United States Patent [19]

Speigel

[11] **3,822,454**

[45] **July 9, 1974**

[54] **METHOD OF FABRICATING A COLOR CATHODE RAY TUBE**

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[22] Filed: **Nov. 30, 1972**

[21] Appl. No.: **310,707**

[52] **U.S. Cl.** **29/25.13**, 96/36.1

[51] **Int. Cl.** **H01j 9/18**

[58] **Field of Search** 29/25.1, 25.11, 25.13, 29/25.18; 96/36.1

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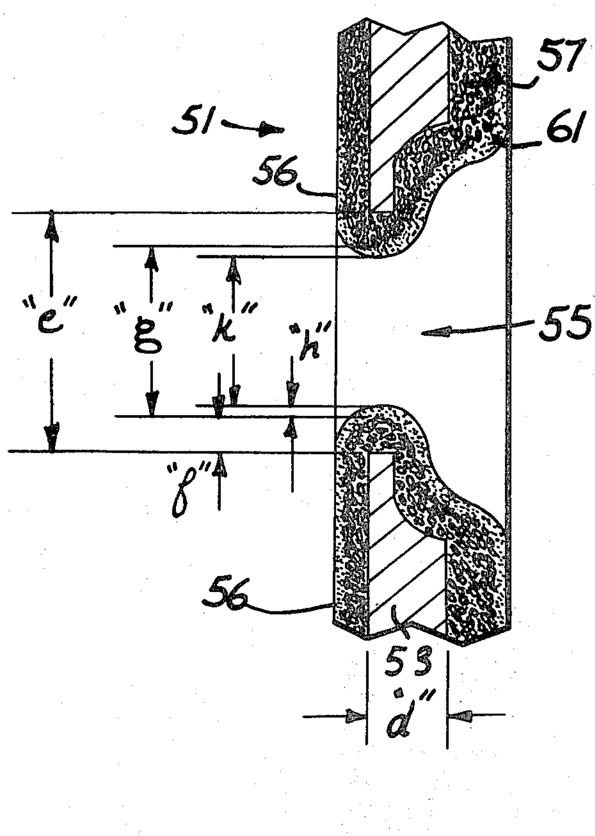
[57] **ABSTRACT**

A method for making a color cathode ray tube utilizing a screen-related apertured mask member wherein the apertures are temporarily reduced in size by an applied coating that is absorbent of actinic radiant energy. The coated mask is used to photo expose a windowed-web, defined by opaque interstices, on the viewing panel of the tube; whereupon, the coated mask is again employed to photo expose a superimposed array of phosphor dots to fully cover each of the window areas. After formation of the screen structure the temporary coating is removed from the mask by treating with a dissolving solution which completely de-coats the mask thereby restoring the apertures to their initial dimensioning without harming the underlying mask material per se. In the mask-screen assembly thus fabricated, the mask apertures in the completed tube are of a size larger than the associated phosphor-filled window areas of the screen.

