

Dec. 26, 1933.

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1,940,937

SOUND RECORDING AND REPRODUCING SYSTEM

Filed March 15, 1930

2 Sheets-Sheet 1

Fig. 1

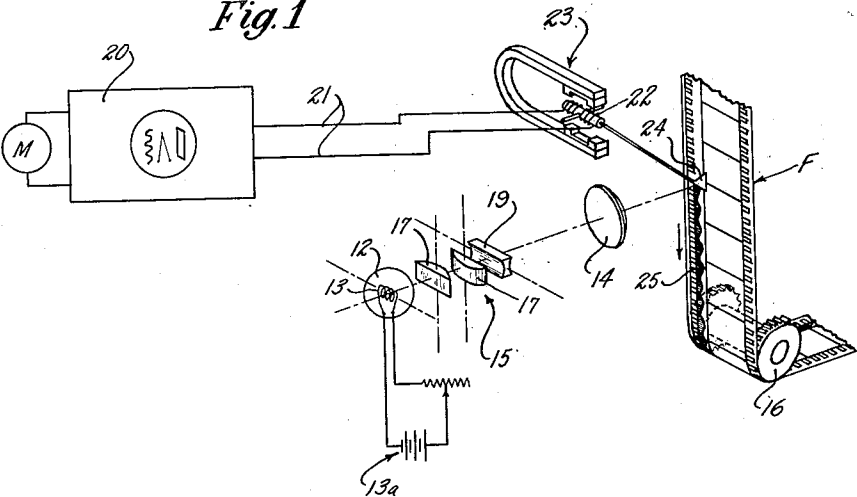
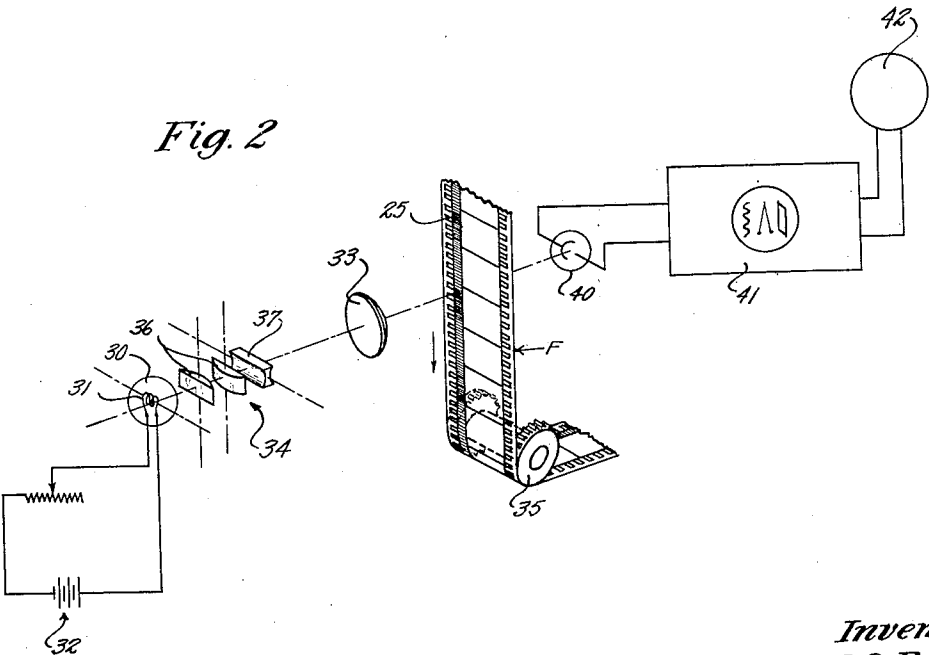


Fig. 2



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Fig. 3

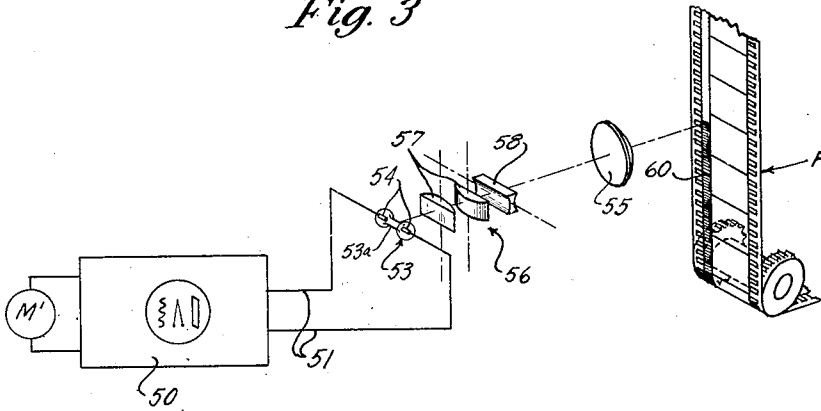
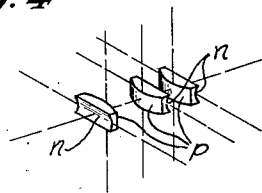


