

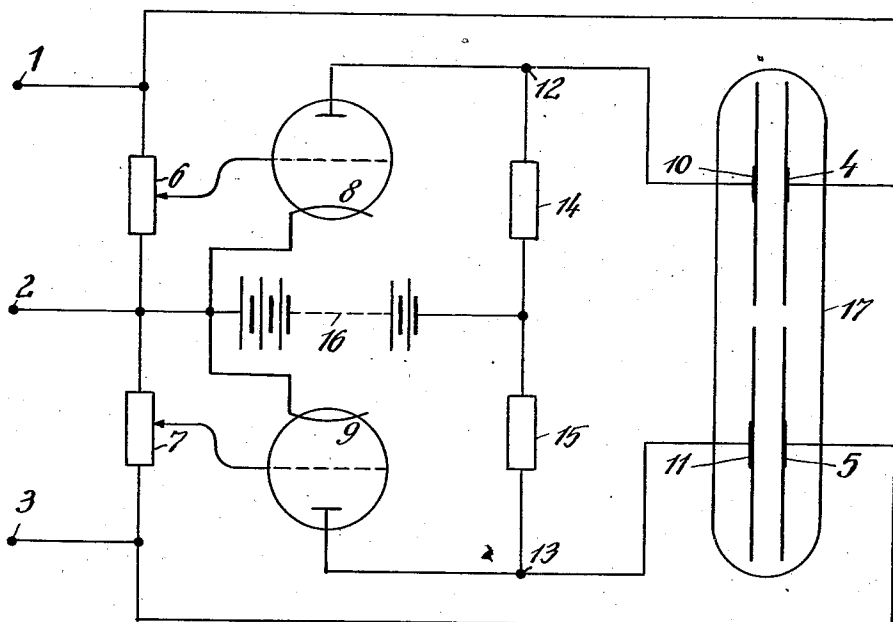
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LEVELING THE CHARACTERISTIC OF PHOTOGRAPHIC EMULSIONS

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LEVELING THE CHARACTERISTIC OF
PHOTOGRAPHIC EMULSIONSCazihelz Becker, Berlin-Wilmersdorf, Germany;
vested in the Alien Property CustodianApplication August 23, 1940, Serial No. 353,974
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5 Claims. (Cl. 179—100.3)

This invention relates generally to methods of recording sound upon film and in a more particular sense is concerned with a circuit to be used in making half-wave intensity records, wherein distortions due to irregularities of the photographic film density characteristic curve are minimized. By the expression photographic film density characteristic curve as hereinafter employed is meant the non-linear curve obtained by plotting film density against exposure, the latter being determined by light intensity with constant exposure period.

When recording sound on film in half-wave-intensity records (push-pull-class B records), it is well known that when the working point lies near the lower end of the photographic film density characteristic curve, the minimum operating transparency is limited by the downward curvature of the photographic film density characteristic curve. For this reason, in order to obtain a sufficiently large reduction of the interference or noise level, the use of the push-pull-class AB or the push-pull-class A recording circuit in which the minimum operating transparency lies above the curvature of the photographic characteristic has been deemed necessary. Hitherto in making half-wave-intensity records, using the so-called sag as well as the so-called straight or direct method, minimum operating transparencies were obtained which at the best amounted to about a fifth to an eighth of the maximum operating transparency. Due to the tonal gradation determined by the image, the photographic film density characteristic curve of the positive cannot be influenced, nor with the use of mere photographic means, can the slope of the negative film density curve be substantially increased beyond the hitherto obtainable degree. Moreover, to obtain reduction of the interference or noise level and volume of sound of half-wave-transverse records, it would be necessary to produce an infinite or even a negative slope of the negative film characteristic curve.

