

[54] **SEGMENT TYPE DISPLAY TUBE FOR SELECTIVELY DISPLAYING ONE OR MORE OF A PLURALITY OF ALPHA-NUMERICAL CHARACTERS**

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[51] Int. Cl. **H01j 61/66**

[58] Field of Search..... **313/109.5, 210, 217; 315/169 TV**

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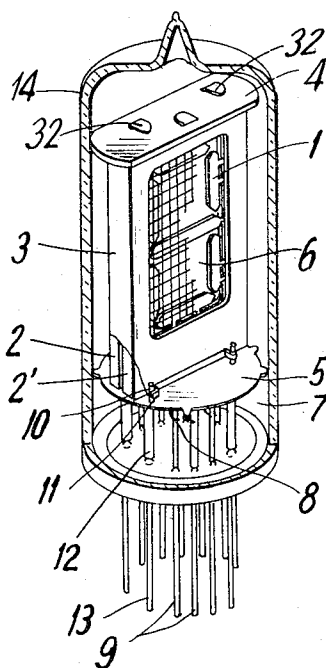
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[57] ABSTRACT

A display tube for use in displaying various characters comprises an electrode assembly sealed in a container. The electrode assembly has a first electrode and a set of character segment electrodes. The tube further comprises a first stem lead connected to the first electrode and a set of second stem leads connected to the set of character segment electrodes, respectively through a set of lead-wires. The set of lead-wires are secured to an insulator frame means defining an opening providing a discharge space so that the set of character segment electrodes may be arranged in one common plane in the opening. The lead-wires and second stem leads may integrally extend from the character segment electrodes.

