Aug. 4, 1942. G. L. DIMMICK 2,292,062

RECORDING AND REPRODUCTION OF ALTERNATING IMPULSES

Filed July 29, 1939 3 Sheets-Sheet 1

FIG. 1.

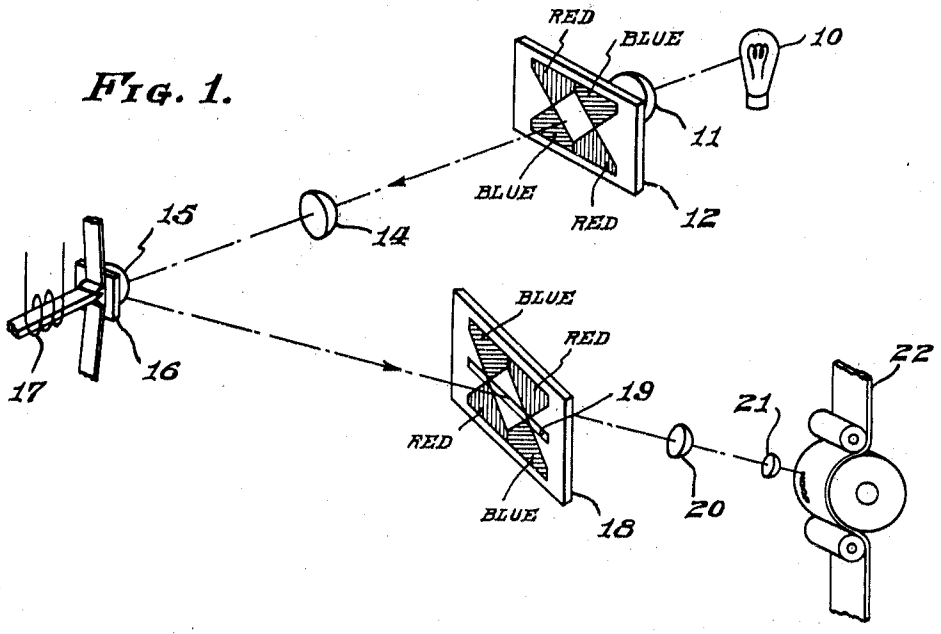


FIG. 2a.

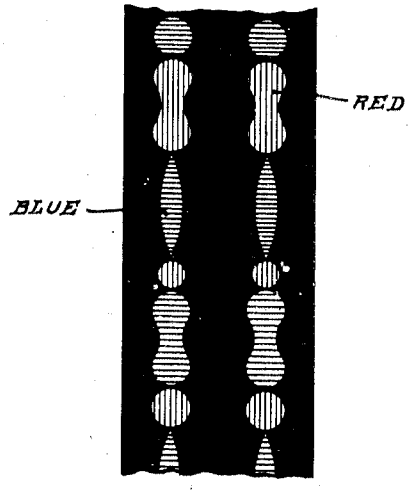
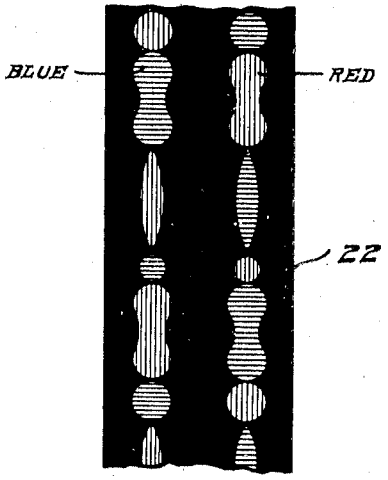


FIG. 2b.



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RECORDING AND REPRODUCTION OF ALTERNATING IMPULSES

Filed July 29, 1939 3 Sheets-Sheet 2

FIG. 3.

