

Oct. 23, 1956

D. W. EPSTEIN

2,767,457

COLOR KINESCOPIES AND METHODS OF MAKING SAME

Filed Nov. 1, 1954

3 Sheets-Sheet 1

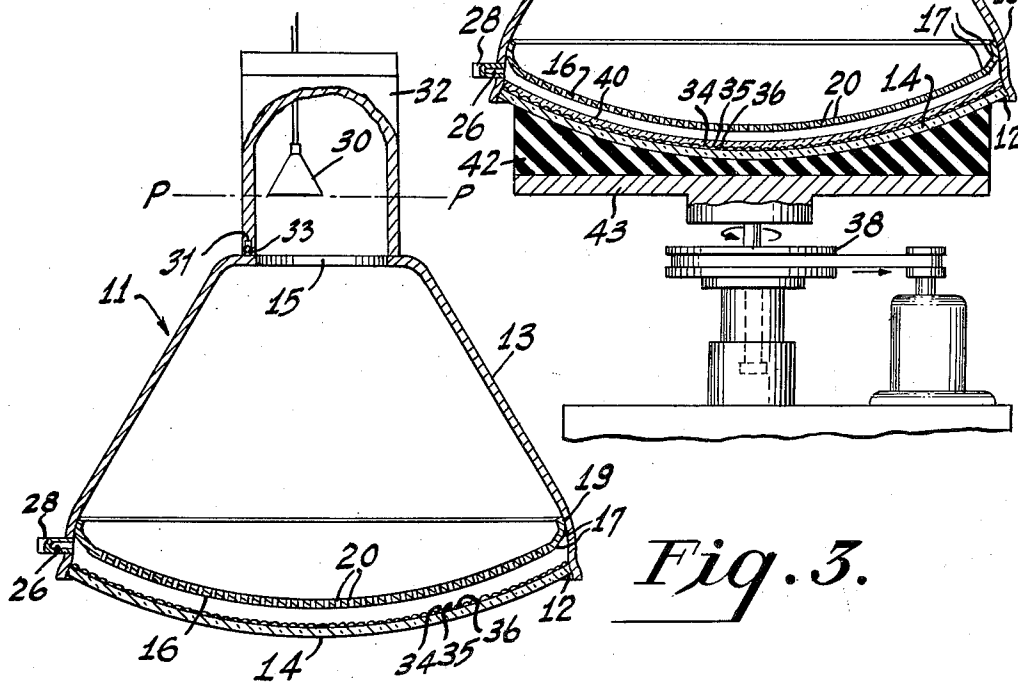
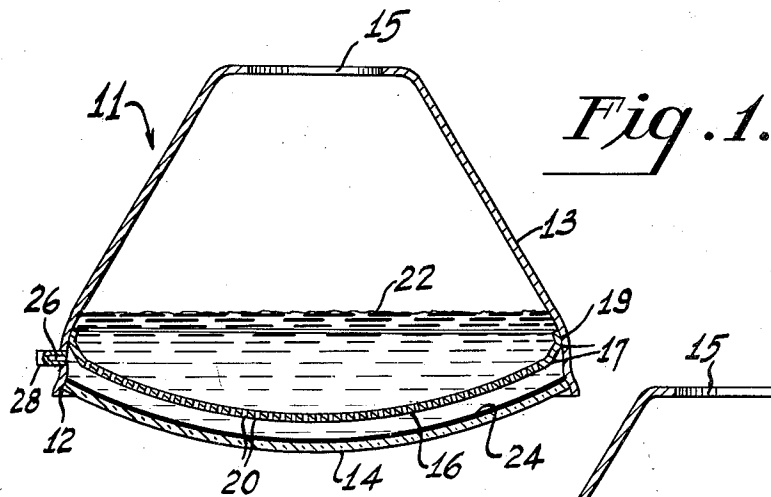


Fig. 2.

Fig. 3.

INVENTOR.
DAVID W. EPSTEIN
BY
William A. Zalesak
ATTORNEY

Oct. 23, 1956

D. W. EPSTEIN

2,767,457

COLOR KINESCOPES AND METHODS OF MAKING SAME

Filed Nov. 1, 1954

3 Sheets-Sheet 2

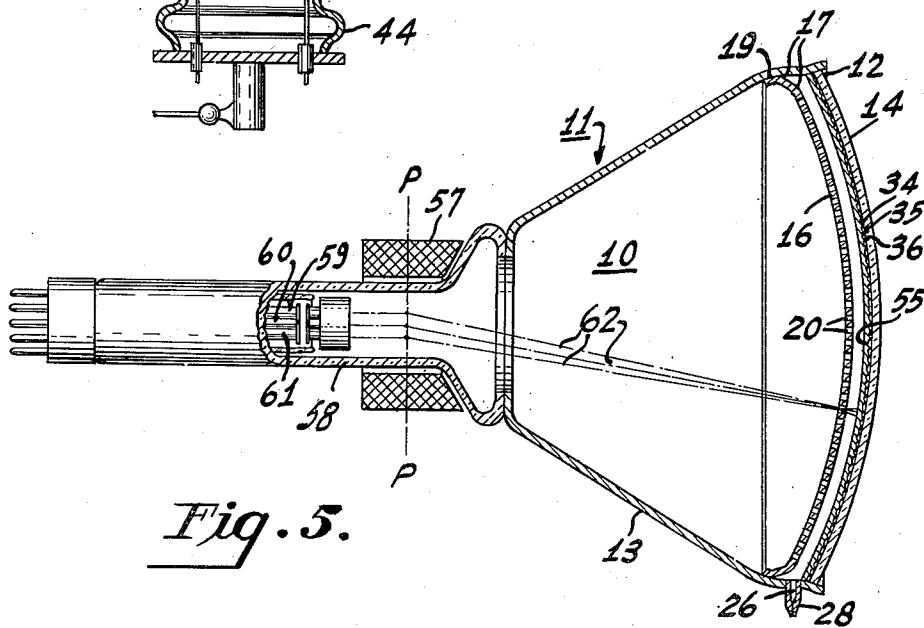
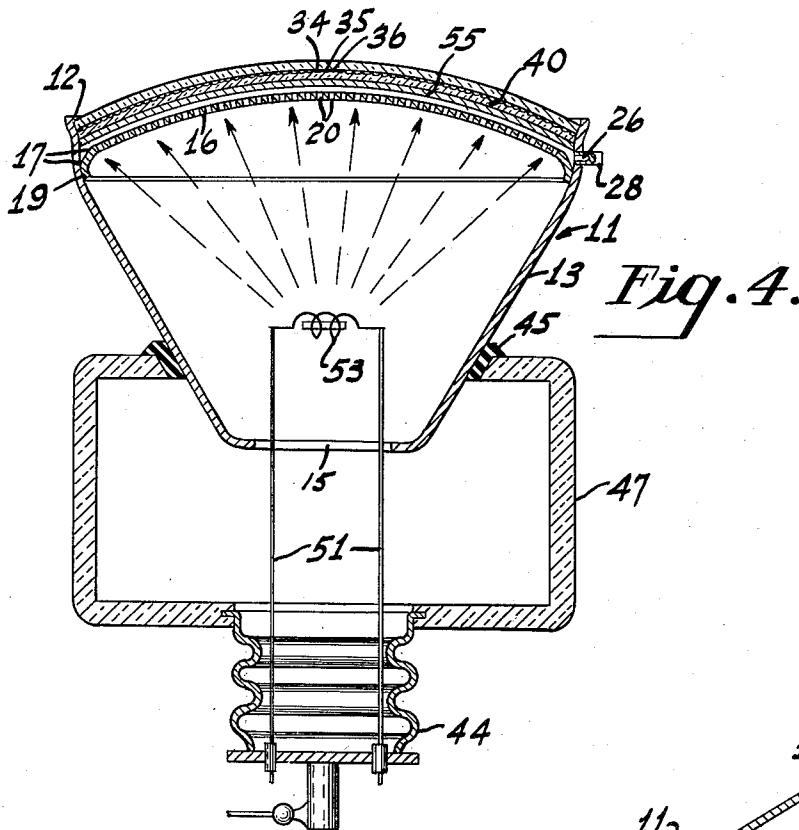


Fig. 5.

INVENTOR.

INVENTOR.
DAVID W. EPSTEIN
BY

BY

William A. Zaluski
ATTORNEY

ATTORNEY

Oct. 23, 1956

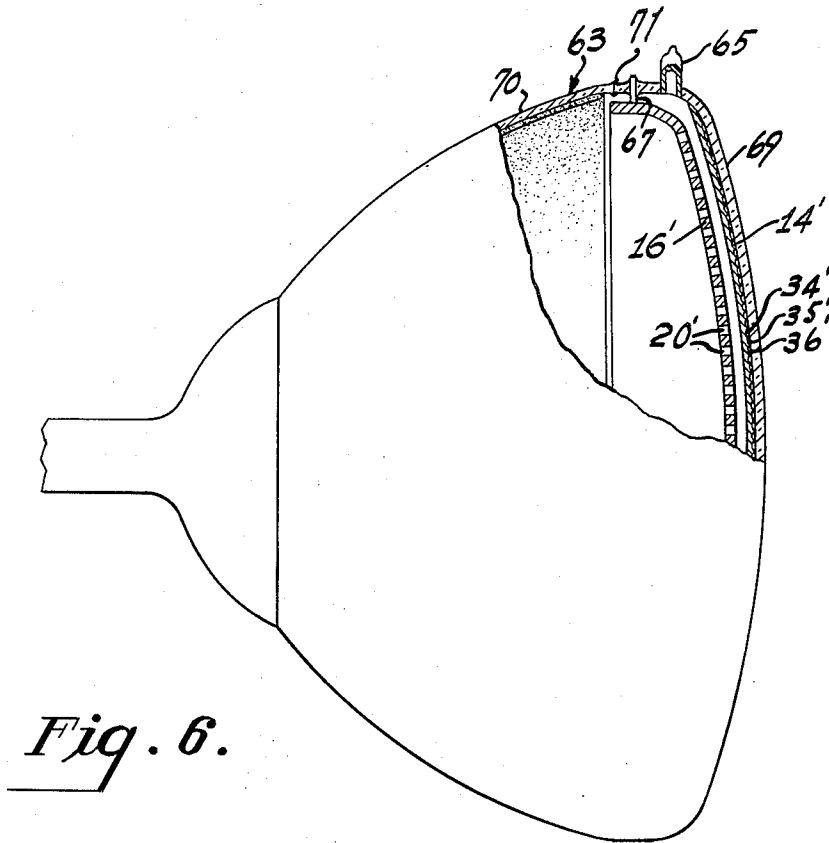
D. W. EPSTEIN

2,767,457

COLOR KINESCOPIES AND METHODS OF MAKING SAME

Filed Nov. 1, 1954

3 Sheets-Sheet 3



INVENTOR.
DAVID W. EPSTEIN
BY
William A. Galesak
ATTORNEY

1

2,767,457

COLOR KINESCOPIES AND METHODS OF MAKING SAME

David W. Epstein, Princeton, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application November 1, 1954, Serial No. 466,016

15 Claims. (Cl. 29—25.13)

This invention relates to improvements in the art of manufacturing color kinescopes and other cathode ray tubes of the type having a plane-of-deflection and containing a screen unit comprising a mask containing a multiplicity of systematically arranged apertures through which beam electrons pass along different angularly related paths in their transit from the plane-of-deflection to selected ones of metallized "dot-like" or "line-like" elemental phosphor areas on the target surface of a nearby screen.

One of the problems encountered in manufacturing a screen for use in color kinescopes of the type briefly described above, and for analogous tubes, has been the problem of depositing the phosphor particles in the "dot-like" or "line-like" elemental areas. One method of applying the phosphor particles which has been used heretofore is the "direct" photographic method wherein the different color emitting phosphors are laid down, one at a time, on the screen-plate. In this method a color emitting phosphor, as well as a photosensitive emulsion, is introduced into the tube and is exposed to a point source of light through the mask which exposes the emulsion in a particular pattern. When this step has been completed the mask is removed and after development of the exposed areas of emulsion, the emulsion and phosphor adhere to the screen-plate, while the emulsion which was not exposed as well as the corresponding phosphor particles are removed. The process is then repeated for the remaining two colors. In the "direct" photographic method the screen unit must be disassembled several times, for the purpose of sensitizing the separately photographed red, blue, and green phosphor patterns of the screen, and subsequently reassembled prior to aligning the unit with a battery of electron guns in the tube in which the screen is to be utilized.

Accordingly, a principal object of this invention is to provide an improved cathode ray tube wherein access may be had to a foundation surface for a color screen through the envelope wall.

Another object of this invention is to provide an improved method of depositing phosphor particles wherein the particles are inserted through the walls of the envelope.

A further object of this invention is to provide a new method of and means for applying an electron permeable metal coating of substantially uniform thickness through an apertured mesh to a permanently mounted screen.

A still further object of this invention is to provide a new method of settling color emitting phosphor particles through a mask and onto a support plate wherein excess phosphor particles may be removed from both the mask and the support plate.

Stated generally, the foregoing and other objects are achieved in accordance with this invention by permanently securing a mask and a curved foundation plate for the color screen, in the required spaced apart relationship within a conical shaped envelope, and thereafter providing the phosphor screen particles, in the proper array, and a metallized coating. In accordance with this invention

2

there is provided means for inserting the phosphor particles and, or the photosensitive emulsion, through the wall of an envelope having permanently sealed therein an apertured mask. The materials are inserted into a space between the mask and the screen support plate. A method of manufacturing is provided such that, when the direct photographic method of applying phosphor particles is employed, there is sufficient room to utilize a high energy light source. When an electron sensitive mosaic pattern is to be provided with an electron transparent metallic layer, means are provided to produce a uniform layer of the metallic material, from a large source, through the apertured mask.

The invention is described in greater detail in connection with the accompanying three sheets of drawings, wherein:

Fig. 1 is a fragmentary sectional view of an envelope for a kinescope, having sealed therein an apertured mask, in the process of having a screen unit applied therein in accordance with the principles of this invention;

Figures 2 through 4 are fragmentary sectional views of further steps in the manufacture of the tube shown in Fig. 1 in accordance with this invention;

Fig. 5 is a longitudinal sectional view of a completed tube in accordance with this invention; and,

Fig. 6 is a fragmentary sectional view of an embodiment of a kinescope tube in accordance with this invention.

Referring now to the drawings in detail, Fig. 1 shows a partial sectional view of an envelope 11 for a tri-color kinescope having permanently sealed therein an apertured mask 16. The mask 16 is supported adjacent to a glass face plate, or screen, 14. In accordance with this invention the mask 16 may be supported within the envelope 11 prior to the sealing of face plate 14 to the cone portion 13 of envelope 11. The glass face plate 14 may be of any desired shape, e. g. circular or rectangular, and curvature, e. g. flat or spherical. In the instant case the glass face plate 14 is in the form of a circular section of a spherical shell. The face plate 14 is sealed to a lip 12 on the cone portion 13 of envelope 11. Any of the conventional glass-to-metal seals may be utilized for sealing the face plate 14 to the lip 12.

The mask 16 may be of any type of conducting material, and preferably includes some type of temperature compensation means such as hinges 17 to insure that the predetermined relationship between the mask 16 and face plate 14 is maintained during the operation of the tube. When, as in the instant case, the phosphor material is to be laid down directly on the inner surface of the curved face plate 14, the mask 16 is appropriately curved. In accordance with this invention a temperature compensated mask 16 is permanently bonded to the inner walls of cone 13. This bond may be made by a weld between a flat portion 19 of mask 16 and the inner surface of the metallic cone 13. It is also within the contemplation of this invention to permanently bond the mask 16 to the inner walls of cone 13 by other well-known means, such as support pins or ridges (not shown). The mask may be made of a copper-nickel alloy of approximately 95% copper and the balance nickel.

Generally, it will be found to be advantageous to bond the mask 16 to the inner periphery of cone portion 13 prior to the sealing of the glass face plate 14 to the lip 12. In accordance with this invention, color emitting phosphor particles are deposited in any of the conventional patterns, i. e. "dot-like" or "line-like" patterns, after the mask 16 has been permanently sealed into the cone portion 13 of envelope 11. When the mask 16 has been sealed into the envelope 11, and the face plate 14 sealed to lip 12, a settling suspension 22, is poured into the cone portion 13 and a single color emitting phosphor

24 is settled out of settling suspension 22. The settling suspension 22, as well as the color emitting phosphor may be inserted through aperture 15 since the phosphor particles are much smaller in size than apertures 20. The color emitting phosphor may be any of the three primary colors as is well known, i. e. blue, red, and green. When the color emitting phosphor 24 has settled on face plate 14 the settling solution is poured out of the envelope 11 through an aperture 26 which is between the face plate 14 and the mask 16, leaving only the single color emitting phosphor 24 evenly distributed over the inner surface of face plate 14. The aperture 26 may have sealed therein a hollow metallic tubulation 28 such as a copper tube, which extends through the side of the cone 13 between the mask 16 and the face plate 14. The aperture 26 may be approximately $\frac{1}{4}$ inch in diameter. Also, a plurality of apertures, similar to aperture 26, are within the contemplation of this invention.

Once the single color emitting phosphor 24 is disposed evenly across the surface of the face plate 14 the next step in the process takes place. This step comprises distributing a photosensitive emulsion on the phosphor and exposing particular portions of the color emitting phosphor 24, and the emulsion, to a point light source (see Fig. 2) which is supported at the plane-of-deflection equivalent to the plane-of-deflection of one of the electron beams (see Fig. 5). The photosensitive emulsion may be introduced through aperture 26 and may be evenly distributed over the phosphor 24 by rotating the cone 11 as will be explained in connection with Fig. 3. The light from the point light source 30 passes through the apertures 20 in the mask 16 to develop the photosensitive emulsion at particular points, i. e. in the desired color array, along the continuous layer of color emitting phosphor 24. In the area where the emulsion is developed, the emulsion hardens so that the single color emitting phosphor 24 is firmly attached to the face plate 14 in these particular "dot-like" areas. After the emulsion for a particular color emitting phosphor 24 has been developed in the "dot-like" array, the balance of the emulsion and the corresponding phosphor is washed out of the envelope 11 by a wash which may be poured in through aperture 15 in the cone 13, or may be pumped into aperture 26, and out through aperture 26. An example of the wash material is water. By this means the color dot array for one color 34 is firmly adhered to the face plate 14. When this has been completed for one of the three colors the process is repeated for each of the remaining colors 35 and 36 with the position of source 30 being shifted 120° around the axis of envelope 11 for each of the additional colors.

When utilizing the settling method described above the phosphor particles 24 readily fall through the apertures 20 in the mask 16 due to the fact that the ratio of size of apertures 20 to phosphor particle size is generally greater than 5 to 1. The photosensitive emulsion should preferably not be applied through the mask for it would then, in the case of a screen settled through mask, coat the phosphor particles on the mask and be developed by the light. However, when the phosphor is settled through the mask and the emulsion inserted through aperture 26, phosphor particles that settled onto the mask are removed by the wash. As an alternative to the method described above, a mixture of water, emulsion, and one of the color emitting phosphors, may be introduced through tubulation 28 and the envelope 11 rotated and tilted to evenly distribute the mixture over the face plate 14. When the mixture is evenly distributed, the rotation of the envelope 11 is stopped and the emulsion is exposed to light in particular areas to render the emulsion insoluble in these particular areas as was described above. Also, as an alternative, the phosphor in the form of a slurry may be introduced through aperture 26 and the envelope rotated to evenly distribute the phosphor after which the photosensitive emulsion may be inserted through aperture 26, or through

the mask, and distributed by rotating the envelope 11. In the latter alternative, if the emulsion is inserted through the mask, the emulsion deposited on the mask will be developed but this is not a particularly great disadvantage since there are no phosphor particles on the mask.

The light source 30 is located at the point which corresponds to the center of scan of one of the electron beams 62 (see Fig. 5) for one of the three colors. The housing member 32 which encloses the light source 30 may be marked with grooves 31 which are spaced 120° apart to receive pins 33, so that the housing 32 may be shifted from a position corresponding to that of the red beam to that of the green and blue beams. As an alternative, a lamp with three point sources (not shown) which can be switched on in succession and mounted in stationary relationship with respect to cone 13 may be employed. As can be seen from Fig. 2, the lamp 30 and housing 32 may be relatively large, due to the relatively large size of aperture 15, to provide a maximum amount of light from a relatively large point source 30 thus reducing the required exposure time resulting in a decrease in the cost of manufacturing such a tube.

Once the three color emitting phosphors 34, 35, and 36 have been laid down in the proper array, an electron pervious, light reflecting, conductive coating is provided on the tri-color array. The first step in the method of providing the conductive coating is explained by reference to Fig. 3. The color emitting phosphors 34, 35, and 36 are thoroughly wetted by being covered with water and the envelope rotated to distribute the water over all of the phosphors. The envelope 11 may be rotated by means such as a pulley arrangement 38 at approximately 60 R. P. M. When the phosphors 34, 35, and 36 are thoroughly wetted a filming lacquer 40 such as isobutyl methacrylate is sprayed onto the phosphor array through aperture 15 by means such as a spray gun (not shown). The rotation of envelope 11 is continued during the spraying, and for about $\frac{1}{2}$ a minute thereafter, for providing a uniform layer of the filming lacquer 40. The filming lacquer 40 may be sprayed through the apertures 20 in mask 16 without clogging the apertures 20. Furthermore, it does not matter if some of the filming lacquer 40 is deposited on the mask as will be explained hereinafter. An alternative to the materials described for filming lacquer 40 is a mixture of isobutyl methacrylate with a plasticizer and solvent such as acryloid and toluene respectively. The filming lacquer 40 is allowed to dry which forms a smooth surface over the array of phosphor dots 34, 35, and 36.

