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W. E. BEATTY

2,096,082

NOISELESS RECORDING

Filed Oct. 30, 1934

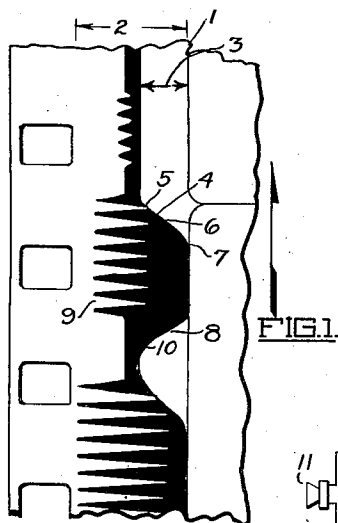


FIG. 1

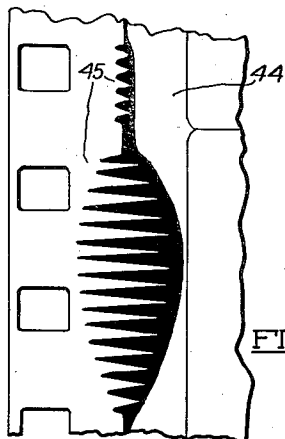


FIG. 4

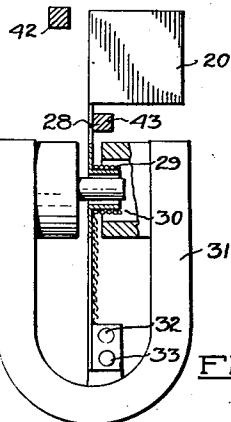


FIG. 8

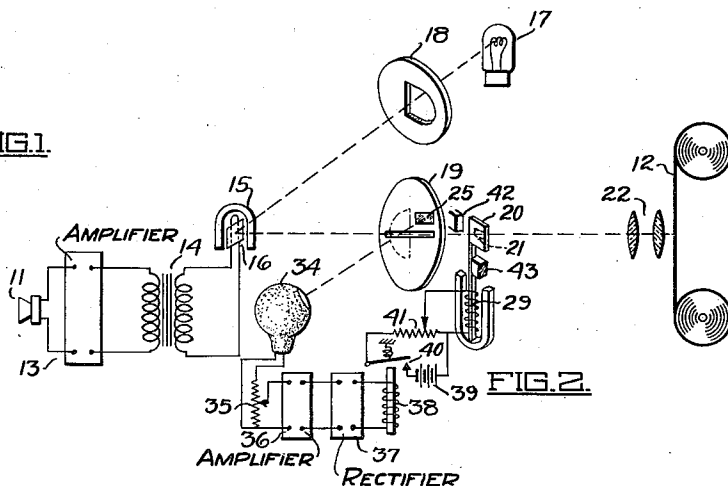


FIG. 2

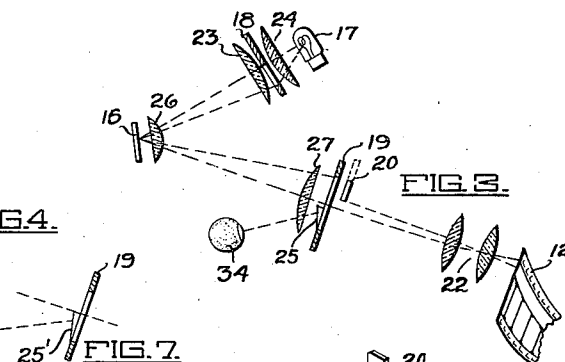


FIG. 3

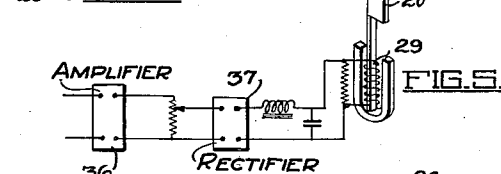


FIG. 5

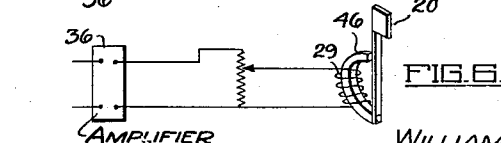


FIG. 6

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NOISELESS RECORDING

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9 Claims. (Cl. 179—100.3)

The invention relates to noiseless recording and has for an object to record sound waves on film in such a manner that the positive print will have substantially high opacity in the sound track where the sound record is of low level or does not appear. This reduces ground noise due to the film, when using a positive print to reproduce the sound.

In anti-ground noise devices it has been common to energize the noise reduction circuit through a bridging amplifier and it may readily happen that faulty operation of the noise reduction circuit is caused by faulty operation of the intervening elements in the noise reduction circuit between the bridging bus and the film itself.

An object of the invention is to largely remove the possibility of such faulty operation. This is accomplished by controlling the noise reduction in response to the modulated light to be recorded, whereby this modulated light is the motivating influence for noise reduction control. It is of advantage to furnish a noise reduction element which is controlled by the light passing to the film and which responds to the quality of the modulated light rather than responding to the quality of the electrical energy appearing in the bridging bus.

The invention may be applied to an arrangement wherein the refinements heretofore proposed, and according to which the bias on a light valve is actuated by the envelope of the sound currents, or according to which the envelope of a variable area sound record is closely and accurately followed by a shuttering device, are not necessary, and in fact may have the following disadvantages. In variable area recording the low level peaks may be clipped by sluggish operation or faulty adjustment of the shutter. In variable density the low level peaks of density may exceed that density for which proportionality between signal and density persists. This type of control has been termed "step" control.

The invention provides a simplification and improvement, according to which, method and means responsive to the modulated light are provided for restricting the recording light in the same sense as the recording at a fixed small amount sufficient to permit low level sounds to be recorded without substantial distortion, and at all higher level sounds for removing said restricting effect from influencing the recording. The above reference, and the similar reference in the claims, to restricting the recording light in the same sense as the recording, is to be understood as meaning that for a variable area record the

restriction is of area, and for a variable density record, the restriction is of density. The result of this is that the volume is recorded in natural amounts, which differentiates from arrangements like that disclosed in British Patent #387,833 according to which the width of a variable density record is changed, the recording and the restriction therefore being in opposite senses, in order to record the volume in modified form.

On the other hand, the invention may be applied to known arrangements wherein the noise reduction control is proportional to the intensity of the light beam to be recorded.

For further details of the invention, reference may be made to the drawing wherein:

Fig. 1 is a diagrammatic illustration of a negative variable area sound track according to the present invention as applied to "still" control of noise reduction.

Fig. 2 is a diagrammatic circuit and optical arrangement for recording the sound track of Fig. 1.

Fig. 3 is a view illustrating in further detail the optical elements of Fig. 2.

Fig. 4 is a diagrammatic illustration of a negative variable area sound track resulting from the modified recording circuit of Figs. 5 and 6, and showing shuttering proportional to the amplitude of the recorded light waves.

Figs. 5 and 6 illustrate two different modifications of Fig. 2 for recording the type of sound track shown in Fig. 4.

Fig. 7 is a plan view partly in section of the slit block of Fig. 2, with its mirror in modified position.

Fig. 8 is a detailed view partly in section, of the shutter mechanism of Figs. 2 and 3.

Referring to the drawing, the negative film 1 in Fig. 1 has a sound track width represented by the dimension 2. I provide a light beam controlled shutter, to be described later, this shutter being arranged so that for low level sounds, e. g. from 0— $\frac{1}{6}$ of the total track width, the sound track is shuttered a fixed amount represented by dimension 3. For all modulations requiring more than this fixed amount of track area, the shutter is entirely removed, and this is accomplished gradually as illustrated by the curved portion 4 of the shuttered area. It will be noted that there is a time lag between the appearance of high level peaks illustrated by 5 and 6, and the point illustrated at 7 where the shutter is entirely removed. Also, when the sound reaches a low level, e. g. a level which can be recorded within $\frac{1}{6}$ of the track width, the shuttering effect again comes into play as illustrated at 8. Again there is a time lag between the disappearance of the high level peak

as illustrated at 9, and the full effectiveness of the shutter as illustrated at point 10.

Apparatus suitable for making the negative record of Fig. 1 is shown in Fig. 2 wherein sound waves received by the microphone 11 are recorded upon the film 12. In circuit with the microphone 11 is an amplifier 13 and transformer 14 which supplies amplified audio frequency current to the galvanometer 15. The mirror 16 of galvanometer 15 receives light from a lamp 17. Between the lamp 17 and the mirror 16 is arranged a mask 18 having a D-shaped opening as shown. Light from the mirror 16 is reflected to a slit block 19, the light passing therethrough impinging partly on shutter 20 as shown at 21, enough of the light passing through the slit block 19 passing by the front edge of shutter 20 to accommodate the low level excursions of the mirror 16, as explained in connection with Fig. 1. The light which passes by the shutter 20 is focused by a suitable lens system 22 onto the negative film 12.

A mirror 25 is mounted on slit block 19 in such a position, and so tilted that it receives light from mirror 16 for all excursions thereof greater than are recordable with the amount of shuttering shown at 3 in Fig. 1, and reflects such light to a light sensitive device such as a caesium or selenium cell 34 to remove shutter 20 as illustrated at 7 in Fig. 1. The removal of shutter 20 is effected as soon as mirror 25 receives any appreciable amount of light and the removal of course persists for all greater amounts of light. The cell 34 operates shutter 20 through an obvious circuit including potentiometer 35, amplifier 36, rectifier 37, relay 38, battery 39, contacts 40, potentiometer 41, and coil 29. When mirror 25 no longer receives light from mirror 16, the relay 38 and shutter 20 assume the positions shown in Fig. 2.

Further details of the optical system of Fig. 2 are illustrated in Fig. 3, wherein lenses 23 and 24 are arranged at opposite sides of the mask 18, a lens 26 being provided adjacent mirror 16, and lens 27 being arranged in front of the slit block 19 which carries mirror 25 for cell 34. The optical arrangement is such that the image of the filament of lamp 17 is focused at mirror 16 and at the lenses 22, an image of the mask 18 appearing on the film 12.

The shutter 20, as shown in Fig. 8, may be mounted on a reed 28 which carries an actuating coil 29 arranged in the air gap 30 of a field magnet 31. The terminals of the coil 29 may be brought to binding posts 32 and 33. Stops 42 and 43 may be employed to limit the movement of shutter 20 in either direction. The stops 42 and 43 may be omitted, the two positions of shutter 20 being determined by the initial position of shutter 20 when relay 38 is open, and by the throw of shutter 20 when the relay 38 is closed. The range of movement of shutter 20 may be controlled by potentiometer, or sensitivity control 41. A positive print of the negative film in Figs. 1 and 4 will of course have transparent and opaque portions in opposite senses from that shown.

Instead of the "step" control as in Fig. 2, the proportionality control of Figs. 5 and 6 may be employed to produce the record of Fig. 4 wherein the shuttering 44 is proportional to the peaks of variable area record 45. For this purpose I dispense with relay 38, and employ rectifier 37 to supply rectified audio impulses to coil 29 as in Fig. 5, or amplifier 36 may supply raw A. C. (audio) to coil 29 which is now provided with a soft iron magnet 46. Also as shown in Fig. 7, the mirror 25' is arranged with its edge substantially coinciding

with the straight edge of the D-shaped spot of light reflected from galvanometer 15 when the latter is de-energized, whereby mirror 25' receives an amount of light proportional at all times to the excursions of mirror 16.

The invention is also applicable to variable density recording.

Having thus described the invention, what is claimed as new and desired to secure by Letters Patent, is:

I claim:

1. Apparatus for recording sound on a moving light sensitive surface comprising a light source, means for modulating light from said source in accordance with the amplitude of said sound waves, means whereby said modulated light is adapted to expose said surface in substantially direct accordance with said light modulations and means responsive to said modulated light for controlling the exposure of said surface, said last mentioned means being positioned between said surface and said light modulating means.

2. Apparatus for recording sound on a moving light sensitive surface comprising a light source, means for modulating light from said source in accordance with the amplitude of said sound waves, means whereby said modulated light is adapted to expose said surface in substantially direct accordance with said light modulations, and means responsive to said modulated light for controlling the exposure of a portion of said surface where the sound record does not appear, said last mentioned means being positioned between said surface and said light modulating means.

3. Apparatus for recording sound on a moving light sensitive surface comprising a light source, means for modulating light from said source in accordance with the amplitude of said sound waves, means whereby one portion of said modulated light is adapted to expose said surface in direct accordance with said light modulations, and means responsive to another portion of said modulated light for controlling the exposure of said surface in accordance with the envelope of said light modulations, said last mentioned means being positioned between said surface and said light modulating means.

4. Variable area sound recording apparatus comprising a light source, a galvanometer therefor, an audio circuit for said galvanometer, a shutter in the path of light reflected from said galvanometer, and means positioned between said galvanometer and said shutter and in the path of light reflected from said galvanometer for controlling said shutter.

5. Variable area sound recording apparatus comprising a light source, a galvanometer therefor, an audio circuit for said galvanometer, a shutter in the path of light reflected from said galvanometer, and means positioned between said galvanometer and said shutter and in the path of light reflected from said galvanometer for controlling said shutter, said controlling means comprising means whereby said shutter is effective for all vibrations of the mirror of said galvanometer within a certain angle, and whereby said shutter is not effective for all vibrations of said mirror beyond said certain angle.

6. Sound film recording apparatus comprising the combination of a galvanometer for exposing variable area on a moving film in accordance with sound waves, means comprising a shutter associated with said galvanometer for preventing exposure of the high level portion of the sound

track by a fixed amount which is sufficient to permit low level sounds to be recorded, and means positioned between said galvanometer and said shutter and associated with said shutter and responsive to wide angle deflections of said galvanometer corresponding to sound having a level higher than said fixed amount for removing the influence of said shutter on the recording.

7. Sound film recording apparatus comprising the combination of a source of audio frequency current, a galvanometer, a light source, a mask between said light source and said galvanometer, a slit block in the path of light reflected from said galvanometer, a mirror on said slit block, a shutter associated with said slit block, said shutter being normally in a position to permit low level sounds to be recorded while shuttering a fixed amount, and means responsive to sound levels higher than said fixed amount, said means being actuated by reflected illumination from said mirror and thereby reduce the shuttering to a lesser fixed amount.

8. Sound film recording apparatus for recording variable area of a film in accordance with modulated light, comprising a constant light

source, means for modulating a light beam from said source, a shutter in the path of said beam, a control circuit for said shutter for moving said shutter into two positions, in one of which the high level portion of the sound track is shuttered a fixed amount to permit low level sounds to be recorded, and in the other of which said shutter is not effective, and means positioned between said shutter and said modulating means and in the path of the modulated light for actuating said control circuit.

9. Sound film recording apparatus comprising the combination of a source of audio frequency current, a galvanometer, a light source, a mask between said light source and said galvanometer, a slit block in the path of light reflected from said galvanometer, a mirror adjacent said slit block and in the path of wide angle deflections of said galvanometer, a shutter associated with said slit block, said shutter being normally in a position to permit narrow angle deflections of the mirror to be recorded while shuttering a fixed amount, and means responsive to light received by said mirror for controlling said shutter.

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