Feb. 23, 1943. O. H. SCHADE 2,312,054

TELEVISION SHADING CONTROL CIRCUIT

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Fig. 1.

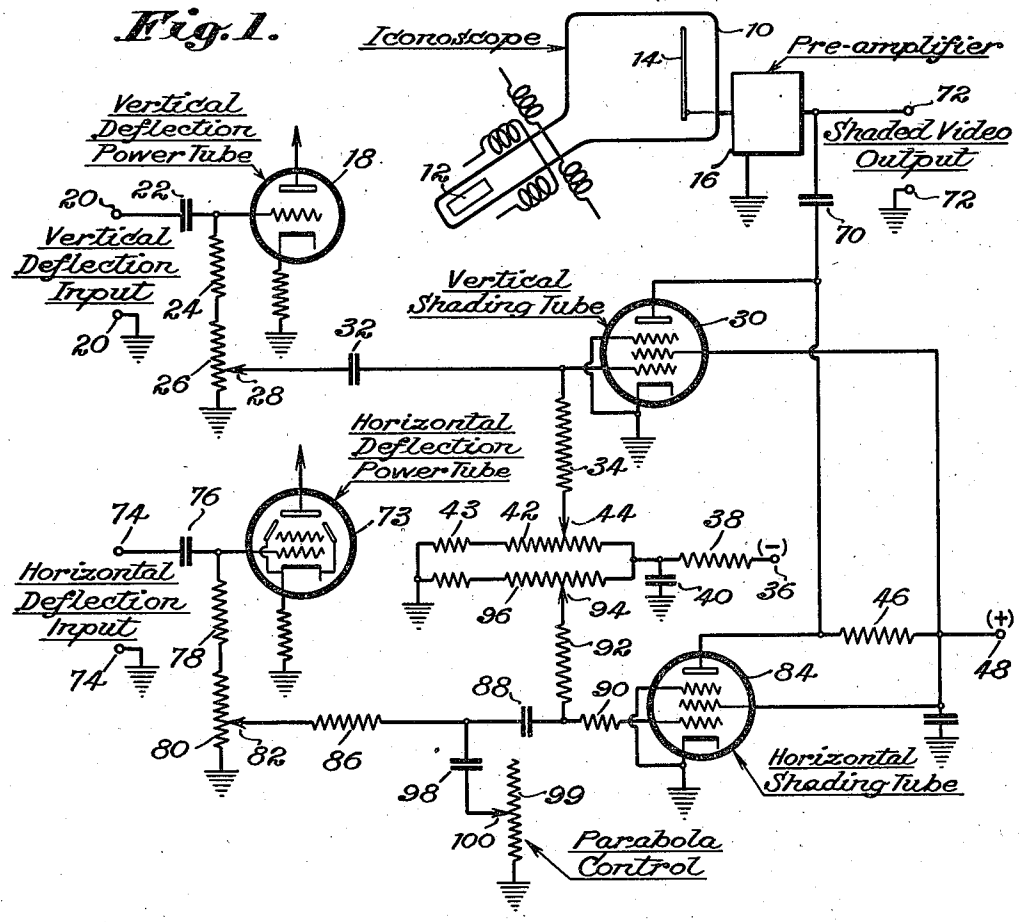
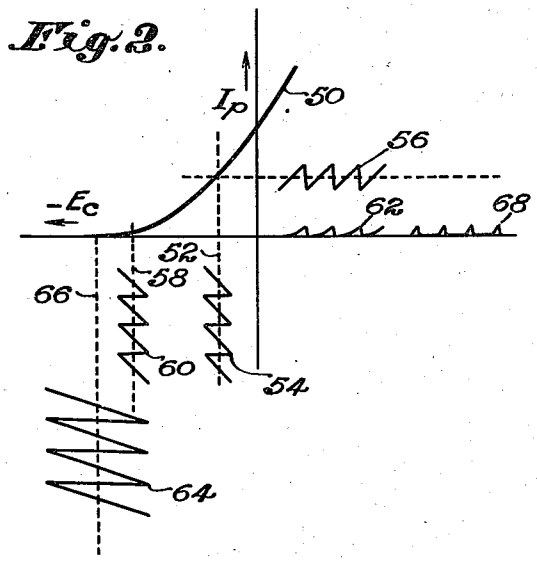


Fig. 2.



