Sept. 26, 1967 S. H. KAPLAN 3,344,301

SUBTRACTIVE TYPE COLOR CATHODE RAY TUBE HAVING OVERLAPPING COLOR PHOSPHOR AREAS

Filed July 25, 1966

FIG. 1

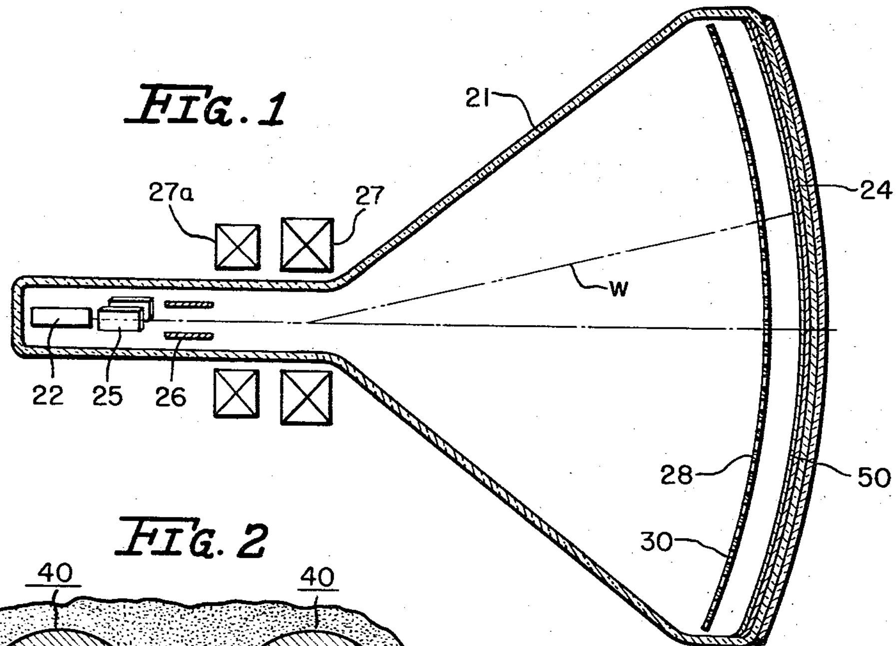


FIG. 2

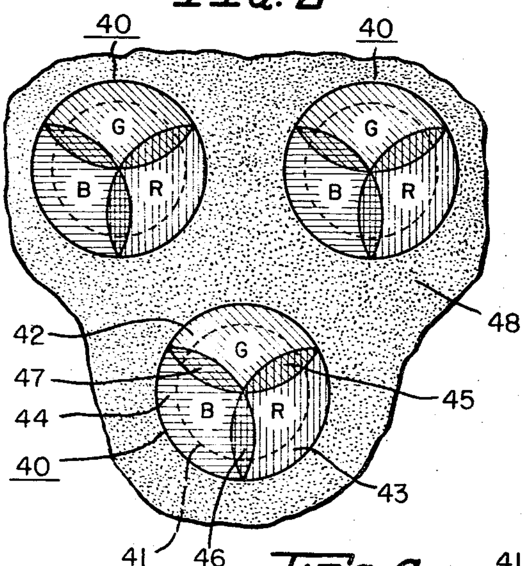


FIG. 3

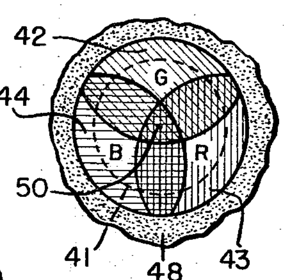


FIG. 4

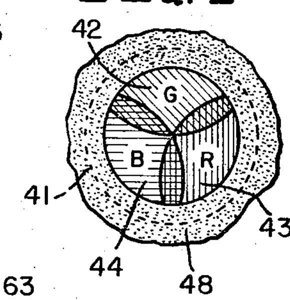


FIG. 5

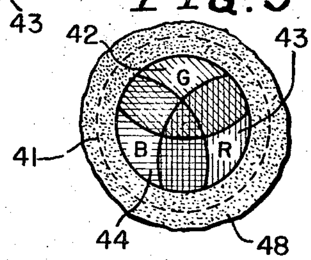
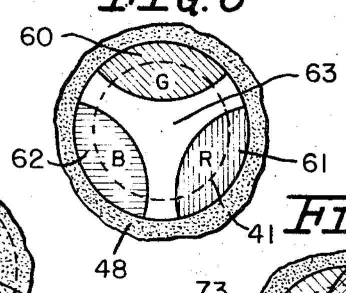


