June 11, 1957 A. M. MORRELL 2,795,719

COLOR-KINESCOPES

Filed Aug. 18, 1954

Fig. 3.

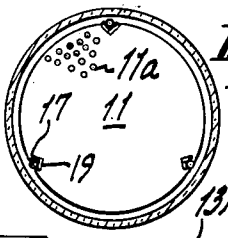


Fig. 1.

Fig. 2.

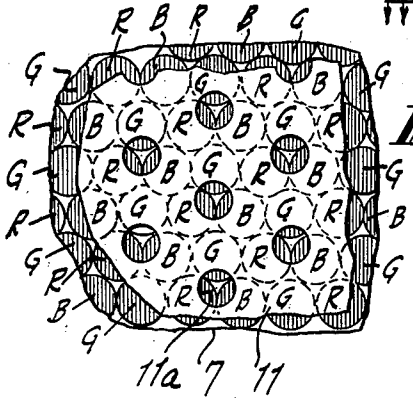


Fig. 6.

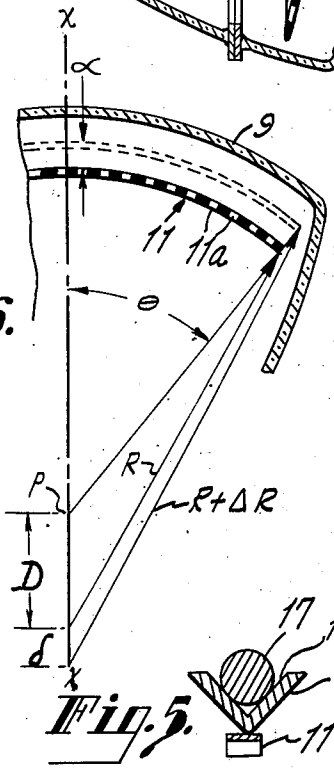


Fig. 4.

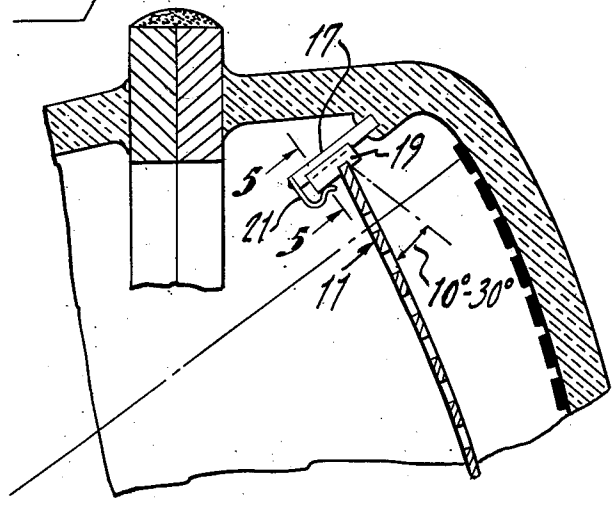


Fig. 5.

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COLOR-KINESCOPES

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11 Claims. (Cl. 313—85)

This invention relates to improvements in color-kinescopes and other (e. g. camera, radar and stereoscopic) cathode-ray (CR) tubes of the kind containing an apertured mask through which beam-electrons pass in their transit to the electron-sensitive mosaic target-surface of a nearby screen.

In cathode-ray tubes of the subject variety the accuracy with which the beam-electrons strike the individual screen-areas depends, to a great degree, upon the accuracy with which the mask-apertures are aligned with said screen-areas. Thus, in the case of a color-kinescope, should the mask expand by reason of thermal effects occasioned by the impact thereon of the electron-beam, or beams, then the beam-electrons, or some of them, may impinge upon color-areas other than the ones upon which they were intended to impinge.

Accordingly, the principal object of the present invention is to provide an improved method of and means for maintaining the apertures of a shadow-mask in alignment with the elemental areas of a mosaic-type screen over a wide range of operating temperatures, and this too without resort to the use of a heavy mask-frame or special (temperature-compensating) mask and/or mask-supporting materials.

Stated generally, the foregoing and related objects are achieved in accordance with the invention by the provision of a curved mask-and-screen assembly wherein a mechanical force, derived directly from the thermally expanding mask material, is applied to a contrivance adjacent to the edge of the mask in such a way that each of its apertured areas moves towards the screen along a substantially straight path which coincides with the deflection angle of the beam at that particular aperture. Thus the alignment between the mask apertures and the elemental areas on the target surface of the mosaic screen is maintained substantially irrespective of the operating temperature of the mask. In the embodiment of the invention that has been selected for illustration the direct conversion of the force of expansion in the mask into a mask-moving force of the correct sign and intensity is achieved by the provision of three or more carriages (secured to the edge of the mask) that ride on tracks which have the same angle of slope as the deflection-angle that the beam would have if its scanning movement included said tracks.

