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THIN IMAGE TUBE ASSEMBLY

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Fig. 1

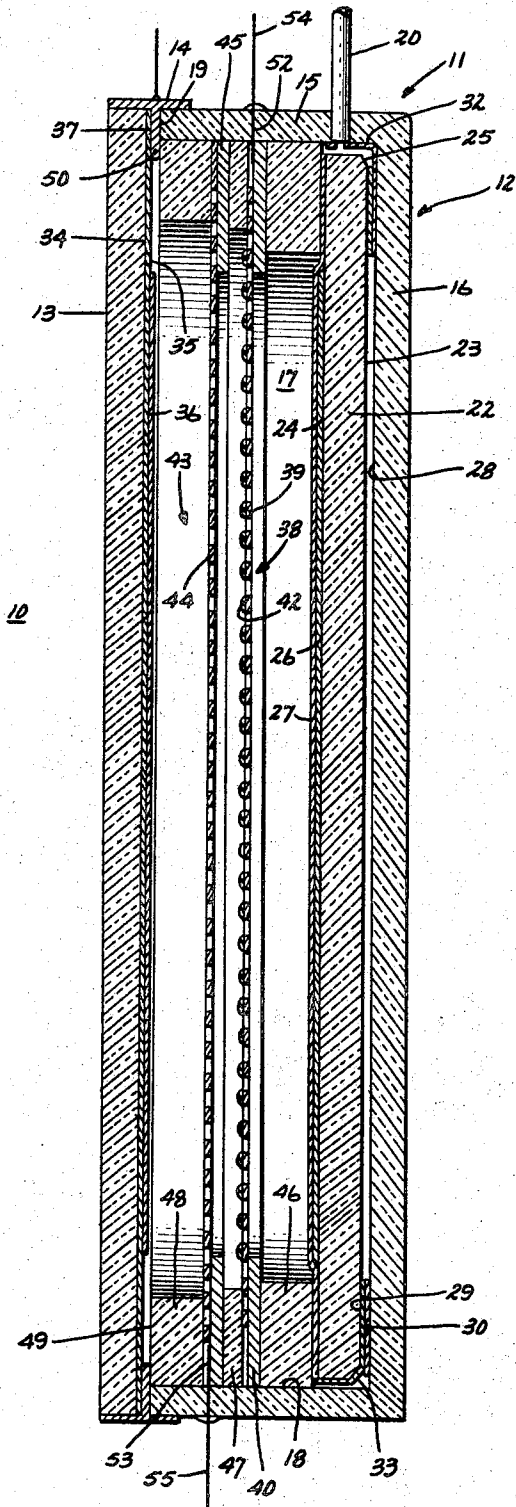
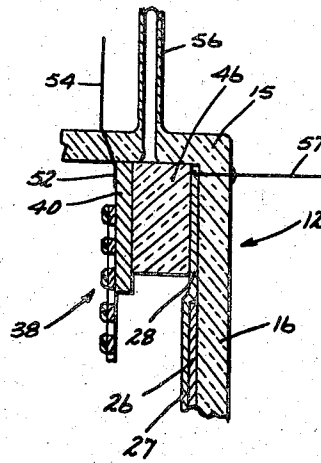


Fig. 2



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THIN IMAGE TUBE ASSEMBLY

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ABSTRACT OF THE DISCLOSURE

A thin image tube assembly and mounting includes a display screen at one end of a cylindrical envelope and a faceplate having a photoconductive screen at the other end. Annular insulating spacers positioned along the inner surface of the tube abut and support two intermediate mesh screens. The spacer adjacent the photoconductive screen is flush with the edge of the envelope and a metal ring forms a seal between the faceplate, envelope and spacer to retain the elements in position. Close spacing between the two ends permits proximity focusing of an image onto the display screen.

This invention relates generally to image tubes, and more particularly, to a storage image tube having an internal structure which permits the provision of an extremely thin tube.

Storage image tubes are commonly used for receiving and storing a radiation image and thereafter optically displaying the stored image. Such tubes conventionally comprise a photocathode, an insulator screen, a collector electrode, a phosphor display screen, and electrostatic lens or magnetic focusing elements. The photocathode converts the incident radiation image into a corresponding electron beam, impingement of the electron beam upon the insulator screen providing by secondary emission a corresponding charge image which can be stored for a period of time. When it is desired visually to display the stored image, uniform illumination of the photocathode provides a flood beam of electrons which pass through the apertures in the insulator screen to the phosphor display screen, being modulated by the charge image on the insulator screen, thereby providing an optical image corresponding to the charge image and in turn to the initial radiation image.

In conventional storage image tube constructions, the insulator or storage screen and the collector electrode, most commonly a fine mesh metal screen, and electrostatic lens elements have been supported by techniques commonly employed in the vacuum tube art, i.e., by various supports fused to the wall of the envelope. While such methods and techniques for supporting the internal elements have been satisfactory in the case of larger tubes having appreciable length, there are applications for storage image tubes where it is desirable that the tube be as thin as possible, it being, however, extremely difficult to provide a tube construction of the desired thinness with such conventional electrode supporting techniques. In addition, proximity focusing may be employed in a thin tube, thus eliminating electrostatic or magnetic focusing. It is therefore desirable to provide a storage image tube construction in which the internal elements are properly spaced and supported without attachment to the envelope wall, thus permitting the provision of an extremely thin tube.

It is accordingly an object of the invention to provide an improved image tube.

Another object of the invention is to provide an improved image tube in which the internal elements are supported and spaced without attachment to the walls of the envelope.

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A further object of the invention is to provide an improved storage image tube which is thinner than tubes heretofore provided.

In accordance with the broader aspects of the invention, the internal electrodes are supported and spaced by a plurality of spacing members which respectively abut the electrodes and the face plates of the tube thereby clamping the electrodes and supporting the same in assembled relation in the tube without requiring that the electrodes be attached to the wall of the envelope for support.

The above-mentioned and other features and object of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawing, wherein:

FIG. 1 is an enlarged cross-sectional view showing an embodiment of the improved storage image tube of the invention; and

FIG. 2 is a fragmentary cross-sectional view showing a modification of the embodiment of FIG. 1.

Referring now to FIG. 1 of the drawing, the improved thin storage image tube of the invention, generally identified at 10, includes an evacuated envelope 11 comprising a cup-shaped member 12 formed of glass or ceramic and a faceplate 13 sealed to the cup-shaped member 12 by an indium seal ring 14 as will hereinafter be more fully described. Faceplate 13 may be formed of suitable material such as glass, sapphire, fused silica or lithium fluoride.

The glass cup-shaped member 12 comprises a cylindrical side wall 15 integrally joined to a bottom wall or faceplate 16. Bottom wall 16 is suitably ground and polished and defines cavity 17 with the side wall 15, the inside surface 18 of the cylindrical side wall having a constant diameter of a size to permit the spacing members and electrodes to slide down into cavity 17 without unnecessary clearance, as will be hereinafter described. The edge 19 of the side wall 15 is optically ground and polished or fire polished, as will be hereinafter more fully described; and it will be seen that the faceplate 13, which is cylindrical and has its opposite surfaces ground and polished, closes the cavity 17. A metal exhaust tubulation 20 is fused or brazed in the side wall 15 in conventional fashion and communicates with cavity 17.

In the illustrated embodiment, a separate cylindrical spacing member or faceplate 22 is provided having flat opposite ground and polished surfaces 23, 24 and a chamfered peripheral edge 25 thereby permitting the faceplate 22 to lay flat or to abut the bottom wall 16 of the cup-shaped member 12. A conventional phosphor display screen 26 is deposited on the inner surface 24 of the faceplate 22 preferably with a conventional aluminum coating 27, as is well known to those skilled in the art. The facing surfaces 23, 28 of the faceplate 22 and the bottom wall 16 respectively having coinciding metallized rings 29, 30 thereon mutually forming contacts, the metallized ring 30 on the bottom wall 16 being coupled to the metal exhaust tubulation 20 by a metallized lead 32 and the metallized ring 29 being coupled to the aluminum coating 27 by a metallized lead 33, the metal tubulation 20 thus serving as an external lead for the phosphor 26. It will be understood that for purposes of illustration in the drawing, the metallized contact rings 29, 30 are shown as having appreciable thickness; however, that in actual practice these rings are of film thickness so that the surface 23 of the faceplate 22 essentially abuts the surface 28 of the bottom wall 16.

The inner surface 34 of faceplate 13 is coated with a conventional transparent conductive coating 35, such as tin oxide, or some other means of making electrical

contact, and a conventional photocathode 36 is deposited on the transparent conductive coating 35, or contact, as is well known to those skilled in the art. The indium seal ring 14 has an annular radially inwardly extending flange portion 37 which engages the edge 19 of the side wall 15 of the cup-shaped member 12 and the transparent conductive coating or contact 35 on the faceplate 13, a cold vacuum-tight seal being formed by the application of pressure, as is well known to those skilled in the art. It will be seen that the indium seal ring 14 also serves as an external contact for the photocathode 36.

An insulator or storage screen 38 is provided extending across the cavity 17 and spaced in parallel relationship with the faceplates 13, 22. Insulator screen 38 comprises a fine mesh metal screen 39 stretched over a heavy, annular metal support ring 40 and fastened thereto, in any suitable fashion, as by resistance welding. A layer 42 of insulating material, such as silicon or magnesium oxide is deposited on the side of the metal screen 39 facing the photocathode 36 in any suitable manner, as by vacuum evaporation methods well known to those skilled in the art.

A collector screen 43 is provided comprising a fine mesh metal screen 44 extending across cavity 17 in spaced parallel relationship to the insulator screen 38 and the faceplate 13. The fine mesh metal screen 44 is stretched over a heavy, annular metal support ring 45 and is fastened thereto in any suitable fashion, as by resistance welding. The outside diameters of the metal support rings 40, 45 are slightly less than the inside diameter 18 of the side wall 15 of the cup-shaped member 12 so as to permit them to be slid down into the cavity 17 with a slip fit.

In order to properly space the insulator and collector screens 38, 43 and to support them within the cavity 17 without attachment to the side wall 15, a plurality of annular spacing members 46, 47, 48 are provided. Spacing members 46, 48 may be formed of glass or a suitable ceramic, while spacing member 47 may be formed either of mica or a suitable ceramic since an annular ring of glass of the requisite thinness would be hard to handle without breaking. Spacing member 46 abuts the aluminum coating 27 on the inner surface 24 of faceplate 22 radially outwardly from the phosphor display screen 26. It will be understood that for purposes of illustration in the drawing, the aluminum coating 27 is shown as having appreciable thickness; however, that in actual practice, aluminum coating 27 will be of film thickness and thus that the spacing member 46 essentially abuts the faceplate 22. The metal mounting ring 40 in turn abuts the spacing member 46 and is abutted by the thin spacing member 47. Spacing member 47 is abutted by the metal mounting ring 45 which in turn is abutted by spacing member 48. The outside diameters of the spacing members 46, 47, 48 are slightly smaller than the inside diameter 18 of the side wall 15 to permit them to be slid down inside the cavity 17 with a slip fit.

When the faceplate 22, spacing member 46, insulator screen 38, spacing member 47, collector screen 43 and spacing member 48 have been assembled in the cavity 17 as shown, the edge 19 of the side wall 15 of cup-shaped member 12 has previously been optically ground and polished until the inside height of the side wall 15 is equal to the combined height of the spacing members and screen, i.e., so that the edge 19 is flush with the outer surface 49 of insulating member 48. The annular flange portion 37 of the indium seal ring 14 has a portion 50 extending radially inwardly from the side wall 15. Indium flows in the nature of solder under pressure and thus, when pressure is applied to the faceplate 13 and the cup-shaped member to form the seal, the annular flange portion 37 of the indium seal ring 14 flows inwardly so as to make contact with and abut the top spacing member 48. It is thus seen that the metal mount-

ing rings 45, 45 are spaced and clamped by the faceplate 22 and the spacing members 46, 47, 48 between the bottom wall 16 and the annular flange portion 37 of the indium seal ring 14, thus eliminating vertical movement of the spacing members and mounting rings and supporting the screens 38, 43 without their being attached to the side wall 15.

Conventional ribbon contacts 52, 53 are attached to the metal mounting rings 40, 45 in any suitable fashion, as by resistance welding, the ribbon contacts 52, 53 in turn being secured to conventional external leads 54, 55 extending through the side wall 15 of the cup-shaped member 12, as is well known to those skilled in the art.

In assembling the thin storage image tube 10 shown in FIG. 1, the phosphor and aluminum coatings 26, 27 and the metallized ring 29 are preformed on the faceplate 22 in conventional fashion prior to assembly of the faceplate 22 in the cup-shaped member 12. The metal exhaust tubulation 20, metallized ring 30 and lead 32, and the leads 54 and 55 are likewise secured to the cup-shaped member 12 before assembly. The faceplate 22 with the phosphor and aluminum coatings 26, 27 and the metallized ring 29 thereon, the spacing members 46, 47, 48 and the insulator and collector screens 38, 43 are then stacked in the cavity 17 in the order shown, the ribbon contacts 52, 53 being connected to the metal support rings 40, 45 by resistance welding as the respective screens are placed on top of the respective spacing members. This sub-assembly may then be placed in a container and sealed to a vacuum system. After this container is well exhausted, the temperature is slowly raised to an elevated level, such as on the order of 400° C. and held there until the pressure drops to at least 2×10^{-7} torr while hot. The container is then cooled and sealed off under vacuum thus keeping the parts therein clean and exhausted for storing until needed for final assembly of the tube.

The transparent conductive coating or contacts 35 on the faceplate 13 is likewise preformed and the faceplate 13 with the transparent conductive coating or contact 35 thereon may then be placed in a separate container which is then evacuated and the photocathode 36 is then deposited in conventional fashion as is well known to those skilled in the art. When it is desired to complete assembly of the tube, the faceplate 13 with the photocathode 36 thereon, as above-described, and the cup-shaped member 12 with the remaining parts therein are removed from their respective processing containers, the indium seal ring 14 is positioned on the edge 19 of the side wall 15, and the faceplate 13 is sealed to the side wall 15 by the application of suitable pressure, as is well known to those skilled in the art. The thus assembled tube is then attached to a vacuum pump (not shown) by means of the exhaust tubulation 20 and is pumped down to the desired vacuum following which the exhaust tubulation 20 is pinched off. An ion pump is conventionally used to pump the ultimate vacuum on the tube.

While an indium seal ring 14 has been illustrated and described for sealing the faceplate 13 to the cup-shaped member 12, it will be readily understood that other conventional means of sealingly attaching the faceplate 13 to the cup-shaped member 12 may be employed and that in such instances, the top spacing member 48 may directly abut the inner surface 34 of the faceplate 13. It will be observed that large central apertures are formed in the metal mounting rings 40, 45 and the annular spacing members 46, 47, 48 thus exposing the insulator screen 38 and the collector screen 44 to the display screen 26 and the photocathode 36. While the use of evacuated processing containers has been described, this method of assembly does not form a part of my invention and in the case of some cathodes, other conventional assembly techniques may be employed.

Referring now to FIG. 2 of the drawing in which like elements are indicated by like reference numerals, a modification of the invention is shown, in which a glass

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exhaust tubulation 56 is provided instead of the metal tubulation 20 of the previous embodiment and in which the phosphor display screen 26 and aluminum coating 27 are deposited directly on the inner surface 28 of the bottom wall 16 of the cup-shaped member 12 rather than on the separate spacing or faceplate member 22, as shown in FIG. 1. In this embodiment, since a glass tubulation 56 is employed, a separate external lead 57 is brought out through the bottom wall 16 from the aluminum coating 28 to provide the phosphor contact.

Here, the bottom spacing member 46 abuts the aluminum coating 27, it again being recognized that for purposes of illustration in the drawing, the aluminum coating 27 is shown as having appreciable thickness whereas in actual practice it will be of film thickness so that the facing member 46 would in essence abut the inner surface 28 of the bottom wall 16.

The remaining structure of the tube incorporating the modification of FIG. 2 is as shown and described in connection with FIG. 1, it being observed that construction of FIG. 2 will permit the provision of a still thinner tube.

It will be seen that the invention permits the provision of an extremely thin storage image tube since the necessity for attaching the internal metal electrodes to supporting elements attached to the wall of the envelope is completely eliminated, the tube being assembled by merely placing the spacing members and screens in the envelope in the proper sequence.

While there have been described above the principles of this invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of this invention.

What is claimed is:

1. A storage image tube comprising: a cup-shaped member having a cylindrical side wall and a flat bottom wall mutually defining a cavity, said cup-shaped member being formed of insulating material and at least said bottom wall being transparent; a first flat circular faceplate member formed of transparent insulating material extending across the open end of said cup-shaped member parallel with said bottom wall and closing said cavity; a metal ring extending over an outer surface of said first faceplate member and sealingly connecting said first faceplate member to the edge of said side wall and having a portion extending into said cavity; a second flat circular faceplate member formed of transparent insulating material abutting said bottom wall and extending across said cavity; a phosphor display screen supported on the surface of said second faceplate member facing said cavity; the abutting surface of said second faceplate member and bottom wall respectively having metallized rings formed thereon mutually forming contacts; first external lead means connected to said ring on said bottom wall and second internal lead means connecting the ring on said second faceplate member and said display screen; a photocathode supported on the surface of said first faceplate member facing said cavity; internal lead means connecting said sealing ring and said photocathode; first and second annular metal rings in said cavity respectively spaced from each other and said faceplate member; first and second fine mesh metal screens respectively secured to said first and second rings and extending across said cavity in spaced parallel relationship with each other and said faceplate members, the screen adjacent said display screen having the side thereof facing said photocathode coated with insulating material; second and third external lead means respectively connected to said first and second rings; and a plurality of annular spacing members formed of insulating material respectively tightly abutting said first faceplate member, and sealing ring portion and said first and second metal rings, and spacing said first and second

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metal rings and the respective screens from each other and from said faceplate members thereby clampingly supporting said first and second screens in assembled relation, the side of said spacing member abutting said first faceplate and sealing ring portion being flush with said edge of said side wall, said spacing members being positioned along the inner surface of said cylindrical wall and being the sole support for said first and second screens, the spacing between said first and second faceplate members permitting proximity focussing of an image from said photocathode onto said display screen.

2. A storage image tube comprising: a cup-shaped member having a cylindrical side wall and a flat bottom wall mutually defining a cavity, said cup-shaped member being formed of insulating material and at least said bottom wall being transparent; a flat circular faceplate member formed of transparent insulating material extending across the open end of said cup-shaped member parallel with said bottom wall and closing said cavity; a metal ring extending over an outer surface of said faceplate member and sealingly connecting said faceplate member to the edge of said side wall and having a portion extending into said cavity, the metal of said sealing ring being formable by pressure applied to said faceplate and side wall; a phosphor display screen supported on said bottom wall facing said cavity; first external lead means connected to said display screen; a photocathode supported on the surface of said faceplate member facing said cavity; internal lead means connecting said sealing ring to said photocathode; first and second annular metal rings in said cavity respectively spaced from each other and from said bottom wall and faceplate member; first and second fine mesh metal screens respectively secured to said first and second rings and extending across said cavity in spaced parallel relationship with each other and with said bottom wall and faceplate member, the screen adjacent said display screen having the side thereof facing said photocathode coated with insulating material; second and third external lead means respectively connected to said first and second rings; and a plurality of annular spacing members formed of insulating material respectively tightly abutting said sealing ring portion, said first and second rings, and said bottom wall and spacing said first and second rings and the respective screens from each other and from said faceplate member and bottom wall thereby clampingly supporting said first and second screens in assembled relation, the side of said spacing member abutting said sealing ring portion being flush with said edge of said side wall, said spacing members being positioned along the inner surface of said cylindrical wall and being the sole support for said first and second screens, the spacing between said faceplate and bottom wall permitting proximity focussing of an image from said photocathode onto said display screen.

3. The tube of claim 2 wherein said first external lead means comprises a metal exhaust tubulation extending through said side wall.

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