

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 is divided from application No. 13075/72 (Serial No. 1,392,202) to which reference may be had for a discussion of the background to the invention.

The parent application is directed to a novel form of information record disc playback system suitable for video information and involving the provision on the record disc of a dielectrically coated conductive surface having therein a spiral groove dimensioned to receive a playback stylus and containing an information track constituted by variations in the bottom geometry of the groove. The conductive surface may be constituted by a conductive coating on a grooved disc substrate. The playback stylus includes a conductive electrode. On playback, changes in capacitance between this electrode and the conductive surface of the disc, resulting from the groove bottom geometry variations, are sensed to provide a signal representative of the recorded information.

The present invention is concerned with certain groove bottom geometries which may be adopted for grooved record discs and especially for such discs adapted for the playback system of the parent application, such discs themselves being the subject of application No. 52207/74 (Serial No. 1,392,206) also divided from the parent application. Attention is also drawn in this regard to application No. 49430/74 (Serial No. 1,392,304).

According to the present invention an information record disc is provided in a surface thereof with a spiral groove having

curved (in cross-section) sidewalls of substantially invariant geometry throughout successive convolutions of the spiral and having a cross-sectional bottom configuration between said sidewalls which alternates between a first configuration in which the groove sidewalls and at least a central section of the groove bottom define respective parts of a smooth curve and a second configuration in which the groove sidewalls define parts of such curve and at least a central section of the groove bottom is depressed relatively thereto.

In the following description reference is made to the accompanying drawings repeated from the parent application and in which:

Figure 1 is a perspective view of a portion of a grooved storage medium and a section of the tip of a pickup stylus tracking in a groove thereof;

Figure 2 is a cut-away transverse view of the groove of Figure 1 showing the profile of the groove and the modulation contained therein and also illustrating the placement of the pickup stylus tip;

Figure 3 is a cut-away side view of the groove of Figure 1 illustrating the modulation elements located in the groove;

Figure 4A is a top view of a portion of a groove in which information is recorded in the form of an amplitude modulated carrier signal according to one embodiment of the present invention;

Figures 4B—4D are diagrams showing the capacitance variations detected by a pickup stylus which scans over the portion of the groove shown in Figure 4A;

Figure 5A is a top view of a groove in which information is recorded in the form of a frequency modulated carrier signal, pursuant to another embodiment of the invention;

Figure 5B is a diagram showing the capacitance variations which would be detected by a stylus tracking the portion of the groove shown in Figure 5A.

Referring to Figure 1, a storage medium

10 comprises a disc which has an elongated spiral groove 14 contained therein and, illustratively, is fabricated from a thermoplastic material, such as vinyl, as is used in a phonograph record.

The playback mechanism may be somewhat similar to a phonograph player, with a turntable used to rotate the disc while a stylus 20 is suitably held in a position to track the spiral groove; such a playback mechanism is described in greater detail in the parent application. It is noted that only a section of the very tip of stylus 20 is shown in Figure 1, which is a greatly enlarged view showing the arrangement of the stylus 20 relative to the groove 14.

Viewing the groove portion of the disc in detail, it is seen that the base material of disc 10 has a conducting surface layer 11 which may, illustratively, be vacuum deposited on its surface. This layer may be of a conductive metal such as aluminum, vapor deposited to a thickness of 500Å, for example. A dielectric coating 12 overlays the metallized layer 11. Layer 12 may, illustratively, be of a dielectric material such as polystyrene, also with a 500Å thickness.

Looking at the topology of the surface of the disc, Figure 1 shows a very small portion of the spiral groove 14 illustrating modulation elements 18 in the groove. The modulation system used in the Figure 1 example is a base band type in which the signal information is recorded directly without the use of a carrier signal. The modulation systems of more particular concern for the present invention will be discussed subsequently. Elements 18 appear as protrusions in a signal information track 16. The elements 18 provide capacitance variations between the pickup stylus 20 and the metallized layer 11.

As the electrode 23 scans over the modulation elements 18, the area of the metallized layer 11 which is immediately adjacent to the electrode 23 varies in accordance with the recorded signal information. The signal information track 16 covers a substantial amount of the groove area to maximize the difference between maximum and minimum detected capacitance. The remaining area in the groove comprises the groove walls 15 which support stylus 20. The area between successive grooves comprises the land areas 19. It is noted that for the most efficient use of the total disc surface, it is desirable to reduce the land areas to a minimum amount; the relative land area dimensions are exaggerated in Figure 1 for ease of illustration.

