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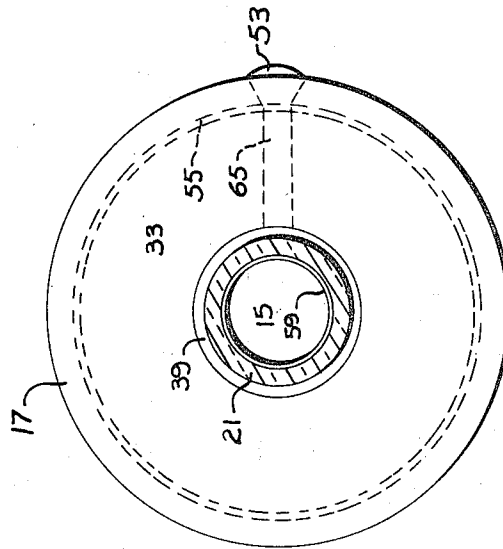
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3,551,973

METHOD AND APPARATUS FOR FABRICATING A CATHODE RAY TUBE
HAVING AN ANNULAR SHAPED REAR WINDOW

Filed Dec. 20, 1968

2 Sheets-Sheet 1



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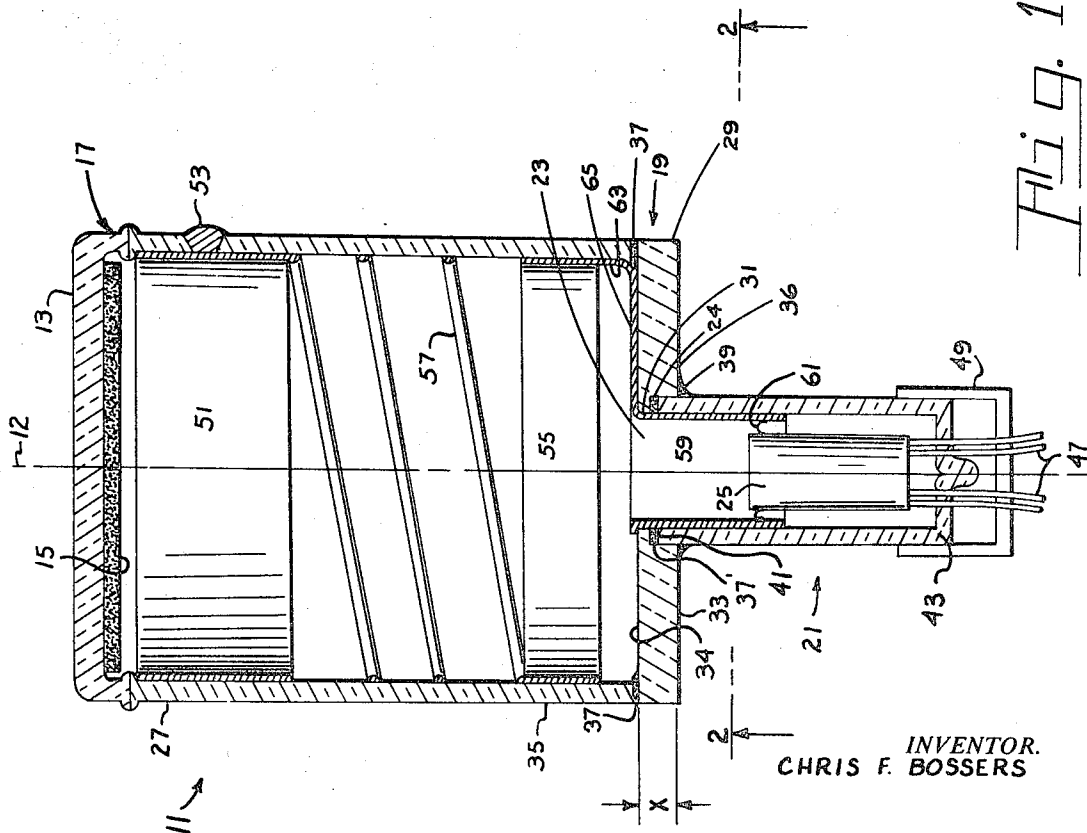


Fig. 1

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2 Sheets-Sheet 2

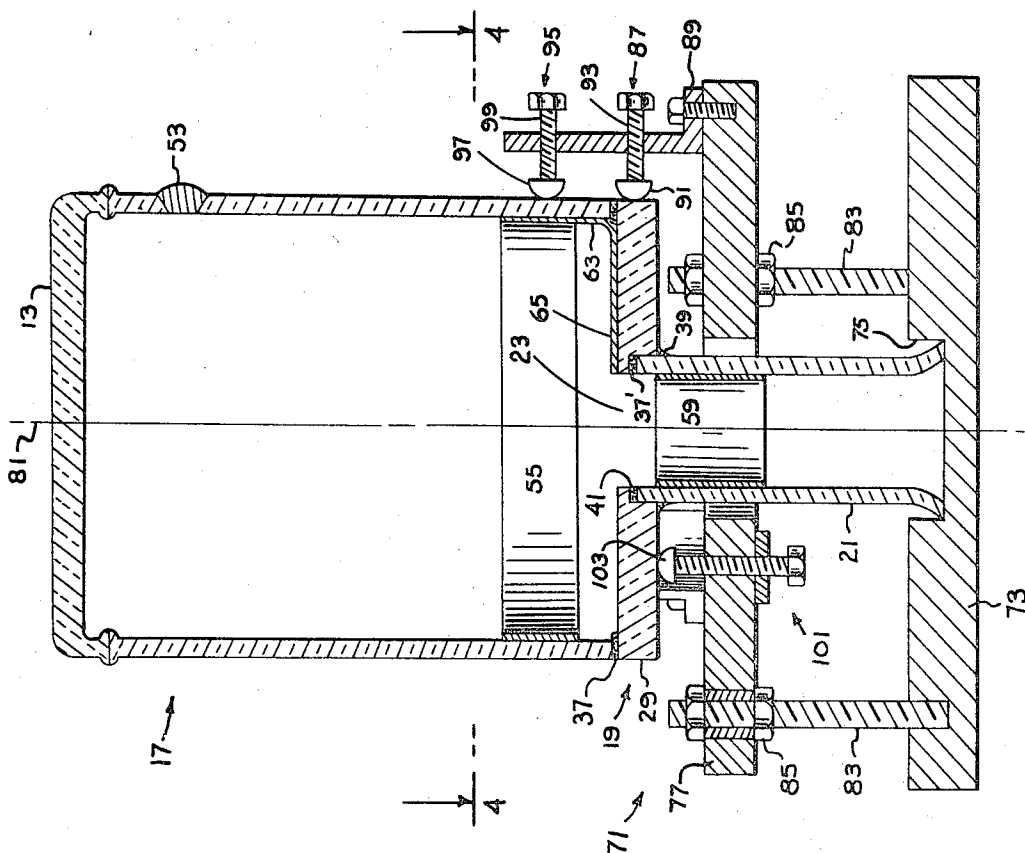


Fig. 3

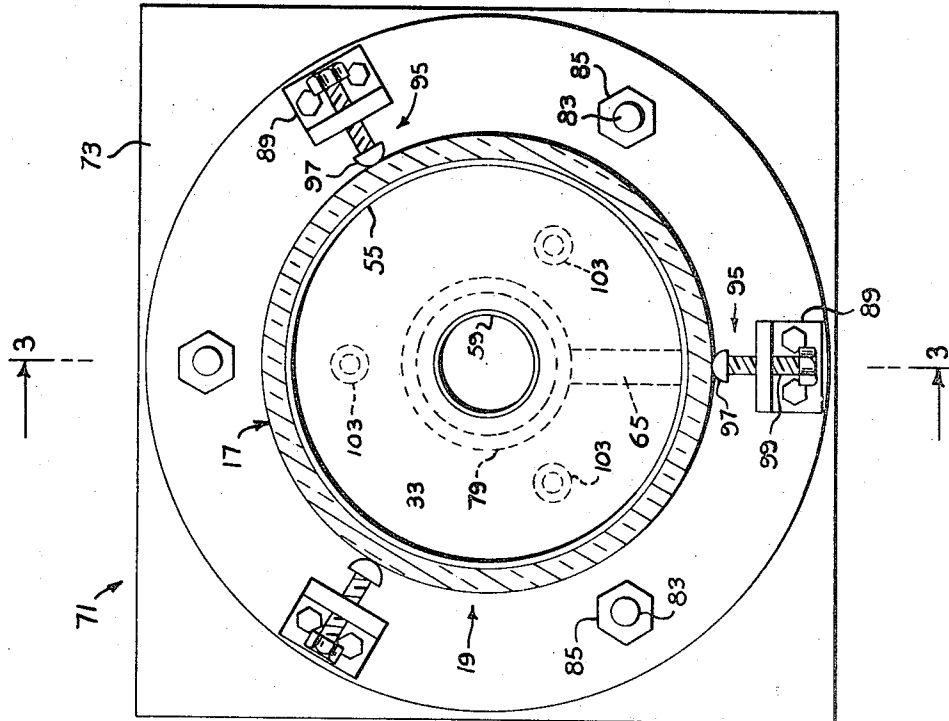


Fig. 4

1

3,551,973

METHOD AND APPARATUS FOR FABRICATING A CATHODE RAY TUBE HAVING AN ANNULAR SHAPED REAR WINDOW

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2 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for fabricating a rear-window cathode ray tube having a longitudinal axis and an envelope of substantially glass construction wherein there is oriented a cathodoluminescent screen and at least one related electron gun. The envelope is formed by hermetically sealing a bulb portion and a tubular neck section to a substantially annular shaped optical access window oriented in substantially symmetrical relationship to the longitudinal axis of the tube to provide a substantially annular viewing area for observing the electron impinged side of the screen.

CROSS REFERENCES TO RELATED APPLICATIONS

This application contains matter disclosed but not claimed in two related U.S. patent applications filed concurrently herewith and assigned to the assignee of the present invention. These applications are: S.N. 785,646, "Cathode Ray Tube Having an Annular Shaped Rear Window," and S.N. 785,648 "Means for Controlling Electrostatic Charge on the Rear Window of a Cathode Ray Tube."

BACKGROUND OF THE INVENTION

The invention relates to cathode ray tubes and more particularly to a method and apparatus for fabricating an improved rear-window type of cathode ray tube and the associated envelope structure for a tube of that type. In certain information display systems, rear-window cathode ray tubes are employed to facilitate full presentation and observation of the display. Such tubes not only provide the conventional frontal viewing area but also have one or more portal provisions oriented in the funnel portion of the tube envelope to permit viewing of the rear surface of the screen. Through this type of funnel oriented viewing port, it is possible to observe, photograph, or project a superimposed image on the information displayed on the screen without interfering with the frontal observation thereof. Since a large number of the conventional rear-window tubes are limited to one or two observation ports, a decision must be made whether to observe, record or project information through a respective port or ports as all media cannot be utilized simultaneously at one or two openings. Furthermore, exact positioning of the projection and photographic equipment is determined by the orientation of the respective viewing port or ports. In the conventional rear-ported tubes, the incorporation of a plurality of optical ports into the funnel portion of the envelope becomes a critically exacting and expensive glass working operation.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to reduce the aforementioned difficulties and to provide a method and apparatus for fabricating an improved rear-window type of cathode ray tube having an extensive provision for rear view utilization from a number of angles.

The foregoing objects are achieved in one aspect of

2

the invention by the provision of a method and apparatus for fabricating an improved rear-window cathode ray tube having an envelope wherein the funnel or bulb portion is perimetrically mated and sealed to a substantially transparent annular plate of optical quality. A tubular neck section is hermetically sealed to the substantially centrally oriented aperture in the annular plate. The sealing of the bulb and neck portions to the annular plate are done in a manner to prevent optical distortion of the plate. Thus, there is provided an annular rear-window tube which permits simultaneous back-of-the-screen projection, photographing and observation of the information displayed on the cathodoluminescent screen of the tube.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view illustrating the rear-window cathode ray tube as fabricated by the method and apparatus of the invention;

FIG. 2 is a plan view taken along the line 2—2 of FIG. 1 illustrating the extensive area of the annular rear-window portal;

FIG. 3 is a sectional view showing the apparatus utilized in fabricating the tube envelope; and

FIG. 4 is a plan view taken along the line 4—4 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

For a better understanding of the present invention, together with other and further objects, advantages and capabilities thereof, reference is made to the following specification and appended claims in connection with the aforescribed drawings.

With reference to FIG. 1 there is shown a rear-window cathode ray tube 11 as fabricated by the method and apparatus of the invention. The tube, as assembled, has a face panel portion 13 upon which is interiorly disposed a cathodoluminescent screen 15. Integral with the face panel portion is the funnel or bulb portion 17 to which is sealed a substantially transparent annular plate 19 of optical quality. A tubular neck section 21 is sealed to the centrally oriented aperture 23 of the annular plate at a seating provision 24 therein to complete the envelope structure. At least one electron source 25 is mounted in the tubular neck in a manner to beam electrons to the screen to form a cathodoluminescent image therein. The light transmissive plate 19 forms an annular shaped optical window which provides extensive visual access to the rear of the screen.

A round tube is shown and described such as, for example, one having an external envelope diameter within the range of five to six inches. It is not intended that the size or shape be limiting. In addition, the term "annular" as used herein is intended to include any shape of substantially continuous optical viewing window oriented to surround the axial oriented tubular neck portion of the tube.

In greater detail, with particular reference to FIGS. 1 and 2, the tube 11 has a longitudinal axis 12 extending therethrough from the face to the base portion thereof. The component parts of the envelope structure have compatible thermal expansion coefficients to insure hermetic jointures therebetween.

The substantially planar face panel portion 13 is of a non-browning type glass having a defined perimetric shape to facilitate a hermetic seal with the compatibly formed first end 27 of the bulb portion 17.

The interior surface of the face panel has a cathodoluminescent screen 15 disposed thereon of phosphor materials chosen to best suit the conditions under which the tube is to be utilized. Usually such phosphor materials are of medium persistence and of a hue and brightness to advantageously present the desired informational display.

A substantially transparent annular planar plate 19, such as of G-12 optical quality glass, is formed to have outer and inner peripheries or boundaries 29 and 31 respectively. These define an annular region 33 therebetween which constitutes an annular shaped planar viewing window that is spacedly related in a substantially symmetrical manner about the longitudinal axis of the tube. The inner periphery 31 defines a substantially centrally oriented opening of aperture 32, while the outer periphery 29 of the annular plate is formed to substantially perimetricaly match the second end 35 of the bulb portion. The bulb is hermetically sealed to the plate in a manner to maintain the optical quality of the viewing window 33. Specifically, the hermetic jointure between the bulb portion 17 and the annular plate 19 is formed of a sandwich-type filling or continuous band of glass solder or devitrifiable frit 37, such as CV-130 obtained from Owens-Illinois, Inc., which has a melting temperature much lower than the softening temperatures of the respective compatible glass portions joined together.

A substantially tubular neck section 21 of the tube has a first or forward end 41 and an opposite second or terminal end 43 of which the forward end 41 is formed to substantially match and seat in the seating provision 24 formed in the centrally oriented aperture 32 of the annular plate. The hermetic seal therebetween is formed of a continuous band of glass frit 37' similar to that utilized in the aforementioned bulb-to-plate seal. The neck-to-plate seal is further strengthened and hermetically insured by an externally applied head of frit 39. Thus, both perimetricaly oriented hermetic seals of the annular plate are accomplished at temperatures that are not detrimental to the optical properties of the annular window member. It is to be noted that the annular optical plate provides a structural foundation for the envelope. It exhibits a sufficient thickness "x" to be free of optical distortion while accommodating the respective weight factors of the associated bulb and neck portions.

One or more electron gun(s) is/are positioned within the neck section of the tube in a manner to beam electrons to the screen. As shown, an undetailed source of electrons 25 denotes the presence of one or several guns. In this instance, both focusing and deflection are accomplished by electrostatic means which eliminates the need for externally oriented yoke means.

A stem portion 45, which supports the source of electrons 25, is hermetically sealed to the terminal end 43 of the neck section. Electrical connective means 47 extend from the stem through the base 49 to provide external connections for the tube.

The interior surface of the bulb portion 17 has two separated bands of conductive material, such as Aquadag, applied thereto. A high voltage band 51 is oriented adjacent the screen area and makes electrical contact with a high voltage anode conductive means or button 53 traversing the wall of the bulb or funnel portion 17 at a region proximal to the face panel. Disposed on the bulb wall near the optical window 33 is a low-voltage conductive band 55 of similar material. The two bands are electrically joined by a conventional accelerating spiral 57 of resistive material. The upper part of the tubular neck section 21 has a neck conductive band 49, such as Aquadag, applied thereto with electrical connection between this band and the electron source 25 effected by conventional resilient connective means 61.

Operation of the tube is dependent upon electrical connection between the neck conductive band 59 and the low-voltage conductive band 55 on the bulb. Such connection is expeditiously effected by one or more conductive paths 63 extending from the low voltage band to make connection with at least one radial conductive stripe 65 across the annular optical plate 19.

With reference to FIGS. 3 and 4, there is illustrated apparatus utilized in the method of fabricating the afore-described rear-window cathode ray tube. The respective

figures show the several portions of the envelope positioned in the apparatus for the sealing step of the operation.

In fabricating the tube, the annular optical plate 19 has at least one conductive stripe 65 applied to the interior surface 34 thereof. This electrical conductive material, such as Aquadag, is disposed in a substantially radial manner on the plate, extending from the inner periphery 31 to almost the outer periphery 29 thereof.

With the plate on a substantially horizontal plane, a continuous ribbon of devitrifiable glass frit 37 is applied on the interior surface 34 of the annular plate adjacent the outer periphery 29. The bulb portion 17, with the low-voltage conductive band 55 thereon, is oriented so that the open end of the bulb is positioned on the peripherally disposed ribbon of frit 37. The perimeter of the open end of the bulb portion substantially matches the outer periphery 29 of the annular plate. Thus assembled, the frit in the bulb-plate combination is allowed to air dry for approximately an hour at ambient temperature. Usually, the conductive path 63 connecting the conductive stripe 65 on the plate with the low-voltage conductive band 55 on the bulb is consummated at this stage in envelope construction.

A continuous ribbon of devitrifiable glass frit 37' is applied around the forward open end 41 of the neck section 21 which has a conductive band 59 already disposed on the inner surface of the forward portion thereof. The frit-coated end of the neck section is then seated in the formed aperture of the annular plate. The seating provision 24 therein is formed inwardly from the exterior surface 36 of the plate. A continuous bead of frit 39 is applied around the jointure area between the neck section and the plate aperture to insure the seal and add strength to the jointure.

The fritted envelope is oriented in the fabricating apparatus 71 in a vertical position with the face panel portion 13 uppermost. The terminal end 43 of the neck section is positioned on the base member 73 in an accommodating provision 75 formed therein to support the neck in a vertical position.

Above the base member is a platform 77 which has an aperture 79 therein that is of a diameter greater than the outer diameter of the neck section. The platform aperture provides sufficient space for the neck section to extend therethrough thereby facilitating vertical positioning of the fritted envelope. The platform is spacedly located above and parallel with the base member; the aperture 79 being in coaxial alignment with the neck positioning provision 75 and the axis 81 of the apparatus. The platform is located by platform support member 83 at a horizontal level relative to the forward end 41 of the neck section but spaced below the annular optical plate 19. As shown, the platform support means are in the form of three spaced apart vertical rods oriented in the base member 73 and having height adjustment provisions 85. Other support means may be utilized if desired.

Oriented on the top of the platform are a plurality of annular plate alignment means 87. These are positioned at a horizontal level in equi-spaced relationship with the axis 81 to make contact with the outer periphery 29 of the plate. They are accommodated by brackets 89 affixed to the platform. Each alignment head 91 is of heat resistant material, such as ceramic, and has provisions 93 for horizontal adjustment.

Also oriented atop the platform are a plurality of bulb alignment means 95. These are positioned in equi-spaced relationship with the axis 81 at a horizontal level to make contact with the perimeter of the bulb portion proximal to the fritted end thereof to provide alignment of the bulb with the plate during the envelope sealing operation. As shown, the bulb alignment means 95 are located on the same bracket 89 as the plate alignment means 87, but separate brackets can be utilized if desired. The bulb

alignment heads **97** are of heat resistant material, such as ceramic, and have horizontal adjustment means **99**. While three of the respective plate and bulb alignment means are shown, more can be utilized if desired.

It will be noted that for the tube size considered, the fritted envelope is positioned in the apparatus in a manner that the envelope structure rests on the neck section. It is desired that upon sealing, the layers of frit should be in the range of .015 to .030 of an inch to effect the desired jointures. When a larger tube is considered, the weight of the annular plate and bulb portion may be of a value to press too heavily on the neck seal area **37'**. In this case, weight regulative means **101**, accommodated in the platform, are adjustably positioned in a vertical manner so that the several heads **103** of heat resistant material make discrete spaced-apart contact with the exterior surface of the annular plate. This effects the proper spacing relationship between the forward end of the neck station and the seating provision in the plate aperture to provide an adequate and uniform layer of frit **37'** therebetween. Just prior to sealing, the regulative means **101** are slightly relaxed to provide for the flow and set of the frit upon sealing.

The base member **73** and the platform **77** are of heat resistant material, such as for example, Marinite which is manufactured by Johns-Mansville, New York, N.Y.

With the fritted envelope so positioned within the apparatus, sealing is accomplished by baking the envelope at a temperature within the approximate range of 445-455 degrees centigrade for a time period of approximately one hour. This temperature is under the softening point of the respective envelope portions but is higher than the melting point of the respective frit depositions. In this manner, both the hermetic seals to the annular plate are simultaneously accomplished. Upon devitrification of the frit, the envelope is cooled in a manner to prevent the formation of undesirable strains therein.

After sealing, the envelope is removed from the apparatus and the resistive accelerating spiral **57** is applied by conventional means to the inner surface of the bulb, starting at the low-voltage conductive band **55** and extending toward the high voltage anode button **53**.

Next, the cathodoluminescent screen **15** is suitably formed on the interior surface of the face panel in a conventional manner, such as by the settling technique.

Upon the completion of screening, the high voltage conductive band **51** is applied to the inner surface of the bulb portion proximal to the screen in a manner to make connection with the accelerating spiral **57** and the high voltage button **53**. The envelope is then baked to remove volatile materials.

At least one electron source **25** is positioned within the neck section of the envelope in a manner to make connection with the neck conductive band **59** which is forwardly disposed on the interior surface of the neck section. The electron source is so oriented to beam electrons to the screen.

The tube is thence conventionally processed and sealed by effecting a hermetic closure at substantially the terminal end **43** of the neck section.

Thus, there is fabricated an improved rear-window cathode ray tube **11** which provides an extensive provision for rear-view utilization from a number of angles. The annular window adequately and simultaneously accommodates several usages such as photographing and projection in addition to visual observation.

While there have been shown and described what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

I claim:

1. A method of fabricating a rear-window cathode ray tube having an envelope with a cathodoluminescent screen

and at least one electron source therein and a longitudinal axis therethrough, said envelope comprising a bulb portion with an open end and an oppositely disposed face panel, a tubular neck section having forward and terminal ends and a substantially annular shaped optical plate oriented between said bulb and neck portions in substantially symmetrical relationship about said longitudinal axis, said optical plate having interior and exterior surfaces and inner and outer peripheries defining therebetween a substantially annular viewing window for observing the cathodoluminescent screen, said neck section having an open forward end diametrically dimensioned to match a seating provision in the centrally oriented aperture defined by the inner periphery of said plate, said tube fabricating method comprising the steps of:

placing said annular plate on a substantially horizontal plane; said plate having at least one electrical conductive means substantially radially disposed on the interior surface of said annular plate;

applying a continuous ribbon of glass frit on the interior surface of said annular plate adjacent said outer periphery thereof;

positioning the open end of said bulb portion on said peripherally disposed ribbon of frit, the perimeter of the open end of said bulb portion being substantially matched with the outer periphery of said plate, said bulb portion having a low voltage band of conductive material disposed on the inner surface thereof proximal to said open end and having high voltage conductive means traversing the wall thereof proximal to said face panel;

connecting the conductive means on said plate with said low voltage conductive band on said bulb;

applying a continuous ribbon of glass frit around the forward open end of said neck section, said neck having a conductive band disposed on the inner surface of said forward end;

seating said frit-coated end of said neck section in the formed aperture of said plate, said seating provision being formed inwardly from said exterior surface of said plate;

applying a continuous bead of glass frit around the area of jointure between said neck section and said plate aperture relative to the exterior surface thereof; orienting said envelope in a vertical position with the face panel uppermost;

sealing said envelope by baking at a temperature under the softening point of the respective envelope portions but higher than the melting points of the respective frit depositions to effect simultaneous hermetic seals to said annular plate;

cooling said frit sealed envelope in a manner to prevent the formation of undesirable strains therein;

applying a resistive accelerating spiral to the inner surface of said bulb starting at said low-voltage conductive band and extending toward said high voltage conductive means;

forming said cathodoluminescent screen on said face panel;

applying a high voltage conductive band to the inner surface of the bulb portion proximal to said screen to make connection with said spiral and said high voltage conductive means;

baking said envelope to remove volatile materials therefrom;

positioning at least one electron source within said neck portion; in a manner to make connection with said neck conductive band forwardly disposed therein and facilitate the beaming of electrons to said screen; processing said tube; and

sealing said tube by effecting a hermetic closure at substantially the terminal end of said neck section.

2. A method of fabricating a rear-window cathode ray tube having an envelope with a cathodoluminescent screen and at least one electron source therein and a longitudinal

7

axis therethrough, said envelope comprising a bulb portion with an open end and an oppositely disposed face panel, a tubular neck section having forward and terminal ends and a substantially annular shaped optical plate oriented between said bulb and neck portions in substantially symmetrical relationship about said longitudinal axis, said optical plate having interior and exterior surfaces and inner and outer peripheries defining therebetween a substantially annular viewing window for observing the cathodoluminescent screen, said neck section having an open forward end diametrically dimensioned to match a seating provision in the centrally oriented aperture defined by the inner periphery of said plate, said tube fabricating method comprising the steps of:

placing said annular plate on a substantially horizontal plane;

positioning the open end of said bulb portion on the interior surface of said annular plate adjacent the outer periphery thereof;

positioning said neck section in the formed aperture of said plate, said positioned neck section being related to the exterior surface of said plate;

8

sealing the respective envelope portions by effecting simultaneous hermetic seals to said annular plate; forming said cathodoluminescent screen on said face panel;

positioning at least an electron source within said neck portion;

processing said tube; and

sealing said tube by effecting a hermetic closure at substantially the terminal end of said neck section.

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