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Andoh et al.

[11] **3,839,715**

[45] **Oct. 1, 1974**

[54] **DISPLAY SYSTEM FOR A PLASMA DISPLAY DEVICE**

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[73] Assignee: **Fujitsu Limited,** Kawasaki, Japan

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[52] **U.S. Cl.** ..... **340/324 M,** 178/7.3 D, 315/169 TV

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

[58] **Field of Search** ..... 340/324 M; 178/7.3 D; 315/169 R, 169 TV, 84.6

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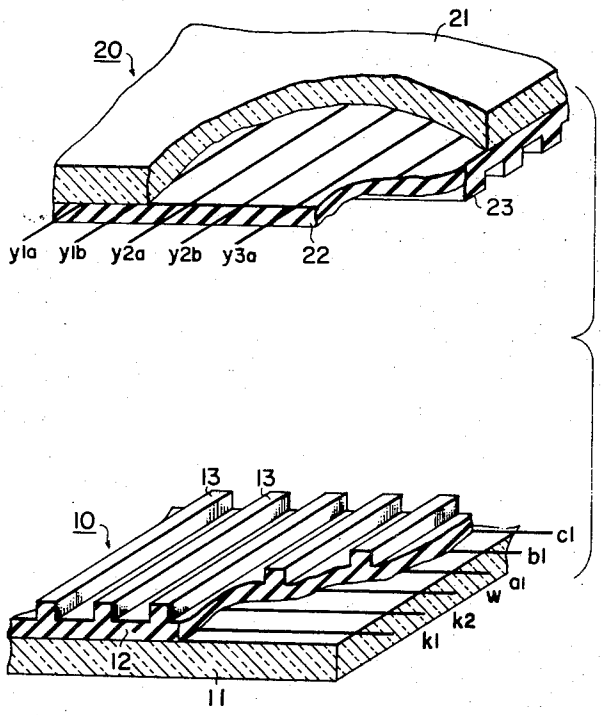
Primary Examiner—David L. Trafton

Attorney, Agent, or Firm—Staas, Halsey & Gable

[57] **ABSTRACT**

A display system for a plasma display device in which a plurality of electrodes are arranged on each of a pair of opposing base plates with a discharge gas space defined therebetween, the plurality of electrodes on each base plate being arranged to intersect those on the other base plate perpendicularly to them; the electrodes on at least one of the base plate are covered with a dielectric layer to form a display layer; the other plate serves as a shift layer; a discharge produced between adjacent electrodes of the shift layer is shifted; and a discharge is caused between adjacent electrodes of the display layer in accordance with the timing of the shifting of the discharge in the shift layer and that of writing in the display layer.

11 Claims, 17 Drawing Figures



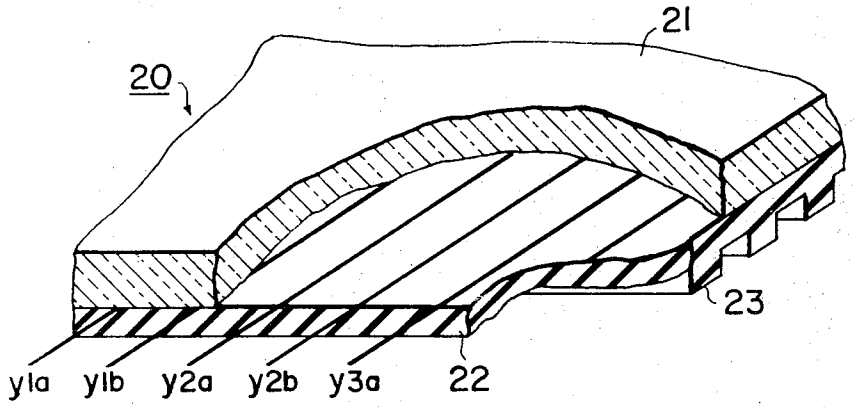


FIG. 1

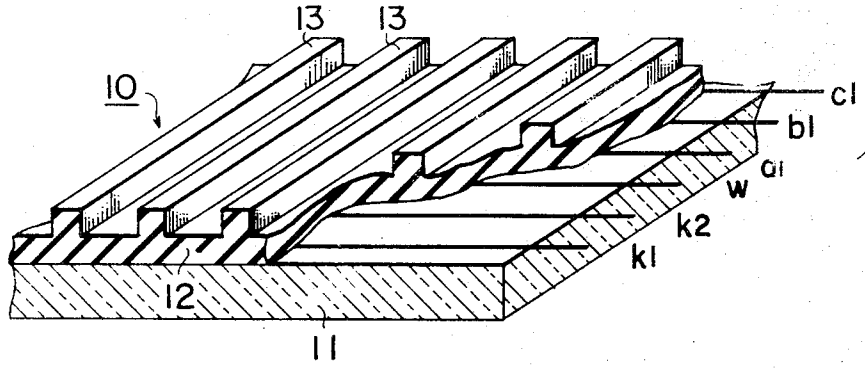


FIG. 2

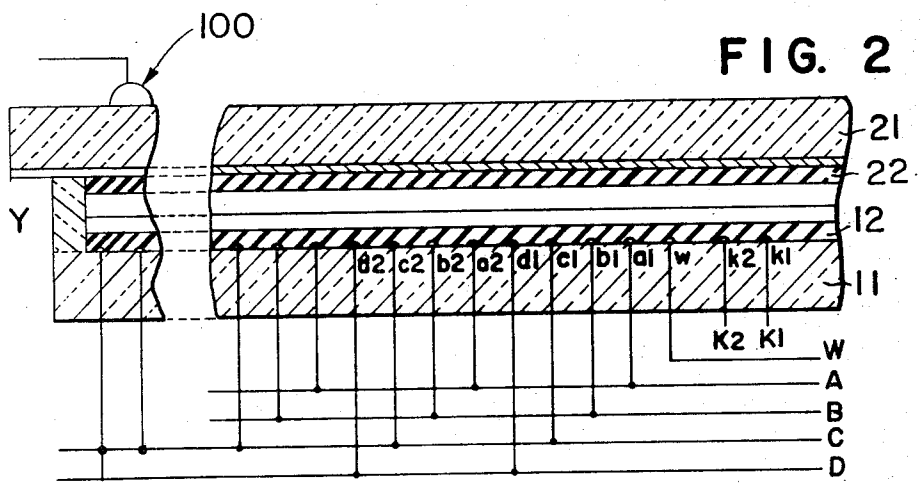

100
Y
21
22
12
11
a2 c2 b2 a2 d1 c1 b1 a1 w k2 k1
K2 K1
W
A
B
C
D

FIG. 3

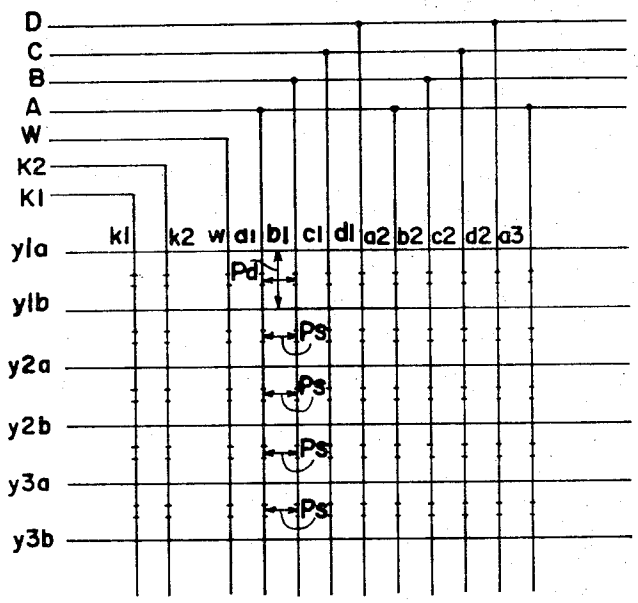
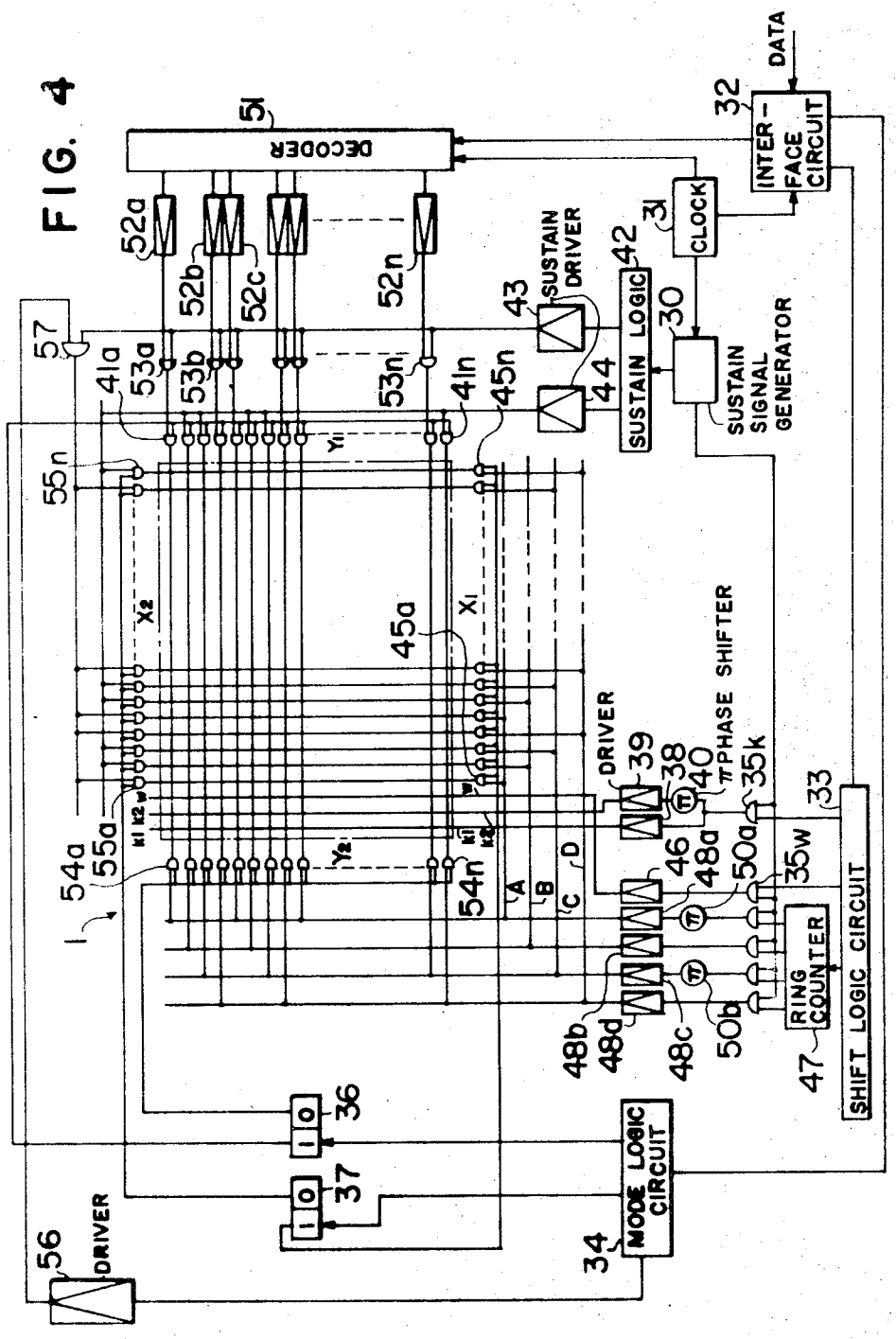

D
C
B
A
W
K2
K1
k1 k2 w a1 b1 c1 d1 a2 b2 c2 d2 a3
y1a
y1b
y2a
y2b
y3a
y3b
Pd
Ps
Ps
Ps
Ps

FIG. 4


DECODER
51
DATA
32
INTER-FACE CIRCUIT
CLOCK
31
SUSTAIN DRIVER
42
SUSTAIN LOGIC
30
SUSTAIN SIGNAL GENERATOR
43
44
52a
52b
52c
52n
53a
53b
53n
41a
41n
45n
57
55n
45a
X1
X2
Y1
Y2
54a
55a
54n
A
B
C
D
1
DRIVER
39
38
40
π PHASE SHIFTER
35k
33
46
48a
50a
35w
RING COUNTER
47
SHIFT LOGIC CIRCUIT
48b
48d
48c
50b
36
37
MODE LOGIC CIRCUIT
34
56
DRIVER

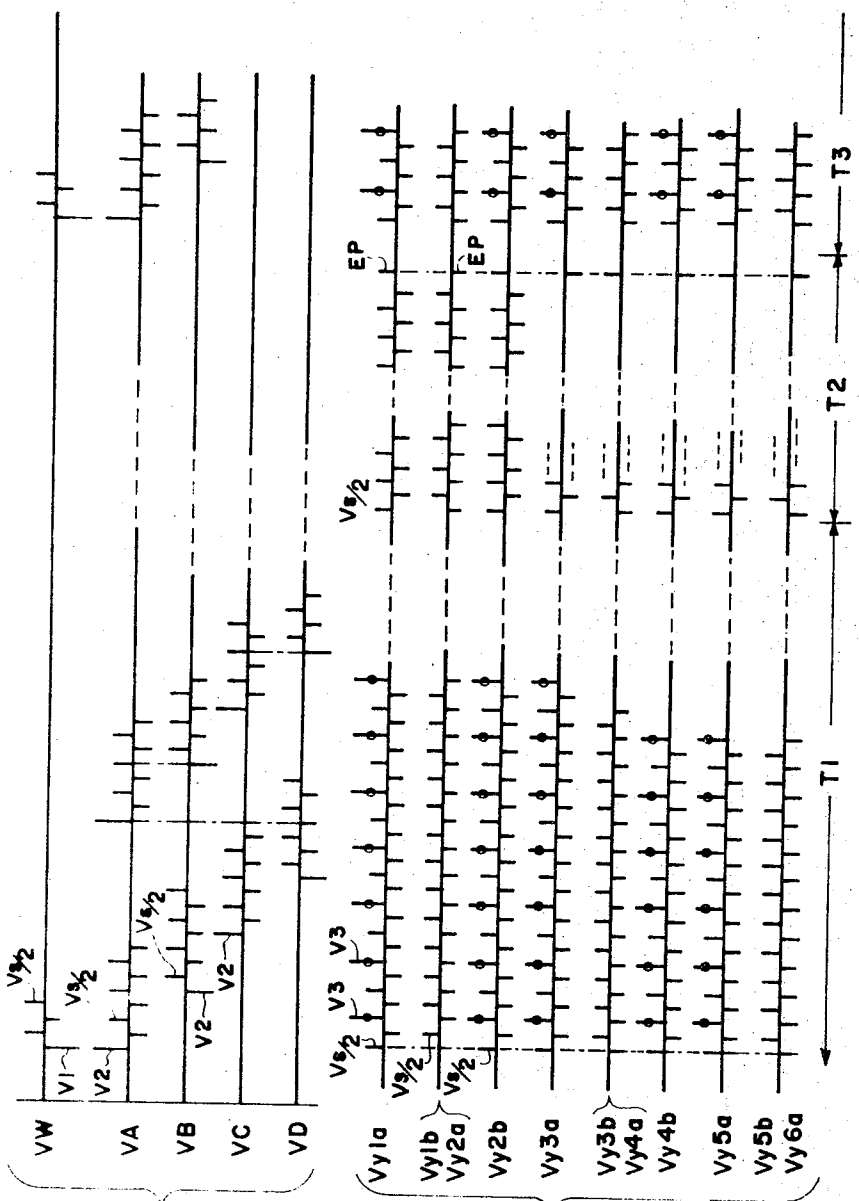

VW
VA
VB
VC
VD
V1
V2
V½
V3
EP
T1
T2
T3
Vy1a
Vy1b
Vy2a
Vy2b
Vy3a
Vy3b
Vy4a
Vy4b
Vy5a
Vy5b
Vy6a

