Aug. 18, 1970 G. R. KAUTZ 3,524,974

SHADOW MASK SUPPORTING STRUCTURE HAVING THERMAL EXPANSION CORRECTION MEANS

Filed Aug. 13, 1968 3 Sheets-Sheet 1

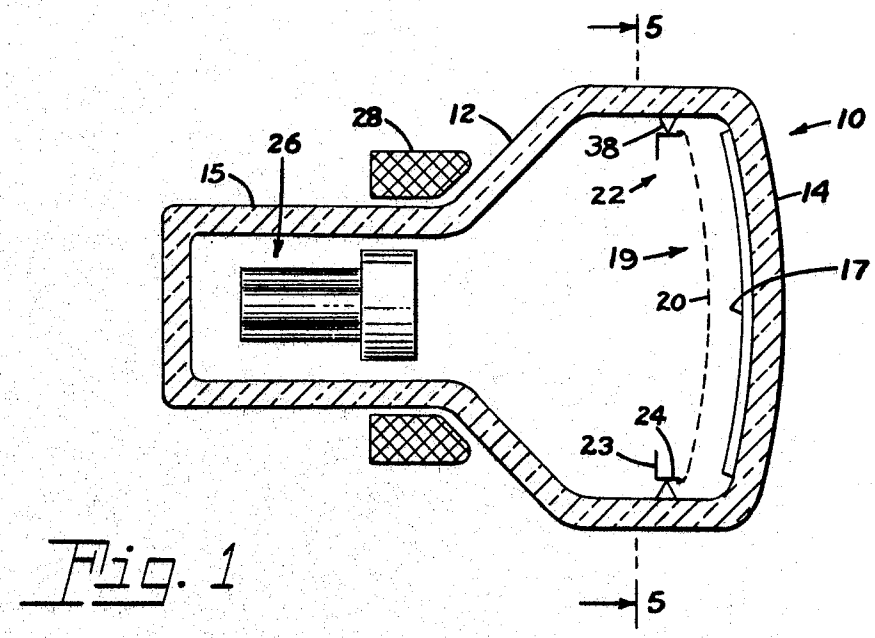



Fig. 1

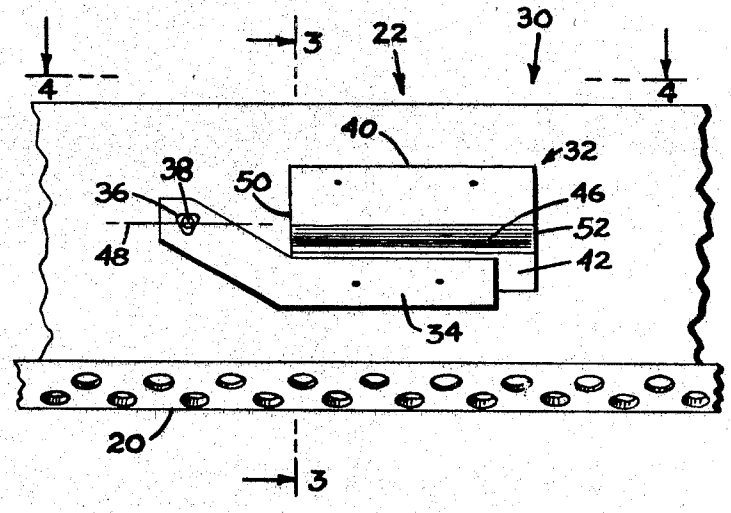



Fig. 2

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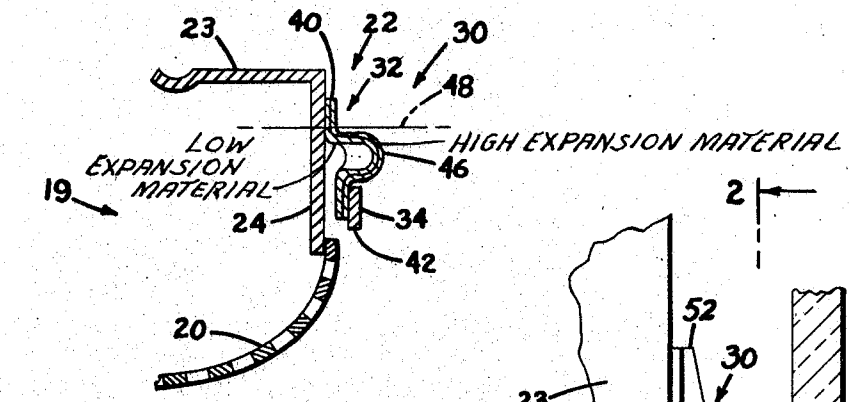



