Aug. 12, 1941. J. H. DE BOER ET AL 2,251,919

VIBRATION RECORD AND METHOD OF MAKING THE SAME

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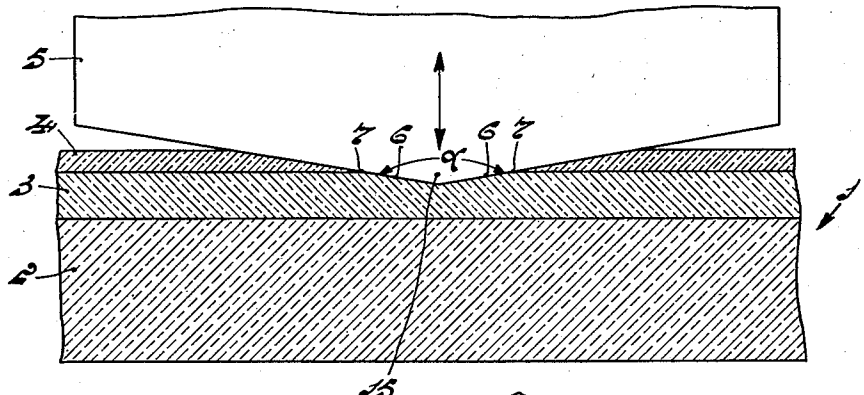


Fig. 1

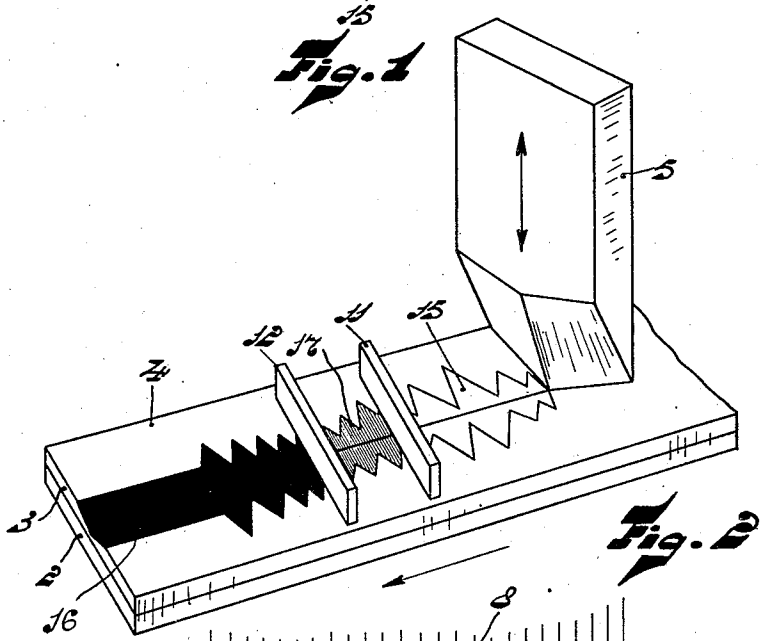


Fig. 2

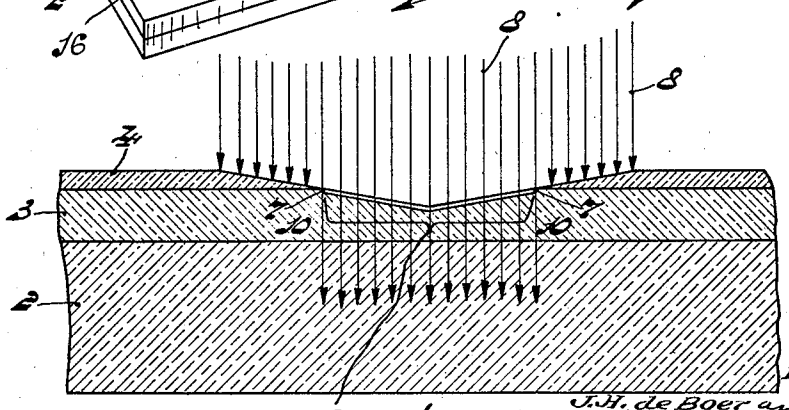


Fig. 3

INVENTORS
J. H. de Boer and
C. J. Dippel
BY
E. J. Kendroth
ATTORNEY

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VIBRATION RECORD AND METHOD OF MAKING THE SAME

Jan Hendrik de Boer and Cornelis Johannes Dippel, Eindhoven, Netherlands, assignors, by mesne assignments, to Hartford National Bank and Trust Company, Hartford, Conn., as trustee

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Our invention relates to carriers for mechanically-recorded and optically-reproducible vibration tracks particularly of the variable area type and to a method of making the same.

