

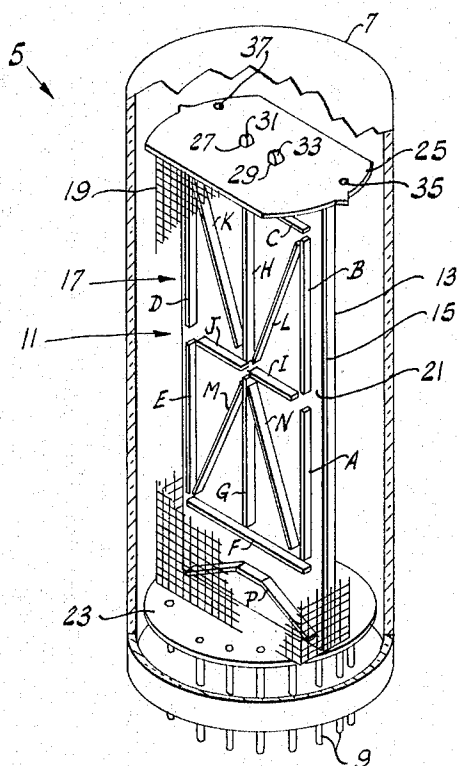
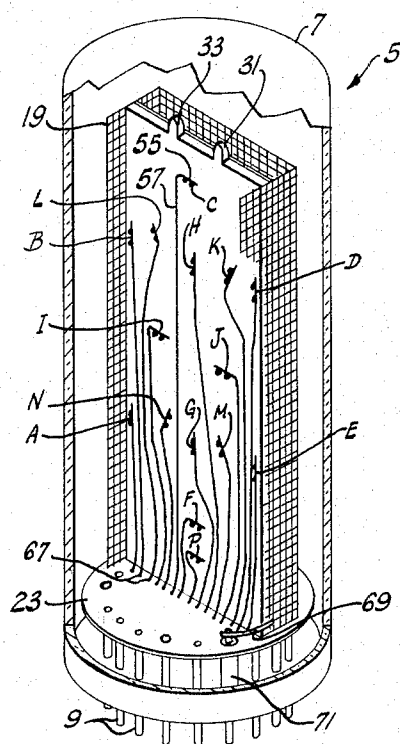
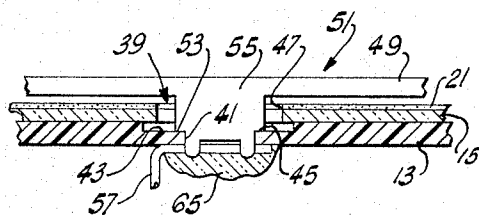
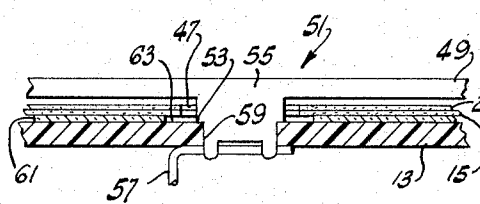
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CATHODE BAR STRUCTURE FOR GLOW DISCHARGE DEVICES

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CATHODE BAR STRUCTURE FOR GLOW DISCHARGE DEVICES

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This invention relates to a glow discharge device and more particularly to a glow discharge device having a planar character display upheld by a rigid planar insulating support.

Of the known glow discharge devices, one of the more common types includes a hermetically sealed transparent glass envelope having electrical conductors sealed therein and containing a gas at glow discharge pressure and a character display having a plurality of cathode segments affixed to a pair of insulating spacers contiguous with opposite surfaces of a metal support. Each segment has a portion supported by and extending through the insulating spacers and attached to an electrical connector. The connectors are attached to the conductors sealed into the envelope and enclosed within a pair of insulating spacers which serve to support the readily flexible connectors, firmly space the connectors from each other, and prevent a glow discharge in the vicinity thereof. Also, a transparent anode is spaced from the character display and supported by affixing each side thereof intermediate a pair of insulating spacers attached to the metal support.

While such devices have found a generally increased acceptance by the public in "readout" applications, the known devices have several important features which leave much to be desired. For example, the use of a metal supporting structure necessitates the attachment of numerous insulating spacers and such attachments and spacers are not conducive to a fabricated product which is economical in time, labor, or materials. Also, the use of connectors which must be supported and firmly held in spaced relationship as well as masked and covered by an attached insulator in order to prevent a glow discharge thereabout adds to the fabricating cost of the device. Moreover, the rather fragile and flexible spacers used to support the cathode segments in such devices does not tend to provide a structure which is rugged and stable under adverse conditions of environment and handling.

Therefore, it is an object of this invention to enhance the structure of a planar character display glow discharge device.

Another object of the invention is to provide a planar character glow discharge device having an improved structure adapted to the economic fabrication thereof.

A further object of the invention is to improve the rigidity of the attaching and supporting means for the cathode segments of a planar character display glow discharge device.

Briefly, these objects are achieved in one aspect of the invention by including within a hermetically sealed transparent envelope having electrical conductors sealed therein and containing a gas at glow discharge pressure, a rigid planar insulating support whereon is affixed an insulating spacer and whereon is upheld a plurality of cathode segments arrayed as a character display with each segment having a portion spaced from the support and a portion passing therethrough and attached to a substantially rigid connector. The connector has an insulator covering and is attached to an insulating covered conductor sealed into the envelope. Also, a transparent electrically conductive anode is equidistantly spaced from the segments of the display and attached to one of the conductors sealed into the envelope.

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

FIG. 1 is a perspective view, partially in section of a planar character display glow discharge device;

FIG. 2 is a cross-sectional view showing the space relationship of a support, insulator spacer, and cathode segment;

FIG. 3 is a cross-sectional view of alternate construction showing the space relationship of a support, insulator spacer, and cathode segment; and

FIG. 4 is a perspective view from a direction opposite to that of FIG. 1, partially in section, of a planar character display glow discharge device.

Referring to FIG. 1 of the drawings, a hermetically sealed glow discharge device 5 includes a transparent envelope 7 having a plurality of electrical conductors 9 extending therethrough and containing a gas at glow discharge pressure and a visual display assembly 11. The assembly 11 includes a planar and rigid insulator support 13, an insulating spacer 15 thereon, a character display 17 upheld by the support 13, and a planar transparent anode 19 spaced from the display 17 and in a plane substantially parallel thereto.

More specifically, the envelope 7 is transparent or at least has a transparent portion and is of a vacuum-tight material which can be hermetically sealed. For instance, the lead and lime glasses commonly used in the electron tube art are applicable materials and a tubular configuration is preferred although most any shape is appropriate depending upon a number of factors such as the viewing area desired.

As is also common in the electron tube art a plurality of electrical conductors 9 are sealed into and extend through the envelope 7 to provide a convenient means for applying energy from an external source to elements contained therein. These conductors 9 may be of most any good electrical conducting material so long as a good hermetic seal may be made without undue scrap; the material has sufficient rigidity to act as a good support; and an electrical insulating coating may be provided thereon which tends to discourage the formation of a glow discharge thereabout during operational use of the device 5.

Preferably, a material such as that disclosed in U.S. Patent No. 2,394,919 issued to W. E. Kingston and assigned to the assignee of the present application may be used for the conductors 9. This material is commonly referred to as "#4 Alloy" and includes about 42% nickel, 4-8% chromium, and the balance iron. Moreover, the material has a coefficient of expansion similar to that of the glass used in the envelope and is adapted to provide an insulating oxide layer thereon having a high work function which deters the formation of a glow discharge thereabout. Other appropriate materials include "Fernihrome," "Kovar," and "Allegheny 55"—a detailed description of which may be found in U.S. Patents 1,942,260 and 2,071,196.

The visual display assembly 11 includes a rigid planar insulating support 13 which preferably, not necessarily, is of a substantially rectangular configuration and extends along the longitudinal axis of the envelope 7. The support is of an insulating material such as ceramic and an especially applicable material is "Fotoceram" produced by the Corning Glass Works of Corning, New York. Also, the support 13 has a thickness of at least 0.025 inch in order to provide the desired rigidity as well as an appropriate means for upholding and attaching the cathode segments A through N and P as will be explained herein-after.

Attached to and substantially covering one surface of the support 13 is a first insulating spacer 15 which may be of a material such as mica. This spacer 15 is cemented, bonded, stapled, or attached by any one of a number of ordinary techniques to the support 13 and has deposited thereon a layer 21 of electrically insulating material which preferably is nonreflective and opaque. This layer 21 serves to enhance the viewability of the character display as well as reduce the possibility of the formation of electrical leakage paths as will be explained.

Regarding suitable materials for the layer 21, chrome oxide may be used, and a preferred material is "Aquadag" which comprises a mixture of graphite, lampblack, a binder, and compatible solvents. Such materials fulfill the necessary requirements for electrical insulating properties, opaqueness, and provide a desired background which enhances the viewability of the display thereon.

Upheld by and attached to the support 13 is a planar character display 17. This display is spaced from the insulating layer 21 adhered to the spacer 15 and includes a plurality of individual cathode segments A through N and P. These segments A through N and P are insulatingly spaced from each other at a distance not greater than about 0.020 inch and preferably arrayed in a substantially rectangular configuration with segment pairs I J and G H disposed substantially normal to the sides of the configuration and segment pairs K N and L M substantially diagonal to the corners thereof. Thus, the spacing of not more than about 0.020 inch between the segments A through N and P in conjunction with a glow discharge of about 0.030 inch surrounding each one of the segments A through N and P provides continuous characters of substantially uniform dimensions in the form of letters, numerals, or both and are readily available within a restricted area by selective energization of the individual segments A through N and P.

Spaced from and having at least a portion thereof in a plane substantially parallel to the plane of the display 17 is a transparent anode 19. This anode 19 is of an electrically conductive material or at least has an electrically conductive layer. For example, a transparent glass surface having a layer of stannous oxide adhered thereto, expanded metal, photoetched conductive material, and numerous similar materials are applicable as an anode 19. A preferred material is stainless steel screen having a mesh in the range of about 10 to 36 squares per inch and a wire diameter of about 0.005 to 0.008 inch. It has been found that stainless steel screen of the above dimensions provides a structure having sufficient rigidity to be self-supporting and is readily oxidized to provide a darkened surface which greatly enhances the viewability of the display 17. Moreover, when the screen has less than 10 squares per inch or a wire diameter less than about 0.005, an accumulation of sublimed materials is deposited on the surface of the envelope 7 which reduces the viewing qualities of the device 5 and the anode 19 lacks the desired self-supporting rigid qualities desired. Also, a screen having more than about 36 squares per inch and a wire size greater than about 0.008 inch lacks sufficient transparency to provide the desired quality of character display 17 viewing.

Within the envelope 7, the visual display assembly 11 is supported on the ends of and attached to one or more of the conductors 9 by way of a second insulating spacer 23. This second spacer 23 upholds and, in conjunction with a third insulating spacer 25, rigidly locates the assembly 11 within the envelope 7.

The third insulating spacer 25 is located along the longitudinal axis of the envelope 7 at a distance which is dependent upon the length of the support 13. This spacer 25 includes a pair of apertures 27 and 29 adapted to receive a second pair of rigid tabs 31 and 33 extending outwardly from the support 13 and is upheld by and affixed to the support 13. Also, a pair of eyelets 35 and 37 are attached to the spacer 25 and to the anode 19

by ordinary means and serve to support and rigidly locate the anode with respect to the support 13. Obviously, rivets, staples, mica slots, and numerous similar means of attachment are equally applicable and appropriate. Further, the spacer 25 is preferably of a rectangular configuration with the longitudinal ends thereof adapted for intimate contact with the envelope 7 in order to maintain the assembly in a fixed location therein and the dimension normal to the longitudinal dimension is of a reduced size in order to lend viewability to the character display 17 above the plane of the spacer 25.

The cathode segments A through N and P are of a substantially rectangular configuration and are attached to the support 13 in a manner such that the distance thereon in a plane normal to the support 13 is in the range of about 0.010 to 0.060 inch. Also, the width of each of the segments A through N and P, as viewed by an observer and in a plane normal to the general viewing location, is dependent upon the thickness of material from which the segments A through N and P were fabricated and may vary in the range of about 0.003 to 0.030 inch. Thus, the segments A through N and P appear as fine and distinct lines to the viewer.

Regarding the attachment of the cathode segments A through N and P, reference is made to FIG. 2 of the drawings. Herein, the support 13 has a plurality of slots 39 therethrough having a first portion 41 of one diameter and a second portion 43 of slightly larger diameter whereby a ledge 45 is provided. The slots 39 are aligned with apertures 47 through the previously mentioned first insulating spacer 15 having the insulating material layer 21 thereon and these apertures 47 are of a diameter intermediate the diameter of the first and second portions 41 and 43 of the slots 39.