The indented portion of the information track (i.e., between modulation elements 18) is of nearly uniform depth as shown by the depth dimension 17 of the information track 16 in Figure 2. Pursuant to an illustrative

set of track dimensions, the depth 17 of track 16 may be about 0.4 micrometer, the groove depth approximately 5 micrometers, and the groove width approximately 11 micrometers.

The pickup stylus 20 illustrated in Figure 1 includes first and second dielectric support members 21 and 22, and a conductive electrode 23. Illustratively, the electrode 23 is approximately 0.3 micrometers in thickness and approximately 5 micrometers in width at the bottom of the stylus at the point where it contacts the groove 14. An alternative form of stylus is also described in the parent application.

Figure 2 shows an end view of the groove 14 of Figure 1 and the relative position of the stylus 20 with respect thereto. In Figure 2, the parts identical to those shown in Figure 1 are labeled with the same reference numbers. It is seen that the groove 14 is generally arcuate in cross-section, and the tip of stylus 20 substantially conforms to, and comes into contact with, the groove. By utilizing a dielectric coating 12 over the metallized disc, the exposed surface of the electrode 23 of stylus 20 can be brought into contact with the dielectric coating 12 thereby increasing the maximum-to-minimum capacitance ratio between the electrode 23 and the metallized layer 11 as the electrode scans the disc. When a uniform dielectric coating is employed, the distance between the electrode 23 and modulation elements 18 is maintained relatively constant so that different size styli or worn styli will still provide satisfactory performance. A polystyrene dielectric coating has a relatively low coefficient of friction, thereby reducing stylus wear.

The motion of stylus 20 relative to the groove 14 in Figure 2 is transverse to the plane of the drawings. As the electrode 23 scans over the modulation elements 18, the area of the metallized disc immediately under the electrode varies, forming a capacitor which varies in accordance with the recorded signal information. It is noted that, for the illustrative parameters, the metal surface of the depressed regions of the information track 16 which surround the modulation elements 18 is spaced more than .4 micrometer from the electrode 23, whereas the metal surface 11 of the modulation elements 18 is only separated from the electrode 23 by approximately 500Å. Thus, while the total surface area 11 below the electrode 23 is constant, the metal area which presents the significant capacitance to electrode 23 is that portion associated with the modulation elements 18. The capacitance thus formed is a function of (1) the area of the fixed electrode, which forms one plate of the capacitance and is constant; (2) the thickness of dielectric coating 12 which is also constant, and (3) metallized

area 11 of the varying modulation elements 18 in Figure 1.

Figure 3 is a side view of the groove 14 of Figure 1 showing the modulation elements 18 as they appear in the cut-away side view.

Figure 4A is a top view of a groove 14 illustrating a modified form of recording in the information track 16, the recording being in the form of an amplitude modulated carrier. The left portion of the illustrated groove, indicated as the portion 42, shows the unmodulated carrier which comprises alternate areas of signal elements 41 and depressed areas 43 (latter indicated by shading in the drawing). Thus, as the pickup stylus (not shown) scans along the groove, the modulation elements 41 will be in contact with the conducting element of the pickup stylus, whereas the depressed areas 43 will be spaced at least .4 micrometer from the pickup stylus. The capacitance between the conductive element and the modulation elements 41 (when provided with a metallized surface having a dielectric coating thereon) is shown diagrammatically in Figure 4B by the pulses 41' which correspond in location to the signal elements 41 in Figure 4A. Figure 4C indicates the capacitance in the intervals corresponding to the depressed areas 43. Over the interval 42, no appreciable capacitance exists between the conducting element of the pickup stylus and the metallized surface at the bottom of the depressed areas. Figure 4D represents the total capacitance detected by the pickup stylus as it moves along the groove 14. This figure may also represent, for example, an output signal from electrical pickup circuitry connected to the stylus to respond to the varying capacitance.

As the carrier signal is modulated by signal information at the right end of the groove (shown by the interval 44), the information track in the groove is selectively cut away in the pattern illustrated in the figure. Successive locations 45—50 are shown which provide capacitance contributions illustrated in Figure 4B by the elements 45', 47' and 49' and in Figure 4C by the elements 46', 48' and 50'. It is seen that the modulation element locations (41 at the left end of the groove) may have portions of the narrow areas depressed in greater or lesser amounts, while the previously completely depressed areas (43 in interval 42) may be more or less completely depressed during the modulation interval 44. One feature of such a modulation system is that corresponding pairs (i.e., 45—46, 47—48, and 49—50) provide a substantially constant support area to the pickup stylus as it moves along the groove. Although providing a substantially constant support area, the modulation format varies the detected capacitance in accordance with recorded signal information. The boundaries

between the unshaded and shaded portions are drawn in heavy lines to indicate the modulation. Figure 4D illustrates the combined detected capacitance due to each interval 45—50 of the remaining elements shown. It is seen that during the interval 52 included in the modulation interval 44 the capacitance remains constant as shown by Figure 4D. Considering Figure 4D as also illustrative of the output signals from an electrical pickup circuit, such a signal will remain at a constant level (zero) during the interval 52.

Figure 5A is a top view of a portion of a groove 14 illustrating a frequency modulation type of recording format in which a carrier signal represented by the elements 53 and 54 at the left end of the groove portion may be frequency modulated by signal information. The depressed areas (54, for example) are indicated by shading in the drawing. At the left end of the illustrated groove, the depressed areas 54 and the interleaved signal element areas 53 represent an unmodulated carrier. As with the amplitude modulation scheme described in conjunction with Figure 4, the capacitance pickup stylus will detect a maximum capacity when the conducting element in the pickup stylus is centered above a modulation element and comes into contact therewith. When the conducting element is aligned with a depressed area, the capacitance decreases. Figure 5B shows diagrammatically the accompanying capacitance variations and is drawn to align the capacitance variations 55', 56', 57' and 58' with the corresponding signal elements 55, 56, 57 and 58 of Figure 5A. As the pickup stylus scans over the modulation information, it is seen that the negative going capacitance portions of Figure 5B correspond to the constant width depressed areas interleaved with the elements 55, 56, 57 and 58 of Figure 5A. The spacing between successive depressed areas is varied by the signal to provide the signal information recording. Although Figure 5B is a graph of the capacitance changes, it may also represent an electrical signal provided by pickup circuitry connected to the stylus electrode.

WHAT WE CLAIM IS:—

1. An information record disc provided in a surface thereof with a spiral groove having curved (in cross-section) sidewalls of substantially invariant geometry throughout successive convolutions of the spiral and having a cross-sectional bottom configuration between said sidewalls which alternates between a first configuration in which the groove sidewalls and at least a central section of the groove bottom define respective parts of a smooth curve and a second configuration in which the groove sidewalls define parts of such curve and at least a central section of



area 11 of the varying modulation elements 18 in Figure 1.

Figure 3 is a side view of the groove 14 of Figure 1 showing the modulation elements 18 as they appear in the cut-away side view.

Figure 4A is a top view of a groove 14 illustrating a modified form of recording in the information track 16, the recording being in the form of an amplitude modulated carrier. The left portion of the illustrated groove, indicated as the portion 42, shows the unmodulated carrier which comprises alternate areas of signal elements 41 and depressed areas 43 (latter indicated by shading in the drawing). Thus, as the pickup stylus (not shown) scans along the groove, the modulation elements 41 will be in contact with the conducting element of the pickup stylus, whereas the depressed areas 43 will be spaced at least .4 micrometer from the pickup stylus. The capacitance between the conductive element and the modulation elements 41 (when provided with a metallized surface having a dielectric coating thereon) is shown diagrammatically in Figure 4B by the pulses 41' which correspond in location to the signal elements 41 in Figure 4A. Figure 4C indicates the capacitance in the intervals corresponding to the depressed areas 43. Over the interval 42, no appreciable capacitance exists between the conducting element of the pickup stylus and the metallized surface at the bottom of the depressed areas. Figure 4D represents the total capacitance detected by the pickup stylus as it moves along the groove 14. This figure may also represent, for example, an output signal from electrical pickup circuitry connected to the stylus to respond to the varying capacitance.

As the carrier signal is modulated by signal information at the right end of the groove (shown by the interval 44), the information track in the groove is selectively cut away in the pattern illustrated in the figure. Successive locations 45—50 are shown which provide capacitance contributions illustrated in Figure 4B by the elements 45', 47' and 49' and in Figure 4C by the elements 46', 48' and 50'. It is seen that the modulation element locations (41 at the left end of the groove) may have portions of the narrow areas depressed in greater or lesser amounts, while the previously completely depressed areas (43 in interval 42) may be more or less completely depressed during the modulation interval 44. One feature of such a modulation system is that corresponding pairs (i.e., 45—46, 47—48, and 49—50) provide a substantially constant support area to the pickup stylus as it moves along the groove. Although providing a substantially constant support area, the modulation format varies the detected capacitance in accordance with recorded signal information. The boundaries

between the unshaded and shaded portions are drawn in heavy lines to indicate the modulation. Figure 4D illustrates the combined detected capacitance due to each interval 45—50 of the remaining elements shown. It is seen that during the interval 52 included in the modulation interval 44 the capacitance remains constant as shown by Figure 4D. Considering Figure 4D as also illustrative of the output signals from an electrical pickup circuit, such a signal will remain at a constant level (zero) during the interval 52.

Figure 5A is a top view of a portion of a groove 14 illustrating a frequency modulation type of recording format in which a carrier signal represented by the elements 53 and 54 at the left end of the groove portion may be frequency modulated by signal information. The depressed areas (54, for example) are indicated by shading in the drawing. At the left end of the illustrated groove, the depressed areas 54 and the interleaved signal element areas 53 represent an unmodulated carrier. As with the amplitude modulation scheme described in conjunction with Figure 4, the capacitance pickup stylus will detect a maximum capacity when the conducting element in the pickup stylus is centered above a modulation element and comes into contact therewith. When the conducting element is aligned with a depressed area, the capacitance decreases. Figure 5B shows diagrammatically the accompanying capacitance variations and is drawn to align the capacitance variations 55', 56', 57' and 58' with the corresponding signal elements 55, 56, 57 and 58 of Figure 5A. As the pickup stylus scans over the modulation information, it is seen that the negative going capacitance portions of Figure 5B correspond to the constant width depressed areas interleaved with the elements 55, 56, 57 and 58 of Figure 5A. The spacing between successive depressed areas is varied by the signal to provide the signal information recording. Although Figure 5B is a graph of the capacitance changes, it may also represent an electrical signal provided by pickup circuitry connected to the stylus electrode.

WHAT WE CLAIM IS:—

1. An information record disc provided in a surface thereof with a spiral groove having curved (in cross-section) sidewalls of substantially invariant geometry throughout successive convolutions of the spiral and having a cross-sectional bottom configuration between said sidewalls which alternates between a first configuration in which the groove sidewalls and at least a central section of the groove bottom define respective parts of a smooth curve and a second configuration in which the groove sidewalls define parts of such curve and at least a central section of



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the groove bottom is depressed relatively thereto.

2. An information record disc according to claim 1 wherein the bottom of the groove has first recurring regions regularly spaced along the length of the groove and in each of which at least a portion of the groove bottom is depressed to a maximum depth with any remaining portion of the groove bottom in each such region raised relative to said maximum depth, and second regions separating the first regions and in each of which at least a portion of the groove bottom is raised to said maximum depth with any remaining portion of the groove bottom in each second region depressed to said maximum depth, the percentage of depressed groove bottom area in each first region varying in accordance with the recorded information, and the percentage of depressed groove bottom area in an adjoining second region depressed varying complementarily with respect to that in the first region so that the percentage of groove bottom area raised relative to said maximum depth in successive pairs of first and second regions remains substantially constant and independent of the recorded information.
3. An information record disc according to claim 1 wherein the groove cross-section alternates along the groove between a first recurring shape in which the surfaces of the

groove sidewalls and the intervening groove bottom define a continuous smooth curve and a second recurring shape in which the surface of said intervening groove bottom is depressed relative to a groove bottom level corresponding to said continuous smooth curve, the spacing of the alternations of the groove cross-section between said first shape and said second shape along the groove varying in accordance with recorded information.

4. An information record disc according to any of claims 1—3 being a video record disc for use with a playback stylus having a support element tapering to a tip at one end thereof for entry into the disc groove and supporting a conductive electrode terminating at said tip with a curved edge surface of predetermined curvature, wherein at least a central part of said smooth curve defined in the groove substantially matches the predetermined curvature of said curved edge surface of the stylus electrode.

5. An information disc according to claim 1 with the groove bottom configured substantially as hereinbefore described with reference to Figure 4A or Figure 5A of the accompanying drawing.

T. I. M. SMITH,
Chartered Patent Agent,
50, Curzon Street,
London, W1Y 8BU,
Agent for the Applicant.