

5 The present invention relates to optical memories
intended for the storage of data in reserved zones of the
surface of an information carrier. In order to permit
easy and rapid access to the data zones, this type of
10 information carrier may be presented in the form of a
disk, the reference surface of which is broken down into
regularly spaced track elements. These track elements
espouse, for example, the trace of the turns of a spiral
of constant pitch having a centre coincident with that of
15 a centring orifice. The arrangement of the data zones
also complies with an angular division into sectors,
which are themselves subdivided into blocks to contain
the data and the addresses which are essential for the
designation of the track elements and of the sectors. By
20 virtue of this radial and angular distribution, it is
possible to manage the transcription of the data in a
particularly flexible manner with a write-read head which
is displaced radially facing the reference surface of the
disk, either to follow regularly a track element or to
25 clear rapidly by jumping the distance separating any two
track elements. The choice of the sector or of the data
block is linked to the rotation of the disk, which
rotation is in general sufficiently rapid to permit a
high data rate. In order to constitute the track elements
30 and the portions of the latter which are allocated for
storing the data, the reference surface of the disk is
marked out with pre-engraved references which are in-
serted between the data zones. The progressively closer
repetition of these references permits the compulsion of
35 a light spot to be centred precisely on the axis of the
track in spite of the defects of eccentricity of the
disk. Certain references are formed from pre-engraved
patterns which are specifically intended for the cali-
bration of a clock which graduates the serial arrangement
of the data and of the other references explored by the
light spot.

 The reference surface of an optical memory
presents at the location of the pre-engraved patterns a
change of optical characteristic which is analysed by a

very fine light spot. Thus, the optical exploration of the disk ensures the detection of the track following errors and of the losses of synchronism which it is necessary to compensate. Other modifications of optical characteristics are produced by the inscription of the data, but measures are taken in order that this writing or post-engraving should not affect the pre-engraved patterns which are necessary for track following and for clock synchronisation.

The use of an optical memory such as a pre-engraved optical disk necessitates the application of an optical reader which comprises means for the projection of a light spot which is as fine as possible into the reference surface of the disk, means for the radial displacement of this spot, photodetector means for analysing the radiation which has interacted optically and which emerges from the illuminated area of the reference surface and means permitting the transfer to the disk of a rotation movement. In the case of an optical disk with a high density of information, it is essential to provide radial slaving of the spot and its automatic focusing.

Finally, in order to inscribe the information on the disk it is necessary to modulate the intensity of the light spot in order to induce in the data zones the modifications of optical characteristics which are indelible or erasable and which represent the useful information.

In the case of optical disks having a track pitch close to two microns, reading with a spot of diameter close to one micron permits the utilisation of the technique of track following by sampling of pre-engraved patterns which are eccentric in relation to the axis of the track. The circuit which executes the radial slaving of the spot is designed to compare two samples of detected signal which correspond to a pair of eccentric patterns. The arrangement adopted is such that the radial offset of the second pattern explored in relation to the first maintains the same direction in each pair found.

If the angular subdivision of the disk into blocks and sectors takes place along radii, the eccentric patterns are radially aligned with a pitch which corresponds to the pitch of the track elements. In order to increase the density of information on an optical disk, it becomes necessary to reduce the track pitch. It is possible to tighten up the pitch of the track to a marked extent below the value indicated hereinabove, while maintaining correct reading of the data, but the detection of a track following error raises difficulties.

The lack of resolution which is found in the radial direction is attributable to the mutual approach of the pre-engraved patterns, since the eccentric configuration of these patterns makes it possible to overlap them by the read light spot.

With a view to alleviating this disadvantage, the present invention proposes to reverse, from one revolution or from one fraction of a revolution to the next, the order of the shifts of the pre-engraved patterns. In the course of reading a disk thus modified, the reversal of order may be taken into account by an appropriate switching circuit.

