

Feb. 3, 1942.

E. W. KELLOGG

2,271,980

RECORDING OF ALTERNATING CURRENT IMPULSES

Filed Nov. 8, 1939

2 Sheets-Sheet 1

FIG. 1.

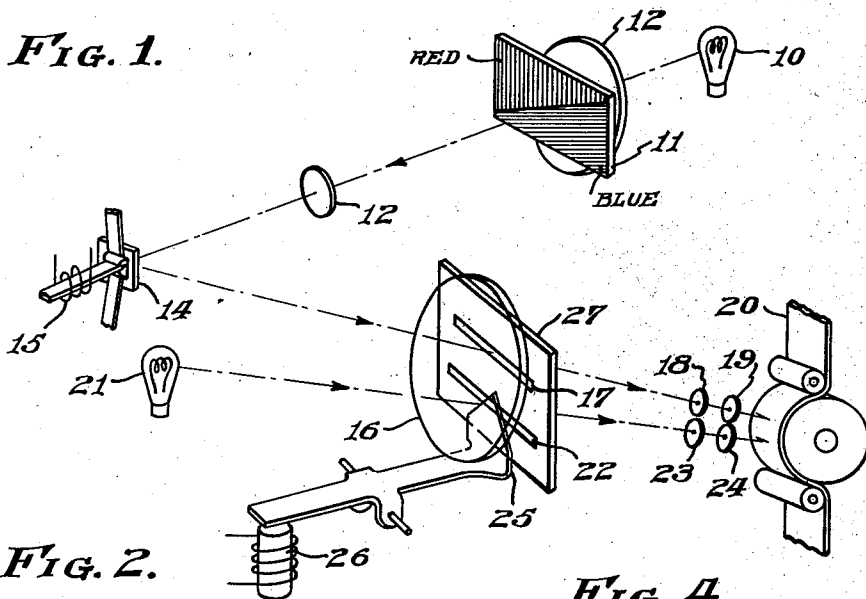


FIG. 2.

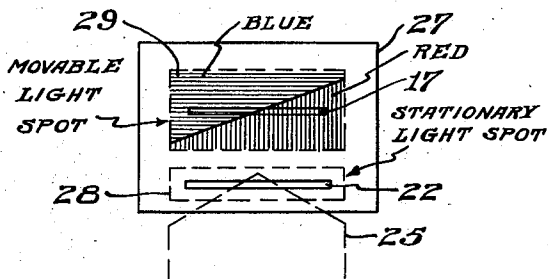


FIG. 4.

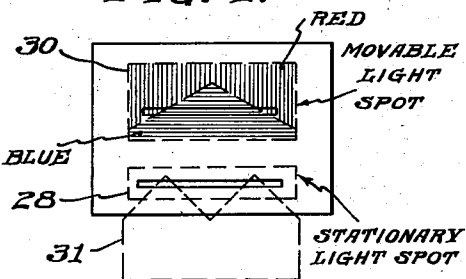


FIG. 3.

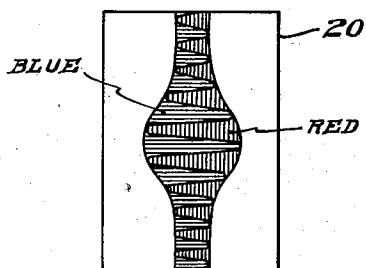
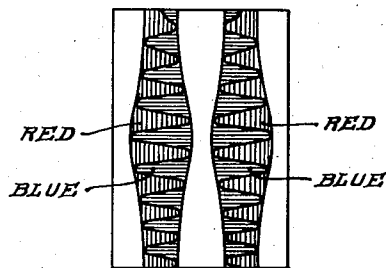


FIG. 5.



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FIG. 6.

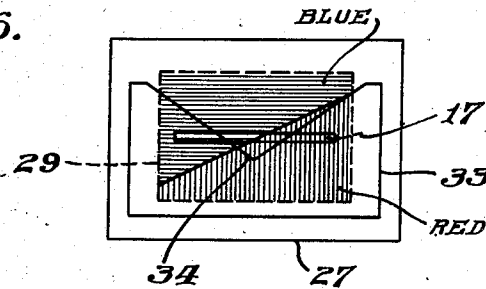
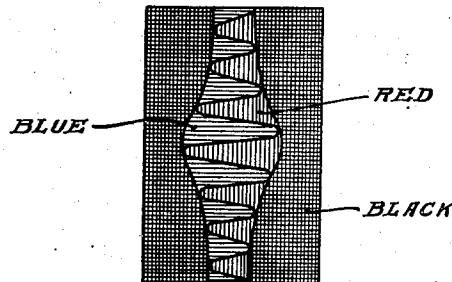


FIG. 7.



