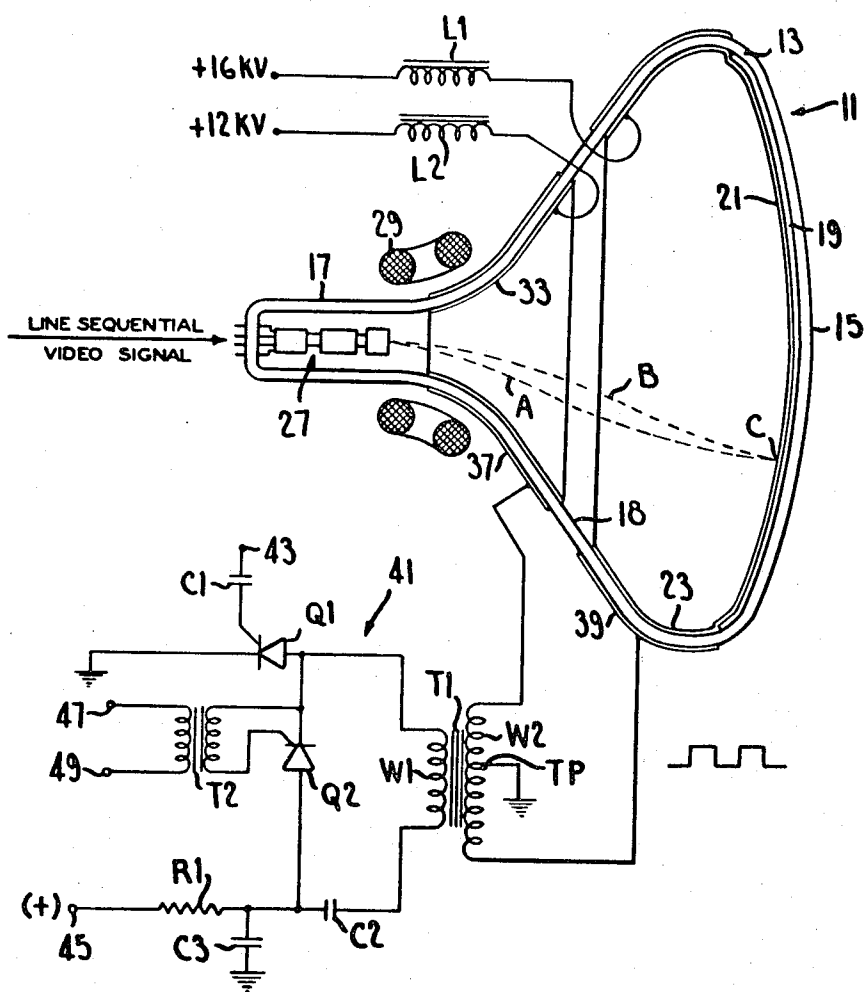


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Filed May 31, 1966

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3,372,298

COLOR DISPLAY SYSTEM

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Filed May 31, 1966, Ser. No. 553,771

9 Claims. (Cl. 315-14)

This invention relates to a color display system and more particularly to such a system which produces multiple color images having color image components which are in substantial registration.

Various kinescope color display systems have been proposed in which electrons of different energies are employed to produce a light of different colors. These known systems typically employ a phosphor screen including a plurality of phosphors which emit light of different colors when struck by electrons having different energies. The screen voltage is varied with time to provide at least two different voltage levels. The energies of electrons impinging upon the screen are thus similarly varied. One problem with this type of display system is that it is difficult to scan the screen uniformly with the electrons of differing energies, since the higher energy electrons are less subject to deflection by the magnetic or electric fields conventionally employed to sweep a beam of electrons in a raster over a phosphor screen than the lower energy electrons. Thus, if this difference in deflection is not compensated for, misregistration will result.

It has been found that by providing a generally annular electrode through which the electrons pass on their way to the screen and by applying time-varying voltages to this electrode which are out-of-phase with the changes in the voltage applied to the screen, a compensating effect may be obtained which causes electrons of the different energies to experience the same total deflection before reaching the screen. The screen and the electrode are both operated at relatively high D.C. voltages and, as a result, systems for applying the various time-varying or switched voltages described above have required either high-voltage insulation of the source providing the time-varying voltages or high-voltage capacitors for coupling the time-varying voltages to the annular electrode and the screen.

Among the several objects of the present invention may be noted the provision of a color display system which produces multiple-color images having color image components which are in substantial registration; the provision of such a system in which the energy of an electron beam is varied to produce light of different colors on a screen including a plurality of phosphors which emit light of different colors when struck by electrons of different energies; the provision of such a system which requires only a single electron gun; the provision of such a system in which the screen voltage is varied with time to provide different electron energies; the provision of such a system employing a generally annular electrode through which electrons pass on their way to the screen, which electrode is provided with a time-varying voltage out-of-phase with the voltage applied to the screen to obtain deflection compensation for electrons of differing energies; the provision of such a system employing novel and inexpensive apparatus for applying out-of-phase voltages to the electrode and the screen; and the provision of such a system which is reliable and which is relatively simple and economical. Other objects and features will be in part apparent and in part pointed out hereinafter.

Briefly, a color display system of this invention employs a kinescope including an envelope of dielectric material. The envelope has a face portion, a neck portion and an intermediate portion connecting the neck portion to the face portion. A phosphor screen, including a plurality of phosphors which emit light of different colors when struck

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by electrons of different energies, is supported on the inner surface of the face portion of the envelope. A first conductive band extends around the inner surface of the intermediate portion of the envelope adjacent the phosphor screen. This first conductive band is electrically connected to the screen for applying electron accelerating voltages thereto. The kinescope also includes a single electron gun in the neck portion of the envelope for emitting a beam of electrons toward the screen. A second conductive band extends around the inner surface of the intermediate portion of the envelope adjacent the neck portion and this second band forms a generally annular electrode which is substantially concentric with the electron gun and axially displaced therefrom toward the screen.

A third conductive band is spaced substantially equidistantly outwardly away from the first band and is in substantial juxtaposition therewith. The first and third bands thus form, with the envelope, a capacitor which couples time-varying signals from the third band to the first band. A fourth conductive band is positioned substantially equidistantly outwardly away from the second band and in substantial juxtaposition therewith, the second and fourth bands forming, with said envelope, a capacitor for coupling time-varying signals from the fourth band to the second band.

D.C. bias voltages are applied to the first and second bands to accelerate electrons emitted from the gun toward the screen and field generating means are provided for deflecting the beam of electrons in a scanning raster. Out-of-phase time-varying voltages are applied to the third and fourth bands whereby electrons emitted from the gun are accelerated to at least two different energies for energizing said screen to produce multiple-color images having color image components which are in substantial registration.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

The accompanying drawing, in which one of various possible embodiments of the invention is illustrated, is a partially schematic diagram of a color display system of this invention.

Referring now to the drawing, there is indicated at 11 a color kinescope constructed according to the present invention. Kinescope 11 includes a conventional glass shell or envelope 13 having a face portion 15, a neck portion 17 and a generally bell-shaped intermediate portion 18 connecting the neck and face portions. Coated on the inner surface of the face portion 15 is a phosphor layer or screen 19 which includes phosphors which emit light of different colors when struck by electrons of different energies. Phosphor screen 19 may, for example, be constituted by a mixture of two different kinds of phosphor particles one of which emits red light when energized by electrons having energies above a relatively low predetermined level and the other of which emits cyan light when energized by electrons having energies above a relatively high predetermined level. Such a screen will emit red light when struck by electrons at the relatively low level and will emit white or substantially achromatic light when struck by electrons at the relatively high energy level, which electrons can energize both of the phosphors. Such red-white image displays are known in the art for the presentation of color images and images so presented appear to have a relatively wide range of hues subjectively having a greater saturation than that which is actually present in the colorimetric sense. Methods of preparing phosphors useful in the present invention are disclosed in copending application Ser. No. 459,582, filed May 28, 1965.

Over phosphor screen 19 is deposited a film 21 of aluminum which is conductive and yet is also thin enough to be substantially electron permeable. By means of film 21 suitable electron accelerating voltages may be applied to

the phosphor screen 19. Aluminum film 21 also extends beyond the face portion 15 of kinescope 11 onto a pre-selected margin of the intermediate portion 18 of envelope 13 thereby constituting a first conductive band 23 on the intermediate portion.

