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3,330,980

SHADOW MASK MOUNTED WITH BI-METALLIC SECTIONS
CONNECTED BY EXPANSIBLE LOOP

Filed July 16, 1965

2 Sheets-Sheet 1

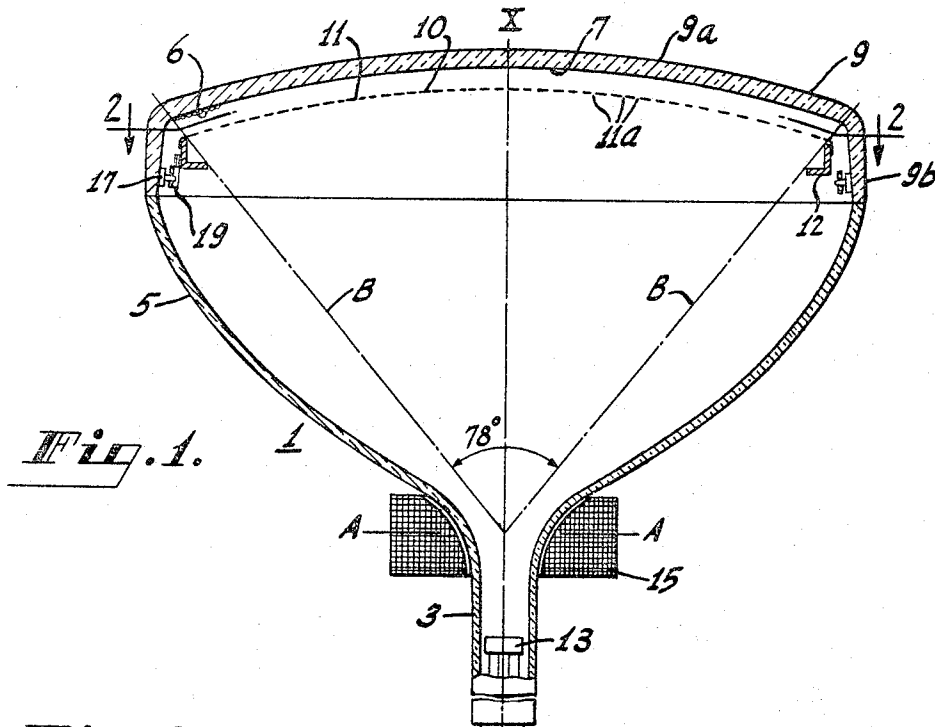


Fig. 1.

