrol and a galvanometric mirror M_1 ensuring the radial servocontrol. The sources of light energy, as is likewise known, include laser sources, for example semiconductor or He Ne gas lasers. Gas lasers deliver a parallel polarised beam the cross-section of which is very small. The laser beam must be enlarged so as to cover the entrance pupil of the objective, whatever the position of the objective along the optical axis. To implement this requirement, it has been proposed in the French Patent Application FR-A-2,462,758 to insert an afocal type optic between the sources of light energy and the moving recording-reading head.

For reading, a parallel laser beam f_1 produced by a laser source (not represented in Figure 1), is enlarged with the aid of an afocal, the magnification of which is such that the emergent beam, also 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. The objective O_b focuses the reading beam at the point 3 on the information-carrying medium disk 5. This disk is instilled with a rotary motion symbolised by the arrow 6. The objective and the mirror are integral with a moving element constituting the recording-reading

head. The advance of this moving assembly may be obtained through any known means.

The same afocal is then used for the recording beam f_e, this beam having previously been modulated. In order to distinguish the spots for reading and recording on the disk, the recording beam f_e is very slightly inclined in relation to the reading beam f_1 in such a way that the decentring of the recording beam on the entrance pupil of the objective is very limited and in such a way that the displacement of the beam during a radial displacement of the head can be neglected. It follows that whatever 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.

The pre-etching of the track in the form of a "smooth" groove 7 can appear in various guises. It may for example be a sunken pre-etching, along an array of track elements arranged according to concentric circles or organised according to a spiral. The width of the track elements is chosen slightly less than the diameter of the light spot and these elements are separated by inter-track gaps whose width is slightly greater than the width of the track. The upper surface of the medium receives a thin layer suitable for writing through a thermo-optic method. This disposition of elements enables the track to be explored before writing, since the interaction of the reading task (sic) with the track delivers dispersed radiation, whereas the inter-track gaps are not generators of dispersion.

As far as the phase for recording the disk is concerned, the exposing of the sensitive layer serving in the writing is performed by a spot whose intensity is modulated for example by a square-wave electrical signal with variable or constant widths depending on the applications which constitute the information-carrying medium. The incorporation of information into the modulating signal is performed as the case may be, by frequency or phase modulation, or by any method of coding capable of

delivering a pulsed coded message; the information may itself also be directly the modulating signal.

To detect the reading beams reflected by the disk, a semi-transparent sheet M_2, for example, is interposed in the path of the beam f_1. The reflected beam is then sent to photodetecting and signal processing means which can deliver on the one hand an error signal ϵ which enables control of the motor 2 enabling guidance of the position of the mirror M_1, thereby implementing a radial servocontrol, and on the other hand an error signal ϵ' which enables control of the coil B integral with the objective OB thereby implementing a focusing servocontrol. All these techniques well known to the expert and (sic) exceed the scope of the invention.

The processing means can also deliver a signal S(t) representing the useful information recorded on the disk. In fact, during the filing past of the elements recorded on the tracks 7, a signal S(t) which faithfully manifests the time variations of the signal recorded on the track is gathered by reading.

In the writing phase, the reading beam f_1 is used to ensure the radial servocontrol with the aid of the pre-etching but can also be used with the aim of real time checking of the information undergoing recording, or "monitoring" following the commonly used expression.

Although requiring only one surface corresponding to the width of a single track, in contrast to the methods which employ one or two pre-etched tracks which are adjacent or flanking the useful track, the prior art method just recalled in relation with Figure 1, nevertheless has disadvantages.

Everything happens, from the detection point of view, as if the tracks were darker than the inter-track zones. Any track-following straying may therefore be easily detected by virtue of this amplitude contrast. When the layer covering the medium is subjected to the writing radiation, the written zones may be brightened for certain heat-sensitive materials, which contributes to creating a good contrast along the track.

Nevertheless, these brightened zones tend to merge with the weaker density of the neighbouring inter-track zones, which causes radial loss of the contrast required to ensure good track-following.

It is therefore seen that the writing is prejudicial to the good radial locating of the tracks in all the zones in which the layer has stored data.

Moreover, two different beams must be employed, at least during the writing periods: a writing beam and a reading and/or radial-following beam.

The invention proposes a pre-etched type optical disk making possible, among other advantages, simultaneously, a single-track configuration and requiring the use of only a single beam, and this without interference of the pre-etching with the etching representing the useful information.

