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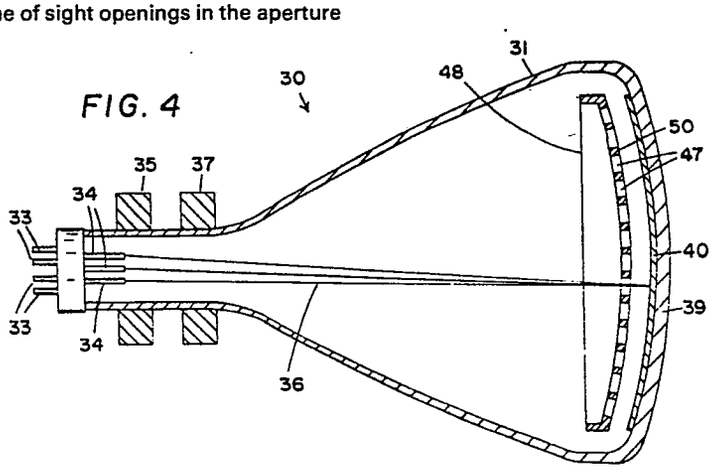
(54) Television picture tubes and hole technology.

(57) An article and a method of making a line of sight opening in an article wherein the line of sight opening in the article is partially defined by material on one surface of the article and partially defined by material on the opposite surface of the article and an application of the hole technology comprising a television tube (30) having an electron gun and an aperture mask with a plurality of line of sight openings in the aperture mask wherein the line of sight openings (47), in the aperture mask (48), are partially defined by material on the cone side surface of the aperture mask (48) and partially defined by material on the grade side surface of the aperture mask (48) with the aperture mask located in the television tube with the cone side of the aperture mask facing the electron guns.

FIG. 4



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This invention relates generally to hole technology and to television picture tubes and, more specifically, to hole technology useful in television picture tubes having aperture masks with a plurality of line of sight openings therein.

Briefly, one part of the present invention comprises a method for making a line of sight opening which may be square, rectangular or the like and the second part comprises an article having a line of sight opening which may be square, rectangular or the like. The article comprises a sheet of material having a line of sight opening wherein a portion of the edges of the line of sight opening is partially defined by surface material located on one side of the article with the remainder of the edges of the line of sight opening defined by material located on the opposite side of the article.

The process involves the selective removal of material from one surface of an article by milling or etching a recess in the article with at least a portion of the material removed by undercutting the surface of the article. After forming a recess, an opening is formed in the opposite side of the material by milling or etching an opening from the opposite side into the recess.

Fig. 1 is a perspective view of a single line of sight opening in a television aperture mask;

Fig. 2 is a top view or cone side view of the line of sight opening of Fig. 1;

Fig. 3 is a bottom view or grade side view of

the line of sight opening of Fig. 1;

Fig. 4 is a cross sectional view of a television picture tube;

Fig. 5 is a partial top sectional view of an aperture mask and television tube;

Fig. 6 is a partial side sectional view of an aperture mask and television tube; and

Fig. 7 is a front schematic view of an aperture mask having a plurality of openings therein.

Referring to Figs. 1, 2 and 3, reference numeral 10 generally defines a portion of a television aperture mask having a cone side surface 10A and a grade side surface 10B. Surface 10A is referred to as the cone side since the larger opening or recess 15 is located therein and surface 10B is referred to as the grade side. In typical use of an aperture mask in a television picture tube the grade side faces the electron guns while the cone side faces the television picture tue. This type of positioning provides the best pictures for conventional etched masks. Located in aperture mask 10 is a line of sight opening which has edges that are defined by the cone side surface 10A and the grade side surface 10B of aperture mask 10. Located in cone side surface 10A is a recess 15 which is defined in cone side surface 10A by pair of side edges 11 and 11A and a pair of end edges 14A and 16A which are all located in the plane of cone side surface 10A of aperture mask 10. Side edges 11 and 11A connect to end edges 14A and 16A to form a closed boundary in the plane of cone side surface 10A. Thus,

edges 11, 11A and edges 14A and 16A define the junction of the side walls of recess 15 with the cone side surface 10A.

The side walls of recess 15 include an undercut surface 14 and an undercut surface 16 which respectively connect to edge 14A and edge 16A. Surfaces 14 and 16 are undercut downward from cone side 10A and radially outward from edges 14A and 16A toward grade side 10B.

The thickness of aperture mask 10 is denoted by T which usually ranges from .004" to .008". The length of undercut is denoted by A. The undercut angle is denoted by θ and the thickness of the remaining material that forms the bottom of recess 15 is denoted by T_1 with T_1 being substantially less than the thickness T of aperture mask 10.

Referring to Fig. 3 (grade side), it will be noted that the bottom view shows the outline of an elongated slot in grade side surface 10B which is defined by edge 12A, edge 12, edge 12B and edge 12C which are all located in the plane of grade side surface 10B. Edges 12 and 12A are straight whereas edges 12B and 12C are curved. The portion of the opening to the outside of lines X-X defines the portion of the opening which contains curved edges 12B and 12C.

The line of sight opening through aperture mask 10 is formed by edges 12A and 12 which define the longitudinal opening and edges 14A and 16A which define the transverse portion of the line of sight openings. Note, in the grade side view (Fig. 3) edge

12 and edge 12A also define the longitudinal opening; and edges 14A and 16A define the transverse portion of the line of sight opening. Although the grade side view of aperture mask 10 is different from the cone side view of aperture mask 10, the line of sight opening through aperture mask 10 is the same.

The two lines X-X, which are located on both ends of the elongated slot, denote the separation point between the curvature of edges 12B and 12C and straight sections 12A and 12. In the embodiment shown, lines X-X are located to the outside of edges 14A and 16A to thereby insure the line of sight opening in aperture mask 10 is comprised of a set of straight edges with substantially square corners. The curved ends are typical of cutting operations such as chemical etching.

Thus, although grade side surface 10B reveals an elongated opening therein which is substantially longer than the line of sight opening through the article, the surfaces 14 and 16, which were produced by undercutting material from edges 14A and 16A, project out sufficiently far to prevent the radiused edges 12B and 12C from forming a boundary of the line of sight opening through aperture mask 10.

In forming elongated openings in aperture mask, the process of etching permits one to etch a recess 15 in aperture mask 10. Typically, the etching process is continued until it produces a recess 15 with undercut surfaces 14 and 16. The size and shape of undercut surface can be controlled by the amount of etchant

and time of etching and is generally within the skill of those in the art.

After forming recess 15 in one side, the elongated opening is etched from the opposite side. If desired, the elongated opening can be formed during the etching of the recess by simultaneously spraying etchant on opposite surfaces 10A and 10B. After etching, the elongated slot appears with radiused corners as shown in Fig. 3. In the process of forming the line of sight opening through the article, the etching continues until the etchant penetrates through the material of thickness T_1. After penetration, the etchant is removed typically leaving an elongated opening such as defined by edges 12A, 12B, 12C and 12D. Lines X-X denote the radius portion of elongated opening which results from the etching action.

An inspection of Fig. 3 shows the radius portion 12B and 12C project onto surfaces 15 and 16. Thus, the radiused corners 12B and 12C of aperture mask 10 do not form a part of the line of sight opening in aperture mask 10. While the article and method have been described with respect to rectangular openings, it is apparent the process can be used to make other unusually shaped line of sight openings which are difficult or impossible to make with conventional techniques.

EXAMPLE 1

To illustrate the improvement in light transmission, a conventional television aperture mask was etched having elongated slots with parallel sides and

rounded ends. The dimensions of the slot were as follows:

slot width	- 175.2 micrometers
tie bar width	- 145 micrometers
slot length	- 613 micrometers (maximum dimension)

The measured light transmission through the slot was measured as 17.7 units.

A second aperture mask was made in accordance with the present invention in which the outline of the line of sight opening had a substantially rectangular configuration in accordance with Figs. 1, 2 and 3. The dimension of the rectangular line of sight opening were as follows:

slot width	- 174.8 micrometers
tie bar width	- 144 micrometers
slot length	- 614 micrometers

The transmission through the opening was measured as 18.36 units or an increase of approximately 4 percent in light transmission. For the second mask, however, since the dimensions of the two holes were not exactly equal, a compensation for the area revealed that the second mask actually had an approximately 6.5 percent greater light transmission capability.

Referring to Fig. 4, reference numeral 30 generally designates a cross sectional view of a television picture tube using the line of sight aperture mask of the present invention. The television picture tube comprises a glass enclosure 31 having a base 32 and prongs 33 thereon for attachment to the electronics of the television set.

Located on the exterior of the neck of television picture tube is a focusing coil 35 that focuses the electron beam so the electron beams converge as they pass through openings 47 in aperture mask 48. Located adjacent focusing coil 35 is a deflection coil 37 which sweeps the electron beam across aperture mask 48. The aperture mask 48 is located with a plurality of elongated openings 47 located therein. Located immediately behind elongated slots 47 is a phosphor strip 40. Although three phosphor strips are located behind each opening in the cross sectional view only one strip is visible in the cross sectional view. The phosphor strips comprise the primary colors red, blue and green which, when excited by the electrons, produce the proper color on face plate 39 of television picture tube 30.

To understand the operation of the present invention in a television picture tube, reference should be made to Figs. 5 and 6 which respectively show a top view of a portion of the television aperture mask and a television picture tube and a side view of a television picture tube. The front glass envelope portion of the television picture tube is designated by reference numeral 39 with reference numerals 40, 41 and 42 designating the red, blue and green phosphor stripes which extend longitudinally parallel to the elongated openings which are located in aperture mask 48. Fig. 7 shows schematically the slot arrangement of a typical aperture mask having a series of elongated slots. Located between phosphor

stripes 40, 41 and 42 is a suitable black light-absorbing medium that does not emit any color should it be struck by electrons.

Referring to Fig. 5, the aperture mask is denoted by reference numeral 48 and with cone side 45 facing the electron gun and the grade side 46 facing the phosphor stripes which are located on face plate 34. Since the most metal is removed from side 45 to provide recess 45A, this side is denoted as the cone side and in the embodiment shown is located facing the electron gun. Typical prior art aperture masks the cone side was located facing the phosphor side. Fig. 5 reveals how the grade side edge surfaces 53 and 54 limit the electrons in the lateral direction.

Fig. 6 shows a side view of aperture mask 48 with reference numeral 39 denoting the face plate and reference numeral 40 indicating a phosphor stripe. The aperture masks 48 has an opening 45A on the cone side 45 and an elongated opening on the opposite side. The tie bar or bridges as they refer to in the prior art are located with the narrow end of the bridge or tie bar facing the phosphor stripe 40 and the tie bar extending from the cone side 45 to grade side 46. Fig. 6 shows tie bar 50 to comprise a grade side surface 50B, a cone side surface 50A and an interior surface 51 on lower tie bar and an upper interior surface 52 on upper tie bar 50. The upper and lower boundaries of the line of sight opening in aperture mask 48 is defined by the junction of surface 52 with cone side surface 44 and junction of surface 51 with cone side

surface 45.

In practice the plurality of tie bars located in the spaced relationship provide for accurate defining of an opening for the excitation of the phosphor stripes located along the television picture tube.

Note, if the aperture masks have the cone side facing the electron gun, one should have the bottom of the recess region, which is located adjacent the sides of the line of sight openings, sufficiently flat or angled so that the electron beams that impinge on the bottom of the recess region do not deflect through the line of sight opening in the aperture mask. Typically, if the bottom of the recess region is parallel to the mask cone side surface, one does not obtain scattering electron reflections through the line of sight openings.

In addition, with the aperture mask cone side facing the electron guns the portion of the recess side walls which do not define a portion of the line of sight opening should be set sufficiently far back from the line of sight opening in the aperture mask so that the path of the electron beam is not obstructed by the recess region side walls or the cone side surface of the aperture mask. In conventional mounting with the grade side toward the electron gun, these adjustments would not be necessary.

CLAIMS

1. A color television tube comprising:

an enclosure (31), having a viewing surface (39), on one end with a plurality of phosphor regions (40, 41, 42) for generating light of three primary colors on the viewing surface of said enclosure, at least one electron gun to excite said phosphor regions (40, 41, 42);

an aperture mask (48) located proximate said viewing surface (39), said aperture mask (48) having a plurality of openings (47), said aperture mask (48), having a grade side surface (46), and a cone side surface (45), said aperture mask cone side surface (45), characterized by a recess region surrounding an opening in said aperture mask, said aperture mask positioned between said electron gun and said phosphor regions, said aperture mask to act as a shield to prevent electrons from impinging on the improper phosphor region of said plurality of phosphor regions;

the improvement comprising a plurality of openings which are characterized as a plurality of line of sight openings and which are defined as follows:

said cone side surface having a plurality of openings defined in said cone side surface of said aperture mask, said plurality of openings in said cone side surface defined by edges located in said cone side surface; and

said grade side surface having a plurality of openings defined in said grade side surface of aperture

mask, said plurality of openings in said grade side surface defined by edges located in said grade side surface, said line of sight openings in said aperture mask partially formed from edges located in said grade side surface and partially formed by edges located in said cone side surface so that a portion of said edges of said opening in said grade side surface and said cone side surface coact to form a line of sight opening in said aperture mask, said plurality of line of sight openings comprising an opening for electrons to pass.

2. The invention of claim 1 wherein said recess regions have side walls that are undercut from said edges of said side wall.

3. The invention of claim 2 wherein said aperture mask includes tie bars located between said line of sight openings.

4. The invention of claim 3 wherein said line of sight openings have a rectangular shape.

5. The invention of claim 4 wherein said aperture masks include line of sight openings located end to end with tie bars having a trapezoidal shape located between end to end openings.

6. The invention of claim 5 wherein the said tie bar has its widest portion facing said electron gun.

7. A member having a line of sight opening therein comprising:

an article having a first surface and a second surface;

a recess located in said first surface, said recess having side walls with said side walls and said first surface coacting to define an outline of a portion of a line of sight opening in said article;

an opening in said second surface, said opening defined by edges located in said second surface, said opening extending from said second surface into said recess so that a portion of said edges of said opening in said second surface forms an outline of a portion of said line of sight opening in said article, said line of sight opening comprising an opening partially bounded by said portion of edges of said recess in said first surface and partially bounded by said edges of the opening in said second surface.

8. The invention of claim 7 wherein a portion of said side walls of said recess are undercut.

9. The method of making line of sight openings in an article having two surfaces comprising the steps of:

forming a recess with side walls and a bottom in a first surface of an article with at least a portion of the side walls of the recess diverging away from said recess; and

forming an opening into the bottom of said recess from the opposite surface of said article.

10. The method of claim 9 wherein the forming of said opening includes cutting material from the bottom of said recess.

11. The method of claim 10 wherein the forming of said recess includes etching material from said

article to form a recess.

12. The method of claim 11 including the step of undercutting said side walls in said recess.

13. The method of claim 12 including the step of forming an opening in the bottom of said recess including etching an opening having end sections until the end sections of the openings extend beyond the top edge of the recess formed in said first surface.

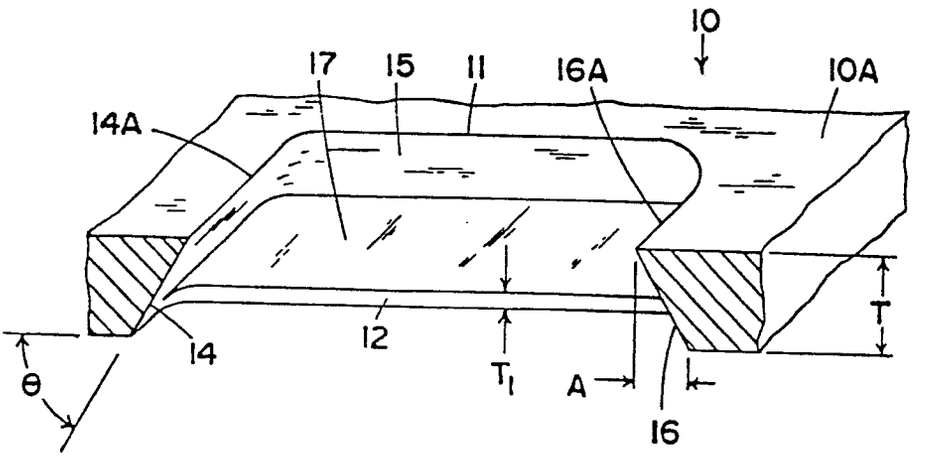


FIG. 1

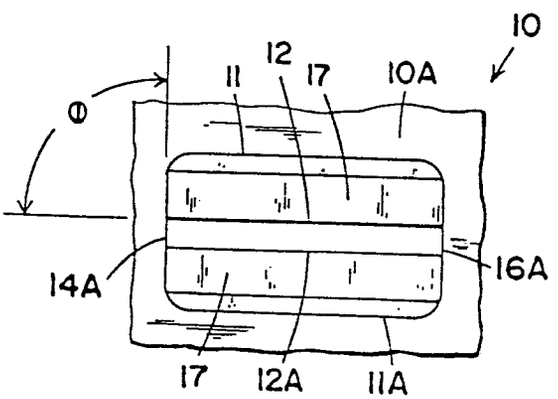


FIG. 2

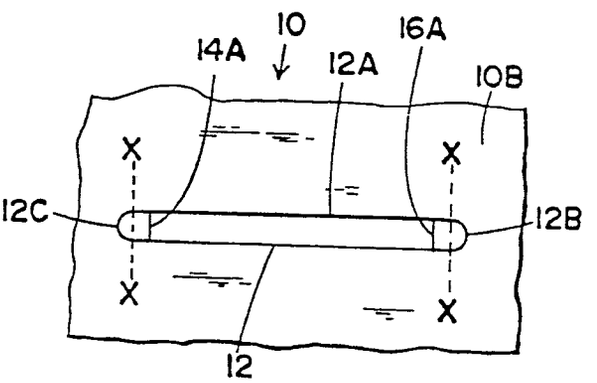


FIG. 3

FIG. 4

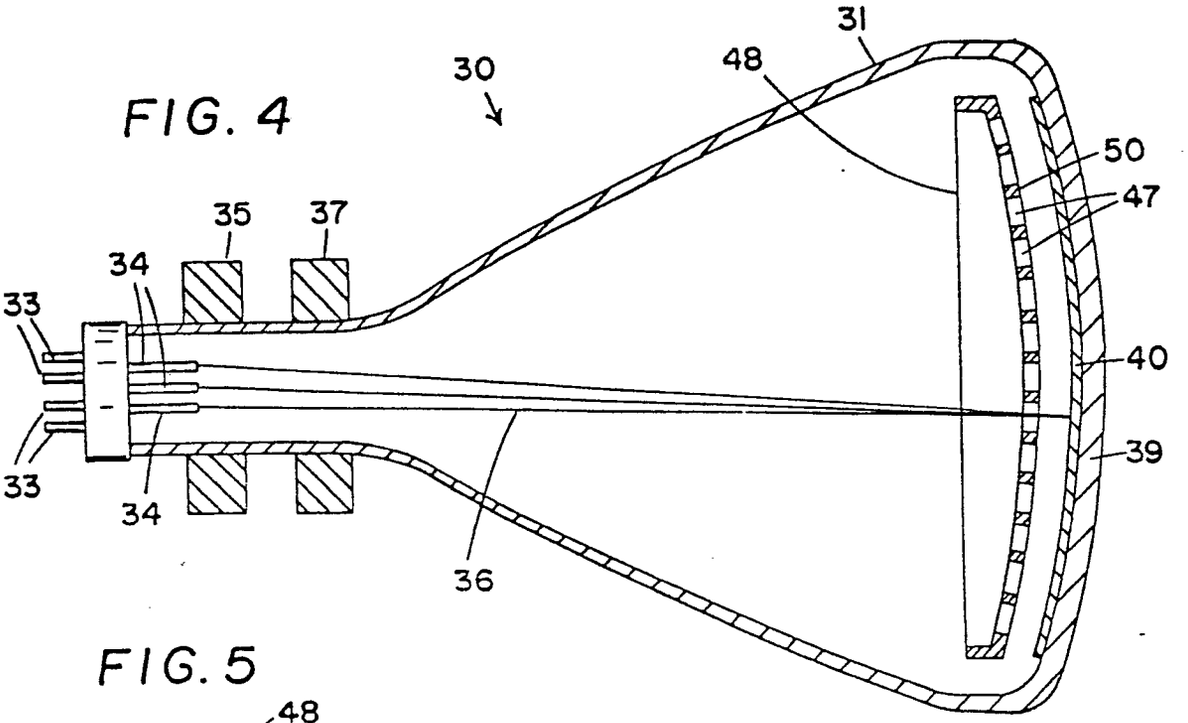


FIG. 5

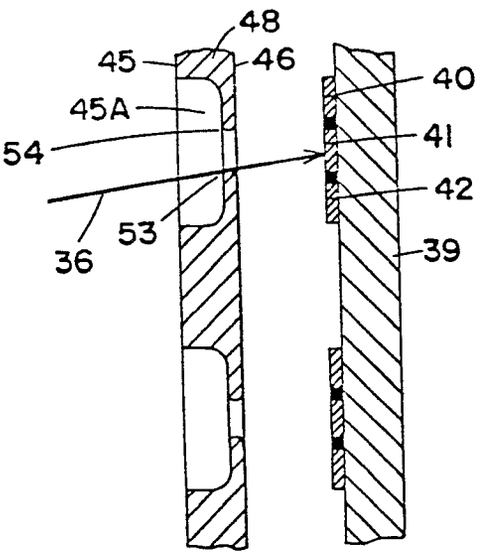
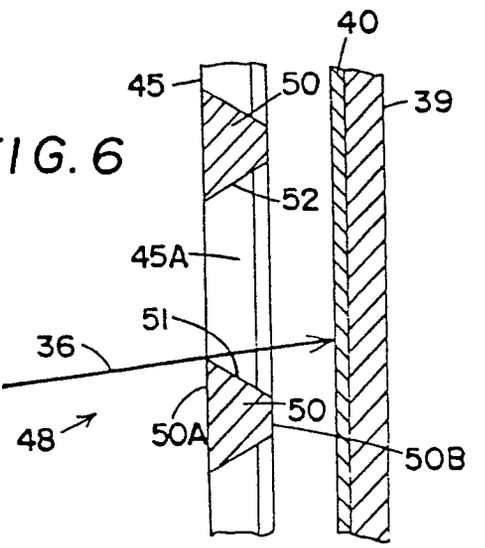


FIG. 6



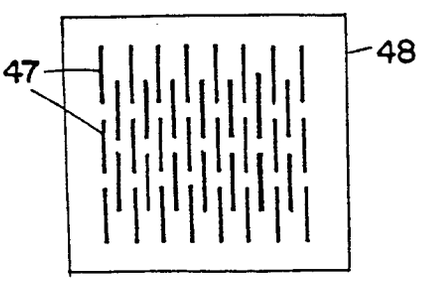


FIG. 7