

May 20, 1969

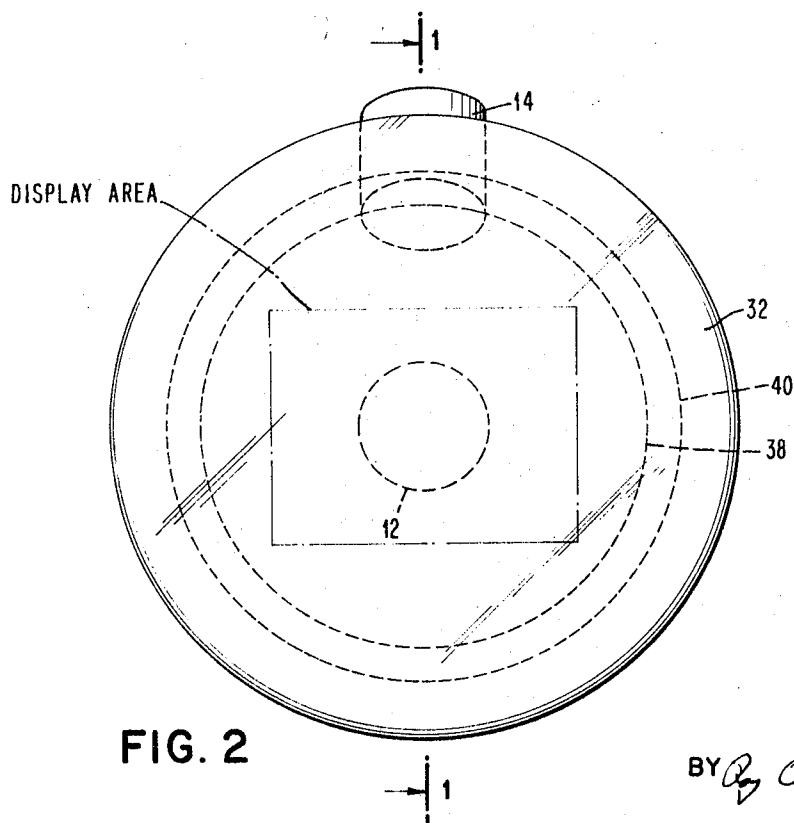
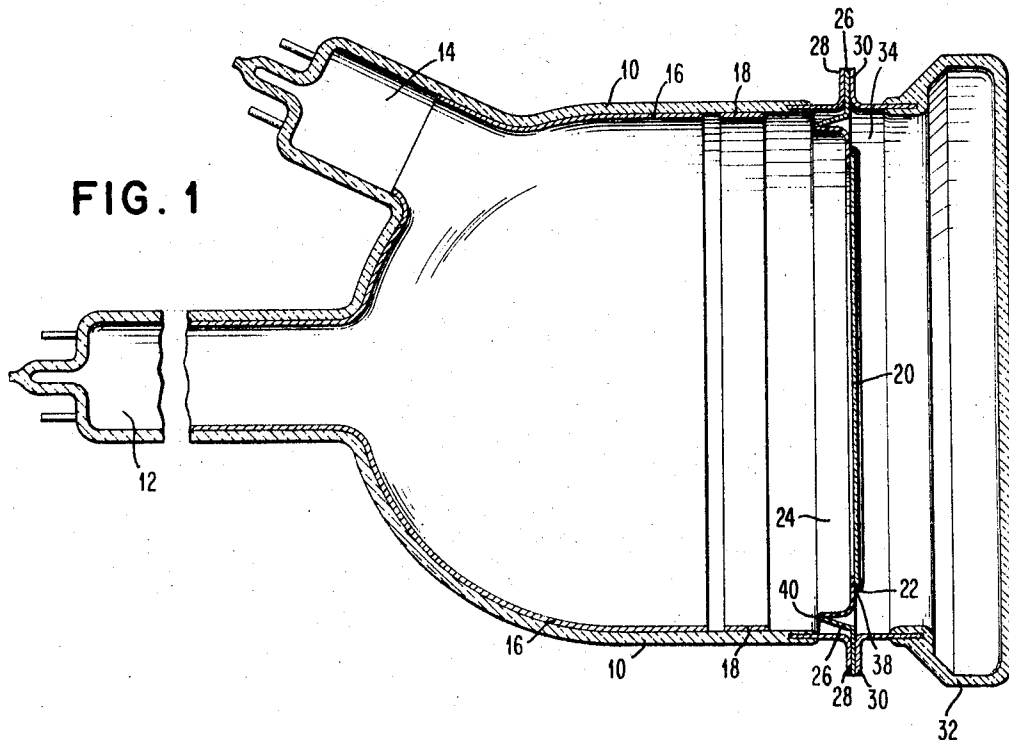
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MICA MEMBRANE MOUNTING STRUCTURE FOR CATHODE-RAY STORAGE TUBE

