

PATENT SPECIFICATION

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(54) INFORMATION RECORDS

(71) We, RCA CORPORATION, a corporation organized under the laws of the State of Delaware, United States of America, of 30 Rockefeller Plaza, City and State of New York, 10020, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The present invention divided from application No. 13073/72, Serial No. 1392201 relates generally to high-density information records and, particularly, to such articles in novel forms providing for cooperative establishment and employment of capacitance variation effects, and readily permitting, for example, relatively inexpensive mass replication and relatively simple playback of video signal recordings of appreciable playing time.

The recovery of recorded information, by use of capacitance variations established through cooperation of a recording with a pickup electrode of associated playback apparatus, has been proposed in the past for low-density recordings, as exemplified by the disclosures of the following U.S. patents relating to sound recording systems: 1,580,112; 1,715,863; 1,859,551; 1,891,780; 2,373,273; and 2,442,140.

The present invention recognizes that such cooperative capacitance varying phenomena may be used to advantage to achieve a high-density information record and playback system, whereby, for example, a video signal recording of appreciable playing time may be realized in a relatively inexpensive form subject to relatively simple playback techniques.

In accordance with the invention, a video or other high density information signal recording takes the form of a spirally grooved disc subject to playback by apparatus employing a pickup stylus riding in

the disc groove. The groove has a constant width and contains an information track constituted by geometry variations in the bottom of the groove representative of recorded information. The instantaneous location of the center of the groove is not varied in accordance with recorded information; rather, the center-to-center spacing of successive convolutions of the spiral is substantially constant and independent of the recorded information, whereby close spacing of the successive convolutions may be achieved. The groove sidewalls have a curvilinear configuration in cross-section which is substantially constant throughout said successive convolutions and independent of the groove bottom geometry variations representative of recorded information. In the overall system as described in the parent application, a stylus having a tip receivable in the disc groove during playback includes a support element of insulating material and an electrode of conductive material supported thereby, this electrode presenting a surface to the disc groove bottom when the tip is received in the disc groove. During playback, rotational relative motion is effected between the disc and the stylus (e.g. by rotation of a disc-supporting turntable) with the stylus tip received in and travelling along the groove. Electrically connected to said stylus electrode are appropriate means for developing an electrical signal representative of groove bottom geometry variations passing the said stylus electrode surface during such relative motion. These variations do not mechanically affect the stylus but rather serve to vary capacitance presented between the stylus electrode and, for example, a conductive surface of a disc supporting turntable.

This electrical circuitry incorporating the varying capacitance can serve to translate the capacitance variations occurring during

playback into electrical signal variations which may be suitably employed to effect visual display of the recorded information. Illustratively, the electrical circuitry may
 5 comprise a resonant circuit which incorporates the varying capacitance, and to which are applied oscillations (at a frequency suitably higher than the recorded signal frequencies) so that a signal representative of the recorded information
 10 can be obtained by detecting the resulting variations in the response of the resonant circuit to such oscillations.

The disc can be of a thermoplastic material, such as vinyl (as used in audio phonograph records), whereby the grooving of such material and the formation of the dimension-varying information track therein may be effected by mass replication techniques akin to the record stamping operations associated with the audio phonograph record industry.

An illustrative dimension variation pattern, that may be employed to vary the geometry of the groove bottom, is the relative raising and/or depression (to an extent less than the maximum depth of the groove bottom) of the groove bottom in accordance with the recorded information.
 25 With the dielectric constant of the thermoplastic disc material greater than that of air, the capacitance presented during playback between the stylus electrode surface and, say, a conductive surface on the turntable will be greater when the stylus electrode surface is positioned over a relatively raised area in the groove bottom than when the stylus electrode surface is positioned over a relatively depressed area.
 30 Thus, as relative motion between the groove and stylus occurs, the successive alignment of the stylus electrode with differently raised and/or lowered regions in the groove results in a succession of capacitance variations representative of the recorded information.
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The invention and its advantages may be more fully understood by those skilled in the art upon a reading of the following detailed description and an inspection of the accompanying drawings, in which:

FIGURE 1 is a transverse sectional view fragment of a disc record showing the engagement during playback thereof of a
 40 stylus tip with the walls of a disc groove containing an information track in the groove bottom, and illustrating an application of the principles of the present invention;

FIGURE 2 is a longitudinal sectional view of the record groove of FIGURE 1, with a further view of the stylus tip in playback engagement therewith;

FIGURE 3 is a top view of illustrative
 65 playback apparatus that may be employed

in association with the stylus and disc record of FIGURES 1 and 2 pursuant to the principles of the present invention;

Referring to FIGURE 1, the pickup stylus 10 includes a body of insulating material which provides the tip of the stylus with insulating sidewalls for engagement with the side wall of the groove, and a conductive electrode 20 accommodated in the insulating body and having
 70 a surface exposed at the end of the stylus tip. The stylus tip rides in a groove 15 in a recording medium 30 constituted by a spirally grooved disc illustrated fragmentarily. The relative motion of the groove 15
 80 with respect to the stylus 10 during playback is perpendicular to the plane of FIGURE 1. It is seen that the stylus tip is supported by sidewalls 12 and 14 of curvilinear form of the groove 15; lands 50
 85 and 60, respectively, form the boundaries for the illustrated groove segment, separating it from adjacent groove convolutions. Electrode 20 is aligned to be centered above an information track 75 in the bottom of the groove 15.

Pursuant to an illustrative example of groove bottom geometry modification, the information track 75 may comprise variations in the height of the groove bottom
 95 along the length of the groove 15 (as best shown in the longitudinal sectional view of FIGURE 2) with the consequence of complementary variations in the magnitude of an air gap 40 between the electrode 20 and the track 75. The illustrated width of the electrode 20 (FIGURE 1) is substantially coincident with the width of the information track 75 in the groove 15. The thickness (FIGURE 2) of the electrode 20
 105 at the exposed tip is of a still smaller magnitude appropriate to resolution of the smallest required information track variation.

As FIGURE 2 shows, the stylus 10 is supported by the groove side walls in such manner that passage of the elements of information track 75 beneath the tip of stylus 10 will desirably impart no mechanical disturbance to the stylus. What will occur, however, during such passage of the track elements, that may be utilized in recorded information recovery, is a variation in the capacitance presented between the electrode 20 and a reference conductive area, positioned, for example, beneath the disc 30. Illustratively, the reference conductor may comprise a conductive surface of a turntable provided to support and rotate disc 30.
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Illustrative dimensions for the stylus electrode 20 and the spiral disc groove 15 are the following: electrode 20 width—5 micrometers; electrode 20 thickness—1 micrometer; groove pitch equivalent to
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2000 grooves per inch. Associating such dimensions with an illustrative disc rotation speed of 600 rpm, one may obtain, for example, recovery of signal frequencies up to about 4 megacycles, with a one-side playing time of approximately 10 minutes, from a 12 1/2 inch diameter disc having the highest frequency variation occupying 2.5 micrometers of groove length per variation wavelength.

Other parameter combinations may, of course, be employed, where, for example, a lower disc rotation speed is desired.

In a copending application No. 13075/72 modifications and improvements of the herein described record and playback arrangements are described in detail. Reference may also be made to application No. 48664/74 divided from that application for examples of record cutting techniques that may be adapted to development of a stamping master suitable for mass replication of the disc 30; see, particularly, the master preparation process described in the above noted application No. 48664/74, and the description of scanning electron microscope processes for recording of groove bottom information tracks. Reference may be made to application 13075/72 for an example of procedures that may be followed in forming stylus 10.

