

Nov. 22, 1960

N. F. FYLER
COLOR PICTURE TUBE

2,961,560

Filed May 6, 1955

8 Sheets-Sheet 1

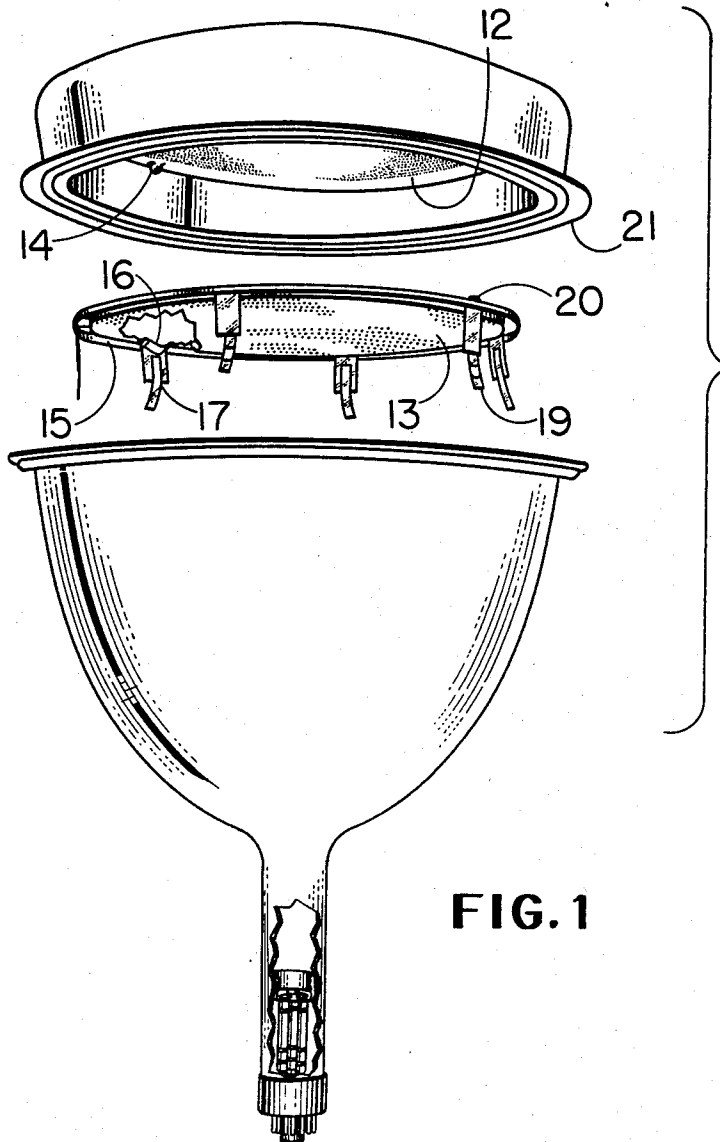


FIG. 1

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8 Sheets-Sheet 2

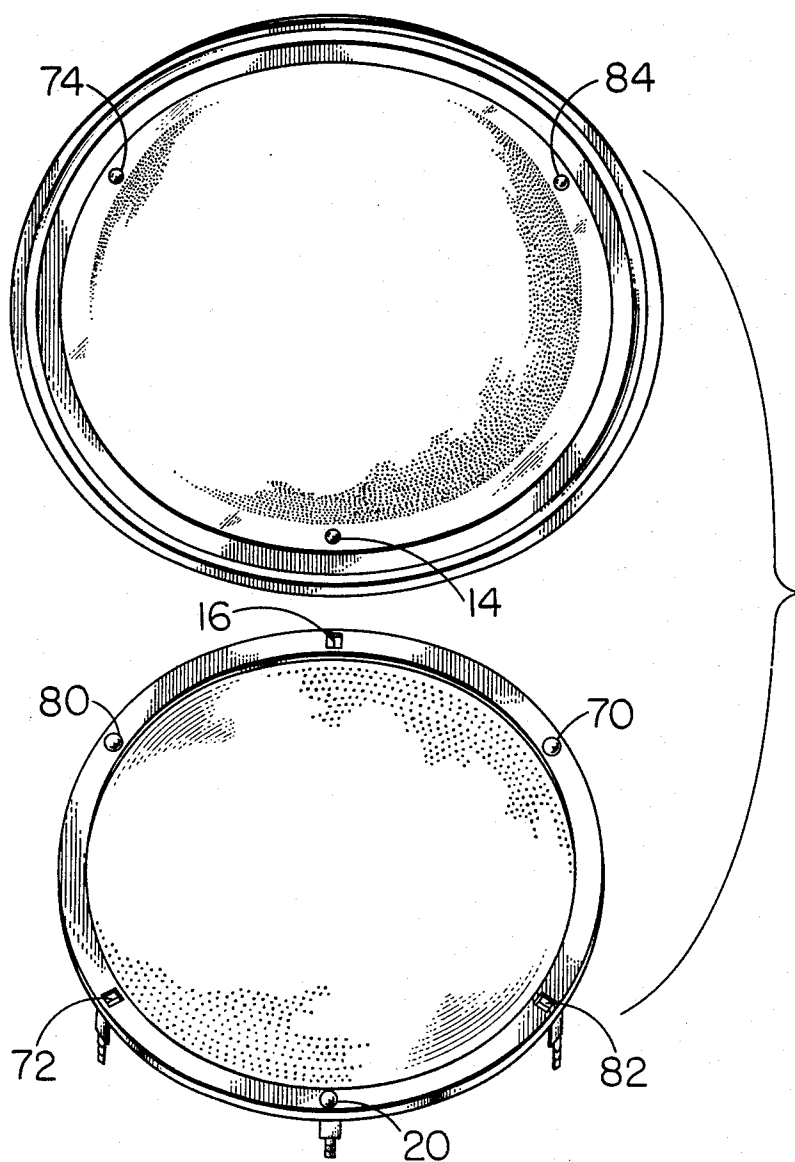


FIG. 1A

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8 Sheets-Sheet 3

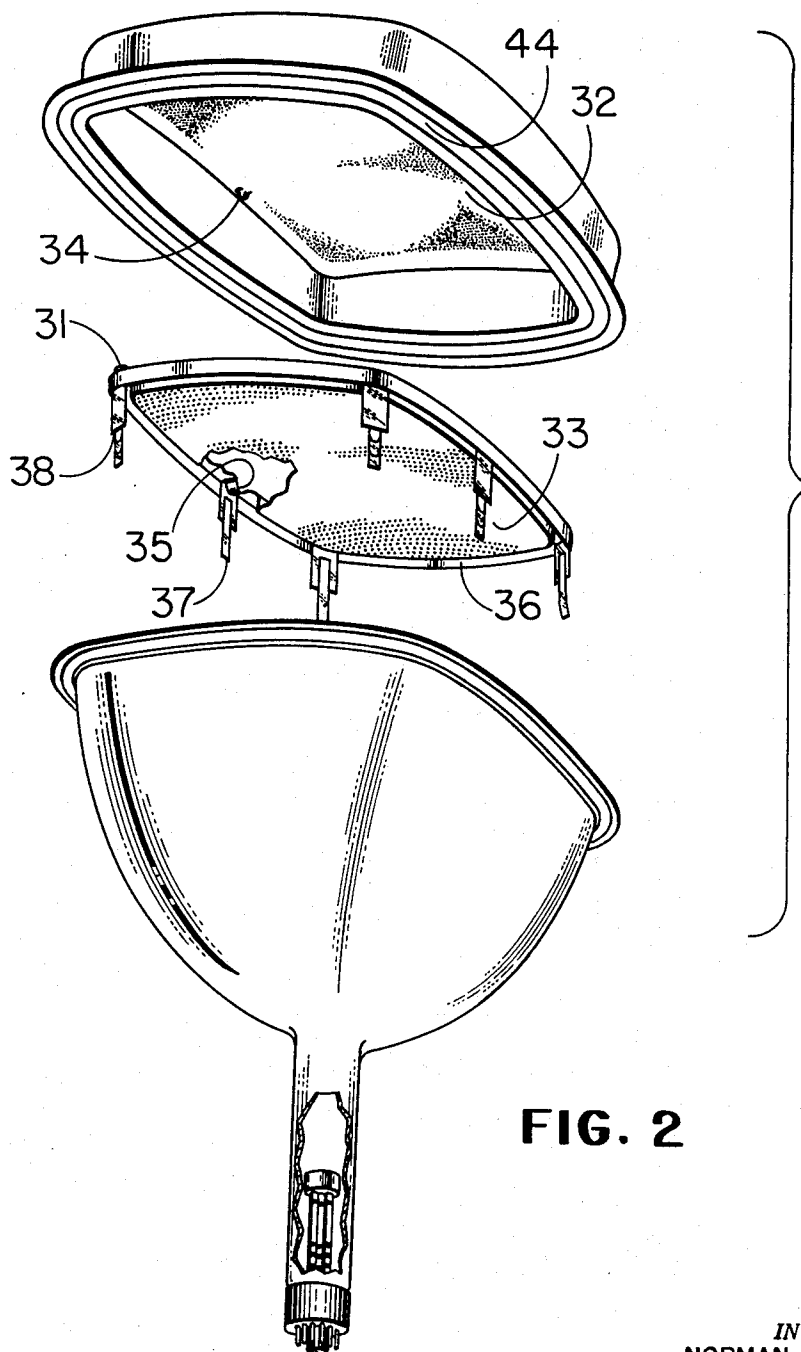


FIG. 2

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8 Sheets-Sheet 4

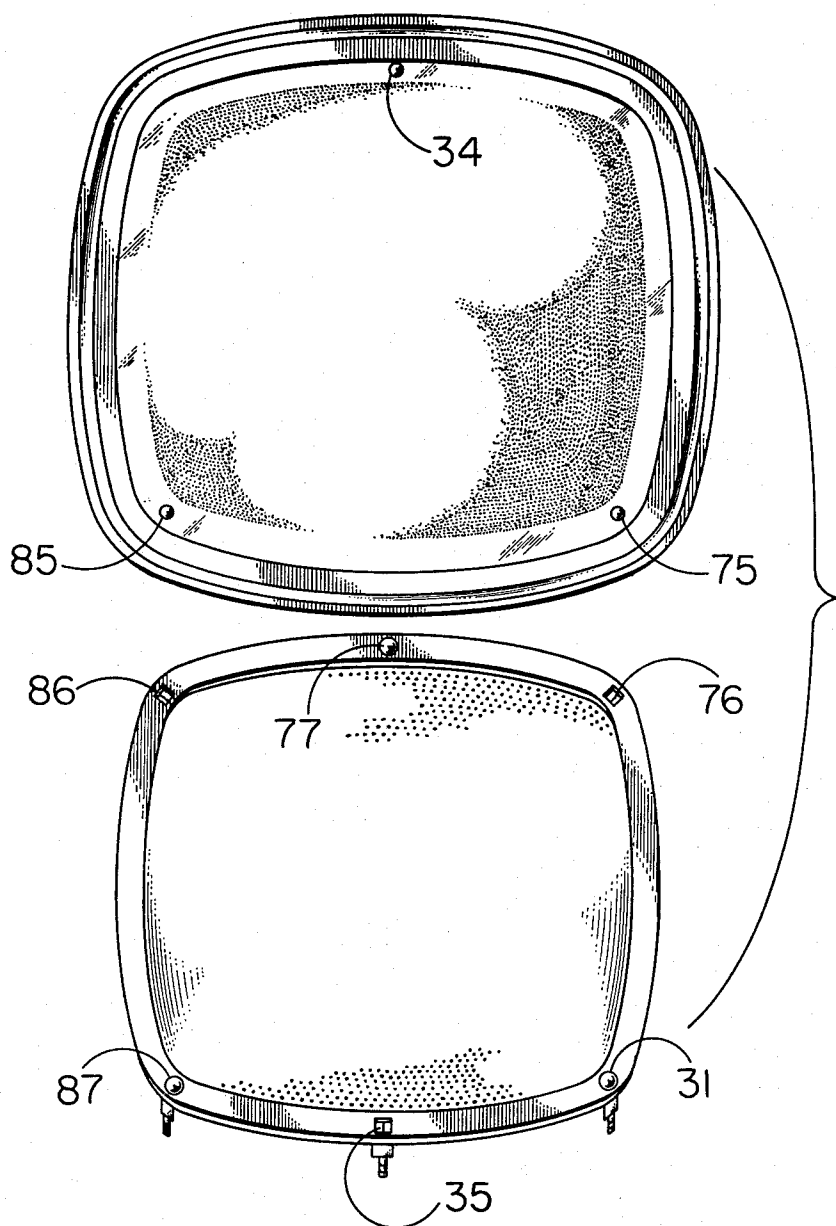


FIG. 2A

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8 Sheets-Sheet 5

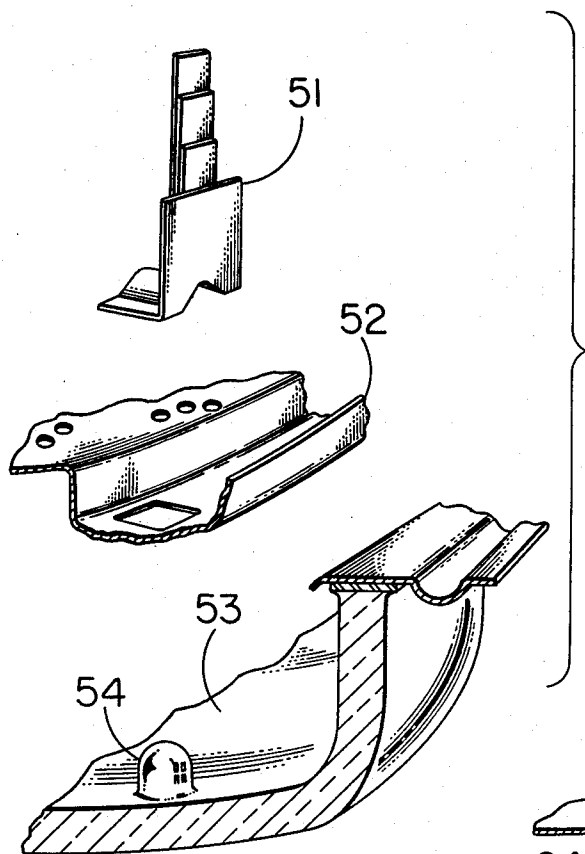


FIG. 3

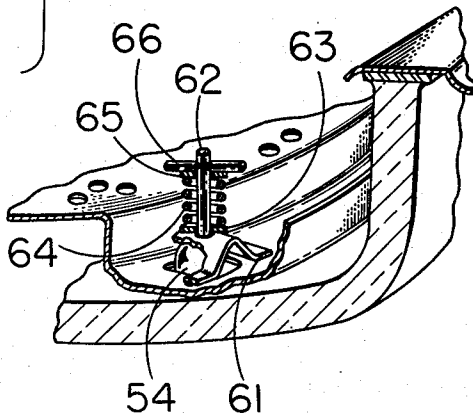


FIG. 5

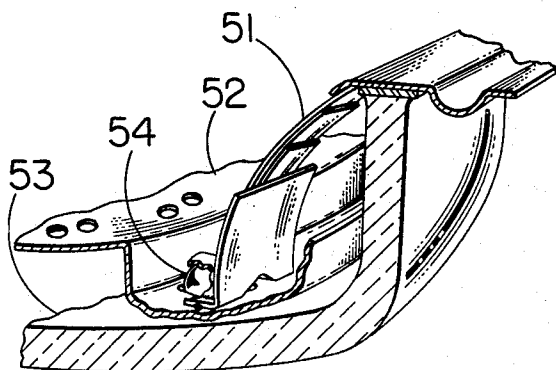


FIG. 4

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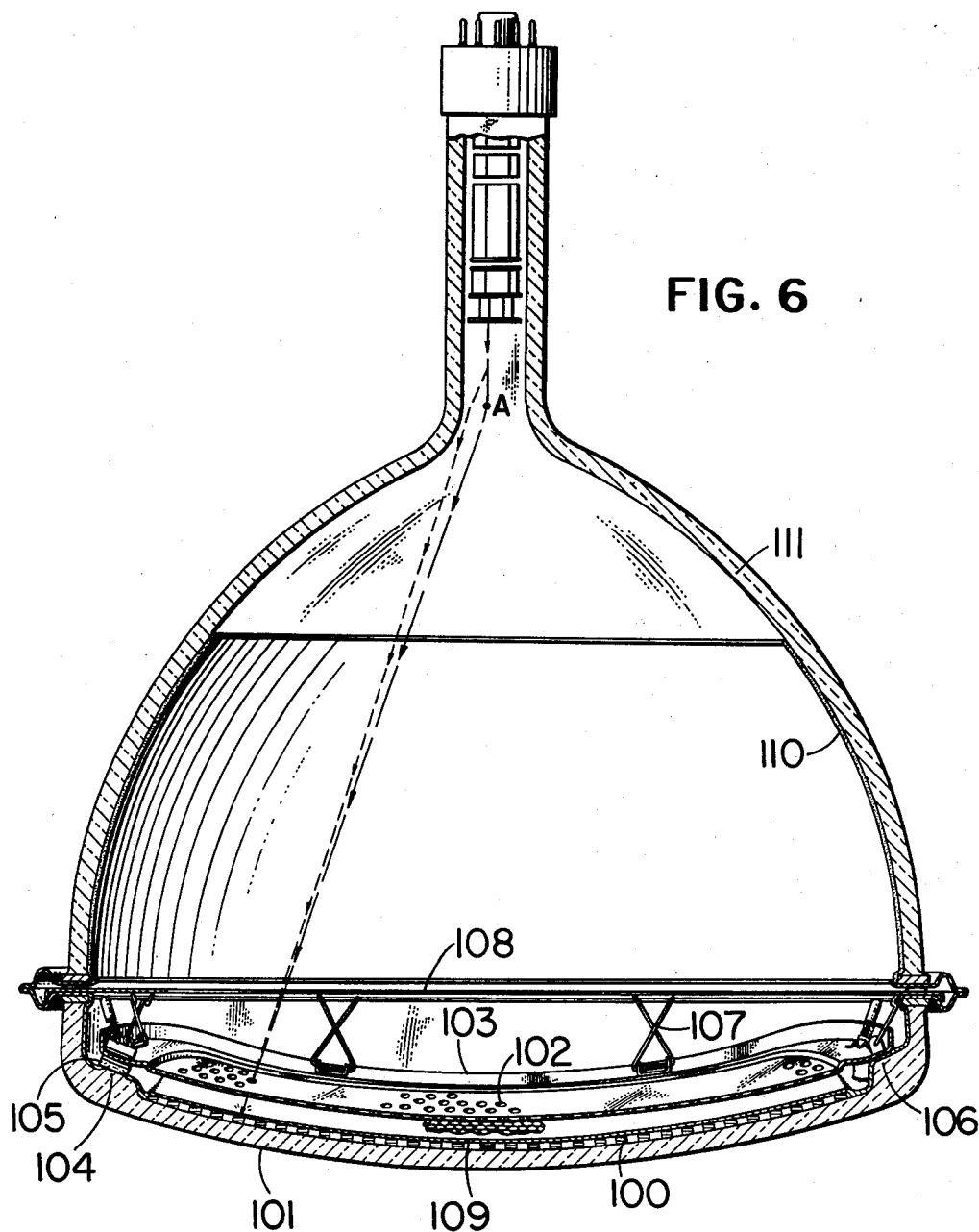
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COLOR PICTURE TUBE

2,961,560

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8 Sheets-Sheet 7

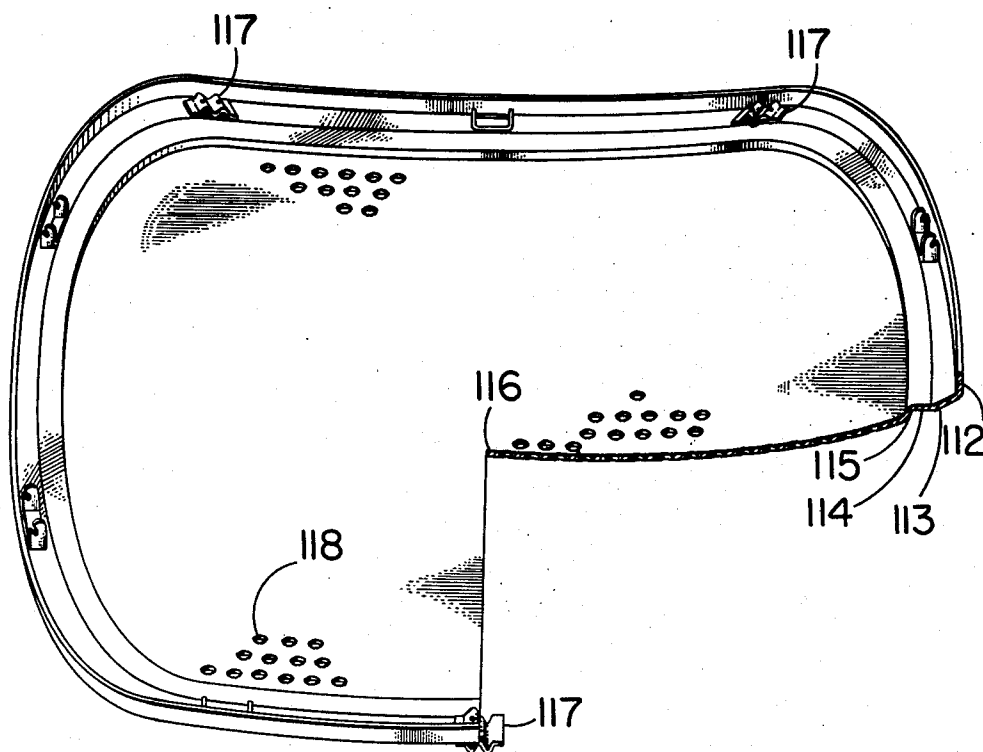


FIG. 7

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8 Sheets-Sheet 8

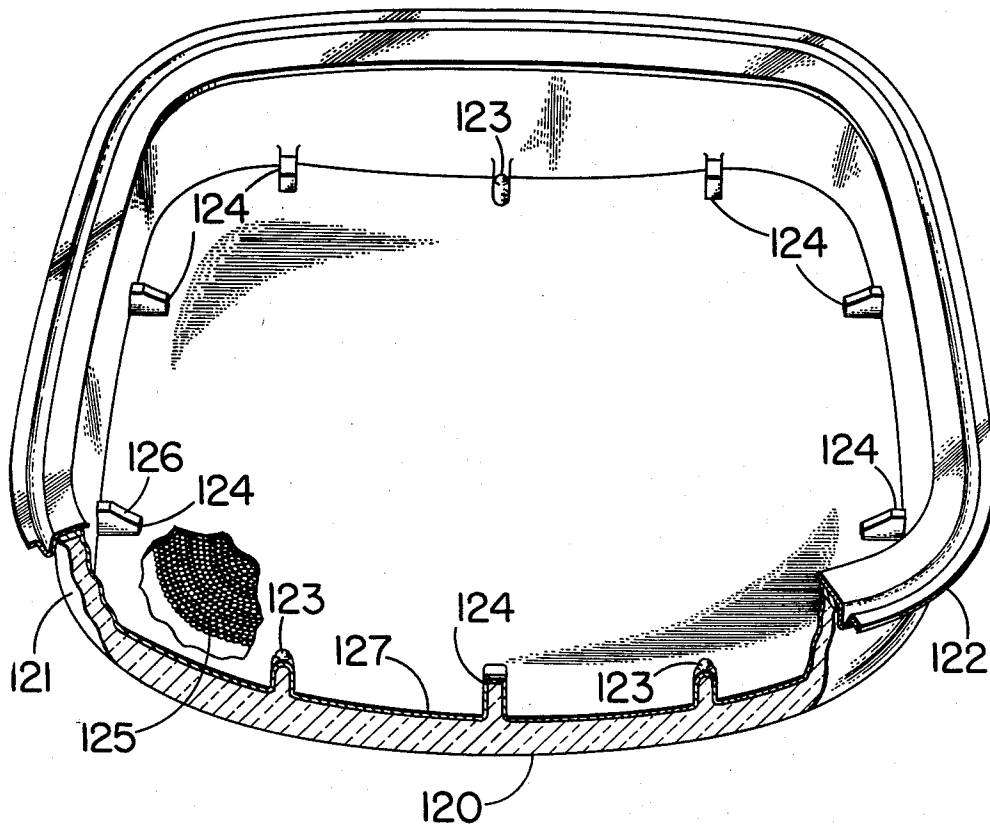


FIG. 8

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COLOR PICTURE TUBE

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Filed May 6, 1955, Ser. No. 506,684

21 Claims. (Cl. 313—64)

This application is a continuation-in-part of application Serial No. 399,264 filed December 21, 1953, now abandoned, for a "Color Picture Tube."

This invention relates in general to color television and in particular to picture tubes for color television.

The present trend in picture tubes is toward one having phosphors for generating the three primary colors distributed symmetrically in groups over its screen surface. Behind the screen is a shadow mask which has an aperture for each color group. Phosphor striped screens with rectangularly apertured masks or phosphor dotted screens with circularly apertured masks have been used, but the latter system now appears more likely to be universally adopted.

The nature of the color picture tube, whether of rectangular or circular aperture mask type, is such that the preservation of color purity is in a large degree dependent upon the accuracy of registration of screen and mask. The desired geometry of the tube is to have straight lines determined by the position at the deflection plane of the beam from a given gun, the phosphor dots to be energized by that gun, and the holes in the shadow mask. Any misregistration between the screen and mask may destroy this straight-line relationship and cause energization of phosphor dots other than those associated with the given gun. The obvious result of such undesired excitation is contamination of color.

Considerable time and effort have been expended to provide mask and screen combinations which are locked in registration permanently. A sizable number of devices have been tried, and most have been rejected for one or more defects. Requirements demand that the material used in the mask itself as well as in the associated clamping and locking components be chosen carefully. Structural strength, electrical characteristics, and behavior in vacuum must all be considered.

One of the more commonly used tubes comprises a glass bulb which is substantially of conventional picture tube design, having a viewing end, a conical section, and a neck section. The conical section, however, is modified by being cut off adjacent the viewing end in a plane perpendicular to the longitudinal axis of the tube. To each cut end a flange is sealed. These flanges are designed to be welded together as a subsequent assembly step in finishing the picture tube.

The flange on the conical section is of smaller internal diameter than the flange adjacent the viewing end, and carries three similar studs spaced 120° apart about its periphery. These studs extend toward the viewing end and are designed to provide ultimate support to a mask and screen assembly.

The mask and screen assembly includes a decorative viewing mask, a phosphor dot screen plate, a spacer frame, a shadow, or aperture mask, a final lower frame member, clamping members, phosphor dot plate clamps, screws and nuts. The assembly technique requires that the shadow mask be laid on the lower frame member such that three elongated radial slots in the mask straddle

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three eccentric pins which are placed in collets located on the periphery of the frame 120° apart. The spacer frame is then placed over the mask and 24 screws are placed in the tapped holes provided, but not tightened.

5 The mask is then "hot-blocked," that is, heated platens are applied from above and below to the mask. The mask is thus raised in temperature while the frame members remain substantially at room temperature. The numerous clamping screws are then tightened and cooling of the mask places it under sufficient tension to maintain the mask flat.

The phosphor dot plate is separately processed to form a screen and is aligned with the shadow mask assembly on a "lighthouse" or by means of other optical apparatus.

15 The collets and eccentric pins, mentioned above, are so designed that rounded heads on the pins cooperate with grooves on the phosphor dot plate to obtain proper alignment. When alignment is completed, the three clamping members are fastened in place to maintain that alignment.

20 The entire assembly is then fastened to the three flange studs and the decorative mask is snapped in place. At this point, the conical section of the tube is substantially completed. The viewing end of the bulb is then placed over the decorative mask and the flanges on the conical section are ready for welding.

Although stressed shadow masks may be operative in the so-called planar screen picture tubes, they are of no practical value in the type of tube described in United States Patent No. 2,690,518, entitled, "Color Picture Tube," granted to Fyler and Rowe and assigned to the same assignee as the present application. Tubes made according to the teaching of the cited patent perform adequately but may be improved when used to reproduce a rectangular field of view.

30 The shortcomings of the circular screen tube arise principally from the inherent inefficiency of a circular screen picture tube in the presently known television systems. The field of view transmitted from a station is substantially rectangular in outline and ideally would be reproduced as a rectangle. Reproduction by a tube having a circular viewing screen requires that the diameter of the circular screen be at least as great as the diagonal dimension of the desired rectangular field. With the rectangle being so inscribed in the screen circle, four circular segments containing no useful information exist on the viewing screen. In practice, the diameter of the circular screen is made equal to the longer side of the desired rectangular field, thus eliminating two unused circular segments. The subsequent gain in useful screen area is balanced by the loss of a portion of the transmitted field.

50 The loss of a portion of the transmitted field in the circular screen picture tube is tolerated in order to reduce the size of the television receiver in which such a tube is used. Since the circuitry in a color television receiver is more complex than a black-and-white receiver having a viewing screen of comparable area, it is evident that the color receiver will be larger than the black-and-white. If, in addition, the color receiver has an unnecessarily large picture tube to present pictures of accepted size, the disparity in size between the two will become even greater. In fact, the dimensions of some color television receivers having a circular viewing screen picture tube approach or exceed the size of door or window openings commonly found in homes. Commercial acceptance of color television is almost impossible if the receivers cannot be easily installed in any potential user's home.

55 The fact that only a portion of the viewing screen is used creates a thermal problem in the shadow mask. Although the mask is fabricated from a highly conductive material, unequal heating of the area of the mask results in some distortion of the shape of the mask. If the mask shape is not substantially spherical over its

operating area, the problem of convergence of the electron beams becomes difficult to solve. The amount of correction required to cause proper convergence in such a case is a function of the radius of curvature of the mask at each point on its surface. If the radius of curvature of the shadow mask is not constant, it is impossible to obtain proper convergence over the face of the mask without shifting the apparent beam sources to compensate for changes in the radius of curvature of the mask as the raster is scanned. It is impossible, however, to predict the exact amount by which the radius of curvature will change since the change depends on such variables as the brightness and color of the transmitted field. Therefore, in a circular picture tube presenting a rectangular field, no provision for complete compensation can be easily incorporated in the tube.

The thermal problem occurring during operation may be minimized by shaping the mask to substantially the same shape as the transmitted field. However, the elevated temperature cycles to which the mask is subjected during fabrication of the tube make it mandatory that provision be made to prevent deformation of the mask during that process. If the periphery of the mask is prevented from moving, strains will be induced in the mask during heat cycling. Even if the periphery of the mask is free to move, variations in stiffness around the periphery may permit distortion of the curvature of a curved shadow mask during heat treatment. Such distortion, occurring as it does after the luminescent dots have been formed, causes misregistration of the electron beams in the finished tube.

It is highly desirable that the shadow mask be centrally located with respect to the screen panel. Such location is desirable to maintain a uniform size of the phosphor dot arrays if they are formed by exposure to light sources through the mask. Uniformity of phosphor dot arrays, of course, results in an even light output per unit area over the entire face of the viewing screen.

It is plain that the very complexity of structure and process rules out the likelihood of general public acceptance of planar-mask tubes. Furthermore, it has been proven in the field of black-and-white television that rectangular tubes are greatly preferred for the presentation of pictures.

Hence, it is an object of the present invention to provide a simplified color television picture tube.

It is another object to simplify assembly techniques and reduce the cost and complexity of color television picture tubes.

It is still another object to provide simple apparatus for retaining and spacing the mask and screen of a color television picture tube.

A still further object is to provide a practical rectangular color television tube.

It is a further object to provide color television picture tubes which are highly efficient in utilization of available bulb size and screen area.

It is a still further object to provide improved performance in color television picture tubes.

In general, the present invention consists in a color television picture tube which includes simple but novel structural assemblies for retaining the aperture mask in a unique position relative to the phosphor dot screen. The phosphor dot screen is formed directly on the viewing end of the bulb. The major reference points for location of the mask are provided on or adjacent to the viewing end of the bulb itself and are thereby directly related to the phosphor dot screen. In one embodiment of the invention, glass projections are molded as part of the inner surface of the viewing end of the bulb. Cylinders may be used in place of the glass projections, such cylinders being sealed in suitably located holes or otherwise firmly attached to the inner surface of the bulb. These locating members are spaced about the periphery of the viewing end. The aperture mask itself

is provided with fittings which cooperate with the locating members on the viewing end. To maintain firm contact of the mask fittings with the locating members, springs are provided. The mask fittings are so designed that both proper spacing and orientation of mask relative to screen are obtained. In addition, the design of the mask and its fittings is such that expansion and contraction of the mask due to temperature changes cause only insignificant variations of registration of mask and screen. For a better understanding of the invention, together with other and further objects, features, and advantages, reference should be made to the following description which is to be read in connection with the accompanying drawings in which:

Fig. 1 is an exploded view partly cut away, of one embodiment of the invention as applied to a circular screen tube;

Fig. 1A is a perspective view of a circular mask and screen tilted on adjacent edges to show details of fittings;

Fig. 2 is an exploded view partly cut away, of an embodiment of the invention as incorporated in a rectangular screen tube;

Fig. 2A is a perspective view of a rectangular mask and screen tilted on adjacent edges to show detail of fittings;

Fig. 3 is a fragmentary exploded view, showing details of the cooperation of the spring, V, and ball support;

Fig. 4 is a fragmentary view of the spring and associated members as assembled;

Fig. 5 is a perspective view of an alternative structure of the spring and auxiliary members;

Fig. 6 is a cross-sectional view of a rectangular screen tube, partly cut away to show assembly details;

Fig. 7 is a perspective view of a rectangular shadow mask, partly cut away to show the details of its fabrication; and

Fig. 8 is a perspective view of a rectangular viewing panel, partly cut away to show the details of its construction.

Referring now particularly to Fig. 1, there is shown a color television picture tube generally of the type disclosed by Fyler and Rowe, cited. This type of tube may, with advantage, be used in practicing the present invention. The tube includes a bulb having a viewing end 12 on the inner surface of which phosphor dots are directly deposited in groups of three primary color generators to form a screen. A shadow mask 13 has a circular opening for each group of three phosphor dots on viewing end 12. Mask 13 is curved to conform substantially to viewing end 12. Supporting mask 13 to space and orient it relative to viewing end 12, are three projections. These projections may advantageously be molded integrally of screen 12, or may be cylinders being sealed into suitable holes or otherwise firmly attached to the bulb. One of these projections, which is typical, is shown at 14. The other two projections may be equally spaced from projection 14 about the periphery of viewing end 12. Equal spacing is not a necessary condition, but may be preferable for reasons of ease of fabrication. Mask 13 has a rim portion 15 which has three spaced apertures formed therein, in locations matching those of the projections on the bulb. One of these apertures is shown at 16. In Fig. 1A, apertures 72 and 82 are also visible. Bridging each aperture is a V-shaped foot on a spring such as 17. As will be shown and described in greater detail hereinafter, the foot of each spring has, in addition to the V, a pair of "flats" which are welded to the rim 15 on either side of the aperture.

The width of each aperture is such that it clears the projection or cylinder over which it is set and each projection or cylinder then rests against the two facing sides of a V. This is the case with three of the springs shown, they being the springs which are designed to cooperate with the projections of the bulb. Between the springs described, however, and spaced about the periphery of rim 15 are three additional springs of which

spring 19 is typical. These springs serve merely to hold mask 12 down and for convenience may be similar in structure to spring 17, although the V shape is unnecessary. No apertures exist in rim 15 to cooperate with these springs, but welded on the opposite side of rim 15 substantially at the points of contact with the three additional springs are rounded metallic protrusions of which protrusion 20 is typical. These protrusions are of a suitable height to give the same spacing between rim 15 and viewing end 12 as is provided by the previously described V's and projections or cylinders.

When the mask 13 is inserted in the viewing end of the bulb, the inwardly extending edge of flange 21 on the viewing end of the bulb serves to retain the six compression springs. The springs are made longer than the spacing between flange 21 and the viewing end 12. A resilient material such as a steel strip is used, and each spring is bowed sufficiently to insure the application of considerable pressure to rim 15.

The location and orientation of the V's is such that the lines formed by their apices lie in a plane perpendicular to the longitudinal axis of the tube. Further, these lines radiate outwardly substantially from that axis. In Fig. 1A, one form of the matching structures is shown. On the viewing end 12, about the periphery of the screen formed thereon, are three projections 14, 74 and 84. In this embodiment of the invention, the projections are hemispherical and are equally spaced about the screen, but these are preferred rather than necessary conditions. As also shown on rim 15, there are three metallic protrusions 20, 70 and 80 which are disposed in locations diametrically opposed to those of the V's. These protrusions may be rounded or otherwise shaped such that the desired spacing between mask and screen is retained. They, too, are preferably, but not necessarily, equally spaced in this case about rim 15.

Openings are provided at three points located by reference numerals 16, 72 and 82 about rim 15 to accommodate projections 14, 74 and 94. These will be determined in their sizes and locations by the configuration, sizes and locations of their cooperating projections or cylinders. These openings are backed by the V's mentioned above, and described in greater detail hereinafter.

The orientation of the V's is such that other benefits are also derived. Expansion and contraction with temperature change takes place evenly and is distributed over the entire surface of mask 13, the V's merely being in firm contact with their associated projections rather than being attached thereto. Because mask 13 responds to changes in temperature much the same as a portion of a spherical surface, expansion and contraction are had partially in a direction along the tube axis. As a result, loss of registration between phosphor dots on the screen and apertures in the mask is negligible, even over wide ranges of temperature. More important, the mask is uniquely located relative to the screen by reason of the six contact surfaces between the V's and the hemispheres.

Referring now to Fig. 2, there is disclosed a picture tube having a rectangular curved screen 32 on which are deposited phosphor trios entirely similar to those described with reference to Fig. 1. Also, as in Fig. 1, a shadow mask 33 is provided having a circular opening for each group of three phosphor dots on screen 32. Mask 33 has a curvature conforming to that of screen 32. At three points on the periphery of screen 32, rounded projections are disposed. These projections, also as in Fig. 1, may with advantage, but not necessarily, be hemispherical and equally spaced. One of these rounded projections 34 is visible in this view. The other two projections 75 and 85 are located in the two corners of the screen at the right as shown in this view. All three of the projections are plainly visible in Fig. 2A. Mask 33 has three openings provided in its rim at points corresponding to the locations of the three projections. Mask 33 has been partially cut away to illustrate more clearly a typical opening at 35.

Bridging opening 35, is a V-shaped foot of spring member 37. Similar openings, V bridges and springs are found at each of the corners of mask 33 remote from spring member as seen at 76 and 86 in Fig. 2A. Each of the openings is of sufficient size to clear the projection with which it is associated. As a result, each of the projections is in contact with the two facing sides of the V with which it cooperates. At three other locations, namely, the right center of the periphery of the screen, and the two corners, at the left of this view, metallic protrusions are provided, protrusion 31 being typical and visible in this view. The additional protrusions 77 and 87 are seen in Fig. 2A. These protrusions are of the proper height to provide the same mask to screen spacing as that provided by the V's and projections. No openings are provided in the rim of mask 33 at the points of location of the protrusions. Springs, however, such as 38 are provided to hold the protrusions on the rim of mask 33 in contact with the screen surface. The metallic protrusions may, if desired, be replaced by glass lands or pads integral with or attached rigidly to the screen surface extending sufficiently far inwardly from the screen to provide the same mask to screen spacing as is provided by the rounded projections and V combinations. All of the springs used in this embodiment are similar and are of greater length than the distance from screen 32 to the interior of flange 44. Hence, when mask 33 is placed against screen 32, all of the springs are bowed sufficiently to cause the application of considerable pressure to the rim of mask 33. In this fashion, the mask is held firmly in place. As described with reference to Fig. 1, the spherical configuration of the mask gives the same benefits of unique location and maintenance of registration that are found in the circular tube of Fig. 1.

Referring now to Fig. 3, there is illustrated, fragmentarily, a typical example of the spring sub-assembly which is used in the embodiments of Fig. 1 and Fig. 2. In the view there are shown a spring, a portion of the mask and its rim, and a portion of the screen including a rounded projection. Fig. 4 shows these parts as assembled. It will be noted that spring 51 may advantageously be made up of leaves which may be fastened together in any convenient fashion, as by welding. The spring is preferably designed in such a manner in order that the major component of force exerted by the spring when it is assembled as shown in Fig. 4 will be in a vertical direction. Numerous resilient structures could be used as alternatives, but the leaved springs described are preferred in the present embodiment. Mask 52, as may be seen, has a typical opening formed in the rim thereof. The V formed in the foot of spring 51 bridges the opening in mask 52 when the device is assembled. The flat areas on either side of the V are welded to the mask rim at opposite points adjacent the opening. This can be better seen by close examination of Fig. 4. Finally, on screen 53, there is provided a rounded projection 54 over which the opening in mask 52 fits and upon which the V of spring 51 rests. As is clear from Fig. 4, when spring 51 is welded in place on mask 52 and the assembly is completed, the placement of mask 52 in the screen end of the bulb results in spring 51 being bowed to some extent. Because the spring is made of resilient material, a great deal of pressure is provided to retain mask 52 in place against the projections on the screen surface.

Referring now to Fig. 5, there is disclosed a structure which operates to produce the same result as is enjoyed utilizing the structure of Fig. 4. In this case, however, mask 52 is supported by a projection 54 being located in the opening of mask 52 and against a V member 61. Extending up from projection 54 is a rod which is sealed in position centrally thereof. An opening elongated substantially radially of the screen is provided in V 61 through which rod 62 extends. Disposed upon V 61, is a washer 63 which aids in retaining the spring 64. A similar washer 65, retains the upper end of spring 64. A crosspiece

66 is welded in place upon rod 62 to bear against washer 65, thereby compressing and retaining spring 64 in place. The strength of spring 64 and the point of welding cross-piece 66 are suitably chosen to insure the application of considerable pressure to retain mask 52 in place.

In Fig. 5, as in Fig. 4, the general principles of the invention outlined hereinabove are used, three spaced rounded projections on the bulb itself and radial V's associated with the mask providing proper spacing and orientation of mask and screen. The elongated openings as in V 61 permit the same degree of freedom of expansion and contraction as previously discussed. Where it is necessary, as has been shown, additional springs and spacers are used, not for orientation, but only to insure uniform spacing of mask and screen about the entire periphery of the mask and screen. These members only provide appropriate spacing without inhibiting freedom of the mask to expand or contract under the influence of temperature changes.

Referring now to Fig. 6, a cross-sectional view of an alternative rectangular tube shows differences in structure over Fig. 1 which provide certain advantages. The phosphor trios 100 are deposited on the inner face of a transparent viewing panel 101 by photographic means through the holes 102 in the aperture mask 103. Unique positioning of the aperture mask 103 with respect to the phosphor trios 100 is again effected by the cooperation of three hemispherical projections 104 (one of which is shown in cross-section) and V blocks 105 (one of which is shown) attached to the aperture mask 103. The manner in which the V's 105 and hemispherical projections 104 cooperate is the same as that of the matching structures explained with reference to Fig. 1A.

Limitations presently existing in the manufacture of glass have made it necessary to grind the inner surface of the transparent viewing panel 101 to provide a suitable spherical contour. More recent developments indicate that the spherical contour may be achieved by molding. The ground surface is buffed to maximize the transmission of light from the phosphor trios 100 through the viewing panel 101 during operation. The radii of curvature of the viewing panel 101 and the aperture mask 103 may be mismatched so that the ratio of the distance from the so-called deflection center of the electron beam (marked "a") to the aperture mask 103 and the distance from the aperture mask 103 to the viewing panel 101 remains substantially constant at all points. Maintenance of such a ratio is necessary to ensure an even distribution of phosphor trios 100 per unit area over the face of the viewing panel 101 when the phosphors are photographically deposited. An even distribution of phosphor trios 100, in turn, results in constant light output per unit area during operation. Several pedestals 106 such as the one shown in cross-section on the right hand side of the panel 101, may be molded integrally with the panel 101. The tops of these pedestals furnish a bearing surface for the aperture mask 103. Resistance to radial expansion of the mask 103 is minimized by grinding the tops of the pedestals 106 to the same radius of curvature as the aperture mask 103. In the preferred embodiment, seven pedestals 106 are formed. However, the number of pedestals 106 is not critical, it merely being necessary that the aperture mask 103 be properly supported around its periphery so that warping does not occur. The aperture mask 103 is resiliently held against each of the pedestals 106 by springs 107 which act in the same manner as the spring 19 described in connection with Fig. 1. An electron shield 108 may be used to advantage to prevent unwanted phosphor excitation and thus improve the color purity around the edges of viewing panel 101. The construction and placing of a device such as electron shield 108 is described in detail in the co-pending application Serial No. 483,923, entitled "Color Tube Shield," by the applicant in the present case, both applications being assigned to the same assignee. In addition,

a thin layer of aluminum may be deposited on the phosphor trios 100 to improve contrast and a thin layer 110 of a conductive material such as that known in the trade as "Aquadag" may be deposited on the inner surface of the panel 101 and the funnel 111 as shown to act as an accelerating anode and to complete the required electrical circuit through the tube. The aluminizing of phosphor and the use of materials such as aquadag are well known in the art. Neither is essential to the invention disclosed herein, but each improves the tube which incorporates the invention.

Referring now to Fig. 7, the details of construction of a rectangular aperture mask are shown. The mask shown in Fig. 7 is preferably constructed from a single piece of electrically conductive material, blackened to make a more perfect radiator of heat. Although the mask is preferably fabricated from a single sheet, explanation is easier if the mask is considered by parts. In Fig. 7, a peripheral fold 112 is shown. Fold 112 is substantially vertical as shown and serves to stiffen the mask to make it easy to handle without danger of bending. Immediately inwardly of the peripheral fold 112, is a curved section 113. The curvature of the section 113 is substantially the same as perforate section 116. Two purposes are accomplished by the curved section 113. The first purpose of the curved section 113 is to provide a base for the mounting of the V's 117. The V's are mounted exactly as those described in connection with Fig. 1 except that section 113 is curved. Since the V's 117 are located on a spherical surface, variation in the exact points of contact between the V's 117 and the hemispherical projections 104 does not affect the distance between the viewing panel 101 and the aperture mask 103 (as shown in Fig. 6). The independence of the mask spacing from the point of contact of the hemispherical projections 104 and the V's 117 allows the use of relatively imprecise parts. Use of such parts, of course, lessens the cost of the tube.

The second purpose of the curved section 113 is to allow expansion of the mask when it is assembled without subjecting it to any forces which may cause the mask to wrinkle around its edges. Immediately inwardly of the curved section 113, is a folded portion consisting of a first section 114 and a second section 115. The ratio of the length of the first section 114 to the second section 115 is held constant around the periphery of the mask. The purpose of the folded portion is to give the mask additional stiffness so that bending is minimized. The ratio of the length of the first section 114 to the second section 115 is preferably held constant to impart a constant amount of stiffness around the periphery of the mask. If the mask has variations in stiffness around its edge, wrinkling of the perforate section 116 is likely to occur during the manufacturing process when the mask is subjected to elevated temperatures. The undulate form of the described portions of the aperture mask is a direct consequence of forming a substantially rectangular shape on the surface of a sphere; if the outline of the aperture mask were round, the undulations would not exist. Immediately inwardly of the folded portion is the perforate section 116. The perforate section has a predetermined radius of curvature depending on the size of the tube, but substantially matching that of the inner surface of the viewing panel of the tube. Circular openings 118 are provided over the area of the perforate section 116 to allow separate energizing of the various phosphors as described hereinbefore with reference to Fig. 1.

Referring now to Fig. 8, the manner in which the transparent viewing panel is constructed can be clearly seen. The spherical shape of the viewing panel 120 is clearly shown in the cutaway section of Fig. 8. Upwardly extending walls 121 are molded integrally with the viewing panel 120 to terminate in a plane. A metallic flange 122 is sealed to the ends of the upwardly extending walls 121 preferably using standard glass-to-metal sealing tech-

niques. An annular groove may be impressed in the flange 122 to serve as a locating means for the electron shield (as at 108 in Fig. 7).

Three projections 123 each having a hemispherical portion are molded integrally with the viewing panel 120. Seven pedestals 124 are also molded integrally with the viewing panel 120. The inner surface of the viewing panel 120 is ground and buffed merely to insure a smooth spherical base on which the phosphor trios 125 are deposited. The tops 126 of each of the pedestals are ground to substantially the same spherical shape as the curved portion of the aperture mask and of the inner viewing panel surface.

The hemispherical portions of the three projections are used as reference points for the grinding operations on the inner surface of the viewing panel 120 and the pedestals 124. The phosphor trios 125 are deposited on the ground and buffed spherical portions of the viewing panel 120 in the manner described hereinbefore with respect to Fig. 1. After the trios 125 have been deposited, a thin layer of aluminum 127 may be advantageously deposited to improve the brightness of the phosphor trios 125 in operation. It should be noted that numerous details of construction of the various parts of the panel may be changed without departing from the concepts of the present invention. Examples of such changes are changing the number and spacing of the pedestals 124 or using inserts in place of the integrally molded pedestals and hemispherical projections.

Although several specific embodiments of the present invention have been disclosed, they are only given by way of illustration. Numerous possible modifications may suggest themselves to those skilled in the art. For example, V members might be formed, as by embossing in the mask, rather than in the feet of the springs. The invention also lends itself to simple adaptations and incorporation in systems employing line color screens and shadow or switching masks formed as grids or having rectangular apertures. Such changes in structure as well as others of a similar nature are believed to be within the concepts of the present invention, which should be limited only by the spirit and scope of the appended claims.

What is claimed is:

1. In a color television picture tube, the combination of a curved screen, a curved mask, three fittings disposed within said tube cooperating with said curved mask at predetermined points on the periphery thereof and three springs maintaining said curved mask in contact with said fittings one of each of said springs bearing on said mask oppositely one of each of said fittings.

2. In a color television picture tube, a bulb having a viewing end, a phosphor screen disposed upon the inner surface of said viewing end, an aperture mask, three projections disposed upon said inner surface adjacent the periphery of said phosphor screen accommodating said aperture mask, and three resilient means maintaining said aperture mask in contact with said projections one of each of said resilient means bearing on said aperture mask oppositely of one of each said projections.

3. In a color television picture tube, a bulb having a viewing end, said viewing end being formed in a curve, a phosphor layer deposited in discrete dot-like portions upon the inner surface of said viewing end, an aperture mask curved to conform substantially to the curvature of said viewing end, said aperture mask having a plurality of circular apertures formed therein, said apertures being disposed in a predetermined relationship to said dot-like phosphor portions three projections disposed upon said inner surface of said bulb adjacent said phosphor layer, said mask having means thereon disposed on said three projections on said inner surface of said bulb for cooperating with said projections, and a like number of means resiliently and slidably holding said aperture mask in contact at said cooperating means with

said projections to maintain the surface of said aperture mask substantially parallel to said viewing end.

4. In a color television picture tube having a luminescent screen, a mask adjacent thereto, and a flange extending inwardly of said tube at a point spaced from said screen and said mask, apparatus for spacing and orienting said mask relative to said screen comprising, a plurality of generally hemispherical projections disposed about the periphery of the inner surface of said screen, a like plurality of openings formed about the periphery of said mask, and compression springs having V bases bridging said openings and welded to the periphery of said mask, said V bases being disposed radially of said mask, said compression springs being disposed between said flange and the rim of said mask to retain said hemispherical projections in intimate contact with said V bases and thereby to space and orient said mask properly relative to said screen.

5. Apparatus for orienting and spacing a mask relative to the screen in a color television picture tube comprising, a plurality of glass hemispheres extending inwardly and spaced about the periphery of said screen, a like plurality of apertures being formed in the rim of said mask, said apertures being sufficiently large to fit over said glass hemispheres, a like plurality of compression springs, each having V indentations formed in one end thereof, a flange on said tube for retaining the other ends of said springs, the ends of said springs having said V indentations being welded to the rim of said mask and disposed such that said V's bridge said openings, are in contact with said glass hemispheres, and lie in lines substantially radial of said mask.

6. In a color television picture tube, a bulb having a viewing end, said viewing end being formed in a curve, a phosphor layer deposited in discrete dot-like portions upon the inner surface of said viewing end, the combination which comprises, an aperture mask curved to conform substantially to said viewing end, said aperture mask having a plurality of circular apertures formed therein, said apertures being disposed in a predetermined relationship to said dot-like phosphor portions, a plurality of projections disposed upon said inner surface about the periphery of said phosphor layer, means on the rim of said aperture mask accommodating said projections, and means resiliently retaining said aperture mask in contact with said projections, said last named means being disposed to exert force only along the longitudinal axis of each said projections.

7. In a color television picture tube of the type having a phosphor dot screen, an aperture mask, and a bulb cut adjacent its viewing end with flanges sealed on the cut ends thereof, apparatus for spacing and orienting said aperture mask relative to said screen comprising, three glass hemispheres spaced about the periphery of said screen and extending inwardly thereof, three openings formed in the rim of said mask and disposed in locations matching those of said three glass hemispheres, said openings being sufficiently large to clear said hemispheres, and three compression springs made of metallic leaves fastened together, one end of each said spring being formed into a right angle, the outwardly extending portion of said right angle being formed into a central V having flat areas on either side thereof, each said V being disposed such that it bridges one of said openings in said rim, said flat areas being welded to said rim, the other ends of said compression springs being retained by said flange on the cut end of said viewing end, the length of said springs being greater than the distance from said flange on said viewing end to said screen, whereby said mask is uniquely located and firmly retained relative to said screen.

8. A color television picture tube including an evacuated envelope, said envelope having a curved viewing end substantially rectangular in outline, a luminescent screen disposed on the inner surface of said viewing end and having a plurality of symmetrically arranged groups

of phosphors, each said group having a plurality of dot-like phosphor elements, each said element having a different predetermined color response, three projections being affixed to said envelope and adjacent the periphery of said luminescent screen at substantially equal intervals, each of said three projects having substantially the same predetermined height, a plurality of pedestals of equal height being affixed to said envelope and being interspaced between said three projections, the top of each of said pedestals having a curvature substantially matching the curvature of said viewing end, the height of said three projections being greater than the height of said pedestal by a predetermined amount, an aperture mask having substantially the same curvature as said viewing end, said aperture mask having a plurality of circular apertures formed therein, said apertures being disposed in a predetermined relationship to said symmetrically arranged groups of phosphors, means being affixed to said aperture mask adjacent the periphery thereof cooperating with two points on each of said three projections, the two points on each of said three projections being substantially equally spaced from the center of said viewing end, and means resiliently urging said aperture mask into contact with said curved tops of said pedestals and said three projections.

9. In a rectangular color television picture tube, the combination of a bulb having a rectangular viewing end, a phosphor screen disposed upon the inner surface of said viewing end, a rectangular aperture mask, pedestals disposed upon said inner surface for accommodating said aperture mask, the top of each of said pedestals having a predetermined curvature, and resilient means for maintaining said aperture mask in contact with each said top.

10. A rectangular color television picture tube comprising, a bulb having a rectangular viewing end, said viewing end being formed in a curve, a phosphor layer deposited in discrete dot-like portions upon the inner surface of said viewing end, an aperture mask curved to conform substantially to said viewing end, said aperture mask having a plurality of circular apertures formed therein, said apertures being disposed in a predetermined relationship to said dot-like phosphor portions, a plurality of projections disposed upon said inner surface about the periphery of said phosphor layer, the top of each of said projections being curved to conform substantially to said curved aperture mask, means on the curved portion of said aperture mask adjacent the rim thereof for accommodating said projections, and means for resiliently retaining said aperture mask in contact with said projections.

11. An aperture mask for a rectangular color television picture tube comprising, a first and a second curved portion with a fold portion disposed therebetween, said curved portions having a predetermined common radius of curvature, said first curved portion having a plurality of apertures formed therein, said aperture mask having substantially a rectangular outline, said folded portion having a first and a second section, the ratio of the length of said first section of said folded portion to said second section of said folded portion being substantially constant at all points about said aperture mask.

12. An aperture mask for a color television picture tube with a curved rectangular viewing screen comprising, a curved sheet having substantially the same curvature as said viewing screen, the periphery of said sheet being substantially rectangular, the central portion of said sheet having a plurality of apertures formed therein, and a continuous fold in said sheet, said fold being disposed outwardly of said central portion and having substantially equal sides at all points.

13. Apparatus for uniquely positioning a curved aperture mask in proximity to the viewing end of a color television picture tube comprising three projections, said projections being affixed to and spaced at predetermined points around said viewing end and projecting inwardly

therefrom a predetermined distance, a plurality of pedestals affixed to the inner surface of said viewing end, interspaced between said projections and projecting inwardly of said viewing end substantially the same distance as said projections, the top of each of said pedestals having substantially the same curvature as the curvature of the inner surface of said viewing end, three V blocks, each of said V blocks being affixed to predetermined curved portions of said aperture mask adjacent the periphery thereof at a point corresponding to one of said projections on said viewing end, said V blocks being disposed radially of said mask, an annular flange affixed to the wall of said tube, said flange being disposed at a predetermined distance from said viewing end and substantially parallel to the periphery thereof, and a plurality of springs, each of said springs being disposed between said flange and said aperture mask to urge each of said V blocks against two points on one of said projections on said viewing end and to urge predetermined curved portions of said aperture mask against the top of each of said pedestals.

14. In a color television picture tube, an assembly of a curved viewing end and curved aperture mask comprising, a predetermined array of phosphor elements, said phosphor elements being disposed on the inner surface of said curved viewing end, three similar projections affixed to said envelope adjacent the periphery of said curved viewing end and projecting inwardly thereof, a plurality of pedestals affixed within said tube adjacent said curved viewing end, projecting inwardly thereof and being interspaced between said projections, the top of each of said pedestals having a radius of curvature only slightly less than that of said viewing end, the height of each of said projections and each of said pedestals being substantially the same, an aperture mask, said mask having a curvature substantially the same as the curvature of said tops of said pedestals and having a predetermined array of apertures formed therein to correspond with said predetermined array of phosphor elements, three V blocks affixed to said aperture mask, an annular flange being affixed to the wall of said tube, said flange being disposed at a predetermined distance from said viewing end and substantially parallel to the periphery thereof, and a plurality of springs, each of said springs being disposed between said flange and said aperture mask whereby two points on each of said V blocks are urged against two points on one of said projections and predetermined curved portions of said aperture mask are urged against said curved tops of said pedestals.

15. In a rectangular color television picture tube having a curved rectangular luminescent screen, a curved rectangular mask adjacent thereto, and a flange extending inwardly of said tube at a point spaced from said screen and said mask, apparatus for spacing and orienting said mask relative to said screen comprising, a plurality of generally hemispherical projections disposed about the periphery of the inner surface of said screen, a like plurality of openings formed about the periphery of said mask through predetermined curved portions thereof, a plurality of pedestals disposed about the periphery of the inner surface of said screen between said projections, said pedestals having tops curved to conform to the curvature of said luminescent screen, a first plurality of compression springs having V bases bridging said openings and welded adjacent the periphery of said mask, the apices of said V bases lying in planes which intersect substantially at the center of said curved luminescent screen, and a second plurality of compression springs attached to said mask in juxtaposition to said pedestals, all of said compression springs being disposed between said flange and the rim of said mask to retain said hemispherical projections in intimate contact with said V bases, to urge said mask against said curved tops, and thereby to space and orient said mask properly relative to said screen.

16. Apparatus for orienting and spacing a curved rectangular mask relative to the curved rectangular screen

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in a color television picture tube comprising, a plurality of glass hemispheres extending inwardly and spaced about the periphery of said screen, a like plurality of apertures being formed adjacent the rim of said mask through curved portions thereof, said apertures being sufficiently large to fit over said glass hemispheres, a like plurality of compression springs, each having V indentations formed in one end thereof, a flange on said tube for retaining the other ends of each said springs, the ends of each said springs having said V indentations being welded to the rim of said mask and disposed such that said V's bridge said openings, are in contact with said glass hemispheres, and lie in lines substantially radial of said mask.

17. In a cathode-ray tube, an assembly comprising an envelope cap including a transparent viewing portion; a fluorescent screen on the inner surface of said viewing portion; an apertured electrode spaced from said screen; and means for mounting said apertured electrode in said envelope cap with predetermined orientation and spacing between said electrode and said screen; said means comprising a rigid frame permanently attached to said electrode, three spaced seats carried by said frame, three rigid protuberances carried by said envelope cap and each engaging one of said seats, and spring means releasably holding said seats and protuberances in engagement.

18. In a cathode-ray tube, an assembly comprising an envelope cap including a transparent viewing portion;

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a fluorescent screen on the inner surface of said viewing portion; an apertured electrode spaced from said screen; and means for mounting said apertured electrode in said envelope cap with predetermined orientation and spacing between said electrode and said screen; said means comprising a rigid frame permanently attached to said electrode, three spaced tracks carried by said frame and having axes that extend outwardly from the central portion of said apertured electrode, three rigid protuberances carried by said envelope cap and each engaging one of said tracks, and means releasably holding said protuberances and tracks in engagement.

19. An assembly as in claim 17, wherein said seats are formed by V-notches formed in said frame.

20. An assembly as in claim 18, wherein said tracks are formed by V-grooves in which said protuberances are seated.

21. An assembly as in claim 20, wherein said holding means comprise at least one leaf spring releasably connected between said frame and said envelope cap.

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