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2,271,980

RECORDING OF ALTERNATING CURRENT
IMPULSESEdward W. Kellogg, Moorestown, N. J., assignor
to Radio Corporation of America, a corpora-
tion of Delaware

Application November 8, 1939, Serial No. 303,373

5 Claims. (Cl. 179—100.3)

This invention relates to the recording of alternating current impulses such as those of audio frequency, and has for its principal object the provision of an improved recording apparatus and method of operation for producing a class A push-pull record having its different record tracks registered in different or complementary colors. As is well known, the recorded impulses are reproduced from such a record through the medium of color filters, prisms or the like.

A class A type of record is one wherein the positive and negative record areas are so disposed as to simultaneously affect a pair of push-pull connected photoelectric elements. The positive and negative half cycle record areas, arranged to simultaneously affect the push-pull photoelectric elements, may be on the same or different record tracks, the selection of the half cycle record areas being effected geometrically, by color, by carrier frequency, by polarization or by other suitable means.

Color separation, for example, involves the employment of two reproducing elements, one of which is affected only by light of a certain color, and the other of which is affected only by light of another color. The sound track includes differently stained areas which will respectively absorb light of the two different colors. For example, the reproducing elements may be two photocells with two complementary color filters such as red and blue in front of the first and second cells, respectively, and the sound track may be recorded by the application of red and blue dyes or stains, each of which absorbs light of its complementary color, but comparatively little light of its own color. Thus the photocell having the red filter receives light which is strongly modulated by the presence of blue dye in the sound track but is relatively little affected by the presence of red dye in the sound track.

This invention is related to those disclosed by United States Patent 2,102,695 of Giesking, by application Serial No. 196,554 of Hullebard, and by application Serial No. 287,324 of Dimmick, all assigned to the same assignee as the present application. As will appear, all of these inventions involve recording in different colors the positive and negative half cycles of a sound wave or other alternating impulse. One suitable recording material for this purpose is the multi-color motion picture film currently sold under the trade-name "Kodachrome," but if the only color requirements are for the sound track, a simpler film having only two emulsion layers, instead of three as in the case of "Kodachrome," would suffice,

and the processing of the two color film would be correspondingly simpler.

The invention will be better understood from the following description considered in connection with the accompanying drawings, and its scope is indicated by the appended claims.

Referring to the drawings:

Figure 1 diagrammatically illustrates a device suitable for recording alternating impulses in the form of duplicate record tracks with their corresponding half cycles of different colors,

Figure 2 illustrates certain details of the device of Fig. 1,

Figure 3 illustrates the record produced by the device of Fig. 1,

Figure 4 illustrates a modification in certain details of the device of Fig. 1, and

Figure 5 illustrates the record produced by the modified device.

Figure 6 illustrates an alternative method of obtaining ground noise reduction.

Figure 7 illustrates a sound film in which the unused areas are black.

The recording device of Fig. 1 includes a light source 10 from which light is projected through a multi-colored mask 11 and lens 12 to a galvanometer mirror 14, which is vibrated in accordance with the electrical impulses transmitted through its operating coil 15. Light is reflected from the mirror 14 through the lens 13, a light slit 17 and lenses 18 and 19 to a film 20 upon which the impulses are recorded. The manner in which this recording system works to produce the photographic record of the sound is well understood, being the same as in the case of the recording systems now in commercial use in making variable area records.

From a light source 21, light is projected through an apertured mask, a slit 22 and lenses 23 and 24 to the record strip 20, for exposing to white light the record area not required for modulating the light beam of the reproducer. This is in accordance with the well known principle employed in ground noise reduction systems as applied to variable area photographic sound recording. In order to restrict this exposure to areas not occupied by the record tracks, a V-shaped shutter 25 is arranged to be moved to and fro transversely of the slit 22, in response to variation in the amplitude or volume of the recorded impulses. To this end, the operating coil 26 of the shutter 25 is supplied with a direct current which varies in accordance with the volume of the recorded impulses. Suitable means for deriving such current are so well known as

to require no description here. The recording device so far described is substantially the same as that employed in the system for making direct positive recordings described by G. L. Dimmick, copending U. S. application Serial No. 287,324, filed July 29, 1939 (RCV D-6030), except that in the system of Dimmick an opaque mask having a triangular opening, instead of the two complementarily colored filters shown at 11 in my Fig. 1.