FIGURE 3 is a top view of record player mechanism which may, illustratively, be employed in playback of the disc 30 of FIGURES 1 and 2. The mechanism includes a turntable mounting board 102 which has a drive motor and drive mechanism (not shown) for rotating a disc-supporting turntable 31 (only partially shown). A shield enclosure 104 includes a stylus arm 106, which rests on a stylus arm centering bracket 107 when the machine is not operating. The stylus 10 is attached to the stylus arm 106 by means of a stylus mounting cap 108. An aperture 109 in shield enclosure 104 permits stylus 10 to pass through the enclosure and contact disc 30. The electrical connection to the electrode imbedded in the stylus is made by means of a flexible conductor 110, which may be fabricated from beryllium copper, for example. The stylus arm 106 is attached to a groove velocity error drive mechanism 125 by means of a flexible pivot assembly 120 which allows the stylus arm 106 to move in a lateral as well as vertical direction during operation. The flexible pivot assembly 120 may be as described in detail in the aforementioned application 13075/72 Serial No. 1392202.

The shield enclosure 104 and stylus arm 106 are driven to allow the stylus 10 to track the groove 15 by means of a drive shaft 130 which is engaged by an engaging mechanism 135 coupled to the shield en-

closure 104 by means of a shield enclosure bracket 136. The drive shaft 130 may be coupled to the drive mechanism in the manner described in detail in application 13075/72 Serial No. 1392202.

In operation, the shield enclosure 104 including the stylus arm 106 is moved across the record by means of the drive shaft 130 to provide tracking with the groove 15. The flexible pivot 120 as well as the flexible conductor 110 allows the stylus arm 106 to float on the disc 30, thereby permitting the stylus 10 to track surface deviations in the disc such as warping. The groove velocity error drive mechanism 125 operates to compensate for velocity errors due to turntable speed variations, record eccentricity, or other velocity errors. The operation of the mechanism 125 is described in detail in copending application 13074/72 (Serial No. 1383336).

It is noted that the stylus arm 106, the shield enclosure 104, and the drive mechanism 130-136 can be replaced in some applications with a relatively long lightweight pickup arm which can pivot on the turntable base in much the same manner as an audio record player pickup arm.

The shield enclosure 104 may also house some of the electrical circuits associated with the stylus, suitable circuitry being described in the parent application. For example, an inductor 145 to which the stylus electrode 20 is coupled can be mounted on a circuit board 140. Other circuit components can be mounted on circuit board 140 without affecting the tracking weight of the stylus 10, since the stylus arm 106 is free floating and independent of the shield enclosure 104.

WHAT WE CLAIM IS:

1. A high-density information record comprising a disc having a constant-width spiral groove in a surface thereof for receiving a stylus, the center-to-center spacing of successive convolutions thereof being substantially constant and independent of recorded information; said groove containing an information track constituted by variations in the geometry of the bottom of the groove representative of recorded information, and having sidewalls the cross-sectional configuration of which is of curvilinear form and is substantially constant throughout said successive convolutions and independent of the groove bottom geometry variations representative of recorded information.

2. A record according to claim 1 wherein the recorded information constitutes a video signal.

3. A record according to claim 1 or 2 wherein said geometry variations of the bottom of the groove comprise variations

2000 grooves per inch. Associating such dimensions with an illustrative disc rotation speed of 600 rpm, one may obtain, for example, recovery of signal frequencies up to about 4 megacycles, with a one-side playing time of approximately 10 minutes, from a 12 1/2 inch diameter disc having the highest frequency variation occupying 2.5 micrometers of groove length per variation wavelength.

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2. A record according to claim 1 wherein the recorded information constitutes a video signal.

3. A record according to claim 1 or 2 wherein said geometry variations of the bottom of the groove comprise variations



- in the depth of the groove in a region disposed between the groove sidewalls, said depth variations being limited to a range of depths in which the difference between the maximum and minimum depth is less than the maximum depth.
- 5 4. A record according to any preceding claim wherein the disc is of thermoplastic material.
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5. A record disc substantially as hereinbefore described with reference to the accompanying drawings.

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