According to the main characteristic of the invention, the pre-etching appears in the form of discrete elements or delimiters which alone define the mid axis of the track to be followed. This track is therefore virtual. Given the speed of rotation of the disk, the spatial distribution of these pre-etch elements must be sufficient to satisfy the Shannon criterion: typically on a 30 cm diameter disk of which an 8 cm wide ring represents the useful recording zone, about 40,000 tracks are available, each comprising of the order of 3500 delimiters.

In what follows, the recording of digital data being the main application envisaged in the scope of the present invention, and this without being limiting, a medium will be described on which the tracks are distributed according to concentric and equidistant circles.

The useful information is recorded between two successive delimiters. In this context, if a recording configuration in block form is desired, the spatial distribution of the delimiters is preferably uniform.

Figure 2 illustrates a first embodiment conforming to the state of the art. The pre-etching appears in the form of smooth track segments 71 defining

the mid axis 70 of tracks along which the information can be recorded. As has just been recalled, between two identical delimiters 71, there is a zone free all (sic) information 72 before recording. The direction of rotation of the disk has been represented in Figure 2 by the arrow R.

It must of course be understood that the track 7 represented in the figure is a virtual track whose mid axis 70 represents the ideal path to be followed by a writing beam.

To do this, the signals required for the radial servocontrol of the writing head will be derived from the detection of the delimiters 71 by track-following means which will be described in a more detailed way in what follows. The recording head can be a head similar to that illustrated by Figure 1. When the pre-etch elements 71 file past under the spot for focusing a track-following beam which may be the reading beam or as will also be detailed subsequently, the writing beam, a track-following signal may be generated in a conventional way. By way of example, the so-called "push-pull" method may be used which consists in using two photodetecting cells each detecting a fraction of the track-following beam, either after reflection, or after transmission through the disk. The two cells are disposed in the space on either side of the optical axis of the beam and the electrical signals produced by these two cells are transmitted to the inputs of a differential amplifier which performs the algebraic sum thereof. When the task (sic) of the track-following beam is centred on the track, the signal at the output of the amplifier is zero. When a decentring appears, the amplitude and the sign of this signal is representative of the direction and of the amplitude of this decentring. This signal is transmitted to the radial servocontrol circuit, 2 in Figure 1.

As opposed to the known methods, the means for processing the signals must record the measurement during the time interval elapsing between two passages of successive delimiters into the zone illuminated by the

track-following spot. According to the invention, the servocontrol signal may be deduced from the change in the signal measured at these two instants.

It is also necessary, if it is required to record information only in the useful zone 72 localised between two successive delimiters 71, to inhibit the writing beam when one of these delimiters lies in the zone illuminated by the writing task (sic). The distinguishing between the delimiters and the information recorded between two delimiters may be facilitated if these delimiters are endowed with a structure which enables their selective identification.

Figure 3 illustrates such an embodiment. Each delimiter 71 is divided into several segments 710, 711 whose lengths and spatial distribution define a code which makes it possible to identify a delimiter without ambiguity.

To improve the quality of the radial servocontrol, it is also known to wobble the beam for following by imparting thereto a mild fixed-frequency oscillation on either side of the mid axis of the track. In a preferred variant of the invention, this wobbling can be created with the aid of motifs which are asymmetric in relation to the axis 70 of the following. To do this, each delimiter comprises, in addition to one or more segments centred on the mid axis of the track and indicating the start of the delimiter, one or more other segments offset in relation to this mid axis.

In a first, simplest variant, illustrated by Figure 4, a first delimiter 71 comprises a segment 710 centred on the mid axis of the track 70 and a second segment 711-L offset to the left of this axis. The following delimiter 71' also comprises a first segment 710 centred on the mid axis 70 and a second segment 711-R offset to the right of the axis. This sequence is repeated. The separation between the offset segments and the axis 70 of the track is of the order of a fraction of the width of the following-spot.

In a second variant, each delimiter comprises at

least one segment offset to the left and one segment offset to the right. This variant is illustrated by Figure 5. This variant has the advantage of offering twice the track-following error signal sampling frequency of the preceding variant. In fact, it is not necessary to wait for the passage of two successive delimiters in order to formulate a track-following error signal.

