COLOR PICTURE TUBE HAVING SHADOW MASK

This invention relates to color picture tubes of the type having a shadow mask attached to a peripheral frame which is suspended in relation to a cathodoluminescent screen.

In these color picture tubes, the accuracy with which the electron beams, emitted from an electron gun, strike individual elemental cathodoluminescent screen areas depends, to a great degree, upon the accuracy with which the shadow mask apertures are aligned with the elemental screen areas during operation of the tube. During initial tube operation, the shadow mask is heated by the impingement of the electron beams thereon at a much faster rate than is the heavier peripheral frame. Because of this heating differential, the shadow mask expands at a greater rate than the frame. Since the shadow mask is peripherally welded to the frame, this more rapid expansion of the shadow mask causes the frame to resist the mask expansion, thereby resulting in mask doming. Such mask doming causes the electron beams, passing therethrough, to misregister with their associated elemental screen areas, thereby resulting in an undesirable shift in color on the screen.

Several prior patents have addressed this doming problem. U.S. Patent No. 3,368,098, issued to Demmy on February 6, 1968, teaches the use of a limited number of mask-to-frame welds to eliminate or reduce a negative distortion of a shadow mask during the warmup period of tube operation. U.S. Patent No. 3,585,431, issued to Long on June 15, 1971, discloses the formation of a flutted mask skirt, wherein the mask is welded to a frame such as to permit radial movement of the mask away from a peripheral surface of the frame during tube warmup. U.S. Patent No. 3,862,448, issued to Ishizuka et al. on January 21, 1975, teaches the use of a reduced mass

cushion zone at a mask skirt to minimize the stresses in the mask caused by heating the mask. U.S. Patent No. 4,099,086, issued to Röder et al. on July 4, 1978, discloses a mask skirt having cutouts near its corners to define corner tongues. The tongues are curved and are welded to a mask frame. In one embodiment, the tongues have a further recess or a corrugation to provide a hinge effect.

Although all of these prior patents solved particular problems associated with the tube types in which they were applied, more recent tube designs necessitate the development of other solutions to the problems caused by mask expansion. One of these more recent tube designs utilizes a flatter, more truly rectangular, shadow mask.

In accordance with the present invention there is provided a color picture tube including an evacuated envelope having a rectangular faceplate panel with major and minor axes, a central longitudinal axis of said tube passing through the center of said faceplate panel perpendicularly to the major and minor axes, said faceplate panel including a shadow mask having a peripheral skirt conforming to a flange of a peripheral frame mounted in said panel, said skirt and said flange each approximately paralleling said central longitudinal axis, and said skirt being welded at various points including its corners to said flange, wherein said mask and said frame each has truncated corners such that portions of said skirt at the corners of said mask and portions of said flange at the corners of said frame are straight, flat and acutely angled with respect to both said major and minor axes, and the corner weld points are located approximately at the centers of the straight, flat and acutely angled portions.

In the drawings:

FIGURE 1 is a plan view in axial section of an apertured mask cathode-ray tube in accordance with the invention.

FIGURE 2 is a back view of the faceplate and mask-frame assembly of the tube of FIGURE 1.

FIGURE 3 is a partially broken-away plan view of a corner portion of a prior art mask-frame assembly.

FIGURE 4 is a partially broken-away plan view of a corner portion of the mask-frame assembly of the tube of FIGURE 1.

FIGURE 5 is a sectional view of the corner portion of the mask-frame assembly taken at line 5-5 of FIGURE 4.

FIGURE 6 is a perspective view of a corner of the frame of the tube of FIGURE 1.

FIGURE 7 is a partially broken-away plan view of a corner portion of another mask-frame assembly in accordance with the invention.

FIGURE 8 is a partially broken-away plan view of a corner portion of yet another mask-frame assembly in accordance with the invention.

FIGURES 1 and 2 illustrate a color picture tube 18 having an evacuated glass envelope 20 comprising a rectangular faceplate panel 22 and a tubular neck 24 joined by a funnel 26. The faceplate panel includes two orthogonal axes; a major axis X-X, parallel to its wider dimension (usually horizontal), and a minor axis Y-Y, parallel to its narrower dimension (usually vertical). The major and minor axes are perpendicular to the central longitudinal axis Z-Z of the tube which passes through the center of the neck 24 and the center of the panel 22. The panel 22 comprises a viewing faceplate 28 and a peripheral

flange or sidewall 30 which is sealed to the funnel 26 by a frit material 27. A three-color cathodoluminescent line screen 32 is located on the inner surface of the faceplate 28. The screen 32 comprises an array of phosphor lines extending substantially parallel to the minor axis Y-Y of the tube. Portions of the screen 32 may be covered with a light absorbing material in a manner known in the art. A mask-frame assembly 33, comprising a novel apertured color selection electrode or shadow mask 34 attached to a novel L-shaped frame 35, is removably mounted within the panel 22 in predetermined spaced relationship to the screen 32 by four springs 42. The mask 34 includes a multiplicity of slit-shaped apertures which are aligned in substantially parallel columns, with web portions separating the slits within each column. The L-shaped frame 35 includes two flanges 36 and 37. The first flange 36 extends toward the screen 32 and approximately parallels the central longitudinal axis Z-Z. The second flange 37 extends inward toward and approximately perpendicular to the central longitudinal axis Z-Z. The mask 34 also includes a peripheral skirt 41 which is telescoped relative to the frame flange 36.