As shown more clearly in Fig. 2, the recording slit 17 and the shading or noise reduction slit 22 may be formed in the same mask 27; a stationary light beam is projected on the slit 22 from the light source 21; the shutter 25 is vibrated transversely of the slit 22; and the multi-colored light beam, or image 29 of the composite filter 11, is vibrated transversely of the slit 17.

It will be noted the red and blue filter areas of the mask 11 are separated by a diagonal boundary line, that the multi-colored image 29 contains similarly separated blue and red areas, and that the diagonal boundary line between the differently colored image areas extends obliquely across the impulse recording slit 17. Vibration of the multi-colored image transversely of the slit 17 therefore causes the boundary between the record areas exposed to the differently colored parts of the beam to vary transversely of the record in accordance with the impulses to be recorded. As a result of this, assuming that the film on which the record is being made is one wherein exposure to light of a given color results in dyed image of the same color, there is produced a record which differs from the usual black and white variable area or variable width record only in that the black and white areas are replaced, respectively, by red and blue areas.

In order to minimize the background noise otherwise incident to the playing of a photographic sound record, it is common practice to blacken the areas of the sound track which lie outside the envelope of the recorded waves. This has no effect on the useful sound as reproduced, provided the boundary of the blackened area has only gradual curvatures, but black film gives rise to much less random ground noise than an equal area of clear film; hence as much area is blackened in this manner as is compatible with avoidance of interference with the recording of the waves. In a sound record of the type involved in this invention, wherein the light for operating two photocells in push connection, is separated by color filters, colorless film is almost as free from noise as black film, on account of the neutralizing action of the push-pull circuit for disturbances which affect both photocells equally. It is therefore almost as effective to make the unused areas clear as to make them black, the ground noise depending principally on the total area of colored film within the area scanned by the reproducing system. The ground noise reduction system employed in connection with a colored sound track system of the type illustrated herein may optionally consist in arrangements for making the unused areas either clear and colorless or black.

I have chosen to illustrate the embodiment of my invention wherein the unused areas are clear. If the film on which the sound is recorded is of a type such as "Kodachrome," wherein exposure to light of a given color, results in the fixing of a dye of the same color, the complementary colored dyes being dissolved out, exposure to white light in sufficient amount results in clear film. Thus the portions of the film which receive white light

exposure through the auxiliary slit 22 of Fig. 1 are clear, and this accomplishes ground noise reduction. The shutter 25 is moved transversely of the slit 22 in accordance with the volume of the recorded impulses, thus producing the clear areas indicated on the record illustrated in Fig. 3. This record may be played by any suitable type of color separation reproducer, such as those disclosed by the aforesaid copending Dimmick application.

An alternative method of obtaining ground noise reduction is to employ a shutter which obscures part of the recording beam, as shown in Fig. 6, in which the plate 27 is provided with only one slit 17 through which the light for recording the sound passes. The lamp 21 and lenses 23-24 are omitted. The filter 11 is imaged on the plate 27 as a red and blue light spot 29 which vibrates up and down in response to sound vibrations as in the case of the arrangement illustrated in Fig. 1. A shutter vane 33 having a V-shaped notch 34 obstructs the light 29 so that it does not pass through the slit 17, except for a small region near the middle of the slit where the boundary between the red and blue areas intersects the slit. As the modulation increases, the shutter vane is moved downward by a magnet corresponding to that shown at 26 in Fig. 1 and uncovers enough of the slit 17 to accommodate the modulation so that the vibratory movements of the light spot 29 never result in the exposed part of the slit being illuminated entirely with light of one color. At 100% modulation, the shutter vane is completely out of the way and the full length of the slit is illuminated. The resulting sound record, if the film is of the same type already discussed, will be like that shown in Fig. 7, areas to the right and left of the modulation area being black instead of clear as in Fig. 3.

The form of apparatus shown in Figs. 1 and 2 has an advantage over that of Fig. 6 in that the use of an extra slit and light source for effecting the ground noise reduction permits a displacement of the position at which the noise reduction exposure is applied and that at which the sound waves are recorded. When there is a quick increase in the amplitude of the modulation, this displacement gives the shutter vane time to move the requisite amount so that none of the wave outlines are obliterated. In the arrangement of Fig. 6, overmodulation occurs if the shutter fails to move out of the way fast enough.