Finally, it may be advantageous to combine the advantages of the structure illustrated by Figure 3 to those of the structure illustrated by Figure 5. Such a configuration is illustrated by Figure 6. A second delimiter 73, used to generate a synchronisation signal, is associated with the main delimiter 71 containing segments offset on either side of the mid axis 70 used to generate a radial-following error signal. Preferably, the delimiter 73 represents a particular code which makes it possible to identify it selectively in relation to the other recorded information.

The precise manner in which the information is recorded exceeds the scope of the invention. Any known method may be used. The delimiters 71, 71' and the useful information recorded in the zones 72 may, to fix ideas and without this being limiting, consist of sunken or raised micro-reliefs, for example through ablation of a surface layer with the aid of the writing laser beam. Preferably, the portions of delimiters all have the same width and the offset portions 711-L and 711-R have equal length and equal offset.

A track-following device of a type bearing pre-etchings according to the invention, that is to say consisting of discrete elements distributed over a track and delimiting useful zones intended for the recording of data, will now be described. The system for recording-reading information on the disk may be similar to that described in relation with Figure 1. Identical elements will not be described again. Only the circuit labelled 1, formulating the radial-following error signal is specific.

Figure 7 illustrates a first, simplified variant

of such a circuit. This variant is more particularly adapted to pre-etchings of the type illustrated by Figure 2. It contains a photoelectric detector 10 and a measuring circuit 11 formulating the radial-following error signal ϵ. The detector 10 can contain two cells as has been previously mentioned. The output signals from these cells V_D are transmitted to measuring circuits 11 which can contain a differential amplifier as has also been described. However, according to the invention, measurements must be performed solely during the times of passage of the delimiters into the zones illuminated by the radial-following spot. If the recording of data is organised by blocks, a clock signal H necessary for the synchronisation of the measurement can be deduced from the length of the blocks and from the speed of rotation of the disk. These clock pulses can be transmitted to a clock input terminal of a sample-and-hold circuit receiving at its input the signal produced by the differential amplifier and generating at its output a signal ϵ, stored from one pulse to the next, representing the radial-following straying. This signal can be smoothed with the aid of a low-pass filter.

Figure 8 illustrates a second circuit variant applying more particularly to pre-etchings of the type illustrated by Figure 3, that is to say coded and identifiable by themselves. The signals V_D are transmitted to sampling circuits 12 containing a decoder generating a synchronisation signal H transmitted to the measuring circuits when the code read corresponds to the specific code of the delimiters. The synchronisation signal H authorises the taking into account of the measurement and the generating of a radial-following error signal.

Figure 9 illustrates a third variant track-following device specially adapted to the delimiters of the type comprising portions offset in relation to the mid axis of the tracks and more particularly to the pre-etching of the type illustrated by Figure 6 containing a first synchronisation delimiter 73 and a second delimiter used with the aim of formulating a track-following error

signal. In this case, the means of detection 10 may consist of a single detector deliver (sic) electrical signals V_D on the one hand to the measuring circuit 11 and on the other hand to sampling circuits 12 and to a decoder 13. This decoder selectively detects the passage of the synchronisation delimiters 73 into the zone illuminated by the track-following spot and formulates a sampling authorization signal V_{AE} transmitted to the sampling circuits 12. The formulation of a radial-following error signal may be performed, according to two main variants, either by peak sampling or, when the offset portions are of equal length, by integration. A signal processing circuit, respectively 110 and 111, is associated with the reading of each of the offset marks 711-L and 711-R. If a peak-sampling method is employed, these circuits may consist of circuits of the sample-and-hold type. In the second case, when an integration method is employed, these circuits may consist of an integrator associated with a storage circuit. As is known, the integration circuit may be based on a controlled integrator associated with an analog memory (capacitor for example). The role of the sampling circuits 12, whose operation is authorised by the synchronisation signal V_{AE}, is to formulate signals H_1 and H_2 synchronising the taking into account of the measurements performed on the portions offset to the left and to the right respectively of the delimiters 71. These signals are transmitted to the first and second processing circuits 110 and 111. These sampling circuits also receive the signals generated by the detector 10.

The diagram of Figure 10 illustrates the three characteristic possibilities for the position of the track-following spot in relation to the mid axis of the track 70. In the upper part of the diagram, the curve V_1 illustrates the case in which the track-following spot is offset to the left of the mid axis of the track, it being understood that the direction of rotation is that indicated by the arrow R in Figure 6. In this case, the interaction of the segment 711-L with the track-following

beam is larger than that of the segment 711-R. The curve V_1 represents the absolute value of the amplitude of the electrical signal delivered by the means of detection 10. During the time window θ_1, which corresponds to the passage of the portion 711-L into the zone illuminated by the track-following spot, the signal V_1 has a larger amplitude variation than the amplitude variation during the time window θ_2 which corresponds to the passage of the portion 711-R. The differences of amplitude and of sign between these two signals are representative of the direction and of the amplitude of the offset of the spot in relation to the mid axis of the track. Outside these windows, in the absence of etching, the signal delivered by the means of detection remains constant.