An inline electron gun 39 (illustrated schematically) is mounted within the neck 24 to generate and direct three electron beams 38B, 38R and 38G along coplanar convergent paths through the mask 34 to the screen 32.

The tube 18 is designed to be used with an external magnetic deflection yoke 40 surrounding the neck 24 and funnel 26 in the vicinity of their junction. When appropriate voltages are applied to the yoke 40, the three beams 38B, 38R and 38G are subjected to perpendicular magnetic fields that cause the beams to scan in a rectangular raster over the screen 32.

FIGURE 3 shows a corner portion of one type of prior art mask-frame assembly 33' including an apertured shadow mask 34' attached to a peripheral frame 35'. The corners of the mask 34' and frame 35' are rounded, and the

mask 34' is welded to the frame 35' at a point 44 on the corner. Because of the bends in the mask 34' at the corners, the mask 34' is relatively rigid in the corners with very little flexibility. The embodiments of the present invention provide greater corner flexibility than this type of prior art structure and do not require cutouts and tabs, as needed by some other prior art structures.

FIGURES 4, 5 and 6 show the details of the novel mask-frame assembly 33 in the tube 18. The major noticeable differences of the novel mask-frame assembly 33 from the prior art assembly 33' of FIGURE 3 are that the sides are straighter and the corners are truncated for the former. The first flange 36 of the frame 35 at the frame corner is straight, flat and acutely angled with respect to both the major axis X-X and the minor axis Y-Y. A peripheral portion of the shadow mask 34 conforms to the shape of the first flange 36 and is telescoped thereon. The skirt 41 of each angled corner portion of the mask 34 is welded to the truncated corner of the frame 35 at a point 46 located approximately at the center of the straight and flat frame corner. The weld also is located near the distal end of the skirt 41 to permit maximum radial flexibility.

In the prior art mask-frame assembly 33' of FIGURE 3, the location of the weld 44 peripherally around the corner and relative to the distal edge of the mask is somewhat critical. Small varations from a predetermined design location can have large effects on mask expansion and doming. However, in the novel mask-frame assembly 33, the location of the weld 46 at the truncated corner is not as critical, thereby reducing tube-to-tube variations that may be caused by variations in mask-to-frame welding. This advantage results from the greater flexibility of the straight flat portion of the mask skirt 41 at the truncated corners. Such flexibility also results in less resistance to mask expansion and, therefore, less mask doming.

The mask skirt flexibility at the truncated corners can be tailored by varying the length A of the straight flat portions of the corners. A shorter length A will result in less flexibility, and a longer length A will result in greater flexibility.

In some applications, the truncation of the mask-frame assembly corners may result in undesirable microphonics of the mask because of the flexibility of the corners. Such microphonics can be controlled by a modification of the truncated corners of a mask-frame assembly 48, as shown in FIGURE 7. The mask-frame assembly 48 includes a shadow mask 50 attached to an L-shaped peripheral frame 52. Each corner of the mask-frame assembly 48 includes three integrally consecutive straight flat segments 54, 56 and 58, all of which are acutely angled with respect to the major and minor axes. The mask 50 is welded to the frame 52 at the approximate center point 60 of the center segment 56. Specific microphonics problems can be controlled by appropriately tailoring the lengths or angles of the segments.

Although the above-described mask-frame assembly 33 has been shown with the mask telescoped over the frame, the truncated corners also may be used in a mask-frame assembly 33", where a mask 34" is telescoped within the frame 35", such as shown in FIGURE 8. In the assembly 33", the mask 34" is dimensioned slightly smaller than the frame 35" so that a gap 62 exists between the mask 34" and frame 35". The purpose of the gap 62 is to permit room for mask expansion. Attachment of the mask 34" to the frame 35" is made at flutes or embossments 64 in the mask skirt that extend outwardly to contact the frame 35". Alternatively, the frame could have tabs or embossments that extend inwardly to contact the mask.

The illustrative mask-frame assemblies according to the invention and described hereinbefore aid in reducing shadow-mask doming during tube operation.

CLAIMS:

1. A color picture tube including an evacuated envelope having a rectangular faceplate panel with major and minor axes, a central longitudinal axis of said tube passing through the center of said faceplate panel perpendicularly to the major and minor axes, said faceplate panel including a shadow mask having a peripheral skirt conforming to a flange of a peripheral frame mounted in said panel, said skirt and said flange each approximately paralleling said central longitudinal axis, and said skirt being welded at various points including its corners to said flange, wherein said mask and said frame each has truncated corners such that portions of said skirt at the corners of said mask and portions of said flange at the corners of said frame are straight, flat and acutely angled with respect to both said major and minor axes, and the corner weld points are located approximately at the centers of the straight, flat and acutely angled portions.

2. A color picture tube according to claim 1, wherein each of said straight, flat and acutely angled portions is bounded at both its sides by an integrally consecutive straight, flat segment also acutely angled with respect to said major and minor axes.

3. A color picture tube substantially as hereinbefore described with reference to; Figures 4, 5 and 6; or Figure 7; or Figure 8 of the drawings.