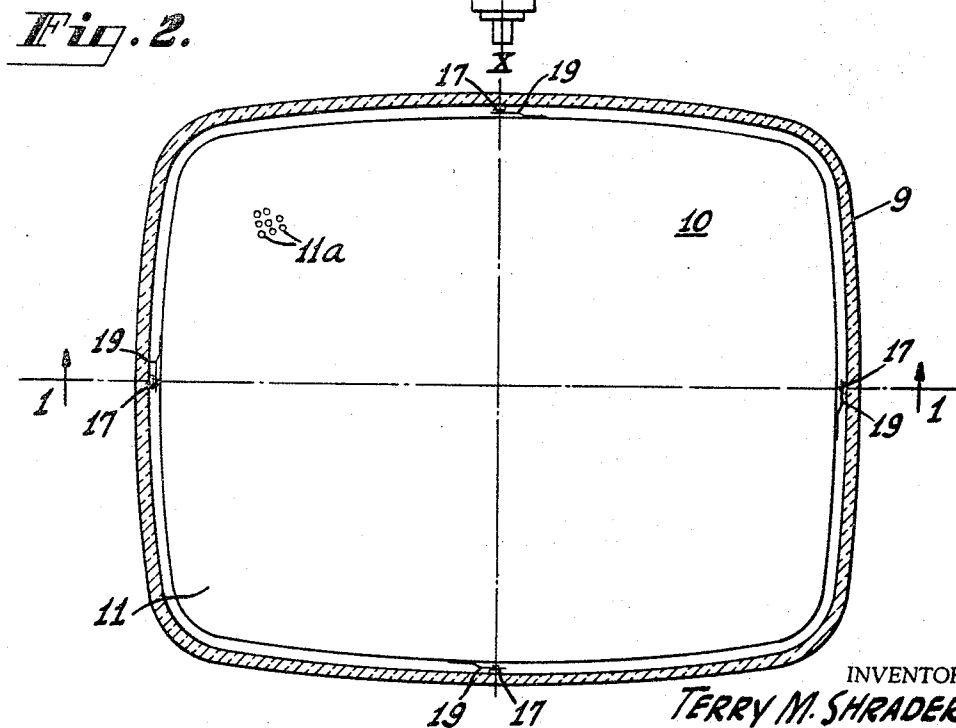


Fig. 2.

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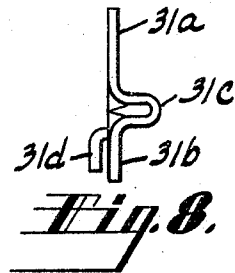
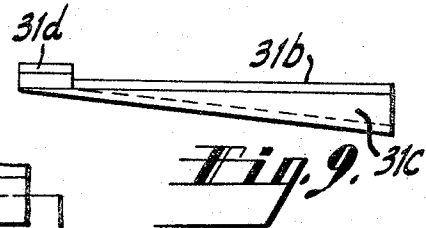
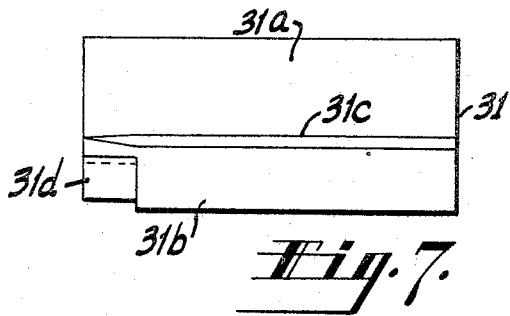
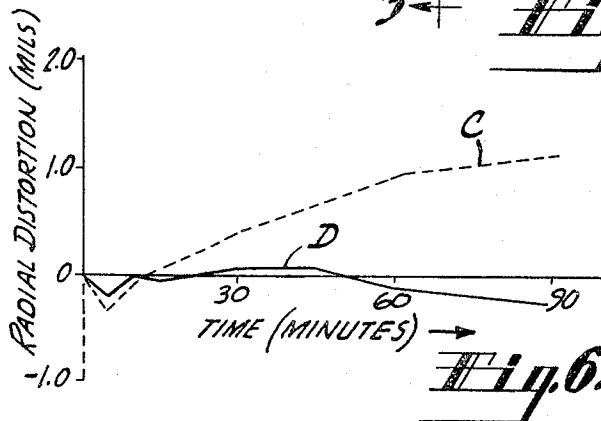
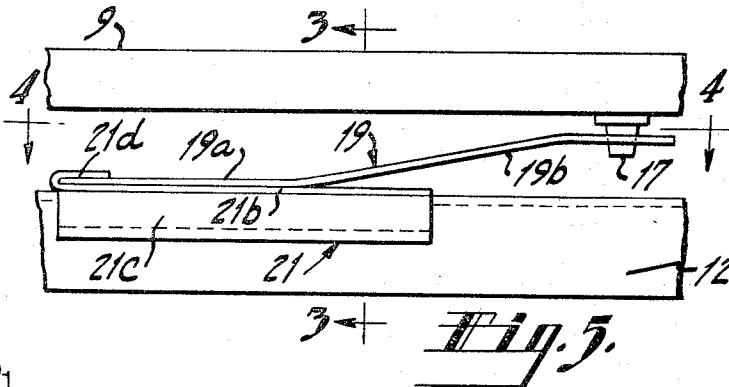
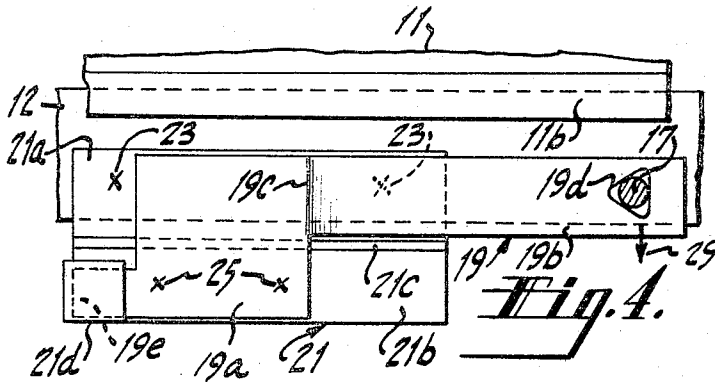
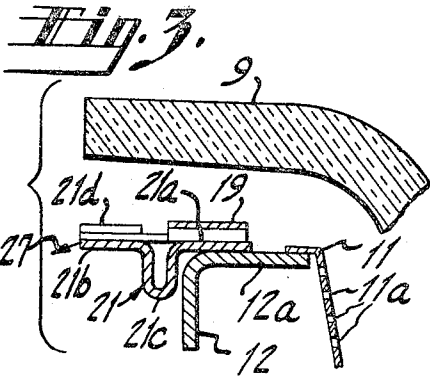
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SHADOW MASK MOUNTED WITH BI-METALLIC SECTIONS CONNECTED BY EXPANSIBLE LOOP

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12 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 a multi-apertured mask or mask electrode 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 elemental screen areas depends, to a great degree, upon the accuracy with which the mask apertures are aligned with the elemental screen areas during the operation of the tube. 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 resulting mis-alignment of the mask apertures and elemental color areas may cause the beam electrons, or some of them, to impinge upon elemental color areas other than the ones upon which they were intended to impinge.

Several methods or means have been proposed for compensating for thermal expansion of the mask by causing the mask to move (axially) toward the screen as it expands outwardly, to maintain the desired alignment of the mask apertures and elemental screen areas. Morrell Patent No. 2,795,719 proposed movably mounting the mask within the envelope by means of three carriages attached to the periphery of the mask and sliding on inclined tracks mounted on the envelope. Van Hakken et al. Patent No. 2,795,918 proposed the use of a multiplicity of flexible hinges connecting the masking member with a supporting frame, or a pivoted bell crank having arms slidably engaging the mask. These compensating means were designed primarily for use with circular masks in round tubes of moderate size and moderate deflection angle.

Actually, the amount of misalignment (or misregister) of the apertures due to thermal expansion of the mask is small enough in 21" round 70° color kinescopes, such as the RCA 21FBP22A, to be tolerated, so that no temperature compensation is presently used. However, the problem is more severe in 90° tubes such as the 19EYP22 and 25AP22A, because of the greater deflection and the rectangular shape of the tubes. In an RCA 25AP22A color kinescope a rectangular, cold rolled steel masking member is mounted in a rectangular envelope cap by four leaf springs each welded at one end to one side of the mask frame and having a hole at its other end detachably engaging a stud on the envelope cap (to permit removal for successive application of the three sets of different color-emitting phosphor dot areas by the conventional "light-house" procedure). The amount of radial misregister of the electron spots relative to the intended elemental color phosphor dot areas in this tube, due to thermal expansion of the mask during operation, is from 1 to 2 mils on a circle of about 7 inch radius. It has been found that the temperature compensating means heretofore proposed have not been satisfactory in the wider angle rectangular tubes.

An object of the present invention is to provide new and improved means for compensating for thermal expansion of an apertured mask of a cathode ray tube.

Another object is to provide effective means for maintaining the apertures of a multi-apertured shadow mask in substantial alignment with the elemental color phosphor areas in a color kinescope over the normal range of operating temperature of the tube.