The invention is described in greater detail in connection with the accompanying single sheet of drawings, wherein:

Fig. 1 is a longitudinal sectional view of a 3-gun tricolor kinescope of the shadow-mask dot-screen variety containing a curved mask mounted in accordance with the principle of the present invention;

Fig. 2 is a fragmentary rear elevational view of the screen-unit of the color kinescope of Fig. 1, showing a conventional (hexagonal) pattern of mask-apertures and color-dots;

Fig. 3 is an elevational view of the mask of the screen-unit, showing a tri-point distribution of its supports.

Fig. 4 is an enlarged fragmentary view, partly in section, of the front end of the color-tube of Fig. 1, showing the manner in which the curved mask is supported for movement therein; and

Fig. 5 is an enlarged sectional view taken on the line 5—5 of Fig. 4 showing details of the carriage and track upon which the mask is mounted.

Fig. 6 is a diagrammatic view illustrating the position of the mask before and after expansion.

In the drawings the invention is shown as applied to color-kinescope comprising an evacuated glass or metal envelope **1** having a longitudinal axis *x—x* which extends through the neck **3** and main-chamber **5** of the envelope. This kinescope is of the so-called "masked-target dot-screen" variety wherein the red (R), blue (B) and green (G) phosphor dots (see Fig. 2) are arranged in a hexagonal mosaic pattern on the rear or target surface **7** of a glass screen-plate **9** which, in the instant case comprises the front-end or window of the device. The glass-plate **9** and its target surface **7** may be of any desired shape (e. g. circular or rectangular) and curvature (e. g. spherical or cylindrical). In the drawings they are shown to be in the form of a circular section of a spherical shell.

The apertured mask **11** for the mosaic target surface **7** of the color-screen plate **9** is preferably constituted of thin (say 0.004" to 0.008" thick) metal (e. g. copper, nickel or iron) or of an homogeneous alloy (e. g. 70–95 percent copper, 30–5 percent nickel) having a positive temperature coefficient of expansion. Alternatively, it may be formed of perforated glass which has been metallized to render one or both of its main surfaces conducting. In either event the mask **11** is appropriately curved so as to be approximately concentric with the curved target surface **7** of the screen-plate **9**, and each "triad" (i. e. cluster of three) phosphor dots, RBG is registered (i. e. centered) with respect to one of the mask holes **11***a*. As will hereinafter more fully appear the curved mask **11** is substantially unconfined at its edges and can expand substantially isotropically when subjected to the force of expansion generated in the mask-material by the thermal energy induced therein by the impact of beam-electrons thereon.

The beam-electrons for activating the different color-phosphors are derived, in the instant case, from a battery of three guns **13***r*, **13***b*, **13***g* arranged delta fashion about the central axis *x—x*, in the neck of the tube, as in Schroeder U. S. Patent No. 2,595,548. The horizontal and vertical scanning forces required to impart the requisite scanning movements to the three beams *rb* and *g* are applied simultaneously by a common deflecting yoke **15** which will be understood to comprise two pairs of electromagnetic coils (as indicated by the four current supply leads) disposed at right angles to each other on the neck **3**. As indicated by the single vertical line A—A the plane of deflection for the three beams *rb* and *g* extends through the yoke **15** and neck **3**.

The "plane of deflection" referred to in the preceding paragraph is the plane in which the axis of each deflected beam, when extended rearwardly, intersects the axis of origin of the beam. The term "deflection angle," as applied to a 3-beam tube, is the angle subtended by a line drawn from any point on the mask or screen along a median line of the beam-paths to the central axis *x—x* of the tube.