Fig. 3

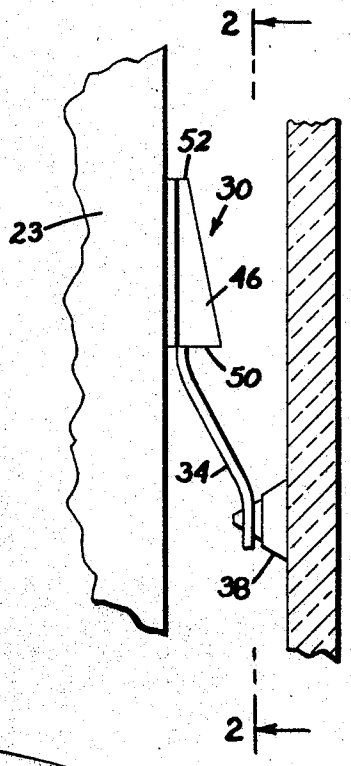



Fig. 4

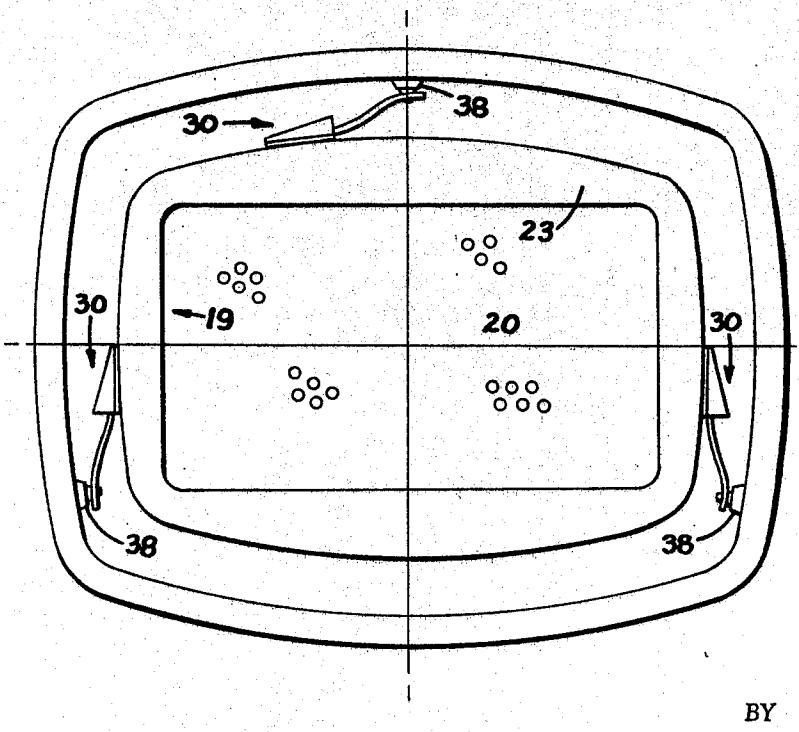



Fig. 5

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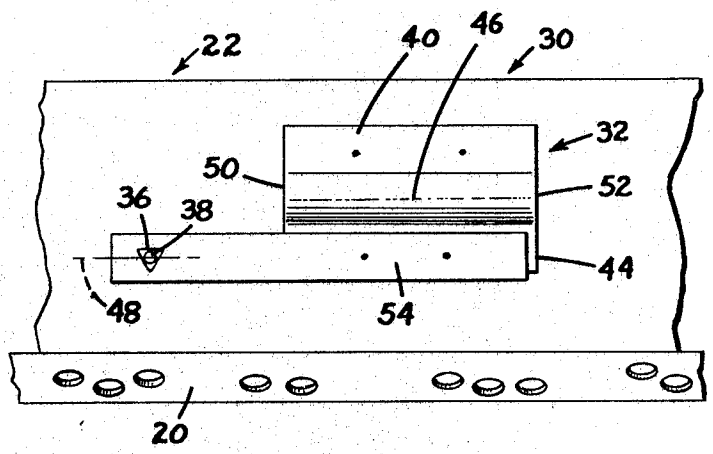



Fig. 6

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3,524,974

# SHADOW MASK SUPPORTING STRUCTURE HAVING THERMAL EXPANSION CORRECTION MEANS

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U.S. Cl. 313—85 4 Claims

## ABSTRACT OF THE DISCLOSURE

Deleterious thermal expansion in the shadow mask of a color cathode ray tube is translated into advantageous, alignment maintaining movement of the mask toward the screen through utilization of an intermediate spring mounting member formed by a bi-metallic material provided with a movement amplifying, contracting hinge. The movement is derived from the shape of the hinge, and the lever arm effect of the free end of the spring. The spring may be mounted below or substantially on the plane of the frame supporting studs.

## BACKGROUND OF THE INVENTION

This invention relates to color cathode ray tubes of the shadow mask variety and more particularly to a supporting means for mounting the shadow mask within the tube. An exemplary tube of this type may be found described in U.S. Pat. No. 2,986,080. It has been conventional practice in the color cathode ray tube industry to support the foraminous shadow mask of the tube from a relatively rigid frame structure and to support this assembly within the tube by means of cooperation between releasable leaf springs attached to the frame and to studs formed on an inside wall of the tube.

To prevent overscanning of the screen by the electron beams with subsequent color impurities caused by stray electrons, a haze shield has generally been formed about the upper edge of the frame. This haze shield or flange projects inwardly toward the center of the tube a prescribed distance and prevents the electron beams from impinging upon the inner wall of the frame and thus substantially reduces the aforementioned color impurities. Flanges of the type described above are preferably planar and an exemplary type may be found described in U.S. Pat. No. 3,345,530.

