

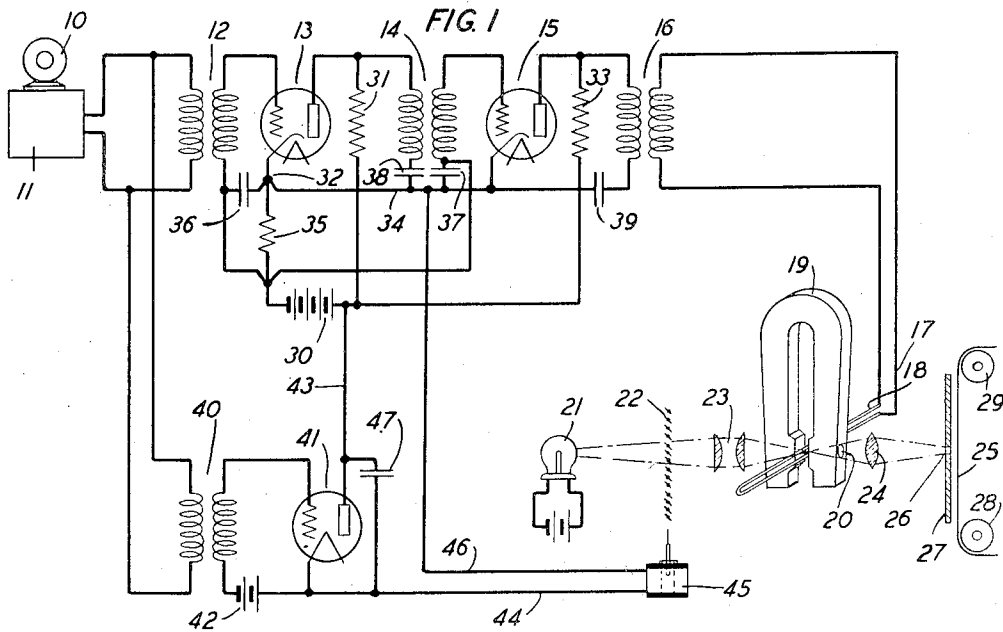
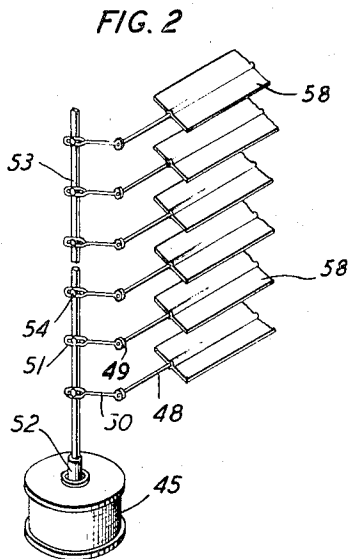
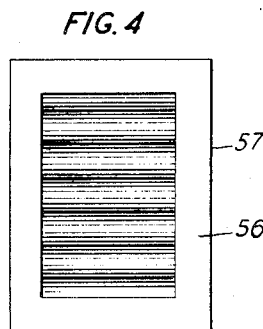
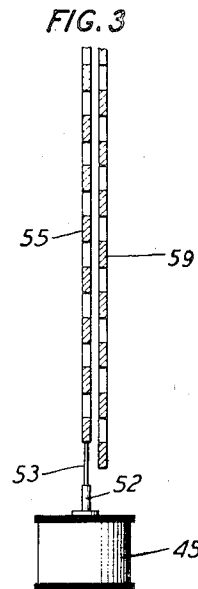
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1,933,267

SOUND RECORDING SYSTEM

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SOUND RECORDING SYSTEM

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6 Claims. (Cl. 179—100.3)

This invention relates to the recording of modulated currents on a sensitive medium and particularly to a method of recording sound by photographic means whereby the volume of noise produced by irregularities in the sound record is materially reduced.

The object of the invention is to vary the intensity of the recording light in accordance with the envelope of the amplitude variations of the modulated currents, and to modulate the light incident on the sensitive medium to a constant degree for all amplitudes of the modulated waves.

A feature of the invention is the control of the effective intensity of the recording light by a mechanical light valve actuated in accordance with the envelope of the amplitude variations of the modulated currents.

Another feature of the invention is the modulation of the recording light by a second light valve actuated by the modulated waves.

A further feature of the invention is the control of the recording amplifier so that the amplitude of movement of the elements of the second light valve is substantially constant.

Recent experiments have shown that the amplitude of the currents which produce noise during the reproduction of a film sound record is approximately proportional to the average transmission of the positive sound record. Thus, if the average transmission of the positive sound record is at all times as small as possible, the reproduced noise will be a minimum. The transmission of a photographic medium is defined as the ratio of the light transmitted through the medium divided by the light incident on the medium. It is known, however, that the volume of the reproduced sound is proportional to the product of the average transmission of the positive sound record multiplied by the percentage change in this average transmission due to the record of the sound. In order to avoid distortion of the volume of the reproduced sound, if the average transmission of the positive sound is reduced, the percentage change in the average transmission must be inversely increased. Thus, if the percentage change in transmission for all volumes of sound is as large as possible and the average transmission is correspondingly small, no distortion of the volume will be produced and the reproduced noise will be a minimum.

If we assume that the photographic processes are controlled so that no photographic distortion is produced, the transmission of the positive sound record will be proportional to the exposure of the negative sound record. The exposure of

any photographic medium is approximately proportional to the intensity of the recording light multiplied by the time of exposure. Thus if the intensity of the recording light for small volumes of sound is small, and is increased in proportion to the increase in the amplitude of the sound, the exposure of the negative sound record will at all times be as small as possible and the average transmission of the positive sound record and the reproduced noise will be a minimum. Simultaneously with this variation of the exposure of the negative sound record by control of the intensity of light, the time of exposure of the negative sound record is varied in accordance with the frequency pattern of the sound.

In the present invention sound waves are detected in the known manner and the modulated currents after suitable amplification, are supplied to a recording amplifier. A portion of the modulated currents is supplied to a control circuit comprising a detector, which may be a thermionic device, an electrolytic device or a contact device such as a copper-copper-oxide rectifier. The output of the detector is supplied to a filter network so proportioned that the filtered current varies with the envelope of the amplitude variations of the modulated currents.

Light from a suitable constant intensity source is directed to a light valve which may consist of a series of pivoted shutters, or a fixed grating and a movable grating, which may be electromagnetically operated. The illuminated area of this light valve is imaged on a second light valve which may be of the type disclosed in U. S. Patent 1,638,555, granted August 9, 1927 to E. C. Wente. The light passing through the second light valve is focussed on a photographic film moved at constant speed past a small aperture. The operation of the first light valve will cause a variation in the light energy imaged on the second light valve which is equivalent to a variation in the intensity of the light.

The modulated output of the recording amplifier actuates the second light valve, producing a variation in the light incident on the film in accordance with the frequency pattern of the modulated currents. The filtered output of the control circuit controls the gain of the recording amplifier so that the power supplied to the second light valve is substantially constant for all amplitudes of the modulated currents. The amplitude of the movement of the light valve ribbons is thus substantially constant and the degree of modulation of the light is correspondingly constant. The time for a complete movement of the light valve

ribbons will vary with the frequency of the modulated currents.

The filtered output of the same, or a similar, control circuit actuates the first light valve and causes the intensity of the light imaged on the second light valve to vary in accordance with the envelope of the amplitude variations of the modulated currents.

In the drawing:

Fig. 1 discloses in diagrammatic form a sound recording system incorporating the invention;

Fig. 2 shows the operative mechanism of one form of light valve;

Fig. 3 shows an alternative form of light valve;

Fig. 4 shows an alternative form of grating for the light valve shown in Fig. 3.

Sound waves are detected by the microphone 10 and amplified in the known manner in the amplifier 11. A part of the amplified currents are applied through a transformer 12 to the input of an amplifying device 13. The output of the amplifying device 13 is applied through a transformer 14 to the input of an amplifying device 15. The output of the amplifying device 15 is applied through a transformer 16 to the ribbons 17, 18 of a light valve. It will be apparent to those skilled in the art that more or less than two amplifying devices in cascade may be used, and that other systems of coupling the amplifying devices may replace the transformer coupling shown.