As previously indicated, the present invention may utilize carriages (on the mask) and inclined tracks (on which said carriages move) for converting the force of expansion (or contraction) in the mask directly into a force of the sign and intensity required to maintain the alignment between the mask apertures and the phosphor-dots (RB and G) with which said apertures are aligned. In the illustrated embodiment of the invention the tracks comprise three metal pins **17** of circular cross-section (see Fig. 5) embedded in the front-end portion or "cap"

of the envelope 1 about the edge of the mask 11. They may, however, comprise glass protuberances formed in the molding operation incident to the manufacture of the front-end or face-plate 9. In any event, the angle of inclination of these mask-supporting pins or tracks 17 should correspond substantially to the deflection angle which obtains adjacent to the edge of the mask. As shown more clearly in Fig. 5, the carriages which support the mask 11 for movement on the tracks 17 may each comprise a metal piece 19 containing a V-groove 19*a* dimensioned to have a sliding line-contact with the circular surface of the pin with which it is paired. Referring particularly to Fig. 4 it will be observed that the surface of the mask is inclined at an angle say of from 10° to 30° with respect to a line drawn perpendicular to the tracks 17 so that the force of expansion of the mask material moves the carriages, and hence the mask along the tracks in the direction of the screen.

The carriages 19 are maintained on their tracks 17 by springs 21 which exert their force on the carriages 19 in a direction normal to the axes of their tracks. Graphite, dioctalsebacate or other lubricant of low vapor-pressure may be applied to the tracks prior to sealing the envelope.

The diagram of Figure 6 shows the position of a spherically shaped mask 11 of a radius R and also its position when expanded by the heat of the beam electrons to another spherical shape of increased radius $R+\Delta R$. The uniform expansion to a spherical shape of a larger radius of curvature assumes uniform heating of the mask, as is essentially achieved in the reproduction of the average television program. The drawing shows that the edges of the mask 11 follow a path which forms an angle (with respect to the central axis x—x) equal to that of the deflection angle θ. As indicated in the drawing the point P is the deflection center of the electron beams and the symbols $\alpha\delta$ and D are constructional values. The expansion of the mask radius ΔR is equal to $\delta+\alpha$. From similar triangles it will be seen that

$$\frac{D}{\delta+D}=\frac{R}{R+\Delta R}, \text{ hence } \delta=\frac{D\Delta R}{R}$$

Since D and R are constants in any given tube, δ is proportional to ΔR which is dependent only on the temperature and expansion rate of the mask material. The system imposes only the restriction that $R>D$ and is completely independent of the angle θ. Therefore if the edge of the expanding mask is restricted in its movement to a path or angle equal to the deflection angle each of the holes 11*a* in the mask, in both its hot and cold conditions, is maintained in registry with its "triad" (RBG) of phosphor dots; hence each beam always strikes the proper color area on the screen, thus maintaining color-purity in the reproduced image.

From the foregoing it should now be apparent that the present invention provides an improved method of and means for maintaining the apertures of a shadow-mask in alignment with the elemental areas of a mosaic type screen over a wide range of operating temperatures.

What is claimed is:

1. A cathode-ray tube comprising, an evacuated envelope having a longitudinal axis and containing means for generating at least one electron-beam, a mask extending across said axis in a position to be scanned by said beam, said mask being constituted essentially of a material that expands when subjected to heat generated as an incident to the impact of beam-electrons thereon and containing a multiplicity of apertures through which beam-electrons pass along substantially straight paths which form various deflection angles with said longitudinal axis as determined by the instantaneous position of said beam during its scanning movements, a screen having an electron-sensitive mosaic target-surface disposed in a fixed position spaced from said mask with the elemental areas of which said mosaic is comprised aligned with respect to the apertures in said mask, and mask-supporting means cooperatively associated with said mask and envelope for causing each apertured area of said mask to move along said straight paths in response to the application to said mask-supporting means of the force of expansion generated in said mask material by the impact of beam electrons thereon.

2. The invention as set forth in claim 1 wherein said mask is substantially unconfined about its edge and is constituted essentially of a homogeneous material whereby said mask expands substantially isotropically when subjected to said electron impact, and wherein said mask-supporting means engages said mask adjacent to its edge.

3. The invention as set forth in the preceding claim and wherein said mask-supporting means engages said mask at spaced points about said edge.

4. A color-kinescope comprising; an evacuated envelope having a longitudinal axis, means for generating at least one electron-beam within said envelope, a mask having a concave surface disposed in a position to be scanned by said beam, said mask being constituted essentially of a material that expands when subjected to heat generated as an incident to the impact of beam-electrons thereon and containing a multiplicity of apertures through which beam-electrons pass along substantially straight paths which form various deflection angles with said longitudinal axis as determined by the instantaneous position of said beam during said scanning movement; a color-phosphor screen having a concave electron-sensitive mosaic target surface disposed in a fixed position spaced from said mask with the elemental color-phosphor areas of which said mosaic is comprised aligned with said apertures at the terminals of said straight electron-paths, and mask-supporting means cooperatively associated with said mask and envelope for causing each apertured area of said mask to move toward said color-phosphor screen substantially along said straight paths in response to thermal energy supplied by impact of beam-electrons upon said mask material.