The subject of the present invention is an information carrier comprising on a reference surface adjacent track elements constituted by pre-engraved patterns, said elements defining equidistant exploration lines and said patterns defining orthogonal straight lines which divide the track elements into equal portions and define intersections to each of which at least one of said patterns is attached, said patterns presenting identical shifts of opposite signs which alternate from one pattern to the other with respect to said exploration lines such that along each of these lines at least one periodic sequence of alternately shifted patterns is constituted, characterised in that the orthogonally aligned patterns are disposed symmetrically with respect to median lines included between two immediately adjacent exploration lines, and are separated by alternately reduced and increased distances.

The subject of the invention is also the device for the optical reading of an information carrier having the arrangement of pre-engraved patterns which is mentioned hereinabove, as the loop which executes the radial following of a track element must comprise at least one permutation means enabled by the track jump command.

Accordingly, the subject of the invention is also a device for reading an information carrier comprising means for the optical detection of a read radiation which has interacted with said carrier in that part of its reference surface illuminated by a read spot, means allowing displacement of said spot transversely with respect to adjacent track elements in said reference surface and slaving means of the sampling type allowing compulsion of said spot to follow the exploration lines of said track elements due to the exploration of pre-engraved patterns constituted by spaced islands which are used to constitute said track elements, characterised in that permutation means are associated with said slaving means of the sampling type, said permutation means being enabled at least at each track jump equal to an odd number of track element steps.

The invention will be better understood by means of the description which will follow and of the accompanying figures, in which:

Figure 1 represents an arrangement of pre-engraved patterns of a known type with illustration of the associated read signal.

Figure 2 is an explanatory figure.

Figure 3 represents an arrangement of pre-engraved patterns according to the invention.

Figure 4 is an explanatory figure.

Figure 5 represents a modified embodiment of the invention.

Figure 6 represents another modified embodiment in which the patterns are also intended for the phase calibration of a clock.

Figure 7 illustrates a form of pattern which is more compact than in Figure 6.

Figure 8 gives an example of a sector heading for a pre-engraved optical disk.

Figure 9 is a diagram of a reading device according to the invention.

5 Figure 10 is a diagram of a modified embodiment of the reading device according to the invention.

Figure 11 is an explanatory figure.

10 In the description which will follow, an optical disk has been chosen as an example of an information carrier, although the invention can also certainly be applied to other forms of carriers such as a card, a tape or a cylinder.

15 Although the expression "pre-engraving" suggests that the reference surface of the information carrier comprises patterns corresponding to surface irregularities, the invention is applied to patterns which are distinguished from the surrounding surface by a change of optical characteristic such as the reflectance, without
20 any necessity to make use of surface irregularities. The pre-engraving may be obtained by a process of copying by contact with a matrix comprising an appropriate surface relief, but it may also result from the optical interaction between a write beam and the initially virgin surface of an information carrier. Accordingly, what is
25 involved is a prior recording which is essential to constitute track elements to be followed.

The distribution of the data to be stored in the reference surface of an optical disk complies with the diagram of Figure 4, which shows a disk 83 viewed from
30 the front. The reference surface is subdivided angularly into sectorial zones by straight lines 67, 69, 70, 71 and 72, that is to say radii which start from the centre M. As illustrated in Figure 4, the sector included between the radii 71 and 72 is further subdivided into equal
35 parts in order to accommodate therein data blocks. In the example chosen, the number of sectors is odd, as is the number of blocks per sector; this leads to an odd number of blocks for a complete revolution of the disk. In certain cases, it is naturally possible to choose an even

number of blocks per revolution. It is moreover known that on an optical disk the data are accommodated along a track. In Figure 4, this track is represented by its exploration line 68 in dot and dash lines, which, by way of nonlimiting example, espouses the form of a spiral of regular pitch of centre M. Accordingly, the track is formed from a network of equidistant elements each representing a complete turn. Three turns are represented in Figure 4, starting and finishing at the reference radius 67. To illustrate the succession of the data blocks, along the track, its axis has been graduated at the height of the heading of each block with the numbers from 0 to 45. Between two consecutive track elements, there is an intertrack diagrammatically shown in Figure 4 by its axis in broken lines 73. Between two graduations, such as 9 and 10, there extends a data zone. Another data zone similar to the first extends between the graduations 24 and 25.

