(7)

PATENT SPECIFICATION (11) 1 574 595

1 574 595

(21) Application No. 10824/77 (22) Filed 15 March 1977
(23) Complete Specification filed 30 Aug. 1977
(44) Complete Specification published 10 Sept. 1980
(51) INT CL³ H04N 5/82; G11B 25/04
(52) Index at acceptance
G5R B21 B261 B262 B263 B361 B36Y B691 B701 B711 B721 B783 B789



(72) Inventors SARWAN KUMAR KHANNA, LEONARD P. FOX, PABITRA DATTA, HIROHISA KAWAMOTO and DENNIS LEE MATTHIES

(54) VIDEO DISC

(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:—

This invention relates to a non-coated disc containing both audio and video information in the form of a surface relief pattern. More particularly, this invention relates to a non-coated conductive video disc which can be played by a metal stylus as part of a capacitance playback system.

A capacitance video recording and playback system has been disclosed in U.S. Patents 3,842,194, 3,842,217 and 3,909,517 to Clemens, incorporated herein by reference. According to this system, disc replicas can be prepared having geometric variations in a spiral groove in the disc surface which correspond to capacitance variations representative of video signals. The discs are coated first with a thin conductive metal layer and then with a dielectric layer. A metal stylus completes the capacitor and, during playback, rides upon the dielectric coating and detects dimensional variations in the groove. These variations are reconstituted in electrical signal form and converted back to video information suitable for display by a television receiver. A suitable system for converting the information representing capacitance variations to electrical signals is described in application No. 48030/75 (Serial No. 1,574,594).

Since the relief pattern and the groove are of very small dimensions, e.g., there are 5,000—10,000 grooves per inch (12,700—25,400 grooves per centimeter), much research and expense have been required to learn how to put down metal and dielectric layers which conform to the relief pattern, are thin enough so they do not fill the grooves and yet are thick enough so as to form a coherent, abrasion resistant and pinhole free layer.

It will be apparent that if the metal and dielectric layers could be eliminated, with no substantial loss of signal or increase in noise level on playback of the disc, it would be a great advance as far as cost savings in manufacturing are concerned.

We have found that non-coated, conductive video discs adapted for use with a playback stylus and containing an information track of a surface relief pattern can be made by molding a plastic material containing sufficient finely divided conductive particles. The video disc material must have a resistivity below about 500 ohm-centimeters at 900 megahertz (MHz) in order for the video signals to be reconstructed on playback by a metal stylus.

Conductive plastic materials suitable for use herein must contain sufficient finely divided conductive particles so that the filled plastic has a bulk resistivity at 900 MHz of less than 500, and preferably less than 100 ohm-centimeters. The conductive particles can be metals, such as nickel, copper, gold and the like, or conductive carbon particles.

Conductive particles suitable for use in the invention include highly electrically conductive, finely divided carbon blacks, preferably which have a low bulk density to reduce loading requirements. Presently preferred is a product of the Armak Co., Ketjenblack EC, which has an apparent bulk density of 150 grams per liter and an average particle size of about 300 angstroms. These carbon black particles have a high surface area and a high proportion of voids within the particles, as measured by dibutyl phthalate absorption, which enables current to flow between the conductive particles in a non-conductive polymer matrix in a highly efficient manner. Other carbon blacks can also be employed, in whole or in part, provided they meet the electrical requirements. Denser particles of carbon will usually require higher loading for an equivalent electrical conductivity. Finely divided conductive metal particles can also be employed.

The particle size of the conductive particles useful herein is not critical and various particle sizes or mixtures of particel sizes can be em-

ployed, provided the conductive particles are not so large that they would form a grainy surface in the plastic matrix which would interfere with the signal patterns in the grooved discs. In general, the particle size should be less than about 500 angstroms.

The amount of conductive particles added depends on the electrical properties required. The more conductive particles are added, the more conductive the composition will become, but large quantities of fillers such as carbon black decrease the processability of the molding composition and increase the brittleness of the product. That amount of conductive particles must be added for the present application to reduce the resistivity to below about 500 ohm-centimeters at 900 MHz, preferably to below 100 ohm-centimeters and, most preferably, to below about 60 ohm-centimeters. Ketjenblack EC can be added in amounts of from about 10 to about 20 parts, preferably about 15 parts, for 100 parts of the molding composition and achieve the desired conductivity. Other carbon blacks, which are denser materials, must be employed at higher loadings to achieve comparable resistivities, e.g., about 25—35 percent by weight of the molding composition. Improved results, insofar as electrical properties are concerned, are sometimes obtained by mixing Ketjenblack EC with minor amounts of another carbon black. Thus optimum compositions will contain the least amount of conductive particles that will give acceptable resistivity.

The conductive particles must be thoroughly mixed with the plastic matrix in order to prevent agglomeration of the particles which would reduce conductivity and also have an adverse effect on the physical properties of the filled plastic, e.g., increased brittleness and reduced processability.

The conductive particles are mixed with any suitable moldable plastic material. The choice depends on the physical properties of the material, e.g., moldability, brittleness, heat distortion temperature, melt temperature, melt viscosity, hardness, ageing characteristics and the like, rather than on any particular composition. Many suitable plastic molding compositions are commonly available, including polyvinyl chloride, polyvinyl chloride copolymers and terpolymers with polyvinyl acetate, propylene and the like, polyethylene-propylene copolymers, acrylic polymers and the like.

The chosen plastic can be mixed with various additional ingredients, such as stabilizers, lubricants, processing aids and the like, as is well known.

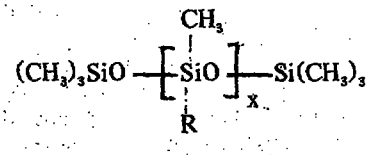
Suitable antioxidant stabilizers include organo-metallic compounds derived from metals such as tin, lead, zinc, barium and cadmium, such as dibutyl tin-β-mercaptopropionate, dibutyl tin maleate and the like. Epoxides, phosphites and alkylated phenols such as t-butyl catechol can also be employed.

Suitable lubricants are also well known and include fatty acids and esters such as stearic acid or hydroxystearic acid and the like; fatty acid esters of alcohols and fatty acids; polyfunctional acid and alcohol esters; soaps such as zinc, lead or calcium stearate and the like; fatty acid amides such as stearic acid amide, oleamide, ethylene bis stearamide and the like; and silanes such as dimethyl siloxanes and the like. Sufficient lubricants must be added to prevent high shear heating during processing and to prevent sticking of the composition to the mold.

Various processing aids can also be added in minor amounts, such as polyvinyl chloride terpolymers, polymethylmethacrylate polymers and the like.

The amounts of additives employed will vary depending on the base polymer employed and the amount of conductive particles added, as well as the molding procedure to be followed, as is known. In general, amounts of from about 0.1 to about 5 percent by weight of the total weight of the molding composition are suitable.

For the present application, a thin dielectric layer must be present at the surface of the disc. This dielectric layer is provided by the presence of a thin film of molding composition around each conductive particle, or by adding sufficient lubricant to the molding composition so that a small amount bleeds to the surface forming a thin film. Alternatively, a thin lubricant film can be applied as a separate layer on the uncoated disc. This film serves as an added dielectric layer and also serves to reduce stylus wear. The lubricant film must be thin enough so that it does not fill the groove, but thick enough so as to form a pinhole-free layer. One lubricant type that has been employed successfully is a methyl alkyl siloxane of the formula



wherein R is an alkyl group of 4—20 carbon atoms and x is an integer. These films can be applied by spinning from solution, as is disclosed in U.S. Patent 3,833,408.

The conductive particles can be added to the molding composition ingredients either prior to mixing or can be added to the molten molding composition. For example, a Banbury mixer and a Brabender apparatus or a twin screw extruder can be employed to mix the plastic and the conductive particles. The filled molding composition can be sheeted on a two roll mill, pelletized and stored for molding.

