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Holz et al.

[11] **3,882,349**

[45] **May 6, 1975**

[54] **MULTI-POSITION, GASEOUS DISCHARGE, CHARACTER DISPLAY PANEL INCLUDING AUXILIARY, CATHODE TRANSFER ELECTRODES**

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[52] **U.S. Cl.** ..... **313/519;** 313/197; 313/210; 315/169 TV

[51] **Int. Cl.**..... **H01j 61/08;** H01j 61/66

[58] **Field of Search** ..... 313/517, 519, 197, 198, 313/210; 315/169 TV

[56] **References Cited**

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Primary Examiner—Palmer C. Demeo

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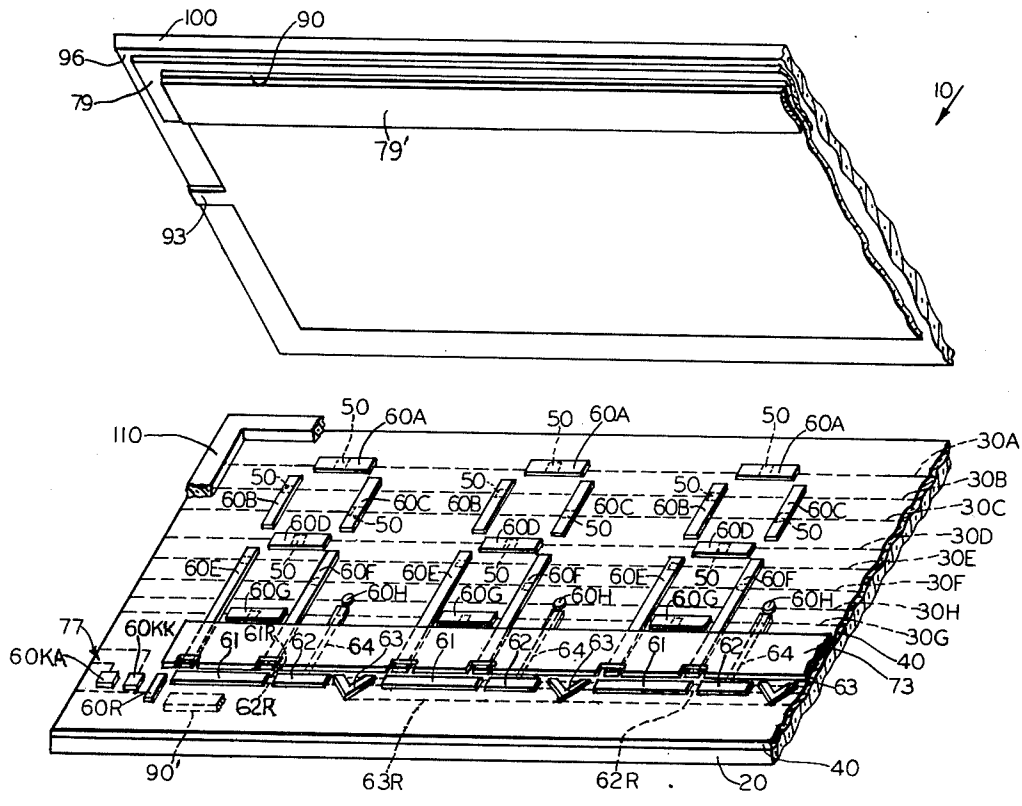
[57] **ABSTRACT**

A multi-position character display panel includes a gas-filled envelope which contains a plurality of groups of cathode segments arrayed in a line of character positions, with a single anode electrode provided for all of the groups of segments. In each group of cathode segments, the segments are long, narrow, rectangular members arrayed in a figure "8" pattern.

In addition, a group of transfer cathodes is disposed adjacent to the lower edge of each figure 8 pattern and between each such pattern for use in transferring cathode glow through each group of cathode segments and from each group of cathode segments to the next group of cathode segments.

The panel is operated by energizing the anode and the first of the transfer cathodes associated with the first group of cathode segments, then energizing each of the cathode segments for the character to be displayed in the first character position as determined by the input information, then transferring back to the first transfer electrode, then to the second transfer electrode and the associated decimal point, if required, then to the third transfer electrode, and then to the first transfer electrode of the next group of cathode segments. The same cycle is repeated for the second character position and the others in the series of character positions.

13 Claims, 6 Drawing Figures



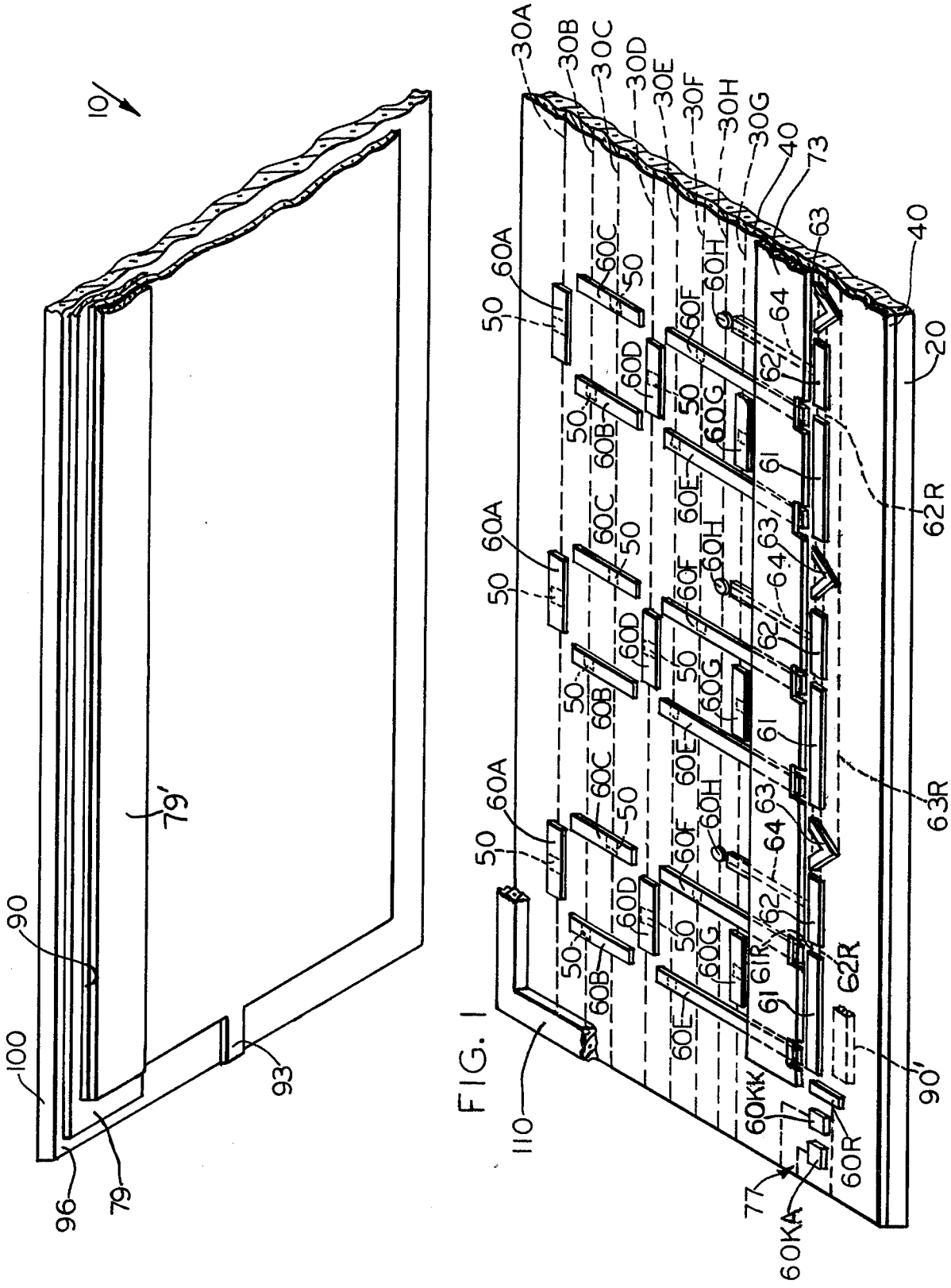

10
79'
90
100
96
79
93
30A
30B
30C
30D
30E
30F
30H
30G
40
73
63
60A
50
60C
60H
60F
64
62
60D
60G
61
60B
60E
62R
63R
20
90'
110
60KK
60R
77
60KA

FIG. 1

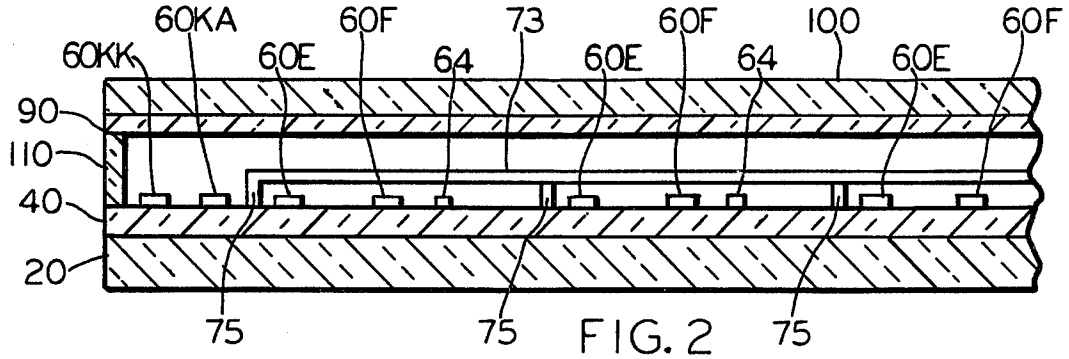


FIG. 2

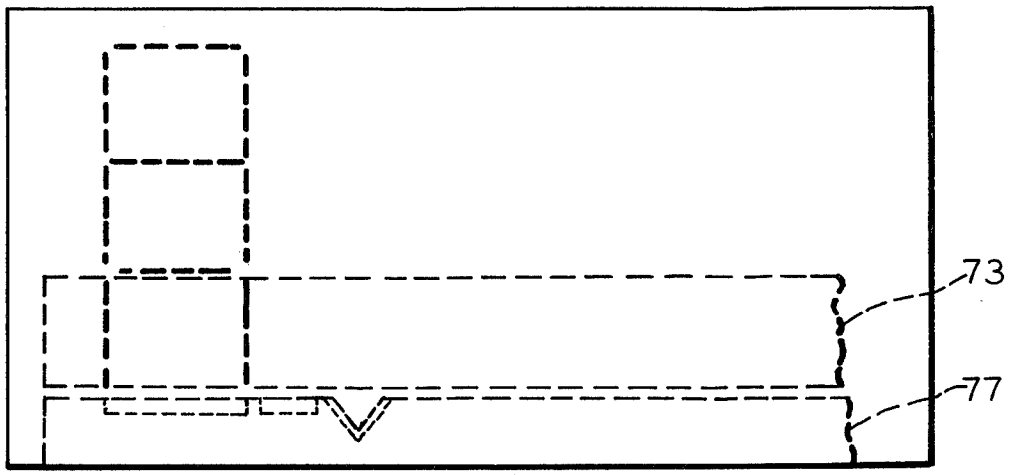


FIG. 3

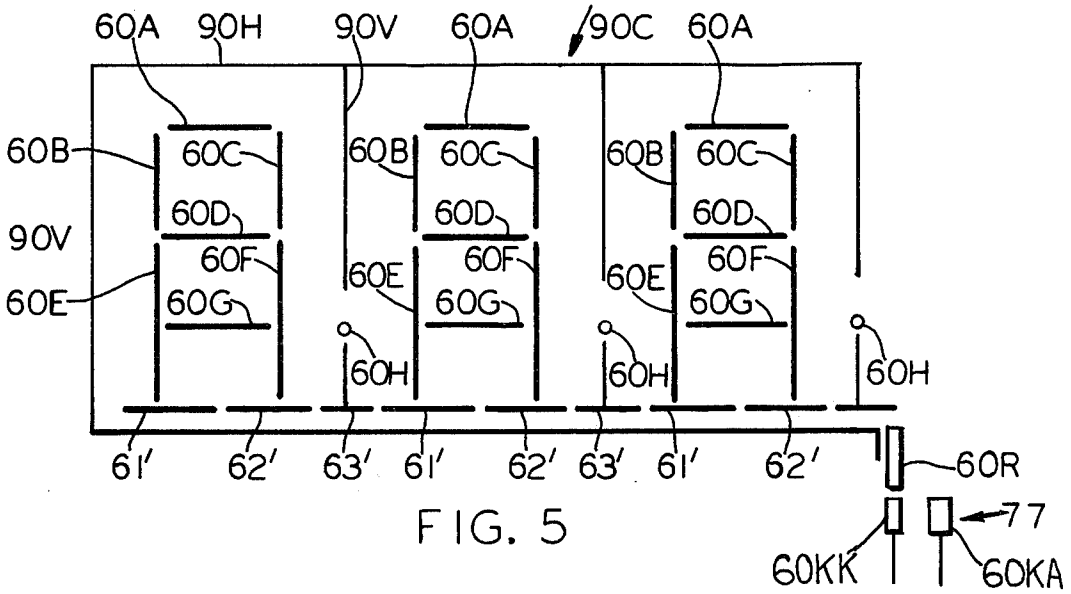


FIG. 5

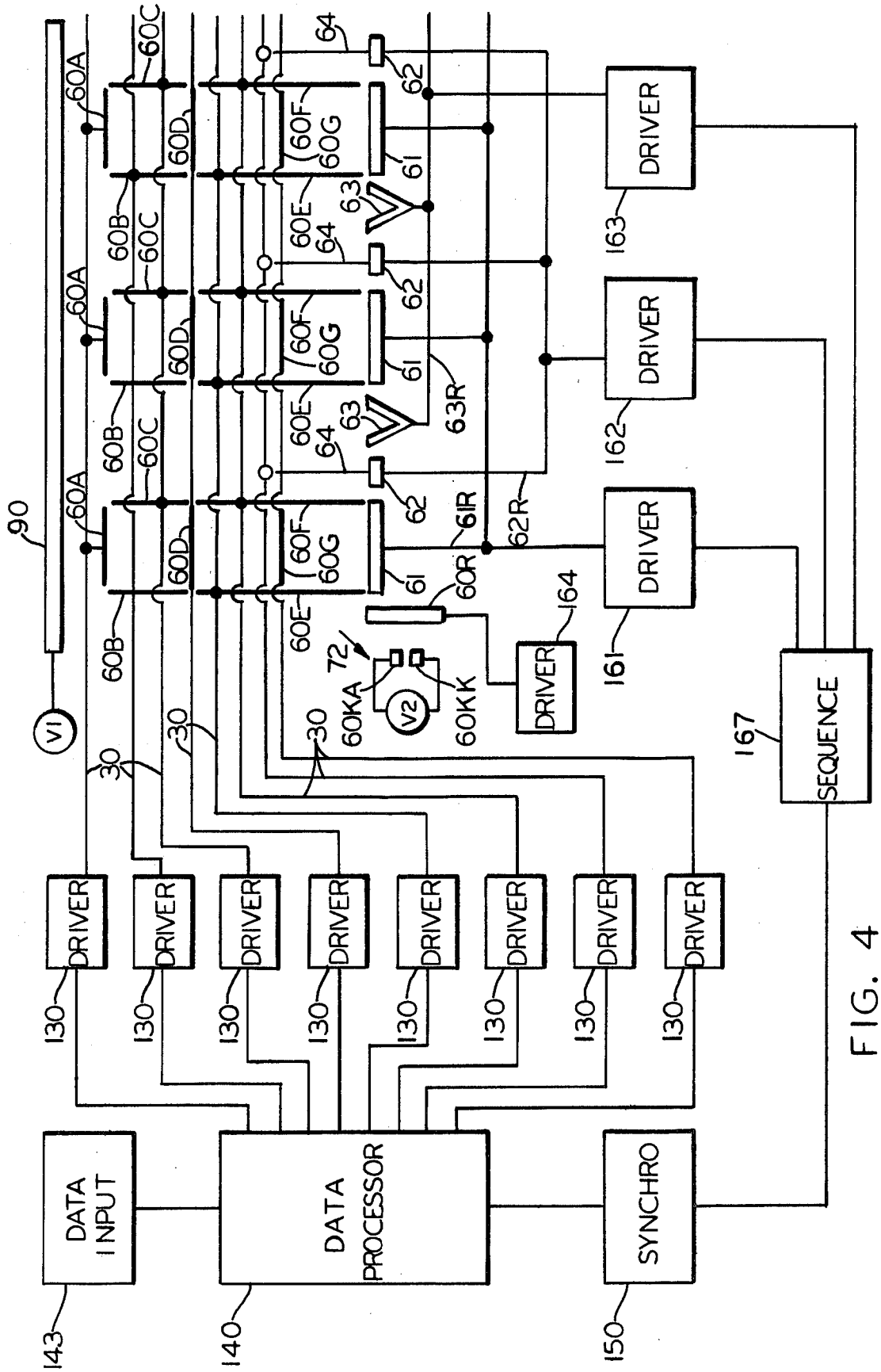

90
60A
60B
60C
60D
60E
60F
60G
60R
60KA
60KK
61
61R
62
62R
63
63R
64
72
V1
V2
30
130
140
143
150
161
162
163
164
167
DRIVER
DATA INPUT
DATA PROCESSOR
SYNCHRO
SEQUENCE

FIG. 4

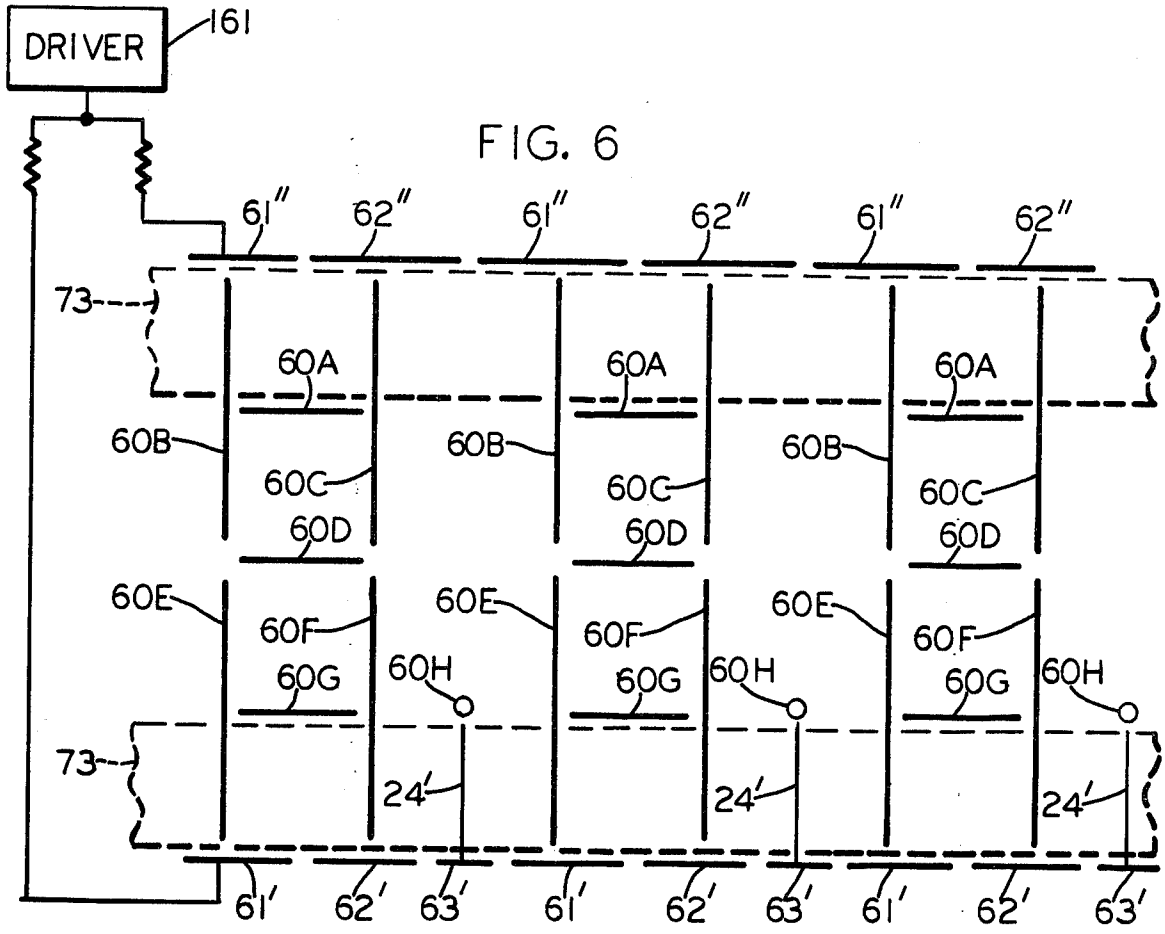

DRIVER
161
61″
62″
61″
62″
61″
62″
73
60A
60A
60A
60B
60B
60B
60C
60C
60C
60D
60D
60D
60E
60E
60E
60F
60F
60F
60G
60G
60G
60H
60H
60H
73
24′
24′
24′
61′
62′
63′
61′
62′
63′
61′
62′
63′

FIG. 6

MULTI-POSITION, GASEOUS DISCHARGE, CHARACTER DISPLAY PANEL INCLUDING AUXILIARY, CATHODE TRANSFER ELECTRODES

BACKGROUND OF THE INVENTION

Multi-position segment-type cold cathode gaseous display devices are now widely used commercially. These devices comprise a gas-filled envelope which contains a plurality of groups of cathode segments and an anode electrode for each such group of segments. Each group of cathode segments and its anode comprise a character position. Generally, each anode has its own contact terminal, and a single common cathode conductor is provided for and connected to one cathode in each group of cathodes. In operation, information signals are applied to the common cathode conductors and to the anodes sequentially to display a character at each character position. This is known as a multiplexing mode of operation and requires a driver for each anode and for each common cathode conductor.

The present invention provides a multi-position display panel which reduces the number of drivers required for its operation since it only requires a single anode. The panel of the invention also embodies a new mode of operation of multi-position cathode segment display panels.

SUMMARY OF THE INVENTION

Briefly, a display panel embodying the invention includes a plurality of groups of cathode segments arrayed in a series, a single anode for all of the cathode groups, and auxiliary transfer electrodes for controlling the operation of the segments of each group and the operation from group to group.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a display panel embodying the invention with the face plate of the panel removed from the rest of the panel;

FIG. **2** is a sectional view through the panel of FIG. **1** assembled;

FIG. **3** is a plan view of the panel of FIG. **1** showing selected portions thereof;

FIG. **4** is a schematic representation of the panel of FIG. **1** and an electronic system in which it may be operated;

FIG. **5** is a schematic representation of portions of the display panel of FIG. **1** and illustrating certain modifications therein; and

FIG. **6** is a schematic representation of another modification of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A display panel **10** embodying the invention includes an insulating base plate **20** of glass, ceramic, or the like which carries, on its top surface, a plurality of conductive leads or runs **30** (A to H). The runs **30** are parallel to each other and aligned with the horizontal axis of the base plate. Eight runs are shown; however, more or fewer may be provided, the number being determined by the total number and type of characters to be displayed. The runs **30** are preferably formed by a screen printing process.

A thin layer **40** of an insulating material, such as glass, is provided on the conductive runs **30**, preferably by a screen printing process. The layer **40** is provided

with a plurality of groups of apertures **50**, each aperture exposing one of the runs **30**. A plurality of groups of numeral-forming cathode electrodes or segments **60** (A to H) are formed on layer **40**, one group being provided for each group of apertures in layer **40**. These cathodes **60** are generally flat elongated bars or segments, and cathodes **60A** to **60G** arrayed in a figure **8**-pattern, as is well known in the art. Cathode **60H** is used as a decimal point and is suitably positioned for this purpose. The cathodes **60** are also formed, preferably by a screen printing process, on layer **40**, and each cathode makes contact with a conductive run **30** through an aperture **50** in layer **40**.

The structural elements described above and the methods by which they are prepared may be the same as those found typically in PANAPLEX display panels manufactured and sold by Burroughs Corporation and in copending U.S. application Ser. No. 173,854, filed Aug. 23, 1971, and now abandoned.

According to the invention, cathodes **60E** and **60F** are longer than those which would normally be employed in a segmenttype display panel such as a PANAPLEX panel. Thus, cathodes **60E** and **60F** are considerably longer than cathodes **60B** and **60C**, and, in some constructions, they may be perhaps twice as long as cathodes **60B** and **60C**. Cathodes **60E** and **60F** extend toward the lower edge of base plate **20** beyond horizontal cathode segments **60G** a suitable distance, for a purpose to be described below. The cathodes **60** are also preferably formed by a screen printing process on layer **40**, as in PANAPLEX panels, and each cathode makes electrical contact with one of the runs **30** through an aperture **50** in layer **40**. It is noted that corresponding cathode segments in each group of cathodes make contact with the same run **30**.

Usually, a second apertured insulating layer is formed on layer **40**, with a separate aperture enclosing each cathode **60**. However, to simplify the drawings, this layer is not shown. This second layer and other details of the structure described above are shown and described in copending application Ser. No. 173,854.

According to the invention, a group of auxiliary cathode electrodes **61, 62, 63** are provided at each character position. These auxiliary electrodes include: a first elongated rectangular electrode **61** which is positioned close to and extends between the lower ends of electrodes **60E** and **60F**; a second generally rectangular electrode **62** positioned closely adjacent to the first electrode **61** and generally axially aligned therewith and in coupling relationship with the decimal point cathode **60H** by means of a line-like conductor **64** which makes contact with cathode **62** and extends from cathode **62** to close to the decimal point cathode; and a third electrode **63** which is positioned between the second electrode **62** of each group and the first electrode **61** of the next adjacent group. Since for uniformity in operation, the three auxiliary electrodes **61, 62,** 63 of each group should have approximately the same area, space considerations may dictate that the electrodes have other than rectangular shapes. As an example, the third electrode may be U-shaped or V-shaped as shown. The auxiliary electrodes **61, 62, 63** are preferably formed by a screen printing process on the insulating layer **40**.

The corresponding auxiliary electrodes are also connected in common, with electrodes **61** interconnected by lead **61R**, electrodes **62** interconnected by lead **62R**, and electrodes **63** interconnected by lead **63R**. The

leads 61R, 62R, and 63R are also formed on base plate 20 in the same way that leads 30 are formed.

A reset cathode 60R is provided on the base plate closely adjacent to the first auxiliary cathode 61 at the arbitrarily selected first character position in the panel. In addition, a keep-alive cell 77 comprising a small-area cathode 60KK and a small-area anode 60KA is formed on insulating layer 40 closely adjacent to the reset cathode 60R. Connecting leads for these electrodes can also be formed on the base plate.

It is noted that the positioning of the keep-alive electrodes close to reset cathode 60R is for the purpose of providing excited particles in the vicinity of this electrode so that it will exhibit cathode glow readily when it is switched ON, and then cathode 61 will fire readily when it is switched ON. In addition, cathode 61 is positioned sufficiently close to cathode segments 60E and 60F so that glow can readily be transferred from cathode 61 to either of cathodes 60E or 60F. The same considerations apply to the closeness of cathode 61 to cathode 62 and cathode 62 to cathode 63. Also, the cathode segments 60A to 60G, which are used to form numerals, must be suitably spaced so that glow can be transferred from one to another so that numerals zero to nine can be formed, in a manner to be described below.

As those skilled in the art will understand, the spacing provided between the various cathode electrodes depends on a number of parameters including gas pressure, the desired speed of transfer, the relative sizes of the transferor and transferee electrodes, the closeness of the envelope walls, the rate of attenuation of excited priming particles, and the like. From information obtained from various panels which have been built, spacings of about five to about forty mils in constructions of typical display devices are suitable.

The panel 10 also includes a large-area anode 90 for use with all of the cathode electrodes, including both the segment cathodes and the auxiliary cathodes. Preferably, the anode comprises a thin, transparent conductive film of gold, tin oxide, or the like, deposited on the lower surface 96 of the panel face plate 100 which is preferably made of glass. The anode film 90 is generally rectangular in shape, and it is dimensioned and positioned so that it overlays and is in operative relation with all of the cathode electrodes 60 and auxiliary cathodes 61, 62, 63.

An opaque mask or shield 73 is provided within the panel of a shape suitable to cover all but the lower tip portions of cathodes 60E and 60F which extend beyond the horizontal cathode segment 60G and the conductors 64 which approach the decimal point cathodes 60H. The shield 73 is provided to obstruct from view these cathode portions so that they are not seen by a viewer. The shield does not cover or overlay the tips of cathodes 60E and 60F and cathode electrodes 61, 62, and 63 which operate with anode 90. The shield may be a sheet of insulating material such as mica or the like which is set in place over the cathodes, as shown, and it may rest by means of suitable insulating supports 75 on insulating layer 40. In addition, the cathodes 61, 62, and 63 are obstructed from view through the face plate by means of an opaque mask in the form of an insulating coating 79 formed on the inner surface of the face plate of the panel between the face plate and anode 90. Coating 79 could also be formed to obstruct from view the portions of cathodes 60E and 60F which extend beyond cathodes 60G, cathodes 61, 62, and 63, and conductors 64, in which case, shield 73 would not be needed.

In still another arrangement illustrated in FIG. 1, the desired obstructive shield might comprise a conductive strip 79', formed on the anode or behind the anode, of a size suitable to obstruct the desired electrode portions from view. The strip 79' would operate as an anode.

Other arrangements can be used for obstructing from view electrodes which should not be seen, and those skilled in the art will be able to devise such arrangements.

It is to be noted that, if desired, a separate anode 90' (shown in dash lines in FIG. 1) may be provided for the auxiliary electrodes and positioned generally coplanar therewith, in which case, shield 73 could also overlay and obstruct cathodes 61, 62, 63 and their anode 90'.

The relationship between the cathode segments and the opaque shields 73 and 79 is illustrated schematically in FIG. 3.

In panel 10, the top glass cover plate 100 is spaced from the base plate and is secured thereto by an hermetic seal formed of a ring or frame 110 of a suitable glass frit. In a display panel of the type described, the spacing is relatively critical, and, in one commercial form of the panel, the spacing is of the order of 20 mils. This spacing and a relatively high gas pressure of about 400 Torr insure that the desired transfer of cathode glow is achieved as described below. Those skilled in the art will understand the effect of spacing and gas pressure on panel operation and can readily select the desired parameters in any particular application.

In order to make electrical circuit connections to the various electrodes of panel 10, the runs 30 are terminated in pads (not shown) at an edge of the base plate 20, and similar pads (not shown) are provided for the keep-alive electrodes 60KA and 60KK and the auxiliary cathode leads 61R, 62R, and 63R. Anode 90 is provided with a contact pad 93 at an edge of the face plate.

A typical circuit for operating panel 10 is shown schematically in FIG. 4. The panel is also represented schematically. In the circuit, each cathode run 30 is connected to a driver 130, and each cathode driver 130 is connected to data processing apparatus 140 which may include a computer, encoders, decoders, character generator, and other circuit modules, as is well known in the art. A source 143 of data signals to be displayed is connected to the input of the data processing apparatus 140. The auxiliary cathodes 61, 62, 63 are each connected by their leads 61R, 62R, 63R to separate drivers 161, 162, and 163 and to a sequence control circuit 167; and the anode 90 is connected to a power source V1. Suitable synchronizing circuits represented by block 150 are provided and connected to the data processor 140, sequencer 167, and the various drivers to achieve the desired operation of the panel, as described below.

The keep-alive electrodes 60KK and 60KA are connected to a source of potential V2 such that the keep-alive cell 77 is always energized and generating excited particles. Reset cathode 60R is connected to a driver 164.

The operation of panel 10 to display characters depends on a function which is called propinquity priming. In this function, characters are displayed by energizing selected cathode segments 60, which make up

the character, sequentially, and in order, determined by the closeness of one cathode to another. This function or mode of operation is illustrated in the following description. With the keep-alive cell **77** ON and generating excited particles, and with the anode **90** connected to operating potential, and assuming that information will be entered in the panel from left to right, first, reset cathode driver **164** is energized to cause the reset cathode **60R** to fire and exhibit cathode glow and thus to generate excited particles in its vicinity. Next, cathode driver **161** is operated to turn on the first transfer electrode **61** which is positioned close to the reset cathode **60R**. Cathode **61** is energized and glows and generates excited particles in its vicinity.

Although all of the cathodes **61** are electrically connected and they are all energized at the same time, only the first cathode **61** fires since it is immediately adjacent to the reset cathode and to the excited particles generated thereby, and the other cathodes **61** are too remote to fire. This illustrates the operation of the principle of propinquity priming, and the principle applies to all cathodes energized in displaying a character and in transferring from one character position to the next. Next, input information signals are applied to selected cathode drivers **130** which, in turn, apply operating potential to the cathode segments **60** in any suitable sequence which permits glow to transfer, with the aid of excited particles, to segments which are adjacent to each other, in accordance with the principles of propinquity priming.

Thus, for example, if it is desired to display a numeral 1, then glow is transferred from transfer electrode **61** to cathode segment **60E** or **60F**, and then to segment **60B** or **60C**, back to **60E** or **60F**, and then to transfer segment **62.** If it is desired to cause, say, a numeral 3 to be represented at the first position, then segments **61, 60F, 60G, 60F, 60D, 60C,** and **60A** are energized in order and then in the reverse direction and to transfer electrode **62.** Alternatively, from vertical cathode **60F**, glow could be transferred to horizontal cathodes **60F** and **60D** simultaneously, or from vertical cathode **60C** to horizontal cathodes **60A** and **60D** simultaneously. Suitable programs can be readily determined by those skilled in the art.

After a character has been displayed at the first character position and glow has been transferred to cathode **62,** glow is then transferred from transfer electrode **62** to the decimal point **60H**, if the information signals so dictate, to the third transfer electrode **63,** and then to the first transfer electrode **61** of the second group of cathode segments where a character is displayed in the manner described above for the first character position. This procedure is carried out through the series of character positions sequentially and repeatedly at such a rate that a stationary but changeable series of characters is displayed in the various character positions.

It is to be noted that all of the arabic numerals, zero to nine, can be formed using cathode **60E** or **60F** as a starting point and then proceeding smoothly, with no interruptions, from cathode to adjacent cathode.

It is also noted that the information source **140,** in particular, the computer thereof, is programmed to provide the required sequencing of the cathodes **60** to display the proper character in response to input signals to the system from source **143.**

Of course, it is clear that the panel can be operated from right to left, rather than left to right, with the appropriate positioning of the keep-alive cell, the reset cathode, and the scanning or transfer cathodes **61, 62,** 63.

It will be clear to those skilled in the art that many modifications can be made in the structure of panel **10** within the scope of the invention. For example, since all of the arabic numerals zero to nine could also be formed with cathodes **60B** or **60C** as the starting point, the transfer electrodes **61, 62, 63** could be disposed along the upper margin of the panel adjacent to the upper ends of cathodes **60B** and **60C**, suitably elongated. Suitable masking would be provided as described above.

In another modification of the invention illustrated in FIG. **6,** a display panel uses a somewhat different arrangement of auxiliary electrodes and includes elongated electrode **61'** positioned close to, and in transfer relation with, cathode **60E**, an elongated electrode **62'** positioned adjacent to, and in transfer relation with, transfer electrode **61'** and display cathode **60F**, and transfer electrode **63'** positioned in transfer relation with electrode **62'** and having an extension **24'** which extends to and is in operative relation with the decimal point cathode **60H**. Transfer electrode **61'** of the next character position is in transfer relation with transfer electrode **63'**. A mask **73,** illustrated by dash lines, is provided to cover the extensions of cathodes **60B** and **60C**. With this arrangement, corresponding upper and lower auxiliary cathodes might be connected together through resistive paths to a single driver, as illustrated only for cathodes **61'** and **61''**. The provision of such auxiliary cathodes **61''** and **62''** would provide a greater range of signal routines permissible for scanning through each group of cathodes to display a character.

A panel embodying the invention may also use an anode, coplanar with the cathodes on the base plate **20,** in place of, or in addition to, anode **90** on face plate **100.** Such an anode **90C** is shown schematically in FIG. **5** and comprises a horizontal metal strip **90H** which extends along the length of the series of cathode groups, with vertical strips **90V** extending therefrom between each group of cathodes and along the sides of the first and last groups of cathodes and suitably insulated from other electrodes in the panel. Such a coplanar anode may take other suitable forms as required.

What is claimed is:

1. A multi-position character display panel comprising

a gas-filled envelope consisting of a base plate and a face plate having a viewing window and containing,

a plurality of groups of display cathode electrodes adapted to be energized in different combinations to display characters, the cathodes in each group being so positioned that cathode glow can transfer readily from one cathode to an adjacent cathode in a selected sequence through the display cathodes of each group whereby each display cathode is in glowtransfer proximity to at least one other display cathode whereby every cathode of each group can be energized and caused to exhibit cathode glow,

an anode electrode in operative relation with each of said groups of display cathode electrodes, and

a plurality of groups of auxiliary cathode electrodes disposed adjacent to and between each group of display cathode electrodes, said auxiliary cathode electrodes being disposed in series, with adjacent

electrodes being close to each other so that cathode glow can transfer readily from one to another, said auxiliary electrodes also being positioned close to selected ones of said display cathode electrodes so that cathode glow can transfer readily from an auxiliary cathode electrode to at least one display cathode electrode in each said group of display cathodes whereby characters can be displayed by each group of display cathodes by means of cathode glow transferred along each group of auxiliary cathode electrodes and from each group of auxiliary cathode electrodes through each group of display cathode electrodes.

2. The display panel defined in claim **1** wherein each of said groups of display cathodes defines a figure **8** pattern which has an upper margin and a lower margin, said auxiliary cathode electrodes being disposed along said lower margin.

3. The display panel defined in claim **2** wherein said auxiliary cathodes are axially aligned in a series.

4. The display panel defined in claim **2** wherein said groups of display cathodes are arrayed in a series along the length of said panel, and said auxiliary cathodes are axially aligned in a series along the entire length of said panel in operative relation with said series of groups of display cathodes.

5. The display panel defined in claim **1** wherein each group of display cathode electrodes defines a figure **8** pattern and includes two upper vertical segments, two lower vertical segments, and three parallel horizontal segments including top, middle, and lower horizontal segments, the two lower vertical segments extending beyond the lowermost horizontal segment toward the lower edge of said panel,

said top horizontal segment being generally aligned with the upper ends of said two upper vertical segments, said middle horizontal segment being disposed adjacent to the lower ends of said two upper vertical segments and adjacent to the upper ends of said two lower vertical segments, and said lower horizontal segment being disposed between the upper and lower ends of said two lower vertical segments,

said auxiliary electrodes being disposed adjacent to the lower free ends of said two lower vertical electrodes.

6. The display panel defined in claim **1** and including an auxiliary anode electrode for said auxiliary cathode electrodes.

7. The panel defined in claim **6** wherein said auxiliary anode electrode is coplanar with said auxiliary cathode electrodes.

8. The display panel defined in claim **1** and including means obstructing said auxiliary cathode electrodes from view.

9. The display panel defined in claim **8** wherein said means comprises an opaque member supported on said base plate of said panel.

10. The display panel defined in claim **1** wherein each group of auxiliary cathode electrodes includes three conductive segments.

11. The panel defined in claim **1** and including a plurality of first conductive runs, each interconnecting corresponding display cathode electrodes in each said group of display cathodes, and a plurality of second conductive runs, each interconnecting corresponding auxiliary cathode electrodes in each said group of auxiliary cathode electrodes.

12. The panel defined in claim **1** and including circuit means for energizing the auxiliary cathodes in each group of auxiliary cathodes in a series and simultaneously energizing selected ones of the associated display cathodes in each group of display cathodes to display a character, the auxiliary cathodes being energized and the selected display cathodes being energized by the transfer of cathode glow from one electrode to another electrode with glow being transferred only from one electrode to an adjacent electrode with which it is in glow-transfer relationship.

13. The panel defined in claim **1** wherein said anode is positioned on said face plate facing said groups of display cathodes and spaced therefrom a distance of about 20 mils, the gas pressure in said envelope being about 400 Torr.

* * * * *