FIG. 5A

FIG. 5B

FIG. 6A

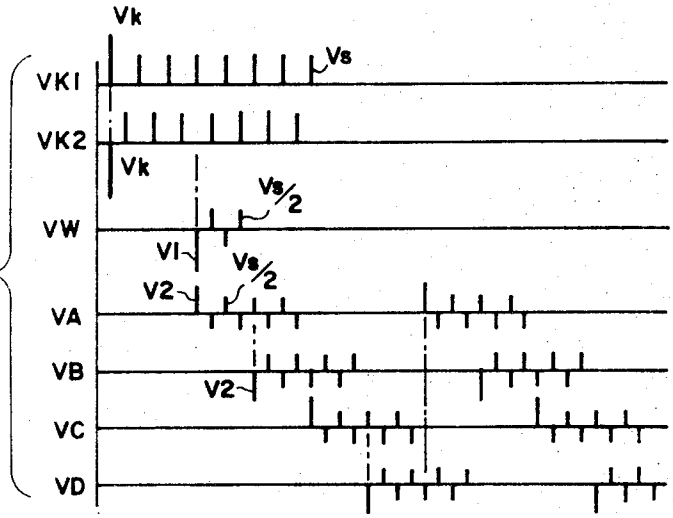
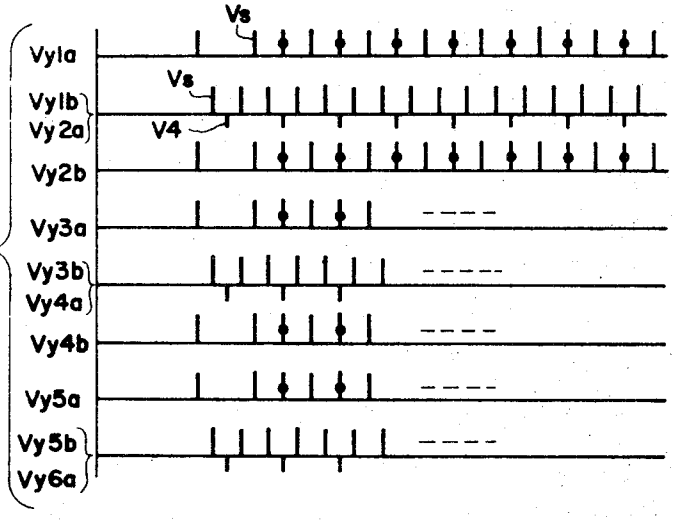

