

April 15, 1941.

E. W. HULLEGÅRD

2,238,734

RECORDING AND REPRODUCING SOUND

Original Filed March 17, 1938 2 Sheets-Sheet 1

FIG. 1.

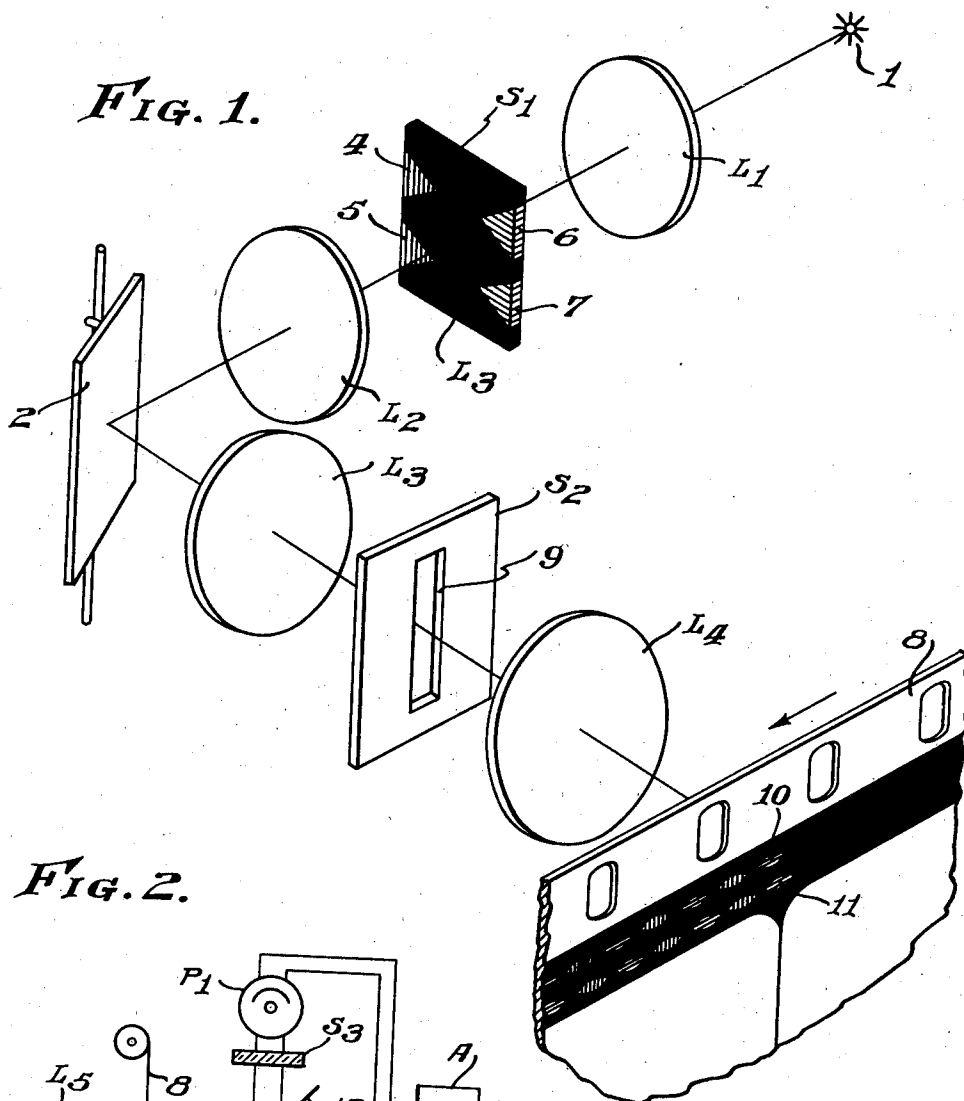
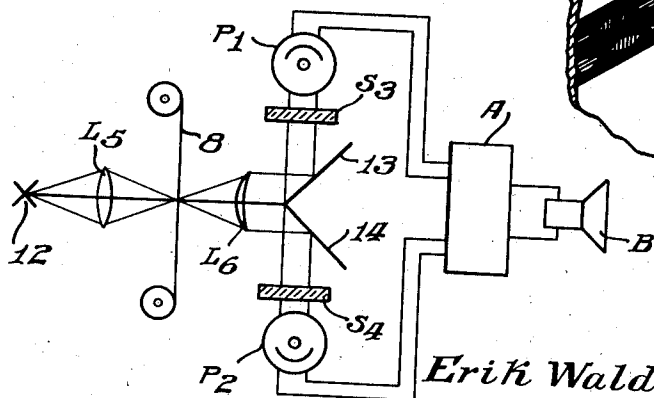


FIG. 2.