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The foregoing and other objects are achieved, in accordance with the present invention, by mounting a mask electrode within a tube envelope and adjacent to a mosaic screen by means including a base plate of bi-metallic sheet metal comprising two substantially flat mounting sections connected by an expansion loop section, one of the mounting sections being attached to the mask, and an elongated leaf spring having one end connected to the envelope and another end attached to the other mounting section. Preferably, the leaf spring is detachably connected to the envelope for quick removal and replacement of the mask between successive screening operations during manufacture of the tube. In the case of rectangular tubes, four temperature-compensating mask mounting means are preferably used, each located at or near the mid-point of each side.

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

FIG. 1 is a longitudinal sectional view, taken on line 1—1 of FIG. 2, of a rectangular, three-beam, tri-color kinescope of the shadow-mask dot-screen variety containing a curved mask mounted in accordance with one embodiment of the present invention;

FIG. 2 is a sectional view taken on the line 2—2 of FIG. 1;

FIG. 3 is an enlarged axial sectional view of one of the mask mounting means of FIG. 1, taken on line 3—3 of FIG. 5;

FIG. 4 is a side view, partly in section, of the mounting means, taken on line 4—4 of FIG. 5;

FIG. 5 is a bottom view of FIG. 4;

FIG. 6 is a graph showing the radial distortion of the shadow mask electrode with time during warm up of the tube of FIGS. 1—5; and

FIGS. 7, 8 and 9 are plan, end and side views, respectively, of a modified mounting plate.

In FIGS. 1 and 2 there is illustrated a shadow-mask color kinescope comprising an evacuated glass envelope 1 having a longitudinal axis X—X which extends through the neck 3 and funnel portion 5 of the envelope. This kinescope is of the so-called "masked-target dot-screen" variety wherein red, blue and green phosphor dots 6 are arranged in mosaic pattern on the rear or target surface 7 of a glass screen plate 9a which, in the instant case, comprises the front-end or window of the tube. The target surface 7 may be of any desired shape (e.g. circular or rectangular) and curvature (e.g. spherical or cylindrical). In the drawing the target surface 7 is shown to be in the form of a generally rectangular section of a spherical surface. The glass screen plate 9a forms the base portion of a cup-shaped envelope cap 9 having a side wall 9b which is sealed to the funnel portion 5.

The apertured mask or mask electrode 10 for the mosaic screen 6 comprises a masking member 11 which is preferably constituted of thin (say 4 to 8 mils thick) metal (e.g. copper, nickel, iron or steel) having a positive temperature coefficient of expansion. Cold-rolled steel is preferably used because of its low cost and strength properties. Alternatively, the masking member may be formed of perforated glass which has been metallized to render one or both of its main surfaces conductive. The masking member 11 is appropriately curved with a contour similar to that of the spherical target surface 7. However, the spacing between the masking member 11 and the target surface 7 may be less at the outer marginal portions of the screen than at the central portions thereof, as in Epstein et al. Patent No. 3,109,116, to compensate for degrouching beam errors caused by dynamic convergence. The masking member 11 has a generally rectangular shape similar to but somewhat smaller than the target surface 7 and is formed with a multiplicity of apertures or holes 11a over most of its area. The masking member 11 is provided with

an integral, axially-extending peripheral rim portion 11b which is telescoped over and welded at a limited number of points (e.g. twelve) to an axially-extending flange 12a of a generally rectangular metal frame 12, of L-shaped cross-section, preferably made of cold-rolled steel like the masking member 11. The thickness of the two flanges of the mask frame 12 is normally at least ten times that of the member 11, in order to provide adequate support for the latter. The means for mounting the mask in the envelope will be described hereinafter.

The beam electrons for activating the different color phosphor areas of the screen 6 are derived from a three-beam electron gun assembly 13 mounted in the neck portion 3, e.g. as in Schroeder Patent 2,595,548. The horizontal and vertical scanning forces required to impart the requisite scanning movements to the three beams from gun assembly 13 are applied simultaneously by a common deflecting yoke 15 which will be understood to comprise two pairs of electromagnetic coils disposed at right angles to each other on the neck 3. The line A—A in FIG. 1 indicates the "plane of deflection," which is the plane in which the axis of each deflected beam, when extended rearwardly, intersects the axis of origin of that beam. The axial location of the plane of deflection changes somewhat with changes of beam deflection. The two dash-dot lines B indicate the centroid of the three beams from the plane of deflection at the maximum horizontal deflection. For a 90° tube (90° diagonal), the maximum horizontal deflection angle (between lines B) is about 78°, and the maximum vertical deflection angle is about 63°.

Normally, the apertured mask is mounted within the envelope of the tube by at least three, and preferably four (for a rectangular tube), leaf springs welded to the mask frame (or to a hook-plate welded to the frame) and detachably mounted on the envelope by engagement of a hole in the spring with a metal stud embedded in the envelope wall. The conventional arrangement permits radial or outward movement of the mask due to thermal expansion but otherwise holds the mask in a unique position with respect to the mosaic target surface 7. The three different sets of red, green and blue phosphor dots are formed on the screen target surface 7 by the conventional "Lighthouse" method, using the detachable mask as a stencil for exposing the appropriate portions of layers of photosensitive phosphor material. This process produces a mosaic comprising triads of red, green and blue emitting phosphor dots 6, with the centroid of each triad substantially registered with one of the mask apertures 11a. The screening process, of course, does not involve appreciable heating the mask.

When the color kinescope is operated the masking member 11 and its frame 12 expand, due to the heat produced by electron bombardment, causing color impurity in the 3 color picture on the screen due to misalignment or misregister of the apertures 11a and phosphor dots 6. In order to eliminate or minimize such misregister, the mask 10 is mounted by means including leaf springs and bi-metallic members adapted to cause the mask to move toward the screen while expanding outwardly, in response to heat generated by electron bombardment.

FIGS. 1-4 illustrate one embodiment of the invention, in which the mask frame 12 is detachably mounted on four metal studs 17, embedded or otherwise permanently attached to the inner wall of the envelope cap 9, by four L-shaped leaf springs 19 and four bi-metallic base plates 21. Preferably, the studs 17, springs 19, and plates 21 are located at or near the midpoints of the sides of the rectangular cap 9a, as shown in FIG. 2. Each spring 19 comprises a base portion or short leg 19a and a long leg 19b. The long leg 19b is bent outwardly at an acute angle from the plane of the base portion 19a, along line 19c as shown in FIG. 5, and formed with a hole 19d, which may be non-circular as shown, to detachably en-

gage the stud 17. Each base plate is formed with two substantially flat mounting sections 21a and 21b integrally connected by an expansion loop or fold section 21c of uniform height above the mounting sections. The upper mounting section, 21a, is welded, e.g. at point 23, to the flange 12a of frame 12, with the fold section 21c substantially parallel to the frame, as shown in FIG. 4. The lower part of the base portion 19a of spring 19 is welded, e.g. at points 25, to the lower mounting section 21b of the plate 21, with the masking member 11 properly positioned with respect to the screen. The base plate 21 may be formed at one end with a hook 21d adapted to receive an end portion 19e of spring 19 to hold the spring assembled to the base plate during assembly prior to welding.

The materials of the bi-metallic base plate 21 are chosen so that, when heated, the lower end 21b thereof will move inwardly toward the frame 12, in the general direction of the arrows 27 in FIG. 3. Thus, the coefficient of thermal expansion of the metal layer next to the frame must be lower than the coefficient of the other metal layer. For example, the metal layer next to the frame may be of Invar (36% Ni, 64% Fe), which has nearly zero thermal coefficient, and the other layer may be of a metal having the composition: 22% Ni, 3% Cr, and 75% Fe.