If the type of film and method of processing the same do not have to be adapted to producing a colored picture of the usual kind, as, for example, when recording sound only, the apparatus of Fig. 1 may be used and a method of processing may be followed which will produce a track of the type just described wherein the unused areas are black instead of clear. The type of film represented by "Kodachrome" is what may be called a color positive in that the exposures makes the film transparent. The making of a colored sound negative, using, for example, the recording system illustrated in Fig. 1, would be substantially as follows. Since only two complementary colors are required, a double emulsion film will suffice.

Next the base would be a red-sensitive emulsion over which would be a thin layer of stained gelatine constituting a yellow-orange or red filter, and the outer layer would be an emulsion sensitive to blue light only. After exposure, the film would be developed without reversal, and

the developed silver images in the two layers would be transformed into colored images by toning or fixing of appropriate dyes. This is a well known photographic process. The under layer may be toned red and the outer layer toned blue, or vice versa, since the sound reproduction will be equally satisfactory in either case. Areas which have not been exposed to light of either color will come out clear, and areas exposed to white light or both red and blue light will be black. The color deposited in the two layers may be determined by depending on the difference in penetration in successive baths as is done in "Kodachrome," or by incorporating in each layer, when the film is made, a suitable dye-coupling agent which will not dissolve out in the developing process, and which will take part in forming the appropriate stain. The last mentioned process is employed in a color film system of the Agfa Company.

A sound film in which the unused areas are black, as in Fig. 7, has an advantage over one in which they are clear in that low ground noise is less dependent on balance between the two photocells and less impaired by lack of saturated colors in the film. A recommended procedure when a number of prints are needed is to use the apparatus of Fig. 1 to make a sound negative like Fig. 7, and to use this negative to print sound tracks on the final or "release" prints, the pictures being printed from a separate master color picture film. The prints would then be processed with reversal development, as in the case of "Kodachrome," to give a final film in which the color is the same as that of the light to which the print film was exposed. This mode of operating will be in accordance with the standard method of making color picture duplicates on "Kodachrome" or similar film, while the sound track will have the two-color sound wave record, with the unused areas substantially opaque.

The modification of Fig. 4 differs from the preceding modification in that (1) the mask 11 is replaced by a mask which produces a multi-colored image 30 wherein the boundary line between the differently colored areas is V-shaped and (2) the noise reduction shutter 25 is replaced by a W-shaped or multi-point shutter 31.

The record resulting from this modification is shown in Fig. 5. This is readily recognized as a multi-track or bilateral push-pull record which may be played by any suitable push-pull reproducer of the color separation type.

While the records of Figs. 3 and 5 are in some respects similar to those of the aforesaid patent and patent application, they differ therefrom in that they include differently colored areas separated by a common boundary line which varies transversely of the record in accordance with the recorded impulses. The outside or non-common boundary lines of these differently colored areas, of course, vary in accordance with the volume of recorded impulses. Modulation of the reproduced light is thus effected by differently colored areas which are interlaced, contiguous, mutually exclusive and restricted to the minimum area required for modulation purposes.

I claim as my invention:

1. An alternating current impulse record including differently colored areas separated by a common boundary line which varies transversely of the record in accordance with the recorded impulses.

2. An alternating current impulse record including differently colored areas separated by a common boundary line which varies transversely of the record in accordance with the recorded impulses, and neutral areas which vary along the non-common boundary lines of said differently colored areas in accordance with the volume of said impulses.

3. An alternating current impulse record including differently colored areas which are contiguous, mutually exclusive and separated by a common boundary line of a contour dependent on the wave shape of the recorded impulses.

4. An alternating current impulse recorder including means affording a light slit, means for producing a pair of differently colored light beams having a common boundary line angularly disposed with respect to said slit, and means for vibrating said beams transversely of said slit in accordance with said impulses.

5. An alternating current impulse recorder including means affording a light slit, means for producing a pair of different colored light beams having a common boundary line angularly disposed with respect to said slit, means for vibrating said beams transversely of said slit in accordance with said impulses, and means responsive to the volume of said impulses for restricting the recording effect of said differently colored light beams to such record area as is required to permit modulation of said impulses.

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