Erik Waldemar Hullegård
 By *[Signature]* Attorney

April 15, 1941.

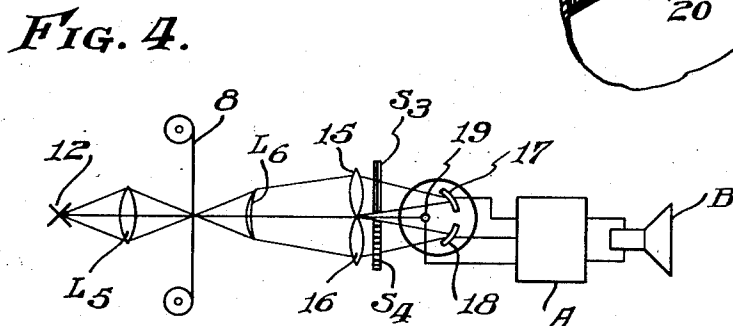
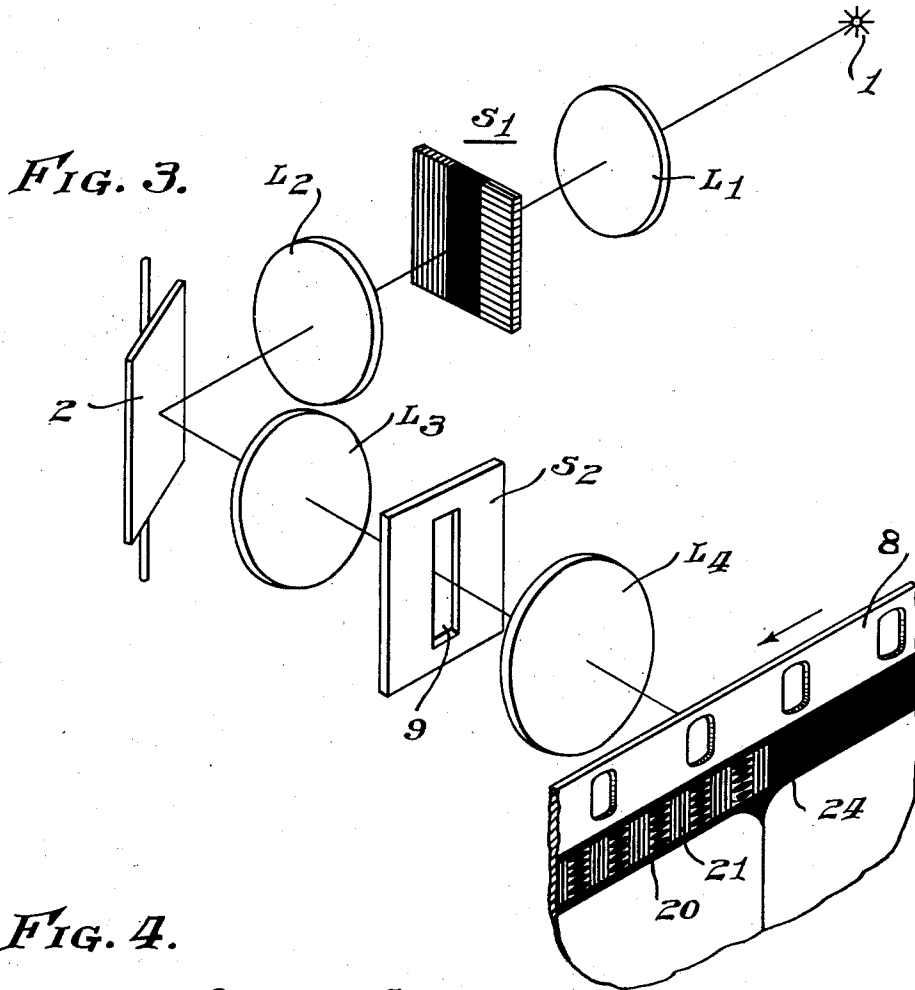
E. W. HULLEGÅRD

2,238,734

RECORDING AND REPRODUCING SOUND

Original Filed March 17, 1938

2 Sheets-Sheet 2



Erik Waldemar Hullegard ^{Inventor}

Erik Waldemar Hullegard ^{Inventor}

 $\mathfrak{B}_y$

23
J. J. Huff
Attorney

Attorney

UNITED STATES PATENT OFFICE

2,238,734

RECORDING AND REPRODUCING SOUND

Erik Waldemar Hullegård, Stockholm, Sweden,
 assignor, by mesne assignments, to Radio Cor-
 poration of America, a corporation of Delaware

Original application March 17, 1938, Serial No.
 196,554. Divided and this application October
 17, 1940, Serial No. 361,572. In Sweden March
 23, 1937

2 Claims. (Cl. 179—100.3)

The present invention relates to such systems for recording and reproducing sound through the intermedium of light-sensitive media, such as photographic films and photocells, in which the positive and negative half-waves of the sound oscillation curve are recorded on the light-sensitive medium independent of one another to facilitate their separation in the reproduction through the intermedium of the photocells.

This application is a division of my application Serial No. 196,554, filed March 17, 1938.

The advantage is afforded that no biasing illumination of the light-sensitive medium is required on which illumination the sound oscillations are optically superposed so that the "background" will be much more silent than in previous systems having a biasing illumination. In a known system, the positive and negative half-waves of the sound curve are recorded each in one or two coextensive tracks which necessitates the provision of complicated apparatus having means for the simultaneous reproduction of two tracks. These two tracks require further a space of the light-sensitive medium, such as a film, which is double that of an ordinary single track.

According to the present invention, said inconvenience is eliminated by arranging that the positive and negative half-waves of the sound curve are not recorded in positions transversely displaced in relation to one another but in one and the same track while receiving such distinctive properties that the record of each half-wave could be separately reproduced. In case the film is color-sensitive, the positive and negative half-waves of the sound curve could be converted each to a light bundle of a distinctive color, to which the film is exposed.

The invention will now be more fully described with reference to the accompanying drawings illustrating, by way of example, two embodiments of the invention. On the drawings, Figure 1 is a perspective and diagrammatic view of a preferred embodiment of a recording device, whereas Figure 2 is a circuit diagram of a reproduction device, Figure 3 is a similar diagram of a recorder adapted to produce a variable density record, and Figure 4 illustrates a modified type of reproducer in which the two photoelectric elements are arranged with a single anode within the same container.

In Figure 1, condensing lenses L_1 and L_2 and a diaphragm S_1 are positioned in a straight line between a source of light 1 and an oscillating mirror 2, as shown in Figure 1. The diaphragm S_1 consists of an opaque or nontransparent por-

tion 3 and four triangular transparent fields, i. e., 4, 5 on the left-hand side of the diaphragm and 6 and 7 on the right-hand side of the diaphragm. The fields 4 and 5 have one distinctive color and fields 6 and 7 another distinctive color. The triangular fields turn their points towards one another, as shown, while leaving an opaque zone between opposing points.

Further condensing lenses L_3 and L_4 and a slit device S_2 are positioned in a straight line between the oscillating mirror 2 and a light-sensitive band 8 in such an angular relationship to the path between parts 1 and 2 that, in an average position of the mirror 2, an image of the diaphragm S_1 is projected on the slit device S_2 . The sharp-edged slit 9 provided therein has a width corresponding to the opaque zone between opposing points in the diaphragm S_1 so that, in the mentioned position of the mirror, the image of the opaque zone covers the slit 9 and no light can penetrate to the color-sensitive film 8.

The mirror 2 is connected to an oscillograph responsive to the sound to be recorded and which is not shown on the drawings.

