

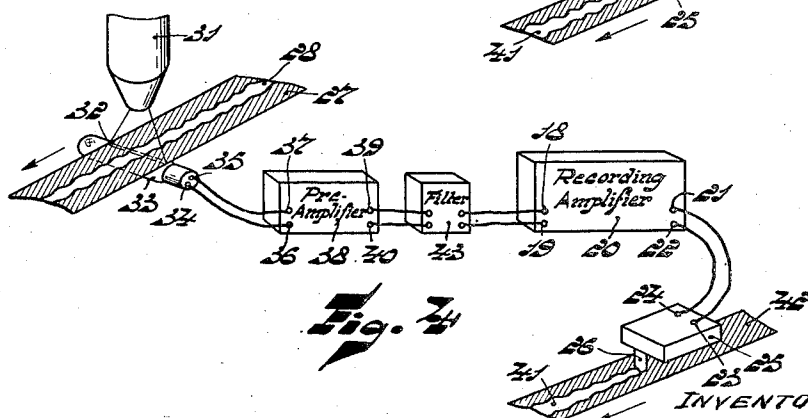
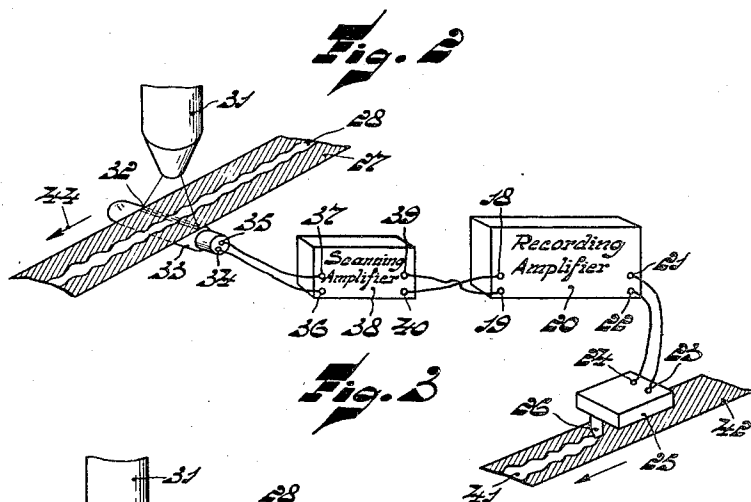
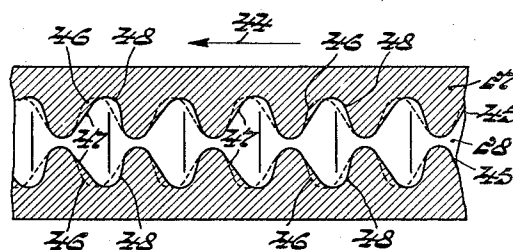
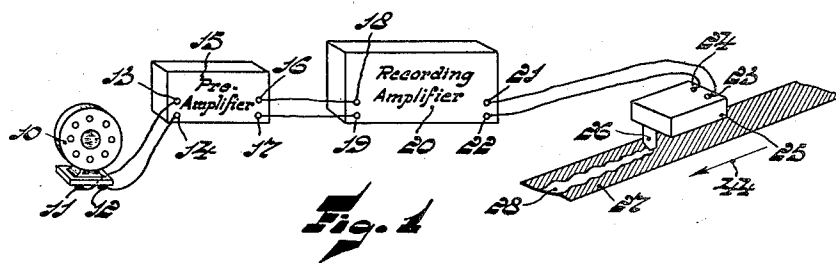
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METHOD OF RECORDING SOUND

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METHOD OF RECORDING SOUND

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3 Claims. (Cl. 179—100.4)

This invention relates to a method of electro-mechanically recording sound vibrations in which a sound track of variable depth is produced on a carrier by a cutting tool.

Although not limited thereto, my invention is particularly adapted for use in recording of the type described in the U. S. Patent #1,919,116 to James A. Miller, and I shall describe the same in connection therewith.

In such recording, a cutting tool having a V-shaped cutting edge with a large apical angle is vibrated in accordance with the sound being recorded and perpendicularly to the surface of a carrier provided with an opaque covering layer, to remove portions of the covering layer and thereby produce an optically-reproducible sound track having depth variations and corresponding width variations. I have found that when reproducing a sound track recorded in this manner there is frequently deformation in the reproduced sound although the originally-recorded sound was free from deformation. I have found that such deformation is inherent to recording systems which produce variable depth sound tracks, and is due to the fact that the cutting tool when moving into the cutting layer of the carrier, i. e. during the movement of penetration, meets with a greater resistance than when it is moving out of the carrier, i. e. during the movement of recession. Consequently the movement of penetration of the cutting tool is retarded relative to the movement of recession, and all of the sound curves are deformed in one direction. This deformation becomes manifest during the reproduction by the presence of higher overtones.

The object of my invention is to overcome the above difficulties, and for this purpose I introduce, during the re-recording of the originally-recorded record on a second carrier, distortions which compensate the distortions produced during the recording. More particularly, I use the distortions introduced in the original record to compensate the distortions in the record. For this purpose, I scan the originally-recorded sound track to produce electrical vibrations, re-record said vibrations with a recording system which is identical with that used during the recording and rotate the phase position of these electrical vibrations by 180° to produce electrical vibrations which are used in the re-recording.

Thus during the re-recording the deformations present in the first record are scanned and are fed to the recording device, but due to the 180° phase displacement they are just in opposite phase with the deformations which are intro-

duced during the re-recording on the second carrier. Thus the deformations caused by the recording system are eliminated as completely as possible.

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

Figure 1 is a diagrammatic view of a recording device for mechanically recording an optically-reproducible sound track having both depth and width variations,

Fig. 2 is a plan view of a carrier with a sound track therein,

Fig. 3 is a diagrammatic view of a re-recording device for carrying out the invention, and

Fig. 4 is a diagrammatic view of a re-recording device according to another embodiment of the invention.

The recording system illustrated in Fig. 1 comprises a microphone 10 having terminals 11 and 12 connected to terminals 13 and 14 respectively of a pre-amplifier 15. Pre-amplifier 15 has output terminals 16 and 17 connected to input terminals 18 and 19 respectively of a recording amplifier 20 for the purpose of conducting the electrical sound vibrations. The electrical energy is conducted from output terminals 21 and 22 of amplifier 20 to the terminals 23 and 24 of a sound recorder 25 having an armature carrying a cutting tool 26 provided with a V-shaped cutting edge having an apical angle of about 174°. A suitable recorder for this purpose has been described in U. S. Patent #2,108,275 to Vermeulen et al.

The electrical energy supplied to terminals 23 and 24 actuates cutting tool 26 to produce in a film carrier 27 a sound track corresponding to the sound vibrations striking microphone 10. Carrier 27, which may be of the type described in U. S. Patent #2,020,861 to van der Willigen et al., comprises three layers, namely a supporting layer of Celluloid, an intermediate cutting layer of gelatin, and a thin opaque covering layer. During the recording, the cutting tool 26 is vibrated perpendicularly to the carrier to remove portions of the opaque layer, and because of the large apical angle of its cutting edge, the resulting optically-reproducible sound track 28 has depth variations, and corresponding width variations which are a proportional enlargement of the depth variations.

During that part of its motion in which it moves into the cutting layer, the cutting tool 26 meets with a greater resistance than when it

moves out in the following part of the amplitude. As a result of this, the movement of penetration of the chisel is retarded relatively to the movement of recession.

5 The resulting deformation produced in the sound track 28 is illustrated in detail in Fig. 2. When the carrier 27 moves at a constant speed in the direction of the arrow 44 during the recording, the sound track 28 is cut according to
10 two symmetrical curves 45 by the removal of portions of the covering layer of the film. During the motion of penetration of the cutting tool its movement, which in case of sound recorded free from deformation extend sinusoidally according to time, is retarded. As the carrier 27 is moved
15 with a constant velocity, the portions 47 of the boundaries of the sound track are straighter than those of the correct sine curve 46. Due to this, however, the position of the cutting lags with respect to the electrical sound curve in the recording device, and during its movements of recession the movement of the cutting tool is accelerated with the result that the portions 48
20 are steeper than those of the correct sine curve 46. Thus, the correct sine curves are deformed into the curves 45, and this deformation becomes manifest during the reproduction as overtones of the recorded frequencies.

In Fig. 3 the sound track 28 obtained in the
30 manner described above in connection with Fig. 1 is scanned optico-electrically. For this purpose an objective 31 projects a line of light 32 upon carrier 27, and the variations in light produced by sound track 28 are converted by a photo-electric cell 33 into electrical oscillations which
35 are conducted from the terminals 34 and 35 of the photocell to the terminals 36 and 37 of a scanning amplifier 38. The phase position of the amplitudes of the electrical variations at the output terminals 39 and 40 of amplifier 38 is the
40 same as that of the electrical variations at the output terminals 16 and 17 of the pre-amplifier 15 of Fig. 1. However, during re-recording the connections between the pre-amplifier 38 and the recording amplifier 20 of Fig. 1 are reversed.
45 More particularly, as shown in Fig. 3, the terminals 39 and 40, which correspond to the terminals 16 and 17 respectively of the microphone amplifier 15 of Figure 1, are connected to the input terminals 19 and 18 respectively. As a result the
50 phase position of the amplitudes at the terminals 18 and 19 of the amplifier 20 during re-recording is displaced exactly 180° relative to the first record.

55 As shown in Fig. 3, the re-recording is effected with the same recording system and recorder 25 as in Fig. 1, and consequently the same deformation of the recorded frequencies would necessarily be introduced. However, due to the reversal of
60 the phase position at the terminals 18 and 19, the deformations are displaced in phase by 180° relative to those present in the first-recorded track 28, so that the sound track 41 obtained after recording on a second film 42 is free from deforming
65 overtones caused by the recording method.

In carrying this method of re-recording into effect it is absolutely necessary that during re-recording the rotation of the phase position occurring between the input of the recording amplifier 20 and the movement of the armature of recorder 25, is not different from that in the recording of sound track 28. For this purpose I use the same or in any case "identical" recording amplifiers and recorders in both cases, i. e.
75 during the recording and re-recording.

The term "identical" as used herein and in the claims is to be understood to mean amplifiers and recorders in which not only the components and tubes used are identical in both cases, but also the adjustment of the tubes is identical as far
5 as possible. In the example illustrated in the drawing, however, the same amplifier 20 and the same sound recorder 25 are used for both the recording and re-recording.

In the embodiment of the invention illustrated
10 in Fig. 4 the same reference numerals indicate the same parts. In this case the required displacement of the phase position by 180° from that at the input side of the recording amplifier is obtained by the interposition of a filter 43 between
15 the pre-amplifier 38 and the recording amplifier 20. In fact, it will frequently occur that in the optico-electrical scanning of the sound track 28, the phase position at the output terminals 39 and 40 is not identical to that during recording at the terminals 16 and 17 of the microphone
20 amplifier. To produce the desired 180° change in phase position at the terminals 18 and 19 during re-recording, relative to the phase position at these terminals, during the first recording, it is necessary to utilize a phase rotation filter 43, which together with the pre-amplifier 38, causes
25 a phase rotation of 180° relative to the phase position during the first recording at the terminals 18 and 19 of the recording amplifier 20, at least for that frequency range in which the deformation stated above becomes most manifest, for example from 2000 to 4000 cycles. According to this embodiment of the invention the re-recorded sound track will therefore be free from
35 overtones brought about by the recording method at least in a certain selectable frequency range.

In a third embodiment of the invention, which is not illustrated in the drawing, I move the carrier, during scanning and re-recording of the first record, in a direction opposite to that in
40 which it was moved during the recording of this record. In this manner a displacement of the phase position of 180° is obtained throughout the frequency range and the second record, which is of course to be moved at reproduction in a direction opposite to the movement at its recording, is free from the overtones caused by the system of
45 recording. More particularly, in Fig. 3 the carrier would be moved opposite to the direction of arrow 44, and the connections between terminals 39 and 40 and terminals 18 and 19 would not be reversed.

I have found that in the latter case it can be
55 ascertained through the nature of the sound track whether the record has been recorded in the natural order of the sound or has been proposed by scanning and re-recording the first record moving in a direction opposite to that of the original recording. I know from experience that
60 on recording in the form of depth variations in a gelatin layer the surface of the track when the chisel is being lifted out, is not only cut, but is planed to a less or greater extent. A planed gelatin surface becomes frosted. Particularly in
65 case of steep slopes of the cuttings, i. e. a high frequency this planing causes a clearly visible frosted surface.

With a record of the natural order of the sound the slopes 43 of the curves of Fig. 2 are
70 located on the side of the cuttings opposite to that of the direction in which the film moves during cutting and this side becomes frosted. A record proposed by scanning and re-recording of the original record moved in a direction oppo-
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site to that of the recording is characterized in that the frosted slopes of the sound curve are located at the front of the cuttings when seen in the direction of reproduction of the record. In this case the slopes 47 of the sound track have become frosted.

While I have described my invention with reference to specific examples and applications, I 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 I claim is:

1. A method of electro-mechanically recording sound, comprising the steps of mechanically recording on a carrier an optically-reproducible sound track having depth variations, scanning the sound track to produce electrical vibrations, displacing the electrical oscillations 180° in phase with respect to the first recording, and feeding the oscillations to recording means identical with those used in the recording to re-record the sound track on a second carrier similar to the first carrier.

2. A method of electro-mechanically recording sound, comprising the steps of mechanically recording on a carrier an optically-reproducible sound track having depth variations, scanning the sound track to produce electrical vibrations, displacing the electrical oscillations in a predetermined frequency range 180° in phase with respect to the first recording, and feeding the oscillations to recording means identical with those used in the recording to re-record the sound track on a second carrier similar to the first carrier.

3. A method of electro-mechanically recording sound, comprising the steps of mechanically

recording on a carrier an optically-reproducible sound track having depth variations, scanning the sound track while moving the carrier in a direction opposite to that in which it was moved during the recording to produce electrical oscillations, and feeding the oscillations to recording means identical with those used in the recording to re-record the sound track on a second carrier similar to the first carrier.

4. A method of electro-mechanically recording sound, comprising the steps of mechanically recording on a carrier an optically-reproducible sound track having depth variations, scanning the sound track to produce electrical oscillations having the same phase position as the electrical oscillations employed in the recording, feeding the latter oscillations to a recording amplifier in 180° phase displacement, and feeding the oscillations produced by the amplifier to recording means identical with those used in the recording to re-record the sound track on a second carrier similar to the first carrier.

5. A method of electro-mechanically recording sound, comprising the steps of mechanically recording on a carrier an optically-reproducible sound track having depth variations, scanning the sound track to produce electrical oscillations, passing the oscillations through a filter to effect for a certain frequency range a phase displacement of 180°, and feeding the displaced oscillations to recording means identical with those used in the recording to re-record the sound track on a second carrier similar to the first carrier.

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