APPARATUS FOR COATING A PATTERN MASK FOR USE IN FORMING A COLOR CRT SCREEN STRUCTURE

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References Cited

UNITED STATES PATENTS
2,851,408 9/1958 Cerulli 204/299 X
3,070,441 12/1962 Schwartz 96/35
3,321,657 5/1967 Granitsas et al. 204/181 X

3,360,450 12/1967 Hays 204/181
3,525,679 8/1970 Wilcox et al. 204/181

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ABSTRACT

An improvement is provided in the apparatus employed in temporarily modifying the aperture sizes in a patterned cathode ray tube mask member for utilization in selected steps of the procedure for fabricating a multiplex patterned color screen structure disposed on the interior surface of the tube viewing panel. By the improved apparatus, a basic or first coating material is electrophoretically disposed as a substantially semi-porous coating to reduce the sizes of the initially defined apertures in the mask. The use of a foraminous electrode discretely spaced from the mask, along with the handling of the coating suspension, comprises a coating apparatus that facilitates the achievement of an improved temporarily modified mask structure.

14 Claims, 7 Drawing Figures
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BACKGROUND OF THE INVENTION

This invention relates to color cathode ray tubes and more particularly to improved apparatus for temporarily modifying the apertured portion of an aperture mask for utilization 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 discrete screen groupings are conventionally disposed as bars, stripes, or dots depending upon the particular type of color tube considered. For example, in the widely-used shadow mask tube construction, the related color 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, produce additive primary hues to provide 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 adjacent dots. Associated with the screen and spaced therefrom in a defined orientation relationship is a multi-apertured shadow mask structure. Each of the apertures therein, being of a substantially round or elongated shape, is conventionally 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 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 weblike 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 screen construction, when a 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, a 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 coating thereon; whereupon the materials so loosened are removed by a subsequent water development step. Thus, there is formed an opaque interstitial web having multitude 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 aforesaid 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-size apertures and the priorly formed windows in the interstitial webbing. While, this too, is a production procedure, the aperture etching requires additional apparatus and 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 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 masking apertures is an inherently costly procedure as it precludes any subsequent reuse of masks which ordinarily could be salvageable 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, for example, by painting, dipping, electrophoreseis, 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 cathaphoretic 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 opaque aluminum oxide 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 improved apparatus for fabricating a patterned shadow mask having improved temporary modifications of the apertures therein. Another object is to provide improved apparatus for temporarily coating a mask pattern for utilization in the forming of a color cathode ray tube screen structure whereof the mask modification can be expeditiously, consistently and satisfactorily reproduced from a production concept. A further object is to provide an improved coating apparatus for effecting the improved temporal mask modification that in no manner alters the basic mask metallic structure or the surface thereof.

These and other objects and advantages are achieved in one aspect of the invention by the provision of an improved electrophoretic coating apparatus for achieving a patterned cathode ray tube shadow mask formed of a temporarily modified multi-apertured metallic pattern member having integral strengthening means conjunctive with the periphery thereof. By this apparatus the sizes of the apertures in the mask are temporarily modified in an improved manner for utilization in selected steps of the procedure for fabricating the windowed opaque webbing and the overlying phosphor elements of the multiplex color screen structure. The improved apparatus utilizing a formed foraminous electrode temporarily modifies the apertures member by electrophoretically disposing a basic or first coating of a substantially semiporous structure on the mask in a manner to effect predetermine temporal reduction in the sizes of the initially defined apertures. The foraminous electrode, the discrete spacing thereof from the mask, along with the handling of the coating suspension, comprises an improved coating apparatus which provides for a markedly improved modified mask structure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is 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 perimetral 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 phosphor pattern element 43 is representative of one of the pattern components. The phosphor area is dimensioned as "b" being at least as large 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 an improved electrophoretic coating apparatus for effecting the temporary modification of the apertured pattern member of the shadow mask; the temporary mask modification being utilized in selected steps of the procedure for fabricating the windowed opaque webbing and the associated phosphor elements of a "windowed-limited" color screen structure.