When the mirror 2 starts oscillation, the image of the diaphragm S_1 oscillates to and from over the device S_2 so that the translucent portions 4 and 5 alternating with the portions 6, 7 send light of corresponding color through the slit 9 on to the film 8. The transversal width, or, in this instance, the vertical extension of the bundle of rays reaching the film, will apparently depend on the vertical dimension of the translucent portions 4 to 7 projected on to the slit device and thus on the angular deflection of the mirror 2 or the amplitude of the sound wave corresponding thereto. Provided the film band 8 is moving at a sufficient rate crosswise to the slit 9, there will accordingly be recorded impressions which, when the film is developed, will appear as oblong traces 10, 11 of the one or the other color on an opaque background 24, depending upon the translucent portions 4, 5 or 6, 7 which is operative at the moment.

In Figure 2 is shown a reproduction device consisting of a light source 12, condensing lenses L_5 and L_6 , stationary mirrors 13, 14, put at an angle to one another, color filters S_3 and S_4 , each letting through only light corresponding to the one color of the translucent portions 4, 5 or 6, 7 respectively, and photocells P_1 and P_2 . These latter are associated in push-pull connection with an amplifier A and a loudspeaker B.

When the colored film 8 is passed between the lenses L_5 and L_6 , the bundle of light will pass

alternately traces of the one or the other color of the passing film band 8, and light of alternating color will be reflected at the mirrors 13 and 14 on to the filters S₃ and S₄ to actuate the one and the other of the photocells P₁ and P₂ respectively, so that the amplifier A and loud-speaker B will respond.

In the shown embodiment, there are two pairs of opposing translucent filter portions 4, 6 and 5, 7 respectively. Instead thereof, only one pair of several pairs of opposing translucent portions can be used. The points of such portions need not be positioned exactly opposite one another, reckoned in a plane parallel with the path of movement of the film band, but may be staggered, in which case the traces on the film band will be correspondingly staggered, although grouped symmetrically in regard to an imaginary base line on the film which line is parallel with the path of movement of the film.

The two photocells shown in Figure 2 could be combined, as shown in Figure 4, to a single one having, for instance, two cathodes 17 and 18 and one anode 19. In this arrangement, the lenses 15 and 16 perform the same function as the reflectors 13 and 14 of Figure 2.

Whereas the above-described apparatus refers to such sound films which are modulated according to the amplitude method, the invention could likewise be applied to sound films, based on an intensity-modulation, and in systems using a combination of amplitude- and intensity-modulation.

Thus, if the aperture plate S₁ be modified so that its center section 3 is opaque, its left-hand section 4 passes only red light, and its right-hand section passes only blue light, a variable density record is produced. This necessarily follows from the fact that, when the mirror 2 is at rest, no light is passed through the slit 9, and, when the light beam is vibrated transversely of

the slit, a red penumbra shadow is produced for one direction of the vibration, and a blue penumbra shadow is produced for the opposite direction of vibration. In this record, the alternate half cycles 20 and 21 are of different colors, as indicated in the drawings. This type of record may evidently be reproduced by any reproducer involving a color-selecting prism or other device suitable for causing light modulated by alternate half cycles to be applied respectively to the cathodes 17 and 18. The reproducer of Figure 4 is suitable for this purpose. This reproducer is also capable of reproducing either of the two tracks of the record of Figure 1. The foregoing method and apparatus are particularly useful with the present type of color films wherein a plurality of color-sensitive layers are provided and the exposure and development produce appropriate colors in each of these layers, as distinguished from earlier types of color films in which each color was printed separately on to the positive.

Having now described my invention, I claim:

1. The sound-recording method which includes recording the positive half cycles of a sound wave in the form of spaced images, each symmetrical about a common longitudinal axis of the record in one color, and recording the negative half cycles of said wave in the form of similar spaced images, each symmetrical about the same common axis in another color.

2. The sound-recording method which includes recording the positive half cycles of a sound wave in the form of spaced images, each symmetrical about a common longitudinal axis of the record in one color, and recording the negative half cycles of said wave in the form of similar spaced images between said first images, each symmetrical about the same common axis in another color.

ERIK WALDEMAR HULLEGÅRD.