By practice of the present invention, a practically linear transfer characteristic curve, with a residual background (no-signal) transparency of any desired density and with any desired reduction of interference or noise level is obtained while making half-wave-intensity records. These remarkable effects are achieved by using a novel divided Kerr-cell having two pairs of plates and applying additional incremental voltages to each pair of plates depending on the amplitude of the recording signal, in addition to the threshold op-

erating voltages and the corresponding half-wave signal voltages. These additional voltages decrease in proportion to increase of the amplitude of the half-wave signal voltages and are so chosen that the product of the slope of the characteristic of the electric transfer device (the Kerr-cell and operating circuit) and the photographic blackening characteristic is a constant value for each amplitude.

10 In accordance with the present invention, to embody the principles above mentioned, an ordinary Kerr-cell is divided to provide two pairs of electrode plates, each pair being supplied with a threshold operating voltage in addition to the corresponding half-wave signal voltage and, during operation on the non-linear portion of the curve of the photographic film density characteristic, with an additional incremental voltage varying whereby its magnitude is progressively larger for progressively smaller values of slope of the photographic film density characteristic curve.

15 An additional or incremental voltage satisfying this requirement is produced according to the present invention by applying a portion of the half-wave signal voltages to the control grids of electron tubes having exponential characteristics and by adding to the two half-wave signal voltages the voltages occurring at the anode resistances of said tubes.

20 Preferably the control circuits of the two sets of Kerr-cell electrodes are arranged whereby the source of the half-wave signal voltages serves also to control operation of the exponential tubes, the anode voltages of which serve as threshold or operating voltages for the Kerr-cell electrodes and the anode resistances of which are connected in series with the cell electrodes in each of the circuits.

25 The accompanying drawing is a circuit diagram illustrating an application of the principles of the present invention.

Two half-wave signal voltages derived from a conventional rectifier circuit are applied to resistances 6 and 7 between the lines 1—2 and 2—3 respectively. Circuits which are adaptable for this use are shown in Patent No. 2,161,369, issued to J. H. McLeod, et al. on June 6, 1939, and in applicant's Patent No. 2,319,289, issued May 18, 1943. The resistances 6 and 7 are independently connected in series with a potential source 16, the two circuits being completed through plates 4—10 and 5—11 respectively of a divided Kerr-cell 17 to resistances 14 and 15 which in turn are connected to the potential source 16 above men-

tioned. The currents flowing through the two circuits are such that threshold operating voltages appear across both pairs of plates of the Kerr-cell. The resistances 6 and 7 are provided with a variable tap whereby a portion of the voltages therein is supplied to the control grids of a pair of exponential tubes 8 and 9 respectively. The cathodes of tubes 8 and 9 are connected together and to the negative side of the source of potential 16. The threshold operating voltage 16 of the Kerr-cell also serves as the anode voltage for the push-pull-connected tubes 8 and 9, and the resistances 14 and 15 provided in the operating circuits of the two pairs of Kerr-cell plates, serve as the anode resistances of the tubes 8 and 9. The potentials appearing in the anode resistances 14 and 15 are added to the threshold operating voltages derived from the resistances 6 and 7, thus providing the additional voltages necessary for compensation of irregularities in the photographic film density curve as above discussed.

The half-wave voltages are applied to the resistances 6 and 7 in a manner such that the points 1 and 3 are negative relative to the point 2 which accordingly is positive whereby each half-wave produces a negative voltage impulse at the control grid of the corresponding exponential tube. Due to the logarithmic characteristic curve of tubes of this type, the anode currents passing through the tubes are not proportional to the amplitudes of the half-wave signals applied to the control grids, but instead an increase of the half-wave signal amplitudes, produces a progressively smaller increase of the anode current until ultimately the anode current no longer increases. From this fact, it will be evident that the additional voltage cannot exceed an upper limiting value, or in other words, with an increasing amplitude of the half-wave signal voltage, the additional or incremental voltage decreases proportionally as this amplitude increases.

A Kerr-cell having four electrically independent plates is required in utilizing the above described circuit, the manufacture of which is very difficult. A reason for this difficulty lies in the fact that when making records the plates of the usual type of Kerr-cells tend to vibrate under the influence of the electric alternating current fields, thereby preventing the production of a record free from distortion. Furthermore, it is necessary that the two electrodes be maintained rigidly in accurately spaced parallelism. Under usual conditions of manufacture these requirements cannot be fulfilled when using the type of electrodes hitherto known, especially those consisting of metal plates and metal blocks.

