Sept. 5, 1944. B. KREUZER 2,357,665

PHOTOGRAPHIC SOUND RECORD SYSTEM AND RECORD

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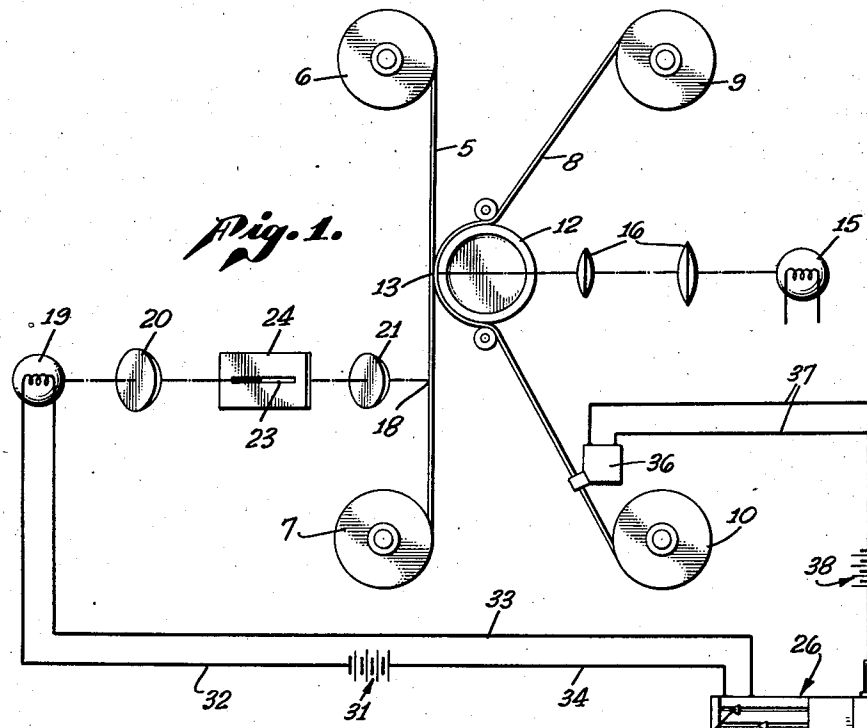
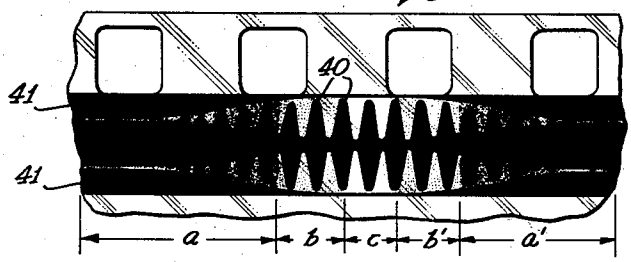


Fig. 1.

Fig. 2.



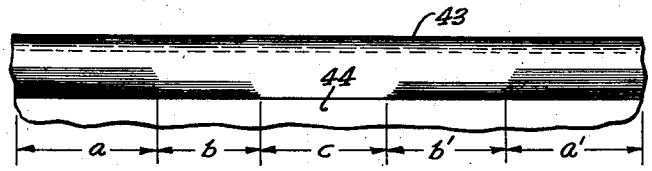


Fig. 3.

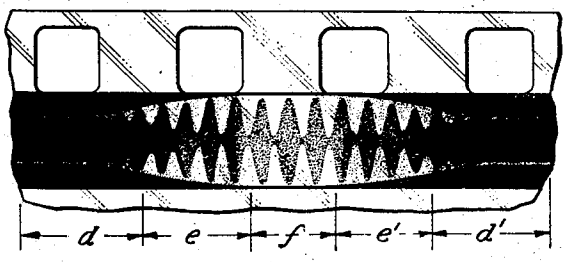


Fig. 4.

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PHOTOGRAPHIC SOUND RECORD SYSTEM AND RECORD

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14 Claims. (Cl. 179—100.3)

This invention relates to motion picture sound apparatus and particularly to a method of and system for controlling the densities of various portions of the sound track record.

In the past, noise reduction has been accomplished by methods such as the light-exposing of the portions of the sound track area in the final print which are not occupied by the actual modulations as in variable area records, or by varying the average density of the sound track area in accordance with the amplitude of the modulations such as in variable density recording. These are standard types of noise reduction, although additional forms have been used in conjunction therewith such as squeeze-track recording wherein the width of the sound track area is varied with variations in the amplitude of the modulations.

The present invention is a method of and system for accomplishing volume control and noise reduction during the printing operation wherein the final positive print is made from the original recorded negative. In the past, when printing from a variable density negative, having a series of sound sequences in which the average volume levels were not uniform, uniformity or increases and decreases were obtained by varying the intensity of the printing light in the correct relationship to the average amplitude of each particular sequence. This, of course, has not been as feasible for variable area types of records, and one solution of the variable area problem is disclosed and claimed in U. S. Patent 2,265,097 of December 2, 1941. The present invention, however, not only permits volume control and additional noise reduction to be applied to variable area sound records, but also permits the equalizing or the increasing and decreasing of the volumes of a series of sequences of different average levels during the printing of variable area negatives. It is also, of course, applicable to variable density records.

In accordance with the preferred method of the present invention, light varied in accordance with the modulations and noise reduction is impressed on one side of the film emulsion, while a volume and noise reduction controlling light beam is impressed on the other or back side of the emulsion through the base of the film. Through control of these light intensities so as not to produce overlapping exposures but at all times maintaining an unexposed section therebetween, it is possible to obtain variations in volume and noise reduction or an equalization of or increase or decrease in the average amplitudes of various sound sequences without substantial distortion. Prior efforts to accomplish these results by varying the printer densities for variable area records were accompanied by such a high degree of distortion as to make the methods impracticable. The lack of distortion in the present system is primarily due to the use of substantially monochromatic light for impression on the print emulsion to produce a surface development of the emulsion which, when so impressed, is easily controllable to prevent an overlapping of the exposures by the respective light sources.

The principal object of the invention, therefore, is to facilitate the making of photographic sound records.

Another object of the invention is to control noise reduction during the printing operation.

A further object of the invention is to accomplish volume control during the printing operation.

A further object of the invention is to equalize, increase or decrease the sound volumes of a series of variable area or variable density sound sequences having unequal volume levels by varying light exposures.

A further object of the invention is to provide a sound film record having variable components of density and area for controlling noise reduction and reproduced volume.

A further object of the invention is to provide a photographic sound track printing system wherein the original or a second exposure of the sound track area is under control of the negative film being printed.

Although the novel features which are believed to be characteristic of this invention are pointed out with particularity in the appended claims, the manner of its organization and the mode of its operation will be better understood by referring to the following description read in conjunction with the accompanying drawing forming a part thereof, in which

Fig. 1 is a diagrammatic view of a sound film printer for printing photographic sound records in accordance with the invention;

Fig. 2 is a detail view of a section of a sound record of the variable area type produced by the printer of Fig. 1;

Fig. 3 is an enlarged cross-sectional detail view of the emulsion of the sound record of Fig. 2; and

Fig. 4 is a sectional detail view of a sound record produced by modification of the system of Fig. 1.

Referring now to the drawing, a positive film stock 5 on which the sound track is to be printed

is supplied from a reel 6 and taken up by a reel 7, while a negative film 8 being printed is supplied by a reel 9 and taken up by a reel 10. The negative film 8 is passed around a printing roller 12 on which the negative film 8 contacts the positive film 5 at a contact point 13, at which point a light beam from a lamp 15 is projected through lenses 16 to the positive film through the negative film. The above described printer may be any standard type of commercial motion picture sound film printer adapted to print both variable area or variable density records.

In addition to the exposing of the positive film 5 at the point 13 a second exposure across the entire sound track area of the film is made at point 18 from a light source 19 through lenses 20 and 21 and a slit 23 of a mask 24. The light from the lamp 19 is projected to the positive emulsion which is in contact with the negative at point 13 through the base of the positive film 5, and the slit may or may not be in focus on the emulsion. Thus, a second exposure is made to the positive film emulsion in a manner to be described. It is to be understood, however, that other means may be used for accomplishing this back exposure such as a glow lamp with or without an optical and slit system.

The control of the second light exposure is accomplished through a variable resistance device 26 having a plurality of adjustable resistance sliders 27 and a step-by-step contact element 28, the latter being under control of a relay 29. This device may be any well known film printer light control box now used in printing commercial release prints. In the operation of such a box, each energization of the relay 29 will drop the contactor 28 from one resistance slider 27 to the next, thus varying the light intensity of the lamp 19 by varying the energy supplied thereto from a battery or other source of supply 31 over conductors 32, 33 and 34. The sliders might also control shutters or vary the size of an aperture positioned in the constant intensity light beam.

The relay 29 is under control of a film switch 36 connected to the relay 29 over conductors 37 through a battery or equivalent energy source 38. The film switch 36 may be actuated in any suitable manner such as by notches placed in the negative film 8. Thus, the various slider resistances, after being set in accordance with the light intensities to be projected on the film 5 to produce certain densities over certain sections of film 5, are inserted into the lamp circuit as the film notches placed along the negative 8 reach the switch 36.

To explain in detail the adjustment of the sliders 27, reference is made to Figs. 2 and 3 wherein a section of a sound track is shown which has had a constant frequency modulation of varying amplitude impressed thereon. It will be noted that the modulations 40 and noise reduction portions 41 have a constant density, while the normally transparent portions of the sound track area have a varying density. The constant density of the modulation and noise reduction areas is produced by the impression of light of a constant intensity from the lamp 15, while the intermediate portions of the sound track area have a varying density in accordance with the varying light intensity from the lamp 19 under control of the resistance box 26. For instance, in the sections *a* and *a'*, the normally transparent section has a certain density produced by a certain setting of the resistance box 26. A different light intensity produced the density of sections *b* and *b'*, and a third light intensity produced the light density of section *c*.

To illustrate the manner of density or fog control by exposure through the film base, reference is made to Fig. 3 in which corresponding sections to those of Fig. 2 are illustrated. It will be noted that the surface of the film emulsion shown at 43 has been exposed to a uniform depth due to the constant light intensity from the lamp 15. However, the emulsion side next to the base 44 has been given different exposures in accordance with the light intensities from lamp 19 projected through the base, as illustrated by the varying thickness of the opaque portions shown in the respective sections. As mentioned above, by the use of a light source substantially monochromatic, such as ultra-violet, a surface development can be obtained to produce the intermediate zone between the exposed portions of the emulsion. It has been found in actual practice that this intermediate zone does exist since the overall density of the film is the addition of the two exposures, thus determining that there is no overlap between them. By maintaining an unexposed section between the two emulsion surfaces, it is possible to predetermine the volume output for any particular sound record. In actual practice, gain variation in the neighborhood of 15 db. has been obtained without overlapping exposures and with substantially no distortion of the sound track reproduction.

By the above-described method and system, noise reduction may be increased during times of no signal by decreasing the light passing through the zero traces as shown in sections *a* and *a'* of Fig. 2. Noise reduction may also be increased for sound track portions of low amplitudes by increasing the track modulation level and increasing the fog to decrease the volume proportionately. For high amplitudes of modulation, the intermediate area between the modulations and noise reduction envelope may be lightened to transparency to increase the volume since a high degree of noise reduction is not essential at the higher levels. Volume control of the reproduced output is accomplished by varying the opacity of any particular section of modulations. That is, this system permits obtaining certain desired volume changes for a sound sequence which was recorded at a substantially uniform level to increase the dramatic effect thereof.

To obtain a substantially uniform level for a series of sequences which vary considerably in average level, the board 26 may be preset to obtain the proper back exposure to equalize the output from the various sequences. As long as the back exposure is insufficient to produce an intermingling of the development of the two exposures, the volume will be proportional to the variations in the back transmission. Although the above-described back exposure method solves a variable area problem, it is also applicable to variable density systems to accomplish the same results.

Referring now to Fig. 4, a sound record made with a modification of Fig. 1 is illustrated. This sound track is made with a system in which the resistance box 26 controls the lamp 15 instead of the lamp 19. For instance, sections *d* and *d'* of Fig. 4 have a certain density which, by way of example, may be a print density of 1.35 and a fog density of .30. Sections *e* and *e'* may have a print density in the neighborhood of 1.20 and a fog density of .15, while the section *f* may have a print density of 1.00 and a fog density of .08.

To illustrate this type of volume control or noise reduction in Fig. 4, the variations in the densities have been considerably exaggerated. That is, the modulations in the section *f* have been shown considerably lighter than they would actually appear from the above densities. However, by controlling the lamp 15 it is possible to obtain a certain amount of volume variation of the reproduced sound record as well as obtain a certain noise reduction thereby, although at present the preferred method, when the apparatus is available, is to expose the emulsion through the base, as shown in Fig. 1. This method is applicable to negatives of low gamma in which the density is of the order of .70.

A further modification which would provide an overall transmission variation similar to the records of Figs. 2 and 4 is in the use of a color film having two or more emulsions wherein one emulsion is exposed to the color to which it is sensitive to produce the modulations and the noise reduction envelope, while another emulsion is exposed to the respective color to which it is sensitive to provide a variation in the overall transmission to vary volume or increase noise reduction. The same general principle is involved with the use of color film, and the record so produced would appear similar to that of Fig. 2.

I claim as my invention:

1. Photographic sound apparatus comprising means for exposing a positive emulsion to light modulated by a negative sound record to provide one exposure of said emulsion, means for exposing the opposite surface of said emulsion to light to provide a second exposure of said emulsion, and means for modulating said second exposure in accordance with a predetermination of the desired overall transmission produced by both of said exposures, said exposures being to insufficient depths to overlap in said emulsion.

2. Photographic sound apparatus in accordance with claim 1 in which said second exposure is varied to control the relative level of reproduction of different portions of said record modulations.

3. Photographic sound apparatus comprising means for exposing a positive emulsion to light modulated by a negative sound record, and means for exposing said emulsion to light modulated in accordance with a predetermination of the desired over-all transmission produced by both of said exposures, said first-mentioned light being substantially monochromatic to produce a surface development and the maximum exposure by said second-mentioned light is insufficient to produce an overlapping development within said emulsion.

4. A sound record printing system comprising a first light source, means for exposing one surface of a positive film to light from said source modulated by a sound film record, a second light source, means for additionally exposing the same transverse portions but the opposite surface of said positive to light from said second source, means for controlling the amount of exposure given said positive from said second light source so that exposures are to insufficient depths to overlap, and means actuated by said sound film record for actuating said exposure controlling means.

5. A sound record printing system in accordance with claim 4 in which at least one of said light sources is substantially monochromatic.

6. A sound film record having variable area modulations produced by a uniform exposure of the emulsion of said film and variable density modulations produced by a varying exposure, the maximum amount of said varying exposure being insufficient to cause said exposures to overlap after development of said emulsion.

7. A sound film record having a variable area component produced by an exposure on one side of the emulsion on said film and a variable density component produced by an exposure on the other side of said emulsion.

8. A sound film record having an exposure on one side of the emulsion on said film in accordance with the instantaneous values of sound waves recorded thereon and a variable density exposure on the other side of said emulsion to control the level of reproduction of said first exposure.

9. A sound film record having a combination variable area and variable density component, the variable area portion being in accordance with the instantaneous values of the sound waves recorded thereon and the variable density portion being adapted to control the level of reproduction of said variable area portion, and a separate variable density component having different densities than said first-mentioned variable density portion to supplement the level control by said first-mentioned variable density portion.

10. A color sound film having variations in one color in accordance with the instantaneous values of sound waves and variations in another color to control the reproduced volume of said sound waves.

11. The method of producing a photographic sound record comprising exposing one surface of a film emulsion to light modulated in accordance with the instantaneous values of sound waves and exposing the same emulsion but the opposite surface thereof to light varying in intensity in accordance with a predetermination of a desired overall transmission for said sound record, said exposures being to insufficient depths to overlap in said emulsion.

12. The method of producing a photographic sound record comprising exposing one surface of a film emulsion to light modulated by a sound film record and exposing the same emulsion but the opposite surface thereof to light modulated in accordance with a predetermined overall density for said record, said exposures being to insufficient depths to overlap in said emulsion.

13. The method in accordance with claim 12 in which the light intensity of said first exposure is constant and the light intensity of said further exposure is varied.

14. The method of producing a photographic sound record comprising exposing a film emulsion to light modulated by a sound film record and further exposing said emulsion to light modulated in accordance with a predetermined overall density for said record, said further exposure being made on the opposite side of said emulsion from said first exposure, the maximum exposure of said further exposure non-overlapping said first exposure.

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