Oct. 10, 1967 A. J. HARDWICK 3,346,759

PLANAR ARRAY OF CATHODE AND ANODE ELECTRODES INSTALLED IN CHANNELS FOR VISUAL INDICATOR DISPLAY DEVICE

Filed Aug. 31, 1965

FIG. 1

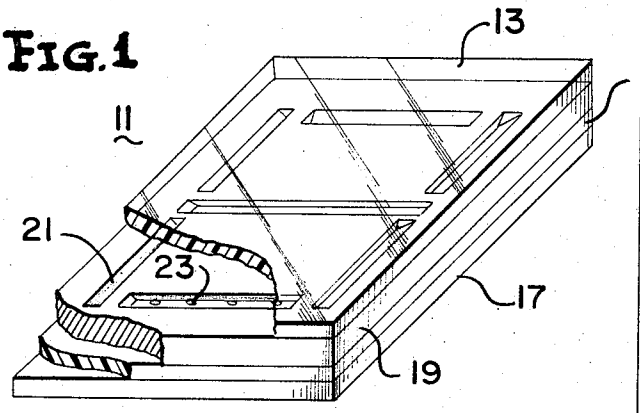


FIG. 2a

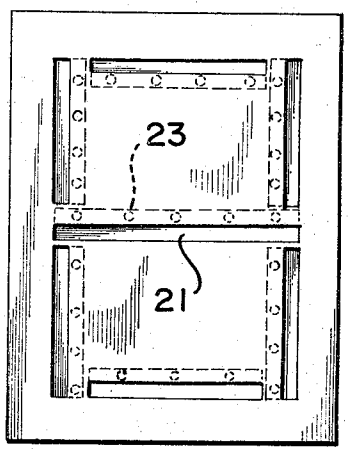


FIG. 2b

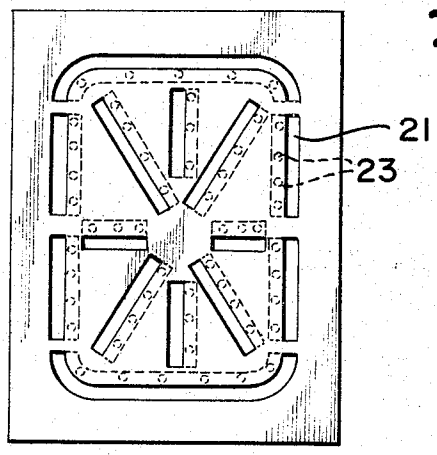


FIG. 3a

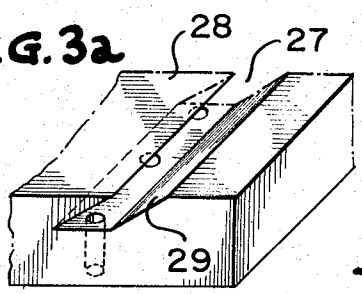


FIG. 3b

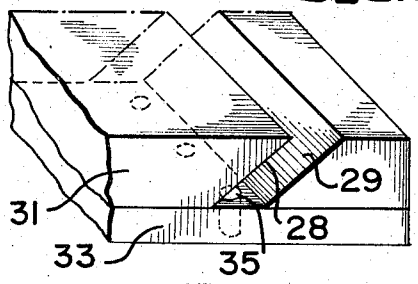


FIG. 4a

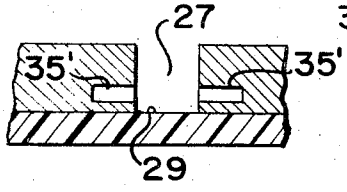


FIG. 4b

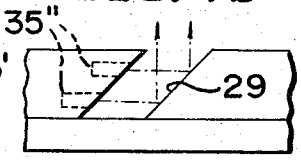
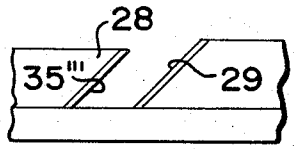