A data zone adjacent to the first is for example that which extends between two other graduations of the same turn. The data zones are in fact interposed zones which are not contiguous either radially or axially, since in line with each graduation there is provided a specific zone which encloses pre-engraved patterns intended to constitute the track.

Figure 1 is a partial plan view of the content of a specific zone. The figure shows the exploration lines 58, 59 and 60 of three successive turns with centres on each one of them, to the left and to the right, the end portions 50 of the data zones which encompass it. The end portions 50 are presented, for example, in the form of pre-engraved patterns in the form of grooves which are interrupted by the specific zone. It is assumed in the example of Figure 1 that the track element is narrower than the intertrack, so that in the course of an optical read with the spot 53 the track appears darker than the intertrack having regard to the fact that it diffracts the light more. The straight lines 67, 69, 70, 71 and 72 are orthogonal to the network of equidistant exploration

lines.

At the centre of Figure 1 it is possible to see the pre-engraved patterns 51 and 52 by virtue of which it is possible to determine the following error of the spot with respect to the axis of the track. These patterns associated with other patterns (not shown) form the heading of a sector or of a data block.

The patterns 51 and 52 are likewise eccentric with respect to the axis of the track, so that their interactions with a centred spot 53 are equal. The lower part of Figure 1 shows as a function of the time t , the read signal $S(t)$ delivered by a photosensor which collects the radiation resulting from the interaction of the area of the pattern with that of the read spot. The solid line curve 61 relates to a spot exploring the track without following error.

A rise in the signal $S(t)$ is observed on each occasion when the part of the spot which illuminates the framing of the patterns increases. The detected level is thus higher in the course of the exploration of the patterns 51 and 52, since they are eccentric and it becomes even higher when it falls into a part free from pre-engraved patterns.

The broken line traces 54 and 56 of the outline of the spot correspond to exploration stages of the line 59 for which the spot has shifted towards the exploration line 58. The signal $S(t)$ then exhibits changes in levels which are illustrated in broken lines. The level rises in the parts 62 and 64, since the spot covers to a lesser extent the patterns 50 and 52. On the other hand, the level falls in the part 63 as the spot is shifted in the same direction as the pattern 51. In sampling the levels 63 and 64 and subtracting the values sampled, a track following error signal is obtained in a known manner. The broken line traces 55 and 57 relate to a spot which is decentred in the opposite direction with respect to the exploration line 60; this produces a reversed sign error signal, the level 63 being on this occasion higher than the level 64.

In a modified embodiment not shown in Figure 1, only one of the patterns 51 and 52 is provided within a specific zone, the other being provided in the specific zone which precedes it and that which follows.

5 The configuration illustrated in Figure 1 is satisfactory when the spacing of the exploration lines 58, 59 and 60 is relatively large in relation to the diameter of the read spot. In fact, the spot is sufficiently fine not to be able to span two adjacent
10 patterns 51 or 52 which are presented with the same spacing as the centred patterns 50.

 The same is no longer true when the same arrangement of shifted patterns is employed while tightening up the pitch of the tracks.

15 An arrangement of density which is one and a half times greater is shown in Figure 2. The diameter 66 of the spot 53 represents, for example, the mid-height width of the distribution law 65 of the luminous intensity received by the surface of the information carrier.
20 Although the spot 53 is still able to read the inscribed data, along the patterns 50, its interaction with the patterns 51 and 52 may lead to a defective detection of the track following error. In the shifted position 56, the spot overlaps with two patterns 52 and in the shifted
25 position 55 it overlaps with two patterns 51. The result of this is that the levels 63 and 64 of Figure 1 no longer exhibit the differentiation which is required to ensure correctly the track following. This loss of transverse readability appears before the crosstalk
30 seriously affects the reading of the data with a correctly centred spot.

 In order to improve the transverse readability within the specific zones, the present invention suggests making a change in the distribution of the pre-engraved
35 patterns which are employed to demonstrate track following errors.

