

Feb. 13, 1968

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3,368,918

SIGNAL RECORDING TECHNIQUE

Filed Sept. 26, 1962

Fig. 1

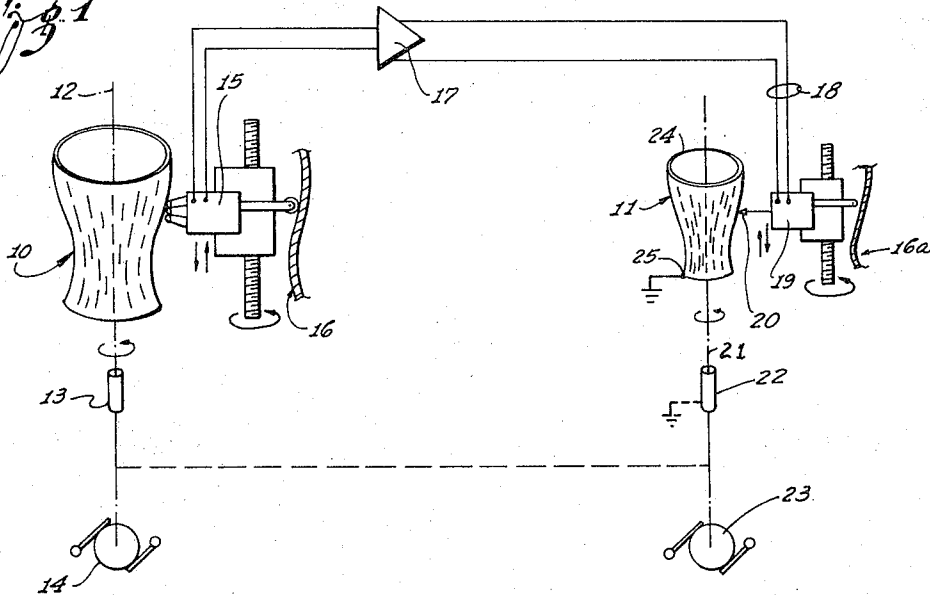


Fig. 2

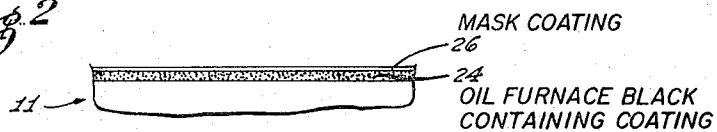
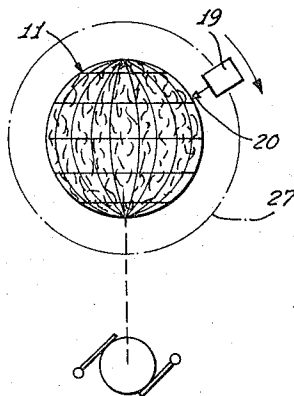


Fig. 3



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1

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SIGNAL RECORDING TECHNIQUE

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Filed Sept. 26, 1962, Ser. No. 226,261

2 Claims. (Cl. 117-216)

This invention relates to coating materials and more especially it relates to such materials as are electrosensitive to produce a distinctive surface characteristic in response to signals representing such characteristics.

An important object of the invention relates to novel electrosensitive coatings which are specially adapted to be sprayed on to a surface with a precise precontrolled electrosensitive response. That is to say, the coating material is so prepared that it is particularly adapted to the application by spraying on to a nonplanar or irregular surface so as to render that surface electrosensitive to applied electric signals.

Another object is to provide a nonplanar surfaced solid article which is an electrosensitive analog of another prototype article whereby the analog provides a permanent duplicate of the prototype both as regards the configuration conformation and the corresponding sensed characteristics of the prototype.

A feature of the invention relates to a novel spraying batch for the formation of electrosensitive recording coatings or nonplanar bodies.

A further feature relates to the novel method of preparing an analog of prototype article which analog has configurational conformations and surface characteristics identical with those of a prototype.

In accordance with one aspect of the invention a three-dimensional record blank, which is noncylindrical, or which has a varying circumference, is provided with a dark-colored undercoating of high resistance material, and an outer or top coating of light-colored material covering the undercoating.

In accordance with another aspect of the invention, the dark-colored undercoating preferably is a water base sprayed coating of carbon material. The use of a water carrier for the sprayed coating is advantageous in avoiding combustible residues from inflammable carriers, and the resultant irregularities in the recording. Furthermore, it preferably includes oil furnace carbon black. This form of carbon black is characterized by small particle size, leading to high image resolution, and relatively high conductivity as compared with carbon from other sources.

Other features and advantages not specifically enumerated will be apparent after a consideration of the following detailed descriptions and the appended claims.

In the drawing:

FIG. 1 shows in schematic form a typical prototype and analog thereof and the associated system for preparing the surface of the analog.

FIG. 2 is a highly magnified sectional view of a portion of the analog prepared according to the invention.

FIG. 3 represents a modified system employing a three-dimensional record member in accordance with the invention.

In the field of ultrasonic recording and in certain other arts, it is highly desirable to make a permanent record or analog of a prototype solid article so that the analog has the same configurational conformation, and also represents the surface characteristics or other properties of the prototype as detected at successive points on the surface of the prototype. One of the more important aspects of this problem of making such an analog is the assurance that the surface of the analog has the same surface characteristics and surface variations located at the identical spots as on the prototype. In accordance with the

2

invention, the original prototype is duplicated as to solid or configurational conformation so that it represents a true conformational analog of the prototype. However, in order to impart to the analog markings corresponding to the characteristics detected at successive points on the surface of the prototype, the analog has sprayed onto its surface an electroresponsive or a pressure-sensitive coating or coatings. These coatings are then scanned in a point-by-point fashion in successive minute spots of elemental area, and in synchronism with the corresponding scanning of the corresponding elemental areas of the prototype in any manner well known in the facsimile transmission and recording arts. The scanning of the prototype produces analog currents which represent the characteristics of the prototype. These characteristics may be of any predetermined kind. For example, the surface of the prototype may be scanned for light reflection properties at the various elemental areas, or for the magnetic or structural characteristics at or below such areas or even for the existence of non-uniformity of depth, smoothness or other physical characteristics of such surfaces, and the like. Similarly, the prototype may be subjected to ultrasonic signals, and the signals detected at the surface of the prototype may then represent structural flaws or defects in the prototype.

While the invention is not limited to the manufacture of an analog of any particular kind of prototype, merely for illustration the drawing shows a prototype of a non-cylindrical object 10 whose characteristics are to be recorded in a corresponding analog 11. The analog 11 is similar in shape to prototype 10 but may be larger or smaller. Merely for explanatory purposes, it will be assumed that the prototype 10 has a symmetrical conformation of nonuniform circumference around an axis of symmetry 12 so that the prototype 10 can be fastened to a suitable rotatable arbor 13 arranged to be driven by a suitable motor 14, such for example as a synchronous motor. Mounted in scanning proximity to the surface of prototype 10 is any well known form of scanning head 15, such for example as illustrated in U.S. Patent No. 2,437,848 issued Mar. 16, 1948, which optically scans the successive elemental areas of the surface of prototype 10 to translate the characteristics of those elemental areas into corresponding electric signals. Alternatively, the scanning head may be of the form disclosed in the U.S. Patent No. 3,036,151, granted May 22, 1962, in which high frequency acoustic pulses are transmitted, received and transformed into electric signals. It will be understood, of course, that the scanning may be done by any other well known form of scanner, providing the scanning head includes a transducing element which is movable with the head to translate the examined characteristics of the surface of prototype 10 into corresponding electric signals.

In the manner well known, for example in the facsimile art, the scanning head can be moved longitudinally with respect to the axis 12 in timed relation to the rotation of the prototype 10 under control of the motor 14 so that, in effect, the surface of prototype 10 is scanned in a helix over its entire surface. Therefore, the currents from the head 15 at any given instant are true analogs of the examined characteristic of the prototype surface. Since the prototype 10 is of non-uniform circumference, but is symmetrical around its longitudinal axis, it is necessary to guide the scanning head 15 so that it maintains the uniform spacing from the surface of the prototype at all the successive scanned points thereof. Thus, the head 15 may be mounted for sliding guided movement by means of rollers (not shown) which ride on a track 16 having a configuration corresponding to the peripheral configuration of the prototype with respect to the longitudinal axis 12. Alternatively, the arbor 13 can be in the form of a

lead-screw and the prototype can carry a half-nut or similar threaded follower which engages the lead-screw to cause the prototype to be indexed longitudinally of the axis 12 at the same time that it is being rotated. In that case the scanning head may have attached thereto a roller which rides on the surface of the prototype to maintain a uniform spacing between the scanning head and the surface of the prototype.

These analog signals are then amplified in any well known signal amplifier 17 and are transmitted over a suitable electric link 18 to a recording head 19 of any well known type. In place of the amplifier 17, the electronic components disclosed in Patent No. 3,036,151 may be employed to convert the recorded pulses into low frequency signals for energization of the recording head 19. For a detailed description of such a head, reference may be had to U.S. Patent No. 3,018,153, issued Jan. 23, 1962. The head 19 carries a needle pointed metal stylus 20 which is therefore energized in accordance with the amplified currents received over link 18. The head 19 and stylus 20 are mounted so as to scan in successive elemental areas the surface of the analog member 11 whose conformational configuration is the same as that of the prototype 10. The analog member 11 may be of any suitable material, such as plastic, spun aluminum or other metal, or metal alloy, it having been previously made in any well known manner, for example by machining, molding, or the like, so as to have the same conformational shape as the prototype 10. The analog body 11 is supported on its axis of symmetry 21 on an arbor 22 driven by a synchronous motor 23, which is driven in synchronism with the motor 14 above described, or mounted on same arbor 13 to eliminate separate motor 22. The synchronous rotation of arbors 13 and 22 is indicated by the interconnecting dashed line. Here again, the scanning head 19 is moved parallel to the axis 21 at the same time that the analog member 11 is being rotated so that the stylus 20 scans the surface of the analog member 11 in successive elemental areas in synchronism with the scanning of the corresponding areas of the prototype 10. If necessary, the head 19 may be guided on a track 16a similar to track 16 so as to maintain the stylus 20 in contact with the coated surface of analog 11.

In accordance with the present invention, the analog member 11 is provided with an electrosensitive or electro-responsive coating 24 which has good electric conductivity, and the electric current from the energized stylus 20 can be returned to ground through a suitable brush or other contact 25 which is in engagement with the said surface. If the analog member 11 is of metal or conductive material, the ground return contact 25 may be deleted since the arbor 22 and the analog 11 would be directly grounded to the frame of the machine, as indicated by the dotted ground connection in FIG. 1. In the case of pressure-sensitive coatings, the pressure applied to the coating 24 by head 19 is varied, and no electrical connections to the analog are required.

We have found that in order to be sure that the electrosensitive coating 24 on the member 11 has the desired uniformity of response, even though the actual surface of the member 11 may be nonplanar or irregular, it is important that the same coating material be applied in a spraying operation. Furthermore, we have found that in order to effect this spraying operation so as to achieve the required uniformity, it is necessary to formulate a coating batch so that the final film coating 24 has the required electric conductivity, the required continuous film form, and the required thinness. This problem of obtaining the required uniform characteristics is particularly important where the electric conductivity of the film coating is derived from the presence of powdered carbon therein. Furthermore, it is desirable that the coating batch for the conductive coating 24 be of a water-base kind since otherwise the solvents or dispersing agents would tend to evaporate before the sprayed material reaches the

surface to be coated, particularly if that surface is relatively widely spaced from the spray gun head and if it is of nonplanar surface conformation. In addition, the presence of readily vaporizable or combustible materials derived from other solvents would introduce undesirable variations in the electrical characteristics of this coating.

In order that the surface characteristics of the coated analog can be made readily visible, the conductive coating 24 is provided with an extremely thin contrasting masking coating 26. This latter coating is of minimum thickness consistent with its ability to mask the dark or blackish hue of the conductive coating 24. The coating batch for the coating 24 is, according to the invention, comprised of a highly conductive powdered carbon black having a high coefficient of surface covering area with very small particle size in a liquid dispersing agent in the form of water. It also comprises a suitable bonding agent in a water dispersion, and also a water soluble film former and thickening agent.

An important ingredient of the base coating of the present invention is the carbon which is employed. As indicated in U.S. Patent No. 2,554,017, for example, it has been customary to employ gas black in the base coating. To obtain the desired conductivity it has been necessary to use gas black of relatively large particle size. The use of gas black carbon having the larger particle or grain size, however, reduces the definition and the resolution of the resultant image.

In accordance with one aspect of the invention, a significant portion of oil furnace carbon black is employed for the base coating instead of gas black. This form of carbon is characterized by a small particle size and a high conductivity comparable to that usually found in gas black or other carbons of much larger particle size.

In one representative spray suspension or batch, the following ingredients were used:

	Total, grams	Solids, grams
Water suspension of 21% (by weight) oil furnace black (9 grams) and 18% by weight of a dispersing agent (sodium salts of polymerized alkyl naphthalene sulfonic acids) -----	42.9	16.8
Additional water -----	107.1	----
Film former and thickening agent (water soluble polymer of poly-N- vinyl-5-methyl-2-oxazolidinone ----	0.3	----
Binder (methyl cellulose, or other film forming copolymer and plas- ticizer), 52% solids, in water -----	50.0	26.0
Additional suspended carbon, gas or oil furnace black, in water, to control conductivity (25% carbon) -	10.0	2.5
Total Weight -----	210.3	----
Total Solids (approximately) -----		45.3

The amount of carbon in the solution is relatively small (about 4%) but it forms a much larger proportion of the final hardened coating (about 20%). In general, the proportions of carbon will vary depending on the mode of application, spray or slurry form; and upon the nature of the binder and other ingredients of the batch. In each case, however, the conductivity and definition of the resultant image is improved by a substitution of a significant amount of oil furnace black for some or all of the carbon which has heretofore been used in electrical marking coatings. For the purpose of the present specification and claims, a significant or a substantial amount of oil furnace black will mean at least 1% of the liquid coating batch, and at least 5% of the hardened coating.

The coating batch is a water suspension and is applied to the surface of the analog body 11 with any well known

form of spray gun under approximately forty pounds pressure. The spraying operation is carried on merely to completely cover the surface of member 11 without causing running of the solution or suspension. Thereupon the coated body is heated in an oven at 100 degrees C. or by the application of heat in other ways, as by infrared lamps, until all the liquid constituents are removed. Thereupon, the coated body is allowed to cool to room temperature before the application of the masking coating 26.

A typical formulation for the masking coating 26 is that given, for example, in U.S. Patent No. 2,554,017, and may comprise, for example, isobutyl methacrylate in a naphtha solvent and containing a white pigment such as zinc sulfide, zinc oxide phosphor or mixture of sulfide and oxide phosphor.

In making the batch for coating 26, the batch elements are put in a pebble mill and milled for approximately forty-eight hours. This batch is applied over the coating 24 with a suitable spray gun under approximately forty pounds pressure. The nozzle of the spray gun should be adjusted to a fine spray to avoid coating roughness. Preferably the coating 26 is put on in two thin layers so as to impart to the finished surface a white grayish hue. In the event that the coating 26 is applied in two layers, the first layer should first be completely dried in an oven at a temperature of 100 degrees C. and thereafter the second layer can be applied and likewise dried at 100 degrees C.

The clarity and sharpness of the recordings on the coated analog will be determined by the amount of the masking coating 26 which is applied, and the thickness of that coating can be determined by trial depending upon the darkness or contrast desired in the recorded markings. The greater the amount of coating 26, the whiter the surface finish and, therefore, the greater contrast with the exposed black conductive coating 24 at those areas where recording has been effected by the recording current. Preferably the finished analog should have a white but grayish appearance for best results.

The present system is not limited to any particular kind of prototype or any particular mechanism for scanning the prototype. Thus, the recording voltage which is fed to the link 18, which may be a radio link, may be derived from an artificial satellite revolving around the earth and carrying any well known scanning equipment which scans the earth to produce electric signals corresponding to some predetermined characteristic of the earth's surface or of the space around the earth. Alternatively, the temperature, radiation level or other factors may be sensed and relayed to the earth by known telemetry techniques. Satellite orbits, such as polar orbits, are known which are suitable for scanning of the entire earth's surface. The analog 11 can, as indicated, be a small globe or sphere having the configurational conformation of the earth and provided with a sprayed-on recording coating as hereinabove described. If desired, the coating can be previously inscribed or otherwise marked, to correspond to predetermined geographical or topographical markings such as latitude, longitude, and the like. Here again the globe is mounted for rotation around one of its axes, and is provided with any suitable driving means to rotate it at a rate correlated with the rate of the earth's rotation, and at the same time the recording head 19 with its recording stylus 20 is provided with any suitable driving means whereby it is moved around the globe in proportionate synchronism with the movement of the satellite. The path of movement of the head 19 may conform to a given orbit of the satellite, and for that purpose the head 19 may be mounted for movement on a suitable guiding track 27. This head may be mounted on a small motor-driven carriage which may ride on an electrically energized track surrounding the globe 11. This track may be mounted for orientation in any desired orbit around the globe.

While the invention is not limited to any particular current amplitude flowing from the stylus 20 through the

recording surface on analog 11, highly desirable results were obtained by recording at the rate of four hundred lines per inch and with a recording current varying up to a maximum of approximately three hundred milliamperes.

The use of an oil furnace black in the recording coating is particularly advantageous in connection with three-dimensional record blanks having multiple or compound curvature which are therefore not cylindrical, as these units are generally used under relatively adverse operating conditions. Accordingly, it is particularly useful to have a high conductivity coating with fine grain. While these advantages are also desirable for conventional coated record blanks, they are particularly useful under the adverse mechanical, electrical and atmospheric conditions encountered during on-the-job testing in manufacturing plants, for which the three-dimensional record blanks are particularly intended.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention. Thus, by way of example and not of limitation, other known coatings and marking techniques may be employed.

Accordingly, it is to be understood that the present invention is to be limited only by the spirit and scope of the appended claims.

What is claimed is:

1. A method of making three dimensional recording member having a compound curvature formed with a varying circumference and having a fine grain recording surface for providing high definition electrical recording comprising the steps of:

forming a self-supporting base member having a compoundly curved surface with a varying circumference,

spraying a coating of a water suspension of small particle oil furnace carbon black to uniformly cover the surface to be recorded with a thin layer without causing running of the spray over the surface,

said water suspension having at least 1% by weight of the liquid spray and at least 5% by weight of the solid content of the spray consisting of small particle carbon black and the remainder comprising water, binder, dispersing agent, thickener, and additional carbon particles,

drying the sprayed coating by heating the base member to a temperature significantly above ambient temperature to form a high electrical resistance, fine grain uniform coating of the small particle carbon black over the surface thereby to provide high image resolution in the recording member,

and spraying an adherent outer coating of a different color on top of the base coating,

2. In the process of claim 1, said water suspension consisting of at least 10% by weight of binder, at least 1/10% by weight of a film former and thickener, and at least 1% by weight of additional carbon particles, and the remainder of water and dispersing agent.

References Cited

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