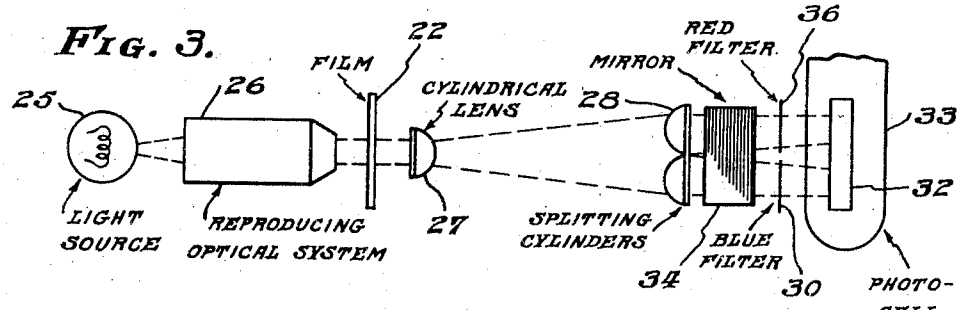


FIG. 4.

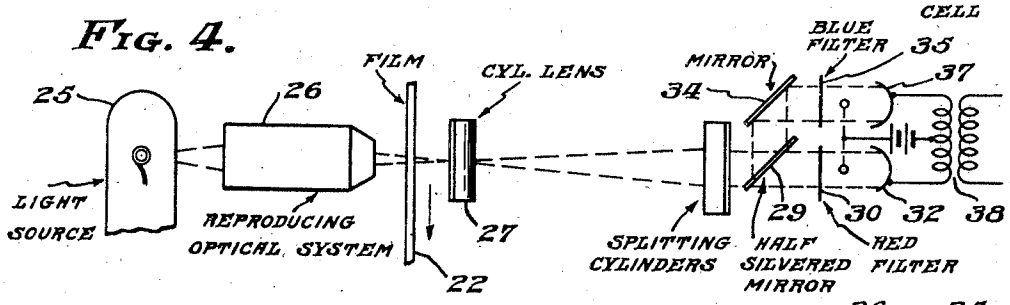


FIG. 5.

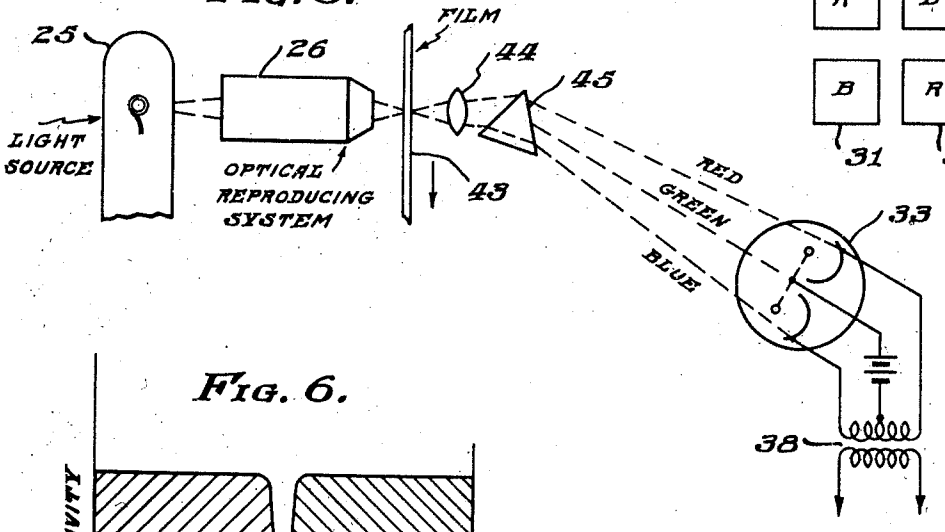


FIG. 4a.

FIG. 6.

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RECORDING AND REPRODUCTION OF ALTERNATING IMPULSES

Filed July 29, 1939 3 Sheets-Sheet 3

FIG. 7.

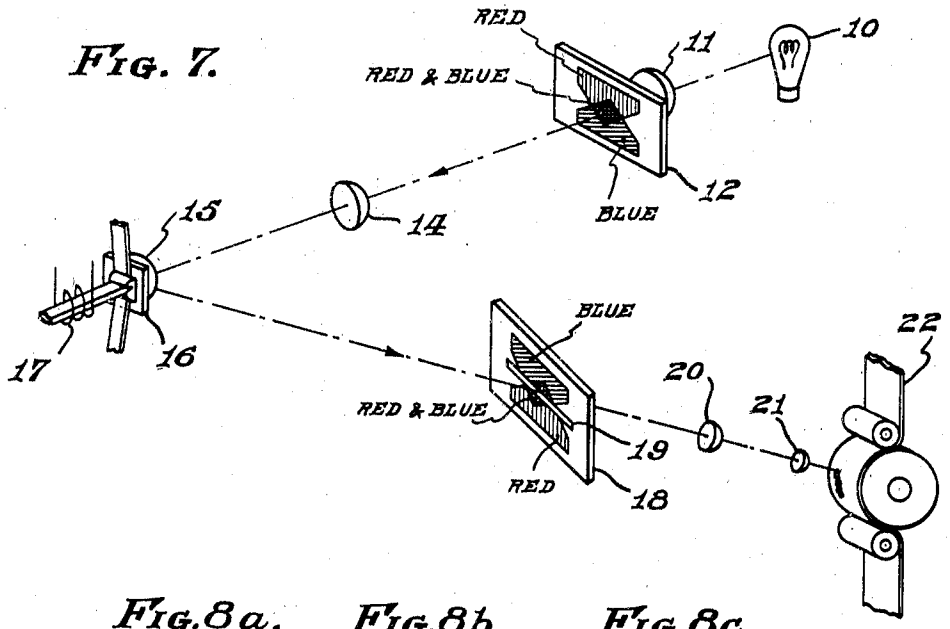


FIG. 8a.

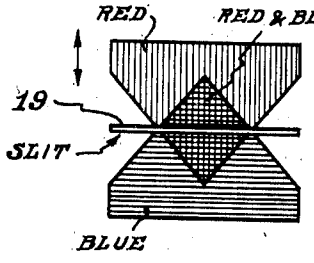


FIG. 8b.

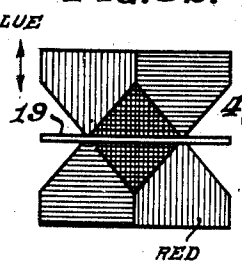


FIG. 8c.

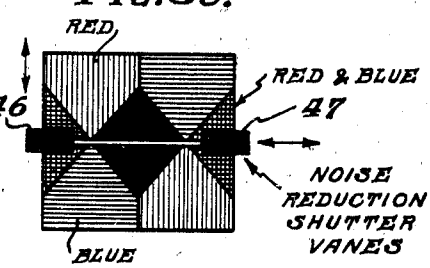


FIG. 8d.

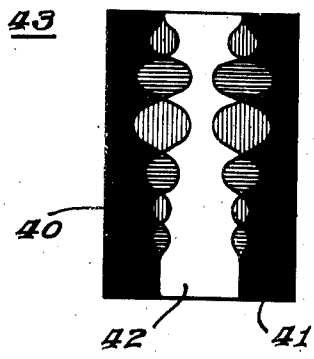


FIG. 8e.

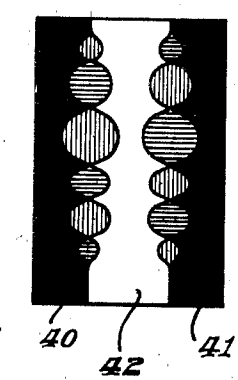
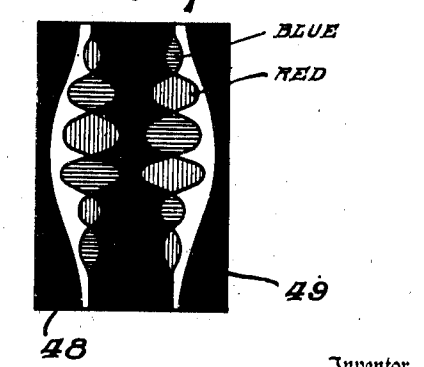


FIG. 8f.



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UNITED STATES PATENT OFFICE

2,292,062

RECORDING AND REPRODUCTION OF ALTERNATING IMPULSES

Glenn L. Dimmick, Haddonfield, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application July 29, 1939, Serial No. 287,324

12 Claims. (Cl. 17.9—100.3)

This invention relates to the recording and reproduction of alternating impulses such as those of audio frequency, and has for its principal object the provision of an improved record and improved means for recording and playing or reproducing the improved record.

The invention is in some respects an improvement over those disclosed by United States Patent 2,102,695 of Glesking and by application Serial No. 196,554 of Hullegard, both assigned to the same assignee as the present application. As will appear, all three 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 of "Kodachrome."

