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GASEOUS COLD CATHODE INDICATOR TUBE HAVING A SEGMENTED ELECTRODE AND AN INSULATING SHIELD PLATE

Filed May 20, 1963 2 Sheets-Sheet 1

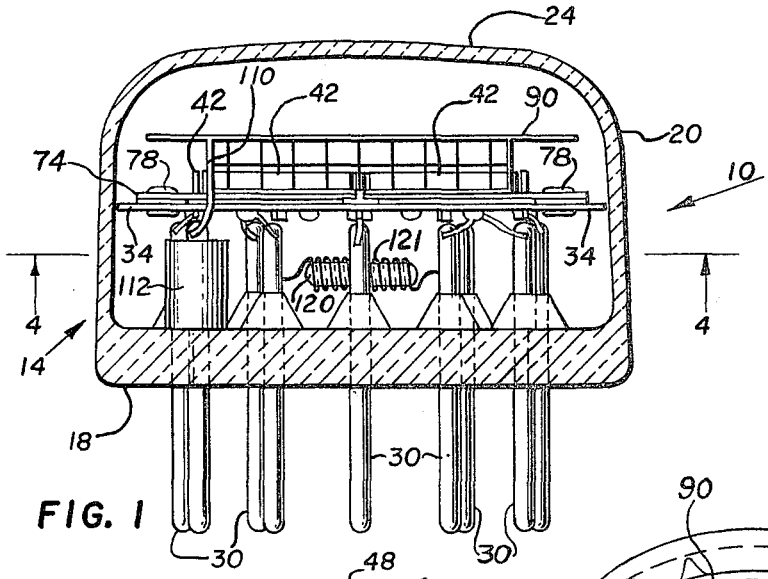

FIG. 1

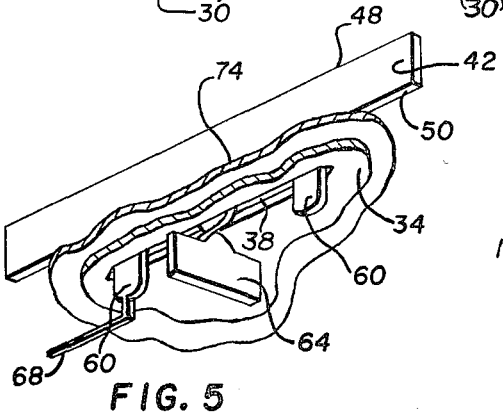

FIG. 5

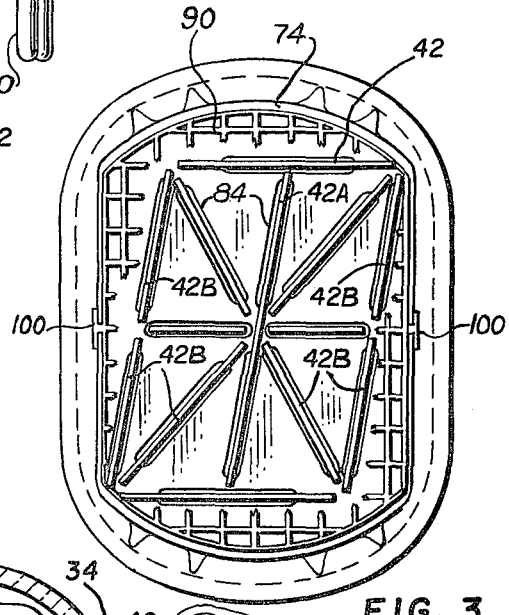

FIG. 3

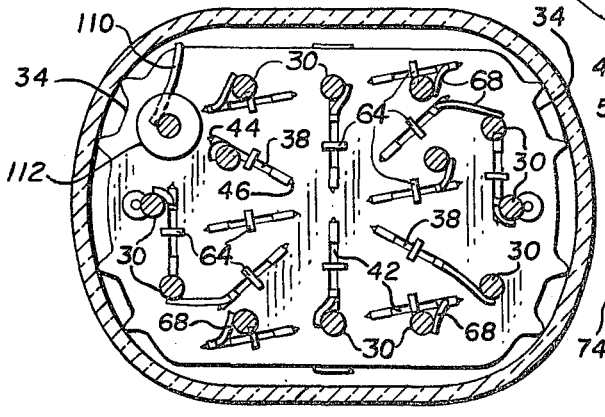

FIG. 4

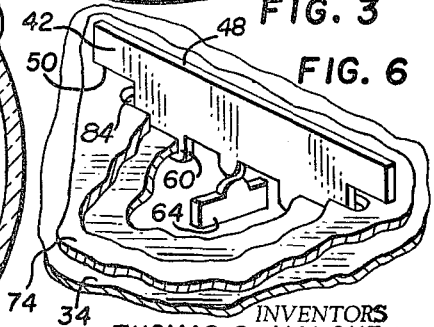

FIG. 6

INVENTORS
THOMAS C. MALONEY
JAMES T. BOYER
BY
Robert A. Green
ATTORNEY

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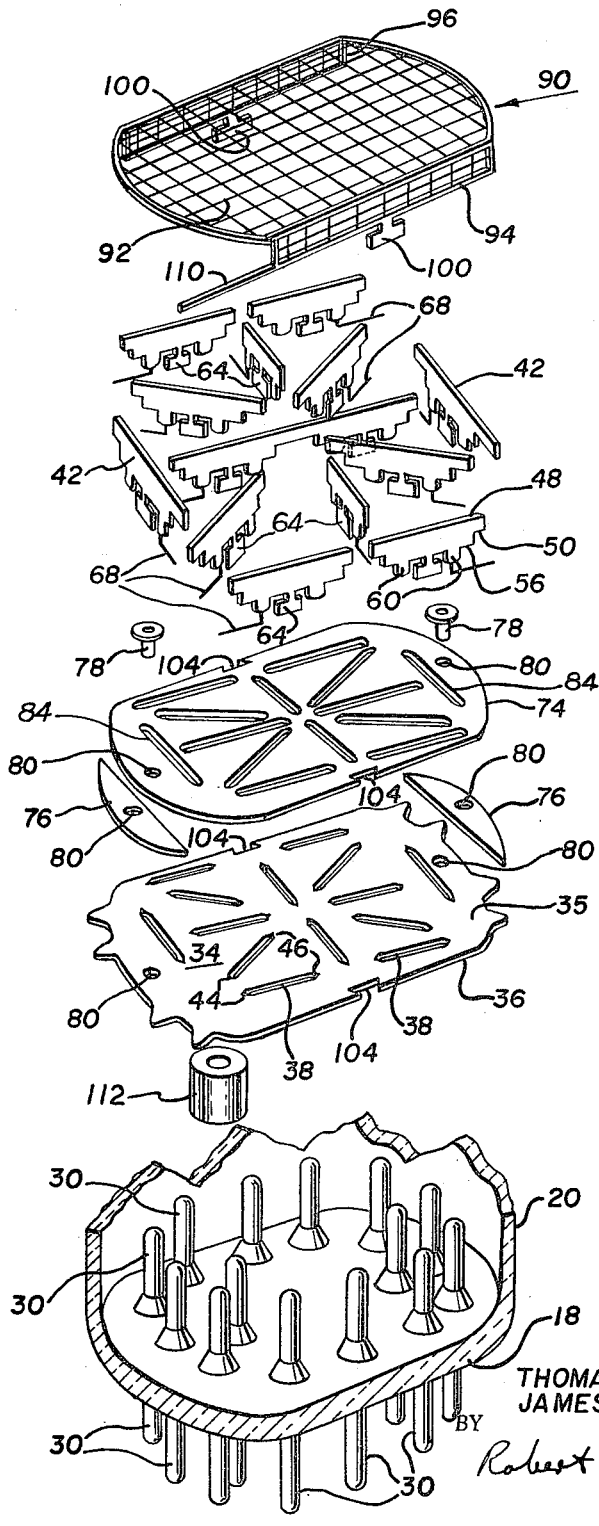
FIG. 2



INVENTORS
THOMAS C. MALONEY
JAMES T. BOYER

BY Robert A. Green

ATTORNEY

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GASEOUS COLD CATHODE INDICATOR TUBE HAVING A SEGMENTED ELECTRODE AND AN INSULATING SHIELD PLATE

Thomas C. Maloney, Bernardsville, and James Thomas Boyer, Plainfield, N.J., assignors to Burroughs Corporation, Detroit, Mich., a corporation of Michigan

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This invention relates to gaseous cold cathode indicator tubes and, particularly, to tubes of the type using groups of cathode segments for providing character representation.

In segmented tubes of this type, each character is displayed by electrically connecting and igniting different combinations of cathode segments. This system of forming characters is well known, and, in fact, several types of electronic display devices have been devised which utilize combinations of segments to provide displays of different characters. But such devices have not achieved commercial success for one reason or another. For example, some prior art devices are not sufficiently bright, or, if they provide sufficient light output, they may be relatively complex and expensive. However, all of these devices are subject to the criticism that the light produced by each of the several segments which make up a character does not blend smoothly with the light produced by other segments, and a smooth, continuous, glowing character is not achieved.

In addition, in order to obtain a character of some size, and to achieve some blending of segment light, known devices generally utilize individual segments of unusual shape so that the characters produced have an abnormal appearance. In addition, because of their unusual shape, all characters do not have the same height and width, and a message display which includes a large number of characters has an unesthetic and disturbing appearance to the viewer. It has been found, also, that unusually shaped display segments generally do not produce uniform glow over their entire lengths, particularly in cold cathode glow tubes.

Accordingly, the principles and objects of the present invention concern the provision of an improved cold cathode segment-type indicator tube.

Briefly, an indicator tube embodying the invention includes a gas-filled envelope which contains an electrode assembly constructed according to the invention. The electrode assembly includes a first insulating base plate which is provided with a plurality of apertures in which glow cathode segments are mounted. The cathode segments are thin, flat metal strips, and they are mounted on edge in the insulating base plate. Each cathode segment includes a pair of ears, which are inserted in an aperture in the base plate and prevent the cathode from moving laterally in its aperture, and a locking tab, which prevents the cathode from being removed from its aperture in the base plate. An insulating shield plate, having apertures corresponding to and aligned with those in the insulating base plate, is positioned above and spaced from the insulating base plate, with its apertures surrounding the associated cathodes. The shield plate is provided primarily to prevent the deposition of sputtered cathode metal on the base plate and to prevent the formation of leakage paths between adjacent cathode segments due to sputtered metal. The electrode assembly also includes a metal screen which lies between the cathode segments and the tube envelope and serves as an anode and as a trap for sputtered cathode metal.

In the drawings:

FIG. 1 is an elevational view, partly in section, of a tube embodying the invention;

FIG. 2 is an exploded view of the tube of FIG. 1;

FIG. 3 is a plan view, partly cut away, of the tube of FIG. 1;

FIG. 4 is a sectional view along the line 4—4 in FIG. 3;

FIG. 5 is a perspective view, partly in section, of a portion of the tube of FIG. 1; and

FIG. 6 is a perspective view, partly in section, of another portion of the tube of FIG. 1.

Referring to the drawings, a gaseous cold cathode indicator glow tube **10** includes an envelope **14**, of glass or the like, which comprises a base or stem **18** and a bulb **20**. The bulb **20** includes a transparent portion **24** which serves as a viewing window. The stem **18** carries a plurality of conductive pins **30**, by which the tube electrodes are connected to external circuit elements. In the completed tube, the envelope is filled with a suitable cathode glow supporting gas such as neon, argon, or the like, and if desired, a quantity of mercury or other heavy, vaporizable substance.

The electrode assembly which is mounted inside the tube envelope includes (FIG. 2) an insulating base plate **34**, of mica or the like, having a top surface **35** and bottom surface **36**. The base plate is generally rectangular in shape and is provided with a plurality of apertures **38** which are arrayed in a pattern corresponding to that in which the cathode electrode segments **42** are to be arrayed. The apertures **38** are narrow, elongated slits which are generally rectangular in shape but have pointed or otherwise constricted ends **44** and **46**. The apertures **38** are adapted to receive the cathode electrodes **42**, and the constricted ends of the apertures serve to lock the cathodes in position in a manner to be described below.

The electrode assembly may include any desired number of cathode electrodes **42**, depending generally on the size of the assembly. In the form of the invention described and illustrated, thirteen separate cathode electrodes are provided, oriented as shown, and adapted to be connected in different combinations to display numerals zero to nine and several letters of the alphabet. The cathodes all lie in a common stratum.

The cathode segments **42** are thin, flat metal strips which have considerably greater width than thickness. Each segment includes a top edge **48** and a bottom edge **50**. The bottom edge of each cathode segment includes a raised shoulder portion **56** from which a pair of spaced-apart locking tabs **60** extend. An auxiliary locking tab **64** is provided between the locking tabs **60**. A cathode connecting lead **68** extends from one of the locking tabs of each cathode. Since each cathode segment is not necessarily of the same length as every other and since each may have its own space requirement when mounted in an aperture **38** in base plate **34**, the location of shoulder **56** and tabs **60** and **64** along the length of the cathode may vary for each cathode segment.

The cathodes **42** are mounted on edge on base plate **34**, with the shoulders **56** bearing against the top surface **35** of the plate and with the locking tabs **60** and **64** projecting into the appropriate aperture in the insulating base plate **34**. The locking tabs **60** are wedged into the pointed ends **44** and **46** of the aperture, and thus lend rigidity to the cathode mounting and prevent the cathodes from moving laterally with respect to the insulating plate **34**. The auxiliary locking tab **64** is twisted so that it lies perpendicular to the main body of the cathode, bears against the bottom surface **36** of the base plate **34**, and locks the cathode in position on the base plate so that it cannot be pulled or shaken out of its aperture. The connecting lead **68** of each cathode is welded or soldered to a tube pin **30**, whereby external connection may be made to each separate cathode segment.

Under some circumstances, which may be determined by the nature of the gas filling of the tube **10**, by the cathode materials, and/or by the method of processing the tube, cathode sputtering may occur, either generally during tube operation and/or during the processing of the tube. Under some circumstances, sputtered cathode metal may deposit on the insulating base plate and may glow, and, under extreme conditions, paths of metal may form on plate **34** between adjacent cathode segments **42** to render the tube inoperative. In order to prevent sputtered cathode metal from adversely affecting the operation of the tube, an insulating shield **74**, of mica or the like, is provided in the electrode assembly. The shield **74** is in the form of a thin plate, comparable in size and shape to base plate **34**, and it is positioned above the top surface of the base plate **34**. The shield is maintained spaced from the base plate by means of insulating spacer plates **76**, of ceramic or the like, positioned between adjacent ends of the shield and base plate. Fastening means such as rivets or eyelets **78** are secured in apertures **80** in the shield **74**, spacers **76**, and base plate **34**, and thus hold these three parts together in a unitary assembly.

The shield **74** is also spaced from and is nowhere in contact with any of the cathode segments. To this end, the shield is provided with elongated apertures **84** which correspond in number, shape, and location to the apertures **38** in the base plate **34**. However, the apertures **84** in the shield are of such a size that their borders do not touch, but surround (FIGS. 3 and 6), the cathode segments and are larger than the apertures in the base plate. In addition, the parts are so arrayed that the bottom surface **50** of the end portions of each cathode are spaced from the top surface of shield **74**. With this arrangement, the base plate **34** is shielded sufficiently from the cathode segments to prevent any significant deposition of sputtered metal on the base plate **34**, and the cathode segments are also shielded from each other so that continuous conductive paths of sputtered metal cannot form between adjacent cathode segments. Such continuous paths would render the tube **10** inoperative.

The electrode assembly of tube **10** also includes a mesh screen electrode **90** which acts as a trap for sputtered cathode metal and which is also adapted to be used as the tube anode. The screen includes a planar portion **92** which has a size and shape comparable to the size and shape of plates **34** and **74** and is adapted to overlie all of the cathode elements and shield them from other portions of the tube, particularly the viewing window. The portion **92** of screen **90** is spaced from the cathodes and lies between the cathodes and the viewing window. The screen **90** also includes two side portions **94** and **96** which depend from the long opposite edges of the large-area portion **92**, and the lower edges of the side portions carry one or more locking tabs **100** which engage notches **104** in the insulating base plate **34** and thereby hold the screen **90** in position. The screen also includes a connecting lead **110** which is welded to a tube pin **30'** so that electrical potentials may be applied to it for operation as an anode. The pin **30'** carries an insulating sleeve **112** to prevent any of the pins **30** from glowing during tube operation.

The entire electrode assembly may be supported by the tube pins, or the assembly may be supported rigidly above the pins by means of the cathode and anode leads **68** and **110** which are welded to the pins **30**.

The completed tube includes a cathode glow supporting gas such as neon or argon, and, in addition, a small quantity of heavy weight substance such as mercury to substantially prevent cathode sputtering when the tube is in operation. The mercury may be introduced into tube **10** in any suitable fashion. For example, a glass tube **120** containing a pellet of mercury and surrounded by a heating wire **121** may be mounted within the tube envelope, with wire **121** secured to two tube pins **30**,

which are provided for that purpose. The tube **120** may be fractured by passing a heating current through wire **121** at a selected time to free the mercury and allow it to mix with the gas in the envelope. The mercury might also be provided in an amalgam from which it could be released by induction heating.

In operation of tube **10**, a positive potential is applied to the anode screen **90**, and a negative potential is applied to selected ones of the cathode segments, depending upon the character to be displayed. For example, if it is desired to display the letter "I" or numeral "1," then cathode segment **42A** is energized. If the letter "W" is to be displayed, then cathode segments **42B** are energized. By thus combining selected cathode segments and applying proper potentials to cause them to glow, various characters may be displayed.

In one manufactured embodiment of tube **10**, each cathode segment was made of stainless steel ribbon having a thickness of about 6 mils, with the height of each segment above the top surface of disk **34** being about 60 mils. In order to obtain smooth blending of glow between adjacent cathode segments, adjacent ends of cathodes were positioned about 10 to 15 mils apart.

The present invention has many advantages over the prior art. One important advantage is that, even though most of the characters which can be displayed are made up of a plurality of straight-line segments, each character has an appearance which is quite normal and quite similar to the appearance to which the average viewer is accustomed. Another advantage, which arises from the fact that the cathodes are mounted on edge, lies in the fact that the adjacent ends of adjacent cathodes may be brought sufficiently close together so that, when two adjacent cathodes glow, the areas of glow at adjacent ends merge and provide uniform, continuous glow from one segment to another. This contributes to the normal appearance of a character. In addition, since the cathodes are mounted on edge and have their narrow viewing edges facing and relatively close to the anode with which cathodes operate, it is likely that cathode breakdown and cathode glow are facilitated.

What is claimed is:

1. A gaseous cold cathode glow tube including

an envelope having a viewing window,

a gaseous atmosphere within the envelope including an ionizable gas at a pressure capable of sustaining cathode glow,

an anode electrode,

a plurality of flat ribbon-like cathode electrodes mounted in said envelope,

said cathodes having considerably greater width than thickness,

an insulating support plate supporting each of said cathode electrodes from one edge with the opposite edge facing said viewing window so that the glowing edge of a cathode may be viewed,

support means securing each cathode electrode to said support plate,

said cathode electrodes being oriented in a pattern so that selected ones thereof may be connected together to glow as a unit having a desired character representation,

the ends of said cathode electrodes being positioned closely adjacent to each other so that although each cathode is spaced from the one adjacent to it, when two adjacent cathodes are electrically connected and properly energized, the glow of one cathode merges with the glow of the adjacent cathode to give the appearance of a single glowing electrode, and

shield means positioned between the glowing edge of each of said cathodes and said support plate to limit the deposition of sputtered cathode material on said support plate,

said shield means comprising a plate spaced from said support plate and including apertures through which

said support members pass without touching said shield means.

2. The tube defined in claim 1 and including a fine mesh screen positioned between said cathodes and said viewing window as a trap for sputtered cathode material.

3. A gaseous cold cathode glow tube including

an envelope having a viewing window,

a plurality of cathode electrodes lying in a common stratum within said envelope for viewing through said viewing window,

said cathodes comprising metallic strips having considerably greater width than thickness;

an insulating base plate supporting each of said cathode electrodes from one edge with the opposite edge of each cathode facing said viewing window so that the glowing edge of a cathode is viewed when a cathode glows,

each cathode and said base plate having cooperating means for locking each cathode in position on said base plate,

a shield plate including means spaced from each cathode electrode and shielding said base plate from said cathodes whereby sputtered cathode material is substantially prevented from depositing on said base plate,

and a mesh screen anode overlying and enclosing said cathode electrode and lying in operative relation with each cathode.

4. A gaseous cold cathode glow tube including

an envelope having a viewing window,

a plurality of cathode electrode segments lying in the same stratum,

each said cathode segment comprising a metallic strip having considerably greater width than thickness and having attached support means,

an insulating base plate for supporting each of said cathode electrodes from one edge with the opposite edge of each cathode facing said viewing window so that the glowing edge of a cathode is viewed when a cathode glows,

said base plate having a plurality of apertures for receiving the support means attached to said cathode segments,

each support means comprising a plurality of tabs on one edge of a cathode segment for insertion into said apertures in said base plate,

a shield plate including means spaced from each cathode segment and its support-means and shielding said base plate from said cathodes whereby sputtered cathode material is substantially prevented from depositing on said base plate,

and a mesh screen anode overlying and enclosing said cathode segments and lying in operative relation with each cathode.

5. A gaseous cold cathode glow tube including

an envelope having a viewing window,

a plurality of cathode electrode segments lying in the same stratum,

each said cathode segment comprising a metallic strip having considerably greater width than thickness and having attached support means,

an insulating base plate for supporting each of said cathode electrodes from one edge with the opposite edge of each cathode facing said viewing window so that the glowing edge of a cathode is viewed when a cathode glows,

said base plate having a plurality of apertures for receiving the support means attached to said cathode segments,

each support means comprising a pair of tabs on one edge of a cathode segment for insertion into said apertures in said base plate to prevent lateral movement of the cathode and a locking tab which engages said base plate and prevents the cathode from being removed from its aperture in the base plate,

a shield plate including means spaced from each cathode segment and its support means and shielding said base plate from said cathodes whereby sputtered cathode material is substantially prevented from depositing on said base plate,

and a mesh screen anode overlying and enclosing said cathode segments and lying in operative relation with each cathode.

6. The tube defined in claim 5 wherein the apertures in the base plate are generally rectangular in form and have their ends constricted, the pair of tabs of each cathode being spaced apart and engaging the constricted ends of an aperture and the locking tab being positioned to engage the base plate to prevent the cathode from being pulled out of the aperture.

7. The tube defined in claim 5 wherein the apertures in the base plate are generally rectangular in form and have their ends constricted, the pair of tabs of each cathode being spaced apart and engaging the constricted ends of an aperture and the locking tab being positioned between said tabs and being twisted transversely to the long axis of the aperture to engage the base plate to prevent the cathode from being pulled out of the aperture.