The cathode segments A through N and P each have a longitudinal portion 49 and a protuberance 51 which extends normal thereto and includes a shoulder portion 53 and a tab portion 55. The tab portion 55 is shaped to pass through the aperture 47 of the insulating spacer 15 and both portions 41 and 43 of the slot 39 while the shoulder portion 53 passes through the aperture 47 in the insulating spacer 15 wherefrom it is spaced and contacts the ledge 45 of the support 13. Thereafter, an electrical connector 57 is brought into contact with the support 13 at the surface opposite whereto the segments A through N and P are disposed and the tab portion 55 is attached to the connector 57 by welding, pasting, or similar attaching means.

Alternately, the cathode segments A through N and P may be attached in a manner such as illustrated in FIG. 3. Herein, the cathode segments A through N and P are identical to those described with reference to FIG. 2 and include a longitudinal portion 49, and a protuberance 51 normal thereto having a shoulder portion 53 and a tab portion 55. The aperture 47 of the insulating spacer 15 has a diameter greater than that of a diametrically uniform slot 59 and a second spacer 61 is introduced intermediate the insulating spacer 15 and the support 13 in the area of the aperture 47 and the slot 59. This second spacer 61 which may be electrically conductive or nonconductive; such as, for instance, metal or a layer of glass frit or almost any material applicable to discharge devices has a hole 63 therethrough which is of a diameter greater than the diameter of the aperture 47 in the insulating spacer 15 and the slot 59 in the support 13. Again, an electrical connector 57 is attached to the tab portion 55 of the cathode segment A through N and P as mentioned above.

Thus, it can be readily observed that the cathode segments A through N and P are upheld in a ruggedized manner by the rigid insulator support 13 which preferably has a thickness of not less than about 0.025 inch. Further, the longitudinal portion 49 of the segments A through N and P is spatially removed from contact with the insulating layer 21 adhered to the insulating spacer 15 by

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the shoulder portion 53 of the protuberance 51 which preferably has a height of about 0.030 inch. Also, the formation of an electrical path from one to the other of the cathode segments A through N and P by materials sublimed therefrom is prevented by shielding a portion of that path in a manner frequently used in the electron tube as illustrated in FIGS. 2 and 3.

As to the electrical connection of the segments A through N and P, reference is made to rear view of the discharge device 5 as illustrated in FIG. 4. The tab portion 55 of each of the segments A through N and P is attached to an electrical connector 57 by welding, cementing, or similar means as mentioned above and the development of a glow surrounding this attachment may be prevented by any one of a number of frequently used techniques. For instance, when the tab portion 55 and connector 57 are welded, a "glob" 65 of material such as aluminum oxide in a suitable binder may be applied to the weld area. Alternately, the tab portion 55 and connector 57 may be hidden from view by most any type of non-transparent shield material such as a piece of mica attached to the insulator spacer 23.

The connectors 57 extend longitudinally along the surface of the support 13 toward the insulating spacer 23 which has a plurality of aligned apertures 67 therein which are adapted for passage of a connector 57 therethrough. Thereafter, each one of the connectors 57 is attached to one of the previously mentioned conductors 9 sealed into and extending through the envelope 7.

As to materials, the connectors 57 are preferably of a material such as the previously mentioned "#4 Alloy" which is sufficiently rigid to assist in maintaining the support 13 at a desired location and need no additional supporting means to maintain a spacing therebetween. Also, such a material may be oxidized to provide an insulating layer thereon having a high work function which prevents the development of a glow discharge immediately adjacent thereto during operational use of the device 5. Alternately, a printed circuit type of electrically conductive material or most any electrical conductive material is applicable so long as any glow discharge which develops thereabout is hidden by a shield member.

Additionally, the transparent anode 19 is electrically attached to one of the electrical conductors 9 by way of a connector 69. This conductor 9 has an insulating layer 71 such as for instance a piece of glass tubing telescoped thereon which prevents current leakage therefrom to any of the connectors 57 or conductors 9 and a glow discharge thereabout.

As a specific example of constructed device, a "Fotoceram," support having a length of about $3\frac{1}{4}$ inches, a width of about $1\frac{1}{8}$ inches, and a thickness of about 0.06 inch had attached thereto a plurality of stainless steel segments having a width of about 0.005 inch, a thickness of about 0.020 inch, and a spacing between segments of not more than 0.020 inch. These segments were arrayed into a character display substantially as illustrated in FIG. 1. Then a stainless steel anode having a mesh of about 24 squares per inch and a wire diameter of about 0.006 inch was spaced about 0.200 inch from the character display and attached to a conductor.

The assembly was hermetically sealed in a transparent glass envelope and the atmosphere therein was replaced with a 99-1% neon-argon gas mixture at a pressure of about 22 mm. of mercury. Thereafter, the device was processed and stabilized in a manner well known in the art.

A 170 v. D.C. supply voltage was connected through an 1800-ohm resistor to the cathode segments and the anode with the anode positive with respect to the cathode segments. As a result, it was found that the device had a tube drop of about 135 to 140 volts at a current of about 0.003 ampere per cathode segment, a total current with 15 cathode segments glowing of about 0.020 ampere, and a maximum cathode segment current of about

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0.006 ampere. Moreover, the resultant glow discharge had a rating of approximately 200-foot lamberts and was clearly legible even under adverse ambient lighting conditions.

Thus, there has been provided a glow discharge device having a rigid planar support which is producible at a reduced cost in time, labor, and materials when compared with any of the known types of glow discharge devices. The firmness with which the cathode segments of a character display can be attached is greatly enhanced by the rigid support and the replacement of attached coverings and insulating materials by the relatively inexpensive oxide-covered connectors has greatly enhanced the structure.

While there has been shown and described what is at present considered the preferred embodiment 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 invention as defined by the appended claims.

What is claimed is:

1. A hermetically sealed glow discharge device comprising:

a transparent glass envelope having a plurality of electrical conductors sealed therein and extending therethrough and containing a gas at glow discharge pressure, said conductors having an electrical insulating layer thereon;

a rigid planar insulating support having an insulating spacer affixed thereto and spaced therefrom by a spacer, said support having a plurality of slots therethrough, said insulating spacer having a plurality of apertures aligned with and larger than said slots, and said spacer having a plurality of holes aligned with and larger than said slots and said apertures;

a plurality of cathode segments formed to provide a substantially continuous planar character display, each of said segments having a longitudinal portion spaced from the other and from said insulating spacer and a protuberance normal to said longitudinal portion, said protuberance having a first portion spaced from and extending through said aperture and hole and contacting said support whereby said segment is upheld and a second portion extending through said slot in said support,

a transparent electrically conductive anode spaced equidistantly from each of said cathode segments and having at least a portion thereof in a plane substantially parallel to said display, said anode being electrically connected to one of said conductors; and means attaching and electrically connecting each of said segments to one of said conductors and upholding said support and said anode, said means being enclosed by an electrical insulating layer.

2. A hermetically sealed glow discharge device comprising:

a transparent glass envelope having a plurality of electrical conductors sealed therein and extending therethrough and containing a gas at glow discharge pressure, said conductors having an electrical insulating layer thereon;

a rigid planar insulating support having an insulating spacer affixed thereto, said support having a plurality of slots therethrough with each slot having a ledge portion and said support having a plurality of apertures smaller than and aligned with said slots;

a plurality of cathode segments formed to provide a substantially continuous planar character display, each of said segments having a longitudinal portion spaced from the other and from said insulating spacer and a protuberance normal to said longitudinal portion, said protuberance including a shoulder portion spaced from said spacer and extending therethrough and contacting said ledge portion of said support and a tab portion extending through said slots in said support;

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a transparent electrically conductive anode spaced equidistantly from each of said cathode segments and having at least a portion thereof in a plane substantially parallel to said display, said anode being electrically connected to one of said conductors; and means attaching and electrically connecting each of said segments to one of said conductors and upholding said support and said anode, said means being enclosed by an electrical insulating layer.

3. A hermetically sealed glow discharge device comprising:

a transparent glass envelope having a plurality of electrical conductors sealed therein and extending therethrough and containing a gas at glow discharge pressure, said conductors having an electrical insulating layer thereon;

a planar ceramic insulating support having an insulating spacer affixed thereto and spaced therefrom by a spacer, said support having a plurality of slots therethrough, said insulating spacer having a plurality of apertures aligned with and larger than said slots, and said spacer having a plurality of holes aligned with and larger than said slots and said apertures;

a plurality of cathode segments formed to provide a substantially continuous planar character display, each of said segments having a longitudinal portion and a protuberance normal thereto, said longitudinal portions being spaced from each other by not more than about 0.020 inch and having a width in a plane parallel to said display in the range of about 0.003 to 0.030 inch, and said protuberance having a first portion spaced from and extending through said aperture and hole and contacting said support whereby said longitudinal portion is held in spaced relationship to said insulating spacer and a second portion extending through said support;

a transparent electrically conductive wire mesh anode spaced equidistantly from each of said cathode segments and having at least a portion thereof in a plane substantially parallel to said display, said anode being electrically connected to one of said conductors and having a mesh in the range of about 10 to 36 squares per inch and an oxide-covered wire in the range of approximately 0.005 to 0.008 inch in diameter; and

means attaching and electrically connecting each of said segments to one of said conductors and upholding said support and said anode, said means being enclosed by an electrical insulating layer.

4. A hermetically sealed glow discharge device comprising:

a transparent glass envelope having a plurality of electrical conductors sealed therein and extending therethrough and containing a gas at glow discharge pressure, said conductors having an electrical insulating layer thereon;

a rigid planar insulating support having a thickness of not less than about 0.025 inch and a plurality of slots therethrough;

an insulating spacer affixed to and substantially covering one surface of said support, said insulating spacer having an insulating layer thereon and a plurality of apertures therein aligned with and larger than said slots;

a spacer intermediate said insulating spacer and said support, said spacer having a plurality of holes therethrough aligned with and larger than said slots and said apertures,

a plurality of rectangular cathode segments formed to provide a substantially continuous planar character display, said segments being arrayed in a substantially rectangular configuration with segment pairs normal to the sides and intermediate diagonal cor-

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ners of said configuration, each of said segments having a longitudinal portion and a protuberance substantially normal thereto, said longitudinal portions being spaced from each other by not more than about 0.020 inch and having a width in a plane parallel to said display in the range of about 0.003 to 0.030 inch, and said protuberance having a first portion spaced from and extending through said aperture and hole and contacting said support, said support and said first portion upholding said longitudinal portion spaced from said insulating layer on said insulating spacer and a second portion of said protuberance extending through said support; electrical connectors attaching each of said segments to one of said conductors, each of said connectors having an electrical insulating layer thereon;

a transparent electrically conductive anode spaced equidistantly from each of said cathode segments and having at least a portion thereof in a plane substantially parallel to said display, said anode being electrically connected to one of said conductors; and

means including a pair of insulator spacers attached to and upholding said support and said anode, said spacers being in a plane substantially normal to said support and separated thereby and one of said spacers being attached to and upheld by said conductors.

5. A hermetically sealed glow discharge device comprising:

a transparent glass envelope having a plurality of electrical conductors sealed therein and extending therethrough and containing a gas at glow discharge pressure, said conductors having an electrical insulating layer thereon;

a substantially rectangular planar ceramic support having a thickness of not less than about 0.025 inch and a plurality of slots therethrough, each of said slots having a first portion of one diameter and a second portion of a larger diameter to provide a ledge intermediate thereto;

an insulating spacer affixed to and substantially covering one surface of said support, said spacer having an insulating layer thereon and a plurality of apertures aligned with said slots, each of said apertures having a diameter larger than said first portion and smaller than said second portion of said slot;

a plurality of rectangular cathode segments formed to provide a substantially continuous planar character display, said segments being arrayed in a substantially rectangular configuration with segment pairs normal to the sides and intermediate diagonal corners of said configuration, each of said segments having a longitudinal portion and a protuberance substantially normal thereto, said longitudinal portions being spaced from each other by not more than about 0.020 inch and having a width in a plane parallel to said display in the range of about 0.003 to 0.030 inch, and said protuberance having a first portion spaced from and extending through said aperture and hole and contacting said support, said support and said first portion upholding said longitudinal portion spaced from said insulating layer on said insulating spacer and a second portion of said protuberance extending through said support;

electrical connectors attaching each of said segments to one of said conductors, each of said connectors having an electrical insulating oxide layer thereon;

a transparent electrically conductive wire mesh anode spaced equidistantly from each of said cathode segments and having at least a portion thereof in a plane substantially parallel to said display, said anode being electrically connected to one of said conductors and having a mesh in the range of about 10 to 36 squares per inch and an oxide-covered wire in the

range of approximately 0.005 to 0.008 inch in diameter; and
means including a pair of insulator spacers attached to and upholding said support and said anode, said spacers being in a plane substantially normal to said support and separated thereby and one of said spacers being attached to and upheld by said conductors. 5

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