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TELEVISION SHADING CONTROL CIRCUIT

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11 Claims. (Cl. 178—7.2)

This invention relates to shading control for television transmitting systems and, more particularly, to circuits whereby the background intensity or average light value of various selectable portions of the television image may be controlled in order to compensate for inherent operating characteristics of the system.

In present day electronic transmitting stations a television transmitting tube is used in which a light responsive electrode (for example, of the mosaic type) is provided, upon which a charge image is produced in accordance with the light values of an optical image projected thereon. The light responsive or mosaic electrode is then scanned in a systematic order by a cathode ray beam which is deflected in bilateral directions in order that electric signals or potential variations may be produced which are representative of the charge values which are present on the mosaic electrode. The operation of such a transmitting tube, particularly the scanning of the mosaic and the resulting production of picture signals, depends to a considerable extent upon secondary electron emission from the mosaic electrode surface and the average value of the signals produced by the transmitting tube are to a certain extent controlled by the secondary electron emissive characteristics of the mosaic electrode. In the production of television picture signals, due to the scanning of the mosaic electrode, a certain relatively high frequency signal series is produced which is indicative of the light values or detail of the optical image projected on the mosaic.

However, due to various reasons, the average value of the high frequency signals may shift or change considerably during the scanning of the complete mosaic area, or, in fact, during the scanning of each line of the area, that is, during each deflection of the cathode ray beam in a particular direction. Such changes in the average value of the signal series may actually exceed the amplitude of the high frequency voltage variations thereof. Such variations in the average value of the picture signal series, as derived from the signal plate of the television transmitting tube, are represented in the received picture by an improper and undesirable background level of the picture in localized areas or portions of the entire picture image, often together with a loss of detail in such areas. This effect is known as "dark spot." One portion of the picture may appear white, and, in fact, so light as to be devoid of substantially all picture detail, whereas another portion of the picture may, under extreme conditions, appear almost black. The change in the average value of the picture signals, as produced by the television transmitting tube, may be caused by several different factors, one of which is the lack of uniformity of the secondary electron emissive effect throughout the entire light responsive electrode surface. Another cause of dark spot is the possible unequal distribution of the produced secondary electrons over the scanned side of the light responsive electrode of the mosaic. Various other causes and effects may also contribute to the existence of dark spot in the presently used television transmitting systems.

The dark spot voltage variations, as stated above, may be the result of several different effects, but it has been noticed that the dark spot voltage variation, or wave form, remains relatively constant for any particular transmitting tube under favorable operating conditions and is not altered in any excessive amount when different light images are projected on the mosaic. There is, however, a slight variation in the dark spot of a particular television transmitting tube when different light images are projected on the mosaic, but the percentage change in the dark spot voltage variation is relatively small and is of such a value as would ordinarily be noticed only when considerable change is present in the average value of the light projected on the light responsive electrode.

In order to compensate for the dark spot, various systems have been devised by means of which there is inserted in the picture signal series a compensating voltage of relatively low frequency as compared with the frequency of the picture signals, the wave shape of the dark spot correcting voltage being controlled both as to amplitude and wave form. Such previously used dark spot correction circuits have heretofore normally employed signals of sine wave formation or harmonics of a sine wave, as well as other related wave forms, the amplitude and the frequencies of which have been controlled in accordance with the wave form of the particular dark spot signal variation which is to be compensated. Examples of previously used dark spot correction systems are to be found in the patent to Bedford, No. 2,166,712, issued July 18, 1939, and in the application of Seeley, Serial No. 281,359, filed June 27, 1939 (RCA D–17618).

