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"READING OPTICAL RECORD CARRIER"

The invention relates to a method for reading a record carrier provided with information in an optically readable information structure of track-wise arranged information areas which alternate with intermediate areas.

In the case of a circular disc-shaped record carrier the information tracks may be concentric tracks, or alternatively, quasi-concentric tracks linked to each other and constituting a spiral track.

Such a record carrier is described in the Applicants' British Patent Specification No. 2,018,489A. The known record carrier may contain a television programme, the information being encoded in the frequency and/or dimensions of the information areas in the track direction. The information areas may comprise pits pressed into the carrier surface or hills projecting from this surface. Alternatively, the information may be encoded in digital form, in which case the information areas and intermediate areas may then have a constant dimension in the track direction. A specific combination of information areas and intermediate areas then represents a specific combination of digital zeros and ones.

For optical record carriers a maximum information density is desirable, which in the case of a carrier containing a television programme means a maximum playing time. For this purpose the information tracks should be arranged as close as possible to each other. However, the distance between the information tracks cannot be made arbitrarily small. For known record carriers, in which the information areas of adjacent information tracks have the same geometry, except for the dimension in the track direction, all the information areas influence the read-beam radiation in a similar manner. The read spot formed on the information structure by the read beam has a specific, for example Gaussian, intensity distribution. The half-value diameter of said spot, i.e. the distance between two diametrically opposite points in the spot where the intensity is equal to $1/e^2$ of the

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intensity in the centre of the spot, is of the order of magnitude of, or greater than, the width of the information areas, hereinafter referred to as the track width. This means that even in the case of correct tracking of the read spot, an amount of radiation will fall outside the track and may be incident on adjacent tracks. The amount of radiation on the adjacent tracks increases as the track distance decreases. The track distance is the distance between the edges of two radially adjacent information areas. This distance is equal to the width of the informationless lands situated between the information tracks. A certain part of the radiation which is incident on the adjacent tracks and which is modulated by the information areas of these information tracks may reach the radiation-sensitive detector provided to receive the radiation modulated by the track to be read. This effect, the crosstalk effect, determines the minimum distance between the information tracks.

In British Patent Application No. 2,018,489A which has been laid open to public inspection, it is proposed to increase the information density by giving the information pits of adjacent tracks different depths and reading said information tracks in different manners. The information tracks whose information areas have a first depth are read by determining the variation of the total intensity of the radiation returning from the record carrier and passing through the pupil of the read objective. This is the so-termed integral read method. The information tracks whose information areas have the second depth are read by determining the intensity difference in two tangentially different halves of the pupil of the read objective. This is the so-called differential read method. When reading a first information track with the one read method an adjacent information track to be read with the other read method is hardly observed, so that the information tracks can be arranged substantially more closely to each other without excessive crosstalk.

For reading such a record carrier a suitably adapted read apparatus must be used, that is to say a read apparatus which can be switched from the one read method to the other. Since the two read methods have different optical transfer functions ("Modulation Transfer Function": "MTF") the alternate use of the two read methods may be perceptible in

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the signal which is ultimately produced by the read apparatus. Moreover, the information areas with a lower spatial frequency cannot be read in an optimum manner by means of the differential method. Furthermore, the transitions between track portions with deeper information areas and the track portions with shallower information areas must be optically marked in the record carrier itself, in order to provide an indication for the read apparatus when switching over is to take place. The tracking servo system is sensitive to the depth of the information areas. Therefore, this servo system should also be adjusted when switching from deeper to shallower information areas and vice versa.

It is an object of the present invention to increase the information density in a record carrier for information such as a television programme, an audio programme or digital information, for example from and for a computer, without requiring switching of the read apparatus between tracks.

According to a first aspect of the present invention there is provided a method of reproducing information stored in a record carrier in the form of an optically readable information structure in one information layer of trackwise arranged information areas which alternate with intermediate areas, comprising scanning a track with a spot of optical radiation of wavelength λ_e, λ_e being the effective wavelength of the radiation at the location of the information structure, and detecting radiation modulated by the record carrier to provide the information, wherein the record carrier comprises parallel adjacent tracks in which the intermediate areas of the tracks are planar and are coplanar with one or other of two parallel planes at different levels, in which the intermediate areas of one track portion lie in one of said planes and the intermediate areas of a laterally adjacent track portion lie in the other of said planes, in which the separation between the two planes defines a first effective depth and hence a first phase depth in relation to λ_e, in which the information areas have the same geometry in two directions perpendicular to the track direction, in which within each track portion the information areas are at the same level, in which the information areas and intermediate areas in a track portion define a second effective depth and hence a second phase depth in relation to λ_e, and in which the

first phase depth is a fraction of the second phase depth whereby the optical radiation from the read spot when centered on one track portion and incident upon the laterally adjacent track portion is not modulated by the information areas and intermediate areas of that laterally adjacent track portion.

