

[54] **PLAYBACK SYSTEM WITH
RADIATION GUIDE MEMBER HAVING
A SLIDE PORTION EXTENDING INTO
THE GROOVE**

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[58] Field of Search179/100.3 V, 100.41 L, 100.6 M;
178/6.6 A, 6.7 R, 6.7 A

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[57] **ABSTRACT**

An improved system for reproducing signals stored on a recording medium in the form of undulations corresponding to the signals, the undulations generally being formed as a spiral groove. The undulations on the recording medium are moved past a suitable radiation source, such as a light source, and the density of the radiation emanating from the undulations, which is a function of the curvature of the undulation, is detected by a suitable radiation detecting means after it passes through a suitable slit aperture arranged at a predetermined distance from the recording medium surface so that variations in the density are a function of the undulations. The undulations may be either frequency or phase modulated with respect to the signal and their amplitude can be modified as a function of their recorded wavelength in such a manner that the curved surface portions of the undulations have nearly the same focal length for all occurring wavelengths.

The tracking of the playback system is improved by providing a radiation guide member which slides along the raised portions of the surface of the recording medium and has a slide member which extends into the particular groove or portion thereof being scanned. Formed within the guide member is an element which is optically effective for the type of radiation utilized to collect the emanating radiation and aids in its evaluation. This element may be either the slit aperture itself or a collecting lens which directs the emanating radiation to the slit aperture.

19 Claims, 6 Drawing Figures

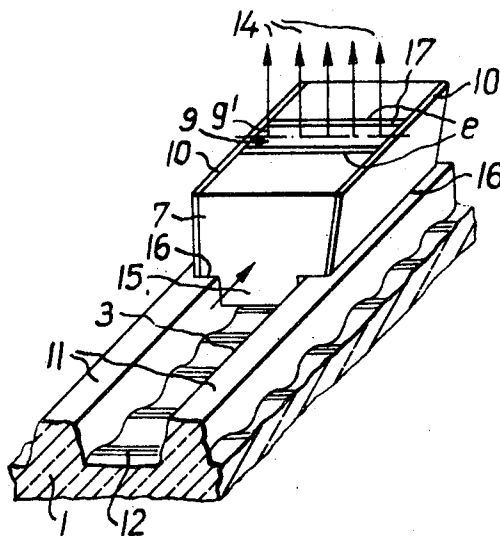


Fig.3

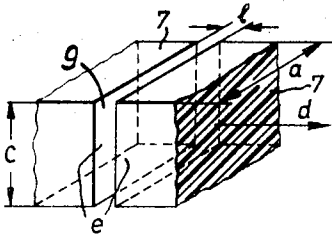


Fig.1

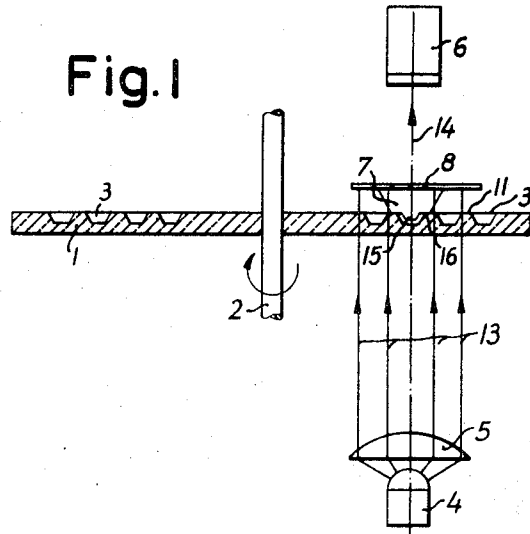


Fig.4

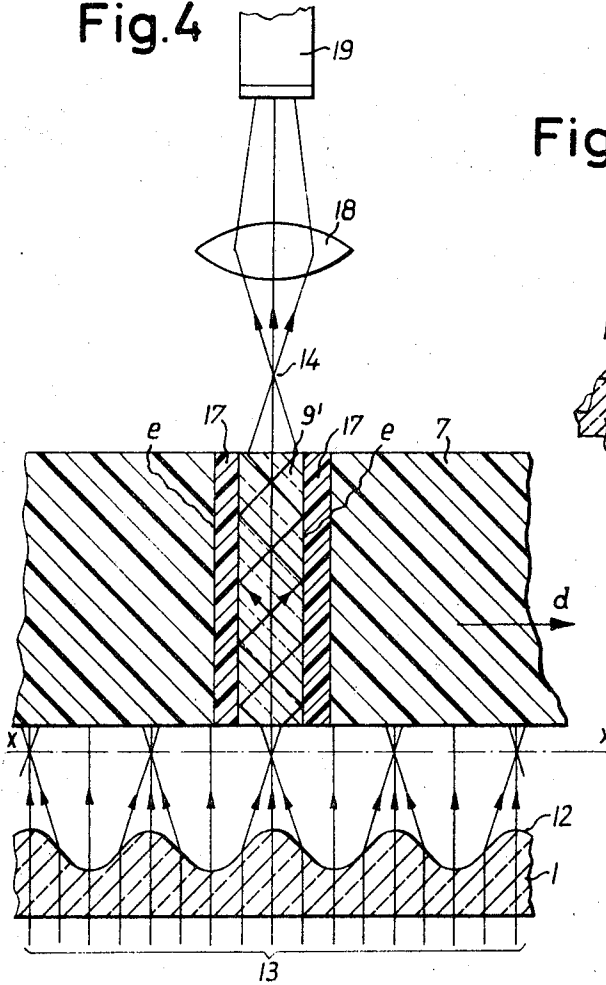
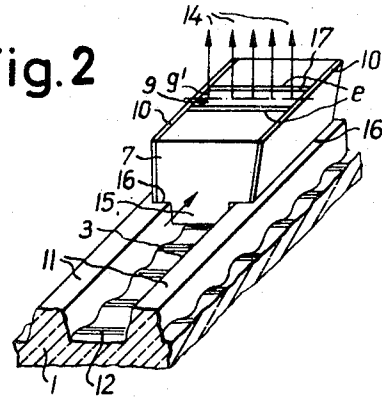


Fig.2



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Fig.6

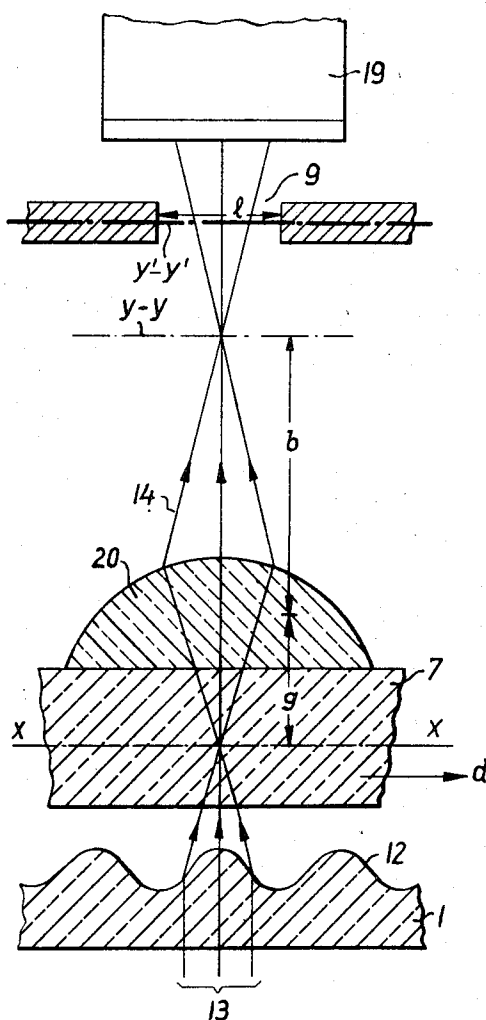
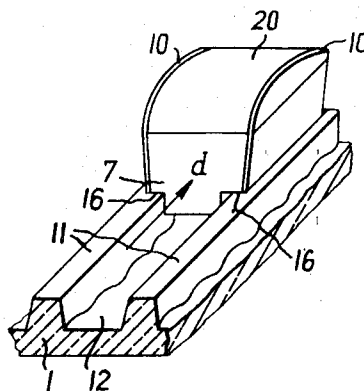


Fig.5



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PLAYBACK SYSTEM WITH RADIATION GUIDE MEMBER HAVING A SLIDE PORTION EXTENDING INTO THE GROOVE

CROSS-REFERENCE TO RELATED APPLICATION

This invention relates to an improvement of the invention disclosed and claimed in copending application Ser. No. 5,341,235 filed Jan. 23, 1970, by Gerhard Dickopp.

BACKGROUND OF THE INVENTION

The present invention relates to an improved system for playing back signals stored on a recording medium whose surface is provided with deformations or undulations which correspond to the time sequence of the signal amplitude by means of light radiation or a radiation related thereto and a radiation detector.

According to the above-mentioned copending related patent application, the signal values are recorded in the form of carrier frequency oscillations having the signal frequency or phase-modulated thereon, and playback is achieved by means of a slit aperture which, together with the surface bearing the undulations are disposed in the path of the radiation beam at such a distance from one another that a change in the density of the radiation emanating from the surface bearing the undulations results in the plane of the slit aperture. The change in density is dependent on the undulations existing on the surface bearing the recorded signals in the direction of the relative movement of the record medium with respect to the reading beam bundle of rays and is at least a qualitative reproduction of the course of the undulations.

While the basic playback arrangement provided in the above-mentioned patent application for such a system operates satisfactorily under optimum conditions there still remain some practical difficulties which have not been overcome satisfactorily. These difficulties arise due to the need for improvement in the basic arrangement of the means for maintaining the optical system, which cooperates with the reading beam bundle of rays, on an even track and for vertically guiding of the optical system. The term "maintaining an even track" is intended to mean that only the signal from a single groove is evaluated and crosstalk from adjacent grooves is prevented. In order to maintain an even track, it is necessary that the reading beam system follow the signal track recorded in the associated groove even when this groove occasionally performs lateral movements with respect to the reading beam system as, for example, might happen with a so-called radial wobble of the recording medium in disc or foil shape. The vertical guiding of the carrier or recording medium in disc or foil shape with respect to a slit aperture or an optical system containing such an aperture must be such that, at the occurrence of a so-called vertical wobble of the carrier, the fluctuating component of the evaluated light flux changes as little as possible, or in any case that a sufficiently large fluctuating component of the light flux is always received even with the greatest practical occurring differences in height.

SUMMARY OF THE INVENTION

It is the object of the present invention to overcome these difficulties which occur in a practical realization of the basic system according to the above-mentioned copending patent application and to provide an arrangement for such a system in which it is possible to positively keep the scanning system on an even track with reference to the associated groove and assure satisfactory vertical guiding during vertical movements of the carrier.

The above object is achieved in that, in a system for playing back, by means of a beam of light radiation or radiation related thereto, stored signals recorded in the form of frequency- or phase-modulated carrier frequency oscillations on a carrier or recording medium whose surface contains undulations corresponding to the time sequence of the signal values, wherein a slit aperture and the surface bearing the undulations are disposed in the path of the reading beam at such a distance

from one another that a change in the density of the radiation emanating from the surface bearing the undulations, which change in density is dependent on the undulations existing on the surface of the recording medium in the direction of relative movement of the recording medium with respect to the reading beam and at least qualitatively reproduces the course of the undulations, occurs in the plane of the slit aperture whereby it can then be received by the radiation detector, according to the present invention, a radiation guide means is provided which has a slide member which extends into the particular groove of the recording medium bearing the undulations to be scanned and which contains an element which is optically effective for the type of radiation employed and aids in the evaluation of the light density fluctuations produced from the associated groove.

The guide means is preferably provided with two laterally extending slide surfaces intended to contact the raised portions existing between adjacent grooves and with a slide member engaging the groove profile with lateral play and having the base thereof not physically engaging the groove bottom which bears the undulations.

According to one embodiment of the present invention, the optically effective element is the slit aperture of the optical system. According to another embodiment, the optically effective element may consist of a lens arrangement which reproduces the plane of evaluable primary light density fluctuations directly produced by the undulations of the recording medium surface in another plane which exhibits corresponding secondary light density fluctuations, i.e., the plane of the system slit aperture. The slit aperture which may be in the form of either an air gap or a clear, transparent optical body of the same dimensions as the air gap, while the lens arrangement — which contains a condenser lens or which is a condenser lens — is selected so that the image length is larger than the object length in order to produce an enlarged reproduction of the plane (object plane) containing the light density fluctuations produced directly by the deformations in another plane (image plane). In both embodiments, the slit aperture or the lens arrangement are preferably contained in substantially the central portion of the guide means.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic representation illustrating the basic playback arrangement according to the present invention.

FIG. 2 is an enlarged view of a guide means according to one embodiment of the invention illustrating the operative relationship between the guide means and a portion of the recording medium with the undulations in a groove thereof.

FIG. 3 is a schematic representation illustrating a slit aperture for the guide means according to one embodiment of the invention and the terminology employed for the dimensions of the slit aperture.

FIG. 4 is an enlarged view of the path of the radiation between a radiation source and the radiation receiver, with total reflection of the laterally impinging radiation occurring within the slit aperture.

FIG. 5 is a representation, similar to FIG. 2, of another embodiment of the invention showing a portion of the recording medium, a groove and a guide element moving therein, the latter being combined with a condenser lens.

FIG. 6 is an enlarged view of the beam path when using a guide means having a condenser lens according to FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1 there is shown a schematic representation of the improved playback system according to the invention. As illustrated in the figure, the recording carrier or medium is a circular disc 1 mounted for rotation about an axis 2. The disc 1, which in the illustrated embodiment is transparent, is preferably formed from a synthetic material which is formable at a temperature higher than the operating temperature. Formed on the surface of the disc 1 when it was

in its formable state are a plurality of grooves 3 having undulations at the bottom thereof which contain the signal recording applied in the manner disclosed in the above-mentioned copending application, i.e., frequency- or phase-modulated carrier frequency oscillations. In order to read and evaluate the signals contained in the undulations the radiation source 4 is disposed on the one side of the carrier which, during signal playback, rotates about axis 2. The output radiation from source 4 is directed through a lens system 5 to produce a plurality of parallel rays 13 which are directed to one side of the disc 1, which in the illustrated embodiment is the underside of the disc 1. The parallel rays 13 perpendicularly strike the planar underside of disc 1 so that there is no deflection of the rays at that point, and penetrate the disc, which is clearly permeable for the type of radiation employed, and exit on its upper side. The portions of the bundle of rays 13 which are penetrating through the undulations in the shape of lenses (preferably cylindrical) disposed transverse to their direction of travel and containing the signal recording are condensed or dispersed, depending on the curvature of these lenses, in a plane disposed above the signal recording track so that variations in the radiation density which correspond to the course of the signal occur in this plane. These variations are now converted, for a selected track, by an optical system into variations of light intensity. The radiation receiver or detector 6 is excited by the exiting light flux 14, whose intensity is now modulated corresponding to the signal course, and converts the changes in radiation into appropriate changes of an electrical output value (not shown).

According to the invention, in order to maintain an even track with respect to the radiation emanating from the upper surface of disc 1 and to allow proper vertical guiding of the optical system with respect to the radiation to be evaluated, a radiation guide element or member, which is generally opaque, is provided to guide the above-mentioned optically effective element (not shown in this figure) which aids or takes a significant part in the evaluation of the light density variations, always in the proper position with respect to the undulations contained in the particular groove 3 being evaluated. According to the preferred embodiments of the invention, the guide element 7 contains the optically effective element utilized in evaluating the light density variations produced by the undulations of the associated groove 3. Preferably an opaque covering member 8 is provided, in the path of the reading beam bundle of rays 13 to shield the radiation receiver 6 against scattered light. To achieve this result the covering member 8 is provided with an opening (not shown) in the area of the optically effective element, for the passage of the useful light flux, and extends laterally beyond the sidewalls of the guide member 7.

In order to provide the desired guiding function for the optical system, the guide element 7 is provided with laterally extending slide or bearing surfaces 16 which slide on the raised portions 11 of the upper surface of the disc 1 defining the walls between adjacent grooves 3, and with a slide member 15 which extends into the particular groove whose signal is being evaluated and engages the groove profile with lateral play. The bottom portion of the member 15 only extends into the groove 3 a distance such that it does not contact the portion of the groove bearing the undulations, preferably the bottom of the groove. This construction of the guide member 7 assures that even when the disc 1 experiences vertical and/or lateral wobble, the guide element 7 performs the respective movements of the groove 3 being scanned with great approximation, so that the lateral position of the optically effective element, which may for example be a slit aperture, with respect to the particular groove being scanned and also its distance from the groove surface containing the signal recording hardly ever changes during operation.

FIG. 2 shows a greatly enlarged representation of a portion of recording carrier or disc 1 with a groove 3 which bears in its bottom the undulations 12 containing the signal recording. In the manner disclosed in the related above-mentioned copend-

ing patent application these undulations preferably form cylindrical collecting and diverging lenses which cause variations in the density of the beam bundle of rays in a plane a short distance above their vertex. The direction of relative movement of the guide element 7 with respect to the groove surface of carrier disc 1 is indicated by the arrow d .

As already discussed above in connection with FIG. 1, the guide element 7 in this embodiment is provided with laterally extending slide surfaces 16 which slide on the upper sides 11 of the walls defining the grooves 3, and the slide member 15 extends into and engages the groove profile with lateral play. This play is necessary at this location because with inclined groove sides there would otherwise occur a static redundancy of the guiding process. The figure illustrates a position for the slide member 7 in which it is in contact with the left side of the groove whereas the lateral play or clearance can be seen at the right side.

According to the embodiment illustrated in FIG. 3, the optically effective element contained in the guide element 7, which in this embodiment is opaque, is a slit aperture 9. The movement of the guide element 7 with respect to carrier disc 1 causes the slit aperture 9 and its entrance opening to be passed through the plane of density variations of the particular track or groove being evaluated so that a light flux of varying intensity enters into the aperture slit entrance. This light flux passes through the slit aperture 9 and exits from the exit opening of the slit as modulated light flux having rays 14, from where it is brought to the radiation receiver 6, not shown in this figure.

The slit aperture 9 is constructed to be clearly permeable for the type of radiation employed, and is formed by two parallel bordering surfaces e which are disposed perpendicular to the direction of relative movement of the guide element 7 with respect to the adjacent surface of groove 3 and which borders on portions of the guide element 7. Preferably the slit aperture 9 takes up a central portion within the peripheral surfaces of the guide element 7, so that relatively slight displacements of the slit aperture 9 with respect to the track occur when the guide element performs tipping movements.

As indicated above, the slit aperture 9 may take a number of different forms. One type of slit aperture, i.e., an air gap, is illustrated in FIG. 3 which will be utilized to explain the general criteria and dimensions for the slit apertures to be included in the guide element 7 according to the invention.

Referring now to FIG. 3, there is shown a schematic representation of an air gap type of slit aperture disposed between adjacent portions of guide element 7. The slit aperture has the spatial shape of a parallelepiped whose major limiting surfaces simultaneously form the adjacent end surfaces of the components of the guide element. The length of the gap in the direction of relative movement d of guide element 7 with respect to the recording carrier is marked l . This slit length l should not be larger, according to known dimensioning principles, than one-half the length of the shortest recorded wavelength of the signal track to be scanned, reference being made to the side at which the signal track is reproduced in the plane of the slit aperture entrance. With direct scanning of a signal track recorded according to the refined high-density recording technique the slit aperture length l is approximately 1.5 to $2\mu\text{m}$.

The gap width a of the slit aperture is the dimension thereof lying in the same direction as the width of the track, i.e., undulations to be scanned. This width a —again with reference to the reproduction in the plane of the slit aperture entrance—should generally be equal to the track width.

The light permeability of a slit aperture does not depend only upon its cross-sectional dimensions, the rectangle with the sides l and a , but substantially also upon its depth c . This is particularly true when the radiation does not always impinge on the slit aperture entrance at a right angle. The entrance of perpendicular light, however, is possible in approximation only for the rays near the axes of the quasi-cylindrical lenses which form the undulations containing the signal recording. A substantial portion of the light flux entering into the slit aper-

ture does, however, not originate from the perpendicularly impinging rays. The slit aperture must thus be so constructed, in order to provide good utilization of the light flux, that the light entering thereinto over a certain angular range also exits therefrom. This is the case, in approximation, when the slit aperture depth c is no greater than the slit length l , or when, with a relatively great slit depth c the slit-delineating surfaces e reflect so well that only slight damping of the light occurs even when multiple reflection occurs between the two surfaces. In the case of well-reflecting delineating surfaces, the scanning slit aperture may be disposed directly in the guide element 7 which takes over the groove guiding. Utilizing a larger slit depth c results in the advantage that the system still remains able to function after the guide element 7 has been worn through use. The light entrance plane of the slit aperture must be able to be displaced within a certain tolerance range while still allowing a sufficiently large, fluctuating component of the light flux to pass through the slit aperture in the direction of the axis of the reading beam bundle of rays 13. For video signals recorded in the high-density recording technique this tolerance range is, for example, up to 10 μm .

To produce a minimum of reflection losses at the border surfaces e of the slit aperture several possibilities are presented. One such possibility is the metallic mirroring of the bordering surfaces e . Since the reflection capability of metallic mirrors is a maximum of 0.96 to 0.98, a 20-fold reflection already produces a loss of more than 50 percent. Such silvering is therefore only appropriate when the slit aperture depth e is not larger than 20 times the slit aperture length l , i.e., in the case of video signals recorded in the high-density recording technique, less than 30 to 40 μm . This requirement makes the production of such a slit aperture difficult.

A further and advantageous possibility consists in the utilization of the phenomenon of total reflection at the bordering surfaces e . In this case the light loss occurring due to reflection is very low so that even after several thousand reflections only a slight intensity loss occurs. A prerequisite for the occurrence to total reflection is that the material contained in the slit aperture be optically denser than the surrounding medium. Such an embodiment of the invention is in fact illustrated in FIG. 2, and the operation thereof explained with the aid of FIG. 4.

Returning again to FIG. 2, as illustrated the slit aperture containing a solid member 9' — hereinafter referred to as a "slit member" — which is permanently connected at the bordering planes e with the adjacent portions of the guide element 7. The material employed for the slit member 9' has such an index of refraction that total reflection results in the useful areas of the optical angles of incidence at the slit aperture entrance along the bordering planes e . In this case, the slit depth c of FIG. 3 may be selected to be substantially larger than if the system were to operate without total reflection at the bordering planes.

The optical requirements for total reflection are that the material of the slit member 9' be optically denser than the surrounding medium. A glass foil having a high index of refraction, e.g., $n_1 = 1.7$ may be inserted into the center portion of the opaque guide element 7 by means of an adhesive 17 or by means of a glass solder having a low index of refraction, e.g., $n_2 = 1.5$. The slit member 9' then acts as a light conductor for all the light which in the case of the above-mentioned indices of refraction impinges on the slit entrance surface at an angle of 36° to 90° . For a difference in the indices of refraction of 0.1, the permissible angular range is still sufficient for the impinging light rays.

In order to protect the slit member 9' or the guide element 7, respectively, against the impingement of light from adjacent tracks or grooves through which the bundle of rays 13 of the reading beam passes, the guide element 7 is provided with lateral coatings 10 which have good reflecting properties on their side facing the guide element 7 or the slit member 9', respectively, but are impermeable to the radiation impinging from the outside.

FIG. 4 shows an illustration of the beam path for an arrangement according to FIG. 2, i.e., with a slit aperture containing a slit member 9'. Corresponding portions of FIGS. 2 and 4 are provided with the same reference numerals. FIG. 4 shows only the portions of the guide member 7 bordering on the slit member 9' or the adhesive 17, and carrier or disc 1 is shown only as a section through the groove bottom. From the figure it can be seen that the portion of the reading beam bundle of rays 13 which comes from the radiation source passes through carrier 1 and that periodic variations in the radiation density occur in a plane $x - x$ which are produced by the recorded signal wave represented by the undulations 12, the plane $x - x$ lying in the vicinity of the entrance opening of slit member 9'. The direction of relative movement between the slit member 9' and carrier surface is again indicated by the arrow d . The entrance opening of slit member 9' now covers light fluxes of varying density in the plane $x - x$ with the illustrated case being that in which the density covered by the slit aperture is a maximum. The axial ray of the portion covered by the slit member 9' passes directly through the center of the slit and of the subsequently disposed lens 18, i.e., without being reflected at the bordering planes e , and travels to radiation receiver 19. The outer beams are totally reflected several times at the bordering planes e of the slit member 9' and then exit from the slit plane under exiting angles which are equal to the corresponding entrance angles. These exiting rays then go to lens 18 from where they are directed to radiation receiver 19.

It should be noted that the light flux coming from the optically effective member of the guide element is guided to the radiation receiver 6 of FIG. 1, or 19 of FIG. 4, respectively, in different ways. In FIG. 1, the radiation receiver is disposed directly behind the exit side of the member contained in guide element 7. This necessitates a reduced distance between the radiation receiver and the guide element which can not always be realized constructively in a simple manner. In FIG. 4 a second possibility is shown in which a lens 18 produces an intermediate reproduction of the slit exit at the input of the radiation receiver 19. The aperture of this lens is so dimensioned that, when a slit aperture is used which has well-reflecting border planes, the outer beams which exit at acute angles with respect to the optical axis of the reading beam bundle of rays are covered in both the axial and radial directions over the entire permissible fluctuation range of the position of guide element 7 with reference to the track. This is a prerequisite for the minimum aperture of the lens. However, the aperture of the lens 18 should not be selected any larger than necessary so that the laterally impinging, interfering scattered rays are not registered. Since only the magnitude of the total light flux is registered by the radiation receiver, no sharp reproduction of the slit aperture exit side is necessary. Thus a vertical wobble of carrier 1 has no influence on the useful signal even if it leads to a change in the width of the object. The only prerequisite is that the entire photo flux be received by the radiation receiver over the entire fluctuation range.

A further possibility for guiding the light flux from the output of the slit member 9' to the input of the radiation receiver 19 would be to employ an advantageously flexible light conductor. Such light conductors are sufficiently well known in the art so that a further description thereof is not required. The input of such a light conductor could be directly connected with the slit exit and its output directly connected to radiation receiver 19 to form the input thereof.

In the arrangement whose details were described in connection with FIGS. 2 and 4, the guide element 7 together with slit member 9' as well as an intermediate optical system, if required, in the form of lens 18, and radiation receiver 19 are advantageously forced to move along the radius of the disc-shaped carrier 1. Radial and axial wobble of the carrier can be absorbed by spring-suspended supports for the above-mentioned parts so that these parts can move along corresponding to the particular wobble. This is not absolutely necessary, however, for lens 18 and radiation receiver 19 so long as the

lens diameter and the area of the input of receiver 19 are large enough so that in spite of the wobble the total light flux exiting from the slit aperture can always be received.

FIGS. 5 and 6 describe an alternate embodiment of an arrangement according to the present invention in which the optically effective member which is connected with the guide element 7 is a lens arrangement which represents the plane of the evaluable primary light density fluctuations directly produced by the deformations in another plane which exhibits corresponding secondary light density fluctuations. As shown in FIG. 5, which is a representation similar to that of FIG. 2, where corresponding portions bear the same reference numerals, the guide element 7 bears a condenser lens 20 on its upper surface. The sides of guide element 7 which are adjacent the adjacent grooves are provided — as in FIG. 2 — with a radiation-impermeable coating 10. Contrary to the embodiment of FIG. 2, at least the portion of guide element 7 which is disposed in the path of the radiation portion to be evaluated, or the entire guide element, is formed of a material which is clearly transparent for the radiation. Since the guide element should have good sliding characteristics together with low wear, at least at the slide surfaces 16, it may consist of a suitable optical glass, a sapphire crystal or a diamond crystal. The guide element 7 may consist of a connected piece of such a material so that the entire element acts as a cylindrical lens. It is, however, also possible to fabricate the guide element 7 to initially have a plane covering surface and then to glue on a cylindrical lens. Instead of a cylindrical lens it is also possible to use a spherical lens. The cylindrical lens, however, is better suited for the problem to be solved and exhibits the advantage that it is easier to manufacture, for example, from a glass filament. The axis of this cylindrical lens 20 is positioned perpendicular to the direction of the relative movement d between guide element 7 and the surface of groove carrier or disc 1. Thus the axis of the cylindrical lens 20 is parallel to the axes of the quasi-cylindrical lenses forming the undulations in the bottom of the grooves. With the aid of cylindrical lens 20 the plane of wide light density fluctuations, which is marked $x - x$ in FIG. 6, is reproduced in a plane in which the slit aperture of the system is disposed or which is closely adjacent to the slit aperture, the reproduction occurring with simultaneous enlargement, e.g., by the factor 10. The length of the slit aperture should then be approximately equal to one-half of the shortest recorded wavelength multiplied by the optical enlargement factor of the cylindrical lens. The width of the slit aperture may be substantially larger than the width of the image of the track in the slit aperture plane.

The slit aperture plane and the radiation receiver are advisably forced to move along a radius of the disc-shaped carrier corresponding to the inclination of the groove. The guide element which is present in the shape of a cylindrical lens may be resiliently fastened to the forcibly moved arrangement so that it can follow the radial and axial wobble of the carrier. The width of the receiving slit aperture 9 should be large enough so that the image of the track is always covered by the slit even when there is a radial wobble. Crosstalk from adjacent grooves is avoided by the above-mentioned coating 10 on the guide element 7 of FIG. 5.

FIG. 6 is a greatly enlarged illustration of the beam path of an arrangement according to FIG. 5. This illustration is similar to that of FIG. 4 and corresponding portions bear the same reference numerals. It can be seen that the parallel bundle of rays 13 of the reading beam are either condensed or dispersed, as in FIG. 4, by the undulations 12 of carrier or disc 1 so that periodic density fluctuations of the radiation result in the plane $x - x$ (which is here disposed inside the transparent guide element 7). From this plane $x - x$ of density variations the cylindrical lens 20 produces in slit plane $y' - y'$ an enlarged image by appropriately directing the exiting beams 14. Thus the length l of slit aperture 9 in this plane may be larger by the enlargement factor than if this slit were disposed in plane $x - x$. The radiation receiver 6 may be combined with slit aperture 9 and guide element 7 into a mechanical unit.

FIG. 6 illustrates that the object length g for the condenser lens 20 is selected to be substantially smaller than the image length b in which the image of the secondary light density fluctuations is produced ($y - y$).

With axial wobble the plane of optimum light density variations, which is shown in FIG. 6 in approximation as the plane $x - x$, is also displaced in an axial direction. The distance between it and the cylindrical lens 20, however, remains unchanged due to the contact of the guide element with the disc surface. The distance between lens 20 and the slit aperture 9, however, does change. The range of focus for image plane $y - y$ is greater, however, with an enlarged reproduction than that for the object plane $x - x$, i.e., by a factor equal to the square of the enlargement. As indicated in the related above-identified patent application sufficient light density fluctuation is present over a vertical range of approximately 5 to $10\mu\text{m}$ when reference is made to the dimensional relationships of the high-density recording technique for video signals. This numerical value thus applies for wavelengths of about $4\mu\text{m}$ and amplitudes of about $0.5\mu\text{m}$. With an enlargement factor of 10 there thus results a corresponding range for the image plane $y - y$ of 0.5 to 1 mm. If the carrier wobble remains within this range, a sufficiently large fluctuating portion of the light flux will always pass through the slit aperture 9. This condition can thus be met without too many difficulties.

The use of an enlargement is thus advantageous for two reasons: firstly, the slit aperture becomes easier to manufacture because its dimensions can be enlarged and secondly, the range of focus within plane $y - y$ is increased.

With the relatively wide range of focus for the object plane of 5 to $10\mu\text{m}$ it is assured that slight vertical fluctuations of the cylindrical lens with respect to the carrier surface, as they might be caused by the deposition of dust particles, will have hardly any interfering effect. The reproducing lens in the indicated arrangement follows each vertical and lateral wobble of the carrier. Wear of the guide element 7 on the slide surfaces 16 can be compensated by appropriate vertical adjustment of the receiving slit plane (slit aperture 9).

It will be understood that the above description of the present invention is susceptible to various modifications, changes and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

We claim:

1. In a system for playing back, by means of a beam of parallel light radiation, signals recorded in the form of a carrier frequency which is frequency or phase modulated with the signals and within a groove or grooves on the surface of a recording medium by means of undulations of said surface corresponding to the time sequence of the signal values, wherein said record medium is moved relative to said beam of light radiation and wherein a slit aperture and said surface bearing the undulations are disposed in the path of said beam of radiation at such a distance from one another that a change in the density of the radiation emanating from the surface bearing the deformations results in the plane of the slit aperture, said change in density being dependent on the undulations existing on said surface in the direction of the relative movement of the recording medium and said reading beam and which change in density at least qualitatively reproduces the course of the undulations, and wherein means are provided behind said slit aperture for detecting the radiation passing through said slit aperture; the improvement comprising: radiation guide means positioned in the path of said beam of said radiation, said guide means including a slide member which extends into the particular groove or portion thereof on said surface of said record medium from which it is desired to play back the recorded signal, said guide means including means optically effective for the type of radiation employed for aiding in the evaluation of the light density fluctuations produced in said particular groove.

2. The playback system as defined in claim 1 wherein said optically effective means is said slit aperture which extends through said guide means.

3. The playback system as defined in claim 1 wherein said optically effective means is a lens arrangement which reproduces the plane of evaluable primary light density variations directly produced by the undulations in a second plane bearing corresponding secondary light density variations, whereby said secondary light density variations can then pass through said slit aperture to said detecting means.

4. The playback system as defined in claim 1 wherein the sides of said guide means which are adjacent the neighboring grooves are provided with a radiation-impermeable coating.

5. The playback as defined in claim 1 wherein said guide means is provided with laterally extending surfaces for contacting the raised portions of said surface forming the walls between adjacent grooves, and wherein said slide member engages the groove profile with lateral play and extends into said groove to such a distance that the base thereof does not touch the groove bottom bearing the undulations.

6. The playback system as defined in claim 5 wherein said optically effective means is a slit aperture which is constructed to be clearly permeable for the type of radiation employed and comprises two parallel bordering surfaces which are disposed perpendicular to the direction of relative movement between said guide means and the surface of the groove being scanned, said bordering surfaces being portions of said guide means, and being substantially centrally located between the peripheral surfaces of said guide means.

7. The playback system as defined in claim 6 wherein said slit aperture takes up a central spatial portion within the outline surfaces of said guide means.

8. The playback system as defined in claim 7 wherein an objective lens is provided in the path of said reading beam of radiation between the outlet of said slit aperture and said detecting means for producing an intermediate reproduction of the slit aperture outlet, the aperture of said objective lens being so dimensioned that when a slit aperture with well reflecting bordering planes is used the outer beams of the reading beam bundle of rays which exit under acute angles with respect to the optical axis of the reading beam bundle are covered over the entire permissible fluctuation range of the position of the guide element with respect to the groove being scanned in both the axial and radial directions.

9. The playback system as defined in claim 6 wherein the length of said slit aperture is not larger than one-half of the shortest recorded wavelength, wherein the width of said slit aperture is approximately equal to the width of the recorded undulations.

10. The playback system as defined in claim 9 wherein the depth of said slit aperture is substantially greater than the length thereof and wherein said bordering surfaces of said slit aperture have good reflecting properties.

11. The playback system as defined in claim 6 wherein said slit aperture is filled with a solid transparent material which is permanently connected to said bordering surfaces and with the adjacent portions of the guide means.

12. The playback system as defined in claim 11 wherein said transparent material has an index of refraction such that total reflection results along said bordering surfaces in the usable range of the optical impingement angles occurring at the slit aperture entrance.

13. The playback system as defined in claim 5 wherein said optically effective means is a lens arrangement which reproduces the plane of evaluable primary light density variations directly produced by the undulations in a second plane bearing corresponding secondary light density variations, whereby said secondary light density variations can then pass through said slit aperture to said detecting means, and wherein said lens arrangement contains a condensor lens whose image length is selected to be greater than the object length.

14. The playback system as defined in claim 13 wherein at least the portion of said guide means which is disposed in the path of said beam portion to be evaluated consists of a material which is clearly permeable for the radiation.

15. The playback system as defined in claim 14 wherein said lens is a cylindrical lens.

16. The playback system as defined in claim 14 wherein the clearly permeable portion of said guide means bears a collector lens on its side facing away from said record medium, with the axis of said lens being perpendicular to the direction of relative movement of said guide means with respect to the undulation-bearing groove surface being scanned.

17. The playback system as defined in claim 16 wherein the length of said slit aperture is at least approximately equal to one-half of the shortest recording wavelength contained in the undulations, multiplied by the enlargement factor between said plane of the primary light density variations and said plane of the secondary light density variations.

18. The playback system as defined in claim 17 wherein the width of said slit aperture is substantially larger than the width of the light track in said plane of the secondary light density changes.

19. The playback system as defined in claim 18 wherein said detecting means is mechanically connected with said slit aperture.

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