With reference to FIG. 2a, 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 efficiency and uniformity in the radiation of heat in the mask induced by electron bombardment. As a result, the mask operating temperature is lowered and heat-up 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 of the invention 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 invention being a temporary coated modification 56 of the mask member is consummated by applying a basic or first coating 57 to the apertured member 51 to effect a predetermine reduction in the order of 0.0011 to 0.0025 inch in the sizes of the initially defined apertures in the pattern member. This first coating is in the form of at least one electrophoretically disposed substantially semiporous application of a discrete particulate material that 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 photo-exposing 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, a mixture of zinc oxide and titanium dioxide. For coating deposition, these materials solids are handled as a suspension wherein the liquid vehicle is comprised of a C1 - C2 monohydric alcohol, such as methanol and/or ethanol, combined with a C3 - C5 monohydric alcohol, such as propyl, butyl or amyl alcohol, or mixtures thereof, and water. A small amount of aluminum nitrate is included to promote electrical conductivity. These suspended solids are preferably of sub-micron size particles having a means 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.

A subsequent application of a second coating material 61 is uniformly applied as by a separate dipping or immersion procedure to provide a permeative coating over the first coating 57. 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, in a water-methanol vehicle, which impregnates the substantially semiporous first coating material thereby imparting improved adherence and abrasion resistance thereto. In FIG. 2a, 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." In referring to FIG. 2b, an enlarged sectional view of a portion of the mask-screen assembly 49 is shown wherein the duo-coated temporally 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 these 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. After forming of the basic window pattern, as exemplified by the polymerized area 67, and the subsequently similarly disposed overlaid pattern of phosphor elements, not shown; the temporary dual coatings 57 and 61 are expeditiously and completely removed from the shadow mask by treatment with a weak solvent, such as acetic acid, followed by a water rinse. Such coating removal treatment is in no way deleterious to the mask material. The precisely formed 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 finished tube. Thus, an efficient and improved color cathode ray tube, utilizing a “window-limited” multiplex color screen structure, is expeditiously manufactured by using the temporarily modified dual-coated mask formed in accordance with the invention.

The application of the temporary modification coating to the domed and formed apertured pattern portion of the completed shadow mask structure is facilitated by the use of an improved electrophoretic coating apparatus and procedure prior to fabrication of the multiplex screen structure. Reference is made to FIG. 3 wherein one embodiment of an improved electrophoretic coating apparatus 71 is illustrated. A shadow mask structure 73, having a domed apertured portion 75 peripherally attached to a compatibly shaped frame-like strengthening means 77, is invertedly positioned in a manner that only the apertured portion is immersed in an electrophoretic bath of a basic or first coating suspension 79 accommodated within an appropriate container 87. 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 the 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 apertured portion 75 into and out of the electrophoretic suspension 79 by appropriate mechanical actuation means not shown. It is also within the scope of the invention for the mask holding means to be substantially stationary with the suspension holding container 87 being capable of vertical reciprocative movement to effect immersion and removal of the apertured portion of the mask into and out of the coating suspension. Such teaching is intended to be within the delineation shown in FIG. 3. In either instance, conventional mechanical movement means is applicable to effect the defined vertical motion required. The coating suspension is held by a non-conductive liquid-holding container 89 which is a freestanding member edge supported by a perimetric frame 91 positioned relative to the bottom 93 of the coating bath container. The container, which has a closed sidewall 92 upstanding from the bottom portion 93 and an open top 94, is of a size whereof the lateral dimensions are larger than those of the mask member to facilitate positioning of the mask and allow for unimpeded circulation of the coating suspension therein. There is, for example, an approximate two inch spacing between the mask and the sidewalls of the container 87 to foster circulation of the suspension therein. The foraminous electrode 89, being formed of a mesh or multitudinous apertured material, 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 foraminous electrode 89 is affixed or bonded to and edge-supported, as at 88, by a substantially perimetrical oriented downstreaming framing member 90 which has the top edge thereof contoured to substantially continuously conform with the associated contour of the electrode member. The framing member may have a plurality of openings 95 formed therein to promote circulation of the coating suspension in the liquid-holding container. The functioning area of the electrode 89 at least equals the area of the apertured portion 75. Preferably, the foraminous electrode is extended at least 0.250 inch larger beyond the periphery of the mask to maintain more uniform fluid distribution over the apertured mask surface to be coated. The advantageous multitudinous openings 95 in the electrode, 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. To achieve a consistency in coating deposition, it has been found that the openings in the electrode 89 should not exceed the modified size of the apertures in the mask being coated to eliminate the possible effect of entrained bubbles which may be present in the suspension. Electrical connections 97 and 99 from a d.c. electrical supply 101 are connected through switching means 103 to the electrode 89 and mask 73 by appropriate connective means, such as clips, to effect electrophoretically 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 cathaporetic deposition of the suspension solids on the mask 73.

A supply of the first coating suspension 79 is contained in supply reservoir 105 wherein agitation means 107, such as a fluid, mechanical or ultrasonic vibration inducer, maintains homogeneity of the suspension, breaks up the agglomerates, and provides for a continuous flow of uniform suspension to the anode-mask area. The consistency of the coating suspension is maintained by replenishment provided from suspension make-up means 108. Supply valving means 109 regulates the gravity-initiated flow of the coating suspension from the supply reservoir through the supply piping 111 to the apparatus coating container 87. The supply piping is flexible in the embodiment wherein the liquid-holding container is capable of vertical reciprocative movement. Within the container 87 are a plurality of spaced-apart agitation means 113, such as ultrasonic transducers or fluid or mechanical vibrators, which are operated to continue the suspension and expedite flow of the suspended particles through the foraminous electrode. Several spaced apart out-flow means 115, of which one is shown, maintain the desired level of suspension within the container. The several outflow means discharge into a collector reservoir 117, from which the coating suspension is conveyed by a pumping means 119 and discharge piping 121 back to the supply reservoir 105 to form a recirculation system. In the embodiment shown in FIG. 3, the liquid-holding container 87 has at least one outlet valving means 123 located in
the bottom of the container to facilitate drainage and cleaning.

The coating procedure is accomplished by invertingly positioning the domed apertured 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 provide homogeneity and circulation of the suspension. The d.c. power supply 101 is then activated by switching means 103 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-cathode spacing therebetween. An electrical potential activation period, of from one to two minutes, effects a semipermeable cathaphore deposition of from 1.0 to 1.5 mls 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 expedient to make a second or repeat application of the first coating material to achieve the desired coating build up 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-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 a gradually increasing 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 predetermined 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, the second coating 61 of the previously mentioned binder material is next applied to the coated mask to permeate the semiporous first coating. Application is accomplished by dipping 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. Upon drying of the second coating, the temporarily modified duo-coated mask is ready for utilization in the fabrication of the color screen structure.

Another embodiment of the electrophoretic first coating apparatus is shown in FIG. 4, wherein the major portion of the bottom 93 of the liquid holding container 87 is of substantially infundibular shaping 125. As shown, the wide or mouth portion of the shaping is oriented adjacent to the foraminous electrode member 89. The coating suspension 79 is introduced into the container through the small opening 129 by pumping means 119 which moves the coating suspension from reservoir 117. Baffle means 118, such as mesh, fins or analogous directors, may be included and positioned within the infundibular shaped portion 125 to enhance circulation and direction of the flowing coating suspension.

The foraminous electrode 89 has a plurality of spaced apart adjustment means 131 affixed to the closed sidewall 92 of the perimetric framing member to effect proper positioning of the anode electrode 89 with reference to the cathode electrode (mask 75). Vertical adjustment means are, for example, threaded screwtype risers 133, that seat against a ledge-like portion 135 of the container bottom. Also included are lateral adjustment means, such as threaded spacers 137, which seat against the inner wall surface of the container 87.

Outflow means 115' formed of a plurality of leveling drains, one of which is shown, convey the overflow suspension material to collector reservoir 117 of the pump-controlled recirculation system. In this embodiment the upward inflowing first coating suspension material is moved substantially through the foraminous electrode 89 in an expansive substantially uniform gentle welling manner which enhances the uniformity of the suspension material reaching the mask.

With reference to FIG. 5, another embodiment of outflow means 139 is shown wherein a peripheral trough-like open channel 141 is affixed to the exterior of the liquid holding container 87. The open channel is oriented in a manner to receive the outflow of the coating suspension as it peripherally overflows the top edge or rim 143 of the container. This arrangement allows for a uniform perimetric outflow and expedites a consistency in the suspension replenishment within the container. At least one outflow pipe 145 connects the channel 141 with the collector reservoir 117.

Still another embodiment of the apparatus is shown in FIG. 6, wherein the coating suspension supply means includes a peripheral trough-like open channel 141' which is likewise affixed to the exterior of the liquid holding container 87. The outer wall 149 of the channel is of a height greater than that of the closed sidewall 92' of the container which, in this embodiment, determines the depth of the coating bath. The coating suspension 79 is moved in a manner reverse to that previously described from the collector reservoir 117' by pump means 119 through supply piping 111' into the peripheral open channel 114, from whence it overflows into the container 87. The outflow of the suspension is down through the infundibular bottom into the collector reservoir relative thereto in accordance with the recirculation system shown.

It is to be understood that the various agitation and pumping means utilized and disclosed in the several embodiments, are capable of being activated and inac-
3,764,514

1. Apparatus for applying an electrophoretic coating to substantially the pattern portion of a formed and strengthened pattern mask member having peripheral support means attached thereto, said mask being subsequently utilized in forming the patterned screen structure of a color cathode ray tube, said apparatus accommodating said pattern mask comprising a liquid-holding container adapted to hold an electrophoretic coating suspension comprising a formed bottom portion with an encompassing side formation and an open-top and having lateral dimensions sufficient to accommodate said mask member; a foraminous metallic electrode member immersed in said electrophoretic coating suspension, said electrode member being positioned relative to the bottom of said container in a manner to provide for the free circulation of said coating suspension through the foraminous openings in said electrode, the foraminous portion of said electrode member being shaped relative to the contour of said mask pattern portion to provide predetermined spacing therebetween;

2. The apparatus for applying an electrophoretic coating to a pattern mask member according to claim 1 wherein said foraminous electrode is substantially a free-standing edge-supported member.

3. The apparatus for applying an electrophoretic coating to a pattern mask member according to claim 2 wherein said foraminous electrode is affixed to and edge-supported by a substantially perimetrically downstanding framing member having the top edge thereof contoured to substantially continuously conform with the associated contour of the electrode member, the bottom edge of said electrode framing member being oriented relative to the bottom of said liquid-holding container.

4. The apparatus for applying an electrophoretic coating to a pattern mask member according to claim 3 wherein the foraminous electrode perimetrically framing member has a plurality of openings formed therein to promote circulation of the coating suspension in said liquid-holding container.

5. The apparatus for applying an electrophoretic coating to a pattern mask member according to claim 1 wherein the major portion of the bottom of said liquid-holding container is of substantially infundibular shaping with the wide mouth portion thereof being adjacent said foraminous electrode member, said coating suspension being introduced into said container through the small opening of said infundibular shaping.

6. The apparatus for applying an electrophoretic coating to a pattern mask member according to claim 3 wherein the bottom of said liquid-holding container is formed to provide support for said perimetric electrode frame.

7. The apparatus for applying an electrophoretic coating to a pattern mask member according to claim 3 wherein said perimetric framing member has a plurality of vertical height adjustment means oriented therearound to facilitate achievement of the desired spacing relationship between said foraminous electrode and said pattern mask member.

8. The apparatus for applying an electrophoretic coating to a pattern mask member according to claim 1 wherein said liquid-holding container has outflow means to control the level of the coating suspension therein.

9. The apparatus for applying an electrophoretic coating to a pattern mask member according to claim 1 wherein the means for accomplishing relative movement between the mask and the coating bath moves said mask member substantially vertically into and out of said bath.

10. The apparatus for applying an electrophoretic coating to a pattern mask member according to claim 1 wherein the means for accomplishing relative movement between the mask and the coating bath moves the bath substantially vertically to and from said mask.

11. Apparatus for applying an electrophoretic coating to a pattern mask member according to claim 1 wherein said liquid-holding container has coating suspension supply means and outflow means associated with reservoir and pump means to provide a substantially continuous flow of coating suspension upon activation of said pump means.

12. Apparatus for applying an electrophoretic coating to a pattern mask member according to claim 11 wherein said outflow means includes a peripheral trough-like channel affixed to the exterior of said liquid-holding container in a manner to receive the outflow of coating suspension peripherally overflowing the top of said container, said suspension being supplied upward through the bottom of said container.

13. Apparatus for applying an electrophoretic coating to a pattern mask member according to claim 11 wherein said coating suspension supply means includes a peripheral trough-like channel affixed to the exterior of said liquid-holding container in a manner to facili-
3,764,514

13. Apparatus for applying an electrophoretic coating to a pattern mask member according to claim 11 wherein said coating reservoir means has agitation means positioned therein to promote the homogeneous dispersion of the solids in said coating suspension.

* * * *
UNIVERSAL STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,764,514 Dated October 9, 1973

Inventor(s) Joseph N. DeBernardis, Walter W. Slobbe and Kenneth Speigel

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

Col. 2, Line 56: delete "masking" and insert --- mask ---

Col. 3, Line 46: delete "apertures" and insert --- apertured ---

Col. 11, Claim 1, Line 29: delete "a liquid holding" and insert --- a non-conductive liquid holding ---

Signed and sealed this 2nd day of April 1974.

(SEAL)
Attest:

EDWARD M. PLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents.