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STATIC COLOR SHIFT CATHODE RAY TUBE HAVING CONTROL FOR SHIFTING
COLOR AT TIME AFTER THE PATTERN PICTURE CHANGES
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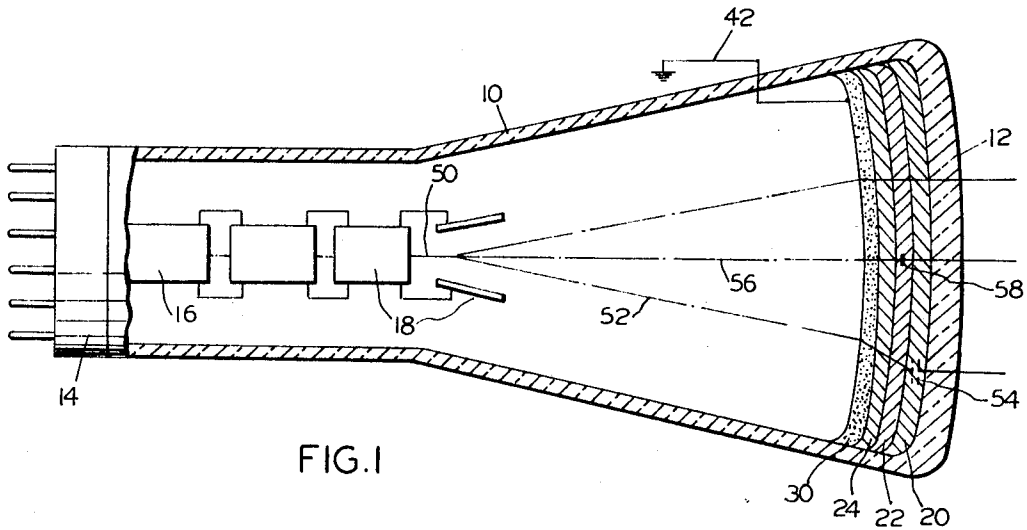


FIG. 1

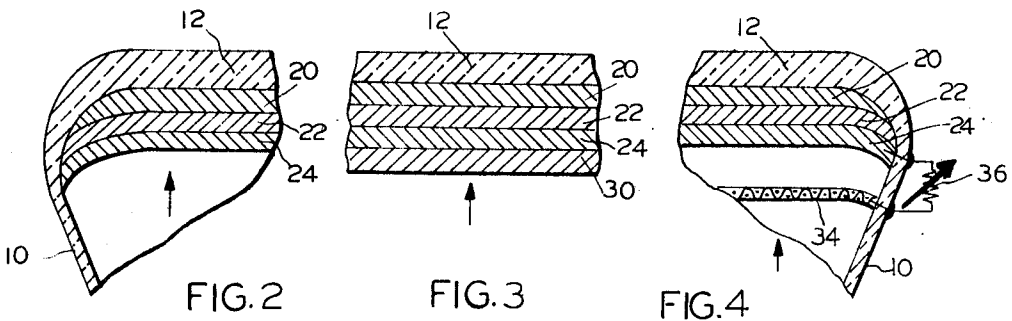


FIG. 2

FIG. 3

FIG. 4

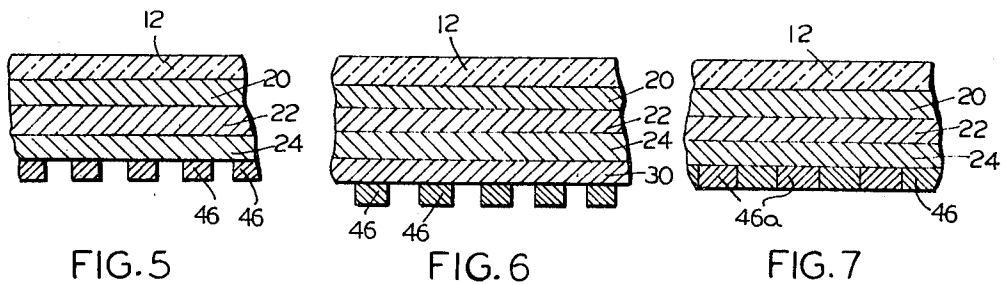


FIG. 5

FIG. 6

FIG. 7

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**STATIC COLOR SHIFT CATHODE RAY TUBE
HAVING CONTROL FOR SHIFTING COLOR
AT TIME AFTER THE PATTERN PICTURE
CHANGES**

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10 Claims

ABSTRACT OF THE DISCLOSURE

A static color-shift cathode ray tube having the characteristics otherwise general to a black and white cathode ray tube, being provided with two or three phosphor films having the elements thereof being presented with changes in voltage-dwell time or frequency repetition rate characteristics of the beam, so that a static charge is derived from the voltage-dwell time characteristics in response to energization of the control layer electrode to shift the production of the static charge to the phosphor film receiving the beam at an element next adjacent beamward, and in this way produce a static charge, each of the static charges producing and emitting a color characteristic of the phosphor material. The control layer electrode may be of resistive dielectric material such as semiconductive material including titanium dioxide (TiO_2) or silicon monoxide (SiO), and a spatially disposed screen or conductive layer segments of wire such as platinum may also be disposed in constructing the control layer electrode.

The present invention relates to cathode ray tubes in which the trace on the face thereof changes color dependent upon the voltage-dwell time characteristics of its beam, or the number of times an electron beam traverses the same spot on the screen within a given short period of time, and more particularly the invention relates to a cathode ray tube for color image reproduction having a plurality of phosphor layers of luminescent material on the screen thereof in which the respective phosphor films may present a color image depending upon the voltage-dwell time that an electron beam provides for an accumulation of an electrical charge from the beam in response to increased voltage-dwell time characteristics, or a relatively frequent repetition rate for developing a charge on one layer and tending to repel the penetration of the beam beyond said charged layer, and thus illuminate that phosphor film with its characteristic color.

It is therefore an object of the present invention to provide multi-color screens for cathode ray tubes in which the simplicity of the electronics and the construction thereof is a substantial improvement over the prior art.

Another feature of the invention is that the screens of the invention may be used for producing vivid colors in various existing scan conversion and storage tubes with little change in the tube design, including providing the screens of the invention in rebuilt tubes, and also using the same signal inputs that are presently used for producing half tones.

Another object of the invention is that simple cathode ray tubes may be used with the invention for providing color displays that are produced by multiple guns or with a single gun focused by a mesh provided near the screen and modulated by post-gun acceleration.

It is a further object of the invention to provide a static charge color shift cathode ray tube arrangement in which the system of phosphor layers or films is provided on the face of the cathode ray tube in which a beam is

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provided to impinge upon one of the phosphors as controlled by a charge control layer which provides an accumulated charge for impeding the beam from traversing beyond the accumulated charge of the phosphor layer, by which the accumulated charge repels the beam from penetrating beyond the charged phosphor layer. The amount of the accumulated charge is dependent upon a voltage-dwell time or frequency repetition rate of the beam of a particular selected point, element or zone on the charge control layer. By controlling the amount of accumulated charge in the control layer, a large voltage-dwell time or frequency repetition of the charge control layer repels the beam and restricts the penetration of the beam to the elements to the next adjacent phosphor layer, and which charged film element may emit a color such as green. A moderate dwell time or occasional repetition of the charge control layer provides for a small charge accumulation and permits the beam to penetrate to the second phosphor layer which may emit a color such as blue. A short dwell time or substantially no repetition of sweep of the beam over the selected zone of the charge control layer provides for no accumulated charge in the control layer so that the beam will penetrate to the layer or film most distant from the gun and provide a color which may be selected as red. The colors may be combined and selected so that all the colors of the visible spectrum may be accordingly produced.

A complete understanding of the invention may be had from the following description of a particular embodiment of the invention. In the description, reference is made to the accompanying drawings of which:

FIG. 1 is a schematic diagram of a cathode ray tube embodying a control layer, several phosphor layers, and other conventional components of a cathode ray tube in accordance with the system of the present invention;

FIG. 2 shows a broken away portion of a portion of a cathode ray tube in which three phosphor layers are provided to produce the color image while the back phosphor layer acts as a charge control layer, in accordance with another embodiment of the present invention;

FIG. 3 shows a broken away portion of a screen of a cathode ray tube in schematic form in which three phosphor layers and a resistive dielectric control layer are provided in accordance with another embodiment of the invention;

FIG. 4 shows a broken away portion of a schematic diagram of a cathode ray tube in which three layers of phosphor film are used with a control layer of metal mesh being spatially disposed with respect to the phosphor layers for producing the improved color image in accordance with another embodiment of the invention; and

FIGS. 5, 6 and 7 show other embodiments of the invention using various control layer or grid arrangements in accordance with other embodiments of the invention.

Referring now to the drawings, there is shown a cathode ray tube 10 having a display surface or screen 12, and in which at the distal end thereof are mounted electrical connections for the plug 14, from which is mounted and supported the writing gun 16, and the deflection system 18. Conventional collimating system may be provided depending upon the space and parameters of the size of the tube, as required.

On the interior surface of the display or screen 12 there is a first phosphor film or layer 20 that may be chosen so that upon it receiving a space charge from the gun 16, and upon the necessary creation of such charge by voltage-dwell time of the beam on a particular element of said phosphor layer 20, or due to the frequency repetition rate characteristics of the beam over such element as the layer, the phosphor layer will emit its characteristic color, which in one case may be a red.

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Similarly, a continuous phosphor layer of luminous material in the form of a film or laminar form is superimposed upon layer 20, the layer 22 being selected to emit a color such as a green, and a third or back phosphor layer or film 24 is selected so that it similarly will emit a blue.

Superimposed on the back phosphor layer 24 there is shown in FIGS. 1 and 3 a resistive-dielectric charge control layer electrode 30 which may be a thin metal or dielectric film of a material such as evaporated gold, titanium dioxide (TiO_2), silicon monoxide (SiO), or other type of semiconductive material, defined in its general sense. Also, the material may be a mixture of controlled conductivity and dielectric properties, such as platinum and quartz, for effecting a control of the time constant and resolution characteristics of the cathode ray tube sometimes known as semiconductor material.

FIG. 2 shows phosphor layers 20, 22, 24, each which emits light of a different color. The back phosphor layer electrode 24 may also function as a charge control layer due to its ancillary characteristic of having the properties of a resistive-dielectric material. While FIG. 2 shows the back phosphor layer electrode 24 performing the function and acting as a charge controlled layer electrode, FIG. 4 demonstrates an embodiment in which there is a metal mesh screen 34 that is disposed continuously across the width of the cathode ray tube 10 at the point where it is spatially disposed from the free surface of phosphor layer 24. In order to orient electrically the relationship between the phosphor layer electrode 24 and the metal mesh or screen 34, a variable resistance 36 is connected between them.

The layers 20, 22 are of transparent material, and layers 24 as well as the charge control layer 30 may also be transparent if desired. The transparent layers allow light emitted from the back layer to be clearly visible through the face of the tube. The back layer 24 need not be transparent, but it needs to be sufficiently thin enough so that an electron beam of normal voltage used in cathode ray tubes, such as voltages from 2 to 20 kv, may penetrate completely through to succeeding layers without being repelled. The back phosphor layer 24 or the resistive-dielectric control layer electrode 30 acts as a dielectric to accumulate a charge from the electron beam. See FIGS. 1, 2 and 3. This charge tends to repel the electron beam and to prevent the beam from penetrating beyond the back phosphor layer. This charge control layer 30 may be of one of various materials which have the proper electrical conductivity or resistivity and dielectric properties such as titanium dioxide (TiO_2), silicon monoxide (SiO), or it may for example be a very thin layer of a metal such as gold or aluminum. The back layer may also be a compound such as containing a material as stannous oxide (SnO) with the oxygen content controlled by the proper ratio or with controlled impurity levels or it may be a mixture of chemical compounds such as silicon monoxide (SiO) with (SnO). The back phosphor layer also functions therefore as a charge control layer.

FIGURE 4 shows a metal mesh electrode 34 mounted very close to the face of the screen 12 and with proper biasing with respect to the screen potential, could act to accelerate or to repel the beam and could in addition act to collect charges from the screen or to intensify the charge accumulation on the screen. The metal mesh screen 34, or the control layer 30 may be connected to a reference or ground potential such as by conductor 42.

The charge control layer electrodes 30 and 34 are constructed to be continuous over the entire surface of the tube, as shown, or, as illustrated in FIGS. 5, 6 and 7, the charge control layer 46, may be applied in small segments or strips that are parallel to each other and disposed across the face of the screen. FIG. 6 shows the added feature of providing a continuous conductive layer, more precisely, a semi-conductive layer of re-

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sistive-dielectric material disposed continuously across the face of the tube, while dielectric layer is shown in segments 46, 46. Further, FIG. 7 contemplates providing small dots or squares, 46a, as an alternative arrangement so that the dots or squares are arranged in a grid structure to present a fine screen pattern that is continuously across the face of the tube. The principle is satisfied and remains the same that a charge control layer electrode 30 with or without an adjacent metal mesh control electrode 34, 46, 46a, controls the charge accumulation of the phosphor layers 20, 22, 24 which in turn controls the depth of penetration of the electron beam 50 and to the multiple layers of phosphor, and thereby controls the colors emitted.

The composition and physical structure of the charge layer are the parameters which vary the details and requirements of resolution and voltage-time constant of the tube.

The tube is operated at a beam voltage which when not repelled would penetrate to the front phosphor layer 20 in contact with the screen face 12 and the tube would display a trace of the color emitted by that phosphor layer, which in FIG. 1 where the electron beam 52 penetrates to the phosphor layer 20, the tube would display a trace of the color red. If the beam is allowed to dwell on the same spot 54, or if it sweeps repetitively across the same spot for a number of times in a substantially short period, the phosphor layer accumulates a static charge on said element or spot 54 from the beam in response to increased voltage-dwell time or frequency repetition rate characteristics that the spot will accumulate a charge which tends to repel the beam until finally the beam can penetrate only to the next layer 22 of phosphor and the tube will display at that spot only the color emitted by this back phosphor layer. Then if the beam 56 is allowed to dwell on the same spot similarly on element 58 of phosphor layer 22 to increase the voltage-dwell time or frequency repetition rate characteristics over the element 58 of layer 22, that element 58 will accumulate a charge which tends to repel the beam until finally the beam can penetrate only to the layer 24 and a tube screen will display at that spot or element 58 only the color emitted by this back phosphor layer 24. Thus, as the beam sweeps across the tube, and where elements such as 54, 58 where a charge has accumulated from previous beam sweeps, the display on the screen 12 will be in one color for each of the layers 20, 22, 24, and at spots where no charge has accumulated from previous beam sweeps, the display screen 12 will be in another color where the beam has impinged on one of layers 20, 22, 24. With the number of layers shown and with the proper characteristics of the charge control layer electrode 30, several colors may be generated showing different numbers of repetitive sweeps or different lengths of voltage-dwell time of the beam.

The voltage-dwell time or number of repetitive sweeps seem necessary to accumulate sufficient charge for maintaining the beam from penetrating beyond the back phosphor layer electrode and may be varied over wide limits by the characteristics of the charge control layer electrode. For example, a layer electrode having the low conductivity and high dielectric constant of many phosphors will accumulate charge very rapidly and prevent the beam from penetrating beyond the back phosphor layer in a small fraction of a second. At the other extreme, if the back phosphor is coated with a thick layer of stannous oxide (SnO), sufficient static charge never accumulates sufficiently to repel the beam 50 from penetrating the phosphor layers 20, 22, 24. Between these two extremes, the rate of charge accumulation may be controlled by the character of the control layer and the auxiliary metal mesh electrode such as electrode 34 mentioned above so that the period of distinguishing between repetitive sweeps and non-repetitive sweeps may be varied from a small fraction of a second to several minutes.

It is contemplated within the present invention to provide a tube structure as is described here in which it is possible to achieve color shifts in a simple fashion by varying only the voltage-dwell time and repetition rates characteristics for achieving static color shifts in a cathode ray tube. This is contrasted to the prior art where use of multiple layers are thin, substantially transparent phosphors to induce color changes in cathode ray tubes is well known, in which the color shift depended on changing the beam voltage or the angle at which the beam penetrated the phosphor layers, or by a complex combination of modulating the voltages and current levels in a tube or plural gun storage tube system.

Additional embodiments of the invention in this specification will occur to others and therefore it is intended that the scope of the invention be limited only by the appended claims and not by the embodiments described hereinabove. Accordingly, reference should be made to the following claims in determining the full scope of the invention.

What is claimed is:

1. A cathode ray tube for color image reproduction comprising a plurality of continuous phosphor layers of luminescent material in film or laminant form superimposed upon each other upon the face of said cathode ray tube, each of said phosphor layers being adapted to produce one of a plurality of different predetermined colors in response to receiving a static charge on an element derived from voltage-dwell time characteristics of the beam of said cathode ray tube, a charge-control layer electrode formed of a composite of controlled conductivity material and a material of dielectric properties being disposed between said layers of luminescent material and a cathode of said cathode ray tube and in close proximity to the free surface of one of said layers uniformly to prevent excessive charge collection and to drain off the charge that would collect on said phosphor layers, each of said phosphor layers having substantially the same build-up and decay rates, but each of said phosphor layers capable of accumulating said static charge on said element from the beam in response to increased voltage-dwell time or frequency repetition rate characteristics of the beam over a zone of said layer and at times to repel further charging from said beam, said static charge being in response to energization of the control layer electrode to shift the color from the element of the phosphor or layer receiving the charge to the element of the phosphor layer next adjacent beamward, said charge tending to repel the penetration of the beam therebeyond and thus illumine the phosphor layer adjacent the charge for allowing penetration of the beam from the cathode until the voltage-dwell time or frequent repetition of the beam produces an accumulated charge in a layer for blocking or terminating penetration of the beam.

2. The cathode ray tube of claim 1 wherein the phosphor film adjacent the face of the cathode ray tube is also a charge control layer electrode for developing a capacitive relation with the other layer electrode.

3. The cathode ray tube of claim 1 wherein the charge control layer electrode is formed of resistive-dielectric material positioned on a surface of one of the phosphor films.

4. The cathode ray tube of claim 1 wherein said charge control layer electrode is a metallic mesh screen spatially disposed parallel with one of the phosphor films and arranged to be biased with respect to one of the phosphor films.

5. The cathode ray tube of claim 1 wherein the charge control layer electrode is a series of parallel disposed conductive layer segments disposed on a surface of one of the phosphor films.

6. The cathode ray tube according to claim 1 wherein the charge control layer electrode is a conductive layer continuously disposed over the surface of one of the phosphor films, and a dielectric layer is segmentally disposed in elements across the conductive layer thereof.

7. The cathode ray tube according to claim 1 wherein the charge control layer electrode comprises alternate elements of conductive and dielectric components in the order of one mil in thickness dimension for providing control of time constant and resolution comparable to the dot structure and spacing of color image reproduction.

8. The cathode ray tube according to claim 3 wherein the resistive-dielectric material is a material selected from the group consisting of TiO_2 and silicon monoxide.

9. The cathode ray tube according to claim 4 wherein the screen is platinum.

10. The cathode ray tube according to claim 5 wherein the segments are platinum.

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