8 Claims, 9 Drawing Figures



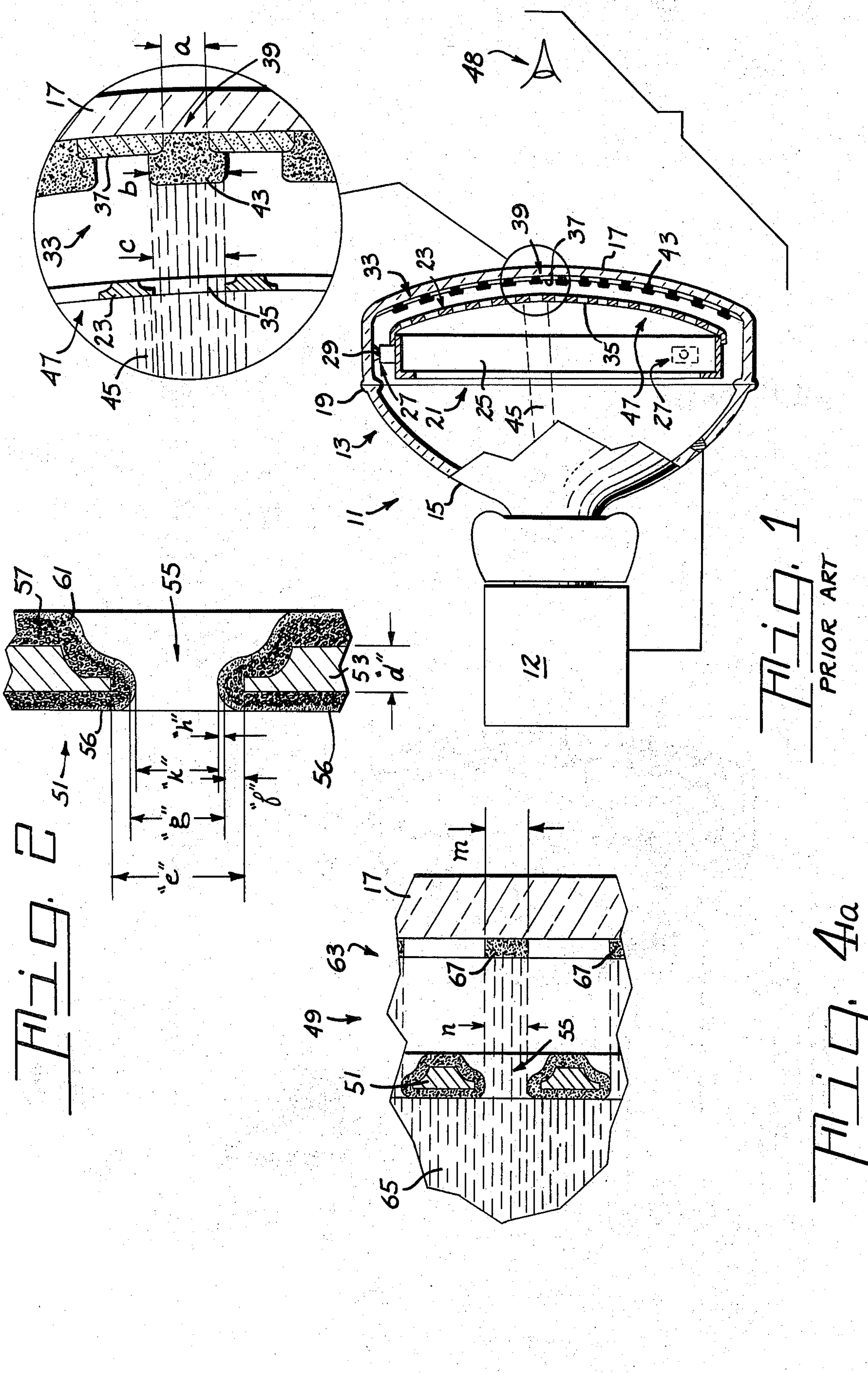


Fig. 1 PRIOR ART

Fig. 2

Fig. 4a

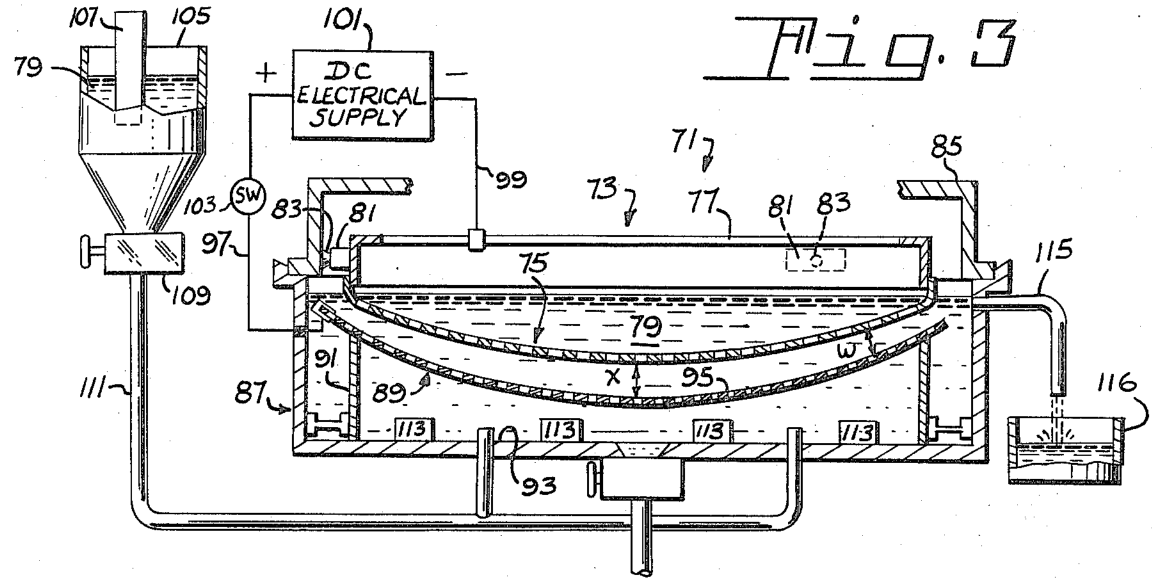
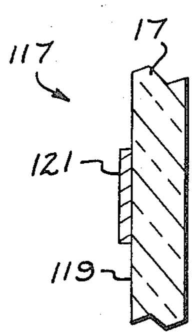
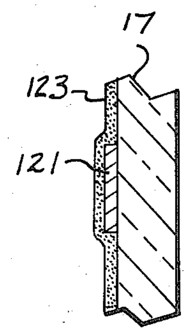


Fig. 3





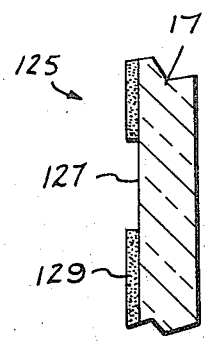
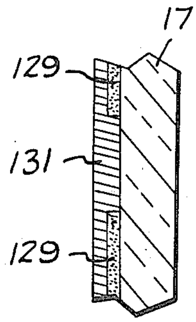


Fig. 4b Fig. 4c Fig. 4d



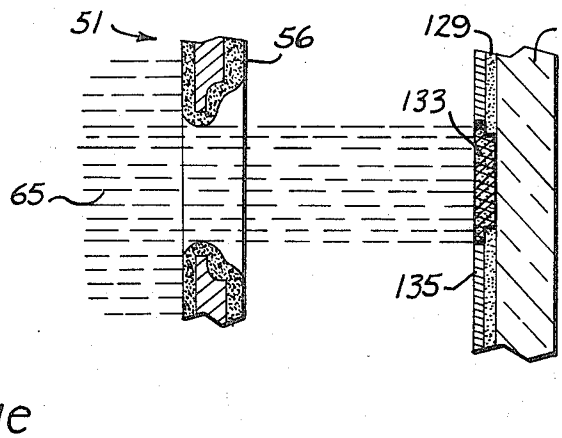


Fig. 4e

Fig. 4f

METHOD OF FABRICATING A COLOR CATHODE RAY TUBE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application contains matter disclosed but not claimed in two related United States patent applications filed concurrently herewith and assigned to the assignee of the present invention. These related applications are Ser. No. 310,704, now U.S. Pat. No. 3,764,514, and Ser. No. 310,706.

BACKGROUND OF THE INVENTION

This invention relates to color cathode ray tubes and more particularly to a method of fabricating a cathode ray tube wherein an improved shadow mask modification means is utilized in the forming of a patterned color screen structure.