6 Claims, 13 Drawing Figures



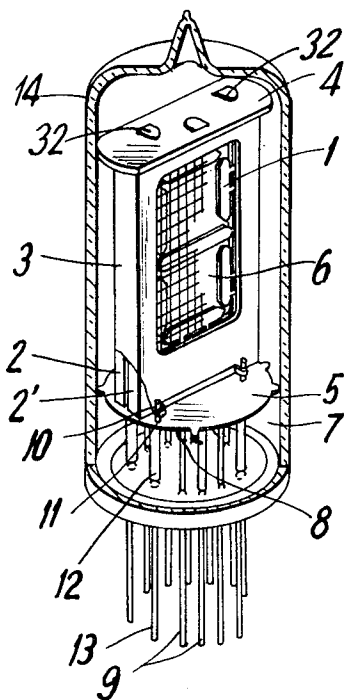


FIG. 1

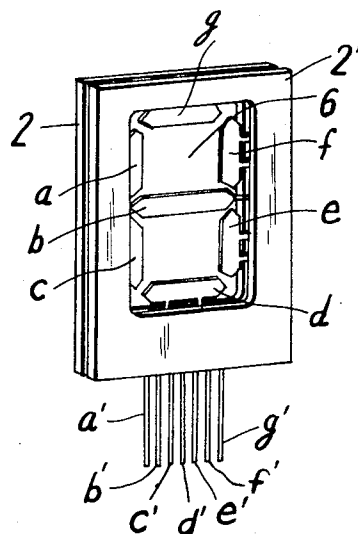


FIG. 2

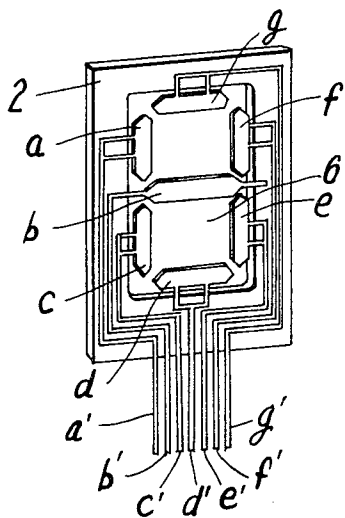


FIG. 3

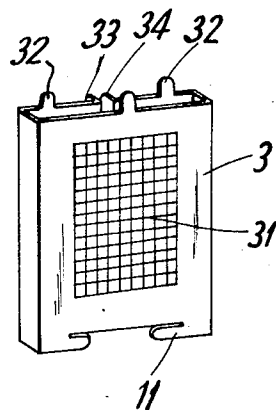


FIG. 4

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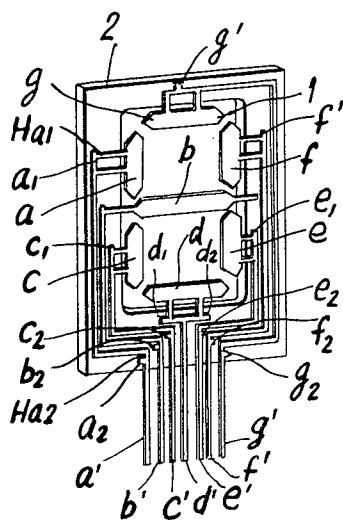


FIG. 5

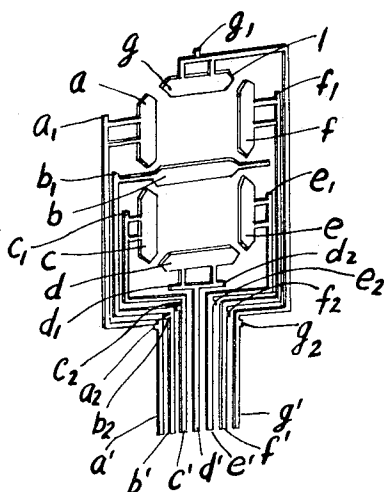


FIG. 6

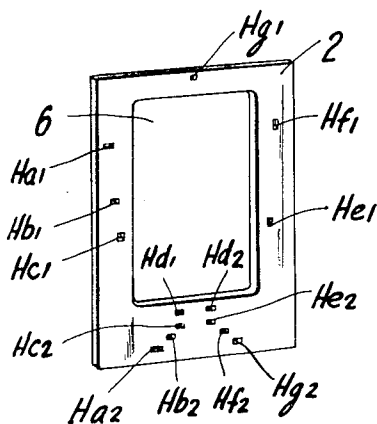


FIG. 7

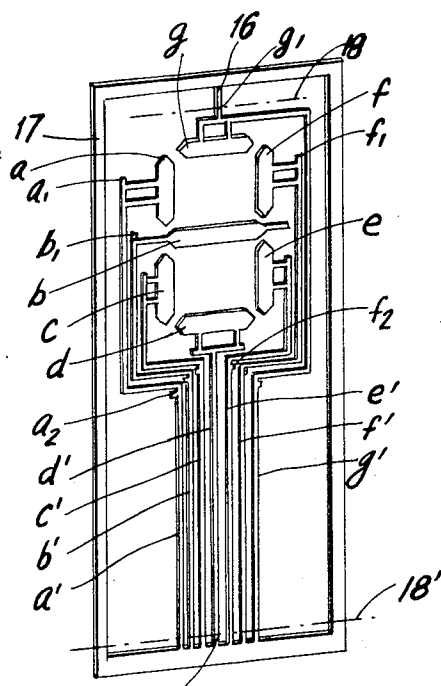


FIG. 8

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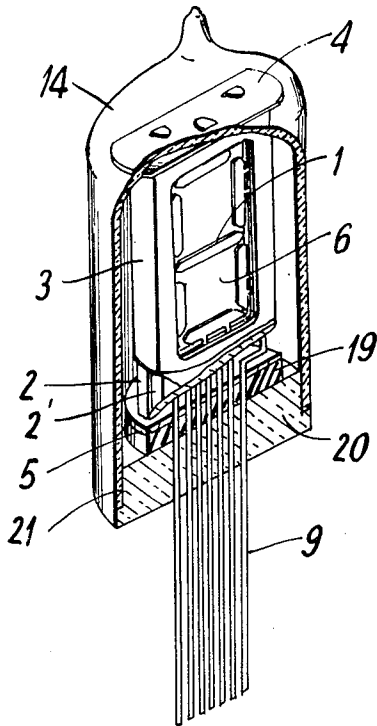


