United States Patent

[11] 3,585,431

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[73] Assignee **RCA Corporation**

[54] **SHADOW-MASK CATHODE RAY TUBE INCLUDING A MASKING MEMBER COMPRISING A SKIRT HAVING INDENTATIONS AND PROJECTIONS OVERLAPPING AND ATTACHED TO A FRAME**
6 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **313/85,** 29/25.17, 313/286, 313/292
[51] **Int. Cl.** **H01j 1/96,** H01j 9/18, H01j 29/46
[50] **Field of Search** ..... 313/64, 85, 92 B

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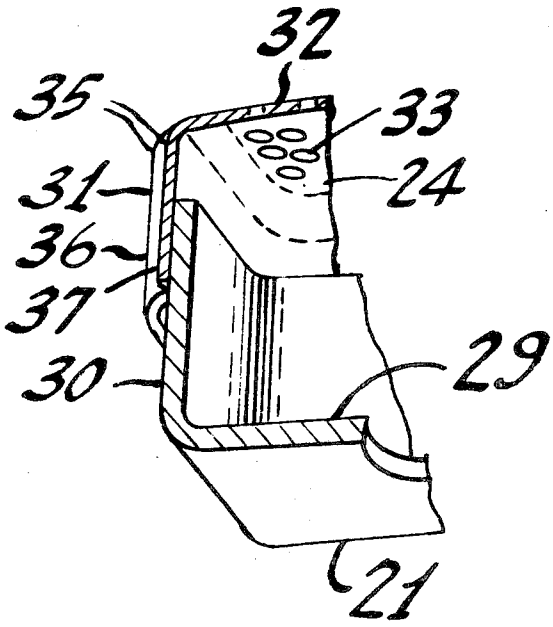
ABSTRACT: A cathode-ray tube including an envelope comprising an outwardly domed generally rectangularly shaped faceplate, a phosphor screen disposed on the internal surface of said faceplate, means for projecting electrons towards the screen, and a generally rectangularly shaped shadow-mask assembly mounted adjacent to the screen in the path of the electrons. The mask assembly comprises a rigid metal frame and a metal masking member welded to the frame. The masking member includes a domed shadow mask integral with a peripheral skirt having a plurality of alternate projections and indentations, which may extend the length of the skirt substantially parallel to the longitudinal axis of the tube.



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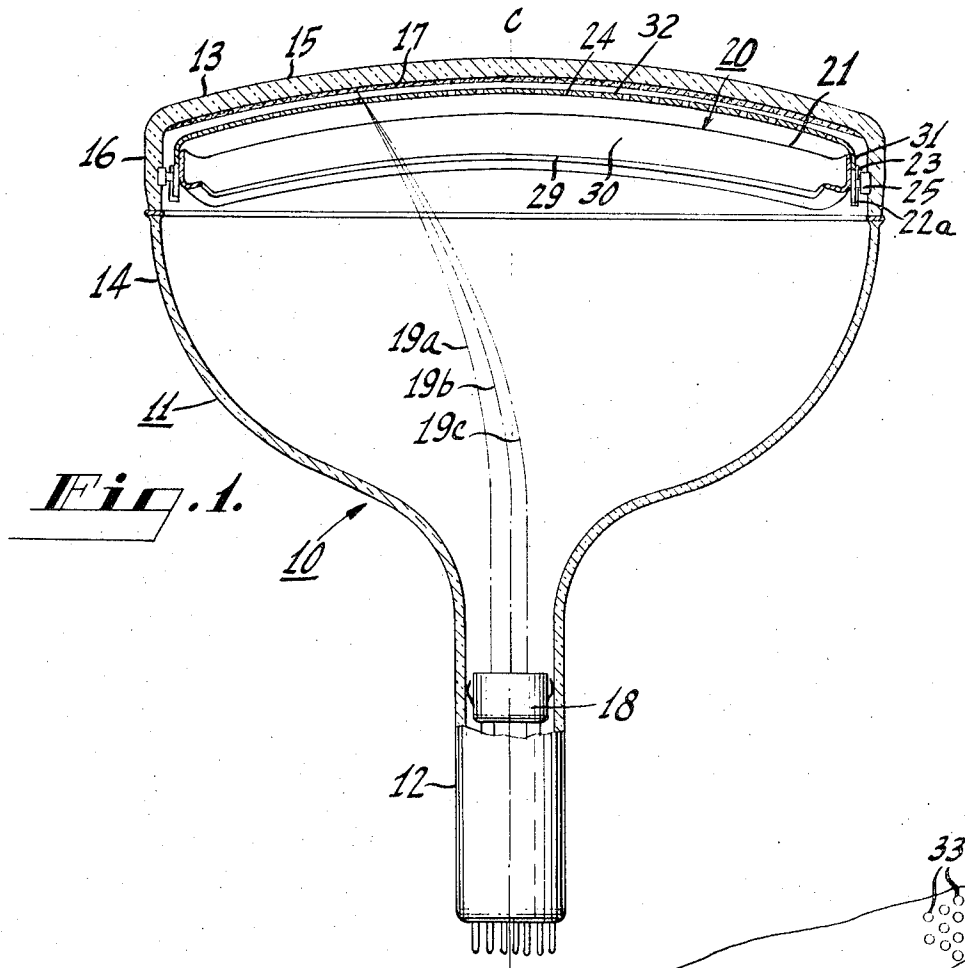