Owing to the different planes of the adjacent information track portions, the side portions of a read spot scanning a specific information track, which side portion passes over laterally adjacent information track, are not modulated by the information contained in said adjacent information track. Care has been taken to ensure that for a specific read method, the differential or the integral method, the detector cannot discriminate between the information areas of the adjacent information track and the intermediate areas of this track.

It is to be noted that, inter alia from United States Patent Specification No. 3,855,426, record carriers are known in which the information is arranged at different levels. However, these record carriers contain a plurality of information layers, all information tracks in each information layer being situated at the same level.

The invention may be employed both with record carriers to be read in reflection and with record carriers to be read in transmission. Furthermore, the invention may be used both for record carriers adapted to be read by the integral method and record carriers adapted to be read by the differential method. The information structure in the information tracks may either be a phase or an amplitude structure.

For an information structure comprising information areas in the form of pits in the information tracks the concept of effective depth may be used. This effective depth is the difference in level between the information areas and the intermediate areas as observed by the read beam. The information structure may be regarded as a diffraction grating which splits the read beam into a zero-order subbeam, a plurality of first-order subbeams and a plurality of higher-order subbeams, the zero-order subbeams and, inter alia, the first-order subbeams having a relative phase difference. The specific phase difference between the zero-order and first-order subbeams which occurs if the centre of the read spot coincides with the

centre of an information area is called the phase depth. For optimum read-out of an information structure in accordance with the integral method or the differential method, said phase depth should have a first or a second value respectively. A specific, measured phase depth corresponds to a specific value of said effective depth of the information areas.

If an information area has perpendicular walls and the width of the information area is greater than the effective wavelength of the read beam, the effective depth of said area is mainly determined by the geometric depth of the information area. If the information areas have a certain wall steepness and the width of the information areas is of the order of magnitude of or smaller than the effective wavelength of the read beam, the effective depth also depends on the said width and wall steepness and on the polarization direction of the read beam.

If the information areas have the form of hills which project from the information track the term effective height instead of effective depth should be used.

By analogy with the foregoing, the concept of: "effective difference in level between the information tracks" may be used. This is the difference in level as observed by the read beam. This difference in level is determined by the geometrical difference in level, the steepness of the walls of the information tracks and the width of the information tracks relative to the effective wavelength of the read beam.

The effective depth of the information areas and the effective difference in level between the information tracks, in the case of a reflecting information structure, may be expressed in terms of the effective wavelength of the read beam. The last-mentioned wavelength is the wavelength at the location of the information structure. If the information structure is covered with a transparent protective layer having a refractive index n, the effective wavelength λ_e is equal to the wavelength in vacuo λo divided by n. For a record carrier having a reflecting phase structure which is read by the integral method or the differential method the optimum effective depth of the information areas is equal to $\lambda e/4$ and $\lambda e/8$ respectively. In accordance with the

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invention the effective difference in level between adjacent information track portions in such record carriers is $\lambda_e/8$ and $\lambda_e/16$ respectively. An effective depth of $\lambda_e/4$ and $\lambda_e/8$ means that the zero-order subbeam and one of the first-order subbeams exhibit a phase difference of π rad. and $\pi/2$ rad. respectively.

If the information structure is an amplitude structure the information areas and the intermediate areas are situated at the same level in their tracks. Such a structure introduces a phase difference of π rad. between the zero-order subbeam and one of the first-order subbeams and with respect to its phase behaviour it may be compared with a reflecting phase structure whose information areas have an effective depth of $\lambda_e/4$.

In accordance with a second aspect of the invention a record carrier is provided in the form of an optically readable information structure in one information layer of trackwise arranged information areas which alternate with intermediate areas, in which the record carrier comprises parallel adjacent tracks, in which the intermediate areas of the tracks are planar and are coplanar with one or other of two parallel planes at different levels, in which the intermediate areas of one track portion lie in one of said planes and the intermediate areas of a laterally adjacent track portion lie in the other of said planes, in which the separation between the two planes defines the first effective depth, in which the information areas have the same geometry in two directions perpendicular to the track direction, in which within each track portion the information areas are at the same level, and in which the information areas and intermediate areas in a track portion define the second effective depth.

In accordance with this second aspect of the invention a record carrier is provided wherein the information structure is a phase structure, the information areas in a track portion being pits extending below or projections extending above the intermediate areas of that track portion by the second effective depth, in which the first effective depth is approximately half the second effective depth.

Also in accordance with the second aspect of the invention, a record carrier is provided wherein the information structure is an amplitude structure, in which the first effective depth has a value

between approximately $\lambda_e/8$ and approximately $\lambda_e/4$.

Further in accordance with the second aspect of the invention, a record carrier is provided which is circular and disk-shaped, wherein the information tracks in the two parallel planes together constitute a first and a second spiral information track respectively, the read direction of the first spiral information track extending from the centre of the record carrier towards its circumference and the read direction of the second spiral information track extending from the circumference of the record carrier to its centre.

The direction of rotation of the record carrier is then reversed between reading the two spirals.

The second aspect of the invention also provides a record carrier which is circular and disk-shaped, wherein consecutive information track portions within one track revolution are situated at different levels.

If a television programme is stored in the record carrier each of the information track portions may contain the information corresponding to one television line.

Embodiments of the invention will now be described in more detail, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a part of a record carrier in plan view,

Figure 2 is a perspective view of a small part of the record carrier of Figure 1,

Figure 3 is a read apparatus which is known per se,

Figure 4 represents different diffraction orders of the read beam,

Figure 5 represents the variation of the information signal as a function of the phase depth,

Figure 6 is a vectorial representation of the information signal and the cross-talk signal,

Figure 7 is a perspective view of a small part of a second embodiment of a record carrier having an amplitude structure, and

Figure 8 is a plan view of a record carrier in which information can be recorded by a user.

As is shown in Figure 1, the information structure of the record carrier 1 comprises a plurality of information areas 5 arranged in

information tracks 2 and 2'. In the track direction, or tangential direction t, the information areas are spaced from each other by intermediate areas 6. The information structure may be a reflecting or radiation-transmitting phase structure. The information areas are then, for example, constituted by pits pressed onto the record carrier surface or by hills projecting from said surface. Alternatively, the information structure may be an amplitude structure. The information areas are then for example non-reflecting areas in a surface which for the remainder is reflecting.

The information to be disseminated by means of the record carrier is contained in the variation of the areas in the tangential direction t only. If a colour television programme is stored in the record carrier, the luminance signal may be encoded in the variation of the spatial frequency of the information areas 5 and the chrominance and audio signal in the variation of the lengths of said areas. The record carrier may alternatively contain digital information. Then a specific combination of information areas 5 and intermediate areas 6 represents a specific combination of digital ones and zeros.

The record carrier can be read by means of an apparatus which is schematically represented in Figure 3. A beam 11 which is emitted by a gas laser 10, for example a Helium-Neon laser, is reflected to an objective system 14 by a mirror 13. In the path of the radiation beam 11 an auxiliary lens 12 is arranged, which ensures that the pupil of the objective system 14 is filled. On the information structure a read spot V is formed. The information structure is schematically represented by the information tracks 2, 2', the record carrier being shown in radial cross-section.

The information structure may be situated on the side of the record carrier which faces the laser. However, suitably, as is shown in Figure 3, the information structure is located on the side of the record carrier which is remote from the laser, so that the record carrier is read through the transparent substrate 8 of the record carrier. The advantage of this is that the information structure is protected against fingerprints, dust particles and scratches.

The read beam 11 is reflected by the information structure and, as the record carrier is rotated by means of a turntable 16 driven by a motor 15, it is modulated in accordance with the sequence of the information areas 5 and the intermediate areas 6 in an information track being read. The modulated read beam again passes through the objective system 14 and is reflected by the mirror 13. In order to separate the modulated read beam from the non-modulated read beam, a beam splitter 17 is arranged in the radiation path. The beam splitter may be a semi-transparent mirror or, alternatively, a polarization sensitive splitter prism. In the last-mentioned case a quarter-wave plate is arranged between the objective system and the splitter prism. Quarter-wave then means a quarter of the wavelength of the read beam 11. The beam splitter 17 reflects a part of the modulated read beam to a radiation-sensitive detection system 19, which, for example, comprises a single photodiode arranged on the optical axis of the read system. The output signal Si of the detector 19 is modulated in accordance with the information stored in the information track to be read. The principle of optical read-out is described in inter alia "Philips' Technical Review" 33, 1973, no. 7, pages 186-189 and will not be discussed in more detail.

The half-value diameter of the read spot V is of the order of magnitude of or greater than the track width, so that a part of the read radiation falls outside the information track. When the track distance is small a part of the read beam using for reading a first information track is incident on an adjacent track. In order to prevent this part of the radiation from being modulated in accordance with the sequence of information areas and intermediate areas in this adjacent information track, the adjacent tracks are arranged at different levels in accordance with the invention, as is shown in Figure 2.

In this Figure, which shows a small part of the record carrier in a sectional view taken on the line II-II' of Figure 1, the information tracks are designated 2 and 2'. The difference in level between an information track 2 and an information track 2' is h. The information areas 5 all have the same depth d. For the sake of clarity d and h are shown exaggerated in comparison with the thickness of the substrate 8.

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Now the physical background of the invention will be explained. The information structure may be regarded as a diffraction grating which splits the read beam into a non-diffracted zero-order subbeam, a plurality of first-order subbeams and a plurality of higher-order subbeams. For read-out, it is mainly the subbeams which are diffracted in the track direction which are of importance and of these beams mainly the first-order subbeams. The numerical aperture of the objective system and the wavelength of the read beam are chosen in relation to the dimensions of the information structure in such a way that the higher-order subbeams mainly fall outside the pupil of the objective system and do not reach the detector. Moreover, the amplitudes of the higher-order subbeams are small relative to the amplitudes of the zero-order subbeam and the first-order subbeams.

Figure 4 represents the cross-sections of the first-order subbeams, which are diffracted in the track direction 26, in the plane of the exit pupil of the objective system. The circle 20 with a centre 21 represents the exit pupil. This circle also represents the cross-section of the zero-order subbeam b (0,0). The circles 22 and 24 with the respective centres 23 and 25 represents the cross-sections of the first-order subbeams b(+1,0) and b(-1,0) respectively. The arrow 26 indicates the track direction. The distance between the centre 21 of the zero-order subbeam and the centres 23 and 25 of the first-order subbeams is determined by λ/p, where p (see Figure 1) represents the period of the areas 2 at the location of the read spot V.

For the present method of describing the read process it may be said that the first-order subbeams overlap the zero-order subbeam and interference occurs in the hatched areas in Figure 4. The phases of the first-order subbeams vary if the read spot moves relative to the information track. As a result of this, the intensity of the total amount of radiation which passes through the exit pupil of the objective system and which reaches the detector 19 will vary.

If the centre of the read spot coincides with the centre of an information area 5, there will be a specific phase difference Ψ, called the phase depth, between a first-order subbeam and the zero-order subbeam. If the read spot moves to a following information area, the

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phase of the subbeam b(+1,0) increases by 2π. Therefore, if the read spot moves in the tangential direction, the phase of this subbeam relative to the zero-order subbeam varies by ωt. Here ω is a time frequency which is determined by the spatial frequency of the information areas 5 and by the velocity with which the read spot moves over a track. The phase $\emptyset(+1,0)$ and $\emptyset(-1,0)$ of the subbeam b(+1,0) and the subbeam b(-1,0) respectively relative to the zero-order subbeam b(0,0) may respectively be represented by:

$$\emptyset\ (+1,0) = \Psi + \omega t, \text{ and}$$

$$\emptyset\ (-1,0) = \Psi - \omega t.$$

In the case of the integral read method, as is shown in Figure 3, the parts of the first-order subbeams passing through the objective system are combined with the zero-order subbeam on one detector 19. The time-dependent output signal of this detector may then be represented by:

$$S_i = A\ (\Psi) \cdot \cos \Psi \cdot \cos\ (\omega t)$$

where A (Ψ) decreases at increasing values of Ψ. The amplitude $A(\Psi) \cdot \cos \Psi$ of the signal S_i is therefore a maximum for a phase depth of $\Psi = \pi$ rad.