FIG. 9

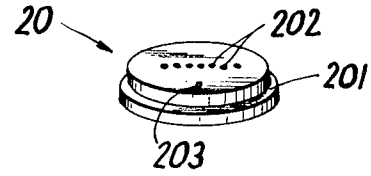


FIG. 10

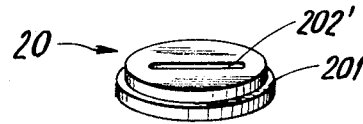


FIG. 11

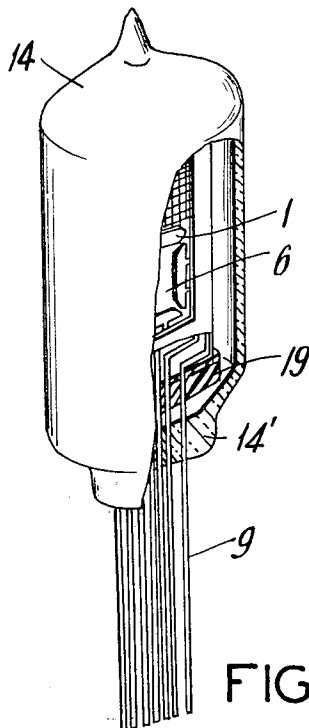


FIG. 12

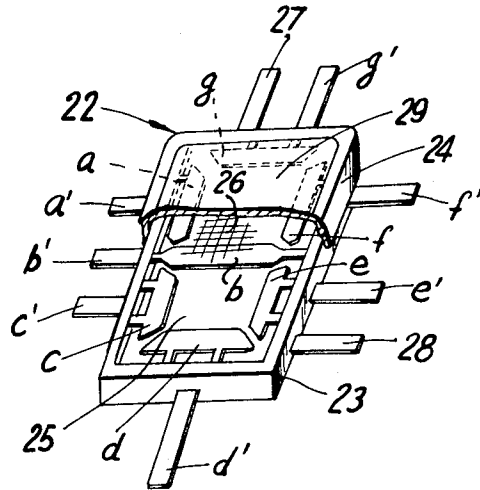


FIG. 13

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BACK GROUND OF THE INVENTION

This invention relates generally to a display tube used for the purpose of displaying an illuminated character or symbol, and more particularly to a discharge tube of the so called segment type wherein a plurality of segment electrodes are provided and various alpha-numeric characters or symbols can be displayed by illuminating selected ones of a set of segment character electrodes.

Display tubes for use in displaying an illuminated character or symbol such as those commonly employed in desk-top calculators and the like, may be broadly classified into three types in view of the illumination mechanism utilized in the operation of the tube. One type of tube employs the cathode glow of neon or a like gas, in which the characters are displayed by glowing cathode elements. Another type of display tube utilizes fluorescence, in which the characters are displayed by fluorescent anode segments subjected to the impingement of electrons emitted from a cathode. Still another type of display tube is a cathode ray tube.

The present invention will be described herein in conjunction with the glow type of display tubes, although it is equally well applicable to the fluorescent type. In addition display tubes may be also classified into two types in view of the formation of the electrodes as a display element representing various characters. One type of tube employs one or more electrodes as a display element, each of which has a shape of one of the desired characters, such as numerical digits, wherein a particular electrode is selectively energized to display a desired character. This display tube is referred to as a numerical display tube. The other type of display tube employs a plurality of electrodes or segment electrodes arranged in a common plane as a display element. In this tube the electrodes are not in the shape of any desired character, and a selected group of electrodes are simultaneously energized to display a desired character. This display tube is referred to as a segment type display tube.

In the numerical display tube, numerical digits or other symbols having natural shapes can be displayed, but, since a plurality of electrodes corresponding to respective characters are disposed at a distance from each other, the planes in which the respective characters are displayed are different. This difference is ordinarily a maximum of 5 millimeter and may create problems when a plurality of such display tubes are arranged in parallel.

In the segment type display tube, numerical digits or other symbols are displayed in abnormal shape because they are displayed by a combination of some of the segment electrodes. However, any symbol can be displayed in a common plane.

This invention relates to the segment type display tube.