FIG. 4c



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PLANAR ARRAY OF CATHODE AND ANODE ELECTRODES INSTALLED IN CHANNELS FOR VISUAL INDICATOR DISPLAY DEVICE

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13 Claims. (Cl. 313—109.5)

ABSTRACT OF THE DISCLOSURE

The invention is an improved gaseous glow indicator display device comprising a planar array of selectively energizible display cathode electrodes and associated anode electrodes installed in channels of an insulating block. The channels have wall portions extending oblique or inclined to the display plane of the device. The anode elements are positioned on wall surfaces normally concealed from view. Cathode elements are positioned on wall surfaces of the channels to be clearly visible. When energized, the cathode and anode elements cooperate to cause unobstructed glow of the gas between the cathode surface and the face of the tube confronting the viewer.

This invention relates to an indicator display device and more particularly to an improved indicator display device having a planar array of selectively energizable, segmented display cathode electrodes and a plurality of juxtapositioned hidden anode electrodes.

The present invention is in the family of display tubes which are known as matrix tubes and include a plurality of coplanar light-producing elements which may be selectively energized in various combinations to make up or form the indicia to be displayed. One tube of this type which is found in the prior art includes light-producing elements which comprise a cathode and a plurality of anodes, with each cathode and its group of anodes mounted in its own compartment on an insulating plate. Each anode is able to cause the cathode to glow when the electrodes are properly energized. In one construction, the cathode comprises a metal strip which surrounds the group of anodes and has its edge facing the viewer so that the viewer observes the glowing edge of the cathode in operation of the tube.

Although these tubes operate satisfactorily, it is sometimes desirable to be able to view a larger surface area of the cathode, and it may also be desirable to conceal the anodes associated with each cathode.

It is, therefore, the principal object of applicant's invention to provide an improved electrode structure for matrix-type indicator display devices.

It is a further object of applicant's invention to provide an improved method for fabricating an electrode structure for matrix-arrayed indicator devices.

It is a further object of applicant's invention to obviate visual interference in matrix-arrayed indicator display devices.

It is a further object of applicant's invention to provide a method for substantially increasing the area of glow electrodes in a matrix-arrayed electrode structure without increasing the display plane area.

In accomplishing the above objects and other desirable aspects, applicant has invented a novel matrix-arrayed electrode structure for indicator display devices and a method of fabricating the same in which the groups of electrode defining areas for the selectively illuminable and non-illuminable electrodes are rigidly formed in spaced apart planes in an area defined by a group of segmented slots cut in the visible surface of an insulating block when viewed from the normal direction of display. The respective groups of electrode defining areas are formed so as to be visible, and hidden when viewed from the normal direction of display.

For a more complete understanding of applicant's invention reference may be had to the following detailed description in conjunction with the drawings in which:

FIG. 1 is an isometric view, partially in section, of an indicator tube embodying the principles of applicant's invention.

FIGS. 2*a* and 2*b* show top views of a seven-segment and a fourteen-segment matrix-arrayed electrode structure, respectively, fabricated in accordance with the principles of applicant's invention.

FIGS. 3*a* and 3*b* are partial isometric views showing constructional details of an electrode structure fabricated in accordance with the principles of applicant's invention.

FIGS. 4*a*, 4*b* and 4*c* are partial front views showing other constructional details of various embodiments of the anode and cathode defining areas of an electrode structure fabricated in accordance with the principles of applicant's invention.

Referring now to the drawings and more particularly to FIGS. 1, 2 and 3, applicant's method for fabricating an improved electrode structure for display devices will be described briefly and then explained later in detail. Applicant's method comprises forming a group of slots in a predetermined pattern in the viewing surface of a block of insulating material to be incorporated in a display tube, providing one or more illuminable cathode electrodes on at least one surface of each of the slots visible from the viewing direction and providing at least one non-illuminable anode electrode in each of said slots substantially invisible from the viewing direction. The non-illuminable electrodes may comprise for example a plurality of apertures filled with conductive material in the bottom of the respective slots underneath the respective overhanging sides of oblique slots or in the sides of perpendicular slots, whereby the apertures are substantially invisible from the normal direction of viewing. As hereinafter to be more fully explained with reference to FIGS. 3 and 4, the non-illuminable group of electrodes may be fabricated in a plurality of positions relative to the illuminable group.