In the middle part of the diagram, the curve V_2 illustrates the case or (sic) the track-following spot is centred on the mid axis of the track. The variations of the signal delivered by the means of detection 10 in the windows θ_1 and θ_2 are identical.

In the lower part of the diagram, the curve V_3 represents the case in which the track-following spot is offset to the right in relation to the mid axis for the following of the track.

If an integration method is employed, the sampling circuits formulate, on the basis of the electrical signals delivered by the means of detection 10 and the signal for authorising the decoder V_{AE}, two pulses H_1 and H_2 coincide (sic) with the time windows θ_1 and θ_2. These two pulses authorise the operating for their respective durations of the first and second integrators 110 and 111.

If the peak-sampling method is employed, it is then necessary to deliver to the two sample-and-hold circuits 110 and 111 two brief duration pulses H_1 and H_2, centred on the middle times T_1 and T_2 of the windows θ_1 and θ_2. Each sample-and-hold circuit takes into account, for example on the rising front of the pulse which is transmitted to it, the signal delivered by the means of detection 10. The value of the signals thus sampled is

then stored until the next measurement. The outputs of the two signal processing circuits 110 and 111 are connected up to the inputs of a comparator 112 which may consist of a differential amplifier and which delivers at its output a staircase signal ϵ_N representing the radial-following error. To be truly exploitable, it is useful to smooth this signal with the aid of a low-pass filter 113 whose output delivers the radial-following error ϵ.

Figure 11 represents an example of variation of offset δ of the radial-following spot 3 in relation to the mid axis 70 of a track, this as a function of time. In the lower part of the same diagram, the corresponding variation of the error signal ϵ as a function of time is represented by the dashed curve. The variation of the radial-following digital error signal ϵ_N is also represented on this same diagram. The latter signal varies in line with the passage of the delimiters 71 under the radial-following spot and it remains constant between two successive passages.

In a preferred variant of the invention, a single beam is employed. For this purpose, during the information recording periods, the writing beam is used sequentially as track-following beam during the intervals of passage of delimiters 71 into the zone illuminated by the spot produced by this beam and as writing beam in the other time intervals. For this purpose, the writing circuits are inhibited during the passage of the delimiters. The signal produced by the decoder 12: V_{AE}, can be used, possibly after logic inversion, to inhibit the writing circuits. The writing circuits are conventional circuits common to the prior art and which do not require any particular description. The same writing beam is also used for reading. For this purpose, there is inserted, as is known, an optical modulator attenuating the light intensity of this beam for a gas laser. In the case of a semiconductor laser the intensity of the energy emitted can be modulated directly by the polarising voltage. As before, the signal V_{AE} can be transmitted to the reading circuits to inhibit this reading during the passage of

the delimiters.

The invention therefore has simultaneous advantages of the single-track systems, that is to say a maximum recording density, bearing in mind that the delimiters occupy only a small area in relation to the useful information, and of the single-beam systems, that is to say simplicity and cost reduction.

CLAIMS

1. Information-carrying medium comprising in at least one optically recordable reference surface an array of adjacent track elements (7) along which is arranged a sequence of non-contiguous sites (72) intended for the storing of information in an optically readable form, the said storing sites (72) being separated from each other by interstitial sites (71) comprising motifs for producing the non-sinuous mid axis (70) of the said track elements (7), which axis represents the ideal path to be followed by the mid transcriptor of the said information; the said motifs appearing in the discrete form of non-contiguous portions with completed outlines of the said reference surface and maintaining their optical characteristics during the said storing of information, each of the said interstitial sites comprising at least one first motif centred in relation to the said mid axis (70), characterised in that each of the said interstitial sites comprises at least one second motif (711-L or 711-R), the said motifs having the same width perpendicular to the mid axis (7C) (sic) and jointly forming along the said mid axis (7C) (sic) a structure which is specific as regards the length of these two motifs and/or as regards their spatial distribution in the length direction which is identical to itself from one interstitial site to the next.