As our invention is particularly advantageous in connection with mechanical sound recording of the type described in the U. S. Patent 1,919,116 to James A. Miller, we shall describe the same in this connection. However, the invention is not limited thereto but can be used in connection with other types of mechanical recording in which an optically-reproducible vibration track particularly of the variable area type is produced.

In such mechanical recording it is general practice to use a carrier comprising a transparent recording or cutting layer and a thin covering layer which preferably contains metals or metal compounds and which possesses, for example, at the time of recording, the degree of opacity required for the light employed in reproduction. During the recording, a cutting tool having a V-shaped cutting edge with an apical angle of about 174° is vibrated perpendicularly to the surface of the carrier and in accordance with the vibrations being recorded, to remove parts of this covering layer as well as parts of the cutting layer, and to thereby produce a vibration track which is transparent to the light used for reproductions. Such tracks have width variations which are about forty times the amplitudes of the cutting tool and may be reproduced immediately without further treatment in the usual sound film apparatus, and have a quality of reproduction which, up to the highest frequencies, generally considerably exceeds that of a photographically-recorded track.

When disregarding the advantage of immediate reproduction, it is possible to use a carrier comprising at least two light-transmitting layers of which one is given the opacity required for optical reproduction only after the recording. Preferably the track is made opaque because this eliminates the majority of difficulties which arise during optical reproduction and which are due to the nature of the track.

More particularly, the optical reproduction of a vibration track which is mechanically recorded in a light-transmitting material suited for this purpose, is deleteriously affected by scratches in its surface due, for example, to injury to the cutting edge of the cutting tool, by other injuries due to irregularities in the depth of the track, and by dirt particles which adhere to the more or less sticky gelatin frequently used for the recording layer. These injuries and the irregularities in the depth of the track cause irregular refraction of the rays of the reproducing light, whereas the noises produced thereby and by the dirt particles deleteriously influence the optical reproduction.

The term "optical reproduction" as used herein is to be understood to also include optically copying the track onto another carrier.

It has been proposed to provide a carrier having a light-transmitting recording layer and a light-transmitting protective layer lying thereon with a mechanically-recorded vibration record and to subsequently color the track with a coloring material which adheres only to the material of the recording layer at the track surface, for example with India ink. Such a method, however, has several disadvantages. For example, to obtain a sufficient covering capacity it is generally necessary to utilize a comparatively concentrated solution of the coloring material, which necessitates the use of a rather thick layer which, particularly when a band-shaped carrier is used, will easily scale off. Even with the use of black India ink, which permits the covering layer to be made rather thin, it frequently happens that this layer, after being dried, becomes loosened.

The object of our invention is to overcome the above difficulties, and to provide a simple and effective method for coloring the track portion of an optically-reproducible, variable-area mechanically-recorded vibration record.

In accordance with the invention we apply to the surface of a vibration track, which is bounded by a suitable thin protective layer, one or more substances which chemically react with one or more molecularly- or colloidally-dispersed substances being already present within or forming the recording layer to bring about the desired coloring of the track.

By the term "coloring" of the track is to be understood to mean that, after the above-mentioned treatment, the track is substantially impervious to the type of light used in the optically-reproducing or copying. Thus the track need not be absolutely colored in conformity with only a few colors of the visible spectrum, but it may be blackened, i. e. completely impervious to white light. This also includes the case in which after the treatment the track has no visible color but absorbs only the infra-red light which is to be used for direct reproduction, only the ultra-violet light which is advantageously utilized in copying, or both these lights. For this reason the ex-

pressions "blackened," "impervious to light," "colored," etc. as used hereinafter are to be considered in view of the type of light used for reproduction or copying.

In accordance with the invention, the substance which colors the track is produced by chemical reaction at the desired point, whereby particularly sharply-defined boundaries between the colored and uncolored portions of the carrier, i. e. between the track and its surroundings, are obtained. Furthermore, as at least one of the substances producing the coloring is already present within or forms the material of the recording layer, when the color-forming reaction takes place, the coloring material will be embodied at least partly within this layer, and there will be a unitary connection between the colored material and the recording layer. Because of this there will be no danger of the layer of colored material becoming loose from the carrier, for example, due to sharp bends in the conveying device during reproduction or copying.

The chemical reaction itself produces a sharply-defined boundary between the track and its surroundings because when the constituent not yet present in the layer is being introduced therein by diffusion during the coloring process, this constituent is transformed by the chemical reaction and thus is consumed. Owing to this the coloring will not be produced at undesired portions as would be the case, for example, if a solution of coloring material were diffused into a layer of gelatin. In the latter case the extent of the diffusion could not be accurately controlled.

To obtain a particularly well-defined boundary by the method according to the invention, we employ color-forming components of such type that the chemical reaction produces an insoluble compound whereby further diffusion is prevented to an appreciable extent.

To produce the coloring, we prefer to use the substances dissolved in a volatile solvent so that the colored track can be dried within the shortest possible time and thus can be reproduced or copied almost immediately. It is also possible to utilize a gas or vapor as the substance which is added to produce chemical reaction.

The method according to the invention may be carried out while utilizing a so-called physical development of the track provided. For this purpose the recording layer of the track is provided with or made from one or more substances which, jointly with one or more substances added, form the basis of a chemical reaction resulting in coloration. In this case the substances act as nuclei which bring about the chemical reaction of the so-called "physical development."

If the nuclei have to be formed by photochemical reaction, this photochemical formation of the nuclei can be readily effected by irradiation with suitable light after the track has been cut. By making the protective layer impervious to the light utilized for this purpose, a well-defined boundary between the track and its surroundings is obtained.

In another embodiment of the invention, the coloring of the track is achieved by utilizing a substance with which it is possible to obtain a colored compound by a purely chemical agency, i. e. without making use of light-rays. This purely chemical method has the advantage that an extremely thin homogeneous layer of coloring material can be obtained by causing a molecular solution to react as one component with a molecularly or colloidally dispersed material, which acts as the other component and which is present in the recording layer consisting, for example of gelatin, so that in this protective milieu a colloidal, i. e. substantially grainless reaction product, is obtained. Accordingly, the coloring material is obtained and remains in a substantially grainless condition. This measure is particularly important if the track is cut with a chisel having a V-shaped cutting edge with an apical angle which is as obtuse as possible, e. g. of about 174°.

In order that the invention may be clearly understood and readily carried into effect, we shall explain the same more fully with reference to the accompanying drawing, in which:

Figure 1 is an enlarged sectional view of a carrier and shows a V-shaped chisel cutting a track therein;

Fig. 2 is a perspective view illustrating the method according to the invention; and

Fig. 3 is an enlarged sectional view of a carrier illustrating the invention.

Referring to Figure 1, a carrier 1, which moves at a constant speed during recording perpendicularly to the plane of the drawing, consists of a supporting layer 2 of transparent material, such as Celluloid, an intermediate or recording layer 3 of gelatin, and a thin protective layer 4. A cutting tool 5 having a V-shaped cutting edge with an apical angle α of about 174° is vibrated in the direction of the double-headed arrow in accordance with the vibrations being recorded, to produce a track 15 having depth variations, and width variations which are enlarged with respect to the depth variations.

If such a carrier is to be used as a negative, at least the surfaces 6 of track 15, which are laid bare in layer 3, must be colored. To insure sharp outlines or boundaries of track 15, it is evident that the layer of coloring material should not extend beneath the remaining portions of the protective layer 4, i. e. extend under the covering layer beyond edges 7.

Thus it is preferable to use a protective layer having such a small capacity for absorbing and transmitting the coloring component applied after recording, that at least during the chemical reaction this component does not penetrate the surface of the covering layer. Thus, after the reaction, it is possible to clean the superfluously wetted portions of the covering layer in a simple manner, for example by wiping off; so that the layer is still, for example, transparent to light.

The invention may be carried into effect in various manners, some of which will be described in the following examples with reference to Figures 2 and 3.

Example 1.—The carrier shown in Fig. 2 is provided with a mechanically-recorded track 15, and has a recording layer 3 of gelatin to which is added in homogeneous distribution, lead acetate in a suitable concentration, for example 19 or 20 gram lead acetate [$Pb(C_2H_3O_2)_2.3H_2O$] for 100 gram air-dry gelatin. After recording, the carrier is treated with an aqueous solution of ammonium sulphide developer, for example 1 N, which produces at least at the surface of track 15, a layer of lead sulphide which makes the track sufficiently black. The lead acetate and the ammonium sulphide concentrations must be suitably chosen with regard to each other. In this case the protective layer 4 should be of a material which is impervious to the ammonium

sulphide and may consist of an artificial resin such as polystyrol, sapon varnish, or a similar material.

Example 2.—The lead acetate is applied only after recording, for example by applying an aqueous solution of this substance to the carrier, whereby the lead acetate penetrates only superficially into the surface of the gelatin layer **3** that has been laid bare. Subsequently the carrier is treated with the ammonium sulphide developer as in Example 1. In this case the materials of the protective layer may be those given in Example 1.

Although we have found that by the method of both the above-mentioned examples, very sharply-defined blackening of the track is obtained, in the method of Example 1 difficulties sometimes arise due to an excessively long treatment with the ammonium sulphide developer. These difficulties, however, are avoided by the method described in Example 2, because the gelatin layer **3** is not provided with the lead acetate throughout its entire thickness, but the lead acetate solution penetrates only to a comparatively small depth.

The method of Example 2 is diagrammatically illustrated in Figure 2 in which the track **15** is wetted with the lead acetate solution by means of a pad **11**, for example of felt, and the track is immediately colored by means of a second pad **12** which contains, for example, ammonium sulphide developer with the result that the black-colored track **16** shown in the figure is obtained. For the sake of clearness the track **17** treated only with the lead acetate is indicated by shading.

Instead of using the lead acetate mentioned in Examples 1 and 2, we have found that good results are obtained by using other suitable lead salts, or other sulphide-producing metal salts, such for example as copper salts, mercuric and mercurous salts and nickel salts, and others. Instead of using a liquid developer such as ammonium or alkaline sulphide, similar results are obtained by applying a gas current of hydrogen sulphide to the track provided with the sulphide-producing metal salts.

Example 3.—The method of Examples 1 and 2 may be carried out with the aid of other chemical reactions. For example, the substance present in the recording layer may be mercurous nitrate, whereas an ammonia solution may be utilized as the added component to produce in the tracks the so-called black precipitate ($NH_2Hg_2NO_3$). Instead of using an ammonia solution, wet NH_3 gas may be used.

Example 4.—If potassium ferrocyanide

$[K_4Fe(CN)_6]$

is used as the first-applied component in the method of Example 1 or 2, a colored track may be obtained by applying a ferric salt solution which acts on the potassium ferrocyanide to produce the colloidally-dispersed dark blue Prussian blue.

Example 5.—Indigo may be provided as the coloring material in the recording layer by the methods of Example 1 or 2. However, as this substance is insoluble in water, it must be taken up in the recording layer in another manner. This may be effected by reducing the indigo, for example with "rongalite" (sodium sulpho-oxylate) or with a hyposulphite salt (e. g. $Na_2S_2O_4$); the indigo being dissolved as indigo-white, and in this state is provided in the recording layer. The track is then treated with an oxidizing solution such as a solution of a ferri-salt, for example potassium ferricyanide, and becomes colored by the transformation of the indigo-white into the blue, insoluble, colloidally-dispersed indigo. The coloration may also be effected by means of oxygen gas or by atmospheric air. In the latter case the protective layer must of course be impervious to air, and for this purpose the protective layer may consist, for example, of a polystyrol layer covered with a layer of nitrocellulose, or of a metal foil.

Example 6.—Coloration of the track necessary for optical reproduction may also be obtained by coloring, after the recording, the material of the recording layer that has been laid bare, by the addition of a suitable substance. For example the recording layer, which advantageously consists of gelatin or of similar decomposed albuminous substances may be treated, after the recording, with an alkaline copper sulphate solution which results in a bluish- to reddish-violet colored compound.

Alternatively it is possible to treat the amino-acid, which is present in the gelatin layer and which is capable of coupling with a diazobenzene sulphonic acid solution, with this latter solution whereby after applying a 2 N. solution of soda to the track a colored compound is formed. In this case the protective covering layer may be Celluloid lacquer or nitrocellulose.

Example 7A.—After a vibration track has been cut through a protective layer of a carrier having a recording layer treated with lead acetate in accordance with Examples 1 and 2, the carrier is exposed, for example, to parallel ultra-violet rays as indicated by reference numeral **8** in Figure 3. In this case the protective layer **4** does not transmit the rays **8** so that only the area **9** of the recording layer is exposed. Subsequently the track is treated, for example, with an acid silver nitrate solution and then with an acid reducing agent, for example a citric acid-methol solution to effect "physical development," with the result that only area **9** of the recording layer is blackened. As the portions **10** of the recording layer located outside the area **9** have not been exposed and therefore cannot participate in the "physical development," it is unnecessary that the protective layer be of a material which is substantially impermeable to the components of the physical developer during the development, which may require considerable time.

On the other hand, the material of the protective layer must be opaque to ultra-violet light and for this purpose we use, for example, polystyrol or an acetyl-cellulose layer containing a substance by which ultra-violet rays are absorbed, such as quinine-sulphate.

If, after coloring, the record has to be optically copied or reproduced with ultra-violet light, it is of course necessary to remove the protective layer with the aid of a suitable solvent. For this purpose and with the protective layer materials above specified, benzol or aceton, may be used.

Example 7B.—The carrier treated with lead acetate by the method of Example 1 may also be exposed to ultra-violet light shortly before the mechanical recording, in which case the protective layer must be transparent to this light. If ultra-violet light is also utilized for the reproduction or copying this can be effected immediately after the coloring of the track and without removal of the protective layer.

Example 8.—The layer of lead acetate and gelatin provided according to Example 1 may be exposed before application of the protective layer,

i. e. during the manufacture of the carrier, and this may be done in the following ways:

Example 8A.—The mass of lead acetate and gelatin to be used for the recording layer is exposed prior to being applied to the supporting layer.

Example 8B.—The layer of lead acetate and gelatin is formed upon the supporting layer and is then exposed, and if required, a protective layer is applied.

In Examples 8A and 8B, the protective layer does not need to be impervious to the type of light required for the physical development because the mass of the recording layer has been exposed prior to the application of this layer. On the other hand, the material of the protective layer must be transparent to the light used in reproduction and must be substantially impervious to the components of the physical development.

Example 8C.—The layer of lead acetate and gelatin is formed on the supporting layer and after a protective layer is applied, is exposed through the protective layer. The latter layer must, of course, be transparent to the type of light utilized for the physical development and for the optical reproduction.

Theoretically the method of Example 7A would insure a greater sharpness of the edges of the colored track than at the methods described in Examples 8, 8A, 8B and 8C, because only those parts of the recording layer which forms the surface of the track have been exposed. However, in practice these methods do not offer advantages which are of importance for obtaining well-defined edges of the track.

Example 9.—The power of the recording layer to be physically developed by exposure to light suitable for this purpose, as set out in the Examples 7, 8, 8A, 8B and 8C, may also be obtained by embodying nuclei into this layer, for example precious metal nuclei such as silver nuclei, which may be effected by adding a colloidal silver solution to the mass of lead acetate and gelatin.

Example 10.—According to the invention, instead of using a physical development, a normal chemical development may be used. In this case the recording layer should preferably consist of a grainless silver bromide emulsion which may be incorporated in the recording layer during its manufacture. On the other hand, the silver bromide may be formed in the recording layer after the track has been cut, for example by causing a silver nitrate solution to act on a colloidal layer containing halogen ions. The layer may be given the capacity of being chemically developed by means of a suitable exposure which may take place either before or after recording. The various possibilities of realization according to the examples described under 7, 8, 8A, 8B and 8C may also be realized in this case.

If the silver bromide is incorporated in the recording layer during the manufacture of the carrier, i. e. before the protective layer is applied, and if the step of rendering it developable has to be effected after the oscillation track has been provided, care should be taken to insure that, with respect to the absorption of light, the protective layer is of a material which is opaque to the light used prior to the development, but is transparent to the light used for optical copying or for reproducing. For this purpose we form the protective layer, for example, of polystyrol and quinine sulphate. Such a layer transmits infrared reproduction light and blue copying light but is impervious to the ultra-violet light that is used prior to the development.

While we have described our invention with reference to specific examples and applications, we do not wish to be limited thereto but desire the appended claims to be construed as broadly as permissible in view of the prior art.

What we claim is:

1. A method of rendering optically-reproducible by chemically coloring a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of introducing a molecularly-dispersed substance within said recording layer, applying a suitable thin protective layer to the surface of said recording layer, and applying to the surface of the track after the recording a second substance capable of cooperating with said first substance to produce a colored product.

2. A method of producing a colored vibration track in a carrier having a recording layer provided with a molecularly-dispersed substance, comprising the steps of mechanically-recording the track in the recording layer, forming a protective layer at the surface of the covering layer bounding the track, and forming colored material in a surface portion of the track by applying to the surface a substance capable of chemically reacting with the molecularly-dispersed substance with the production of colored material.

3. A method of producing a colored vibration track in a carrier having a recording layer provided with a colloidally-dispersed substance, comprising the steps of mechanically-recording the track in the recording layer, forming a protective layer at the surface of the covering layer bounding the track, and forming colored material in a surface portion of the track by applying to the surface a substance capable of chemically reacting with the colloidally-dispersed substance with the production of colored material.

4. A method of rendering optically-reproducible by chemically coloring a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of introducing a colloidally-dispersed substance within said recording layer, applying a suitable thin protective layer to the surface of said recording layer, and applying to the surface of the track after the recording a second substance capable of cooperating with said first substance to produce a colored product.

5. A method of rendering optically-reproducible by chemically coloring a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of introducing a molecularly-dispersed substance within said recording layer, applying a suitable thin protective layer to the surface of said recording layer, and applying to the surface of the track after the recording a substance capable of chemically reacting with said first substance to form a colored product at the surface of the track by a purely chemical reaction between said substances.

6. A method of rendering optically-reproducible by chemically coloring a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of introducing a colloidally-dispersed substance within said recording layer, applying a suitable thin protective layer to the surface of said recording layer, and appyling to the surface of the track after the recording a substance capable of chemically reacting with said first substance to form a colored

product at the surface of the track by a purely chemical reaction between said substances.

7. A method of rendering optically-reproducible by chemically coloring a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of applying a suitable thin protective layer to the surface of said recording layer, and applying to the surface of the track after the recording a substance capable of chemically reacting with the material of the recording layer to form a colored product within a surface portion of the track.

8. A method of rendering optically-reproducible a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of placing within said recording layer a molecularly-dispersed substance, applying a suitable thin protective layer to the surface of said recording layer, and applying to the surface of the track after the recording a second subtsance capable of forming a colored insoluble compound within a surface portion of the track by a purely chemical reaction with said first substance.

9. A method of rendering optically-reproducible a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of placing within said recording layer a colloidally-dispersed substance, applying a suitable thin protective layer to the surface of said recording layer, and applying to the surface of the track after the recording a second substance capable of forming a colored insoluble compound within a surface portion of the track by a purely chemical reaction with said first substance.

10. A method of rendering optically-reproducible by chemically coloring a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of introducing a molecularly-dispersed substance into said recording layer after the recording of the track, subsequently applying a suitable thin protective layer to the surface of said recording layer bounding the track, and applying to the surface of the track a second subtsance capable of chemically reacting with said first substance to form a colored product within a surface portion of the track.

11. A method of rendering optically-reproducible by chemically coloring a vibration track mechanically-recorded on a carrier having a recording layer, comprising the steps of introducing into said recording layer a colloidally-dispersed subtsance after the recording of the track, subsequently applying a suitable thin protective layer to the surface of said recording layer, and applying to the surface of the track a second substance capable of chemically reacting with said first substance to form a colored product within a surface portion of the track.

12. A method of rendering optically-reproducible a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of placing a substance within said recording layer, applying a suitable thin protective layer to the surface of said recording layer, and applying to the surface of the track after the recording a second substance capable of forming by a purely chemical reaction with said first substance a colored insoluble metal sulphide substantially free from deleterious graininess.

13. A method of rendering optically-reproducible a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of placing a metal salt within said recording layer, applying a suitable thin protective layer to the surface of said recording layer, and applying after the recording a sulphide solution to the surface of the track to form a colored sulphide substantially free from deleterious graininess.

14. A method of rendering optically-reproducible a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of placing a metal compound in molecular dispersion within said recording layer, applying a suitable thin protective layer to the surface of said recording layer, and applying after the recording a reducing agent to the track to reduce said compound and form at the surface of the track a colored layer substantially free from deleterious graininess.

15. A method of rendering optically-reproducible a vibration track mechanically recorded in the recording layer of a carrier, comprising the steps of incorporating a metal compound in molecular dispersion within said recording layer prior to the recording, applying a suitable thin protective layer to the surface of said recording layer, and applying after the recording a reducing agent to the surface of the track to reduce said metal compound and form at the surface of the track a colored layer substantially free from deleterious graininess.

16. A method of rendering optically-reproducible a vibration track mechanically recorded in the recording layer of a carrier, comprising the steps of placing a photo-chemically-sensitive metal compound in molecular dispersion within said recording layer, exposing the surface of the track to actinic light, applying a suitable thin protective layer to the surface of said recording layer, and developing the exposed metal compound after recording to form at the surface of the track a colored layer substantially free from deleterious graininess.

17. A method of rendering optically-reproducible a vibration track mechanically recorded in the recording layer of a carrier, comprising the steps of forming by means of a chemical reaction a photochemically-sensitive metal compound in molecular dispersion within said recording layer, exposing the surface of the track to actinic light, applying a suitable thin protective layer to the surface of said recording layer, and developing the exposed metal compound after recording to form at the surface of the track a colored layer substantially free from deleterious graininess.

18. A method of rendering optically-reproducible a vibration track mechanically recorded in the recording layer of a carrier, comprising the steps of forming by means of a chemical reaction a photochemically-sensitive metal compound in colloidal dispersion within said recording layer, exposing the surface of the track to actinic light, applying a suitable thin protective layer to the surface of said recording layer, and developing the exposed metal compound after recording to form at the surface of the track a colored layer substantially free from deleterious graininess.

19. A method of rendering optically-reproducible a vibration track mechanically recorded in the recording layer of a carrier, comprising the steps of placing a photochemically-sensitive metal compound in molecular dispersion within said recording layer, applying to the surface of said recording layer a suitable thin protective layer opaque to a predetermined light, photochemically decomposing the metal compound at the track surface with actinic light to which said protective layer is opaque, and applying after

recording a developing substance to form at the track surface a colored layer substantially free from deleterious graininess.

20. In the manufacture of optically-reproducible vibration records on a carrier having a recording layer and a thin protective layer and provided with a vibration track which is bounded by portions of the protective layer and whose surface is formed substantially by the recording layer, the steps of placing a molecularly-dispersed substance in at least the portion of the recording layer forming the track, and chemically forming colored material within said portion of the recording layer by applying to the surface of the track a second substance capable of chemically-reacting with the first substance with the production of colored material.

21. In the manufacture of optically-reproducible vibration records on a carrier having a recording layer and a thin protective layer and provided with a vibration track which is bounded by portions of the protective layer and whose surface is formed substantially by the recording layer, the steps of placing a colloidally-dispersed substance in at least the portion of the recording layer forming the track, and chemically forming colored material within said portion of the recording layer by applying to the surface of the track a second substance capable of chemically-reacting with the first substance with the production of colored material.

22. A method of rendering optically-reproducible a vibration track mechanically-recorded in the recording layer of a carrier, comprising the steps of placing a metal compound in colloidal dispersion within said recording layer, applying a suitable thin protective layer to the surface of said recording layer, and applying after the recording a reducing agent to the track to reduce said compound and form at the surface of the track a colored layer substantially free from deleterious graininess.

23. A method of rendering optically-reproducible a vibration track mechanically recorded in the recording layer of a carrier, comprising the steps of incorporating a metal compound in colloidal dispersion within said recording layer prior to the recording, applying a suitable thin protective layer to the surface of said recording layer, and applying after the recording a reducing agent to the surface of the track to reduce said metal compound and form at the surface of the track a colored layer substantially free from deleterious graininess.

24. A method of rendering optically-reproducible a vibration track mechanically recorded in the recording layer of a carrier, comprising the steps of placing a photochemically-sensitive metal compound in colloidal dispersion within said recording layer, exposing the surface of the track to actinic light, applying a suitable thin protective layer to the surface of said recording layer, and developing the exposed metal compound after recording to form at the surface of the track a colored layer substantially free from deleterious graininess.

25. A method of rendering optically-reproducible a vibration track mechanically recorded in the recording layer of a carrier, comprising the steps of placing a photochemically-sensitive metal compound in colloidal dispersion within said recording layer, applying to the surface of said recording layer a suitable thin protective layer opaque to a predetermined light, photochemically decomposing the metal compound at the track surface with actinic light to which said protective layer is opaque, and applying after recording a developing substance to form at the track surface a colored layer substantially free from deleterious graininess.

JAN HENDRIK DE BOER.
CORNELIS JOHANNES DIPPEL.