The present invention, therefore, has for one of its purposes the provision of a dark spot correcting or shading circuit which is simple in operation and which involves a minimum of electrical apparatus and controls.

Another purpose of the present invention resides in the provision of a dark spot correction and shading control circuit in which voltage variations of substantially sawtooth wave form are used and in which components of such a voltage may be derived from the circuit.

Another purpose of the present invention resides in the provision of a shading control circuit in which the shading of the image may be controlled both in a horizontal and in a vertical direction selectively and independently.

A still further purpose of the present invention resides in the provision of a dark spot correction or shading control circuit in which the wave form of the shading impulses, as applied to the television system, may be altered in accordance with the particular correction required.

Still another purpose of the present invention resides in the provision of a dark spot correction or shading control circuit in which the system and the means used for correction in a horizontal direction are substantially identical with the system and means used for correction in a vertical direction, and the entire circuit is of such a nature that the individual shading signals may be combined into a composite signal series which may be superimposed upon the picture signals as developed by the transmitting tube, in order that the resultant signal variations may correspond to the actual light variations of the optical image which is projected on the light responsive electrode of the television transmitting tube.

A further purpose of the present invention resides in the provision of a dark spot correction or shading control circuit for developing signals which may be applied directly to the signals derived directly from the pre-amplifier associated with the television transmitting tube in order that such dark spot correction may be exercised prior to any appreciable amplification of the picture signals to thereby eliminate any attenuation of excessive amplification of portions of the picture signals as a result of the non-linear operation characteristics of various of the television signal amplifying tubes, when such tubes are operated over a wide range.

Still other purposes and advantages of the present invention will become more apparent to those skilled in the art from the following specification and claims, particularly when considered with the drawing, wherein like reference characters represent like parts and wherein:

Figure 1 represents schematically one form of the present invention, and

Figure 2 shows various curves to assist in the explanation of the operation of the system.

Referring now to the drawing, and particularly to Figure 1 thereof, a television transmitting tube 10 is shown, which may be a conventional "Iconoscope," including an electron gun structure 12 for generating a focused cathode ray beam and a mosaic electrode 14, with which is associated a signal plate. The cathode ray beam is deflected in mutually perpendicular directions by electromagnetic and/or electrostatic means in order that the cathode ray beam may scan the mosaic electrode. When an optical light image is projected on the mosaic electrode, certain charge conditions will result and when the mosaic electrode is scanned by the cathode ray beam, picture signals are produced in the output load circuit included in the pre-amplifier 16. The picture signals which are available at this point in the system are, as explained above, not truly representative of the light values, but contain certain inaccuracies because of the dark spot condition.

Inasmuch as the undesired voltage variations of dark spot signals vary in accordance with the response of the transmitting tube, it is possible to compensate for the dark spot signals by introducing compensating voltage variations corresponding in frequency to the line and frame (or horizontal and vertical) deflection frequencies. Accordingly, therefore, the means for generating the dark spot correcting voltages may be controlled by the same voltage variations as are used to control the deflection of the cathode ray beam.

Figure 1 shows the vertical deflection power tube 18, which includes a cathode, a control electrode, and an anode, and the controlling electrode of the vertical deflection power tube 18 is supplied with energy or voltage variations of vertical deflection frequency. These voltage variations are applied to the terminals 20 and are impressed upon the control electrode of tube 18 by way of condenser 22. The control electrode or grid resistance of tube 18 includes a fixed resistance 24 and a potentiometer 26, with which cooperates a movable contact 28. Inasmuch as voltage variations of the vertical deflection frequency are applied to the control electrode of tube 18, these same voltage variations may be derived from the movable contact 28 of the potentiometer 26, and the intensity of the voltage variations available at that point is, of course, a function of the position of the movable contact 28 along its cooperating potentiometer resistance 26.

A vertical shading tube 30 is provided, which includes at least a cathode, a control electrode, and an anode. The tube 30 is preferably a pentode of the sharp cutoff type. The voltage variations, as derived from the potentiometer contact 28, are applied to the control electrode of tube 30 by way of condenser 32. A grid resistance 34 is connected to the control electrode of tube 30 and the control electrode is supplied with a variable negative potential in order to control the operating characteristic of the region of operation of the tube 30. In order to provide an adjustable negative potential for application to the control electrode of tube 30, a source of negative potential is connected to the terminal 36. A decoupling resistance 38 is connected to the terminal 36 at one end and the other end of the decoupling resistance is connected to ground by way of a condenser 40. A potentiometer 42 and a fixed resistance 43 are connected in series and extend from the coupling resistance 38 to ground or a point of fixed potential. The control electrode resistance 34 of the tube 30 is connected to the movable contact 44 of the potentiometer 42. By adjusting the position of the contact 44 along the potentiometer 42 varying degrees of negative potential may be applied to the control electrode of tube 30 in order that the potential bias of the control electrode with respect to its cathode may be controlled. The anode circuit of tube 30 includes a load resistance 46 which is connected between the anode and the terminal 48, to which a source of positive potential is normally connected.

When a system such as that so far described has been provided, voltage variations of vertical deflection frequency may be applied to the control electrode of tube 30 in varying degrees of intensity, as determined by the position of the contact 28 on the potentiometer 26. The potentiometer 26 is separated from the fixed resistance 24 in order to provide more accurate control of

the intensity of the signals which are to be applied to tube 30. The wave form, as well as the intensity of the voltage variations appearing at the anode of tube 30, is a function not only of the intensity of the applied voltages but also of the grid bias voltage which is applied to the tube. In order to more completely describe the operation of the system, reference is made to the curves shown in Figure 2, wherein the plate current-control electrode operating characteristic of tube 30 is shown. This characteristic is operated by the curve 50. If the negative potential applied to the control electrode of tube 30 is set at a point represented by the dotted line 52 by means of an adjustment of the potentiometer contact 44, the voltage variations having an intensity as represented by the curve 54 will cause voltage variations similar to those represented by the curve 56 to appear at the anode of tube 30. If, however, the bias which is applied to tube 30 is set at a value corresponding to the dotted line 58, then voltage variations having a wave form similar to those shown by the curve 60 will cause voltage variations of relatively low amplitude, such as indicated by the curve 62, to appear in the anode circuit. If the applied voltage variations are increased in intensity, as indicated by the curve 64, and the negative bias on the tube 30 is increased to a value as represented by the dotted line 66, then the voltage variations appearing at the anode of tube 30 will correspond to the curve shown at 66. Accordingly, it may be seen that the intensity of the voltage variations appearing at the anode of tube 30 may be controlled and, furthermore, the length of time duration of the voltage variations may be readily controlled by altering the bias applied to tube 30. In other words, by increasing the bias applied to tube 30, and by simultaneously increasing the amplitude of the voltage variations applied to the control electrode of tube 30, a continuous change in the shading wave form may be accomplished. Furthermore, the time duration that the voltage variations at the anode of tube 30 are present may also be controlled so that the shading will be confined to a greater or lesser amount of a vertical deflection of the scanning cathode ray beam. The voltage variations which are produced at the anode of tube 30 are then applied to the output circuit of the television transmitting tube 10 by way of condenser 70 in order that they may be mixed with the produced picture signals. The composite wave form, including picture signals and vertical shading control signals, is then available at the output electrodes 72.

The horizontal correction circuit is somewhat similar to the above described vertical correction circuit, and, in Figure 1, the horizontal deflection power tube 73 is shown. This power tube normally is in the form of a beam power tube, such as the type 6L6, since considerable energy is necessary to deflect the cathode ray beam in the horizontal direction at the desired rate. It is to be understood that the energy from the anodes of tube 18 and tube 73 is applied to the deflecting coils and their deflecting plates of the television transmitting tube, although, for reasons of simplicity, such connection is not shown in Figure 1. The control electrode of tube 73 is supplied with voltage variations of horizontal deflection frequency, these voltage variations being applied to terminals 74. The voltage variations are applied to the control electrode through the condenser 76. The control electrode of tube 73 is provided with a grid resistance including a fixed resistance 78 and potentiometer resistance 80. Cooperating with potentiometer 80 is movable contact 82 by means of which voltage variations of horizontal deflection frequency may be derived in varying degrees of intensity.

A horizontal shading control tube 84 is provided which includes at least a cathode, a control electrode, and an anode. This tube, as in the case of the vertical shading tube, is preferably a pentode of the sharp cutoff type. The voltage variations, as derived from the movable contact 82, are applied to the control electrode of tube 84 through a resistance 86, condenser 88, and a second resistance 90. The control electrode of tube 84 is provided with a resistance 92 which is connected to movable contact 94 of potentiometer 96. The potentiometer 96 is connected with a source of negative potential in a manner similar to the manner in which a potentiometer 42 is connected. By adjusting the position of the movable contact 94 along the potentiometer 96, varying degrees of negative biasing potential may be applied to the control electrode of tube 84. The anode of the horizontal shading tube 84 is connected to a source of positive potential by means of the load resistance 46 which is common to both the vertical shading tube 30 and the horizontal shading tube 84.

With the horizontal shading control circuit, as so far described, voltage variations of horizontal deflection frequency and of variable intensity and duration may be caused to appear at the anode of tube 84 by adjusting potentiometer contacts 82 and 94. These voltage variations, as are caused to appear at the anode of tube 84, are applied to the television transmitting tube circuit through condenser 70 along with the vertical shading control voltage variations from tube 30.

There are instances when it is desirable to use voltage variations other than of substantially sawtooth wave form, since frequently the dark spot variation does not vary linearly. Accordingly, a condenser 98 and a potentiometer 99 are provided and are connected between ground (or a point of fixed potential) and a conductor for supplying voltage variations to the control electrode of the horizontal shading tube 84. By adjusting the movable contact 100 along the potentiometer 99, the condenser 98 may be effectively applied or removed from the circuit in varying degrees in order to attenuate the high frequency component of the voltage variations of sawtooth wave form. When the high frequency components of the voltage variations are suppressed, then the wave form takes the form of a distorted sawtooth wave form or even a parabola and the voltage variations of distorted or parabolic wave form are then applied to the control electrode of the horizontal shading tube 84.

It may be seen, therefore, that in addition to being able to control the intensity and the time duration of the voltage variations, as appearing at the anode of tube 84, the wave form of these voltage variations may also be controlled.

Although in Figure 1 no circuit is shown in the vertical dark spot correction channel for altering the wave form, a parabola or wave form control circuit may be incorporated between potentiometer 26 and tube 30, if it is desired.

Through the use of the present invention, as above described, it is possible to compensate for

the dark spot signal and to substantially completely overcome the effects of the undesired dark spot voltage variation. By an adjustment of the few controls provided, proper intensity balance and dark spot correction may be accomplished. Furthermore, it will be observed that the system described herein is relatively simple and, in fact, includes only two tubes, namely, the vertical shading tube 30 and the horizontal shading tube 84, in addition to the usual tube components in the television transmitter. When the various adjustment are properly set, a properly shaded video or picture signal output may be derived from the output terminals 72.

Although the present invention is described as being applied to a television transmitter of the type wherein a single sided mosaic electrode 14 is used, it is obvious that the system may readily be applied to any type of television transmitting tube where dark spot correction is necessary. A system such as shown and described above may, of course, be readily applied to the so-called image-dissector tube or the system may be applied to a transmitting tube of the image intensifying type. Furthermore, it is not necessary that the correction signal for compensating for dark spot be applied directly to the output of the pre-amplifier of the television transmitting tube, as indicated in Figure 1, although it is preferable to apply the correction signals at this point, since the correction signals may readily be applied to any portion of the complete transmitting system.

Although the system shown and described herein is rather specific in nature, it is to be understood that various alterations and modifications may be made therein without departing from the spirit and scope thereof, and it is desired that any and all such modifications be considered within the purview of the present invention, except as limited by the hereinafter appended claims.

What I claim is:

1. A shading control circuit for a television transmitting system including a discharge tube having a cathode, a control electrode and an anode, means for applying voltage variations of a predetermined wave form between the cathode and control electrode of said tube, the voltage variations corresponding in frequency to one of the television scanning rates, means for controlling the amplitude of the applied voltage variations, means for maintaining the anode positive with respect to the cathode, and means for varying the potential bias between the control electrode and the cathode of said tube whereby the tube will operate on different portions of its characteristic curve to distort the applied wave form and to cause the voltage variations appearing at the output of said tube to be confined to variable portions of each scanning cycle.

2. A shading control circuit for a television transmitting system including a discharge tube having a cathode, a control electrode and an anode, means for applying voltage variations of substantially sawtooth wave form between the cathode and control electrode of said tube, the voltage variations corresponding in frequency to one of the scanning rates, means for controlling the amplitude of the applied voltage variations, means including a load circuit for maintaining the anode positive with respect to the cathode, and means for manually varying the potential bias between the control electrode and the cathode of said tube whereby the tube will operate on different selected portions of its operation characteristic curve to distort the wave form and to cause the voltage variations appearing at the anode of said tube to be confined to selected portions of each scanning cycle.

3. A shading control circuit for a television transmitting system including a discharge tube having a cathode, a control electrode and an anode, means for applying voltage variations of substantially sawtooth wave form between the cathode and control electrode of said tube, the voltage variations corresponding in frequency to one of the scanning rates, means for varying the amplitude of the applied voltage variations, means including a load circuit for maintaining the anode positive with respect to the cathode, means for manually varying the potential bias between the control electrode and the cathode of said tube whereby the tube will operate on different selected portions of its characteristic curve to distort the wave form and to cause the voltage variations appearing at the anode of said tube to be confined to selected portions of each scanning cycle, and whereby the amplitude of the distorted wave form may be controlled.

4. A shading control circuit for a television transmitting system including a discharge tube having a cathode, a control electrode and an anode, means for applying cyclically varying voltages of a predetermined wave form and of a frequency corresponding to one of the television scanning rates between the cathode and control electrode of said tube, means for varying the amplitude of the applied voltage variations, means for maintaining the anode positive with respect to the cathode, and means for altering the average potential bias between the control electrode and cathode to operate the tube at different portions of its characteristic curve to distort the applied wave form and to cause the voltage variations appearing at the output of the tube to be controllable in amplitude and to be confined to selectable portions of each scanning cycle.

5. A shading control circuit for a television transmitting system including a discharge tube having a cathode, a control electrode and an anode, means for applying cyclically varying voltages of substantially sawtooth wave form and of a frequency corresponding to one of the television scanning rates between the cathode and control electrode of said tube, means for varying the amplitude of the applied voltage variations, means including a load circuit for maintaining the anode positive with respect to the cathode, and means for manually altering the potential bias between the control electrode and cathode whereby the tube will operate on different portions of its characteristic curve to distort the applied wave form and to cause the voltage variations appearing at the anode of said tube to be controllable in amplitude and to be confined to selectable portions of each scanning cycle.

6. A shading control circuit for a television transmitting system including a discharge tube having a cathode, a control electrode and an anode, means for applying cyclically varying voltages of substantially sawtooth wave form and of a frequency corresponding to one of the television scanning rates between the cathode and control electrode of said tube, means including a load circuit for maintaining the anode positive with respect to the cathode, means for varying the intensity of the applied voltage variations, and means for manually altering the average poten-

tial bias between the control electrode and cathode whereby the tube will operate on different portions of its characteristic curve to distort the applied wave form and to cause the voltage variations appearing at the anode of said tube to be confined to selectable portions of each scanning cycle.

7. A shading control circuit for a television transmitting system including a discharge tube having a cathode, a control electrode and an anode, means for applying the voltage variations of a predetermined wave form between the cathode and the control electrode of said tube, the frequency of the voltage variations corresponding to one of the television scanning rates, means connected between the cathode and the control electrode of said discharge tube to vary the attenuation of the high frequency component of the voltage variations, means for maintaining the anode positive with respect to the cathode, and means for varying the bias applied between control electrode and cathode whereby the tube may be caused to operate on a selected portion of its characteristic curve to thereby distort the wave form of the applied voltage variations and to cause the voltage variations appearing at the output electrode of the tube to be confined to selectable portions of each scanning cycle.

8. A shading control circuit for a television transmitting system including a discharge tube having a cathode, a control electrode and an anode, means for applying the voltage variations of substantially sawtooth wave form between the cathode and the control electrode of said tube, the frequency of the voltage variations corresponding to one of the television scanning rates, means for controlling the amplitude of the applied voltage variations, manually operable means connected between the cathode and the control electrode of said discharge tube to vary the attenuation of the high frequency component of the voltage variations of sawtooth wave form, means including a load resistance for maintaining the anode positive with respect to the cathode, and manually operable means for varying the potential bias applied between control electrode and cathode whereby the tube may be caused to operate on a selected portion of its characteristic curve to thereby distort the wave form of the applied voltage variations and to cause the voltage variations appearing at the anode of the tube to be confined to selectable portions of each scanning cycle.

9. A shading control circuit for a television transmitting system including a discharge tube having a cathode, a control electrode and an anode, a source of voltage variations of a predetermined wave form and of a frequency corresponding to one of the television scanning rates, means for varying the attenuation of the high frequency component of the voltage variations, means for applying the voltage variations between the control electrode and the cathode of said discharge tube, means for varying the amplitude of the applied voltage variations, means for maintaining the anode positive with respect to the cathode, and means for varying the bias voltage applied between control electrode and cathode whereby the tube may be caused to operate a selected portion of its characteristic curve to cause the voltage variations appearing at the output electrode of said tube to be distorted and to be confined to a variable selected portion of each scanning cycle.

10. A shading control circuit for a television transmitting system including a discharge tube having a cathode, a control electrode and an anode, a source of voltage variations of substantially sawtooth wave form and of a frequency corresponding to one of the television scanning rates, manually controlled means for varying the attenuation of the high frequency component of the voltage variations, means for applying voltage variations between the control electrode and the cathode of said discharge tube, means for varying the amplitude of the applied voltage variations, means including a load circuit for maintaining the anode positive with respect to the cathode and manually controlled means for varying the bias voltage applied between control electrode and cathode whereby the tube may be caused to operate a selected portion of its characteristic curve to cause the voltage variations appearing at the anode of said tube to be distorted and to be confined to a variable selected portion of each scanning cycle.

11. A shading control circuit for a television transmitting system including a first electron discharge tube having a cathode, a control electrode and an anode, means for applying cyclically varying voltage variations of substantially sawtooth wave form and of a frequency corresponding to one of the television scanning rates between the cathode and control electrode of said tube, a second electron discharge tube having a cathode, a control electrode and an anode, means for applying voltage variations of a predetermined wave form between the cathode and the control electrode of said second electron discharge tube, the frequency of the voltage variations corresponding to another of the television scanning rates, means connected between the cathode and the control electrode of said second discharge tube to vary the attenuation of the high frequency component of the voltage variations applied to that tube, means including a common load circuit for maintaining the anodes positive with respect to their associated cathodes, and means for independently varying the average potential bias between the control electrode and cathode of the two tubes whereby they may be caused to operate on independent selected portions of their characteristic curves to thereby distort the wave forms of the voltage variations and to cause the voltage variations appearing at the anodes of the tubes to be confined to selectable portions of each scanning cycle of each of the scanning rates.

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