Color cathode ray tubes, such as those employed in television applications, usually have patterned screen structures comprised of repetitive groups of related phosphor materials. These discretely arranged cathodoluminescent groupings are conventionally disposed as bars, stripes, or dots depending upon the particular type of color tube construction under consideration. For example, in the widely-accepted shadow mask tube construction, the related screen pattern is usually composed of a vast multitude of substantially round or discretely elongated dots formed of selected cathodoluminescent phosphors, which, upon predetermined electron excitation, evidence additive primary hues to produce the desired color imagery. The individual dots comprising the screen pattern are often separated by relatively small interstitial spacings to provide improved color purity by reducing the possibility of electron excitation of adjacently oriented dots. Associated with the screen and spaced therefrom in a defined relationship is a multi-apertured shadow mask structure. Each of the apertures therein, being of a substantially round or elongated shaping, is cognitively related to a specific grouping of similar-shaped phosphor dots, comprising the spatially related screen pattern, in a manner to enable the selected electron beams traversing the apertures to impinge the proper phosphor areas or dots therebeneath.

Improved brightness and contrast of the color screen image has been achieved by a patterned multiplex screen structure wherein the dot-defining interstitial spacing between adjacent phosphor dots is covered by an opaque light-absorbing material. Specifically, each phosphor dot is defined by a substantially dark opaque encompassment which collectively comprises a foraminous pattern in the form of a windowed webbing having an array of substantially opaque connected interstices. Such web-like structures have been fabricated, either before or after screening, by several known procedures wherein photo-deposition techniques play a prominent part. An example of a typical web-forming procedure is disclosed in Ser. No. 41,535 by R. L. Bergamo et al., filed May 28, 1970, and assigned to the assignee of this invention.

It has been found that further improvement in tube characteristics can be realized from a mask-screen relationship wherein the respective phosphor covered windows of the opaque webbing in the finished multiplex screen are slightly smaller than the apertures in the related shadow mask. This aperture-to-window relationship is referenced in the art as "negative guardband" or as a "window-limited" screen. In this type of color screen construction, when a superimposed phosphor dot is impinged by an aperture-sized electron beam, the excited phosphor area completely fills the associated window area with a luminescent hue.

Several techniques have been employed to achieve a patterned multiplex window-limited color screen structure in which the window openings in the opaque interstitial webbing are smaller than the associated apertures in the shadow mask subsequently utilized in the operable tube.

In accordance with one screen forming procedure, wherein the size of the mask apertures remains fixed, an array pattern of clear polymerized PVA dots is light disposed on the panel, on those areas subsequently to be windows in the opaque webbing, by photo-exposure through the related apertured shadow mask. After development, the resultant island-like polymerized dots are reduced in size by an erosion technique involving a chemical degrading agent. Next, an opaque graphite coating is applied to completely overcoat the pattern of the reduced-in-size clear dots and the adjacent interstitial areas of bare glass. Then, an oxidizing agent is applied to completely degrade the pattern of dots thereby loosening the superjacent opaque graphite coating thereon; whereupon the materials so loosened are removed by a subsequent water development step. Thus, there is formed an opaque interstitial web having multitudinous windows defined as bare glass areas that are of a size smaller than the related mask apertures. The phosphor pattern elements are then disposed on these window areas upon photo-exposure through the same size mask apertures by one of the various processes known to the art. While the aforedescribed dot-erosion procedure is an acceptable production technique, it necessitates the inclusion of additional process steps.

By another screen forming procedure, after the dot-initiated windows and the overlaying phosphor elements are formed by a separate series of photo-exposures through the initially apertured mask, the mask apertures are subjected to a chemical etching process to enlarge their sizes thereby effecting the desired dimensional differential between the final-sized apertures and the priorly formed windows in the interstitial webbing. While, this too, is a production procedure, the aperture etching requires additional closely controlled processing steps. In addition, as a result of this aperture etching procedure, metallurgical inconsistencies of the mask material have been evidenced such as a ragged aperture periphery, weakening of the mask material per se, and the destruction of the desirable dark oxide coating on the surface of the mask. Furthermore, with reference to the economics of tube production, etching of the mask apertures is an inherently costly procedure as it precludes any subsequent reuse of masks which ordinarily would be salvagable from the final stages of the tube manufacturing operation.

The prior art is replete with a variety of techniques for modifying the size of the shadow mask apertures for utilization in the forming or operation of specific types of color screen structures. In several disclosures the changing of aperture sizes is executed by the deposition within the aperture openings of peripheral fill-in substances applied, as for example, by painting, dipping, electrophoresis, electroplating and vaporization. The results of the respective depositions and their subsequent removals have been evidenced by varying degrees of success involving additional apparatus along with extra concomitant procedures and expense. In some instances, the controlled repeatability relative to production and consistent quality aspects has been annoyingly unsatisfactory. By one known cataphoretic coating procedure and apparatus, a metallized curved glass plate formed as an anode is employed in depositing a coating of aluminum oxide on an apertured mask. In this type of apparatus, difficulties in maintaining a consistent coating suspension have been evidenced. Additionally, subsequent removal of the temporarily disposed aluminum oxide opaque material is difficult and can leave small residual particles which may be detrimental to the quality of the finished tube.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to reduce the aforementioned disadvantages by providing a method of fabricating a cathode ray tube wherein the shadow mask includes improved temporary modifications of the apertures. Another object is to provide a method of fabricating a cathode ray tube utilizing a temporarily coated pattern mask in forming the patterned screen structure whereof the mask modification can be expeditiously, consistently and satisfactorily effected and removed therefrom. A further object is to provide a method of fabricating a cathode ray tube whereof the improved temporal mask modification utilized in forming the screen structure in no matter alters the basic mask metallic structure or the surface of the mask per se.

These and other objects and advantages are achieved in one aspect of the invention by the provision of a method for fabricating a color cathode ray tube utilizing a mask member having a multitude of apertures discretely formed therein, the mask being positioned within the tube envelope adjacent to the viewing panel portion thereof. By this method, the apertured portion of the formed mask member is coated to temporarily modify the dimensions of the initial apertures prior to utilization in forming the screen structures. The coating material is substantially absorbent of ultraviolet radiant energy in substantially the 340 to 380 nanometer range, the coating being soluble in a substance that is nondestructive to the mask material. By using the discretely coated mask, a windowed-web having opaque interstices is expeditiously formed as part of the screen structure on the viewing panel by a known photo exposure technique. The coated mask is again beneficially employed to photo expose a pattern array of phosphor dots that are superimposed on the priorly-formed windows to fully cover the window areas. The temporary modification is thence removed from the mask by solubilizing the coating with a compatible dissolving solution to de-coat the mask thereby restoring the apertures to their initially defined dimensioning without harming the underlying mask material per se. In the mask-screen assembly thus formed, the mask apertures in the fabricated tube are larger than the associated phosphor-filled window areas of the screen.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a prior art view of a color cathode ray tube in an operable environment and partially in section showing the relationship of the multi-apertured shadow mask to the patterned screen structure disposed on the viewing panel of the tube;

FIG. 2 is an enlarged sectional view of the apertured pattern member of the mask showing the temporary modification thereof;

FIG. 3 is a sectional view illustrating a procedure for electrophoretically coating the mask; and

FIGS. 4*a* through 4*f* are enlarged sectional views of a portion of the mask-screen assembly illustrating utilization of the mask modification during certain sequential steps in the formation of the color screen structure.

DESCRIPTION OF THE PREFERRED EMBODIMENT

For a better understanding of the present invention, together with other and further objects, advantages and capabilities thereof, reference is made to the following specification and appended claims in connection with the aforedescribed drawings.

While the following description is primarily directed to an exemplary tube employing a window-limited shadow mask-screen assembly and a method of tube fabrication the concept of utilizing temporarily modified apertures in the screen forming operation is likewise applicable for tubes employing a focus mask-screen structure.

With reference to the drawings, there is shown in FIG. 1 a prior art view illustrating a shadow mask type of color cathode ray tube **11** in an operable environment denoted diagrammatically as **12.** The encompassing envelope **13** of the tube includes a funnel portion **15** to which a viewing panel **17** is suitably attached as by a continuous bead of bonding frit **19.** Within the panel there is positioned a metallic shadow mask structure **21** which comprises a curved or domed multi-apertured pattern member **23** formed of, for example, an iron alloy material having a strengthening means or a perimetric frame **25** integral with the periphery thereof. This peripheral frame has a plurality of spring-like positioning means **27,** attached at spaced-apart locations thereon, which mate with supporting protuberances such as metal studs **29** projecting inwardly from the sidewall portion **31** of the viewing panel **17.** Disposed on the interior surface of the viewing panel is a patterned screen structure **33,** the elements of which are formed in accordance with the apertures **35** in the adjacent mask pattern member **23,** the substantially domed contour of the mask being related to the surface contour of the interior of the panel.

The multiplex patterned screen structure is comprised of repetitive groupings of two or more elemental cathodoluminescent areas of different phosphors overlaid on the discretely formed window areas of the opaque interstitial webbing portion of the structure **33.** For example, in the screen structure shown in FIG. **1,** the opaque interstitial webbing **37** has an exemplary window area **39** which is dimensioned as *a;* such is intended to be normally representative of the multitudinous windows therein. The window openings per se are substantially round, elongated, or of other discrete shapings in keeping with the screen pattern desired. Overlaid on each of the window areas is a related phosphor area, of which, for purposes of illustration, the phosphor pattern element **43** is representative of only one of the respective phosphor components comprising the screen array. The phosphor area is dimensioned as *b* being at least as large as or preferably larger than the associated window area **39.** To facilitate clarity in the drawing, the usually present aluminum coating or backing on the screen structure is omitted. Spaced rearward from the screen structure **33** is the shadow mask multi-opening pattern member **23**, wherein a representative aperture denoted as **35**, is dimensioned as *c* and is larger than the related window area **39**. The aforementioned windows and related phosphor areas are usually formed in accordance with the shapings of the apertures by known photo-exposure techniques. An exemplary electron beam **45**, emanating within the tube from a source not shown, is directed toward the mask-screen assembly **47**. Upon striking the apertured pattern member **23** of the mask, a portion of the beam that is sized by the large aperture **35**, traverses therethrough, impinges a related phosphor area **43** therebeneath and substantially excites the whole of the phosphor area to a state of luminescence. Since each of the excited phosphor areas **43** in this "window-limited" screen is as large as or larger than its associated window area **39**, the total area of each window comprising the screen pattern is fully luminous. The resultant display in an operating tube is easily discernible by the viewer **48**.

The present invention provides a method for fabricating a color cathode ray tube wherein a temporary dimensional modification of the apertured pattern member of the shadow mask is utilized in selected steps of the procedure for fabricating the windowed opaque webbing and the associated phosphor elements of a "window-limited" color screen structure. The temporary modification is in the form of a discretely applied coating which is thence removed prior to final positioning of the mask relative to the screen structure during tube fabrication.

With reference to FIG. **2**, an enlarged sectional view of a single aperture portion of the temporarily modified shadow mask pattern member **51** is illustrated. This apertured member, for example, is formed of a basic material **53** such as S.A.E. 1010 cold rolled steel having a conventional thickness "*d*" within the range of 0.005 to 0.007 inches, and is normally domed in a manner related to the interior contour of the viewing panel as priorly shown in FIG. **1**. The mask structure is priorly subjected to a known controlled atmospheric heat treatment to form a dark coating comprising a mixture of iron oxides, not shown, on both the inner and outer surfaces thereof. It is conventionally desired to retain such dark coating for use in the finished tube to enhance efficiently and uniformity in the radiation of heat in the mask induced by electron bombardment. As a result, the mask operating temperature is lowered and heatup distortion in the mask is noticeably reduced. It has been found that tubes having the dark coated masks can be expeditiously and facilely adjusted in operating environments. Therefore, it is important that the temporary mask modification should in no manner affect the advantageous dark iron oxide surface condition on the mask, nor should it in any way permanently alter the initially formed apertures in the mask.

An exemplary initially formed aperture **55** in the pattern member material **53** is dimensioned as *e* and may be in the order of 0.0145 inches. The temporary coated modification **56** of the mask member is consummated by applying a first coating **57** to the apertured member **51** to effect a predeterminate reduction in the order of 0.0015 to 0.0025 in the sizes of the initially defined apertures in the pattern member. This first coating is in the form of at least one uniformly disposed substantially semiporous application of a discrete particulate material that is applied, for example, by electrophoretic deposition. The coating material is substantially absorbent and non-reflective of ultraviolet radiant energy in substantially the 340 to 380 nanometer range. This material characteristic is a very important consideration in photoexposing both the basic window pattern and the subsequently disposed pattern of phosphor elements thereover. The uv absorbent material prevents deleterious reflections of the actinic exposure radiation thereby promoting better control of the exposure technique with marked improvements in size control and definition of the respective resultant patterns. In addition, the first coating material has the chemical characteristic of being soluble in an easily removed substance nondestructive to the mask material. This electrophoretically applied first coating is an opaque minutely particulate uv absorptive material selected from the group consisting essentially of zinc oxide, titanium dioxide, and a mixture of zinc oxide and titanium dioxide. Zinc oxide is preferred in the procedure because of its property of being readily soluble in a weak acid. While on the other hand, it appears that minute particles of titanium dioxide are readily maintained in long-life suspension, the resultant coating is not appreciably dissolvable in a desired weak type of solvent, such as acetic acid. Therefore, when employing the long-life suspension characteristics of titanium dioxide, sufficient zinc oxide should be present to assure subsequent removal of the temporal coated modification **56** from the mask material **53**. Two procedures for utilizing titanium dioxide are:

1. Electrophoretic application of a base or primary coating of zinc oxide from a zinc oxide suspension followed by the electrophoretic application thereupon of a secondary coating of titanium dioxide from a substantially titanium dioxide suspension. Later dissolution or removal of the primary coating with a weak solvent carries with it the overlaid secondary coating of titanium dioxide.
2. Electrophoretic application of a composite coating from a suspension comprising a mixture that is predominantly zinc oxide with not more than **40** percent by weight of total solids being titanium dioxide. Subsequent dissolution of the zine oxide component likewise removes the associated titanium dioxide.

The liquid vehicle of the suspension is comprised of a $C_1 - C_2$ monohydric alcohol, such as methanol and/or ethanol, combined with a $C_3 - C_5$ monohydric alcohol, such as methanol and/or ethanol, butyl or amyl alcohol or mixtures of the same. A small amount of aluminum nitrate is included to promote electrical conductivity. A generic formulation per liter for cataphoretic deposition comprises, for example:

a C_1–C_2 monohydric alcohol	cc	100–800
a C_3–C_5 monohydric alcohol	cc	200–900
water	cc	10–80
suspended solids	gr	5–20
aluminum nitrate	gr	0.1–0.2

The suspended solids are preferably of sub-micron size particles having a mean particle size within the range of approximately 0.10 to 0.20 microns. The upper limit of particle size should not exceed substantially 5.0 microns.

A first coating thickness, of such materials, being defined as "*f*", effectively decreases the size of the aperture **55** from, for example, 0.0145 inches to the reduced dimension of "*g*" which may be of a modified value such as 0.012 to 0.013 inches.

The application of the temporary modification coating to the domed and formed apertured pattern portion of the complete shadow mask structure is facilitated by an improved electrophoretic coating procedure prior to fabrication of the multiplex screen structure. Reference is made to FIG. **3** wherein an improved electrophoretic coating apparatus **71** is illustrated. A shadow mask structure **73**, having a domed aperture portion **75** peripherally attached to a frame-like strengthening means **77**, is invertedly positioned in a manner that only the apertured portion is immersed in an electrophoretic bath of a first coating suspension **79**. A plurality of supportive means **81**, attached in a spaced-apart manner about the mask frame **77**, are mated with stud-like projections **83** extending from mask holding means **85**. This partially shown mask holding means is constructed to move the mask in a vertical predetermined manner to effect immersion and removal of the domed aperture portion **75** into and out of the electrophoretic suspension **79** by actuation means not shown. The coating suspension is held by a non-conductive liquid-holding container **87** having sufficient depth to accommodate a formed foraminous electrode **89** which is edge supported by a perimetric frame **91** positioned relative to the bottom **93** of the coating bath container. The foraminous electrode which is of a mesh or multitudinous aperture structure is shaped to a contour relative to that of the domed aperture portion **75** of the mask to which it is spacedly related when the mask is immersed in the coating suspension **79**. The functioning area of the electrode **89** at least equals the area of the apertured portion **75**, and the multitudinous openings **95** in the electrode are, for example, in the order of from **15** to **20** mils in diameter, being much larger than the solid particles comprising the coating suspension **79**. Electrical connections **97** and **99** from a d.c. electrical supply **101** are connected through switching means **103** to the electrode by appropriate connective means **89** and mask **73** to effect electrically induced coating deposition on the mask apertured portion **75**. In the example shown, the foraminous electrode **89** is the anode and the mask **75** the cathode to effect cataphoretic deposition of the suspension solids on the mask **73**.

A supply of the first coating suspension **79** is contained in reservoir **105** wherein agitation means **107** maintains homogeneity of the suspension breaks up the agglomerates, and promotes circulation of the suspension. Valving means **109** regulates the flow of the coating suspension from the reservoir through the piping **111** to the apparatus coating container **87**. Within the container are a plurality of spaced-apart agitation means **113**, such as ultrasonic, mechanical, or fluid vibrators, which are operated to continue the suspension and expedite flow of the suspended particles through the foraminous electrode. Several spaced-apart outflow means **115**, of which one is shown, maintain the level of suspension within the container and discharge into a collector reservoir **116**.

The coating procedure is accomplished by invertedly positioning the domed apertured pattern member **75** of the shadow mask in the first coating bath **79** to a predetermined depth in spaced relationship to the aforedescribed foraminous electrode structure **89** as for example in the order of 0.5 to 1.0 inch spacing. Movement is initiated and maintained within the electrophoretic bath by activation of the plural agitation means **113** to promote homogeneity and circulation of the suspension. The d.c. power supply **101** is then activated by switching means to apply an electrical potential of, for example, 100 to 200 volts to establish a coating application current of a sufficiency, such as two amperes, between the mask **73** (cathode) and the electrode **89** (anode); the voltage being dependent upon the inter-electrode anode-to-cathode spacing therebetween. An electrical potential activation period of from one to two minutes effects a semiporous cataphoretic deposition of from 1 to 1.5 mils of particulate material, such as zinc oxide, on the pattern portion of the mask which temporarily modifies or reduces the size of the apertures therein. Upon inactivation of the d.c. supply, the mask is removed vertically from the coating suspension by a relatively rapid withdrawal, whereupon the mask is turned dome-up to allow the residual liquid coating to flatten or evenly spread thereover. The mask is then dried in any appropriate orientation. It has been found expeditious to make a second or repeat application of the first coating material to achieve the desired coating buildup to further reduce the aperture dimensioning. Sequential applications of a relatively thin coating deposition, such as approximately 1 mil of thickness, produces a composite first coating that is less prone to crack, and one wherein slight irregularities become smoothed and minimized.

The relationship between mask-coating thickness and anode-to-cathode spacing is an important consideration during the electrophoretic coating procedure. At a constant coating potential, the current density varies in accordance with the inter-electrode spacing, the closer the electrodes, the thicker the coating. With reference to FIG. **3** wherein the exemplary separated aperture locations "*x*" and "*w*" are noted, the cathode-to-anode spacing at "*x*" is greater than at "*w*"; therefore, the thickness of the coating deposition at location "*x*" is less than coating thickness at "*w*". Since, the coated mask thickness evidences an increased thickness from "*x*" to "*w*", the gradient of aperture dimensions exhibits a gradual temporary reduction in size. By this manner, when so desired, a coating gradient on the mask can be predeterminately and expeditiously achieved by the inter-electrode spacing relationship effected by specific shaping of the foraminous electrode **89**.

After the electrophoretic deposition of the first coating material, a second coating **61** of a binder material is next applied to the coated mask to permeate the semiporous first coating. The second coating material differs from the first coating material and is disposed in at least one uniform application of a substantially ultraviolet transparent synthetic binder solution in the form of a polyhydric secondary alcohol, such as polyvinyl alcohol, which impregnates the substantially semiporous first coating material thereby imparting improved adherence and abrasion resistance thereto. Application is accomplished by diping or immersing only the domed apertured portion **23** of the mask structure into a vat, not shown, containing the second coating binder material. Usually one immersion application is sufficient to provide enough binder to adequately permeate the first coating. An exemplary second coating of uv transparent binder solution comprises:

water	10 to 20 percent by volume
methanol	80 to 90 percent by volume
polyvinyl alcohol	0.20 to 0.50 percent by weight

In FIG. **2,** the presence of the second coating is designated as having a thickness "*h*." Actually, practically all of the second coating **61** permeates the minutely particulate material of the semiporous first coating **57** whereupon only a thin film or residuum is evidenced on the surface of the first layer. Upon deposition of the second coating **61** the final dimension of the aperture **55** is denoted as "*k*" which substantially equals the first coating modified aperture dimension "*g*." Upon drying of the second coating, the temporarily modified duo-coated mask is ready for utilization in the fabrication of the color screen structure.

In referring to FIG. **4***a*, an enlarged sectional view of a portion of the mask-screen assembly **49** is shown wherein the duo-coated temporarily modified mask **51** is positioned for utilization in fabricating the windowed interstitial webbing of the color screen structure. The inner surface of the panel **17,** having been coated with a substantially clear photosensitive resist material **63,** such as dichromated polyvinyl alcohol, is exposed to substantially actinic light **65,** from a discretely located source not shown, which is beamed through the temporarily modified apertures of the positioned shadow mask **51.** In those photoresist areas **67** impinged by the actinic exposure radiation, the affected area of sensitized coating is light-polymerized as a pattern dot having the dimension "*m*", this being directly related to the dimension "*n*" of the light beam which is sized by the modified aperture **55.** This polymerized pattern dot **67** subsequently becomes a window in the opaque interstitial webbing of the color screen structure such as taught in the previously mentioned web-forming procedure disclosed in U.S. Pat. Application Ser. No. 41,535 by R. L. Bergamo et al. In keeping with the aforementioned teaching, the exposed dot pattern **67** is developed such as by rinsing with water to remove the unexposed polyvinyl alcohol, thereby providing a negative web pattern **117,** as shown in FIG. **4***b*, of substantially bare glass defining interstitial spacings **119** between the substantially clear polymerized pattern elements **121.**

The patterned panel is then overcoated with a uniform layer of an opaque colloidal suspension of graphite **123** as illustrated in FIG. **4***c*, after which, the coated panel is treated with a degrading agent, such as hydrogen peroxide, to effect an effervescence and degradation of the clear polymerized PVA dot material thereby loosening the associated graphite thereon. Removal of the degradation materials and overlying graphite, as by pressurized water, provides a positive opaque interstitial web pattern **125,** as evidenced in FIG. **4***d*, which defines a multitude of bare glass window areas **127** on the interior surface of the panel **17** surrounded by opaque material **129.**

The coated mask **51** is again utilized in forming the phosphor screen pattern wherein the areas of the different phosphor components, such as the red, blue and green cathodoluminescent elements, are disposed over the window areas. The deposition of the phosphor pattern is accomplished by conventional means utilizing, for example, actinic photo exposure **65** of light sensitized polyvinyl alcohol and associated phosphor material **131** whereof the temporarily coated mask is employed as an exposure pattern member, as shown in FIG. **4***f*, in forming the array of the respective polymerized phosphor areas **133.** Removal of the shadowed unpolymerized material **135** by a liquid development step, provides a window-limited screen structure **33** as priorly illustrated in FIG. **1.** Each of the discrete phosphor areas is of a size to fully cover an individual window area.

After the screen structure is formed, the temporary coating modification **56,** being zinc oxide in this instance, is removed from the mask member by immersing the coated portion in a bath of a weak dissolving substance such as 10 to 20 percent ethanoic acid, commonly known as acetic acid CH_3COOH. The ethanoic acid readily solubilizes the zinc oxide to form water soluble zinc acetate which is disposed of as a solution. The acid treatment is followed by water and alcohol rinses, whereafter the mask is dried and is then ready for subsequent usage.

Another or second embodiment of coating removal involves a plural step procedure wherein the coated portion of the mask is pre-treated to partially loosen the coating material **56** by penetrating the bonding of the second coating material **61.** The pre-treatment comprises immersing the coated portion of the mask for a period of for example 10 to 20 seconds in a weak solution of a common wetting agent in water, for instance, a one percent by volume water solution of a natural or synthetic detergent substance, to soften and impair the bonding of the impregnated second coating material. If the coating material is particularly hard due to a long lapse of time between coating application and removal, during which temperature and humidity variations are contributive factors to hardness, the addition of, for example, 5 percent ethanoic acid to the pre-treatment wetting solution has been found beneficial in penetrating the second coating permeation and partially loosening the peripheral bonding of the oxide coating. Upon completion of the pre-treatment wetting, the coated mask is immersed in an agitated water bath wherein a considerable amount of coating is removed from the mask, the separated oxide material becoming suspended in the bath. The mask is then immersed in ethanoic acid to completely remove the residual oxide coating thereby completing the decoating procedure. Regardless of which de-coating embodiment is practiced, the key to coating removal is the complete and facile solubility of the coating material in the acid which is harmless to the mask material per se.

The above-described second de-coating procedure lends itself to the ecological environment in that the separated coating material, which is suspended in the agitated water bath, is not chemically altered. Thus, this suspended coating material can be removed and recovered from the bath by the addition thereto of, for example, a 1 percent (by volume) of a 4 percent (by weight) solution of sodium phosphate. This addition coagulates the suspended coating material which then separates out as a solid. If desired, by decanting and filtering, the filtrate can be recycled back to the agitated water bath for continued utilization.

Each of these de-coating embodiments, being in no manner harmful to the underlying metallic mask material or the beneficial oxides thereon, restores the apertures to their initially defined dimensioning. Therefore, in the finished mask-screen assembly, the window-areas of the opaque interstitial web of the screen structure are smaller than the de-coated initial basic apertures in the mask thereby forming an expedient window-limited screen structure.

In some screening techniques, the deposition of the respective cathodoluminescent phosphor areas is effected by photo-exposure through mask apertures of a size larger than those used for fabricating the windowed interstitial webbing. On such occasions, the temporarily coated mask is employed in forming the web, after which, the mask is de-coated and the initially dimensioned apertures utilized in disposing the pattern of phosphor elements over the window areas.

Regardless of whether the mask is de-coated prior to or subsequent to the forming of the phosphor areas, upon completion of the screen structure, the de-coated mask is again positioned in an operable position within the panel portion adjacent to the screen. Whereupon, the mask-panel assembly is joined to the funnel portion of the envelope. Electron gun means are positioned in a conventional manner within the envelope at a location whereof the beams emanating therefrom are directable to traverse the apertures in the mask and impinge the respective phosphor screen areas therebeneath. Normal sealing, exhaust, and processing of the enveloped structure completes fabrication of the color tube.

Thus, there is provided an improved method of fabricating a color cathode ray tube wherein the mask includes a temporary modification to reduce the size of the apertures during forming of the screen structure. Subsequently, the mask is expeditiously de-coated for operational usage in the finished tube. The mask coating, by being uv absorptive, facilitates the formation of the desired precisely defined photo exposed areas comprising the screen, by eliminating deleterious reflections of actinic radiant energy which have been evidenced in some prior art coatings. Furthermore, the coating utilized in this invention is readily removable from the mask without effecting any surface or structural change to the mask material per se, a feature which is an enhancement to the quality and performance of the resultant tube. The precisely formed mask apertures are maintained as initially fabricated, and the dark iron oxide coating formed on the surface of the mask material is desirably retained to enhance uniform heat radiation in the tube upon subsequent operation.

While there has been shown and described what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

1. A method for fabricating a color cathode ray tube employing a mask member having a multitude of initially formed apertures therein and positioned within the tube envelope enclosure relative to the viewing panel portion thereof, said method comprising the steps of:

coating said mask prior to utilization in the screen forming procedure with a deposition of a substantially semiporous first coating of a material substantially absorbent and non-reflective of actinic radiant energy in substantially the 340 to 380 nanometer range and having the chemical characteristic of being soluble in a substance non-destructive to said mask material, said coating being applied in a continuous manner to temporarily modify the dimensions of the initial apertures therein;

applying a second coating of a substantially ultraviolet transparent binder material to said coated mask to impregnate said semiporous first coating and provide a duo-coating of appreciable adherence and abrasion resistance;

forming at least part of a patterned screen structure in the interior surface of said viewing panel by utilizing said temporarily modified mask for photo exposing a light polymerized pattern of photo sensitized material by substantially actinic radiation through the modified apertures of said coated mask;

treating said modified mask with dissolving solution means to solubilize said coating thereby de-coating said mask without harming the underlying mask material, said mask apertures being restored to their initially defined dimensioning;

orienting said de-coated mask within said envelope at a location adjacent to said formed screen structure;

positioning electron gun means within said envelope in a manner that the beams therefrom will traverse the apertures in said mask and impinge the phosphor screen areas therebeneath; and

sealing and processing said tube structure to complete the fabrication of said tube.

2. A method for fabricating a color cathode ray tube employing a mask member having a multitude of initially formed apertures therein and positioned within the tube envelope enclosure relative to the viewing panel portion thereof, said method comprising the steps of:

electrophoretically coating said mask prior to utilization in the screen forming procedure with a deposition of a substantially semiporous first coating of a particulate material substantially absorbent and non-reflective of ultraviolet radiant energy in substantially the 340 to 380 nanometer range and having the chemical characteristic of being soluble in a substance nondestructive to said mask material, said coating being applied in a continuous manner to temporarily modify the dimensions of the initial apertures therein;

applying a second coating of a substantially ultraviolet transparent binder material to said coated mask to impregnate said semiporous first coating and provide a duo-coating of appreciable adherence and abrasion resistance;

forming a windowed web having opaque interstices as part of said tube screen structure on the interior surface of said viewing panel by utilizing said temporarily modified mask for photo exposing a light-polymerized dot pattern of photosensitized material by substantially actinic radiation through the modified apertures of said mask, overcoating said photo exposed surface with an opaque material, treating said coated photo exposed surface with a degrading agent and a liquid rinse to break up and remove the polymerized dot pattern and the loosened opaque coating superposed thereon, the resultant window areas of said interstitial web being smaller than the initial basic apertures in said mask;

forming a pattern of a plurality of different luminescent cathodoluminescent phosphors by employing said temporarily modified mask for photo exposing by actinic radiation a light-polymerized dot pattern of photosensitized material and associated electron responsive phosphors with subsequent developing to effect the deposition of a pattern of defined phosphor dots superimposed on the window areas of said webbing to form a screen structure, said defined phosphor areas being of a size to fully cover each of said window areas;

removing said temporary coating modification from said mask by treating said coated mask with a dissolving solution to solubilize said coating to de-coat said mask without harming the underlying mask material, the apertures of said mask being restored to their initially defined dimensioning;

orienting said de-coated mask in an operable position within said envelope at a location adjacent to said formed screen structure;

positioning electron gun means within said envelope at a location whereof the beams therefrom are directable to traverse the apertures in said mask and impinge the phosphor screen areas therebeneath; and

sealing and processing said tube structure to complete the fabrication of said tube.

3. The method for fabricating a color cathode ray tube according to claim **2** wherein said electrophoretically disposed coating is selected from the group consisting essentially of zinc oxide, titanium dioxide, and a mixture of zinc oxide and titanium dioxide.

4. The method for fabricating a color cathode ray tube according to claim **2** wherein said dissolving solution utilized to solubilize and remove said temporary coating from said mask is ethanoic acid.

5. The method for fabricating a color cathode ray tube according to claim **2** wherein said mask member is a shadow mask associated with a window-limited screen structure.

6. A method for fabricating a color cathode ray tube employing a mask member having a multitude of initially formed apertures therein and positioned within the tube envelope enclosure relative to the viewing panel portion thereof, said method comprising the steps of:

electrophoretically coating said mask prior to utilization in screen forming procedure with a deposition of a substantially semiporous first coating of a particulate material substantially absorbent and nonreflective of ultraviolet radiant energy in substantially the 340 to 380 nanometer range and having the chemical characteristic of being soluble in a substance nondestructive to said mask material, said coating being applied in a continuous manner to temporarily modify the dimensions of the initial apertures therein;

applying a second coating of a substantially ultraviolet transparent binder material to said coated mask to impregnate said semiporous first coating and provide a duo-coating of appreciable adherence and abrasion resistance;

forming a windowed web having opaque interstices as part of said tube screen structure on the interior surface of said viewing panel by utilizing said temporarily modified mask for photo exposing a light-polymerized dot pattern of photosensitized material by substantially actinic radiation through the modified apertures of said mask, overcoating said photo exposed surface with an opaque material, treating said coated photo exposed surface with a degrading agent and a liquid rinse to break up and remove the polymerized dot pattern and the loosened opaque coating superposed thereon, the resultant window areas of said interstitial web being smaller than the initial basic apertures in said mask;

treating said coated mask with a dissolving solution to solubilze said coating thereby de-coating said mask without harming the underlying mask material, the apertures of said mask being restored to their initially defined dimensioning;

forming a pattern of a plurality of different luminescent cathodoluminescent phosphors by employing the initially sized apertures of said de-coated mask for photo exposing a light-polymerized dot pattern of photosensitized material and associated electron responsive phosphors with subsequent developing thereby effecting the deposition of a pattern of defined phosphor dots superimposed on the window areas of said webbing to form a screen structure;

orienting said de-coated mask in an operable position within said envelope at a location adjacent to said formed screen structure;

positioning electron gun means within said envelope at a location whereof the beams therefrom are directable to traverse the apertures in said mask and impinge the phosphor screen areas therebeneath; and

sealing and processing said tube structure to complete the fabrication of said tube.

7. The method for fabricating a color cathode ray tube according to claim **6** wherein said electrophoretically disposed coating is selected from the group consisting essentially of zinc oxide, titanium dioxide, and a mixture of zinc oxide and titanium dioxide.

8. The method for fabricating a color cathode ray tube according to claim **6** wherein said dissolving solution utilized to solubilize and remove said temporary coating from said mask is ethanoic acid.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,822,454 Dated July 9, 1974

Inventor(s) Kenneth Speigel

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 46 - delete "zine" and insert -- zinc --

Column 6, line 53 - delete "methanol and/or ethanol" and insert -- propyl --

Signed and sealed this 29th day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents