March 13, 1934. B. E. G. MITTELL, ET AL 1,951,198

SOUND RECORDING

Filed Oct. 25, 1928

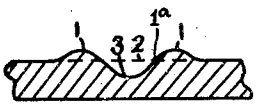


FIG. 1.

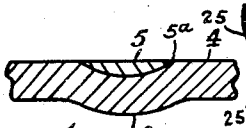
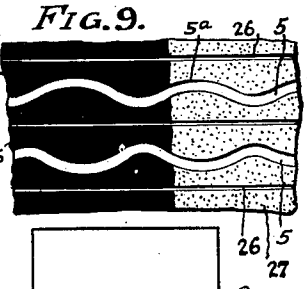


FIG. 2.

FIG. 9.



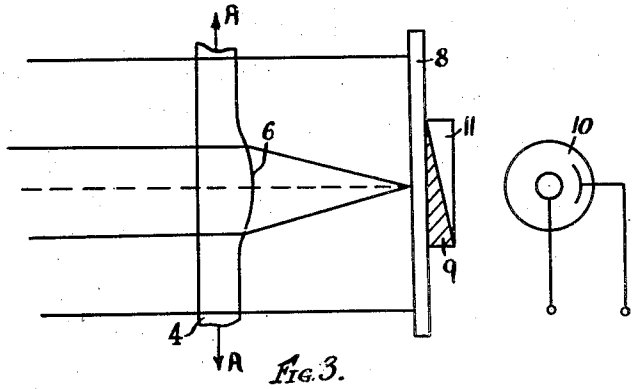


FIG. 3.

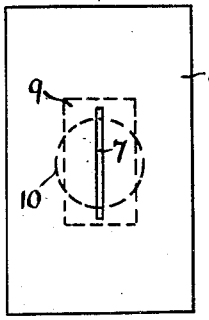


FIG. 4.

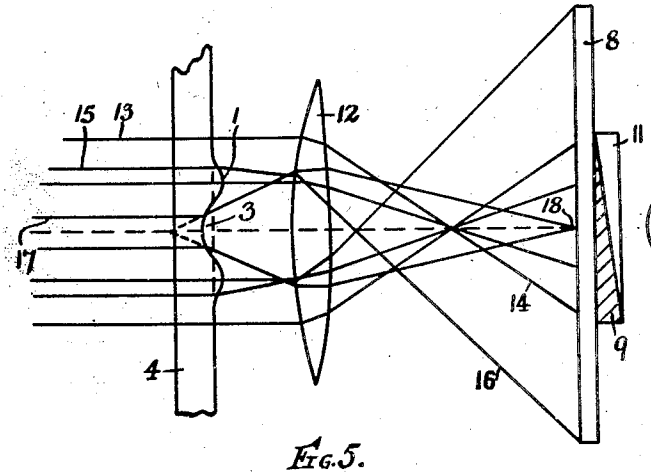


FIG. 5.

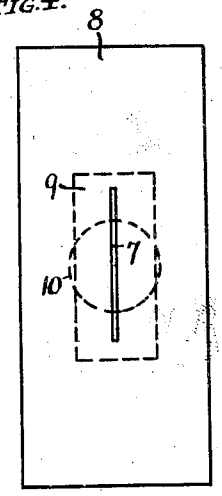


FIG. 6.

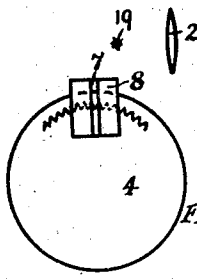


FIG. 8.

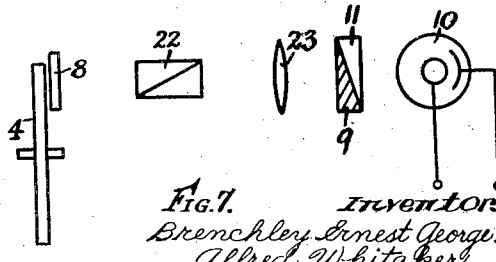


FIG. 7.

INVENTORS.

Brenchley Ernest George Mittell and Alfred Whitaker.

By Cameron, Kerkam and Sutton.

Attorneys.

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UNITED STATES PATENT OFFICE

1,951,198

SOUND RECORDING

Brenchley Ernest George Mittell, Iver, and Alfred Whitaker, West Drayton, England, assignors, by mesne assignments, to Radio Corporation of America, New York, N. Y., a corporation of Delaware

Application October 25, 1928, Serial No. 315,049
In Great Britain October 31, 1927

12 Claims. (Cl. 274—46)

The present invention relates to sound recording and reproduction. According to the present invention, a smooth pointed stylus, adapted to be vibrated by the sounds to be recorded, is caused to produce plastic deformation of the surface of a transparent material such, for example, as celluloid, without removal of any of the material. A method of this sort has hitherto been used in recording movements in connection with certain scientific instruments.

