United States Patent

[11] **3,609,746**

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[21] Appl. No. **765,938**
[22] Filed **Oct. 8, 1968**
[45] Patented **Sept. 28, 1971**
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[54] **APPARATUS FOR DRIVING PLASMA PANELS**
6 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** ..... **340/324 R,**
315/169, 340/166, 340/343
[51] **Int. Cl.** **G08b 5/36**
[50] **Field of Search** 340/324,
166, 343, 324 R; 315/169

[56] **References Cited**

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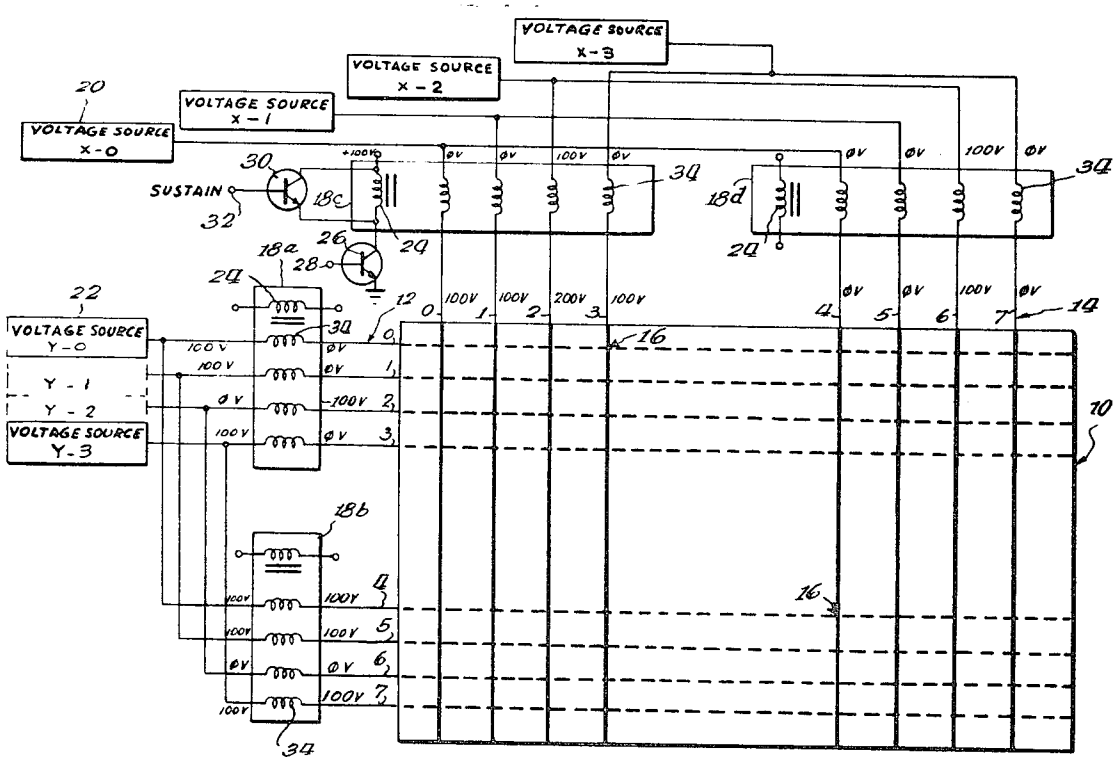
ABSTRACT: Apparatus for driving a gaseous discharge display panel in order to display information at selected discrete points in the display panel defined by the intersection of corresponding column and row electrodes, including at least one transformer having multiple secondary coils each connected to a respective column electrode, and at least one other transformer having multiple secondary coils each connected to a respective row electrode, a pair of complementary signal sources each connected to a corresponding one of said transformers, means for addressing selected points in the display panel coupled to a primary coil of respective transformers for entering information into the panel, and the signal sources coupling sustaining signals through the respective secondary coils for maintaining the information in the panel, the signal sources and the addressing means being electrically isolated from the panel electrodes.



