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TELEVISION SYSTEM

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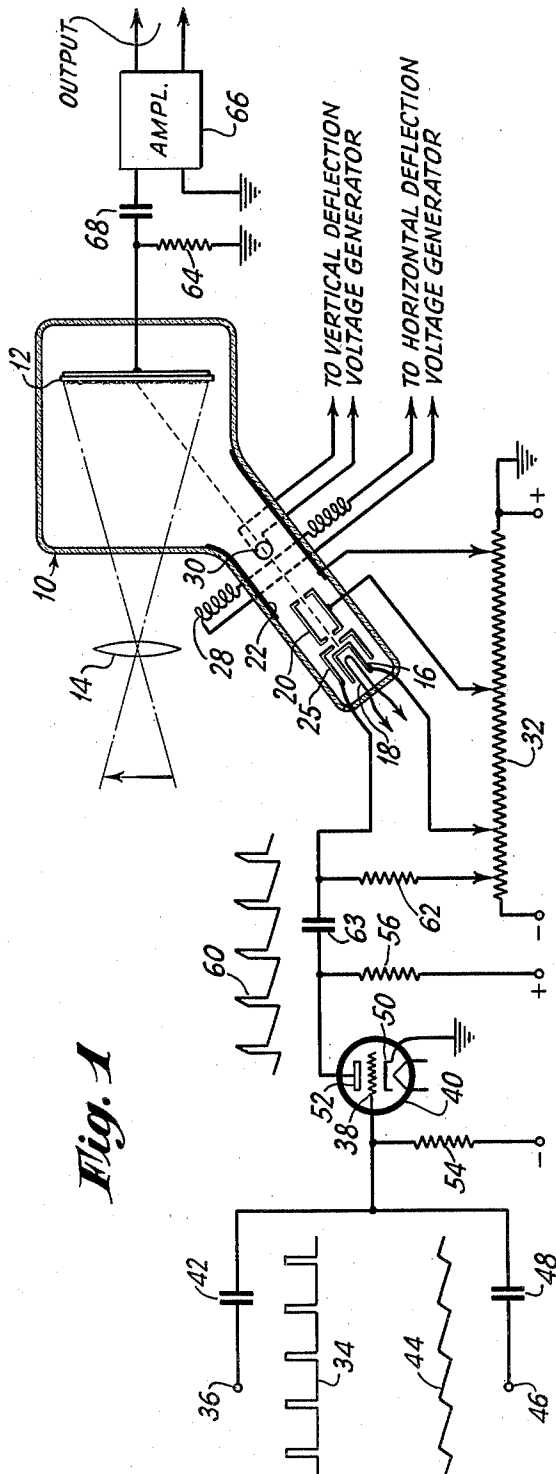


Fig. 1

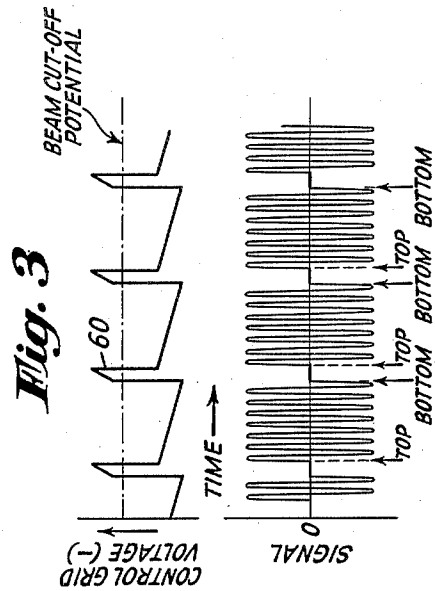


Fig. 3

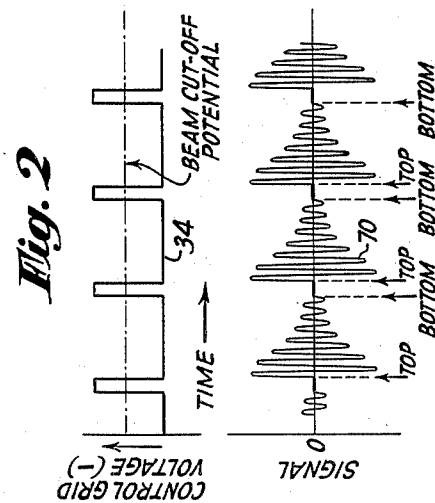


Fig. 2

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TELEVISION SYSTEM

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This invention relates to a television system and more particularly to the manner in which the television transmitting tube is controlled during the scanning of an optical image in order to produce a series of electrical signals truly representative of the light values of the image.