In reproduction from a sound record made in the manner above set forth, optical means are preferably employed.

The advantages of the common form of cut record which is produced from a wax master record for general use are well known, but it sometimes happens that it is inconvenient or impracticable to produce a record in this manner. For example, certain climates are unsuitable to the production of satisfactory records on wax. The present invention, in one aspect, provides novel means whereby the sounds may first be recorded upon a celluloid surface by plastic deformation, and this record may be transferred later by electro-optical means to a wax disc of the usual type. In order to determine whether the record made upon the celluloid is satisfactory, it may be played back immediately after recording with the aid of the usual stylus tracking in the depression formed in the surface of the celluloid, or preferably with the aid of the optical means to be described later, without injury to the record.

The invention is illustrated in the accompanying drawing in which

Figs. 1 and 2 are cross-sectional views of two forms of sound line, in accordance with the invention, greatly enlarged.

Figs. 3, 5 and 7 are diagrammatic views in front elevation of a reproducing system in accordance with the invention.

Figs. 4, 6 and 8 are side elevational views of parts of the systems of Figs. 3, 5 and 7 respectively, and

Fig. 9 is an enlarged, fragmentary, plan view of another form of sound record in accordance with our invention.

The usual recording stylus, which may be operated by any suitable means, such as electromagnetic means, is replaced by a smooth pointed stylus and the record is made upon a disc of thin celluloid. The smooth pointed stylus, tracking along the surface of the thin celluloid, produces a deformation of the surface. The stylus should preferably be given a very fine point in order to reduce the total pressure necessary.

If a backing of hard material, such as glass, is used, a deformation such as is shown in Fig. 1 is produced, while if a soft backing, such as felt or rubber, is used, the deformation is of the kind shown in Fig. 2. It will be noticed that the deformation shown in Fig. 1 comprises two humps 1 raised above the level of the record surface (shown dotted at 2) and a depression 3 between the humps.

In reproducing from these records, use is preferably made of the optical properties of the deformations in the celluloid. In one method, applicable to the sound line of Fig. 2, the upper surface of the celluloid disc 4, after recording, is flooded with celluloid solution, which fills in the depressions as shown at 5 and leaves once more a smooth upper surface. The lower surface of the record still has raised portions 6 upon it.

Figs. 3 and 4 show a method by which such a record may be reproduced. Light, in a parallel beam, is transmitted through the raised portion 6 of the transparent record 4, of which a small portion, greatly enlarged, is shown. The record in this case is in the form of a disc having a spiral sound line upon its surface and the disc is mounted for rotation in a plane perpendicular to the paper and parallel to the line A—A. The light which passes through the raised portion 6 is brought to a focus at the slit 7 formed in the plate 8, which is shown more clearly in the side elevation view of Fig. 4. The light which does not pass through the portion 6 of the record is diffused over the plate 8. It will be clear that, as the record disc rotates, that portion of the raised sound line which is in the path of the beam of light will move to and fro in the direction of the arrows on the line A—A. The spot of light which is focussed upon the slit 7 will therefore move up and down the slit. Behind the slit are arranged a neutral tint wedge 9 and a photo-electric cell 10. A clear wedge 11 is preferably combined with the neutral tint wedge 9 for well known optical reasons. It will be clear that, as the spot of light moves upwardly, the intensity of the light falling upon the cell 10 will increase, and vice versa, owing to the different thickness of the neutral tint wedge at different points, and the currents from the photo-electric cell 10 will accordingly vary in accordance with the wavy trace upon the record. These currents may be amplified in known manner and utilized to actuate a recording device for recording upon wax or they may be caused to generate sound directly.

A method of reproducing from a record having a sound line in the form shown in Fig. 1 is illustrated in Figs. 5 and 6, the depression 3 being

utilized as a concave lens. Light in a parallel beam passes through the record 4, through a convex lens 12 and a slit 7 in a plate 8 and through a neutral tint wedge 9 on to the photo-electric cell 10. A ray, such as 13, which passes through an undeformed part of the record falls upon the plate 8 at 14, and a ray, such as 15, which passes through the raised portion 1 of the sound trace falls on the plate 8 at 16, and such light rays are therefore diffused over the plate 8. Rays, such as 17, on the other hand, are brought to a focus on the plate 8 at 18.

As described in connection with Figs. 3 and 4, the sound trace, as it is rotated in front of the light source, will thus vary the illumination of the cell 10 and so produce current variations corresponding to the sound trace. Suitable means are, of course, provided in all cases where a spiral sound line is used for traversing the record relatively to the optical apparatus so that the point at which the light is passed through the record follows the spiral of the sound trace.

An alternative optical system which may be used, for example with the type of deformation shown in Fig. 1, is illustrated diagrammatically in Figs. 7 and 8.

Light from the source 19 passes through an optical system 20, a polarizing device 21, the record 4, a slit 7 in the plate 8, another polarizing device 22, a second optical system 23, a neutral tint wedge 9, and on to the cell 10. The polarizing devices 21 and 22 are so adjusted that, when the light passes through an undeformed part of the record 4, no light falls upon the cell 10 but when the light passes through a part, in and around the groove, which as been strained, light passes on to the cell 10. The groove produces an image on the wedge 9 in the form of a bright line on a dark ground.

As an alternative to the methods above described of reproducing from the record made by plastic deformation, a black line 25 may be made with ink or other suitable fluid adjacent the sinuous depression in the record surface and the fluid may be caused to flow by surface tension as far as the sinuous groove, that is, no farther than the edge 1*a* of the hump 1, in the case of the record shown in Fig. 1, and as far as the edge 5*a* of the filling 5 in the case of the record shown in Fig. 2, but no further. In order to limit the width of the black line in the other direction, a spiral depression 26 may be formed in the record surface between neighbouring record grooves, as by impressing into the record a thin, hard stylus without vibrating it, so as to form a narrow silent groove in the surface of the record. In applying this method, the celluloid disc may be given a fine matt surface 27 before recording, for example by the application of a suitable solvent, and this will assist the flow of the ink which will be arrested at the polished surface of the grooves, formed when the recording stylus is pressed into the matted surface of the record blank. If light be projected through a record of this type and through a slit arranged at right angles to the direction of motion of the record line, a portion of the light will be excluded by the black line 25 and the total amount of light passing to the photo-electric cell 10 will be varied in accordance with the recorded sound. This light of varying intensity may be passed through a suitable optical system on to a light sensitive cell as before.

It will be clear that in transferring from the celluloid record of the type described to a record of a different type, such for example as a wax record, any speed of working can be adopted. The transfer may, for example, be carried out at a lower speed than that used in recording originally, as in U. S. Patent #1,555,281.

One advantage of the method according to the present invention over recording upon wax is that the quality of a record can be judged without the record first having to be put through factory processes.

We claim:—

1. The method of forming a transparent sound record which comprises vibrating a smooth pointed stylus in accordance with sounds, causing the vibrated stylus to produce plastic deformations in the surface of a transparent material to form a sound line therein, applying an opaque liquid to the surface of said material and allowing said opaque liquid to flow by surface tension up to but not over the deformation constituting said sound line.

2. A method of recording sounds according to claim 1, wherein the record surface is given a matt surface prior to the application of said liquid.

3. An optical sound record having a sound line the cross-section of which is in the form of two humps which are above the level of the record surface and a depression between these humps which is below the level of the record surface, said depression constituting a lens for focusing a reproducing light beam.

4. A sound record as claimed in claim 3 in which an opaque band is provided upon the record surface on each side of the sound line.

5. The method of forming an optical sound record on a transparent record blank of material capable of plastic deformation which consists in vibrating a smooth pointed stylus in accordance with sounds to be recorded and causing said stylus to produce plastic deformation of the record material throughout the thickness thereof without removal of any of the material.

6. The method of forming an optical sound record upon a transparent record blank which consists in deforming the material of said record throughout its thickness in accordance with sounds to be recorded.

7. A transparent sound record having the material thereof deformed throughout the thickness of the record to form a sound line.

8. A transparent sound record having a sound line depression therein filled with transparent material.

9. A transparent sound record depressed throughout its thickness to form a sound line and having the sound line depression filled with transparent material.

10. A transparent sound record having its material deformed throughout its thickness to form a sound line depression on one side of the record and a corresponding raised sound line on the other side and having the sound line depression filled with transparent material to form a smooth record surface.

11. The method of making a transparent sound record which consists in deforming the record material throughout its thickness to form a sound line depression on one side of the record and a raised sound line on the other side and filling in the sound line depression with transparent material to form a smooth record surface.

12. An optical sound record having a sound line constituting a lens for focusing a reproducing light beam.

BRENCHLEY ERNEST GEORGE MITTELL.
ALFRED WHITAKER.