In the record of the aforesaid Glesking patent, the impulses are recorded in the form of positive and negative half cycles which are differently colored and extend from bases at opposite sides of the record to peaks which overlap at the center of the record. This type of record has the disadvantage that the cross-over points between the half cycles are located at opposite ends of the light beam and distortion of the reproduced impulses may result from different light intensities at the two ends of the beam or from misalignment of the beam.

The record of the copending Hullegard application involves duplicate record tracks on which the corresponding negative half cycles are recorded in one color and the corresponding positive half cycles are recorded in a different color the positive and negative half cycle records being in alignment longitudinally of the record strip. This Hullegard type of record is an improvement over that of Glesking for the reason that (1) the transition point between the negative and positive half cycles is at the center of the record track, (2) the distortion due to misalignment of the light beam or to difference in the intensity of its opposite ends is therefore avoided, and (3) the noise otherwise resulting from transparent spots produced in the background area by scratches or the like is balanced out or neutralized in the reproducer.

The duplicate tracks of the Hullegard record have their corresponding half cycles recorded in the same color, and any change in the color of the light transmitted through the record therefore tends to unbalance the reproducer output and produce distortion in the reproduced impulses. Standardization of the color of the light emanated by an incandescent exciter lamp is hardly feasible under present conditions. In the absence of such standardization, the impulses reproduced from the Hullegard type of record may be distorted due to unbalance of the reproducer output, for the reason that the output is balanced for only one band of light waves. Thus, whenever the exciter lamp is replaced or whenever the heating current of the lamp is changed, the reproduced impulses may be distorted.

In one modification of the present invention, this difficulty is avoided by recording the corresponding half cycles of the different record tracks in different colors. Thus if the negative half cycles of one track are blue, for example, the negative half cycles of the other record track are of a different color, such as red. Likewise, the positive half cycles of the two record tracks are of different colors. This form of the improved record therefore includes a pair of duplicate record tracks each of which has differently colored positive and negative half cycles, the corresponding half cycles of the two tracks being of different color. As will appear, this record is of a type commonly known as a class B record.

Since the corresponding half cycles of the two record tracks are of different color, the unbalancing effect of change in the color of the exciter light source is avoided and the exciter lamp may be replaced or its heating current varied without the necessity of readjustment of the reproducer.

A class B type of record is one whereon the positive and negative half cycle record areas are so disposed as to separately and alternately affect a pair of push-pull connected photoelectric elements. A class A type of record is one wherein the positive and negative half cycle record areas are so disposed as to simultaneously affect a pair of push-pull connected photoelectric elements. In the case of either record, the positive and negative half cycle record areas arranged to separately or 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 the like.

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 and 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 persence of red dye in the sound track.

While the invention is disclosed in connection with color separation, it is obviously useful in connection with other means of selecting and utilizing the various positive and negative half cycle areas of the record, it being only necessary that the corresponding half cycles be depicted on the record as modulating carriers of different wave lengths, whether the carriers be differently colored light, differently polarized light beams, different radio frequency carriers, or the like.

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*a* illustrates the prior art record of Hullegard whereon the corresponding half cycles of the different tracks are depicted in the same color,

Figure 2*b* illustrates the class B type of record produced by the device of Fig. 1,

Figures 3 and 4 are, respectively, top and side views of a device suitable for reproducing the impulses recorded on the record of Fig. 2*b*,

Figure 4*a* illustrates certain details of the reproducer of Figs. 3 and 4,

Figure 5 illustrates a modified form of reproducer,

Figure 6 is an explanatory diagram relating to the operation of the reproducer of Fig. 5,

Figure 7 diagrammatically illustrates a device suitable for producing a class A type of record wherein two sets of duplicate record tracks, 180 degrees out of phase with one another, are recorded in different colors and in alignment with one another along the boundary between opaque and transparent background areas of the record,

Figures 8*a* and 8*d* respectively illustrate the varicolored light beam of the class A record produced by the device of Fig. 7,

Figure 8*b* illustrates a modified form of light beam which may be utilized to produce the class A type of record shown by Fig. 8*e*, and

Figure 8*c* illustrates a further modified light beam and noise reduction shutter arrangement which may be utilized to produce the class A type of record shown by Figure 8*f*.

The recorder of Fig. 1 includes a source **10** from which light passes through a lens **11**, the aperture of a plate **12** and lenses **14** and **15** to a galvanometer mirror **16** which is vibrated in accordance with the electrical impulses supplied to the galvanometer operating coil **17**. From the mirror **16**, an image of the aperture of the plate **12** is reflected through the lens **15** to the member **18**, across the light slit **19** of which the aperture image is vibrated by movement of the mirror **16**. The light thus modulated passes from the slit **19** through lenses **20** and **21** to the longitudinally moved record strip **22** on which the impulses are to be recorded.

The characteristic feature of this recording device is the aperture of the plate **12** and the type of light beam which it produces. This aperture is varicolored as indicated by the legends applied to the various aperture sections, and the light beam image at the slit **19** is varicolored as indicated by similar legends.

Vibration of the varicolored image across the light slit **19** produces two record tracks such as those of Fig. 2*b*. This is a class B type of record and differs from the Hullegard class B record, which is shown in Fig. 2*a*, in that the corresponding half cycles of the record tracks are differently colored. As previously indicated, the record of Fig. 2*b* is superior to the prior art record of Fig. 2*a* in that the corresponding half cycles are of different colors and the reproduced impulses are substantially unaffected by variation in the color of the light of the exciter lamp.

The improved record of Fig. 2*b* may be played or reproduced by the reproducer of Figs. 3, 4 and 4*a*.

This reproducer includes an exciter light source **25**, which may be of the incandescent type and functions to transmit light through an optical system, the record **22**, a cylindrical lens **27** and light splitting lenses **28** to a half silvered mirror **29** or other suitable means adapted to simultaneously transmit and reflect the incident light.

Light is transmitted through the mirror **29** and the red filter **30** or a blue filter **31** to the cathode **32** of one of a pair of push-pull connected photoelectric elements **33**. Light is reflected from the mirror **29** to a mirror **34** from whence it is reflected through a blue filter **35** or a red filter **36** to the cathode **37** of the other of the push-pull connected photoelectric elements. The output of the push-pull circuit is delivered through a transformer **38** and a suitable amplifying channel to the loudspeaker or other reproducing or indicating device.

Assuming the record **22** to be moved in the direction indicated by the arrow of Fig. 2, it is apparent that light reaches the cathode **32** only when the corresponding half cycles of the two tracks are arranged with the blue at the left and the red at the right. Likewise, light reaches the cathode **37** only when the corresponding half cycles of the two tracks are reversely colored. Thus each photoelectric element is subjected to half cycle areas which are differently colored, and the distortion otherwise resulting from change in the color of the scanning exciter light beam is avoided.

The invention is not restricted to Class B type records, such as that of Fig. 2*b*, but is equally applicable to class A type records such as those illustrated by Figs. 8*d*, 8*e* and 8*f*. Which of these three different class A types of record is produced, of course, depends on the coloring of the different aperture sections of the plate **12**.

Thus if these aperture sections are colored as indicated by the legends applied to Fig. 7, the light beam appearing at the light slit member **18** is colored as indicated by the legends of Fig. 8*a* and the record of Fig. 8*d* is produced. It will be observed (1) that this record includes two pairs of record tracks, each of which consists of duplicate records recorded in different colors and in opposition or with a phase difference of 180 degrees, (2) that the record background areas **40** and **41** are opaque, and (3) that the record background area **42** is transparent.

Either one or both of the class A type tracks of the record of Fig. 8*d* may be reproduced by the reproducer of Fig. 5, wherein light modulated by the record **43** passes through a lens **44** to a color separating prism **45** which directs the differently modulated light component to the different photoelectric elements of the device **33**.

The aperture sections of the plate **12** may also

be arranged to produce a varicolored light beam such as that of Fig. 8*b* or that of Fig. 8*c*.

Vibration of the beam of Fig. 8*b* across the light slit 19 produces a class A type of record such as that of Fig. 8*e*, which is similar to that of Fig. 8*d* with respect to its background areas but differs in that its corresponding half cycle areas are differently colored. This record may be reproduced by the reproducer of Figs. 3, 4 and 4*a*.

Vibration of the beam 8*c* across the slit 19, and movement of the noise reduction shutters 46 and 47 in opposite directions longitudinally of the slit, produces the record of Fig. 8*f*. This record is similar to those of Fig. 8*d* and Fig. 8*e* in that it includes a class A type of record track recorded along the boundary between opaque and transparent background areas, is similar to the record of Fig. 8*e* in that the corresponding half cycles of the two class A tracks are differently colored, and differs from the records of Figs. 8*d* and 8*e* in that the shutters 46 and 47 are oppositely moved in accordance with the volume or level of the recorded impulses to produce noise reduction record areas 48 and 49 in the manner disclosed by McDowell Patent 1,855,197 and numerous other prior art disclosures.

The records of Figs. 8*e* and 8*f* may be reproduced by the reproducer of Figs. 3, 4 and 4*a*.

Although the colors of the record have been described as red and blue, it is obvious that any two separate bands of frequencies may be used. The preferred method is to divide the spectrum of actinic rays into two parts, as indicated by Fig. 6. The widths of the two bands are preferably such as to produce approximately the same signal from the two push-pull connected cathodes. Under these conditions, when the reproducer is so adjusted as to balance the currents of the two photoelectric elements, change in the color of the light emanating from the exciter lamp does not unbalance the output of the reproducer.

I claim as my invention:

1. An alternating current record including opaque and transparent background areas having a boundary therebetween, positive half cycle record tracks of said current in one color along the said boundary between said backgrounds, and negative half cycle record tracks of said current in a different color along said boundary.

2. An alternating current impulse record including a plurality of record tracks on which the corresponding half cycles of said current are recorded in different colors.

3. An alternating current impulse record including a plurality of record tracks on which the corresponding half cycles of said current are recorded in different colors, and on which said corresponding half cycles are recorded in alignment with one another transversely of said record.

4. An alternating current impulse record including a plurality of record tracks on which the corresponding half cycles of said current are recorded in different colors, and on which the noncorresponding half cycles of each track are recorded in alignment with one another longitudinally of said record.

5. An alternating current record including a plurality of record tracks on which corresponding half cycles of said current are recorded in different colors in alignment with one another transversely of said record, and on which the positive and negative half cycles of each track are recorded in alignment with one another longitudinally of said record.

6. In a device for the reproduction of alternating current impulses from a record including a plurality of record tracks having their corresponding half cycles differently colored and each having differently colored positive and negative half cycles, the combination of a plurality of push-pull connected photoelectric elements, a light source, and means for causing light transmitted through the corresponding positive half cycles of said tracks to be applied to one of said photoelectric elements and for causing light transmitted through the corresponding negative half cycles of said tracks to be applied to another of said photoelectric elements.

7. In a device for the reproduction of alternating current impulses from a record including a plurality of record tracks having their corresponding half cycles differently colored and each having differently colored positive and negative half cycles, the combination of a plurality of push-pull connected photoelectric elements, a light source, and means including groups of differently colored filters arranged in reverse order for causing light from only corresponding half cycles of said tracks to be applied to each of said photoelectric elements.

8. In a device for the reproduction of alternating current impulses from a record whereon the positive and negative half cycles are recorded in different colors at the boundary line between opaque and transparent background areas, the combination of a light source, a pair of push-pull connected photoelectric elements, and means for causing substantially all light transmitted through one colored area of said record to be applied to one of said elements and substantially all light transmitted through a differently colored area of said record to be applied to the other of said elements.

9. In a device for the reproduction of alternating current impulses from a record whereon the positive and negative half cycles are recorded in different colors at the boundary line between opaque and transparent background areas, the combination of a light source, a pair of push-pull connected photoelectric elements, and means including a prism for causing substantially all light transmitted through one colored area of said record to be applied to one of said elements and substantially all light transmitted through a differently colored area of said record to be applied to the other of said elements.

10. An alternating current impulse record including a plurality of record tracks on which corresponding half cycles of said impulses are depicted as each modulating a carrier of different frequency.

11. An alternating current impulse record including a plurality of record tracks on which corresponding half cycles of said impulses are depicted as each modulating light of a different character.

12. An alternating current impulse record including a plurality of record tracks on which corresponding half cycles of said impulses are depicted as each modulating radiation of a different wave length.

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