The subject matter of this invention is concerned primarily with the operation of a television transmitting tube (commonly known as an "iconoscope") where the tube is used in connection with the transmission of images derived from a moving picture or cinema film. In the transmission of film by television, where the film movement is intermittent, as is the case where the film is projected in a theatre, the light images of the separate film frames are projected on the light sensitive mosaic electrode of the television transmitting tube for a relatively short space of time, the projection being interrupted for an appreciable length of time during which time the mosaic electrode is scanned by the cathode ray beam and one television field is transmitted. In other words, the mosaic is scanned in darkness, the image of a particular film frame being projected on the mosaic during the vertical return period of the cathode ray beam, which time corresponds to from 7 to 10 percent of the total time required for one complete field scanning cycle. According to systems now conventionally used, 60 television fields are transmitted per second and accordingly the time required for one complete field scanning cycle is $\frac{1}{60}$ of a second and the time between successive field scanning periods, i. e., the vertical return time for the cathode ray beam, is from 7 to 10 percent of this total time.

Inasmuch as the light responsive electrode of the television transmitting tube is supplied with the light image of a particular film frame for a very short space of time, the complete charge image must be built up on the light sensitive electrode during this space of time in order that a series of signals may be produced when the electrode is scanned by the cathode ray beam. Even though the time for one complete field scanning cycle is only $\frac{1}{60}$ of a second, this length of time is, however, sufficient to permit a certain degree of migration of the separate charges of the discrete elements of the photo-mosaic so that that portion of the image which is scanned during the latter portion of the cycle does not supply signals which are as truly representative of the image or as intense as are the signals supplied from that portion of the image which is scanned during the first portion of the cycle.

This is because a shorter space of time transpires between the instant that the charges are stored on the electrode and the instant that they are removed by the scanning cathode ray beam from the top portion (the portion first scanned) of the electrode as compared to the elapse of time between the storage and the removal of the charges from the bottom or lower portion of the electrode.

This migration of the electrical charge on the separate discrete elements of the mosaic electrode is a result of several factors, one of which is the lateral resistivity of the surface of the electrode, which, of course, is appreciable but is not infinite; another is the result of the presence of a cloud of secondary electrons which exists on the scanned side of the mosaic electrode and which is, of course, available to neutralize some of the higher positively charged elements of the mosaic. In addition, various other factors are present, which for one reason or another, may disturb, destroy or tend to neutralize charges which exist on the mosaic electrode of the transmitter tube. Insofar as the neutralization of certain of these charges is concerned by reason of the electrons which exist on the scanned side of the mosaic, it must be remembered that the number of these electrons which are available increases during the field scanning cycle as a result of the bombardment of the cathode ray beam against the electrode and the resulting production of a certain number of secondary electrons therefrom.

This disturbance or redistribution of the charge image which is created on the mosaic electrode has not heretofore been entirely and satisfactorily compensated for, and as a result of this disturbance and change in the charge condition of the elements of the mosaic electrode, particularly at the lower portion of the electrode, the intensity and contrast of the lower portion of the reproduced image is materially reduced as compared to the intensity of the upper portion of the image.

It is therefore one purpose of the present invention to provide means whereby an undesirable change in signal level of the output of a television transmitting tube during successive field scanning cycles may be compensated for.

A further purpose of the present invention resides in the provision of means whereby the intensity of the scanning beam of a television transmitting tube may be cyclically controlled in accordance with the scanning of each field transmitted.

Still another purpose of the present invention resides in the provision of means whereby the intensity of the scanning electron beam in a television transmitting tube may be gradually altered during the interval from the beginning of the scanning of a television field to the end of the scanning of that field.

Still another purpose of the present invention resides in the provision of means whereby the control electrode of a television transmitting tube may be so controlled that the intensity of the signals produced by the tube are cyclically altered in accordance with the scanning of each television field.

Still another purpose of the present invention resides in the provision of means whereby the scanning beam of a television transmitting tube may be entirely biased to cut-off between successive vertical scanning cycles while at the same time the intensity of the scanning beam is gradually increased during the vertical scanning cycle.

Still other purposes and advantages of the present invention will become more apparent to those skilled in the art from a reading of the following specification wherein like reference characters represent like parts, and wherein:

Figure 1 represents one form of the present invention, and

Figures 2 and 3 show diagrammatically the effects which may be produced both before and after the essential elements of the present invention are used.

Referring now to Figure 1, a television transmitting tube is shown generally at 10. The tube includes a mosaic electrode 12, upon which an optical image may be brought to focus by an appropriate lens system 14. This electrode comprises a plurality of discrete light responsive elements, each of which assumes a particular charged condition when light is projected upon the electrode, the amount of the charge depending upon the intensity of the light projected thereon. The tube also includes means for generating a beam of electrons and this means comprises a cathode 16, which is heated directly or indirectly by a heater element 18. The electrons which originate at the cathode 16 are accelerated toward and brought to focus upon the mosaic electrode 12 by means of anodes 20 and 22. Between the cathode 16 and the first anode 20 is positioned a control electrode 25, the potential of which determines the number of electrons which are permitted to be projected through the gun structure for scanning the mosaic electrode 12. In order that the cathode ray beam which is generated by the gun structure may be deflected in substantially bi-lateral directions, a pair of deflecting coils 28 and 30 are provided, the coils 28 operating to cause horizontal deflection of the cathode ray beam whereas the coils 30 are for the purpose of causing vertical deflection of the cathode ray beam. These two coils 28 and 30 are connected respectively to the horizontal and vertical deflection voltage sources. The frequency of the voltage applied to the horizontal deflecting coils 28 is, of course, considerably in excess of the frequency of the voltage applied to the vertical deflecting plates. In systems which have successfully been used, the frequency applied to the vertical deflecting coils may be in the vicinity of 60 cycles, whereas the frequency applied to the horizontal deflecting coils may be in the vicinity of 13,230 cycles. It is to be understood that although electromagnetic deflecting means is shown for deflecting the cathode ray beam in order to

produce scanning of the mosaic electrode, any other appropriate beam deflecting means could be used, such as electrostatic deflecting plates or any combination of electrostatic and electromagnetic deflecting means.

The elements of the electron gun are supplied with proper operating potentials through the use of a potentiometer or voltage divider 32, the second anode 22 of the cathode ray tube being connected at or near the positive end of the potentiometer, whereas the control electrode is adjustably connected toward the negative end of the potentiometer. The control electrode is, of course, normally maintained slightly negative with respect to the cathode 16, as is conventional in electron discharge tubes.

In order to control the potential of the control electrode 25 of the television transmitting tube as desired and in accordance with the invention as referred to above, two sources of cyclically varying potential may be used. These two potentials are combined in order to produce a wave form which is desirable and one which will produce the proper cyclical variation in the potential of the control electrode 25 with respect to the cathode 16.

A wave form such as is shown at 34 is applied to the input terminal 36 which is connected to the control electrode 38 of a discharge tube 40 by means of a condenser 42. A second wave form such as is shown at 44 is applied to the terminal 46 which is also connected to the control electrode 38 of the discharge tube 40 by way of the condenser 48. The discharge tube 40 may be in the form of a triode, and may include an addition to the control electrode 38, a cathode 50 and an anode 52. The control electrode 38 is maintained negative with respect to the cathode 50 by an appropriate source of potential (not shown), the control electrode being connected to the negative terminal of such source of potential through a high resistance 54. Connected in the anode circuit of the discharge tube 40 is a load resistance 56 which is connected to the positive terminal of a source of potential. When the wave forms which are shown at 34 and 44 are applied to the terminals 36 and 46, they both affect the potential of the control electrode 38 and accordingly the discharge current which is permitted to flow through the load resistor 56 varies in accordance with the cyclic voltage variations of both of the wave forms 34 and 44. The potential drop along the resistance 56 depends upon the current flow therethrough, and accordingly the potential of the anode 52 varies in accordance with the current which is permitted to flow through the discharge tube 40.