8. The tube defined in claim 5 wherein said anode includes a first large-area portion which lies between said cathodes and said viewing window and parallel to said cathodes, said anode also including side portions which extend downwardly from said large-area portion and engage said base plate whereby said anode is held in place.

9. The tube defined in claim 5 wherein said anode includes a first large-area portion which lies between said cathodes and said viewing window and parallel to said cathodes, said anode also including side portions which extend downwardly from said large-area portion, said side portions having locking tabs which engage said base plate whereby said anode is held in place.

10. The tube defined in claim 5 wherein insulating spacers are provided between said base plate and said shield plate and a fastener is provided to secure said plate, said spacer, and said shield in a unitary assembly.

11. The tube defined in claim 5 wherein insulating spacers are provided between said base plate and said shield adjacent opposite ends thereof and a fastener is provided threaded therethrough to secure said plate, said spacer, and said shield locked together in a unitary assembly.

12. A gaseous cold cathode glow tube including

an envelope having a viewing window,

an ionizable gas in said envelope for sustaining cathode glow,

a plurality of cathode electrodes lying in a common stratum within said envelope for viewing through said viewing window,

said cathode electrodes comprising elongated metallic members,

an anode electrode in operative relation with said cathode eectrodes,

an insuating base pate supporting each of said cathode electrodes facing said viewing window so that the glowing length of a cathode is viewed when a cathode glows,

each cathode and said base plate having cooperating means for locking each cathode in position on said base plate, and

a shield plate of insulating material positioned between said cathodes and said base plate and shielding said base plate from said cathodes whereby sputtered cathode material is substantially prevented from depositing on said base plate,

said shield plate having apertures through which said cooperating means extends between said cathodes and said base plate without coming in contact with said shield plate.

13. A gaseous cold cathode glow tube including

an envelope having a viewing window,

a gaseous atmosphere within the envelope including an ionizable gas at a pressure capable of sustaining cathode glow,

a plurality of elongated cathode electrodes mounted in said envelope to have a lengthwise viewing surface facing said viewing window, the viewing surfaces of said cathodes lying in a common plane,

an anode electrode in the envelope positioned in operative relation with said cathode electrodes,

a base member of insulating material having a continuous surface,

a plurality of support members supporting the cathodes from the base member, each of the cathodes being supported at least at one point by one of said support members,

a plurality of conductive leads each connected to one of the cathodes for selectively energizing the cathodes and producing a cathode glow at least along the viewing surface thereof, and

a shield member of insulating material disposed generally parallel to the base member and lying between the viewing surfaces of the cathodes and the base member, the shield member having a plurality of spaced-apart apertures, each of which is aligned with one of the support members, the sizes of the apertures being larger than the cross-section of the respective support members and being in registry with the support members such that the support members pass through the apertures without touching the edges thereof, whereby the shield member is at all points spaced from the support members and does not form a continuous surface between any two such members, the spaces between the shield member and the support members containing only the gaseous atmosphere,

the shield member also being spaced from the base member and the cathodes, and serving to intercept sputtered material from the glowing portions of the cathodes to prevent the formation of a continuous conductive path of sputtered material along the surface of the base member and electrical short circuits between two or more of the support members.

14. A cold cathode glow tube in accordance with claim 13 wherein the support members are made of conductive material and their conductive surfaces are exposed.

15. A cold cathode glow tube in accordance with claim 13 wherein the support members lie closely adjacent to the edges of the apertures in said shield member.

16. A cold cathode glow indicator lamp in accordance with claim 13 wherein the cathodes are arranged in the pattern of a character and selective groups are energizable to display different glow characters, and have contiguous portions so that the glow characters are uninterrupted.

17. A cold cathode glow indicator lamp in accordance with claim 13 characterized by at least one spacer interposed between the shield member and the base member.

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R. JUDD, *Assistant Examiner.*

GEORGE N. WESTBY, *Examiner.*

JAMES W. LAWRENCE, *Primary Examiner.*