March 23, 1937. P. LOHN ET AL 2,074,406

METHOD AND APPARATUS FOR RECORDING AND REPRODUCING SOUND

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Fig. 1.

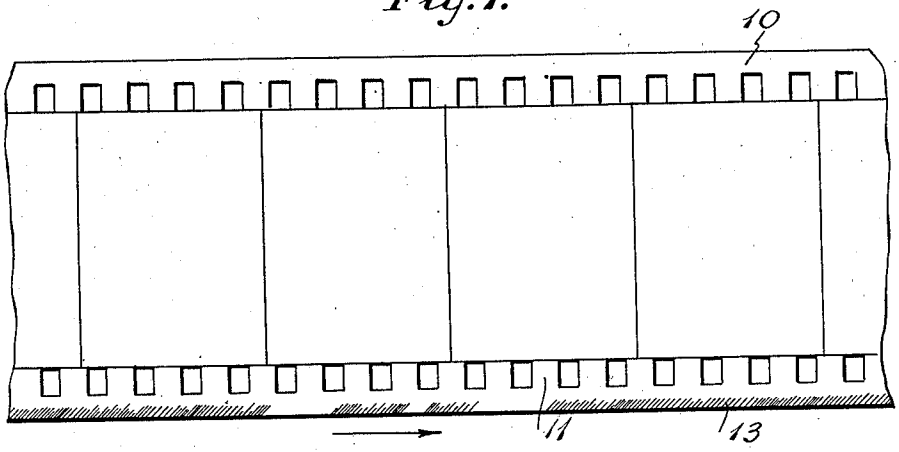


Fig. 2.



Fig. 3.

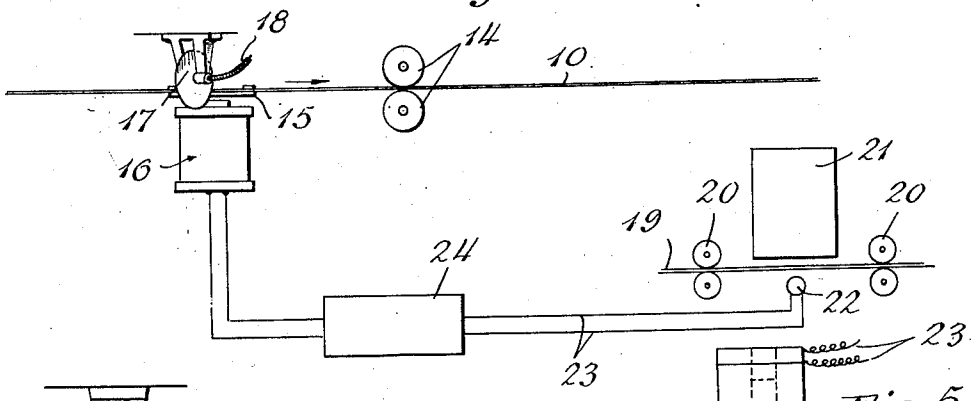


Fig. 4.

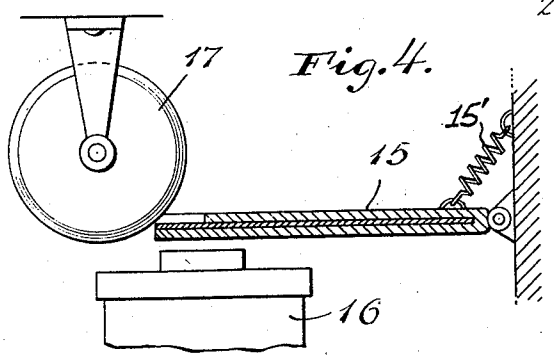
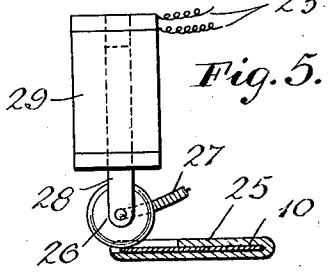


Fig. 5.



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Fig. 6.

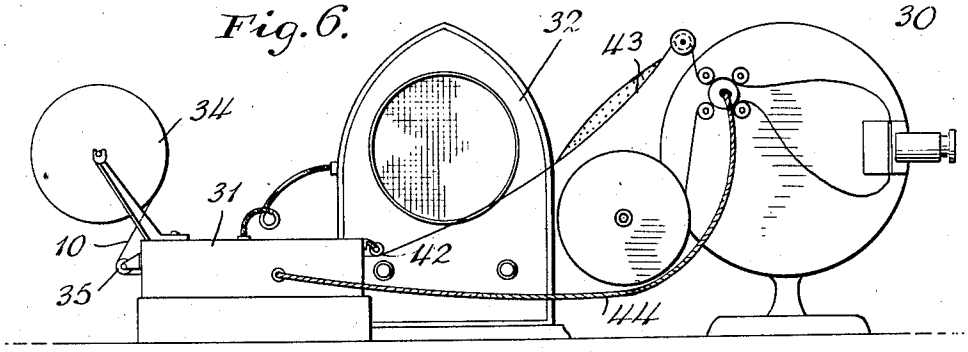


Fig. 7.

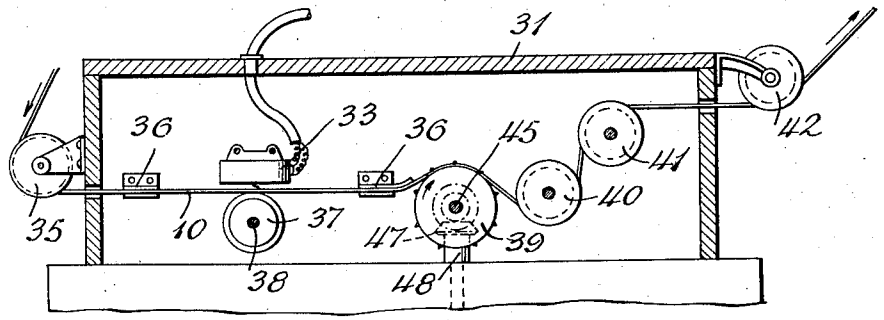


Fig. 8.

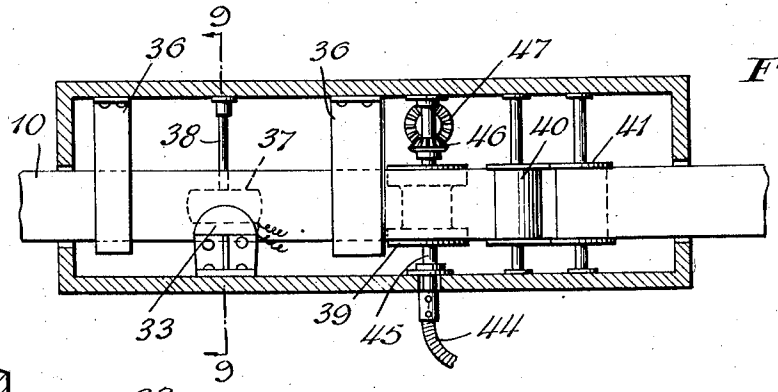
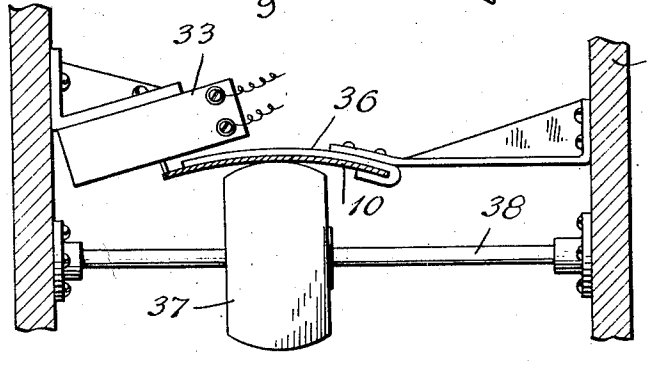


Fig. 9.



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METHOD AND APPARATUS FOR RECORDING AND REPRODUCING SOUND

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Application July 26, 1933, Serial No. 682,292

2 Claims. (Cl. 274—11)

This invention relates to improvements in the recording and reproduction of sound and has particular reference to a method and apparatus for making and reproducing a sound record on a recording medium such, for example, as a film employed in the motion picture art.

The invention pertains more especially to the production of a motion picture film which is capable of being employed in conjunction with projectors of the type used in the home and which will enable the synchronous reproduction of sound with the picture on the film, but it will be understood that the inventive concept embodied herein is not to be construed as limited to such use.

Various kinds of films having sound records thereon have heretofore been used among which are those in which the film is provided with a photographic sound record. Such a film has been found quite effective in projectors employed in motion picture theatres. But the necessity of utilizing the expensive equipment, including photo-electric cells and associated apparatus, makes its use with a home projector too expensive and therefore impractical either when such equipment is installed originally in the machine or is provided as a separate unit for application to a projector theretofore unequipped for the reproduction of sound.

Another previous proposal involves the formation of an ordinary hill and dale record groove cut in a surface of the film. Such a record necessitates the use of a stylus which, if of a relatively soft material, wears down and must be frequently replaced, and which, if of a hard substance such as steel or the like, has an adverse effect upon the record groove. In either instance, the reproduction of the sound is materially impaired and its quality therefore diminished.

A further prior suggestion, which has been practiced to some extent, resulted in forming the record groove in an edge of the film for engagement by the stylus of a pick-up device. Such practice has never, so far as known, been entirely successful in obtaining quiet reproduction, owing to the roughness of the edge of the film as compared to the surfaces thereof, which roughness, in spite of attempts to obliterate the same by polishing said edge, has resulted in the production of extraneous sounds. Nor has such reproduction approached perfection in its accuracy due to the tendency of the film to buckle by reason of the pressure of the stylus thereagainst.

In accordance with the present invention, it is proposed to eliminate the difficulties encountered in known types of sound recording films by the production of an improved recording medium in which the sound record therein is of such nature that its engagement with a recording stylus will result in an accurate reproduction, without extraneous noises, of the sound to be reproduced. The present medium is also of such a character that the same can be produced at a cost which will make feasible its use with home projection apparatus.

The invention further contemplates a sound record produced in a flexible strip, as for example a photographic film, by a relative vibratory movement between said film and a cutting tool which will result in the latter cutting a record groove in one surface and an edge of said strip. The term "trace" as employed throughout this description is intended, in its broadest sense, to cover a record in which either a continuous cut or a series of individual but correlated cuts combine to produce the desired sound waves.

A still further feature of the invention resides in reproducing the sound record in a flexible strip by moving the latter past a pick-up device in such a manner that the inherent tendency of the strip to assume a normal flat position is utilized to effect sufficient pressure of the strip and its record against the stylus of said device to faithfully reproduce the sound.

The inventive idea involved is capable of receiving a variety of expressions, some of which, for purposes of illustration, are shown in the accompanying drawings, wherein:—

Figure 1 is an enlarged fragmentary plan view of a motion picture film to which the sound record of the present invention has been applied.

Figure 2 is a greatly enlarged transverse section through the film, the dotted lines indicating the relative position of the stylus of a pick-up device when engaged with the sound record.

Figure 3 is a diagrammatic elevation of one form of apparatus used for recording sound upon the film.

Figure 4 is an enlarged elevation, partly in section, of the sound record-forming apparatus of Figure 3.

Figure 5 is a view similar to Figure 4 showing another form of recording apparatus.

Figure 6 is an assembly view, in elevation, of a projection apparatus, and sound reproducing mechanism made in accordance with a present invention.

Figure 7 is an enlarged longitudinal section through a part of the reproducing mechanism.