The speed of rotation, i. e. 60 R. P. M., is also sufficient for evenly distributing the photosensitive emulsion and the phosphor particles as described in connection with Figure 1. The envelope 11 may be supported on the pulley 38 by being placed onto a curved rubber gasket 42 which is supported upon the rotatable base 43 as shown.

Referring now to Fig. 4 there is shown a sectional view of the next step in the process of obtaining the conductive coating previously mentioned. In this process the envelope 11 is inverted into a rubber gasket 45 that is a portion of an evacuated chamber 47. The evacuated chamber 47 may include a flexible seal, for the purpose of providing a reduced atmosphere, such as a sylphon bellows 44 through which extends support rods 51 for an evaporator 53. In accordance with this invention the evaporator 53 is as large as possible, but small enough, or flexible enough, so that it may pass through aperture 15. The evaporator 53 is energized by current through lead-ins 51 from a potential source (not shown). Due to the large area of the evaporator 53, the conductive coating 55 is evaporated in such a manner as to pass through the apertures 20 in all directions which provides a continuous layer of conductive coating 55 on the smooth surface provided by the filming lacquer 40. The conductive coating 55 may be a coating of aluminum as is

well-known in the art. The aluminum coating is a continuous and is an even coating due to the large size of the evaporator 53, irrespective of the shadowing effect of the mask 16.

After the conductive coating 55 has been applied to the filming lacquer 40, the layer of filming lacquer is baked out of the envelope and the conductive coating 55 provides a smooth surface over the color emitting phosphor particles 34, 35, and 36. The backing out of filming lacquer 40 also removes any of the filming lacquer material that may have been deposited on mask 16. When this step has been completed the cone 13 may be sealed to a funnel 58 having sealed therein a battery of electron guns 59, 60, and 61. The funnel 58 may be aligned with the cone 13 by well-known means such as alignment pins 31 (shown in Fig. 2), on the believed portion of cone 13. The funnel 58 may be sealed to the metallic cone 13 by any of the well-known glass-to-metal seals.

As seen from Fig. 5 the completed tube 10 has a plane-of-deflection for the three electron beams 62, provided by deflection yoke 57, each of which corresponds to the exact location of the point light source 30 in one of its locations shown in Fig. 2. Thus, the electron beams 62 from guns 59, 60, and 61 each strike one of the arrays of color emitting phosphors 34, 35, and 36 which are arranged in the conventional hexagonal pattern of red, blue, and green. Each triad group of phosphors is arranged behind an aperture 20 in the mask 16. When the tube 10 has been completed the tubulation 28 may be utilized for exhausting the envelope 11 and may be pinched off by any of the well-known low temperature sealing methods for such an element.

Referring now to Fig. 6 there is shown a partial sectional view of an embodiment of this invention comprising a glass envelope 63 for use as a tri-color television tube. As in the embodiment described in Figures 1 through 5 there is provided between a permanently secured mask 16' and a face plate 14' a tubulation 65 which may be utilized for inserting the color emitting phosphor particles and emulsion as previously described. The mask 16' is bonded to support pins 67 which are bonded within the cap portion 69 of envelope 63. When the mask is affixed into cap 69, the cap is sealed by means of seal 71 to a cone 70. As in the metal tube the mask 16' is temperature compensating and the entire process of manufacturing the tube occurs after the mask 16' has been sealed into the cap portion 69 and the cap sealed to the cone portion of the envelope 63. The process for completing the tube is substantially the same as that previously described.

As should be obvious to those skilled in the art this invention provides a method of and means for manufacturing a color television tube after the mask and face plate are sealed to the cone portion of an envelope. The features of this invention permit tube manufacturers to obtain the combination of a cone, face plate, and mask from an envelope vendor, either glass or metal, and complete the tube by economical methods.

What is claimed is:

1. Method of depositing color emitting phosphors on a screen plate of a cathode ray tube of the type including an apertured mask spaced from said screen plate, said method including the step of applying said phosphors onto said screen plate through a wall of the envelope of said tube at a point intermediate said screen plate and said apertured mask.

2. Method of making a cathode-ray tube of the kind having an envelope containing a plane-of-deflection and a target-assembly comprising a mask spaced from a foundation surface of a phosphor screen, said mask containing a multiplicity of apertures systematically arranged in a pattern to define a target area through which an electron-beam normally passes from one of three substantially fixed points in said plane-of-deflection to pre-selected ones of the elemental areas of a similar pattern on

said foundation surface of said screen, said envelope having an open neck-portion through which access may be had to said points in said plane-of-deflection, said method comprising; permanently securing said mask and said foundation surface in spaced relationship within the main chamber of said envelope, inserting a color emitting phosphor into said envelope, evenly distributing said phosphor on said foundation surface, inserting a photosensitive emulsion through an opening in the wall of said envelope and into said space between said mask and said foundation plate, evenly distributing said emulsion on said phosphor, removably locating a projector in said open neck portion of said envelope in a position whereat the outlet of said projector coincides with one of said fixed points in said plane-of-deflection, projecting along a multiplicity of angularly related straight paths, from said outlet, emanations capable of passing through said mask-apertures and of recording upon said target surface the pattern of said apertures whereby said emulsion is developed in said pattern, removing said projector from said neck, removing the undeveloped portions of said emulsion and the corresponding phosphor particles through said opening, repeating said steps utilizing a second and a third color emitting phosphor and a second and a third of said substantially fixed points, wetting the array of color emitting phosphor particles, spraying a filming lacquer onto said phosphor particles through the apertures in said mask, evaporating an electron pervious conductive film onto said lacquer and through the apertures in said mask, baking said envelope to remove said lacquer, and mounting three sources of beam-electrons in said neck in a position whereat the beam from each of said sources is in line with one of said fixed points in said plane-of-deflection.

3. The method of claim 2 as applied to the manufacture of a tri-color kinescope, and wherein the step of projecting emanations through said mask from said projector is repeated with the outlet of the projector located, successively, at each of the three points in the plane-of-deflection each of which is peculiar to one of the three color emitting phosphors of said tri-color kinescope.

4. A sub-assembly for use in the manufacture of a cathode-ray tube of the color kinescope variety, said sub-assembly comprising a cone portion of an envelope, a transparent screenplate forming a closed end on said cone portion and adapted to support electron sensitive material on the inner surface thereof, an apertured electrode permanently secured in said envelope and spaced from said screen-plate, and means through the wall of said envelope and opening into said space between said apertured electrode and said screen plate for inserting said electron sensitive material onto said screen plate.

5. A sub-assembly as in claim 4 wherein said cone is metallic and said means includes a hollow metallic tubulation of the type capable of being pinched off to form a low temperature seal.

6. A sub-assembly as in claim 4 wherein said cone is glass and said means includes a hollow tubulation adapted to be sealed after said electron sensitive material is inserted.

7. Method of making a cathode-ray tube comprising an envelope containing a target-assembly comprising an electrode containing a multiplicity of apertures systematically arranged in a pattern to define a target area through which an electron-beam normally passes from one of three substantially fixed points in a plane-of-deflection to pre-selected ones of the elemental areas of a similar pattern on a screen spaced from said electrode, said envelope having an open neck-portion through which access may be had to said point in said plane-of-deflection, said method comprising; permanently securing said apertured electrode and said foundation surface in spaced relationship within the main chamber of said envelope, inserting a color emitting phosphor into said envelope through an opening into said space and through the wall

of said envelope, evenly distributing said phosphor on said foundation surface, inserting a photosensitive emulsion into said envelope through said opening, evenly distributing said emulsion on said phosphor, removably locating a projector in said open neck portion of said envelope in a position whereat the outlet of said projector coincides with one of said fixed points in said plane-of-deflection, projecting along a multiplicity of angularly related straight paths, from said outlet, emanations capable of passing through said mask-apertures and of recording upon said target surface the pattern of said apertures whereby said emulsion is developed in said pattern, removing said projector from said neck, removing the undeveloped portions of said emulsion and the corresponding phosphor particles through said opening, repeating said steps utilizing a second and third of said substantially fixed points, wetting the resultant array of color emitting phosphor particles, spraying a filming lacquer onto said phosphor particles through the apertures in said mask, evaporating an electron pervious conductive film onto said lacquer and through the apertures in said mask, baking said envelope to remove said lacquer, and mounting three sources of beam-electrons in said neck in a position whereat the beam from each of said sources is in line with one of said fixed points in said plane-of-deflection.

8. Method of making a cathode-ray tube comprising an envelope containing a target-assembly comprising an apertured electrode spaced from a foundation surface of a phosphor screen, said apertured electrode containing a multiplicity of apertures systematically arranged in a pattern to define a target area through which an electron-beam normally passes to pre-selected elemental areas on said foundation surface; said method comprising; permanently securing said apertured electrode and said foundation surface in spaced relationship within the top cap of said envelope, securing a cone portion of said envelope to said top cap, inserting a color emitting phosphor into said envelope through an aperture in said top cap opening into said space between said apertured electrode and said foundation surface, evenly distributing said phosphor on said foundation surface, inserting a photosensitive emulsion into said envelope through said opening, evenly distributing said emulsion on said phosphor, developing said emulsion in a pattern, and removing the undeveloped portions of said emulsion and the excess phosphor particles through said opening.

9. Method of making a cathode-ray tube comprising an envelope containing an apertured electrode spaced from a foundation surface of a nearby screen; said method comprising; permanently securing said apertured electrode and said foundation surface in spaced-apart relationship within the main chamber of said envelope, inserting a color emitting phosphor into said envelope through an opening in the wall of said envelope and into said space between said apertured electrode and said foundation surface, inserting a photosensitive emulsion into said envelope through said opening, and projecting light from a source through the apertures in said apertured electrode for developing said emulsion in a pattern.

10. Method of making a cathode-ray tube comprising an envelope containing a mask electrode spaced from a foundation surface of a phosphor screen, said method comprising; permanently securing said mask and said foundation surface in spaced-apart relationship within the main chamber of said envelope, inserting a color emitting phosphor into said envelope through an opening in said envelope and into said space between said mask and said

foundation surface, inserting a photosensitive emulsion into said envelope through said opening, removably locating a projector in an open neck portion of said envelope in a position whereat the outlet of said projector coincides with a fixed point in the plane-of-deflection of said tube, projecting along a multiplicity of angularly related straight paths, from said outlet, light capable of passing through said mask-apertures and of recording upon said target surface the pattern of said apertures whereby said emulsion is developed in said pattern, removing said projector from said neck, removing the undeveloped portions of said emulsion and the corresponding phosphor particles, repeating said steps utilizing a second and third color emitting phosphor and a second and a third substantially fixed point, wetting the array of color emitting phosphor particles, spraying a filming lacquer onto said phosphor particles through the apertures in said mask, evaporating an electron pervious conductive film onto said lacquer and through the apertures in said mask, baking said envelope to remove said lacquer, and mounting electron beam producing means in said neck in a position whereat at least a portion of an electron beam is in line with each of said fixed points in said plane-of-deflection.

11. Method of making a cathode-ray tube comprising an envelope containing an apertured mask electrode spaced from a foundation surface for a phosphor screen, said method comprising; permanently securing said mask and said foundation surface in spaced relationship within the main chamber of a cathode-ray tube-envelope, settling a color emitting phosphor into said envelope through the apertures in said mask, introducing a photosensitive emulsion through the wall of said envelope into the space between said mask and said surface, securing said phosphor onto said foundation surface in a pattern similar to the pattern of the apertures in said mask, removing the unsecured portions of said phosphor particles from said surface and from said mask, repeating said steps utilizing a second and third color emitting phosphor, spraying a filming lacquer onto said phosphor particles through the apertures in said mask, evaporating an electron pervious conductive film onto said lacquer and through the apertures in said mask, baking said envelope to remove said lacquer, and mounting three sources of beam-electrons in said neck in a position whereat the beam from each of said sources is in line with one of said fixed points in said plane-of-deflection.

12. A method as in claim 11 wherein said unsecured phosphor particles are washed from said mask and said foundation surface.

13. A method as in claim 11 wherein said unsecured phosphor particles are removed through the wall of said envelope between said mask and said foundation surface.

14. A sub-assembly for use in the manufacture of a cathode-ray tube comprising an envelope including a transparent screen-plate having a target surface area adapted to support an electron-sensitive target, a mask mounted in permanently fixed spaced-relation with respect to said screen-plate, and said envelope having at least one aperture therein opening into the space between said screen-plate and said mask.

15. The invention as set forth in claim 14 further comprising a hollow tubular member sealed to said envelope and surrounding said aperture, and said tubular member being a material of the type adapted to be pinched off to form a low temperature seal.

No references cited.