2. Information-carrying medium comprising in at least one optically recordable reference surface an array of adjacent track elements (7) along which is arranged a sequence of non-contiguous sites (72) intended for the storing of information in an optically readable form, the said storing sites (72) being separated from each other by interstitial sites (71) comprising motifs for producing the non-sinuous mid axis (70) of the said track elements (7), which axis represents the ideal path to be followed by the mid transcriptor of the said information; the said motifs appearing in the discrete form of non-contiguous portions with completed outlines of the said reference surface and maintaining their optical

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characteristics during the said storing of information, each of the said interstitial sites comprising at least one first motif centred in relation to the said mid axis (70), characterised in that each of the said interstitial sites comprises at least one second motif (711-L or 711-R), the said motifs jointly forming along the said mid axis (70) a structure which is specific as regards the length of these two motifs and/or as regards their spatial distribution in the length direction which is identical to itself from one interstitial site to the next and in that the first motif has a width perpendicular to the mid axis substantially equivalent to the width of the tracks.

3. Information-carrying medium comprising in at least one optically recordable reference surface an array of adjacent track elements (7) along which is arranged a sequence of non-contiguous sites (72) intended for the storing of information in an optically readable form, the said storing sites (72) being separated from each other by interstitial sites (71) comprising motifs for producing the non-sinuous mid axis (70) of the said track elements (7), which axis represents the ideal path to be followed by the mid transcriptor of the said information; the said motifs appearing in the discrete form of non-contiguous portions with completed outlines of the said reference surface and maintaining their optical characteristics during the said storing of information, each of the said interstitial sites comprising at least one first motif centred in relation to the said mid axis (70), characterised in that each of the said interstitial sites comprises at least one second motif (711-L or 711-R), offset in relation to this axis; the projection on an axis perpendicular to the mid axis (7C) (sic) of the second motif (711-L or 711-R) not being included in the projection on the same axis of the first motif (710), the said motifs jointly forming along the said mid axis a structure which is specific as regards the length of these two motifs and/or their spatial distribution in the length direction which is identical to itself from one



interstitial site or (sic) next.

4. Medium according to Claims 1 to 3, characterised in that the spatial distribution of the said interstitial sites (71) along the said track elements (7) is uniform.

5. Medium according to any one of Claims 1 to 4, characterised in that the medium being in the form of a disk, the said mid axes (70) of the said track elements (7) assume, in the said reference surface, the form of circles configured as concentric equidistant turns.

6. Medium according to any one of Claims 1 to 5, characterised in that each of the said centred motifs is a constant width, smooth track segment defined by an optically detectable modification of the said reference surface.

7. Medium according to any one of Claims 1 to 6, characterised in that each of the two interstitial sites (71, 71') contiguous to any one of the said storing sites (72) is provided with an auxiliary pre-etch motif which has a lateral misalignment in relation to the said mid axis (70); the said mid axis (70) being situated at an equal distance from the said auxiliary pre-etch motif and from another auxiliary pre-etch motif having a lateral misalignment in the opposite direction and of equal extent; the said auxiliary pre-etch motifs occupying positions which are predetermined in relation to the said structure.

8. Medium according to Claim 7, characterised in that two consecutive interstitial sites (71, 71') respectively comprise a misaligned motif (711-L) offset on one side of the said mid axis (70) and a misaligned motif (711-R) offset on the other side of the said mid axis (70).

9. Medium according to Claim 7, characterised in that each interstitial site (71, 71') successively comprises a first misaligned motif (711-L) offset on one side of the said mid axis (70) and a second misaligned motif (711-R) offset on the other side of the said mid axis (70).

10. Optical device for radially following a track

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appearing in at least one reference surface of an information-carrying medium in the form of an array of adjacent elements (7) along which is arranged a sequence of non-contiguous sites (72) intended for the storing of information in an optically readable form, the said storing sites (72) being separated from each other by interstitial sites (71) each comprising at least one first motif centred in relation to a non-sinuous mid axis (70) which represent the ideal path to be followed by the means for optically exploring the said track, which means is constituted by a light spot constrained by the said device to follow the said mid axis (70); the said motifs being pre-etch motifs which maintain their optical characteristics during the said storing of information and appearing in the discrete form of non-contiguous portions with completed outlines of the said reference surface; the said device comprising photodetecting means (10) supplying, in response to the radiation emerging from the portion of the said reference surface illuminated by the said spot, an electrical signal (VD) sensitive to the transverse displacement of the said spot in relation to the said track elements and means (11) for measuring variations, from one pre-etch motif to the next, the said measuring means being sensitive to the values of the said signal which are detected exclusively while exploring the said interstitial sites and generating a compensating signal (ϵ) intended to maintain the said reading spot between the ideal paths of the two guide track elements, characterised in that decoding means analyse the said electrical signal in order to recognise selectively the exploring by the said spot of a structure which is specific as regards its spatial distribution in the length direction and identical to itself from one interstitial site to the next with the exclusion of interstitial sites comprising at least one first centred motif with width greater than the track width; the said structure comprising jointly in each interstitial site at least the said first centred motif and at least one second motif whose lengths and/or