Vk
Vs
VK1
VK2
Vk
Vs/2
VW
VI
Vs/2
V2
VA
VB
V2
VC
VD

FIG. 6B


Vs
Vy1a
Vs
Vy1b
Vy2a
V4
Vy2b
Vy3a
Vy3b
Vy4a
Vy4b
Vy5a
Vy5b
Vy6a

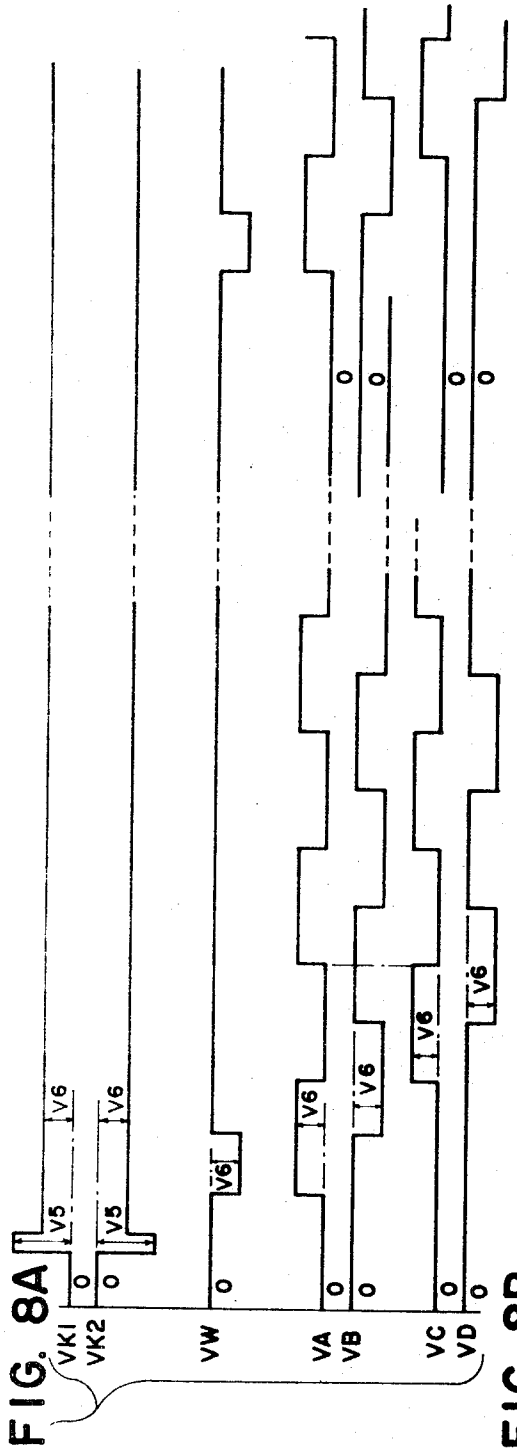

VK1
VK2
VW
VA
VB
VC
VD
V5
V6
0

FIG. 8A

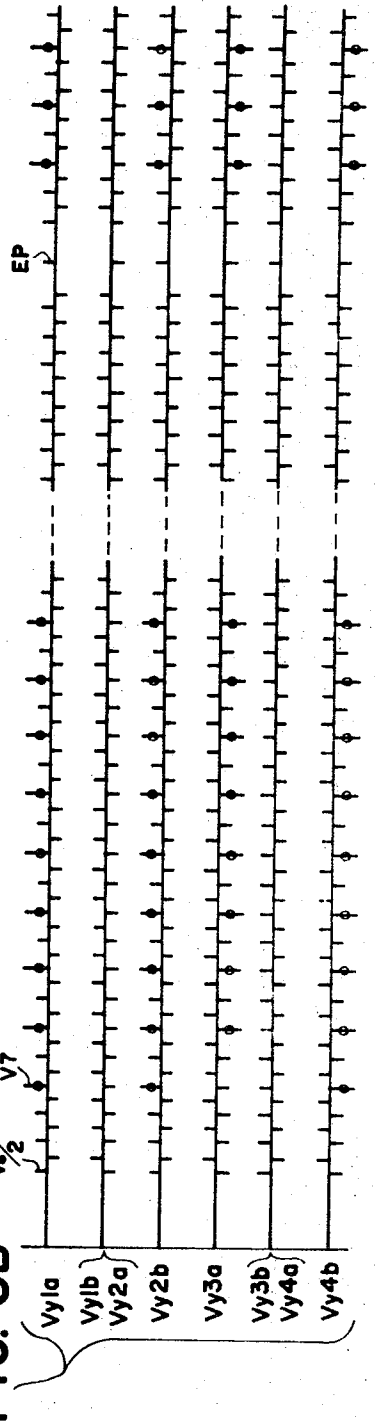

EP
V7
V8/2
Vy1a
Vy1b
Vy2a
Vy2b
Vy3a
Vy3b
Vy4a
Vy4b

FIG. 8B

FIG. 7A

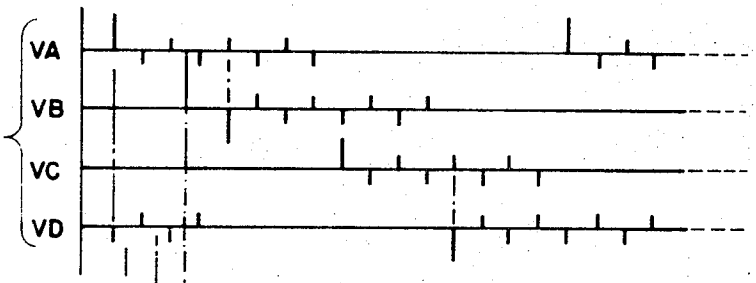


FIG. 7B

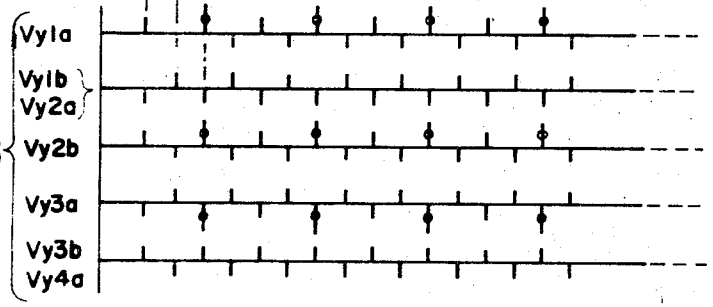


FIG. 9

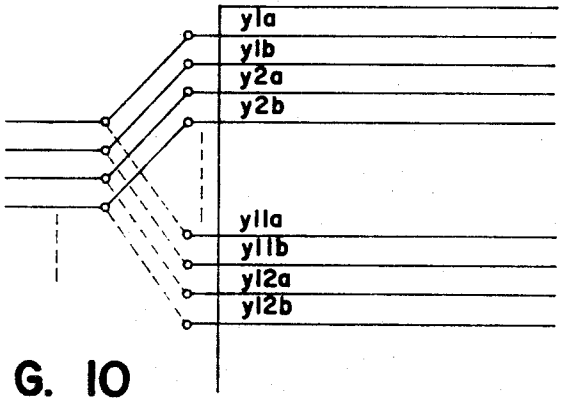


FIG. 10

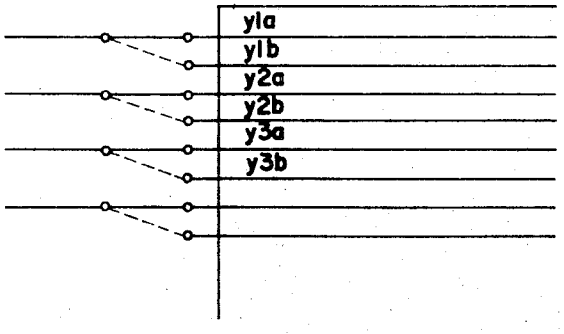


FIG. 11

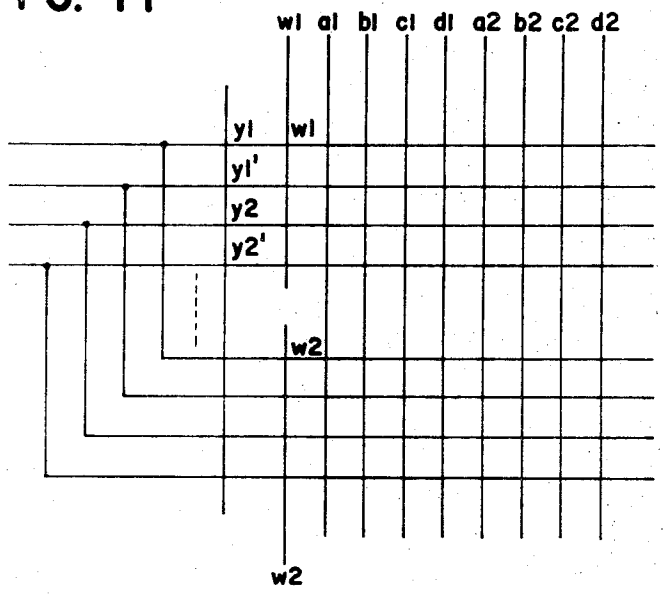

w1 a1 b1 c1 d1 a2 b2 c2 d2
y1
w1
y1'
y2
y2'
w2
w2

FIG. 12

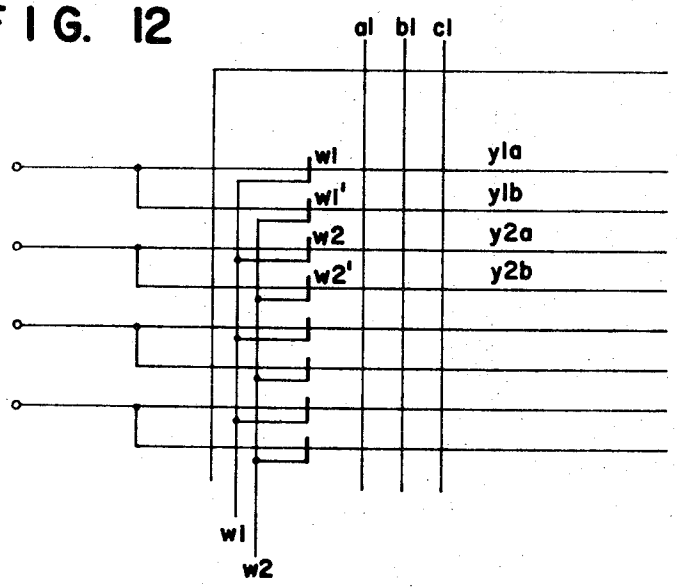
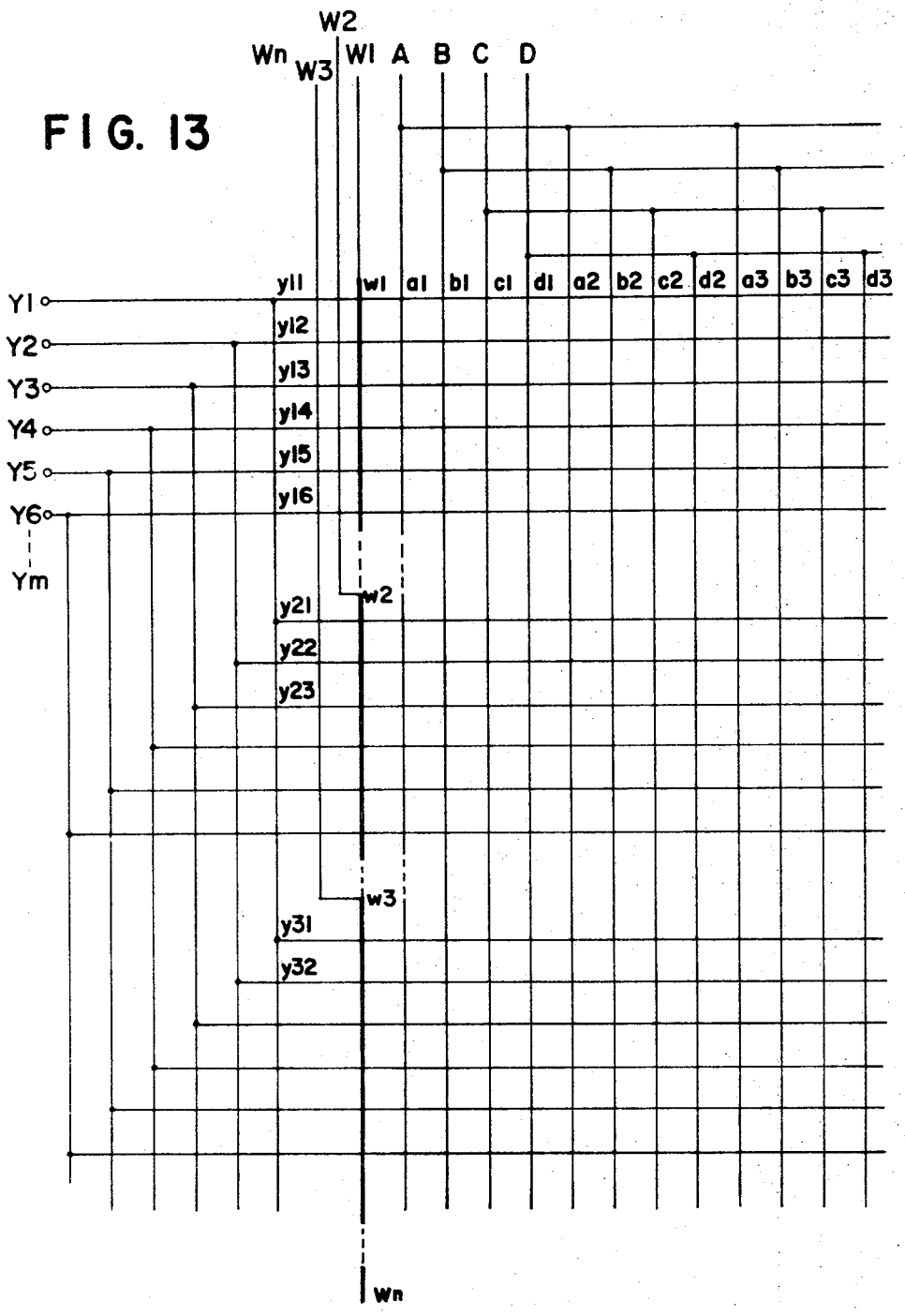