In practicing applicant's invention the number and positions of the slots would be determined by the type of information to be displayed. As is known in the art a seven-segment array may be utilized to display numeric information and a nine- or fourteen-segment array may be employed to display alphanumeric information. After the slots and, for example, the apertures have been formed in the insulating block, the respective electrodes may be emplaced by employing conductive painting, vapor deposition or other well-known techniques for applying emissive and conductive materials. Thereafter, the electrode structure would be mounted within a sealed envelope containing a noble gas at a glow discharge pressure. Selective groups of the segmented electrode array would be energized by applying across the selected cathode-anode group an appropriate source of electric potential, as is well known in the art.

Referring now to FIG. 1, there is shown a display tube **11** having a transparent viewing plate **13**, side walls **15** and bottom **17**. The side walls **15** or casing may be of any type known in the art, for example, metal or glass and, while shown in a generally rectangular configuration, the casing may comprise any geometric shape.

Positioned within and, for example, supported by side walls **15** is an insulating base member **19** having formed therein in accordance with applicant's invention, a matrix-arrayed segmented electrode structure including cathode elements **21** and anode elements **23**. As hereinafter to be more fully explained, the respective segmented

cathode electrodes 21 and the juxtaposed anode elements 23 are respectively electrically connected to individual pins, not shown, which normally project from the bottom 17 of tube 11. The respective electrodes 21 and 23 may be coupled to the pins by any manner known in the art, for example, printed circuit techniques. The respective cathode elements 21 and anode elements 23 of the display tube 11 are, in accordance with the principles of applicant's invention, formed such that only cathode elements 21 are visible from the normal direction of viewing, i.e., through the transparent viewing plate 13.

As hereinafter to be more fully explained, the cathode elements 21 may be defined by at least a portion of the area of a plurality of inclined surfaces of insulating base member 19 formed by obliquely cutting slots of predetermined length and substantially uniform depth in a surface of the insulating member 19. The anode elements 23 are preferably formed in insulating member 19 underneath the overhanging edge of the slot as seen from the direction of normal viewing. The respective cathode elements 21 and groups of the anode elements 23 are cooperably juxtapositioned and connected in any well-known manner to predetermined ones of the tube pins such that the selective application of an appropriate potential in the normal manner for operating glow discharge tubes, causes a glow discharge to be established at the selected cathode electrodes. For a more complete understanding of the operation of cold cathode gas display tubes reference may be had to U.S. Patents Nos. 2,874,320 and 2,878,407 which are of common ownership with the assignee of the present invention.

As shown in FIGS. 2*a* and 2*b*, the matrix-arrayed electrodes of applicant's electrode structure may be arranged in any configuration determined primarily by the type of information to be displayed. In FIG. 2*a* there is shown, by way of example, a seven-element matrix-array which, as is known in the art, may be employed to display numeric information. FIG. 2*b* shows a fourteen-element matrix-array which may be employed to display alphanumeric information. For a more complete understanding of the various planar-arrayed electrode structures which may be employed to display information, reference may be had to U.S. application, Ser. No. 115,128 filed June 6, 1961 by George A. Kupsky which is of common ownership with the present invention.

As shown in FIGS. 1, 2*a* and 2*b*, applican'ts electrode structure comprises a plurality of segmented cathode sections and a plurality of hidden anode electrodes in cooperable position therewith. As hereinabove stated, the non-illuminable anode electrodes 23 are hidden when viewed from the normal direction of display. The anode electrodes are preferably formed in a plane substantially below the top surface of insulating base member 19. The base member 19 may be formed of any opaque insulating material which exhibits substantial rigidity and may comprise, for example, an opaque glass slab.

Referring to FIGS. 3*a* and 3*b* there are shown isometric views of a portion of an electrode structure embodying a hidden electrode array in accordance with the principles of applicant's invention. As shown in FIG. 3*a*, the insulating base member 19 has therein a transverse slot 27. Surface 29 of slot 27 defines the cathode area and the respective apertures 35 in the bottom of transverse slot 27 define the cooperably positioned anode area. As hereinbefore stated, in the preferred embodiment the walls of slot 27 form an acute angle with the normal to the surface of the plane of display or viewing in order that the anode areas may be tucked under the overhanging edge 28 of slot 27 thereby obscuring them from view in relation to the normal direction of viewing.

Referring now to FIG. 3*b*, there is shown another embodiment and method for fabricating a matrix-arrayed display electrode structure in accordance with another aspect of applicant's invention. The insulating plate in accordance with the embodiment shown in FIG. 3*b* comprises a top portion 31 and a bottom portion 33. The top portion 31 has formed therein the inclined channel 27 in accordance with the hereinabove stated manner and the bottom portion 33 has formed therein a plurality of apertures 35. The top insulating portion 31 is thereafter fixedly mounted on bottom insulating portion 33 by any appropriate means, for example, ceramic cement, with the apertures 35 defining the anode area in cooperable glow discharge relationship with surface 29 of transverse slot 27.

It is apparent that the slot 27 can be formed by any convenient means. For example, the insulating block 19 could be molded or preformed with the slots 27, and apertures or channels 35 in single or multiple operations. It is further apparent that when formed obliquely in this manner the channels 27 and 35 exhibit a rhomboidal formation in cross section having the bases of the channels in offset relation to the openings of the channels in the display plane. As shown in FIG. 3*b*, at least a portion of the surface 29 of transverse slot 27 which is visible from the normal direction of viewing is preferably coated with appropriate glow discharge material. Similarly, appropriate conductors are preferably inserted through apertures 35, thereby forming cooperably positioned glow cathode and anode electrodes, respectively.

As shown in FIGS. 4*a*, 4*b* and 4*c*, the positioning of the anode defining areas 35 and cathode defining areas 29 as well as the form of slot 27 may be considerably modified within the scope of applicant's invention. As illustrated in FIGS. 4*a*, 4*b* and 4*c*, the hidden anodes 35′, 35″ and 35‴ may be positioned in the bottom of slot 27, in or on a side or sides of slot 27, when viewed from the normal direction of display. As shown in the various embodiments, the hidden anode electrode defining areas may comprise a plurality of apertures, a channel cut in the insulating block 19 under the overhanding projection 28, or simply a portion of the hidden side wall surface of slot 27 when viewed from the normal direction of display. In all of the embodiments a portion of the hidden anode defining areas would be cooperably juxtapositioned with each of the segmented cathode defining areas to support a glow discharge in response to the application of a normal glow discharge potential thereacross.

In FIG. 4*a* the slot 27 is formed perpendicularly to the viewing surface with the anodes 35′ in the sides of the slot and the cathode 29 on the bottom of the slot. In FIG. 4*c* the anode 35″ is formed on the hidden inclined surface of the slot.

In a variation of the embodiment utilizing an inclined slot, as shown in FIG. 4*c*, a portion of the overhanging shelf 28 has been cut away to increase the viewing angle of the cathode bearing surface.

As hereinabove stated, a cold cathode display tube having an electrode structure formed in accordance with the principles of applicant's invention may be selectively energized to display information by applying, in a manner well known in the art, a source of potential across a preselected group of electrode elements. As is also known in the art, the information to be displayed may be illiminated by connecting an appropriate source of potential through, for example, mechanical switching contacts and conductors to the respective groups of cathode-anode electrodes which define or form the indicia. As taught in the hereinabove mentioned application Ser. No. 115,128, the interconnection of the various anode electrodes and cathode electrodes may be accomplished by connecting the respective groups to conductors, for example, with printed circuit conductors on the bottom surface of insulating member 19.

While applicant's invention has been described in conjunction with a glow discharge display tube, it is equally applicable to an electrode structure for various types of light producing electro or electro-optical display

tubes including both cold glow discharge and electroluminescent elements.

As will be evident to those skilled in the art, minor modifications may be made in the arrangement of the various electrodes and the dimensioning of the respective portions of an electrode structure for a display tube without departing from the spirit of applicant's invention which is specifically pointed out and distinctly claimed in the appended claims.

What is claimed is:

1. In a cold glow discharge tube having an array of selectively energizable electrodes, the improvement comprising:
- an insulating block mounted within said tube and having a display plane disposed for viewing from outside of said tube;
- an array of channels formed oblique to said display plane in said display block;
- at least one cathode defining area visible through said display plane on a side wall of at least one channel; and
- anode defining areas formed beneath the projection of the overhanging edges of the oblique channels and thus substantially invisible from the normal to the display plane.

2. The improvement defined in claim 1 wherein said insulating block is opaque.

3. The improvement defined in claim 1 wherein the overhanging edges of the inclined channels have a portion removed to increase the viewing angle of the cathode defining areas through the display plane.

4. The improvement defined in claim 1 wherein said anode defining areas comprise a plurality of ancillary channels formed in the surfaces of said array of channels.

5. The improvement defined in claim 1 wherein said anode defining areas comprise a plurality of apertures formed in the surface of said array of channels.

6. The improvement defined in claim 1 wherein said anode defining areas comprise surfaces of the walls of said channels.

7. The improvement defined in claim 1 wherein said insulating block comprises first and second fixedly secured insulating members and wherein said group of cathode defining areas and said group of anode defining areas are formed in said first and second members, respectively.

8. In a cold glow discharged tube having an array of selectively energizible electrodes, the improvement comprising:
- an insulating block mounted within said tube and having a display plane disposed for viewing from the outside of said tube;
- at least one channel in the display plane of said insulating block;
- a cathode having its major surface area visible through said display plane and comprising a surface portion of at least one of said channels;
- at least one anode area below said display plane in said insulating block;
- said anode area associated with said cathode area for allowing a glow along that part of cathode surface directly visible through said display plane.

9. The improvement defined in claim 8 wherein said channels are perpendicular to said display plane, said cathode defining areas are on bottom surfaces of said channels and said anode defining areas are within the side walls of said channels.

10. The improvement defined in claim 8 wherein said channels are oblique to said display plane, wherein said cathode areas are located on the side walls of said channels directly visible through the display plane, and wherein said anode areas are formed beneath the projection of the overhanging edges of the oblique channels.

11. The improvement defined in claim 8 wherein said anode area is invisible from the normal to said display plane.

12. A display electrode structure for a cold glow discharge tube comprising:
- a plate-like member of electrical insulating material having one side thereof serving as a display plane;
- said member having an array of channels in said display side thereof arranged in configured relation to one another for forming a plurality of characters;
- said channels each extending in a general oblique direction away from the display plane such that the base portion of each channel is offset to its opening in the display plane;
- a coating of cathode glow material on that side wall portion of each channel facing toward and exposed to view through its opening in the display plane; and
- one or more anodes in each channel in cooperable glow discharge relation to the cathode coated wall of its respective channel and located in another portion of the channel such that the anodes are at least partially concealed from view by an overhanging wall portion of the channel.

13. A display electrode structure for a cold glow discharge tube comprising:
- a plate-like member of electrical insulating material having a one side thereof serving as a display plane;
- said member being formed interiorly with an array of channels of approximately rhomboidal cross section;
- a coating of cathode glow material on a side wall of each channel facing toward and exposed to view through the display plane of the member; and
- one or more anodes in each channel in cooperable glow discharge relation to the cathode coated wall of its respective channel and located in another wall of the channel such that the anodes are at least partially concealed from view through the dislay plane by the material of which the member is composed.

References Cited

UNITED STATES PATENTS

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JAMES W. LAWRENCE, *Primary Examiner.*

J. JUDD, *Assistant Examiner.*