A modified form of the light valve disclosed in U. S. Patent 1,638,555, granted August 9, 1927 to E. C. Wente is shown. Two flat ribbons 17 and 18 are disposed in parallel relation to define a small slot between their opposed edges. The ribbons 17 and 18 are immersed in a uniform magnetic field formed between the pole pieces of a permanent magnet 19. The pole pieces of the magnet 19 are pierced by a small orifice 20 aligned with the slot formed by the ribbons 17 and 18. When an electric current flows in the ribbons 17 and 18, the magnetic field due to the current reacts with the magnetic field due to the magnet 19 and causes the ribbons to move, thus increasing or decreasing the height of the slot.

Light of constant intensity from the source 21 illuminates a light valve 22. An image of the illuminated area of the light valve is formed by the lens system 23 on the slot formed by the ribbons 17 and 18. The lens system 24 forms an image of the slot on a sensitive film 25 moved past a small aperture 26 in a plate 27 by the sprockets 28 and 29 which are uniformly rotated in the known manner.

Plate current is supplied from a battery 30 through a coupling resistor 31 to the amplifying device 13, and flows through the device to the junction 32. Plate current is similarly supplied through resistor 33 to the amplifying device 15, and flows through the device and wire 34 to the junction 32. The combined plate currents flow through resistor 35 back to the battery 30. When no modulated currents are applied to the recording circuit, the bias voltage applied to the control elements of the amplifying devices 13 and 15 is determined by the potential difference between the ends of the resistor 35 due to the combined plate currents. The capacitors 36 and 37 bridged across the resistor 35 prevent modulated voltages from being developed between the ends of the resistor 35. The capacitors 38 and 39 prevent steady currents from flowing in the windings of the transformers 14 and 16.

A portion of the modulated currents is applied through transformer 40 to a rectifier 41, which

may be a thermionic device as shown, or some other suitable rectifier such as a copper-copper-oxide couple. A battery 42 applies a potential to the control electrode so that the device 41 operates as a rectifier. Current from the battery 30 flows through wire 43, rectifier 41, wire 44, electromagnet 45, wires 46 and 34, resistor 35 to battery 30. A potential is developed across the resistor 35 by the rectified current and changes the bias applied to the control electrodes of the amplifying devices 13 and 15. A capacitor 47 is connected across the output of the rectifier 41 and this capacity combined with the inductance of the electromagnet 45 causes the potential developed across the resistor 35 to vary with the envelope of the amplitude variations of the modulated currents. The changed bias impressed on the control electrodes of the amplifying devices 13 and 15 will change the gain of the amplifier, and by a suitable choice of the constants of the circuit, the gain is varied inversely proportional to the amplitude of the modulated currents so that the output is substantially constant, and the amplitude of the movement of the ribbons 17 and 18 is substantially constant. By suitably designing the amplifier, the amplitude of movement of the ribbons 17 and 18 may be made of such magnitude as to produce substantially complete modulation of the light incident on the film 25 for all amplitudes of the modulated currents, or such other degree of modulation as may be desired.

The rectified currents flowing in the electromagnet 45 will actuate the light valve 22, which varies the intensity of the light impressed on the film 25 in accordance with the envelope of the amplitude variations of the modulated currents.

As shown in Fig. 2, the light valve 22 may comprise a series of shutters 58, supported on axial shafts 48, which may be supported in suitable journals (not shown). A collar 49, encircles the shaft 48 and is affixed thereto. The collar 49 forms one end of a lever 50 extending at right angles to the shaft 48. The other end of the lever 50 terminates in a flat slotted portion 51. A movable mass of iron 52 forms the core of the electromagnet 45. A rod 53, attached to the core 52, has small studs 54 engaging the slot in the flat portion 51. When current is supplied to the electromagnet 45, the core 52 will be drawn into the electromagnet, oscillating the levers 50 and causing the shutters 58 to be rotated about the axis of the shaft 48. A suitable spring (not shown) may be arranged to act on the core 52 and supply a restoring force.

In Fig. 3, the shutters 58 have been replaced by a stationary perforated screen 59 and a movable perforated screen 55 actuated by the rod 53. The movement of the rod 53 due to the currents flowing in the electromagnet 45 will bring the openings in the screens 59 and 55 more or less into alignment and will thus vary the light energy transmitted through a unit area of the screens.

In a light valve as illustrated in Fig. 3, the screen 55 should be light enough that the valve will respond fairly rapidly to a variation of the current in the electromagnet 45. As the screen is of rather small size, difficulty may be found in constructing a screen having accurate perforations. As shown in Fig. 4 a suitable screen may be formed of a variable density record of a constant frequency current impressed on a photographic film and suitably developed. A section of the film 56 may be supported in a light

metal frame 57. By varying the frequency recorded, any desired spacing of the striations may be obtained, and the variation of density in each cycle may be varied by controlling the wave shape of the recorded frequency.

What is claimed is:

1. In a system for recording modulated currents on a photographic medium, in combination, a control circuit energized by said modulated currents, a source of light of constant intensity, a light valve comprising alternately disposed areas of differing transmitting power controlling the transmission of light from said source to said medium, means actuated by said control circuit to vary the relative proportion of said areas in said light in accordance with the envelope of the amplitude variations of said modulated currents, and a second light valve actuated by said modulated currents to produce a predetermined degree of modulation of the light from said source incident on said film.

2. In a system for recording modulated currents on a photographic medium, in combination, a control circuit energized by said modulated currents, a source of light of constant intensity, a light valve comprising areas of gradually differing translucency controlling the transmission of light from said source to said medium, means actuated by said control circuit to vary the relative proportion of said areas in said light, and a second light valve actuated by said modulated currents to produce a predetermined degree of modulation of the light from said first valve incident on said film.

3. In a system for recording modulated currents on a photographic medium, in combination, a control circuit energized by said modulated currents, a source of light of constant intensity, a light valve comprising alternately disposed areas of gradually differing translucency controlling the transmission of light from said source to said medium, means actuated by said control circuit to vary the relative proportion of said areas in said light, and a second light valve actuated by said modulated currents to produce a predetermined degree of modulation of the light from said first valve incident on said film.

4. In a system for recording modulated currents on a photographic medium, in combination, a control circuit energized by said modulated currents, a source of light of constant intensity, a

light valve comprising alternately disposed areas of gradually differing transmitting power interposed in the light from said source directed on said medium, means actuated by said control circuit to vary the relative proportion of said areas in said light in accordance with the envelope of the amplitude variations of said modulated currents, means for amplifying a portion of said modulated currents, means energized by said control circuit for varying the amplification of said amplifier inversely with the envelope of the amplitude variations of said modulated waves and a second light valve actuated by the output of said amplifying means to modulate the light from said source incident on said film.

5. In a system for recording modulated currents on a photographic medium, in combination, a control circuit energized by said modulated currents, a source of light of constant intensity, a plurality of rotatable shutters interposed in the light from said source directed on said medium, means actuated by said control circuit to rotate said shutters and vary said light in accordance with the envelope of the amplitude variations of said modulated currents, means for amplifying a portion of said modulated currents, means energized by said control circuit for varying the amplification of said amplifier inversely with the envelope of the amplitude variations of said modulated waves and a light valve actuated by the output of said amplifying means to modulate the light from said source incident on said film.

6. In a system for recording modulated currents on a photographic medium, in combination, a control circuit energized by said modulated currents, a source of light of constant intensity, a plurality of perforated screens interposed in cascade, in the light from said source directed on said medium, means actuated by said control circuit to relatively displace said screens and vary said light in accordance with the envelope of the amplitude variations of said modulated currents, means for amplifying a portion of said modulated currents, means energized by said control circuit for varying the amplification of said amplifier inversely with the envelope of the amplitude variations of said modulated waves and a light valve actuated by the output of said amplifying means to modulate the light from said source incident on said film.

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