Fig. 1.

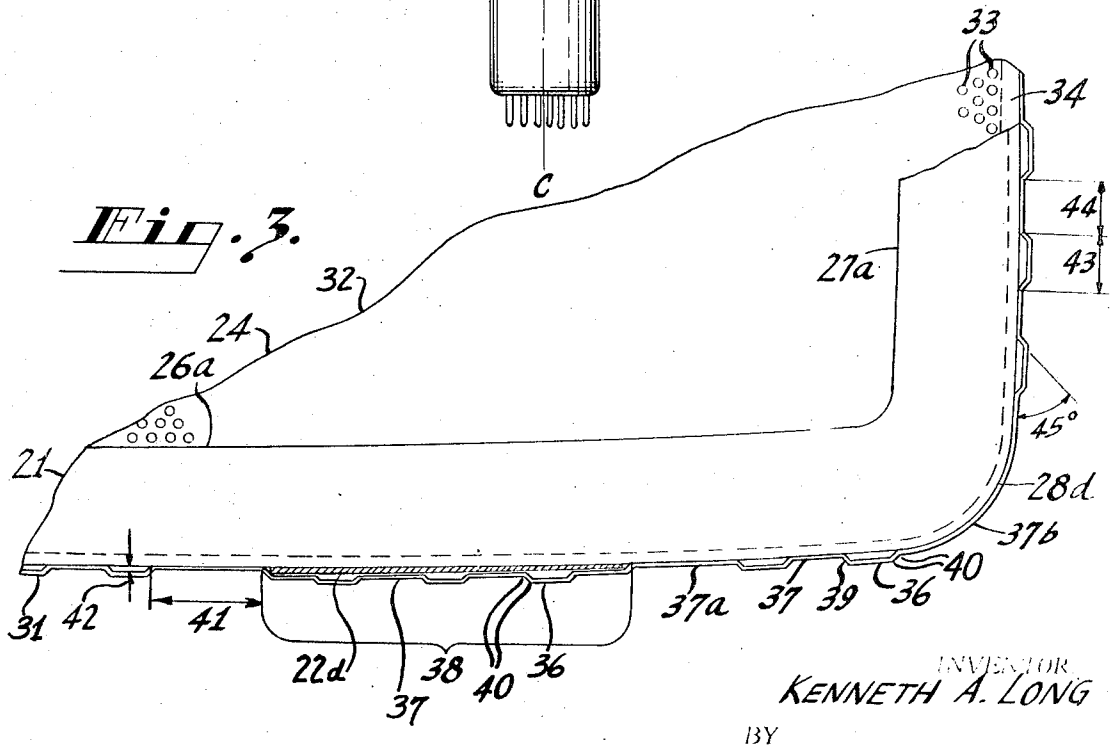

Fig. 3.

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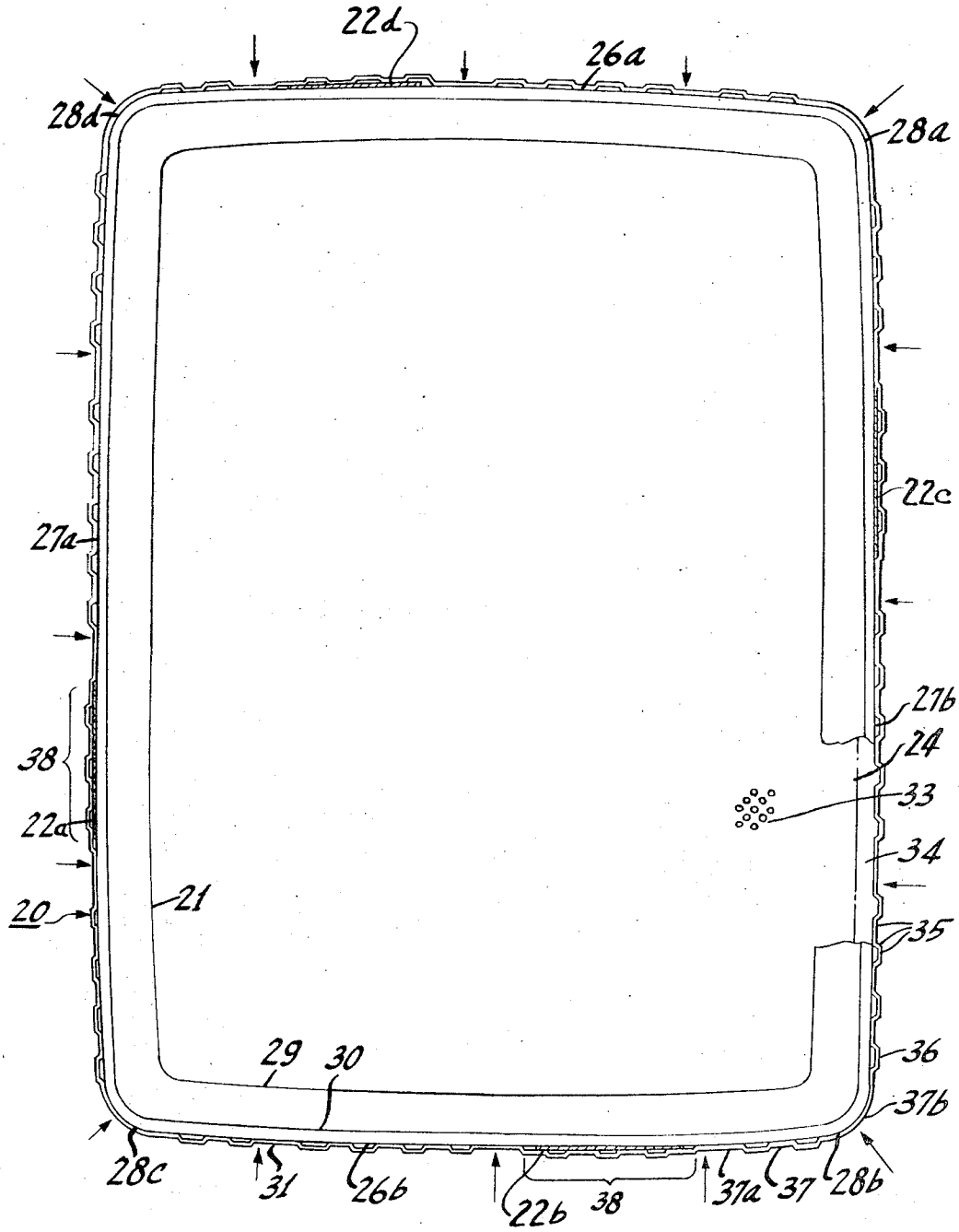

Fig. 2.

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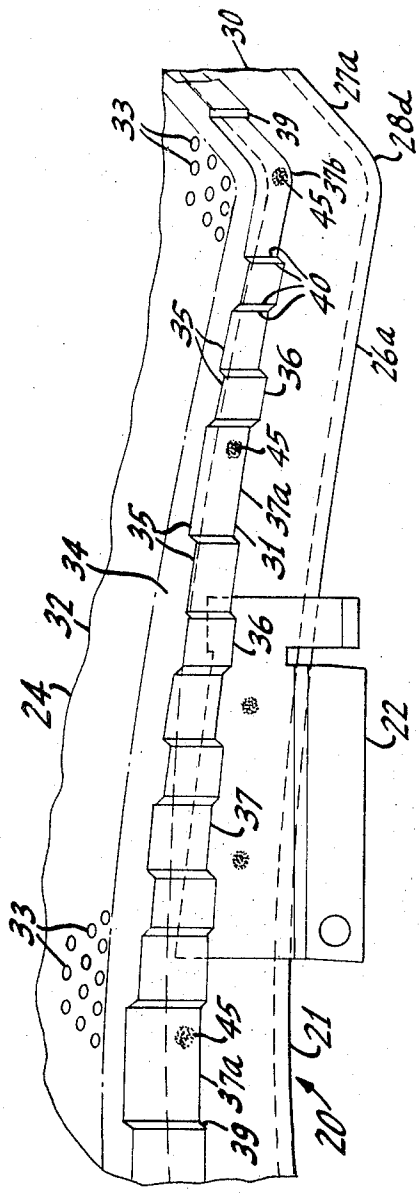

Fig. 4.

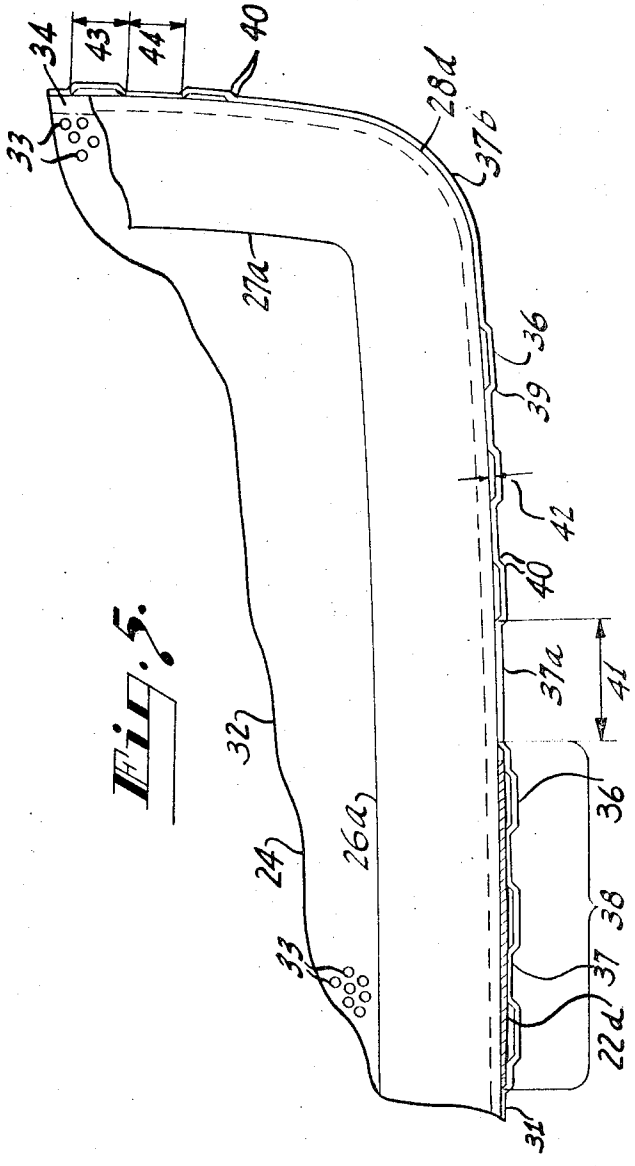

Fig. 5.

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PRIOR ART

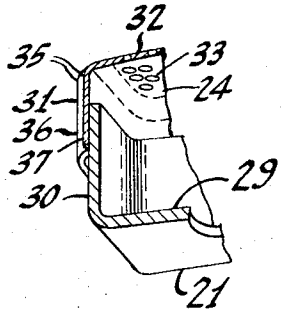

Fig. 6a.

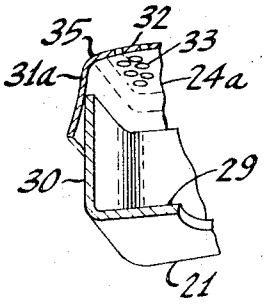

Fig. 6b.

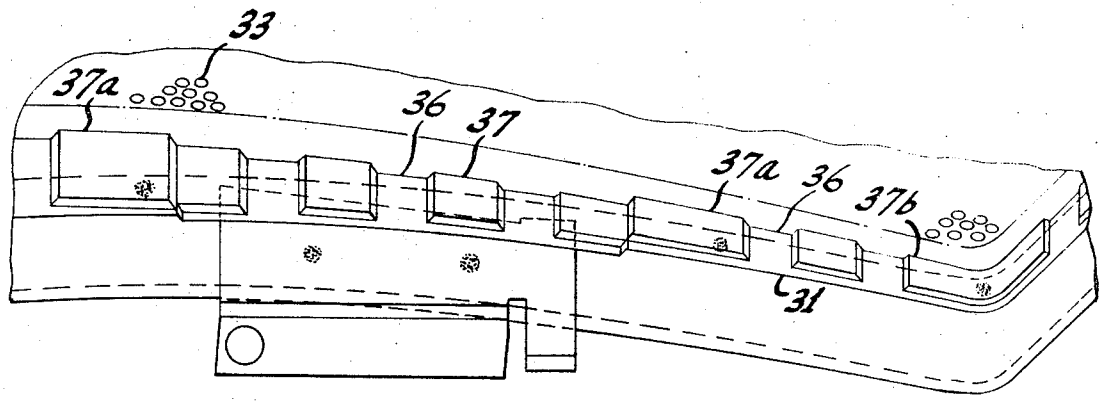

Fig. 7.

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SHADOW-MASK CATHODE RAY TUBE INCLUDING A MASKING MEMBER COMPRISING A SKIRT HAVING INDENTATIONS AND PROJECTIONS OVERLAPPING AND ATTACHED TO A FRAME

BACKGROUND OF THE INVENTION

This invention relates to a novel cathode-ray tube and particularly, but not exclusively, to a shadow-mask color-television-picture tube.

Color-television-picture tubes of the shadow-mask type (also called aperture-mask type) usually comprise a mosaic screen of phosphor elements, means including an electron gun for exciting the screen, and a shadow-mask assembly positioned between the electron gun and the screen. The shadow-mask assembly includes a thin-apertured metal masking member, a frame for supporting the masking member, and frame mounting means for supporting the masking member adjacent to and in a predetermined spaced relationship with the elements of the mosaic screen.

In some prior shadow-mask color-television-picture tubes, the mosaic screen and the masking member are generally rectangular, with rounded corners, and have outwardly bowed sides. In one form, the masking member comprises a domed, apertured mask and a substantially imperforate peripheral skirt integral with the mask. The skirt is substantially normal to the plane of the mask and is attached, as by welding, at a limited number of points to a rectangular support frame. The frame has a substantially L-shaped cross section, and the four sides of the frame may be curved so that they are substantially parallel to the curvature of the domed mask.

Although the prior-art mask skirt is ideally formed straight and normal to the plane of the mask, in practice it curls or angles from the desired position. When welding the skirt to the frame, the curled or angled skirt does not lie flat on the surface of the frame and must be pressed against the frame. Pressing the curled or angled skirt distorts the contour of the mask and leaves a residual stress. This distortion and the residual stress remain in the mask and may adversely affect the color purity of the image displayed on the screen when the tube is operated.

SUMMARY OF THE INVENTION

The novel cathode-ray tube includes an envelope, a mosaic phosphor screen, an electron-gun means, and a shadow-mask assembly comprising an apertured, domed masking member and an integral peripheral skirt welded to a metal frame at a limited number of points as in the prior art. Unlike the prior art, the skirt has a plurality of alternate projections and indentations or flutes therein. The projections and indentations may extend the length of the skirt and substantially parallel to the longitudinal axis of the tube.

Making the skirt with projections and indentations in the skirt forms and draws the metal in a manner which reduces or eliminates curling and angling of the skirt. As a result, the skirt lays substantially flat against the frame during the welding of the mask to the frame, thereby eliminating the need for counteracting any curl or angling of the skirt, reducing or eliminating distortion of the mask contour, and reducing residual stress in the mask.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a longitudinal view partly in section of a novel cathode-ray tube embodying the invention.

FIG. **2** is a plan view partially in cross section of the shadow-mask assembly of the novel tube of FIG. **1**.

FIG. **3** is an enlarged detail view of a portion of the mask assembly of FIG. **2** for a 19 inch color-television-picture tube.

FIG. **4** is a broken-away perspective view of a portion of the novel tube of FIG. **1** illustrating the aperture-mask assembly.

FIG. **5** is an enlarged detail view of a portion of the shadow-mask of FIG. **2** for a 25-inch color-television-picture tube.

FIGS. **6A** and **6B** are an enlarged broken-away sectional detail view of a portion of the novel tube of FIG. **1** and of a prior-art tube.

FIG. **7** is an enlarged broken-away perspective view illustrating an alternative construction for the novel tube of FIG. **1**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** illustrates a shadow-mask-type color-picture tube **10** comprised of an envelope **11** including a neck **12**, a panel **13**, and an interconnecting funnel **14** along a longitudinal axis C–C. The panel **13** includes an outwardly domed generally rectangularly shaped faceplate **15** and panel sidewall **16**. A screen **17** comprised of a multiplicity of phosphor dots, formed in a manner well known in the art, is supported on the internal surface of the faceplate **15**. An electron-gun means **18** for projecting electrons towards the screen **17**, which may be a conventional tricolor electron gun **18**, is positioned in the neck **12**. The electron gun **18** is adapted to project three electron beams **19***a*, **19***b*, and **19***c* towards the screen **17**.

A generally rectangular shadow-mask assembly **20** is positioned in the envelope **11** between the electron-gun means **18** and the screen **17** adjacent to, and substantially parallel to, the screen **17**. The assembly **20**, which is shown in FIGS. **1**, **2** and **3**, comprises a rigid metal support frame **21**, four clip plates **22** (**22***a* through **22***d* in FIG. **2**), four support straps and a metal asking member **24**. The clip plates **22** are attached to the frame **21**, and the support straps **23** are attached at one end to the clip plate **22**. The other end of the support straps **23** is provided with suitable apertures into which support studs **25** are received. Four electrode support studs **25** extend from the internal surface of the panel sidewall **16** at locations about midway between the corners thereof.

Referring to FIGS. **1** and **2**, the frame **21** preferably comprises an endless strip of metal formed in a generally rectangular shape having short sides **26***a* and **27***b*, and corners **28***a* through **28***d*. The strip has a generally L-shaped cross section which is of substantially uniform size along the strip. The L is oriented with a traverse flange **29** extending inwardly from the rear edge of an axial flange **30**. In the preferred embodiment, each of the sides **26***a* and **26***b* and **27***a* and **27***b* is bowed outwardly away from the central longitudinal axis C–C of the tube and, also, is bowed parallel to the longitudinal axis of the tube towards the screen **17**. A preferred frame is known in the art as a barrel-type frame. In a barrel-type frame, the midpoints of the long sides **26***a* and **26***b* and the midpoints of the short sides **27***a* and **27***b* are substantially planar.

The masking member **24** includes a mask **32** which is generally perpendicular to the axis C–C of the tube integral with a peripheral skirt **31** that is substantially parallel to the axis C–C of the tube and substantially normal to the plane of the assembly **20**. The masking member **24** is attached to the axial flanges **30** of the frame **21** and includes a domed mask **32** having a multiplicity of apertures **33** within a field of approximately rectangular configuration surrounded by substantially imperforate border **34**. A border fillet **35** is provided at the periphery of the imperforate border **34** between the border portion **34** and the skirt **31**.

The skirt **31** is comprised of a plurality of alternate projections **36** and indentations **37**, or flutes, which may be formed and drawn using a punch and die in a manner well known in the art. The projections **36** and indentations **37** extend substantially parallel to the longitudinal axis C–C of the tube. This may be accomplished in the same single punch-and-die operation used for forming the domed rectangular shape of the masking member **24**.

The dimensions between inside surfaces of the indentations **37** permit the masking member to telescope over the axial flange **30** of the frame **21**. The surface of each of the projections **36** and indentations **37** is approximately parallel to the corresponding matching outside surface of the axial flange **30** of the frame **21**. The dimensions of the masking member **24** and the frame **21** are preferably such that when the masking

member **24** is on the frame **21** there is no more than 0.030 inch of play between the skirt **31** and the frame **21**.

EXAMPLE 1

For a 19 inch ultrarectangular color-television-picture tube, the projections **36** and indentations **37** are spaced around the skirt **31** as partially shown in FIG. **3**. The skirt **31** is enlarged at four places, hereinafter called the pocket areas **38**, to provide clearance where the skirt **31** overlaps the clip plates **22**. A pocket area **38** is also formed with projections **36** and indentations **37**. The pocket area **38**, projections **36** and indentations **37** are better illustrated in FIG. **4**.

The projections **36** and indentations **37** or flutes, shown in FIG. **3**, are substantially the same width along the outside peripheral surface of the skirt **31**. Wide indentations **37***a* (FIG. **4**) are provided in a predetermined pattern on the rectangular short sides **26***a* and **26***b* and long sides **27***a* and **27***b*, and wide indentations **37***b* (FIG. **4**) are provided on the corners **28***a* through **28***d* of the peripheral surface of the skirt **31**. The wide indentations **37***a* and the corner indentations **37***b* are provided at the attachment points of the skirt **31** and the axial flange **30**.

The wide indentations **37***a* and corner indentations **37***b* each provide two attachment points. One attachment point is used for initial manufacture, and the other is used for salvage manufacture. The attachment points are asymmetrical preferably for each 180° position of the masking member, thereby providing for reuse of a salvaged masking member by rotating the masking member 180°. The preferred width **41** of the wide indentations **37***a* of the four sides **26***a*, **26***b*, **27***a* and **27***b* is 0.750 inch. The indentations **37***b* on the corners **28** are at least as long as the 90° segment of the corner radius. The corner indentations **37***b* vary in length somewhat since uniform projections **36** and indentations **37** are spaced between the nearest wide indentations **37***a* and the corners **28** starting from the nearest wide indentations **37***a* and spacing projections **36** and indentations **37** until the available space remaining is less than the width of the projections **36** and indentations **37**.

The depth **42** between the inside peripheral surface of the projections **36** and the inside peripheral surface of the indentations **37**, or the wide indentations **37***a*, or the corner indentations **37***b* is approximately 0.045 inch. The skirt portion **39** connecting between the projection **36** and the indentations **37** is at an approximate 45° angle to the peripheral sidewall of the indentations **37**.

The projections **36** and indentations **37** blend into the border fillet **35** at the periphery of the border portion **34** and the skirt **31**. The width **43** of the projections **35** is approximately 0.375 inch, and the width **44** of the indentations **36** is approximately 0.375 inch.

The length of the skirt **31** varies between the short sides **26***a* and **26***b*, long sides **27***a* and **27***b*, the corners **28**. The approximate preferred skirt length on the midpoint of the short sides **26***a* and **26***b* (major axis) is 0.417 inch, on the midpoint of the long sides **27***a* or **27***b* (minor axis) is 0.835 inch, and on the midpoint of the corners **28***a* through **28***d* (diagonal axis) is 0.429 inch.

In attaching the skirt **31** to the axial flange **30**, it is preferred that 16 attachment points, shown by the arrows in FIG. **3**, are used. The skirt **31** is attached to the axial flange **30** by spot welding as is well known in the prior art.

EXAMPLE 2

For a 25 inch ultrarectangular color-picture-tube, the projections **36** and indentations **37** are spaced around the skirt **31** as shown in FIG. **5**. The skirt **31** includes pocket areas **38**, wide indentations **37***a*, corner indentations **37***b* skirt portion **39**, and fillets **40** as described in example 1. The skirt **31** of example 2 differs from the skirt **31** of example 1 by the size and number of projections **36**, indentations **37** and wide indentations **37***a*.

The depth **42** between the inside surface of the projections **36** and the inside surface of the indentations **37** or the wide indentations **37***a* or the corner indentations **37***b* is approximately 0.045 inch. The width **43** of the projections **36** is approximately 0.400 inch, the width **44** of the indentations **37** is approximately 0.400 inch, and the width **41** of the wide indentations **36***a* is approximately 0.875 inch. The skirt **31** of example 2 is spot welded to the frame at 20 attachment points.

In making the novel cathode-ray tube, as previously described, clip plates **22** are first welded to the frame **21**. The masking member **24** is then positioned in a telescopic manner over the frame **21** with the skirt **31** overlapping the axial flange **30** in a certain fixed relationship with respect to the clip plates.

In this position, the wide indentations **37***a* and **37***b* of the skirt **31** overlap the axial flange **30** by approximately three-eighths inch. The inside surface of the wide indentations **37***a* and **37***b* may not be in contact with the frame since the masking member **24** and the frame **21** are manufactured with tolerances as previously described. Therefore, the outer edge of the axial flange **30** may be initially spaced from the adjacent surface of the wide indentations **37***a* of the skirt **31** at the attachment points.

The skirt **31** is then pressed against the flange **30** so that the wide indentations **37***a* and corner indentations **37***b* are substantially in intimate contact with the axial flange **30** at the attachment points.

After the indentations **37***a* and **37***b* are in intimate contact with the axial flange **30** of the frame **21**, the skirt **31** is attached, such as by spot welding, at the attachment point in a manner which is well known in the art. Preferably each weld **45** is at or below the midpoint of the overlap of the skirt **31** and the axial flange **30** to permit slight radial movement of the masking member **24** away from the outer peripheral surface of the axial flange **30** on thermal expansion and contraction of the parts during warm up.

FIGS. **6A** and **6B** illustrate the relationship of the masking member **24** and the frame **21** for the tube **10** of the invention and for a prior-art tube prior to welding the skirt **31** to the frame **30**. As shown in FIG. **6A**, the skirt **31** of the novel masking member includes projections **36** and indentations **37** is straight and is approximately normal to the plane of the masking member **24**, with side indentations **37***a* and corner indentations **37***b* substantially parallel to and near or against the matching surface of the axial flange **30** within the tolerances previously described. Thereby, at most, only a minor movement of the skirt **31** occurs in pressing the wide indentations **37***a* and **37***b* into intimate contact for subsequent attachment.

As shown in FIG. **6B**, the prior-art skirt **31***a* of the prior-art masking member **24***b* does not include projections and indentations, and, similarly positioned over the axial flange **30**, is not parallel to or near to the matching surface of the axial flange **30**. This occurs since the prior-art skirt **31***a* is not normal to the plane of the prior-art masking member **24***b* but angles out from the mask. In addition, the prior-art skirt **31***a* curls outwardly from a straight position as shown in FIG. **6B**. In some prior-art tubes, the skirt **31***a* must be moved as much as approximately three-sixteenths inch at the lower edge to provide intimate contact for subsequent attachment. The actual amount of the lower edge of the skirt **31***a* must be moved to make intimate contact with the frame **21** is not the same for different skirt lengths but increases with skirt length. When the prior-art skirt **31***a* is straightened and pressed against the frame **21** in this manner, the domed contour of the masking member **24** is distorted from the desired position by the spring of the metal.

After the masking member **24** is attached to the frame **21**, the masking member —frame assembly is positioned in a fixed relationship spaced from the screen **17**, and the support straps **23** are attached to the clip plates **22** in a manner well known in the art.

GENERAL CONSIDERATIONS

The novel tube may be a color-television-picture tube or may be any other cathode-ray tube which includes a mask assembly having an integrally formed mask and skirt attached to a frame. The electron-gun means, although described as a tricolor three-electron-gun unit, may also be a single-gun unit. Any suitable electron gun which emits an electron beam may be used.

Although a barrel-shaped frame is illustrated for support of the masking member, any suitable support means may be used that can be suitably attached in a manner, as by welding, to the skirt indentations. For example, a spherically shaped frame such as described in U.S. Pat. No. 3,333,134 to R.C. Demmy may be used.

The frame **21** and masking member **24** are preferably both made of cold-rolled steel. It is preferred that the frame be of considerably thicker material than the masking member. For example, in one embodiment of the shadow-mask assembly **20**, the frame **21** is made of 0.093 inch, thick material, whereas the masking member is made of 0.006 inch thick material. A relatively thin masking member **24** is very desirable from a practical standpoint because it minimizes electron interception by the sidewalls of the apertures therein. However, the thin masking member is sufficiently rigid to maintain its domed shaped without external support. The provision of a relatively thick, massive frame is highly desirable so as to provide a good heat sink to stabilize the operational temperature of the shadow-mask electrode **20** and prevent temperature fluxations of the thin masking member **24**.

The preferred skirt **31** of the masking member **24** in the preferred embodiment is of nonuniform length. Other masking members having skirts of uniform length that include indentations and projections may also be used.

The size, quantity, and location of the projections and indentations in the skirt can vary, especially within different tube sizes, and for different length skirts. Since the masking member, including the skirt, is formed from a flat sheet of metal, the size, quantity, and location of the projections and indentations must be sufficient to result in a straight skirt parallel to the longitudinal axis C–C of the table. Although projections are not shown on the corners of the rectangular shape of the skirt, projections may be used when necessary to form a straight skirt.

Although the depth **42** is preferred to be approximately 0.045 inch, it can be within the range of 0.030 to 0.050 inch. If the depth **42** is larger than 0.050 inch, the material of the skirt may tear during forming, and if the depth is less than 0.030 inch, the skirt is not formed sufficiently to be straight and normal to the plane of the assembly.

Although the projections and indentations are preferred substantially parallel to the longitudinal axis of the tube and the full length of the skirt, this is only necessary to economically form the masking member in one operation. Other forms of projections and indentations such as triangular or oval may be used some of which may necessitate multiple forming operations. In addition the projections or indentations need not be formed the full length of the skirt. FIG. **7** illustrates a portion of a skirt where the indentations **37** are formed less than the full length of the skirt. A reversal of the projections **36** and indentations **37** of FIG. **7** would be an example where the projections **36** are formed less than the full length of the skirt. By not extending the indentations **36** the length of the frame, the free edge of the skirt is larger than the periphery of the frame **21** by the depth **42**, thereby providing ease of assembly of the skirt **31** over the frame **21**.

I claim:

1. A shadow-mask cathode-ray tube including:

a. an envelope comprising an outwardly domed generally rectangular faceplate,

b. a mosaic phosphor screen disposed on the internal surface of said faceplate,

c. electron-gun means for projecting electrons towards said screen, and

d. a generally rectangular shadow-mask assembly mounted adjacent to said screen in the paths of said electrons, said assembly comprising a rigid metal frame and a thin sheet metal masking member welded at a limited number of points to said frame, said masking member including

i. a multiapertured, domed mask integral with

ii. a peripheral skirt substantially normal to the plane of said mask,

the improvement comprising:

said peripheral skirt having a plurality of alternate projections and indentations therein forming means for attaching said skirt to said frame.

2. The tube of claim **1** wherein the faces of said indentations are substantially parallel to said frame, said indentations forming a surface for overlapping attachment to a surface of said frame.

3. The tube of claim **2** wherein said indentations are substantially parallel to the longitudinal axis of said tube and extend the length of said skirt.

4. The tube of claim **2** wherein said projections are substantially parallel to the longitudinal axis of said tube.

5. The tube of claim **4** wherein said projections and indentations are in the range of 0.250 to 0.625 inch wide and in the range of 0.030 to 0.050 inch in depth.

6. The tube of claim **1** wherein said projections extend less than the length of said skirt.