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(54) **Color cathode ray tube and component thereof and method of manufacturing same.**

(57) A tensed color selection electrode assembly is utilized in screening a pattern of phosphor areas upon the target surface of the faceplate of a color cathode ray tube and is thereafter incorporated as a component of the tube. The faceplate is formed of a material having a predetermined temperature coefficient of expansion and has registration affording means thereon. The initial assembly includes a severable mount formed of a material having a temperature coefficient of expansion greater than that of the faceplate and has a central opening of a predetermined expanse. A planar metal foil having a predetermined pattern of apertures and formed of a material having a temperature coefficient of expansion not greater than that of the mount is secured to the mount. First and second frames, each having an overall span less than the mount opening and each having a central aperture dimensioned to enclose the target surface, are formed of a material having a temperature coefficient of expansion approximating that of the faceplate. Each frame further includes a pair of spaced apart sealing lands with one sealing land of each frame disposed in a confronting relation. Devitrifying frit disposed between the confronting sealing lands bond the frames and a peripheral portion of the foil in sandwich fashion to maintain the foil in tension. Indexing means associated with the other sealing land of the first frame co-operate with the registration affording means on the faceplate to permit repeated precise registrations between the foil and the faceplate to facilitate screening of the phosphor pattern as well as to facilitate mating of the electrode assembly to the faceplate. Finally, the invention contemplates a method of utilizing the electrode assembly for screening a phosphor pattern as well as methods of making a color cathode ray tube having such an electrode assembly.

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This invention relates in general to a "flat-square" color cathode ray tube, that is, a color tube having a flat faceplate and square screen corners, and in particular to a color selection electrode assembly for use therein. Of equal significance, the invention is concerned with methods of manufacturing the electrode assembly, as well as a flat-square cathode ray tube utilizing the assembly.

In general, a color selection electrode or "shadow mask" is a device which is disposed adjacent the luminescent phosphor screen that forms the target electrode of a color cathode ray tube, to control the landing pattern of one or more electron beams as they are swept across the screen. The shadow mask achieves color selection by partially shadowing the surface of the screen from scanning electron beams, permitting access to selected elemental phosphor areas by those beams. The choice of a color selection electrode for use in color television cathode ray tubes is, by and large, a choice between a non-tensed electrode and a tensed electrode. The most common type of color selection electrode used in color television receivers today is the non-tensed type.

In color picture tubes utilizing an untensed shadow mask, there is a tendency on the part of the mask to "dome" (localized buckling) in those areas where a scene characterized by very high brightness is depicted. For example, in a scene where a high concentration of white is presented for an extended period of time, when the beams sweep that area of the screen the current in each beam peaks precipitously with

an attendant localized heating of the mask. As a result of such a concentration of heat, that area of the mask expands and displaces itself from its original "cold" position to a position in which it does not effect proper masking of the writing electron beams. As a result, color purity is degraded. Moreover, because of its vulnerability of "doming", an untensed mask cannot accommodate the power density that a "doming-resistant" tensed mask can.

The general practice in cathode ray tubes manufactured for use in color television receivers is to position the untensed mask at an assigned location, relative to the phosphor screen, by suspending it from three preselected points disposed about the periphery of the tube's face panel. This suspension accommodates overall thermal expansion of the mask by causing the mask to be displaced toward the screen from its original position by provision of bi-metallic support springs; however, such provision can not resolve the above-described localized "doming" problem caused by concentrated heating in localized areas of the mask.

Cathode ray tubes using a tensioned color selection electrode are known such as the electrode used with a cylindrical faceplate CRT as described in U.S. Patent No. 3,638,063. In that tube, the color selection electrode comprises a grid formed of a multitude of parallel conductors tensed across a rigid frame. This grid serves to mask the wiring beams to fall upon the desired light emitting phosphor.

The mask supporting frame is mechanically stressed, as by compressing it, prior to attaching the shadow mask thereto. Upon release of the compression force, restoration forces in the frame establish tension in the mask.

An advantage of utilizing a tensed mask resides in the fact that the mask, while under tension,

will not readily submit to "doming". The mask retains its desired configuration until the heat generated by the scanning beams impinging thereon is sufficient to cause the area of the mask under bombardment to "relax" enough to negate the pre-established expansion of the mask with resultant development of color impurities.

The color television cathode ray tube in most common usage today employs a faceplate which approximates a section of a large radius sphere. The shadow mask in such a tube, of course, is contoured to match the faceplate. A trend today is toward a flatter faceplate which, in turn, calls for a flatter shadow mask. One approach currently being pursued resorts to an untensed flat metal mask employed in conjunction with a substantially flat faceplate. However, a flat mask is inherently less mechanically stable than a curved mask. Accordingly, to acquire stability, resort is had to a thicker mask, for example, one having a thickness in the order of 10 to 12 mils. This is approximately twice the thickness of a conventional curved mask. However, when one goes to a flat 10 to 12 mil mask the aperture etching process is presented with horrendous problems. Specifically, in order to prevent aperture limiting of the beam at the outer reaches of the mask, as would be encountered in a 90 degree tube, the apertures have to be etched at an angle to the plane of the mask, rather than etched substantially perpendicular to that plane as is the case for a conventional curved mask.

An early example of a tensed shadow mask for use in a color television cathode ray tube is described in U.S. Patent No. 2,625,734. The tensed mask described therein was created by resort to a process called "hot-blocking". The practice was to insert a flat mask between a pair of frames which loosely re-

ceived the mask. A series of tapped screws joining the two frames served to captivate the mask when the screws were subsequently drawn-down. The loosely assembled frame and mask was then subjected to a heat cycle by positioning heated platens adjacent the mask to heat and thereby expand it. The frame, however, was kept at room temperature. When the mask attained a desired expansion, the frame screws were tightened to captivate the mask in its expanded state. The heating platens were then removed. Upon cooling down to room temperature, the mask was maintained under tension by the frame. The resultant assembly was then mounted inside the tube adjacent the phosphor screen.

U.S. Patent No. 3,284,655 to -Oess is concerned with a direct viewing storage cathode ray tube employing a mesh storage target which is supported in a plane perpendicular to the axis of the tube. The mesh target comprises a storage surface capable of retaining a charge pattern which, in turn, control the passage therethrough of a stream of electrons. From a structural standpoint, it is proposed that mesh storage screen be affixed (no details given) to a circumferential ring that is disposed across the open end of envelope member. One end of the ring is in contact with the edge of the envelope member which has a coating of glass frit applied thereon. The end wall of another envelope member, also coated with frit, is placed in contact with the other side of the ring so that the end walls of the envelope members now abut both sides of the ring. Thereafter this assembly is frit sealed to secure the ring and mesh target within the tube.

It is of particular significance that the electrode spanning the inside of the tube envelope is a mesh screen that is not said to be subject to ten-

sion forces. Morevoer, the mesh screen is not a color selection electrode that serves to direct a writing beam selected elemental areas of color phosphors. Finally, there is no criticality, perceived or discussed, as respects mesh target registration with the phosphor layer on the faceplate.

U.S. Patent No. 2,813,213 describes a cathode ray tube which employs a switching grid mounted adjacent the phosphor screen to provide a post deflection beam deflecting force. Basically, it is proposed to employ a taut wire grid that is sealed in the tube envelope wall. In one embodiment, an external frame is used to relieve the tension forces applied by the taut grid to the glass wall of the tube. In another embodiment, an arrangement is generally suggested but not specifically disclosed utilizing a glass donut-shaped structure into which the grid wires are sealed. This donut assembly is proposed for insertion between the faceplate of the tube and its conical section. Following tube assembly, the patent indicates that the phosphors may be deposited on the faceplate by conventional photographic processes. Since the application of elemental color phosphor areas to the faceplate of a tube is, in itself, a formidable task, it is quite unclear how this could be achieved with a grid structure in situ across the faceplate as would be the case in the patent which does not address this problem.

Other examples of the prior art practice in this general area include structures utilizing a tensioned grid-type structure in a cathode ray tube environment as described in the following U.S. Patents: 2,842,696, 2,905,845, 3,489,966, and 3,719,848. Also, attention is directed to U.S. Patent No. 3,898,508 disclosing a faceplate and shadow mask (untensed) assembly representative of current practice.

Accordingly, it is a general aim of the invention to provide a color cathode ray tube employing

an improved color selection electrode arrangement and methods of manufacturing same which offers significant economic advantages over prior art tube and methods.

The present invention therefore provides a color cathode ray tube including a funnel having a sealing land, a faceplate comprising a target surface having a pattern of elemental phosphor areas deposited thereon and a sealing land circumscribing said target surface, said faceplate having registration affording means selectively located and oriented thereon, a color selection electrode assembly permitting selective excitation of said phosphor areas by a scanning beam of electrons comprising, frame means defining a central opening dimensioned to enclose said target surface of said faceplate, said frame means being formed of a material having a temperature coefficient of expansion approximating that of said faceplate and comprising a pair of substantially flat, axially spaced surfaces comprising sealing lands, a planar tensed foil, having a predetermined pattern of apertures supported by said frame means, said foil being formed of a material having a temperature coefficient of expansion greater than that of said frame means, and indexing means mechanically associated with said frame means and cooperable with said faceplate registration affording means to permit precise registration between said apertured foil and said faceplate, said indexing means and said registration affording means being structured to facilitate multiple registered matings of said frame means and said registration affording means during screening of said target surface, and sealing means disposed between confronting sealing lands of said frame means and said faceplate.

One of the features of the invention is that it provides a color selection electrode of the tensed type which has the anti-doming attribute of tension-type electrodes, but without the power handling limitations of prior art tension electrode systems.

A further feature of the invention is that it provides an envelope-captivated tensed color selection electrode system having the advantages of such systems, yet which is readily adapted to conventional color tube photoscreening methods and apparatus.

Further features and advantages of the invention will be evident from the following description of preferred embodiments of the invention taken together with the accompanying drawings wherein:

Figure 1 is an exploded view, in perspective, of the principal components of a color cathode ray tube embodying the invention;

Figure 2 is a fragmented sectional view of the electrode assembly shown in Figure 1, in which components of that electrode are partially assembled;

Figure 3 is an elevational view of a partially assembled version of the tube shown in Figure 1;

Figure 4 is a schematic representation of a lighthouse arrangement for screening a cathode ray tube faceplate according to this invention;

Figure 5 is a fragmentary sectional view of a portion of CRT faceplate and a color selection electrode assembly depicting an alternative faceplate/color selection electrode registration arrangement;

Figure 6 is a sectioned view of a portion of a further alternative embodiment of a color cathode ray tube embodying the invention;

Figure 7 is a fragmented sectioned view of another alternative embodiment of a color cathode ray

tube utilizing an alternate embodiment of the invention;

Figure 8 is a fragmented sectioned view of the foil mounting frame shown in Figure 7;

Figure 9 is an exploded view, in perspective, of the principal components of a further modification of a color cathode ray tube embodying the invention;

Figure 10 is a sectional view of an assembled color cathode ray tube, as taken along line 10-10 in Figure 9;

Figure 10a is a sectional view taken along lines 10a-10a in Figure 10, in which elements of the mask indexing arrangement are detailed;

Figure 11 is a perspective view depciting the cooperative interaction of two elements of a registration affording and indexing arrangement; and

Figure 12 is a schematic representation of a lighthouse arrangement utilizable for screening a cathode ray tube face panel using the electrode assembly of Figure 9.

A color selection electrode assembly 10 is shown in Figure 1 associated with and forming an integral part of a flat-square color television cathode ray tube 12. Tube 12 is depicted therein in a perspective exploded format as an aid in visualizing the inventive concept. As will be described, electrode assembly 10 is utilizable as a stencil for use in screening a pattern of luminescent primary color elemental phosphor areas upon the target surface 14 of the envelope section 16 that comprises the faceplate of tube 12. Preferably, faceplate 16 is depicted as a flat panel of glass formed from sheet glass so as to take advantage of material substantially less expensive than a conventional glass face panel. The flat glass faceplate has a predetermined temperature coefficient of expansion and has a sealing land 18 that

circumscribes target surface 14. This sealing land, constitutes a surface for receiving a bead of frit 20, a devitrifying glass adhesive employed in fabricating cathode ray tubes. Preferably, the frit employed is a low-temperature solder glass material which is available from Owens-Illinois Inc. under their designation CV-130.

The electrode assembly 10, upon completion of its screening function, is thereafter, at the option of the practitioner, frit sealable to faceplate 16 to permit selective excitation of the primary color phosphors by a scanning electron beam(s) when that assembly forms a constituent of a color cathode ray tube. To this end, faceplate 16 is provided with registration affording means or alignment elements, which take the form of a plurality of V-grooves 22. Preferably, the grooves 22 constitute three slots which are milled into the surface of the faceplate's sealing land 18. The included angle defined by the sloping walls of the grooves 22 preferably approximate sixty degrees and they are oriented so that the bottom of each groove lies along a line that extends radially from the geometric center of the faceplate.

Moreover, it is of particular significance that V-grooves 22 do not extend to the edge of the faceplate, see Figure 1. This is done to avoid a direct communication to the atmosphere which could compromise vacuum integrity once the faceplate has been frit sealed to electrode assembly 10 and to a funnel 24. While discernible only in phantom in Figure 1, funnel 24 has a sealing land 26 which geometrically matches a mating surface of one component of electrode assembly 10, the composition of which is described in detail below. If desired, funnel sealing land 26 may be provided with a corresponding plurality of alignment elements which also take the form of V-grooves 22' milled into sealing land 26 and which can be spatially

aligned with indexing means associated with the aforesaid one component of electrode assembly 10. Recourse to V-grooves 22' is optional since it is appreciated that other means for aligning the funnel sealing land 26 with electrode assembly 10 are well known. In fact, a common practice is to use an "outside" reference system, which, for the case at hand, would entail aligning the funnel to the electrode assembly, after that assembly had been mated to the faceplate, by positioning the funnel against referencing snubbers. For sealing purposes, which will be described, either funnel land 26 or the upper sealing land surface of electrode assembly 10 is provided with a bead of devitrifying frit. Finally, funnel 24, which includes a neck 27, is formed of a material, e.g., a glass or ceramic composition which, preferably has the same, or approximately the same, temperature coefficient of expansion as faceplate 16.

The color selection electrode arrangement 10 shown in Figure 1 comprises a temporary severable mount 30 defining a central opening 31 of a predetermined expanse. Mount 30, which adopts a rectangular configuration, is readily formed from four butt-welded strips of L-shaped angle metal. Strips of other geometry, of course, are also suitable. In any case, the four-sided mount is formed of a material having a temperature coefficient of expansion greater than that of envelope sections 16 and 24. Thus, mount 30 can be formed from cold rolled steel, stainless steel, nickel or monel to name a few of the materials found acceptable in practicing the invention.

Electrode assembly 10 further comprises, at this stage, an untensed planar foil 32 which has a predetermined array, or pattern, of apertures which may be triads of minute circular holes or, as now favored in state of the art color television tubes, a myriad of

elongated narrow slots disposed perpendicular to the major axis of the foil. The foil is tautly drawn across opening 31 of the mount under whatever tension is required to render the foil planar and it is then secured to the four sides of mount 30 by brazing or welding. In a manner to be described, foil 32 will subsequently be converted to a tension mask. Foil 32 has a temperature coefficient of expansion which is not greater than that of mount 30 and, preferably, a temperature coefficient less than that of the mount. Thus, foil 32 can be formed from cold rolled steel, or invar, to name two substances, each of which are utilizable with mounts made from any of the above-mentioned mount materials.

Desirably, the thickness of foil 32 is preferably less than 2 mils (.002 in.), otherwise unacceptable stresses may be induced in envelope glass when the foil, under tension, is incorporated in a tube. Preferably, a foil having a thickness equal to or less than 1 mil (.001 in.) is most suitable in practicing the invention. In fact, when resort to electroforming of foils is had, foils having a thickness of one-half mil (.005 in.) or less are realizable and find practical application in the practice of the invention. For purposes which will soon be apparent, mount 30 is provided with a plurality of adjustable positioning devices. More particularly, four identical sets 34, 36, 38 and 40 of such devices are deployed around the mount with one set centered, approximately, upon each side of the mount. In this fashion, and as shown in Figure 1, set 34 is disposed opposite set 36 while set 38 is opposite set 40. Since the sets of positioning devices are identical, only set 34 need be detailed. Accordingly, this set comprises a pair of inwardly directed threaded spindles 34s each of which is rotatably received in a conventional nut 34n for dis-

placement along an axis perpendicular to the central axis of tube 12. One nut is secured, as by welding or brazing, to the upper surface, as viewed in Figure 1, of its assigned mount side while the other is secured to the underside of the depending wall of that side, see also Figure 2.

In order to establish a permanent support for foil 32, electrode assembly 10 includes a first frame means comprising a substantially rectangular frame member 42 which has an overall span that is less than the expanse of central opening 31 in mount 30. In other words, the outside dimensions of frame member 42 are such as to permit the frame to be received within central opening 31 of mount 30. In practice, frame 42 is nested inside opening 31 of the mount with its outer bounding wall 44 abutting against the ends of the lower spindles of positioning devices 34, 36, 38 and 40. First frame member 42 defines a central aperture 46 which is dimensioned to enclose, or frame, target surface 14 of faceplate 16. Frame 42 is formed of a glass or ceramic material having a temperature coefficient of expansion approximating that of faceplate 16 and, if formed from glass, is desirably cut from the same type of sheet glass as that utilized for the faceplate. In the central axial direction, as viewed in Figure 1, frame 42 is bounded by a pair of substantially flat, spaced-apart, parallel surfaces 48, 50 which comprise sealing lands that curcumscribe aperture 46. The distance between surfaces 48, 50 in other words, the axial thickness of frame 42, is partially determinative of the Q-spacing for the cathode ray tube in which electrode assembly 10 is subsequently incorporated. Q-spacing is defined as the spacing between the luminescent screen of a cathode ray tube and its shadow mask, in this case, it is the spacing be-

tween target surface 14 and foil 32.

By way of further support for foil 32, electrode assembly 10 includes a second frame means comprising a substantially rectangular frame member 54 having an overall span that conforms substantially to the span of first frame member 42 and has a central aperture 56 substantially conforming, in expanse, to aperture 46 of frame 42. Frame 54 is also nestable within opening 31 of mount 30 with its aperture coaxially aligned with aperture 43 of frame 42 and with its outer bounding wall 57 abutting against the ends of the upper spindles of the mount supported positioning devices. The function of these adjustable positioning devices is now apparent; they serve to accurately align frame members 42 and 54 so that their respective apertures are coaxial as well as to retain them in mount 30 for the subsequently to be described fabrication of the tensed color selection electrode assembly 10.

Frame 54, preferably, is formed from the same type of material as that utilized for frame member 42 and thus has a temperature coefficient of expansion approximating that of faceplate 16. Frame 54 is also bounded by a pair of substantially flat, spaced-apart parallel surfaces 58, 60 that constitute sealing lands that circumscribe aperture 56 of this frame.

With frame members 42 and 54 supported in the manner shown and described, sealing land 58 of frame 54 is disposed in a confronting relation to sealing land 50 of frame 42 and with the periphery of foil 32 sandwiched therebetween. Specifically, foil 32 presents the upper side of a peripheral portion thereof to sealing land 58 of frame 54, and at the same time, presents the lower or opposite side of that peripheral portion to sealing land 50 of frame 42. As has been indicated, electrode assembly 10 is utilizable as a stencil for screening a pattern of elemental phosphor

areas upon target surface 14 of faceplate 16. Moreover, as can be appreciated, a precise and, as important, a repeatable, kinematic registration between assembly 10 and faceplate 16 is essential in order to utilize foil 32 as a stencil in screening such a pattern upon that target surface. By way of securing the required precise registration between electrode assembly 10 and faceplate 16, sealing land 48 of frame member 42 has indexing means associated therewith. More particularly, such means comprises a plurality (three) of rounded abutments, or bosses, 64 selectively located upon and affixed to sealing land 48 for cooperation with the registration affording grooves 22 milled into the surface of faceplate sealing land 18. The function of each of bosses 64 is to effect a two point contact with the groove it is received by, for a total six-point contact as between frame member 42 and faceplate 16. To that end, each boss adopts a geometry such that when it is seated upon the inclined walls of its assigned faceplate groove, the target surface of the faceplate and foil 32 are maintained in a predetermined spaced-apart relation, that is, the previously adverted to Q-spacing. It is thus seen that, in addition to the axial thickness of frame member 42, Q-spacing is also determined by the geometry of V-grooves 22 and bosses 64. It is appreciated, of course, that the registration format can be reversed, that is, sealing land 48 of frame 42 can be provided with grooves while the faceplate sealing land is fitted with boss elements. Since bosses 64 will ultimately be frit-sealed between the faceplate sealing land and sealing land 48 of frame member 42, it is desirable that they be formed from a glass sealable material, e.g. a metal alloy. An alloy particularly suited for this purpose is available from Carpenter Technology Corporation in Reading, Pennsylvania under their designation 430TI.

If it is decided that a like registration arrangement is desired to align electrode assembly 10 with funnel 24, a plurality of boss elements 64' can be selectively located upon and affixed to sealing land 60 of frame member 54 for cooperation with grooves 22' milled into the funnel's sealing land 26.

On the other hand, an alternative registration arrangement for effecting a six-point contact between electrode assembly 10 and faceplate 16 contemplates the "external" approach shown in Figure 5. More particularly, as a registration affording means the faceplate 16 is fitted with three (only one shown) externally mounted, outwardly directed, break-away pins 65 which, geometrically, adopt the same relative locations as those occupied by V-grooves 22 on the faceplate shown in Figure 1. Indexing means cooperating with each of the pins 65 comprises a break-away tab 66 affixed to lower frame member 42. Tab 66 has a depending finger 67 which, in turn, is provided with a bifurcation 68 at its distal end. Accordingly, to effect a kinematic registration with this embodiment, electrode assembly 10 is supported over the faceplate with a finger bifurcation 68 poised over its assigned pin. When the assembly 10 is lowered, a six-point contact is established between the three pins 65 and their cooperating bifurcations 68. This registration between the electrode assembly and the faceplate is repeatable as often as is required to accomplish screening of the target surface 14 of the faceplate, as well as to effect a final registration between the electrode assembly and the faceplate prior to frit sealing. After the funnel and faceplate have been frit sealed to bond electrode assembly 10 between their confronting sealing lands (a process described below) pins 65 may be broken away from the

faceplate and tabs broken away from frame member 42. Moreover, it is appreciated that the physical locations of the pins and the bifurcated fingers can be reversed and that other indexing structure within the knowledge of one skilled in the art could be employed. Of course, a like external registration arrangement can be adopted, if desired, for aligning funnel 24 will the foil mount.

Now that the basic components of electrode assembly 10 have been described, attention is directed to the fabrication of a tensed color selection electrode. Referring specifically to the fragmented sectional view of Figure 2, as well as Figure 1, a bead 70 of frit is applied to sealing land 50 of frame 42 and permitted to dry. In this instance, as well as in any other frit application hereinafter resorted to, the previously mentioned Owens-Illinois type CV-130 is the preferred material. Another bead 72 of frit is applied to sealing land 58 of frame member 54 and is also permitted to dry. Mount 30, with foil 32 tautly secured thereto, is then positioned over frame 42 with the underside of the foil's peripheral portion in contact with frit bead 70. Frame member 54 is then nested into mount 30 with its frit bead 72 in contact with the upper side of the foil's peripheral portion. Positioning devices 34, 36, 38 and 40 are then adjusted to coaxially align apertures 46 and 56 of respective frame members 42 and 54. It is appreciated, of course, that the frit applications are a matter of choice since the beads of frit can be applied to the upper and lower peripheral portions of foil 32 instead of to sealing lands 50 and 58.

This assemblage is then inserted into a heat chamber, or oven, the temperature of which is elevated to approximately 430 degrees Centigrade and maintained

thereat for thirty to forty-five minutes. These are the temperature and time parameters required to devitrify low-temperature CV-130 frit material. As the temperature rises frame members 42 and 54 will expand by an amount determined by their characteristic temperature coefficients of expansion. Simultaneously, mount 30 and foil 32 will also expand but, because of their greater temperature coefficients of expansion, their growth, relative to the frame members, will be greater. By the time this assemblage has reached a temperature of 430 degrees Centigrade, and by the time the frit has devitrified, mount 30 and foil 32 will have stabilized their expansion, as will have the frame members.

When the frit has devitrified, the periphery of foil 32 is captured therein between frame members 42 and 54. Thereafter, as the assemblage cools down to room temperature and the materials return, or attempt to return, to their normal dimensions, foil 32 will be tensed by virtue of being captured within the frit junctions between the foil periphery and frame sealing lands 50 and 60, which junctions will prevent the foil from returning to its normal room temperature dimension. Thus the mask, which was "grown" by the heat attendant upon the frit sealing process, is trapped in tension and is so maintained thereafter by the devitrified frit bonding the frame members and the foil.

After the frame members and the foil have been frit bonded, mount 30 is removed from the captured foil by severing the foil along the inside perimeter of the mount. (The mount, of course, is reusable.) The foil is then trimmed as close to the outside perimeter of the frame-foil junction as possible.

There will now be described a process that utilizes electrode assembly 10, as a stencil, to screen

a pattern of primary color elementary phosphor areas upon the target surface 14 of faceplate 16. A known and widely used method of preparing color phosphor screens utilizes a process which has devolved from familiar photographic techniques. To this end, a slurry comprising a quantity of a primary color phosphor particles suspended in a photosensitive organic solution e.g., pva, is applied, as a coating, to the target surface 14 of faceplate 16. The now tensed electrode assembly 10 (sans mount 30) is then seated upon faceplate 16 by effecting a registration between bosses 64 and their assigned faceplate grooves 22. As schematically depicted in Figure 4, the registered faceplate and electrode assembly is then inserted in a lighthouse 74 comprising a source of light 76 actinic to the photosensitive coating and a conventional beam trajectory compensating lens 78. This lens serves to compensate for the fact that the trajectory of an electron beam, under deflection, differs from the path of a light ray originating from the same point source as the electron beam. At any one instant light source 76 occupies a spatial position corresponding, in effect, to the axial position of the source of the electron beam that will subsequently excite the phosphor pattern to be created. The slurry coating is then exposed to the actinic light rays that pass through compensating lens 78 before encountering the foil apertures. The light transmitted through foil 32 then creates a latent image of the foil's aperture pattern on the coated faceplate.

Accordingly, after the initial exposure through lens 78, electrode assembly 10 is then removed and the substrate is washed. By way of example, in a positive resist, positive guardband system this wash will remove the exposed portion of the coating. How-

ever, it is to be appreciated that the invention is equally utilizable in a negative resist, negative guardband system or even in the tacky-dot dusting system. In any event, the exposed coating is processed to establish upon target surface 14 a pattern of elemental phosphor areas corresponding to the aperture pattern of foil 32.

The slurry coating, faceplate-electrode assembly registration, exposure and wash steps are then repeated for each of the other primary color phosphor areas to be applied to target surface 14, with the source of actinic light, of course, disposed at appropriately different positions with respect to assembly 10. A similar slurry coating, registration, exposure and wash procedure can be employed to provide the target surface with a black matrix pattern of the type employed in a negative guardband tube. The resultant luminescent screen comprises a pattern of interleaved primary color phosphor areas corresponding to the aperture pattern in foil 32. In practice, successive repositioning of the light source, prior to exposing the target screen through the foil, is such as to effectively mimic the positions of three scanning electron beams issuing from a gun mount later to be fitted to the tube. In this regard, it should be noted that the resultant luminescent screen pattern will bear a unique geometric relationship, or orientation, to the light sources and, thereby, to the electron beam axes of the subsequently fitted electron gun mount.

After the screening process has been completed, desirably, the electrode assembly 10 employed to pattern the screen is mated to faceplate 16 and to funnel 24. In this process, the upwardly facing sealing land surface 18 of faceplate 16 and the downwardly facing land surface 26 of funnel 24 are coated with beads of

low-temperature frit 22, 22' which are permitted to dry. Again, the frit applications are a matter of choice since the beads of frit could as well be applied to first frame sealing land 48 and to second frame sealing land 60 instead of to surfaces 18 and 26. Assembly 10 is then re-registered with faceplate 16 by inserting bosses 64 into grooves 22. The sealing land of funnel 24 is then fitted over assembly 10 with its V-grooves 22' receiving bosses 64'. This assemblage is then inserted into the heat chamber the temperature of which is again elevated to approximately 430 degrees Centigrade and maintained thereat for thirty to forty-five minutes. These are the temperature and time parameters required to devitrify low-temperature Owens-Illinois type CV-130 frit material. After this assemblage has reached a temperature of 430 degrees Centigrade and after a suitable period of time at this temperature, the frit will have devitrified and electrode assembly 10 will be captured between funnel 24 and the faceplate 16 to form an integral part of cathode ray tube 12. Thereafter, when the assemblage cools down to room temperature and the materials return to their normal dimensions, foil 32 will remain tensed by virtue of its prior capturing by the frit junction bonding frame member 42 to frame member 54 along their confronting respective sealing lands 50, 58. Thus the foil, which was tensed, by the heat attendant upon the frit sealing process employed to fabricate electrode assembly 10, is trapped in tension and maintained thereafter by the devitrified frit joining the frame members 42 and 54.

After the faceplate-electrode-assembly-funnel assemblage has been frit sealed and a neck section fitted thereto, the tube is subjected to an exhaust process. The frame-foil junction of electrode 10

is then covered with a coating of insulating material to prevent external contact with the foil which, depending upon the excitation system utilized with the completed tube, may be maintained at a high electrical potential.

It is to be noted that materials other than those disclosed for the envelope sections the frame members and the mount and foil can be used so long as the coefficients of expansions of such materials provide the differential expansion required to tense an initially untensed planar foil. Similarly, the alignment elements utilized by the faceplate and funnel, as well as the indexing means used for the frame members need not be restricted to the groove and boss format disclosed. Figures 6-8 disclose further alternative arrangements for assuring proper registration of the face panel in the screen forming operation discussed above.

Figure 6 discloses color cathode ray tube 110 similar to tube 12 of Figure 1 comprising a funnel 112 (only partially illustrated) having a central axis and including a bell portion 114. The depicted extremity of bell portion 114 has a predetermined wall thickness and it comprises a sealing land 116.

Like tube 12, tube 110 comprises a flat, substantially rectangular, glass face panel 118 formed of a material having a predetermined temperature coefficient of expansion. Panel 118 comprises a target area 120 having a patterned screen 119 of luminescent primary color elemental phosphor deposits thereon, which deposits may be arranged in triads of red, green, and blue phosphor dots. A sealing land 121 circumscribes target area 120.

To facilitate its role in screen forming, face panel 118 is provided with registration affording means similar to the V-shaped grooves 22 provided

for the faceplate 16 of Figure 1. In this modified construction the registration affording means comprises means defining a first plurality of cavities 122, 124 and which in a preferred execution, constitute three holes of predetermined depth with each presenting an oval entrance that affords each cavity an elongated portion, so that, effectively, each cavity is provided with a fore-shortened V-sided runway. This registration affording means, as well as an associated indexing means, is described below. The cavities are formed at selected locations upon the target side of panel 18, specifically on or near sealing land 21. As discussed in detail later, it is of particular significance that the elongated portion of each cavity be aligned along a radial extending from the geometric center of panel 18 and that the cavities do not extend completely across sealing land 21 to the "outside."

A color selection electrode arrangement 127 that affords selective excitation of the phosphor deposits by a scanning beam of electrons comprises a substantially rectangular ring-like frame 128 (since panel 118 is rectangular) defining a central opening 130 dimensioned to enclose target area 120 of panel 118. Frame 128, which adopts the format of a section of a rectangular cylinder, is formed of a material having a temperature coefficient of expansion approximating that of panel 118, for example, glass or a ceramic of compatible coefficient of expansion. Frame 128 comprises first and second substantially flat, spaced apart, parallel surfaces 132, 134, respectively. As will be seen, surfaces 132 and 134 ultimately serve as sealing lands, with surface 132 disposed in a confronting relation to face panel sealing land 121. Frame 128 also includes registration affording means comprising means defining a second like plurality of cavities 136, 138, formed at selected locations on surface 132 of the frame. Cavities 136, 138 while of

a predetermined different depth than that of cavities 122, 124 adopt a similar profile in that each of the former likewise presents an oval entrance constituting an elongated portion aligned along a radial extending from the geometric center of frame 128.

Surface 134, on the other hand, comprises a shadow mask mounting surface which is characterized by an overall external span which is less than the span of face panel 118 by at least the wall thickness of funnel bell portion 114. The significance of this dimensioning is intended to insure that no part of the mask will be exposed to the "outside", since in operation, tube 110 will maintain a 20KV to 30KV voltage on the mask. By relegating the peripheral portion of the mask to a location within the confines of the funnel, the safety objective is attained.

Arrangement 127 further comprises a color selection electrode, or shadow mask, in the form of a tensed planar foil 140 similar to foil 30 of Figure 1 having a predetermined pattern of apertures corresponding to the pattern of screen 119 on face panel 118. Foil 140 has a temperature coefficient of expansion which is greater than that of frame 128 and preferably is formed from cold rolled steel with a glass or ceramic being utilized for frame 128. The peripheral portion of foil 140 is bonded to frame surface 134 by a bead of frit 144, a devitrifying glass adhesive employed in fabricating cathode ray tubes.

In order to neutralize the application of any bending or flexing moment to frame 128, attributable to the tension forces in foil 140, arrangement 127 comprises a centrally apertured stabilizing, or stiffening, member 146, in the form of a rectangular ring (assuming, of course, that frame 128 and face panel 118 are rectangular). Ring 146 has a predetermined axial

thickness and is formed of a material having a temperature coefficient of expansion compatible with that of frame 128. Ring 146 comprises a flat end face 147, which is bonded to the frame, and has an overall span such that it does not extend beyond the foil bonding surface 134 of frame 128. Preferably, at the same time the peripheral portion of foil 140 is bonded to surface 134 stabilizing ring 146 is bonded to that surface and by the same application of frit 144 so that foil 140 is sandwiched therebetween.

It is important that a precise and repeatable kinematic registration between foil frame 128 and face panel 118 is obtained in order to utilize foil 140 as a stencil in screening the pattern of elemental phosphor deposits upon target surface 120 of the panel. For this purpose indexing means are provided comprising a plurality of spherical elements 150 individually receivable between an assigned one of the panel cavities and an adjacent, oppositely disposed confronting one of the frame cavities. More particularly, elements 150 comprise balls formed of an alloy composition, the coefficient of expansion of which is compatible with the envelope glass since they will ultimately be frit sealed, in situ, when tube 110 is assembled. A glass sealable metal alloy suitable for this purpose is available from Carpenter Technology Corporation in Reading, Pennsylvania under their designation 430TI. Insofar as dimensional specifications are concerned, each of balls 150 desirably exhibits a sphericity of .000050 inches. Additionally, because the cavities are of elongated configuration, each ball is afforded limited radial freedom along the confronting V-sided runways of its assigned panel and frame cavity to urge and establish a precise, repeatable registration between foil 140 and target area 120 of

panel 118. Additionally, the ball diameter is such as to establish a predetermined Q spacing between target area 120 and foil 140.

As noted, the result of the ball and cavity cooperation is to effect a repeatable registration, as between panel target area 120 and foil 140, to facilitate screening the face panel. Prior to the actual screening operation, electrode arrangement 127 is prepared as a tensed foil subassembly comprising frame 128 with foil 140 and ring 146 bonded thereto.

In the final assembly of cathode ray tube 110, sealing land 121 of panel 118 is bonded to frame surface 132 and is also bonded to funnel sealing land 116. The particular bonding agent is not critical, however, it is contemplated that, in each instance, resort may be had to a bead of frit 152. As in the case with the frit bead 144 employed to bond foil 140 to frame 128, frit bead 152 can also constitute a devitrifying glass adhesive of the type commonly employed in fabricating cathode ray tubes. In each instance, the frit to be employed can be a low temperature solder glass material which is available from Owens-Illinois, Inc. under their designation CV-130.

Figure 7 illustrates a further alternate embodiment of the invention, which is specifically addressed to the construction adopted by the color selection electrode arrangement 127. Since the cathode ray tube 110 shown in Figure 7 is, except for arrangement 127', the same as that illustrated in Figure 6., like reference numerals are employed to identify like elements. Electrode arrangement 127', differs from its counterpart in Figure 6 principally in its lateral dimension. As shown in Figure 7, the outwardly facing wall 160 of frame 128' essentially coincides with the outer side wall 162 of face panel 119 as well as

with the outside wall 164 of funnel bell portion 114. Frame 128', which is formed of the same material as its counterpart in Figure 6, also comprises first and second substantially flat spaced-apart parallel surfaces 166, 168. Surface 166 comprises a groove 170 that extends completely around that surface to divide that surface into an inner, or foil mounting, area 172 and an outer sealing land area 174. Inner area 172, which serves to receive the peripheral portion of foil 140, is also the surface to which end face 147 of stabilizing ring 146 is bonded. The outer, or sealing land, area 174 of frame 128' serves to receive sealing land 116 of funnel bell portion 114.

Since it is contemplated that frame 128' foil 140 and stabilizing ring 146 will be fabricated as a subassembly during the foil tensioning process, it can now be appreciated that a function of groove 170 is to isolate the sealing land area 174 of surface 166 from surface 172 during the foil tensioning process which, of course, involves area 172, foil 140 and ring 146. As a result, a clean, readily workable area 174 is preserved for the subsequent frit sealing operation that bonds funnel sealing land 116 to that area.

Moreover, in this regard, the plane of foil mounting area 172 need not coincide with the plane of sealing land area 174. Figure 8 shows an alternate construction for the foil mounting frame, wherein the frame 128" exhibits the same basic configuration as frame 128' of Figure 7 except to the extent that the foil mounting area of frame 128" is positively isolated from its sealing land area by virtue of a shouldered, or pedestal construction. More particularly, frame 128" which defines a central opening 130 dimensioned to enclose target area 120 of foil 118, also comprises first and second substantially flat spaced-apart paral-

lel surface 166', 168'. Again, a groove 70' extends around one surface of frame 128" to divide surface 166' into an inner foil mounting area 172' and an outer sealing land area 174'. Inner area 172' which serves to receive the peripheral portion of foil 140, is also the surface to which end face 147 of stabilizing ring 146 is bonded. The outer area 174' serves, of course, to receive the sealing land 116 of the funnel.

In this alternate construction of frame 128" the plane of area 172' (and, of course, foil 140) is "below" (as one views Figure 8) sealing land surface 174'. Additionally, the shoulder construction for frame 128" materially eases practicing the above described process for tensing a foil and bonding it to its frame by affording a positive and definite isolation of area 172', from area 174'. Moreover, it should be appreciated that the differences in elevation as between areas 172' and 174' is not indicative of scale. In practice, the difference in elevation is small, the depicted illustration is intentionally exaggerated to distinguish from the Figure 7 embodiment.

In all other respects, that is insofar as materials are concerned, the alternate embodiments of Figures 7 and 8 are substantially similar to that of the embodiment of Figure 6.

Figure 9 depicts an electrode assembly 210 used in forming a patterned screen of phosphor deposits upon a substrate as a constituent of a flat-square color television cathode ray tube 212 in a manner similar to assembly 10 of Figure 1.

Thus, assembly 210 comprises a flat, substantially rectangular, glass panel 214 formed of a material having a predetermined temperature coefficient of expansion having a sealing land 216 circumscribing a target area 218 serving as a substrate for receiving a patterned phosphor screen 220.

As in the case of face panel 16 of assembly 10, face panel 214 is provided with registration affording means comprising means defining a first plurality of cavities 222, 224, 226; in a preferred execution they constitute three holes of predetermined depth with each presenting an oval entrance that affords each cavity an elongated portion, see Figure 11, that effectively provides the cavity with a foreshortened V-sided runway, see in particular Figure 10a.

The cavities are formed at selected locations upon the target side of panel 214, specifically upon sealing land 216. It is of particular significance that the elongated portion of each cavity be aligned along one of radials 222R, 224R, 226R extending from the geometric center of panel 214 and that the cavities do not extend completely across sealing land 216 to the "outside". This construction is imperative, and it applies to any subsequently described cavities, in order to avoid a direct communication across the sealing land which could compromise vacuum integrity once assembly 216 has been frit sealed to a funnel 227 to form a constituent of a cathode ray tube. Moreover, it is preferred that one of the cavities, 222, be located upon the minor axis of panel 214 while cavities 224 and 226 be located at those corners of the panel across from cavity 222. Additional details respecting the registration affording cavities will be given at such time as the indexing means associated therewith are introduced.

Assembly 210 further comprises a frame 228 defining a central opening 230 dimensioned to enclose target area 218 of panel 214, see Figure 10. Frame 228 is formed of a material having a temperature coefficient of expansion approximating that of panel 214, for example, glass or a ceramic of compatible coefficient of expansion. Frame 228 comprises first and second substantially flat, spaced apart, parallel

surfaces, 232, 234, respectively. As will be seen, surfaces 232 and 234 ultimately serve as sealing lands. Frame 228 also includes registration affording means comprising means defining a second like plurality of cavities 236,238 and 240 formed at selected locations on surface 232 of the frame. These cavities are depicted in broken line construction in Figure 9 since they are on that surface 232 of frame 228 that confronts face panel sealing land 216. Cavities 236, 238, 240, while of a predetermined different depth than that of cavities 222, 224, 226, adopt a similar profile in that each of the former likewise presents an oval entrance constituting an elongated portion aligned along a respective radial 236R, 238R, and 240R extending from the geometric center of frame 228. Thus, cavities 236,238, and 240 also establish foreshortened V-sided runways which are disposed in a confronting, and aligned relation, to their respective counterparts 222, 224 and 226 respectively, on panel sealing land 216. In fact, cavities 236, 238, and 240 are geometrically similar to cavities 222, 224, and 226, and differ only in depth, the latter cavities are deeper, see Figure 10 or 10a.

As depicted in Figure 9, the plurality of panel cavities and the plurality of frame cavities are arranged so that, collectively, the axes of the elongated portions of the panel cavities exhibit substantially the same radial geometry as that collectively exhibited by the axes of the elongated portions of the frame cavities.

Assembly 210 further comprises a color selection electrode 242, in the form of a tensed planar foil similar to foil 32 of Fig. 1. The peripheral portion of foil 242 is bonded to an assigned inner area 244 of frame surface 234 by a bead of frit 245.

In order to neutralize any bending or flexing moment applied to frame 228, by virtue of the tension forces in foil 242, a centrally apertured stabilizing, or stiffening, member 246 identical to ring 146 of Figure 7 is employed.

Ring 246 has an overall span such that it does not extend beyond the foil bonding area 244 on frame surface 234, and it is also bonded to frame surface area 244. Preferably, at the same time the peripheral portion of foil 242 is bonded to area 244, stabilizing ring 246 is bonded to area 244 and by the same application of frit 245 so that foil 242 is sandwiched therebetween.

As described above regarding foil frame 128 and face panel 118, a precise and repeatable kinematic registration between foil frame 228 and face panel 214 is essential in order to utilize foil 242 as a stencil in screening the pattern of elemental phosphor deposits upon target surface 218 of the panel. Hence, there is provided indexing means comprising a similar plurality (three) of spherical elements 250 similar to the balls 150 shown in Figures 6 and 7. As noted above regarding Figures 6 and 7, the indexing balls 250 are individually receivable, or seated, between an assigned one of the panel cavities and an adjacent, oppositely disposed confronting one of the frame cavities. Since the cavities are of elongated configuration, each ball is afforded limited radial freedom along the confronting V-sided runways of its assigned panel and frame cavity pair to urge and establish a precise, repeatable registration between foil 242 and target area 218 of panel 214. Since Figure 10 is a section taken along panel radial 222R, the aforementioned limited radial displacement is therein readily discernible. Moreover, the manner in which the V-sided

runways of confronting cavities 222 and 236 embrace ball 250 and effect a four-point contact therewith is clearly depicted in Figure 10a. Specifically, when frame cavities 236, 238 and 240 each have a ball 250 inserted therein and panel 214 is mounted thereon with its cavities 222, 224 and 226 overlying and receiving an assigned ball, in other words, when the previously mentioned radial geometries of the frame and panel are disposed in an overlying near coincident relation, the panel is urged to seek a unique transverse registration relative to the frame and, of course, foil 242. This unique registration obtains because the elongated axes of the frame cavities and those of the panel cavities are directed along substantially identical radial geometries. Thus the transverse registration is kinematic and is not dependent upon an exact positioning of any particular ball along its radial provided, of course, the ball remains within its assigned cavity.

As noted, the result of the ball and cavity cooperation is to effect a repeatable registration, as between panel target area 218 and foil 242, to facilitate screening the face panel.

There will now be described, in connection with Figure 12, a process that utilizes assembly 210, in conjunction with a lighthouse 252, as a stencil to screen a pattern of primary color elementary phosphor deposits upon target surface 218 of panel 214. A known and widely used method of preparing color phosphor screens utilizes a process which has evolved from familiar photographic techniques. To this end, a slurry comprising a quantity of a primary color phosphor particles suspended in a photosensitive organic solution (pva), is applied, as a coating, to target surface 218. Frame 228 with tensed foil 242 bonded thereto is then seated upon the sidewalls 254 of

lighthouse 252, which sidewalls are surmounted by any suitable indexing arrangement that will effectively maintain frame 228 immobile in a plane perpendicular to the central axis of the lighthouse. If desired, a ball and cavity arrangement of the type described above can be resorted to, in fact, such an arrangement will be described below in connection with the manner in which assembly 210 is mated to a cathode ray tube funnel. In any event, after frame 228 is mounted atop lighthouse walls 254, a series of balls 250 are inserted between frame cavities 236, 238, 240 and confronting panel cavities 222, 224, 226, respectively, to effect a registration between frame mounted foil 242 and target area 218 of panel 214. As schematically shown in Figure 12, lighthouse 252 is seen to comprise a source of light 256 actinic to the photosensitive coating on panel target 218. At any one instant light source 256 occupies a spatial position corresponding, in effect, to the axial position of the source of the electron beam that will subsequently excite the phosphor deposits to be created. Thereafter, as in the ordinary practice, the slurry coating is exposed to actinic light rays that pass through a conventional beam trajectory compensating lens 258 before encountering the apertures in foil 242. The light transmitted through the foil, or mask, then creates a latent image of the mask's aperture pattern on the coated faceplate.

The purpose, of course, for introducing lens 258 between the light source and the stenciling foil is to compensate for the fact that the trajectory of an electron beam under deflection differs from the path of a light ray originating from the same point source as the electron beam.

Accordingly, after the initial exposure through

lens 258, panel 214 is removed and the target area is washed. By way of example, in a positive resist, positive guardband system this wash will remove the exposed portion of the coating. However, it is to be appreciated that the invention is equally utilizable in a negative resist, negative guardband environment or even in the tacky-dot dusting system. In any event, the exposed coating is processed to establish upon target area 218 a pattern of elemental phosphor deposits corresponding to the aperture pattern of foil 242, as initially exposed.

The slurry coating, panel registrations, exposure and wash steps are then repeated for each of the other primary color phosphor deposits to be applied to target area 218, with the source of actinic light, of course, disposed at appropriately different positions with respect to foil 242. The resultant luminescent screen then comprises three groups of primary color phosphor deposits with each said group corresponding to the aperture pattern of foil 242. In practice, the successive repositioning of the light source, prior to exposing the target screen through the foil, is such as to effectively mimic the positions of three scanning electron beams issuing from a gun mount later to be fitted to the tube. In this regard, it should be noted that the resultant luminescent screen pattern will bear a unique geometric relationship, or orinetation, to the light sources and, thereby, to the electron beam axis of the subsequently fitted electron gun mount.

Referring back to Figure 9, attention is redirected to foil supporting frame 228. More particularly, frame 228 includes additional registration affording means comprising means defining a third, like plurality of cavities 260, 262, and 264 of predetermined depth and each presenting an oval entrance that affords each cavity an elongated portion that

provides the cavity with a fore-shortened V-sided runway. The cavities are individually formed at selected locations upon surface 234 of the frame. Again, the elongated portion of each cavity is aligned along a radial 260R, 262R, and 264R extending from the geometric center of the frame. It will be noted, that cavity 260 lies along the minor axis of frame 228 while cavities 262 and 264 are disposed in corners of the frame across from cavity 260. Note further that frame 228 is fitted with six cavities three on surface 232 and three on surface 234. It is significant that the locations of the cavities are staggered to the end that no two cavities are "back-to-back" which arrangement, of course, contributes to the integrity of frame 228.

Turning now to funnel 227, that component is shown to be characterized by a bell portion 268 comprising a sealing land 268, which is identified by a broken construction line since it is hidden in the Figure 9 perspective view. Sealing land 268 is symmetrically disposed relative to the geometric center of bell portion 266.

Funnel 227 also includes registration affording means comprising means defining a fourth, like plurality of cavities 270, 272, 274 of predetermined depth and each presenting an oval entrance that affords each cavity an elongated portion that provides the cavity with a fore-shortened V-sided runway. The cavities are individually formed at selected locations upon bell portion sealing land 268. Again, as typical of all registration affording cavities described herein, the elongated portion of each of cavities 270, 272, and 274, is aligned along a respective one of radials 270R, 272R, 274R, extending from the geometric center of the bell portion 261.

Indexing means comprising a plurality of spherical elements 276 are individually receivable between an assigned one of the cavities formed on frame surface 234 and an adjacent oppositely disposed confronting one of the cavities formed on bell portion sealing land 268. Each of spherical elements 276, can adopt the same construction as previously described balls 250 and is of such diameter as to be afforded limited radial displacement along the elongated portion of its assigned frame and sealing land cavities so as to establish the geometric center of bell portion 266 in coincidence with the geometric center of frame 228. The manner in which the cavities frame 260, 262, 264 cooperate with respective bell portion cavities 270, 272,274 respectively to receive an assigned one of balls 276,278, 280 is readily discernible from the exploded view of Figure 9. Moreover, it will be appreciated that the manner in which the funnel sealing land cavities, in conjunction with balls 276, cooperate with the cavities on frame surface 234 is identical to the manner in which the panel cavities 222, 224, 226 balls 250 and frame cavities 236, 238, 240 cooperate. This cooperation has been described above and is graphically illustrated in Figures 10 and 10a.

In the final assembly of cathode ray tube 212, sealing land 216 of panel 214 is bonded to frame surface 232 while frame surface 234 is bonded to funnel sealing land 268. The particular bonding agent is not critical, however, it is contemplated that, in each instance, resort may be had to beads of frit 280, 282, for bonding panel 214 to frame surface 232 and for bonding frame surface 234 to funnel sealing land 268, respectively. As in the case with the frit bead 245 employed to bond foil 242 to frame 228, frit beads 280, 282 can also constitute a devitrifying glass adhesive of the type commonly employed in fabricating cathode ray

tubes. In each instance, the frit to be employed can be a low temperature solder glass material which is available from Owens-Illinois, Inc. under their designation CV-130.

Insofar as effecting a registration between panel 214 and frame 228 and between frame 228 and funnel 227 is concerned, it is paramount that friction be substantially eliminated in the unions therebetween during the frit sealing operation. Specifically at the onset of that operation, and insofar as one of the aforesaid unions is concerned, a bead of frit is applied to face panel sealing land 216, or to surface 232 of frame 228. A series of balls 250 will be occupying confronting ones of panel and frame cavities so that the balls will be nested in frit material. Thereafter, at the proper elevated temperature, the frit devitrifies (liquifies) to afford each ball the opportunity for rolling contact within its assigned confronting cavities.

Obviously, friction elimination in the second of the aforesaid unions is achieved in like fashion. That is, after a bead of frit is applied to frame surface 234, or to bell portion sealing land 268, the series of balls 250 occupying confronting ones of frame and sealing land cavities will also be nested in frit material. Again at the proper elevated temperature the frit devitrifies and each of these balls is also availed of the opportunity for rolling contact within its assigned pair of cavities. Of course, in practice, both unions would be effected in one operation.

It is of consequence to note that, during the above described frit sealing operation, there is the possibility of a differential expansion occurring as respects components e.g., panel and foil, that originally were in registration. However, since the nature of this misregistration would be radial about the geometric center of the components, the effect of

this misregistration in the assembled tube can be readily accommodated by a yoke adjustment.

While a preference has been indicated for forming confronting cavities to different depths, it is appreciated that confronting series of cavities, e.g. cavities 222, 224, 226 and 236, 238 and 246 can be of substantially the same depth without departing from the spirit of the invention, so long as the diameter of spherical elements assigned to the confronting series of cavities is such as to maintain, in this instance, panel 214 and frame surface 232 in a spaced-apart relation.

CLAIMS

1. A color cathode ray tube including a funnel having a sealing land, a faceplate comprising a target surface having a pattern of elemental phosphor areas deposited thereon and a sealing land circumscribing said target surface, said faceplate having registration affording means selectively located and oriented thereon, a color selection electrode assembly permitting selective excitation of said phosphor areas by a scanning beam of electrons comprising, frame means defining a central opening dimensioned to enclose said target surface of said faceplate, said frame means being formed of a material having a temperature coefficient of expansion approximating that of said faceplate and comprising a pair of substantially flat, axially spaced surfaces comprising sealing lands, a planar tensed foil, having a predetermined pattern of apertures supported by said frame means, said foil being formed of a material having a temperature coefficient of expansion greater than that of said frame means, and indexing means mechanically associated with said frame means and cooperable with said faceplate registration affording means to permit precise registration between said apertured foil and said faceplate, said indexing means and said registration affording means being structured to facilitate multiple registered matings of said frame means and said registration affording means during screening of said target surface, and sealing means disposed between confronting sealing lands of said frame means and said faceplate.

2. The tube of claim 1 wherein said frame means comprises first and second axially spaced members sandwiching said foil therebetween.

3. The tube of claim 1 or 2 wherein said frame means comprises means for supporting said foil completely within said tube.

4. The tube of any of claims 1 to 3 wherein one of said registration affording means and said indexing means comprises cavity means and the other comprises mating protuberant elements preferably of conical form.

5. The tube of any of claims 1 to 4, wherein said frame means comprises a first frame member defining a central aperture dimensioned to enclose said target surface of said faceplate, said first frame member being formed of a material having a temperature coefficient of expansion approximating that of said faceplate and comprising a pair of substantially flat, spaced-apart parallel surfaces comprising sealing lands a second frame member defining a central opening of a span substantially conforming to that of said first frame member, and coaxially aligned with said first frame member, said second frame member formed of a material having a temperature coefficient of expansion approximating that of said faceplate and also comprising a pair of substantially flat, spaced-apart parallel sealing lands, one of said second frame sealing lands being disposed in a confronting relation to one of said first frame member sealing lands; the foil presenting one side of its peripheral edge portion to said one sealing land of said first frame member and presenting the opposite side of said peripheral edge portion to said one sealing land of said second frame member, said indexing means being associated with the other of said first frame member sealing lands and cooperable with said faceplate registration affording means to permit precise registration between said foil apertures and said elemental phosphor areas of said target surface, and said sealing means comprising devitrifying frit means disposed between said confronting sealing lands of said first and second frame members and said peripheral edge portions of said foil presented to said confronting sealing lands for capturing said foil therebetween and for maintaining said foil in tension.

6. The tube of claim 5, in which said first frame member has an axial thickness that establishes Q spacing, that is, the spacing between said target surface and said foil.

7. The tube of claim 5 or 6, wherein said devitrifying frit means, disposed between said confronting sealing lands of said first and second frame members is in intimate contact with said sides of said peripheral portion of said foil presented to said confronting sealing lands, for bonding said first frame member to said second frame member, and for maintaining said foil in tension, said frit means also being disposed between said faceplate sealing land and said other of said first frame member sealing lands for bonding said faceplate to said color selection electrode, and further disposed between said funnel sealing land and the other of said second frame sealing lands for bonding said funnel to said color selection electrode.

8. The tube according to any of claims 1 to 4, wherein said funnel has a bell portion, one extremity of which has a predetermined wall thickness, one of said pair of frame means surfaces comprises a foil mounting surface while the other comprises a sealing land surface disposed in a confronting relation to said face panel sealing land, said foil mounting surface of said frame means having an overall external span which is less than the span of said face panel by at least the wall thickness of said one extremity of said funnel bell portion, said foil having its peripheral portion frit bonded to said frame means foil mounting surface, and said sealing means, bonding said funnel, said frame means and said face panel together and with said foil wholly enclosed within said funnel bell portion and with said foil aperture pattern in registration with said pattern of elemental

phosphor areas.

9. The tube of claim 8, in which said frame means has a thickness dimension, as measured in a direction parallel to said funnel central axis, which is principally determinative of a desired Q-spacing.

10. The tube of claim 8 or 9, in which said color selection electrode assembly further comprises a stabilizing member having an overall peripheral span not greater that the peripheral span of said frame means foil mounting surface, said stabilizing member further comprising at least one substantially flat surface disposed in a confronting relation to said foil mounting surface of said frame means and adapted to be frit sealed to said foil mounting surface.

11. The tube of claim 8, 9 or 10 in which said frame means foil mounting surface and said foil are arranged to be wholly enclosed by said funnel bell portion.

12. The tube of any of claims 8 to 11 in which said frame means is wholly enclosed within said funnel bell portion and in which said funnel sealing land is disposed in a confronting relation to said face panel sealing land.

13. The tube of any of claims 8 to 10 in which said foil mounting surface comprises a sealing land adapted to receive said funnel sealing land.

14. The tube of any of claims 8 to 10 in which said frame means comprises a pedestal portion comprising a foil-mounting area and a sealing land area disposed in a parallel spaced-apart plane from said foil-mounting area and adapted to receive said funnel sealing land.

15. The tube of any of claims 8 to 14 in which said face panel registration affording means are selectively located and oriented upon said face panel sealing land.

16. The tube of any of claims 8 to 10, 13 or 14 in which said sealing land surface of said frame means has an overall external span that essentially coincides with the overall external span of said face panel.

17. The tube of any of claims 1 to 7 or 8 to 16 wherein the faceplate registration affording means comprises means defining a first plurality of cavities each comprising an elongated portion, individually formed at selected locations upon the target area side of said faceplate, with each said elongated portion aligned along a radial extending from the geometric center of said faceplate; said frame means further including registration affording means comprising means defining a second, like plurality of cavities, each also comprising an elongated portion, individually formed at selected locations upon one of said pair of flat surfaces of said frame means with each said elongated portion aligned along a radial extending from the geometric center of said frame means, said plurality of faceplate cavities and said plurality of frame means cavities being arranged so that, collectively, the axes of said elongated portions of said faceplate cavities exhibit substantially the same radial geometry as that collectively exhibited by the axes of said elongated portions of said frame means cavities, said indexing means comprising a similar plurality of spherical elements individually receivable between an assigned one of said faceplate cavities and an adjacent, oppositely disposed confronting one of said frame mean cavities, so that, when said faceplate and frame means cavity radial geometries are disposed in an overlying near coincident relation, said spherical elements are caused to urge a precise transverse registration between said foil and said target area, said tube having means for bonding said

faceplate sealing land to one of said pair of flat surfaces of said frame means with said spherical elements in situ, and means for bonding said funnel sealing land to the other of said flat surfaces of said frame means.

18, The tube of claim 17, wherein said frame means includes additional registration affording means comprising means defining a third, like plurality of cavities, each also comprising an elongated portion individually formed at selected locations upon the other of said flat surfaces of said frame means with each said elongated portion aligned along a radial extending from the geometric center of said frame means, said funnel having a bell portion which includes said funnel sealing land symmetrically disposed relative to the geometric center of said bell portion, said funnel including registration affording means comprising means defining a fourth, like plurality of cavities, each also comprising an elongated portion, individually formed at selected locations upon said bell portion sealing land with each said elongated portion aligned along a radial extending from said geometric center of said bell portion, the first plurality of spherical elements being individually receivable between an assigned one of said faceplate cavities and an adjacent, oppositely disposed confronting one of said cavities formed on said one flat surface of said frame means, and said indexing means including a second, similar, plurality of spherical elements individually receivable between an assigned one of said cavities formed on the other flat surface of said frame means and an adjacent oppositely disposed confronting one of said cavities formed on said bell portion sealing land, so that when said frame and said bell portion cavity radial geometries are disposed in an overlying near coincident relation, said second plurality of spherical elements

are caused to establish a precise transverse registration between said frame means and said bell portion, said tube including means for frit sealing said faceplate sealing land to said one flat surface of said frame means with said first plurality of spherical elements in situ, and means for frit sealing said bell portion sealing land to said other flat surface of said frame means with said second plurality of spherical elements in situ.

19. The tube of claim 18 in which each cavity of said first and third pluralities of cavities is characterized by a predetermined depth and in which each cavity of said second and fourth pluralities cavities is characterized by a predetermined different depth.

20. The tube of claim 19 in which said cavities of said predetermined depth are deeper than said cavities of predetermined different depth.

21. The tube of any of claims 17 to 20 in which said spherical elements are of such diameter as to establish a predetermined Q spacing between said faceplate target area and said foil.

22. A tensed color selection electrode assembly utilizable for screening a pattern of luminescent primary color elemental phosphor areas upon the target surface of a faceplate of a color cathode ray tube, and which is adapted to thereafter become a component in a color cathode ray tube, said faceplate having a sealing land and having registration affording means associated therewith, said electrode assembly including first frame means defining a central opening dimensioned to enclose said target surface of said envelope section and comprising a pair of substantially flat, spaced-apart surfaces that are preferably parallel and which constitute sealing lands; second frame means defining

a central opening of a span substantially conforming to that of said first frame means, and also comprising a pair of substantially flat, spaced-apart surfaces constituting sealing lands, said first and second frame means being formed of a material having a temperature coefficient of expansion approximating that of said faceplate, one of said second frame means sealing lands being disposed in a confronting relation to one of said first frame means sealing lands; a planar tensed foil, having a predetermined pattern of apertures, presenting one side of a peripheral portion thereof to said one sealing land of said first frame means and presenting the opposite side of said peripheral portion to said one sealing land of said second frame means, said foil being formed of a material having a temperature coefficient of expansion greater than either of said frame means, indexing means associated with the other of said first frame means sealing lands and cooperable with said faceplate registration affording means to permit precise registration between said apertured foil and said faceplate, and devitrifying frit means, disposed between said confronting sealing lands of said first and second frame means and in intimate contact with said peripheral portion of said foil presented to said confronting sealing lands, for bonding said first frame means to said second frame means for capturing said foil therebetween and for maintaining said foil in tension.

23. The assembly of claim 22 in which said foil is formed of cold rolled steel or invar, preferably having a thickness in the range of 1/2 mil to 2 mils (.0005-.002 inches).

24. The assembly of claim 22 or 23,

in which said indexing means comprises a plurality of rounded abutments affixed to said other of said first frame means sealing lands and cooperably receivable by said registration affording means of said faceplate to effect said precise registration.

25. A color selection electrode assembly employable in forming a patterned screen of luminescent primary color elemental phosphor deposits upon a substrate and, thereafter, utilizable as a component of a color cathode ray tube, said assembly including a flat glass panel formed of a material having a predetermined temperature coefficient of expansion and comprising a target area serviceable as a substrate for receiving said screen, said panel further including registration affording means comprising means defining a first plurality of cavities each comprising an elongated por-

tion and individually formed at selected locations upon the target area side of said panel, with each said elongated portion aligned along a radial extending from the geometric center of said panel, a frame defining a central opening dimensioned to enclose said target area of said panel, said frame being formed of a material having a temperature coefficient of expansion approximating that of said panel and comprising first and second substantially flat, spaced-apart parallel surfaces, said frame further including registration affording means comprising means defining a second, like plurality of cavities, each also comprising an elongated portion and individually formed at selected locations upon said first surface of said frame with each said elongated portion aligned along a radial extending from the geometric center of said frame, said plurality of panel cavities and said plurality of frame cavities being arranged so that, collectively, the axes of said elongated portions of said panel cavities exhibit substantially the same radial geometry as that collectively exhibited by the axes of said elongated portions of said frame cavities, a color selection electrode comprising a planar tensed foil having a predetermined pattern of apertures and having a temperature coefficient of expansion greater than that of said frame, the peripheral portion thereof being bonded to said second surface of said frame; and indexing means comprising a similar plurality of spherical elements individually receivable between an assigned one of said panel cavities and an adjacent, oppositely disposed confronting one of said frame cavities, so that, when said panel and frame cavity radial geometries are disposed in an overlying near coincident relation, said spherical elements are caused to urge and establish a precise repeatable transverse registration between said foil and said target area.

26. The assembly of claim 25 in which said spherical elements are formed of an alloy composition having a coefficient of expansion that is compatible with that of said panel and frame.

27. The assembly of claim 25 or 26, in which at least one of said panel cavity locations is disposed upon the minor axis of said panel and in which at least one of said frame cavity locations is disposed upon the minor axis of said frame.

28. The assembly of any of claims 25 to 27 in which said panel cavities are characterized by a predetermined depth and said frame cavities are characterized by a predetermined different depth and wherein said panel cavities are preferably deeper than said confronting frame cavities.

29. A method of utilizing a tensed color selection electrode assembly as a stencil for screening a pattern of luminescent primary color elemental phosphor deposits upon a substrate having a target area and registration affording means formed at selected locations about said target area, said substrate utilizable as a component of a color cathode ray tube, said assembly including frame means defining a central opening dimensioned to enclose said target area, said frame means comprising a pair of substantially flat, axially spaced surfaces comprising sealing lands, and indexing means associated with said frame means and cooperable with said substrate registration affording means to facilitate multiple registered matings of said frame means and said substrate during screening of said target area, and a planar tensed foil, having a predetermined pattern of apertures, bonded to said frame means, said method including the following steps:

(a) applying a photosensitive coating to said target area of said substrate;

(b) registering said frame means with said substrate to enable said foil to serve as a stencil by mating said registration affording means and said indexing means to enable said foil to seek and effect a precise, repeatable registration with said target area;

(c) selectively locating a source of actinic light rays to expose said photosensitive coating through the pattern of apertures in said foil, said light source being so located as to effectively mimic the position to be occupied by the electron beam subsequently employed to scan the to be developed pattern of phosphor deposits;

(d) removing said frame means;

(e) processing said exposed coating to establish a pattern of elemental phosphor deposits upon said target area corresponding to the aperture pattern of said tensed foil, and

(f) repeating said steps (a) through (e) for each pattern of elemental phosphor deposits desired to be established.

30. The method of claim 29, including the steps of re-registering said frame means with said substrate by mating said registration affording means and said indexing means to effect a precise registration between said foil and said pattern of phosphor deposits, and sealing said substrate sealing land to said frame means sealing land, with said registration affording means and said indexing means in mating register whereby said frame means, said registration affording means and said indexing means become integral components of said cathode ray tube.

31. The method of claim 29 or 30, wherein the frame means of said electrode assembly comprises first and second frit bonded frame members formed of a material

having a temperature coefficient of expansion approximating that of said substrate, said frame members having coaxially disposed central openings dimensioned to enclose said target surface of said substrate, and the indexing means being affixed to one of said frame members, said method including the steps of registering said electrode assembly with said substrate to enable said foil to serve as a stencil by temporarily mating said indexing means of said one frame member with said registration affording means of said substrate and interposing a beam trajectory correction lens between said source of actinic light rays and said registered electrode assembly to direct said rays through said foil apertures to impinge said photosensitive coating to create on said target area a latent image of said predetermined pattern of foil apertures; and removing said electrode assembly before processing said exposed coating.

32. The method of claim 29, 30 or 31, wherein the registration affording means of said substrate comprises means defining a first plurality of cavities each comprising an elongated portion and individually formed at selected locations upon the target area side of said substrate, with each said elongated portion aligned along a radial extending from the geometric center of said substrate, and registration affording means comprising means defining a second, like plurality of cavities, each also comprising an elongated portion and individually formed at selected locations upon one of said spaced surfaces of said frame means with each said elongated portion aligned along a radial extending from the geometric center of said frame means and the indexing means comprising a similar plurality of spherical elements individually receivable

between an assigned one of said substrate cavities and an adjacent, oppositely disposed confronting one of said frame cavities, said method including the steps of registering said frame means with said substrate by inserting said plurality of spherical elements individually between an assigned one of said frame means cavities and the adjacent oppositely disposed confronting one of said substrate cavities to enable said foil to seek and effect a precise, repeatable registration with said target area, and retaining said spherical elements in one of said substrate or said frame means plurality of cavities; following exposure to the light rays and removal of the frame means.

33. The method of making a color cathode ray tube, which tube includes, a funnel having a sealing land, a faceplate having a pattern of luminescent primary color elemental phosphor areas deposited on a target surface thereof and further having a sealing land surrounding said target surface, said faceplate sealing land having a plurality of alignment elements, and a color selection electrode assembly including: first and second frit bonded frame members formed of a material having a temperature coefficient of expansion approximating that of said funnel and said faceplate, each of said frame members having an outwardly directed sealing land, said frame members having coaxially disposed central openings dimensioned to enclose said target surface of said envelope section, a tensed apertured planar foil, having a temperature coefficient of expansion greater than that of said frame members, extending across said coaxially disposed openings and having its peripheral portion frit bonded between said frame members, and indexing means affixed to said outwardly directed sealing land of one of frame members and co-operable with said

alignment elements of said faceplate, the method including the steps of:

(a) applying a bead of frit to the sealing lands of said funnel and said faceplate;

(b) positioning said color selection electrode upon said faceplate with said indexing means of said one frame member in registration with said faceplate alignment elements;

(c) positioning said funnel upon said color selection electrode with said funnel sealing land in registration with said outwardly directed sealing land of said other frame member;

(d) inserting the assemblage of said funnel, said color selection electrode and said faceplate in a heat chamber;

(e) elevating the temperature of said chamber to expose said assemblage to a frit devitrifying temperature;

(f) maintaining said assemblage at said frit devitrifying temperature until said color selection electrode assembly is captured between said funnel and said faceplate by devitrified frit; and

(g) cooling down said assemblage to room temperature.

FIG.1

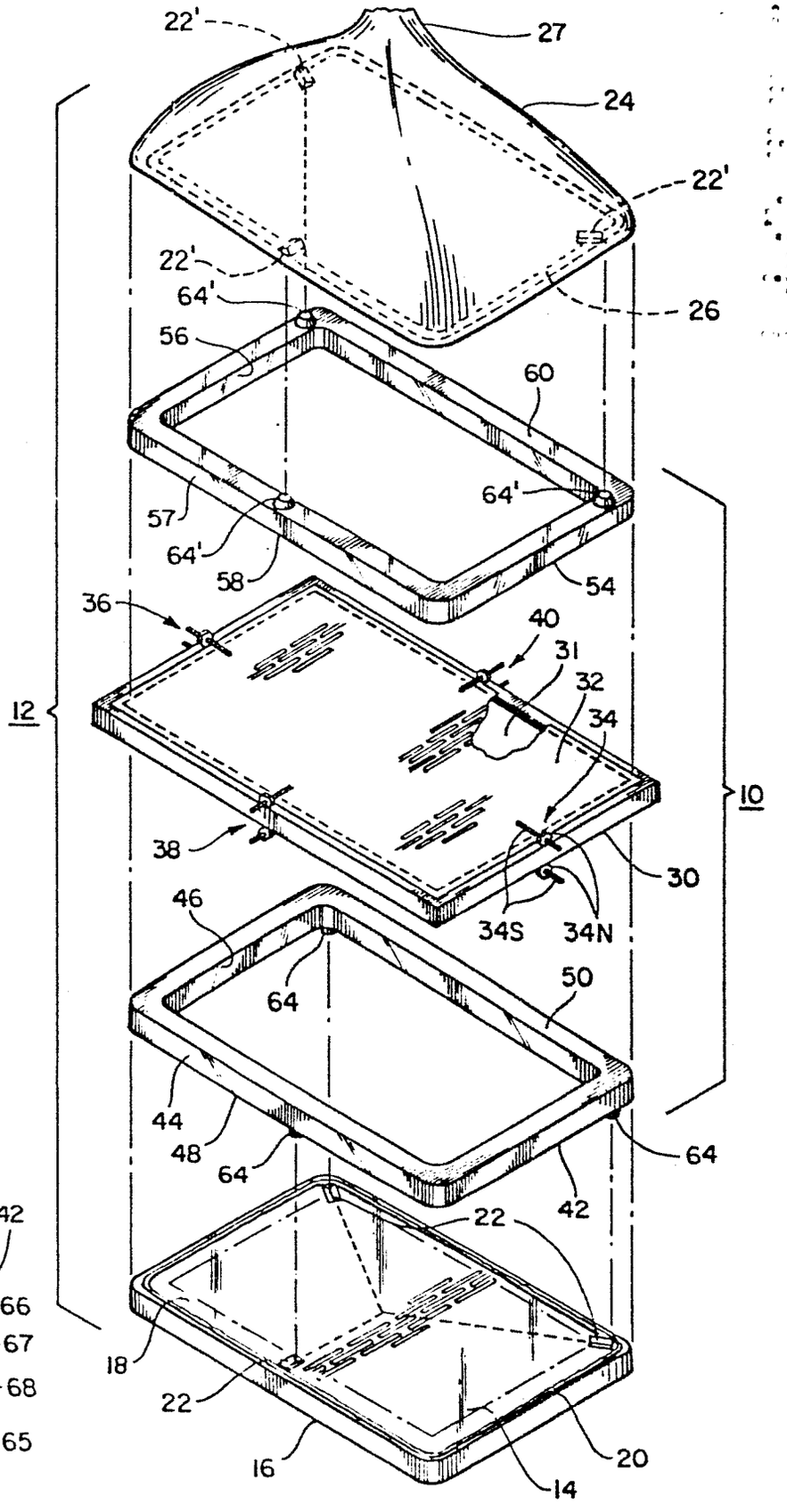
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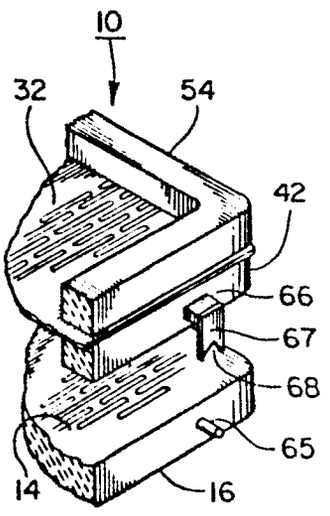
FIG.5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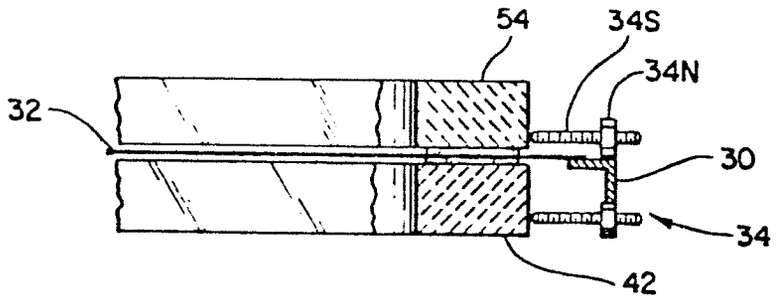

FIG.2

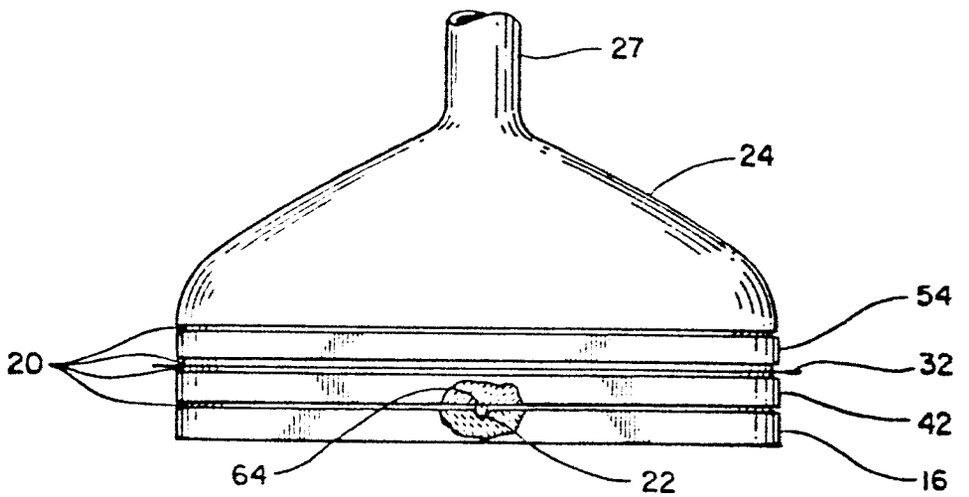

FIG.3

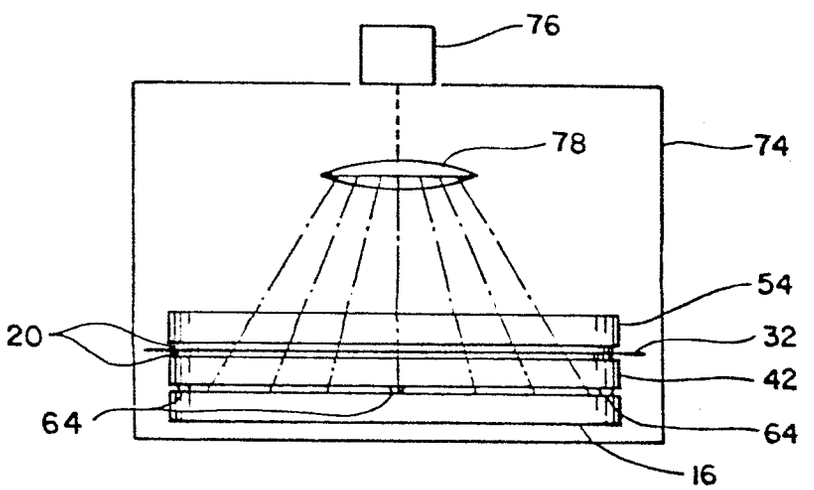

FIG.4

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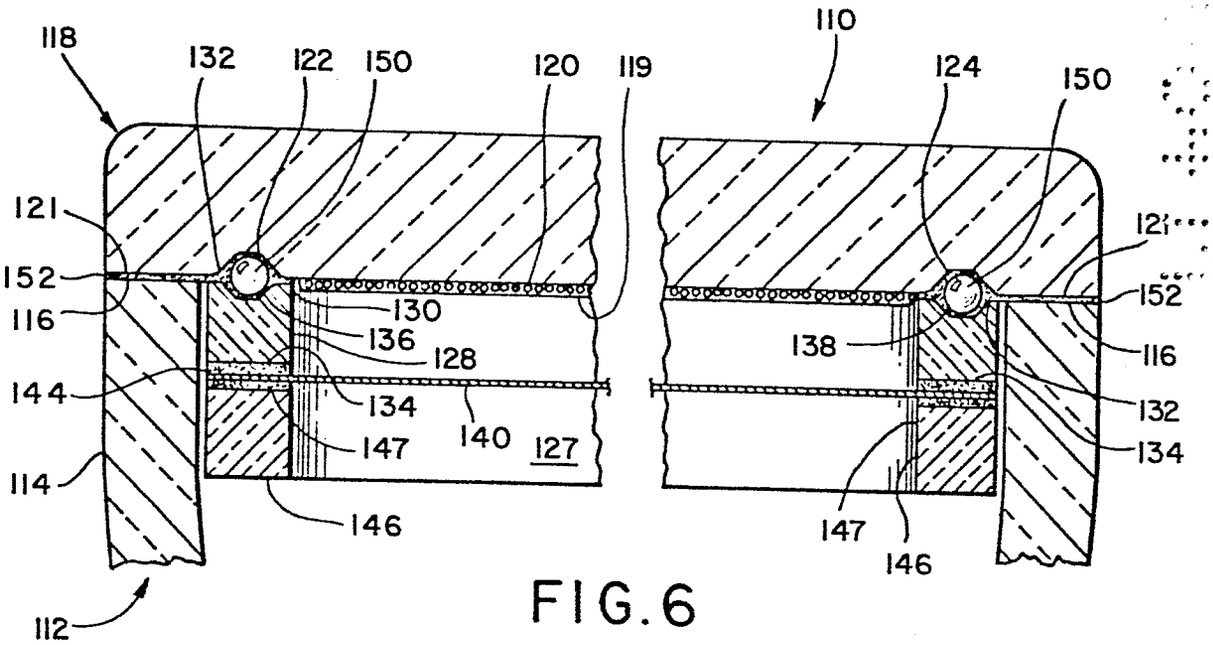

FIG. 6

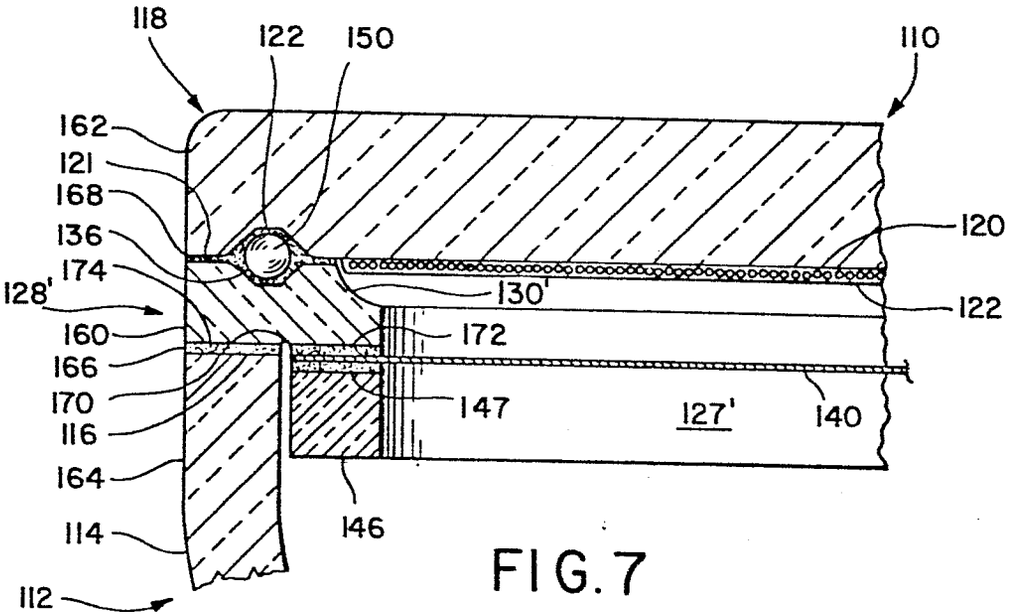

FIG. 7

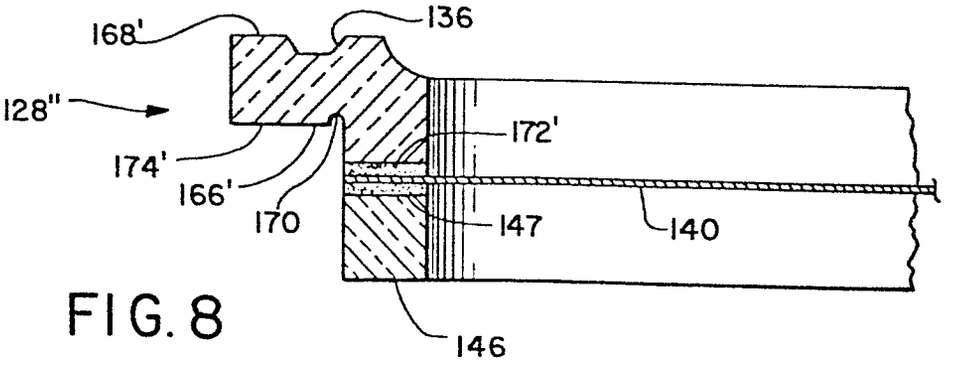

FIG. 8

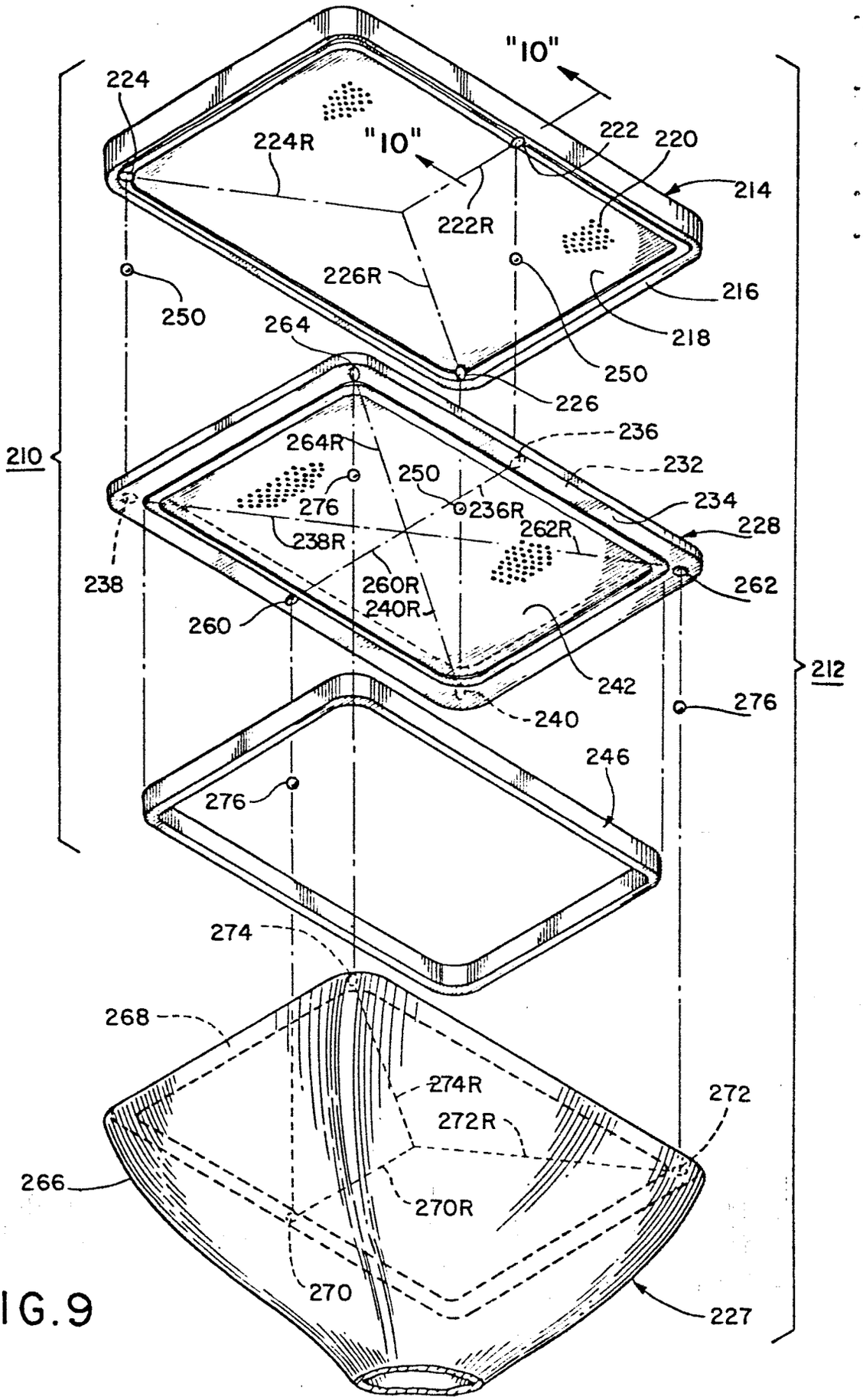
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FIG.9

0143938

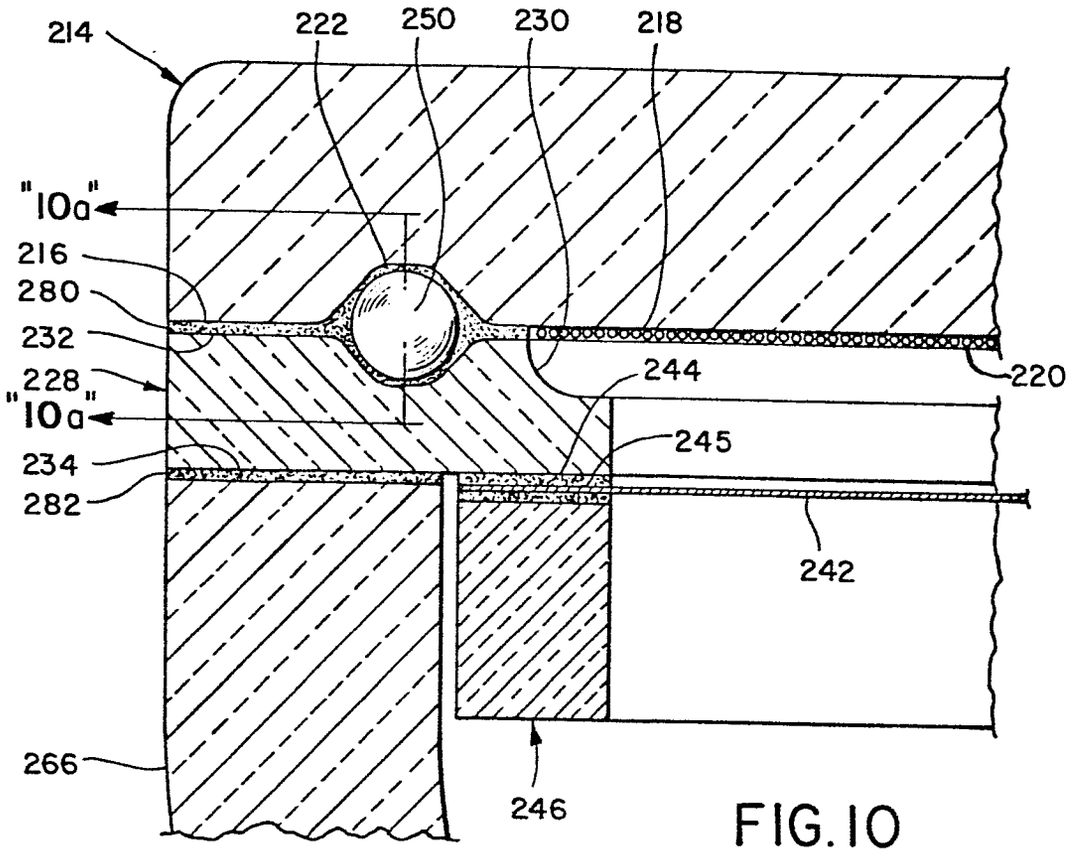

FIG. 10

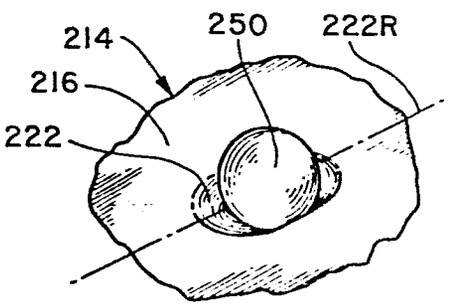

FIG. 11

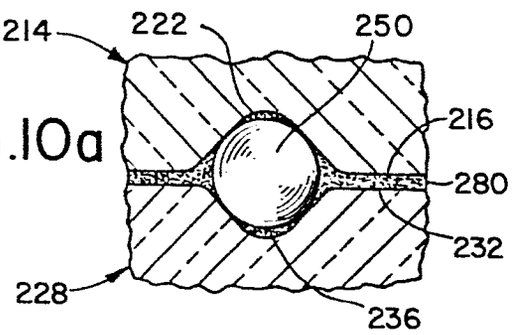

FIG. 10a

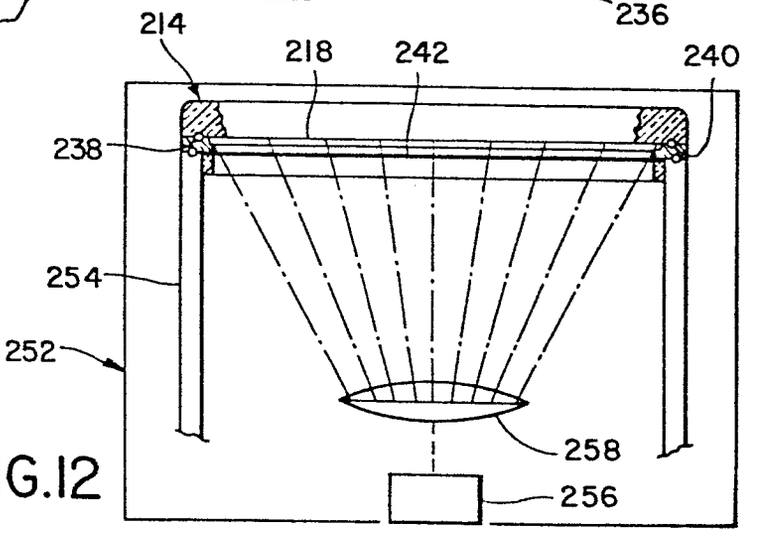

FIG. 12