United States Patent

Kuznetzoff

[15] **3,663,997**

[45] **May 23, 1972**

[54] **METHOD FOR MAKING A KINESCOPE COMPRISING PRODUCTION AND TREATMENT OF A TEMPORARY MASK**

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[73] Assignee: **RCA Corporation**

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[52] **U.S. Cl.** **29/25.14,** 29/25.17, 29/25.18

[51] **Int. Cl.** **H01j 9/00**

[58] **Field of Search** ....29/25.1, 25.11, 25.13, 25.14, 29/25.17, 25.18; 313/85 S, 92 B

[56] **References Cited**

UNITED STATES PATENTS

2,663,821 12/1953 Law ....29/25.14 X

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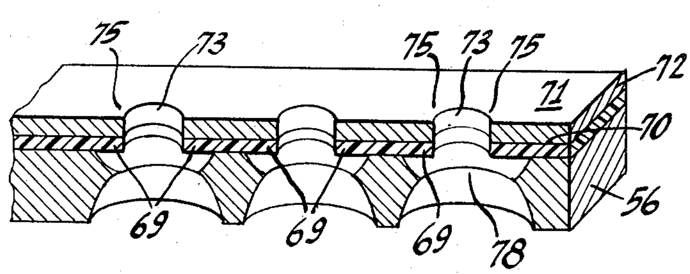
[57] **ABSTRACT**

Method for producing a color kinescope by steps comprising the provision of a perforated etch-resistant layer on a substrate and providing apertures in the substrate, which apertures are in substantial register with and individually larger than the openings of the perforated layer; providing a heat-resistant layer on the exposed surface of the perforated etch-resistant layer; substantially eliminating the bond between areas of the etch-resistant layer that extend partially across the apertures and the parts of the heat-resistant layer located on these areas; heating the workpiece thus far produced and comprising at least the apertured substrate and heat-resistant layer, and possibly the etch-resistant layer or portions thereof to an elevated temperature (e.g., the annealing temperature of the substrate) to stress relieve the substrate and then shaping the substrate-heat-resistant layer assembly to produce a temporary mask; producing an image screen with the temporary mask; removing the heat-resistant layer and any remains of the etch-resistant layer from the apertured substrate to produce a color-selection mask; and incorporating the color-selection mask and the image screen in a kinescope.

10 Claims, 10 Drawing Figures



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3 Sheets-Sheet 1

Fig. 1.

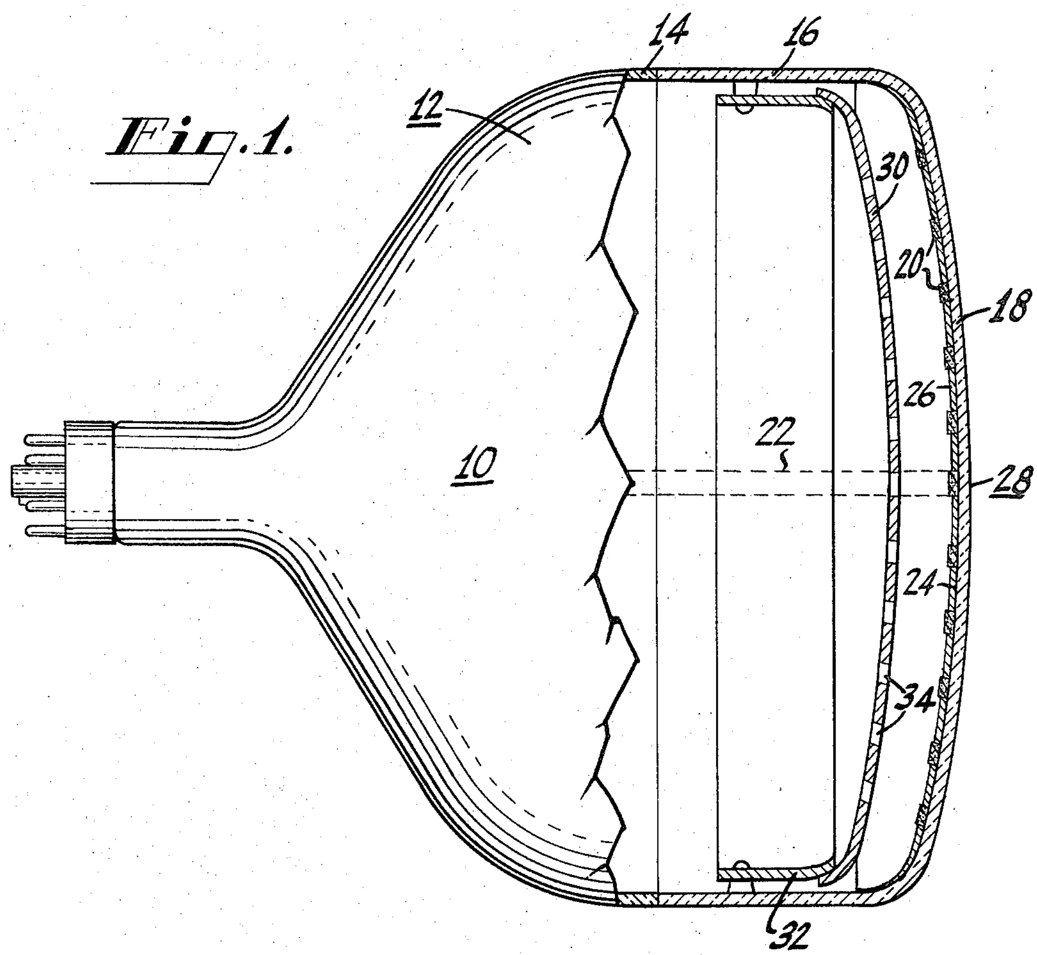

Fig. 2.

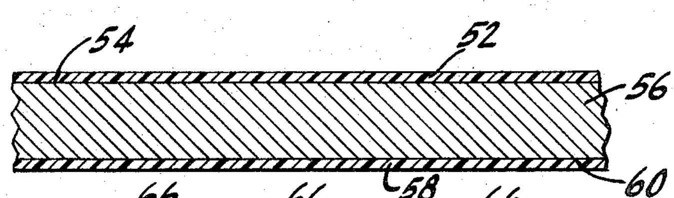

Fig. 3.

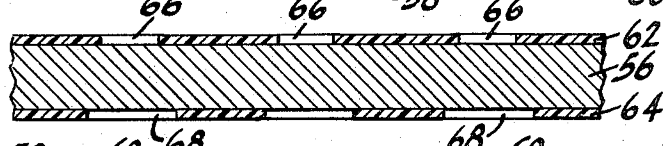

Fig. 4.

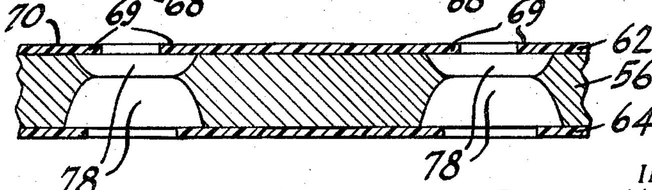

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Fig. 5.

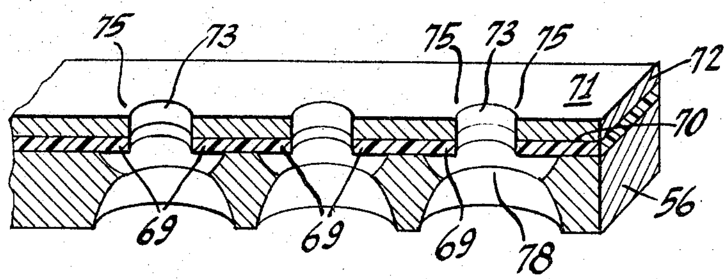


Fig. 6.

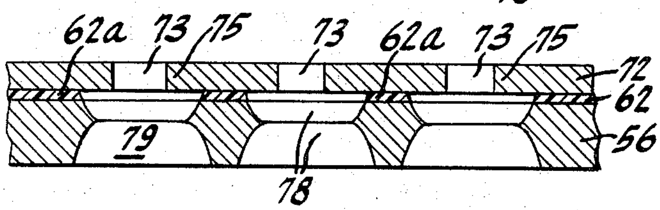


Fig. 7.

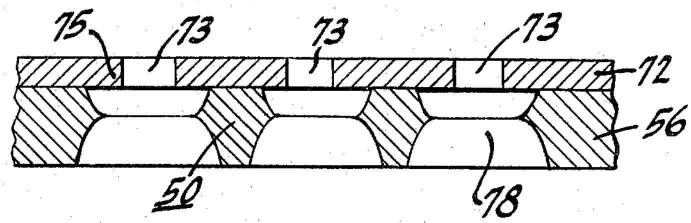


Fig. 8.

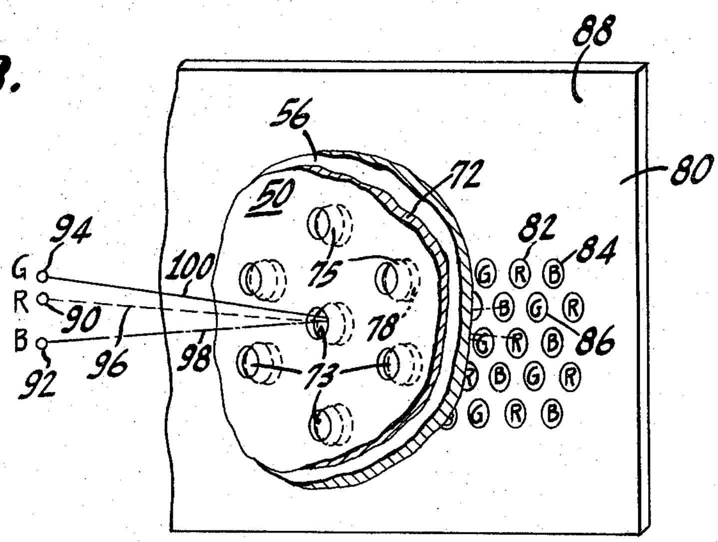
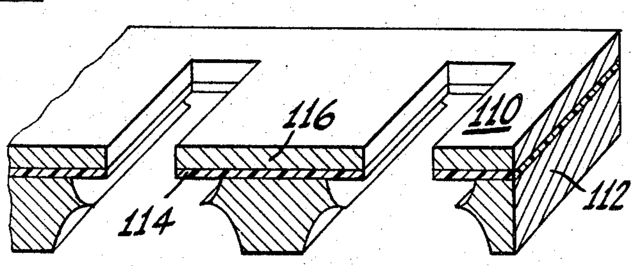


Fig. 9.



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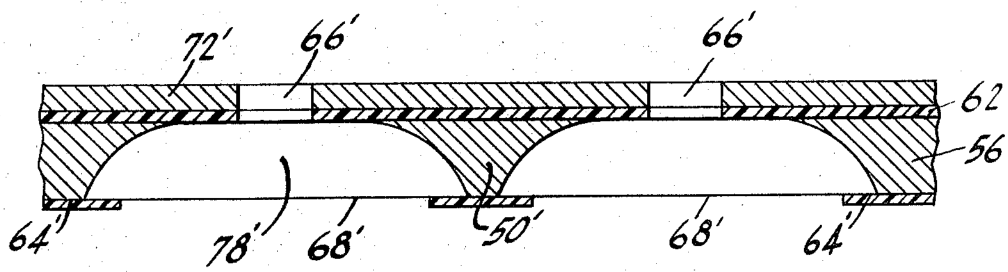

Fig. 10.

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METHOD FOR MAKING A KINESCOPE COMPRISING PRODUCTION AND TREATMENT OF A TEMPORARY MASK

BACKGROUND OF THE INVENTION

The present invention relates to color kinescopes and particularly to a novel method for making a masked-target color kinescope wherein the image screen is produced with the use of a temporary mask having temporary apertures of given size which temporary mask is subsequently converted to a permanent color-selection mask having larger apertures of a second size.

The prior art discloses color kinescopes having an image screen, which includes a mosaic comprising a multiplicity of groups of closely spaced elemental phosphor deposits, the elemental deposits of each of such groups emitting light of a particular color when struck by an electron beam, and a color-selection mask disposed between the image screen and the electron source of the kinescope. Such masks (including focusing and non-focusing masks) and their mode of operation are well-known and may be of a planar, or spherical, or some other non-planar contour, the contour of a particular mask generally being similar to that of the image screen with which it is used. Usually, the size of the apertures in the color-selection mask is graded from a maximum at the center to a minimum at the edge of the mask.

In the conventional non-focusing shadow mask color kinescope, the mask apertures and also the beam spots on the screen are somewhat smaller than the phosphor areas. Generally, commercial screen printing procedures involve using a color-selection mask having apertures of a desired final size as a master for photographically printing the phosphor areas thereof. The mask, with the size of its apertures unchanged, it then used in a color kinescope for color-selection.

To increase the electron transmission of the color-selection mask and, in the case of a non-focusing type tube, the proportion of each phosphor area impinged by an electron beam, so that the brightness of the image of a color kinescope can be increased, the prior art discloses masks having apertures that are individually larger than those in a conventional shadow mask kinescope, and that may be larger than the respective elemental phosphor areas of the image screens associated therewith. If no focusing action is involved, such larger apertures provide electron beam spots of greater size as measured at the screen, so that a larger proportion (or, in many cases, all) of each phosphor area is impinged than in conventional color kinescopes. On the other hand, in the case of a focusing-type color kinescope, the beam spot size at the screen generally is reduced to approximately the phosphor area size by focusing the beamlets in the space between the mask and the screen. For the reasons discussed in the U. S. Pat. application of H. B. Law (Ser. No. 834,759, filed 6/19/69), masks with such larger apertures are not satisfactory for direct screen printing (for both focusing and non-focusing-type tubes) because they generally lead to oversize (and, therefore, overlapping) phosphor areas and associated problems with color purity and white uniformity.

In order to allow the use of a mask, first, as a photographic master for screen printing and, then, as a color-selection mask (either focusing or non-focusing type) exhibiting increased electron transmissivity, the prior art has sought ways to provide, and use for screen printing, a "temporary mask" having temporary apertures of a first size and, after screen printing, to convert the temporary mask to a permanent, or final, color-selection mask having the desired larger, final-size apertures, this with substantial maintenance of the desired kinescope operating tolerances.

Such use of a "temporary mask" as a photographic master for "printing" the phosphor areas of image screens and subsequent conversion of the temporary mask to a color-selection mask for use as such in a color kinescope, is referred to herein as "post-printing apertures enlargement." As used with respect to this invention, a "color-selection mask" is not a preliminary mask since the apertures of the former are larger in size and the former is used only for the color-selection function (including focusing), not for screen printing.

One method disclosed in the prior art for achieving this "-post-printing aperture enlargement" involves applying to each major surface of an unperforated sheet of conductive material, a coating of a photosensitive resist material, such as bichromated glue or shellac. The two photosensitive coatings are then provided, by photographic methods known in the art, with matching respective patterns of perforations of a predetermined size to leave the conductive sheet partially coated with resist. This partially coated sheet is then immersed in an etching solution to produce, in uncoated portions thereof, apertures of a final size desired for the color-selection mask. The minimum diameter of each aperture of final size is larger than the associated perforation in the resist coating, so that portions of the resist coating overhang the final-size apertures in the conductive sheet and form printing apertures of smaller size than the apertures. Then the partially coated sheet is used as a master in the well-known image screen-printing operation, the light rays utilized for printing passing through and being defined by the small perforations in the resist coating. The resist coatings are subsequently removed so that the apertured conductive sheet can be used as a color-selection mask.

However, because of several reasons, this method is not completely satisfactory from a commercial stand-point, especially in those cases where the color-selection mask is desired to have a non-planar final configuration. One reason is that the bichromated glue or shellac, as well as comparable other organic resist materials disclosed in the prior art, deteriorate at the annealing temperatures (e.g., about 900° C) generally employed in producing non-planar masks by continuous mask-making processes practiced in the art. More specifically, in these continuous mask-making processes, a flat band of a suitable conductive material (e.g., cold-rolled steel), which is in a comparatively hard condition, is passed through the mask-making equipment where the band is, inter alia, provided with suitable apertures. The conductive material is used in a relatively hard condition to impart strength thereto and thereby minimize tearing and/or deformation of the band while it is being passed through the mask-making equipment.

When a non-planar (e.g., spherical) mask is required, it is generally desirable to shape the mask to the desired configuration after the mask-making operation is completed but before the screen-printing operation. For such a shaping operation, it is desirable, first, to anneal (at about 900° C for 10 minutes, for example) the mask, which is still in a comparatively hard condition, in order to reduce the hardness, and thereby facilitate the shaping, thereof. After the mask is annealed and shaped, it is generally mounted on a frame and used as a master for printing the phosphor areas of the image screen in a manner known in the art (see U. S. Pat. No. 3,406,068). As indicated with respect to the above method, the perforated resist coating is required to remain on the preliminary mask during the screen-printing operation, which necessitates the resist coating's remaining on the preliminary mask throughout the preceding annealing operation. However, the aforementioned resist materials (i.e., shellac or glue), as well as other organic resists known in the art, are not capable of withstanding these annealing temperatures. As a result, color-selection masks made by either of the above methods must be made from a sheet of comparatively soft material in order to avoid annealing of the preliminary masks and yet allow the shaping thereof with relative ease.

The use of such comparatively soft materials results, however, in the following: (a) an increased incidence of tear and/or deformation of the conductive band where continuous manufacturing processes are used, which leads to a relatively low production yield, and (b) the relatively desirability of using a batch-type, as compared to a continuous process for making such masks, in order to minimize tearing and/or deformation. Where a batch-type, instead of a continuous process is used, however, sheets of conductive material from which preliminary masks are to be produced are required to be handled individually in the operation. This results in an increase in the time and cost of making such preliminary masks.

Furthermore, the above method is not completely commercially satisfactory for the reason that the resist materials, such as shellac or glue, as well as other resists known in the art, used therein are not completely opaque. Hence, opaquing materials are required to be added to the resist material to minimize the amount of light passing therethrough during the screen printing operation. This addition of opaquing materials involves additional steps in the manufacture of the kinescope. Also, because in the above method, portions of the resist coating overhang the final size apertures in the preliminary mask and because the prior art resist materials used therein are comparatively fragile, considerable care must be exercised in handling the preliminary mask to avoid damage to these overhanging portions during the mask forming operation.

Another method for achieving post-printing aperture enlargement is disclosed in the abovementioned application of Law et al., where an apertured metal layer is provided directly on a substrate of a second metal that is to be processed ultimately into a color-selection mask. The apertured metal layer is produced in one embodiment therein by producing a suitable photosensitive resist pattern on the substrate area and thereafter depositing the second metal directly on accessible areas of the same surface, but substantially not on the resist pattern, and then removing the resist pattern. The apertures in the metal layer serve as the temporary apertures for screen printing, the aperture size and shape being adjusted for this purpose by regulating the resist pattern's dimensions and configuration. The substrate-metal layer workpiece is then etched with a suitable material so that portions of the substrate that are accessible through the apertures of the metal layer are removed, thereby producing the color-selection mask with final size apertures. Because the apertured metal layer is on the substrate during the etching of the substrate, it is necessary that the second metal comprising this layer be resistant to the etchants that are used. Where the second metal is not completely so resistant, it, too, is attacked by the etchant so that the size of the temporary apertures in the metal layer might vary significantly from the proper dimensions, thus leading to improperly sized phosphor areas. Therefore, the range of materials from which the second metal can be selected is limited by the material comprising the substrate.

SUMMARY OF THE INVENTION

The invention comprises a method for producing a color kinescope containing a color-selection (final) mask having apertures of given dimension at each location on the mask (which apertures, in a conventional graded mask, will vary from the center to the edge thereof) and an image screen, which screen is produced with a temporary mask having light-permeable corridors aligned with the apertures and having respective maximum dimensions smaller than the respective minimum dimensions of the associated apertures. The method includes the steps of providing a perforated layer of etch-resistant material on at least one surface of a suitable substrate and producing apertures that extend through the substrate, the apertures being larger than and in substantial register with the openings of the perforated etch-resistant layer.

Then, an opaque layer of heat-resistant material (e.g., a metal, preferably one having a melting point that significantly exceeds the thermal treatment temperatures intended for the temporary mask previous to the printing of the screen) is provided on the exposed surface of the etch-resistant layer. The heat-resistant layer includes corridors that extend therethrough and that equal substantially the size of the openings of the etch-resistant layer. Thereafter, the workpiece comprising the apertured substrate, etch-resistant layer, and heat-resistant layer is treated (e.g., given a caustic rinse or heated in an oxidizing atmosphere) to "eliminate substantially the bond" between the areas of the etch-resistant layer extending partially across the apertures and the parts of the heat-resistant layer located on these areas. Then, the assembly including the substrate and the heat-resistant layer is heated to reduce any stresses in the substrate, and, later shaped to the desired contour, thereby producing the temporary mask that is later used to print the image screen by photographic methods. After the printing of the image screen, the heat-resistant layer is removed, along with any remaining portions of the etch-resistant layer, from the substrate and the apertures substrate, which constitutes the color-selection mask, is then incorporated in the kinescope along with the screen.

The present method provides a number of improvements over the prior art, such as, for example, a temporary mask that can withstand the thermal treatments (e.g., annealing) generally conducted in kinescope manufacture, and a comparatively broad range of materials that can be used for the heat-resistant layer of the temporary mask.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view, partly in axial section, of a mask-type color kinescope including an image screen prepared with the use of a temporary mask made by the present invention, which temporary mask is later converted to the color selection mask of the kinescope.

FIG. **2** is a fragmentary, transverse sectional view of a resist-coated substrate prior to the conversion thereof to a temporary mask according to the present invention.

FIG. **3** is a fragmentary transverse sectional view of the structure shown in FIG. **2** at a subsequent processing step of the present invention, wherein perforations are provided in the resist layers.

FIG. **4** is a fragmentary transverse sectional view of the structure shown in FIG. **3**, there being produced in the substrate apertures extending therethrough, and there being areas of the resist layers extending partially across these apertures in the substrate.

FIG. **5** is a sectional perspective view of the structure in FIG. **4**, there being, additionally, an opaque layer of heat-resistant material disposed on and substantially co-extensive with the resist layer.

FIG. **6** is a fragmentary transverse sectional view of the structure in FIG. **5**, with those parts of the resist layer overhanging the corridors of the substrate substantially eliminated.

FIG. **7** is a fragmentary transverse sectional view of the temporary mask produced by the steps including those shown in FIGS. **2** through **6**.

FIG. **8** is a fragmentary perspective view of the temporary mask shown in FIG. **7**, in position for use as a photographic master in preparing an image screen for a color kinoscope.

FIG. **9** is a fragmentary sectional perspective view of a structure comprising a grille-type color-selection mask during processing into a temporary mask according to this invention, the structure further comprising a perforated etch-resistant layer and an opaque heat-resistant layer.

FIG. **10** is a fragmentary sectional transverse view of a structure comprising a substrate wherein the apertures extending therethrough have been produced by etching through the openings of only one of the perforated etch-resistant layers thereon.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates a mask-type color kinescope **10** produced by the novel method and temporary mask structure disclosed herein, which kinescope **10** includes a glass envelope **12** comprising a funnel portion **14** and a panel or cap **16**, which cap **16** includes a transparent faceplate **18**. A plurality of elemental phosphor areas **20**, which collectively comprise two or more groups of deposits of two or more different phosphors, the deposits of each group being individually capable of emitting luminescence of a particular color (e.g., red, blue, or green) when struck by an electron beam **22**, are deposited on the internal surface **24** of the transparent faceplate **18**. The faceplate **18** (or other transparent substrate), the phosphor areas **20** and, optionally, a light absorbing matrix **26** (discussed below), are collectively referred to herein as an image screen **28**. Generally, there is included on the image screen a light-reflective, electron-permeable, conductive layer (not shown) of aluminum, for example, which covers the phosphor areas and also serves as an electrode. The phosphor areas **20**, are, for illustration purposes, exaggerated in size and proportion (as are other parts of FIG. **1** and the other figures) and shown as having a dot configuration, which dots may be arranged in the well-known hexagonal dot pattern (FIG. **8**). Alternatively, each phosphor area may have a well-known stripe configuration (not shown), these stripes being arranged in an array of parallel lines of different color phosphors to provide a line color screen. The kinescope **10** further includes a number of electron guns equal to the number of different colors in the screen and either electrostatic or magnetic deflection and convergence means, none of which are shown for simplicity. In generally parallel, spaced relation with the screen **28** is a color-selection mask (or mask electrode) **30** which may be, for example, of the focusing or non-focusing variety, both of which are known in the art. A suitable frame **32** or other means can be used to support the color-selection (final) mask **30** in the cap **16**. Unless stated otherwise, for purposes of example, the color-selection mask **30** is understood to be of the non-focusing mask variety, which is operated at substantially the same potential as the screen **28** to form a field-free region therebetween. The mask **30** is made form a sheet or wide band of electrically conducting material (e.g., cold-rolled steel) and has a plurality of apertures **34** of desired final size at each point therein. The size of the apertures **34** may be graded from a maximum at the center to a minimum at the edge of the mask, as is well known in the art. While the apertures **34** are, for simplicity, shown in FIG. **1** to be substantially circular in shape, apertures having other shapes may be used; for example, the mask may be of the "grille" type (FIG. **9**), having elongated slot-shaped apertures and used with a line screen. The apertures **34** are related in size and position to respective phosphor areas **20** of the image screen **28**. In the present invention, the size relationship is such that, where the color-selection mask **30** is of the non-focusing variety, each aperture **34** is of such size as to be capable of passing an electron beam **22** whose spot dimensions, as measured at the screen **28** (i.e., the spot size of the beam) are at least substantially equal to, or preferably larger than, the size of the individual phosphor area **20** upon which the electron beam spot impinges. The electron beam spot size is preferably sufficiently large to provide a negative leaving tolerance (beam spot larger than corresponding phosphor area) but not so great that the electron beam spot impinges any ones other than the intended phosphor areas. However, where, in the prior art, color-selection masks have apertures of a given size that are used for both screen printing and the color-selection function, the effective size of the light spots produced during screen printing generally exceeds by a significant amount the size of the electron beam spots produced in the operation of the kinescope. This results in the size of the individual phosphor areas being considerably greater than the spot size of their associated electron beam so that the beam spot impinges only a portion of each phosphor area. Such differences in size between the printing light spots and the electron beam spots are familiar to the art, the difference therebetween being attributable to the more extensive penumbra-umbra effect taking place in the screen printing screen.

Generally, it is preferred that the apertures **34** exceed in size their associated phosphor areas **20**. The apertures of a focusing-type mask are much greater in size than their respective individual phosphor areas where the color tube is of the positive leaving tolerance type (beam spot smaller than a corresponding phosphor area) or the negative leaving tolerance type. In mask-type color kinescopes in the prior art, there is a single aperture in the color selection barrier for each trio of phosphor areas **20** (i.e., one area each of red, green and blue phosphors); however, for purposes of simplicity, each aperture **34** is shown in FIG. **1** to correspond in position with only one phosphor area **20**.

In the operation of the kinescope **10**, electrons are emitted by the respective electron guns (not shown) and thereafter, directed, by means known in the art, as respective electron beams (only one beam **22** is shown for simplicity) through the apertures **34** to impinge upon the trios of phosphor areas **20**. Because a larger electron beam spot is produced, which spot impinges upon substantially an entire individual phosphor area, the kinescope **10** exhibits improved characteristics, such as increased image brightness and contrast, over positive tolerance kinescopes.

In the method illustrated in FIGS. **2** through **7**, a color kinescope (e.g., **10** of FIG. **1**) is manufactured by steps including the production of a temporary mask **50** FIG. **7**) for screen printing. The first step in making the temporary mask **50** is the provision of a continuous first layer **52** (FIG. **2**) of a photosensitive resist material (e.g., bichromated fish glue) on one major surface **54** of a substrate **56** of a suitable, relatively hard material (e.g., cold-rolled steel, having a thickness of about 7 mils) and a continuous second layer **58** of a photo-sensitive resist material on the other major surface **60** of the substrate **56** (the second layer **58** is not shown in the drawings in FIGS. **5** to **7** for simplicity). The layers **52** and **58** of resist material are converted into perforated layers **62** and **64**, respectively, by methods known in the art, for example, by light exposure through a suitable stencil and subsequent selective removal of the unexposed, unhardened areas by washing, to produce patterns of openings **66** and **68** therein. The openings **66** and **68** are disposed at and substantially concentric with the sites where the color-selection apertures (**78** in FIG. **4**) are intended, the openings **66** or **68** of each respective perforated layer **62** or **64** being in register with those of the other layer. The openings (e.g., **66**) of one of the layers (**62**) are of a predetermined size at each point on the mask suitable for screen printing, this size being significantly smaller than the minimum size of the subsequently-produced apertures (**78** in FIG. **4**). The other openings (i.e., **68**) preferably are significantly larger at each location than the corresponding openings (**66**) of predetermined size such that the apertures (**78** in FIG. **4**) that are later produced are generally tapered from one surface **54** toward the other surface **60**, according to general practice in the art. Such tapered apertures generally are preferred to minimize interference of the color-selection mask with the electron beams during operation of the kinescope; for example, to minimize impingement of electrons on the side walls of the apertures.

Those portions of the substrate **56** (FIG. **3**) located generally between the openings **66** and **68** of the perforated resist layers **62** and **64**, respectively, are removed, as by etching with ferric chloride, from both surfaces **52** and **60** of the substrate **56**, so as to produce apertures **78** (FIG. **4**) thereat. Such removal of material from the substrate **52** is carried out so that there are also removed portions thereof located beneath that layer (i.e., **62**) surrounding the openings (i.e., **66**) of the predetermined size necessary for screen printing, and consequently, areas **69** (FIG. **4**) of this layer **62** extend partially across the apertures **78** so produced. It is preferred that these areas **69** of the layer **62** overhang the apertures **78** so that substantially all of these respective areas **69** are located above the apertures **78**. In the preferred embodiment illustrated in FIG. **4**, certain substrate portions located beneath the second resist layer **64** also have been removed so that areas of this layer **64** also extend partially across the apertures **78**, to produce a relatively large taper angle, although it is not necessary for purposes of this invention that this be so. Where it is desired, etching of the substrate to produce apertures **78'** (FIG. **10**, where the elements corresponding to those in FIG. **4** are designated with primed corresponding numerals) can be done through only the openings

68' of one perforated etch-resistant layer 64' on the substrate 56', these openings 68' being significantly larger than the other openings (66') that are of predetermined size suitable for screen printing and that are located in the second etch-resistant layer 62'. Also, after the provision of the apertures in the substrate, the heat-resistant layer 72' is provided, and the second perforated etchresistant layer 64' (or 64 of FIG. 4) can be removed from the substrate 56 where it is desired to eliminate any interference by that layer 64 with the subsequent screen printing operation.

Thereafter, the exposed surface 70 of the resist layer 62, which includes the openings 66 of the predetermined size for screen printing, is covered with a heat-resistant layer 72 of a material capable of withstanding the annealing temperatures (i.e., the melting point of such material exceeds the annealing temperature of the substrate) to which the temporary mask is subjected (as discussed below), an exemplary annealing temperature being about 900° C. The heat-resistant layer 72 includes light-permeable corridors 73 that are in substantial register with and substantially co-extensive with the openings 66. The term "heat-resistant" is defined herein to include material capable of withstanding thermal treatments (e.g., annealing) to which the temporary mask might be subjected. Such a heat-resistant material can be a metal, such as copper or nickel, for example; and the layer 72 should be sufficiently thick so that the parts 75 thereof over the apertures 78 can be self supporting (e.g., about one-half mil in thickness). The material of the layer 72 preferably is substantially opaque and, where the mask is to be formed to a non-planar contour, is of relatively ductile material. This layer of heat-resistant material can be produced by, for example, painting directly on the resist layer; evaporation; electroless chemical deposition; electrolytic deposition; or electrophoresis, according to known practices.

Then, the workpiece 71 (shown in FIG. 5 and comprising the apertured substrate 56, perforated resist layer 62, and heat-resistant layer 72) is annealed (e.g., at about 900° C), thereby relieving any stresses that may be present in the substrate 56 and facilitating the mask forming operation (discussed below).

However, to reduce significantly the possibility of deformation, tearing, or other damage to the parts 75 of the heat-resistant layer 72 overhanging the apertures 78, due, for example, to thermally-caused physical movement of the overhanging areas 69 of the resist layer 62 during the annealing (or some other heating) operation, the work-piece 71 (shown in FIG. 5 and comprising the apertured substrate 56, perforated resist layer 62 and heat-resistant layer 72) is treated, before such an annealing operation, so as to reduce or to eliminate substantially the bond between at least the parts 75 of the heat-resistant layer 72 that overhang the apertures 78 and the areas 69 of the resist layer 62 that co-extend therewith and overhang the apertures 78. Such "elimination" or "reduction of the bond," both being referred to herein as "elimination of the bond," can be achieved, for example, by completely removing these overhanging areas 69 of the resist layer from the workpiece 71, as in the structure 79 (FIG. 6); by physically separating these areas 69 of the resist layer 62 from the corresponding parts 75 of the heat-resistant layer 72; or by crazing these areas 69 of the resist layer 62 so as to produce a number of fragmented portions (not shown).

One way for achieving such elimination of the bond is to wash the above workpiece 71 (FIG. 5) in a caustic solution, such as sodium hydroxide. Another way is to heat the workpiece in an oxidizing atmosphere (e.g., air), a minimum temperature of about 350° C being generally preferred for most organic resist materials. A temperature of about 400° C to 500° C is preferred where the resist layer material is fish glue. Whereas the heating the workpiece 71 in an oxidizing atmosphere might lead to the conversion of a metallic heat-resistant layer into an oxide thereof, which oxide might be undesirable because of its brittleness, the execution of annealing of the workpiece, which is carried out after the elimination of the bond, at about 900° C, for example, in a chemically reducing atmosphere, such as "forming gas" (i.e., 90% N_2 – 10% H_2), for example, serves to reduce the less desirable metal oxide to the metal.

The workpiece that has been treated to eliminate the bond (e.g., 79 in FIG. 6) is then annealed in the manner described above (e.g., at 900° C). While some portions (e.g., 62*a* in FIG. 6) of resist material may, after the above preferred treatment to eliminate the bond with the heat-resistant layer 72, remain between the heat-resistant layer 72 and the substrate 56, these portions 62*a* do not, during the annealing operation, adversely affect significantly the parts 75 of the heat-resistant layer 72 over-hanging the apertures 78. These portions 62*a* are, in fact, substantially removed by this annealing operation.

After annealing the resulting assembly including the substrate 56 and the heat-resistant layer 72 (FIG. 7) is formed (shaped) according to known practices in the art to produce a temporary mask 50 of non-planar contour where a non-planar color-selection mask is desired. At this point, substantially all of the resist layers (62 and 64) have been removed (due, in part, to the annealing), as shown in FIG. 7, and the heat-resistant layer 72 is located on the apertured substrate 56.

The temporary mask 50 (FIG. 7) thus produced is then positioned (FIG. 8) in spaced relation with a suitable transparent substrate 80 (e.g., a faceplate) and used as a photographic master to "print" the various elemental phosphor areas 82, 84, and 86 of the respective phosphor groups (e.g., red, blue, and green) on the substrate 80. The printing process is known in the art (see, for example, U. S. Pat. No. 3,406,068 to H. B. Law). Where the color-selection masks of non-planar configuration are desired, the shaping of the temporary mask to this configuration is done, as mentioned above, as the final step in temporary mask-making, and before screen printing. Briefly, in the screen-printing process, one surface 88 of the transparent substrate 80 may be coated with a mixture (not shown) comprising a first one of the desired phosphors and a suitable photosensitive material and then exposed to a suitable light which is passed through the corridors 73 of the temporary mask 50. Those portions of the photo-sensitive-phosphor coating (not shown) struck by the light rays are hardened and then the unhardened portions of the coating are removed, by washing, for example, to leave a pattern (not shown) of areas (dots) of a phosphor of a first color mixed with the hardened resist material. This sequence of steps is repeated for the other phosphors. The hardened resist material is subsequently removed from the phosphor dots by baking or by chemical dissolution methods known in the art. In first-order color printing, a light source (not shown) intended for a particular phosphor group is located at a point (90, 92, or 94) so as to be in substantially the same spatial relation with the image screen (e.g., 28 of FIG. 1) as the center of deflection or apparent source of the electron beam (not shown) used for exciting that particular phosphor group. The paths followed by the light rays during printing and by the electrons during operation of the kinescope are indicated, for purposes of illustration, by the lines 96, 98 and 100.

The screen printing operation may include providing, by using the temporary mask 50 disclosed herein, a light-absorbing matrix (e.g., 26 of FIG. 1) of an opaque, non-light-reflective material on the image screen (e.g., 28 of FIG. 1). For purposes of this invention, where such a matrix is provided on an image screen, it is considered to be included in the term "image screen." This matrix can be produced, for example, in the manner described in the abovementioned application of Law et al. The phosphor areas may, if desired, be somewhat larger than the openings of the matrix so that portions of the respective phosphor areas overlap the matrix. The "effective size" of such phosphor areas is, however, equal to the size of their respective matrix openings. As used with respect to the phosphor areas of a matrix-bearing image screen, the term "-size" is defined to be the effective size thereof.

Upon completion of the screen printing operation, the temporary mask 50 (FIG. 7) is converted to a color-selection mask (not shown) that corresponds to mask **30** in FIG. **1**, by removing the layer **72** of heat-resistant material. Such removal is carried out, for example, where the heat-resistant material is metal, by a second etching operation utilizing a suitable etching material. It is preferred that the second etching material be selected so as substantially not to attack the substrate **56**. However, because the quantity and thickness of the heat-resistant layer is comparatively small with respect to the apertured substrate, a relatively insignificant dimensional change might result in the apertured substrate due to etching, in the relatively short time needed to remove the heat-resistant layer. Where it is desired, the material comprising the heat-resistant layer can be chosen so as to be more readily attached by etching agents than the substrate so as to facilitate removal thereof from the substrate. Such materials include those having oxidation-reduction potentials significantly higher than the material comprising the substrate **56**.

In another embodiment, an assembly **11** (FIG. **9**) comprising a substrate **112** that has been processed (generally in the manner outlined above) into a grille-type color-selection mask of desired dimensions; an etch-resistant perforated layer **114** on the substrate **112**, which layer **114** serves the same purposes as and is comparable to layer **62** in FIGS. **3** to **5**; and an opaque layer **116** of heat-resistant material co-extensive with the perforated layer **114**, which opaque layer **116** is comparable to and serves the same purpose as the layer **72** in FIGS. **3** to **5**. The processing of the assembly **110** and the screen printing therewith are comparable to those recited above.

The elimination of the bond disclosed herein comprises an inventive improvement on the method of making a color kinescope described and claimed in an application filed concurrently herewith for Glenn R. Fadner, Jr., and assigned to the same assignee, which method involves some of the steps herewithin. The title of the Fadner application is "Method For Making A Kinescope Comprising A Color Selection Mask With Temporary Corridors."

What is claimed is:

1. A method for producing a color kinescope comprising a color-selection mask having apertures of given minimum dimension at each location thereon and an image screen, said screen being produced with a temporary mask having light-permeable corridors registered with said apertures and having a dimension at each location substantially smaller than said given minimum dimension, comprising the steps of:

a. providing on at least one surface of a substrate from which said color-selection mask is to be made a perforated layer of etch-resistant material, having openings of said smaller dimension;
b. producing said apertures of said given minimum dimension that extend through said substrate in substantial register with said openings in said perforated layer, whereby areas of said perforated layer extend partially across said apertures;
c. providing an opaque layer of heat-resistant material on the exposed surface of said perforated etchresistant layer, said layer of heat-resistant material including corridors therethrough aligned with and substantially equal in size to said openings, whereby parts of said heat-resistant layer extend partially across said apertures;
d. substantially eliminating the bond between said resist layer and said heat-resistant layer at at least said areas of said perforated resist layer extending partially across said apertures and respective said parts of said heat-resistant layer located at said areas;
e. heating the assembly in d above so as to reduce any stresses therein and then shaping said assembly, thereby producing said temporary mask;
f. providing said image screen by steps including photographic exposure through said corridors of said temporary mask;
g. removing said layer of heat-resistant material and any remaining portions of said etch-resistant perforated layer from said substrate; and
h. then incorporating the apertured substrate adjacent to said image screen to serve as said color-selection mask.

2. The method defined in claim **1**, wherein said elimination of said bond is achieved by completely removing said areas of said etch-resistant layer extending partially across said apertures.

3. The method defined in claim **1**, wherein said elimination of said bond is achieved by physically separating said areas of said etch-resistant layer extending partially across said apertures from the corresponding said parts of said heat-resistant layer located at said areas.

4. The method defined in claim **1**, wherein said elimination of said bond is achieved by crazing said areas of said etch-resistant layer extending partially across said apertures.

5. The method defined in claim **1**, wherein said elimination of said bond is achieved by treating with a caustic material at least said areas of said etch-resistant layer extending partially across said apertures.

6. The method defined in claim **1**, wherein said elimination of said bond is achieved by heating at least said etch-resistant layer in a chemically oxidizing atmosphere.

7. The method defined in claim **6**, wherein said heating is carried out at a temperature of at least **350°** C.

8. The method defined in claim **6**, wherein the later said heating of said assembly to reduce stresses therein is carried out in a chemically reducing atmosphere so as to eliminate substantially any oxides of said heat-resistant material that might be formed during the preceding said heating of said resist layer.

9. The method defined in claim **8**, wherein the later said heating of said assembly is carried out at an annealing temperature of said substrate.

10. The method defined in claim **1**, wherein said areas of said perforated etch-resistant layer over-hang respective ones of said apertures.

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