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(54) Cathode ray tube (CRT) including a shadow mask with a partially etched mask border and skirt

(57) A shadow mask for use in a color cathode ray tube (CRT) is described. The shadow mask comprises a multi-aperture masking portion surrounded by a border and a skirt. The border and skirt have cavities across portions of one or more sides thereof. In one embodiment, the border and a portion of the skirt on an outer, screen-facing, surface of the mask have cavities formed therein. Additionally, a portion of the skirt on an inner, gun-facing, surface of the mask adjacent to the perimeter of the skirt may have cavities formed therein.

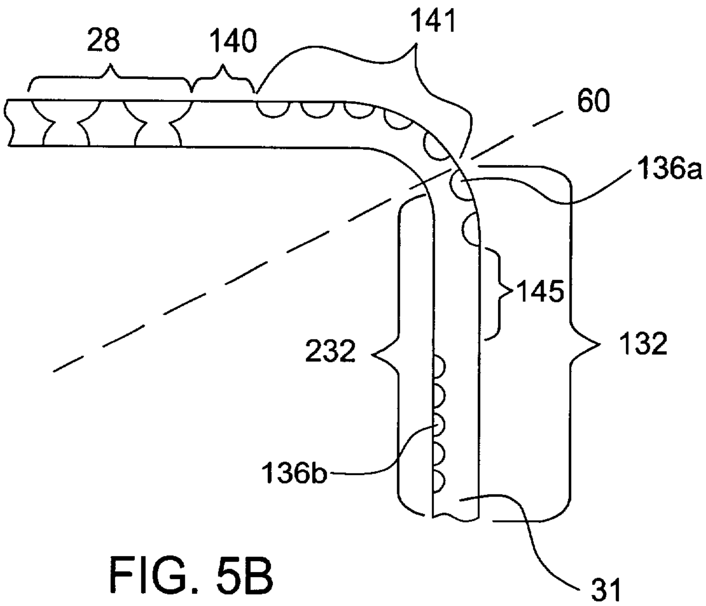


FIG. 5B

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates to a color cathode ray tube (CRT) of the type having a shadow mask mounted in spaced relation to a luminescent screen and, more particularly to a border and skirt of the shadow mask.

2. Description of the Related Art

[0002] A color cathode ray tube (CRT) typically has an electron gun, an aperture mask and a screen. The screen is located on an inner surface of the faceplate of the CRT tube. The screen may be a luminescent screen. Luminescent screens typically comprise an array of three different color-emitting phosphors (e.g., green, blue and red) formed thereon. Each of the color-emitting phosphors is separated from another by matrix. The matrix is typically formed of a light absorbing black, inert material.

[0003] The aperture mask, also referred to as a shadow mask, is interposed between the electron gun and the screen. The shadow mask comprises a multi-aperture thin sheet of metal, such as steel, that is contoured to approximately parallel the inner surface of the CRT tube faceplate. The shadow mask functions to direct electron beams generated in the electron gun toward appropriate color-emitting phosphors on the screen of the CRT tube.

[0004] During some shadow mask fabrication steps, it is difficult to achieve the desired contour of the shadow mask, causing the mask apertures to become deviated in space relative to their desired location. This deviation causes grouping or degrouping of the phosphors, which in turn, leads to the loss of register tolerance. Deviation of the mask apertures during tube processing or during tube operation may undesirably misdirect the electron beams directed therethrough. The effect of the misdirection is a misalignment of the electron beam centers with the centers on their intended matrix openings. Depending upon the magnitude of the deviation, local light output, global light output and color purity can be degraded. In severe cases where electron beams excite unintended color-emitting phosphors, a large deterioration in color purity can be observed.

[0005] Thus, a need exists for a shadow mask that overcomes the above drawbacks.

SUMMARY OF THE INVENTION

[0006] The present invention relates to a shadow mask for use in a color cathode ray tube (CRT). The shadow mask comprises a multi-aperture masking portion surrounded by a border, which is, in turn, surrounded by a skirt. The multi-aperture masking portion may include an array of apertures as well as a partially etched continuation of the aperture array such as an Extended Large Side Array (ELSA). The demarcation between the border and the skirt is preferably at the bend line of the mask. The skirt is substantially perpendicular to the multi-aperture masking portion as well as the border. The border and skirt are partially etched across portions of one or more sides thereof. In one embodiment, an outer, screen-facing, surface of the border has a plurality of cavities formed therein. The plurality of cavities extends around the bend line and continues a predetermined distance down the skirt. As a result, contour control of the shadow mask is improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The invention will now be described in greater detail, with relation to the accompanying drawings, in which:

[0008] FIG. 1 is a plan view, partially in axial section, of a color cathode ray tube (CRT) made according to embodiments of the present invention;

[0009] FIG. 2 is a plan view of the shadow mask assembly of the CRT of FIG. 1;

[0010] FIG. 3A-3B are enlarged fragmentary views of the multi-aperture masking portion of the shadow mask shown in FIGS. 1 and 2 illustrating two different aperture patterns;

[0011] FIG. 4 is an enlarged fragmentary view of the multi-aperture masking portion of the shadow mask shown in FIGS. 1 and 2 illustrating the aperture cross-section configuration;

[0012] FIG. 5A is a top view of one quadrant of the flat shadow mask shown in FIGS. 1 and 2 before the mask is shaped;

[0013] FIG. 5B is a cross-sectional view of the formed mask including the multi-aperture masking portion, a partially etched border and a partially etched skirt;

[0014] FIGS. 6A-6B are top and cross-sectional views of cavities formed in a screen-facing portion of the border and skirt; and

[0015] FIGS. 7A-7B are top and cross-sectional views of cavities formed in a gun-facing portion of the skirt.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] FIG. 1 shows a conventional color cathode ray tube (CRT) 20 having a glass envelope 21 comprising a faceplate panel 22 and a tubular neck 24 connected by a funnel 23. A three-color luminescent phosphor screen 25 is carried on the inner surface of the faceplate panel 22.

[0017] The screen 25 is a line screen (although disclosure is not limited to a line screen structure), which includes a multiplicity of screen elements (not shown) comprised of red-emitting, green-emitting and blue-emitting phosphor stripes R, G, and B, respectively, arranged in triads, each triad including a phosphor line of each of the three colors. The R, G, and B phosphor stripes extend in a direction that is generally normal to the plane in which the electron beams are generated. A light-absorbing matrix (not shown) separates each of the phosphor stripes. A thin conductive layer (not shown), preferably of aluminum, overlies the screen 25 and provides means for applying a uniform first anode potential to the screen 25, as well as for reflecting light, emitted from the phosphor elements, through the viewing surface thereof. The screen 25 and the overlying aluminum layer (not shown) comprise a screen assembly.

[0018] A multi-aperture color selection electrode, or shadow mask assembly 26 is removably mounted, by conventional means, within the faceplate panel 22, in a predetermined spaced relation to the screen 25. An electron gun 27, shown schematically by the dashed lines in FIG. 1, is positioned in the neck 24 to generate three electron beams through the shadow mask assembly 26 to the screen 25.

[0019] The shadow mask assembly 26, shown in FIGS. 1 and 2, is of a generally rectangular configuration and includes a mask 31 comprising a multi-aperture masking portion 28 surrounded by a border 41 and a skirt 32. The mask 31 is attached to a peripheral frame member 29 (FIG. 1) along a peripheral portion of the skirt 32. The masking portion 28 is formed with a convex outer surface 33 (FIG. 1) and a concave inner surface 34 (FIG. 1) with an array of apertures 36 therethrough. The apertures in the masking portion 28 may comprise for example, slots as shown in FIG. 3A as well round-shaped openings as shown in FIG. 3B, among others.

[0020] The mask 31 is formed of a conducting material, such as, for example, steel, or Invar, among others, having a thickness of about 0.18 mm (millimeters) to about 0.30 mm. The mask 31 is attached to the peripheral frame member 29 along portions of the skirt portion 32 by welds 37. In the embodiment shown, the mask is welded to the inner surfaces of the frame using a mask in frame assembly (MIFA) configuration. However, other mask and frame arrangements may also be used. The welds 37 are positioned to fall within the overlapping area of the skirt portion 32 and the peripheral frame member 29 and are preferably within about 3 mm from the edge of the skirt portion 32. The thickness of the skirt portion should preferably be about the same as that of the masking portion.

[0021] Referring to FIG. 4, a cross-sectional view of each of the apertures 36 (such as the types shown in FIGS. 3A-3B) formed in the masking portion may have an intersecting cavity shape having a large cavity 38 formed in the convex outer surface 33 of the masking portion 28 and a small cavity 39 formed in the concave inner surface 34 of the masking portion 28. The two cavities 38, 39 intersect at a knife-edge 40, which determines the size of the apertures 36. In FIG. 4, the mask 31 thickness is shown by the dimension T, while the depth of the large cavity 38 is shown by the dimension t. In FIGS. 3A-3B, the aperture to aperture spacing is shown by dimension a. For some embodiments, the large cavities 38 may extend through the masking portion 28, negating the need for small cavities 39.

[0022] The multi-aperture masking portion is formed by sequentially coating each side of the mask 31 with a photoresist material. The photoresist material is exposed to light and developed to define the aperture pattern therein to the surface of the mask 31. The mask 31 is etched to form the apertures 36 therethrough.

[0023] The border 41 and skirt 32 of the mask 31 may be partially etched across portions of one or more sides thereof, as shown in FIGS. 5A-5B. Referring to FIG. 5A, a top view of one quadrant of mask 31 including the aperture masking portion 28 and the partially etched border 41 and skirt 32 are shown. The demarcation between the border 41 and skirt 32 is the bend line 60. In one exemplary embodiment shown in FIG. 5B, the convex outer surface of the border 141 and a portion of the outer surface of the skirt 132 preferably have cavities 136a formed therein. In addition, a portion of the inner surface of the skirt 232, located down the skirt away from the cavities 136a may have cavities 136b formed therein.

[0024] Preferably, the cavities 136a extend about 2-3 mm down the outer surface of the skirt 132 past the bend line 60. Referring to FIG. 5B, the cavities 136a in the outer surface of the border 141 may be separated from the masking portion 28 by a transition region 140, which may or may not have cavities formed therein. Additionally, the cavities 136b may be separated from the cavities 136a on the skirt by a transition region 145, which may or may not also be free of cavities. The skirt regions containing cavities 136a and 136b may be coincidental. However, the cavities 136a and 136b should preferably not intersect so as to form perforations in the skirt 32.

[0025] Referring to FIGS. 6A-6B, the cavities 136a may have any shaped opening including, for example, round, hexagonal, triangular or rectangular, among others. The sidewalls may be for example, cup-shaped or substantially perpendicular to the surfaces of the border 41 and the skirt 32. In FIG. 6B, the mask 31 thickness is shown by the dimension T, while the depth of the cavities 136a is shown by the dimension t. In this example, the cavities 136a describe a general hexagonal pattern having a spacing "a" between the apertures and a 60° included angle between the rows of apertures, as shown in FIG. 6A.

[0026] For an exemplary shadow mask assembly 26, the cavities 136a may have diameters of about 0.335 mm to about 0.365 mm. The center-to-center spacing "a" (FIG. 6A) of the cavities 136a may be about 0.460 mm. The cavities may have a depth of about 0.160 mm.

[0027] The cavities 136a may be formed by coating the mask 31 with a photoresist material. The photoresist material is exposed to light and developed to define the cavity pattern therein on the outer surface of the border 141 and the skirt 132. The mask 31 is etched to form the cavities 136a therein.

[0028] Referring to FIGS. 7A-7B, the cavities 136b may have any shape opening including, for example, round, hexagonal, triangular or rectangular, among others. The sidewalls may be cup-shaped or substantially perpendicular to the surface of the border 41. In FIG. 7B, the mask 31 thickness is shown by the dimension T, while the depth of the cavities 136b is shown by the dimension t. In this example, the cavities 136b describe a general hexagonal pattern having a spacing "a" between the apertures and a 60° included angle between the rows of apertures, as shown in FIG. 7A.

[0029] For an exemplary shadow mask assembly 26, the cavities 136b formed in the inner surface of the skirt 232 may have diameters of about 0.485 mm to about 0.455 mm. The center-to-center spacing "a" (FIG. 7A) of the cavities 136b may be about 0.620 mm. The cavities may have a depth of about 0.160 mm.

[0030] The cavities 136b are formed by coating the mask 31 with a photoresist material. The photoresist material is exposed to light and developed to define the cavity pattern therein on the inner surface of the skirt 232. The mask 31 is etched to form the cavities 136b therein.

[0031] The presence of cavities 136a on the border outer surface 141 and at least a portion (2-3mm) of the skirt outer surface 132 improves the control of the formed contour of the masking portion 28 of the mask 31 during the process of forming the mask 31. The presence of cavities 136a in these regions also reduces the formed flare of the skirt 32, thereby facilitating insertion of the mask 31 into the frame 29 during CRT fabrication where the mask 31 is welded inside the frame 29 (MIFA). For embodiments where the mask 31 is welded outside the frame 29 (MOFA), the reduced flare of the skirt 32 improves the fit of the mask 31 to the frame 29 for the placement of welds 37.

[0032] The presence of the cavities 136a on the outer border surface 141 also aids removal of the formed mask 31 from the mask forming punch during the mask forming procedure.

[0033] The presence of cavities 136a on the outer surface of the skirt 132 and/or the presence of cavities 136b on the inner surface of the skirt 232 reduce the stiffness of the skirt 32 thereby reducing the transmission of motion from the skirt 32 into the contour of masking portion 28. Reducing the stiffness is useful to minimize disturbance of the masking portion 28 when there is differential thermal expansion between the mask 31 and the frame 29.

[0034] The presence of cavities 136b on the lower portion of the inner surface of the skirt 232 rather than on the outer surface reduces mask-forming die wear during the mask forming procedure. Also, the presence of cavities 136b on the lower portion of the inner surface of the skirt 232 rather than the outer surface also avoids the creation of fluid-entrapping volumes undesirably created by the juxtaposition of cavities 136a and the inside surface of the frame 29 for a MIFA arrangement. Such fluid entrapment. may retard the drying of the mask assembly 26 following a mask assembly wash operation during CRT fabrication processes.

Claims

1. A shadow mask for a color cathode-ray tube (CRT), comprising:

   an aperture portion having a plurality of apertures formed therein, the aperture portion being formed over a predetermined area of the shadow mask; and
   a border and a skirt each having a first side and a second side, wherein the border is adjacent to and surrounding the aperture portion, wherein the skirt is adjacent to and surrounding the border, and wherein a plurality of cavities are formed in at least one of the first side and the second side of at least one of the border and the skirt.

2. The shadow mask of claim 1 wherein the first sides of the border and the skirt are CRT screen-facing sides.

3. The shadow mask of claim 2 wherein the second sides of the border and the skirt are gun-facing sides.

4. The shadow mask of claim 3 wherein the first and second sides of the border and the skirt have cavities formed therein.

5. The shadow mask of claim 2 wherein a transition area of the border separates the aperture portion of the shadow mask from the plurality of cavities formed in the first side of the skirt.

6. The shadow mask of claim 3 wherein a transition area of the skirt separates the plurality of cavities formed in the first side of the skirt from the plurality of cavities formed in the second side of the skirt.

7. A color cathode-ray tube (CRT), comprising:

   a luminescent screen located on an inner surface of a faceplate panel of the cathode-ray tube;
   an electron gun for producing electron beams; and
   a shadow mask interposed between the electron gun and the luminescent screen, wherein the shadow mask includes an aperture portion having a plurality of apertures formed therein, the aperture portion being formed over a pre-

determined area of the shadow mask, and a border and a skirt each having a first side and a second side, wherein the border is adjacent to and surrounding the aperture portion, the skirt is adjacent to and surrounding the border, and a plurality of cavities are formed in at least one of the first side and the second side of at least one of the border and the skirt.

8. The color cathode-ray tube of claim 7 wherein the first sides of the border and the skirt are cathode ray tube screen-facing sides.

9. The color cathode-ray tube of claim 8 wherein the second sides of the border and the skirt are electron gun-facing sides.

10. The color cathode-ray tube of claim 9 wherein the first and second sides of the border and the skirt have cavities formed therein.

11. The color cathode-ray tube of claim 8 wherein a transition area of the border separates the aperture portion of the shadow mask from the plurality of cavities formed in the first side of the border.

12. The color cathode-ray tube of claim 9 wherein a transition area of the skirt separates the plurality of cavities formed in the first side of the skirt from the plurality of cavities formed in the second side of the skirt.

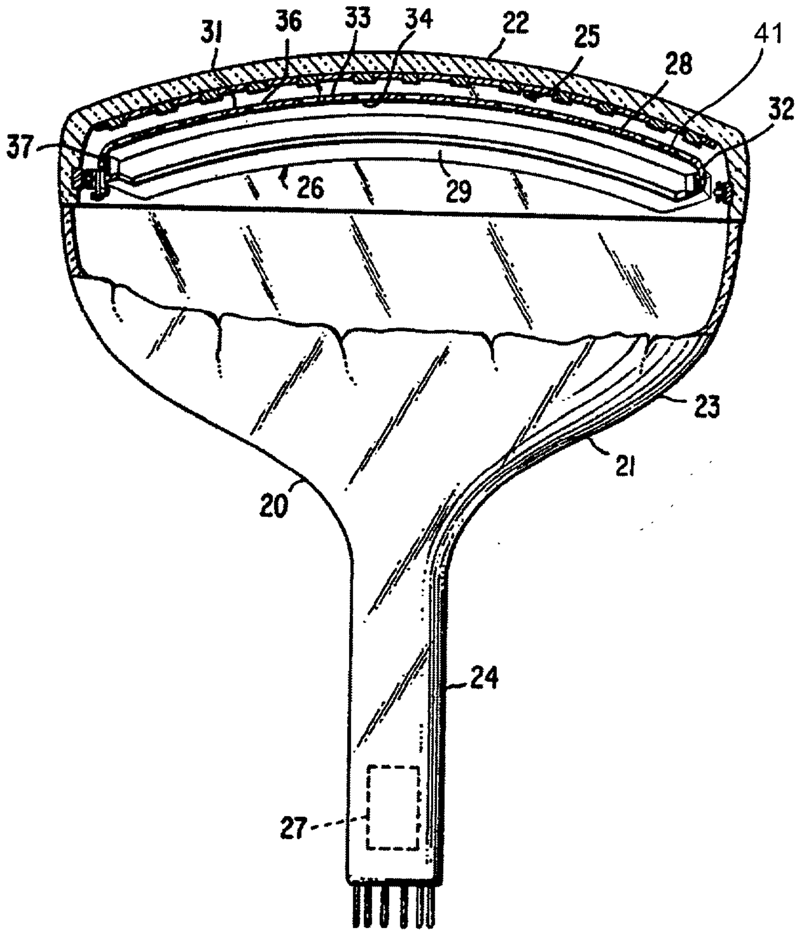


FIG. 1

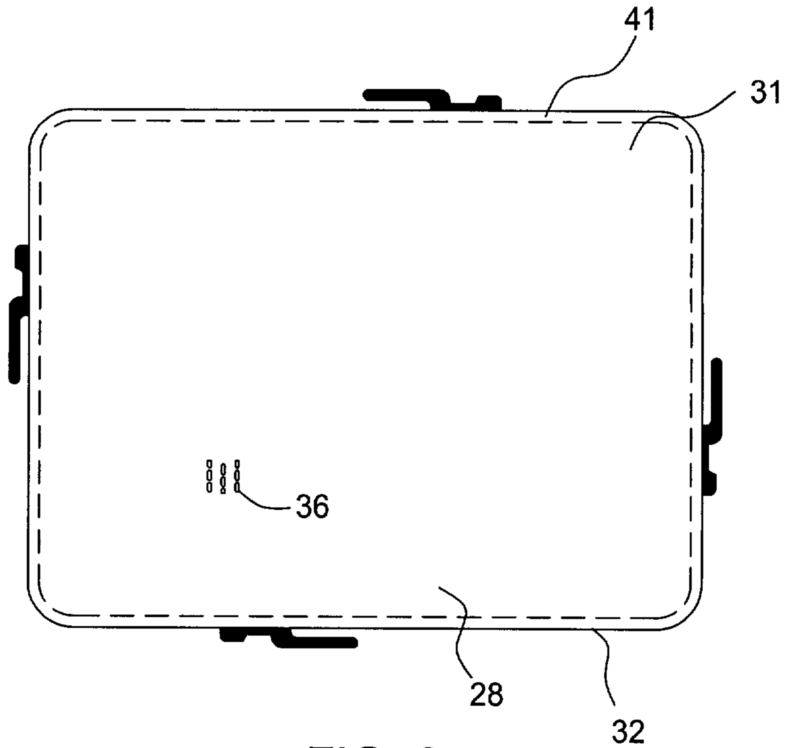


FIG. 2

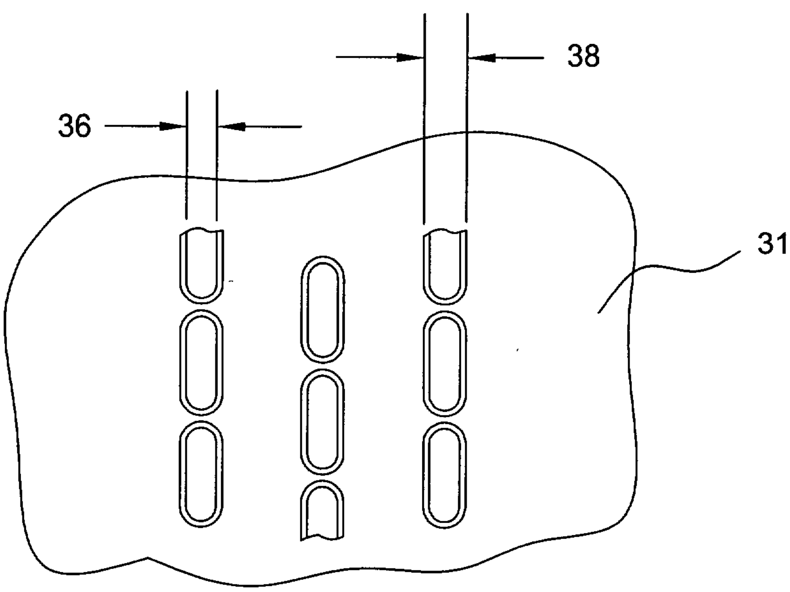


FIG. 3A

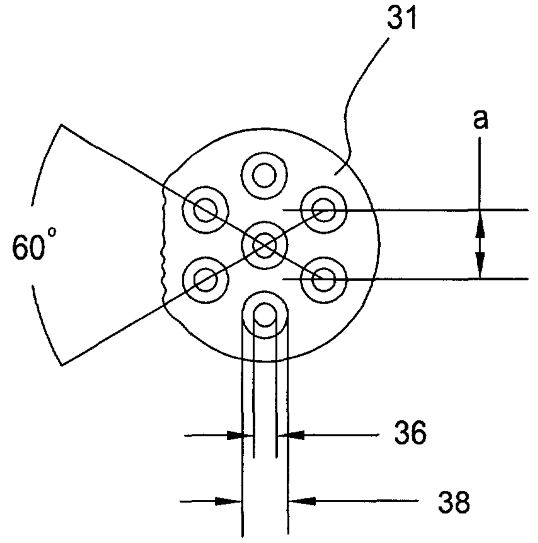


FIG. 3B

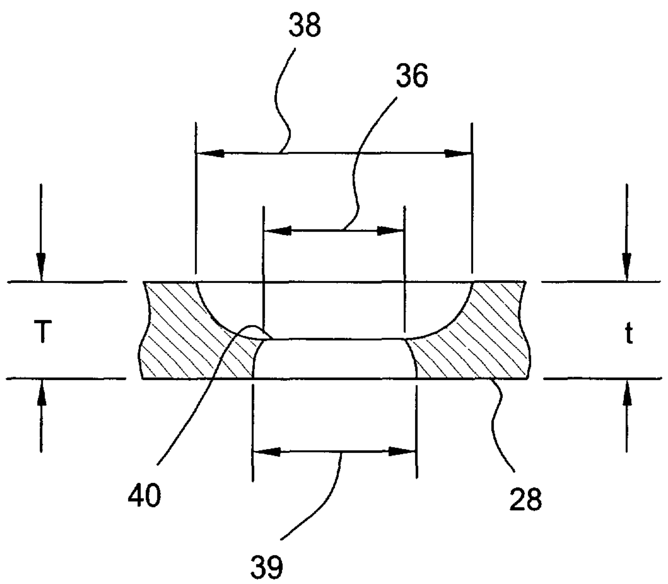


FIG. 4

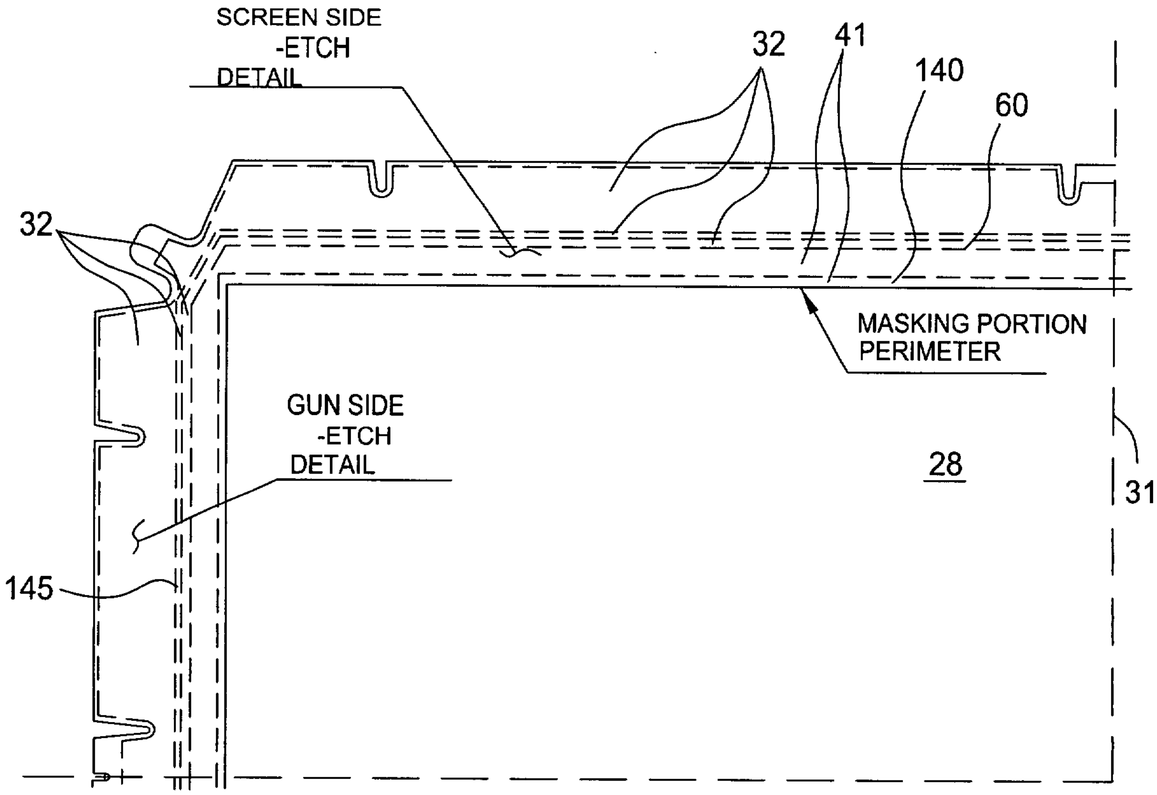

SCREEN SIDE
-ETCH
DETAIL
32
41
140
60
32
MASKING PORTION
PERIMETER
GUN SIDE
-ETCH
DETAIL
28
31
145

FIG. 5A

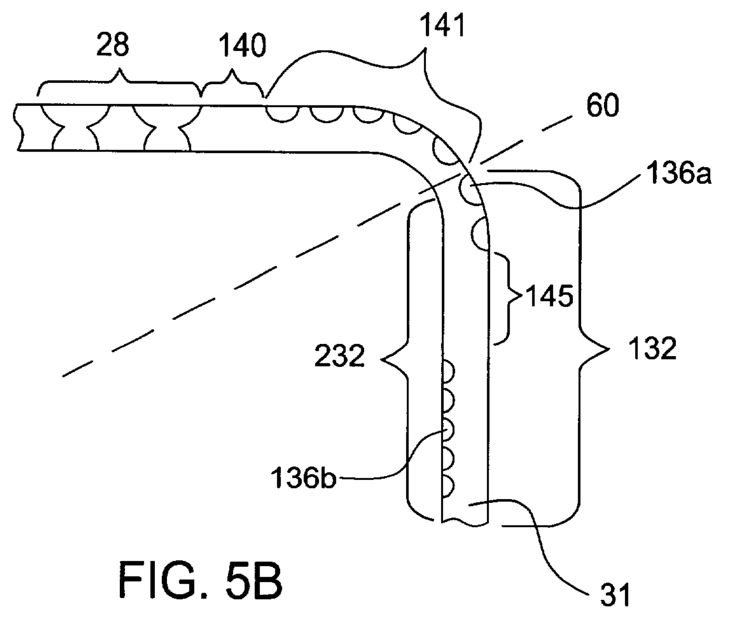
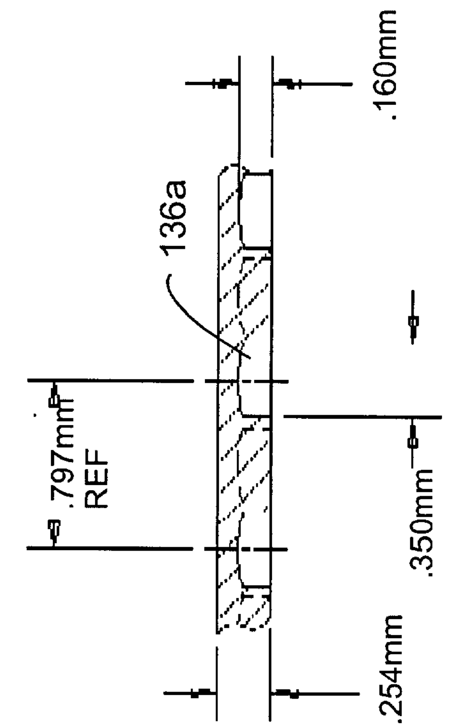

28
140
141
60
136a
145
232
132
136b
31

FIG. 5B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136a
.797mm
REF
.350mm
.254mm

FIG. 6B

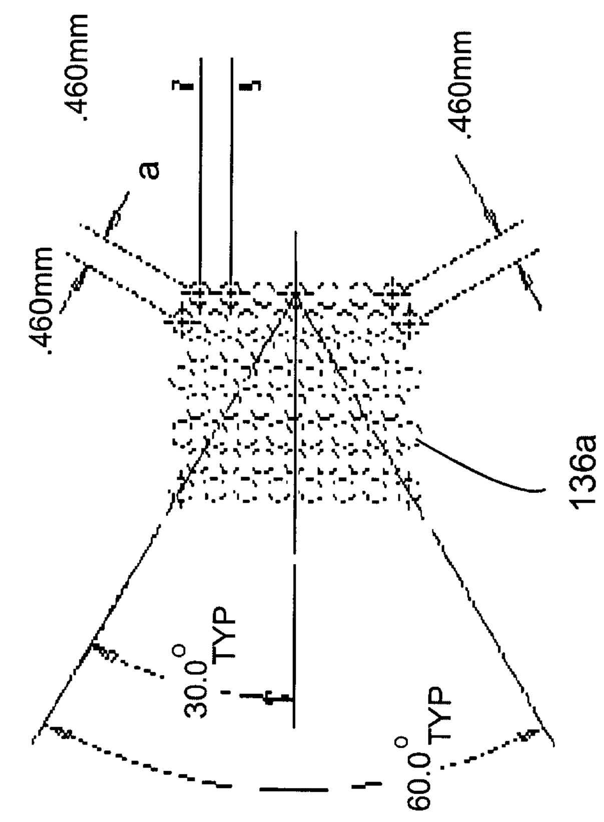
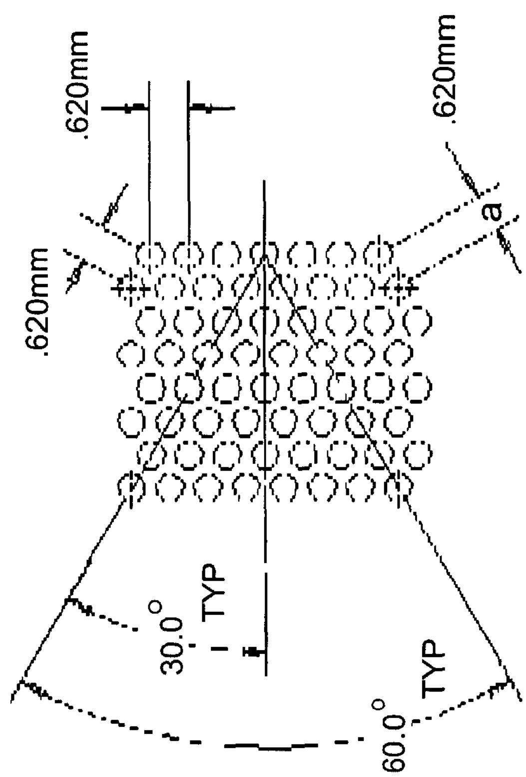

.460mm
a
.460mm
.460mm
136a
30.0° TYP
60.0° TYP

FIG. 6A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.620mm
.620mm
a
30.0°
TYP
60.0°
TYP

FIG. 7A

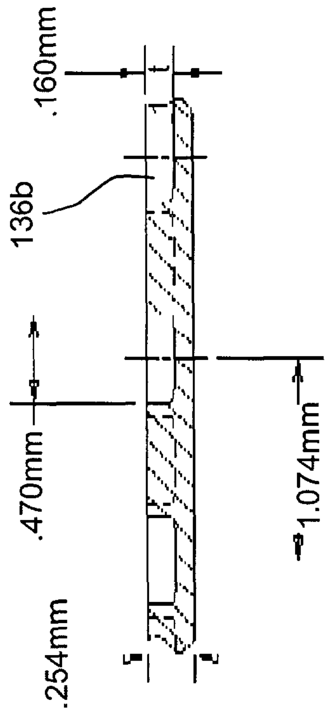
.160mm
136b
.470mm
1.074mm
.254mm

FIG. 7B

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 02 8679

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	21 May 2003	Weisser, W

CATEGORY OF CITED DOCUMENTS

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DOCUMENTS CONSIDERED TO BE RELEVANT

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