Fig. 4



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UNITED STATES PATENT OFFICE

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SOUND RECORDING AND REPRODUCING
SYSTEM

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5 Claims. (Cl. 88-24)

This invention relates generally to the recording and reproducing of sound by photographic methods and apparatus; and has for one of its objects elimination of the usual light-slit now commonly utilized in such systems.

Heretofore, both in recording and in reproduction, a light-slit has been utilized to define and restrict to a narrow band a light beam which is projected upon the sound track area of the film, this light-slit being located either closely adjacent the film, or else spaced therefrom and an image of the slit being cast upon the film by a suitable lens arrangement. Light-slits, however, have a number of inherent disadvantages, among which may be mentioned the necessity for frequent cleaning in order to insure a sharply defined light beam, and dispersion of light due to diffraction at the slit, which reduces the sharpness of definition of the light beam and consequently reduces the accuracy of reproduction.

According to one embodiment of the present invention there is provided a light source of substantial but limited extent, and a combination of modifying lenses for projecting upon the film a modified source image which illuminates the sound record on the film in an extremely narrow but uniform transverse light band of high intensity, much the same as that produced with the use of the well known light-slit, but of higher intensity and better definition.

The invention itself will best be understood from the following detailed description of a present preferred embodiment thereof, reference for this purpose being had to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view showing a sound recording system embodying my invention;

Fig. 2 is a diagrammatic view showing a sound reproducing system embodying my invention;

Fig. 3 is a diagrammatic view showing a variational sound recording system embodying my invention; and

Fig. 4 shows a variational assembly of lenses according to the invention.

Referring to Fig. 1 of the drawings, the numeral 12 indicates an incandescent lamp having a filament 13 comprising, in the present instance, a somewhat elongated coil having substantial breadth, and illuminated as by a battery 13a. The filament here illustrated is merely typical of any suitable light source having limited dimensions, and suggests no limitation on the general form which that light source may take. An objective lens 14 is positioned to cast

an image of filament 13, modified by a lens combination 15, as presently to be described, upon the sound track area of a traveling actinic film F, which film is driven in a direction transverse to the direction of elongation of the present illustrated filament by means of a sprocket 16.

The lens combination 15 includes a pair of positive cylindric lenses 17, positioned before lamp 12 with their axes parallel to the direction of film movement, and at right angles to the direction of elongation of the present illustrated filament 13. Lenses 17 are positioned to act as enlarging lenses, the filament 13 being within their focal point; but, being cylindric in form, the enlargement is only in the direction perpendicular to their axes, as is well understood in the art, and since the axes of lenses 17 are parallel to the direction of film movement, it will be seen that the lenses 17 function to elongate the image of the filament formed upon the film in a direction transverse to the direction of film movement, which direction is in the direction of elongation of the present filament itself.

The lenses 17 thus cause the image of filament 13 to be extended longitudinally. If, however, the filament actually used by itself is sufficiently elongated so that its image will extend entirely across the sound track area of the film, then the lenses 17 may be dispensed with; although it is believed that it will usually be more desirable to utilize relatively short filaments due to the greater stability thereof, and in such cases the lenses 17 will be included.

Adjacent lenses 17 is a negative cylindric lens 19 with its axis perpendicular to the axes of lenses 17, and parallel to the direction of elongation of the present illustrated filament. Lens 19 acts as a reducing lens in the direction perpendicular to its axis, and therefore functions to reduce the breadth of the image of filament 13 upon the film in the direction longitudinally of the film.

Thus by virtue of the lenses 17 and 19 the image of filament 13 cast upon the film is elongated transversely of the film and reduced or flattened longitudinally of the film; and the sound track area of the film is therefore illuminated by a flat beam of light projected upon the film in a narrow band transverse to the direction of film movement.

