United States Patent [19]

Lee

[11] **3,891,983**

[45] **June 24, 1975**

[54] **MULTI-POSITION CHARACTER DISPLAY PANEL HAVING DISPLAY CATHODES AND AUXILIARY CATHODES AND CIRCUITS FOR OPERATING THE SAME**

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[73] Assignee: **Burroughs Corporation,** Detroit, Mich.

[22] Filed: **June 20, 1974**

[21] Appl. No.: **481,172**

[52] **U.S. Cl.** ..... **340/336;** 315/168; 315/169 R; 340/324 M

[51] **Int. Cl.** **G08b 5/36**

[58] **Field of Search** ..... 340/324 M, 336, 166 EL; 315/168, 169 R, 169 TV

[56] **References Cited**

UNITED STATES PATENTS

3,694,693	9/1972	Holz	340/336
3,778,675	12/1973	Harvey	315/169 TV
3,790,850	2/1974	Doane et al.	340/336
3,801,863	4/1974	Lee	315/169 TV
3,809,952	5/1974	Eisenberg et al.	315/169 TV
3,821,598	6/1974	Holz	315/169 R

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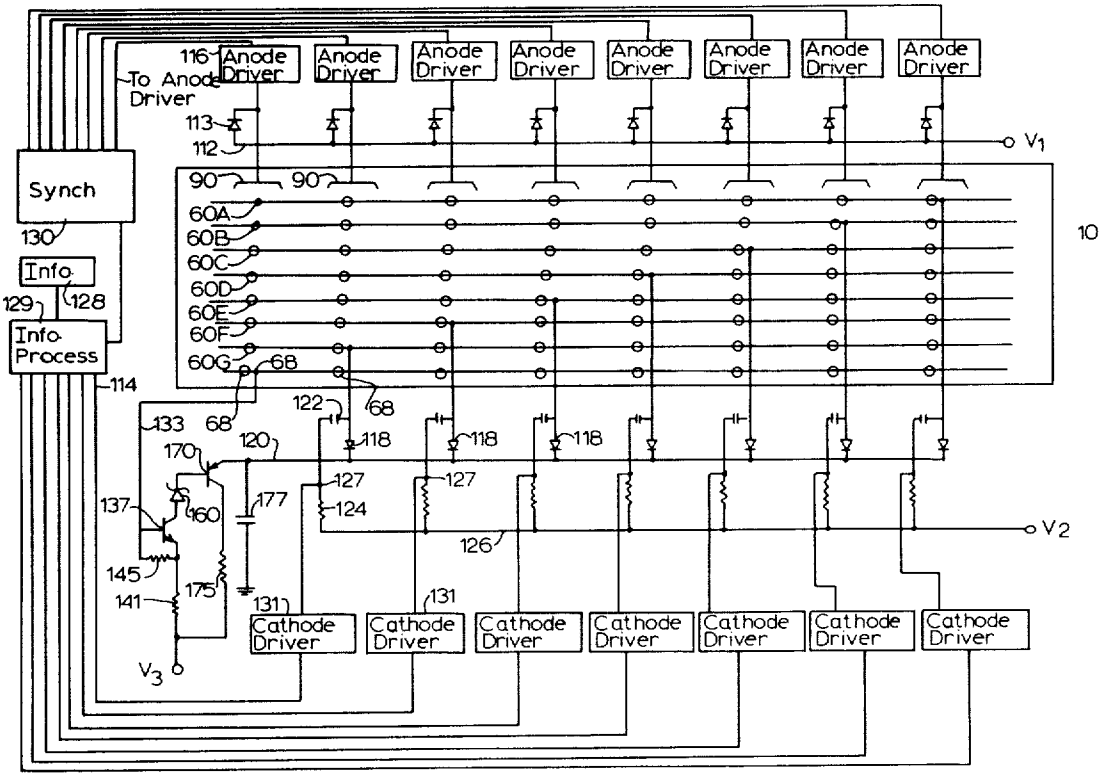
Attorney, Agent, or Firm—Paul W. Fish; William B. Penn; Robert A. Green

[57] **ABSTRACT**

The display panel is gas-filled and includes a base plate on which a plurality of groups of display cathodes and their conductors are formed, each group of display cathodes being operable to display a character. The panel also includes anode electrodes, one associated with each group of cathodes. The base plate and face plate are spaced apart a small, critical distance and are hermetically sealed together. The panel also includes an auxiliary cathode electrode for each group of display cathodes, the auxiliary cathode electrodes being operable either as sources of electrons for each group of display cathodes to facilitate the operation thereof, or as voltage-regulating elements in the circuit used for driving the panel.

10 Claims, 4 Drawing Figures



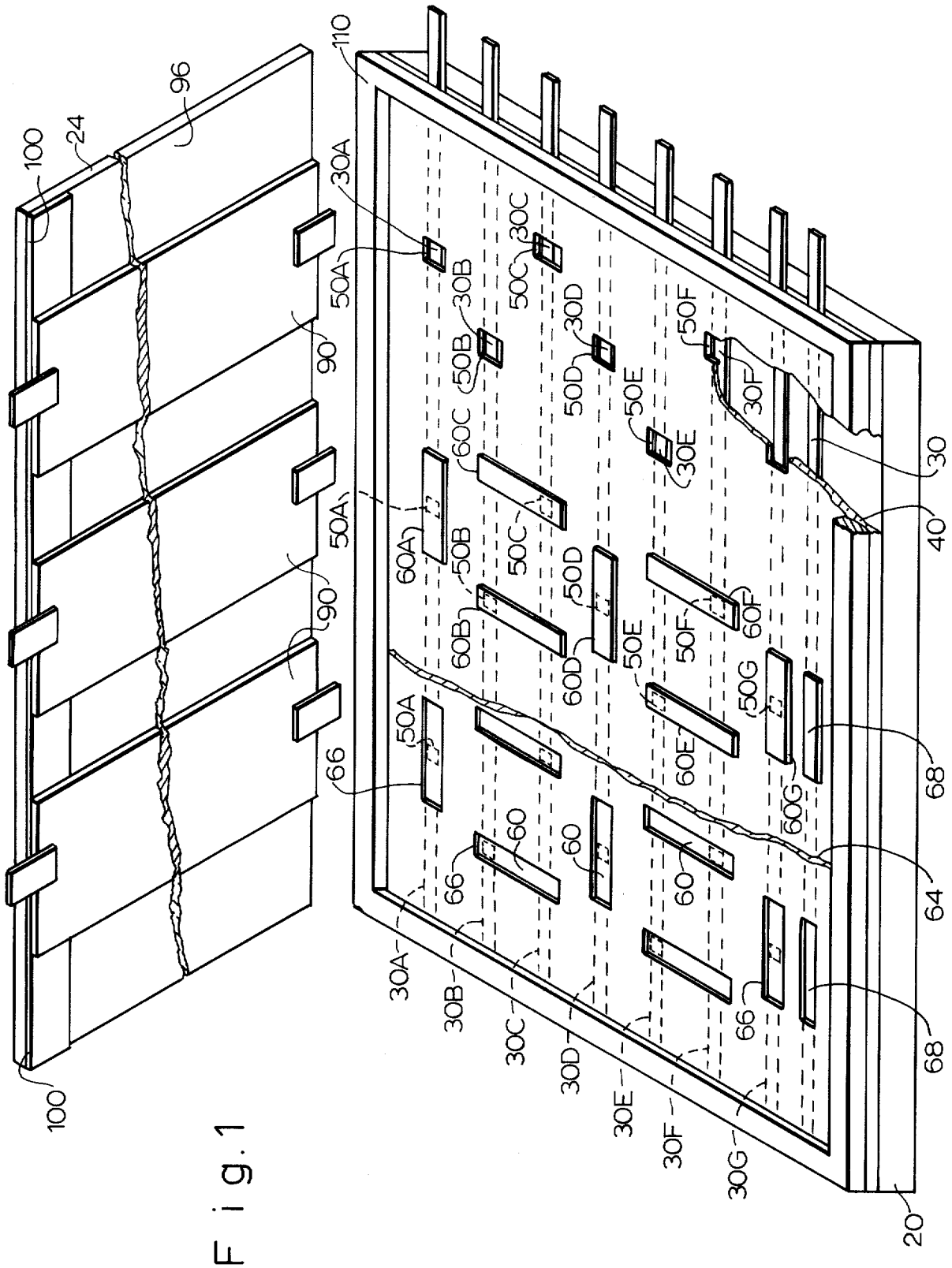

110
30A
30B
30C
30D
30E
30F
30G
30
40
20
50A
50B
50C
50D
50E
50F
50G
60A
60B
60C
60D
60E
60F
60G
60
66
68
64
90
96
24
100

Fig. 1

Fig. 2

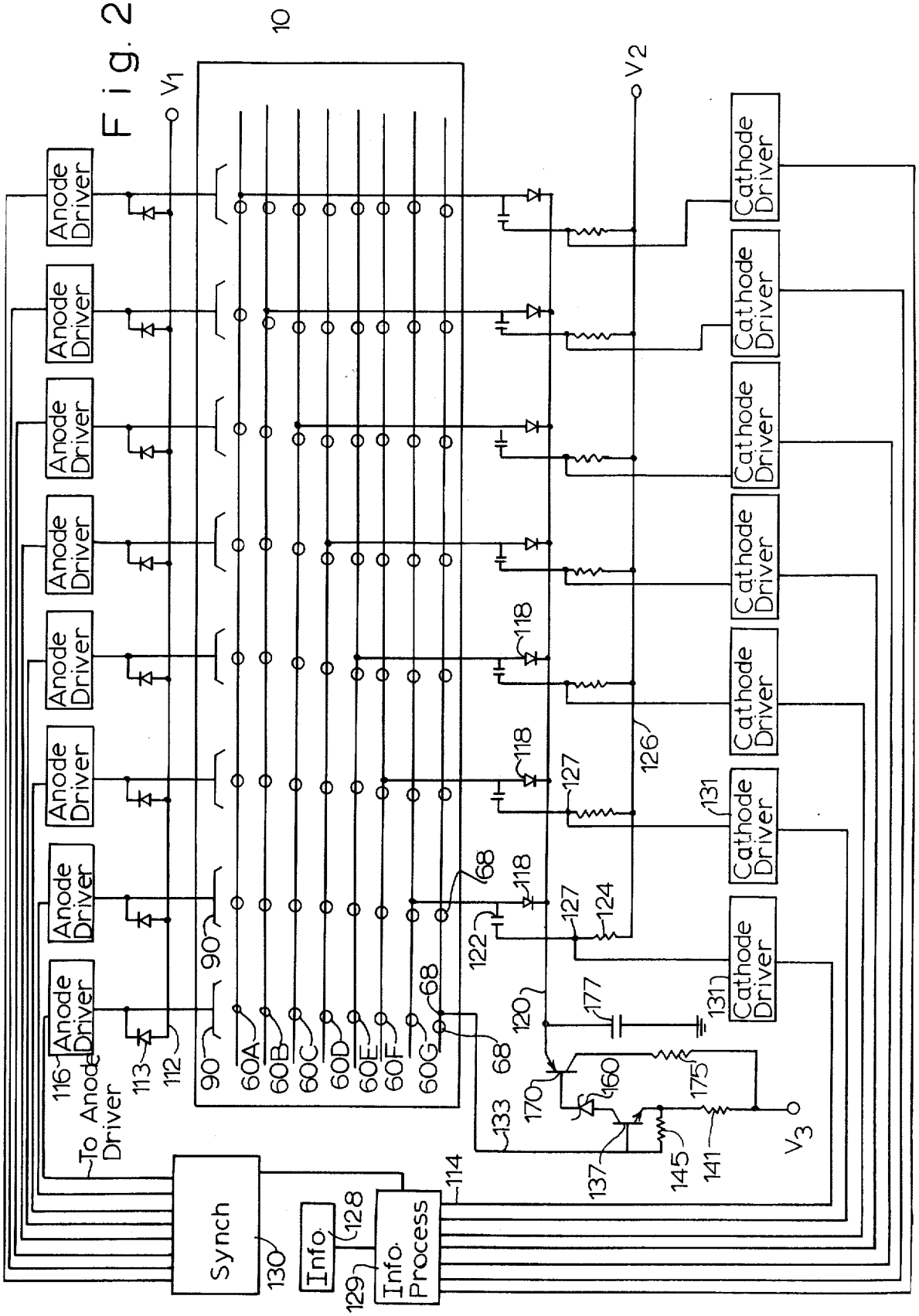
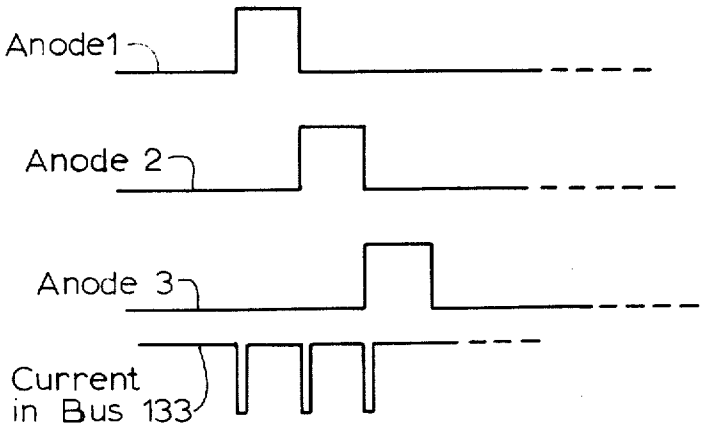

10
V1
V2
V3
Anode Driver
Cathode Driver
Synch
Info.
Info. Process
To Anode Driver
60A
60B
60C
60D
60E
60F
60G
90
112
113
116
118
120
122
124
126
127
128
129
130
131
133
137
141
145
160
170
175
177
68
114

Fig. 3


Anode1
Anode 2
Anode 3
Current
in Bus 133

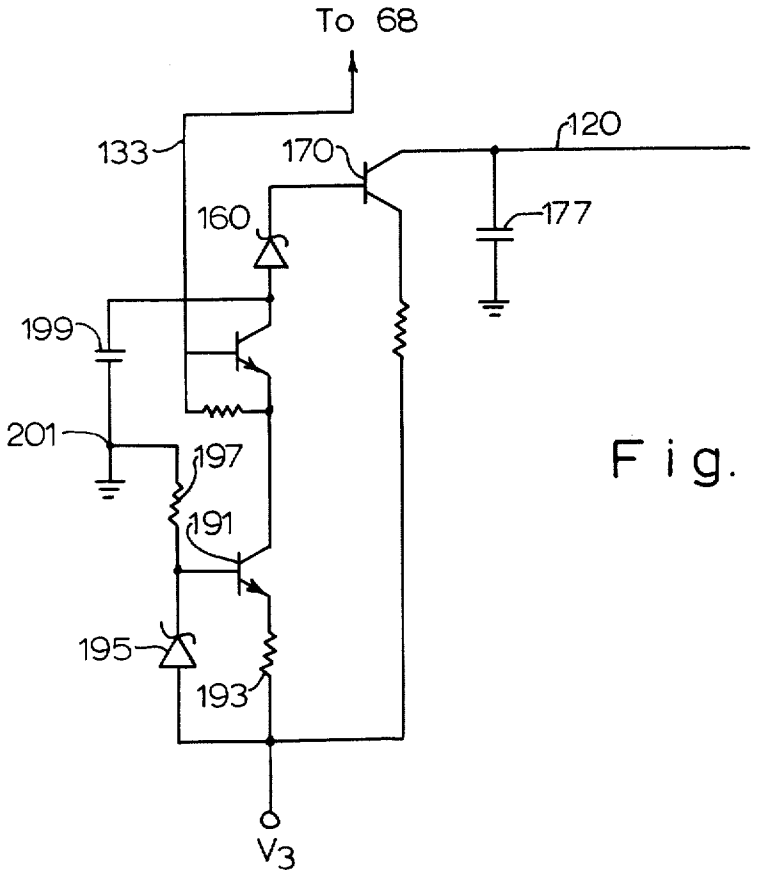

To 68
133
170
120
160
177
199
201
197
191
195
193
V3

Fig. 4

MULTI-POSITION CHARACTER DISPLAY PANEL HAVING DISPLAY CATHODES AND AUXILIARY CATHODES AND CIRCUITS FOR OPERATING THE SAME

BACKGROUND OF THE INVENTION

The present invention relates to panel-type segment display devices which include a plurality of groups of cathode electrodes, the cathode electrodes comprising elongated bars or segments arrayed in a pattern so that the cathodes of each group can be selectively energized to display a character. For reasons of economy, the same corresponding cathode electrodes in each group have a common conductor, but the anodes are separately energizable and the panel is operated in a multiplex mode of operation.

In this mode of operation, information signals are applied to all of the cathode electrodes continually, and the anodes are pulsed into operation sequentially. Thus, at any instant, as an anode is energized, the appropriate corresponding information is applied to the associated cathodes which are turned on and display a character. This type of operation is carried out continuously throughout the panel at such a rate that stationary but changeable characters are displayed therein.

While panels of this type operate quite satisfactorily, under some circumstances, as the anodes are operated sequentially, all of the associated cathodes may not turn on. The reason for this failure in cathode operation is not completely understood.

SUMMARY OF THE INVENTION

Briefly, a multiple position display panel embodying the invention includes a plurality of groups of cathode electrodes, each representing a character position, and an associated anode electrode. To insure turn-on of the cathodes at each position, an auxiliary gas cell is provided in operative relation with each character position to supply excited particles to facilitate cathode turn-on, and to provide, in a loop circuit, operating bias potential for the associated cathode electrodes.

DESCRIPTION OF THE DRAWINGS

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

FIG. 2 is a schematic representation of the panel in FIG. 1 and a circuit in which it may be operated;

FIG. 3 shows curves of anode voltage and the associated current pulses through one of the other electrodes of the panel of FIG. 1 when operated in the circuit of FIG. 2; and

FIG. 4 is a schematic representation of a modification of a portion of the circuit of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The principles of the invention are applicable to a gas-filled display panel of the type known as a PANAPLEX panel and sold commercially by Burroughs Corporations. This type of panel **10** is a thin, flat, sheet-like member which includes an insulating base plate **20** of glass, ceramic, or the like, and an insulating face plate **24** of glass or the like hermetically sealed together with a small spacing between them provided by an insulating spacer frame **26.** The base plate carries, on its top surface, a plurality of conductive leads or runs **30,** and a thin layer **40** of insulating material such as glass or ceramic is provided on the conductive runs **30.** The layer **40** is provided with a plurality of groups of apertures **50,** each aperture exposing one of the runs **30.**

Panel **10** includes a group of display cathode electrodes **60** for each group of apertures **50.** The cathodes **60**A to **60**G are used to represent numerals and are generally elongated bars or segments arrayed in a figure "8" pattern, as is well known in the art. Normally, cathodes are also provided to represent decimal points and commas; however, these are omitted to simplify the drawing. Each cathode **60** makes contact with a conductive run **30,** with the corresponding cathodes in each group making contact with the same run.

According to the invention, the panel **10** is also provided with an auxiliary cathode **68** at each character position, and each such auxiliary cathode comprises a generally triangular or elongated member disposed adjacent to the lower or upper margin of each group of display cathodes and connected through an aperture in layer **40** to a conductive run **30** on the base plate.

Under some circumstances, it may be desirable to provide a second layer of insulating material **64** having a plurality of apertures **66,** each enclosing one of the cathode electrodes. Such an arrangement is shown in copending application Ser. No. 446,832, filed Feb. 28, **1974.**

All of the panel elements which are supported on the base plate **20** may be formed by a screen-printing process.

Panel **10** includes an anode electrode **90** for each group of display cathode electrodes **60** and auxiliary cathode **68.** The anode electrodes **90,** in one arrangement, comprise thin, transparent conductive films of gold, tin oxide, or the like formed on the inner surface **96** of the panel face plate **24** and overlaying the cathodes with which they operate.

The panel includes means for shielding the auxiliary electrodes **68** from view through face plate **24,** and one such means comprises a layer **100** of opaque material formed on the inner surface **96** of face plate **24** between the anodes **90** and the face plate. Any one suitable shield means may also be provided.

The panel **10** also preferably includes a keep-alive cell (not shown) positioned at the left-hand or right-hand end of the panel, depending on the direction in which the panel is scanned. The keep-alive cell usually comprises small-area cathode and anode electrodes formed on the insulating layer **40.**

The panel **10** is filled with the desired gas atomsphere such as neon, argon, xenon, etc., singly or in combination, along with a vapor of a metal such as mercury included in the gas to minimize cathode sputtering. A wide range of gas pressures may be used, for example, from about 20 to about 350 Torr, or more, at ambient temperature, with a pressure selected from the range of about 70 to about 125 Torr at room temperature being commonly and conveniently used.

Any suitable arrangement may be used to make electrical connection to the anodes and to the cathodes through their runs **30.** One such arrangement is shown and described in copending application Ser. No. 370,786, filed June 18, 1973.

The display panel **10** and a circuit in which it may be operated are shown schematically in FIG. **2.** In the circuit, the anode electrodes **90** are each connected through a diode **113** to a first bus **112** which is connected to a positive D.C. power source VI. Each anode

is also connected to an anode driver **116** for energizing each anode sequentially. Each cathode conductor **30** is connected through a diode **118,** oriented as shown, to a second bus **120,** known as a cathode restoring bus, and through a capacitor **122** and a resistor **124,** in series, to a third bus **126** which is connected in turn to a negative D.C. power supply V2 of the order of −40 volts. The junction **127** of each capacitor **122** and resistor **124** is also connected to a cathode driver **131** for applying information signals to the cathode leads **30** and the associated cathodes **60.** The circuit includes a source **128** of information signals coupled to signal processing circuitry **129** including, for example, a computer, encoders, decoders, character generator, and the like, as is well known in the art. Circuit **129** has an output lead **114** to each cathode driver. Also provided are synchronizing circuits **130** for operating each of the anodes sequentially and simultaneously applying information signals on leads **114** to the cathode drivers, as is well known in the art.

According to the invention, the common conductor **30** connected to each of the auxiliary cathodes **68** is connected by lead **133** to the base of a PNP transistor **137,** the emitter of which is connected through a relatively large resistor **141** to a negative D.C. power source V3 of the order of −150 volts to −180 volts. Resistor **141** is sufficiently large to constitute the cathode current-determining element of the circuit. The emitter of transistor **137** is also connected through a resistor **145** to its base electrode, and its collector is connected through a Zener diode **160,** oriented as shown, to the base of a PNP transistor **170.** The collector of transistor **170** is connected through a resistor **175** to the power supply V3, and its emitter is connected both to bus **120** and through a capacitor **177** to ground.

In operation of the invention, in general terms, each of the anode electrodes **90** is energized separately and in turn, and simultaneously, information signals are applied to the cathode drivers **131** and thus to the display cathodes **60** so that, as each anode is energized, selected display cathodes are energized and a character is displayed. In this operation of panel **10,** the auxiliary cathode electrodes **68** serve to set the display cathodes **60** to the required operating bias level as follows.

When the system is turned on, the anodes begin to scan, and information signals are applied to the cathode drivers; however, the display cathodes **60** do not turn on because the cathode bus **120** is held at ground potential by capacitor **177.** The auxiliary cathodes see the power supply V3, and at some panel position, determined randomly by circuit and panel parameters, the auxiliary cathode **68** exhibits cathode glow, and current flows between it and its anode **90.** This current flows from source V3 through resistors **141** and **145,** and this causes transistor **137** to turn on and conduct current through its emitter collector path. This current flow produces a voltage drop across diode **160** and drives the base of transistor **170** in a generally negative direction, and current flows through its emitter collector path. This causes capacitor **177** to charge negatively until a potential is reached which is more positive than that on auxiliary electrode **68.** Diode **160** determines this potential which appears on bus **120** and comprises the proper hold-off bias for the cathode segments **60.** This potential is just sufficient to prevent these display cathodes from glowing until selected cathode drivers are energized and negative potentials are applied to the associated selected display cathodes. The negative potentials, coupled with the applied bias, are sufficient to cause the selected cathodes to exhibit cathode glow.

With the cathode electrodes thus biased, information signals of minimal magnitude can be used to cause cathode glow. Typically, in panels of the type known as PANAPLEX panels, such signals may be about 25 to 50 volts in amplitude.

As the panel **10** operates each position in turn, as each anode is energized, its associated auxiliary cathode **68** performs the biasing operating described above before its associated display cathodes, selected by the input information signals, exhibit cathode glow.

FIG. 3 shows voltage pulses applied to three anodes sequentially with the accompanying current pulse which passes through the auxiliary electrode circuit as each anode is energized.

In a modification of the invention illustrated in FIG. **4,** the resistor **141** of FIG. **2** is replaced by an NPN transistor **191** connected as a constant current source with its collector connected to the emitter of transistor **137,** its emitter connected through a resistor **193** to voltage supply V3, and its base connected both through a Zener diode **195** to the voltage supply V3 and through a series resistor **197** and capacitor **199** to the collector of transistor **137** and thus to the anode of diode **160.** The junction **201** of the resistor **197** and capacitor **199** is connected to a source of reference potential such as ground.

In the modification of FIG. **4,** transistor **191** represents a constant current source which provides improved regulation and control of the current flow through the auxiliary electrodes independently of variations in the system power supply.

In one circuit used for operating a PANAPLEX panel of the type manufactured and sold by Burroughs Corporation, the following circuit parameters were used:

Resistor 124	27,000 ohms
Resistor 145	5,000 ohms
Resistor 141	200,000 ohms
Resistor 175	1,000 ohms
Capacitor 122	.01 uf
Capacitor 177	1.0 uf
Transistor 170	2N4888
Transistor 137	2N5551
V3	−180 volts
V1 and V2	− 20 volts
Diode 160	1N4627

What is claimed is:

1. A display panel and system for operating the same comprising

a gas-filled envelope including a base plate and a face plate having a viewing window,

a plurality of groups of display cathode electrodes supported on said base plate and adapted to be operated in different combinations to display different characters,

corresponding cathodes in all of the groups being interconnected by a single common conductor, there thus being a single common conductor for each corresponding cathode electrode in each of said groups,

an auxiliary cathode electrode associated with each said group of display cathodes,

an auxiliary common conductor connected to all of said auxiliary cathodes,

an anode electrode associated with each said group of cathodes,

means coupled to said anodes and said common conductors for sequentially energizing each of said anode electrodes and simultaneously applying information signals to selected ones of said common conductors and their associated display cathodes, and

a circuit loop connected between said auxiliary common conductor and all of said single common conductors including means for generating a bias voltage in response to current flow through an auxiliary electrode and applying said bias voltage to all of said display cathodes.

2. The system defined in claim **1** wherein said circuit loop includes a diode for generating said bias voltage.

3. The system defined in claim **1** wherein said loop includes a current flow path through a resistive path to a source of negative D.C. potential, and a plurality of semiconductor devices coupled between said path and said common conductors, said semiconductor devices operating to couple said bias voltage to said common conductors.

4. The system defined in claim **1** wherein all of said common conductors are connected to a common bus, and said common bus is coupled through a capacitor to ground.

5. The system defined in claim **3** wherein said plurality of semiconductor devices includes a first semiconductor device coupled through a diode and a second semiconductor device to all of said common conductors.

6. The system defined in claim **5** wherein said diode is a Zener diode.

7. A system for operating a multiple position display device having a plurality of groups of display cathode electrodes and an anode electrode associated with each said group, corresponding cathodes in the different groups being interconnected by a single common conductor, there thus being a single common conductor for each corresponding cathode electrode in each of said groups, there being an auxiliary cathode electrode associated with each group of cathode electrodes and auxiliary common conductor interconnecting all of said auxiliary cathode electrodes, said system including

an anode driver circuit connected to each of said anode electrodes,

a cathode driver connected to each of said common conductors for applying display signals thereto,

a bus coupled to all of said common conductors connected to said display cathode electrodes, and

a current flow path from each anode through said auxiliary common conductor including means for developing a voltage proportional to current flow therein and for applying said voltage to said bus,

said voltage biasing all of said display cathodes at a level such that said display signals, when applied to selected cathode drivers, can cause such cathode drivers to energize the associated display cathodes to exhibit cathode glow.

8. The system defined in claim **7** and including a capacitor coupling said bus to ground.

9. The system defined in claim **7** wherein said current flow path includes a first semiconductor device coupled through a diode and a second semiconductor device to said bus.

10. The system defined in claim **7** wherein said current flow path extends from said auxiliary common conductor through a resistor to a power supply, and it includes a first transistor having its base connected to said path, its emitter connected through said resistor to said power supply, and its collector connected through a Zener diode to the base of a second transistor which has its emitter connected both to said bus and through a capacitor to ground, and has its collector connected through a resistor to said power supply.

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