Figure 8 is a plan view of the mechanism shown in Figure 7, with the casing thereof in section, and

Figure 9 is an enlarged transverse section substantially on the line 9—9 of Figure 8.

The present invention is illustrated in its application to a photographic film such as used in motion picture projecting machines but it is to be expressly understood that the sound record involved herein may be applied to any other kind of flexible recording medium without departing from the spirit or scope of the invention. The film 10 shown herein is of the usual type made of plasticized material including the united layers of celluloid 11 and sensitized emulsion 12 the former of which is of the greater thickness. According to the present invention the record trace generally indicated by the numeral 13 is preferably formed, by a cutting means later to be described, in the celluloid surface 11 and a longitudinal edge of the film. The trace consists of minute series of cuts made in said surface and edge and these cuts extend transversely of the film body, and preferably diagonally thereof as clearly shown in Figure 1, although it is conceivable that they may be perpendicular to said edge. The cuts forming the record trace vary in depth and length in accordance with the frequency of the vibrations which are transmitted either to the film or to the cutting tool, as will appear in the course of the description, but it is desirable, in order to effect reproduction of high quality, that the depth of said cuts at no point shall be equal to the thickness of the film and preferably do not exceed the thickness of the celluloid layer 11. Also, due to the relative position of the edge of the film and the cutting tool, the length of the cut in the film surface will be substantially the same as the greatest depth of the film, as shown in Figure 2. In no event, however, will the length of the cut be such that it will extend into the central area of the film which is occupied by the picture photographed upon the emulsion side 12. When the cuts of the trace are formed diagonally, as shown in Figure 1, they preferably extend outwardly in a direction opposite that to the travel of the film as it is being moved past and engaged with the stylus of a pick-up device so that said stylus, which may be of any desired hard material and of substantially the form shown in Figure 2, will easily and accurately engage the undulations of the record trace with a constancy which will faithfully reproduce the record. In Figure 1 several blank spaces have been shown between series of the cuts forming the record trace. These blank spaces are actually a part of the complete sound record but represent silent intervals in said record. By reason of the fact that the sound record is formed in the smooth celluloid surface of the film the engagement of the stylus with the said blank spaces will reduce to an absolute minimum any possibility of scratching noises being created during the said silent intervals.

In Figures 3 and 4 there is illustrated diagrammatically one form of recording apparatus.

The film 10, with its celluloid side 11 uppermost is fed between rollers 14 to and through the armature 15 of a quick-acting electromagnetic device 16 of any well-known construction capable of responding to high frequencies and accurately transmitting the same to its armature in order to vibrate the latter in accordance with such frequencies, there being a spring 15' connected to the armature to hold the latter in engagement with the cutting tool 17 against the action of the device 16. The cutting tool is preferably in the form of a disc knife, driven at the desired speed by a flexible shaft 18, and is suitably suspended adjacent the edge of the film in which the sound record is to be made and the plane of said knife is preferably disposed diagonally to the direction of travel of the film so that the cuts forming the record trace will be disposed diagonally relative to the longitudinal edge of said film. Preferably, when the electromagnet 16 is deenergized the armature 15 is so positioned that the film is in contact with the cutting edge of the cutter 17 but as the armature is vibrated said film, as it is moved along, will be likewise vibrated relative to the cutter and the desired cuts made in the surface 11 and its longitudinal edge.

The apparatus shown in Figure 3 is employed when translating or transferring a sound record from one film to another and is especially adapted for making the sound record in a small film, such as the film 10 which may be used with small home projection apparatus. The master film 19 which is employed to form the sound record in the film 10 has a photographic sound record therein and is fed by series of rollers 20 between a projection unit and a photo-electric cell conventionally illustrated by the numerals 21 and 22, respectively. The cell 22 is responsive to the sound record on the film 19 and impulses are transmitted from said cell through the circuit 23 connected to the electromagnet 16, there being a suitable amplifying unit 24 interposed in said circuit between said magnet and the photo-electric cell.

Instead of vibrating the film 10 into contact with the cutter 17, as shown in Figures 3 and 4, the film 10 as illustrated in Figure 5, may be moved through a stationary guide 25 and the cutter 26, constantly rotated by the flexible shaft 27, may be carried by the solenoid of the electromagnetic device 29 which would be included in the circuit 23 in the same manner as the device 16. Thus the cutter 26 would be vibrated in response to the impulses transmitted thereto by the photo-electric cell and said cutter would constantly be moved into and out of engagement with the surface 11 of the film and its edge to form the record trace therein.

Figures 6 to 9 of the drawings illustrate an apparatus for reproducing the sound record of the above described film. In Figure 6 there is conventionally shown various instrumentalities which may be employed in a combined sound and motion picture apparatus especially suitable for home use. The numeral 30 indicates a picture projection machine which may be of a well known construction. The sound reproducing unit generally indicated by the numeral 31 is designed so that it can be sold as a separate unit and coupled with a projection machine already in use and has associated therewith any well known loud speaker 32 electrically connected to a pick-up device 33 located within the casing of the unit 31. The film 10 having the record groove 13 therein is mounted upon a reel 34 supported upon the exterior of the casing 31 and is fed from said reel around an idler 35 and from thence into said casing with the celluloid side of the film containing the record groove uppermost. As the film enters the casing 31 it is passed through what is commonly known as a gate consisting of the horizontally spaced guide members 36 which, in this instance, are made arcuate in cross section as best shown in Figure 9. The purpose of this

gate is to tension the portion of the film located between the members of the gate and where the sound record 13 thereof is being engaged by the stylus of the pick-up device. In accordance with the present invention it is proposed to utilize the natural tendency of the film to assume a flat condition after it has been flexed in order to obtain the pressure sufficient to cause the record in the film to properly engage the stylus of the pick-up device. To this end, there is provided an idler roller 37 journalled on the shaft 38 extending between the side walls of the casing 31 beneath the film 10 and in vertical alignment with the device 33. The bearing surface of the roller 37 engages the lower or emulsion side of the film 10 and is curved transversely so that the film 10 will be similarly curved as it passes beneath the stylus of the device 33. This transverse flexing of the film 10 places the same under sufficient tension so that the previously referred to natural tendency of the film to flatten out will produce sufficient upward pressure against the stylus to cause the latter to firmly engage the undulations in the record groove 13 and thus accurately reproduce the record in the film.

After leaving the tension gate in its travel through the reproducing unit the film is passed over the drive sprocket 39 and from thence successively under and over the idlers 40, 41 and 42, the latter being located on the exterior of the casing 31. From this point the film is led to the projection machine 30 and between the latter and said idler 42, said film is twisted, as indicated at 43, so as to bring the emulsion side thereof uppermost.

In order to secure absolute synchronism between the projection machine 30 and the sound reproduction, the shaft of said machine is connected by a flexible shafting 44 to a shaft 45 extending transversely of and mounted in the casing 31, said shaft carrying the drive sprocket 39. A pinion 46 on said shaft 45 meshes with a bevel gear 47 carried by the drive shaft 48 operated by any suitable prime mover such as an electric motor (not shown).

What is claimed is:

1. Sound reproducing apparatus, comprising, in combination, a pick-up device, a film having a sound record in one surface thereof, means to move said film and said device relative to each other with the stylus of the latter in engagewith said sound record, and means to bow said film transversely so that the surface thereof containing the sound record will be in the convex arc of curvature of the film.

2. Sound reproducing apparatus, comprising, in combination, a pick-up device, a film having a sound record in one edge of one surface thereof, means to move said film and said device relative to each other with the stylus of the latter in engagement with the edge of said film containing said sound record, an arcuate guide through which said film is moved, and a roller having a transversely curved surface, contacting only the medial portion of the surface of said film opposite to that containing the sound record so as to bow said film.

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