A very important feature of this invention already referred to, is that an extremely narrow but uniform transverse light band is projected onto the film. It remains now to explain how, with a commercially desirable striated source of

light such as a spirally wound automobile head-lamp filament, it is possible to achieve this uniform intensity of light in a sharp edged band with the structure illustrated. It is necessary for satisfactory recording of sound that the edges of the image on the film which are transverse to the direction of travel of the film be sharply defined. Hence, lens 19 and lens 14 are of such curvatures as to cooperate in sharply focusing upon the film reduced images of line elements of the light source which are chosen parallel to the axis of the negative cylindrical lens 19. Two such images are the two sharply focused edges of the light band which are transverse to the travel of the film and these sharply focused images are images of the line elements constituting the edges of the filament parallel to axis of the negative cylindrical lens. If, however, the images of line elements of the light source parallel to the axis of the positive cylindrical lens were also sharply focused on the film a well defined but distorted image of the striated filament would result, which would be impossible to use in the recording of sound. Therefore, the curvatures of the positive lens combination comprising lenses 17, and of the objective 14 are so adjusted as to produce enlarged unsharp images of line elements of the light source chosen parallel to the axis of the positive cylindrical lens. In other words, these line elements are focused sharply at some other plane along the axis than at the film, so that they must be imaged out of focus at the film. This unsharpness causes any non-uniformities in the light source in the direction of the axis of the positive cylindrical lens to be completely wiped out in the image on the film. Thus, using as a source a spiral filament 13 as illustrated, having striations substantially parallel to the axis of lenses 17, the images of these striations overlap on the film resulting in a narrow band of light of uniform intensity.

The optical system thus makes possible the use of a filament or other light source of such substantial size and form as will not be subject to vibration, and which is of sufficient size to give high illumination. And it will be apparent that the lenses can be designed to conform to the requirements of light sources of a wide variety of forms and dimensions.

As regards the power of the lenses, it may be stated, though without intention of imposing any limitation upon the invention, that in a present physical make up of the optical system the combined power of the positive cylindric lens surfaces may be within 15 to 60 diopters, while the combined power of the negative cylindric surfaces is more negative than 50 diopters.

Such an optical system as has been described is suitable for use in either a recording or a reproducing system. In Fig. 1 the system is shown embodied in a recording system for making a sound record of the variable area type. In that figure, the letter M indicates a microphone, and the numeral 20 an amplifier connected thereto. The output leads 21 of amplifier 20 are connected to the pivoted coil 22 of an electromagnetic recording device conventionally illustrated at 23. Coil 22, which is thus in circuit to be energized by an amplified microphone current, carries a shutter 24 before the sound track area of film F, which shutter varyingly intercepts the beam of light striking the sound track in accordance with the sound wave current passing through the coil 22, and thereby causes a variable area sound

record 25 to be taken upon the film, as in accordance with well known practice.

In reproduction, as illustrated in Fig. 2, there is provided a light source which may be an incandescent lamp 30 with a filament 31 having characteristics similar to those of the filament 13 of lamp 12. Filament 31 is constantly illuminated by means of a battery 32. An objective lens 33 casts an image of filament 31, modified by a lens combination 34, upon the sound record 25 of the moving film F, which film is moved by a sprocket 35 transversely to the direction of elongation of the specific filament 31 here illustrated.

The illustrated lens combination 34 is similar to the combination 15 described above, including a pair of positive cylindric lenses 36 located before lamp 30 with their axes parallel to the direction of film movement, and at right angles to the direction of elongation of the specific filament here illustrated; and a minus cylindric lens 37 positioned adjacent lenses 36 with its axis perpendicular to the axes of lenses 36 and to the direction of film movement. The function of lens combination 34 is the same as that stated above for the combination 15 in the recording system, acting as before to elongate the light beam thrown by lens 32 onto the record transversely of the film until it reaches across the sound track area thereof, and to reduce or flatten the beam longitudinally of the film until it illuminates only a very narrow transverse band of the sound track.

In a similar manner to that stated above for the system shown in Fig. 1, so also in that of Fig. 2, the lens combination 34 and the objective 33 cooperate to sharply focus on the film 25 line elements of source 31 which are parallel to the axis of lens 37 and to unsharply project onto the film 25 line elements of the source which are parallel to the axis of lenses 36.

The light rays projected onto the sound record 25 as above described, are transmitted through the film proportionally to the width of the sound record. The transmitted light rays as so modulated are then allowed to impinge upon a photoelectric cell 40, and through the agency of the cell, causing the electric current passed through the cell to vary correspondingly to the variations of the sound record. The current passing through the cell 40 is amplified by means of an amplifier 41, and finally reproduced as audible sound by means of the speaker unit 42.