One of the current and most persistent problems in color tubes of this type has been a loss of color purity during operation of the tube caused by the expansion of the mask-frame assembly from the heating effect of the scanning electron beam. This expansion leads to misalignment between the discrete phosphor elements on the tube face, the apertures in the mask, and the electron beam.

Several method have been proposed for compensating for this thermal expansion of the shadow 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. One such prior art proposal suggested 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. Another proposal suggested the use of a multiplicity of flexible hinges connecting the masking member with the supporting frame, or a pivot bellcrank having arms slidably engaging the mask. While all of these approaches were theoretically



possible, none of them were very successful as a practical matter.

A still further innovation in the frame support system to correct for impurity color problems caused by the thermal expansion of the mask-frame assembly has been proposed in U.S. Pat. No. 3,330,980. This innovation provides for an intermediate mounting member between the frame and the supporting spring which comprises a bi-metallic element having upper and lower portions connected by an expansion loop. The lower portion is affixed to the frame and the upper portion has one end of a leaf spring attached thereto in such a manner that the free end of the leaf spring engages a mating tapered stud which projects inwardly from an upstanding wall of the face plate. In designs of this type the expanding hinge or loop projects inwardly toward the center of the tube and thus some modification of the frame to accept this projecting article is necessary. One of the suggested modifications involved curving the haze shield and frame to substantially conform to the curvature of the face plate of the tube. This modification thus left the center areas of the edges of the frame lower than the ends and provided the necessary space for the expanding loop; however, this modification was not completely successful because it destroyed some of the efficiency of the haze shield.

## OBJECTS AND SUMMARY OF THE INVENTION

Therefore, it is an object of this invention to enhance color television tube operation.