In the known segment types display tube the, segment electrodes are retained on a common substrate made of an insulating material by mechanically fastening electrode plates on the substrate or by a forming electrodes on the substrate by metal evaporation or metal etching process. In the known segment type dis-

play tubes, the insulation between the segment electrodes is frequently significantly decreased due to spattering from each segment electrode, and the required number of parts and assembling processes are comparatively large.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a segment type display tube of simple construction and which is easily manufacturable.

It is another object of this invention to provide a segment type display tube wherein properties of the tube are not affected by spattering from segment electrodes.

It is still another object of this invention to provide a segment type display tube in which discharge other than between electrodes is prevented.

It is a further object of this invention to provide a segment type display tube in which connection between the stem leads or pins and the corresponding lead-wires of electrodes may be omitted.

To those ends the display tube of the invention comprises an electrode assembly sealed in a container. That assembly includes a first electrode and a set of segment electrodes arranged to display a desired character when voltage is applied between the first electrode and the selected segment electrode. The first electrode and the set of segment electrodes are connected to a first stem lead and a set of second stem leads, respectively, for applying the voltage between the first electrode and the selected one of the segment electrodes through the stem leads. A set of lead wires connects each set of segment electrodes to the corresponding one of the set of second stem leads, and an insulator frame has an opening for retaining the set of lead wires so that the set of segment electrodes is arranged in a common plane in that opening and the set of lead-wires extends through said frame means.

Further objects and features of this invention will be understood from the following detailed description relating to preferred embodiments of this invention with reference to the annexed drawings which:

BRIEF EXPLANATION OF THE DRAWING

FIG. 1 is a perspective of a character display tube according to an embodiment of this invention, the tube being partly cut away to better illustrate the construction;

FIG. 2 is a perspective of an assembly of segment electrodes used in the embodiment shown in FIG. 1;

FIG. 3 is a perspective illustrating the construction and arrangement of the segment electrodes in the assembly of FIG. 2;

FIG. 4 is a perspective of an electrode used in the embodiment shown in FIG. 1;

FIG. 5 is a perspective illustrating an alternative constructions and arrangement of segment electrodes of the assembly shown of 2;

FIG. 6 is a perspective of segment electrodes used in the assembly of FIG. 5;

FIG. 7 is a perspective of an insulator plate used in the assembly of FIG. 5;

FIG. 8 is a perspective view illustrating a method for fabricating the segment electrodes shown in FIG. 6;

FIG. 9 is a perspective in partial cross-section of another embodiment of the invention;

FIG. 10 is a perspective of a stem base used in the embodiment shown in FIG. 9;

FIG. 11 is a perspective of an shows another stem base for use in the embodiment shown in FIG. 9;

FIG. 12 is a perspective partially cut away of a further embodiment of the invention; and

FIG. 13 is a perspective partially cut away of a still further embodiment of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG. 1, which illustrates a perspective view of a display tube according to one embodiment of this invention, the display tube includes an electrode assembly which comprises a plurality of segment electrodes or cathode electrodes 1 arranged in common plane within a discharge space 6. Insulator plates 2 and 2', each of which has an opening for defining the discharge space retain the lead-wires of segment electrodes 1 therebetween. Insulator plates 2 and 2' may be advantageously made of mica, steatite, or any other suitable material. An anode electrode 3 is spaced from and insulated from the segment electrodes.

An insulator plate 4 is disposed on and secured to the top of the electrode assembly, and a shield plate 5 is disposed beneath and secured to the bottom of the electrode assembly to define a space 7. Insulator plate 4 and shield plate 5 are also advantageously fabricated of mica, steatite, or any other suitable material. A plurality of stem leads or pins 9 are connected respectively to the segment electrodes 1 and a stem lead or pin 13 is connected to the anode electrode 3.

The above described components are accommodated within a transparent airtight container 14, such as a glass container filled with gasses, such as argon, neon or the like, and a little mercury. The electrode assembly is retained at its position by the engagement between the inner surface of the container 14 and the edge portion of the insulator plate 4 and by the engagement between the inner surface of the container 14 and the edge portion of the shield plate 5.

The lead wire 8 of each of segment electrodes 1 is as described hereinafter, led between insulator plates 2 and 2' to the bottom of the electrode assembly and to the space 7 through openings formed in the shield plate 5. Lead wire 8 is connected in space 7 to an end portion of the corresponding stem lead or pin 9 which extends from the space 7 to the exterior of the container 14.

The anode electrode 3 has finger portions 11 cut-out from the anode electrode surface (FIG. 4), each of which is connected to the end portion 10 of the corresponding stem lead or pin 13 which extends from space 7 and the exterior of the container 14. The end portion 10 of the stem lead 13 is, in this embodiment, extends over the shield plate 5 and is connected to the finger portion 11 in a space where the electrode assembly is disposed.

The portion of each stem lead 13 which is connected to the anode electrode 3 and extends in the space 7 is covered with an insulator tube 12 so that the stem lead portion does not lie directly opposite to the portion of stem leads 9 in the space 7 and discharge is prevented in the space 7.

When a voltage is applied between the stem lead 13 and selected ones of stem leads 9, a set of segment electrodes 1 corresponding to the selected ones of the stem leads are illuminated so that the desired character is displayed. In order that the displayed character can be viewed and the discharge between the anode electrode 3 and cathode electrodes 1 can be readily effected, a

region of the anode electrode 3 covering the discharge space 6 is formed in mesh, as described hereinafter with reference to FIG. 4.

Referring to FIG. 2, in which an assembly of the segment electrodes 1 is illustrated in detail, that assembly is shown as including seven segment electrodes $a - g$, respectively connected to seven lead wires $a' - g'$ by means of parallel connecting legs extending perpendicular to their corresponding lead wires, and two insulator plates 2 and 2', each of which has a similar opening 6 which defines a discharge space. The segment electrodes $a - g$ extend into the discharge space 6 and are arranged in a common plane so that they assume the shape of a constituent part of one or more alphanumeric characters. The segment electrodes $a - g$ are maintained in their positions by the corresponding lead-wires $a' - g'$ which are connected to electrodes $a - g$ in the region between two insulator plates 2 and 2'.

Referring to FIG. 3, which illustrates the construction of the segment electrodes and lead-wires of the segment assembly shown in FIG. 2, on one surface of insulator plate 2 in which opening 6 is formed there are disposed seven segment electrodes $a - g$ and seven lead-wires $a' - g'$ which integrally extend from segment electrodes $a - g$, respectively at the border of insulator plate 2 that surrounds opening 6. The seven electrodes $a - g$ extend inwardly from the border of insulator plate 2 and are exposed in the opening 6.

The segment electrodes assembly as shown in FIG. 2 may be fabricated an insulator plate 2' (FIG. 2) having a similar construction as the insulator plate 2 in an overlying relationship with on the plate 2 so that the holding lead-wires $a' - g'$ are sandwiched between insulator plates 2 and 2'.

It should be noted that each of segment electrodes $a - g$ is arranged separately and insulated from each other and that, each of lead-wires $a' - g'$ is spaced and insulated from each other.

Referring to FIG. 4, in which an embodiment of the anode electrode 3 is illustrated, the anode electrode 3 is a conductive member having a rectangular shape in its cross-section. In the anode electrode 3 is fitted the segment electrode assembly shown in FIG. 2. A mesh region 31 is formed in one side of the rectangular hollow anode electrode 3 at a location corresponding to the opening or discharge space 6 so that the segment electrodes arranged in that space can be viewed through the mesh region.

Fingers 32 extend from an edge of one open end of the anode electrode 3, three of such fingers being provided as an example in the drawing, for securing the insulator plate 4 to the electrode assembly by insertion into corresponding holes provided in the insulator plate 4 (FIG. 1). Additional fingers are formed the at the edge of the other open end of the anode electrode 3 for connecting anode electrode 3 to corresponding stem leads or pins 13 (FIG. 1).

Anode electrode 3 may be made of one metal sheet by a photo-etching method or any other suitable fabricating method and may be bent into its shape during the operation of assembling the anode and the segment electrode assembly or prior to at assembling step.

After assembling the anode electrode 3 and the segment electrode assembly as shown in FIG. 2, both ends 33 and 34 of the metal sheet constituting the anode electrode may be connected and secured to each other

by an electric welding method or other suitable connecting method.