FIG. 6



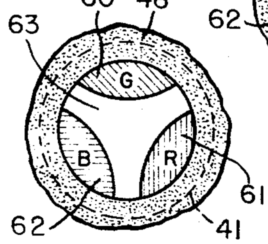
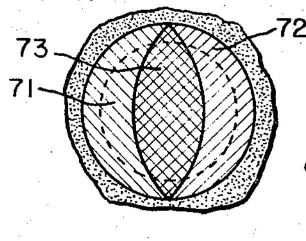


FIG. 7

FIG. 8



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SUBTRACTIVE TYPE COLOR CATHODE RAY TUBE HAVING OVERLAPPING COLOR PHOSPHOR AREAS

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Filed July 25, 1966, Ser. No. 567,465
10 Claims. (Cl. 313—92)

The present invention is directed to a single beam subtractive type color cathode-ray tube and is a specific improvement over the tube described and claimed in applicant's Patent 3,146,369, issued August 25, 1964, and assigned to the assignee of the present invention.

The color tube disclosed in the earlier patent has a mosaic image screen comprising a multitude of similar clusters of elemental phosphor areas. Each cluster is composed of one area of each of a plurality of phosphors exhibiting different color radiation in response to electron bombardment and collectively balanced to produce white light output in response to excitation of the total area of the cluster. There is a color selection electrode, usually referred to as an aperture or shadow mask, in juxtaposition to the image screen. This electrode has a corresponding multitude of apertures individually aligned with one of the clusters on the screen and each aperture corresponds in shape with the cluster with which it is aligned. They may be of the same size or one may be larger than the other; as illustrated in the patent, however, the aperture is larger than the cluster. The tube has an electron gun for projecting a single electron beam through the apertured electrode onto the image screen and this beam is modulated in intensity with picture information. Finally there are means, such as deflection electrodes, for varying the angle of incidence of the beam on the apertured electrode to establish total-area excitation of the clusters for white light output or selectively to establish partial-area excitation of the clusters for developing different component colors of the reproduced image.

It is also preferred, as explained in the earlier patent, to improve the contrast of the tube and the influence of incident light on the surface of the image screen by blackening the screen areas that intervene the individual phosphor clusters. This is accomplished by coating these areas with a light absorbing material such as black manganese dioxide or finely divided silver particles. This is sometimes referred to as providing the screen with a "black surround" by which is meant that each cluster is surrounded by a black light absorbing material.

The present invention concerns more particularly the composition of the phosphor clusters to improve the white uniformity of the screen. Accordingly, it is a principal object of the invention to improve the single beam subtractive type color cathode-ray tube particularly as respects its mosaic image screen.

It is a specific object of the invention to improve the uniformity of the white field of such a color cathode-ray tube.

A single beam subtractive type color tube, having the general construction described above and including the improvement of the subject invention, is characterized by the fact that each of the clusters is composed of primary areas of phosphor deposits each having an area small compared to the cross-sectional area of the single beam of the tube. Further, each primary area exhibits a different color radiation in response to impingement by the beam. Moreover, each cluster has at least one secondary area of phosphor deposit interposed between the primary areas. If there are only two primary areas, there is but a single secondary area but if the clusters feature three primary areas, there will also be three secondary areas. The secondary areas in any case collectively exhibit an approximately white radiation or white light output in response to impingement by the beam.

In accordance with one aspect of the invention, the secondary areas of each cluster constitute overlapping portions of contiguous primary areas.

In accordance with another aspect of the invention the primary areas of each cluster are separated from one another by secondary areas having a deposit of a white phosphor, that is to say, a phosphor which upon excitation emits approximately white light.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in the several figures of which like reference numerals identify like elements, and in which:

FIGURE 1 is a schematic view of a single beam subtractive type color cathode-ray tube embodying the invention; and

FIGURES 2 to 8, inclusive, show various specific structures that may be adopted for the phosphor clusters constituting the mosaic image screen of the tube of FIGURE 1.

Referring now more particularly to FIGURE 1, the single beam subtractive type color cathode-ray tube there represented has a glass envelope 21 housing a single electron gun, indicated by a rectangle 22, disposed in the neck portion of the envelope. The gun emits an electron beam W which is accelerated in known manner and passes through a deflection field produced by scan signals applied to a deflection yoke 27. After leaving the deflection field, the beam W is directed through the apertures of a color selection electrode or mask 28 to impinge on a mosaic screen 24 facing the gun. The tube is also provided with a convergence system represented by a yoke *27a* for converging the beam both statically and dynamically in the plane of mask 28 as well understood in the art. Mask 28 has a plurality of apertures 30 corresponding in number with a like plurality or multitude of clusters, to be described hereafter, which cover screen 24. An electron transparent, conductive and light-reflecting layer 50, usually formed of aluminum, covers the rear surface of the screen. While the details of the phosphor clusters deposited on screen 24 will be considered hereafter, suffice it now to say that each cluster has the same configuration as the apertures of mask 28. As shown in FIGURE 2 they are circular but other shapes are suitable including hexagonal, rectangular or square. The aperture size may be the same as the cluster or one may be larger than the other. In each cluster there are deposits of phosphor related to one another at least in respect of their radiation to the end that if the total area of the cluster is excited by the beam of the tube, its response is an output of approximately white light.

Color selection is accomplished by controlling the angle of incidence of beam W with screen 24 and this selection may be controlled electromagnetically or electrostatically. For convenience, the latter has been shown in the form of two pairs of deflection plates 25, 26 arranged in quadrature relation between gun 22 and convergence yoke *27a*. These electrodes are energized by chroma information.

As thus far described, the tube of FIGURE 1 is the same as that of the earlier patent and includes by distinct preference the black surround feature in that the areas of the screen which are intermediate the clusters are covered with a black light absorbing material. The beam from gun 22, modulated with video information, is caused to scan screen 24. Concurrently deflection electrodes 25, 26 are energized with color information and determine the manner in which the beam impinges upon the phosphor clusters of the screen, producing whites if the entire area of a cluster is impacted in the approximate center but producing specific colors where the cluster is only partially excited or impacted off-center. The color, of course, is determined by the particular portion of the cluster upon which the beam impinges and it may vary as between the several primary colors and combinations thereof as clearly explained in the earlier patent.

More particular consideration will now be given to various forms that the phosphor clusters of screen 24 may take in practicing the invention. FIGURE 2 shows a preferred form both of the composition of the clusters and the relative positions of clusters on the screen. In this view, each cluster 40 is composed of primary areas of phosphor deposits each having an area small compared to the cross sectional area of the beam of the tube. For the case under consideration, the cross section of the beam is indicated in the broken-line circle 41 and the primary areas of phosphor deposits are identified 42, 43 and 44. Each primary area exhibits a different color radiation in response to impingement by the beam. For the three color system which FIGURE 2 presupposes the primary areas are deposits of red, green and blue phosphors. As shown, they are similar in dimension which is the ideal case for phosphors of equal efficiency. If one phosphor is less efficient, as has been the case heretofore with respect to red, the primary area devoted to that color may be larger so that the integrated output of the less efficient phosphor matches that of the remaining two.

In addition to these primary areas, the cluster has at least one secondary area of phosphor deposit interposed between the primary areas. In the modification of FIGURE 2 there are three secondary areas 45, 46 and 47 and collectively they exhibit an approximately white radiation in response to impingement by the beam. More specifically, collectively their radiation matches that resulting from concurrent and equal excitation of primary areas 42–44.

The shading in FIGURE 2 indicates that each cluster 40 is composed of three segments of circles of the same diameter as the cluster and arranged symmetrically to have a common intersection of all three segments at the center of the cluster and an intersection of adjacent pairs at the periphery of the cluster, to define overlapping and non-overlapping portions. It is the overlapping portions that constitute the secondary areas of the clusters while the non-overlapping portions serve as the primary areas.

It is not necessary to repeat here the process of depositing the several phosphors because that is well explained in the earlier patent. The only difference in processing is that the deposits of the primary phosphors, accomplished by the usual photo resist and exposure procedure, is carried out to provide the overlapping areas 45–47. When this is done, each secondary area, such as 45, is a deposit of the phosphors corresponding to the deposits in the primary areas contiguous thereto. In particular, secondary area 45 has a deposit of both green and red phosphors and the composition of the other secondary areas 46, 47 is apparent from the drawing.

Reference numeral 48 indicates the "black surround" applied to the portions of the screen intermediate clusters 40. Aside from the overlapping or the presence of secondary areas in the clusters, the arrangement of FIGURE 2 is in most material respects the same as that of FIGURE 6c of the earlier patent. There is one other specific difference, namely, the cross sectional area of beam 41 in FIGURE 2 is less than that of cluster 40. This, however, is no limitation on the invention; the electron beam may be the same in cross section as the cluster or it may be larger or smaller.

The modification of FIGURE 3 differs from that of FIGURE 2 in that the minor dimension of each of the overlapping segments exceeds ½ the diameter, or the radius, of the cluster. As a consequence, the central section 50 of the cluster is a deposit of red, green and blue phosphors and it responds with essentially a white radiation when excited by an electron beam.

In the embodiment of FIGURE 4, the diameter of the cluster is reduced from that of FIGURE 2 and the cross sectional area of the beam is increased correspondingly to now exceed that of the cluster. Otherwise, the arrangements of the two figures are the same.

Similarly, the modification of FIGURE 5 is like that of FIGURE 3 differing in that the cluster has a smaller diameter and the beam is larger than the cluster.

The modifications of FIGURES 6 and 7 are essentially alike, differing from one another principally in the relative size of the beam and cluster. In FIGURE 6 the beam has a smaller diameter while in FIGURE 7 the cluster is smaller. In both instances the primary areas 60, 61 and 62 are separated from one another by a Y-shaped white phosphor deposit 63. Such a cluster would be formed by basically the same procedure as outlined in the earlier patent. After the primary areas have been formed, a white phosphor slurry is deposited over the screen and exposed with a light source which is on the opposite side of the panel supporting this screen. Such an exposure is effective essentially only with respect to the Y-shaped portion 63 of the cluster and is otherwise rendered ineffective because of the previous deposits defining the primary areas. It may be desirable to dye previous deposits to completely suppress transmission of active light.

Of course, the invention is not restricted to a three color cluster. A two color system, such as that indicated in FIGURE 8 is entirely feasible. In this case there are but two primary areas 71 and 72 of complementary colors and a single intervening secondary area 73 having a deposit of the phosphors of both primary areas 71, 72.

Cluster compositions of the type described provide better white field uniformity for the screen but at some sacrifice in the amount of area that is otherwise available for producing saturated colors. Where the overlapping patterns of FIGURES 2–5 are used, the least efficient phosphor is deposited last. This permits maximum response of the poorer phosphor which is desirable in balancing the radiation outputs to simulate white.

It will be observed that the entire beam is not used when producing a single saturated color because saturated colors are produced only by deflecting the beam so that it strikes but a single primary area. This produces no material loss in brightness since there is no need for a saturated color brightness that exceeds the contribution of that color to the white field.

The blank surround feature permits the use of a clear face plate as distinguished from the practice of filter safety plates which have a transmissivity of the order of 55%. The black surround provides improved contrast and relief from reflected light because of a reduced albedo.

While particular embodiments of the invention have 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, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. In a single-beam substractive type color cathode-ray tube having a mosaic image screen comprising a multitude of similar clusters of elemental phosphor areas and a color-selection electrode in juxtaposition with said screen and comprising a similar multiude of apertures aligned with said clusters, the improvement which is characterized by the fact that each of said clusters is composed of primary areas of phosphor deposit each having an area small compared to the cross sectional area of said beam and each of which exhibits a different color radiation in response to impingement by said beam

and at least one secondary area of phosphor deposit interposed between said primary areas, said secondary areas collectively exhibiting an approximately white radiation in response to impingement by said beam.

2. A color tube in accordance with claim **1** in which each of said clusters has three primary areas and three secondary areas and in which each secondary area has deposits of phosphors corresponding to that of the two primary areas contiguous to each such secondary area.

3. A color tube in accordance with claim **1** in which each of said clusters has three overlapping sections and in which the overlapping portions of said sections constitute said secondary areas while the remaining portions of said sections constitute said primary areas.

4. A color tube in accordance with claim **1** in which each of said clusters has a given diameter and is composed of three circular segments of the same diameter symmetrically positioned within the cluster to have overlapping portions which constitute said secondary areas and non-overlapping portions which constitute said primary areas.

5. A color tube in accordance with claim **1** in which each of said clusters is composed of three similar circular segments symmetrically positioned within the cluster to have a common intersection in the center of said cluster and further to have overlapping portions which constitute said secondary areas and non-overlapping portions which constitute said primary areas.

6. A color tube in accordance with claim **1** in which each of said clusters is composed of three similar circular segments symmetrically positioned within the cluster to have a common intersection for all three segments at the center of the cluster and to have intersections for every two of said segments at the periphery of said cluster thereby to provide overlapping portions which constitute said secondary areas and non-overlapping portions which constitute said primary areas.

7. A color tube in accordance with claim **1** in which each of said clusters is composed of three similar circular segments individually having a minimum dimension exceeding the radius of said cluster, said segments being symmetrically positioned within the cluster to have overlapping of all three segments in the central region of said cluster and to other overlapping along radial directions of every two of said segments thereby to provide overlapping portions which constitute said secondary areas and non-overlapping portions which constitute said primary areas.

8. A color tube in accordance with claim **1** in which the phosphor deposit of each of said secondary areas radiates approximately white light in response to impingement by said beam.

9. A color tube in accordance with claim **1** in which said cluster has two primary areas with complementary phosphor deposits and one secondary area having a deposit of both of said complementary phosphors.

10. A color tube in accordance with claim **1** in which said cross sectional area of said beam is less than the area of each of said clusters.

No references cited.

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ROBERT SEGAL, *Examiner.*