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K. SCHWARZ

2,208,937

SOUND RECORDING APPARATUS

Filed April 30, 1937

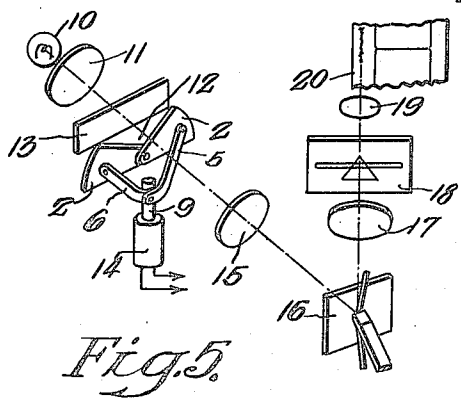


Fig. 5.

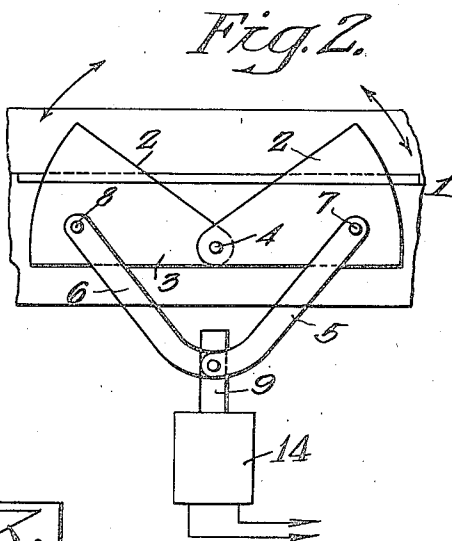


Fig. 2.

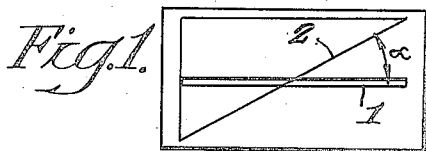


Fig. 1.

Fig. 3.

Fig. 3a.

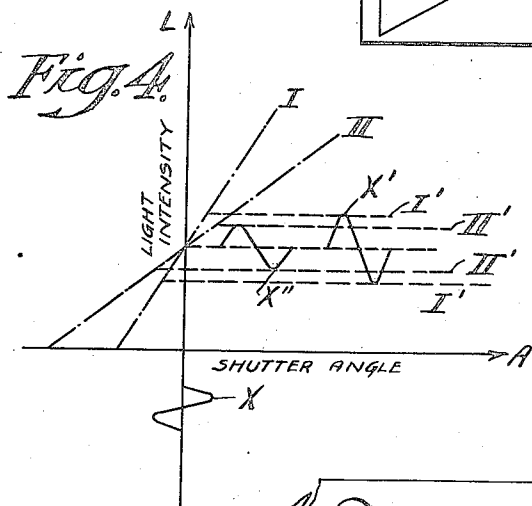


Fig. 4.

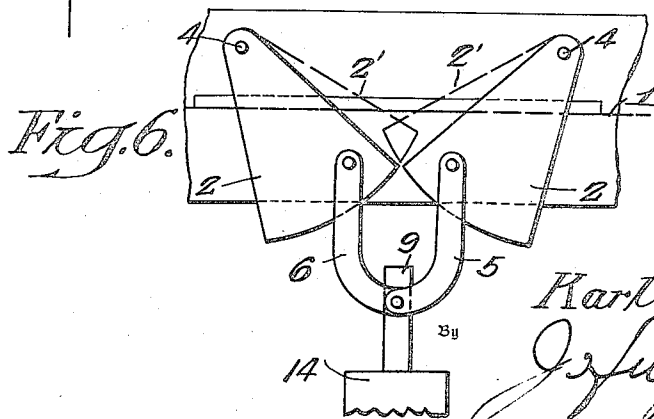
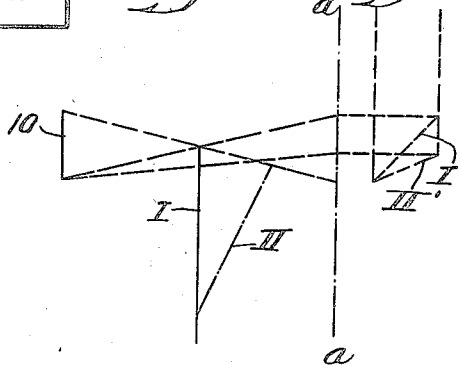


Fig. 6.

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SOUND RECORDING APPARATUS

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7 Claims. (Cl. 179—100.3)

This invention relates to sound recording apparatus, and more particularly to apparatus for recording sound photographically on a strip of film or the like.

5 More specifically, an apparatus is provided which adjusts the shape of the light beam used in variable density recording so as to vary the sensitivity of the apparatus in a predetermined manner, and to thereby secure either volume expansion or volume compression. The terms
10 "volume expansion" and "volume compression" are often referred to as "dynamic regulation."

Sound recording with volume compression is well known in the art. For example, in accordance with Hanna Patent 1,888,724, a part of the sound current is rectified, and this rectified part, which corresponds to the amplitude or envelope of the sound impulses, is employed for the purpose of controlling the degree of amplification of the recording amplifier so that the soft sounds
15 are recorded with a larger degree of amplification than the loud sounds, thereby securing volume compression.

In the present invention, a particularly simple
25 process of volume compression is provided, which is distinguished by the fact that it does not operate on the recording amplifier, and nothing in the electrical part of the recording apparatus is affected. Thus the control in this case is effected mechanico-optically, and this is done in such a manner that the angle of intersection of the light beam with the optical slit changes according to the amplitude of the sounds. This change of angle is accomplished by means of
30 movable diaphragms, and may be applied both to variable area and variable density films.

In recording variable area films, a rotatable straight edged diaphragm is moved about an axis parallel with the optical axis of the apparatus, so that at small amplitudes the angle of intersection of the light beam with the slit is small, and at larger amplitudes it is large.

In recording variable density sound records, the diaphragm may be so arranged as to produce a partially shaded area over the recording slit, in the same manner as is done in what is commonly referred to as "penumbra" recording; or a variable density wedge may be utilized for controlling the light intensity in accordance with the sound
35 amplitude.

In recording variable area film, I prefer to use a recording system such as that shown and described in Dimmick Patent 1,999,721, wherein a recording galvanometer vibrates about a horizontal axis and moves a triangular light spot ver-

tically across the recording slit. In such an apparatus, however, instead of using a triangular aperture of fixed shape, I use a pair of movable diaphragms to define the sides of the triangle, and move these diaphragms angularly in accordance with the amplitude of the sound in order to secure volume compression.

This portion of the apparatus may be designed in such a way that all sounds are recorded with the same or nearly the same amplitude, or the characteristics of the apparatus may be so chosen as to secure any desired degree of volume compression.

One object of my invention is to provide a novel method of volume compression or expansion.

Another object of my invention is to provide a novel apparatus for volume compression or expansion.

Another object of my invention is to provide a novel apparatus for securing ground noise reduction.

Another object of my invention is to provide a novel means for controlling the shape of a recording light beam.

Other and incidental objects of my invention will be apparent to those skilled in the art from a reading of the following specification and an inspection of the accompanying drawing, in which
30 Figure 1 is an illustration of a triangular light spot as it appears upon the slit of an optical system in unilateral recording,

Figure 2 is an elevation of one form of the invention, showing the relation of the movable shutters to the recording slit as projected on the shutters,

Figure 3 is a diagrammatic illustration of the application of one shutter according to my invention to unilateral recording,

Figure 3a and 4 are diagrams illustrating the manner of operation of my apparatus,

Figure 5 is a perspective schematic view of an optical system constructed in accordance with my invention, and

Figure 6 is an elevation of a modified form of shutter particularly applicable to ground noise reduction in combination with volume compression.

For the purpose of illustrating and explaining the invention in detail a few styles of execution according to the invention are shown in the illustrations. In Fig. 4, the principle of the invention is illustrated by means of differently steep light characteristic lines. The angular rotation of the light controlling organ is indicated on the abscissa A, and the amount of light transmitted through

the slot is indicated on the ordinate I. There are shown two light characteristic lines, having a different steepness, with I and II. When amplitude x is controlled outward on characteristic line I, a recorded amplitude x' is obtained between the two limiting lines I and II. In case the same amplitude x is controlled outward on the other characteristic line II, there results a recorded amplitude x'' between the dotted lines II'. This amplitude is smaller than amplitude x' . If it is, therefore, intended to obtain a recording with dynamic compensation in such a manner that the sounds are previously recorded with a constant amplitude, one proceeds so as to change the steepness of the light characteristic line in such a way that there exists a small steepness (characteristic line II) with large amplitudes and a large steepness (characteristic line I) with small amplitudes.

In Fig. 1 is illustrated how the idea illustrated in Fig. 4 may be utilized. The slot is indicated at 1 and the edge of the diaphragm on the slot is indicated at 2. When the angle α between slot 1 and the diaphragm edge 2 is changed in such a way that the image of the diaphragm edge 2 is displaced in the direction of the double arrow, the steepness of the light characteristic line experiences a change by this fact. If the angle α is small, there is a large steepness. In case the angle α is large, there is a small steepness of the characteristic line.

In order to make a record with an arrangement according to Fig. 1, one proceeds, for instance, in such a way that diaphragm 2 is portrayed on the slot over a swinging mirror, and that the turning of the diaphragm edge 2 in relation to slot 1 is obtained by turning the diaphragm according to the volume or envelope of the sound currents. In Fig. 2 there is shown another style of execution, viz. for recording a double-hump record. The slot is again indicated at 1, and the diaphragm edge at 2. In principle, there is no difference between illustration 2 and illustration 1. The recording takes place in the same manner; only the style of execution of the diaphragm and its drive is different as will now be explained. The diaphragm consists of two circular sectors, 3, turning around the pivot or axis 4. There are two lever arms 5 and 6 pivoted to these two diaphragm sectors by pins 7 and 8. The ends of levers 5 and 6 are pivoted to a common pin 9. This pin rests in a guide which is designed as a straight guide. By a dynamic or magnetic system, acting on this straight guide, it is possible to effect the control of the diaphragm according to the volume of the sound as will become more apparent upon consideration of Fig. 5.

On the basis of Fig. 3, it will be shown schematically that in recording variable density films one can proceed according to the same principle of the invention. A light source is indicated at 10, and a diaphragm edge at I or II. When light source 10 is allowed to illuminate the area $a-a$ over diaphragm edge I, there is obtained a light characteristic line, as it is shown with I' in Fig. 3a. When the diaphragm edge is turned from position I into position II, a light distribution according to characteristic line II' is obtained. According to the invention, this diaphragm edge is allowed swinging with the light distribution indicated by the characteristic line over a swinging mirror and over a slot. As the steepness of the light characteristic line can be changed, as stated above, the recording takes place in principle exactly like that which has been described in connection with amplitude or variable area recording.

This will be recognized as "penumbra" recording such as that disclosed by Dimmick Patent 2,095,317. Instead of employing a planar light source and a diaphragm edge, one can also use a blurredly portrayed diaphragm edge or a gray wedge, as this is well known in sound film techniques. If these well-known arrangements are employed for applying the idea of the invention, they will also come under the invention.

The optical system shown in Fig. 5 illustrates the practical application of this invention to an optical system such as shown in the Dimmick patent above referred to. In this arrangement, the exciter lamp 10 passes light through the lens 11 to the aperture 12 which is constructed in the manner shown in Fig. 2, the reference characters being the same on corresponding parts, and an additional stop 13 being added to define the upper edge of the triangular beam. The magnetic means 14 for actuating the shutters in accordance with the volume of the sound is also shown. The lens 15 directs the light on the galvanometer mirror 16 where the beam is vibrated in accordance with the sound waves to be recorded and from which it is reflected through the lens 17 to the aperture plate 18. An objective lens 19 focuses the image of the line of light passing through the plate 18 upon the film 20.

In the further modification of the invention shown in Fig. 6, the movable shutters 2 are pivoted at their outer ends and the links 5 and 6 are connected to them at their adjacent ends. In this case the position of the image of the light slit is indicated at 1 and it will be apparent that movement of the shutters 2 instead of merely changing the shape of the triangular aperture also changes the position thereof, as indicated at 2'. By means of this arrangement, not only can the sensitivity of the apparatus be varied in accordance with the volume, as is the case in Figs. 2 and 5, but ground noise reduction may also be accomplished in a manner similar to that described in the aforesaid Dimmick patent. For example, at low amplitudes the magnet 14 will not be energized and the shutters will be in the position 2' giving it a high sensitivity and at the same time providing a very narrow track width producing very little ground noise. As the amplitude of the sounds is increased, the magnet 14 is correspondingly energized and moves the shutters 2 downwardly to the position shown where the average exposure covers approximately one-half of the track width and where the sensitivity is correspondingly less due to the changed shape of the triangular beam of light.

Having now described my invention, I claim:

1. Apparatus of the class described, including means providing a light slit, means for projecting on said slit an image of a light aperture having a straight edge, means for moving said image in accordance with sounds to be recorded, and means for changing the angular relation between said edge and said slit in accordance with the amplitude of the sounds to be recorded.

2. Apparatus of the class described, comprising a pair of shutters movable to define the shape of a light beam, and means for moving said shutters in accordance with only the average amplitude of the sounds to be recorded.

3. Apparatus of the class described, including means for projecting an image of a light aperture upon a slit, means for moving said image in accordance with sounds to be recorded, and means for varying the angular relation between

the sides of said image in accordance with the amplitude of the sounds to be recorded.

4. Apparatus of the class described, comprising means for projecting a triangular beam of light upon a narrow slit, and means for changing the angular relation between the sides of said image in accordance with only the average amplitude of the sounds to be recorded.

5. Apparatus of the class described, comprising a pair of shutters having cooperative straight edges movable to define the shape of a light beam, and means for changing the angular relation between said edges in accordance with only the average amplitude of the sounds to be recorded.

6. Apparatus of the class described, comprising a pair of shutters pivoted at their adjacent ends and movable to define the shape of a light beam, and means for moving said shutters in accordance with only the average amplitude of the sounds to be recorded.

7. Apparatus of the class described, comprising a pair of shutters pivoted to rotate about their non-adjacent ends and movable to define the shape of a light beam, and means for moving said shutter in accordance with only the average amplitude of the sounds to be recorded.

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