It is another object of the invention to obviate the difficulties inherent in the above-cited prior art structure.

It is yet another object of the invention to provide within the color television tube a temperature compensating means which requires no modification to the frame or the planar haze shield.

These objects are accomplished in one aspect of the invention by providing means for removably mounting the shadow mask which comprises a base plate of bi-metallic sheet metal having upper and lower mounting sections connected by a contracting, movement amplifying hinge. The upper section of the bi-metal sheet is fixedly attached to the shadow-mask electrode and the lower section has fixedly mounted thereon a projecting, elongated leaf spring having an aperture in the free end thereof, formed to cooperate for engaging purposes with a projecting stud on the interior wall of the face plate. The hinge is formed so that the outermost material has a co-efficient of thermal expansion greater than that of the inside layer and, thus, when heated during operation of the tube, the hinge contracts and forces the mask substantially axially downward toward the screen and thus substantially maintains the desired beam alignment.

This modification allows the loop to extend outwardly away from the shadow-mask frame and thus it may be utilized with shadow-mask electrodes of the type having a planar haze shield.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatical sectional view of a typical shadow-mask type color cathode ray tube;

FIG. 2 is a partial elevational view illustrating one embodiment of the supporting structure of the invention and is taken along the line 2—2 of FIG. 4;

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 2;

FIG. 4 is a partial plan view taken along the line 4—4 of FIG. 2;

FIG. 5 is a sectional view taken along the line 5—5 of FIG. 1; and

FIG. 6 is a partial elevational view of another embodiment of the invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

For a better understanding of the present invention, together with other and further objects, advantages, and capabilities thereof, reference is made to the following disclosure and appended claims in connection with the above-described drawings.

Referring now to the drawings with greater particularity, in FIG. 1 there is shown diagrammatically a typical color cathode ray tube **10** comprising a substantially infundibular portion **12**, face plate portion **14**, and a neck portion **15**. The interior surface of face portion **14** has formed thereon a mosaic cathodoluminescent screen **17** of conventional design. A shadow-mask assembly **19** comprised of a foraminous portion **20** and a frame **22** having an inwardly extending planar haze shield or flange **23** at the upper surface thereof and a peripheral wall **24** projecting therefrom is positioned adjacent to the screen. An electron source **26**, which is shown diagrammatically and which is typically a package of three electron guns, is positioned within the neck **15** of the tube. Positioned adjacent the jointure of infundibular portion **12** and neck **15** is a deflection yoke **28** for causing the electron beams to scan the face of the tube in a particular manner, all as is well understood in the art.

Referring now to FIG. 2 there is shown a temperature compensating, shadow-mask supporting system **30** comprised of an intermediate bi-metallic mounting member **32** and an elongated leaf spring **34**. The free end of the spring **34** is provided with an aperture **36** which cooperates for mounting purposes with a stud **38** formed on an upstanding wall of face plate **14**. Stud **38** is shown more fully in FIG. 4. The spring mounting system for this type of tube is necessary because of the photographic system used to deposit the elemental phosphor areas on the face plate of the tube. Each of the separate colors is applied individually and the shadow mask is used as the negative for forming these areas; thus after each exposure of a single phosphor color, the mask must be removed so that the screen may be properly developed. For more specific information in regard to screen forming techniques utilized with this type of tube, reference is hereby made to U.S. Pat. No. 3,025,161 which fully describes at least one method for so forming the screen.

Returning now to the mask support means per se, the bi-metal mounting member **32** is composed of an upper section **40** and a lower section **42** connected by a contracting, movement amplifying hinge **46**. As stated above, structure **32** and, consequently, hinge **46** are formed so that the material having the highest thermal co-efficient of expansion is on the outside of the hinge; i.e., the side remote from the shadow mask. Suitable materials for bi-metal plate **32** may comprise, for example, an inner layer of Invar (36% Ni, 64% Fe) which, at the temperatures encountered at the mask area, has a nearly zero thermal co-efficient, and the other layer may be of a material having the composition, 22% Ni, 3% Cr, and 75% Fe. A suitable thickness for the material is in the neighborhood of .030" to .060".