It has now been found that the Kerr-cell for use in the above described circuit can be constructed in a manner such that the two pairs of electrodes are formed upon the surfaces of two glass and porcelain plates, ground in plane parallelism, which can be separated from each other by insulating spacers of similar nature. In this instance, the surfaces facing each other are provided with a thin metal layer, each divided in the middle of the plate, thus providing pairs of coplanar electrodes separated from each other by a narrow line of unsurfaced, hence insulative, material.

More specifically, the electrodes for this type of Kerr-cell are made by providing two relatively elongate rectangular glass or porcelain plates,

ground in plane parallelism, with a metallic surfacing layer by cathode atomising, galvanisation or the like. After surfacing in this manner, a narrow linear area near the middle of each of the plates is removed, parallel to the shorter edge of the plate, whereby two metal surfaced areas, electrically separated from each other, are provided side by side upon each plate. The two plates thus prepared are mounted in the Kerr-cell with the metal layers facing each other and maintained in proper spaced relationship by plane parallel insulating spacers.

Double Kerr-cells of this type, in addition to ruggedness of construction have the advantage that the plates comprising each of the two pairs of electrodes are positively held in equally spaced relationship, thus from the standpoint of electrical characteristics the two pairs of plates are equivalent.

What I claim is:

1. The method of compensating for the non-linear density characteristic curve of photographic film when recording half-wave intensity records by apparatus including a Kerr cell having a pair of plates mounted rigidly in accurately placed parallelism, which method comprises impressing a portion of the operating voltage applied to the plates of the cell as a negative bias on the grid of an electron tube having an exponential characteristic, and adding the anode voltage of said tube to the operating voltage of the cell.

2. Apparatus for half-wave photographic sound recording comprising a Kerr cell having a pair of plates mounted rigidly in accurately spaced parallelism, means for supplying to the pair of plates a half-wave voltage modulated in response to the sound to be recorded, an electron tube having exponential characteristics, the grid circuit of said tube being coupled to be negatively biased by a portion of the half-wave voltage, and the anode circuit of said tube being connected to the pair of plates in series adding with said half-wave voltage whereby the anode voltage compensates for the non-linear portion of the photographic film density characteristic curve.

3. In the process of recording sound photographically using a divided Kerr cell light valve having two aligned pairs of rigidly mounted accurately spaced parallel plates having modulated half-wave voltages applied to the respective pairs of plates, the improvement which comprises separately applying a portion of each of the half-wave voltages as a negative bias to the control grid of each of a pair of electron tubes having an exponential characteristic, and adding to the corresponding half-wave voltages the anode voltages of said tubes.

4. Apparatus for half-wave photographic sound recording comprising a divided Kerr cell having two aligned pairs of rigidly mounted accurately spaced parallel plates, means for supplying to the pairs of plates, respectively, half wave voltages modulated in response to the sound to be recorded, a pair of electron tubes having exponential characteristics, the grid circuits of said tubes being coupled to be negatively biased by a portion of the respective half-wave voltages, and the anode circuits of the tubes being respectively connected to the pairs of plates in series adding with said half-wave voltages whereby the anode voltages compensate for the non-linear portion of the photographic film density characteristic curve.

5. Apparatus for half-wave photographic sound recording comprising a divided Kerr cell including an envelope, within the envelope a pair of rigidly mounted accurately spaced plane-parallel electrically insulative bodies, said plates bearing two facing pairs of superficial conductive coatings, means for supplying to said pairs of coatings, respectively, half-wave voltages modulated in response to the sound to be recorded, a pair of electron tubes having exponential characteristics, 10

the grid circuits of said tubes being coupled to be negatively biased by a portion of the respective half-wave voltages, and the anode circuits of the tubes being respectively connected to the pairs of coatings in series adding with said half-wave voltages whereby the anode voltages compensate for the non-linear portion of the photographic film density characteristic curve.

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