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**[54] GASEOUS DISCHARGE DISPLAY DEVICE WITH
INTERCONNECTING STRUCTURE FOR THE
ELECTRODES
8 Claims, 5 Drawing Figs.**

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313/109.5, 315/169R

[51] Int. Cl. H01j 17/04

[50]	Field of Search.....	313/109.5.
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210, ; 315/169, 169T.V.

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UNITED STATES PATENTS

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ABSTRACT: A cold cathode gaseous display device including a plurality of cathode plates having spaced-apart cathode tabs, each adapted to exhibit cathode glow. The cathode plates are identical and are positioned so that each tab of one is physically associated with the corresponding tabs of the others. Corresponding cathode tabs of each plate are thus physically arranged in a group. The device also includes an anode electrode for each group of cathode tabs, with each anode electrode including a separate anode tab for each cathode tab in the associated group.

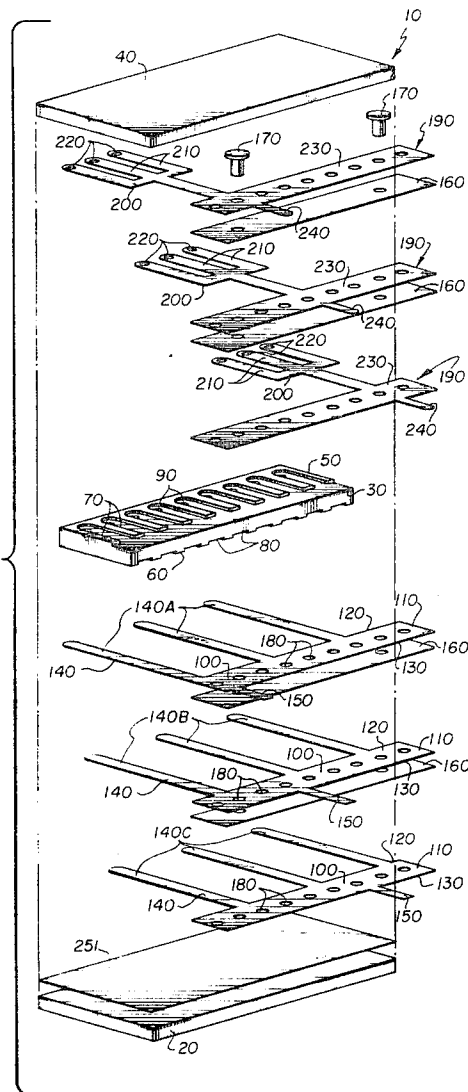
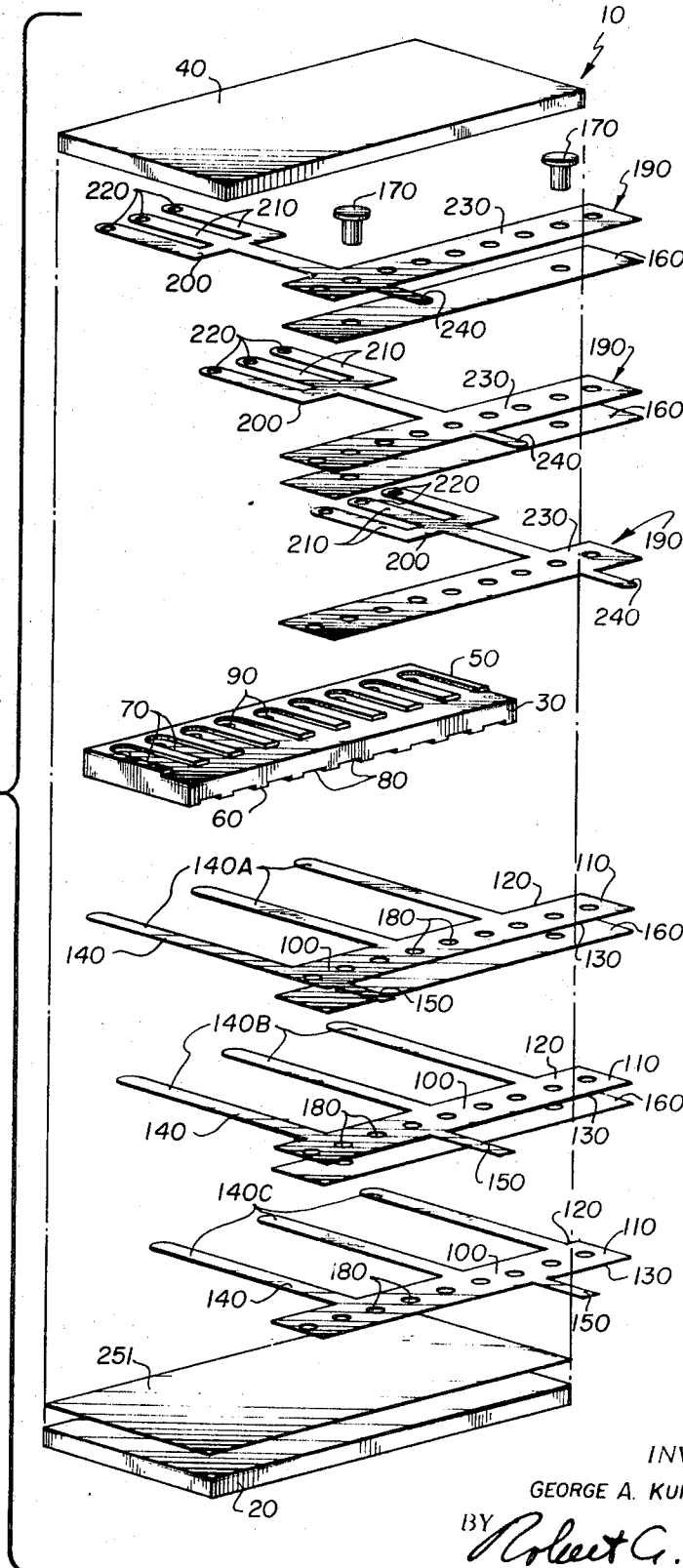


FIG. 1



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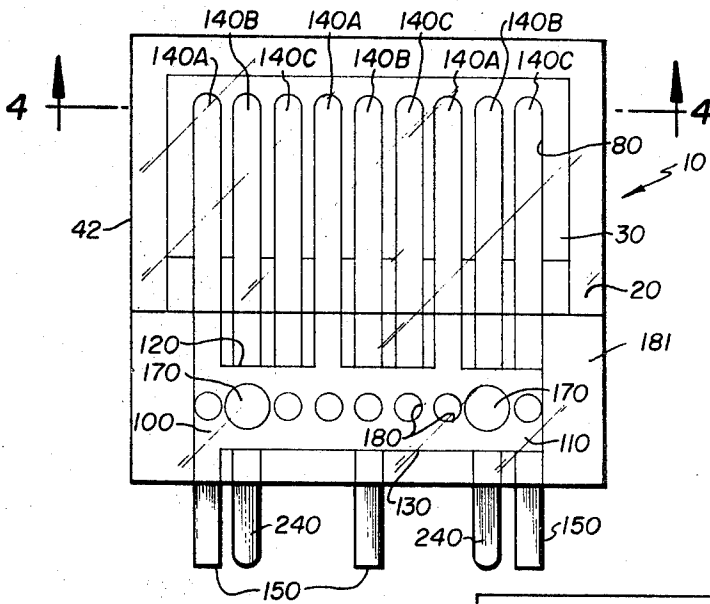


FIG. 2

FIG. 3

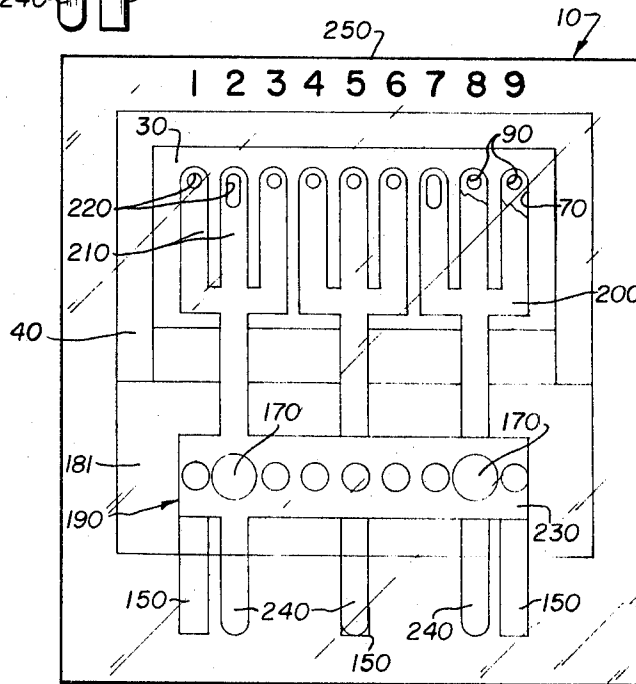


FIG. 4

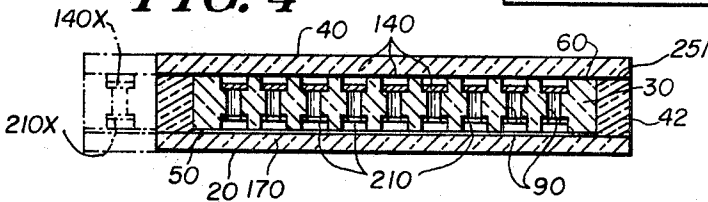
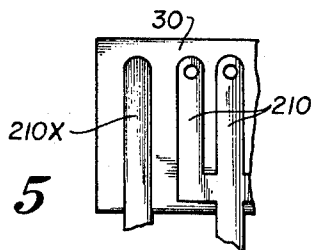


FIG. 5



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GASEOUS DISCHARGE DISPLAY DEVICE WITH INTERCONNECTING STRUCTURE FOR THE ELECTRODES

BACKGROUND OF THE INVENTION

The prior art includes examples of display devices which have a series of cathode rods or tabs. However, the devices shown do not appear to be practical for mass production, and, for one reason or another, they are not commercially available. One reason for this may be the fact that devices which have a relatively large number of cathodes present problems with respect to (1) the making and assembly of the cathodes, (2) the making of connections to the cathodes, and (3) the relationship between the cathodes and the anode or anodes associated therewith.

SUMMARY OF THE INVENTION

The present invention provides a novel construction of a multicathode display device, a novel cathode and anode construction, and a novel arrangement for interconnecting the cathodes to simplify making external electrical connections thereto.

DESCRIPTION OF THE DRAWING

FIG. 1 is an exploded view of a display device embodying the invention;

FIG. 2 is a bottom plan view of the device of FIG. 1 as it appears when assembled;

FIG. 3 is a top plan view of the device of FIG. 1 when assembled;

FIG. 4 is a sectional view along the lines 4-4 in FIG. 2; and

FIG. 5 is a plan view of a portion of the device shown in FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A cold cathode gas-filled display device or panel 10 embodying the invention comprises an assembly of three insulating plates, a bottom plate 20 of glass, a center plate 30 of glass, ceramic or the like, and a top or viewing plate 40 of glass. The top and bottom plates are somewhat larger than the center plate to facilitate the sealing together of all of the plates by means of a quantity of a sealing material 42 such as glass, Pyroceram, or the like disposed between the top and bottom plates around the edge of the device (FIG. 4). The device 10 and its parts are preferably relatively narrow and elongated as shown. The top and bottom glass plates may be considered to be the envelope of the device, and the envelope contains an ionizable gas such as neon, argon, or the like, or mixtures of gases at a suitable pressure. Mercury is usually added to the gas to minimize cathode sputtering.

The center plate 30 has a top surface 50 and a bottom surface 60 and a series of parallel notches, slots or depressions 70 formed in the top surface 50 and a similar series of notches 80 formed in the bottom surface 60. Corresponding notches 70 and 80 are aligned with each other, and a hole 90 through the plate 30 provides communication between each pair of notches and between the top and bottom surfaces of plate 30. Each pair of notches, their gas-filled hole 90, and the electrodes to be described comprise a display cell.

The display device 10 includes cathode electrodes 100 which are adapted to exhibit cathode glow and are positioned adjacent to the bottom surface 60 of plate 30. The cathodes are identical, and each comprises an elongated, thin metal plate 110 which is about as long as the device itself and which has a top edge 120 and a bottom edge 130. A plurality of narrow cathode tabs 140 extend from the top edge 120 of each cathode 100, and a terminal 150 extends from the bottom edge 130 of each tab. In the device 10, three such cathode electrodes 100 are used, and they are offset laterally from each other so that each has its tabs 140 and terminal 150 at a different location along its length. Thus, one cathode has tabs 140A which are seated in the first, fourth, and seventh notches

80. The second cathode has its tabs 140B seated in the second, fifth, and eighth notches 80, and the third cathode has its tabs 140C seated in the third, sixth, and ninth notches 80. Thus, in each group of cathode tabs, 140B is adjacent to 140A, and 140C is adjacent to 140B. Similarly, the terminals 150 of the cathodes 100 are positioned so that they are side-by-side when the cathodes are in place.

When the cathodes are in place, the plates 110 overlie each other outside the device 10, and they are insulated from each other by sheets 160 of mica or the like. The plates 110 are secured together by insulating rivets 170 or the like which are seated in suitably aligned holes 180 in the plates. In the completed device, the portions of cathode plates 110 and other electrodes outside the envelope of device 10 may be embedded in a plastic sheath 181, with only tabs 150 and the like extending therefrom for connection to external circuits.

It is clear that device 10 may include any number of slots in plate 30, any number of individual cathodes 100, and any convenient number of tabs 140 on each cathode. In any case, when the cathodes are stacked on each other, the tabs farthest from the plate 30 are bent so that all tabs lie in the same plane in the notches 70. This insures uniform operation of the electrodes 140 in producing cathode glow.

To summarize, the cathode tabs 140 described above are arranged in groups, with one tab 140A, 140B, and 140C in a group. Thus, as seen in FIGS. 2 and 3, the first three tabs are in one group, the next three are in another group, and the third three are in another group.

The device 10 includes three identical anode electrodes 190, one for each group of cathode tabs 140A, B, C, etc. Each anode includes an arm 200 from which a plurality of anode tabs 210 extend, there being a separate anode tab 210 for each cathode 140 in a group. Thus, in device 10, each anode carries three tabs 210 for cathodes 140A, 140B, 140C in each group. Each anode arm 200 is disposed on the top surface 50 of plate 30 with its tabs 210 seated in notches 70 aligned with the notches 80 in which its associated cathode tabs are seated. Each anode tab 210 has a hole 220 which is aligned with the associated hole 90 in plate 30 to permit viewing of cathode glow from beneath plate 30 through the top glass plate 40. Selected holes 220, say every fifth hole, is enlarged or specially shaped to permit a viewer to count or otherwise identify lighted holes. The corresponding holes 90 in plate 30 are also enlarged.

Each anode 190 also includes an elongated plate or strip 230 secured to arm 200 by connecting strip 231 and of the same general size and shape as the cathode plates 110. Each anode plate 190 carries a terminal 240. The elongated strips 230 of the anodes are included in the package of cathode plates 110 and are insulated from each other and from the cathodes by insulating sheets 160. The anode terminals 240 are positioned in any convenient location on plates 230 so that, in the completed device 10, they are suitably spaced laterally from the cathode terminals 150. The anode terminals 240 also extend through sheath 181. The anode plates 200 and tabs 220 are located inside the envelope of device 10, and the elongated strips 230 and terminals 240 are outside the envelope, in one construction.

Under some circumstances, it may be desirable to improve cell isolation by providing a sheet 251 of flexible insulating material between the cathode tabs 140 and the bottom glass plate 20 and intimately following the contour of and embedding the cathode tabs. For this purpose, a strip or sheet of a material known as Vitta tape may be used. Vitta tape comprises a layer of powdered glass in a binder, and is flexible. In assembling device 10, the sheet of Vitta tape 251 is set in place, and the other plates and electrodes are assembled, and, when the device is baked out and otherwise processed, as is well known in the art, the binder is driven off and the powdered glass is fused into a sheet which has the desired intimate relationship with the cathode tabs.

If it is considered necessary to speed up the starting operation of display device 10, an auxiliary cathode 140X and

anode 210X are provided in slots in plate 30 to provide first electrons or to perform a "keep-alive" function, as is well known in the art. These electrodes are operated to produce cathode glow and to generate excited particles for facilitating the firing of other cathodes. Thus, these electrodes need not be seen by the viewer, and the anode need not be apertured. They may also be provided at any suitable location in the device, and they are illustrated only in FIGS. 4 and 5.

In operation of the device 10, if the keep-alive electrodes 140X and 210X are used, they are kept ON continuously to produce glow in their cell constantly throughout the entire period of operation of the device.

The device 10 may be operated in different ways. For example, it may be scanned from one end to the other with each cell being caused to glow in turn, or selected cells may be turned on in accordance with controlling information signals. In any case, to cause a group of cathodes 140A, 140B, and 140C to glow, positive potential is applied to the proper associated anode 190 having tabs 210 associated with the selected cathodes, and then the proper generally negative potential is applied to each of the cathode tabs separately and in the desired order. This is repeated with each anode to cause the other cathodes to glow. The device 10 can be used in various systems, but it is particularly suited for providing a direct indication of the state of a series of remote devices, with each cathode representing one of the remote devices. Thus, for example, the device 10 may be positioned behind a panel 250 (FIG. 3) which carries numbers 1 to 9 which are associated with corresponding cathodes or cells of device 10.

The invention has many advantages, with one advantage arising from the fact that all parts can be mass-produced. In particular, since the cathodes are identical and the anodes are identical, considerable savings can be achieved in manufacture and assembly. In addition, with the plate construction described, the connections between cathodes, e.g., between all cathodes 140A, cathodes 140B, etc., and the external connection to the cathodes are integral, and are all made in one operation. Thus, auxiliary handmade connections are not required during assembly.

I claim:

1. A gaseous cold cathode display device comprising a gas-filled envelope, an insulating support plate disposed within said envelope and having top and bottom surfaces with a series of parallel first depressions formed in said top surface and a series of parallel second depressions formed in said bottom surface, there being a hole in said plate between each first depression and the corresponding second depression,
 - a first metal plate carrying a plurality of first apertured metal tabs seated in successive ones of said first depressions,
 - a second metal plate positioned adjacent to but insulated from said first plate and carrying a plurality of second apertured metal tabs seated in successive ones of said first depressions in series with said first metal tabs, the first of said second metal tabs lying next to the last of said first metal tabs,
 - a third metal plate positioned adjacent to but insulated from said first and second plates and carrying a plurality of third apertured metal tabs seated in successive ones of said first depressions and in series with said first and second metal tabs, the first of said third tabs lying next to the last of said second tabs,
 - a fourth metal plate positioned adjacent to said bottom surface of said insulating support plate and having a plurality of spaced-apart fourth metal tabs seated in spaced-apart ones of said second depressions, each of said fourth metal tabs being aligned with and in operative relation, through ones of said holes, with the first tab in each of said series of first, second and third metal tabs,
 - a fifth metal plate positioned adjacent to but insulated from said fourth metal plate and having a plurality of spaced-apart fifth metal tabs seated in spaced-apart ones of said

second depressions, each of said second metal tabs being aligned with and in operative relation, through ones of said holes, with the second tab in each of said series of said first, second, and third metal tabs, and

a sixth metal plate positioned adjacent to but insulated from said third and fourth metal tabs and having a plurality of spaced-apart sixth metal tabs seated in spaced-apart ones of said second depressions, each of said sixth metal tabs being aligned with and in operative relation, through ones of said holes, with the third tab in each of said series of first, second and third metal tabs,

each of said first, second and third metal tabs being thus in operative relation with one of said fourth, fifth and sixth metal tabs to form electrode pairs which can cause glow discharge visible through said apertured tabs when operating potentials are applied therebetween, the relationship between said first, second and third metal tabs being such that operating potential can be applied to all of the tabs of a series at one time and each can be caused to exhibit cathode glow by the application of operating potential to each of said fourth, fifth and sixth metal tabs, in turn,

each of said metal plates having a portion projecting through said envelope whereby operating potential can be applied thereto and to said tabs.

2. The device defined in claim 1 wherein said metal plates overlay each other in a sandwich array, with a sheet of insulating material disposed between adjacent plates to insulate them from each other.

3. A display device comprising a gas-filled envelope including:

- a first group of first apertured electrodes, arrayed in series, having a first common terminal outside said envelope,
- a second group of second apertured electrodes, arrayed in series with said first electrodes, and having a second common terminal outside said envelope,
- a third group of third apertured electrodes, arrayed in series with said first and second electrodes, and having a third common terminal outside said envelope,
- a fourth electrode in operative relation with the first electrode in each of said groups of electrodes and forming an electrode pair therewith, there being as many fourth electrodes as there are groups of electrodes, all of said fourth electrodes having a fourth common terminal outside said envelope,
- a fifth electrode in operative relation with the second electrode in each of said groups of electrodes and forming an electrode pair therewith, there being as many fifth electrodes as there are groups of electrodes, all of said fifth electrodes having a fifth common terminal outside said envelope,
- a sixth electrode in operative relation with the third electrode in each of said groups of electrodes and forming an electrode pair therewith, there being as many sixth electrodes as there are groups of electrodes, all of said sixth electrodes having a sixth common terminal outside said envelope, and

insulating means associated with each of said electrode pairs and forming a separate and distinct gas cell therewith, there thus being a continuous series of gas cells formed by said groups of electrodes arrayed in series, each of said electrode pairs being able to cause glow discharge when operating potentials are applied therebetween, the relationship between all of said electrodes being such that operating potential can be applied to all of the electrodes of a group at one time and each can be caused to exhibit cathode glow by the application of operating potential to each of the associated fourth, fifth, and sixth electrodes, in turn, the application of operating potential to each group of electrodes, in turn, and to each of said fourth, fifth, and sixth electrodes as each of said groups is energized, causing glow to be generated in each of said gas cells, in turn, along the se-

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ries of gas cells, said glow being visible through said apertured electrodes.

4. The device defined in claim 3 wherein said insulating means comprises a plate of insulating material having top and bottom surfaces and having a series of depressions on one surface receiving said groups of first, second, and third electrodes in series, said insulating means having a series of depressions on the opposite surface receiving said fourth, fifth, and sixth electrodes.

5. The device defined in claim 3 wherein said first, second, 10 and third groups of electrodes extend from and are each coplanar with a large-area metal plate, the electrodes in each group being positioned side-by-side, said metal plates being arrayed in sandwich relation overlaying each other and insulated from each other by means of insulating sheets.

6. The device defined in claim 5 wherein said large-area 15 plates are secured together outside said envelope.

7. The device defined in claim 3 wherein said first, second,

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and third electrodes each extends from and is coplanar with a large-area metal plate, the electrodes in each group being positioned side-by-side,

said fourth, fifth, and sixth electrodes extend from and are coplanar with large-area metal plates, said fourth electrodes being spaced apart along their metal plate, said fifth electrodes being spaced apart along their metal plates and said sixth electrodes being spaced apart along their metal plates,

all of said metal plates being secured together outside said envelope in sandwich fashion with insulating sheets disposed between them to insulate them from each other.

8. The device defined in claim 3 wherein the apertures in 20 said apertured electrodes are arrayed in series as are the electrodes, and selected, spaced-apart apertures are enlarged to provide a grouping effect to said apertures.

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