Within the neck portion 17 of envelope 13 there is mounted a conventional electron gun 27 for emitting a beam of electrons directed toward phosphor screen 19. For the purpose of the example described herein, it is assumed that this color display system is operated in a line sequential mode. For this purpose a line sequential, color video signal is applied to gun 27 for varying the electron beam current, that is, the rate at which electrons are emitted by the gun. The video signal thus controls the instantaneous brightness of the light produced by the beam on phosphor screen 19. It should be understood, however, that a dot sequential or field sequential presentation of the different colors may also be employed by appropriately varying the different switching rates described hereinafter and applying a corresponding video signal to gun 27.

Electrons emitted from gun 27 pass through the magnetic influence of a deflection yoke 29. Yoke 29 is energized in conventional manner to deflect the beam of electrons in a scanning raster over the envelope face portion 15. However, as is understood by those skilled in the art, the raster will be of uniform size only if the electrons emitted by gun 27 are all accelerated to the same energy or if compensation is made for the different deflection effects experienced by electrons having different energies.

The inner surface of the part of the intermediate envelope portion 18 adjacent neck 17 is coated with a conductive band as indicated at 33 thereby to constitute a generally annular, horn-shaped electrode which is concentric with gun 27 and through which the beam of electrons emitted by the gun pass on their way to phosphor screen 19. Band 33 may conveniently be constituted by a so-called "dag" coating on envelope 13. As is explained in greater detail hereinafter, electrode band 33 is employed to exercise a radial corrective effect on the deflection of the electron beam passing therethrough. Electrical connections are made to the electrode band 33 and to the phosphor screen-covering aluminum film 21 as indicated at 37 and 39 and these connections extend through envelope 13 by means of conventional feed-through terminals (not shown). Respective D.C. biasing potentials are applied to electrode band 33 and to the screen 19 through chokes or inductors L1 and L2 which serve to effectively block A.C. or time-varying voltages as explained hereinafter. Appropriate nominal D.C. potentials for electrode 33 and screen 19 are approximately 12 and 16 kilovolts, respectively.

On the outside of the intermediate portion 15 of envelope 13 there is deposited a band 37 of a conductive material such as aquadag or aluminum in juxtaposition with band 33. Band 37 is thus spaced substantially equidistantly outwardly from electrode band 33 and is thus capacitively coupled to it through the glass envelope 13. A similar band 39 of conductive material is deposited on the envelope 13 in juxtaposition with the marginal band 23 of the aluminum film covering phosphor screen 19. Conductive band 39 is thus capacitively coupled to the screen 19 through the glass envelope 13. In addition to providing a means for capacitively coupling A.C. or time-varying voltages to electrode band 33 and screen band 23, the outside bands 37 and 39 also effectively shield these elements so that their shunt capacitances to ground are reduced making them easier to drive to the desired voltage levels.

Aluminum bands 37 and 39 are provided with out-of-phase time-varying voltages, and in particular with voltage waves of rectangular waveform and of several kilovolts amplitude, by the circuit indicated generally at 41. Other known circuits for generating such waveforms may also be used. Bands 37 and 39 are connected to the opposite ends of the secondary winding W2 of a transformer T1. Winding W2 includes an intermediate tap TP which is connected to ground. Transformer T1 also includes a pri-

mary winding W1, one end of which is connected to ground through the anode-cathode circuit of an SCR (silicon controlled rectifier) Q1. Triggering signals applied to a terminal 43 are coupled to the gate terminal of SCR Q1 through a coupling capacitor C1. The other end of winding W1 is connected to a positive supply terminal 45 through a D.C. blocking capacitor C2 and a current limiting resistor R1. The voltage existing between capacitor C2 and resistor R1 is smoothed by a filter capacitor C3. Primary winding W1 and capacitor C2 together are shunted by the anode-cathode circuit of a second SCR Q2. Triggering signals for SCR Q2 applied to a pair of terminals 47 and 49 are coupled to the gate-cathode circuit of the SCR by a transformer T2.

The operation of circuit 41 is explained in greater detail in copending U.S. application Serial No. 553,946, filed May 31, 1966. For the purpose of the present invention, however, the following brief explanation of its operation is sufficient.