Thus it will be understood that the electrode assembly used in the embodiment shown in FIG. 1 may be easily manufactured.

Lead-wires $a' - g'$ may be secured to the inner border surface of at least one of the two insulator plates 2 and 2' by means of a suitable adhesive, for reliably maintaining the disposed positions of segment electrodes $a - g$. Alternatively, lead-wires $a' - g'$ may be mechanically secured to one insulator surface as will be described referring to FIGS. 5 - 7. Of course both of these securing means may be employed.

Referring to FIG. 5, in which an alternate construction of the segment electrode assembly is shown, and in which corresponding reference characters denote similar parts as in the embodiment of FIG. 3, the assembly is very similar to that shown in FIG. 3, except for the provision of projections $a_1, a_2; b_1, b_2; c_1, c_2; \dots; f_1, f_2$ and g_1, g_2 at the ends of respective lead-wires $a' - g'$ which are for securing respective lead-wires $a' - g'$ to insulator plate 2 by their insertion through corresponding holes or hollows provided in the insulator plate. as described more completely below with respect to FIG. 7.

FIG. 6 illustrates an arrangement of the segment electrodes and corresponding lead-wires used for the segment electrode assembly construction shown in FIG. 5. Each of lead-wires $a' - g'$ has two projections ($a_1, a_2; b_1, b_2; \dots; f_1, f_2$ and g_1, g_2) which are formed at separate positions thereof and which extend from each lead-wire in a common plane in which the lead-wires and segment electrodes lie.

FIG. 7 illustrates an insulator plate 2 having an opening 6 for defining a discharge space, which is used with the electrode assembly having the construction shown in FIG. 5. This plate 2 has a plurality of hollows or openings $Ha_1, Ha_2; Hb_1, Hb_2; \dots; Hf_1, Hf_2$ and Hg_1, Hg_2 , each of which corresponds to each of projections $a_1, a_2; \dots; f_1, f_2$ and g_1, g_2 as shown in FIG. 6.

When the segment electrodes and lead-wires shown in FIG. 6 are disposed on the insulator plate 2, each of projections $a_1 - g_2$ is bent in the perpendicular direction to the common plane on which all the segment electrodes and lead-wires are disposed, and are inserted into the corresponding one of hollows $Ha_1 - Hg_2$, respectively.

The length of each projection should be selected to be less than the thickness of the insulator plate.

As a result of this arrangement, each segment electrode is retained by friction between the surface of the projection and inner wall of the hole to thereby reliably retain the electrode assembly in position on the insulator plate.

By piling up another similar insulator plate 2' as in FIG. 2 on the insulator plate 2 the two insulator plates retain the lead-wires therebetween. Thus the construction of the segment electrode assembly shown in FIG. 5 is obtained, wherein the segment electrodes and the corresponding lead-wires are mechanically secured to the insulator plate 2, and are separately disposed in a common plane. The segment electrodes are exposed in an opening 6, and a segment electrode assembly as shown in FIG. 2 may be obtained.

If holes are provided in insulator plate 2 rather than the hollows, the length of each of the lead wire projections may be longer than the thickness of the plate 2.

In this case the end portion of each of the projections which is extended through the corresponding hole, is bent further so that each of the segment electrodes and lead-wires may be fastened to the insulator plate 2.

Since the ends portion of each projection is exposed at the rear side of the insulator plate 2, it will be easily understood that further insulator means (not shown) which cover these exposed ends, such as a insulator plate covering the rear surface of the plate 2, must be employed for providing the necessary insulation between these ends and the anode electrode, so that the segment electrode assembly having the construction shown in FIGS. 5 - 7 and the anode electrode as shown in FIG. 4 can be assembled.

The segment electrodes and lead-wires, which are used for the electrode assembly constructions as shown in FIG. 3 and FIGS. 5 and 6, may be made by various making method. FIG. 8 shows a perspective view of a set of segment electrodes and lead-wires, which are made from a sheet of metal plate by a photoetching or punching method. In FIG. 8, a set of segment electrodes $a - g$ and lead-wires $a' - g'$ which integrally extend from corresponding segment electrodes are made from a sheet of metal plate with their relative positions to be finally arranged. An end portion 15 of each of lead-wires $a' - g'$ and another suitable extending portion such as a portion 16 in are integrally connected to a common suspending frame 17 which surrounds the set of segment electrodes and lead-wires and is made from a sheet of common metal plate.

According to the construction shown in FIG. 8, a set of segment electrodes and lead-wires can be handled as a piece of a larger component, so that the assembly of the electrode assembly can be easily carried out.

By cutting frame 17 along chain lines 18 and 18' prior to, during or after assembling the segment electrode assembly as shown in FIG. 2, each of the segment electrodes having corresponding lead-wires integrally connected thereto can be separately obtained with maintaining a given relationship with respect to each other.

In FIG. 8 there is shown a set of segment electrodes having corresponding lead-wires which have projections $a_1, a_2; \dots; f_1, f_2$ and g_1, g_2 as may be adapted to the construction shown in FIGS. 5 and 6, but it will be easily understood that a set of segment electrodes having corresponding lead-wires to be adapted to the construction shown in FIG. 3 can be similarly made from a sheet of metal plate by a similar fabricating method.

FIG. 9 illustrates another embodiment of the invention, in which the same reference numerals denote similar parts as in the embodiment of FIG. 1.

The embodiment of FIG. 9 is similar to that shown in FIG. 1, except that each of lead-wires $a' - g'$ of segment electrodes $a - g$ (represented by reference numeral 1 in the drawing) integrally extends out of the tube through shield plate 5, as well as through a spacer 19 and stem base 20 having a ringed stage 201 to provide a stem lead for the connection of the display tube to an external circuit. Spacer 19 is provided between the shield plate 5 and the stem base 20 to space and maintain insulation between lead-wires $a' - g'$.

In this embodiment, the segment electrode assembly as shown in FIGS. 2, 3, 5, 6 and 7 and the anode electrode as shown in FIG. 4 can be employed. The stem lead connecting to the anode electrode 3 is omitted in the drawing to simplify the drawing. It will be obvious

by that the anode electrode and the stem lead connecting to the anode electrode are similarly constructed as the embodiment in FIG. 1. But it should be noted that the length of each of lead-wires $a' - g'$ is longer than the segment electrode assembly employed in the embodiment shown in FIG. 1.

Furthermore the fabrication method described referring to FIG. 8 is also employed to make a set of segment electrodes having corresponding lead-wires including stem-leads used in this embodiment.

According to this embodiment, there is no particular process for forming the connection between each lead-wire and the corresponding stem lead or pin, so that the assembling process is greatly simplified.

The stem base 20 is made of glass or other suitable insulating material and has a construction as shown in FIG. 10 or FIG. 11.

Referring to FIG. 10, the stem base 20 is a circular plate having ringed stage 201 formed along its ringed edge. A row of holes 202 which correspond to location of stem leads 9 is formed in stage 201 along with a hole 203 which corresponds to the stem lead (not shown) for connection to the anode electrode.

The construction of the stem base 20 illustrated in FIG. 11 has one slot 202' formed in stage 201 rather than a row of holes 202 in the construction of FIG. 10.

The stem base 20, as shown in FIG. 10 or FIG. 11, is inserted into the open end of container 14 and is sealed with a suitable sealing agent as a glass or the like between the ringed outer surface of the stem base and the corresponding surface of the container at 21 (FIG. 9). Stem leads 9 or lead-wires $a' - g'$ pass through corresponding holes 202 or slot 202' to extend out of container 14 and are sealed to the stem base 20 with a suitable sealing material.

The spacer 19 may be omitted in the case that each of lead-wires 9 (or $a' - g'$) can be maintained at the desired space from each other, and electrically insulated each other by the use of a particular stem base, such as the one shown in FIG. 10.

If the material employed for the lead-wires and segment electrodes is one which can be directly sealed to the container, the stem base may not be employed and the lead-wires may be directly sealed to the bottom of the container.

The embodiment of the invention is similar to the embodiment shown in FIG. 9 except that in FIG. 12 the stem base is not employed and lead-wires $a' - g'$ or stem leads 9 are directly sealed to the bottom 14' of the container 14. In all other respects this embodiment is identical to that shown in FIG. 9 so that no further description of the embodiment of FIG. 12 is provided herein.

In the above described embodiments of the invention, stem-leads $a' - g'$ have been arranged so that, they extend from one end of the electrode assembly so as to be adapted to the discharge tube wherein the stem leads or pins are disposed at one particular region of the container. But it will be clear that the lead-wires may respectively extend in different direction from the electrode assembly.

FIG. 13 shows a perspective view of a still further embodiment of the invention, which comprises a container 22 consisting of a half-box 23 and a corresponding lid 24. A set of segment electrodes $a - g$ is arranged in a common plane within a space 25 in box 23, and a mesh anode 26 is arranged in space 25 so that the mesh

anode 26 is spaced from the set of segment electrodes $a - g$ and stem leads $a' - g'$, 27 and 28 which are secured and sealed to the box 23. Each of segment electrodes $a - g$ is connected to a corresponding one of stem leads $a' - g'$ by a lead-wire which extends through and is secured to the wall of the box, so that each of segment electrodes $a - g$ is supported by the lead-wire to be retained at its position in the space 25. The mesh grid 26 is also supported by lead-wires connecting the grid to stem-leads 27, 28 and passing through and sealed to the wall of the box 23.

The lid 24 is sealed to the box 23 to make an airtight container. At least one region 29 of the lid of this airtight container is made of a transparent material, such as a glass so that the displayed character can be viewed through the transparent region 29.

In this construction, if each electrode, corresponding lead-wire and stem lead may be formed integrally, for example, they are formed integrally from one sheet of metal plate by a photo-etching or punching method, this display tube can be more easily manufactured.

This invention has been described relating to specific embodiments thereof for simplification of explanation, but those embodiments do not limit this invention. It will be clearly understood that various other designations and modifications are possible within the scope of this invention. For example, this invention is equally applicable to a display tube employing other number of segment electrodes and other arrangements of segment electrodes than in the specifically described embodiments.

What we claim is:

1. In a display tube for selectively displaying one or more of a plurality of characters comprising a container transparent at at least a portion thereof, an electrode assembly sealed in said container, said electrode assembly having a first electrode and at least one set of segment electrodes, a first stem lead connected to said first electrode through a lead wire, and a set of second stem leads respectively connected to said set of segment electrodes, said set of segment electrodes being arranged in a common plane to display a desired one of said characters by electric discharge produced therebetween by a voltage applied between said first stem lead and at least a selected one of said second stem leads, said container containing a gas for sustaining said discharge, the improvement which comprises: first and second insulator plates each having a similar opening for permitting the viewing of said set of segment electrodes and being stacked one upon the other to define a discharge space, said insulator plates retaining said second stem leads therebetween so that said segment electrodes are arranged in said common plane in said discharge space together with said second lead wires, said first electrode being formed of one sheet of metal plate and having a mesh region and holding said insulator plates in the stacked position with said mesh region in substantial registration with said space, each of said segment electrodes and a corresponding one of said second stem leads being integrally formed.

2. The display tube claimed in claim 1, wherein each of said lead wires integrally formed with the corresponding ones of said segment electrodes has at least one finger means extending therefrom, and at least one of said first and second insulator plates having corresponding hollows formed therein for receiving said fin-

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ger means to thereby fasten each of said lead wires to said one of said first and second insulator plates.

3. The display tube claimed in claim 1, wherein each of said segment electrodes, the corresponding one of said lead wires, and the corresponding one of said second stem leads are integrally formed.

4. The display tube claimed in claim 3, wherein said tube further comprises spacer means made of an insulator material for providing insulation between said stem leads and for maintaining said stem leads at their positions.

5. The display tube claimed in claim 1, wherein said

insulator frame means consists of one portion of the wall of said container, a portion of an inner space of said container providing said opening, said lead wires extending through and being sealed to said one wall portion of said container, said segment electrodes being arranged in one common plane in said wall portion of said container.

6. The display tube claimed in claim 5, wherein each of said segment electrodes, the corresponding one of said lead wires, and the corresponding one of said second stem leads are integrally formed.

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