Dec. 12, 1967 J. P. FIORE 3,358,170

COLOR TELEVISION PICTURE TUBE AND MATING SUPPORT MEMBERS FOR MOUNTING THE COLOR SELECTION MASK WITHIN THE TUBE

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FIG. 1

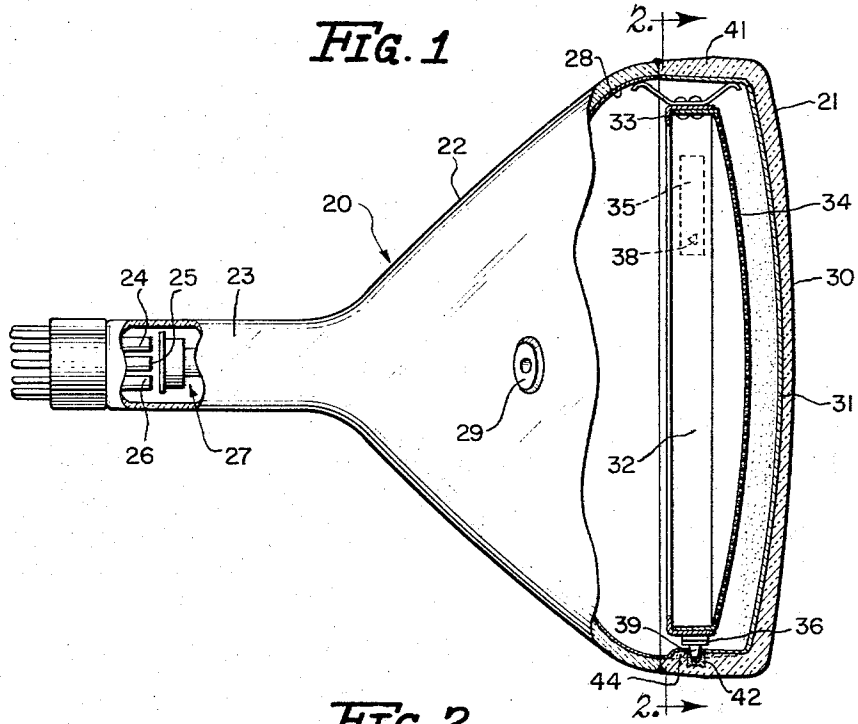
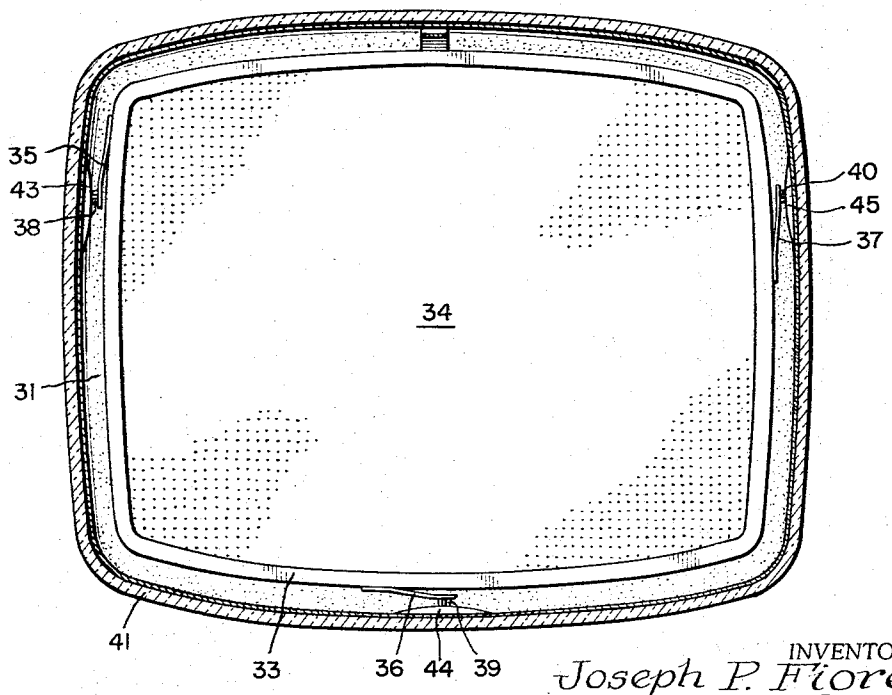



FIG. 2




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FIG. 5

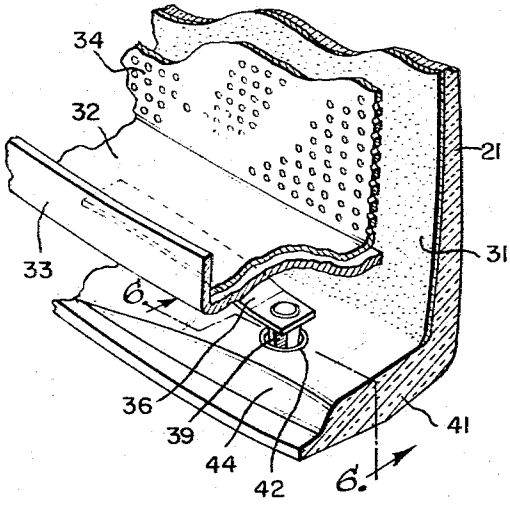



FIG. 6

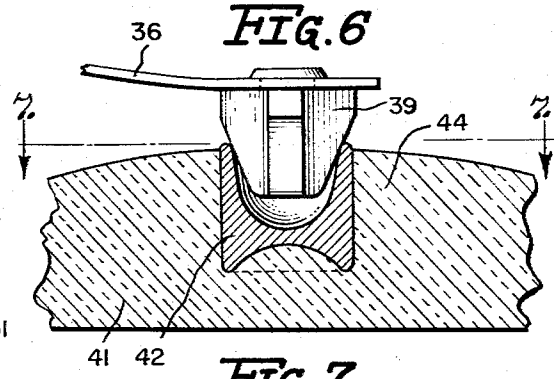



FIG. 7

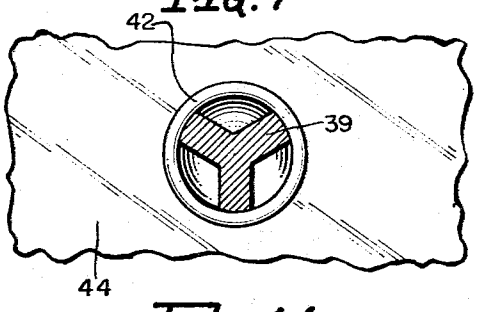



FIG. 10

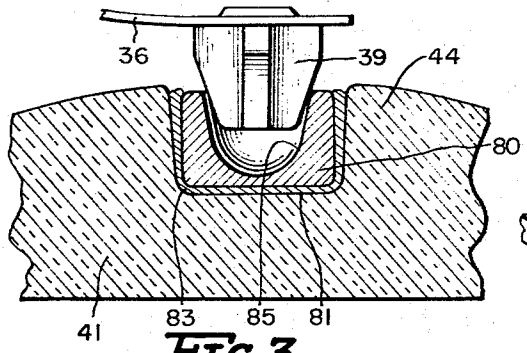



FIG. 11

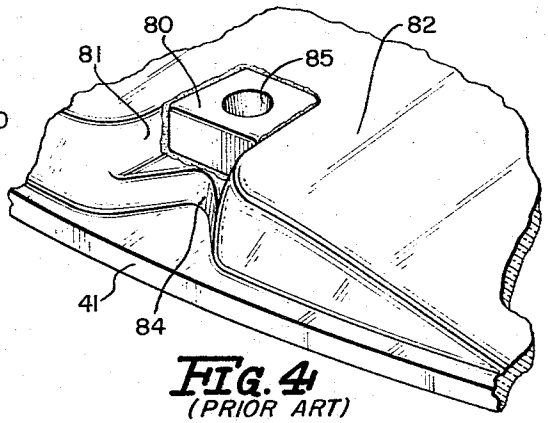



FIG. 3
(PRIOR ART)

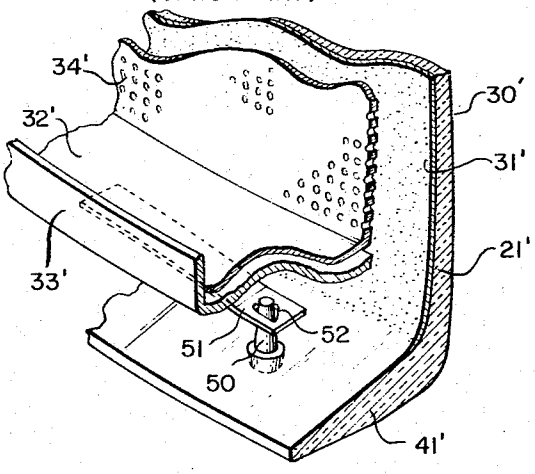
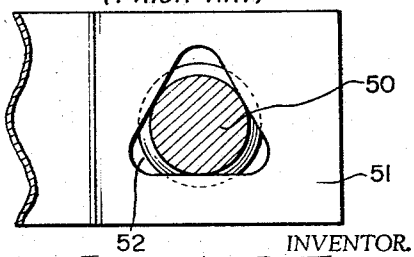



FIG. 4
(PRIOR ART)




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FIG. 8

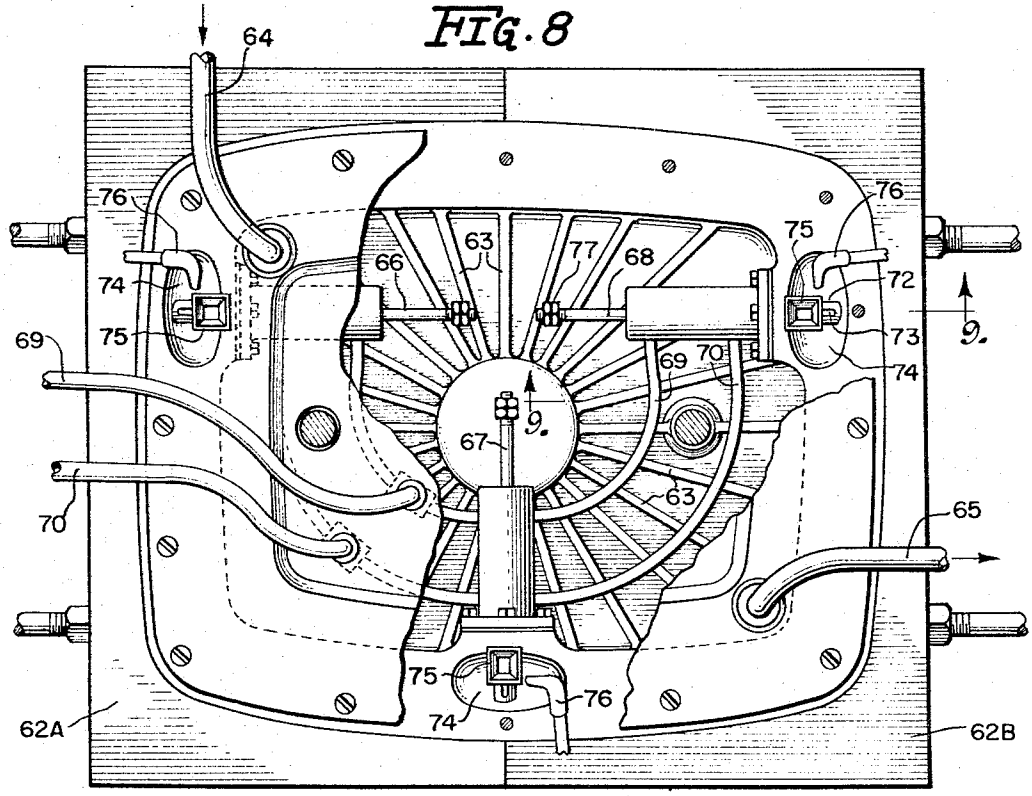
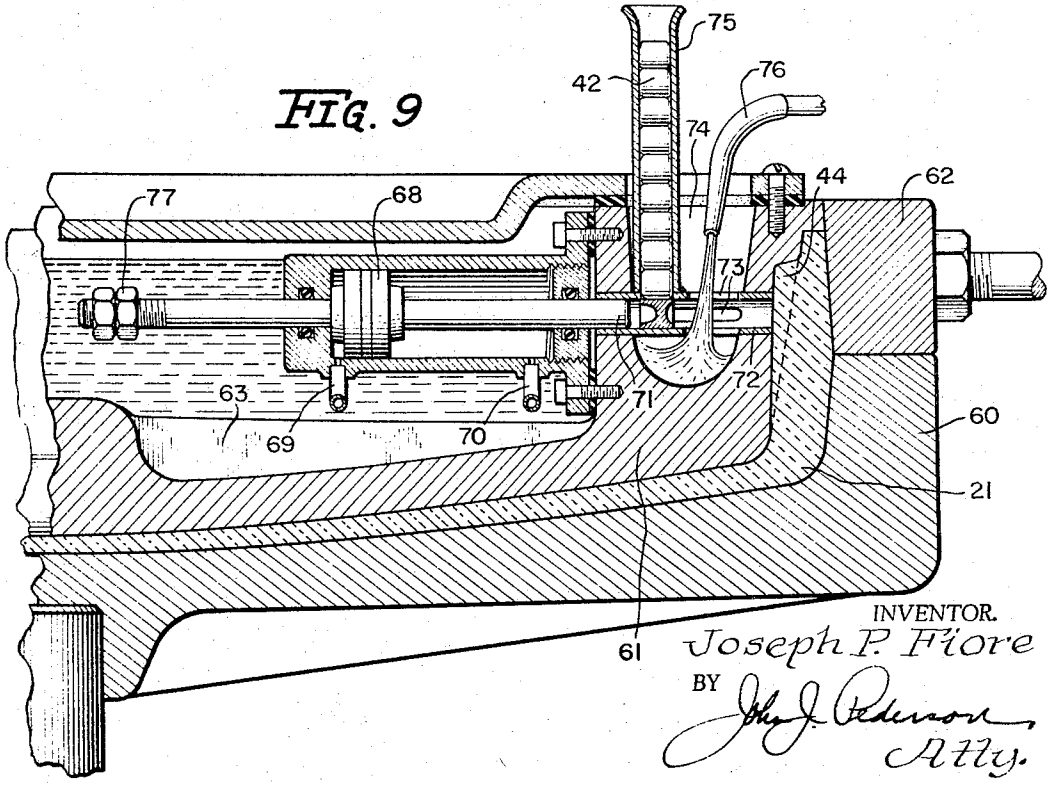



FIG. 9




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FIG. 12

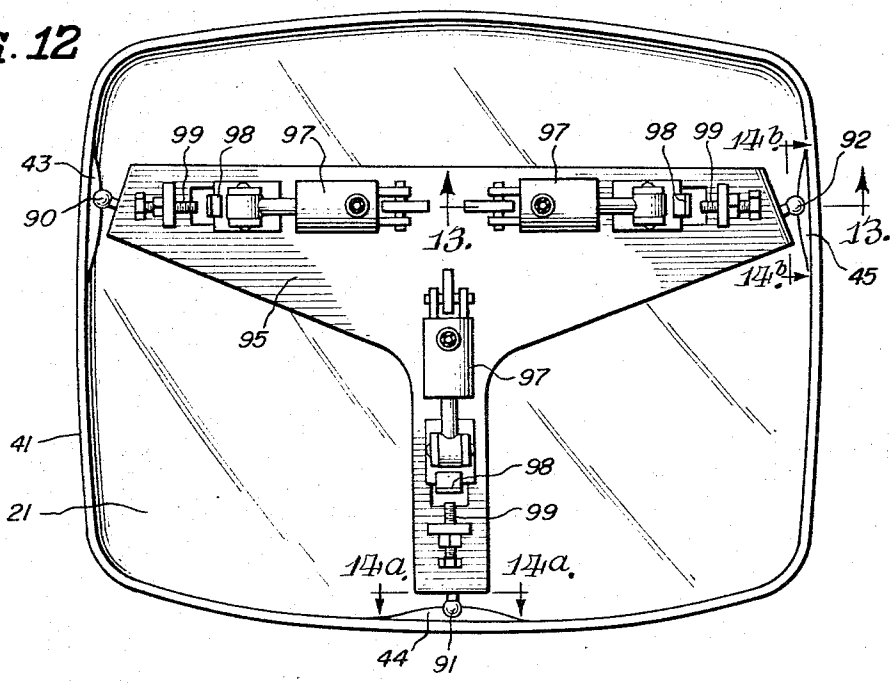



FIG. 13

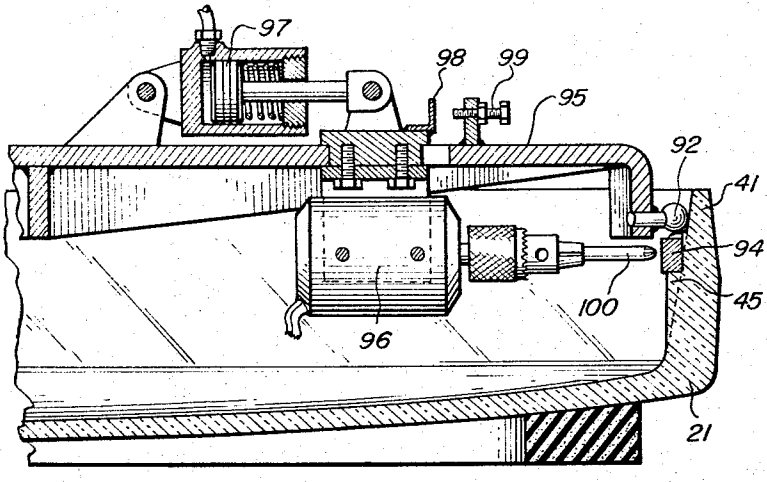



FIG. 14

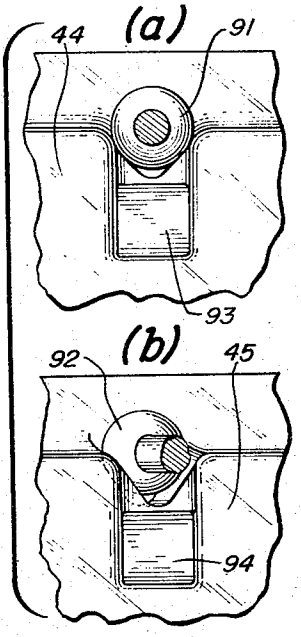
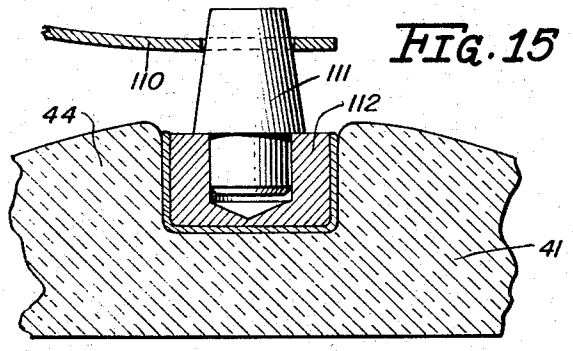



FIG. 15




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3,358,170

# COLOR TELEVISION PICTURE TUBE AND MATING SUPPORT MEMBERS FOR MOUNTING THE COLOR SELECTION MASK WITHIN THE TUBE

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Filed Jan. 11, 1962, Ser. No. 165,476
6 Claims. (Cl. 313—64)

This invention relates to color television picture tubes and to new and improved methods of manufacturing such tubes.

The color television picture tubes now in commercial use are of the type comprising a mosaic tri-color phosphor screen and a color-selection device in the form of a shadow mask having an aperture pattern corresponding to the distribution pattern of the component phosphors in the mosaic screen, in conjunction with three electron guns for projecting separate electron beams through the mask onto the phosphor screen at different angles. Color selection is achieved by selectively controlling the intensities of the electron beams. In order to achieve faithful color reproduction, it is essential that the spacing and alignment of the color-selection aperture mask with respect to the mosaic phosphor screen be precisely determined; even very slight rotational or longitudinal misalignment or mis-orientation of the mask with the screen leads to color contamination and consequent degradation of both color and monochromatic images.

In the manufacture of such tubes, it has been conventional practice to fabricate the envelope in sections which are sealed together after completion of the mask-and-screen assembly. Conventionally, the envelope comprises a faceplate section which is composed of an end or screen portion of substantially spherical curvature and an integral rim portion or skirt extending outwardly from the screen portion toward the electron gun assembly. The remainder of the tube envelope comprises a funnel section adapted to be sealed to the rim portion of the faceplate section, and a neck section which is sealed to the funnel and which houses the electron gun assembly. The mosaic phosphor screen is formed on the internal surface of the screen portion of the faceplate section, the mask is then mounted to the rim portion of the faceplate section, and the faceplate and funnel sections are frit-sealed together to complete the tube assembly.

In order to secure the requisite degree of precision in the alignment of the mask and screen assembly, the customary practice is to form the screen by photographic processes including exposure of a photo-sensitive resist through the mask to fix the areas on the internal surface of the screen portion of the faceplate to which a phosphor applied by a slurry process will adhere. The photographic exposure process is repeated several times, once for each component phosphor of the mosaic screen, and this of course involves removal and reinsertion of the mask as an incident to the screen forming process. It is therefore essential that the mounting arrangement for the mask be sufficiently rigid and precise to define a unique mask position, both during the screen processing and in the subsequent final assembly of the tube.

The mask mounting arrangement now employed in conventional color television picture tubes involves the provision of mounting studs or pins which are fused into the rim portion of the faceplate and which mate with generally triangular apertures in cantilever-mounted leaf springs which are affixed to the rigid frame of the color-selection mask. These mounting studs or pins are inserted by localized heating of the glass above its softening point, at which time the pins are inserted and the faceplate cooled. After application of the pins in this



fashion, it is necessary to re-anneal the entire faceplate section to relieve strains produced by the localized softening of the glass, and the re-annealing process involves re-heating the entire faceplate above the strain poinnt of the glass and slowly cooling to an ambient temperature well below the strain point. This leads to sagging of the faceplate and, sometimes, to slight mis-alignment of the pins, with the result that the studded faceplate section is often found to fall outside the narrow and highly critical dimensional tolerance range for faceplate curvature and/or pin alignment. In mass production, an excessively high proportion of studded faceplate sections must be scrapped despite the exercise of every available precaution, and this of course substantially increases the per unit manufacturing cost of completed tubes.

Accordingly, it is a principal object of the invention to provide a new and improved method of manufacturing color television picture tubes, in which the screen curvature and other critical dimensions of the faceplate section of the envelope may be accurately controlled in production quantities within critically small dimensional tolerance ranges.

It is a further object of the invention to provide a new and improved method for mounting the color-selection device in the faceplate section of a color picture tube envelope.

Still another object of the invention is to provide a new and improved faceplate section for a color picture tube envelope, which includes provisions for greatly facilitating the mounting of the color-selection device in a precise predetermined space relation to the phosphor screen formed on the internal surface of the screen portion of the faceplate section.

Yet another object of the invention is to provide a new and improved mask and screen assembly for a color television picture tube, in which the color-selection mask is firmly and securely mounted.

A more specific object of the invention is to provide a new and improved mask and screen assembly for a color television picture tube, and a novel method of manufacturing such an asembly, in which the degree of precision of the spacing and alignment between the mask element and the mosaic phosphor screen is greatly enhanced with respect to that achieved by conventional structures and methods, even in mass production, with an attendant substantial reduction in the cost of manufacturing a color television picture tube.

The invention is directed to the manufacture of a color television picture tube of the type comprising an envelope having substantial symmetry with respect to a predetermined axis and composed of a glass faceplate section with an end or screen portion and a rim portion, and a funnel section sealed to the faceplate section, a mosaic phosphor screen on the inner surface of the end portion of the faceplate section, and a multi-apertured color-selection device having a rigid frame and a mask element with an aperture pattern corresponding to the distribution pattern of the component phosphors in the mosaic screen. The invention provides a new and improved method of mounting the color-selection device in a precise predetermined space relation to the phosphor screen by the use of mating pairs of male and female support members adapted for spring-biased mutual engagement in predetermined respective engagement planes. The mounting method of the present invention comprises the following steps, which are not necessarily performed in the recited sequence. The glass faceplate section is molded and annealed, which may be accomplished by the use of conventional techniques. A first support member of each mating pair is secured to the frame of the color-selection device at circumferentially spaced loca-

tions thereon and in outwardly directed orientation with respect thereto, whereby the first support members are maintained in predetermined mutually spaced relation to each other. The other support member of each mating pair is affixed to the rim portion of the faceplate section with its plane of engagement with the associated first support member at an accuracy predetermined distance from the axis of the envelope, and with the other support members positioned in a circumferential array accurately corresponding to the predetermined mutually spaced relation of the first support members; the other support members may be affixed to the faceplate section as a part of the molding operation, or by frit-sealing after the faceplate section has been molded and annealed. The temperature of the faceplate section is maintained below its strain point at all times except during the molding and annealing operations. After the support members have been affixed to the rim portion of the faceplate section, the phosphor screen is formed on the end portion of the faceplate section. To complete the assembly, the mating pairs of support members are brought together to securely mount the color-selection device to the faceplate section in the desired precise predetermined space relation to the phosphor screen.

In accordance with another feature of the invention, a new and improved glass faceplate section for an envelope of a color television picture tube comprises a screen portion having substantially spherical curvature, and a rim portion integral with the screen portion and extending outwardly therefrom. The faceplate section also includes a plurality of internal bosses integral with the rim portion at circumferentially spaced locations thereon. Each of the bosses is provided with an indexing surface and an adjacent recess, and all of the indexing surfaces have corresponding reference points situated in a common plane substantially parallel to a plane tangent to the screen portion.

In accordance with still another feature of the invention, a color television picture tube comprises a glass faceplate including a spherically curved generally rectangular screen portion and a rim portion extending outwardly therefrom. A mosaic phosphor screen is provided on the internal surface of the screen portion of the faceplate. The tube also comprises a color-selection device having a rigid generally rectangular frame with a configuration similar to that of the rim portion of the faceplate and having outside dimensions less than the corresponding inside dimensions of the rim portion by a predetermined substantially uniform distance. The tube further comprises means for mounting the color-selection device to the faceplate in predetermined space relation to the mosaic phosphor screen, the mounting means comprising three cantilever springs on the frame, three tapered studs respectively affixed to the springs and outwardly biased thereby, and three sockets on the rim portion of the envelope for receiving the studs. One of the cantilever springs is positioned with its stud at the center of one of the longer legs of the generally rectangular frame, and the other two are situated at opposed locations on the shorter legs with their studs substantially three-fourths of the distance from the longer leg to which the first spring is affixed; all the springs are outwardly biased in a common circumferential direction. The bias of the springs is sufficient to maintain all of the studs in mating engagement with their respective sockets even upon temporary lateral displacement of the frame by a maximum distance in any direction.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:



FIGURE 1 is a side view, partly cut away and partly in section, of a color television picture tube embodying the invention;

FIGURE 2 is a cross-sectional view taken along the line **2**—**2** of FIGURE 1;

FIGURE 3 is a fragmentary perspective view, partly in section, illustrating the conventional prior art mounting of a color-selection mask and phosphor screen;

FIGURE 4 is an enlarged fragmentary detailed view, partly in section, illustrating the engagement of mating mask mounting members in a conventional prior art color television picture tube;

FIGURE 5 is a view, similar to that of FIGURE 3, of a mask and screen assembly embodying the present invention;

FIGURE 6 is a cross-sectional view taken along the line **6**—**6** of FIGURE 5;

FIGURE 7 is a cross-sectional view taken along the line **7**—**7** of FIGURE 6;

FIGURE 8 is a plan view, partly cut away and partly schematic, of a manufacturing fixture useful in practicing the method of the present invention;

FIGURE 9 is a fragmentary cross-sectional view taken along the line **9**—**9** of FIGURE 8;

FIGURE 10 is a cross-sectional view, similar to that of FIGURE 6, illustrating an alternative embodiment of the invention;

FIGURE 11 is a fragmentary perspective view of a portion of the rim portion of the faceplate embodying the present invention;

FIGURE 12 is a plan view, partly schematic, of a manufacturing fixture useful in constructing the embodiment of FIGURES 10 and 11;

FIGURE 13 is a fragmentary cross-sectional view taken along the line **13**—**13** of FIGURE 12;

FIGURES 14*a* and 14*b* are fragmentary detailed views, partly in section, taken along the lines **14***a*—**14***a* and **14***b*—**14***b*, respectively, of FIGURE 12; and

FIGURE 15 is a fragmentary cross-sectional view, similar to those of FIGURES 6 and 10, illustrating a still further alternative embodiment of the invention.

FIGURE 1 illustrates a rectangular-screen color television picture tube which may be of conventional construction except for the mounting arrangmeent of the aperture mask. The tube comprises an envelope **20** composed of a glass faceplate section **21**, a glass funnel section **22**, and a glass neck section **23** which are frit-sealed together after assembling the internal components of the tube. In the neck section **23** are provided three electron guns **24**, **25** and **26** and a conventional accelerating and focusing electrode system **27**, and the tube further comprises a final anode **28** in the form of an internal conductive wall coating, to which is connected a contact terminal or anode button **29**. On the inner substantially spherically curved surface of the generally rectangular end portion or screen portion **30** of faceplate section **21** is provided an aluminized mosaic phosphor screen **31** which, in an illustrative embodiment, may constitute a conventional tri-color phosphor dot screen composed of three interspersed groups of phosphors emitting visible radiation of different primary colors, e.g., red, blue and green, in response to electron bombardment. The tube further comprises a color-selection device **32** composed of a rigid metal frame **33** to which is affixed a generally rectangular aperture mask **34** having a curvature generally corresponding to that of mosaic screen **31** and having an aperture pattern corresponding to the distribution pattern of the individual component phosphors of mosaic screen **31**. Color-selection device **32** must be precisely spaced from and aligned with the mosaic phosphor screen **31** in order to insure that the electron beams originating at guns **24**, **25** and **26** may each have access only to individual phosphor components of screen **31**. The entire construction may be conventional with the exception of the mounting arrangement for color-selection device **32**.

In accordance with the present invention, color-selection device 32 is mounted to faceplate section 21 of the envelope in the required precise predetermined space relation with mosaic phosphor screen 31 by means of three cantilever springs 35, 36 and 37 which, as best seen in FIGURE 2, are affixed to generally rectangular frame 33 of color-selection device 32. Springs 35, 36 and 37 are respectively provided with outwardly directed tapered studs 38, 39 and 40 respectively, each of which is of a length less than the substantially uniform distance between frame 33 and the internal surface of rim portion 41 of faceplate section 21. They are of tapered configuration, preferably extruded of stainless steel having a cross-section of Y-configuration, as best seen in FIGURE 7, although other forms of substantially triangular cross-section are also appropriate. Spring 36 is affixed to frame 33 with its stud 39 at the center of one of the longer legs of the rectangular frame, while springs 35 and 37 are affixed to frame 33 wtih their studs 38 and 40 at opposed locations on the shorter legs substantially three-fourths of the distance from the leg to which spring 36 is affixed. Studs 38, 39 and 40 are outwardly biased by cantilever springs 35, 36 and 37 respectively, all of which are outwardly biased in a common circumferential direction, e.g., counterclockwise around the frame as viewed in FIGURE 2. Studs 38, 39 and 40 are received in respective metal sockets such as socket 42 in FIGURE 1 which are sealed in recesses provided in internally projecting bosses 43, 44 and 45 (FIGURE 2) which are integral wtih rim portion 41 of faceplate 21. The engagement between the male and female support members is shown in detail in FIGURES 5–7.

This mounting construction provides a positive-locking firm support for color-selection device 32, securing the latter in a fixed position which is duplicated precisely each time the color-selection device 32 is removed and reinserted during the processing of the phosphor screen. Moreover, the bias of springs 35, 36 and 37 is made sufficiently strong to maintain all of the studs 38, 39 and 40 in mating engagement with their respective sockets even upon temporary lateral displacement of frame 33 by a maximum distance in any direction, as may be encountered upon severe shock. The frame is prevented from substantial movement in either the upward or downward direction as viewed in FIGURE 2 by virtue of the positive engagement of studs 35 and 37 in their respective sockets, and if the frame is displaced laterally in either direction under heavy shock, one of the side springs 35 and 37 bottoms on the frame 33 before the maximum outward excursion of the opposed side spring is reached. As will be appreciated from the ensuing discussion with respect to the manufacturing processes employed in accordance with the inventioin, the described mounting arrangement also achieves a greatly improved degree of precision, relative to prior art constructions, in the alignment of color-selection device 32 with respect to the phosphor screen 31, and this objective is achieved with greater uniformity and at lower cost in mass production than can be obtained with presently employed methods.

In order to facilitate a more complete understanding of the merits and advantages of the constructions and methods of the present invention, a detailed understanding of the mounting arrangements and processing techniques employed in the manufacture of conventional color television picture tubes will be helpful. FIGURES 3 and 4 illustrate the essential features of the presently employed mounting construction; for convenience, the corresponding components of the mask and screen assembly are designated by corresponding primed reference numerals. As seen in FIGURE 3, rim portion 41′ of faceplate section 21′ is provided with a plurality of support pins 50, of which only one is shown, which are fused into the glass of the rim portion. Pins 50 are engaged by correspondingly situated female support members in the form of cantilever springs 51, only one of which is shown in FIGURE 3, which are secured to frame 33′ and are provided with triangular apertures 52 adapted for mating engagement with pins 50, as shown more specifically in FIGURE 4.

In manufacturing a device of conventional construction, as shown in FIGURES 3 and 4, the glass faceplate 21′ with integral screen and rim portions 30′ and 41′ is molded of an appropriate glass such as type 9019 furnished by Corning Glass Company. This glass has a softening point around 683° C. and a strain point of approximately 450° C. After molding, the faceplate section 21′ is annealed by raising it to a temperature above the annealing point 490°–500° C., and then gradually reducing the temperature at a rate of about 2° a minute to an end temperature well below the strain point, e.g., 350° C., after which it may be rapidly cooled to room temperature. During the annealing operation, the faceplate section is maintained in an inverted position, with the screen portion 30′ up, resting on the exposed edge of rim portion 41′. The annealing operation is required in order to relieve internal stresses inherent in the molding operation, and although the glass is not appreciably softened at the annealing temperatures, the weight of the screen portion 39′ is sufficiently great that a small but measurable and significant amount of sagging is usually encountered. The tolerances in color television picture tubes, and particularly in the mask and screen assembly, are sufficiently critical that only a very small amount of sagging can be tolerated; for mass production purposes, a maximum deviation from the prescribed spherical curvature of plus or minus .020 inch has been found to represent a practical limit; with care, this tolerance range can be maintained during the annealing operation.

The faceplate section 21′ is then withdrawn from the annealing oven and pins 50 are inserted by locally softening the glass above its melting point, inserting the metal pins 50 with an appropriate jig or fixture, and cooling whereupon the pins are fused to the glass rim. This process, however, creates internal stresses and strains in the faceplate section 21′ and consequently it is necessary to re-anneal the faceplace section after insertion of pins 50. The re-annealing operation is attended by a further sagging or warping of the screen portion, which adds to that resulting from the original annealing operation. It is extremely difficult to maintain the total sag within the nominal .020 inch tolerance range; consequently, a large number, which may be as high as 80% or 85%, of mass produced faceplates are rejected for falling outside the required tolerance range. Moreover, the re-annealing operation may also result in a slight canting or misalignment of one or more of the support pins 50, with a resultant instability or misalignment of the mask assembly.

In the manufacture of a color television picture tube in accordance with the present invention, a much greater degree of precision is maintained in that the positioning of the color-selection device is rendered substantially independent of the more difficultly maintained tolerances in dimensions of glass parts. In the preferred manufacturing method of the invention, employing the construction shown in FIGURES 1, 2 and 5–7, this is achieved by affixing metal sockets or female support members 42 to rim portion 41 as a part of the original molding operation.

FIGURE 8 and FIGURE 9 illustrate an exemplary form of apparatus for accomplishing this objective. The apparatus includes a three-part mold including a conventional dish section 60, a plunger section 61, and a retaining ring 62 which, as shown in FIGURE 8, is centrally split into two parts 62*a* and 62*b*. Dish section 60 and plunger section 61 are contoured to provide the requisite faceplate curvature. A charge of molten glass is placed in dish section 60, plunger 61 is inserted and retaining ring 62 clamped in place to mold or cast the faceplate section 21 including integral bosses 44. Plunger section 61 is provided with cooling fins 63, and is water-cooled by means

of a circulating system including inlet and outlet ducts 64 and 65 respectively.

Plunger section 61 is equipped with three pistons 66, 67 and 68 which are operated by compressed air through ducts 69 and 70. To each of the pistons 66, 67 and 68 is connected an outwardly extending plunger rod such as rod 71 in FIGURE 9. Plunger rod 71 is slidable in a tube 72 inserted in the plunger section 61 of the glass mold, and tube 72 is vented with longitudinal slots 73 communicating with a well 74 at the top of plunger section 71. Communicating with plunger rod receiving tube 72 is a magazine 75 for receiving a plurality of metal eyelets or socket members 42 to be inserted in the rim portion of faceplate section 21. Means are provided for heating the eyelet, such means being schematically shown in the form of gas jets 76 communicating with well 74.

When the charge of molten glass is placed in the mold, pistons 66, 67 and 68 are driven outwardly to a position in which the end of plunger rod 71 is flush with the outer surface of the plunger mold section 61, closing off the end of tube 72. When the glass has taken a partial set, but while it is still in a softened or semi-molten condition, the plunger rods are driven outwardly to a maximum displacement determined by adjusting nuts 77. This preforms a recess or well in the boss 44 for receiving the eyelet which is inserted by first returning the plunger to the position indicated in FIGURES 8 and 9. The eyelet is then fed into tube 72 from magazine 75. Plungers 66, 67 and 68 are again driven laterally, forcing eyelets 42 into the semi-molten bosses 44 of rim portion 41. The plane of engagement (plane 7—7 of FIGURE 6) of the metal eyelet or socket member 42 with its associated stud, as so inserted into the glass boss 44, is thus precisely indexed relative to the axis of the tube envelope, adjusting nuts 77 being set to provide the desired spacing from the axis. The glass is then permitted to cool, after which the usual annealing operation is performed by placing the faceplate section 21 in an inverted position, with the screen portion 30 up, in an annealing oven, raising the temperature to about 500° C., and slowly reducing the temperature at a rate of about 2° C. per minute to a terminal temperature of 350° C. At this point, the annealing operation is complete and subsequent handling of the faceplace does not significantly affect any of the critical dimensional relationships.

In this manner, the metal support members 42 are affixed to the rim portion 41 of faceplate section 21 as a part of the molding operation in which the faceplate itself is formed, and the critical dimensional relationships with reference to the tube axis are independent of the dimensional tolerances of the glass. The processing of the tube is then completed by assembling the color-selection mask to the faceplate section and forming the mosaic phosphor screen on the end portion 30 of faceplate section 21 in any desired conventional manner. In the usual case, the formation of the phosphor screen involves multiple photographic exposures of photo-sensitive resist material through the assembled aperture mask, requiring removal and reinsertion of the mask 32 as many times as there are component phosphors in the mosaic screen. After the phosphor screen is formed, the assembly is completed by bringing the mating pairs of support members 39 and 42 together to securely mount the color-selection device 32 to faceplace section 21 in the desired precise predetermined space relation to the phosphor screen.

In accordance with the invention, the temperature of the faceplate section 21 is maintained below its strain point, e.g., about 450° C. for Corning type 9019 glass, at all times except during the molding and annealing operations. Thus, there is no re-annealing of the faceplate section as in the prior art assembly techniques. The aperture mask 34 may be custom-formed to correspond closely to the contour of the substantially spherical inner surface of end portion 30 on which the phosphor screen is to be deposited, and since there is no subsequent re-annealing operation, this contour remains fixed and is not subject to sagging. Moreover, the position and orientation of the socket members 42 in the rim are determined only by the parameters of the fixture of FIGURES 8 and 9, these elements being unaffected in their location and orientation by the subsequent tube processing. The manufacturing method of the invention not only eliminates an expensive and time-consuming re-annealing operation, but also enables the critical manufacturing tolerances to be maintained in mass production. Since the prior art fabricating techniques have led to reject rates as high as 80% or 85% of the studded faceplates, a major cost saving is accomplished by the constructions and techniques of the present invention.

In accordance with another embodiment of the invention, the female support members or sockets may be installed after the molding and annealing of the faceplate section. Such a construction is illustrated in FIGURES 10 and 11, which show the engagement between stud 39 and a socket 80 which is sealed within a recess 81 in a preformed boss 82 on the internal surface of rim portion 41 of the faceplate section by means of a glass frit 83. Boss 82 is also formed, as a part of the molding operation, with an indexing surface in the form of a V-shaped notch 84 adjacent the recess 81 which receives the metal support member 80, as shown in FIGURE 11. Indexing notches 84 determine a reference plane, substantially parallel to a plane tangent to the spherically curved screen portion of faceplate 21, from which the mask forming and socket locating operations are indexed. It will be understood that three boses are provided in appropriate locations to receive the studs which are spring mounted to the frame 33 of the color-selection mask, and that each is provided with an adjacent indexing notch 84.

To secure the requisite degree of accuracy, comparable to that obtained with the previously described embodiment in which the metal socket members 42 are affixed to the faceplate section as a part of the molding operation, blank metal pads are frit-sealed in the recesses before the formation of the stud receiving sockets 85. If the faceplate is of Corning type 9019 glass, the blank pads may be composed of industry type 446 stainless steel having a thermal coefficient of $114\times10^{-6}$ inches per degree C. The composition of the glass frit employed is selected to substantially match the temperature coefficient of expansion of the glass employed in molding the faceplate section. For example, if the faceplate section 21 is formed of Corning type 9019 glass, which has a thermal coefficient of expansion of approximately $104\times10^{-6}$ inches per degree centigrade, a commercially available frit having a thermal coefficient of about $105\times10^{-6}$ inches per degree centigrade may be employed; such a frit is available from the Kimble Glass Company under the commercial type designation CV130. The metal pad 80 is coated with the frit, which comes in the form of a paste, and the coated pad is then inserted in the recess 81 and fired at a temperature below the strain point of the glass; the CV130 Kimble frit fires at a temperature of 440° C. The amount of frit applied is not critical, since the pad is inserted before the socket 85 is formed.

The indexing notches 84, which are preformed in the bosses as a part of the molding operation, are all oriented or directed toward the axis of the tube envelope. The faceplate section 21, with the blank metal pads affixed, is then placed screen portion down and a jig or fixture inserted as shown in FIGURE 12. The fixture is provided with indexing elements 90, 91 and 92 of generally spherical configuration which are radially directed with respect to an axis corresponding to that of the tube envelope and which engage the indexing notches 84 in the bosses. The engagement of indexing elements 91 and 92 with the associated notches in the faceplate bosses is shown in FIGURES 14*a* and 14*b*, respectively, in which the blank metal pads 93 and 94 are also illustrated. The engagement of spherical indexing elements 90, 91 and 92

with the indexing notches provides a uniquely determined stable support for the processing fixture shown in FIGURES 12 and 13.

The fixture comprises a frame **95** on which are mounted three electric drills, of which one is shown at **96** in FIGURE 13. Associated with the drills, which are mounted for lateral movement on frame **95**, are associated compressed-air-operated pistons, such as **97** in FIGURE 13, which are spring-biased inwardly of the faceplate. Upon the application of compressed air to the operating pistons, the drill **96** moves laterally to the right until a stop member **98** engages an adjusting screw **99** which determines the maximum lateral traverse of the drill **96**. The drill is provided with a bit **100** which engages the blank metal pad **94** and forms the stud receiving socket **85** shown in FIGURES 10 and 11; the engagement plane of socket **85** with its associated mounting stud on the frame is thus determined solely by the fixture of FIGURES 12 and 13 and may be preset by adjusting screw **99**.

After formation of the stud receiving sockets in the blank metal pads, the processing of the tube is completed in the same manner as in the previously described embodiment, being certain to maintain the temperature of the faceplate section below its strain point at all times except during the molding and annealing operations. Accordingly, the same advantages specified with respect to the previously described process are achieved.

In the previously described embodiments, the male support members or studs are affixed to the cantilever springs on the aperture mask frame, and the female support members or sockets are affixed to the rim of the faceplate section. It is also possible to obtain the beneficial results and advantages of the present invention in a consrtuction in which the support members on frame and faceplate are reversed. Thus, as shown in FIGURE 15, the female support members may constitute cantilever springs such as **110** mounted to the frame of the color-selection mask, and each provided with a triangular aperture for receiving a tapered conical stud **111** which is pressed or otherwise secured in a pre-drilled metal pad **112** frit-sealed into a preformed recess in the internal boss of the faceplate section rim. In order to secure the benefits of the invention, the taper should be put on the stud **111** after insertion of the latter in the metal pad **112**; this can be achieved with a fixture similar to that shown in FIGURES 12 and 13, in which the drill bits **100** are replaced with cutting tools similar to those employed in a conventional pencil sharpener.

Thus the invention provides a new and improved manufacturing construction and technique for the production of color television picture tubes, in which the degree of precision alignment between the color-selection device and the mosaic phosphor screen is greatly enhanced, and in which such tubes can be produced in large quantities without encountering excessive manufacturing rejects attributable to alteration of the configuration of the glass faceplate after insertion of the support members. These advantages are achieved by maintaining the glass faceplate at a temperature below its strain point at all times except during the initial molding and annealing operations. The metal support members may be affixed to the faceplate either as part of the original molding operation or subsequent to the molding and annealing operations by frit-sealing at temperatures below the strain point of the glass. In all cases, the plane of engagement of each stud with its mating socket is determined exclusively by reference to the axis of the tube envelope and is therefore independent of the variations in dimensions within the working tolerance range of the glass.

The invention also provides a new and improved color-selection mask mounting construction particularly adapted to rectangular color television picture tubes, in which the mask is positively locked in place in a unique position and held secure against accidental shock in any direction after the tube has been assembled. This is accomplished with the positioning of one pair of support members at the center of one of the longer legs of the generally rectangular frame, with the studs of the other two support members being located on the shorter legs at a distance approximately three-fourths of the length of such legs from the longer leg to which the first mounting member is affixed.

The invention provides not only a substantially reduced manufacturing cost, but also results in a construction in which the rendition of both color images and monochrome images is enhanced by virtue of the higher degree of precision in manufacturing tolerances. The cost reduction achieved may be of the order of several dollars per tube, and the techniques of the invention permit the use of faceplate sections fabricated for monochrome picture tubes to be employed, with but minor modification, in the manufacture of color tubes.

In processing the tube, particularly in laying down the tri-color screen, it is frequently necessary to remove residual screening material from faceplate section **21**. It is customary to use a blade which is driven around the inner periphery of the rim **41** in removing such material. The prior tube structure, featuring studs projecting radially inward from the rim as shown in FIGURE 3, impedes the wiping operation but this difficulty is avoided in the described structures wherein the bosses, such as **43**, **44** and **45**, are circumferentially tapered on both sides to merge gradually to the inner wall of rim portion **41**. Because of the need to accommodate this wiping action, it is preferred that the female of the pairs of supporting devices be accommodated within such bosses.

The described bosses are preferably cast into the tube faceplate section whether the eyelets **42** are utilized as in the structure of FIGURE 6 or whether the blanks **80** of FIGURE 11 are employed. In either case there is a possibility of scratching at the time the metal insert or the mask assembly is placed in position. However, any such scratching occurs on the surfaces of the bosses rather than on the faceplate panel itself. In this way, weakening of the faceplate through scratching is avoided. Further protection from scratching may be realized by ribbing the bosses, that is, by casting a series of ribs on the inner face of the bosses spaced from one another and extending perpendicular to the direction in which mask **34** is inserted.

It should be noted that the V-shaped notches **84** provide positive gage points as references against which measurements may be accurately made to check the desired conformation of the faceplate. Additionally, they locate the mask-holding fixtures independently of variations in contour of the faceplate and thus avoid another difficulty of the prior tube structures.

While particular embodiments have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

**1.** In a color television picture tube:

a glass faceplate comprising a spherically curved generally rectangular screen portion and a rim portion extending outwardly therefrom;

a mosaic phosphor screen on the internal surface of said screen portion of said faceplate;

a color-selection device having a rigid generally rectangular frame having a configuration similar to that of said rim portion and having outside dimensions less than the corresponding inside dimensions of said rim portion by a predetermined substantially uniform distance;

and means for mounting said color-selection device to

said faceplate in predetermined space relation to said mosaic screen, said means comprising

(a) three cantilever springs on said generally rectangular frame, one at the center of one of the longer legs and the other two at opposed locations on the shorter legs substantially three-fourths of the distance from said one longer leg, said springs being outwardly biased in a common circumferential direction,

(b) three tapered studs, each of a length less than said predetermined distance, respectively fixed to said springs and outwardly biased thereby, and

(c) three sockets on said rim portion of said envelope for receiving said studs,

the bias of said springs being sufficient to maintain all of said studs in mating engagement with their respective sockets even upon temporary lateral displacement of said frame by a maximum distance in any direction.

2. In a color television picture tube:

a glass faceplate comprising a generally rectangular screen portion and a rim portion extending outwardly therefrom;

a mosaic phosphor screen on the internal surface of said screen portion of said faceplate;

a color-selection device having a rigid generally rectangular frame having a configuration similar to that of said rim portion and having outside dimensions less than the corresponding inside dimensions of said rim portion by a predetermined substantially uniform distance;

and means for mounting said color-selection device to said faceplate in predetermined space relation to said mosaic screen, said means comprising

(a) three cantilever springs on said generally rectangular frame, one with its free end at the center of one of the longer legs and the other two at opposed locations on the shorter legs with their free ends substantially three-fourths of the distance from said one longer leg, said springs being outwardly biased in a common circumferential direction,

(b) three pairs of mating support members, one member of each of said member-pairs being located on one of said springs at its free end and the remaining support member being located on said rim portion of said envelope in juxtaposed relationship with said spring-mounted member,

each of said member-pairs comprising a stud member and a socket member, said stud members having a length less than said predetermined distance, and the outward bias of said springs being sufficient to maintain all of said stud members in mating engagement with their respective socket members even upon temporary lateral displacement of said frame by a maximum distance in any direction.

3. For use in a color television picture tube of the type comprising a fluorescent screen, a color-selection mask having a rigid frame, and a plurality of outwardly-biased spring members affixed to said color-selection mask frame and provided with mounting members of one gender at circumferentially spaced locations:

a glass faceplate section having a curved screen portion for receiving said fluorescent screen and further having a rim portion extending outwardly therefrom, said glass faceplate section being provided with a plurality of internal bosses integral with said rim portion and at predetermined circumferentially spaced locations corresponding to the spaced locations of said mounting members on said mask frame,

each of said bosses being provided with a recess adapted to receive a metal insert mounting member of the opposite gender and further being provided with an indexing surface adjacent said recess,

all of said indexing surfaces having corresponding reference points situated in a common plane substantially parallel to a plane tangent to said screen portion to permit accurate alignment of said metal insert mounting members with said mounting members on said color-selection mask frame when the latter is inserted in said faceplate section.

4. A glass faceplate section as claimed in claim 3 wherein each of said bosses is circumferentially tapered on both sides of its recess to merge gradually with said rim portion.

5. A glass faceplate section as claimed in claim 3 wherein each of said outwardly-biased mounting members are studs and wherein each of said metal insert mounting members are sockets.

6. A glass faceplate section as claimed in claim 3 wherein each of said indexing surfaces are indexing notches.

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