June 15, 1937. M. BENDER 2,083,815

RECORDING AND REPRODUCING SOUND

Filed Oct. 12, 1931

Fig. 1.

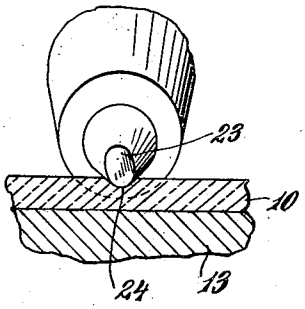

Fig. 2.

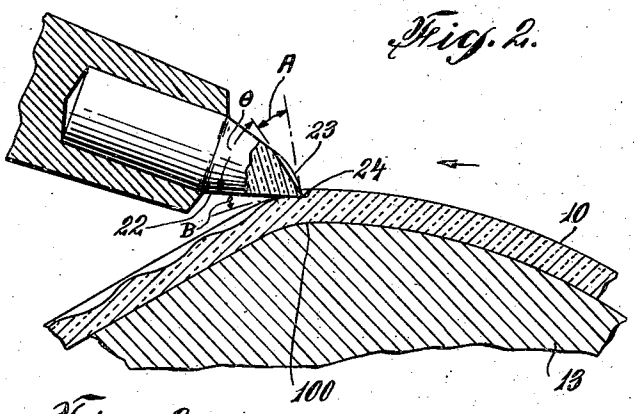

Fig. 3.

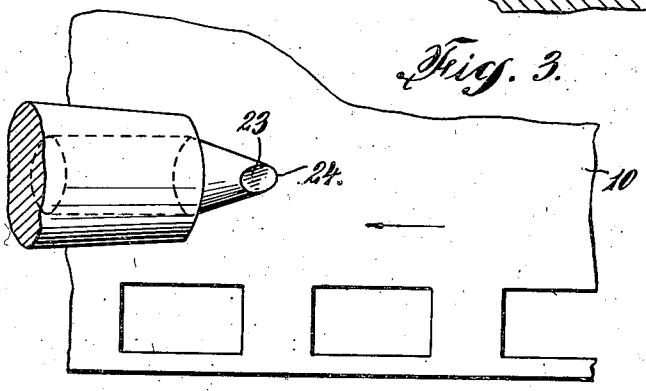

Fig. 4.

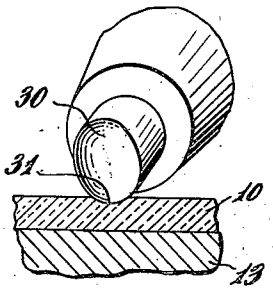

Fig. 5.

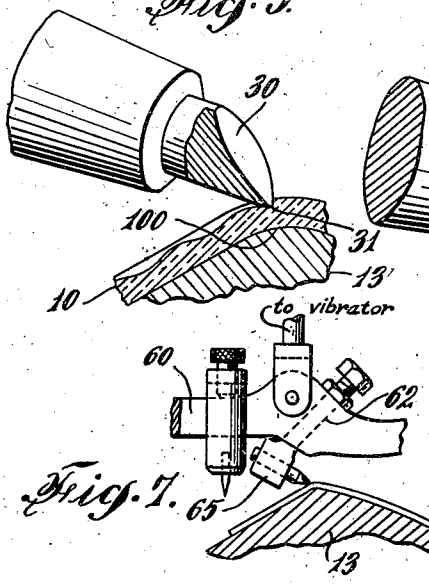

Fig. 6.

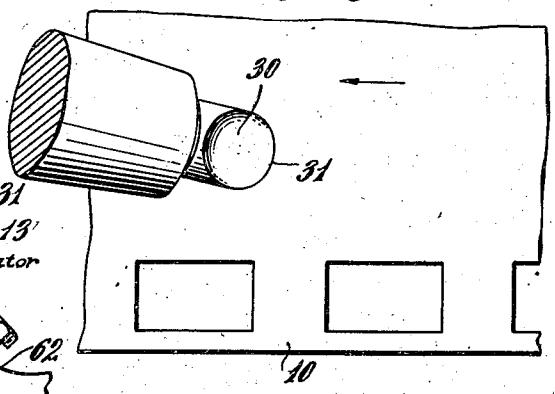

Fig. 7.

INVENTOR
Max Bender
BY
Sheldon H. Graves
his ATTORNEY

Patented June 15, 1937 2,083,815

UNITED STATES PATENT OFFICE

2,083,815

RECORDING AND REPRODUCING SOUND

Max Bender, New York, N. Y., assignor, by mesne assignments, to United Acoustigraph Corporation, a corporation of Nevada

Application October 12, 1931, Serial No. 568,317

7 Claims. (Cl. 274—46)

This invention relates to recording and reproducing of sound and has for its principal object an improved method and apparatus for recording sound in the form of a groove on relatively hard material such as a film of celluloid or similar material.

In my co-pending application Serial Number 539,103, filed May 21, 1931, I disclose a method and apparatus for recording sound in the form of a "hill and dale" groove wherein the styluses employed are of such form and so positioned with respect to the film as to permit accurate record over a wide range of frequencies.

The present invention constitutes an improvement in the form or angulation of the cutting stylus. As disclosed in my co-pending application the cutting stylus has an edge extending in a general direction normal to the direction of movement of the film. In the present form of my invention the cutting edge of the stylus as it meets the film is for the most part inclined to the normal so that the cutting operation is somewhat similar to the action of a plow which cuts a furrow by an edge which is inclined both to the direction of movement and also to a plane normal to that direction.

I find that by employing the present modification of the structures described in my co-pending application I am able to form an exceptionally clean cut with substantially none of the roughness which normally causes disturbing surface sound.

Other objects of my invention will appear from the following description taken in connection with the accompanying drawing wherein:

Figure 1 is an enlarged front view of a cutting stylus engaging a film, the view being taken in the direction of movement of the film and the cutting stylus being shown in elevation and the film in section;

Figure 2 is a side elevation partly in section of the structure shown in Figure 1 showing the film as it is drawn over an anvil of relatively small diameter;

Figure 3 is a top plan view of the structure shown in Figure 1;

Figure 4 is a view similar to Figure 1 but showing a modified form of stylus, this stylus being positioned with its axis inclined to a vertical plane passing through the longitudinal axis of the groove;

Figure 5 is a side elevation partly in section of the structure shown in Figure 4;

Figure 6 is a top plan view of the structure shown in Figure 4; and

Figure 7 is a fragmentary view showing a means for holding and vibrating the stylus.

It will be understood that the styluses disclosed will normally be operated by electromagnetic devices such as that shown in my co-pending application although in certain cases they may be operated by diaphragms. The cutting point of the stylus is moved upward and downward in accordance with the sound vibrations and serves to cut a "hill and dale" groove in the film 10. In practice, suitable means will be employed for compensating for the differences in force required to press the cutting edge into the film and that required to move it out. This compensating means may take the form of an eccentric positioning of the armature with respect to the magnetic poles or a difference in the elastic and frictional damping such as disclosed and claimed in the patent of Earl H. Foley, No. 1,870,446, the purpose being to produce a sound groove of regular or substantial form.

The anvil 13 which is preferably formed of metal such as steel has a smooth upper guiding surface for the film. The drive for the film may be frictional or by means of a sprocket engaging the usual side openings in the film. The film is fed against the cutting edge of the stylus under considerable tension and it will be noticed, for example, from Figure 2 that the film 10 as it passes the stylus is moved over an arc 100 of relatively short radius as for example ¼ inch in radius which is one of the important features of the invention disclosed in my co-pending application.

Figures 1 to 3, I show on an enlarged scale one form of stylus in contact with a moving film. This stylus has a lower conical side 22 and an upper side 23 which as shown is elliptical in form and which meets the lower side in a curved cutting edge 24 which should be formed as sharp as possible. The angle θ between the longitudinal axis of the side 23 and the element of the conical surface 22 which meets the side 23 is substantially 55°. There should be a clearance angle B of approximately from 10° to 18° between the lower side or surface 22 and the tangent to the film at the cutting point and also a substantial angle A of say between 17° and 25° between the normal to the film at the cutting point and the side 23.

It will be seen particularly from Figure 3 that the cutting edge does not extend directly across the sound groove but is inclined thereto, thus cutting the material of the film by a slicing action which greatly improves the character of the cut.

I find that by placing the cutting stylus with the longitudinal axis of the stylus and also the longitudinal axis of the side **23** in a vertical plane passing through the axis of the groove at the angle to the film before mentioned and then turning the stylus on its own axis say 15° to 25°, I secure the desired inclination of the cutting edge to the axis of the groove. As in the case of the stylus disclosed in my co-pending application the material of the film cut away is in the form of a continuous core of exactly the form of the groove.

In Figures 4, 5 and 6, I show a modified form of stylus of cylindrical shape with an inclined end hollowed out to form an upper cutting surface **30**. The angle between the plane of the outer edge of this surface and the lower face **31** of the cylinder, that is, between this plane and any element of the cylinder may be as great as 70° and it is understood that generally by this structure I am able to reduce the cutting angle, that is, the angle between the cutting face **30** and the lower surface **31** which in the form illustrated is approximately 45°. It will be seen that there is a relatively large clearance angle between the lower face of the stylus and the film and it will also be seen from Figure 6 that the axis of the cutting stylus is inclined to a vertical plane passing through the axis of the groove and that the cutting edge is also inclined across the groove as in the case of the stylus shown in Figures 1 to 3. The groove cut by the styluses will be elliptical or approximately cylindrical in section. It is obvious that by properly designing the stylus the angles above noted may be maintained at substantially the proper values, and the groove cut by them at any given depth, be substantially cylindrical.

In reproducing, I preferably employ a pick-up stylus constructed as disclosed in my co-pending application, the lower surface of the stylus being curved to contact along the width of the groove, this pick-up stylus being turned slightly on its own axis so that its lower edge is inclined to a plane normal to the axis of the groove.

By the use of the invention herein described, I have been able to record on a film moving at the rate of 60 feet a minute, sound vibrations within an audible range up to a frequency in excess of five thousand and to reproduce without appreciable distortion and perceptible surface sound and by recording and reproducing at a film speed of 90 feet a minute I am able to increase the upper frequency range 50% that is to a frequency of seven thousand five hundred.

In practice I preferably employ a light cut of approximately 1.5 mils.

In Figure 7, I show one means for holding the cutting and reproducing styluses. Lever **60** is designed to be actuated by an electromagnet (not shown) and carries a clamping device **65** for holding the stylus at the proper angle. In Figure 7, I show at the right a cutting stylus which may be of any of the forms illustrated in the previous figures, and at the left I show a reproducing stylus designed to operate in the groove formed by the cutting stylus. In changing from the cutting to the reproducing operation, either the anvil **13** or the recorder head will be shifted so that the reproducing stylus will operate in the sound groove.

I claim:

1. A method of progressively cutting a "hill and dale" sound record groove in tough plasticized film by means of a tool formed with two surfaces meeting at an angle of from 45° to 60° to form a cutting edge, which method consists in drawing said film against said edge under considerable tension at a speed substantially in excess of 40 feet per minute, holding the tool with said edge inclined, transversely of the groove, to a plane normal to the direction of movement of said film and one of said faces adjacent said film at an angle in excess of 7° thereto and another of said faces at an angle of more than 17° from the normal to said film at the cutting edge measured in a direction of movement of the film and vibrating the tool in a direction substantially normal to said film.

2. A method of progressively cutting a hill and dale sound record groove in a thin, flexible film of tough plasticized material by means of a cutting tool having a sharp cutting edge, which method consists in drawing the film over an anvil having a sharp bend, holding the tool to cut the film at the point where the film passes over the bend and with the cutting edge at a general incline, transversely of the groove, to a plane normal to the axis of the groove to be cut and causing the tool to vibrate substantially normal to the film in accordance with sound waves to be recorded.

3. A method of progressively cutting a hill and dale sound record groove in tough plasticized material by means of a tool formed with two surfaces meeting at an angle of from 45° to 60° to form a cutting edge, which method consists in drawing said film over an anvil having a sharp bend, holding said tool with its cutting edge at said bend and inclined, transversely of the groove, to a plane normal to the direction of movement to said film and one of said faces adjacent said film at an angle in excess of 7° thereto and another of said faces at an angle of more than 17° from the normal to said film at the edge, said angle being measured in the direction of motion of the film and vibrating the tool in a direction substantially normal to the film.

4. Means for cutting a sound record groove in a thin tough film comprising a cutting tool having surfaces meeting to form a sharp curved cutting edge, an anvil for supporting the film, means for drawing the film over said anvil and against said cutting edge, means for supporting said tool with the surfaces extending away from the edge in the direction of movement of the material, with the edge extending transversely of the groove and with the edge curve components, transverse of the groove, lying at a general incline to the normal to the axis of the groove so as to effect a slicing action of the film and means for vibrating the tool in accordance with sound waves to be recorded.

5. A method of progressively cutting a sound record groove in tough plasticized sheet by means of a tool formed with two surfaces meeting at an angle of from 45° to 60° to form a cutting edge, which method consists in drawing said sheet against said edge, holding the tool with the tool penetrating the sheet and the edge inclined, transversely of the groove, to a plane normal to the direction of movement of the sheet and with one of said faces adjacent the film at an angle in excess of 7° thereto and another of said faces at an angle of more than 17° from the normal to said sheet at the cutting edge, said angle being measured in direction of movement of the sheet and vibrating the tool in accordance with the sound to be recorded.

6. The method of cutting a record groove in a sheet of tough plasticized material by means of a cutting tool having a sharp cutting edge, which method consists in drawing said material against

said edge, holding the tool with the edge penetrating the material and the edge inclined, transversely of the groove, to a plane normal to the direction of movement of the sheet, whereby a slicing action is effected and vibrating the tool in accordance with sound to be recorded.

7. The method of cutting a hill and dale record groove in tough plasticized film by means of a cutting tool having a sharp cutting edge, which method consists in drawing said film against said edge, holding the tool with the edge penetrating the film and the edge inclined, transversely of the groove, to a plane normal to the direction of movement of the film, whereby a slicing action is effected and vibrating the tool in accordance with sound to be recorded, and in a direction normal to the film surface.

MAX BENDER.