

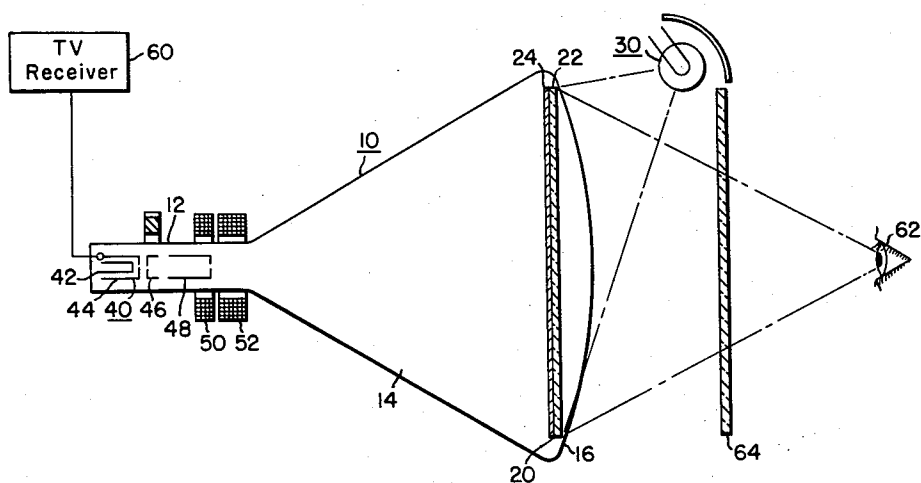
Jan. 24, 1961

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2,969,474

KINESCOPE SCREEN FOR DAYLIGHT VIEWING

Filed March 19, 1956



WITNESSES

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2,969,474

KINESCOPE SCREEN FOR DAYLIGHT VIEWING

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Filed Mar. 19, 1956, Ser. No. 572,390

8 Claims. (Cl. 313—92)

This invention relates to methods and means for producing images upon a target and more particularly to targets in which a change of color is obtained under the influence of localized heating.

In nearly all the types of kinescopes and display devices used in television and radar systems, the scanning electron beam produces light upon impingement of the phosphor screen. This method of light production is suitable for viewing only in subdued light surroundings since the picture loses contrast when viewed in a room with high ambient light level. The most desirable type of viewing device suitable for viewing in daylight or in high ambient lighting does not produce its own light but varies the reflectivity of its screen in accordance with the beam intensity of the scanning beam. This invention is directed to a kinescope wherein the reflectivity of the screen is changed by the modulation of an electron beam.

One of the earliest type tubes utilizing the reflectivity or transmission of a screen material for presentation of an image was a device known as the dark trace tube. In this type of tube the electron beam impinges on a layer of an alkali halide material and produces dark regions or F centers within the halide layer, and thus the material is changed from a substantially transparent material to an opaque material. This opaque condition, which may be of varying colors, may be bleached by heating the material for a short time or exposing the material to infrared radiations. The impingement of the electron beam on the alkali halide material results in a formation of spots or centers in the lattice of the alkali halide which are different from the remainder of the lattice. These spots or centers are believed to be one or more vacancies in the lattice with which one or more electrons are associated. In the formation of these centers, diffusion of ions, atoms or vacancies in and through the lattice is an important process. The rate of formation and disappearance or bleaching of these centers is affected by temperature of material and usually their formation is considered a result of the interaction of the lattice with highly energy particles. It is found that these alkali halide screens deteriorate after repeated operations so that the centers are not completely eradicated by the application of heat. It is also found that regardless of the method of bleaching of the color that a considerable amount of time is required to return the opaque material to the transparent condition. The alkali halide device also requires a considerable amount of auxiliary equipment in order to perform the function of eradicating the centers within the alkali halide screen.

It is an object of our invention to provide an image screen in which the wave length of light reflected by the screen may be varied by the utilization of localized heating so as to change the reflectivity of the screen from one visible color to another visible color.

It is another object of our invention to provide a simple compact kinescope structure for presentation of an image without need of auxiliary equipment.

It is another object of our invention to provide a high

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speed response type reflective screen for utilization in television.

These and other objects are effected by our invention as will be apparent from the following description taken in accordance with the accompanying drawing throughout which like reference characters indicate like parts, and in which the single figure of the drawing is a schematic showing of a preferred embodiment of our invention.

Referring in detail to the drawing, there is shown a cathode ray tube comprising an evacuated envelope 10 having a neck portion 12, a flared portion 14 and a face plate 16. The face plate 16 is the viewing portion or window of the tube and a target member 20 is positioned within the interior of the envelope 10 of similar area as the face plate 16. The face plate 16 is of a transparent material such as glass, and light from an exterior source 30 is projected through the face plate 16 onto the target 20.

The target 20 is comprised of a support member 22 of fused quartz material with a layer 24 of heat responsive material deposited thereon. In the specific embodiment shown, the layer 24 is a solid solution of chromium oxide and aluminum oxide. This target 20 shown in the specific embodiment is prepared by heating aluminum and chromium oxides together at a temperature of 1200° C. so that they react in the solid state. Because of the high reaction temperature, it is advisable to utilize a fused quartz plate as a support member 22 for the target or screen 20.

The screen member 20 may be fabricated in the following manner. A thin layer of aluminum is first deposited on the quartz plate 22 by a suitable method such as evaporation and then a thin layer of chromium is similarly deposited on top of the aluminum layer. The quartz plate with the two metal layers deposited thereon is then heated in an oxygen atmosphere so that the oxides are formed and after the formation of the oxides the assembly is maintained at a temperature of 1200° C. until the oxides have fully reacted in the solid state. The thickness of the layers of metals deposited by evaporation must be suitable so that the right proportionality of aluminum and chromium is obtained in the finished screen. The thickness of the completed layer 24 is dependent on the heat response desired.

It is found that when this completed layer 24 of a solid solution of chromium oxide and aluminum oxide is heated, it will change from red to green at a temperature dependent on the chromium content within the layer. It is also found that with a chromium content of 58 atoms percent that the transition temperature from red to green is 90° Kelvin. It is also found that with an 8 atoms percent chromium content that the transition temperature is 460° Kelvin. It is therefore indicated that with a chromium content between 8 and 58 atoms percent of the metallic atoms a transition temperature slightly above room temperature may be obtained.

The mechanism of absorption and the change in absorption is entirely different from that with respect to the alkali halides. The chromium oxide which is dissolved within the aluminum oxide forms a homogeneous substitution type solid solution. It is found that certain frequencies of radiant energy in the visible portion of the spectrum are readily absorbed by the chromium ions. The chromium ions are distributed homogeneously throughout the crystal lattice. The frequencies absorbed by the target material 24 and therefore the frequencies reflected will depend on the electronic energy levels associated with the chromium ions and the splitting of these levels caused by interaction of the electronic shells of two or more chromium ions. The electron population of the split levels is dependent on temperature and the frequencies absorbed are different at different tempera-

tures. It is therefore seen that the screen layer 24 exhibits the property of having a thermally reversible color change.

In the specific embodiment shown, on illumination with white light from an auxiliary light source 30, red light will be reflected back at lower temperatures and green light will be reflected back at higher temperatures. It is found that the temperature dependence of the absorption or reflection is effected by the concentration of chromium ions within the lattice. At higher concentration of chromium ions, the chromium ions are near to the other chromium ions, and the electronic shells of two or more ions can interact to a greater extent. This interaction results in a greater degree of splitting of energy levels and a consequent change in the temperature at which various transitions can take place.

In the process described with respect to the target 20 described herein, there are no centers formed in a manner similar to the color centers formed in the alkali halide targets. The utilization of an electron beam in the device described is only for the purpose of obtaining localized heating of the target 20. The cathode ray tube provides a method of scanning a raster for presentation of an image. In the aluminum oxide lattice which is generally not considered to be a purely ionic lattice, the binding energy is partially due to polarization and probably to a small extent to homopolar bonds or shared electrons.

Other suitable materials which may be used in the target member 20 include crystalline materials such as a spinel selected from the group consisting of rock forming aluminates and ferrates having the general formula $M''M'''_2O_4$ in which M'' is a metal selected from the group consisting of magnesium, zinc, manganese and ferrous iron and M''' is a metal selected from the group consisting of aluminum, chromium, ferric iron and manganese. Spinel is defined in Hack's Chemical Dictionary, Third Edition. Some examples of spinels are $MgAl_2O_4$, $FeAl_2O_4$, $ZnAl_2O_4$, $FeFe_2O_4$, $MgFe_2O_4$, $FeCr_2O_4$ and $MgAl_2O_4$. The spinels are also capable of thermally reversible color change from red to green by dissolving chromium therein, depending on the concentration and temperature of the solid solution.

An electron gun assembly 40 is provided within the neck portion 12 of the envelope 10, and in the specific embodiment shown an electromagnetic focus gun is illustrated. The gun is comprised of a cathode 42, control grid 44, screen grid 46 and anode 48. An electromagnetic coil 50 is provided around the neck portion 14 of the tube for focussing the electron beam after leaving the electron gun assembly 40. A deflection yoke 52 is also provided around the neck 14 of the tube and by application of suitable voltages provides a means of scanning a raster on the target 20 of the tube.

In the operation of the device described, a suitable video signal derived from a conventional television receiver 60 may be applied to the control grid 44 of the electron gun 40 so as to modulate the intensity of the electron beam in accordance with the video modulation. In the specific embodiment shown, the observer 62 will view a red background due to the reflectivity of the aluminum chromium oxide target 20 when there is no video modulation applied to the electron gun 40. Since the electron gun 40 will be substantially cut off when there is no video modulation applied, there will be no heating of the screen 20 due to electron impingement. With the video modulation applied to the gun, the electron beam will heat the screen 20 in accordance with the video modulation and change the color to green, and therefore a heat pattern corresponding to the video modulation will be formed on the target. The higher the video modulation applied, the higher will be the average brightness of the green color in that the green color will be reflected for a longer time. The length of time that the green color is reflected is dependent on the temperature.

It may be desirable to place a filter 64 between the

face plate 16 of the tube and the observer 62 so that only the green image will be seen by the observer and the red will be filtered out.

In the specific embodiment shown, a quartz member 22 was utilized to support the layer 24. It is also possible to form the heat sensitive layer 24 by grinding up pre-formed crystals of the correct chromium content, making a suitable suspension of the powder with the binder, and preparing the screen by a settling process onto the face plate 16 similar to the well known method of settling phosphors in cathode ray tubes. It is also possible that the ground-up powder may be mixed into a paste form and the layer deposited by printing or photoresist processes onto the face plate 16.

While we have shown our invention in only one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit and scope thereof.

We claim as our invention:

1. An image display system comprising an opaque screen member, means for impressing a heat pattern on said screen, means for directing radiations onto said screen of a uniform nature, said screen including a layer of homogeneous substitution type solid solution for reflecting said radiations of a given wave-length at one temperature and another wave-length at another temperature in response to the heat pattern impressed on said screen.
2. A cathode ray tube comprising a screen, said screen including a layer of homogeneous substitution type solid solution having the property of reflecting light of a given wave-length at one temperature and of another wave-length at another temperature, means for generating and directing an electron beam to scan a raster on said screen to raise the temperature of localized portions of said layer of material and thereby vary the reflective wave-length of said localized portions of said screen.
3. A display device comprising an evacuated envelope containing an electron gun for generating an electron beam, a screen member positioned within said tube and onto which said electron beam is directed, said screen member including a layer of homogeneous substitution type solid solution having the property of varying its reflective wave-length in response to thermal excitation thereof by said electron beam and a radiation source for directing radiation onto said screen to produce a radiation image corresponding to the heat image written on said screen by said electron beam.
4. A cathode ray tube comprising an evacuated envelope having therein an electron gun for generating an electron beam, a screen member positioned to intercept said electron beam, said screen member including means having the property of changing color under thermal excitation by said electron beam, said screen comprising a spinel and a metallic material in solid solution.
5. A color display system comprising a cathode ray tube having a screen therein, said screen comprising a transparent support member and an opaque layer of homogeneous substitution type solid solution disposed on said support member, said layer exhibiting the property of reflecting light of a given wave-length at one temperature and another wave-length at another temperature, means for generating an electron beam to scan a raster on said screen to raise the temperature of localized portions of said screen and thereby produce a temperature pattern on said screen corresponding to the modulation applied to said electron beam, and means for directing radiations onto said screen to produce a color image on said screen corresponding to the temperature pattern on said screen.
6. A color display system comprising a cathode ray tube having a screen therein, said screen comprising a transparent support member and an opaque layer of homogeneous substitution type solid solution disposed on

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said support member, said layer exhibiting the property of reflecting light of a red color at one temperature and of a green color at another temperature, means for generating an electron beam to scan a raster on said screen to raise the temperature of localized portions of said screen and thereby produce a temperature pattern on said screen corresponding to the modulation applied to said electron beam, and means for directing radiations onto said screen to produce a color image on said screen corresponding to the temperature pattern on said screen.

7. A color display screen comprising a transparent support member, a layer of opaque material consisting of aluminum oxide and chromium oxide in solid solution deposited on said support member, said solid solution being from 8 to 58 atoms percent chromium of the metallic atoms of the solid solution, said layer of opaque material exhibiting the property of thermally reversible color change within a predetermined thermal range without substantial crystalline change.

8. A cathode ray tube comprising an evacuated envelope containing an electron gun for generating an electron beam, a screen member positioned within said envelope having the property of changing color under thermal excitation due to said electron beam, said screen comprising a spinel selected from the group consisting of

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rock-forming aluminates and ferrates having the general formula $M''M'''_2O_4$ in which M'' is a metal selected from the group consisting of magnesium, zinc, manganese, and ferrous iron and M''' is a metal selected from the group consisting of aluminum, chromium, ferric iron, and manganic manganese.

References Cited in the file of this patent

UNITED STATES PATENTS

2,330,171	Rosenthal	Sept. 21, 1943
2,418,779	Leverenz	Apr. 8, 1947
2,454,488	Sukumlyn	Nov. 23, 1948
2,479,458	Barthelemy	Aug. 16, 1949
2,684,885	Nakken	July 27, 1954
2,819,332	LaVia	Jan. 7, 1958

FOREIGN PATENTS

720,532	Great Britain	Dec. 22, 1954
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OTHER REFERENCES

"An Introduction to Luminescence of Solids," Leverenz, 1950, John Wiley & Sons, Inc., pp. 68 and 238.

"Some Aspects of the Luminescence of Solids," Kroger, 1948, Elsevier Pub. Co., Inc., pp. 98-101.