Filed Nov. 13, 1967

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FIG. 3

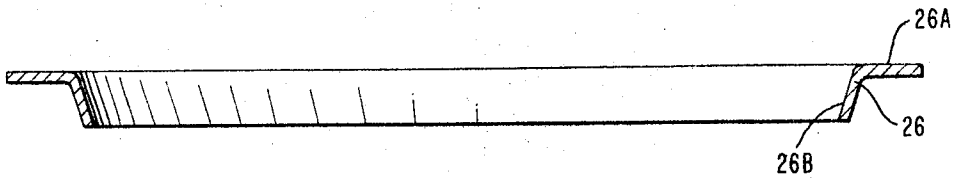


FIG. 4

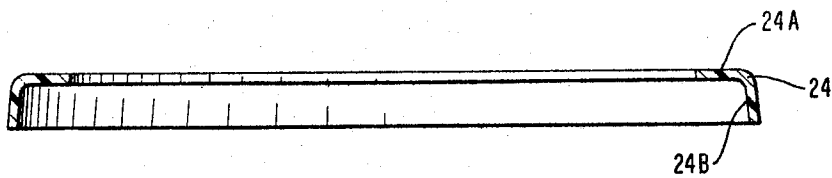
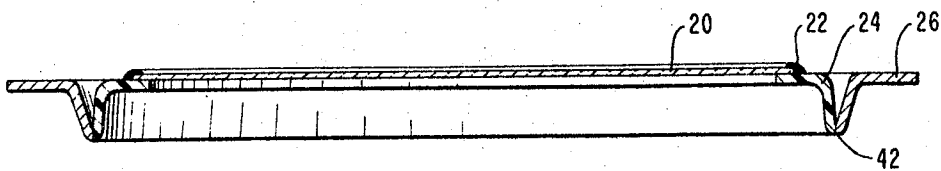


FIG. 5



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6 Claims

ABSTRACT OF THE DISCLOSURE

A target electrode and support structure therefore for use in an electrostatic storage display tube comprising an inner annular member for supporting said target electrode at the periphery thereof said member having a flange on the outer periphery thereof adapted for joining with a similar flange on the inner periphery of an outer support member said two flanges forming a bellows configuration wherein the inner and outer support members have different coefficients of thermal expansion. A method for producing said support means at an elevated temperature whereby the target electrode supported by said inner member is kept under tension over the entire thermal operating range of said tube.

Background of invention

The present invention relates in general to electronic display devices and relates more particularly to apparatus for producing a visible display of information represented by an information-bearing electrical signal which is converted to an electrostatic charge distribution pattern.

There are numerous applications where it is desirable to provide a static visual display of information transmitted in the form of electrical signals; such as those transmitted over a video communication link. The conventional method of displaying such information is by means of a cathode ray tube having a phosphor coated face on which an electron beam impinges to produce a visible display in response to the information which modulates either the intensity or the deflection of the electron beam. However, the use of phosphors for displays of the type contemplated herein is not particularly satisfactory. Owing to the persistence problems associated with most phosphors, frequent scanning of the phosphor is necessary to maintain the stationary image visible. This requirement of frequent scanning is objectionable both from the standpoint of the band width requirements which it places on the transmitting link and also from the standpoint of registration problems on successive scans, since it is difficult to produce exact registration on successive scans of an electron beam over a phosphor tube face.

An alternative prior art solution which is somewhat more satisfactory for the purposes of producing a visible display involves the formation of an electrostatic image of the information to be displayed on a target surface in an evacuated envelope, and the dusting of this electrostatic image with small particles of an opaque developing material. These particles are deposited on and attracted to the electrostatically charged surface to produce a visual indication of the information represented by the electrostatic charge distribution.

In one form of prior art apparatus an electrostatic image is formed by an electron beam directed toward an electrically non-conductive surface capable of storing electrostatic charges in small discrete areas thereof. The electrostatic target surface is disposed in one end of an evacuated envelope having a transparent window or face plate therein. The target surface is disposed adjacent to but

spaced from the transparent window, and disposed in the space between the target surface and the transparent window is a supply of small particles capable of retaining an electric charge and of a suitable color to produce a visible image.

During writing of the electrostatic charge pattern on the rear surface of the target surface, these particles are maintained out of the influence of the electrostatic field. Upon completion of the electrostatic writing on the target surface, the charged particles are cascaded across the front or reverse side of the target in some suitable manner such as by tumbling. The electrostatic field resulting from the deposition of electrical charges in different discrete areas of the target surface extends through the thin target member and exerts an attractive force on the cascading charged particles, causing them to adhere to the reverse side of the target surface in the charged areas thereof. The adherence of the suitably colored charged particles to the oppositely charged areas of the target surface produces a visible image of the information which had been written on the target surface in the form of an electrostatic charge distribution pattern. The visible image may then be viewed or photographed through the transparent face plate at the end of the evacuated envelope or utilized in any other manner, depending upon the nature of the application.

When it is desired to erase the electrostatic image and the visible image, a flood or erase beam of electrons within the envelope is activated to flood and erase the charged side of the target surface with electrons. The accelerating velocity of the electron beam forming the flood beam is such in relation to the secondary emission properties of the insulating material forming the target surface that the secondary emission ratio from the target surface is greater than unity under the action of the electron flood beam. This means that for every incoming electron from the flood beam, more than one electron leaving the target surface has been removed. The flood beam is then turned off and the target surface is available for storage of the next electrostatic image thereon.

Summary and objects

In its broadest aspect the present invention provides a means for mounting a thin rigid sheet membrane such as glass, quartz, mica or alumina on a material having a different thermal expansion characteristic and for insuring that said thin sheet will not be distorted due to variations in operating temperature of the device. As indicated previously, the invention has particular utility for forming the target electrode or screen for an electrostatic storage display tube wherein the support means and membrane may serve the additional function of forming a vacuum tight seal. The membrane is mounted on an inner support member which in turn is fastened to an outer support ring adapted for mounting in the forward portion of an electrostatic storage display tube. The selection of materials is such that after the seal has been made, the membrane is under slight tension whereby the membrane remains in a substantially flat plane. The assembly may be heat cycled from about room temperature to over 400° C. without either rupturing the membrane or materially distorting same.

It is accordingly a primary object of the present invention to provide a membrane mounting means for use in a cathode ray tube assembly wherein the membrane material has a substantially different coefficient of expansion from the envelope.

It is a further object to provide such a membrane mounting means whereby the membrane is maintained substantially flat at its operating temperature.

It is yet another object of the invention to provide such a mounting means whereby the material is maintained under a certain amount of tension.

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It is a still further object to provide such membrane and mounting means for use as the target electrode or writing surface in an electrostatic storage display tube.

Other objects, features and advantages of the present invention will be apparent from the subsequent description of the drawings.

Description of drawings

FIG. 1 is a cross-sectional view of an electrostatic storage display tube showing the target electrode and mounting means therefore in place in the tube envelope.

FIG. 2 is a front view of the tube of FIG. 1.

FIG. 3 is a cross-sectional view of the outer mounting member.

FIG. 4 is a cross-sectional view of the inner mounting member.

FIG. 5 is a cross-sectional view of the entire target membrane mounting assembly showing the inner and outer rings as well as the membrane affixed to the inner mounting ring.

Description of the disclosed embodiment

The objects of the present invention are accomplished in general by a mounting means for a thin rigid membrane to be placed in the front end of a cathode ray type tube, said mounting means being capable of supporting the membrane in a substantially flat configuration and being capable of maintaining a vacuum within said tube. The mounting means comprises an inner mounting member comprising an annular ring having a flat portion of an inner diameter slightly smaller than the diameter of the rigid membrane and having a flange on the outer portion thereof. An outer annular mounting member is provided which includes a flat portion and an inner flange, the flanges on the inner and outer mounting members are of such relative diameter and configuration that they meet in a continuous junction in a bellows configuration and said flanges are welded together at said junction. A sealing means is provided for rigidly attaching the rigid membrane to the flat surface of the inner mounting member and further means are provided for affixing the outer member in the forward portion of the cathode-ray tube.

In the preferred embodiment of the present invention, the rigid membrane comprises sheet mica and the mounting assembly including said mica membrane comprises the target electrode in an electrostatic storage display tube such as is well known in the art.

By properly selecting the coefficients of thermal expansion of the inner mounting member and the rigid membrane and by forming the membrane assembly and mounting means at an elevated temperature, the membrane will be kept in a state of continual tension by the mounting means and will remain substantially flat at the normal tube operating temperature.

The invention will now be more particularly pointed out and described with reference to the drawings in which FIG. 1 is a cross-sectional view of a typical electrostatic storage display tube (E.S.D.T.) 10 wherein the primary writing electron gun (not shown) would be located in area 12 and the erase electron gun (not shown) would be located in the area 14. The two electrically conductive coatings 16 and 18 are for the usual purpose of removing any unwanted space charge electrons as from secondary emission, etc. The target electrode 20 is shown attached to the mounting means 24 and 26 by a seal 22. The outer member 26 is illustrated in the disclosed embodiment of FIG. 1 as being supported around its periphery by the two members 28 and 30 which are respectively mounted and sealed in appropriate grooves in the rear portion and face portion of the E.S.D. tube. The face portion 32 of the tube forms a chamber 34 within the tube between the target electrode 20 and said face portion. A suitable display powder would normally be located in this cavity and would be caused to fall across the face of the target electrode, adhere to a charge pattern thereon, and form

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an image when desired. Neither the powder nor a means for moving the tube to distribute the powder are shown in the present drawing as they have no direct bearing on the present invention. The outer mounting member 26 may be fastened between the two members 28 and 30 by any suitable means such as welding, bolting with a suitable sealant, etc. or some other means suitable for maintaining a vacuum on both sides of the membrane 20.

Referring briefly to FIG. 2, the face view of the tube is shown wherein the Display Area is shown by the rectangular dotted-dashed line. The outer periphery of the membrane 20 is indicated by the dotted line 38 and the joiner or weld between the inner and outer members 24 and 26 is shown by the dotted line 40. As will be apparent from the preceding description, the operation of such an electrostatic storage display tubes involves the tracing of an image by the writing electron beam on the target electrode 20 in the Display Area shown on FIG. 2 and once the tracing operation is complete, the display powder is caused to pass across the face of the target electrode 20 by suitable means and a display is thus produced. When it is subsequently desired to remove said display, an erasing beam is caused to flood the inner surface of the target electrode 20 from the source 14 whereby the display powder is removed from the opposite face of said target electrode and the tube is ready to have another pattern or display traced on the face thereof.

The following is a somewhat more detailed description of the operation of a typical E.S.D. tube in which the present invention has particular utility. Referring to FIG. 1 the envelope 10 may be of any suitable shape, such as that of a conventional cathode ray tube having electron gun means (not shown) at one end 12 thereof for generating a beam of electrons and having at the other end thereof an enlarged face plate member 32. The electron beam generating means would normally include a cathode and a grid to which modulating signals are applied to regulate the intensity of the electron beam emitted from the electron gun elements including the cathode. The modulating input signals representing information to be stored and visibly displayed on the target electrode of the device may be from any suitable source, such as from a video output device. A video input network would apply a modulating input to the grid relative to the cathode to modulate the electron emission in response to variations in the video input information signals. The modulated electron beam is preferably swept across the target surface by deflection means, such as a magnetic deflection yoke disposed around the neck of the envelope 10. The deflection yoke is energized by a suitable sweep voltage signal generator. The sweep voltage generator receives synchronizing pulses from the video signal source to synchronize the beginning of the beam sweep with the start of the information signals to be displayed. The electrostatic charge is placed on the rear surface of the target electrode (membrane 20) by the controlled electron beam and the display powder adheres to this charge pattern on the front face to produce a visible image of the electrostatic charge distribution pattern. The display powder conventionally comprises a plurality of small particles of electrical insulating material which are capable of retaining an electrical charge. The powder is preferably of a dark color so as to produce a maximum contrast with the target electrode 20 when the particles adhere thereto in response to the electrostatic charge distribution pattern. The powder may be charged in any suitable manner, such as through triboelectric effect whereby agitation of two dissimilar particles produces opposite electrical charges thereon. The two types of particles utilized may be of any suitable type having the required relationship in the triboelectric series. One example of suitable materials is the use of resin or plastic particles and small glass beads. As stated previously the powder would be disposed in the space between the target membrane 20 and transparent window member 32, but is main-

tained away from the target membrane 20 and the electrostatic charge distribution pattern thereon during the writing process on membrane 20 by the modulated electron beam.

To remove the electrostatic charge distribution pattern and the charged particles adhering thereto from the target surface, means such as an erase electron gun is disposed in area 14 and is utilized to generate a flood beam of electrons directed at the writing side of target membrane 20. The erase electron gun is operative when energized to produce a large quantity of electrons which are accelerated toward target membrane 20. The erase gun preferably operates by producing a secondary emission ratio greater than unity for electrons striking target membrane 20. For many electrical insulating materials, such as the material of target membrane 20, the secondary emission ratio is greater than unity within a given range of accelerating voltages applied to electrons directed at the material. This means that within this range of accelerating voltages, for every incoming electron from the electron erase beam, more than one electron is emitted by secondary emission from the target surface 16 until equilibrium is reached. This erase beam bombardment causes the electrons forming the electrostatic charge on membrane 20 to be removed from membrane 20, thus dissipating the electrostatic charge and preparing it for receiving another electrostatic charge pattern from the modulated electron beam. During erasure of the electrostatic charge pattern, the remaining loose powder is cascaded across the reverse side of target 20 to remove any charged particles still adhering thereto.

The details of the present invention, i.e., the actual target electrode mounting means are shown in detail in FIGS. 3, 4, and 5.

FIG. 3 is a cross-sectional view of the outer mounting member 26 shown in the assembly drawing of FIG. 1. It will be noted that the member 26 comprises two portions, the first being a flat annular ring 26A which is adapted for mounting at its outer periphery directly on the tube enclosure assembly, i.e., members 28 and 30. An inner annular flange 26B is adapted for joining at its lower edge to the outer edge of the inner mounting member 24. The flange portion 26B together with the flange portion 24B of the inner mounting member 24 thus forms half of a bellows or a resilient annular member.

Referring to FIG. 4, the inner mounting member 24 has a flat annular portion 24A and a downturned flange 24B adapted, as stated previously, to be attached as by welding to the lower portion of the flange 26B on the member 26. The reference numeral 42 in FIG. 5 indicates a welded area where an annular weld is made to join the two members 24 and 26 together, thus forming the composite membrane mounting member. In FIG. 5 the rigid membrane 20 is shown affixed to the inner mounting member 24 by means of a suitable seal 22. In a preferred form of the invention, the target electrode or rigid membrane 20 is made from a thin sheet of mica and the sealing means 22 comprises solder glass preferably having substantially the same coefficient of thermal expansion as the mica membrane.

Referring again to FIG. 5, it will be noted that the two flange portions of the inner and outer mounting members 24B and 26B are joined by a continuous annular weld indicated by the numeral 42. The subassembly thus formed may be seen to form a single bellows arrangement with the attendant ability to withstand at least a small amount of flexure without materially moving the flat portions of the assembly 24A and 26A. The bellows formed by the flanges 24B and 26B thus provides mechanical isolation between the inner and outer mounting members and also compensates for differential expansion of the inner and outer mounting members. The thermal expansion of the outer member would normally be chosen to match the thermal expansion of the tube envelope.

By choosing materials of the proper thermal expansion

and by sealing the rigid membrane to the inner mounting means at an elevated temperature, preferably somewhat above the normal operating temperature of the E.S.T. tube, a very stable mounting means for the rigid membrane or target membrane 20 may be realized.

The material of the inner ring is preferably selected to have a coefficient of thermal expansion between 1 and 3 times 10^{-7} in./in./° C. less than that of the membrane 20. Performing the joining step of forming the seal 22 of solder glass at said elevated temperature will result in the assembly being at its maximum expansion condition. Then as the device cools down, it will readily be seen that the membrane and the inner support ring are continually in tension thus maintaining a substantially uniform radial tension on the membrane 20 as long as the assembly remains at any temperature below the fabrication temperature.

According to a preferred embodiment of the invention, a very thin sheet of mica is utilized as the membrane 20. The inner ring 24 is fabricated from Carpenter Alloy #49 which is an alloy of about 51% iron and 49% nickel having a coefficient of expansion of about 90×10^{-7} in./in./° C. The outer ring 26 is constructed of an alloy such as Kovar which has a thermal expansion closely matching that of the tube envelope. The members 28 and 30 utilized in the disclosed embodiment of FIG. 1 to mount the membrane mounting assembly in the front of the tube 10 are also preferably constructed of Kovar or a similar alloy. The material for fabricating the seal 22 which rigidly affixes the membrane 20 to the inner mounting member 24 comprises a commercially available solder glass. The solder joint 22 was made at a temperature of 435° C. or higher. The assembly thus constructed, even when rigidly connected to the joining support members 28 and 30, has repeatedly undergone heat cycling tests from room temperature to over 400° C. without rupturing or seriously distorting the mica membrane.

The resulting assembly including the mica membrane 20 sealed to the frame comprising the two support members 24 and 26 has been found capable of effectively isolating the two chambers, one including the electron gun assembly and the other the trace producing powder provided that some degree of vacuum exists in both chambers.

It will be apparent from the above description of the present invention that essentially three factors are involved in manufacturing a membrane support structure in accordance with the present invention. The first is the selection of the relative coefficients of thermal expansion of the rigid membrane itself and the inner mounting member, such that the membrane has the larger coefficient. The second comprises forming the bond or seal between the membrane and the inner mounting member at a temperature in excess of the highest temperature which the resulting structure will experience in normal operation. This results in the rigid membrane being maintained under at least some tension throughout the E.S.D. tube operating range thus assuring a substantial flatness or non-warping of the membrane. The importance of this factor in constructing a target electrode or viewing surface for a display type tube is obvious. Finally, the bellows configuration between the inner and outer mounting members 24 and 26 permits a certain amount of isolation of the membrane 20 which is rigidly attached to the inner member from mechanical movement or expansion of the outer member and its mounting means.

As indicated previously, while Carpenter Steel Company Alloy #49 constitutes a preferred material for the inner mounting means, other materials, such as Carpenter Steel Company Alloy #426 or Driver Harris Company Alloy #52 could be used in place of the Carpenter alloy for the inner mounting member.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art

that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. Means for mounting a thin rigid membrane in one end of an evacuated device, said rigid membrane comprising a thin sheet of mica and being the target electrode of a cathode-ray storage tube containing an electron gun, said membrane and mounting means being capable of maintaining said membrane in a substantially flat configuration throughout the operating temperature range of said device, said mounting means comprising an annular inner mounting member having a flat portion adjacent to its inner periphery, the inner diameter of said inner member being slightly smaller than the diameter of the rigid membrane to be mounted thereon, and a flange portion located adjacent to the outer periphery thereof,

an annular outer mounting member having a flat portion adjacent to its outer periphery and a flange portion, adjacent to its inner periphery the flanges on the inner and outer mounting members being of such a diameter and configuration that they are not parallel and meet in a continuous junction at the inner and outer peripheries respectively of the outer and inner mounting members and a continuous weld joining said flanges at said junction,

means for effecting a secure mechanical seal between the rigid membrane and the flat surface of the inner mounting member, said member having a coefficient of thermal expansion between about 1 and 30×10^{-7} in./in./° C. less than the coefficient of thermal expansion of said mica membrane.

2. A rigid membrane and mounting means therefor as set forth in claim 1 wherein the thin mica sheet is sealed to the flat portion of said inner mounting member by a

solder glass having a coefficient of expansion substantially the same as that of the mica.

3. A rigid membrane and mounting means therefor as set forth in claim 2 wherein said inner mounting member is fabricated from an alloy consisting essentially of 49% nickel and 51% iron.

4. A rigid membrane and mounting means therefor as set forth in claim 1 wherein said membrane further comprises the target electrode of an electrostatic storage display tube including a rear chamber containing said electron gun and a front chamber between the membrane and the front face of said tube, said membrane and mounting means forming a seal between the electron gun chamber and the front chamber of said tube.

5. A rigid membrane and mounting means therefor as set forth in claim 4 wherein the flanges on said inner and outer mounting members meet at an angle less than 90° to form a bellows.

6. A rigid membrane and mounting means as set forth in claim 1 wherein the mechanical seal between the rigid membrane and the inner mounting member is made at a temperature greater than the normal operating temperature of said tube whereby the membrane is maintained under continual tension at said operating temperature.

References Cited

UNITED STATES PATENTS

2,923,843	2/1960	Turk et al.
3,102,212	8/1963	Schlesinger.
3,155,859	11/1964	Koert.
3,202,854	8/1965	Ochs.

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