 Figure 3 shows a plan view of an arrangement of patterns according to the invention. The pitch of the tracks and the size of the read spot are essentially the

same as those of Figure 2, but the transverse distribution of the pre-engraved patterns 51 and 52 has ceased to be regular.

5 The shift of the pre-engraved patterns 51 and 52 with respect to the track axes has maintained the same absolute value as in the preceding two figures, but the order of the signs is permuted from one track element to the next.

10 When consideration is given to the transverse alignment of the patterns 51 or 52, it is found that they are separated by distances which are alternately reduced and increased. Moreover, in contrast to the arrangements of Figures 1 and 2, they exhibit an arrangement which is symmetrical with respect to the intertrack axis situated
15 at mid-distance from the axes of two adjacent track elements.

The intertrack axis is shown in Figure 4 by the broken line 73, and this figure shows pre-engraved patterns having the arrangement of Figure 3 in the
20 regions of the radii 67, 69, 70, 71 and 72. If it is assumed that a positive shift is directed towards the periphery of the disk, the order of the shifts is plus-minus on the turn starting at the graduation 0 and ending at the graduation 15. For the turn starting at the graduation 15 and ending at the graduation 30, the order
25 of the shifts is minus-plus and resumes its earlier form when the reference radius 67 is again cleared. In the case of data blocks preceded by a pair of pre-engraved patterns 51 and 52 which are shifted in opposite directions, it is possible to provide any number of data
30 blocks per revolution, but in order to extract a following error signal by sampling the pre-engraved patterns 51 and 52 it is necessary to take account of the reversal of order introduced upon each clearing of the reference radius 67. Nothing prevents the provision of a
35 plurality of reversals of order according to a plurality of reference radii such as 67, 69, 70, 71 and 72.

In the case of data blocks preceded by a single pre-engraved pattern, the shift of which is alternately

positive or negative, each revolution or track element may comprise an even or odd number of patterns. If this number is odd, without in any way changing the alternation of the shifts along the track, the desired distribution is obtained. On the other hand, if this number is even it is necessary to permute the shifts at least once per revolution.

In order to have an idea of the arrangement of the patterns in this last case, it is possible to imagine in Figure 3 that the patterns 51 and 52 are separated by a data block 50.

Figure 5 shows an arrangement of patterns which is also within the scope of the invention. This is a limiting case which amounts to shifting the patterns 51 and 52 sufficiently for them to cover one another completely within the approach zone. The density of the patterns is reduced by one half, the offset being equal to one half of the pitch of the tracks. Any intermediate arrangement between those illustrated in Figures 4 and 5 may also be appropriate.

The construction of pre-engraved pattern makes use of an insulated photosensitive resin with a light beam, the spot of which creates in a single pass a latent image giving rise to a pattern of constant width W .

By laterally displacing the spot with respect to the exploration line, an offset of the pattern is produced. However, when the pitch of the track elements is tightened up and when the permutation of order according to the invention is effected, the pre-engraved pattern may adopt an overlap form originating from two successive insulations. The illustrations of Figure 11 represent a plurality of situations which are liable to be encountered in practice. The shift of a pattern involves two quantities, which are the spacing e of the pattern edge with respect to the exploration line and the offset E of the axis of a pattern produced by simple insulation with respect to the exploration line.

In Figure 11, (a) shows two exploration lines 100 and 101 and a pattern resulting from an insulation in two

applications affecting oblong zones 102 and 103 of width W. The axis 105 of the zone 102 presents an offset E with respect to the exploration line 100 and the same offset with opposite sign characterises the position of the axis 106 of the zone 103 with respect to the exploration line 101.

The edge 107 of the zone 102 exhibits a spacing ϵ with respect to the line 100 and the same spacing in reverse characterises the position of the edge 108 of the zone 103 in relation to the line 101. If the spacing ϵ and the offset E are counted as positive, the edge 107 and the axis 106 being on the same side of the axis 100, it can be seen that these quantities satisfy the algebraic relation $E - \epsilon = W/2$ where $W/2$ is a positive number. As the edge 107 may change side (see Fig. 11 (d)), the sign of the spacing ϵ may reverse. The result of this is that an offset E of value zero is characterised by $\epsilon = -W/2$. This particular value of the spacing ϵ is excluded when writing the shifted patterns.

Having said this, (a) shows the outline 104 of the read spot with a shift in relation to the exploration line 100. To make the position clear, this positive shift is, for example, equal to ϵ ; this means that one half of the spot interacts with the resulting pattern, only the edge 107 being involved in this interaction.

Thus, the only parameter of the resulting pattern which has an effect on the detection of the following error is the spacing ϵ , which must be different from the value $-W/2$, but which may be positive, negative or zero.

With the pitch p shown at (a) in Figure 11, the resulting pattern reveals precisely the offset E via the spacing ϵ which emerges therefrom by the relation: $\epsilon = E - W/2$.

Tightening up the pitch p by the value Δp , (b) shows the particular case where the zones 102 and 103 overlap completely; this gives a resulting pattern 109, the interaction of which with the spot 104 satisfies parameters which have not undergone the influence of the pitch variation. Nevertheless, the value $p - \Delta p$ equal to

$W + 2\epsilon$ represents the minimum value of the pitch which can be accepted in the course of the construction of the pre-engraved patterns. In fact, as illustrated in Figure 11 at (c), if the pitch were to reach a value $p-a$ lower than $W + 2\epsilon$, the resulting pattern would adopt a form such that the external edges would no longer be spaced from the exploration lines 100 and 101. A new spacing ϵ' is created, which is a function of the value of the pitch; this constitutes a disadvantage.

It should, however, be noted that the resulting pattern illustrated at (c) is not defective except as regards the manner in which it was constructed. If the zones 102 and 103 which the one (sic) created had exhibited the new spacing (almost zero) in place of the spacing ϵ , it would have been possible to resume the situation (a) or (b).

It is possible to conclude from the foregoing that the concept of shift in an overlap pattern is especially linked to the spacing within the pitch limits in which it is reproducible. It is found that the patterns obtained according to the invention exhibit an arrangement which is symmetrical with respect to the median of the exploration lines 100 and 101. It is also found that a zero spacing ϵ does not signify a zero shift and that it is the spacing ϵ equal to $-W/2$ which represents the absence of shift. In Figure 11, (d) shows an example of a resulting pattern in which the spacing ϵ is of opposite sign to that which appears at (a) and which permits a high degree of tightening of pitch. The increase in the pitch of the track elements may cause cessation of the overlap of the insolation zones 102 and 103, so that the arrangement changes from one to two patterns, but this does not disturb the spacing ϵ .

It is, however, possible to construct pre-engraved patterns having simultaneously at least one shifted part and at least one centred part placed at the end of the pattern. The presence of centred ends permits the creation, in the course of the exploration of the pre-engraved patterns, of transitions of the read signal

which, by an appropriate processing, generate a synchronisation signal. This signal is emitted only in the course of the exploration of a pre-engraved pattern encoded to this end, no other readable entity on the information carrier being capable of triggering this signal.

Figure 6 shows forms of pre-engraved patterns of dual application. The elemental pattern appears at the top on the left and at the bottom on the right in Figure 6. It exhibits a substantially uniform width, but it is shifted in its centre although its ends are centred on the exploration line shown as a broken line. On account of the implementation of the reversal rule set forth hereinabove, the elemental patterns may merge as indicated in Figure 6, adopting the form of an X.

Figure 7 shows a form which is similar, but with an extreme degree of interpenetration.

As regards the shifted part, the remarks made with respect to Figure 11 continue to be fully applicable. In the course of the insolation of the pre-engraved patterns, it is necessary to ensure that the concave edge of the elemental profile is insolated on only a single occasion, since otherwise it is the convex part which would become decisive as regards the final profile of the pattern.

On account of the arrangements illustrated by Figures 3, 5, 6 and 7, it can be seen that the positive and negative shifts meet in a specified order on one track element and that this order is reversed for the two closest track elements. This permutation must be reflected in the circuit which determines the track following error.

It is accordingly generally necessary to define on the information carrier the exploration phase to which the order permutation corresponds.

In the case of the information carrier illustrated in Figure 4, it is the radius 67 which marks the sequencing of the track elements.

Figure 8 shows the start of a sector comprising

data blocks at regular intervals. Exploring from left to right the sector which extends along a track element over a fraction of a revolution, for example $1/32$ of a turn, at regular intervals specific zones 77 are found which

5 enclose pre-engraved patterns intended to ensure the synchronisation and the following of the track element. Typically, each zone 77 has an extent A of eight times the dimension of the bit cell, and it is separated from its nearest neighbour by an inserted zone which is

10 capable of containing 96 bit cells. Thus, each zone b_1 , b_2 , b_3 forms a group of 104 cells. The heading H of the sector is constituted by the first group b_1 which comprises a zone 79 reserved for the addressing of the memory zones. The zone 79 contains the address of the

15 sector expressed by three words of 24 bits. The intermediate zone 78 may contain a sign to indicate the permutation of order which takes place, for example, upon each revolution. There then remain the zones 80, 81 and its following zones which are allocated to the storage of

20 the data. On an indicative basis, the extent B may correspond to 24 bits, the zone 79 having an extent C of 72 bits; the data zones each have the extent D of 96 bits.

The reading of an information carrier as described hereinabove necessitates an adaptation of the

25 circuits permitting the compulsion of the light spot to follow the track elements or to execute track jumps.

Figure 9 shows a first illustrative embodiment of an optical reading device according to the invention.

30 The information carrier 83 is carried by a rotary pin of axis M driven for example with a uniform angular velocity of rotation. The reference surface of the information carrier 83 is illuminated by a laser source 85 via a semitransparent plate 86, a pivoting mirror and

35 a focusing objective 84. The rotation of the pivoting mirror is controlled by a motor 88, in order to displace the light spot formed by the objective 84 in the reference surface of the carrier 83. This displacement takes place transversely with respect to the exploration

line of the track elements. The light which has interacted with the information carrier is taken up by the objective 84 and deflected via the pivoting mirror and the plate 86 towards photodetector means 87 which deliver an electric read signal containing the various information items read successively along each one of the track elements.

This electric signal is applied to a circuit for generating sampling windows 93, to an evaluating circuit 94 for the shift of the spot with respect to the exploration line and, if necessary, to a circuit 92 for identifying the specific mark of the order permutation. A control circuit 91 actuates the motor 88 according to two input quantities which are the track following error to be compensated and the amplitude of the track jump to be achieved. The latter quantity is determined by a control circuit 90 which manages the accesses according to the write or read requests originating from outside and which may act on an access motor not shown in Figure 9. The quantity representing the track following error is produced by the circuit 94 without taking account of the permutation of order of the pre-engraved patterns allocated to this task. It is therefore necessary to modify consequentially the sign of the signal delivered by the evaluating circuit 94 and, to this end, the invention provides the insertion between the circuits 91 and 93 of a permutation circuit 89 permitting the restoration of the appropriate sign of the track following error to ensure correct functioning of the slaving loop which compensates this error. The permutation circuit 89 illustrated in Figure 9 comprises two cascade-linked stages to transpose the links between the input terminals and the output terminals in response to two separate commands. One of these commands is supplied by the circuit 90 where a track jump is executed corresponding to an odd number of steps. The other command is supplied by the identification circuit 92 in the course of the exploration of the order permutation mark present in one of the zones 78 referred to hereinabove.

If a track jump coincides with the detection of this mark, the two stages permute and the double change of sign which results therefrom returns the link to its earlier form.

5 By way of variant, the information carrier 83 may be equipped with a reference track simply composed of pre-engraved patterns relating to the synchronisation of its movement opposite the read head. This is the case if the information carrier is a disk comprising a ring
10 concentric with the annular zone containing the track elements. This ring may be indexed by a mark specific to the permutation of order of the pre-engraved patterns situated within the annular zone in which the information is stored. The optical exploration of this ring is
15 entrusted to an auxiliary optical head 95 which delivers a read signal characterising the rotation of the disk. As illustrated in broken lines in Figure 9, this read signal is substituted for the read signal originating from the detection circuit 87 and it is the mark indexing the ring
20 which is recognised by the circuit 92. In this case, the zone 78 illustrated in Figure 8 may contain a specific sign declaring the exploration of the address of the sector.

25 In the case of Figure 9, the permutation circuit 89 is outside the circuit 94 which determines the shift signal of the spot by the comparison of two samples of the read signal which are taken in the course of the exploration of the shifted parts of the pre-engraved patterns.

30 It is also possible to permute the samples at the input of the comparator circuit, as illustrated in Figure 10.

35 The rectangle referenced 94 comprises the circuit 89, while the elements external to the rectangle 94 are the same as in Figure 9.

 The circuit for evaluating the shift of the spot comprises two analog gates 96 and 97 receiving the read signal delivered by the detection circuit 97. Each gate is controlled by a sampling pulse originating from the

generating circuit 93, but the two pulses are switched to the gates 96 and 97 by the circuit 89 in such a manner that the sample available at the output of the gate 96 is systematically representative of the interaction of the spot with a pre-engraved pattern having a predetermined shift sign. As the situation is the same for the other gate and the other shift sign, it can be seen that the comparator circuit 98 gives a value of the shift of the spot having the appropriate sign. This value may be stored in memory or smoothed by the circuit 99 before being applied to the control circuit 91. The control of the permutation circuit 89 remains unchanged, and it could just as well be integrated in the generator 93.

The read devices of Figures 9 and 10 may be made compatible in order to read information carriers utilising pre-engraved patterns in monotonic arrangement. To do this, it is sufficient to maintain the permutator 89 in one and the same condition chosen in advance. The circuit 92 which detects the mark signalling the permutation of order may easily, with a time delay circuit, recognise which mode of operation is to be implemented.

The invention is also applicable to pre-engraved patterns comprising two shifts of opposite signs. This version derives from the configurations illustrated in Figures 6 and 7, where the pre-engraved patterns would slide towards one another parallel to the exploration line of the track elements to achieve fusion of their centred ends. As two ends are lost on account of the fusion of the patterns to form an X, it is possible to rely upon the ends of the centred patterns 50 to define the transitions code necessary for the synchronisation of the exploration. It is further possible to add at the head or at the foot of the merged X-shaped pattern structure a centred pattern of which the two ends supply the complement with a view to a four-transition decoding.

With regard to the demonstration of an order permutation, it is possible to do without a specific mark if the procedure is based on the reading of the addresses of the track elements. In fact, if two consecutive track

elements have as their addresses the numbers n and $n + 1$, the change of parity may serve as a means for selecting the correct permutation. In this case, the circuit 92 of Figures 9 and 10 will determine the parity of the addresses of track elements by signalling the change in parity when this takes place upon each revolution. It would also be possible to adopt as a basis the addresses of sectors, by detecting, for example, the change from the last sector to the first and by executing the order permutation at the instant when the first sector is initiated.



CLAIMS

1. Information carrier comprising on a reference surface adjacent track elements (68) constituted by pre-engraved patterns, said elements defining equidistant exploration lines (100, 101) and said patterns defining orthogonal straight lines (67, 69, 70, 71, 72) which divide the track elements into equal portions and define intersections to each of which at least one of said patterns is attached, said patterns presenting identical shifts of opposite signs which alternate from one pattern to the other with respect to said exploration lines such that along each of these lines at least one periodic sequence of alternately shifted patterns is constituted, characterised in that the orthogonally aligned patterns (51, 52 in Figures 3 and 5; 74, 75 in Figure 6; 76 in Figure 7) are disposed symmetrically with respect to median lines included between two immediately adjacent exploration lines, and are separated by alternately reduced and increased distances.
2. Information carrier according to Claim 1, characterised in that the orthogonally aligned patterns present a symmetrical outline with respect to said median line.
3. Information carrier according to Claim 1, characterised in that two alternate patterns are respectively attached to two consecutive orthogonal straight lines.
4. Information carrier according to Claim 1, characterised in that two alternate patterns are attached to each one of said orthogonal straight lines.
5. Carrier according to any one of Claims 1 to 4, characterised in that the track elements are concentric elements in an annular zone intended for the storage of information, said orthogonal straight lines passing through the centre (M) of said zone.
6. Carrier according to Claim 5, characterised in that it further comprises an annular ring concentric with said zone.
7. Carrier according to any one of Claims 1 to 6, characterised in that said shifts are uniform from one end of said patterns (51, 52) to the other.



8. Carrier according to any one of Claims 1 to 7, characterised in that said shifts are located inside said patterns, said patterns (74, 75, 76) having end portions which are situated on said exploration lines.

5 9. Carrier according to Claim 8, characterised in that said patterns are X-shaped.

10. Carrier according to Claim 8, characterised in that each pattern (74, 75) comprises two end portions without shift which encompass a portion having a shift.

10 11. Carrier according to any one of Claims 1 to 6, characterised in that said shifts are constituted by a predetermined offset (ϵ) between the border of one pattern and the closest exploration line.

15 12. Carrier according to Claim 9, characterised in that, said patterns having at least one centred portion, the half-width of this centred portion differs from said predetermined offset (ϵ) when the latter is negative.

20 13. Carrier according to Claim 1, characterised in that the shape of said pattern is derived from the scanning of said surface with a circular spot.

14. Carrier according to Claim 1, characterised in that each track element corresponds to one complete turn about the centre and in that said sequence extends over said turn.

25 15. Device for reading an information carrier for a sampled format, comprising means for the optical detection of a read radiation which has interacted with said carrier in that part of its reference surface illuminated by a read spot, means allowing displacement of said spot transversely with respect to adjacent track elements in
30 said reference surface and slaving means of the sampling type allowing compulsion of said spot to follow the exploration lines of said track elements due to the exploration of pre-engraved patterns constituted by
35 spaced islands which are used to constitute said track elements, characterised in that permutation means are associated with said slaving means of the sampling type, said permutation means being enabled at least at each track jump equal to an odd number of track element steps.



5 16. Device according to Claim 15, characterised in that the permutation means comprise two cascade-linked stages, one of which switches at least once during transition from one track element to the next one, while the other is switched by said track jump.

10 17. Device according to either one of Claims 15 and 16, characterised in that the permutation means influence the sign of an electric signal representing, apart from the sign, the shift of the read spot with respect to any one of said exploration lines scanned by this spot.

15 18. Device according to either one of Claims 15 and 16, characterised in that the permutation means are inserted into two channels which transmit pulse signals intended to sequentially control means of the sampling type which receive the electric signal produced by the optical detection means.

20 19. Device according to Claim 16, characterised in that said information carrier comprises a specific information item which marks the access to a periodic sequence of pre-engraved patterns presenting, with respect to another periodic sequence which precedes it, a permutation of order applied to the sign of the shifts of said patterns with respect to said exploration lines, said device comprising means for identifying said specific information in a signal read from said information carrier, the presence signal delivered by said identifying means being used to control the switching of one of said cascade-linked stages.

30 20. Device according to Claim 19, characterised in that said information carrier is a disk which has a centre of rotation, and in that one at least of said sequences extends over a complete turn of said disk.

35 21. Device according to Claim 20, characterised in that said pre-engraved patterns are situated in an annular information storage zone, and in that said specific information is a pre-engraved information item situated in a ring which is concentric with said annular zone.

22. Device according to Claim 19, characterised in



that in order to read an information carrier which does not comprise said permutation of order, the permutation means are maintained in a predetermined switching state by means which react on the absence of said specific information.