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Kaplan

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[45] **July 24, 1973**

[54] **COLOR TELEVISION PICTURE TUBE WITH SUBTRACTIVE COLOR FILTERS**

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[73] Assignee: **Zenith Radio Corporation,** Chicago, Ill.

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[21] Appl. No.: **240,568**

[52] **U.S. Cl. 313/92 B,** 117/33.5 CM, 117/33.5 CP, 313/85

[51] **Int. Cl.** **H01j 29/26**

[58] **Field of Search** ..... 313/92 B, 92, 85

[56] **References Cited**

UNITED STATES PATENTS

3,344,301	9/1967	Kaplan	313/92 B
3,569,761	3/1971	Lange	313/92 B

Primary Examiner—John Kominski

Attorney—Nicholas A. Camasto, John H. Coult et al.

[57] **ABSTRACT**

The screen of a three gun shadow mask type of color picture tube is formed of three filters each predominantly transmissive of magenta, yellow and cyan which are the respective complements of the primary colors green, blue and red. Each filter covers the faceplate except in image areas assigned to its complementary primary phosphor. Each image area thus includes two overlying filters cooperating to allow transmission of light associated with its assigned primary color. The spaces between image areas are covered by all three complementary filters and are substantially opaque to visible light.

7 Claims, 4 Drawing Figures

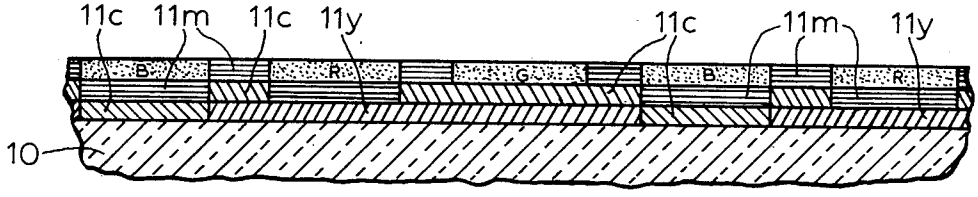


FIG. 1

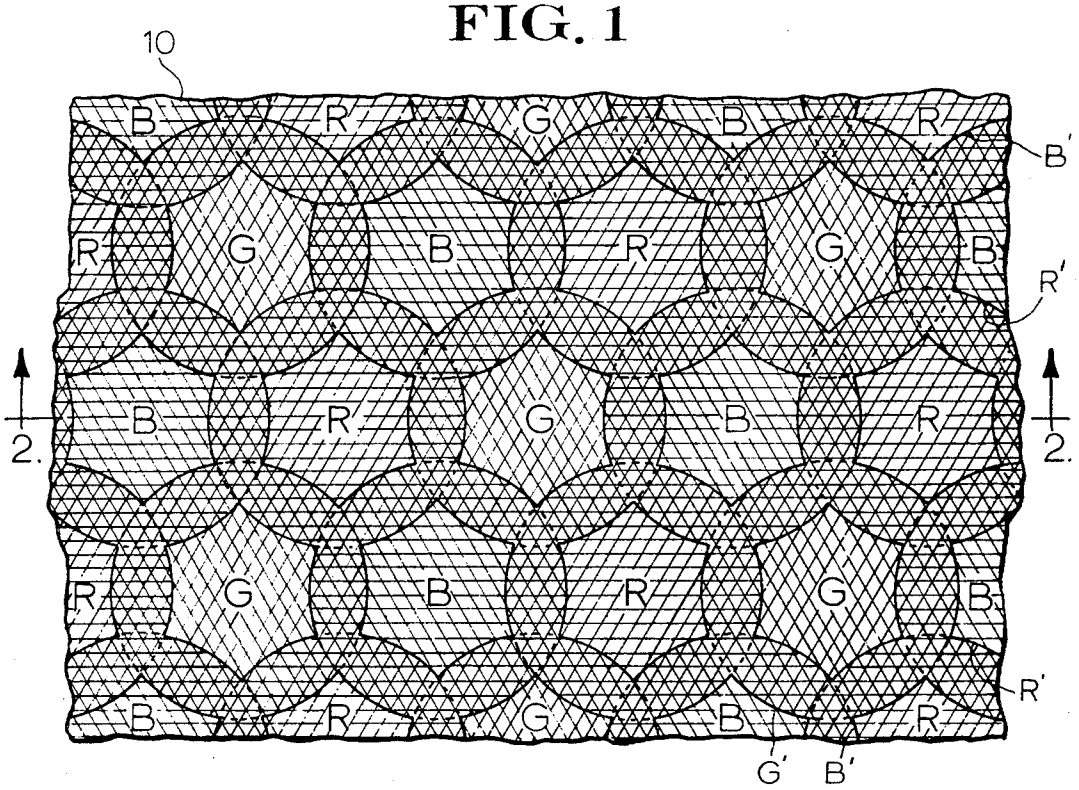


FIG. 2A

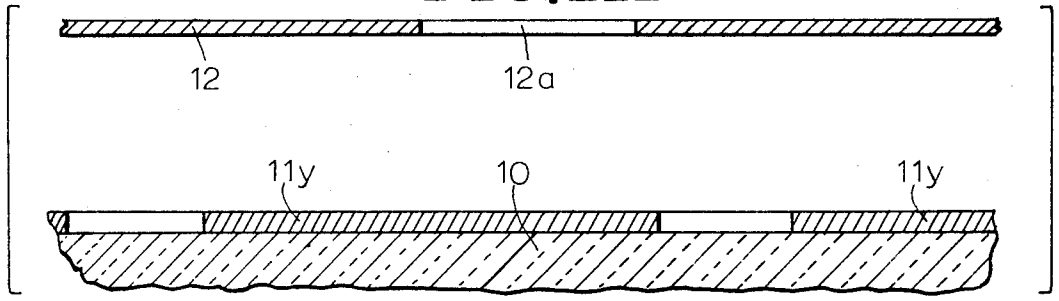


FIG. 2B

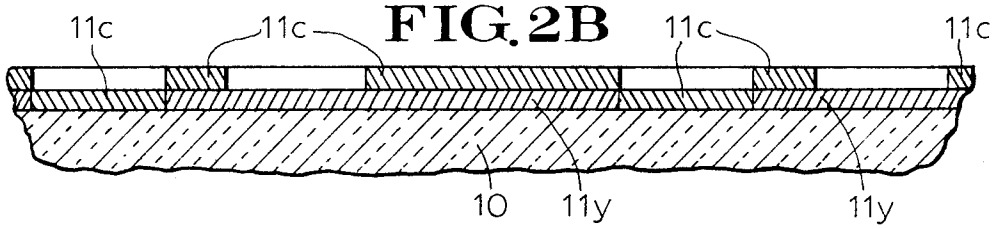
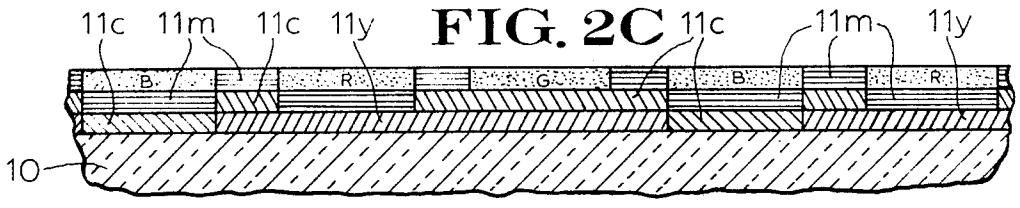


FIG. 2C



COLOR TELEVISION PICTURE TUBE WITH SUBTRACTIVE COLOR FILTERS

RELATED PATENTS

The screen structure herein is related to those described and claimed in U. S. Pat. No. 3,114,065 issued Dec. 10, 1963 in the name of Sam H. Kaplan, U. S. Pat. No. 3,146,368 issued Aug. 25, 1964 in the name of Joseph P. Fiore et al. and U. S. Pat. No. 3,569,761 issued Mar. 9, 1971 in the name of Howard G. Lange. All these related patents are assigned to the assignee of the present invention.

BACKGROUND OF THE INVENTION

The present invention is directed to a screen structure for a color television picture tube. In particular it is concerned with color television picture tubes incorporating a black surround which yields many performance benefits. The screen structures of black surround color tubes have spaced elemental phosphor deposits on a substantially clear faceplate with the spaces between phosphor deposits filled with a black or reflective substance such as manganese dioxide or graphite.

Black surround screens are useful in post deflection type tubes as well as shadow mask types and are not restricted to any particular shape of aperture in a shadow mask. However, post deflection tubes are not in current commercial use and are, consequently, of lesser interest than shadow mask tubes. Further, since the great majority of shadow masks have substantially circular apertures, it is to this type of color tube that the description will be confined.

The shadow mask associated with the color tube screen has a pattern of circular apertures corresponding to primary groupings of the elemental phosphor deposits. Normally the projected area of the apertures (i.e., area of the electron beam impacting the screen) is smaller than the elemental phosphor deposits. This is so since in the manufacturing process, conventional optical printing techniques are employed using the shadow mask as a negative and phosphor dot size tends to increase with exposure. Optimum conditions, however, are achieved in a black surround type tube if the electron beams are larger than the phosphor deposits as explained in U.S. Pat. No. 3,146,368 above. With the desirable relationship of the electron beams being larger than the color phosphor deposits, portions of the beams strike the black surround material, which provides a "guard band" to prevent erroneous excitation of adjacent color phosphor deposits. The black material surrounding the phosphor deposits constitutes a large percentage of the faceplate surface and absorbs ambient light falling on the surface of the tube. Tubes of this type exhibit contrast characteristics which previously had been achieved only by using lower transmission filter glass for, or in conjunction with, the tube faceplate. Thus the need for filter glass is substantially eliminated in black surround tubes resulting in a decided increase in tube light output. Such tubes exhibit markedly superior characteristics over conventional color tubes and have been well received in the market place.

Full utilization of the light output capability of black surround tubes is approached by insuring that the electron beams are larger than the phosphor deposits, as mentioned above. The necessary size relationship between phosphor deposit and shadow mask aperture size

is difficult to achieve in practice. A technique in widespread commercial use achieves the desired relationship by subjecting the shadow mask to additional etching for aperture enlargement after screening of the color tube faceplate. This process is commonly referred to as etch-back.

Other techniques for manufacturing black surround tubes with the desired beam-phosphor dot relationship have been proposed, such as those mentioned in the Fiore et al patent. The Lange U.S. Pat. No. 3,569,761 discloses a color picture tube screen having a plurality of sets of filters each transmissive of light wavelengths corresponding to that of an assigned primary color. As is fully set forth in that patent, the different filter sets are overlapped in the spaces between phosphor deposits. These spaces should be substantially opaque to visible light since each overlapped filter set absorbs all three primary colors. That is, each filter absorbs two of the primary colors and the two filters absorb all three. Practically, however, it is difficult to obtain efficient primary filters of desired characteristics.

Accordingly, the object of this invention is to provide a novel screen structure for a color television picture tube which achieves the benefits of black surround.

SUMMARY OF THE INVENTION

The screen for a color television picture tube embodying the invention includes a faceplate, substantially transmissive of all light wavelengths in the visible spectrum, having a plurality of sets of interleaved image elements disposed thereover. The elements of each set are excitable by appropriate electron beams to emit light of a particular one of a corresponding plurality of primary colors. The image elements include phosphor deposits of a given primary color in association with overlapped filter elements having light transmission characteristics complementary to each of the remaining primary colors. The spaces between the image elements comprise a visible light attenuator made up of a plurality of overlapped filters each of which exhibits a light transmission characteristic complementary to a corresponding one of the primary colors.

BRIEF DESCRIPTION OF THE DRAWING

The features of the invention which are believed to be novel are set forth with particularity in the appended claims. The invention may best be understood by reading the following description in conjunction with the accompanying drawing in which:

FIG. 1 is a fragmentary plan view of a portion of the image screen of a color television picture tube constructed in accordance with the invention; and

FIGS. 2A–2C are sections of the image screen of FIG. 1 taken along the lines 2—2 in different stages of fabrication.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The described screen structure is similar to that disclosed in the aforementioned Lange patent with the exception that the filters are complementary to the primary colors red, blue and green. Every image element includes two filters, each complementary to one of the other primary colors. For example, in the image area of the faceplate where red phosphor deposits are to be made, the filters are yellow and magenta. Similarly, in the areas of the faceplate assigned to blue light emitting

phosphors, the filters are magenta and cyan and in areas of the faceplate assigned to green light emitting phosphors, the filters are yellow and cyan. In all intervening spaces, all three filters are present which renders these areas substantially opaque to visible light.

The materials suitable for the various filters may be similar to those described in the Kaplan U.S. Pat. No. 3,114,065 and may be applied through a process similar to that claimed in U. S. Pat. No. 2,959,483 issued Nov. 8, 1960 in the name of Sam H. Kaplan and assigned to the present assignee. Specifically, vitreous color filter materials having a relatively low fusing temperature (on the order of 430° C.) are suitable for use as the filters. Some appropriate commercially available materials are designated as Corning Glass No. 7570 and 8363 marketed by Corning Glass Works. Similarly, the Kimball Glass Company has a No. 50 solder glass which has an acceptable fusing temperature. These glasses are basically of the lead borate type and may have inorganic colorants added to provide the necessary color filter characteristics. Such vitreous materials are especially advantageous in screens for color picture tubes since they are known to be compatible with these devices. Further, they may be applied to the faceplates by photoprinting or electrostatic techniques similar to those used in applying phosphor color materials. The low fusing temperatures allow fixing of the filters to the face-plate during the course of normal tube processing.

The characteristics of the screen are illustrated in the drawing which shows a fragment of a faceplate **10** which is substantially transmissive of all light wavelengths in the visible spectrum. since the screen structure yields the benefits of a black surround, it is desirable that faceplate **10** have a very high degree of transmissivity to maximize tube brightness.

A plurality of sets of image elements are disposed in an interleaved pattern over faceplate **10.** Each of the image elements includes a corresponding phosphor deposit of red, blue or green as indicated by the legends R, G and B in the cusp-shaped areas distributed over the faceplate. The primary phosphors of red, blue and green are colorimetrically related to produce white light upon appropriate electron beam excitation.

A shadow mask (shown in cross section in FIG. 2A) is omitted in the depiction of FIG. **1** for purposes of clarity. As pointed out in the Lange patent, the phosphor deposits need only cover the cusp-shaped areas which relaxes the degree of phosphor screening control required. The arrangement of the phosphor deposits over the faceplate is the same as that of the circular apertures in the shadow mask since the screen is manufactured by successive exposures through the mask apertures. It will also be seen that the largest dimension of a cusp-shaped area is less than the diameter of its associated aperture in the shadow mask. This results from the overlapping exposures with actinic energy of the sensitized faceplate coating through the shadow mask.

It will be appreciated that the photoexposure processes and the processes for achieving deposition of filter material on the faceplate are fully described in the abovementioned patents and form no part of the present invention.

In accordance with conventional screening techniques using a slurry process, a photosensitive resist generally consisting of polyvinyl alcohol (pva) sensitived with ammonium dichromate, is coated on the faceplate. In accordance with the teachings of the Kaplan patents, the filter material in pulverulent may be mixed with the photoresist prior to coating of the faceplate.

As is well-known, the subtractive primaries bear a complementary relationship to the additive primaries. Yellow is equivalent to minus blue, cyan is minus red, and magenta is minus green. Thus a yellow filter will pass visible light of all wavelengths except those corresponding to the primary blue and the other subtractive primaries will pass visible light of all wavelengths except those corresponding to their respective complements. Accordingly, in the areas of the faceplate assigned to the red color phosphor primary, it is desired to have filters complementary to green and blue. These filters are yellow and magenta, respectively. Similarly, in the blue areas of the faceplate, the filters will be magenta and cyan and in the green areas, yellow and cyan. In the areas intervening phosphor deposits, all three filter materials will be deposited making these areas substantially opaque to visible light.

In fabricating the screen, a complementary filter is deposited everywhere on the faceplate except in the areas assigned to its associated color primary. Thus for each primary, the sensitized coating on the faceplate is exposed from the two positions in the lighthouse corresponding to the other primary exposure positions. For example, if the "blue" areas are to be defined first, exposure of the photosensitive slurry (and pulverized yellow filter material, for example) is made from the lighthouse positions corresponding to green and red.

The exposure is made through shadow mask **12,** shown in cross section in FIG. 2A. Aperture **12***a* is shown in illustrative manner only and assumed to be representative of all mask apertures. The depictions of the faceplate and phosphor deposits are idealized for descriptive purposes.

Exposure will harden the sensitized pva in the dashed line circular areas of FIG. **1** labeled R′ and G′. Development of the faceplate by a waterwash, for example, removes the unhardened pva from the cusp-shaped areas marked B and leaves a yellow filter **11***y* deposited over the rest of the faceplate surface as shown in FIG. 2A where yellow filter **11***y* is depicted by section lines of positive slope.

The process is repeated with another coating of sensitized slurry containing pulverized cyan filter material and exposures are made from lighthouse positions corresponding to blue and green. The pva is hardened over the surface of the faceplate in all areas except those cusp-shaped areas marked R. The faceplate is again developed by waterwashing with the result that the cyan filter **11***c* extends thereover except in the cusp-shaped areas marked R and the screen cross section takes on the idealized form depicted in FIG. 2B, where cyan filter **11***c* is indicated by section lines of negative slope.

A third application of slurry containing sensitized pva and pulverized magenta filter material is made on the faceplate and exposures performed from the lighthouse positions corresponding to red and blue. After development, the magenta filter material is deposited over the screen except in the cusp-shaped areas marked G. The magenta filter **11***m* is indicated by the horizontal section lines in FIG. 2C. Thereafter, the primary color phosphor materials are deposited in the appropriate cusp-shaped areas by conventional techniques resulting and the screen structure cross section of FIG. 2C results.

It will be noted that the green phosphor deposits have yellow and cyan filters **11***y* and **11***c* between them and faceplate **10**, the red phosphor deposits have yellow and magenta filters **11***y* and **11***m* and the blue phosphor deposits have magenta and cyan filters **11***m* and **11***c*. The combination of the phosphor deposit and associated filters constitutes an image element. The spaces between image elements all include a yellow, a cyan and a magenta filter which effectively blocks transmission of visible light and yields a black surround effect.

A bakeout of the faceplate and screen will fuse the filter to the faceplate. The screen may then be aluminized and further processed into a finished picture tube in accordance with conventional techniques.

Instead of using pulverized filter material, the teachings of a copending application in the name of Ronald C. Robinder, Ser. No. 666,457 filed Aug. 24, 1970 and assigned to the assignee of the present invention, may be employed. That application discusses applying colored filters to the faceplate by using metallic oxide lusters in conjunction with a photosensitive resist. These lusters in general comprise metal resinates which are reaction products of metal compounds or oxides neutralized with organic resinate acids. Their properties are such that upon being heated to a predetermined firing temperature, the organic ingredients volatilize and develop inorganic oxide colorants as residues. The deposited film of colorants impart an iridescent appearance to the faceplate, the color of which is selectable by choice of metal compound.

Such metallic lusters are commercially available from the Hanovia Liquid Gold Division of Engelhard Industries, East Newark, N.J. Representative lusters available from this company suitable as subtractive primary filters in screens constructed in accordance with the invention are as follows:

Magenta Luster — No. A2000
Cyan Luster — No. 1290–A
Yellow Luster — uranium oxide luster

While cusp-shaped color areas are produced by this procedure, the invention is not limited to such shaped areas. By use of a ring-shaped annulus exposure source, of proper geometry, with only one exposure per color (that of the phosphor color in question), circular-shaped areas instead of cusp-shaped hexagonal areas may be produced. In this method for blue phosphor areas, an exposure would be made at the blue color position in the lighthouse with yellow filter material in the photoresist. After development, subsequent exposures would be made from the other two primary positions with suitable filter material in the photoresist.

While a particular embodiment of the invention has been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects as defined in the appended claims.

I claim:

1. A screen for a color television picture tube comprising: a faceplate substantially transmissive of all light wavelengths in the visible spectrum; a plurality of sets of interleaved image elements on said faceplate, the elements of each set being excitable by an electron beam to emit light of a particular one of a corresponding plurality of primary colors; and a visible light attenuator comprising a corresponding plurality of overlapped filters each exhibiting light transmission characteristics complementary to a corresponding one of said primary colors, said filters extending at least between the spaces adjacent said image elements.

2. A screen in accordance with claim **1** wherein the image elements in each set include a phosphor component for emitting light of one of said primary colors and a filter component formed by different overlying filters each exhibiting light transmission characteristics complementary to a different one of the remainder of said primary colors.

3. A screen in accordance with claim **2** wherein said filter component is deposited on said faceplate and said phosphor component is deposited over its associated filter component; said filter component extending over portions of said faceplate surrounding its image element and constituting a portion of said attenuator.

4. A screen in accordance with claim **3** wherein said primary colors are red, blue and green and said filters are cyan, yellow and magenta, the image elements associated with said red, blue and green primaries consisting respectively of red light emitting phosphor and overlying filters of yellow and magenta, blue light emitting phosphor and overlying filters of magenta and cyan and green light emitting phosphor and overlying filters of yellow and cyan.

5. A screen for a color television picture tube that includes a shadow mask having a pattern of apertures mounted adjacent a faceplate which is transmissive of substantially all wavelengths of light in the visible spectrum comprising: a plurality of sets of image elements disposed in similar patterns and interleaved with one another over said faceplate, the image elements being smaller in area than the projected areas of their corresponding apertures in the shadow mask and including a phosphor component for emitting light of one of a plurality of primary colors and a filter component consisting of overlying filters having transmission characteristics complementary to a different one of each of the remaining primary colors; and a visible light attenuator disposed on the faceplate in the portions intervening the image elements, said attenuator comprising extensions of the filters which project into the immediately contiguous part of the intervening portions in overlapping relationship with similar extensions of filters associated with adjacent ones of the image elements.

6. A screen in accordance with claim **5** wherein said primary colors are red, blue and green and wherein said filter components comprise, respectively, yellow and magenta filters for the image elements associated with said red primary, magenta and cyan filters for the image elements associated with said blue primary, and yellow and cyan filters for the image elements associated with said green primary; and wherein said intervening portions include all three filters.

7. A screen in accordance with claim **6** wherein said apertures are substantially circular and wherein said filter components are substantially hexagonal with their maximum dimension being less than the diameter of their respective projected aperture area.

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