When SCR's Q1 and Q2 are triggering alternately, a voltage of rectangular waveform is applied to each of the bands 37 and 39, the two signals being out-of-phase with respect to ground potential. The rectangular waveforms applied to bands 37 and 39 are capacitively coupled to the electrode band 33 and to the screen 19 respectively, this coupling being accomplished without any need for expensive high voltage capacitors separate from the kinescope. The waveforms are, however, effectively blocked from the D.C. sources biasing these elements by the inductors L1 and L2 as noted previously. Similarly, the D.C. biasing voltages are effectively blocked from the stepped voltage source by the capacitances between the various conductive bands and thus the secondary winding W2 of transformer T1 operates effectively at D.C. ground potential and does not have to be heavily insulated. Electrons emitted by gun 27 during the different time intervals corresponding to the two different voltage levels of the rectangular waveform are thus accelerated to different energy levels before reaching phosphor screen 19. The energy levels are adjusted in relation to the characteristics of the phosphors which make up screen 19 so that the lower energy electrons excite only the red phosphor while the higher energy electrons excite both the red and cyan phosphors thereby causing white light to be emitted.

The frequency of the rectangular wave is adjusted and synchronized so that the different accelerating voltages are produced during periods which correspond to the sequencing of the color video signal applied to gun 27. The beam current is thus modulated to reproduce the various image components in their respective colors. In the example illustrated this is assumed to be at a line sequential rate.

The color display system illustrated is operated to produce color images having component color images which are in substantial registration as follows, a red-white, line-sequential mode of operation being assumed. At the start of a white line, SCR Q1 is triggered so that the aluminum band 39 is driven positive with respect to ground. Because of the capacitive coupling between this band and the aluminum layer 21, the screen 19 is driven to the higher of its two potentials and electrons emitted from gun 27 are accelerated to a relatively high energy level. These electrons thus produce white light when they strike phosphor screen 19 as explained previously. As the band 39 is driven to a positive voltage, the band 37 is driven to a negative voltage and thus the electrode 33 is capacitively driven to the lower of its two voltage levels. Accordingly, electrons emitted from gun 27 are not greatly accelerated as they first leave the gun but rather attain only a relatively low velocity in the region of the yoke 29. These electrons are thus relatively highly subject to deflection by the yoke's field and therefore follow a path having an early high curvature as represented at A. As these electrons leave the vicinity of electrode 33, however, they are subjected to a relatively intense electric field and are thus accelerated to approach screen 19 at a relatively steep angle, impinging at a point indicated at C.

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When a red line is to be displayed, the SCR Q2 is triggered and the aluminum band 39 is driven negatively with respect to ground. The screen 19 thus assumes the lower of its two voltage levels. The total acceleration experienced by electrons emitted by gun 27 is then relatively small and only the red phosphor is energized.

Simultaneously with the application of the negative voltage to aluminum band 39, a positive voltage is applied to band 37 so that the electrode 33 is capacitively driven to the higher of its two voltage levels. Electrons emitted from gun 27 during this period are thus rapidly accelerated as they first leave the gun and thus are not greatly deflected by yoke 29. These electrons thus follow a path substantially as indicated at B. As the screen 19 is then at the lower of its two potentials, these electrons are not further greatly accelerated and therefore approach the screen substantially at the angle determined by their earlier deflection, striking the screen substantially at the same point C as the higher energy electrons following the path A.

As the particular configuration of the kinescope 11 will affect the distribution of the electric fields within the kinescope, as will the boundaries of the electrode band 33 and the aluminum screen coating 21, it may be seen that the particular D.C. biasing voltages and rectangular wave amplitudes which must be applied to achieve best registration will vary from tube to tube. Typically the rectangular waves coupled to the focusing electrode and to the screen will have to be of somewhat different amplitudes, the intermediate tap TP being shown off-center for this reason.

The present invention may also be employed to obtain proper registration of color image components in a three-color display system in which case out-of-phase time-varying voltages having three discrete steps may be applied to the compensating electrode and to the phosphor screen.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A color display system comprising:

a kinescope including,

an envelope of dielectric material, said envelope having a face portion, a neck portion and an intermediate portion connecting said neck portion to said face portion,

a phosphor screen on the inner surface of the face portion of said envelope, said phosphor screen including a plurality of phosphors which emit light of different colors when struck by electrons of different energies,

a first conductive band around the inner surface of the intermediate portion of said envelope adjacent said phosphor screen and electrically connected thereto for applying electron accelerating voltages to the screen,

a single electron gun in the neck portion of said envelope for emitting a beam of electrons toward said screen,

a second conductive band around the inner surface of the intermediate portion of said envelope adjacent said neck portion forming a generally annular electrode which is substantially concentric with said gun and axially displaced therefrom toward said screen,

a third conductive band substantially equidistantly spaced outwardly away from said first band and in substantial juxtaposition therewith, said

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first and third bands forming with said envelope a capacitor for coupling time-varying signals from said third band to said first band, and

a fourth conductive band substantially equidistantly spaced outwardly away from said second band and in substantial juxtaposition therewith, said second and fourth bands forming with said envelope a capacitor for coupling time-varying signals from said fourth band to said second band;

means for applying D.C. bias voltages to said first and second bands to accelerate electrons emitted from said gun toward said screen;

field generating means for deflecting said beam of electrons in a scanning raster; and

means for applying out-of-phase time-varying voltages to said third and fourth bands whereby electrons emitted from said gun are accelerated to at least two different energies for energizing said screen to produce multiple-color images having color image components which are in substantial registration.

2. A color display system as set forth in claim 1 wherein said third and fourth bands are outside of said envelope.

3. A color display system as set forth in claim 1 wherein said envelope comprises a glass shell and said third and fourth bands each comprise a conductive coating deposited on the outer surface of said shell.

4. A color display system as set forth in claim 1 wherein said electron gun includes means for modulating the electron beam current in response to a sequential video signal.

5. A color display system as set forth in claim 1 wherein the means for applying D.C. bias voltages to said first and second bands includes respective inductors connected to those bands for effectively blocking time-varying voltages coupled thereto by said third and fourth bands.

6. A color display system as set forth in claim 1 wherein the means for applying out-of-phase time-varying voltages to said third and fourth bands comprises a transformer having secondary winding means connected to said third and fourth bands and operated substantially at D.C. ground potential.

7. A color display system as set forth in claim 1 wherein the means for applying out-of-phase time-varying voltages to said third and fourth bands comprises a transformer including a secondary winding having end taps connected to said third and fourth bands and an off-center intermediate tap which is connected to ground whereby said secondary winding is operated substantially at D.C. ground potential.

8. A color display system as set forth in claim 1 wherein said field generating means comprises a magnetic deflection yoke.

9. A color display system comprising:

a kinescope including,

a glass envelope, said envelope having a face portion, a neck portion and an intermediate portion connecting said neck portion to said face portion,

a phosphor screen on the inner surface of the face portion of said envelope, said phosphor screen including a plurality of phosphors which emit light of different colors when struck by electrons of different energies,

a first conductive band around the inner surface of the intermediate portion of said envelope adjacent said phosphor screen and electrically connected thereto for applying electron accelerating voltages to the screen,

a single electron gun in the neck portion of said envelope for emitting a beam of electrons toward said screen, said gun including means for modulating the electron beam current in response to a sequential video signal,

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a second conductive band around the inner surface of the intermediate portion of said envelope adjacent said neck portion forming a generally annular electrode which is substantially concentric with said gun and axially displaced therefrom toward said screen, 5

a third conductive band on the outer surface of said glass envelope in substantial juxtaposition with said first band, said first and third bands forming with said glass envelope a capacitor for coupling time-varying signals from said third band to said first band, and 10

a fourth conductive band on the outer surface of said glass envelope in substantial juxtaposition with said second band, said second and fourth bands forming with said envelope a capacitor for coupling time-varying signals from said fourth band to said second band; 15

means for applying D.C. bias voltages to said first and second bands to accelerate electrons emitted from 20

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said gun toward said screen, said means including inductors for effectively blocking time-varying voltages;

a magnetic deflection yoke for deflecting said beam of electrons in a scanning raster; and

means for applying out-of-phase time-varying voltages to said third and fourth bands whereby electrons emitted from said gun are accelerated to at least two different energies for energizing said screen to produce multiple-color images having color image components which are in substantial registration.

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