a1 b1 c1
w1
w1'
w2
w2'
y1a
y1b
y2a
y2b
w1
w2

FIG. 13


W2
Wn
W3
W1
A
B
C
D
y11
w1
a1
b1
c1
d1
a2
b2
c2
d2
a3
b3
c3
d3
Y1
Y2
Y3
Y4
Y5
Y6
Ym
y12
y13
y14
y15
y16
w2
y21
y22
y23
w3
y31
y32
Wn

DISPLAY SYSTEM FOR A PLASMA DISPLAY DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a display system for a plasma display device of the type that a display is provided by producing a discharge between adjacent electrodes.

2. Description of the Prior Art

A conventional type of plasma display device provides a display by causing a discharge between electrodes disposed opposite to each other with a discharge gas space defined therebetween. In the prior art plasma display device, X- and Y-direction electrodes are arranged in a matrix form and writing is effected at a selected one of intersecting points of the electrodes. This type of plasma display device has a defect that an increase in the number of the electrodes requires an increase in the number of addressing circuits, making the device expensive. To avoid this, it has been proposed, for example, to achieve writing by utilizing the self shift action by an address circuit of one line. At the time of writing in this case, a display being produced is moved, as if provided on an electrical sign and, upon completion of writing of, for example, one line, the entire display can be made stationary. Since the display is sequentially moved as described above, this method is inappropriate for high-speed writing and, further, an electrode for the subsequent shift is present between electrodes with a discharge spot being produced therebetween resulting in a display with low resolution.

SUMMARY OF THE INVENTION

One object of this invention is to provide a novel display system for a plasma display device which is free from the aforementioned defects encountered in the prior art and in which shift of a seeding discharge and a display by writing are achieved on opposing plates, respectively, to enable high-speed writing.

Another object of this invention is to provide a display system for a plasma display device which is capable of various modes of operation such as nondestructive reading and multiple writing.

Still another object of this invention is to provide a display system for a plasma display device which reduces the number of write drivers as compared with the number of electrodes.

In the display system for a plasma display device according to this invention, a plurality of electrodes are disposed to intersect each other at right angles on corresponding ones of a pair of opposing base plates with a discharge gas space being defined therebetween. A dielectric layer is formed on the electrodes of at least one of the base plates and used as a display layer; the side of the other base plate facing the dielectric layer is used as a shift layer to shift a discharge produced between adjacent ones of the electrodes. A discharge is produced between adjacent ones of the electrodes of the display layer in accordance with correlating the timing shift of the discharge in the shift layer and the timing of writing in the display layer, thereby to provide a display. Further, the display content in the display layer is shifted by sequential changeover of a sustain voltage applied to the electrodes of the display layer and the display content in the display layer is transferred to the shift layer and sequentially shifted in the shift layer.

The display content in the display layer is transferred to the shift layer while being retained as it is and the display content is sequentially shifted in the shift layer to be read out at the termination of shifting, and writing is achieved by dividing the electrodes of the display layer into a desired number.

Further, the electrodes of the display layer are periodically connected to write buses. A start electrode for the shift layer is divided corresponding to the number of the write buses and writing is achieved at the electrodes of the display layer corresponding to their logical products.

Moreover, the phase of the shift pulse impressed to the electrodes of the shift layer and the phases of discharge sustain and write-in pulses impressed to the electrodes of the display layer are displaced apart from each other.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded fragmentary perspective view, partly cut away, showing one example of a plasma display panel for use in a display system for a plasma display device according to this invention;

FIG. **2** is a cross-sectional view of the principal part of the plasma display panel depicted in FIG. **1**;

FIG. **3** is a schematic diagram, for explaining the principle of this invention;

FIG. **4** is a circuit diagram illustrating an example of this invention;

FIGS. **5A**, **5B**, **6A**, **6B**, **7A**, **7B**, **8A** and **8B** are waveform diagrams, for explaining the operation of other examples of this invention; and

FIGS. **9** to **13** are schematic diagrams showing electrode arrangements employed in other examples of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. **1** and **2** are an exploded perspective view, partly cut away, and a cross-sectional view, respectively, showing a plasma display panel for use in the display system of this invention. The plasma display panel is made up of a lower portion **10** acting as a discharge spot shift layer and an upper portion **20** acting as a display layer.

The lower portion **10** comprises a lower base plate **11** on which a plurality of shift electrodes ***a*1, *b*1, *c*1, *a*2,** . . . are arranged in parallel at regular intervals and a start electrode *w* and keep alive electrodes k1 and k2 are disposed. These electrodes are covered with a dielectric layer **12** as of low-melting-point glass, on which insulating partition walls **13** forming discharge spot shift channels are provided in a direction perpendicular to the electrodes.

The upper portion **20** serving as a display layer comprises a transparent upper base plate **21,** on the underside of which a plurality of electrodes ***y*1*a*, *y*1*b*, *y*2*a*, *y*2*b*,** . . . are arranged in parallel at regular intervals. These electrodes are also covered with a dielectric layer **22,** on which a plurality of insulating partition walls **23** are formed in a direction perpendicular to the electrodes.

The upper and lower portions **20** and **10** are disposed in adjacent but spaced relation to each other with their electrodes being perpendicular to each other and an ionizable gas is sealed in the space defined between the portions **20** and **10.**

In the lower portion **10**, that is, the shift layer, the electrodes are connected so that a lateral discharge between adjacent ones of them is sequentially shifted.

FIG. **3** illustrates the above electrode connection, in which the shift electrodes *a*1, *b*1, *c*1, *d*1, *a*2, . . . are connected to corresponding ones of common buses A, B, C and D. The buses A, B, C and D are supplied with four pulse voltages which are sequentially phase displaced.

In the upper portion **20**, that is, the display layer, adjacent ones of the electrodes are paired such as *y*1*a* and *y*1*b*, *y*2*a* and *y*2*b*, . . . and are connected so that a discharge sustain voltage and a write-in voltage of appropriate timing may be impressed between the electrodes of each pair.

With reference to FIG. **3**, the operational priciple of the plasma display panel will now be described. The operation starts with impression of a firing voltage between the keep alive electrodes *k*1 and *k*2 to cause a discharge therebetween, after which the discharge is maintained by the impression of the sustain voltage. Under this condition, by impressing a shift voltage to the start electrode *w*, a discharge is produced between the electrodes *k*2 and *w*. Then, by impressing the shift voltage between the electrodes *a*1 and *b*1, a discharge is produced therebetween. Next, by impressing the shift voltage between the electrodes *b*1 and *c*1 after the voltage supplied to the electrode a1 is cut off, a discharge is caused between the electrodes *b*1 and *c*1.

This shift operation is achieved dependent upon a primary current effect, that is, a phenomenon that a firing voltage V_{F1} between electrodes adjacent to a discharging region is reduced lower than a normal firing voltage V_F by a supply of electrons, ions and metastable atoms from the discharging region to the electrodes adjacent thereto. By selecting a shift voltage V_1 such that $V_{F1}<V_1<V_F$ and impressing the shift voltage V_1 to the buses A to D in a sequential order, a discharge spot can be shifted to the end of the panel.

By impressing a write-in voltage to a selected one of the electrode pairs of the display **20** in association with the above discharge spot shifting operation in the shift layer **10**, a discharge spot is produced at the position, between the display electrode pair receiving the write-in voltage, corresponding to the position of the discharge spot being shifted. For example, as shown in FIG. **3**, where a write-in voltage is impressed between the display electrodes *y*1*a* and *y*1*b* at such timing that a discharge spot Ps in the shift layer **10** is shifted to a position between the electrodes *b*1 and *c*1, a display discharge spot P*d* is produced between display electrodes *y*1*a* and *y*1*b* at a position corresponding to that of the discharge in the shift layer **10**, and thus between electrodes *a*1 and *b*1. A wall voltage is generated by the discharge spot Pd, so that, thereafter, the discharge spot P*d* is maintained by the sustain voltage between the electrodes *y*1*a* and *y*1*b*.

Thus, a desired display can be provided in the display layer **20** by impressing the write-in voltage between the display electrodes in association with the timing of shifting the discharge spot in the shift layer **10**.

In the shift and display operations such as described above, the partition walls **13** provided on the shift layer **10** separate the discharge spot P*s* produced between adjacent electrodes into a number of such spots P*s*, respectively corresponding to the number of display electrode pairs, to form thereby a shift channel along each display electrode pair. The partition walls **23** provided on the display layer **20** separate, or isolate, the display discharge spot Pd produced between the display electrodes of each pair to the position corresponding to a present shift discharge, thus determining fine picture elements. The operations of these partition walls **13** and **23** can be obtained by the employment of auxiliary electrodes supplied with a shield voltage, strip layers formed of a material having a relatively small coefficient of secondary emission or electrodes of a pattern widened at predetermined positions.

Turning now to FIG. **4**, a description will be given of the concrete operation of an example of the display system of this invention. Reference numeral **1** indicates the above described plasma display panel. The shift electrodes and the display electrodes are led out from opposing sides of the panel **1** as indicated by X1, X2, Y1 and Y2. A sustain signal generator **30** is controlled by a clock pulse derived from a clock pulse generator **31** to generate a sustain signal. Upon receipt of data by an interface circuit **32**, a control signal is separated and supplied to a shift logic circuit **33** and a mode logic circuit **34**, by which an AND gate circuit **35**K is opened and, at the same time, flip-flop circuits **36** and **37** are set as illustrated.

With the opening of AND gate circuit **35**K, the one keep alive driver **38** is supplied with the sustain signal and the other keep alive driver **39** is supplied with the sustain signal whose phase has been shifted by a π phase shifter **40**. Then, a voltage exceeding the firing voltage V_F is applied between the keep alive electrodes k1 and k2 from the keep alive drivers **38** and **39** to cause a seeding discharge. While, AND gate circuits **41***a*, **41***b*, . . . and **41***n* on the side of Y1 are opened by the set output from the flip-flop circuit **36** and two sustain voltages such as shown in FIG. **5**B are applied between the display electrods of each pair from two sustain drivers **43** and **44** which are controlled by a sustain logic circuit **42**. At the same time, AND gate circuits **45***a*, **45***b*, . . . and **45***n* on the side of X1 are also opened by the set output from the flip-flop circuit **37**, thus making preparations for the shift operation.

Then, upon application of a start signal to the shift logic circuit **33**, the AND gate circuit **35**W is opened to actuate a start driver **46** to supply the start electrode *w* with a voltage indicated by VW in FIG. **5**A, that is, a voltage V1 and a sustain voltage $\pm Vs/2$ within a predetermined period. At the same time, a four-stage ring counter **47** starts counting.

Pulse trains VA to VD such as shown in FIG. **5**A, which include a shift voltage V2 and the sustain voltage $\pm Vs/2$ and overlap, are applied to the buses A to D from shift drivers **48***a* to **48***d* through the AND gate circuits **45***a* to **45***m* opened by the set output of the flip-flop circuit **37**. In this case, the pulse trains VA and VC are displaced 180° apart in phase from the pulse trains VB and VD by π phase shifters **50***a* and **50***b* respectively.

The discharge spot thus produced between the electrodes *k*2 and *w* by the aid of the primary current supplied therebetween by the seeding discharge between the keep alive electrodes *k*1 and *k*2 is sequentially shifted to the right in accordance with the circular counting operation of the ring counter **47**. In this case, the start voltage V1, the shift voltage *V*2 and the sustain voltage *Vs*/2 are selected to bear the following relationships with the firing voltage V_{F1} between the electrodes

subject to the influence of the primary current effect from the neighboring region;

$$|V1 + V2| > V_{F1}$$
$$|V2 + Vs/2| > V_{F1}$$

On the other hand, pulse trains of $\pm Vs/2$ such as depicted in FIG. 5B which are displaced 180° apart in phase are applied from the two sustain drivers **43** and **44** to terminals of the display electrode pairs of the display layer on the side **Y1**, as described previously.

The display information received by the interface circuit **32** is decoded by a decoder **51** for every line and applied to write drivers **52***a*, **52***b*, . . . and **52***n* at a timing corresponding to the discharge shift position in the shift layer. The output from each of the writing drivers **52** is applied through OR gate circuits **53***a*, **53***b*, . . . and **53***n* to one electrode of each display electrode pair and is combined with the sustain voltage *Vs*/2 applied to the other electrode and, at the same time, a display discharge is caused at a position corresponding to that of the discharge being shifted in the shift layer by the primary current effect due to the discharge in the shift layer.

A write-in voltage V3 corresponding to the write-in information is impressed at the timing of the sustain voltage indicated by small circles in FIG. **5B**, producing a display discharge. In the absence of the write-in information, the sustain voltage of *Vs*/2 is also impressed at the timing indicated by the small circles. In FIG. **5B**, reference characters *Vy***1***a*, *Vy***1***b*, *Vy***2***a*, . . . identify the voltages impressed to the electrodes *y***1***a*, *y***1***b*, *y***2***a*, ...

Once the display discharge has been produced, a wall charge is produced and, thereafter, the discharge is maintained only by the sustain voltage. Consequently, even if the discharge on the side of the shift layer is shifted, the discharge on the side of the display layer continues, at the position established. If a firing voltage between the electrodes of the display electrode pair subject to the primary current effect due to the discharge in the shift layer is taken as V_{F2}, it is selected such that $V3+Vs/2>V_{F2} \leqslant V_{F1}$.

Upon completion of writing of one picture frame, the four-stage ring counter **47** is returned to zero by a control signal. As a result of this, only the discharge between the keep alive electrodes *k***1** and *k***2** remains on the side of the shift layer **10** and the information written between the electrodes of each display electrodes is displayed by the sustain voltage supplied thereto from the side **Y1.** The waveform of the sustain voltage applied to each display electrode pair is such as shown within the period T2 in FIG. **5B**. Namely, the period T1 is a write-in operation period and the period T2 is a display operation period.

The display on the display layer can also be shifted in a direction perpendicular to the display electrodes. This will now be discribed. In the case of achieving such a display shift, the flip-flop circuits **36** and **37** are reset by the output from the mode logic circuit **34.** Accordingly, the AND gate circuits **45***a*, **45***b*, . . , and **45***n* on the side X1 are closed and those **54***a*, **54***b*, . . . and **54***n* on the side Y2 are opened. Further, the AND gate circuits **41***a*, **41***b*, . . . and **41***n* on the side Y1 for the application of the sustain voltage are closed and the AND gate circuits **55***a*, **55***b*, . . . and **55***n* are opened to apply two kinds of sustain voltages to the side **X2.** Under such conditions, the ring counter **47** starts counting, by which the discharge spot on the display layer is shifted in accordance with changeover of the shift drivers **48***a*, **48***b*, **48***c* and **48***d*. In order to achieve this shift operation, it is necessary to apply information to the display electrodes previously at the time of write-in operation so that a display may be provided to every other display electrode pair. Namely, the information is applied to either even-or odd-number display electrode pairs and the display is shifted in the same manner as in the shift layer **10** by utilizing the display electrode pairs which have not been supplied with the information. After the display content has been shifted to a predetermined position, the flip-flop circuits **36** and **37** are set again to provide the display at rest.

A description will be given of an operation wherein the display pattern on the display layer **20** is transferred to the shift layer **10** is shifted to a desired position in the shift layer and then is transferred again to the display layer **20** to be displayed thereon.

At first, the keep alive discharge is stopped and the flip-flop circuits **36** and **37** are reset and a transfer driver **56** is started with the output from the mode logic circuit **34.** A transfer voltage derived from the transfer driver **56** is impressed to all of the electrodes on the side X2 through an OR gate circuit **57,** by which the discharge display pattern on the display layer **20** is transferred to the shift layer **10.** At this time, the discharge pattern now established between the electrodes of adjacent electrode pairs in the shift layer **10** is maintained by the sustain voltage supplied thereto from the side **X2.** Then, the flip-flop circuits **36** and **37** are reset by the mode logic circuit **34** and the display pattern as now transferred to the shift layer **10** is shifted to successive shift layer electrode pairs and thus in the direction of the display electrodes in accordance with the cyclically advancing count content of the ring counter **47.**

When the display pattern has been disposed to a predetermined position, a write-in signal is applied to the write drivers **52***a*, **52***b*, , . . and **52***n* to impress a write-in signal to all the electrodes from the side **Y1,** by which the discharge pattern on the shift layer is transferred again to the display layer **20.** Thereafter, the display pattern, as now transferred again to the diaplay layer **20** is sustained by the sustain voltage supplied from the side **Y1.**

Upon completion of the display for a desired period, an erasing pulse is impressed between the electrodes of all the display electrode pairs from the side Y1 at such a timing as indicated by EP in FIG. **5B**. The wall voltage is extinguished by the erasing pulse to erase the display. Then, the write-in operation is achieved again as described previously. Namely, reference characters **T1,** T2 and T3 in FIG. **5B** indicate the write-in period, the display period and the next write-in period respectively. The voltages VA to VD impressed to the buses A to D may also be composed of only the pulse *V*2 but it is convenient for high-speed shift that the voltages VA to VD are composed of pulses *V*2 and *Vs*/2 as in the foregoing example because the wall voltage is rapidly extinguished after the discharge shift.

FIGS. **6A** and **6B** are waveform diagrams, for explaining a different method of operation in accordance with another example of this invention. Reference characters VK1 and VK2 designate voltages impressed to the keep alive electrodes *k***1** and *k***2.** The voltages VK1 and VK2 are selected so that for their initial value

of $\pm Vk$, $2Vk > V_F$ and an initial discharge is thereby produced and thereafter continuously is sustained by the pulses Vs. The voltages VA to VD provided for application to the buses A to D are the same as those depicted in FIG. 5A, by which the discharge is shifted as described previously. The electrodes *y*1*a*, *y*2*b*, *y*3*a*, *y*4*b*, *y*5*a*, . . . are supplied with voltages, Vy1*a*, Vy2*b*, . . . and electrodes *y*1*b*, *y*2*a*, *y*3*b*, . . . are supplied with voltages Vy1*b*, Vy2*a*, Vy3*b*, Vy4*a*, Vy5*d*, Vy6*a*, . . . each of which is composed of pulses Vs and V4. The pulse of the voltages Vy1*b*, Vy2*a*, Vy3*b*, Vy4*a*, . . . is displaced apart in phase from that of the aforementioned Vy1*a*, Vy2*b*, Vy3*a*, . . . and the pulse V4 is selected such that $V4+Vs>V_{F2}$. Further, those pulses of the voltages Vy1*a*, Vy2*b*, Vy3*a*, Vy4*b*, . . . which are marked with small circles are write-in pulses and they are impressed only in the presence of input information.

In the foregoing example, the pulse for shifting the seeding discharge is impressed at the same timing as the write-in pulse, so that there is the possibility of causing a discharge between opposing electrodes to result in a faulty operation. This can be avoided by displacing the timing of the impression of the pulses of the voltages VA to VD and Vy1*a*, Vy1*b*, Vy2*a*, Vy2*b*, . . . as shown in FIG. 7A and 7B. Further, the pulse for shifting discharge is composed of positive and negative pulse pairs, or 2N total pulses, but N can be selected to be a desired integer and also one-half. The timing indicated by small circles in FIG. 7B shows the timing of the impression of the write-in pulse, as in the case with FIGS. 5B and 6B.

FIGS. 8A and 8B are waveform diagrams, for explaining the operation of another example of this invention, in which the dielectric layer 12 in FIGS. 1 and 2 is left out and the electrodes *k*1, *k*2, *w*, *a*1, *b*1, *c*1, *d*1, . . . are exposed in the discharge gas space. In the present example, DC voltages VK1 and VK2 which become of a level V6 after V5 are impressed between the keep alive electrodes *k*1 and *k*2 to maintain the seeding discharge and DC voltages VW and VA to VD of amplitude V6 are periodically impressed to the buses W and A to D. The conditions for th respective voltages are as follows:

$$(V5 + V5) > V_F > V_{F1} < V_{FV}$$

$$(V6 + V6) > V_{F1}$$

$$(Vs/2 + V7) > V_{F2}$$

V_{FV} is a discharge voltage between the opposing electrodes and V7 is write-in voltage. In this case, the voltages Vy1*a*, Vy1*b*, Vy2*a*, Vy2*b*, . . . are the same as those shown in FIGS. 5A and 5B but their waveforms can be made such as shown in FIGS. 6A and 6B. In the foregoing examples described with regard to FIGS. 1 to 7, a discharge is produced between the electrodes through the dielectric layer and shifted, so that the system of these examples will hereinafter referred to as an indirect discharge system. In the example of FIG. 8, a discharge is directly produced between adjacent electrodes and shifted, so that this will hereinafter be referred to as a direct discharge system. In both discharge systems, the dielectric layer 22 is provided on the display layer for memory and display. Further, if the side on which the seeding discharge is shifted is used as a shift layer and if the side on which writing is effected to provide a display is used as a display layer, the discharge can also be shifted on the display layer by sequentially changing over the voltage applied to the electrodes of the display layer as is the case with the shift voltage applied to the electrodes of the shift layer. In a similar manner, the display can also be provided on the shift layer. Consequently, in the indirect discharge system non-destructive reading can be achieved by holding the display on the display layer as it is after the writing operation, transferring the discharge as a seeding discharge to the shift layer, sequentially shifting the display on the shift layer and sequentially reading out the shifted content by means of a light detector or a discharge current detector provided at the shifting end of the shift layer as shown at 100 in FIG. 2. Such a detector and the use threof for the purpose as set forth is taught in U.S. Pat. No. 3,559.190 to Bitzer et al. Similarly, destructive reading can be effected by sequentially shifting the display on the display layer.