In the operation of the tube shown in FIGS. 1-4, as the mask electrode 10 heats up, due to electron bombardment, the bi-metallic plate 21 also heats up, by conduction and radiation from the frame 12, and the expansion loop 21c opens up, causing the lower portion 21b and also the attached portion 19a of the spring 19 to move downwardly in the general direction 27. This causes a downward movement of the hole 19d, relative to the frame 12, in the direction of the arrow 29 (FIG. 4). This movement of the hole 19d is amplified by the inclination of the leg 19b with respect to the plane of the base portion 19a. Since the hole 19d is fixed by stud 17 on the envelope cap 9a, the end result of the movement of the bi-metallic portion 21b relative to the frame is a component of motion of the mask electrode 10 in the opposite direction, i.e. toward the screen, as the mask electrode expands outwardly. Preferably, the shape of the spring 19 and the thermal coefficients of the bi-metallic base plate 21 are chosen so that the resultant movement of the mask apertures 11a at the periphery of the mask over the normal operating temperature range of the tube is substantially along the maximum deflection beam path (B in FIG. 1) to minimize misalignment or misregister of the apertures with the intended phosphor dots.

FIG. 6 is a graph showing the effect of the distortion due to expansion of the masking member 11 with time during the first ninety minutes of operation. The ordinate is the radial movement, in mils, of the electron spots, caused by the radial movement of the mask apertures 11a, relative to the phosphor dots of screen 6, at various times after the tube is turned on, as measured at predetermined points on a 25 inch rectangular tube with 90° deflection in a color television receiver. The measurements are made at eight points on a circle of about seven inch radius, at the 12:00 o'clock, 1:30, 3:00, etc. positions in FIG. 2. The ordinate of each point on the curves in FIG. 6 is the average of the eight measurements at a particular time. A positive ordinate indicates an outward movement of the electron spots, and a negative ordinate indicates an inward movement. The dotted curve C shows the average spot distortion during the first ninety minutes of operation of a tube having a mask mounted within the envelope by four conventional leaf springs. Curve C shows a small initial negative distortion of about .35 mil followed by a positive distortion up to about 1.2 mils. The initial negative distortion results from an initial doming of the spherical masking member 11 toward the screen 6 as the thin masking member 11 heats up faster than the thick frame

12 during the first five minutes of operation. After about fifteen minutes of operation, the expansion of the frame 12 overcomes the initial doming of the masking member 11 and produces the subsequent positive distortion of the electron spots.

The solid curve D in FIG. 6 shows the average spot distortion at the seven inch radius during the first ninety minutes of operation for a similar tube having the mask mounted by four bi-metallic plates 21 and four leaf springs 19, as shown in FIGS. 1-5. The maximum positive or negative distortion was less than .3 mil, which is well within the .5 mil distortion that can usually be tolerated without producing noticeable color dilution in the viewed picture. The negative portion of the curve beyond about fifty minutes is the result of slight over-compensation, that is, too much movement of the mask toward the screen as it expands radially outwardly. These tests were made only for the first ninety minutes because it has been found that the temperature of the mask becomes stable by that time.

FIGS. 7, 8 and 9 show a modified bi-metallic plate 31, which may be used in place of the plate 21 in FIGS. 1-5. The plate 31 is formed with two substantially flat mounting sections 31a and 31b integrally connected by an expansion loop or fold section 31c. Instead of having uniform height (as in FIG. 5), the loop section 31c varies in height from a maximum at one end to substantially zero at the other end, as shown in FIG. 9. When this modified base plate 31 is substituted for the base plate 21 in FIGS. 1-5, the spring 19 is caused to rotate slightly, clockwise in FIG. 4, thus further amplifying the movement of the hole 19d relative to the frame in the direction 29.

FIGS. 7-9 also show a modified hook 31d on the plate 31, which is lanced from the mounting section 31b and faces laterally instead of longitudinally of the plate. The bi-metallic base plates 21 and 31 are preferably formed with the grain running across instead of along the elongated plate, in which case it is easier to form the hook 31d than the hook 21d.

What is claimed is:

1. A cathode ray tube comprising an envelope including a faceplate, a multi-apertured mask electrode, and temperature compensating means mounting said electrode in said envelope in spaced relation to said faceplate, said means comprising:

(a) a base plate of bi-metallic sheet metal comprising two mounting sections connected by an expansion loop section, one of said mounting sections being attached to said electrode; and

(b) an elongated leaf spring having one end connected to said envelope and another end attached to the other of said mounting sections.

2. A cathode ray tube as in claim 1, wherein the connection between said leaf spring and said envelope comprises an opening in said spring detachably engaging a tapered stud on said envelope.

3. A cathode ray tube as in claim 1, wherein said base plate is an elongated rectangular plate having a longitudinal fold of U-shaped cross-section forming said expansion loop section, and said base plate is attached to said electrode with said fold extending substantially parallel to said electrode.

4. A cathode ray tube as in claim 3, wherein the height of said fold from said mounting sections is substantially uniform along the length thereof.

5. A cathode ray tube as in claim 3, wherein the height of said fold from said mounting sections is tapered from a maximum at one end to nearly zero at the other end.

6. A cathode ray tube as in claim 1, wherein said leaf spring is attached to said base plate with the longitudinal axis of said spring extending substantially parallel to said electrode.

7. A cathode ray tube as in claim 1, wherein said other

end of said leaf spring extends outwardly at an acute angle from said base plate.

8. A cathode ray tube as in claim 1, wherein said base plate comprises a hook portion adapted to hold said one end of said leaf spring in contact with said base plate prior to attachment of said spring to said base plate.

9. A cathode ray tube comprising:

(a) an evacuated envelope having a longitudinal axis;

(b) a screen having an electron sensitive mosaic target surface mounted across said axis at one end of said envelope;

(c) an electron gun mounted on said axis near the other end of said envelope for generating at least one electron beam for scanning said screen;

(d) a mask electrode extending across said axis between said gun and said screen and located adjacent to said screen, said mask electrode comprising a rigid frame and a masking member mounted across said frame, said masking member containing a multiplicity of apertures through which beam electrons pass along paths toward elemental areas of said screen mosaic which are aligned with said apertures along said paths, said masking member and frame being constituted of materials that expand when subjected to heat generated by electron bombardment; and

(e) at least three temperature compensating means for flexibly mounting said mask electrode, each of said means comprising:

(1) a base plate of bi-metallic sheet metal comprising two substantially coplanar mounting sections connected by an expansion loop section, one of said mounting sections being attached to the outer periphery of said frame; and

(2) an elongated leaf spring having one end connected to said envelope and another end attached to the other of said mounting sections.

10. A cathode ray tube as in claim 9, wherein said screen and mask electrodes are generally rectangular, and said mask electrode is mounted within said envelope by four mounting means respectively located near the mid-points of the four sides of said electrode.

11. A rectangular shadow-mask type color kinescope comprising:

(a) an evacuated envelope having a longitudinal axis and including a rectangular glass face plate having a substantially spherical concave internal surface disposed normal to said axis;

(b) a rectangular electron-sensitive mosaic three-color phosphor screen disposed on said surface;

(c) an electron gun assembly mounted in said envelope and on said axis for projecting three electron beams onto said screen;

(d) a rectangular domed shadow-mask electrode having a substantially spherical surface disposed adjacent to said screen in the paths of said beams, said electrode comprising a rigid metal frame and a cap-shaped metal masking member having an axially-extending peripheral part telescoped over and welded to said frame, said masking member containing a multiplicity of apertures through which electrons of said three beams pass along paths toward elemental areas of said screen mosaic which are aligned with said apertures along said paths, said masking member and frame being constituted of a metal that expands when subjected to heat generated by electron bombardment; and

(e) four mask electrode mounting means respectively located near the mid-points of the four sides of said mask electrode, said means causing said mask electrode to move toward said screen while expanding outwardly in response to heat generated by electron bombardment of said electrode an amount sufficient

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to maintain substantially said alignment of said apertures and elemental areas during operation; each of said means comprising:

- (1) a bi-metallic base plate comprising two substantially co-planar flat sections connected by an expansion loop section, one of said flat sections being welded to the outer periphery of said frame: and
- (2) an elongated leaf spring having one end con-

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nected to said envelope and another end welded to the other of said flat sections.

12. A color kinescope as in claim 11, wherein said masking member and frame are made of cold-rolled steel.

No references cited.

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ROBERT SEGAL, *Examiner*.