In the case of differential read-out a detector is arranged in each of the areas of overlap which are shown hatched in Figure 4. The output signals of these detectors are subtracted from each other, so that a signal S'_i is obtained which is given by:

$$S'_i = B\ (\Psi) \cdot \sin \Psi \cdot \sin\ (\omega t)$$

where $B(\Psi)$ decreases at decreasing values of Ψ. The amplitude $B(\Psi) \cdot \sin \Psi$ of the signal S' is a maximum for the phase depth $\Psi = \pi/2$ rad.

In general, the signal S_i as a function of the phase depth Ψ will vary as shown in Figure 5. The maxima of this signal are situated at Ψ, 3Ψ etc. and the minima at $0, 2\Psi$ etc, where $\Psi = \pi$rad for the integral method and $\Psi = \pi/2$ rad for the differential method.

It is now assumed that, at a specific instant, an information track 2' is being read. This information track is flanked by adjacent tracks 2. Since the read spot is not point-shaped but is a spot having a specific size and intensity distribution, these tracks 2 will

receive a part of the read radiation and reflect a certain amount of radiation to the objective system 14 and the detector 19. In accordance with the invention, the adjacent track is situated at a different level than the track being read. The detector then "observes" two different gratings. The resulting signal from the detector then comprises two signals: the main signal S_i and the cross-talk signal S_i,n. These signals as well as the complete signal S_i,t are represented as vectors $\overline{S_i}$, $\overline{S_i,n}$ and $\overline{S_t}$ in Figure 6. The direction of $\overline{S_i}$ is determined by the phase depth Ψ. As the read spot V moves over an information track 2' the length of the vector $\overline{S_i}$ and thus that of the vector $\overline{S_i,t}$ will vary. To minimise the modulation of the signal S_i,t resulting from the sequence of information areas and intermediate areas in an information track 2, the vector $\overline{S_{i,n}}$ should be perpendicular to the vector $\overline{S_i}$, as indicated by the broken line $\overline{S_i},n$ in Figure 6. The magnitude of $\overline{S_{i,t}}$ then equals the magnitude of $\overline{S_i}$ to an optimum extent. This means that the difference in level between the information tracks 2' and 2 should be half the phase depth Ψ.

This will also be evident from Figure 5. The crosstalk of an information track 2 to the information track 2' is minimal if the signal S_i,n remains constant throughout a transition from an information area in an information track 2 to an intermediate area in this track and vice versa. On the other hand, the phase depth of the information area in an information track 2 is equal to the phase depth Ψ of the information areas in the information track 2'. It follows that the information track 2 itself should be situated at a depth (or height) below (or above) the information track 2' corresponding to half the phase depth Ψ, whilst the information areas of said information track should be situated at a depth (or height) relative to the information track 2' corresponding to 3/2 Ψ. The depth (or height) of the information track 2 relative to track 2' and of the information areas of this track are represented by $\Psi_{n,t}$ and $\Psi_{n,g}$ in Figure 5.

As stated previously, the optimum phase depth is $\Psi = \pi$ rad. for a record carrier having a phase structure read by means of the integral method. For such a record carrier the effective difference in level between the information tracks 2 and 2' should correspond to $\pi/2$ rad.

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If the information structure is a reflecting structure, the phase depth $\Psi = \pi$ rad. is obtained if the effective depth of the information areas if pits or the effective height of the hills, if the information areas are hills, is $\lambda_e/4$. The effective difference in level of the information tracks is then half this value, hence $\lambda_e/8$.

If the information structure is a transparent phase structure on a transparent substrate having a refractive index n_1 and covered with a transparent protective layer having a refractive index n_2, the optimum phase depth $\Psi = \pi$ rad is obtained if the effective depth or height of the information areas is $\frac{\lambda 0}{2(n_1-n_2)}$. Here λ_0 is the wavelength in vacuo. The effective difference in level h of the information tracks for minimum crosstalk between these tracks is then equal to $\frac{\lambda 0}{4(n_1 - n_2)}$.

It is to be noted that the effective depth of the information areas 5 or the effective difference in level between the information tracks 2 and 2' only correspond to the depth d and the difference in level h respectively if the information areas and the information tracks have perpendicular walls and widths greater than the effective wavelength of the read beam. In the case of non-perpendicular walls and widths of the order of the effective wavelength, the wall steepness and the direction of polarisation of the read beam also influence the effective depth and the effective difference in level. In general, in the cases considered in the foregoing of a phase structure read in reflection or transmission, the phase depth of the information areas should be π rad. and the phase depth difference of the information tracks should be $\pi/2$ rad.

As already stated, for a record carrier read in accordance with the differential method the phase depth should be $\Psi = \frac{\pi}{2}$ rad and the effective difference in level between the information tracks should correspond to $\frac{\pi}{4}$ rad.

If the information structure is a reflecting phase structure the phase depth $\Psi = \pi/2$ rad. of the information areas is obtained if said areas have a depth or height of $\lambda_e/8$. The desired effective difference in level between the information tracks is then $\lambda_e/16$.

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If a transparent phase structure, provided on a substrate having a refractive index n_1 and coated with a protective layer having a refractive index n_2 is to be read in an optimum manner in accordance with the differential method, the information areas should have an effective depth of $\frac{\lambda 0}{4(n_1-n_2)}$, whilst the effective difference in level between the information tracks should be $\frac{\lambda 0}{8(n_1-n_2)}$.

Figure 7 shows a radial cross-section of a small part of a record carrier in accordance with the invention having an amplitude structure. The information areas 5 now, for example, comprise radiation-absorbing areas in a reflecting substrate. As stated previously, a phase depth of $\Psi = \pi$ rad. may be attributed to such a structure. This structure can only be read by means of the integral method. To correctly separate the read-out of the information tracks 2 and 2' the effective difference in level should be at least $\lambda_e/8$. In the case of an amplitude structure the phase depth, to a greater extent than in the case of a phase structure, depends on the geometry of the information areas, mainly on the width of the areas relative to the effective wavelength of the read beam. Depending on this geometry a value somewhere between $\lambda_e/8$ and $\lambda_e/4$ should be selected for the effective difference in level.

It is to be noted that the values specified in the foregoing for the effective depths of the information areas and for the effective difference in level between the information tracks are not strict values. A satisfactory read-out can also be achieved if the effective depth and the effective difference in level differ slightly from the specified values.

It has already been proposed, for example, in British Patent Specification No, 2,016,744A to employ an optical record carrier as a storage medium for information other than video information and specially as a storage medium which may store information provided by the ultimate user. This may, for example, be information supplied by an (office) computer or radiograms made in a hospital. For this use the user is supplied with a record carrier which is provided with a so-called servo-track, which for example, may be a spiral which extends over the entire record carrier.

During the recording of information by the user the radial position of the write spot relative to the servo-track is detected and corrected with an opto-electronic servo-system, so that the information can be recorded with great accuracy in a constant-pitch spiral track or in concentric tracks with a constant track spacing. The servo-track is divided into a multitude of sectors, for example 128 per track revolution.

Figure 8 shows such a record carrier 40 embodying the second aspect of the invention. The concentric servo tracks are designated 41 and the sectors are designated 42. Each sector comprises a track portion 44, in which information can be written and a sector address 43, in which, in addition to further control information, the address of the associated track portion 44 is encoded, for example in digital form, in address information areas. The address information areas are spaced from each other in the track direction by intermediate areas. The address information areas are suitably pits pressed into the record carrier surface or hills projecting from said surface.

In accordance with the invention the radially adjacent recording portions of the servo track are situated at different levels. The user information is then for example recorded by melting pits into the blank servo track portions, which are, for example, coated with a tellurium layer.

If for inscribing or reading said record carrier use is made of a so-called differential tracking system, that is a system in which the difference between the intensities in two radially different halves of the pupil of the read objective is determined, the blank servo track portions themselves should have a phase depth of approximately 110°. In that case the effective difference in level between adjacent track portions should be approximately $\lambda_e/16$.

In the record carrier shown in Figure 8 the radially adjacent sector addresses are also situated at different levels. The information in said addresses takes the form of a phase structure and can be read by means of the integral method. The effective difference in level between the sector addresses should then be $\frac{\lambda e}{8}$ for a reflecting structure.

A record carrier in accordance with the invention with a video and/or audio programme can be manufactured starting from a record carrier body in which an informationless track in the form of a groove with a comparatively large pitch is formed. The video and/or audio information may be written into a first track, coinciding with the groove, and in a second track situated between the turns of the groove in a manner as described in the article: "Laser beam recording of videomaster disks" in "Applied Optics" Vol. 17, No. 13, pages 2001-2006. The pre-grooved track may be formed in a record carrier body by means of the techniques described in said article, the intensity of the write beam being maintained constant.

A record carrier in accordance with the invention provided with a video and/or audio programme can also be obtained by the use of different illumination sequences, for the consecutive track revolutions during the actual information recording process, in such a way that during a first track revolution only information areas and during a second track revolution both track and information areas in said track are recorded.

CLAIMS

1. A method of reproducing information stored in a record carrier in the form of an optically readable information structure in one information layer of trackwise arranged information areas which alternate with intermediate areas, comprising scanning a track with a spot of optical radiation of wavelength λ_e, λ_e being the effective wavelength of the radiation at the location of the information structure, and detecting radiation modulated by the record carrier to provide the information, wherein the record carrier comprises parallel adjacent tracks in which the intermediate areas of the tracks are planar and are coplanar with one or other of two parallel planes at different levels, in which the intermediate areas of one track portion lie in one of said planes and the intermediate areas of a laterally adjacent track portion lie in the other of said planes, in which the separation between the two planes defines a first effective depth and hence a first phase depth in relation to λ_e, in which the information areas have the same geometry in two directions perpendicular to the track direction, in which within each track portion the information areas are at the same level, in which the information areas and intermediate areas in a track portion define a second effective depth and hence a second phase depth in relation to λ_e, and in which the first phase depth is a fraction of the second phase depth whereby the optical radiation from the read spot when centered on one track portion and incident upon the laterally adjacent track portion is not modulated by the information areas and intermediate areas of that laterally adjacent track portion.

2. A record carrier, for use in the method as claimed in Claim 1, in the form of an optically readable information structure in one information layer of trackwise arranged information areas which alternate with intermediate areas, in which the record carrier comprises parallel adjacent tracks, in which the intermediate areas of the tracks are planar and are coplanar with one or other of two parallel planes at different levels, in which the intermediate areas of one track portion lie in one of said

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planes and the intermediate areas of a laterally adjacent track portion lie in the other of said planes, in which the separation between the two planes defines the first effective depth, in which the information areas have the same geometry in two directions perpendicular to the track direction, in which within each track portion the information areas are at the same level, and in which the information areas and intermediate areas in a track portion define the second effective depth.

3. A record carrier as claimed in Claim 2, wherein the information structure is a phase structure, the information areas in a track portion being pits extending below or projections extending above the intermediate areas of that track portion by the second effective depth, in which the first effective depth is approximately half the second effective depth.

4. A record carrier as claimed in Claim 2, wherein the information structure is an amplitude structure, in which the first effective depth has a value between approximately $\lambda_e/8$ and approximately $\lambda_e/4$.

5. A record carrier as claimed in Claim 2, 3 or 4, which is circular and disk-shaped, wherein the information tracks in the two parallel planes together constitute a first and a second spiral information track respectively, the read direction of the first spiral information track extending from the centre of the record carrier towards its circumference and the read direction of the second spiral information track extending from the circumference of the record carrier to its centre.

6. A record carrier as claimed in Claim 2, 3 or 4, which is circular and disk-shaped, wherein consecutive information track portions within one track revolution are situated at different levels.

7. A record carrier for use in the method as claimed in Claim 1, wherein the record carrier, in certain record carrier portions, may be inscribed with further information, wherein information already present is servo information in the form of sector addresses included in an optically detectable servo track

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containing addresses of associated uninscribed record carrier portions containing a radiation-sensitive material.

8. A record carrier for use in the method as claimed in Claim 1, which record carrier, in certain record carrier portions, may be inscribed with further information, wherein information already present is servo information in the form of sector addresses included in an optically detectable servo track containing addresses of associated uninscribed record carrier portions containing a radiation-sensitive material, and wherein the first effective depth of laterally adjacent sector addresses is approximately $\lambda_e/8$.

9. An optically readable record carrier substantially as hereinbefore described with reference to and as shown in Figures 1 and 2 of the accompanying drawings.

10. An optically readable record carrier substantially as hereinbefore described with reference to and as shown in Figure 7 of the accompanying drawings.

11. An optically readable record carrier substantially as hereinbefore described with reference to and as shown in Figure 8 of the accompanying drawings.

12. Means for carrying out the method as claimed in Claim 1, comprising a record carrier as claimed in any one of Claims 2 to 11 inclusive in combination with a read apparatus substantially as hereinbefore described with reference to and as shown in Figure 3 of the accompanying drawings.

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