In Fig. 3 there is shown a variational recording system embodying my invention. The letter M' indicates a microphone, and the numeral 50 an amplifier connected thereto. The output leads 51 of amplifier 50 are connected to a glow tube 53, which includes a linearly extending tubular section 53a of constant cross section, between a pair of electrodes 54. The tube glows with a varying intensity determined by the variations of a sound wave impressed upon the microphone, as is well understood in the art.

An objective lens 55 is positioned to cast an image of the tubular section 53a, modified by a modifying lens combination 56 of the type previously described, upon an actinic film F traveling transversely to the direction of the section 53a of the glow tube.

The lens combination 56, which again includes a pair of positive cylindric lenses 57 disposed with their axes parallel to the direction of film movement and a negative cylindric lens 58 adjacent thereto and disposed with its axis perpendicular to the direction of film movement, then functions as before to extend the image of the tube trans-

versely of the film, and to compress or flatten the image longitudinally of the film, so that the film is illuminated by a very narrow band of light extending transversely across the sound track area of the film. And since the glow of the tube, and hence the intensity of the image on the film, varies with the sound wave impressed upon the microphone, the actinic film will take a variable density record 60 of the sound.

It is again to be pointed out that the positive cylindric lens may not in all cases be required; for if the original light source is itself of sufficient length so that its image will extend entirely across the sound track, then it only remains to flatten the image to a narrow band, which is accomplished by the negative cylindric lens.

In Fig. 4 is shown a variational assembly of lenses in which each lens combines a positive surface p and a negative surface n , in such a manner that the axes of the two surfaces are perpendicular to each other. Several of these lenses may be combined into an assembly as illustrated with the result that the image is elongated by the position surfaces and flattened by the negative surface in a like manner to the assemblies described above.

It will be recognized that the illustrative system specifically described herein is capable of considerable modification and rearrangement without departing from the spirit and scope of my invention; and it is therefore to be understood that the following claims embrace all such modifications and equivalent arrangements as may fairly be construed to fall within the scope of my invention.

I claim:

1. An optical system for illumination of a field, embodying a spherical objective lens positioned before the field to be illuminated, a source of light of limited dimensions and elongated in one direction, said light source being positioned beyond the objective from the field, a positive cylindrical lens between said objective and said light source, and a negative cylindrical lens between said objective and said light source, said negative lens being positioned with its axis parallel to the direction of elongation of said light source, and said positive lens being positioned with its axis at right angles to the direction of elongation of said light source.

2. An optical system for illumination of a field, embodying a spherical objective lens positioned before the field to be illuminated, a striated source of light of limited dimensions, said light source being positioned beyond the objective from the field, a positive cylindrical lens between said objective and said light source, and a negative cylindrical lens between said objective and said light source, said negative lens being positioned with its axis substantially at right angles

to the direction of the striations of the light source, and said positive lens being positioned with its axis substantially parallel to the direction of the striations of the light source.

3. An optical system for illumination of a field, embodying a spherical objective lens positioned before the field to be illuminated, a source of light of limited dimensions, said light source being positioned beyond the objective from the field, a positive cylindrical lens between said objective and said light source, and a negative cylindrical lens between said objective and said light source, said negative lens being positioned with its axis at right angles to the axis of the positive cylindrical lens and cooperating with said spherical objective to sharply focus upon said field reduced images of line elements of the light source which are chosen parallel to the axis of the negative cylindrical lens, and said positive lens cooperating with said spherical objective lens to form on said field enlarged, unsharp images of line elements of said light source chosen parallel to the axis of said positive cylindrical lens.

4. In combination with a traveling sound record film, an optical system for illumination of said film including a spherical objective lens positioned before the sound record portion of the film, a source of light of limited dimensions and elongated in one direction, said light source being positioned beyond the objective from the film, a positive cylindrical lens between said objective and said light source, and a negative cylindrical lens between said objective and said light source, said negative lens being positioned with its axis parallel to the direction of elongation of said light source, and said positive lens being positioned with its axis at right angles to the direction of elongation of said light source.

5. In combination with a traveling sound record film, an optical system for illumination of said film, embodying a spherical objective lens positioned before the sound record portion of the film, a source of light of limited dimensions, said light source being positioned beyond the objective from the film, a positive cylindrical lens between said objective and said light source, and a negative cylindrical lens between said objective and said light source, said negative lens being positioned with its axis at right angles to the axis of the positive cylindrical lens and cooperating with said spherical objective to sharply focus upon said film reduced images of line elements of the light source which are chosen parallel to the axis of said negative cylindrical lens, and said positive lens cooperating with said spherical objective lens to form on said film enlarged unsharp images of line elements of said light source chosen parallel to the axis of said positive cylindrical lens.

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