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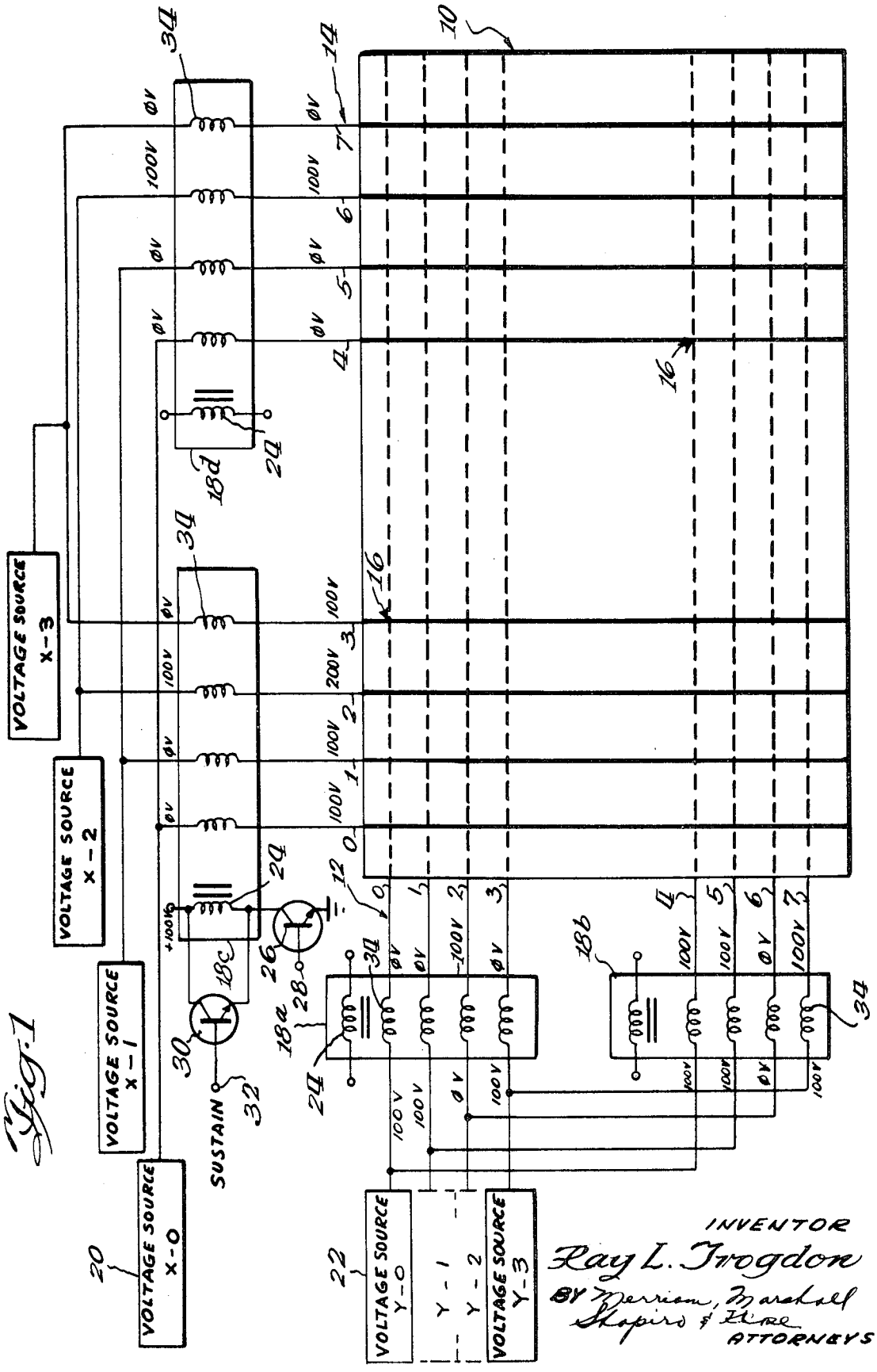

Fig-1

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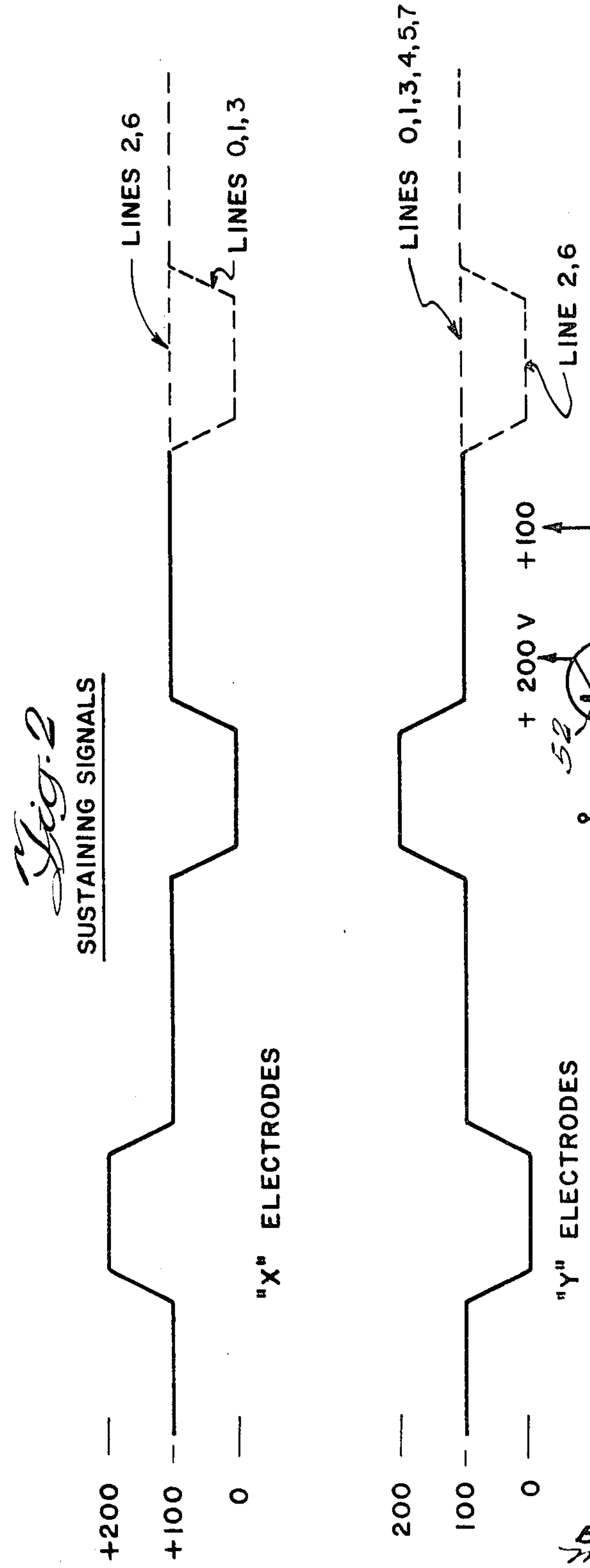

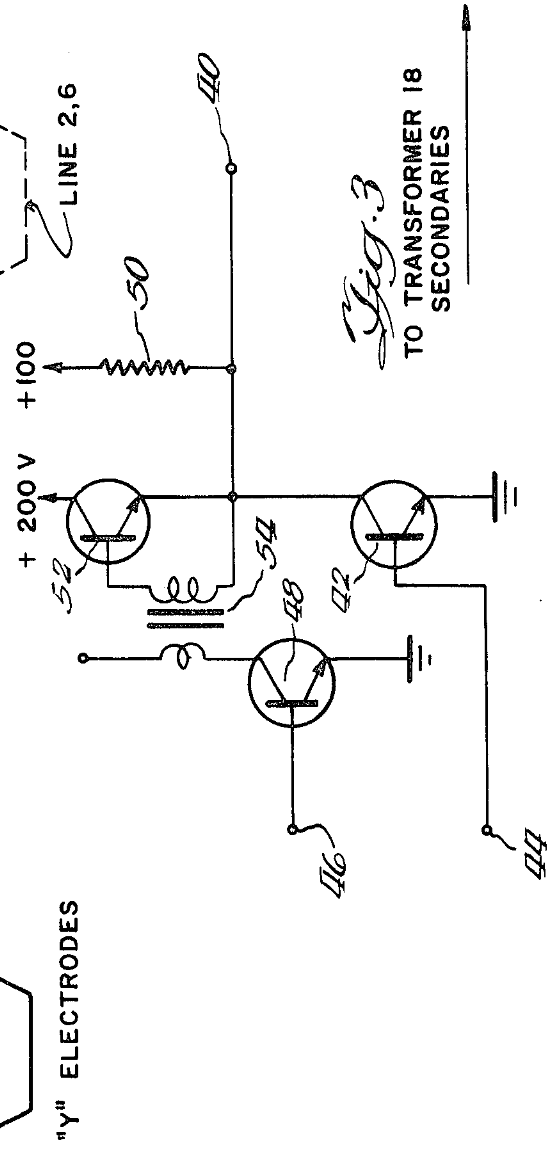

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APPARATUS FOR DRIVING PLASMA PANELS

This invention relates to display apparatus, and in particular to apparatus for driving a gaseous discharge display panel in order to display information at selected discrete points in the display panel.

The subject matter of the present invention is related to apparatus disclosed in a copending application of Donald L. Bitzer, H. Gene Slottow and R. H. Willson, U.S. Pat. Ser. No. 613,693, now U.S. Pat. No. 3,559,190, filed Dec. 22, 1966 and entitled "Gaseous Display and Memory Apparatus." In the disclosure of this prior copending application which is incorporated herein in its entirety, there is described a panel incorporating gaseous discharge cells of a unique pulsing discharge, wherein the presence or absence of suitably formed wall charges in the cells imparts information. Such a gaseous discharge panel has become known in the art as the "plasma panel," and when utilized for display purposes is commonly referred to as the "plasma display panel." Reference may also be had to the following publications disclosing the type of plasma panel related to the present invention, such publications being incorporated herein in their entirety;

1. Bitzer, D. L. and Slottow, H. G. "The Plasma Display Panel—A Digitally Addressable Display with Inherent Memory," *Proceedings of the Full Joint Computer Conference*, San Francisco, Calif., Nov. 1966.
2. Arora, B. M., Bitzer, D. L. Slottow, H. G., and Willson, R. H., "The Plasma Display Panel—A new device for Information Display and Storage," *Proceedings of the Eighth National Symposium of the Society for Information Display*, May 1967.
3. Bitzer, D. L. and Slottow, H. G. "The Plasma Display Panel—A New Device for Direct View of Graphics," *Conference on Emerging Concepts in Computer Graphics*, University of Illinois Nov. 1967, to be published by Benjamin Publishing Company, New York.
4. Bitzer, D. L. and Slottow, H. G., "Principles and Applications of the Plasma Display Panel," *Proceedings of the OAR Research Applications Conference*, Office of Aerospace Research, in the *Proceedings of the* 1968 *Microelectronics Symposium*, I.E.E.E., June 1968.

It is to be understood that the terms "plasma panel" and "plasma display panel" as used herein are defined by and characterized by the gaseous discharge panel described in the previously mentioned copending application and the above listed publications.

This application is concerned with improved apparatus for driving the plasma panels so that particular display points within the panel defined by pairs of intersecting electrodes can be selected in order to enter the desired information into the panel. The plasma display panel described in the previously mentioned application and publications incorporates a gaseous medium, a first set of row electrodes on one side of the panel, and a second set of column electrodes on the other side thereof disposed orthogonal to the row electrodes, the cells or display points each being associated with a respective pair of intersecting row and column electrodes. It being understood that since the principle of the plasma panel being understood that since the principle of the plasma panel as explained in the previously mentioned copending application is the manipulation of the wall charges to impart information, either one or both electrodes associated with the cell can be electrically insulated from the gaseous medium. In any case, the gaseous medium associated with each pair of electrodes can be discharged by coupling a discharging signal of an amplitude greater than the firing voltage to the electrodes. The wall charges which are thereafter formed in these selected cells can be maintained by providing a sustaining signal to the corresponding electrodes, the sustaining signal having an amplitude sufficient to discharge a cell having wall charges, but not one without wall charges. Such selection and sustaining operations are fully explained in the prior mentioned copending application and in the publications, reference to which may be had for this purpose.

Therefore, for each line of the plasma display panel, two types of driving signals are required, an addressing or selection signal for selecting a particular pair of lines and thus the cell which is to be adjusted in accordance with the information, and a sustaining signal which will maintain this information in the selected cells as long as desired. Since both of these driving signals must be connected to all of the panel electrodes, sufficient isolation must be provided between the voltage generators or driving sources of these signals. Various isolation elements have been used, such as resistors or capacitors, but in such cases an additional impedance is placed in series with the driving sources, which places limitations on these addressing and sustaining apparatus. The number of such isolation elements required in connection with any panel of practical size has also been a serious consideration in the art. One alternative which has been suggested is to employ individual voltage sources for each electrode on the panel, since the ideal generator for driving the plasma display panel is a voltage source. However, such a technique would required an extremely large number of very costly apparatus even considering current semiconductor technology such as proving integrated circuits for such apparatus. Thus, at the present time it has become necessary to employ the previously described technique of "signal mixing" for addressing and sustaining the display panels, and utilizing a number of isolation elements as previously described.

Therefore, in accordance with the principles of the present invention, there is provided novel apparatus for driving the plasma display panel which uses the "signal mixing" technique, but which greatly reduces the number of isolation elements commonly required. The apparatus of the invention utilizes transformers having multiple secondaries for coupling and suitably isolating the driving signal sources to the plasma panel. Assuming ideal transformers, the present invention provides apparatus which is equivalent in operation and performance to the desired system of having individual voltage generators associated with each electrode. The leakage inductance of the transformers presents some impedance to the panel, however, this impedance value can be kept to a minimum by careful construction of the transformers. As an example, the transformers which have been constructed in accordance with the present invention employ printed circuit secondary windings which offer good uniformity at a reasonable cost.

The invention will be better understood from the following detailed description thereof taken in conjunction with the accompanying drawings in which;

FIG. 1 s a schematic diagram illustrating a plasma panel having 64 cells and associated electrodes, and the driving apparatus in accordance with the principles of the present invention for selecting and sustaining cells in the panel;

FIG. 2 is a schematic diagram illustrating the sustaining signal waveforms provided by the apparatus; and

FIG. 3 is an example of apparatus which can be utilized for providing the sustaining signals shown in FIG. 2.

Referring now to FIG. 1, there is indicated the plasma display panel 10 of the type which may be constructed in accordance with the disclosure of the previously mentioned Bitzer, Slottow and Willson copending application or the previously listed publications, and having a series of eight row electrodes 12 and eight column electrodes 14. The column and row electrodes intersect to form 64 different cell points 16 on the display panel 10, any intersecting point or cell being selected by coupling suitable signals to a respective row and column electrode. The particular cell will then be discharged and the desired information entered therein.

A series of transformers 18 each having multiple secondaries connected between respective row electrodes 12 or column electrodes 14 and a respective X-voltage source 20 and Y-voltage source 22. As can be seen from FIG. 1, the top four row electrodes 12 are each connected to respective secondaries of a first transformer 18*a* and the bottom four row electrodes 12 are connected to respective secondaries of a

second transformer 18*b*. The column electrodes 14 are similarly connected to respective secondaries of transformer 18*and 18d*. In the first column transformer 18*c*, the primary coil 24 is connected between +100 volts and a gating transistor 26, which is gated on by a suitable addressing signal applied to input terminal 28. Another gating transistor 30 is connected in parallel with the primary coil 24, and through a suitable signal applied to input terminal 32 during the sustaining operation, the primary coil 24 is effectively shorted out so as to reflect a very low impedance to the secondary coils 34 of the transformers. Similar gating transistors 26 and 30 and connections there between, are provided for all of the primary coils 24 of each of the transformers 18, all of the above-mentioned interconnections being shown only for transformer 18*c* on FIG. 1 for convenience.

The voltage sources 20 and 22 provide the sustaining signals illustrated in the upper and lower diagrams of FIG. 2, and one example of an apparatus suitable for use as such a voltage source is indicated in FIG. 3. The apparatus shown in FIG. 3 represents either or both the voltage source 20 and 22, and provides a unipolar output signal having any one of three voltage levels; e.g., 0, 100 or 200 volts. These three levels of output are selectively provided by the voltage source of FIG. 3 at the output terminal 40; the output terminal 40 being connected to a respective secondary coil in each of the transformers associated with either the column or row electrodes.

As can be seen from FIG. 3, if the transistor 42 is gated on from input terminal 44, the terminal 40 will be conducted through the low impedance of transistor 42 to ground or a zero reference potential. If no selecting signal is supplied to input terminal 44 or to input terminal 46 of transformer 48, the output terminal 40 is connected to +100 volts through a low value resistor 50. Transistor 52 is coupled between a +200 voltage source ad the terminal 40, the operation of transistor 52 being controlled by a transformer 54 coupling the output of gating transistor 48 with the input to transistor 52. Thus, in response to a suitable selection signal at input terminal 46, transistor 52 is gated on so that the +200 voltage source is connected through the low impedance of transistor 52 to the output terminal 40. It is to be understood, of course that the selection signals coupled to input terminals 44 and 46 of the respective voltage source are obtained from the information to be displayed on panel 10.

FIGS. 1—3 can be referred to for the following description of the operation of the apparatus illustrated therein to selectively fire a single cell in the panel 10 having 64 cells. In FIG. 2 there is indicated in dashed lines the voltage levels of the signals from the respective voltage sources 20 and 22 applied to the transformers 18. For convenience, the row electrodes 12 starting from the top row and proceeding towards the bottom row of the panel 10 have been labeled with reference numerals 0 through 7 respectively, so that the top line 0 corresponds to the top row electrode. Similarly, the columns 14 have been identified as lines 0 through 7 starting from the first column 14 at the extreme left of the panel 10 in FIG. 1 and proceeding to the extreme right-hand column electrode 14. In the operation of the gaseous discharge cells in display panel 10, it must be noted that in accordance with the previous description of such pulsing discharge type cells as described in the previously mentioned Bitzer, Slottow, and Willson application, the cells in the plasma panel only fire once if successive sustaining amplitude excitation signals are of the same polarity. In connection therewith, it is assumed that the last firing of the cells in panel 10 occurred with the column electrodes 14 being coupled to a larger driving voltage than the row electrodes 12. Furthermore, it is to be understood that if a voltage difference of at least 300 volts is supplied across respective row and column electrodes, the associated cell will discharge and the information will be entered; whereas, if a potential difference of 200 volts is applied between respective row and column electrodes, the associated cell will discharge and the information will be entered; whereas, if a potential difference of 200 volts is applied between respective row and column electrodes, the corresponding cells will discharge only if the cells contain a wall charge and only if the polarity of the previous sustaining signal is opposite to the subsequent sustaining signal. Similarly, if a sustaining amplitude signal with a suitable slope or duration or with other suitable characteristics is supplied to the row and column electrodes, the cell having wall charges will discharge only once and the wall charges will be thereafter removed.

In FIG. 1, there is indicated on each side of the transformer secondaries of 34 the value of voltage required for selecting the specific cell associated with row line 2 and the column line 2. This is provided in the following manner. Note that the voltage sources 20 identified as X–0, X–1 and X–3 all have the associated transistor 42 operated so that the corresponding terminal points 40 are connected to ground or zero potential. The voltage source 20 identified as X–2 remains in the normal 100 volt output mode at its terminal 40 which is correspondingly connected to column lines 2 and 6. Selection of only the column line 2 is provided by suitably operating the gating transistor 26 connected to the primary 24 of the multiple secondary transformer 18*c*. The primary and secondary windings of transformers 18*c* and 18*d* connected to column lines 0–7 are wound such that the voltage applied across the primary windings adds to the voltage applied across the primary windings adds to the voltage in the secondary windings. Therefore, by coupling a suitable selecting signal or addressing signal to terminal 28 of transistor 26, the 100 volts placed across primary 24 is directly coupled to the associated secondary windings so that column line 2 is connected to +200 volts whereas column lines 0, 1 and 3 are connected to +100 volts. Note that the primary 24 of transformer 18*d* has not been selected, so that the voltages appearing at the voltage source end of the secondary windings of transformer 18*d* are coupled directly to column lines 4–7.

In a similar manner, the voltage sources 22 identified as Y–0 through Y–3 are selectively operated to provide the unipolar output signals of the indicated voltage levels at one side of transformers 18*a* and 18*b*. However, the primary and secondary windings of transformers 18*a* and 18*b* are wound in an opposing manner, such that a voltage applied to the primary winding 24 of these transformers subtracts from the secondary voltage. Therefore, by transferring a selection signal to the primary winding 24 of transformer 18*a* simultaneously and in a similar manner as the selection signal is coupled to transformer 18*c*, the row line 2 is connected to −100 volts from the respective secondary of transformer 18*a*. Thus, examining FIG. 1, it can be seen that the only lines having a 300 volts discharge potential difference between them are row line 2 and column line 2, thus, the cell associated at their intersection point is discharged and the suitable information has been entered.

During the sustaining operation, the transformers 18 are not driven, so that they are only required to provide power to charge the line capacity and the conduction current of a single cell during addressing. In the sustaining operation, it is desired to reflect a low impedance across the secondaries of transformers 18 in order to prevent a voltage buildup. For this reason, a gating transistors 30 has been provided to all of the transformers (only illustrated in connection with transformer 18*c* in FIG. 1) so as to operate when the sustainer is "on" and thereby short out the associated primary 24. Another alternative would be to provide a second primary wound in a suitable manner and closely coupled to the first primary 24, the second primary being shorted during the sustaining time so as to reflect a low impedance short across the secondaries of the transformers.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom as modification s will be obvious to those skilled in the art.

What is claimed is:

1. In gaseous discharge display panel apparatus, including a gaseous medium in said panel, and display points defined by

intersecting paired electrodes, wherein information to be displayed is entered into the panel at selected display points by coupling to the respective intersecting electrodes, (1) an addressing signal sufficient to discharge the gaseous medium and enter the display information at the selected display point, and (2) a sustaining signal sufficient to maintain the information at the display point,

the improvement comprising:

a pair of transformers each having primary and secondary windings and associated with at least one of said electrodes;

addressing means for supplying said addressing signal to the selected display point, said addressing means coupled to the primary and secondary windings of each of the transformers;

said secondary windings of each transforming interconnecting the associated electrode and the addressing means; and

sustaining means coupled to the secondary windings of each transformer for supplying said sustaining signal to maintain the information in said panel.

2. Display panel apparatus as claimed in claim 1, wherein said addressing means comprises a unipolar signal source providing a multilevel signal, including means for selecting the suitable level of said signal for each electrode so as to discharge the gaseous medium at one of said discrete display points.

3. Display panel apparatus as claimed in claim 2, wherein said addressing means includes a selection transformer having the secondary winding associated with the electrode to be addressed for increasing the potential difference between the addressed electrodes sufficient to discharge the gaseous medium at the associated display point.

4. Display panel apparatus as claimed in claim 3, wherein said selection means includes first drive means coupled to the primary winding of one of said selected transformers for increasing the voltage level of said unipolar signal at the output of the associated secondary windings, and second drive means coupled to the primary winding of the other of said selected transformers for decreasing the voltage level of said unipolar signal at the output of the associated secondary windings.

5. Display panel apparatus as claimed in claim 2, wherein one of said signal levels corresponds to said sustaining signal applied to all of said electrodes.

6. Display panel apparatus as claimed in claim 1, including means coupled to each primary winding for effectively lowering the impedance of each secondary winding during the application of said sustaining signal to the panel electrodes.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,609,746 Dated September 28, 1971

Inventor(s) Ray L. Trogdon

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 40, after "Research" insert --Arlington, Va. March 1968. Also published--.

Column 1, lines 59, 60 delete "being understood that since the principle of the plasma panel".

Column 2, line 20, "required" should be --require--.

Column 2, line 49, "s" should be --is--.

Column 3, line 3, "18and" should be --18c and--.

Column 3, line 35, "ad" should be --and--.

Column 3, line 55, after "electrode" delete "." and insert --12 and the bottom line 7 corresponds to the bottom row electrode.--.

Column 3, line 73 et seq., delete "the associated cell will discharge and the information will be entered; whereas if a potential difference of 200 volts is applied between row and".

Column 4, line 1, delete "column electrodes".

Column 4, line 25, delete "applied across the primary windings adds to the voltage".

Column 4, line 71, "modification s" should be --modifications--.

Column 6, line 4, delete "a".

Column 6, line 4, after "selection" insert --means coupled to the primary winding of each selected--.

Signed and sealed this 13th day of June 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents