

[54] **MULTI-POSITION GASEOUS DISCHARGE DISPLAY PANEL**

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[21] Appl. No.: 216,538

Related U.S. Application Data

[63] Continuation of Ser. No. 88,047, Nov. 9, 1970, abandoned, which is a continuation-in-part of Ser. No. 61,642, Aug. 6, 1970, abandoned.

[52] U.S. Cl.....313/108 R, 313/109.5, 313/204,
313/210, 313/220, 315/169 TV

[51] Int. Cl. H01j 61/38, H01j 61/66

[58] **Field of Search**.....313/220, 109.5, 210, 108 R,
313/204; 315/169 TV, 169 R

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[57]

ABSTRACT

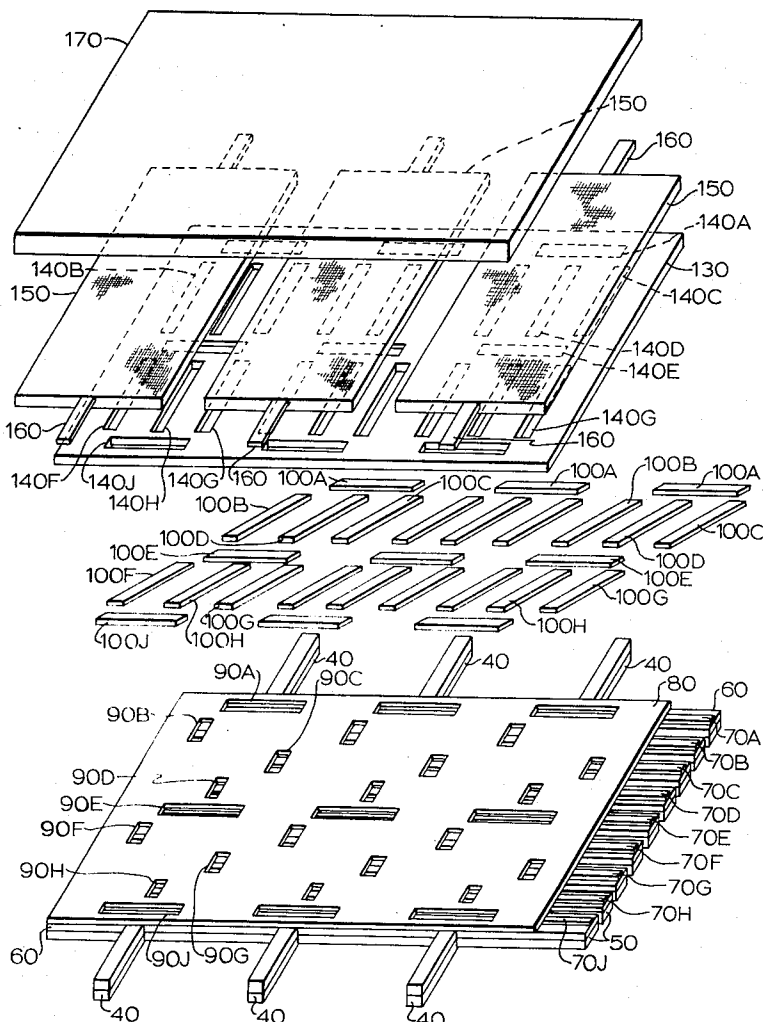
The display device is of a sandwich construction and includes a base plate on which a plurality of the electrode components of the device are formed by a screening or printing process or the like. The base plate may also include a sheet of metal having an insulating coating, the metal sheet having preformed portions which can be used to support electrode contacts after the entire device has been assembled.

[56] **References Cited**

15 Claims, 8 Drawing Figures

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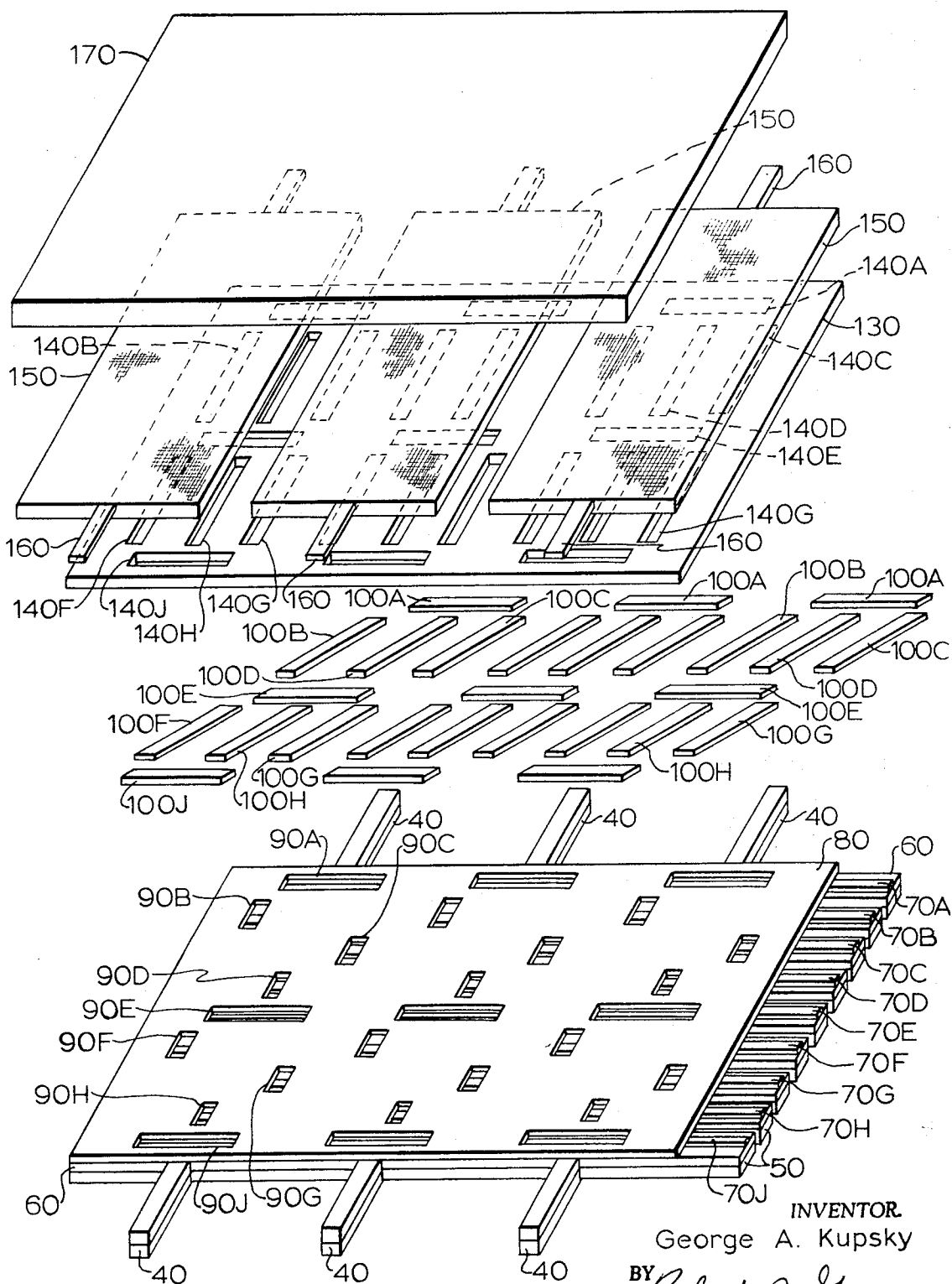


Fig. 1

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Fig. 2

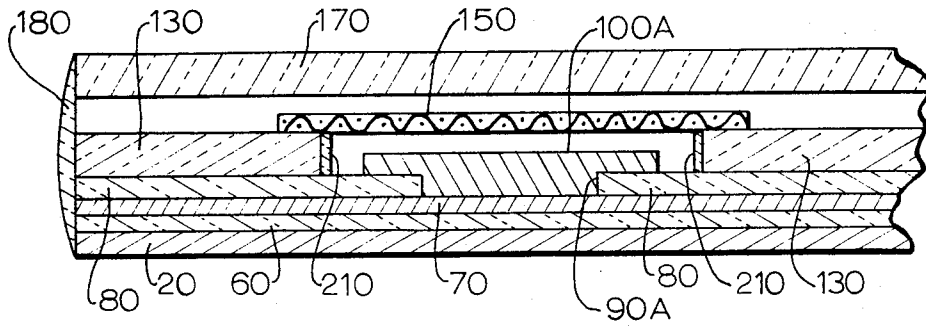


Fig. 3

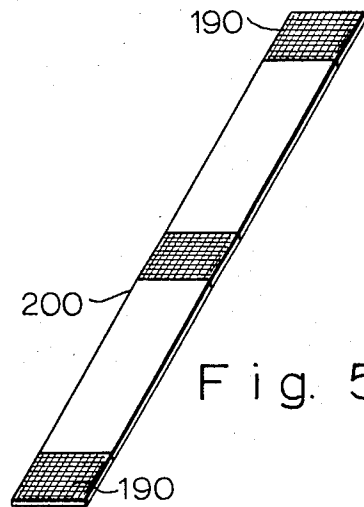
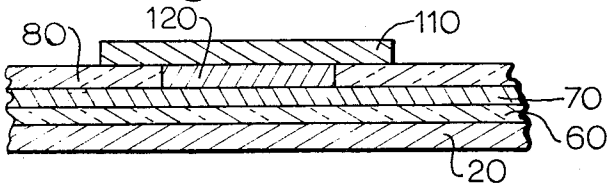


Fig. 5

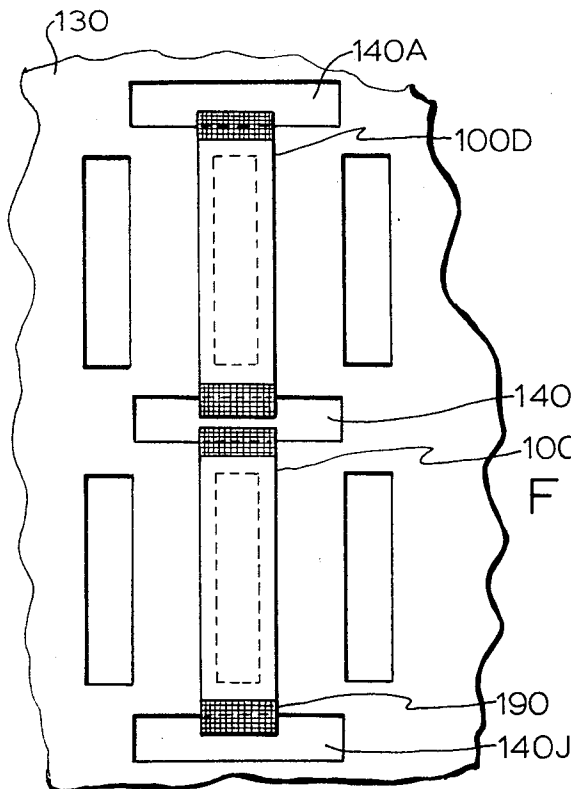


Fig. 4

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Fig. 6

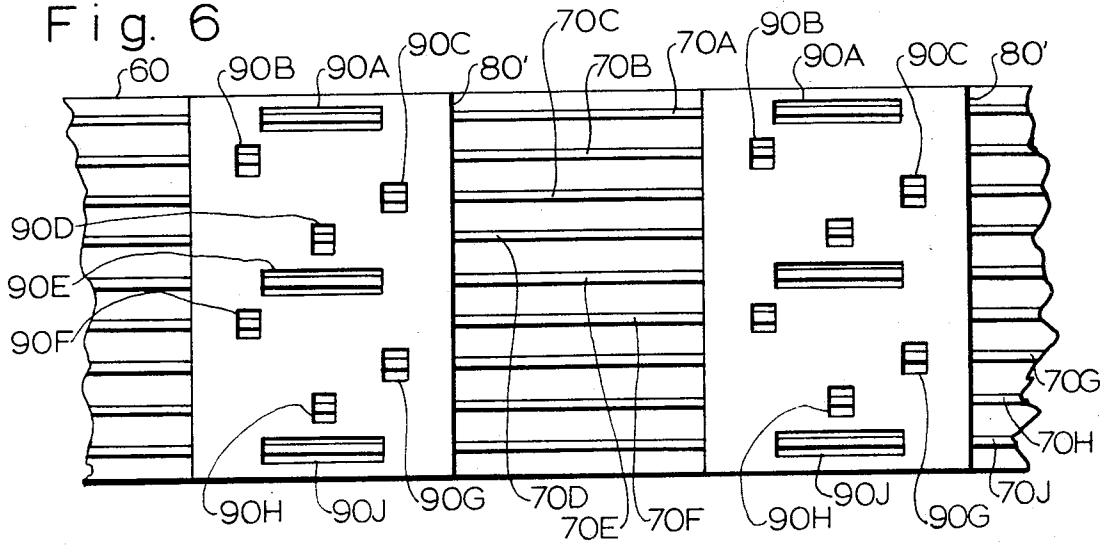


Fig. 6A

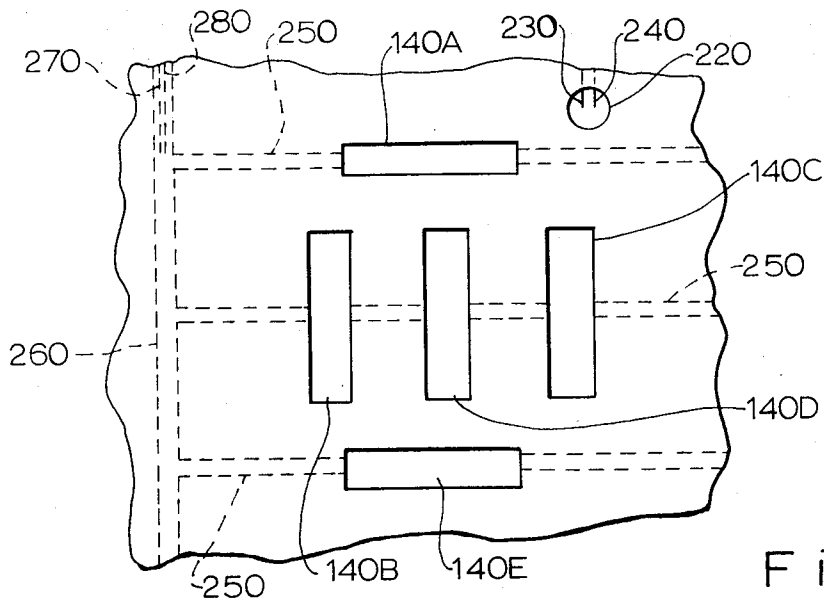
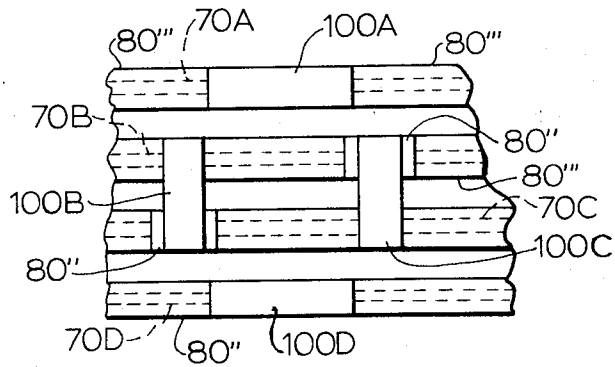


Fig. 7

MULTI-POSITION GASEOUS DISCHARGE DISPLAY PANEL

This application is a continuation of application Ser. No. 88,047, filed Nov. 9, 1970, and now abandoned, which is a continuation-in-part of application Ser. No. 61,642, filed Aug. 6, 1970, and now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to segment devices which include a plurality of groups of electrodes, the electrodes comprising elongated bars or segments arrayed in a figure "8" pattern so that they can be selectively energized to display a plurality of characters, with each group displaying one character. For reasons of economy, the same corresponding electrodes, usually cathodes, in each group have a common conductor, and electrode selection is carried out by applying a selective potential to the anode associated with each group of cathodes. At the present time, one of the important problems encountered in manufacturing these devices relates to the making of contacts to the cathode electrodes and to the anode electrodes. In addition, improvements can always be made in electrode layout and electrode construction.

SUMMARY OF THE INVENTION

Briefly, a display device embodying the invention includes a plurality of groups of cathode electrodes, each having an associated anode electrode, and a support plate having portions adapted for expediting the making of electrical contact to electrodes of the device. Unique electrode structures and arrangements are also included.

DESCRIPTION OF THE DRAWINGS

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

FIG. 2 is a sectional view through a portion of the device of FIG. 1 when assembled;

FIG. 3 is a sectional view of a portion of a modification of the invention;

FIG. 4 is a plan view of a modification of the invention;

FIG. 5 is a perspective view of a modified electrode which may be used in practicing the invention;

FIG. 6 is a plan view of a portion of a modification of the invention;

FIG. 6A is a plan view of a modification of FIG. 6; and

FIG. 7 is a plan view of a portion of still another modification of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The display panels described herein are thin, flat, sheet-like members which may have substantially any desired size and shape, and may include substantially any number of display positions. The panels may also include any suitable ionizable gas such as neon, argon, xenon, etc., singly or in combination, with a vapor of a metal such as mercury usually included in the gas to minimize cathode sputtering. A wide range of gas pressures may be used, for example, from about 20 to about 250 Torr at ambient temperature, with about 75 Torr being a pressure which is commonly used.

A display device 10 embodying the invention includes a base plate 20 which comprises a thin, flat sheet of metal which is stamped or otherwise formed to include a generally rectangular main body portion which includes an upper edge and a lower edge and left hand and right hand edges. The upper and lower edges carry aligned vertically projecting tabs 40, arrayed in opposed pairs, and one of the ends, for example, the right hand end, carries a plurality of horizontally projecting tabs 50. The various tabs are located as shown for a purpose to be described. The metal plate 20 is coated with a layer 60 of an insulating material, for example, glass, ceramic, or the like, in any suitable fashion, for example, by spraying. Alternatively, the insulating layer 60 may comprise a thin separate plate of insulating material such as glass or ceramic suitably secured to the metal plate 20.

A plurality of conductive leads or runs 70 are formed on the top surface of the insulating layer 60. The runs are parallel to each other, aligned with the horizontal axis of the base plate, and each extends over one of the horizontal tabs 50. Nine runs 70A to 70J are shown, but all may not be required in practicing the invention, the number being determined by the total number and type of characters to be displayed. The runs 70 may be formed by an evaporation process or a silk-screen process or the like, or they may be discrete strips of metal, heat sealed or otherwise secured to the insulating layer 60. A silk-screen printing process is particularly fast and efficient.

A second layer 80 of insulating material such as glass or ceramic is formed on the conductive runs 70, preferably by a silk-screen process, and the second layer includes a plurality of groups of apertures 90A to 90J, each aperture exposing one of the runs 70A to 70J. Thus, each group of apertures includes aperture 90A which exposes run 70A, aperture 90B which exposes run 70B, aperture 90C which exposes run 70C, etc. Plate 80 does not cover the portions of runs 70 overlaying tabs 50.

Panel 10 includes a group of cathode electrodes 100 (A to J) for each group of apertures 90; the cathodes are generally elongated bars or segments, and they are generally arrayed in a figure "8" pattern, as is well known in the art. Each group of cathodes includes two aligned vertical cathodes 100D and H disposed on the central vertical axis of each group of cathodes. These cathodes provide added flexibility in forming characters. The cathodes are preferably formed by means of a silk-screen process with a conductive paste such as palladium-gold, platinum-gold, palladium-silver, or the like. Each cathode element is in direct contact with one of the runs 70 exposed in an aperture 90, and it fills the aperture 90 and covers a portion of layer 80 to achieve the desired shape and size for each cathode.

The cathodes may also be discrete strips of metal 110 (FIG. 3), each of which is preferably brazed to a conductive run 70 by means of a mass of brazing material 120 deposited in each of the apertures 90 in the insulating layer 80. The brazing material may also be deposited by a silk-screen process. One suitable brazing material is a gold-germanium substance known as FORMON and sold by DuPont.

The panel 10 includes an insulating plate 130 which is seated on the insulating layer and includes a plurality

of groups of apertures 140 (A to J), which comprise the display cells in panel 10, and each encloses one of the cathode electrodes 100 so that the cathodes are positioned beneath the top surface of the plate 130. Plate 130 is substantially the same size as plate 80 and does not cover the ends of runs 70.

The panel 10 includes an anode electrode 150 for each group of cathode electrodes 100, and the anodes may have any suitable form. For example, they may be metallic rings, each of which surrounds a group of cathodes, with the rings being discrete pieces of metal or screened layers of metal. The anodes may also comprise separate metallic screens, as shown, which are positioned over each group of cathode electrodes. Whatever form of anode is employed, each includes conductive tabs 160 which are aligned with and overlay one of the pairs of projecting tabs 40 formed on the base plate 20 and coated with the insulating material of plate 60.

The panel 10 finally includes a top glass cover or viewing plate 170 which is of substantially the same size and shape as the main body of the metal base plate 20 and plates 80 and 130 so that, when the cover plate is sealed to the base plate and the various intermediate plates to form the completed panel, the tabs 50 and conductive runs 70 project beyond the edges of the panel. It may be desirable to have the cover plate spaced above the anode screens, and this may be achieved in any suitable manner, for example, by means of a rectangular lip (not shown) integral with the lower surface of the cover plate. The cover plate is sealed to the other portions of the panel by means of a suitable cement such as a glass frit or Pyrocera or the like to form a seal 180.

The panel 10 can be filled with the desired gas atmosphere through a tubulation secured to the metal base plate 20 and layer 60, and generally mercury is introduced from a glass capsule held in the tubulation and suitably processed at the desired stage in the assembly process. After the panel has been thus assembled, the tabs 40 and 50 which carry the anode tabs 160 and runs 70 (A to J), respectively, are used to make electrical contact, both to the anodes and to the groups of cathodes. If desired, the tabs may be bent downwardly and inserted into a printed circuit board or the like on which the panel is thus mounted and supported. If the tabs are to be bent, the bending operation would be performed at the beginning of the assembly procedure before any parts are mounted thereon.

The central vertical cathodes are used, generally, to represent numeral "1." In order to achieve a numeral height which is close to or equal to the height of the other numerals which can be formed, the cathodes used with these two central apertures are made of metallic pieces which overlay the horizontal cathodes 100A, E, and J and are suitably elevated above the other cathodes, to be separated from them electrically. Also, these cathodes are either entirely in mesh form, or they are formed with mesh or apertured portions 190 (FIG. 4) 4) where they overlay other cathodes so that they do not obscure these other cathodes. The central cathode might also comprise a single strip of mesh or solid metal 200 (FIG. 5) with mesh or apertured portions 100 where it crosses other cathodes. These cathodes may be brazed or welded to the runs 70D and

70H with which they are associated. With this arrangement, a numeral "1" of suitable size is obtained without obstructing other cathode segments.

The cathode electrodes 100 and their conductive runs 70 may also be formed by an electroplating process. In this case, the entire top surface of the insulating base plate 60 is plated with a layer of nickel by an electroless nickel plating process. Next, an etch-resistant resist is deposited on the nickel layer in a pattern of parallel strips with narrow strips of nickel between them, and the assembly is then etched to remove the exposed strips of nickel. The resist is then removed to leave parallel strips of metal which will comprise the cathode connections in the completed device. If desired, the nickel runs could be formed by plating between strips of resist formed on the plate 60. Next, the apertured dielectric layer 80 is formed with apertures 90 as described above, with each aperture exposing one of the conductive runs. A layer of resist is now coated on the conductive runs at the right hand edge of the plate where external contact is to be made, and the rest of the layer 80 is plated with nickel. The nickel plate is coated with resist in the segment pattern, and the entire assembly is etched to leave a pattern of resist-coated nickel segments. Finally, the resist is removed, and the desired pattern of nickel segments remain, each being in direct contact with one of the runs. In the foregoing process, the resist may be a photosensitive substance such as Kodak KPR, with which the resist patterns are formed by a photographic process. Non-photographic resists may also be used such as masking compound SM 1000 made by Davis Electronics. With this material, the resist pattern is formed by a silk-screen process.

It is to be noted that panels embodying the invention may be constructed without metal plate 20 but including all other parts described.

In addition, the insulating plate 130 may be made of metal and coated on both surfaces with a layer of insulating material.

In another modification of the invention, a portion of which is shown in FIG. 6, the entire insulating plate 80 is not required, with the desired insulating effect being achieved by depositing individual rectangular areas 80' of insulating material for each group of cathodes only. Each insulating area 80' is provided with the apertures 90 A to J at the desired locations and exposing runs 70A, B, C, etc., to which cathodes 100A, B, C, etc. (not shown) are applied as described above. This arrangement provides a saving in the amount of insulating material required in mass production manufacture.

A related modification of the invention is illustrated in FIG. 6A. As can be seen, if the conductive runs or leads 70 are not too closely spaced, then only the vertical cathodes 100 (B and C are shown) overlay two such runs and thus must be insulated from one of them. Thus, cathode 100B, which is to contact run 70B, is insulated from run 70C by means of a small insulated tab 80'', and cathode 100C, which contacts run 70C, is insulated from run 70B by a tab 80''. Each of the vertical cathodes is thus insulated from the appropriate conductive run. If insulating plate 130 is not used in the display device of FIG. 6A to prevent the bare portions of runs 70 from glowing, then a suitable insulating means should be provided covering them. Such insulat-

ing means may be lateral extensions 80''' of tabs 80'' or any suitable insulating coating. The bare leads 70 would also have to be covered in the structure shown in FIG. 6. In FIG. 6A, if the conductive runs 70 are so close together that the horizontal cathodes 100A, 100E, and 100J would contact runs adjacent to their own, then insulating tabs 80'' would be required on such adjacent runs.

For the most part, devices embodying the invention operate efficiently and satisfactorily. However, under some circumstances where extremely fast turn-on is necessary, it may be desirable to provide a source of first electrons which facilitate the initiation of gas discharge and cathode glow. In one suitable arrangement, a phosphor material which includes barium is provided in the panel. The phosphor may be provided at any suitable location. For example, a thin layer 210 may be painted on the walls of the apertures 140 in plate 130. This is shown only in FIG. 2.

Alternatively, as shown schematically in FIG. 7, an auxiliary small cell 220 is provided in operative relation with each group of electrodes, and each such cell has its own anode 230 and cathode 240. In operation, the cells 220 are held on continually at a low level so that they provide a constant source of excited particles without interfering with the normal display operation of the panel.

In still another arrangement, one or more horizontal slots 250 are provided in the lower surface of plate 130 and extend through corresponding display cells 140. In addition, a vertical slot 260 at one end of the panel is connected with all of the slots 250, and an anode 270 and cathode 280 are seated in slot 260 and are held on continually to provide excited particles. These excited particles can communicate with the display cells through slots 260 and 250. Other arrangements may also be used.

Although many of the intimate details of manufacture of the display device 10 have not been set forth, these details are known or readily obtainable by those skilled in the art. For example, it is well known that materials which are silk-screened comprise particles of the desired substance in a suitable carrier including a binder and that some time after the material is screened on a surface, it is normally necessary to bake to remove the binder and fuse the base material. In addition, the details of the electroless plating process and other procedures are well known to those skilled in the art and need not be described in detail.

What is claimed is:

1. A display device comprising

- a sealed envelope having a swinging window and containing an ionizable gas at a pressure capable of sustaining cathode glow,
- a metal base plate forming a part of said envelope having a large-area portion and a first plurality of fingers projecting therefrom,
- a first insulating layer covering said large-area portion and said projecting fingers,
- a plurality of substantially parallel conductors extending along said insulating layer over the large-area portion and over the projecting fingers,
- a second insulating layer covering said conductors over most of their length along the large-area portion,

a first group of apertures in said second insulating layer, each aperture of the group being aligned with a different one of said conductors,

a first group of elongated cathode segments arrayed in a predetermined pattern with a portion of each such cathode segment being aligned with one of said apertures and connected electrically through the aperture to one of said conductors,

a plurality of additional groups of apertures in said second insulating layer, the apertures of each group being aligned as said first group, with each aperture of each group aligned with one of said conductors, the aperture groups being disposed side-by-side along said second insulating layer in the direction of said parallel conductors,

a plurality of additional groups of elongated cathode segments with the cathode segments of each group arrayed in substantially the same pattern as those of the first group, said additional cathode segment groups being aligned with the additional aperture groups and connected electrically through the respective apertures thereof to said parallel conductors, and

a plurality of anode electrodes each associated with one of said cathode segment groups.

2. A display device as in claim 1 wherein the cathode segments of each group are disposed in a character-shaped array.

3. A display device as in claim 1 including means to energize selective combinations of said parallel conductors along the portions thereof which extend onto said projecting fingers, and means for energizing said anode electrodes one after the other in synchronism with the sequential energization of different combinations of said conductors.

4. A display device as defined in claim 1 including electron-emitting phosphor material disposed within said envelope.

5. A display device as defined in claim 1 including a gas cell source of first electrons disposed in communicating relationship with each of said cathode segment groups.

6. A display device as in claim 1 including a second plurality of fingers projecting from said large-area portion of said metal base plate, perpendicular to said first plurality.

7. A display device as in claim 6, further including an insulating layer covering said second plurality of projecting fingers, and conductors connected to said anodes and extending along said further insulating layer.

8. A display device comprising

- an envelope containing an ionizable gas at a pressure capable of sustaining cathode glow,
- a metal base plate having a large-area portion and a plurality of discrete contact fingers projecting therefrom,
- a first insulating layer disposed on said large-area portion and on said fingers, said first insulating layer having a top surface,
- a plurality of conductive strips on said top surface of said insulating layer and extending onto the portions of said first insulating layer on said fingers,
- a second insulating layer on said conductive strips only over the portions of said conductive strips on said large-area portion,

a plurality of groups of apertures in said second insulating layer, each such aperture aligned with and exposing one conductive strip, said groups of apertures being spaced apart in a series, one group next to the other,

a conductive member in each of said apertures in direct contact with the associated conductive strip and operable as a glow cathode in the gas in said envelope, there thus being a plurality of groups of conductive members with corresponding members of each group in contact with the same conductive strip,

a plurality of anode electrodes, one being associated with each group of conductive members, and

a glass cover plate through which glowing cathodes can be viewed, said base plate and said cover plate being hermetically sealed together to form said envelope.

9. The device defined in claim 8 wherein each conductive member is generally elongated and rectangular in shape and, in each group, the conductive members are arrayed generally in a figure "8" pattern.

10. The device defined in claim 8 wherein each conductive member extends into its aperture and is therein secured to its conductive strip, and each conductive member also extends over and covers a portion of the surface of said second insulating layer adjacent to its aperture.

11. A display device comprising

- a sealed envelope containing an ionizable gas at a pressure capable of sustaining cathode glow,
- a viewing window in said envelope,
- an insulating base plate within said envelope having a surface facing said viewing window,
- a plurality of substantially parallel conductive strips extending along said surface,
- a group of elongated cathode segments disposed in a predetermined array, each cathode segment of the group being in direct contact with one of said conductive strips and operable as a glow cathode in said envelope,
- a plurality of additional groups of elongated cathode segments, each such group being disposed in an array substantially the same as said first group, said cathode segment groups being disposed side-by-side along the insulating base plate in the direction of the conductive strips, with the corresponding cathode segments in each of said groups in direct contact with the same conductive strip,
- at least certain ones of said cathode segments overlying at least one of said conductive strips in addition

to the one in which it is in direct contact,

a small area of insulation in each of said overlying regions forming a layer over the conductive strip in such region and separating the cathode segment from the conductive strip it overlies, and

a plurality of anode electrodes each associated with one group of said cathode segments.

12. The device defined in claim 11 wherein each cathode segment is rectangular in shape and the cathode segments of each group are arrayed generally in a figure "8" pattern, and wherein each of four of said cathode segments overlies at least one of said conductive strips in addition to the conductive strip in which it is in direct contact.

13. A display device comprising

- a sealed envelope having a viewing window and containing an ionizable gas at a pressure capable of sustaining cathode glow,
- an insulating base plate within said envelope having a top surface,
- a plurality of conductive strips on said top surface of said base plate,
- an insulating layer on said conductive strips,
- a group of apertures in said layer, each aligned with and exposing one conductive strip, said apertures being arrayed generally in a figure "8" pattern,
- a first plurality of cathode segments on said insulating layer, each connected through one of said apertures into direct contact with the associated conductive strip and operable as a glow cathode, there thus being a group of cathode segments arrayed in a figure "8" pattern,
- an auxiliary cathode segment disposed in the center of said figure "8" pattern and adapted to represent the numeral "1" and making contact through said insulating layer to a separate conductive strip,
- said auxiliary cathode segment overlying a portion of at least one of said first cathode segments and including a transparent portion where it overlays said first cathode segment, whereby when said first cathode segment exhibits cathode glow, the glow is visible through said transparent portion, and
- an anode electrode associated with said first and said auxiliary cathode segments.

14. A display device as in claim 13, wherein said viewing window is a glass cover plate, said base plate and said cover plate being hermetically sealed together to form said envelope.

15. A display device as in claim 13 wherein said transparent portion is of a mesh-like conductive material.

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