

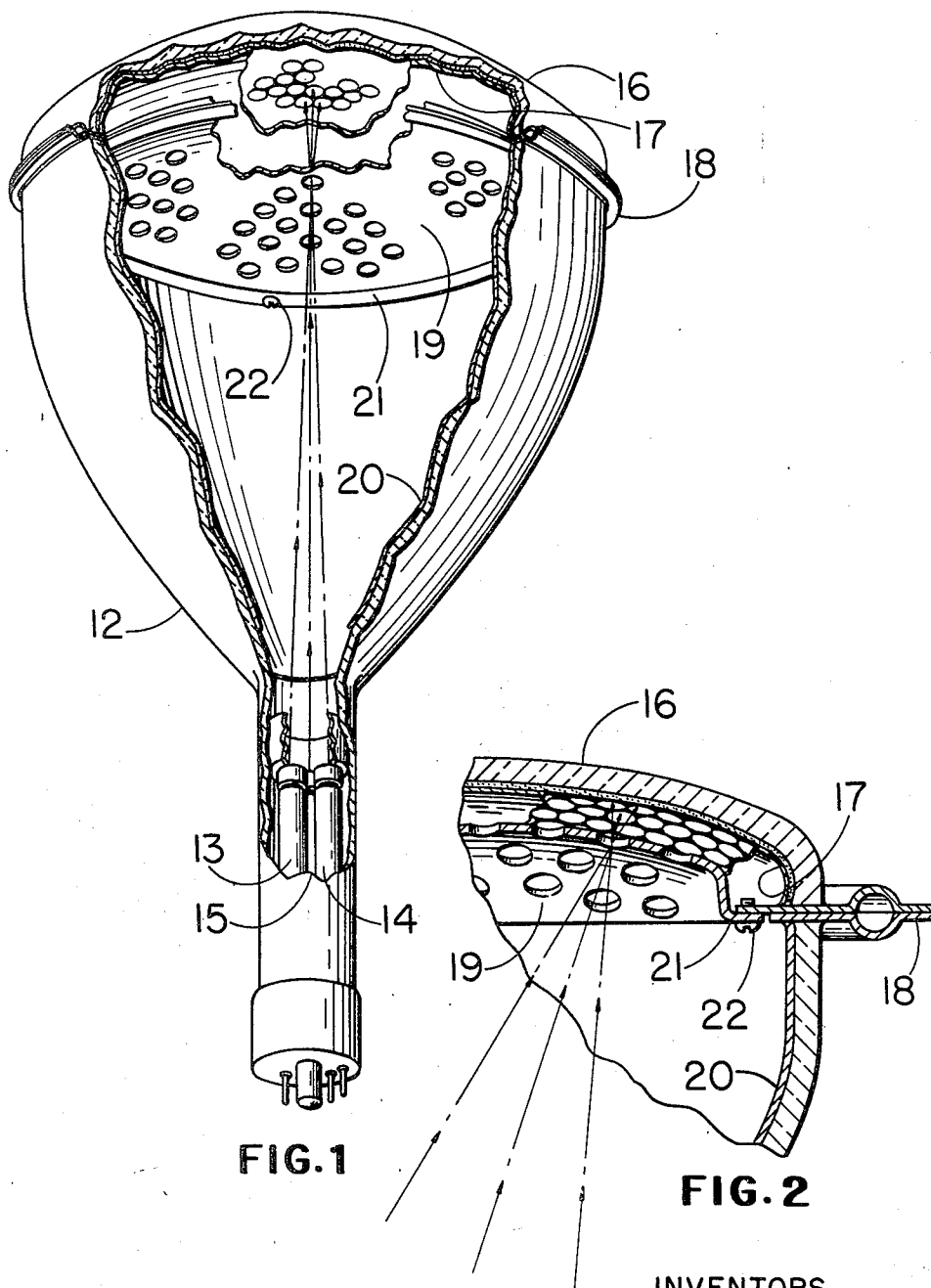
Sept. 28, 1954

N. F. FYLER ET AL
COLOR PICTURE TUBE

2,690,518

Filed June 1, 1953

3 Sheets-Sheet 1



INVENTORS
Norman F. Fyler
William E. Rowe
By: *George W. Crowley*
ATTORNEY

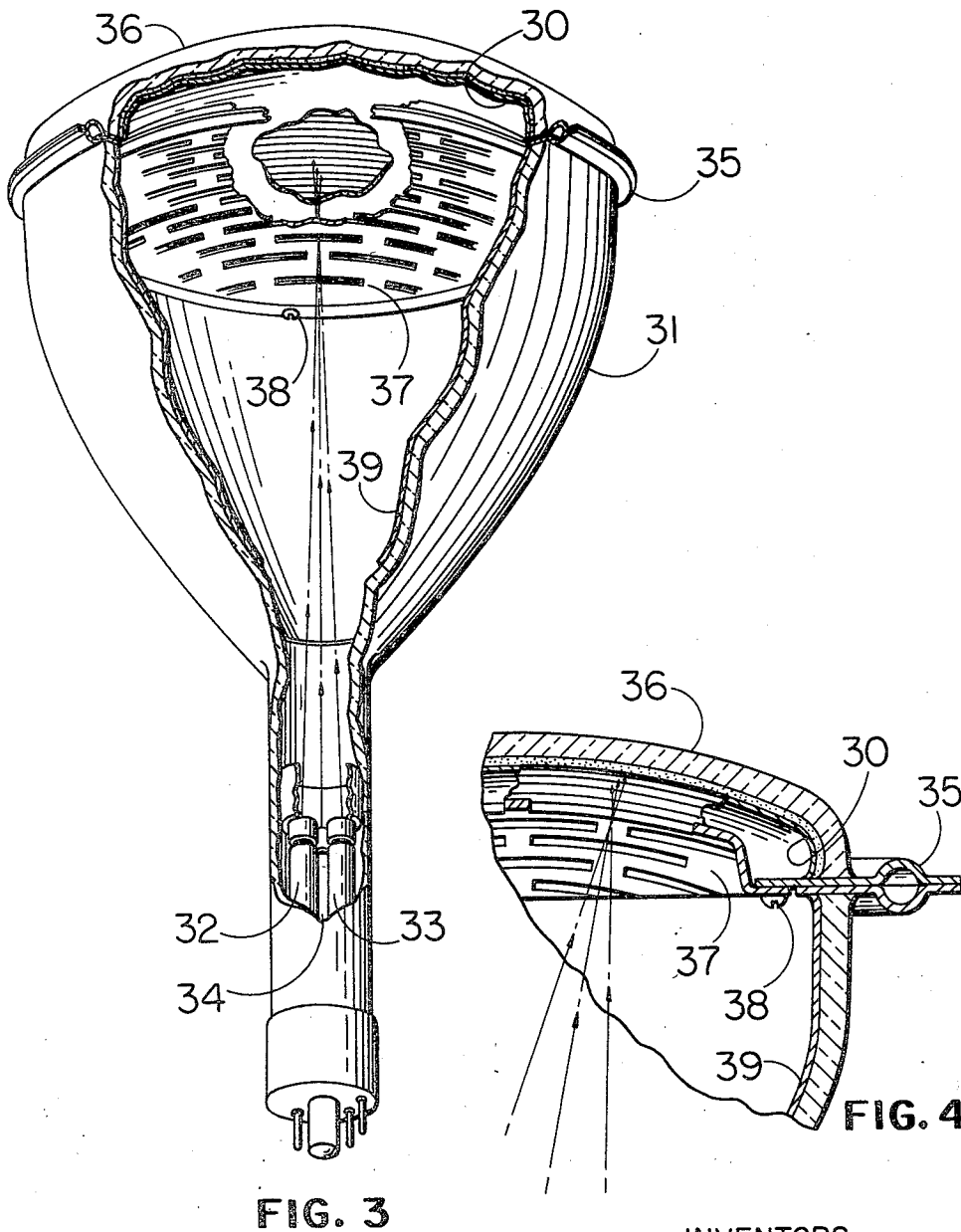
Sept. 28, 1954

N. F. FYLER ET AL
COLOR PICTURE TUBE

2,690,518

Filed June 1, 1953

3 Sheets-Sheet 2



INVENTORS
Norman F. Fyler
William E. Rowe
By: *George W. Crowley*
ATTORNEY

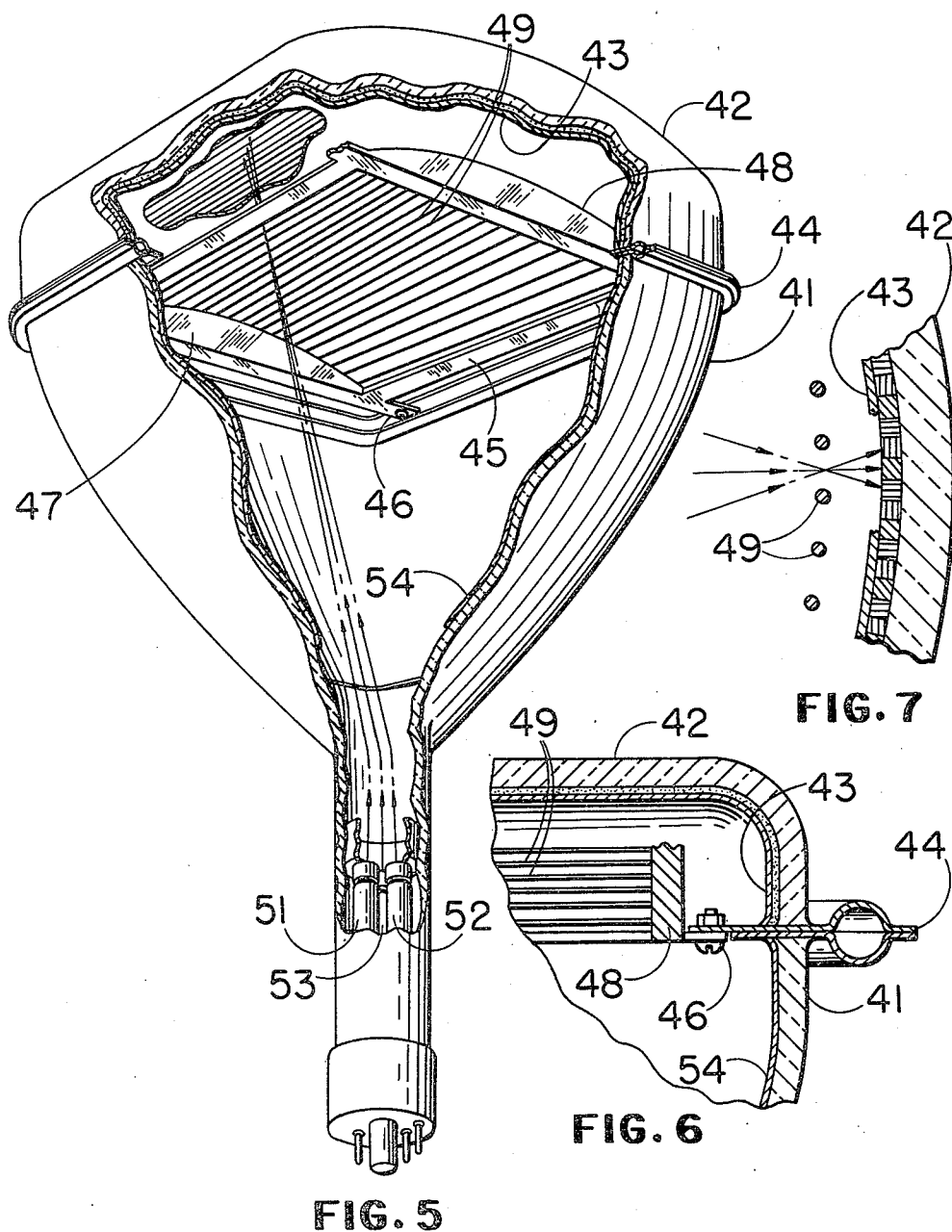
Sept. 28, 1954

N. F. FYLER ET AL
COLOR PICTURE TUBE

2,690,518

Filed June 1, 1953

3 Sheets-Sheet 3



INVENTORS
Norman F. Fyler
William E. Rowe
By: *George W. Crowley*
ATTORNEY

UNITED STATES PATENT OFFICE

2,690,518

COLOR PICTURE TUBE

Norman F. Fyler and William E. Rowe, Newburyport, Mass., assignors to Columbia Broadcasting System, Inc., Danvers, Mass., a corporation of New York

Application June 1, 1953, Serial No. 358,712

11 Claims. (Cl. 313—70)

1

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

Terminal devices in color television systems have taken numerous forms. At this time, however, the emphasis is on cathode ray tubes utilizing phosphors generating the primary colors: red, blue, and green. In most present-day tubes, a separate gun is used for each type of phosphor, the phosphors themselves are usually disposed upon a flat plate either as minute dots or, in some instances, as stripes running either vertically or horizontally.

The present invention is primarily concerned with improved structures for tube types which utilize the phosphor dots or stripes and triple guns as mentioned above. In these tubes it has been the practice to mount three guns in the neck of the tube and to provide a single deflection yoke for the beams of these guns. The guns are disposed such that the electron beams converge in an opening in a so-called shadow mask or aperture mask. This shadow mask is and has been made of metal, or conductive glass, or other suitable material and is in the form of a thin perforated sheet. Adjacent the mask and on the side remote from the electron guns, a flat glass plate is placed. On this plate, in the case of the dot type phosphors, for each perforation in the aperture mask, there is disposed a trio of phosphor dots for generating each of the three primary colors. These dots are arranged relative to the holes of the mask and to the guns such that a straight line drawn from the point of deflection of the beam of each gun through any given hole in the aperture mask will strike only dots of the color associated with that gun. In other words, each electron beam as it scans, can strike only one dot of each trio and thus may excite only one color. As a result of this arrangement, all three beams can be modulated properly to produce a full color picture. In the case of the phosphor stripe types, the shadow mask has rectangular apertures therein, each aperture being centrally disposed relative to a group of three stripes, each of which emits a primary color upon excitation. Other structures, such as line grids adjacent the screen, have been used in conjunction with the phosphor stripes. Much background information has been published on various tubes of these types, particular attention being invited to the October, 1951, issue of "Proceedings of the Institute of Radio Engineers" which was devoted exclusively to color television papers.

2

Although some success has been achieved with tubes of the type briefly described above, numerous disadvantages have been encountered. Many of the disadvantages stem directly from the design of the tube. The preparation of a mask which must be maintained flat and parallel with a flat screen is a very difficult procedure. The mask is heated and kept at an elevated temperature by means of hot blocks or other cumbersome apparatus during assembly into its frame. The mask is clamped while hot across the frame and subsequent cooling causes shrinkage of the mask and considerable tension to be built up which tends to maintain the mask flat and parallel to the screen after assembly therewith. Despite these precautions, the mask becomes seriously distorted and buckles under the influence of heat created by electron bombardment when that bombardment exceeds a critical point. The effect of the bombardment is to enlarge the mask sufficiently to neutralize the initial elastic distortion introduced by hot blocking. When this point is reached, any slight further expansion in length or width of the mask causes a disproportionately large amplitude displacement of the mask. In other words, the flat mask actually flips to either side causing serious loss of registry between mask and screen.

The composite assembly is fastened in place within the conical end of the picture tube bulb. A face plate completes the envelope of the tube, and the screen is then viewed through this face plate. Of necessity, this face plate must have clear glass of excellent optical characteristics.

When exhausting the envelope of the completed tube, still another difficulty is encountered because of the extraordinarily heavy mass of the mask and screen assembly. Great quantities of occluded gases must be removed and it is not convenient to raise the temperature of the mass to the necessary degree in a reasonable length of time. The use of a screen smaller than the face plate makes for insufficient utilization of structure, the mass of a heavy frame and bulky clamping mechanism adds difficulties to assembly and exhaust procedures and the very weight and complexity of the structure makes handling and processing of the tube difficult and hazardous.

Two other problems, similar in nature, are encountered with the flat screen-flat mask structure. One is focus, it being necessary, of course, that each beam come to as small a diameter as possible at the point of contact with the screen.

With a flat screen, a given focus voltage or cur-

rent can bring the beam to focus only at a spot or in any one of a series of substantially circular patterns. Thus, the need arises for dynamic focussing system wherein the focus voltage or current varies with deflection of the beam. The convergence problem is much the same. The three beams must be made to converge at each of the apertures of the mask in order that each may pass through to impinge upon the appropriate phosphor portion. The mask being flat, a dynamic convergence system is also required. Any modification of tube or system to eliminate the need of such special circuitry as is required for dynamic convergence and dynamic focus would be a desirable advance.

Other objectionable features of current color picture tubes are the light loss which necessarily exists as the light passes from the phosphors through the phosphor screen glass and then through the actual face plate of the tube, and, worse, light emanating from the screen being reflected from each surface of the face plate of the tube back to the screen. In this fashion, ghosts are created which dilute the color of the original image, give discomfort in viewing, and, in general, detract from the quality of the picture being presented.

Therefore, it is an object of the present invention to provide a design for a color picture tube which is of simple construction and greater efficiency than those presently being used.

It is a further object of the present invention to provide a color picture tube having higher contrast than present tubes.

It is a still further object to provide a color picture tube of a design which is adaptable to existing and suggested types of picture reproducers.

It is another object to provide a color picture tube structure in which screen and mask are inherently of great mechanical strength.

It is still another object to provide a picture tube requiring negligible convergence circuitry and voltages.

In general, the present invention consists in the combination of a bulb having a curved face plate and a curved shadow mask, or grid, as required by the type of presentation being used. In addition, the phosphors for emitting light of appropriate colors are disposed directly upon the face plate of the tube. The structure of the tube is simple and follows conventional glass bulb design, the only departure from standard structure being in the conical portion adjacent the face plate wherein provision is made to accommodate a shadow mask, or grid. The phosphors on the face plate of the tube may be deposited in any one of several ways, photographic means, however, being preferred. 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 drawings in which:

Fig. 1 is a perspective view of an embodiment of the invention which includes phosphor dot trios and a shadow mask having circular perforations.

Fig. 2 is a section taken through the screen end of a tube similar to that shown in Fig. 1, the curvature of screen and mask being exaggerated;

Fig. 3 is a perspective view of an alternative embodiment of the invention which utilizes vertical phosphor stripes and an aperture mask having rectangular openings;

Fig. 4 is a section taken through the screen end of a tube similar to that shown in Fig. 3 showing details of screen and mask and the means of attachment;

Fig. 5 is a perspective view of a color picture tube which incorporates a line grid adjacent the screen;

Fig. 6 is a sectional view of the screen end of a tube similar to that shown in Fig. 5 showing details of screen and grid, the curvature of both these members being exaggerated; and

Fig. 7 is a cut away view of an end portion of grid and screen of a tube similar to that shown in Fig. 5.

Referring particularly to Fig. 1, a picture tube 12 is illustrated. Within the neck of tube 12 are three electron guns 13, 14, and 15. At the upper end of tube 12 is a screen 16 which has the shape of a spherical section. Deposited upon screen 16 are myriads of phosphor dots and overlying the phosphor dots is a film of aluminum 17. The phosphor dots are arranged in trios having red, blue, and green light emission characteristics. At a short distance along the cone of the tube from the screen 16 is a metallic flange 18. Metallic flange 18 is composed of two roughly similar members, the upper or screen portion of bulb 12 being sealed to one of these members and the lower or conical section being sealed to the other member, the members being welded together. Aluminum film 17 contacts the upper member of flange 18. Details of flange 18 and its function may be better seen and will be explained further hereinbelow in the discussion of Fig. 2. Within tube 12 and supported from upper member of flange 18 is a domed mask 19. Mask 19 contains an opening for each of the phosphor trios mentioned above. The opening in each case is disposed centrally relative to a given trio of phosphor dots. In other words, the apertures in mask 19 are arranged relative to screen 16 and guns 13, 14, and 15 such that a beam emanating from any one of the guns and being deflected across the shadow mask 19 can, in passing through any one of the circular apertures, impinge on only those phosphor dots of a given color. Both the screen 16 and the shadow mask 19 are curved to form spherical sections. It has proven desirable to have the radius of curvature of the screen 16 slightly mismatched to that of the shadow mask 19. It should be noted, however, that excellent performance may still be obtained with matched curvatures for both screen and mask.

The spherical configuration of screen 16 results in substantially perfect focussing of each beam over the entire screen of the tube without resort to dynamic focussing circuits. Similarly, the spherical configuration of mask 19 results in substantially perfect convergence of the three beams in each aperture formed in mask 19. Placement of the phosphors so as to form the screen directly on the face plate of the tube permits the full amount of light emanating from the phosphors, less only that lost in transmission through the screen glass itself, to be available to the viewer. In this connection, the screen being made of dark glass adds to the contrast of the picture. Too, the increased light efficiency obtained permits the outer screen surface to be frosted if that is desirable to reduce specular glare, light output being ample despite the frosted surface of the screen.

Several mechanical and process gains are also obtained. The spherical mask configuration sim-

5

plifies assembly technique, no preheating or maintenance of tension by heavy frame and clamp devices being needed. As is obvious from the drawing and description, the rim is used to support the spherical mask from the flange. This, of course, increases pumping speed when the tube is in process and lowers the cost by a considerable amount both in parts and in process. Most important, the disadvantages of buckling and distortion mentioned hereinabove in the discussion of the flat mask are completely overcome. In a structure of curved cross-section, such as the mask in the present invention, such expansion and contraction as may be encountered is taken up over the entire surface and is partially in a direction parallel to the tube axis resulting in negligible amplitude displacement or loss of registration between mask and screen.

Referring now to Fig. 2, various details of the actual structure of the mask 19, screen 16, and bulb 12 are apparent. A conventional bulb is first made, then the section adjacent the screen end is cut off. The screen section is sealed to a flange member and the conical section is sealed to a similar flange member. The phosphors are photographically deposited in the screen end and then aluminized to enhance light output. A suitably curved shadow mask is prepared and attached to the screen end. The screen section and the conical section are then brought together and a heliarc weld is made to join the flange members. This process generally outlined, as applied to the embodiment shown in Fig. 2, results in a curved screen 16 having phosphor dots symmetrically deposited over its entire inner surface in trios. Each trio includes a red, a green, and a blue light-emitting phosphor dot. A shadow mask 19, curved to substantially conform to the curvature of screen 16 has a rim 21. Rim 21 is attached to the upper or screen member of flange 18 by means of three screws which are threaded into that member through rim 21 at three points spaced 120° apart about rim 21. Screw 22 and its attachment are representative as visible in this view of one type of retaining device which may be used.

Referring now to Fig. 3, there is disclosed a tube which is similar in many respects to that shown in Fig. 1. The bulb 31 is entirely similar to bulb 12 and the electron guns 32, 33, and 34 are identical to the electron guns 13, 14, and 15. The flange 35 is made up of two members similar to the members making up flange 18. Screen 36 is spherical in contour as is the shadow mask 37, again following the design illustrated in Fig. 1.

In this embodiment, however, the shadow mask 37 has a number of rectangular apertures formed therein. The phosphors deposited upon screen 36 are vertical stripes running cyclically, red, green, and blue. For each group of three phosphor stripes on screen 36, there exists a single rectangular aperture which is centrally disposed relative to a group of three phosphor stripes. The rectangular apertures in mask 37 ideally would run entirely across the screen, but to provide sufficient structural strength, each rectangular opening is broken up into a series of rectangular apertures by a series of ribs which are discontinuous from one rectangular opening to another.

The mask 37 is domed to conform to screen 36 and it is held in place by means of three screws or other suitable retainers spaced about the periphery of the mask, screw 38 being visible in this view. The actual method of attachment may be

6

better seen by reference to Fig. 4 which is discussed hereinbelow.

The tube includes an aluminum film 30 which overlies the phosphor stripes to increase contrast, film 30 being carried back to actually contact the upper member of flange 35. Also, as is conventional, a graphite coating 39 is placed within the tube and it also extends to flange 35, contacting the lower member thereof.

The operation of the tube shown in this embodiment is similar to the operation of the tube shown in Fig. 1. Each of the electron beams emanating from gun 32, 33, or 34 can impinge upon phosphors of only one light-emitting type. In other words, as a beam, for example, from gun 32 is scanned across the screen 36, straight lines traced from the point of deflection of the beam from that gun through the apertures of mask 37 impinge upon only phosphor stripes for producing red light. Beams from guns 33 and 34 similarly can excite only phosphors for producing green and blue light respectively.

Referring now to Fig. 4, a sectional view, cut away to show details, is illustrated. The upper member of flange 35 is threaded to receive screw 38 which passes through the rim of mask 37. As mentioned hereinabove, three screws of this type are used to retain mask 37 in place. The sectional view shown here indicates the operation of mask 37. Beams from guns 32, 33, and 34 pass through the rectangular aperture through which this section is taken. By virtue of the displacement of the electron guns relative to one another, the directions of the beams are such that each strikes a phosphor stripe of the group of this color. The same holds true, of course, for each group of phosphor stripes and its associated rectangular aperture. Here, as in the version of the tube shown in Figs. 1 and 2, a heliarc weld is made between the extremities of the two members of flange 35 when the tube is completely assembled.

Referring now to Fig. 5 of the drawing, there is shown a bulb 41 having a cylindrical face 42 upon which phosphors are deposited in parallel stripes to form a screen. To enhance brightness, a thin film of aluminum 43 overlies the phosphor stripes. Bulb 41 is of the rectangular screen type, for ease of accommodation of the various elements making up the tube, but could have a circular screen and be used with equally good results. As in the case of the other types described hereinabove, a flange 44 surrounds the envelope of bulb 41 adjacent the screen end. Flange 44 comprises two members, one sealed to the screen portion and the other to the conical portion of the bulb, the two members being welded together to form the final assembly. Aluminum film 43 and a conventional graphite coating 54 are carried to a point of contact with flange 44. A frame 45 is supported at its corners from the upper member of flange 44, the tongue and screw at 46 being one suitable type of retainer. Frame 45 includes arcuate combs 47 and 48, the upwardly facing surfaces having radii of curvature closely matching that of the cylindrical face of the screen. Grid wires 49 are stretched in parallel relationship from cone 47 to cone 48. The spacing of these wires has been exaggerated in order that the operation of the device may be more easily seen. The distance from grid wires 49 to the phosphors on screen 42 has also been exaggerated to indicate more clearly the separation of the three beams from electron guns 51, 52, and 53.

In Fig. 6, a section of the tube shown in Fig. 5 is illustrated. As in the case of the other versions of the invention disclosed above, the two members comprising flange 44 are welded together at their extremities. Tongue and screw 46 attach mask frame 45 to the upper member of flange 44, similar tongues and screws being utilized at the other three corners of frame 45.

In Fig. 7, detail of screen 42 is shown. A section taken along the longitudinal axis of the tube shows grid wires 49, and electron beams are represented as passing between a pair of those grid wires. The aluminum film 43 is cut away to better indicate the impingement of specific electron beams upon specific phosphor stripes.

The version of the tube discussed above in reference to Figs. 5, 6, and 7, may be operated in a manner entirely similar to the embodiment shown in Figs. 3 and 4. However, by simple modification, operation of this embodiment may be had with comparable advantages where alternate grid wires have potentials for beam shifting applied thereto. That is, switching with a single gun, or correction of beam position in the case of three guns, may be obtained without departure from the concepts of the present invention. The major modifications required would be to insulate alternate grid wires from each other, either by the use of metallic combs with inserts of insulating material, or by the use of insulating surfaces at the point of contact between combs and grid wires and to provide suitable electrical connections through the bulb to appropriate grid wires. Although the embodiments of the present invention now preferred include only spherical mask and screen surfaces or cylindrical mask and screen surfaces, most of the advantages of the invention can be realized by use of matched parabolic, hyperbolic, or elliptical surfaces for screen and mask. Such matched curved surfaces used in conjunction with phosphors deposited in the manner disclosed directly upon the screen of a picture tube are believed to be within the purview of the invention which should be limited only by the spirit and scope of the appended claims.

What is claimed is:

1. A picture tube for the presentation of television images in color comprising, an envelope having a curved surface, phosphors for emitting light of the three primary colors, red, blue, and green being symmetrically disposed in groups of three light-emitting types in discrete portions in a single layer over said surface within said envelope, three electron guns within said envelope, each of said guns generating an electron beam to excite separately phosphor portions of each light-emitting type, a mask having a contour substantially matching that of said curved surface disposed within said envelope between said electron guns and said curved surface, but closer to said curved surface, said mask having a plurality of apertures formed therein, said apertures being so disposed relative to said curved surface and said electron guns that the beam from each gun can trace a straight line from the deflection plane thereof to only phosphor portions of a given light-emitting type, and support means free of lateral tension projecting inwardly of the inner wall of said envelope around at least a portion thereof for retaining said mask in substantially fixed spaced relationship to said curved surface.

2. In a color television picture tube having three electron guns and a curved viewing screen on which phosphors for generating light of three

primary colors are deposited, means for limiting the impingement of the beam from each gun to phosphors of a given light-emitting type comprising, a mask disposed adjacent said curved screen, said mask being shaped to substantially conform to the curvature of said screen and having a plurality of apertures formed therein for the passage of beams from said guns and means for supporting said mask in substantially fixed spaced relationship to said curved screen, said mask being free of lateral tension.

3. A color television picture tube comprising, an envelope having a conical section, a neck section joined to the smaller end of said conical section, and a spherical screen section joined to the larger end of said conical section, first, second, and third electron guns symmetrically disposed in said neck section, phosphors for generating light of red, green and blue colors respectively being deposited symmetrically in groups of three discrete portions in a single layer over substantially the entire inner surface of said spherical screen section, each of said groups including a red, a green, and a blue light-emitting phosphor, a mask disposed adjacent said spherical screen section between said phosphors and said electron guns, said mask having a series of apertures formed therein and being so disposed relative to said phosphor portions and said guns that beams from said first gun impinge only upon said phosphor portions for generating red light, beams from said second gun impinge only upon said phosphor portions for generating green light, and beams from said third gun impinge only upon said phosphor portions for generating blue light, and means for supporting said mask in substantially fixed spaced relationship to said spherical screen, said mask being free of lateral tension.

4. A picture tube for the presentation of television images in color comprising, an envelope having a curved viewing surface, phosphors for emitting light of three primary colors being symmetrically disposed in discrete portions in a single layer on said curved surface, means for generating at least one electron beam for exciting said phosphors, a mask having apertures formed therein for the passage of electrons therethrough to said phosphors, said mask having a contour substantially similar to that of said curved viewing surface, and means directly connecting peripheral portions of said mask to corresponding portions on the inner wall of said envelope.

5. A picture tube for the presentation of television images in color comprising, an envelope having a curved viewing surface, phosphors for emitting light of three primary colors being symmetrically disposed in discrete portions in a single layer on said curved surface, means projecting inwardly of the inner wall of said envelope around at least a portion thereof and an aperture mask having a contour substantially similar to that of said curved viewing surface, said last named means providing direct support for said mask.

6. A picture tube for the presentation of television images in color comprising, an envelope having a curved viewing portion, a conical portion, and a neck portion, said conical portion being joined to said viewing portion at its large end and joined to said neck portion at its small end, phosphors for emitting light of three primary colors being symmetrically disposed in discrete portions in a single layer on said viewing portion, at least one electron gun disposed in said neck portion, an internally projecting means in

said envelope adjacent the junction of said conical portion and said viewing portion, and a mask curved to conform substantially to said viewing portion retained in position by said internally projecting means, said mask being free of lateral tension, being disposed in substantially fixed spaced relationship to said viewing portion and having a plurality of apertures formed therein for the passage of beams from said electron gun to the phosphors on said viewing portion.

7. A picture tube for the presentation of television images in color comprising, an envelope having a viewing end having substantially the configuration of a spherical surface, phosphors for emitting light of three additive primary colors upon excitation by an electron beam, said phosphors being symmetrically disposed in a plurality of groups of three light-emitting types in discrete portions in a single layer on said viewing end within said envelope, three electron guns within said envelope for generating electron beams, an aperture mask having a contour substantially matching that of said viewing end disposed adjacent said viewing end, said mask having a plurality of circular apertures formed therein, each aperture of said mask being formed adjacent one of said groups of phosphors, said circular apertures being so disposed relative to said three electron guns and said groups of phosphors that the electron beam from each gun is directed to impinge upon only phosphors of one light-emitting type, and support means free of lateral tension projecting inwardly of said tube for retaining said mask in substantially fixed spaced relationship to said viewing end.

8. A picture tube for the presentation of television images in color comprising, an envelope having a curved viewing surface, phosphors for generating light of red, green, and blue colors symmetrically disposed in groups of three different colored light emitters upon said curved viewing surface, three electron guns mounted within said envelope remote from said viewing surface, a mask disposed adjacent said viewing surface between said viewing surface and said electron guns, and support means free of lateral tension projecting inwardly from the inner wall of said envelope for maintaining said mask in substantially fixed spaced relationship to said viewing surface, said mask having a plurality of apertures formed therein and being so oriented that beams from one of said electron guns are directed to impinge only on phosphors for generating red light, beams from the second of said electron guns are directed to impinge only on phosphors for generating green light, and beams from the third of said electron guns are directed to impinge only on phosphors for generating blue light.

9. A picture tube for the presentation of television images in color comprising, an envelope having a curved viewing surface, phosphors for generating light of three additive primary colors disposed in groups of three discrete circular portions on said viewing surface, each phosphor por-

tion of each group generating a different one of said three additive primary colors upon excitation thereof, three electron guns disposed within said envelope, an aperture mask disposed adjacent said viewing surface and having one circular aperture formed therein for each group of three phosphor portions, and internally projecting means on said envelope for retaining said mask in substantially fixed spaced relationship to said curved viewing surface, said mask being free of lateral tension and oriented such that beams from each of said electron guns are directed to impinge upon and excite phosphor portions of different color generating types.

10. A color television picture tube comprising, an envelope having a curved viewing surface, phosphors for generating light of three additive primary colors being disposed sequentially in stripes on said viewing surface, three electron guns disposed in said envelope, internally projecting apparatus within said envelope adjacent said viewing screen, and a mask retained in position by said internally projecting apparatus, said mask being free of lateral tension and having a plurality of rectangular openings formed therein, said openings being shaped similarly to said phosphor stripes and being disposed relative to said phosphor stripes and to said electron guns that beams from one of said electron guns are directed to impinge only upon phosphor stripes for generating light of a first additive primary color, beams from the second of said guns are directed to impinge only upon phosphor stripes for generating light of a second additive primary color, and beams from the third of said guns are directed to impinge only upon phosphor stripes for generating light of a third additive primary color.

11. A color television picture tube comprising, an envelope having a viewing surface having the shape of a cylindrical section, phosphor stripes for generating light of three additive primary colors being disposed upon said viewing surface, at least an electron gun for generating electron beams to excite said phosphors, internally projecting apparatus on the wall of said envelope, a mask including two widely spaced combs having cylindrical surfaces adjacent to and conforming with said cylindrical viewing surface, and a grid of closely spaced wires stretched between said combs on said cylindrical surfaces, said mask being directly supported in position by said internally projecting apparatus.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,595,548	Schroeder	May 6, 1952
2,630,542	Goldsmith	Mar. 3, 1953
2,635,203	Pakswar	Apr. 14, 1953

FOREIGN PATENTS

Number	Country	Date
866,065	France	Mar. 31, 1941