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spatial distribution define a code which makes it possible to identify a site without ambiguity; the said detected values being selected by command signals (H) derived from the recognition by the said decoding means of each phase of exploring the said specific structure; each detected value being significant of the optical interaction of the said spot with a pre-etch motif contributing to producing the mid optical axis of the track element during the course of exploration; the said compensating signal changing value in a discrete manner by modification of the content of a memory circuit comprised in the measuring means.

11. Optical device according to Claim 10, characterised in that the said compensating signal (ϵ) arises from the comparison of two components of the said electrical signal (VD), respectively produced by two adjacent photodetecting cells belonging to the said photodetecting means (10); the said components representing the interaction of the said spot with a centred pre-etch motif situated in each of the said interstitial sites (71).

12. Optical device according to Claim 10, characterised in that the said compensating signal (ϵ) arises from the comparison of two samples taken from the same output terminal of the said photodetecting means (10); the said samples representing the successive interactions of the said spot with two pre-etch motifs having equal misalignments of opposite signs in relation to the said mid axis; the said misaligned motifs being situated in the said interstitial sites (71).

13. Device according to any one of Claims 10 to 12, characterised in that, the photodetecting means (10) comprising at least one photodiode, the means (11) for measuring the compensating signal (ϵ) comprise at least one sample-and-hold circuit intended to measure the amplitude of electrical signal generated by the said photodiode at an instant determined by a time window coinciding with the passage of a discrete pre-etch element assigned to the track-following in the portion of the reference surface illuminated by the said spot and to

store this measurement during the time interval elapsing between two successive measurements.

14. Device according to any one of Claims 10 to 12, characterised in that, the photodetecting means (10) comprising at least one photodiode, the measuring means (11) comprise at least one signal integrator permanently receiving the electrical signal generated by the said photodiode during the time window elapsing during the passage of at least one given portion of the said discrete pre-etch element assigned to the track-following in the portion of the reference surface illuminated by the said spot and storing the signal thus integrated during the time interval elapsing between two successive measurements.

15. Device according to Claim 13, characterised in that sampling means (12) generate a brief pulse centred on the said time windows which are applied to the sample-and-hold circuit and authorising the taking into account of the said measurement.

16. Device according to Claim 14, characterised in that sampling means (12) generate the pulses of equal durations synchronised on the said time windows and transmitted to the said integrator in order to authorise integration during the intervals of the said time windows.

17. Device according to either of Claims 10 and 12, characterised in that, the said discrete pre-etch elements (71) being divided into several portions and comprising a first (711-L) and a second (711-R) portion which are offset respectively on either side of the said mid axis (70), the measuring means (11) are divided and comprise a first means (110) performing a measurement synchronised on the passage in the portion of the reference surface illuminated by the said spot of the portion (711-L) of the said pre-etch elements, offset on a first side of the said mid axis (70) and storing this measurement in the time interval elapsing between two successive measurements and a second measuring means (111) performing a measurement synchronised on the passage of the

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portion (711-R) of the said discrete pre-etch elements, offset on the other side of the said mid axis (70) and storing this measurement in the time interval elapsing between two successive measurements, a comparison means (112) with differential inputs continuously receiving the signals stored by the said first (110) and second (111) measuring means and a low-pass filtering means (113) supplying a smoothed feedback signal (ϵ) applied to means for displacing the said spot.

18. Device according to any one of Claims 10 to 17, characterised in that the means for optically exploring the said track comprises inhibiting means intended to prevent the said light spot from modifying the optical characteristics of the reference surface while exploring the said interstitial sites; the said optical exploration means being capable of modifying the said optical characteristics during the course of exploring the information storing sites; the said inhibiting means being controlled by the said command signals.