When the two wave forms shown at 34 and 44 are impressed upon the control electrode of the discharge tube 40, the potential of the anode 52 varies cyclically in a manner such as shown by the wave form 60. The anode 52 of the discharge tube 40 is connected to the control electrode 25 of the cathode ray beam by means of a condenser 63. In order to prevent voltage variations which are present at the anode 52 and which are transferred to the control electrode 25 of the cathode ray tube from being absorbed or reduced in intensity by the source of potential for the cathode ray beam, a resistance 62 is included in the connection between the control electrode 25 and the negative source of potential or the potentiometer 32.

The wave form shown at 34 is more or less similar to the conventional blanking wave form

which is applied to the control electrode of a cathode ray television transmitting tube in order that the cathode ray tube may be biased to cut-off during the vertical return period. This wave form may be derived from any known oscillation source which will produce such a wave form or in fact from any source which is capable of producing the voltage variation shown at 34. The frequency of this voltage variation is, of course, identical with the frequency of vertical scanning which of course corresponds to the rate at which television fields are transmitted.

The saw-tooth wave form shown at 44 may be derived from a relaxation oscillator or a multi-vibrator which is so adjusted that a wave form similar to that shown may be produced. The frequency of this voltage variation is also identical with the vertical scanning period, and accordingly corresponds to the frequency of voltage variation of the wave form shown at 34. These two wave forms are, therefore, of the same frequency and are so adjusted in phase relationship that, when the two wave forms are combined a wave form such as that shown at 60 may be produced.

When the photo-sensitive electrode 12 is scanned by the cathode ray beam, a series of signals representative of the optical image projected thereon is derived from the signal plate of the electrode and these signals are impressed across a load resistor 64 to produce a potential drop which is applied to an amplifier 66 by way of a coupling condenser 68. The output of the amplifier 66 may be used to modulate the television carrier frequency in order that the video signals which are derived from the television transmitting tube may be transmitted to a receiving point in a conventional and known manner.

The operation of the television transmitting tube both without and with the application of the present invention is shown in Figures 2 and 3. In Figure 2 is shown a curve representing the control grid voltage of a television transmitting tube when a single wave form such as 34 is applied thereto. This wave form is of such shape and the voltage of the wave form is of such intensity with respect to the cathode that the cathode ray beam is interrupted or biased to cut-off at a point on the curve shown by the dot-dash line. During the major portion of each cycle the potential of the control electrode is, therefore, such that a beam of predetermined uniform intensity is generated by the cathode ray gun, and, due to the application of deflecting voltages to the deflecting means 28 and 30, the cathode ray beam is caused to scan the light sensitive electrode 12. As a result of this scanning, a series of television picture or video signals may be derived which are represented at 70. It will be seen that these television signals are most intense at the top of each frame, which is the beginning of the field scanning cycle, and decrease according to a particular function to a minimum or lower value at the end of each field scanning cycle, which of course corresponds to the bottom of the picture. Between separate field scanning cycles the beam is interrupted and a new image is flashed upon the light sensitive electrode 12. This light image is then interrupted, and as stated above, the mosaic electrode is scanned in complete darkness and a second series of signals is derived from the mosaic electrode, which series of signals, as stated above, begins with considerable intensity and decreases according to a

particular function to a minimum or lower value at the bottom of the picture. This decrease in signal strength is not desirable since the signal strength should remain uniform, assuming, of course, that the mosaic electrode of the television transmitting tube is, for the purpose of experimentation and illustration, illuminated at uniform average intensity, the image being that of a series of bars.

It has been found that if the intensity of the scanning cathode ray beam is gradually altered or increased during each field scanning cycle, the intensity of the signals derived from the television transmitting tube may also be altered cyclically in accordance with each television field, and for producing this change in beam current during the scanning of each separate television field, a wave form such as is shown at 60 is impressed upon the control electrode 25 of the television transmitting tube. When this is done, as is shown in Figure 3, the output signal strength of the television transmitting tube remains uniform throughout the entire vertical scanning cycle. It is to be understood, however, that the signal strength shown in Figure 3 is that which should be developed if the light sensitive electrode is subjected to uniform average illumination, as was explained above in regard to Figure 2.

It may be seen, therefore, by comparing Figures 2 and 3 that the signal strength produced by a scanning beam of constant current decreases during each vertical scanning cycle, whereas if the cathode ray beam is gradually increased or altered in intensity during the scanning of a television field, that is, during each vertical deflection of the beam, the intensity of the signal may be maintained uniform and no attenuation of the signal results between the beginning of the scanning of a particular television field and the conclusion of the scanning of the same field.

Obviously, when the signals represented in the lower portion of Figure 3 are transmitted and received at a remote point, and used to control a television receiving apparatus, the screen of the television receiving apparatus will appear uniformly illuminated, and the contrast of the image produced will be the same over the whole picture area, as should be the case. However, if signals such as are shown in the lower portion of Figure 2 are transmitted, the viewing screen of the television receiving set will show a satisfactory degree of contrast at the top portion, the contrast gradually decreasing toward the lower portion of the picture area, which is improper and not in accordance with the presupposed condition at the television transmitting station.

The amount by which the scanning beam must be increased in intensity may be ascertained by experimentation, and furthermore, the amount of increase of beam intensity may be readily controlled by varying the intensity of wave form 44 which is applied to the terminal 46. Any conventional means for varying the intensity of this voltage variation as applied to the terminal 46 may, of course, be used. It is therefore obvious that the percentage of variation in the intensity of the scanning beam may be readily controlled during the actual operation of the system by merely adjusting the voltage wave form applied to the terminal 46.

It is not necessary that a separate wave form 44 be used since the parameters of the discharge

tube 40 and the immediately associated circuit may be so chosen that the wave form supplied by the tube is similar to that shown at 60. If the resistances 54, 56 and 62 are made relatively large, and the condenser 63 made relatively low in impedance, i. e., large in capacity, the condenser would offer relatively low impedance to low frequency voltage variations, and the wave form such as shown at 60 could be produced merely by the application of a wave form such as shown at 34. This method of producing the desired wave form may be used, particularly after the degree of beam variation is ascertained, by experimentation, since the values of the resistances 54, 56 and 62, as well as the value of the condenser 63 may be so chosen that the desired wave form is produced.

It may be seen, therefore, that through the use of the above invention, and through the application of appropriate potentials to the control electrode 25, the intensity of the cathode ray beam which is used to scan the light responsive electrode 12 may be so varied that the cyclic attenuation of the signals derived from the television transmitting tube may be compensated for. As stated above, these attenuations are due to various reasons and are present particularly where the light responsive electrode is subjected to a light image only for a very brief space of time, the light responsive electrode being scanned during the non-illuminated condition of the electrode as is the case when moving picture film is transmitted by television by the normal intermittent method.

It has been found that the amount of variation in beam current necessary to compensate for this attenuation is not appreciably great and that the control electrode 25 may be readily varied in potential and accordingly the cathode ray beam may be readily varied in intensity by an amount sufficient to produce the desired result and to compensate for the attenuation due to equalization of the charge of the light responsive electrode during the vertical scanning cycle.

Although the applicant's invention is shown as associated with a more or less specific type of television transmitting tube, it is to be understood that the invention may as well be applied to various other transmitting tubes wherein the beam current is controllable, and in which the tube readily adapts itself for producing a series of television or video signals from images derived from a moving picture film.

Various other modifications and alterations may be made in the present invention 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.

I claim:

1. A television transmitting system comprising a cathode ray tube, a light responsive electrode in such tube upon which an optical image is adapted to be intermittently projected to produce a charge image on the electrode, means for producing a beam of electrons and for directing the beam in the direction of said electrode, means for deflecting the cathode ray beam in substantially mutually perpendicular directions in order to scan said electrode between each intermittent light projection to produce picture signals thereby, and means for cyclically varying the intensity of the cathode ray beam at a predetermined rate in synchronism with its deflection in one of said direc-

tions to compensate for undesired changes in the picture signal strength during each scanning cycle as a result of a change in the produced charge image during the time interval between the projection of the light image onto the electrode and the scanning of a particular portion of the electrode.

2. A television transmitting system comprising a cathode ray tube, a light responsive electrode in said tube upon which a light image is intermittently and successively projected, means for producing a beam of electrons in said tube, means for horizontally deflecting the beam of electrons at a predetermined scanning rate, means for vertically deflecting the beam of electrons at a different scanning rate in synchronism with and during the intervals between the successive light projections whereby said electrode may be scanned to produce picture signals, and means for cyclically altering the intensity of the cathode ray beam by a predetermined substantially fixed amount during each vertical deflection period in order to compensate for changes in the produced charge image during the time interval between the projection of the light image onto the electrode and the scanning of a particular portion of the electrode whereby substantially constant picture signal strength throughout each scanning cycle may be maintained.

3. A television transmitting system comprising a cathode ray tube, a photosensitive mosaic electrode positioned in said tube upon which a light image is adapted to be intermittently projected, means for producing a beam of electrons and for directing the electrons in the direction of the electrode, means for rapidly deflecting the cathode ray beam in substantially mutually perpendicular directions in order to produce successive scanings of the electrode in synchronism with and during the intervals between the intermittent light image projections to produce picture signals, means for extinguishing the beam of electrons between the successive scanings and during each light image projection, and means for gradually changing the intensity of the cathode ray beam by like amounts during deflection in one of said directions of each scanning cycle in order to compensate for undesired changes in the picture signal strength during each scanning cycle that result from changes in the produced charge image during the time interval between the projection of the light image onto the electrode and the scanning of a particular portion of the electrode.

4. A television transmitting system comprising a cathode ray tube, a light responsive electrode positioned in said tube, means for producing a beam of electrons and for projecting the beam against said electrode, means for rapidly deflecting the cathode ray beam in substantially mutually perpendicular directions in order to rapidly and cyclically scan the said electrode, means for intermittently projecting an optical light image upon said electrode during the interval between successive scanings to produce a charge image on said electrode, and means for gradually and cyclically changing the intensity of the cathode ray beam during each scanning cycle to compensate for changes in the intensity of the charge image on the unscanned portion of the electrode that occur during the interim between the projection of the light image onto the electrode and the scanning of the particular portion of the electrode.

5. In a television transmitting system includ-

ing a light responsive electrode on which an optical light image is intermittently projected, means for intermittently scanning said electrode by a cathode ray beam in substantial darkness between successive light projections to produce electrical signal variations, and means for gradually and cyclically altering the intensity of the cathode ray beam between predetermined limits and at a substantially constant predetermined rate during each scanning cycle to compensate for undesired changes in the signal strength during each scanning cycle that result from changes in the produced charge image during the time interval between the projection of the light image onto the electrode and the scanning of the entire electrode.

6. In a television transmitting system including a light responsive electrode upon which a light image is intermittently projected to produce a charge image, means for intermittently and cyclically scanning said electrode by a cathode ray beam during the periods of substantial darkness between successive light projections to produce picture signals, and means for gradually and continuously increasing the intensity of the cathode ray beam during each scanning cycle whereby the effect of changes in the produced charge image on the unscanned portion of the electrode during the scanning cycle may be overcome and whereby the produced picture signals

may be caused to remain substantially proportional to the intensity of the projected light image.

7. A television transmitting system comprising a cathode ray tube, a photosensitive mosaic electrode positioned in said tube upon which a light image is adapted to be intermittently projected to produce a charge image on said mosaic electrode, means for producing a beam of electrons and for directing the electrons against said electrode, means for rapidly deflecting the cathode ray beam in substantially mutually perpendicular directions in order to produce successive scanings of said electrode between the intermittent light image projections to produce picture signals from the charge image, means for extinguishing the beam of electrons between the successive scanings and during the light image projections, and means for gradually and cyclically increasing the intensity of the cathode ray beam by a predetermined amount throughout each scanning cycle to compensate for undesired changes in the picture signal strength during each scanning cycle that result from changes in the produced charge image during the time interval between the projection of the light image onto the electrode and the scanning of a particular portion of the electrode.

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