Further, the display can be moved in parallel by transferring the display on the display layer to the shift layer, erasing the display on the display layer, shifting the transferred display on the shift layer and transferring the display to the display layer again. Moreover, if the display on the display layer is left as it is, a plurality of displays of the same content can be provided. In addition, after the first write-in operation period by, writing other information without erasing the first written-in information, and writing it again with a second discharge shift, writing of multiple, superposed images in one display area can be achieved.

However, the display panel of the direct discharge has no memory function in the shift layer, so that the shift layer serves only to shift the seeding discharge and cannot enable the parallel movement of the display, the multiple writing operation and non-destructive reading described above. Since the display can be shifted on the display layer, destructive reading can be effected. In the case of the destructive reading, if rewrite means is provided, non-destructive reading can be performed.

The number of the write drivers for the display layer can be decreased by changing over full and broken lines by means of a switching circuit as shown in FIGS. 9 and 10. For example, if the electrodes *y*1*a*, *y*1*b*, . . . are divided into *n* groups in FIG. 9 each group having the same number of electrodes, the writing operation can be achieved by drivers of a number 1/*n* that of the electrodes. However, the writing speed is lowered to 1/*n*. In FIG. 10, the electrodes are alternately changed over, so that this method is suitable for interlace.

In FIG. 11, divisional writing is carried out by dividing start electrodes *w*1 and *w*2 as in the case of FIG. 9 and the electrodes *a*1, *b*1, *c*1, *d*1, . . . are continuously provided as in the foregoing. FIG. 12 shows the case where start electrodes *w*1, *w*1′, . . . are divided corresponding to the electrodes *y*1*a*, *y*1*b*, *y*2*a*, *y*2*b*, . . . and connected to buses W1 and W2, an interlace operation and so on are possible as in the example of FIG. 10.

FIG. 13 illustrates another example of this invention in which a display is provided on a large screen by using a small number of leads and write-in can be achieved with the logical products of the buses Y*l* to Y*m* and W*l* to W*n*. For example, where the buses Y1 and W2 are selected, write-in is effected on the electrode *Y*21 at a position to which a discharge has been shifted. It is possible to make selections mxn with the numbers *m* and *n* of the buses Y*l* to Y*m* and W*l* to W*n*, respectively.

Consequently, the number of the drivers can be greatly decreased.

As has been described in the foregoing, in the present invention , plane discharges are produced in the opposing shift and display layers respectively and the shift timing and the write-in timing are selected, by which it is possible to effect writing from one to the other end without shifting the display and achieve various display operations such as non-destructive reading, multiple writing, parallel movement of the display and so on. Further, it is also possible to provide a display on a large screen economically by reducing the number of write drivers.

Numerous changes may be made in the above described apparatus and the different embodiments of the invention may be made without departing from the spirit thereof; therefore, it is intended that all matter contained in the foregoing description and in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed:

1. A display system comprising:

a. a plasma display device including first and second base plates disposed opposite to each other for confining a discharge gas therebetween, first and second pluralities of electrodes disposed respectively upon said first and second base plates whereby said first and second pluralities of electrodes intersect each other, a dielectric layer formed on said first plurality of electrodes to provide a display layer, said display dielectric layer including partitioning means defining corresponding, separate display discharge spot positions along the lengths of said adjacent electrodes of said first plurality, said positions corresponding to the positions of discharges between successive, adjacent ones of said second plurality of electrodes, and a surface of said second base plate disposed toward said display layer serving as a shift layer;

b. first means for producing a discharge between adjacent ones of said second plurality of electrodes and for shifting a discharge so produced to successive positions between successive, adjacent ones of said second plurality of electrodes; and

c. second means for applying write signals between selected, adjacent ones of said first plurality of electrodes in timed relationship to the said shifting of a discharge in the shift layer, thereby to produce a discharge between said adjacent, selected ones of said first plurality of electrodes at the display discharge spot positions thereof corresponding to the discharge shift positions in said shift layer, thereby to provide a display.

2. A display system for a plasma display device as claimed in claim **1,** wherein there is included means for applying a sustain voltage between the electrodes of said first plurality on said display layer where by the display on said display layer as established by discharge between selected electrodes of said first plurality is maintained.

3. A display system for a plasma display device as claimed in claim **1,** wherein there is included means for supplying a sustain voltage to said first plurality of electrodes whereby the display on said display layer is sustained, and transfer means for applying a transfer voltage to said electrodes of said second plurality, the discharge pattern upon said display layer providing a seeding discharge for said shift layer, and the transfer voltage thereby producing discharges in said shift layer corresponding to the discharges of said display layer, and means for shifting sequentially the transferred display discharges in said shift layer.

4. A display system for a plasma display device as claimed in claim **3,** wherein there is included means for detecting and reading out the display transferred to said shift layer.

5. A display system for a plasma display device as claimed in claim **1,** wherein said first plurality of electrodes is divided into a number of groups and there is further provided:

switch means for selectively applying said write signals to corresponding electrodes of each said group, sequentially for the said number of groups of said first plurality of electrodes.

6. A display system for a plasma display device as claimed in claim **1,** wherein said first plurality of electrodes is divided into plural groups, each of a common number of electrodes, and wherein said second means includes a plurality of write buses connected to the respectively corresponding electrodes of each said group, and wherein:

said second plurality of electrodes includes an individual start electrode associated with each said group of electrodes of said first plurality, and there is further provided switch means for applying a start signal to a selected one of said start electrodes of said second plurality whereby upon application of writing signals to said write buses, writing is achieved in said display layer at the spot discharge positions of the electrodes of a given group in accordance with the logical product of a selected, start electrode and said write buses.

7. A display system for a plasma display device as claimed in claim **1,** wherein there is included means for applying a shift pulse to successive ones of said second plurality of electrodes of said shift layer, and means for applying sustain pulses to said first plurality of electrodes whereby said sustain pulses and said write signals are displaced in phase from the shift pulses.

8. A display system for a plasma display device as claimed in claim **1,** wherein there is included a first plurality of dielectric partitions spaced from each other and disposed on said dielectric layer in a substantially parallel relation with each other along a direction substantially perpendicular to said first plurality of electrodes.

9. A display system for a plasma display device as claimed in claim **8,** wherein there is included a second dielectric layer disposed on said second plurality of electrodes and a second plurality of dielectric partitions spaced from each other disposed on said second dielectric layer in a substantially parallel relation with each other along a direction substantially perpendicular to said second plurality of electrodes.

10. A display system for a plasma display device as claimed in claim **1,** wherein there is included:

first switching means for applying shift pulses successively to said electrodes of said second plurality, and

second switching means for applying sustain pulses to said electrodes of said first plurality.

11. A display system for a plasma display device as claimed in claim **10** wherein said first switching means is operable to a switched position to remove the shift

pulses from said electrodes of said second plurality and to apply said shift pulses to the electrodes of said first plurality and said second switching means is operable to a switched position to remove the sustain pulses from said electrodes of said first plurality and to apply the sustain pulses to said electrodes of said second plurality, thereby to effect shifting of said display discharges in said display layer.

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