For the present application, suitability of the conductive plastic material for video discs is also determined by measuring certain elec-

trical properties during playback of the molded disc according to the playback system of Application No. 48030/75 (Serial No. 1,574,594) referred to hereinabove. A test signal is recorded at a carrier frequency of 5 MHz. Carrier level at 5 MHz (C), measured at millivolts peak to peak, is a function of the conductivity of the filled molding composition and generally increases at lower resistivities. To illustrate, playback of a prior art metal coated disc having a signal track modulation of about 600 angstroms representing a 5MHz carrier, can provide a recovered carrier level of about 7.4 millivolts peak to peak. A similar carrier level is desirable for the present, non-coated disc having a similar signal track modulation, although good pictures can be viewed at lower levels of about 1 millivolt peak to peak.

Another property which measures the quality of the picture obtained is the carrier to noise (C/N) level ratio obtained during playback of a signal recorded at 5 MHz, which ratio should be as high as possible and at least about 40 decibels (dB) for commercially acceptable video. The prior art metal coated disc has a C/N ratio of about 54 dB. This ratio generally increases as resistivity decreases.

To determine low frequency noise perform ance, the ratio of the noise level at 0.5 MHz as related to the noise level at 5 MHz, obtained during playback of a signal recorded at 5MHz is measured to indicate the slope of the noise floor. As the resistivity decreases, the slope of the noise floor decreases, i.e., the low frequency noise/high frequency noise level is smaller in low resistivity discs. Optimally, the slope of the noise floor (0.5/5 MHz) value should approach 3 dB.

The relative dielectric constant increases as resistivity decreases also. This constant at 900 MHz should have a value of 15 or higher for good quality video discs.

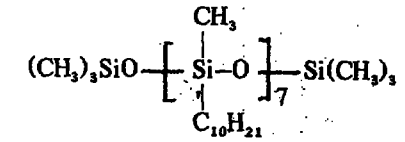
The invention will be further illustrated by the following Examples but it is to be understood that the invention is not meant to be limited to the details disclosed therein. In the Examples parts and percentages are by weight.

EXAMPLE 1.

Eighty-one parts of a copolymer of polyvinylchloride and 15 percent of vinylacetate copolymer VYHH from Union Carbide Corporation, 2.5 parts of dibutyltin maleate stabilizer available as MK-275 from Argus Chemical Company, 1.2 parts of a fatty ester lubricant commercially available as Wax E from Hoechst Chemical Company and 16.2 parts of Ketjenblack EC of the Armak Company were mixed in a Banbury mixer under 20 pounds of steam for 1.5 minutes.

Good quality video discs were compression molded from a metal video disc master as described by Clemens in U.S. Patent, 3,842,194, at 330° F (165° C) using a 60 second cycle.

A thin layer of a methyl alkyl siloxane having a viscosity of 50 centistokes and the formula



commercially available as SF-1147 of General Electric Company was applied by spinning.

The disc had a bulk resistivity of 10 ohm-centimeters at 900 MHz and a 5 MHz C/N level ratio on playback of 42 dB. The carrier level was 7.4 millivolts peak to peak (mVpp). The slope of the noise floor was 5 dB.

EXAMPLES 2—7

Good video discs were fabricated utilizing other carbon blacks or mixtures with the carbon black of Example 1, following the general fabrication procedure of Example 1. The data are summarized below in Table 1.

TABLE 1

Example	VYHH Resin, %	Wax E, %	MK–275, %	Carbon Black	%	Resistivity at 900 MHz, ohm-cm.	Dielectric Constant, 900 MHz	C/N, dB	$\left(\frac{N_s}{N_{0.s}}\right)^{-1}$	C, mVpp
2	72.23	0.5	2.25	C–960 (a)	25	120	26	42	9	2.3
3	72.23	0.5	2.25	Raven 1500 (b)	25	440	13	38	11	0.37
4	72.23	0.5	2.25	Raven 3500 (c)	25	120	24	47	15	1.0
5	72.23	1.0	2.2	Vulcan XC–72 (d)	25.3	69	33	37	12	0.47
6	80.6	0.8	2.5	Ketjenblack EC	8	80	29	42	15	0.93
				Raven 3500 (c)	8					
7	80.6	0.8	2.5	Ketjenblack EC	12	46	45	42	8	4.2
				Raven 3500 (c)	4					

(a) Conductex–960 of Columbia Carbon Corp. having a particle size of 210 angstroms.

(b) Raven 1500 of Columbia Carbon Corp. having a particle size of 180 angstroms.

(c) Raven 3500 of Columbia Carbon Corp. having a particle size of 160 angstroms.

(d) Vulcan XC–72 of Cabot Corp.

EXAMPLES 8—11.

Good video discs were fabricated utilizing the carbon black of Example 1 and other molding compositions. The components were mixed and compression molded following the general procedure of Example 1. The data are summarized below in Table 2.

TABLE 2

Ex.	Resin	%	Lubricant	%	Stabilizer	%	Carbon Black, %	Resistivity at 900 MHz, ohm-cm.	Dielectric Constant, 900 MHz	C/N, dB	$\left(\frac{N_s}{N_{o\,s}}\right)^2$	C, mVpp
8	AP—480 (a)*	80.25	Calcium Stearate	0.75	T—35 (b)	2	15	9.6	—	43	7	5.5
9	AP—480	83.5	Wax E	0.9	MK—275	2.6	13	57	38	38	13	2.3
10	FS 965 (c)	83.5	Wax E	0.9	MK—275	2.6	13	17	—	40	12	3.7
11	AP—480*	83.35	G—30 (d) G—70 (e)	0.43 0.21	T—35	1.76	12.4	71	28	35	16	1.0

(a) a copolymer of vinyl chloride and 8% propylene of Air Products and Chemicals Inc.

(b) dibutyl tin-β-mercaptopropionate of M & T Chemical Company Inc.

(c) a vinyl chloride homopolymer of Firestone Co.

(d) Loxiol G—30 is a monofatty acid ester of various molecular weight alcohols and fatty acids available from Henkel International GmbH.

(e) Loxiol G—70 is a mixture of polyfunctional acids and alcohol esters of Henkel International GmbH.

* also contains 1.75% of K—175, an acrylic processing aid of Rohm & Haas.

EXAMPLE 12—PART A

A molding composition was prepared by mixing the following ingredients in a Henschel mixer: 44 parts of a vinyl chloride — 8 percent propylene copolymer, AP-480 from Air Products and Chemicals, Inc.; 10 parts of a vinyl chloride copolymer containing 15 percent of vinyl acetate, copolymer VYHH from Union Carbide Corporation; 10 parts of a vinyl chloride — 25 percent maleate ester, FPC-471 from the Firestone Company; 4 parts of 70 percent chlorinated paraffin wax, Unichlor 70 AX from Neville Chemical Co.; 3 parts of glyceryl tribenzoate available as Benzoflex S-404 from Velsicol Chemical Corporation; 2 parts of epoxidized soybean oil, having a molecular weight of about 1000 available from Rohm & Haas Co. as Paraplex G-62; 1.0 part of dibutyl tin-β-mercaptopropionate stabilizer, T-35 from M&T Chemical Company, Inc.; 1.0 part dibutyl tin maleate, Mark 275 from Argus Chemical Company; 1.5 part of barium-cadmium-lead stearate, Mark Q232B from Argus Chemical Company; 2.0 parts of a polymethylmethacrylate processing aid K-147 from Rohm & Haas Co., 0.5 part of calcium stearate; 0.4 part of Wax E, an esterfied montan wax from Hoechst Chemical Company; 0.3 part of Loxiol G-30 from Henkel International GmbH, a mono-fatty acid ester of varying molecular weight alcohols and acids; and 15.0 parts of Ketjenblack EC carbon black.

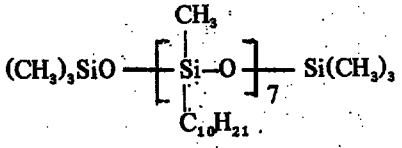
After the temperature of the mixture reached about 130° F (54° C) 5.0 parts of diisooctylphthalate plasticizer and 0.3 part of a low molecular weight parffin oil from Carlo ERBA, a division of Chemica Industrialle, Milan, Oil Vaselina, lubricant were added and mixing continued until the temperature reached about 180° F (82° C).

Twelve inch (30.5 cm) video discs were compression molded at 330° F (165° C) using a 60 second cycle with a metal stamper described by Clemens in U.S. Patent 3,842,194, referred to hereinabove.

The molding composition had a bulk resistivity at 900 megahertz of 13 ohm-cms. On playback, the molded discs had a 5 MHz C/N level ratio of 44 dB; the carrier level was 7.4 millivolts peak to peak. The slope of the noise floor was 7 dB.

PART B

A thin layer of a methyl alkyl siloxane lubricant having a viscosity of 50 centistokes and the formula



commercially available as SF-1147 of General Eletcric Co., was applied by spinning.

These discs had a 5 MHz C/N level ratio on play-back of 46 dB; the carrier level was 6.6 millivolts peak to peak and the slope of the noise floor was 7 dB.

COMPARATIVE EXAMPLE.

This example shows a carbon-filled molding composition having a high resistivity.

To the polymer composition of Example 11 was added 8.6 percent of Ketjenblack EC in a Banbury mixer for 1.5 minutes. The molding composition was compression molded at 330° F (165° C).

The conductivity was 3600 ohm-centimeters at 900MHz, and the dielectric constant at 900 MHz was 8.1. The carrier level was 0.06 mVpp. No picture could be seen on playback.

WHAT WE CLAIM IS:—

1. A video information record, adapted for use with a playback stylus to effect recovery of signals occupying a bandwidth of at least several megaherz when relative motion at a desired rate is established between said record and said stylus, said record comprising a disc of a moldable plastics material containing a sufficient amount of finely divided conductive particles so that the material has a bulk resistivity below about 500 ohm centimeters at 900 MHz and including an information track constituted by a surface relief pattern dimensioned to accommodate recovery of signals of said bandwidth upon establishment of said motion at said rate.

2. An information record according to Claim 1 wherein said information track is contained in a spiral groove dimensioned for reception of said playback stylus therein.

3. An information record according to Clam 2 which has a spiral groove containing such an information track on both major surfaces.

4. An information record according to Claim 1, 2 or 3 wherein the bulk resistivity is below about 100 ohm-centimeters.

5. An information record according to any preceding Claim wherein said plastics material is a polymer of vinyl chloride.

6. An information record according to any preceding Claim wherein said conductive particles are carbon black.

7. An information record according to Claim 6 wherein said carbon black has an apparent bulk density of about 150 grams per liter.

8. An information record according to Claim 7 in which the record is made from a composition composed of:

44 parts of a vinyl chloride — 8 percent by weight propylene copolymer,

10 parts of a vinyl chloride copolymer containing 15 percent by weight of vinyl acetate,

EXAMPLE 12—PART A

A molding composition was prepared by mixing the following ingredients in a Henschel mixer: 44 parts of a vinyl chloride — 8 percent propylene copolymer, AP-480 from Air Products and Chemicals, Inc.; 10 parts of a vinyl chloride copolymer containing 15 percent of vinyl acetate, copolymer VYHH from Union Carbide Corporation; 10 parts of a vinyl chloride — 25 percent maleate ester, FPC-471 from the Firestone Company; 4 parts of 70 percent chlorinated paraffin wax, Unichlor 70 AX from Neville Chemical Co.; 3 parts of glyceryl tribenzoate available as Benzoflex S-404 from Velsicol Chemical Corporation; 2 parts of epoxidized soybean oil, having a molecular weight of about 1000 available from Rohm & Haas Co. as Paraplex G-62; 1.0 part of dibutyl tin-β-mercaptopropionate stabilizer, T-35 from M&T Chemical Company, Inc.; 1.0 part dibutyl tin maleate, Mark 275 from Argus Chemical Company; 1.5 part of barium-cadmium-lead stearate, Mark Q232B from Argus Chemical Company; 2.0 parts of a polymethylmethacrylate processing aid K-147 from Rohm & Haas Co., 0.5 part of calcium stearate; 0.4 part of Wax E, an esterfied montan wax from Hoechst Chemical Company; 0.3 part of Loxiol G-30 from Henkel International GmbH, a mono-fatty acid ester of varying molecular weight alcohols and acids; and 15.0 parts of Ketjenblack EC carbon black.

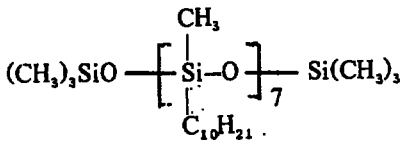
After the temperature of the mixture reached about 130° F (54° C) 5.0 parts of diisooctylphthalate plasticizer and 0.3 part of a low molecular weight parffin oil from Carlo ERBA, a division of Chemica Industrialle, Milan, Oil Vaselina, lubricant were added and mixing continued until the temperature reached about 180° F (82° C).

Twelve inch (30.5 cm) video discs were compression molded at 330° F (165° C) using a 60 second cycle with a metal stamper described by Clemens in U.S. Patent 3,842,194, referred to hereinabove.

The molding composition had a bulk resistivity at 900 megahertz of 13 ohm-cms. On playback, the molded discs had a 5 MHz C/N level ratio of 44 dB; the carrier level was 7.4 millivolts peak to peak. The slope of the noise floor was 7 dB.

PART B

A thin layer of a methyl alkyl siloxane lubricant having a viscosity of 50 centistokes and the formula



commercially available as SF-1147 of General Eletcric Co., was applied by spinning.

These discs had a 5 MHz C/N level ratio on play-back of 46 dB; the carrier level was 6.6 millivolts peak to peak and the slope of the noise floor was 7 dB.

COMPARATIVE EXAMPLE.

This example shows a carbon-filled molding composition having a high resistivity.

To the polymer composition of Example 11 was added 8.6 percent of Ketjenblack EC in a Banbury mixer for 1.5 minutes. The molding composition was compression molded at 330° F (165° C).

The conductivity was 3600 ohm-centimeters at 900MHz, and the dielectric constant at 900 MHz was 8.1. The carrier level was 0.06 mVpp. No picture could be seen on playback.

WHAT WE CLAIM IS:—

1. A video information record, adapted for use with a playback stylus to effect recovery of signals occupying a bandwidth of at least several megaherz when relative motion at a desired rate is established between said record and said stylus, said record comprising a disc of a moldable plastics material containing a sufficient amount of finely divided conductive particles so that the material has a bulk resistivity below about 500 ohm centimeters at 900 MHz and including an information track constituted by a surface relief pattern dimensioned to accommodate recovery of signals of said bandwidth upon establishment of said motion at said rate.

2. An information record according to Claim 1 wherein said information track is contained in a spiral groove dimensioned for reception of said playback stylus therein.

3. An information record according to Clam 2 which has a spiral groove containing such an information track on both major surfaces.

4. An information record according to Claim 1, 2 or 3 wherein the bulk resistivity is below about 100 ohm-centimeters.

5. An information record according to any preceding Claim wherein said plastics material is a polymer of vinyl chloride.

6. An information record according to any preceding Claim wherein said conductive particles are carbon black.

7. An information record according to Claim 6 wherein said carbon black has an apparent bulk density of about 150 grams per liter.

8. An information record according to Claim 7 in which the record is made from a composition composed of:

44 parts of a vinyl chloride — 8 percent by weight propylene copolymer,

10 parts of a vinyl chloride copolymer containing 15 percent by weight of vinyl acetate,

10 parts of a vinyl chloride — 25 percent maleate ester,
4 parts of a 70 percent chlorinated paraffin wax,
3 parts of glyceryl tribenzoate,
2 parts of epoxidized soybean oil having a molecular weight of about 1000,
1 part of dibutyl tin-β-mercaptopropionate,
1 part of dibutyl tin maleate,
1.5 part of barium-cadmium-lead stearate,
2.5 parts of a polymethylmethacrylate resin processing aid,
0.5 part of calcium stearate,
0.4 part of an esterified montan wax,
0.3 part of a monofatty acid ester of varying molecular weight alcohols,
15 parts by weight of carbon black having an apparent bulk density of 150 grams per liter and an average particle size of about 300 angstroms,
5 parts of diisooctylphthalate, and
0.3 parts of a low molecular weight paraffin oil, all of the above parts being by weight.

9. An information record according to Claim 1 and substantially as any of the herein described and exemplified alternatives.

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

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1980.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

* C L M S *