5. A cathode-ray tube comprising an evacuated envelope having a longitudinal axis and containing means for generating at least one electron beam, a target electrode substantially normal to said axis in a position to be scanned by said beam, said electrode being constituted essentially of a material that expands when subjected to heat generated as an incident to the impact of beam-electrons thereon and containing a multiplicity of apertures through which beam electrons pass along substantially straight paths which form various deflection angles with said longitudinal axis as determined by the instantaneous position of said beam during its scanning movements, a screen having an electron-sensitive mosaic surface disposed in a fixed position spaced from said target electrode with the elemental areas of which said mosaic surface is comprised aligned with respect to the apertures in said target electrode, and means disposed adjacent to the edge of said target-electrode providing a surface inclined with respect to said longitudinal axis and upon which surface said target electrode is supported for movement in response to the force of expansion generated in said mask material by the thermal energy induced therein by impact of beam-electrons thereon, the angle of inclination of said supporting surface corresponding substantially to the deflection angle of said beam adjacent to said edge of said target electrode.

6. A color-kinescope comprising, an evacuated envelope having a longitudinal axis, means for generating at least one electron beam within said envelope, a mask having a concave surface disposed in a position to be scanned by said beam, said mask being constituted essentially of a material that expands when subjected to heat generated as an incident to the impact of beam-electrons thereon and containing a multiplicity of apertures through which beam-electrons pass along substantially straight paths which form various deflection angles with said lon-

gitudinal axis as determined by the instantaneous position of said beam during its scanning movements, a color phosphor screen having a concave electrosensitive mosaic target surface disposed in a fixed position spaced from said mask with the elemental color-phosphor areas of which the mosaic is comprised aligned with respect to the apertures in said mask, means disposed adjacent to the edge of said mask and providing a surface inclined with respect to said longitudinal axis and upon which surface said mask is supported for movement in response to the force of expansion generated in said mask by the thermal energy induced therein by impact of beam-electrons thereon, the angle of inclination of said mask-supporting surface corresponding substantially to the deflection angle of said beam adjacent to said edge of said mask whereby the alignment between said mask-apertures and said elemental color-phosphor areas is maintained substantially irrespective of the operating temperature of said mask.

7. A cathode-ray tube comprising an evacuated envelope having a longitudinal axis and containing means for generating at least one electron-beam, a target electrode centered on said axis in a position to be scanned by said electron beam, said electrode being constituted essentially of a material that expands when subjected to heat generated as an incident to the impact of beam-electrons thereon, carriage means supported on said target electrode at spaced points about the edge thereof, and a plurality of tracks extending from the inner surface of said envelope along axes inclined with respect to said longitudinal axis and upon which said carriage means are supported for movement in response to changes in the overall dimensions of said target electrode resulting from expansion and contraction of said electrode material.

8. The invention as set forth in claim 7 and wherein said mask is inclined at angle of the order of 10° to 30° with a line drawn perpendicular to said tracks.

9. In a cathode ray tube of the kind comprising an evacuated envelope having a longitudinal axis and a plane-of-deflection normal to said axis whereat electrons are subjected to a scanning movement in their transit to a target electrode centered on said axis, the improvement which comprises: a plurality of tracks upon which said target electrode is supported for movement along said longitudinal axis, said tracks extending away from the inner surface of said envelope toward the edge of said target electrode along axes which intersect said longitudinal axis at a common point adjacent to said plane-of-deflection.

10. In a cathode ray tube of the kind comprising an evacuated envelope having a longitudinal axis and a plane-of-deflection normal to said axis whereat electrons are subjected to a scanning movement in their transit to an electrode having a concave target surface centered on said axis, the improvement which comprises: a plurality of tracks upon which said electrode is supported for movement along said longitudinal axis, said tracks extending from the inner surface of said envelope along axis which intersect the edge of said concave target surface at an angle of less than 90°.

11. In the operation of a color-tube of the masked target variety, the method of minimizing color dilution occasioned by variations in the alignment of the mask's apertures with respect to the color-areas on the screen when the mask is subjected to heat generated by electron-bombardment; said method comprising: varying the spacing between said mask and screen as a function of the operating temperature of said mask in the direction and to the extent required to maintain said mask-apertures and said color-areas in alignment.

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