As may be seen more clearly in FIG. 3, the upper portion **40** of bi-metal **32** is fixedly positioned to the frame wall **24**, as by welding. The lower portion **42** is spaced away from wall **24**, a distance sufficient to allow for downward movement of the device during operation without frictional engagement with the wall (see FIG. 3). The end of spring **34** which is spaced from aperture **36** is fixedly positioned on this lower portion **42**, as by welding. It will also be seen from a comparison of FIGS. 2 and 3 that in this embodiment the fixed end of spring **34** lies below a transverse plane passing through studs **38**. This transverse plane of the stud is indicated in the drawings at **48**. Thus the free end of spring **34** is formed at an angle to project upwardly toward the top of bi-metallic element **32** in order to perform its mating function with stud **38**.

The amplifying factor in the contracting hinge **46** stems from its triangular configuration, when viewed in plan, as may be seen quite clearly in FIG. 4. This substantially triangular configuration, in operation, causes the wide end **50** of hinge **46** to contract more than narrow end **52**. This unequal contraction of the hinge when coupled with the length of the free end of spring **34** causes the mask-frame assembly to be forced downwardly toward the screen in a substantially axial direction, thus translating what would otherwise be an expansion of the shadow mask into downward movement thereof toward the screen. This downward compensation for the mask expansion substantially maintains the necessary alignment between the electron beam, the apertures in the shadow mask, and the elemental phosphor areas of the mosaic screen.

In FIG. 5 there is shown a complete mounting system for the shadow-mask assembly which comprises three studs **38** and three associated support systems **30**. While the embodiment shown utilizes a three-point suspension system, it is to be understood that the concept of invention defined herein is equally applicable to a four-point suspension system utilized by some tube manufacturers.

In FIG. 6 is shown an alternate embodiment of mounting system **30**, wherein the bi-metallic member **32** is mounted in a higher position on wall **24** of frame **22**. In this instance the spring utilized, designated as **54**, may be substantially straight and thus may be mounted substantially along the plane **48** of studs **38**.

Thus, there has been provided by this invention a new and novel shadow-mask supporting system which substantially translates deleterious heat caused expansion of the shadow-mask electrode into downward movement thereof, thereby substantially maintaining the desired alignment within the tube and having the added advantage that it permits utilization of the desirable planar haze shield feature of this type of tube.

While there have been shown and dscribed what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

**1.** In a cathode ray tube comprising an envelope having a face plate at one end thereof and an electron source at another end thereof, an apertured mask electrode adjacent said face plate, a plurality of support means for removably mounting said electrode each of said support means comprising: a base plate of bi-metallic sheet metal having two contiguous layers, a first layer of which has a relatively high coefficient of thermal expansion and the second layer of which has a relatively low coefficient of thermal expansion, said base plate comprising upper and lower mounting sections connected by a contracting, movement amplifying hinge, said hinge being formed with said high expansion material on the ouside thereof, said upper one of said mounting sections being attached to said electrode and being more remote from said face plate than said lower section, and an elongated leaf spring having one end connected to said envelope and another end attached to said lower one of said mounting sections.

**2.** The tube of claim **1** wherein said springs are connected to said envelope by means of an aperture in said springs and cooperating tapered studs fixed in the upstanding wall of said face plate, said studs being positioned on a plane transverse of said tube and passing through said studs and all being an equal distance from said face plate, said hinges being positioned below said transverse plane and thus closer to said face plate than said studs.

3. The tube of claim 1 wherein said springs are connected to said envelope by means of an aperture in said springs and cooperating tapered studs fixed in the upstanding wall of said face plate, said studs being positioned on a plane transverse of said tube and passing through said studs and all being equal distance from said face plate, said hinges being positioned above said transverse plane and said springs being positioned substantially on said transverse plane.

4. The tube of claim 1 wherein said contracting hinges are substantially laterally U-shaped.



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U.S. Cl. X.R.

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